



Decarbonization and Electrification: A Roadmap to Federal Net-Zero

September 2024

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List of Acronyms

AFFECT	Assisting Federal Facilities with Energy Conservation Technologies program
CO _{2e}	carbon dioxide equivalent
DOE	U.S. Department of Energy
ECM	energy conservation measure
EPA	U.S. Environmental Protection Agency
ERM	emissions reduction measure
ERP	Emissions Reduction Planning framework
ESPC	energy savings performance contract
FEMP	Federal Energy Management Program
GBAC	Green Building Advisory Council
GHG	greenhouse gas
GSA	U.S. General Services Administration
HVAC	heating, ventilation, and air conditioning
M&V	measurement and verification
NREL	National Renewable Energy Laboratory

Executive Summary

This resource proposes five broad steps for federal agencies to follow to decarbonize and electrify their building and fleet portfolios (Figure ES-1). Existing decarbonization resources and roadmaps were reviewed and their steps and processes were synthesized into these five broad steps that apply to federal portfolios.



Figure ES-1. Five federal agency portfolio decarbonization steps

Illustration by Fred Zietz, NREL

These steps—referred to more specifically as federal agency portfolio decarbonization action plan steps—include:

1. **Collection and assessment.** Establish and/or review goals and targets, assemble relevant stakeholders and available data, inventory portfolio of buildings and fleets. Establish baseline energy consumption and emissions for each building and fleet within the portfolio.
2. **Solution development.** Perform energy audits and other actions to identify potential energy and water conservation measures (ECMs) and emissions reduction measures (ERMs).¹ Assemble a list of potential solutions and strategies tailored for the relevant context.
3. **Prioritization plan.** Prioritize portfolio by key buildings attributes or by individual building and/or fleets, crafting solutions that identify the most cost-effective and strategically optimal decarbonization and electrification strategies. Classify measures and prioritize solutions based on the following order:
 - 1) Energy efficiency/load reduction
 - 2) Electrification
 - 3) Carbon-free electricity
 - 4) Innovative/emerging technologies

¹ ERMs include energy and water efficiency and conservation measures in addition to other emissions-reducing actions such as switching refrigerants and fuel switching, as defined by the Better Buildings Emissions Reduction Planning framework.

Evaluate decarbonization and electrification measures with multiple scenarios, with varying assumptions. Perform a cost-benefit analysis and estimate payback period. Consider auxiliary benefits. Note that innovative/emerging technologies, if cost-effective, may be considered in the energy efficiency/load reduction and/or electrification categories.

4. **Implementation and training.** Develop an implementation plan that identifies which measures will be implemented and where. Determine key personnel that must be trained and develop a training plan. Implement identified decarbonization and electrification measures, perform (retro)commissioning, and train facility staff. Ensure relevant documentation and resources are available to site staff.
5. **Monitoring, reporting, and revising.** Perform measurement and verification (M&V) to ensure measures are performing as expected. Ongoing performance monitoring is key to ensure implemented actions continue to align with goals and allows for the option to make revisions when they are not. M&V efforts for both building and fleet performance should be documented and reported annually. When revisions are required, the above process should be repeated, beginning with collection and assessment, and the new actions should be again monitored and reported. Revisions should be documented, and lessons learned assembled.

Relevant resources for federal agencies pertaining to each step are listed and discussed in this report. Finally, financing options for identified ERMs are included as well.

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1 Introduction

As the nation's largest energy consumer, with more than 350,000 energy-utilizing buildings and 600,000 vehicles, the U.S. federal government has a critical role in advancing clean energy, scaling up energy conservation solutions, and reducing greenhouse gas (GHG) emissions. In 2022, federal agencies used 827 trillion British thermal units (Btu) of delivered electric and thermal energy. In other words, the total energy production of Denmark and Finland combined would be barely sufficient to cover the energy needs of U.S. federal agencies (EIA n.d.). In 2022, total GHG emissions from standard operations across the federal government comprised 32.5 million metric tons of carbon dioxide equivalent (MMmtCO_{2e}) (DOE 2023a).²

Federal decarbonization and electrification efforts face unique challenges compared to emissions reductions in the private sector. While corporations may set their own climate targets and pathways for emissions reductions, federal agencies derive their climate targets from enacted laws and legal mandates. Also, federal agencies need to balance a more sophisticated matrix of energy security, national security and mission-critical functions, energy affordability, and environmental sustainability. Although the private sector may leverage market-based initiatives to address energy and climate challenges, federal agencies rely mostly on compliance policies and rules to address these challenges.

Energy conservation mandates (e.g., National Energy Conservation Policy Act [NECPA]) and emissions reduction targets have proven to be effective tools in enabling clean energy technologies and improving resilience. Since the Energy Independence and Security Act was enacted in 2007 and required agencies to conduct comprehensive energy and water evaluations, energy intensity in federal facilities decreased by 26.5% in 2022 (compared to a 2003 baseline) through cost-effective energy conservation measures (ECMs), as shown in Figure 1. Similarly, other legislative (e.g., Energy Act of 2020, Clean Energy for New Federal Buildings and Major Renovations of Federal Buildings Rule) and executive requirements (e.g., Executive Order 14057, Federal Buildings Performance Standards) can help federal agencies reach more ambitious energy and climate targets.

² Nonstandard operations are vehicles, vessels, aircraft and other equipment used by federal government agencies in combat support, combat service support, tactical or relief operations, training for such operations, law enforcement, emergency response, or spaceflight (including associated ground-support equipment). Nonstandard operations also include generation of electric power produced and sold commercially to other parties.

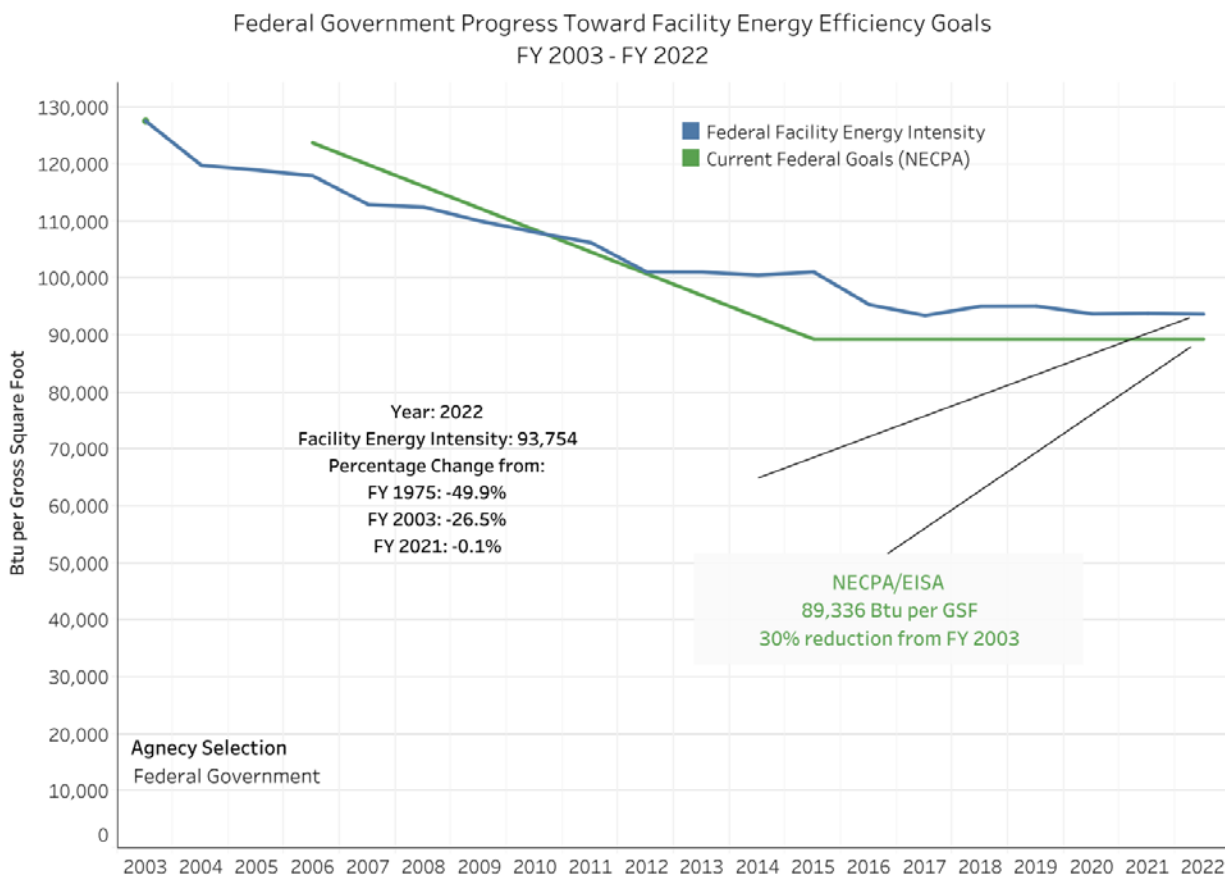


Figure 1. Goal-subject building site-delivered energy use per gross square foot

Figure source: DOE (2023a)

While there has been progress on reducing energy intensity and GHG emissions across the federal portfolio, there is still a need to move from ad-hoc projects to a pipeline of decarbonization and electrification interventions that are part of a holistic decarbonization strategy. This comprehensive strategy would enable federal agencies to identify cost-effective energy solutions, prioritize decarbonization interventions, and achieve their climate targets. It will also help agencies leverage available resources to spur public-private partnerships and implement replicable, well-designed projects.

This resource focuses on Scope 1 emissions (direct emissions from agency buildings and fleets) and Scope 2 emissions (indirect emissions from purchased utilities), as shown in Figure 2.

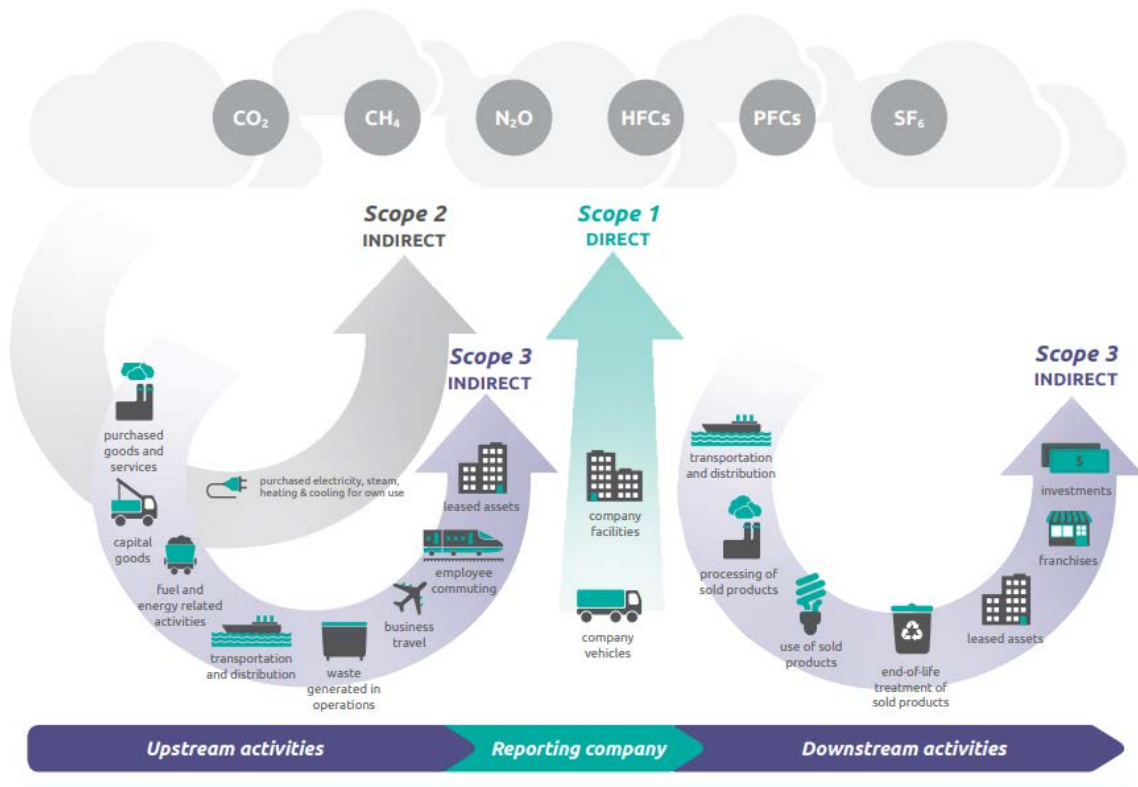


Figure 2. Graphic representing Scope 1, Scope 2, and Scope 3 emissions

Figure source: World Resources Institute (2011)

2 Emissions Reduction Planning for Federal Agencies

There are multiple existing resources and frameworks that can support federal agencies wherever they are along their decarbonization journey, from just beginning to draft goals and plans to implementing emissions reduction measures (ERMs) such as energy efficiency and renewable energy projects. The resources referenced in this document include the U.S. Department of Energy (DOE) Better Buildings Emissions Reduction Planning (ERP) framework, DOE National Laboratories Campus Climate Action Plan process steps, site-level decarbonization steps, and recommendations from the Green Building Advisory Council (GBAC). These range in scope from portfolio level to campus level and finally site level. However, the focus of this resource is on the agency portfolio level. Each of these resources is outlined in greater detail below.

2.1 DOE Better Buildings ERP

The Better Buildings “Framework for Greenhouse Gas Emissions Reduction Planning: Building Portfolios” (Kramer et al. 2023) includes five primary milestones—plus an implementation step—for building portfolios:

1. Establish Inventory and Scope of Work
2. Categorize Portfolio
3. Assess Measures
4. Develop Scenarios
5. Define ERP
6. Ongoing Implementation.

The ERP defines measures as ERMs. This term is used in the rest of this document to refer to decarbonization measures. More details for each ERP milestone are shown in Figure 3.

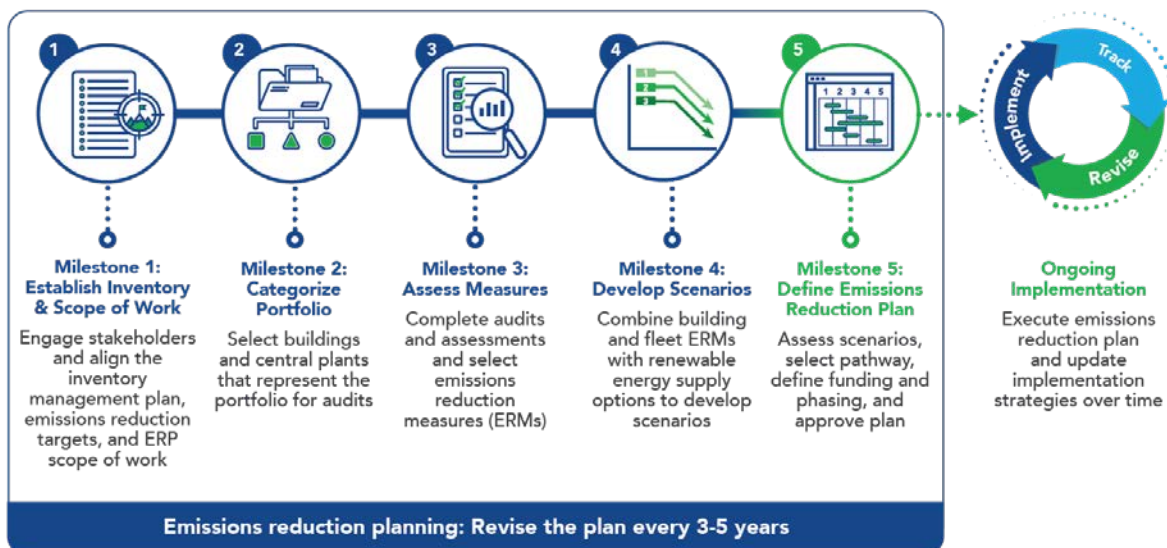


Figure 3. Framework for ERP milestones

Figure source: Kramer et al. (2023)

This framework is high level, beginning with engaging stakeholders and identifying emissions reduction targets and ending with a plan for reducing emissions. Building-specific decarbonization plans can supplement the ERP milestones by providing greater specifics.

2.2 Better Buildings Action Plan for Building Decarbonization

Better Buildings Action Plan for building decarbonization includes six steps (Torcellini and Goetsch 2023). These are targeted at the building, rather than portfolio, level. The steps include:

- 1. Provide organizational profile and highlights:** Identify key points of contact and on what sections of the organization to focus.
- 2. Set and track goals:** These could be on the organization or portfolio level and include carbon emission reduction goals along with methods and tools used to track progress toward these goals.
- 3. Select a building:** Either in the building’s entirety or a portion of it.
- 4. Prioritize CO₂e emission reduction strategies and report data:** Energy efficiency strategies should be prioritized before all other emission reduction strategies. Evaluate and compare different strategies, including estimating the percentage of carbon reduction attributable to each strategy.
- 5. Identify barriers:** List barriers and rate on a scale from 1–5 for comparison purposes.

6. **Develop CO₂e emission reduction implementation strategies:** Including identifying implementation details and prioritizing energy efficiency strategies, as shown in Figure 4.

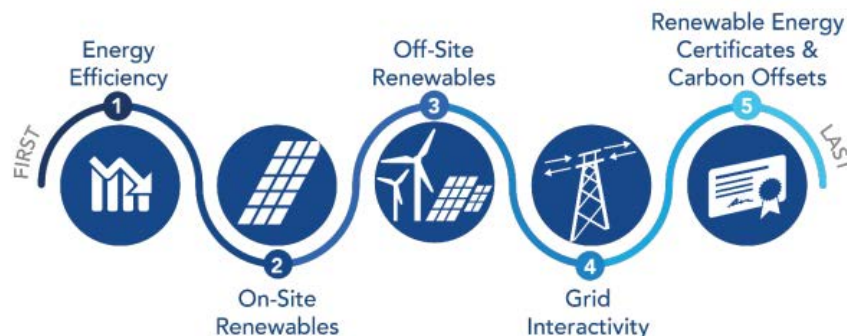


Figure 4. Prioritizations of emissions reduction implementation strategies

Figure source: Torcellini and Goetsch (2023)

The Better Buildings GHG Emissions Reduction Audit Scope of Work Template also contains additional details for building site-level emissions reductions (Hart, Kramer, and Granderson 2024). These Better Buildings resources emphasize that agencies must begin with assessing their portfolio’s current energy consumption and consider energy efficiency measures to reduce that consumption. In-depth energy efficiency actions (i.e., lighting retrofits, building insulation assessments) must be completed prior to considering other solutions, such as on-site renewable energy installations (i.e., solar panels) or heating, ventilation, and air conditioning (HVAC) equipment retrofits (i.e., ground-source heat pumps). These energy efficiency measures can reduce the costs of later actions; for example, if the overall electricity demand of a building is decreased due to lighting and HVAC retrofits, an on-site solar-plus-battery storage system could be sized smaller (lower capacity), and therefore be less expensive.

2.3 Campus Climate Action Planning Process Steps

Four national laboratories (including the National Renewable Energy Laboratory [NREL]) are part of a net-zero laboratory initiative intended to decarbonize operations at DOE national laboratories (NREL n.d.). The four pilot labs have each developed their own roadmaps using similar approaches and are implementing the process at their respective locations. Seven steps for campus decarbonization were developed by NREL, applying to all types of campuses, including national laboratories. The steps include:

1. **Determine energy and emissions footprint (across the campus):** Through audits, measurements, monitoring, and utility data analysis.
2. **Outline GHG reduction goals:** Including a timeline associated with the goals.
3. **Determine unique needs:** For the campus, including geographic considerations and expansion and renovation plans.

4. **Identify solutions and barriers:** To help the campus reach its GHG reduction goals. Solutions fall into three main categories: energy reduction measures, technology innovation, and behavioral and policy changes. Behavioral changes are an often overlooked, yet potentially high-impact and low-cost, category. Examples of behavioral changes that can save energy include building occupants turning off lights when rooms are not in use (i.e., overnight) and closing windows when the building HVAC system is in operation to reduce air-conditioning and heating requirements.
5. **Prepare a plan and set priorities:** Develop an action plan for implementing the identified decarbonization solutions and prioritize these solutions based on site-specific conditions.
6. **Implement climate action plan:** Including implementing specific energy reduction measures, technology innovations, and behavioral and policy changes.
7. **Measure and evaluate progress:** Continually monitor the campus' progress toward the established GHG emissions reduction goals. Once these goals are met, monitoring must continue to ensure adequate performance.

These steps are also shown in Figure 5.



Figure 5. Steps of campus climate action planning process

Images from NREL and Getty Images

While most of these steps are under the control of the campus energy and sustainability managers, there are some interventions that would require action from other stakeholders (e.g., building occupants, technology vendors, policymakers).

2.4 Sample Site-Level Decarbonization Process

Site-level processes for decarbonization are similar to portfolio- and campus-level processes, but include consideration of greater specifics, such as on-site vs. off-site carbon-free electricity. For example, a sample site-level decarbonization process developed by NREL and presented at the Energy Exchange Conference in 2022 included the following steps:

1. **Document baseline Scope 1 and 2 emissions:** Leveraging existing resources such as site emission calculators from the U.S. Environmental Protection Agency (EPA) and ENERGY STAR®:
 - EPA GHG Equivalencies_Calculator (Scope 1):
<https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>
 - EPA_eGRID Power_Profiler (regional Scope 2):
<https://www.epa.gov/egrid/power-profiler#/>
 - EPA Simplified GHG Emissions Calculator (spreadsheet used for annual reporting): <https://www.epa.gov/climateleadership/simplified-ghg-emissions-calculator>
 - ENERGY STAR Portfolio Manager Building Emissions Calculator (import data directly from Portfolio Manager):
<https://portfoliomanager.energystar.gov/buildingEmissionsCalculator/>.
2. **Identify load reduction and efficiency opportunities:** Including lighting retrofits and building insulation. Load reduction should precede replacing equipment.
3. **Equipment electrification:** Such as replacing inefficient fossil fuel-based HVAC equipment with electric heat pumps and internal combustion engine fleet vehicles with battery electric or plug-in hybrid electric vehicles. The largest GHG reductions are in areas where either current or future utility carbon emissions are relatively low (i.e., high renewable energy grid mix). Existing budgets for planned equipment replacements can be leveraged to increase efficiency and/or replace equipment.
4. **On-site carbon-free electricity generation and storage:** Such as solar photovoltaic panels and battery energy storage systems. The largest GHG reductions for on-site generation and storage are in areas where either current or future utility carbon emissions are relatively high (i.e., low renewable energy grid mix).
5. **Consider off-site carbon-free electricity purchase options:** Such as paying for renewable energy-sourced electricity through a local utility.

This process typically applies to a single building (site level) and is similar to the prioritizations of emission reduction implementation strategies from Better Buildings shown in Figure 4, where efficiency is prioritized above equipment electrification and renewable energy projects.

2.5 GBAC Advice Letters

GBAC publishes advice letters with recommendations for building decarbonization (GSA 2024). The most recent GBAC advice letter (“Recommendations for Federal Building Decarbonization,” December 2023) contains steps for site-level “strategic electrification.” These include:

1. **Review:** Assess existing building heating and cooling demands, marginal and average grid emissions intensity, utility rate structures, spatial considerations, and available funding resources.
2. **Reduce:** Deploy energy efficiency measures such as envelope improvements, controls optimization, conservation through behavioral change, and ventilation improvements.
3. **Reconfigure:** Convert centralized HVAC systems to lower-temperature hydronic distribution, including any necessary conversions at terminal units or air handlers.
4. **Recover:** Recover heat from condenser water, airside exhaust, wastewater, or other heat sources such as data centers or thermal networks where compressor-driven heat recovery and thermal storage can maximize these free, available heat sources.
5. **Replace (initial electrification):** Consider a range of heat pumps for the remaining thermal load, including air-source, ground-source, and other water source, segmenting loads, layering heat sources, and/or cascade heat pumps to optimize systems, and solving or deferring decarbonization of peak loads separately as needed due to technical or economic constraints.
6. **Replace (full electrification):** Add heat pump capacity, thermal storage, thermal network connections, renewable energy systems, and/or grid-interactivity to decarbonize any remaining annual load and to meet or manage outlier peak conditions effectively.

Another GBAC advice letter from November 2022, “Recommendations for Advancing Greenhouse Gas Reductions in Existing Federal Buildings,” includes a building decarbonization prioritization methodology, shown in Figure 6. This methodology emphasizes the importance of energy efficiency retrofits for buildings. A Building Decarbonization Screening Tool is also introduced in this advice letter, for use by facility managers to prioritize buildings for decarbonization measures.

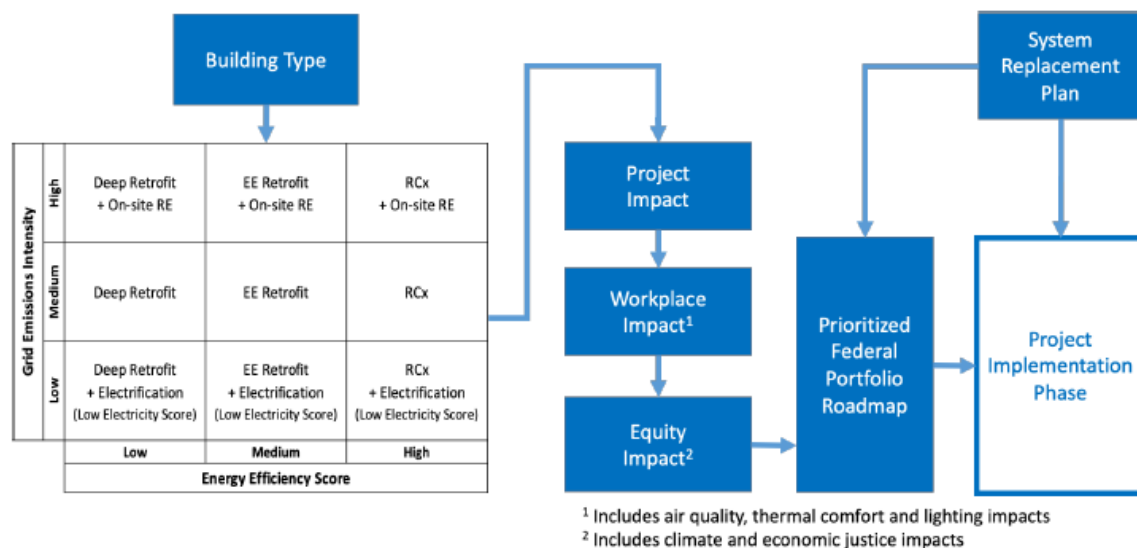


Figure 6. Building decarbonization prioritization methodology

Figure source: GBAC Advice Letter “Recommendations for Advancing Greenhouse Gas Reductions in Existing Federal Buildings” (November 2022)

There are many other GBAC advice letters, including one from 2021 covering adoption of energy storage in federal buildings and another from the same year with policy recommendations for procuring low embodied energy and carbon materials. In 2020, a renewable energy outleasing for federal buildings advice letter was also published. These advice letters are too numerous and extensive to cover in-depth in this resource but can be used by federal agencies to aid in their decarbonization process. A full list of GBAC advice letters is available at <https://www.gsa.gov/governmentwide-initiatives/federal-highperformance-green-buildings/policy/green-building-advisory-committee/advice-letters-and-resolutions> (GSA 2024).

2.6 Overview of Federal Agency Decarbonization Action Plan Framework

The framework proposed in this document consolidates the existing research outlined above into five broad steps for federal agencies aiming to decarbonize. A summary of these resources and their scopes is in Table 1, categorized into the five proposed steps by color. This visualization illustrates that some existing resources only focus on certain parts of the decarbonization action plan process (such as assessment or prioritization).

The five federal agency portfolio decarbonization action plan steps include:



Collection and Assessment

1. **Collection and assessment.** Establish and/or review goals and targets, assemble relevant stakeholders and available data, inventory portfolio of buildings and fleets. Establish

baseline energy consumption and emissions for each building and fleet within the portfolio.



Solution Development

2. **Solution development.** Perform energy audits and other actions to identify potential ERM. Assemble a list of potential solutions and strategies tailored for the relevant context.



Prioritization Plan

3. **Prioritization plan.** Prioritize portfolio by key buildings attributes, individual building, and/or fleets. Craft solutions that identify the most cost effective and strategically optimal decarbonization and electrification strategies. Classify measures and prioritize solutions based on the following order: (1) energy efficiency/load reduction, (2) electrification, (3) carbon-free electricity, and (4) technology. Evaluate decarbonization and electrification measures with multiple scenarios, with varying assumptions. Perform a cost-benefit analysis and estimate payback period. Consider auxiliary benefits.



Implementation and Training

4. **Implementation and training.** Identify which measures will be implemented and where in an implementation plan. Determine key personnel that must be trained and develop a training plan. Implement identified decarbonization and electrification measures, perform commissioning, retrocommissioning, and train facility staff. Ensure relevant documentation and resources are available to site staff.













Monitoring, Reporting, and Revising

5. **Monitoring, reporting, and revising.** Perform M&V to ensure measures are performing as expected. Performing ongoing performance monitoring is key to ensure implemented actions continue to align with goals and allows for the option to make revisions when they are not. M&V and monitoring-based commissioning efforts for building and M&V and monitoring fleet performance should be documented and reported annually. When revisions are required, the above process should be repeated, beginning with collection and assessment, and the new actions should be again be commissioned, M&V, monitored and reported, including updated training. Revisions should be documented and lessons learned assembled.

Table 1. Federal Agency Decarbonization Planning Resources

Table includes resources referenced in this document and categorized into five categories (action plan steps).

Resource: DOE Better Buildings ERP framework (Kramer et al. 2023)	
Level/Scope: Portfolio Level (Buildings)	
Resource Steps	Federal Agency Decarbonization Action Plan Steps
<ol style="list-style-type: none"> 1. Establish inventory and scope of work. 2. Categorize portfolio. 3. Assess measures. 	 Collection and Assessment
<ol style="list-style-type: none"> 4. Develop scenario. 	 Solution Development
<ol style="list-style-type: none"> 5. Define emissions reduction plan. 	 Prioritization Plan
<ol style="list-style-type: none"> 6. Ongoing implementation. 	 Implementation and Training
Resource: Better Buildings Toolkit—A Guide for Creating a Building-Level Action Plan to Improve Energy Efficiency and Reduce Carbon Emissions (Torcellini and Goetsch 2023)	
Level/Scope: Portfolio and Site Level	
Resource Steps	Federal Agency Decarbonization Action Plan Steps
<ol style="list-style-type: none"> 1. Provide organizational profile and highlights. 2. Set and track building-level goals. 	 Collection and Assessment
<ol style="list-style-type: none"> 3. Select a building. 	 Solution Development
<ol style="list-style-type: none"> 4. Prioritize CO₂e emission reduction strategies... 	 Prioritization Plan
<ol style="list-style-type: none"> 4. ...and report data. 	 Monitoring, Reporting, and Revising
<ol style="list-style-type: none"> 5. Identify barriers. 6. Develop CO₂e emission reduction implementation strategies: <ol style="list-style-type: none"> a) Energy efficiency b) On-site renewables c) Off-site renewables d) Grid integration e) Power purchase agreements, utility offerings f) Offsets. 	 Solution Development
Campus Climate Action Plan Process Steps	
Level/Scope: Campus Level	

Resource Steps	Federal Agency Decarbonization Action Plan Steps
<ol style="list-style-type: none"> 1. Determine energy and emissions footprint. 2. Outline GHG reduction goals. 3. Determine unique needs. 	 Collection and Assessment
<ol style="list-style-type: none"> 4. Identify solutions and barriers. 5. Prepare a plan... 	 Solution Development
<ol style="list-style-type: none"> 5. ... and set priorities. 	 Prioritization Plan
<ol style="list-style-type: none"> 6. Implement climate action plan. 	 Implementation and Training
<ol style="list-style-type: none"> 7. Measure and evaluate progress. 	 Monitoring, Reporting, and Revising
Site-Level Decarbonization Steps Level/Scope: Site Level	
Resource Steps	Federal Agency Decarbonization Action Plan Steps
<ol style="list-style-type: none"> 1. Document baseline Scope 1 and 2 emissions. 	 Collection and Assessment
<ol style="list-style-type: none"> 2. Identify load reduction and efficiency opportunities. 3. Equipment electrification. 4. On-site carbon-free electricity generation and storage. 5. Consider off-site carbon-free electricity purchase options. 	 Solution Development
GBAC advice letters (GSA 2024) Level/Scope: Site Level	
Resource Steps	Federal Agency Decarbonization Action Plan Steps
<ol style="list-style-type: none"> 1. Review existing data and building energy demand. 	 Collection and Assessment
<ol style="list-style-type: none"> 2. Reduce energy use through energy efficiency measures. 3. Reconfigure centralized HVAC systems and controls. 4. Recover heat throughout the building. 5. Replace heating and cooling equipment (initial electrification). 6. Replace (full electrification) energy sources with on-site renewable energy and storage. 	 Solution Development

3 Federal Agency Decarbonization Action Plan Framework

This broad framework aims to help federal agencies move from target-setting to concretely laying out action plans that will help agencies meet their portfolio-level emissions reduction targets. These steps (Figure 7) focus on the portfolio level; site-level considerations are included also. The primary focus of this decarbonization framework is on buildings but also includes vehicle fleets and phase-out of hydrochlorofluorocarbons refrigerants.

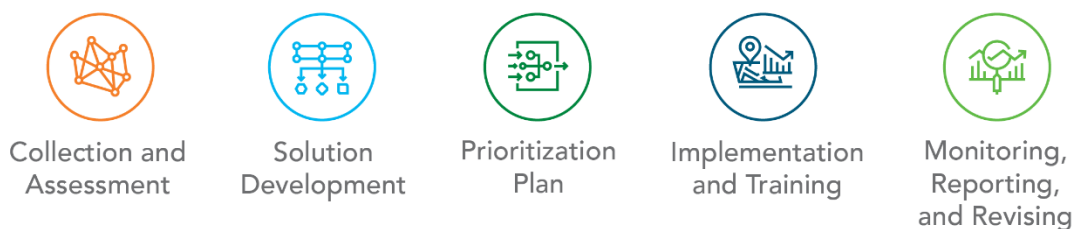


Figure 7. Five federal agency portfolio decarbonization steps

Illustration by Fred Zietz, NREL

Each of these steps is discussed in detail in this section.

3.1 Collection and Assessment

The first step of the federal agency decarbonization action plan framework includes assembling a team of relevant stakeholders and collecting and assessing data.

3.1.1 Assemble Team

Initially, agencies should develop an internal team with a diverse set of representation within the agency, including decision makers, site staff, and subject matter experts with technical expertise and institutional knowledge. These representatives shall become champions for the agency's mission toward achieving their decarbonization goals. This team and steering committee will provide valuable contributions, information, and insight, advancing the planning and development of the agency's strategic plan and its future policies and procedures. The steering committee will provide guidance and assess the portfolio of buildings and fleets developed by the project team, enabling the design of a comprehensive blueprint for moving toward the agency's decarbonization goals.

Agency team roles and responsibilities are listed in Table 2. Specifics will differ by agency.

Table 2. Agency Team Roles and Responsibilities

Roles	Responsibilities
Champion/Project Lead (Agency Executive)	Lead of decarbonization effort provides authority and financial resources, keeps a timeline, and assigns tasks.
Agency Steering Committee	Acts as the liaison between the agency director (champion) and the sites (site senior management). This is the primary body crafting agency policies and procedures, coordinating communications, identifying priorities and funding, etc.
Organization or Site Senior Management Advocate	This advocate interfaces between the champion and senior agency staff, providing review, guidance, and direction decision-making.
Buildings/Facilities Staff	Facilities staff are in charge of building operations and maintenance, providing subject matter expertise.
Fleet Operations Staff	Responsible for fleet operations, maintenance, and possibly acquisition, providing subject matter expertise.
Energy/Sustainability Manager	Sites may have dedicated energy managers as part of their facilities staff, providing subject matter expertise.
Data Analyst(s)	Supports program administration team and subject matter experts with analyzing GHG emission and energy reductions.
Procurement/Contracts Specialist	Procurement specialist provides contract administration, management, finance options, analysis, and recommendations.
Financial Analyst(s)	Supports the program administrative team in analyzing the costs of different scenarios.
Information Technology Expert	Responsible for information technology support, evaluations, guidance, and policy information to the program administration team.
Communications and Training Expert	Provides project communications support and coordinates training of team members.
External consultants	External consultants may be used for various purposes such as commissioning, retrocommissioning, engineering, or other technical assistance.
Other Subject Matter Experts	Other subject matter experts may be required, depending on the projects selected, such as those specializing in HVAC, building automation and controls, project scheduling, etc.

For the long term, best practices show that agencies who assign a centralized, dedicated team to provide program administration, management, and enforcement of the agency’s decarbonization plan, as well as site-level support, will achieve the best results. Depending on the agency’s organization structure, the team can provide, at a minimum, coordination, centralized communications, information, education and training, engagement, and reporting for the agency sites. There are various ways for these team members to be structured. An example organizational structure within an agency is shown in Figure 8. This structure includes the

project lead, steering committee, program management team, program support, and site staff. The steering committee or senior management reports to the project lead with status updates, planned projects, etc. The steering committee evaluates the findings of the project management/administration team and provides direction and decision-making. The project management team collects and analyzes data and designs and develops proposed solutions. Subject matter experts and consultants provide specialist support to the program management team. Finally, site level staff receives trainings and implements identified projects and/or policy.

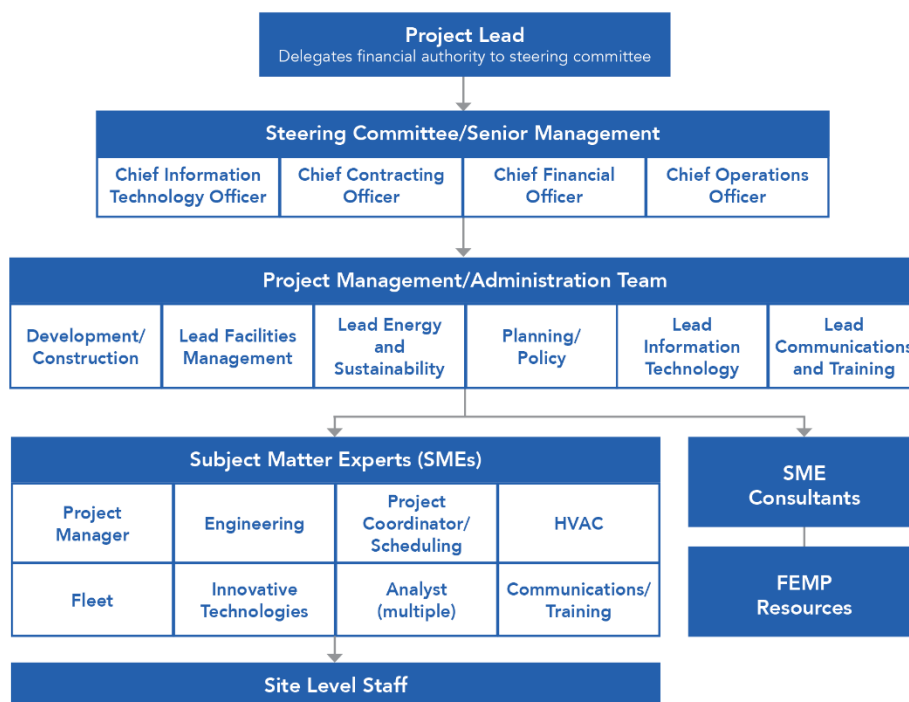


Figure 8. Example agency organizational structure for implementing the federal agency portfolio decarbonization action plan framework.

This master strategic decarbonization plan (or blueprint) will provide an agency-wide pathway for all agency sites to follow, including emissions reductions goals. It includes detailed plans, policies, procedures, milestones, metrics, and the ERM protocols. Moving forward with a unified approach, with centralized and consistent communications, would eliminate confusion and maverick actions. With specific plans supported by agency leadership and communicated to site-level staff at individual locations, agencies will see consistency and efficiency in actions and efforts.

This consistent framework for all the agency’s facilities and sites will better prepare the agency as a whole to modify, revise, or pivot on its journey toward decarbonization. Operating under a unified strategy will mitigate risks and allow greater control to address unforeseen circumstances that may dictate a revision or change in the plan.

3.1.2 Data Collection and Assessment

Following the development of an agency-wide decarbonization plan with emissions reduction goals and coordination of a centralized agency team, the agency shall coordinate a portfolio-wide collection and assessment of agency facility data. This is key to understanding agency emissions and the categories of those emissions. Baseline Scope 1 and 2 emissions must be calculated and reported to the agency. Accurate baseline emissions estimates provide insight into unique parameters, which may further aid in the development of strategies to reduce, mitigate, or eliminate those emissions.

The more comprehensive the dataset, the better the agency can assess their facilities. A sample set of data points, including relevant resources, are identified in Table 3 from which agencies can craft strategies based on key facility information. These data points will help inform the development of ERM's identified for implementation. For example, a building's orientation can identify opportunities for implementation of certain features, such as passive solar heating.

Table 3. Sample Set of Site Data Points for Agency Collection

Data Point	Purpose	Resources
Building Physical Address With ZIP Code	Complete property location information will provide a more comprehensive dataset to sort and classify its portfolio of buildings	Benchmark Your Building With Portfolio Manager: https://www.energystar.gov/buildings/benchmark .
Building Size (square footage)	Necessary data point to calculate energy use intensity Data point for benchmarking building	“Metrics for Energy Efficient Buildings: How Do We Measure Efficiency?”: https://www.aceee.org/files/proceedings/2016/data/papers/9_421.pdf .
Year Built/Building Age	Data point for benchmarking building	“Metrics for Energy Efficient Buildings: How Do We Measure Efficiency?”: https://www.aceee.org/files/proceedings/2016/data/papers/9_421.pdf .
Building Use (identify functional building types—research, hospital, office, warehouse, etc.)	Data point for benchmarking building	“Metrics for Energy Efficient Buildings: How Do We Measure Efficiency?”: https://www.aceee.org/files/proceedings/2016/data/papers/9_421.pdf .
Facility Current Operational Parameters (number of occupants, hours of operation)	Data point for benchmarking building	“Metrics for Energy Efficient Buildings: How Do We Measure Efficiency?”: https://www.aceee.org/files/proceedings/2016/data/papers/9_421.pdf .
Building Regional Parameters	Geospatial data and analysis providing building data for design standards based on geographic zone location	ASHRAE <i>Climatic Data for Building Design Standards</i> (see Table A-3. United States Stations and Climate Zones): https://www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20addenda/169_2020_a_20211029.pdf .
Building Orientation (optional)	Geospatial data and analysis	“An investigation of the impact of building orientation on energy consumption in a domestic building using emerging BIM (Building Information Modelling)”: https://www.sciencedirect.com/science/article/pii/S0360544216000037 .
Building Construction Documents (including recent major renovations and/or energy improvement projects)	Historical data point for strategic planning	Collect all original, and renovation as-build drawings and specifications for all agency buildings and systems

Data Point	Purpose	Resources
Utility Data for all Energy, Fuels, On-Site Generation (all)	<p>Three years preferably, at a minimum one year, of utility data for facility baseline</p> <p>Document rate class for each account and resource type, if applicable</p> <p>Collect interval load data for each building, if applicable</p>	<p>“Metrics for Energy Efficient Buildings: How Do We Measure Efficiency?”: https://www.aceee.org/files/proceedings/2016/data/papers/9_421.pdf.</p>
Trend Data From Building Automation System (if available)	<p>Three years preferably, at a minimum one year, of building automation system trend data</p> <p>Leverage performance data to identify trends, anomalies, and reduce costs</p>	<p>“Metrics for Energy Efficient Buildings: How Do We Measure Efficiency?”: https://www.aceee.org/files/proceedings/2016/data/papers/9_421.pdf.</p>
Detailed Itemization and Age of all Major Energy-Consuming Equipment	<p>Collect all equipment make, model, serial number, capacities, and motor nameplate rating details</p>	<p>“Why Users Should Pay Attention to the Motor Nameplate Rating”: https://www.pumpsandsystems.com/why-users-should-pay-attention-motor-nameplate-rating.</p>
On-Site Electric Vehicle Supply Equipment Quantity, Type (Level 1, Level 2, or DC fast charger), Power Rating (amperage and kW)	<p>Data point for strategic planning</p>	<p>Joint Office of Energy and Transportation Public Electric Vehicle Charging Infrastructure Playbook: https://driveelectric.gov/resources.</p> <p>DOE Alternative Fuels Data Center: https://afdc.energy.gov/vehicles/electric-fleets.</p>
Refrigerant Logs by Type (including volume/weight or charge)	<p>Track reporting requirements and phase out plan for refrigerants with high global warming potential and ozone-depleting potential</p>	<p>EPA’s Greenhouse Gas Inventory Guidance, Fugitive Emissions: https://www.epa.gov/sites/default/files/2015-07/documents/fugitiveemissions.pdf.</p> <p>ASHRAE Greenhouse Gas Management of Refrigerants: https://www.ashe.org/sustainability/decarbonization/management-refrigerants.</p>
Number and Type of Fleet Vehicles	<p>Data point for strategic planning</p>	<p>Joint Office of Energy and Transportation Public Vehicle Charging Infrastructure Playbook: https://driveelectric.gov/ev-infrastructure-playbook.</p> <p>DOE Alternative Fuels Data Center</p>
Fleet Vehicle Typical Daily Range and Dwell Times	<p>Data point for strategic planning</p>	<p>Joint Office of Energy and Transportation Public Vehicle Charging Infrastructure Playbook: https://driveelectric.gov/ev-infrastructure-playbook.</p>

Data Point	Purpose	Resources
		DOE Alternative Fuels Data Center
Fleet Parking Location	Data point for strategic planning	Joint Office of Energy and Transportation Public Vehicle Charging Infrastructure Playbook: https://driveelectric.gov/ev-infrastructure-playbook . DOE Alternative Fuels Data Center
Prior Energy Audit Documents or Renewable Energy Generation Feasibility Studies	Data point for strategic planning; ensure pre-existing work is leveraged and not repeated unless required	Collect all energy audit documents, renewable energy resource contracts, and documents for strategic planning and prioritization of decarbonization strategies

The collection and assessment of the agency’s data for its portfolio of buildings and fleets is a key component in its decarbonization strategy. Therefore, ensuring a complete and accurate dataset, followed by calculating, cataloging, analyzing, and assessing that information allows the agency to develop sound solutions and alternatives to meet their decarbonization goals and timelines.

3.2 Solution Development

Moving forward into the second phase of the decarbonization process, agencies will utilize the data that was collected and assessed. This data provides a clear picture of the current state of its facilities conditions and operating parameters. This detailed information will allow an agency to identify holistic and individual strategies to achieve their planned future-state decarbonization goals. Strategies should be prioritized to maximize carbon reduction at the minimum cost (CO₂e/\$). The strategies developed may include multiple pathways, programs, and vehicles to focus their investments, actions, selected ERMs, and the innovative technologies deployed under the unique conditions of their portfolio. Agencies must also identify how to manage trade-offs between economic gains and emissions reductions throughout this evolutionary process.

Many agency portfolios are vast, include diverse building types, and may be spread out nationwide, and in some cases worldwide. Some agencies will consist of primarily commercial facilities, while others may include hospitals, research facilities, fleets, or a combination. Therefore, a one-size-fits-all solution will likely not be possible. Where one solution may be effective for a certain facility type in the southwestern United States, that same solution may not be the best option for that facility type located on a remote island, or even in the northeastern part of the United States. Agencies should develop a set of future-state ERM options addressing each building’s unique type, location, and profile.

For example, to replace a gas-fired furnace or boiler located in the midwestern United States, an agency may have identified ground-source heat pumps as their primary selected ERM strategy.

The agency may also select a secondary option to utilize electric boilers in the event the ground-source heat pumps are not a viable option.

Through the adoption of multiple future-state ERM solutions and decarbonization strategies, individual agency sites will be positioned to proceed with meeting agency goals according to the adopted future-state decarbonization plan. As a result, the individual agency sites will have the agency's blueprint of approved ERM solutions to select from to implement this transition. This will provide consistency and predictability in the overall portfolio transition, provide individual sites with informed decision-making tools, and will better position the agency's ability to adapt, modify, or change its strategies in order to meet its milestones and decarbonization targets over the course of many years.

Investment-grade audits, or energy and water audits, are an effective method for identifying potential ERMs for implementation. Relevant resources include the Federal Energy Management Program (FEMP) Investment Grade Audit Tool (<https://www.energy.gov/femp/articles/federal-energy-management-program-investment-grade-audit-tool>) and FEMP's Energy and Water Audits for Federal Buildings page (<https://www.energy.gov/femp/energy-and-water-audits-federal-buildings>). Other useful audit resources include the FEMP Facility Evaluation (Audit) Decision Tree (<https://www.energy.gov/femp/articles/femp-facility-evaluation-audit-decision-tree>) and the Better Buildings GHG Emissions Reduction Audit Guidance (https://betterbuildingsolutioncenter.energy.gov/sites/default/files/attachments/Emissions_Reduction_Audit_Checklist.pdf).

ERM categories include, but are not limited to, the following:



Energy Efficiency

- Lighting retrofit, HVAC updates, building automation system changes (i.e., HVAC schedules), building controls, building insulation, building envelope, retrocommissioning, etc.



Deep Energy Retrofits

- See Deep Energy Retrofit Challenge:
<https://www.energy.gov/management/osp/articles/deep-energy-retrofit-fact-sheet>
- Whole-building analysis and construction process that achieves greater energy savings (40%–50%).



Electrification

- Heat recovery chillers, air-source heat pumps, ground-source heat pumps, water-source heat pumps, electric boilers.



Innovative/Emerging Technologies

- Innovative building technologies that aim to drive down operational costs, such as fault detection and diagnostics
- Innovative electric vehicle charging station technologies such as those integrated into building controls to optimize charging time based on grid or site generation mix.



On- or Off-Site Purchased Clean Energy/ Carbon-Free Electricity/Fuels

- On-Site or Off-Site Purchased Clean Energy/Carbon-Free Electricity/Fuels
- Solar/wind
- Marine/hydrokinetic energy (tidal, wave, current, and thermal)
- Hydroelectric
- Nuclear
- Geothermal
- Renewably sourced hydrogen and fuel cells

- Biofuels/biogas with active capture and storage of carbon dioxide emissions.
 - *Note: Agency must obtain and retire the renewable energy credits, also referred to as energy attribute certificates, for any resource generated or procured (excluding grid-supply carbon-free electricity).*

Carbon Capture, Utilization, Storage

- Carbon dioxide storage.

Supply Chain

- Supplier engagement/incentivize electrification
- Source with electrified suppliers
- Develop agency policy to reduce emissions from business travel.

Fleet/Transportation/Logistics

- Electrify fleet trucks and vehicles
- Installation of electric vehicle charging infrastructure.

A follow-on FEMP resource will provide further information and details surrounding situational ERMs and site-level considerations.

3.3 Prioritization

During the third phase of the process, agencies will begin mapping and prioritizing their identified solutions and strategies based on the knowledge gathered and analyzed through the data collection and assessment from the initial phase, and the adopted ERMs and decarbonization protocols and strategies established during second phase. The agencies will then prioritize their approach and focus their investments based on their established timeline, milestones, available capital resources and contracting vehicles, and carbon reduction options at the lowest cost (CO₂e/\$). Agencies will develop actionable processes for the pathways selected based on the ERMs, the estimated costs and benefits, available funding, and milestone objectives.

Agencies will evaluate and develop prioritization plans to reduce emissions by identifying mission-critical sites, campuses and/or facilities with equipment reaching its end of useful life, and sites with high baseline emissions. These locations provide the greatest potential for cost-effective ERMs.

Considering classifying strategies in this order:

1. Energy efficiency/load reductions
2. Electrification
3. Carbon-free electricity
4. Innovative/emerging technologies.

Each of these categories is further described below.

1. **Energy efficiency:** Agencies should first consider the reduction of emissions through energy efficiency improvements. These will typically be pursued using an individual building assessment or audit to identify needed improvements. Agencies can identify individual ERMs based on the energy audit or investment-grade audit reports, as well as energy baseline data, and incorporate other details surrounding the building such as: building age, location, and other existing conditions, which will all aid the agency in determining a path forward. Carbon emission reductions for each ERM should be calculated as well. Methods for improvement can be achieved through the identification and execution of individual ERMs, or more comprehensive efforts through the options available through energy performance contracting and deep energy retrofits. Special attention should be paid to fossil fuel-fired equipment such as furnaces and boilers. Rather than replacing fossil fuel-fired equipment with more-efficient fossil fuel-fired equipment, heat pumps (powered by electricity) should be considered and evaluated to see if they could meet the heating requirements. Energy efficiency measures include, but are not limited to, those listed in Table 4.

Table 4. Examples of energy efficiency measures

Source: DOE (2023b)

Energy Efficiency Measures ¹	
Boiler and Chiller Plants	Refrigeration
Energy Management Control Systems	Energy/utility distribution
Building Envelope	Water and sewer
HVAC	Electrical peak shaving/load shifting
Chilled/Hot Water and Steam Distribution	Commissioning/retrocommissioning
Lighting	Advanced metering infrastructure
Electric Motors/Drives	Plug load reductions

¹ For additional energy efficiency measures and associated detail, see the American Society for Health Care Engineering's (ASHÉ) support handbook (ASHÉ 2023) which addresses 52 actionable ECMs in 8 categories to help facilities management teams better manage energy use.

2. **Electrification:** Agencies can pursue electrification based on multiple approaches: (1) full electrification of a whole building, (2) electrification of a building addition, (3) electrification of a building system (e.g., HVAC), or (4) electrification of a piece of equipment. This provides pathways for full electrification, or, alternatively, partial electrification of certain systems or equipment, while still operating some fossil fuel-based equipment. This allows the agencies to leverage multiple strategies to achieve their objectives. The DOE Stakeholders Guide to Electrification (<https://www.energy.gov/electricity-insights/stakeholders-guide-electrification>) is a multimedia guide to help industry stakeholders better understand not only the benefits of electrification, but also the impact it will have on electric distribution systems and the technology, policies, and investments by both the utility and its customers that will be needed.
3. **Carbon-pollution free electricity:** Agencies can also make significant impacts to reduce emissions utilizing renewable and carbon-free energy. There are multiple ways agencies can incorporate carbon-free electricity into their blueprint, including investment in distributed renewable generation resources, or entering into an energy sales agreement, power purchase agreement, or procuring qualified renewable energy in eligible markets. The Carbon Pollution-Free Electricity Resources for Federal Agencies (<https://www.energy.gov/femp/carbon-pollution-free-electricity-resources-federal-agencies>) provides multiple resources to aid in the strategy development of implementing this ERM solution.
4. **Innovative/emerging technologies:** Technology solutions can be integrated across all previous categories to reduce carbon intensity. The U.S. General Services Administration (GSA) Green Proving Ground (<https://www.gsa.gov/climate-action-and-sustainability/center-for-emerging-building-technologies/about-green-proving-ground>)

[ground](#)) program evaluates next-generation building technologies in real-world operational settings to recommend the most promising for deployment on federal properties. The program aims to drive down operational costs in federal buildings and help lead market transformation through the deployment of new technologies, such as grid-interactive efficient “smart” buildings (<https://www.gsa.gov/governmentwide-initiatives/federal-highperformance-green-buildings/resource-library/energy-water/gridinteractive-efficient-buildings-gebs>). In addition, the U.S. Department of Defense’s Environmental Security Technology Certification Program (<https://serdp-estcp.mil/>) aims to improve environmental performance and reduce costs across the agency.

Examples of building ERMs in order of priority, including relevant resources, are included in Table 5.

Table 5. Building ERMs in Order of Priority and Associated Resources for Building and Energy Managers

Priority	Resources
1. Reduce energy use through energy efficiency measures	<p>Energy Conservation Measures: A Support Handbook for Facilities Management Teams https://www.ashe.org/sustainability/ECM-support-handbook</p> <p>Deep Energy Retrofits https://www.energy.gov/management/osp/articles/deep-energy-retrofit-fact-sheet</p> <p>Building Re-Tuning Simulator https://retuning-simulator.pnnl.gov/</p> <p>Climate Smart Buildings Initiative (CSBI) Tracking Tool https://www.energy.gov/femp/articles/climate-smart-building-initiative-csbi-target-tracking</p> <p>FEMP: Energy and Water Audits for Federal Buildings https://www.energy.gov/femp/energy-and-water-audits-federal-buildings</p>
2. Reconfigure centralized HVAC systems and controls	50001 Ready Navigator (for energy management systems) https://navigator.lbl.gov/
3. Recover heat throughout the building	ACEEE Low-Cost Decarbonization through Heat Recovery https://www.aceee.org/sites/default/files/pdfs/ssi21/panel-3/Zahlan.pdf
4. Replace heating and cooling equipment (initial electrification). Includes investigating which refrigerants are used.	<p>Decarbonizing HVAC and Water Heating in Commercial Buildings https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Decarbonizing%20HVAC%20and%20Water%20Heating%20in%20Commercial%20Buildings%2011.21.pdf</p> <p>EPA's Greenhouse Gas Inventory Guidance, Fugitive Emissions https://www.epa.gov/sites/default/files/2015-07/documents/fugitiveemissions.pdf</p>
5. Replace (full electrification) energy sources with on-site renewable energy and storage	<p>FEMP's Distributed Energy Program https://www.energy.gov/node/3614077</p> <p>Renewable Energy Integration and Optimization (REopt®) https://reopt.nrel.gov/tool</p>
6. Consider off-site carbon-free electricity purchase options	<p>Carbon Pollution-Free Electricity Resources for Federal Agencies https://www.energy.gov/femp/carbon-pollution-free-electricity-resources-federal-agencies</p> <p>REopt https://reopt.nrel.gov/tool</p>
7. Sequestration of unabated emissions and innovative technologies	GSA Center for Emerging Technologies https://www.gsa.gov/climate-action-and-sustainability/center-for-emerging-building-technologies/about-green-proving-ground

For fleets, the following characteristics must be considered:

- Daily range
- Predictability of daily trips
- Daily dwell times
- Types of current vehicles used and associated fuel economies
- Overnight parking location
- Feasibility for electric vehicle charger installation (availability and speed of chargers).

Fleets with shorter daily vehicle miles traveled, more predictable trips, and a consistent overnight parking location in a depot are the best candidates for electrification. Many agency fleets meet these criteria. In addition, vehicles with low fuel economy should be replaced with battery electric or plug-in hybrid electric vehicles (depending on daily range and charging availability) first.

Fleet decarbonization resources include:

- FEMP: Electric Vehicles for Federal Fleets (<https://www.energy.gov/femp/electric-vehicles-federal-fleets>)
- FEMP: Fleet Electrification and Optimization (<https://www.energy.gov/femp/fleet-electrification-and-optimization>)
- FEMP: Deploying Electric Vehicles and Electric Vehicle Supply Equipment (<https://www.energy.gov/femp/articles/deploying-electric-vehicles-and-electric-vehicle-supply-equipment>)
- FEMP: Procuring Electric Vehicle Infrastructure (<https://www.energy.gov/femp/procuring-electric-vehicle-infrastructure>)
- GSA: Federal Fleet (<https://www.gsa.gov/about-us/climate-action/federal-fleet>).

3.4 Implementation and Training

The implementation and training phase includes deploying the ERM strategies selected during the prioritization process, including training relevant staff. The timing and methods of implementation will vary, considering cost and planned renovations or retrofits, among other relevant factors.

Implementation also includes commissioning (new construction), recommissioning (post-retrofit) or retrocommissioning (existing construction) of a building and/or electric vehicle charging system when significant ERM strategies are deployed (such as deep energy retrofits or solar installation). Ideally, continuous commissioning or monitoring-based commissioning is performed to ensure adequate performance and energy savings. Commissioning is further discussed in the “Monitoring, Reporting, and Revising” section.

Agencies must also consider training to be a key component of any ERM implementation. Training should be targeted toward facility and/or fleet managers, energy managers, building technicians, and any other relevant staff that will interface with the technologies and equipment affected by the ERM. A training plan should be developed and training participants identified. Training can include lectures, hands-on inspection and operation of relevant equipment, and the explanation of relevant resources and tools available to staff after the completion of the training. Refresher trainings may be necessary on a semiannual or annual basis, particularly in the case of technical and/or technology-related ERMs. Documentation including equipment specifications, warranty information, parts lists, setpoints, schedules, and operations and maintenance plans should be clearly provided by the contractors to the facility manager or other relevant personnel. A final walk-through should be performed with the trained personnel of the operating ERM(s). Relevant resources for the implementation and training phase include:

- Fleets
 - Decarbonizing the U.S. Economy by 2050: A National Blueprint for the Buildings Sector (<https://www.energy.gov/eere/decarbonizing-us-economy-2050-national-blueprint-buildings-sector>)
 - Electrification and Decarbonization Strategies for Federal Agencies (<https://www.energy.gov/femp/electrification-and-decarbonization-strategies-federal-agencies>).
- Buildings
 - Electrification and Decarbonization Strategies for Federal Agencies (<https://www.energy.gov/femp/electrification-and-decarbonization-strategies-federal-agencies>)
 - Better Buildings *GHG Emissions Reduction Audit Guidance* (https://betterbuildingsolutioncenter.energy.gov/sites/default/files/attachments/Emissions_Reduction_Audit_Checklist.pdf)
 - *FEMP Energy Savings Performance Contract Project Development Resource Guide* (<https://www.energy.gov/sites/default/files/2019/12/f69/espc-project-development-guide-2019.pdf>)
 - GSA Center for Emerging Building Technologies (<https://www.gsa.gov/climate-action-and-sustainability/center-for-emerging-building-technologies/about-green-proving-ground>)
 - National Definition of a Net Zero Building (<https://www.energy.gov/eere/buildings/national-definition-zero-emissions-building>)

- FEMP Utility Energy Service Contract Guide (<https://www.energy.gov/femp/articles/utility-energy-service-contract-guide>)
- Resources for Implementing Federal Utility Energy Service Contracts (<https://www.energy.gov/femp/resources-implementing-federal-utility-energy-service-contracts>)
- Whole Buildings Design Guide–FEMP Courses (<https://www.wbdg.org/continuing-education/femp-courses>).
- Training
 - FEMP Training Catalog (<https://www7.eere.energy.gov/femp/training/>)
 - FEMP Workforce Development and Training (<https://www.energy.gov/femp/workforce-development-and-training>).

3.5 Monitoring, Reporting, and Revising

Following the implementation of ERMs, which includes the initial commissioning, the measure should be continuously monitored, and findings reported, and if needed, changes made. Types of ongoing commissioning include monitoring-based commissioning and continuous commissioning. Monitoring-based commissioning typically uses data analytics, leveraging a program such as a building energy management system with advanced metering and analytics to continuously monitor the performance of a building and any ERMs over time and under different conditions (Kramer, Crowe, and Granderson 2017). Continuous commissioning activities are incorporated into standard operations and maintenance and similar to monitoring-based commissioning, involve ongoing monitoring and resolving of issues, but are typically more costly, as greater staff is required (EERE n.d.).

Another component of ongoing monitoring the ERMs should also include M&V. M&V ensures the agency is achieving the expected energy reductions, including the associated emission reduction. By maintaining records and leveraging existing tools and processes wherever possible, agencies can track their progress. The results from all monitoring should be evaluated and recommissioning completed in instances in which ERM performance or the decarbonization protocols fall outside design intent. This will reestablish performance and ensure the ERM is meeting its intended goals. Any changes not able to be made (such as due to high costs) should be documented in reports and communicated as lessons learned for other sites and portfolios.

Reporting and revision should also be completed at the portfolio level. For an agency’s portfolio, existing tools such as the FEMP Energy Independence and Security Act 432 Compliance Tracking System

(<https://ctsedweb.ee.doe.gov/CTSDDataAnalysis/Default.aspx?ReturnUrl=%2fCTSDDataAnalysis%2fComplianceOverview.aspx>), Annual Energy Management Data Report

(<https://www.energy.gov/femp/articles/annual-energy-management-data-report>), and Federal Sustainability Scorecards (<https://www.sustainability.gov/progress.html>) can be used to track

progress and compliance without creating a reporting overburden for agencies. These reports can be used to revise an agency's decarbonization and electrification strategy where necessary to optimize decarbonization measures and interventions.

Where changes are required, the full process outlined above shall be repeated, starting with collection and assessment, in order to identify and implement corrective actions and monitor resulting performance.

Relevant resources for monitoring, reporting, and revising include:

- FEMP *M&V Guidelines: Measurement and Verification for Federal Energy Projects, Version 5.0* (https://www.energy.gov/sites/default/files/2024-03/femp-mv-5-0-guidelines_DRAFT.pdf)
- *International Performance Measurement & Verification Protocol: Concepts and Options for Determining Energy and Water Savings Volume I (2002)* (<https://www.nrel.gov/docs/fy02osti/31505.pdf>)
- FEMP Electric Vehicle and EVSE Reporting (<https://www.energy.gov/femp/electric-vehicle-and-electric-vehicle-supply-equipment-reporting>)
- Best Practices for Federal Facility Measurement and Reporting Electricity From EVSE (<https://www.energy.gov/femp/best-practices-federal-facility-measurement-and-reporting-electricity-electric-vehicle-supply>)
- DOE Building Data Tools (<https://buildingdata.energy.gov/#/collection-reporting>)
- Better Buildings Software Tools (<https://betterbuildingssolutioncenter.energy.gov/better-plants/software-tools>)
- FEMP Measurement and Verification Activities Required in the Energy Savings Performance Contract Process (<https://www.energy.gov/femp/measurement-and-verification-activities-required-energy-savings-performance-contract-process>)
- FEMP Monitoring-Based Commissioning (<https://www.energy.gov/femp/articles/enhancing-performance-contracts-monitoring-based-commissioning>).

4 Financing of Federal Decarbonization and Electrification Projects

There are a variety of options for funding agency ERM, once the desired ERM have been identified. These fall into three primary categories: direct funding, performance contracting, and incentive programs. These are further described below.

4.1 Direct Funding

In general, direct funding includes appropriations or other funding from centralized agency funding accounts for larger capital-intensive projects or from decentralized operating budgets for smaller projects.

Examples of centralized agency funding include agency infrastructure improvement funds, the U.S. Department of Defense's Energy Resilience Conservation Investment Program (<https://www.acq.osd.mil/eie/er/cr/ie/ercip.html>) and the General Services Administration's Federal Buildings Fund (<https://www.gsa.gov/reference/reports/budget-and-performance/annual-reports/2022-agency-financial-report/managements-discussion-and-analysis/analysis-of-financial-statement-and-stewardship-information/federal-buildings-fund>). Decentralized operation and maintenance budgets administered by agency regions and sites are also important sources for efficiency investment.

Agency sites should apply for centralized capital improvement funding for those projects that most closely match the selection criteria for that funding. Also, agencies should explore revolving fund arrangements supported by project savings funding streams.

4.2 Assisting Federal Facilities with Energy Conservation Technologies Program

FEMP provides direct funding to federal agencies through the Assisting Federal Facilities with Energy Conservation Technologies (AFFECT) program (<https://www.energy.gov/femp/federal-energy-management-program-funding-opportunities>). AFFECT provides grants for the development of energy and water efficiency projects and processes at U.S. federal government-owned facilities.

Federal agencies can submit applications for AFFECT grants explaining how they plan to use the funding to make energy and water efficiency upgrades to new and existing federal buildings and help them achieve net-zero through initiatives like efficiency and conservation improvements, electrification, on-site clean energy generation, and sustainable design.

Applications may be submitted under three topic areas:

- Assistance with Net-Zero Emissions Buildings Opportunity Development
- Modification of Existing Projects for Net-Zero Emissions Buildings
- New/In Development Net-Zero Emissions Buildings Projects.

4.3 Performance Contracting and Alternative Financing Approaches

In addition to directly funding the projects solely with appropriations, agencies may negotiate and use performance contracting approaches to implement projects paid for from cost savings realized over time. Also, the Energy Act of 2020 requires agencies to use performance contracting to address at least 50 percent of the identified ECMs. These approaches include utility energy service contracts (<https://www.energy.gov/femp/utility-program-and-utility-energy-service-contracts-federal-agencies>), energy saving performance contracts (ESPC) (<https://www.energy.gov/femp/energy-savings-performance-contracts-federal-agencies>), ESPC ENABLE (<https://www.energy.gov/femp/energy-savings-performance-contract-enable-federal-projects>), ESPC energy sales agreements (<https://www.energy.gov/femp/energy-savings-performance-contract-energy-sales-agreements>), and, if specifically authorized, power purchase agreements and enhanced use leases.

Agencies may also leverage their appropriated dollars to fund a more comprehensive performance contract through the combination of different funding sources, which may also be referred to as braiding and stacking; however, there may be tax credit limitations on combining multiple resources. More information on braiding and stacking is available in a 2024 American Council for an Energy-Efficient Economy press release (<https://www.aceee.org/press-release/2024/05/study-shows-how-states-can-maximize-impact-federal-home-energy-retrofit-funds>) and in an Oak Ridge National Laboratory 2023 report titled *Leveraging of Funds in Performance Contracting Projects* (<https://info.ornl.gov/sites/publications/Files/Pub192303.pdf>). Agencies are encouraged to talk to their appropriate legal and financial offices about the potential for employing all sources of available funding and contracting authority for energy efficiency and water improvements at federal facilities, as described below.

4.3.1 ESPCs

An ESPC is a contract (such as a task order under DOE's multiple award, indefinite-delivery, indefinite-quantity (<https://www.energy.gov/sites/default/files/2023-08/2023-doe-idmq-esp-generic-contract.pdf>) umbrella contract awarded to an energy service company that provides for the performance of services for the project development, design, acquisition, installation, testing, and, where appropriate, operation, maintenance, and repair, of an identified ERM or series of ERMs, at one or more locations. Such contracts shall provide that the contractor incurs costs of implementing energy savings measures, including at least the cost (if any) incurred in performing energy audits, acquiring and installing equipment, and training personnel in exchange for a predetermined share of the value of the energy savings resulting from implementation of such measures during the term of the contract and a guarantee that the savings cover the full cost of the investment. More details can be found on FEMP's Energy Savings Performance Contracts for Federal Agencies webpage (<https://www.energy.gov/femp/energy-savings-performance-contracts-federal-agencies>).

ESPC ENABLE is a newer federal program designed to permit a standardized and streamlined procurement process for small federal projects to install ECMs in 6 months or less. ENABLE

does not have a specific size or cost restriction but utilizes a set of pre-established ECM categories and an Investment Grade Audit Tool (<https://www.energy.gov/femp/articles/federal-energy-management-program-investment-grade-audit-tool>) to administer the projects.

ESPC energy sales agreement is a project structure, similar to a power purchase agreement, that uses the multiyear ESPC authority to implement distributed energy projects—referred to as energy sales agreement ECMs—on federal buildings or land. The energy sales agreement ECM is initially privately owned for tax incentive purposes, and the federal agency purchases the electricity it produces with guaranteed cost savings. Energy sales agreements must include a provision transferring title to the federal agency at the end of the term at fair market value.

4.3.2 Utility Energy Service Contract

A utility energy service contract is a contract between a federal agency and its local serving utility providing energy, water, and/or wastewater services, as well as provision of technical services and/or upfront project financing for energy efficiency, water conservation, and renewable energy investments. It allows federal agencies to pay for the services from the savings generated from improvement projects over time, either on their utility bill or through a separate agreement. Agency sites should leverage existing relationships with their servicing utilities to request energy and/or water savings proposals that reduce demand of the commodities provided, especially if demand-side incentives are available from the utility, or other commodities. Agencies may also use a contract, basic ordering agreement, or GSA areawide public utility contract (<https://www.gsa.gov/real-estate/facilities-management/utility-services/areawide-public-utility-contracts>) to procure utility services and to finance energy efficiency projects with generated savings. More information can be found on FEMP's Utility Program and Utility Energy Service Contracts for Federal Agencies webpage (<https://www.energy.gov/femp/utility-program-and-utility-energy-service-contracts-federal-agencies>).

4.3.3 Enhanced Use Leasing

An enhanced use lease is an authority by which some federal agencies can lease underutilized real property to the public or private sector that enhances their mission as a means of obtaining services, facilities, revenue, space, etc. Under an enhanced use leasing agreement, underutilized agency land or facilities can be leased to a developer or energy service company in exchange for a wide variety of energy improvements, including large or long-term renewable energy and cogeneration projects.

4.3.4 Power Purchase Agreements

A power purchase agreement is a contract for the purchase of electricity, which may be generated by on-site renewable energy projects where permitted. By purchasing the electricity from on-site renewable resources, the facility can contribute to the agency energy intensity reduction goal (42 U.S.C. 8253(a)) and obtain a percentage of its energy from renewable sources per 42 U.S.C. 1585(a) while providing an ongoing source of new renewable power.

4.3.5 Electric Vehicle Supply Equipment Blanket Purchase Agreements

Electric vehicle supply equipment has particular finance considerations. Multiple resources outlining electric vehicle supply equipment blanket purchase agreement offerings are available on the GSA website: <https://www.gsa.gov/buy-through-us/products-and-services/transportation-and-logistics-services/fleet-management/fleet-electrification/evse-purchasing-resources>.

4.4 Incentive Programs

Many states and utilities have incentive programs that help offset energy or water costs while promoting energy and water efficiency and renewable energy technologies. The following sections include examples of these programs.

4.4.1 Energy Efficiency and Renewable Energy Programs

Public purpose programs are administered by utilities, state agencies, or other third parties and paid for by utility ratepayers, typically through a non-bypassable system benefits charge instituted as part of restructuring legislation or rules.

Utility programs are administered by the local utility and paid for by utility ratepayers through their bundled rates.

Programs sponsored by state agencies are designed to promote energy efficiency and renewable energy and are usually funded out of general tax revenues.

4.4.2 Demand Response/Load Management Programs

These are programs that provide incentives to curtail demand during peak energy usage periods in response to system reliability or market conditions. Agencies can participate in state and utility incentive programs in order to reduce their energy usage and control their energy costs. More details can be found on FEMP's Incentives and Load Management webpage (<https://www.energy.gov/femp/incentives-and-load-management>).

Additionally, the Database of State Incentives for Renewables & Efficiency (<https://www.dsireusa.org/>) offers a comprehensive, up-to-date listing of federal, state, local, and utility incentives and policies that support renewable energy and energy efficiency projects.

4.4.3 Electric Vehicle Supply Equipment Programs

There are multiple charging station incentives available both on the federal and state level.

Federally, the National Electric Vehicle Infrastructure Formula Program (<https://afdc.energy.gov/laws/12744>) includes funding for up to 80% of electric vehicle charging station costs. State funding and incentive options vary by state.

5 Conclusion

This decarbonization and electrification roadmap for federal agencies provides a high-level framework for agencies aiming to reduce emissions associated with their building and fleet portfolios. Leveraging existing resources and processes, agencies can achieve their clean energy and emissions reduction targets by adopting five main steps, referred to as the federal agency portfolio decarbonization action plan framework. These steps include collection and assessment; solution development; prioritization; implementation and training; and monitoring, reporting, and revising. This roadmap can help agencies move from goal setting to implementing actions that reduce energy use and associated emissions. This portfolio-level roadmap will be followed with a campus- and site-level resource that delves into the specific details, nuances, and considerations for specific measures, sites, and locations.

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