



GSA Green Building Advisory Committee Federal Building Decarbonization Task Group

09 November 2022

Federal Building Decarbonization Task Group – Charter and Scope

Charter - The Federal Building Decarbonization Task Group will explore opportunities and challenges for reducing greenhouse gas emissions - in alignment with national climate goals and action plans - through the use of renewable energy, energy efficiency, electrification and smart building technologies at federal facilities.

Scope - Individual buildings, campuses, and supporting infrastructure, including central energy plants, distributed energy resources, and EV charging.

Building decarbonization includes operational emissions, refrigerant emissions, and building life cycle emissions.



Federal Building Decarbonization Task Group – Federal Policy

- Executive Order 14057 mandates that the federal building portfolio achieve net-zero greenhouse gas emissions by 2045, including a 50% reduction by 2032.
- The Climate Smart Buildings Initiative sets a goal of leveraging over \$8 billion in private sector investment through performance contracts for building retrofits.
- The Energy Act of 2020 mandate for agencies to complete at least 50% of all identified lifecycle cost effective energy and water savings measures through performance contracts.
- The Inflation Reduction Act provided over \$3 billion in funding to GSA for various purposes related to greenhouse gas reduction, clean energy, sustainable buildings, and clean materials purchasing.



Federal Building Decarbonization Task Group – Participants

GBAC Members and Designees

Clay Nesler, The Nesler Group (Co-Chair)
Kent Peterson, P2S Inc (Co-Chair)
Fernando Arias, Clark Construction
Kevin Bates, Sharp Development
Erin Beddingfield, NBI
Cara Carmichael, CEQ
Nael Nmair, Rick Mears, Chris Tremper,
Skye Schell, Jay Wrobel, DOE FEMP
Harry Bergmann, Jeffrey Wanner, BTO
Bruce Hedman, AMO
Victor Olgyay, Mark Kresowik, RMI
David Kaneda, IDeAs Consulting
John Park, VA
Jane Rohde, JSR Associates, Inc.
Costa Samaras, OSTP
Timothy Unruh, NAESCO
Conan Wilson, EPA

GSA

Ken Sandler, OFHPGB (DFO)
Don Horn, OFHPGB
Krystal Brumfield, Associate Administrator, OGP
Lance Davis, PCAE
Matthew Harbeson, GSA
Kinga Porst Hydras, OFHPGB
Meredith Holland, Anna Soyka, OFHPGB (contractors)
Mishal Ahmad, OFHPGB
Ky Nguyen Zubroski, PBS
Brad Nies, OFHPGB
Sandrine Schultz, OFHPGB
Lariza Sepulveda, PBS

Federal Building Decarbonization Task Group – Observers

Observers

Dannie Dilonno, Branch Pattern

Bing Liu, Supriya Goel, PNNL

Matthew Joyner, Sheila Hayter, Deb Vasquez, NREL

Lisa Jacobsen, Business Council for Sustainable Energy

Greg Johnson, American Wood Council

Laurie Kerr, USGBC

Hannah Kramer, Paul Mathew, LBNL

Renée Lani, American Public Gas Association

Jeffrey Mang, Policy Consultant

Loren Ross, American Wood Council

Lois Vitt Sale, Wight & Company

Jessica Shipley, Regulatory Assistance Project (RAP)

Alice Yates, ASHRAE



Federal Building Decarbonization Task Group – External Presentations

- **Hannah Kramer**, Lawrence Berkeley National Lab (LBNL): DOE Better Buildings Program's Better Climate Challenge and Low Carbon Pilot
- **Harry Bergmann**, DOE Building Technologies Office (BTO) and **Supriya Goel**, Pacific Northwest National Lab (PNNL): DOE Audit Template Tool
- **Chris Tremper**, DOE Federal Energy Management Program (FEMP): EISA 432 Compliance Tracking System (CTS) Database
- **Paul Mathew**, LBNL: DOE BTO Integrated Systems Packages Project
- **Michael Bloom**, GSA OFHPGB: GSA Public Buildings Service (PBS) Total Workplace Scorecard
- **Laurie Kerr**, US Green Building Council (USGBC): Deep Energy Retrofit Plan Analysis (DERPA) tool)
- **Tim Unruh**, National Association of Energy Service Companies (NAESCO): Promoting ESPCs/UESCs for Building Decarbonization
- **Bruce Hedman**, DOE Advanced Manufacturing Office (AMO): Combined Heat and Power (CHP) and Decarbonization
- **Max St-Denis**, Public Service and Procurement Canada (PSPC): National Portfolio Decarbonization – Driving The Green Building Agenda in Canada
- **Ken Sandler**, GSA OFHPGB: Executive Order 14057 Implementing Instructions
- **Sheila Hayter**, NREL and **Kathleen Judd**, PNNL: Net Zero Labs Pilot Initiative

Federal Building Decarbonization Task Group Approach

Portfolio Prioritization

Building Portfolios

Quickly utilize portfolio building asset data to provide a high-level roadmap of where to focus efforts towards reducing building carbon emissions

Project Implementation

Individual Building Decarbonization

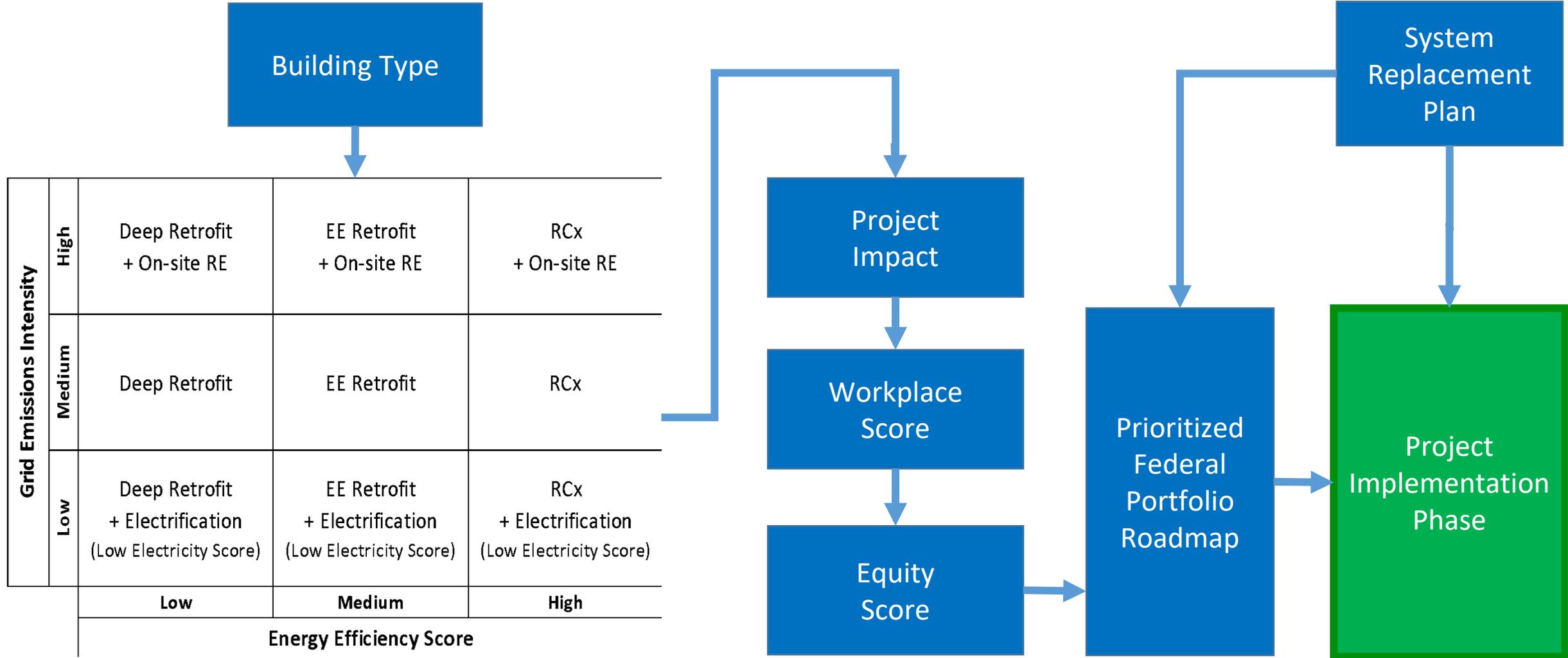
Utilize building asset data, energy audit data, and specific information relative to the building to provide a list of the identified potential measures and packages targeting different scenarios towards operational GHG emission reductions

Federal Building Prioritization Challenges

- How to prioritize existing federal buildings for decarbonization?
- How to estimate potential energy and greenhouse gas reductions?
- How to estimate required investments and payback?
- How to select high-level decarbonization measures?
- How to do all four using minimal existing data?



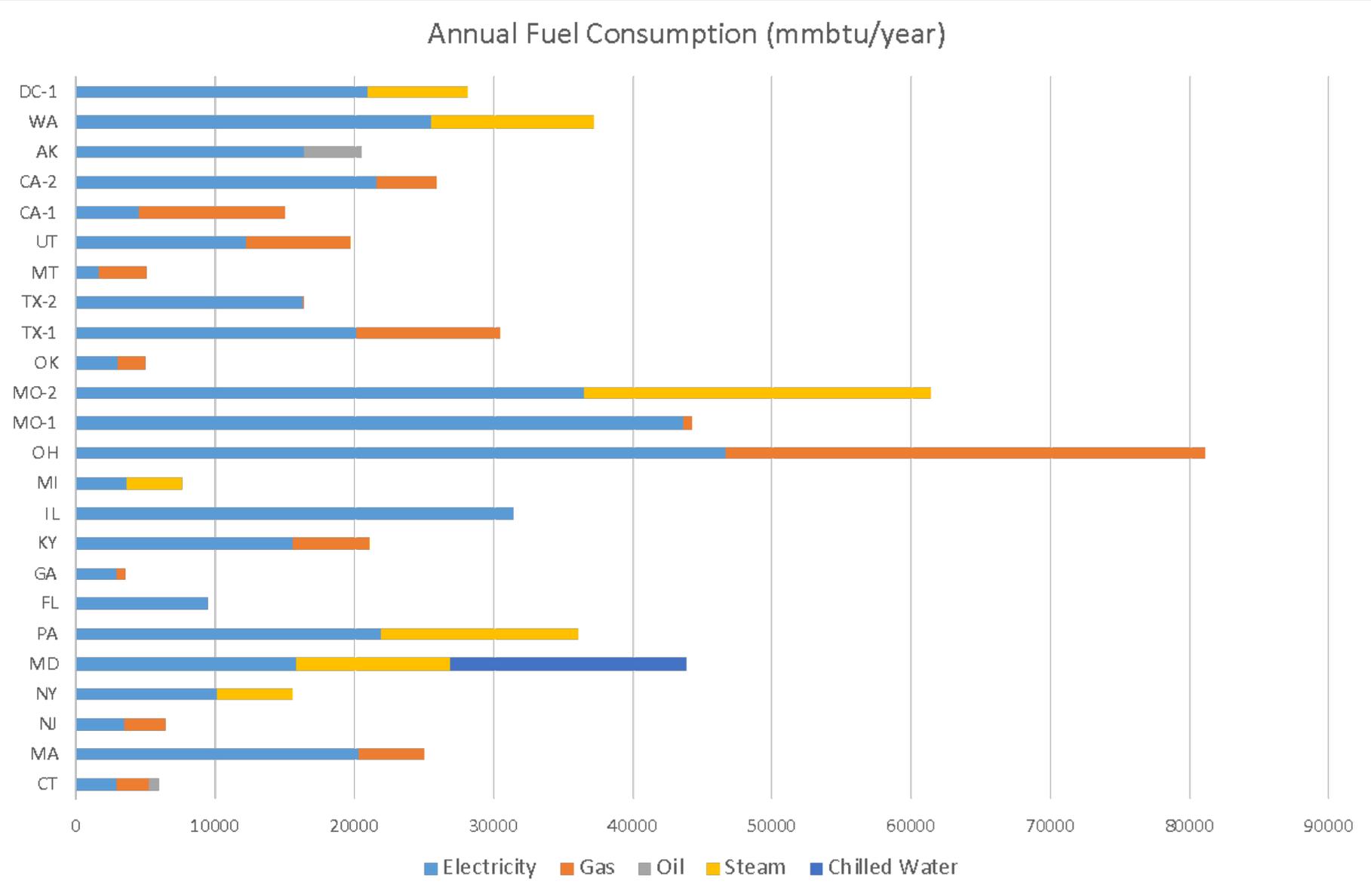
Federal Building Decarbonization Prioritization Approach



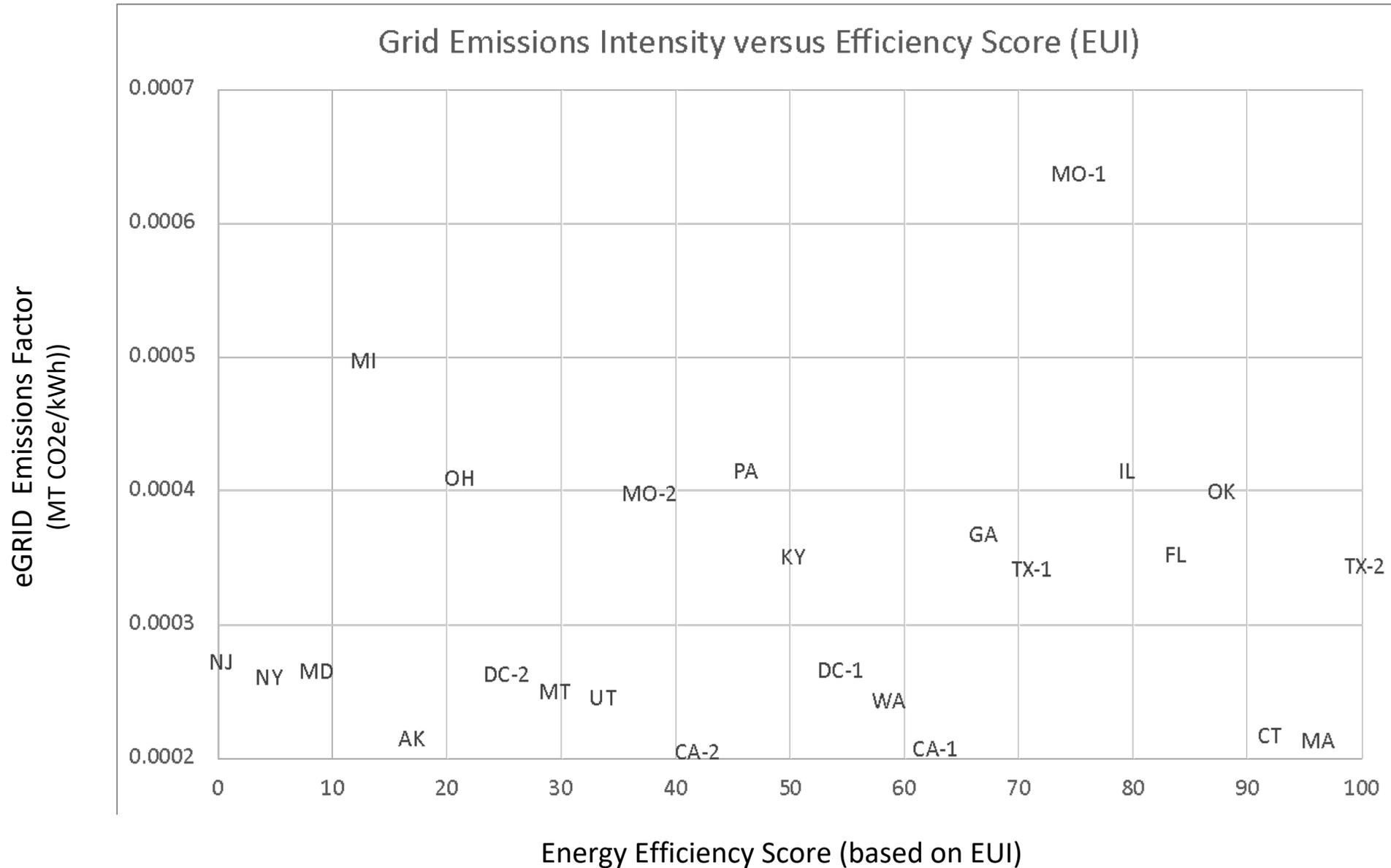
Federal Building Prioritization Methodology Data Requirements

- Building Size
- Building Address
- Building Climate Zone
- Energy Use Intensity (BTU/GSF)
- Energy Star Score (percentile rank)
- eGRID Factor - Scope 2 Emissions in (MTCO₂e/kWh)
- Scope 1 GHG emissions (MTCO₂e)
- Scope 2 GHG emissions (MTCO₂e)
- Electricity, Gas, Oil, Steam, Chilled Water Consumption (mmbtus)
- Electricity, Gas, Oil, Steam, Chilled Water Cost (\$)

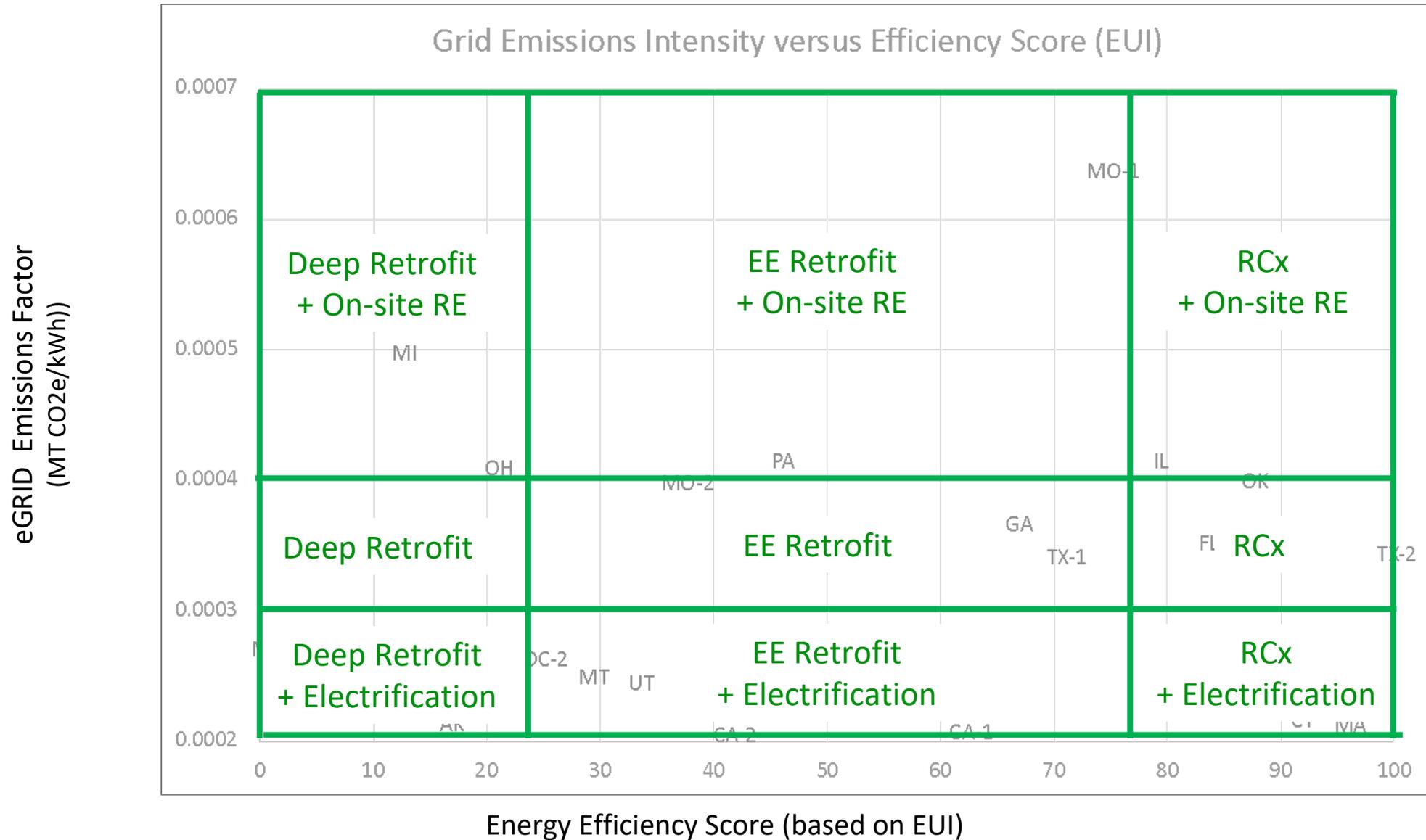
GSA Example Portfolio – 25 Office Buildings



Building Decarbonization Screening Matrix



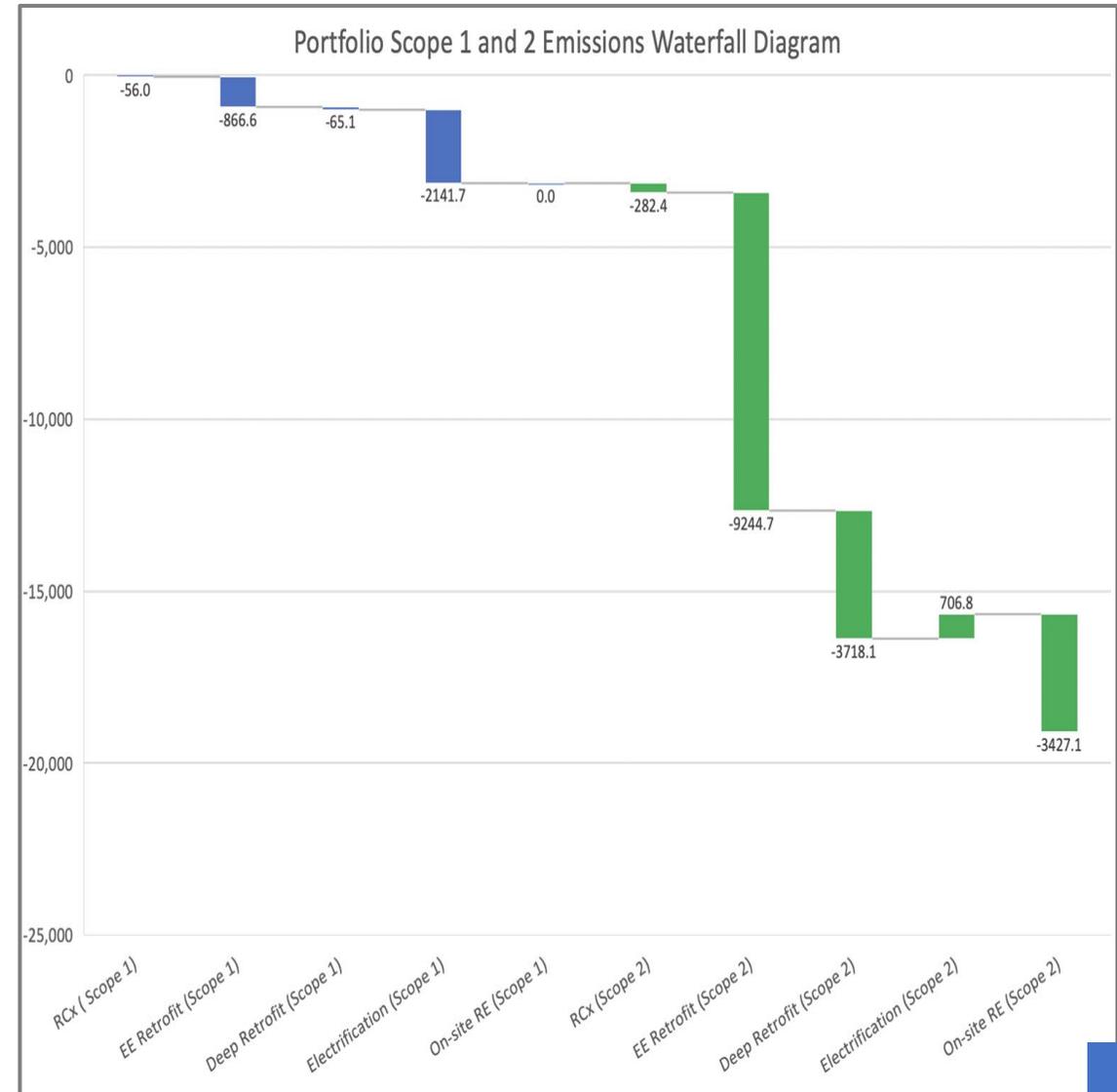
Building Decarbonization Screening Matrix



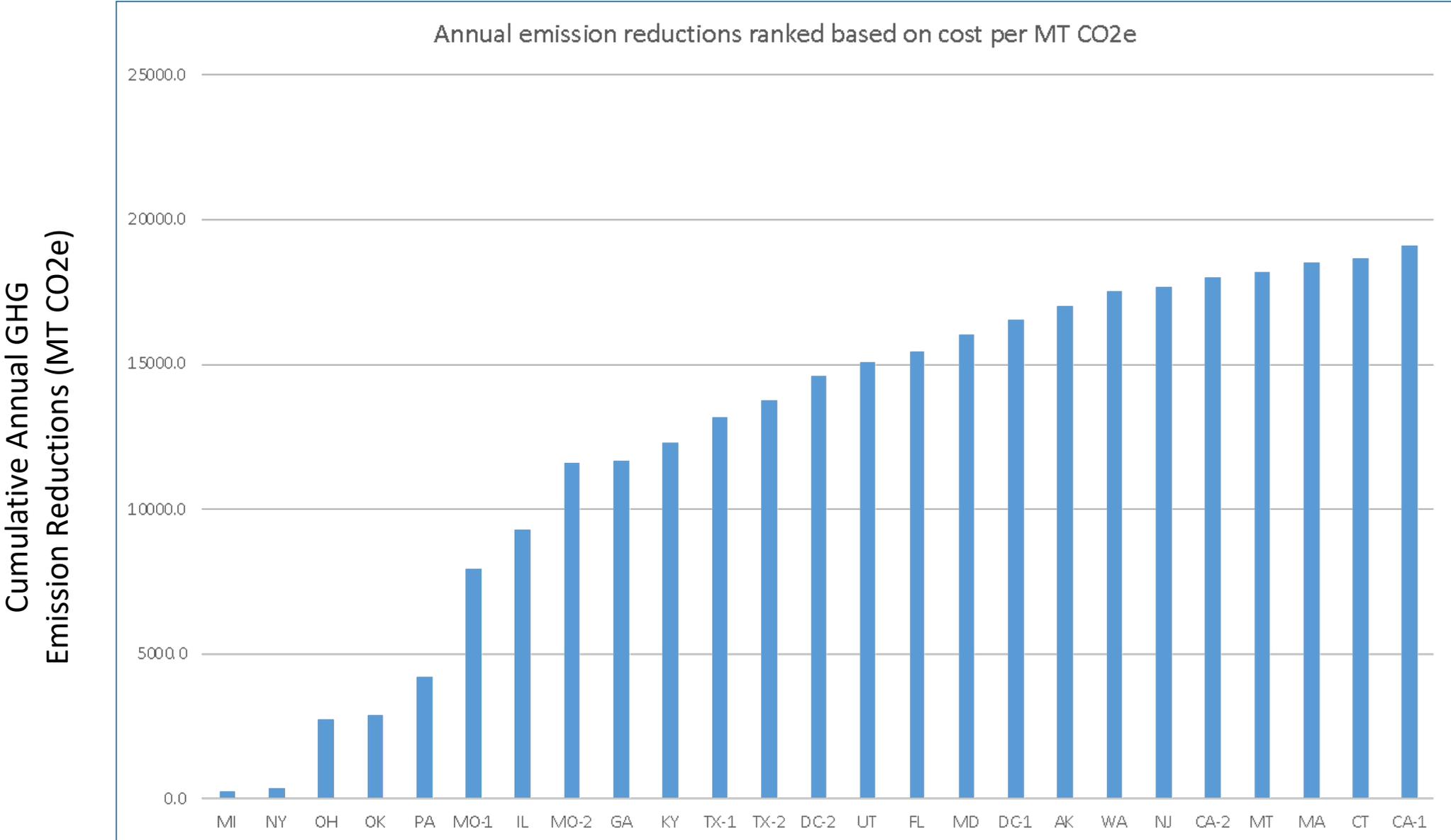
Federal Building Prioritization Portfolio Analysis – Base Case Analysis

Portfolio Annual GHG Reduction	19,095 tonnes
Portfolio Annual GHG Reduction Percentage	28.7%
Portfolio Annual Cost Savings	\$4,007,000
Portfolio Investment	\$53,375,000
Portfolio Simple Payback	13.3 years
RCx Only	3
EE Retrofit	18
Deep Retrofit	4
Electrification	8
On-site Renewables	7
Portfolio Investment/Tonne	\$140
Portfolio Net Present Value	\$6,246,000

Number of Sites



Portfolio Cost Optimization – Emission Reductions per Dollar Invested



Federal Building Prioritization Portfolio Analysis – Cost Optimal Analysis

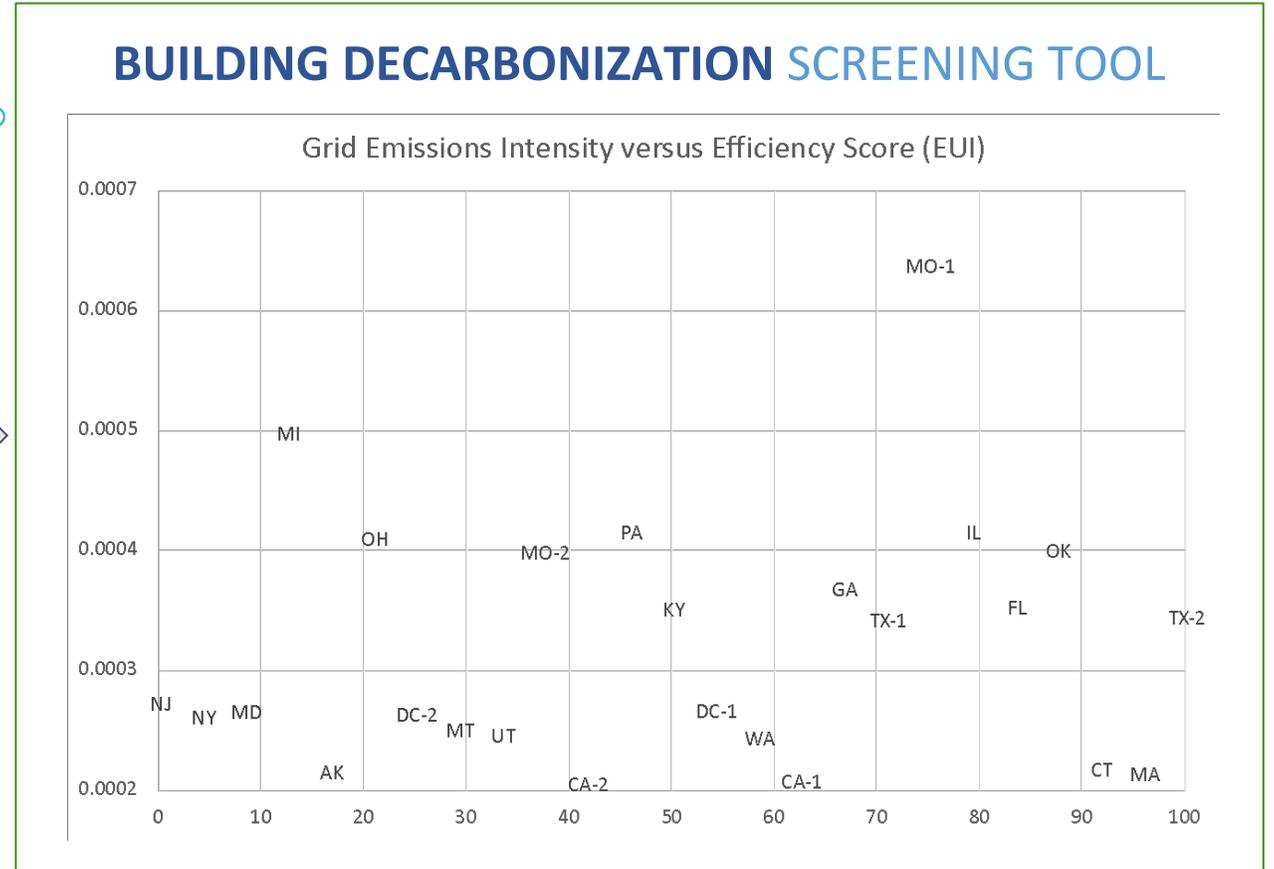
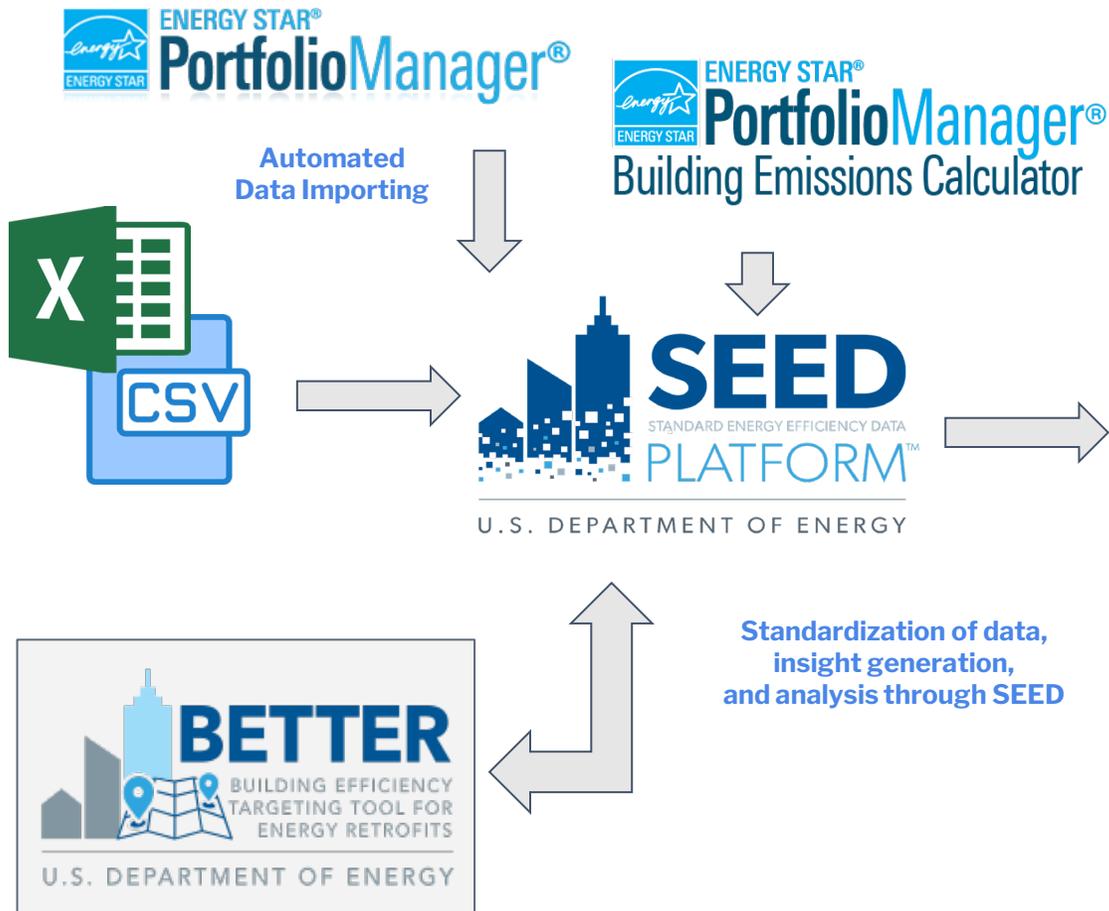
Portfolio Annual GHG Reduction	19,095 tonnes	16,897 tonnes
Portfolio Annual GHG Reduction Percentage	28.7%	25.4%
Portfolio Annual Cost Savings	\$4,007,000	\$3,166,000
Portfolio Investment	\$53,375,000	\$33,351,000
Portfolio Simple Payback	13.3 years	10.5 years
EE Retrofit	18	11
Deep Retrofit	4	2
Electrification	8	4
On-site Renewables	7	7
Portfolio Net Present Value	\$6,246,000	\$13,756,000

Number of Sites

Federal Building Prioritization Portfolio Analysis – Carbon Price Analysis

Portfolio Annual GHG Reduction	19,095 tonnes	19,095 tonnes
Portfolio Annual GHG Reduction Percentage	28.7%	28.7%
Portfolio Annual Cost Savings	\$4,007,493	\$4,007,493
Portfolio Investment	\$53,374,916	\$53,374,916
Portfolio Investment/Tonne	\$140	\$140
Portfolio Investment/GSF	\$3.82	\$3.82
Carbon Price (Social Cost of Carbon)	\$0 per MT CO ₂ e	\$51 per MT CO ₂ e
Portfolio Simple Payback	13.3 years	10.7 years
Portfolio Net Present Value	\$6,246,457	\$20,734,716

Potential Implementation Path for Building Decarbonization Screening Tool



Illustrative example of how the building decarbonization screening tool could be integrated with the SEED platform

Portfolio Prioritization

Building Portfolios

Quickly utilize portfolio building asset data to provide a high-level roadmap of where to focus efforts towards reducing building carbon emissions

Project Implementation

Individual Building Decarbonization

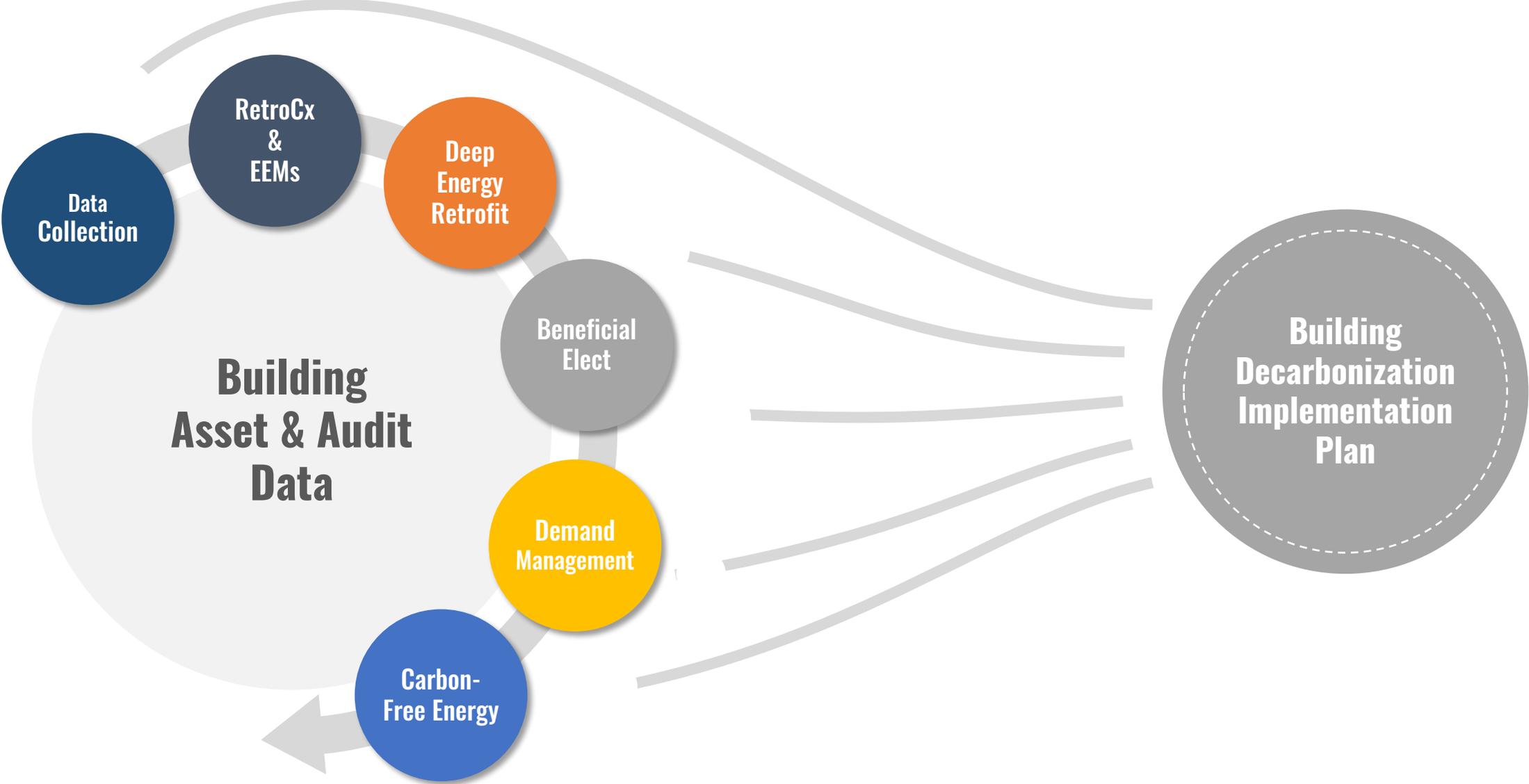
Utilize building asset data, energy audit data, and specific information relative to the building to provide a list of the identified potential measures and packages targeting different scenarios towards operational GHG emission reductions

- Defining the challenge
 - ✓ Massive quantity of existing buildings owned by U.S. federal agencies
 - ✓ Facility managers need to understand what decisions to make in the next 20 years towards building decarbonization
 - ✓ Specific emphasis was placed on smaller to medium sized facilities that usually do not get improved with typical energy saving procurement processes

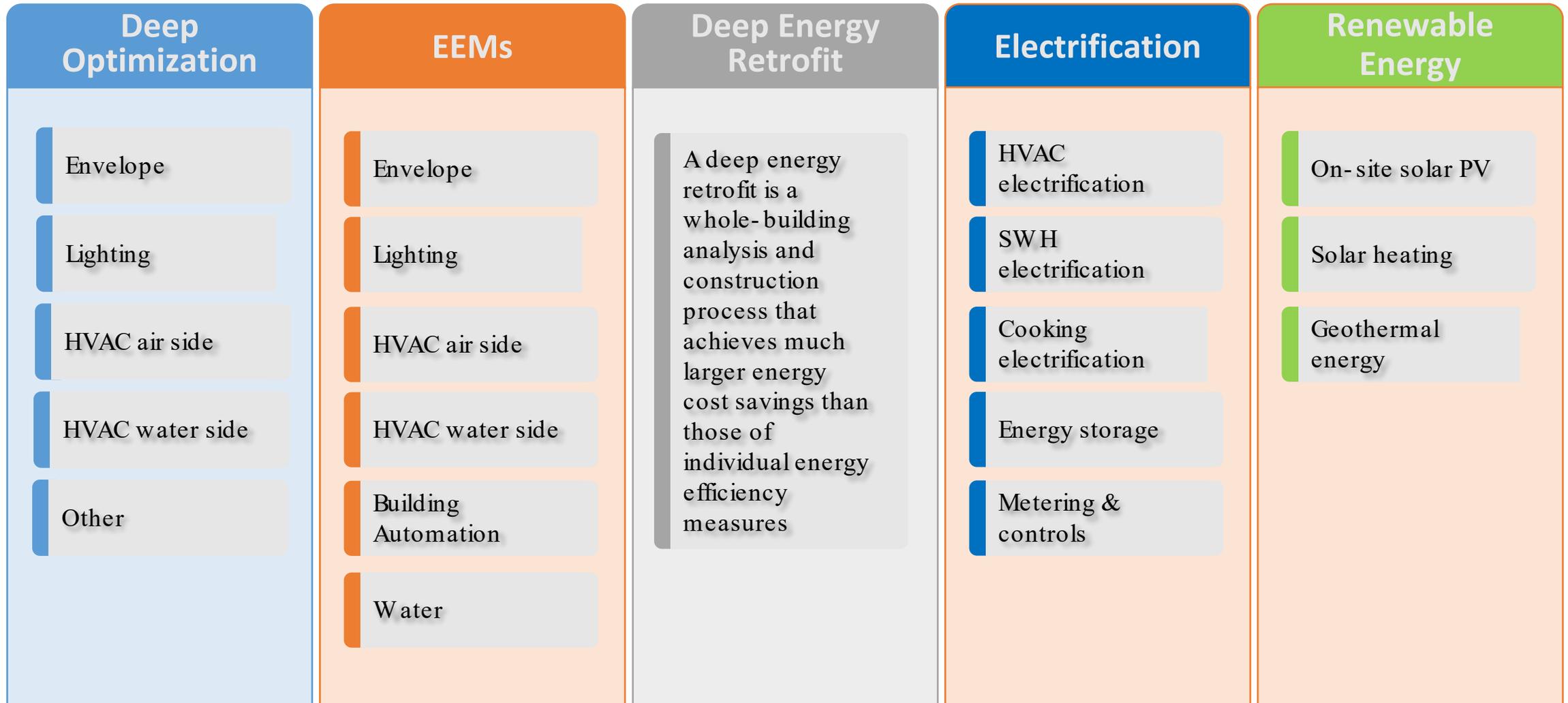
Federal Building Decarbonization Implementation Tool

- The Implementation Tool Concept specification was developed to answer the question of how to proceed using more detailed building-specific information
 - ✓ Measures and sequencing will be highly specific to any given building
 - ✓ Output would help federal facility managers develop a building specific roadmap with decarbonization measures and sequencing specific to the building

Federal Building Decarbonization Implementation Concept

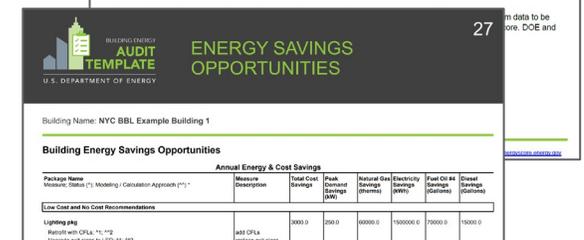
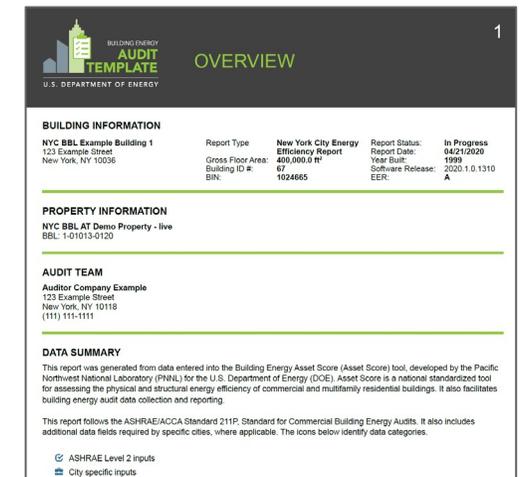


Federal Building Decarbonization Implementation Tool



Introduction to Audit Template Tool

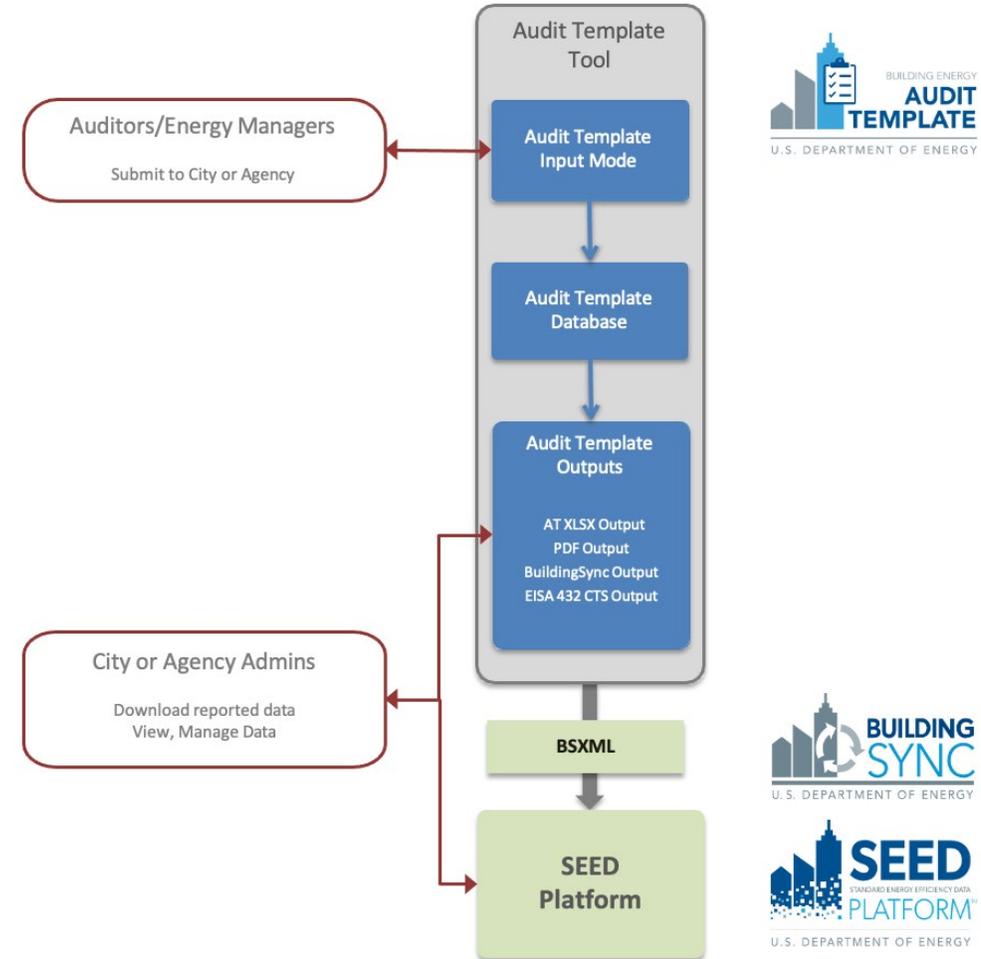
- DOE free, web-based tool to collect, store and report building energy audit data (ASHRAE Level 2, based on Standard 211)
- Produces an audit data report which includes calculated tables outlining building energy use and energy efficiency measures
- Has customized templates to support different agencies that have different data collection and reporting requirements



Audit Template was developed by PNNL for DOE

Federal Building Decarbonization Implementation Tool

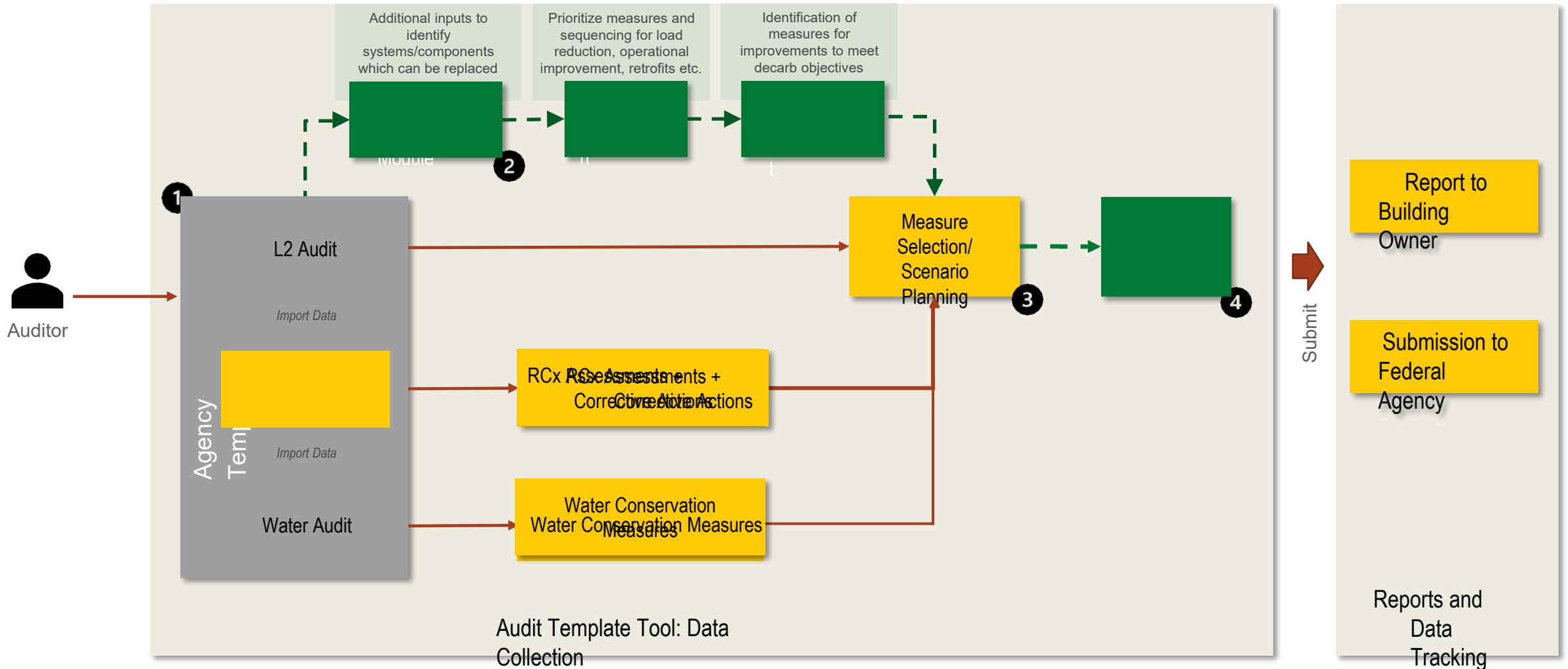
- The **Audit Template** tool provides the base functionality needed in a building decarbonization tool
 - ✓ Audit Template database
 - ✓ Secure data
 - ✓ Federal template based on EISA 432 requirements
 - ✓ Several ways to output data



<https://buildingenergyscore.energy.gov/resources>

**Current Audit Template
Workflow**
(Source: PNNL)

Audit Template Proposed Decarbonization Capabilities



- - - - - → Decarbonization Assessment Module (Proposed)
- - - - - → Typical Audit Process

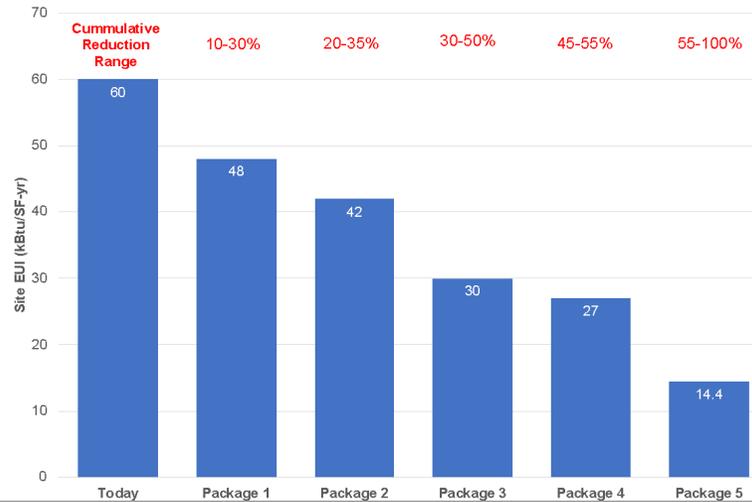
Federal Building Decarbonization Implementation Tool

- Audit Template tool input data
 - ✓ Input data collection allows automatic import of data from ENERGY STAR Portfolio Manager data and monthly metered data for each utility
 - ✓ Additional input data capability proposed
 - ❖ Prioritization Tool asset input data
 - ❖ Systems/operations contributing to emissions
 - ❖ Equipment useful life and year of manufacture
 - ❖ Utility service provider (to identify grid emissions intensity)
 - ❖ Additional information on building operational schedules
 - ❖ Estimated operational GHG emissions (Scopes 1&2), and emission reduction targets
 - ❖ Evaluation of solar readiness (space availability for rooftop solar or on-site solar)

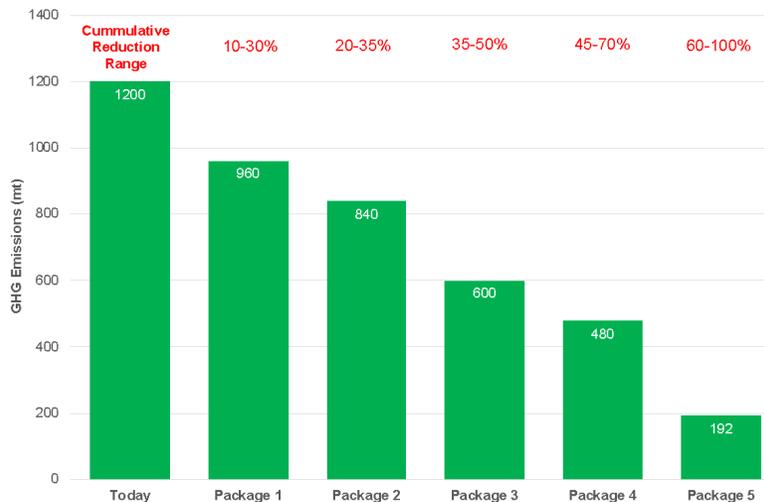
Federal Building Decarbonization Implementation Tool

Sample Output

Potential Site Energy Use Reductions



Potential Annual GHG Emission Reductions



Package 1 – Deep Optimization Measures

Measure	Description	Health & Comfort
1-E1	Replace worn out weather stripping at exterior doors: Weather stripping helps to reduce the amount of outside air infiltration into the space between the door and the frame. Over time, this weather stripping develops gaps due to normal wear and tear. By replacing worn out weather stripping, energy savings can be realized due to reduced infiltration and, thus, reduced load on the building HVAC equipment.	+
1-E2	Reduce envelope leakage: Energy savings can be achieved by identifying significant air leaks in the building envelope and sealing them. Specific methods of sealing will vary depending on the component(s) being sealed. In general, large gaps should be sealed with structural material before applying caulk. Tools to help identify air leaks include as-built drawings and an infrared camera.	+
1-L1	Calibrate exterior lighting photocells: Photocells that are out of calibration could be causing energy waste or unsafe conditions. If the lights are operating beyond nighttime hours, when they don't need to be operating, energy is being wasted.	
1-M1	Re-enable supply air temperature reset: For multi-zone air systems, whether CAV or VAV, automatically changing the supply air temperature setpoint to better match the needs of the zones is typically more energy efficient than maintaining a constant setpoint, due to reduced amount of zone reheat (simultaneous heating and cooling). The supply air temperature setpoint is typically reset based on an indication of zone demand - e.g., average difference between zone temperature and zone temperature setpoint.	
1-M2	Test and fix chilled and heating water coil valves: Water control valves are a common component of a facility's HVAC system. These valves are typically either open/closed, or modulating. Chilled and heating water systems usually include water control valves as a means of varying flow through a heat exchanger (coil) in response to demand. The actuators for these valves should have sufficient seating force to close the valve completely when commanded to do so against the system's pressure. Over time, valves and actuators can degrade to the point that they are no longer capable of closing completely. When this happens, a small amount of water can leak by to the coil, and this can create an unnecessary heating or cooling load on the system which results in energy waste. More specifically, simultaneous heating and cooling could be taking place. Periodically testing the valves and actuators can identify leaky valves, and corrective action can then be determined and conducted to eliminate the related energy waste.	+
1-M3	Implement a night purge cycle: A night purge cycle is a method of cooling the building at night using 100% outside air (no mechanical cooling), to pre-cool the building for the next day. The night purge cycle typically compares outside air temperature to average indoor temperature and operates for a couple of hours just before the occupied period when the conditions are beneficial.	+

- Audit Template tool additional output data
 - ✓ Offer options for users to tailor results based on building knowledge and their own assessments of feasibility of implementation, etc.
 - ✓ Include a building system replacement timeline based on energy audit input data and using ASHRAE equipment life expectancy database
 - ✓ Include building decarbonization sequencing guidance:
 - ❖ Ideal sequencing
 - ❖ Space turnover
 - ❖ Existing building system optimization
 - ❖ Existing building system end of life

Federal Building Decarbonization Task Group - Recommendations

1. GSA and other federal agencies should utilize the proposed **building prioritization methodology, based on the proof-of-concept spreadsheet tool**, to screen all significant and long-term owned assets for decarbonization opportunities.
 - a. GSA should request that DOE support the integration of the building prioritization tool into the DOE SEED platform.
 - b. GSA should incorporate the use of the building prioritization tool as a means of complying with EO 14057 Implementing Instructions and the Inflation Reduction Act.
2. GSA and other federal agencies should utilize the proposed **building decarbonization project implementation methodology** for existing buildings.
 - a. GSA should request that DOE support the further development of the existing DOE Building Audit Template tool to provide building decarbonization implementation recommendations for existing buildings as outlined herein.
 - b. The tool should utilize building asset data, energy audit data, and other building information to identify a building decarbonization plan with decarbonization measures, organized into packages, and phased over time to achieve operational net zero emissions goals.
3. GSA should expand data collection on smaller (non-covered) facilities and perform EPA Portfolio Manager analysis so they can be analyzed using the building prioritization and project implementation process.

Federal Building Decarbonization Task Group – Next Steps

The Committee recommends that the Federal Building Decarbonization Task Group extend its work into 2023 with a focus on **building and campus electrification**:

- A procurement policy with supporting guidance has the potential to drive the **replacement of fossil-fuel heating equipment with electric alternatives** (e.g., heat pumps) at scale, especially in widely distributed small buildings with packaged HVAC equipment
- After a preliminary assessment of potential improvement measures earlier this year, the task group suggests a more **detailed study of opportunities to decarbonize district energy plants and combined heat and power plants**, which are significant emitters in the federal building portfolio
- There is also an opportunity to **update existing energy analysis tools** (e.g., DOE's Building Efficiency Targeting Tool for Energy Retrofits (BETTER) tool) to incorporate building electrification and decarbonization measures