



# GBAC Federal Building Decarbonization Task Group

November 16<sup>th</sup>, 2021

# Federal Building Decarbonization

## Agenda

### Task Group Overview

- Tim

### Sub-team #1 – Key Principles

- Victor

### Sub-team #2 – Barriers and Solutions

- Kevin, Fernando, David

### Sub-team #3 – Decarbonization Playbook

- Kent, Clay

### Task Group Recommendations/Next Steps

- Clay

### Discussion

- Tim

# Federal Building Decarbonization Participants

## GBAC Members

Clay Nesler – Co-Chair, World Resources Institute

Timothy Unruh – Co-Chair, NAESCO

Fernando Arias – Clark Construction

Nicolas Baker – DOE (designee of Leslie Nicholls)

Kevin Bates – Sharp Development

David Kaneda – IdeAs Consulting

Victor Olgyay – RMI

Kent Peterson – P2S Engineering

Jane Rohde – JSR Associates

## GSA Support

Kinga Porst Hydras

Michael Bloom

Meredith Holland

# Federal Building Decarbonization Participants

## GSA

Krystal Brumfield – OGP

Kevin Kampschroer – OFHPGB

Michael Bloom – OFHPGB, Designated Federal Officer

Kinga Porst Hydras – OFHPGB

Ken Sandler – OFHPGB

Meredith Holland – OFHPGB (c)

Lariza Sepulveda – PMA/OFHPGB

Lance Davis – PCAE

Sonal Larsen – Office of the Administrator

## GSA OSC

Teressa Wykpiwz-Lee

Drew Jack

Amy Chiou (Public Engagement)

## DOE

Nael Nmair

Jay Wrobel

# Federal Building Decarbonization Participants

## Observers

Cara Carmichael – RMI

Nick Carrillo – Western Wall and Ceiling Contractors  
Association (WWCC)

Dannie Diionno – Branch Pattern

Ralph DiNola – NBI

Jake Jackson – Pioneer Public Affairs

Greg Johnson – American Wood Council

Laurie Kerr – NYSID

Robert Klugh – Martin Bros & WWCCA

Christopher Lindsay – International Association of Plumbing  
and Mechanical Officials (IAPMO)

Jeffrey Mang – Policy Consultant

Alexi Miller – NBI

Heather Powen – Martin Bros

Robert Simpson – Signatory Wall and Ceiling Contractors  
Alliance

Jessica Shipley – Regulatory Assistance Product (RAP)

Ashley Stewart – Steptoe & Johnson

# Federal Building Decarbonization Charter/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, including embodied carbon of materials.

Decarbonization can provide additional benefits such as health, water conservation, grid reliability and resilience. Primary focus will be on existing buildings and actions that can be taken in the short term (3-5 years).

# Federal Building Decarbonization Activities

## Presentations

- ASHRAE Task Group on Building Decarbonization
- Secretary Granholm at the Better Buildings
- America's Zero Carbon Action Plan
- NYSERDA Carbon Neutral Building Roadmap
- GSA Decarbonization Strategy and Plans
- National Roadmap for GEBs
- GSA Sustainability Scorecard
- NBI Zero Codes Presentation

## Sub-teams

- Key Principles for Building Decarbonization
- Barriers and Solutions
- Building Decarbonization Playbook

# Key Building Decarbonization Principles

**GSA GBAC  
Decarbonization Task Group**

**By: Victor Olgyay, Lois Vitt Sale, Cara  
Carmichael, Laurie Kerr**

**November 16<sup>th</sup>, 2021**

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1. Context
2. Purpose
3. Definitions
4. Principles



# Context: Relevant Targets and Executive Orders

Most important and relevant	Source/Link
<p data-bbox="56 515 206 582">GSA</p> <p data-bbox="257 379 794 418">“GSA will lead by example” ...</p> <ul data-bbox="257 429 1926 568" style="list-style-type: none"> <li>• “...Federal Building Decarbonization Task Group....”</li> <li>• “...GSA goals of ... the <u>elimination of fossil fuel use</u> in newly constructed facilities and facilities undergoing major modernization and achieving net zero emissions by 2030.”</li> </ul>	<p data-bbox="2015 379 2435 454"><a href="#">GSA Press Release May 17, 2021</a></p>
<p data-bbox="257 668 1900 758">“Today, the U.S. General Services Administration (GSA) announced its commitment to <u>100 percent renewable electricity sources</u> for the federal real estate portfolio by 2025...”</p>	<p data-bbox="2015 668 2435 743"><a href="#">GSA Press release, April 22, 2021</a></p>
<p data-bbox="257 851 639 889">Economy wide targets:</p> <p data-bbox="257 901 1964 1039">“Today, President Biden will announce a new target for the United States to achieve a <u>50-52 percent reduction from 2005 levels in economy-wide net greenhouse gas pollution in 2030</u> – building on progress to-date and by positioning American workers and industry to tackle the climate crisis...”</p> <p data-bbox="257 1051 1829 1140">“...The United States has set a goal to reach <u>100 percent carbon pollution-free electricity by 2035...</u>”</p>	<p data-bbox="2015 851 2435 926"><a href="#">Target announced by Biden, April 22, 2021</a></p>
<p data-bbox="257 1248 1921 1338">“...Environmental Protection Agency Issues Final Rule to <u>Reduce Emissions of Hydrofluorocarbons</u> by 85% over 15 Years...”</p>	<p data-bbox="2015 1248 2435 1323"><a href="#">The White House Fact Sheet Sept 23, 2021</a></p>

All Federal Buildings

# Purpose Statement

- **To reduce the impacts of climate change and hold to 1.5C increase, we must decarbonize our buildings.**
- **By implementing visionary decarbonization efforts, GSA will lead by example.**
- **These principles shape federal decarbonization activities, prioritizing the next 5 years.**
- **These principles build on the GSA commitment of 100% renewable electricity sources for the federal real estate portfolio by 2025.**
- **These principles could be used to inform:**
  - P100 decarbonization updates
  - Project selection and funding rubrics for GSA and others
  - Decarbonization strategies and planning efforts
- **These principles apply to new and existing buildings, across all federal agencies (including DOD) and across all use types**

# Definitions

**There are 2 considerations to building decarbonization – Operational and Embodied.**

*Operational carbon* pertains to carbon emissions from operations, including electricity and gas use, and refrigerants)

*Embodied carbon* pertains to the carbon emissions from the manufacturing, transportation, installation, maintenance, and disposal of building materials.

*Most of our focus is on operational carbon, since the federal building portfolio is almost entirely existing buildings.*

## **What is a Carbon-Neutral Building?**

*“A carbon neutral building is one where the design, construction, and operations do not contribute to emissions of greenhouse gases that cause climate change.” NYSERDA Carbon Neutral Buildings Roadmap*

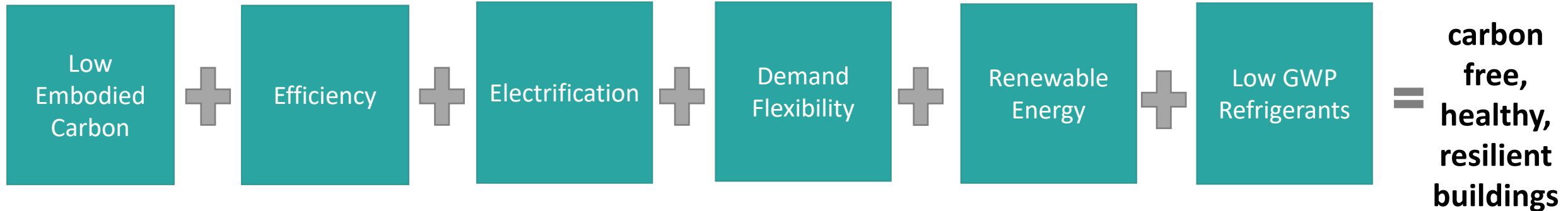
## **What is a Zero Carbon-Ready Building?**

*A Zero-Carbon Ready building is a building that has implemented energy efficiency and has a plan to implement full electrification, demand flexibility and add renewable generation at key trigger events (e.g. equipment replacement or roof replacement) – Refer to [RMI/ULI’s Zero Over Time](#) concept paper*

# The Recipe for Carbon-Free Buildings

Low  
Embodied  
Carbon

Zero Operational Carbon



Contextual and Infrastructure Factors

Industrial emissions  
(Raw materials extraction,  
processing, manufacturing  
and transportation)

Carbon-Free Mobility  
(Managed EV charging and  
Public Transportation)

Carbon-Free Electric Grid

# Federal Building Decarbonization Principles

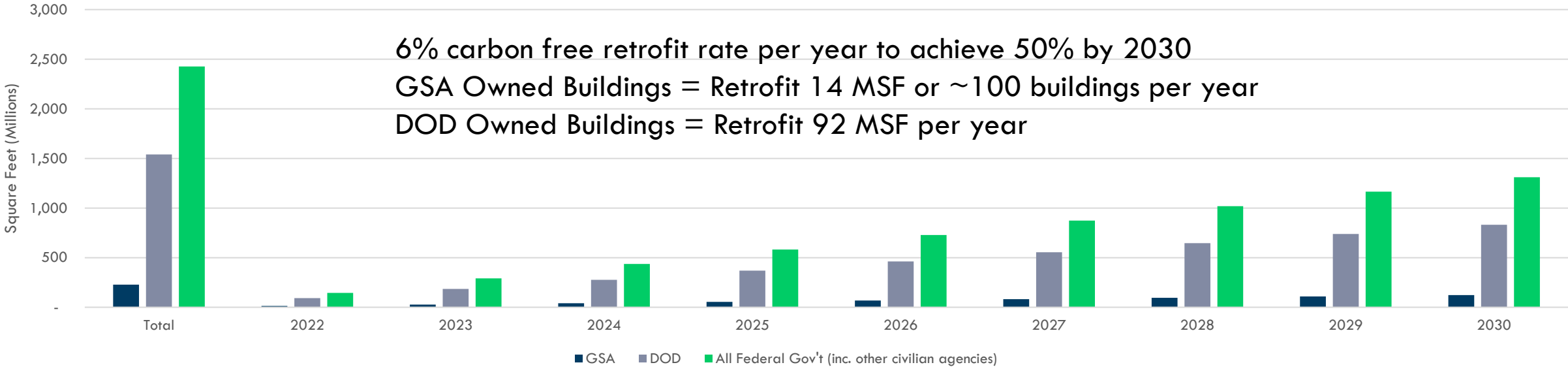
To decarbonize our federal buildings and cut GHG emissions in half by 2030 to meet Biden administration targets and limit warming to 1.5 C, we must...

- 1. Accelerate the rate of carbon-free building retrofits.**
- 2. To optimize for cost and impact, plan comprehensively to include efficiency, electrification, demand flexibility and solar/storage. Loading order matters, and varies with location and existing conditions.**
- 3. Maximize the use of onsite renewable generation**
- 4. Include embodied, refrigerant and EV charging emissions.**
- 5. Support resilience, health and comfort.**
- 6. Support system wide optimization to avoid unintended consequences.**
- 7. Support equal opportunity job creation and training underpinned by equitable procurement practices.**

# 1. Accelerate the rate of carbon-free building retrofits.

Retrofit 6% of the federal portfolio each year between 2022 and 2030 to operational zero carbon and operational zero carbon-ready standards to reach 50% reduction by 2030.

GSA, DOD and Federal Building Cumulative Retrofits Over Time

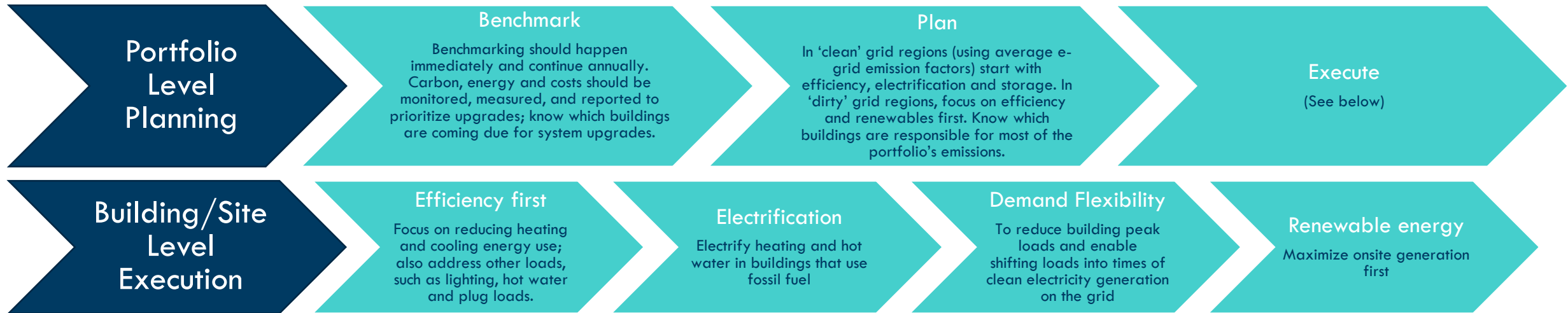


\* Includes all buildings (even small ones). Does not include 'leased' or 'otherwise' buildings. Does not include 'structures' or land.

\*Source: [FY 2019 Federal Real Property Profile](#)

## 2. To optimize for cost and impact, plan comprehensively to include efficiency, electrification, demand flexibility and solar/storage.

### Key Process Steps:



### Key Considerations:

1. Loading order matters and varies with location and existing conditions.
2. Improvements should include both capital and operational expenses and savings (and should be lifecycle cost effective, per P100) and include the social cost of carbon.
3. Zero carbon retrofits should coincide with upgrade cycles where possible - each building should have a decarbonization roadmap including vulnerabilities and solutions to align around deferred maintenance and end of equipment life. (e.g. Facilities Conditions Assessments)

# 3. Maximize onsite renewable generation before considering Renewable Energy Certificates.

## 1. Maximize onsite renewable production (and storage).

This includes installing solar on or adjacent to the building or load. It is important since it lowers the demand for electricity at the source, potentially reducing infrastructure for transmission and distribution and associated line losses. Coupling solar with storage enhances the value proposition and solar utilization. Further, if connected to microgrids, they can provide resilience benefits during grid outages. Retain RECs for onsite solar.

### a. Next, consider green power purchasing through your utility.

Utility scale green power programs, or community solar, are usually generated within the same grid region as the building.

### b. Lastly, consider renewable energy procurement and Bundled Renewable Energy Certificates (RECs).

Renewable energy procurement, including 24x7 hourly matching strategies which align use with renewable production, play an important and growing role in decarbonizing power systems. However, costs increase significantly for higher levels of load matching and near-term emissions reductions depend on the regional grid mix and how storage resources are operated. \* If purchasing renewable energy through a Power Purchase Agreement, retain RECs.



# 4. Include embodied, refrigerant and EV charging emissions.

1. **Embodied carbon:** Invest in creating a knowledge base.
  - a. **Establish baselines:** Assess the embodied carbon of new construction, existing buildings, and renovations in the major types of federal buildings.
  - b. **Do pilot projects:** Invest in pilot projects that reduce the embodied carbon of new construction and renovations. Publish results and promote best practices learned.
  - c. **Create policies:** Aim to reduce embodied carbon in new construction and renovations by a minimum of 40% below baselines as per the federal building stock or Carbon Leadership Forum data as appropriate, reducing that threshold over time. Extend the lifespan of existing buildings to reduce the need for new buildings.
2. **Refrigerants:** Reduce refrigerant need, use low GWP refrigerants, reduce refrigerant charge, mitigate leakage, and enhance recovery.\*
3. **Transportation:** Ensure GSA buildings can support EV charging and ensure charging is managed.
4. **Water:** Minimize water use in buildings to reduce treatment and pumping related emissions.



\* Source: Integral Group, 2020: [Refrigerants + Environmental Impacts Best Practices Guide](#)

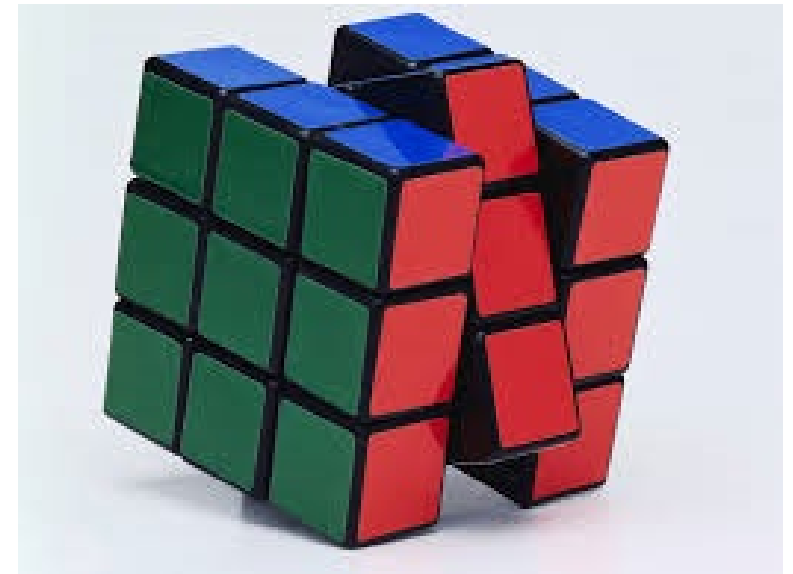
# 5. Support resilience, health and comfort.

1. Consider incorporating resilience strategies in all buildings at the time of retrofits. Especially by designing to withstand increasing and more extreme weather events, which are the new norm, per [IPCC 6<sup>th</sup> Assessment Report](#).
2. Thermal comfort should leverage an expanded suite of parameters (beyond just air temperature, but also to include mean radiant temperature, humidity, air velocity, etc.)
3. Ensure 1-2 days of passive survivability (limited mission fulfilment functionality with no active energy input to maintain comfort criteria, per P100. For residences and critical facilities, aim to provide a minimum of two days survivability if the grid goes down.



## 6. Support system wide optimization to avoid unintended consequences.

1. Decarbonization should avoid creating a bigger problem for the grid, subsequently increasing costs for all building owners and occupants. Solutions should account for the regional energy mix.
2. Interventions should be planned proactively, creating a roadmap to a zero-carbon portfolio – don't do something that will prevent or negate future options.
3. Validate and align building/site decarbonization plans or roadmap based on utility plans.



## 7. Support equal opportunity job creation and training underpinned by equitable procurement practices.

1. New building selection should be encouraged in locations where it will bring benefits to the local community, including supporting public transportation.
2. Design, retrofit, procurement, implementation, etc. should support diversity, equity and inclusion.



# SUMMARY OF BARRIERS & SOLUTIONS TO DECARBONIZATION FOR EXISTING & NEW BUILDINGS

GSA Advisory Committee - Decarbonization Task Group



Image Source: SurfaceMag

## Meet the Team:



**Kevin Bates**

President  
Sharp Development  
Company



**Fernando Arias,**  
Assoc. AIA, LEED AP BD+C

Director of Sustainability  
Clark Construction Group



**David Kaneda,**  
PE, FAIA, LEED Fellow

Principal  
IDeAs Consulting

# Embodied and Operating Carbon: Building Life Cycle

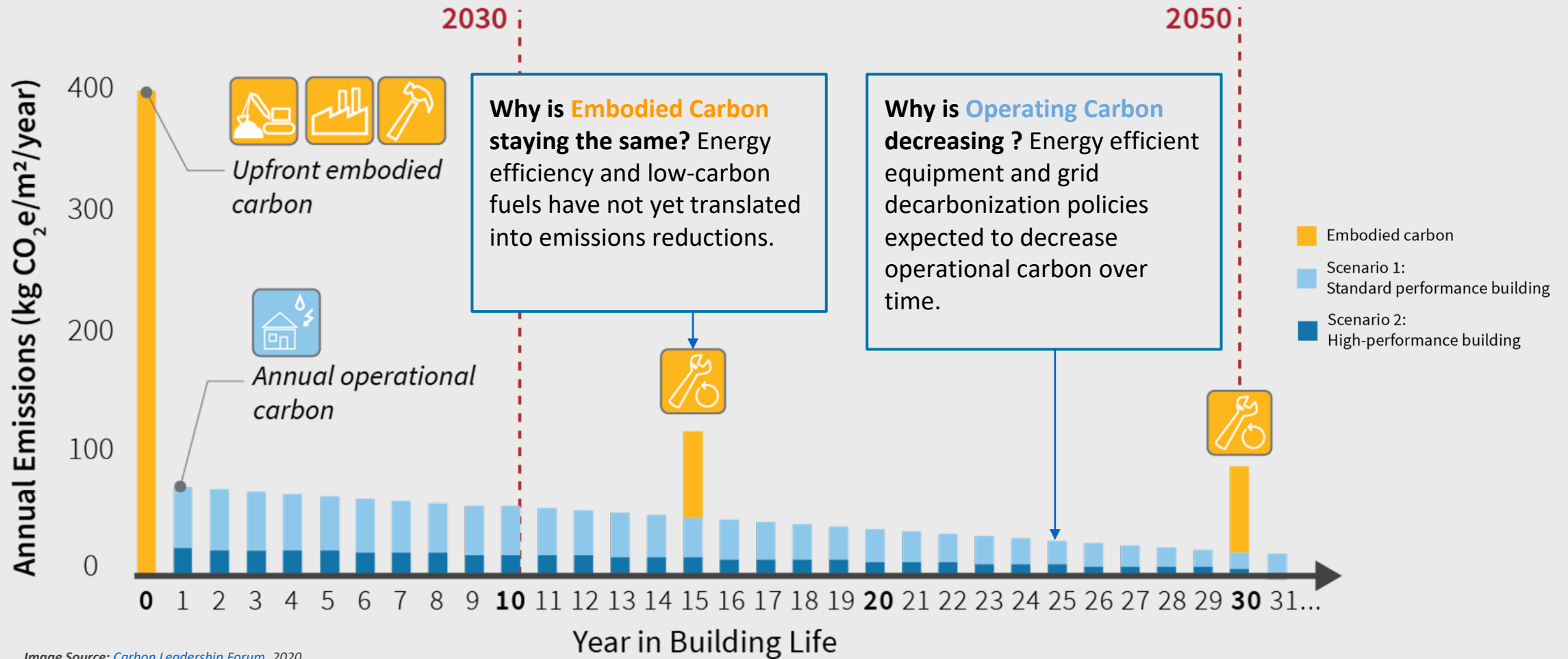


Image Source: [Carbon Leadership Forum](#), 2020

# Appendix to the Primary Barriers & Solutions to Decarbonization for Existing & New Buildings

Capital Access & Investments: ROI, NPV, First Cost/Operating Cost			
Barriers		Solutions	
Embodied	Operating	Embodied	Operating
<ul style="list-style-type: none"> <li>Some financial decisions are being made based on ROI, vs. impact on asset value.</li> <li>A reduction in energy is easier to value than a reduction in carbon.</li> <li>Materials with low embodied carbon may be more costly, with increasing ROI.</li> <li>Investment decisions are sometimes made on a short-term basis.</li> <li>There is currently no income/value stream associated with embodied carbon.</li> <li>Lack of demand from customers for low-carbon products.</li> </ul>	<ul style="list-style-type: none"> <li>Financing options are not efficient.</li> <li>Regional differences in first cost of power and RECs along with building differences may take the NPV below the first cost.</li> <li>Storage is relatively expensive &amp; not commonly installed.</li> <li>Despite a potentially high ROI, meaningful up-front capital will be required.</li> </ul>	<ul style="list-style-type: none"> <li>Assigning a "Carbon Score" to each building.</li> <li>Companies are beginning to ask vendors for its ESG compliance including carbon footprint, and considering this as part of vendor selection. This trend may create value for embodied carbon.</li> <li>ESG investors are starting to recognize low-carbon buildings as a lower risk investment, with higher returns than conventional buildings.</li> </ul>	<ul style="list-style-type: none"> <li>A holistic design mentality can make many solutions cost-neutral.</li> <li>The cost of many products and technologies are projected to come down. GSA demand will help accelerate this.</li> <li>Projects with stronger valuations will help support the weaker ones when looked at as a portfolio.</li> <li>Due to higher returns at lower risk (low embodied), lending community gives value to sustainable improvements and lends toward first cost.</li> </ul>

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Capital Access & Investments: Bonds, Green Bank, Appropriations/Policy			
Barriers		Solutions	
Embodied	Operating	Embodied	Operating
<ul style="list-style-type: none"> <li>Lack of clear risk indicators (cost of Carbon?)</li> <li>Banks are currently underwriting ZNE / carbon.</li> <li>Neutral asserts the same as conventional design.</li> <li>Appraisers are not giving value to sustainable improvements.</li> <li>Will funding be appropriated if an economic return is hard to justify, despite a strong carbon reduction?</li> </ul>	<ul style="list-style-type: none"> <li>Source of equipment (energy savings) will vary from project to project.</li> <li>Lenders are not recognizing the value to its collateral that ZNE, more resilient carbon neutral buildings provide.</li> <li>What criteria will need to be met to be awarded funding? ROI thresholds, carbon reduction, over what time frame, etc.?</li> </ul>	<ul style="list-style-type: none"> <li>Green Bonds would help certify "First Cost" on a more reasonable ROI.</li> <li>Source of equipment would need to be tied to Operating. Savings in lieu of carbon tax savings.</li> <li>A Green Bond, like an SBA loan guarantee, could be utilized by the private sector that acts as a landlord to GSA.</li> <li>The mentality of a triple bottom line outcome (P&amp;L) must be part of the value proposition.</li> <li>The private sector is already beginning to do this.</li> </ul>	<ul style="list-style-type: none"> <li>The Appraisal Institute's "Green Registry" and "Green Addendum" will help lenders get more "First Cost" dollars out.</li> <li>Low-cost Green Bonds will help enable acceptable ROI's in areas with inexpensive power (which is often "dirty" / high carbon power) furthering the impact.</li> <li>A carbon neutral building is more resilient while stabilizing (locking) tenant operating costs, leading to stronger (more valuable) collateral for the banks to lend against.</li> <li>Take a long-term approach, and if the GSA looks at its portfolio, the higher return projects will justify the tougher (lower ROI) projects when averaged out.</li> </ul>

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Workforce & Building Technologies: Skill Set Availability			
Barriers		Solutions	
Embodied	Operating	Embodied	Operating
<ul style="list-style-type: none"> <li>Lack of skilled labor relative to procurement, delivery, execution of low carbon materials.</li> <li>Demand may create a shortage of skilled labor where it currently exists.</li> <li>Skilled, permitted technicians in short supply.</li> </ul>	<ul style="list-style-type: none"> <li>Inertia (GSA project managers resist change to new technologies).</li> <li>Demand may create local shortages of skilled labor.</li> <li>Lack of skilled labor relative to design, implementation, operation and maintenance of energy &amp; storage systems along with BAS, etc.</li> </ul>	<ul style="list-style-type: none"> <li>Create educational resources for local labor.</li> <li>Certified training and placement workforce programs to add 25% capacity into the economy.</li> <li>Establish internal GSA procurement advisory team to assist Government PM staff guidance on implementing P100 requirements in alignment with decarbonization strategies.</li> </ul>	<ul style="list-style-type: none"> <li>Leadership from the top will be needed to help change PM's habits and mindset.</li> <li>Certified training and placement workforce programs to add 150% capacity into the economy.</li> <li>Establish internal GSA procurement advisory team to assist Government PM staff guidance on implementing P100 requirements in alignment with decarbonization strategies.</li> </ul>

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Workforce & Building Technologies: Materials Supply Chain			
Barriers		Solutions	
Embodied	Operating	Embodied	Operating
<ul style="list-style-type: none"> <li>Locations where local materials are N/A not readily available.</li> <li>Make information on where equipment/materials are sourced from available.</li> </ul>	<ul style="list-style-type: none"> <li>Locations where local materials are N/A</li> </ul>	<ul style="list-style-type: none"> <li>Incentivize and/or require subcontractors to use vehicle telematics technologies, synchronized to maps/programs to show lowest carbon transportation routes and mode (truck, rail, etc.). (i.e. Google is doing to GPS routing).</li> <li>Partner with technology providers that operate tools to streamline carbon in delivery and implement such tools to track embodied carbon.</li> <li>Adopt recommendations from the "GSAC Policy Recommendations for Procurement of Low Embodied Emissions and Carbon Materials by Federal Agencies" including use of materials with EPDs and verifiable Global Warming Potential (GWP) analysis.</li> <li>Update the GSA Federal Contractor Climate Action Scorecard metrics to include updated targets and establish new scorecard metrics that track whether contractors are tracking GSA project-specific CO2 emissions.</li> </ul>	<ul style="list-style-type: none"> <li>N/A</li> </ul>

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Workforce & Building Technologies: Carbon Management and Technology			
Barriers		Solutions	
Embodied	Operating	Embodied	Operating
<ul style="list-style-type: none"> <li>N/A</li> </ul>	<ul style="list-style-type: none"> <li>Subcontractor operating emissions during construction and renovations not easily captured.</li> <li>Need to introduce carbon reduction calculations into building controls packages.</li> <li>Need for integration of BMS, lighting, PV and battery system controls to be integrated.</li> <li>Need to incorporate best practice EV charging strategies into building design.</li> <li>Availability of appropriate building management systems and cost (generally smaller medium sized projects).</li> <li>Technology - Data Security can present unfamiliar technologies that can potentially increase hacking risks.</li> <li>BMS technologies proprietary and not interoperable across all GSA facilities.</li> </ul>	<ul style="list-style-type: none"> <li>N/A</li> </ul>	<ul style="list-style-type: none"> <li>Incentivize and/or require subcontractors to track and report operational emissions during construction and renovations, with a target to reduce emissions during their contract work.</li> <li>Grid connected energy management controls to maximize time of use and peak load flexibility.</li> <li>Software to track carbon content of local grids to inform fuel mix procurement.</li> <li>Electric Vehicles and bi-directional EV charging equipment.</li> <li>Open source software may accelerate tech upgrades.</li> <li>Techology - Data Security training and coaching, along with better data security software and procedures.</li> <li>Isolate the range of BMS technologies that include interoperability or push data access API.</li> </ul>

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Climate Zones & Building Performance Design: Geometry, Size, Material and Equipment			
Barriers		Solutions	
Embodied	Operating	Embodied	Operating
<ul style="list-style-type: none"> <li>Embodied carbon in new buildings represent about 13% of operational carbon.</li> <li>Building materials, especially envelope/curtain wall assemblies, shipped long distances add CO2 in transport.</li> <li>Replacement of worn equipment increases embodied carbon.</li> <li>Loss of economies of scale for smaller projects.</li> </ul>	<ul style="list-style-type: none"> <li>Huge variations in buildings: <ul style="list-style-type: none"> <li>New vs. existing</li> <li>Large vs. small</li> <li>Different orientations and geometries</li> </ul> </li> <li>Poor envelope design and material selection decreases building energy performance.</li> <li>Gas equipment often costs less to purchase and operate than electric equipment.</li> <li>First cost of high performance energy related systems is higher.</li> </ul>	<ul style="list-style-type: none"> <li>Educate GSA staff on embodied carbon. Reuse existing building when possible, design buildings for flexible use, use low carbon materials such as low carbon concrete, re-use, recycled steel, and mass timber, consider open ceilings and floor plans to minimize building materials.</li> <li>Source building materials locally when feasible.</li> <li>Consider design to provide better flexibility for use changes, durability, deconstruction and end-of-life use of materials.</li> <li>Consider group purchases for small projects.</li> </ul>	<ul style="list-style-type: none"> <li>Utilize an integrative design process and experienced teams to optimize efficiency. Publish successful case studies of various building types and locations.</li> <li>Require high performance envelopes and detailed energy models.</li> <li>Require all electric buildings.</li> <li>Incorporate life cycle assessment and carbon impacts into budget and financial decisions.</li> </ul>

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Climate Zones & Building Performance Design: Location			
Barriers		Solutions	
Embodied	Operating	Embodied	Operating
<ul style="list-style-type: none"> <li>Lack of industry awareness of the benefits of local sourcing.</li> <li>Local grids may not be adequate for all electric transportation.</li> </ul>	<ul style="list-style-type: none"> <li>Various climate zones have challenging weather and temperature conditions.</li> <li>Locations where temperature, noise and air quality discourage natural ventilation.</li> <li>Building locations with poor solar access.</li> <li>Insufficient renewable energy resources.</li> </ul>	<ul style="list-style-type: none"> <li>Work with design professionals to communicate the benefits of local sourcing. Encourage local manufacturers to provide information for local designs.</li> <li>Prioritize locally-based envelope/curtain wall assemblies.</li> <li>Add incentives based on "bio-based fuel" or EV delivery.</li> </ul>	<ul style="list-style-type: none"> <li>Utilize an integrative design process and teams experienced with high performance design to optimize for local climate.</li> <li>Use DOAS, HRV's, and economizer cycles with high quality filters to introduce outdoor air.</li> <li>Consider ground mount solar and portfolio wide approaches.</li> <li>Use energy storage to reduce grid demand when renewables are unavailable.</li> <li>Minimize EUI and mandate generation of carbon free energy at grid level, incentivize renewables, resilience / microgrids.</li> </ul>

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Climate Zones & Building Performance Design: Energy Markets, Codes and Standards			
Barriers		Solutions	
Embodied	Operating	Embodied	Operating
<ul style="list-style-type: none"> <li>Dirty grids with low cost energy supply power for manufacturing increasing embodied carbon.</li> <li>Fossil fuel based transportation of materials increases embodied carbon in building materials.</li> <li>Few if any codes regarding embodied energy.</li> </ul>	<ul style="list-style-type: none"> <li>Codes do not address embodied carbon and items such as FAR, height limitations make installation of solar difficult.</li> <li>Availability of low cost, questionable RECs.</li> <li>Lack of available utility scale renewable energy or energy storage.</li> <li>Developers resist using new technologies that could reduce carbon emissions.</li> <li>Local grids with carbon content below the national average make onsite renewables less effective for reducing carbon emissions.</li> </ul>	<ul style="list-style-type: none"> <li>Federal support to more rapidly decarbonize electrical grids and move manufacturing to 100% electrical.</li> <li>Federal support shipping to 100% electrical.</li> <li>Train code officials on issues regarding building codes, and incentivizing the embodied carbon of materials used in buildings and calculating and incentivizing the embodied carbon used in delivering materials to sites.</li> </ul>	<ul style="list-style-type: none"> <li>Encourage the use of "smarth codes" to find new methods to reduce carbon emissions.</li> <li>Develop more rigorous vetting of RECs and benefits.</li> <li>Use "time of use" and "demand" charges to encourage on-site installed solar and storage.</li> <li>Provide case studies of successful carbon reduction strategies.</li> <li>Encourage ISO to increase use of renewables. Use on-site energy efficiency and renewables to minimize carbon emissions.</li> <li>Consider use of energy storage systems and bi-directional EV charging to minimize carbon emissions, add to the P100.</li> </ul>

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# Summary:

## Capital Access & Investments



- **Barrier:** It may be hard to justify appropriations for low economic returns, despite a strong carbon reduction.
- **Solution:** Taking a “portfolio-wide approach” will enable GSA’s high value projects to support those with weaker returns.
  
- **Barrier:** Banks are underwriting carbon neutral assets the same as conventional designs.
- **Solution:** GSA should advise its private sector landlords to utilize the Appraisal Institutes “Green Addendum” and “Green Registry” to enable them to increase loan dollars to pay for low-carbon improvements.
  
- **Barrier:** There is currently no income or value stream associated with embodied carbon, as a result appraisers are not giving value to sustainable & low-carbon improvements.
- **Solution:** A Green Bank, similar to an SBA loan guarantee, and Green Bonds could be utilized by GSA’s private sector landlords to help satisfy “First Costs” more cost effectively.
  
- **Barrier:** There are no baseline metrics to value and budget for the social cost of carbon.
- **Solution:** Quantify embodied carbon and assign a score or grade to a building’s embodied footprint.

# Summary:

## Workforce & Building Technologies



- **Barrier:** A shortage of skilled industry professionals that understand how to design, build, and operate lower-carbon existing buildings.
- **Solution:** Establish in-person and virtual trainings to industry professionals in how to design, build, and operate lower-carbon existing buildings.
  
- **Barrier:** A shortage of non-structural materials for renovations with product-specific EPDs that facilitate carbon accounting for the project.
- **Solution:** Adopt recommendations from the “GBAC Policy Recommendations for Procurement of Low Embodied Energy and Carbon Materials by Federal Agencies”
  
- **Barrier:** GSA PM staff resistant to adopting lower-carbon materials and management processes.
- **Solution:** Engage senior GSA leadership to establish pilot projects that will persuade broader adoption of key concepts.
  
- **Barrier:** Subcontractor operating emissions during construction and renovations not easily captured.
- **Solution:** Update the GSA Federal Contractor Climate Action Scorecard metrics to incentivize and/or require subcontractors to track and report operational emissions during construction.

# Summary:



## Climate Zones & Building Performance Design

- **Barrier:** Variation in a building's shape and climate zone, affect the ability to reduce the EUI.
- **Solution:** Use an integrated design approach sensitive to shape and climate zones to minimize EUI. Encourage on-site renewables to further reduce EUI. Publish successful case studies.
  
- **Barrier:** Lack of local utility-scale renewables/storage in many locations, make carbon emissions reduction challenging. Utility rate differences effect paybacks for on-site renewables/storage.
- **Solution:** Encourage ISO's to invest in renewables and storage. Where grid emissions factors are above average, utilize efficiency and renewables. Where emission factors are below average, increase focus on efficiency, electrification and energy storage. Provide incentives for renewables and storage.
  
- **Barrier:** Current building codes often restrict FAR and heights, making on-site renewable installations difficult and these codes rarely address embodied carbon.
- **Solution:** Encourage the use of local "stretch codes" to test decarbonization strategies. Convene building code officials to discuss how to integrate embodied carbon into building codes.
  
- **Barrier:** Embodied carbon represents a significant amount of carbon emissions in buildings.
- **Solution:** Educate GSA staff on embodied carbon and adaptive building reuse, while using low carbon materials, and designing buildings that last long and can serve multiple uses.

# Federal Building Decarbonization

## Retrofit Playbook Objectives

- Provide practical guidance for GSA and practitioners to advance federal government building decarbonization goals
- Leverage the work of the key principles and barriers/solutions sub-teams
- Use the 80/20 principle to develop playbooks aligned with critical events in large numbers of existing federal facilities

# Federal Building Decarbonization

## Retrofit Playbook Priorities

- Building types:
  - Small buildings with distributed HVAC (<50K ft<sup>2</sup>)
  - Large buildings with central plant (>50K ft<sup>2</sup>)
- Project scenarios:
  - Equipment replacement
  - Building envelope repair
- Project scope
  - Building envelope
  - HVAC equipment
  - Building controls
  - Lighting
  - Water
  - Solar energy and storage
  - Demand flexibility
  - Resilience

# Federal Building Decarbonization

## Retrofit Playbook Content

- Project Development Checklist
  - Specific to building type and project driver
  - Based on the key building decarbonization principles and solutions
  - Considerations for grid emissions, climate zones, energy costs, health and resiliency
- Project Development Process and Tools
  - ESPC ENABLE process (FEMP)
  - Commercial Building Energy Saver Pro (LBNL)
  - Integrated Systems Packages (LBNL)
  - Controller Retuning (PNNL)
  - Healthy Buildings & Energy Support Tool (PNNL)
  - Reopt Lite Tool (NREL)
  - Water Project Screening Tool (FEMP)

# Federal Building Decarbonization Retrofit Playbook Envelope Repair For All Buildings

1. Take advantage of **building envelope repair** to improve passive efficiency and incorporate complementary building decarbonization and resiliency measures.
2. Evaluate **passive survivability** through passive efficiency measures, targeting 48 hours without grid power for critical areas and functions.
3. Estimate **reduction in heating and cooling energy use** through implementation of passive building envelope measures.
4. Identify **additional low-cost, no-cost and short payback energy efficiency measures**, and especially those that reduce heating and cooling loads, to further reduce building energy use.
5. Evaluate current equipment load trend data and compare with current equipment capacity to identify **opportunities for equipment downsizing**.

# Federal Building Decarbonization

## Retrofit Playbook HVAC Equipment Replacement for Small Buildings

1. Take advantage of **planned HVAC equipment replacements** to incorporate complementary building decarbonization/resiliency measures.
2. Evaluate current equipment load trend data and compare with current equipment capacity to identify **opportunities for downsizing** during replacement.
3. Identify **low-cost, no-cost and short payback energy efficiency measures**, and especially those impacting heating and cooling loads, to further reduce building energy use.
4. **Replace any packaged heating equipment using high efficiency heat pumps** - carbon reduction costs favor clean grids and high energy prices.
5. In very cold climate zones, **consider using hybrid heating equipment** (dual fuel rooftop units) to provide efficient and resilient operation.



# Federal Building Decarbonization Retrofit Playbook For All Buildings

6. Replace packaged space cooling equipment with **high efficiency, low GWP cooling equipment** including variable refrigerant flow (VRF) or packaged rooftop units.
7. Replace **fossil fuel water heating with heat pumps** or heat recovery chillers and heat pumps
8. Reduce **water consumption** to save electricity and heating energy requirements.
9. Install **solar photo-voltaic panels** on buildings and other on-site structures and grounds, carbon mitigation economics favors dirty electrical grids and high electricity costs.
10. Install **energy storage (electric and/or thermal)** to provide demand flexibility and increase resilience.

# Federal Building Decarbonization Retrofit Playbook For All Buildings

11. Install **EV charging stations** with the ability to provide smart charging and demand flexibility.
12. Install **automated building controls** with the ability to integrate distributed energy resources and EV charging and provide automated demand response and flexibility services.
13. Install **energy sub-metering, energy information management systems** and automated fault detection and diagnostic systems.
14. Maintain **comfortable and healthy indoor environments** through proper air filtration, ventilation and air treatment.
15. Increase **building resiliency** through a combination of passive measures (thermal insulation, day lighting, operable windows and water storage) and backup energy generation and energy storage.

# Federal Building Decarbonization Retrofit Playbook For All Buildings

16. Review facility condition indicators to identify any **deferred maintenance projects** which could be integrated into the current project.
17. Estimate energy savings and carbon reductions for all potential improvement measures to determine which deliver the **largest carbon reductions at the lowest cost**.
18. Use **lifecycle cost analysis** to determine the most cost-effective carbon reductions which meet financial return targets.
19. Target projects in **underserved communities, using local contractors, diverse suppliers and workers** participating in apprentice programs.
20. Maximize the use of **low-carbon building materials**, and especially the use of reused, remanufactured, recycled and locally-sourced materials.

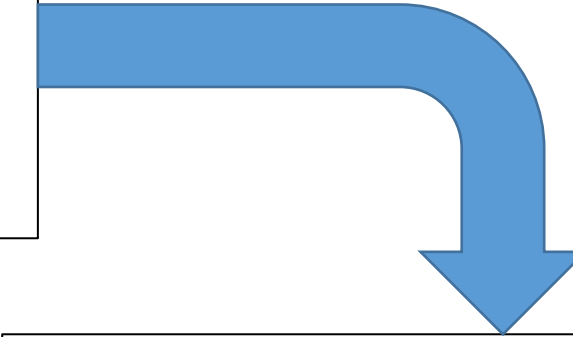
# Federal Building Decarbonization Scorecard

## Building Checklist

XXX

XXX

XXX



## Building Decarbonization Scorecard

1. Passive Efficiency (10 pts)
2. Active Efficiency (10 pts)
3. Controls and Energy Analytics (10 pts)
4. Building Operations (5 pts)
5. Water Conservation (5 pts)
6. Electrification and Renewable Fuels (10 pts)
7. On-site Renewables (10 pts)
8. Off-site Renewables (10 pts)
9. Demand Flexibility (10 pts)
10. Embodied Carbon and Refrigerants (10 pts)
11. Resilience Health and Equity (10 pts)

# Federal Building Decarbonization Scorecard

## 1. EFFICIENCY (5 Sections, 40 Points Total):

Description

### 1.1 Passive Efficiency (10 Points)

		Elements	Criteria	Weight	Notes / Observations	Instructions
Envelope	1	Highly insulated	Yes	25%		
	2	Natural daylighting		25%		
	3	Natural ventilation		13%		
	4	Green roof or walls		13%		
	5	High Efficiency Windows		13%		
	6	Reflective roofs in cooling climate or dark roof in heating climate		13%		
			<b>Score</b>	<b>2.5</b>	/ 10 Points for section	
			<i>Share of section score achieved: 25%</i>			

### 1.2 Active Efficiency (10 Points)

		Elements	Criteria	Weight	Notes / Observations	Instructions
HVAC	1	Centralized systems		13%		
	2	Distributed and Packaged Systems		13%		
	3	Thermal Storage		13%		
Lighting	4	LED Lighting		13%		
	5	Occupancy-controlled Lighting		13%		
	6	Active daylighting		13%		
MELS	7	Occupancy-controlled plug loads		7%		
		Energy Star equipment and appliances		7%		
	8	Energy Star IT equipment		7%		
			<b>Score</b>	<b>0.0</b>	/ 10 Points for section	
			<i>Share of section score achieved: 0%</i>			

### 1.3 Controls and Energy Analytics (10 Points)

		Elements	Criteria	Weight	Notes / Observations	Instructions
Controls	1	Programmable zone thermostats		13%		
	2	Basic building automation		25%		
	3	Advanced building automation		13%		
Analytics	4	Energy sub-metering		13%		
	5	Energy Information Systems		13%		
	6	Fault Detection and Diagnostics		13%		
	7	Building Optimization		13%		
			<b>Score</b>	<b>0.0</b>	/ 10 Points for section	

# Federal Building Decarbonization Recommendations

1. Incorporate the key decarbonization principles of into **GSA policy and practices**
2. Update **P100 building standards** to drive building decarbonization
3. Complete development of the **building decarbonization scorecard** and test with GSA and other agency staff
4. Develop an approach for **portfolio-level implementation planning**, based on facility-level technical assessments, carbon emissions impact analysis and lifecycle cost/benefit analysis incorporating health, equity and resilience impacts

# Federal Building Decarbonization

## Next Steps

1. Produce an **advice letter** summarizing the task group's activities, key findings, recommendations and next steps
2. Work with GSA staff to incorporate the **key principles, solutions and tools** into policy and practices
3. Continue the **task group** with a focus on providing input to GSA on:
  - P100 building standard enhancement
  - Building decarbonization scorecard development and evaluation
  - Decarbonization pilot project selection
  - Portfolio-level decarbonization project prioritization and implementation planning

# Federal Building Decarbonization Questions

1. Should the work of this task group continue?
2. What are the highest priority activities?
3. What other activities should be considered?
4. Other questions?