U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Decarbonization of Federal Buildings

DOE Building Technologies Office

Presentation During April 2022 Interagency Sustainability Working Group Meeting

April 14, 2022

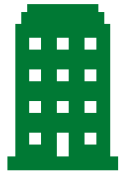
Agenda

1. Executive Order 14057: Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability
2. BTO's Building Energy Codes Program Work on Decarbonization
3. Decarbonization Examples and Intersection with Federal Buildings
4. Conclusions

Executive Order 14057:
Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability

Executive Order 14057: Buildings-Related Goals

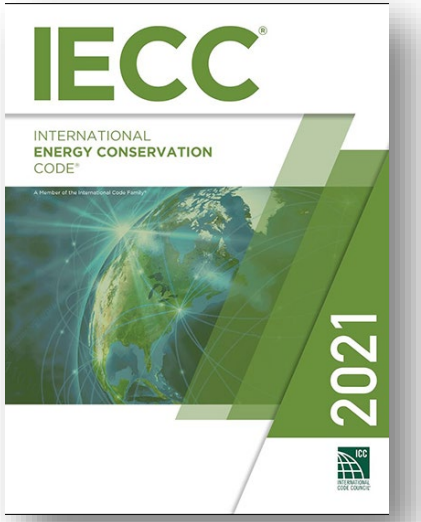
- **Existing buildings**
  - Net-zero emissions across each agency's portfolio by 2045
  - Reduce greenhouse gas emissions by 50% by 2032 (over 2008 levels)
  - Prioritize improving energy efficiency and reducing fossil fuel use
  - Utilize deep-energy retrofits, commissioning, performance contracting, federal building performance standards, and other strategies
- **New construction buildings**
  - Net-zero emissions by 2030 (buildings ≥ 25,000 sq. ft.)
- **Other (related)**
  - 100% zero-emission light-duty vehicle acquisitions by 2027 and all vehicles by 2035



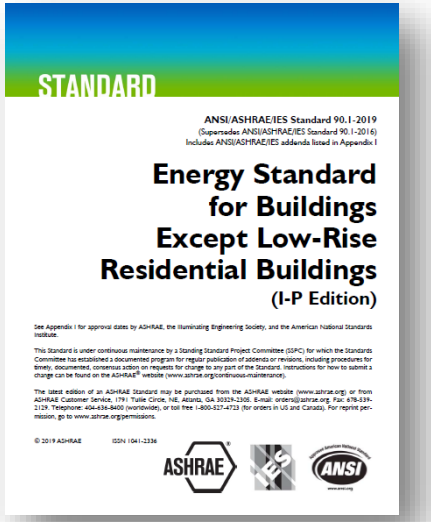
BTO's Building Energy Codes Program (BECP) Work on Decarbonization

Federal Buildings Will Adopt the Latest Energy Codes

- **On March 30, 2022, DOE announced its newly constructed buildings and major renovations will comply with the latest building energy codes**
  - They are estimated to save $4.2 million in operating costs within the first year of implementation
  - The requirement goes into effect in April 2023



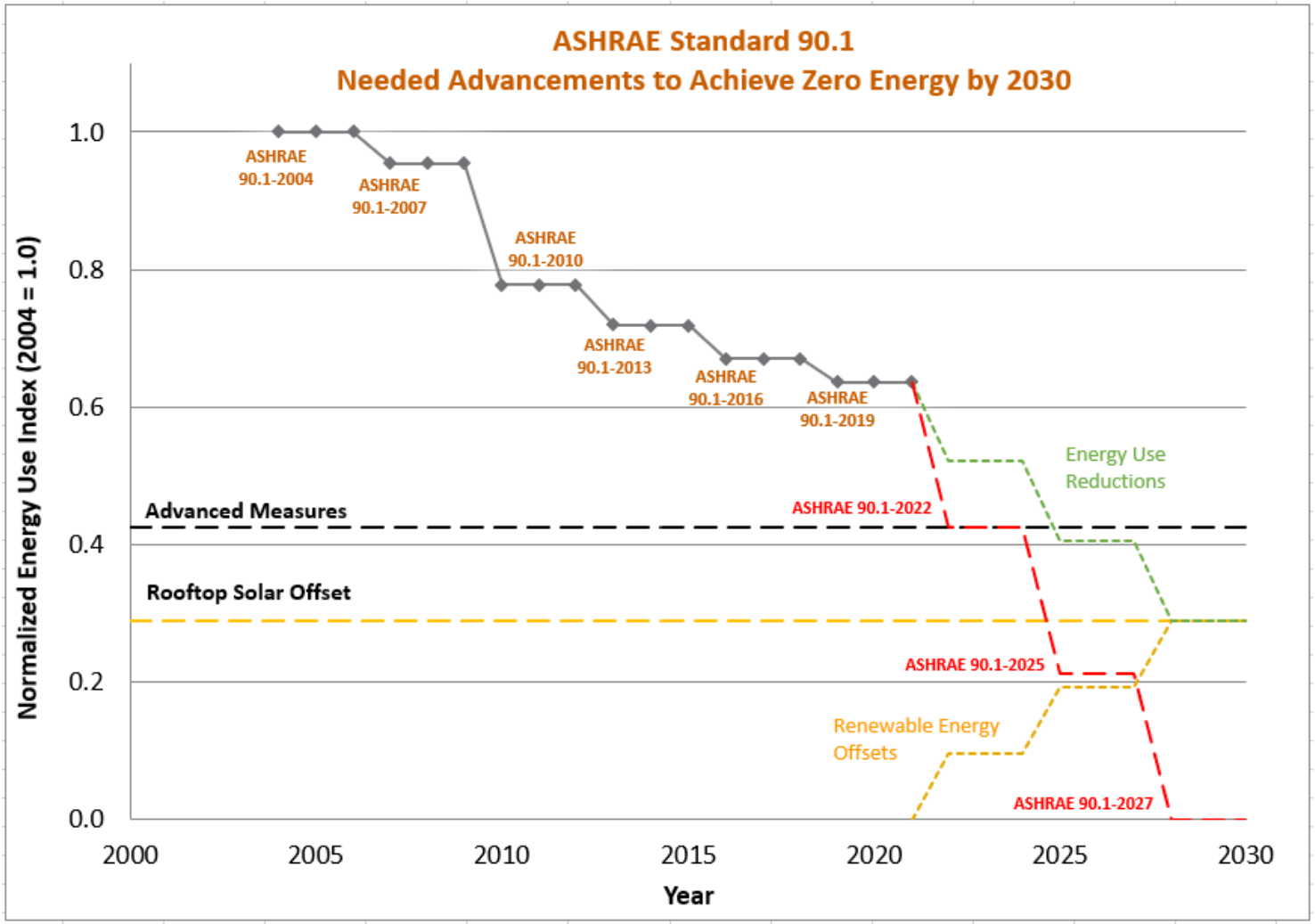
Residential: 2021 IECC



Commercial: ASHRAE 90.1-2019

www.energy.gov/articles/doe-releases-energy-saving-rules-federal-buildings-and-proposes-new-standards-consumer

Achieving Zero Energy Model Building Codes by 2030



Achieving zero energy building codes by 2030 requires continued reduction of energy use (green dotted line) and increasing renewable energy offsets (yellow dotted line)

BECP's Stretch Code Provisions Empowering Local Governments

Improved HVAC and Lighting System Performance

Energy Efficiency Upgrade Credits

Electric Readiness

Electric Vehicle Charging Infrastructure

Grid-interactivity

Solar Photovoltaic Requirements

More information at www.energycodes.gov/stretch-codes

Building Performance Standards (BPS) Technical Assistance

- **DOE's Resource Library –** energycodes.gov/BPS
  - Financing resources & strategies
  - Stakeholder engagement guidance
  - Implementation tools & resources
- **Direct Technical Assistance on:**
  - Characteristic representation of your building stock
  - Setting trajectories & interim targets for your BPS
  - Identifying high-impact measures & measure packages
  - Impact analysis for companion policies
    - e.g.: electrification requirements, equity considerations
  - Financial considerations to ensure cost-effective technology deployment and alignment with new construction codes.

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BUILDING ENERGY AUDIT TEMPLATE U.S. DEPARTMENT OF ENERGY

UBID UNIQUE BUILDING IDENTIFIER

National BPS Coalition

Coordinated TA from both DOE & EPA
Commitment to advance BPS by legislation or regulation by Earth Day 2024

Decarbonization Examples and Intersection with Federal Buildings

Federal Buildings Have a Decarb Advantage Over Private Sector

- Electrifying space and water heating in the commercial building sector has been relatively slow to date.
- Return on investment thresholds in the commercial sector are often very short (e.g., 3–5-year simple payback) and can be a major barrier.
- **However, the government typically holds buildings much longer, giving it greater flexibility to implement decarbonization projects.**

Key stats for government-owned buildings:

Criteria	Statistic
Buildings	252,277
Floor area (sq. ft.)	2.4 billion
Largest Building Type (sq. ft.)	Office (21%)
Largest Owner (sq. ft.)	DoD (63%)
Average Building Age*	**60 years**

**Data for GSA buildings only*

Sources: www.gsa.gov/policy-regulations/policy/real-property-policy/data-collection-and-reports/frpp-summary-report-library, www.gao.gov/assets/gao-18-420.pdf

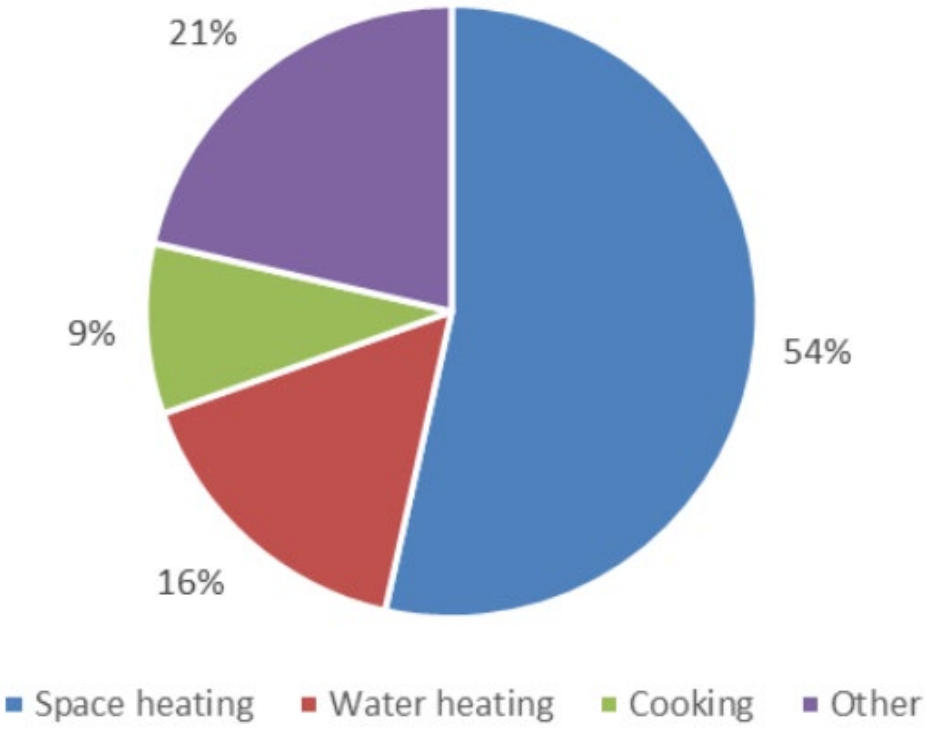
Improving Energy Efficiency Reduces GHG Emissions

Cellulose insulation (left) and LED lighting (right)

In addition, energy efficiency provides nonenergy benefits for occupants like improved resilience, comfort, health, and productivity.

fiberlitetech.com/Fiberlite-Technologies-2nd.php?pagename=Uses-Commercial-Building, www.architectsjournal.co.uk/buildings/stagg-architects-opens-up-introverted-office-building-in-detail-led-retrofit

Fossil Fuel Usage Energy Breakdown

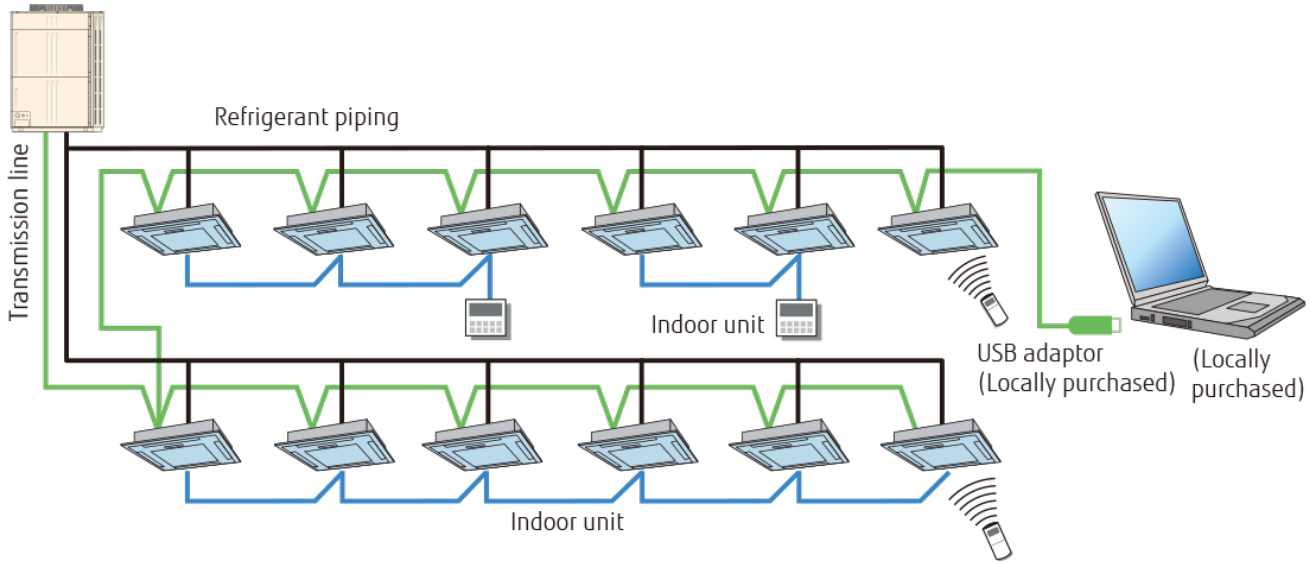


Over half of the average commercial building's fossil fuel usage is from space heating, with water heating at roughly 16% (but much higher in multifamily)

Source: 2018 EIA CBECS Database www.eia.gov/consumption/commercial/

Decarbonizing Space Heating With Heat Pumps

- **A 2020 ACEEE report found favorable economics in many cases for decarbonizing existing small-to-medium sized buildings, e.g.,**
  - Replacing gas-fired packaged rooftop unit (RTU) with a packaged heat pump RTUs
  - Replacing gas furnaces with heat pumps
  - Replacing small boilers and space heaters with variable refrigerant flow (VRF) heat pumps



Packaged rooftop unit (left) and VRF diagram (right)

www.aceee.org/sites/default/files/pdfs/b2004.pdf, www.energy.gov/eere/buildings/articles/whats-your-roof-rooftop-unit-rtu-efficiency-advice-and-guidance-advanced, www.electric.co.id/fujitsu/produk=vrf&kat=maintenance-series.php

Decarbonizing Space Heating With Heat Pumps

- **Large buildings (i.e., 100,000 square feet and greater) typically have large built-up HVAC systems (air handling units, chillers, cooling towers, boilers, etc.) which require a more challenging decarbonization retrofit.**
  - Air-to-water heat pumps, ground-source heat pumps, multi-pipe heat pumps, and thermal storage can all be important technologies for large building decarbonization.

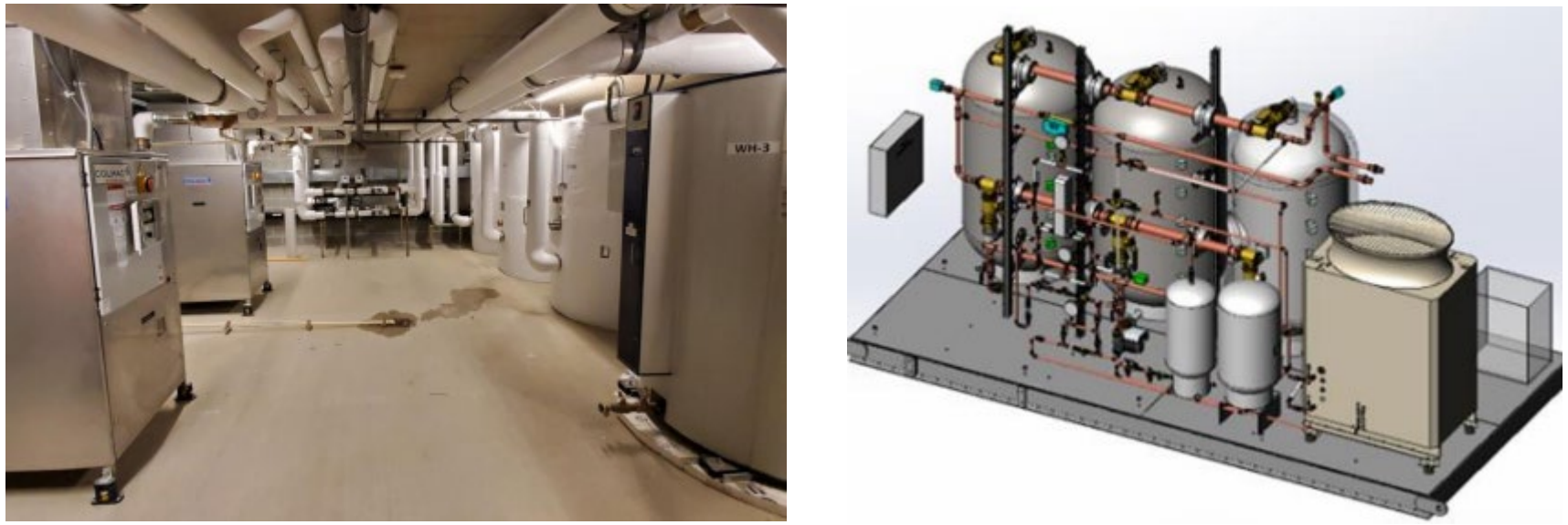
An incremental approach (e.g., 80-90% electrified) can be a good short-term solution

In 2015, Stanford University replaced its 100% fossil-fuel based combined heat and power plant with a 90% electric system that uses heat recovery chillers, large thermal storage tanks, and backup boilers

sustainable.stanford.edu/sites/default/files/ZGF_Stanford_CEF.pdf

Decarbonizing Water Heating With Heat Pump Water Heaters

- Central heat pump water heater systems are starting to be installed in commercial buildings, with most examples in California, the Pacific Northwest, and New York.
- These systems are typically custom built, with a relatively high upfront cost; however, manufacturers are in the process of bringing new more affordable options to the U.S. market, like prepackaged skid-mounted systems.

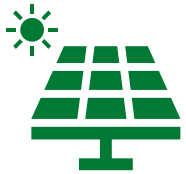


Custom built system (left) and prepackaged skid-mounted system drawing (right)

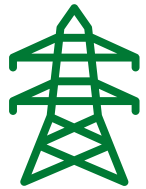
www.aceee.org/sites/default/files/pdfs/b2101.pdf, energytrust.org/wp-content/uploads/2021/10/BESF-Commercial-Heat-Pump-Water-Heater-Systems_Sizing_Modeling.pdf

Other Opportunities for Decarbonization

- On-site renewable energy
- Energy storage
- Electric vehicle charging infrastructure
- Grid-flexible resources
- Cooking equipment
- Miscellaneous (e.g., emergency generators)







Building Decarbonization Pathways Project Overview

EERE is interested in identifying building decarbonization pathways to inform individual strategies to help maximize Federal impact.

Project Scope

Includes both U.S. residential and commercial building sectors, including Federal band new construction and existing buildings

Includes both deep energy efficiency as well as the decarbonization of onsite emissions

Project Objectives

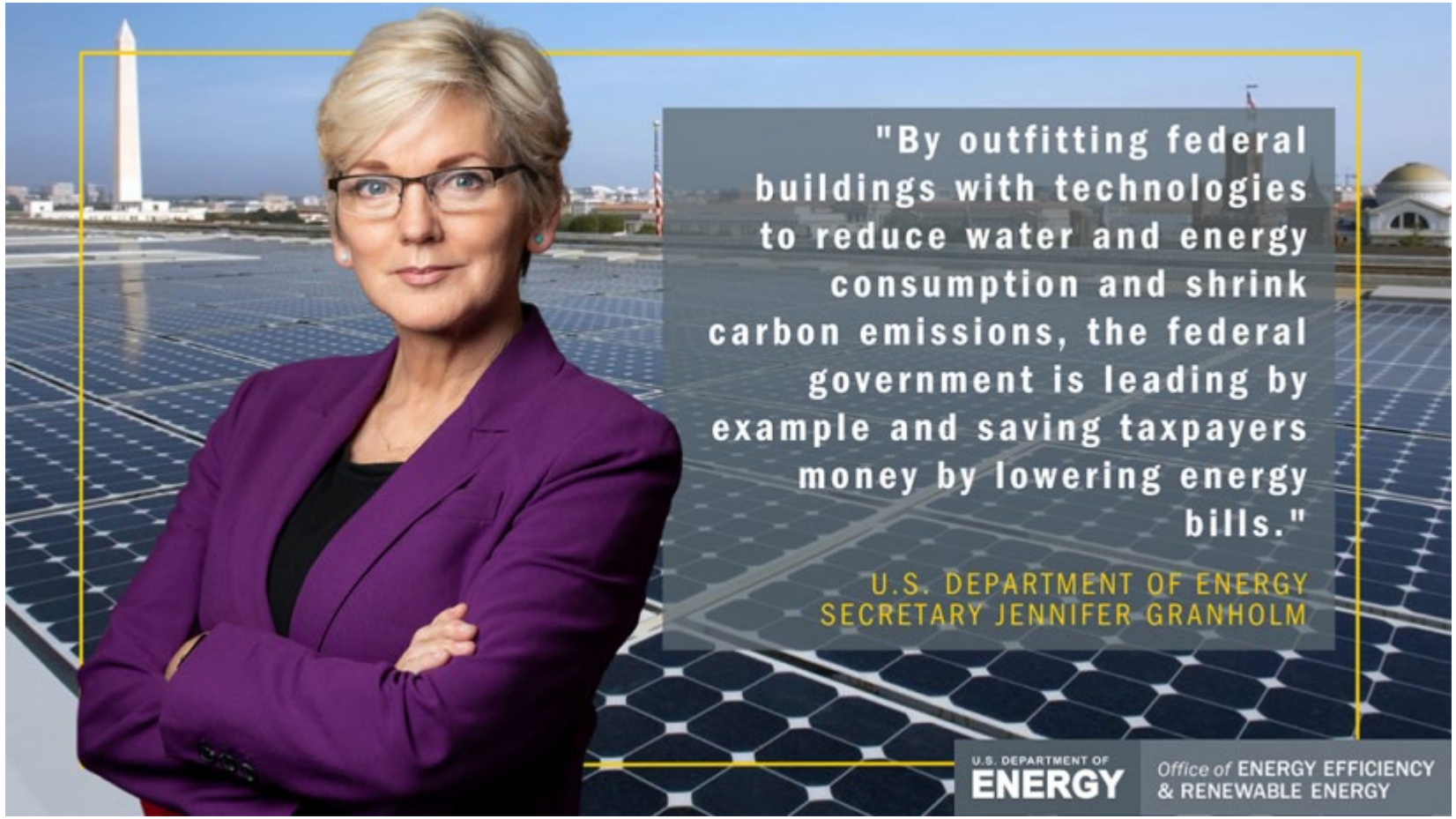
Provide a **foundation for DOE strategies** on building decarb. activities and policies

Provide **actionable information** on how to decarbonize American buildings for building owners, operators, and service providers (including federal facilities)

Provide insights on **research, development, and deployment (RD&D) priorities** for the acceleration of building decarbonization

Inform strategic planning and program/policy development within EERE and assist EERE offices in collaborating and gaining consistency within their work

Energy Performance Contracts Can Help Finance Initiatives



For example, FEMP's AFFECT funding will lead to a total investment of over $737 million in federal buildings when combined with Energy Performance Contracts.

www.energy.gov/articles/doe-announces-13-million-energy-efficiency-technologies-federal-buildings

Conclusions

Conclusions

1. E.O. 14057 sets ambitious goals to drastically cut energy use and greenhouse gas emissions
2. Federal buildings are uniquely positioned to lead the way on implementing decarbonization strategies
3. Energy efficiency is a critical component to any building decarbonization strategy
4. Existing and emerging heat pump technologies can help decarbonize space and water heating (consider partial electrification, if needed)
5. Other opportunities include on-site renewable energy, energy storage, electric vehicle charging infrastructure, and others
6. Tools like building performance standards, funding mechanisms like performance contracting, and additional decarbonization research can help agencies meet the targets in E.O. 14057

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