FEMP 50

50 Years of Federal Energy Management

Decarbonization and Electrification

Learning Objectives

Upon completion of this training, you will be able to:

- Learn how operations and maintenance can drive decarbonization
- Understand best practices for implementing federal building performance standards
- Examine case studies from the national labs on achieving net zero efforts

Panelists

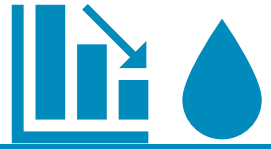
- Nael Nmair, Supervisor, Facility and Fleet Optimization, Federal Energy Management Program
- Rick Mears, Net-Zero Buildings Program Manager, Federal Energy Management Program
- Sheila Hayter, Laboratory Program Manager, National Renewable Energy Laboratory

Overview

- Decarbonization and Electrification
- Federal Building Performance Standards
  - Proposed Clean Energy Rule
- Operations and Maintenance
  - Re-tuning and decarbonization
  - Audit template
- Net Zero Lab Initiative & Smart Labs

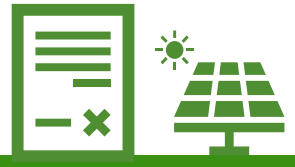
Decarbonization and Electrification

Why decarbonization and electrification now?



Energy Independence and Security Act of 2007 (Sect 432/433)

- Comprehensive Energy and Water Evaluations (CEWEs) (i.e., facility audits and existing building commissioning (EBCx) projects) every 4 years
- Performance Requirements (Sect. 433) - Clean Energy for New Federal Buildings and Major Renovations of Federal Buildings Rulemaking - https://www.energy.gov/sites/default/files/2022-12/doe-clean-energy-snopr.pdf



Energy Act of 2020 (Sect 1002)

- Execute 50% of ECMs identified using performance contracting
- Implement all cost-effective ECMs identified within two years
- FEMP to establish a Federal Smart Building Program

Executive Order 14057

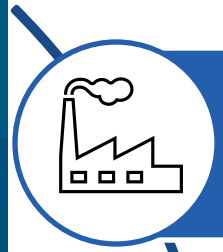
- Establishes goals for GHG emissions reductions, carbon pollution-free (CFE) electricity, and building electrification
- 100% net zero buildings, zero-emission fleets, 24/7 carbon pollution-free electricity
- Net zero federal government operations by 2050 or sooner
- Federal facility performance objectives are detailed in the "Implementing Instructions for EO 14057" see https://www.sustainability.gov/pdfs/EO_14057_Implementing_Instructions.pdf

Federal Building Performance Standard

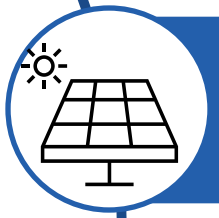
- Instructions to support federal facilities achieving the facility performance goals in EO 14057 https://www.sustainability.gov/pdfs/federal-building-performance-standard.pdf
- Applies to federally-owned, EISA-covered facilities in U.S. and U.S territories

Note: Descriptions are illustrative and not comprehensive.

Buildings are Nexus to Achieve Climate Goals

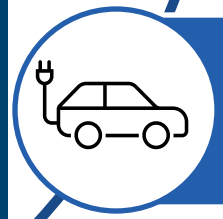


Eliminate Scope 1 Emissions through Electrification
Preparing for clean energy future



Procure Carbon-Free Electricity
Reducing energy use and peak demand

Resilient facilities
Adapt, respond and recover from disruptions



EV infrastructure (EVSE) and procurement
Managed EV Charging

FEMP Assistance with Facility Decarbonization

		FEMP Technical Assistance	Key Takeaways
	Planning, Evaluating, Prioritizing	Acquisition Planning Emerging Technologies Building Performance Standards	Identifying 'suitable' facilities, optimal use of available funding opportunities, support agency mission needs
	Development, Deployment, Procurement	ESPC, UESC Technical Assistance Carbon-free electricity Distributed generation Technology validation Grid-interactive Efficient Buildings (GEB) Environmental Justice	Develop opportunities, technologies and impacts through qualified projects; combining best measures for greatest impact within economic limits
	Monitoring, Sustaining, Optimizing	Measurement & verification Life of contract support O&M support	Ensuring persistence of savings and performance of facilities and implemented measures over the life of the project
	Tracking, Reporting, Recognizing	Annual reporting Leveraging EISA 432 evaluations FEMP Energy and Water Management Awards	Accountability in public disclosure of building portfolio; recognizing agency individuals, projects and programs contributions to energy and water efficiency

Workforce Development and Training through Whole Building Design Guide

FEMP Supports Decarbonization and Electrification through Tools and Resources, Technical Assistance and Training

Identify, document opportunities for facilities to reduce greenhouse gas emissions	Evaluate technologies and opportunities to reduce energy consumption and electrify facilities	Develop and implement projects that enhance energy and climate resilience	Realize decarbonization and electrification goals
• **Audit Template Tool** • Energy and Water Treasure Hunts • Federal Fleet ZEV Ready Center • 50001-Ready • eProject Builder	• REOpt • **Re-tuning** • GEB • Smart labs • Data centers • Technology Validation	• Performance contracting (ESPC, UESC, ESA) • AFFECT grant	• Executive order 14057 • Climate Smart Building Initiative • **Federal building performance standard** • Energy Act of 2020

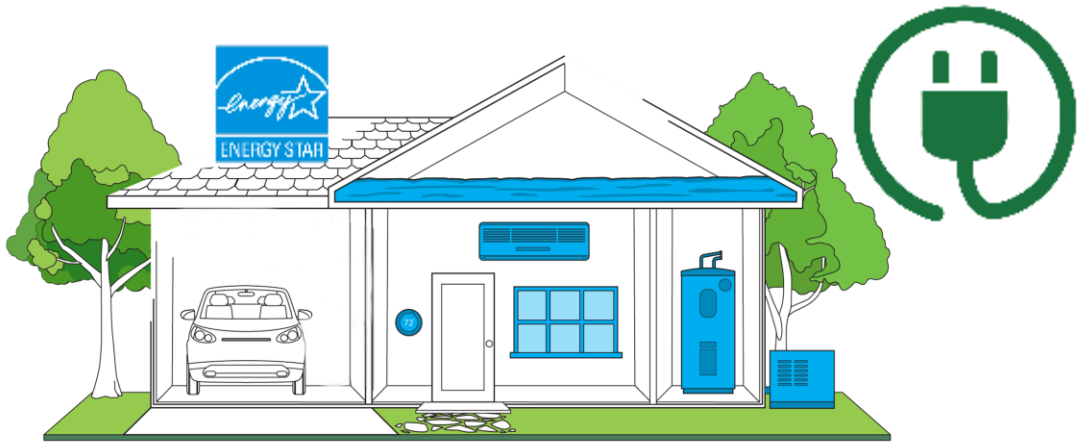
FEMP has tools and resources, technical assistance, and training to support agencies in meeting **decarbonization and electrification** goals, engaging key stakeholders to support all stages of energy management through working groups, workforce development, and agency engagement

Decarbonization Strategies

Strategy is unique to each site

- Primarily a function of on-site fossil fuel use (scope 1)
- Influenced by serving utility's current and future generation mix (scope 2)

Baseline Load



Optimized Load

Energy efficiency, optimization and load reduction

- Lighting, chillers, and load reduction
- When replacing inefficient fossil fuel-based equipment, begin with load reduction, then electrification and demand flexibility
- Avoid new long-lived fossil fuel burning equipment (e.g., boiler) when possible

Electrification (electric vehicles, heat pumps)

- Reduces emissions in most locations
- Largest reductions where current/future utility carbon emissions are relatively low

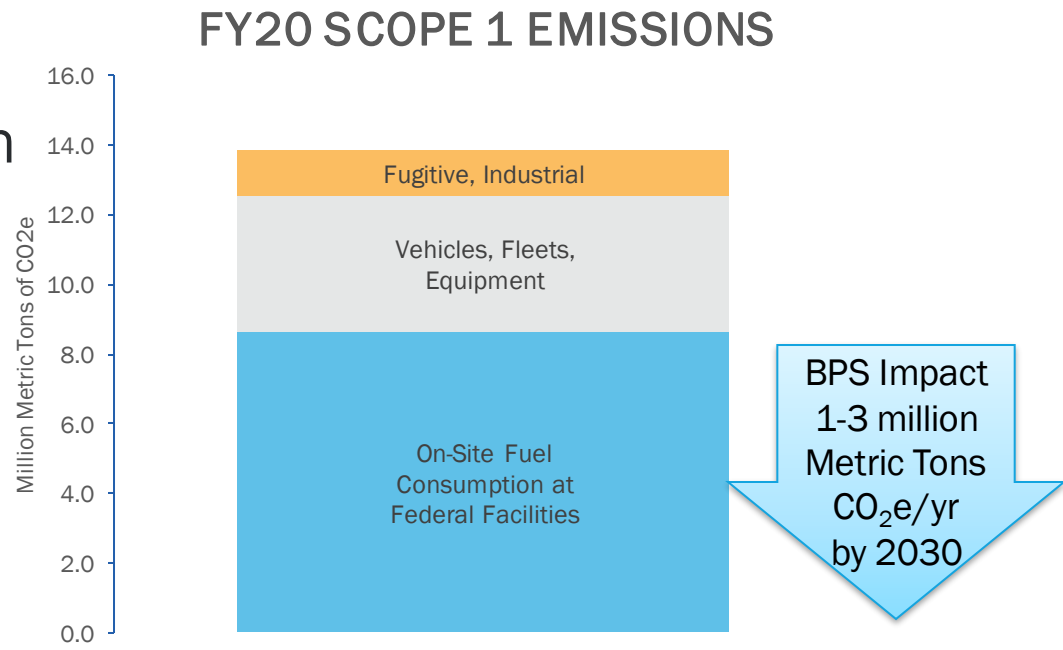
On-site carbon free energy generation/storage

- Largest emissions reduction where current/future utility carbon emissions are relatively high

Federal Building Performance Standard

Federal Building Performance Standard (BPS)

- Goal: Reduce scope 1 on-site fossil fuel use in federal buildings and facilities
- Target: Achieve zero scope 1 emissions from on-site fossil fuel use through building electrification in at least 30 percent of applicable facilities measured by square footage by 2030
  - Supports achievement of net-zero emissions for the Federal building portfolio and as a stepping stone to achieve a 50 percent emissions reduction by 2032
  - Promotes deep energy retrofits, strategic equipment replacement in existing buildings, campuses, and installations to meet emission and energy reduction goals



The Federal BPS addresses on-site fossil fuels consumed in Federal facilities, the largest source of scope 1 emissions from standard operations.

Federal BPS: Applicable Buildings

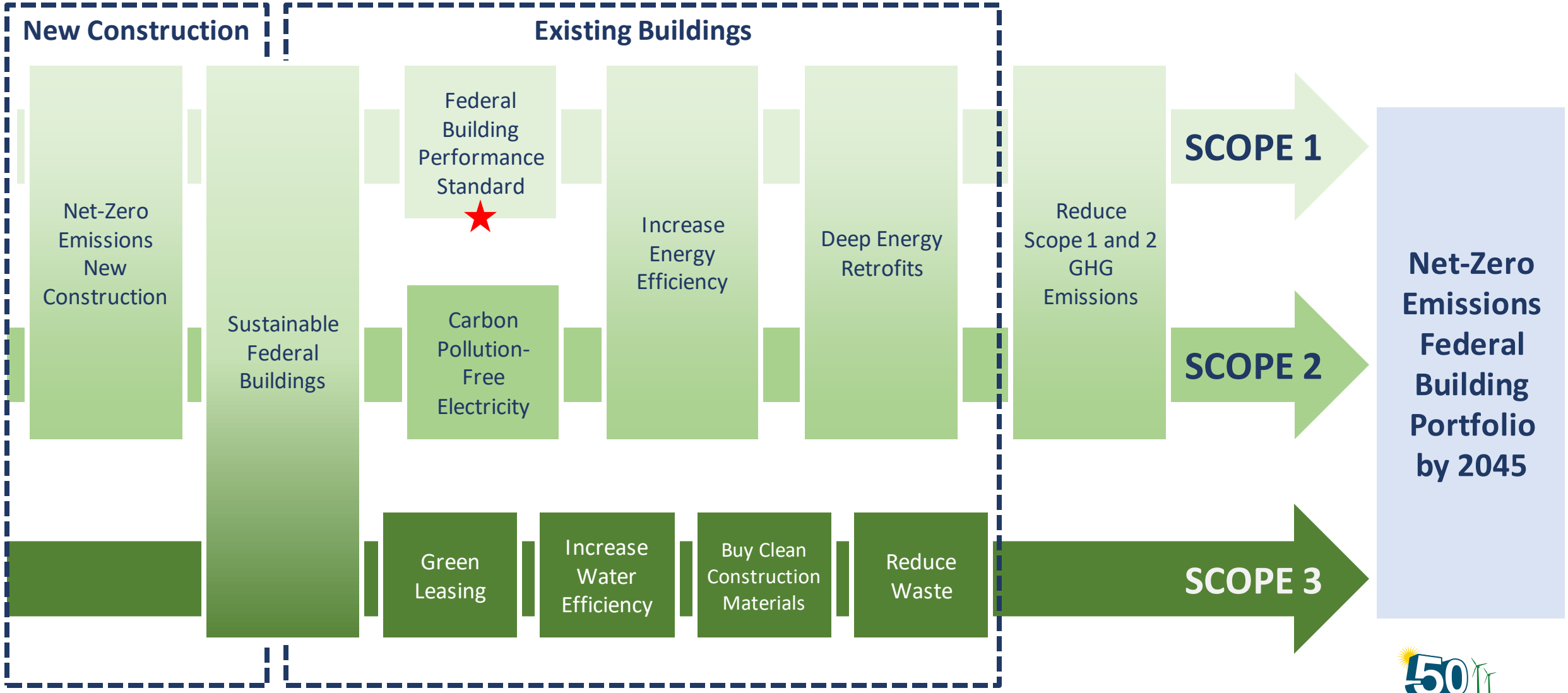
Criteria for applicable facilities:

- All federally-owned, EISA-covered facilities* located within the United States and U.S. territories
- Has scope 1 emissions attributed to standard building operations as of October 1, 2021,
- New facilities that have completed construction after October 1, 2021

Goal: By FY 2030, at least 30 percent of an agency's applicable facilities, by gross square footage (GSF), achieve zero scope 1 emissions from on-site fossil fuel use through building electrification

*as defined by 42 U.S.C. §8253 (f)(2)(B)

The Federal BPS works with other Federal buildings' goals and requirements to reduce GHG emissions



Adapted from CEQ presentation on E.O.14057 Implementing Instructions

Interactive Federal Regulation Widget

Interactive resource (widget) to explore Existing Building and New Construction Federal requirements under development by FEMP

- Clarifies Executive Order requirements vs. Statutory regulations
- Interactive capabilities allow users to explore how items work together; details of requirements and additional information
  - Zoom out to show regulatory interaction
  - Zoom in to show:
    - Info Summary “Here is what you have to do”
    - Links to details, training, resources, etc.
    - Identify, clarify, communicate implementation penetration targets and qualifying metrics such as capital cost / lifecycle cost effectiveness / exemptions

CEQ's Agency Planning Process to Meet the Federal BPS

Prioritize	Prioritize facilities
List	List of applicable facilities and associated GSF
Quantify	Quantify scope 1 emissions and associated GSF
Calculate and remove	Calculate and remove process and mission emissions exclusions
Identify	Identify equipment and appliances that eliminate scope 1 emissions
Plan	Plan upgrades for efficient electrification. Choose appropriate pathway

Planned Prioritization Approaches and Resources

- "How do I decarbonize and electrify, my building cost-effectively?" FEMP-developed quick reference
  - Step-by-Step process to evaluate a building for electrification compatibility
    - Focus on big picture operating cost / efficiency gains metrics
    - Limiting details on capital costs, load analysis / modeling, advanced financial evaluation, health benefit / social costs of carbon (SCC), that necessitate deeper analysis
  - 'Screening guide' for early steps of understanding candidate sites and finding those most suitable
- Plan to integrate with Audit Template, leveraging specific data present once an audit is complete

Note: Separate from and should be considered in addition to the contextual prioritization provided by CEQ in the Dec 2022 BPS scoping document.

Planned Prioritization Approaches and Resources

Audit Template will be able to leverage inputs about specific sites, facilities to quickly assess how "suitable" a site may be for electrification supporting Federal BPS

Compare delivered energy rates in comparable units ($/MMBtu)

Scope 1 Natural Gas / Fuel Rates to delivered Electricity rates
Current National Average shows electricity as ~3.3x more expensive than natural gas*
Actual utility rates vary much more widely and should be considered on a site-by-site basis

Compare Pre- and Post retrofit equipment efficiencies

Audit Template captures system level data on existing systems
Users can input expected post retrofit performance or defaults
Example:
Pre-retrofit:~80% efficient natural gas furnace
Post Retrofit: Heat pump with heating COP ~1.78
~2.3x more efficient!

Compare actual emissions rates pre- and post-retrofit

Facility locational data (e.g., zip code) to lookup electric emissions rate to compare to stationary combustion

Federal BPS Reporting and Tracking Compliance

- Council on Environmental Quality (CEQ) and Office of Management and Budget (OMB) review agency progress towards Federal BPS 30% goal by FY2030
- In FY24, CEQ working with FEMP on updates to EISA 432 Compliance Tracking System (CTS) to report and track facility compliance with meeting the BPS

Required Data Reporting:
Gross Square Feet (GSF) of Applicable Facilities
– as defined by BPS policy document
– using either pathway

- Progress toward FY2030 Federal BPS goal reported annually in Building Strategic Plans
  - FY 2023 Strategic Plan: Assess baseline by taking stock of facility portfolio, identify applicable facilities
  - FY 2024 Strategic Plan: Set annual progress targets towards meeting BPS goal

Clean Energy Rule

- Complementary to the Federal Building Performance Standard
- Proposed rule announced December 7, 2022
- Electrify and reduce emissions from new or newly renovated federal buildings for large projects
  - Reduce on-site fossil fuel use as compared to a 2003 baseline by 90% if designed for construction in FY25 –FY29
  - Eliminate on-site fossil fuel use if designed for construction in FY2030 or beyond
  - Mission-critical loads excluded and exemptions to be considered through petition
- Accelerate electrification of federal building stock
  - Phasing out fossil-fuel usage (e.g., heating, water heating)
- FEMP to provide further guidance upon finalization of rule
- Clean Energy for Federal Buildings Rule: https://www.regulations.gov/document/EERE-2010-BT-STD-0031-0073

Building Re-tuning and Decarbonization

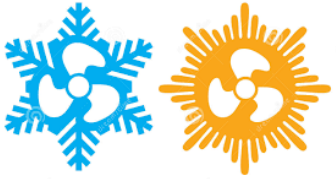
Re-tuning Definition

Data-driven process of improving control of existing building energy systems, centered on the building automation system (BAS) through:

- Application of simple principles, embodied in best-practice re-tuning measures
- Identification and correction of possible O&M issues
- Adoption of strategies for better monitoring and controls (e.g., utilize trend data and training to manipulate reset parameters for “tuning”)

“Turn it off”

“Turn it down”

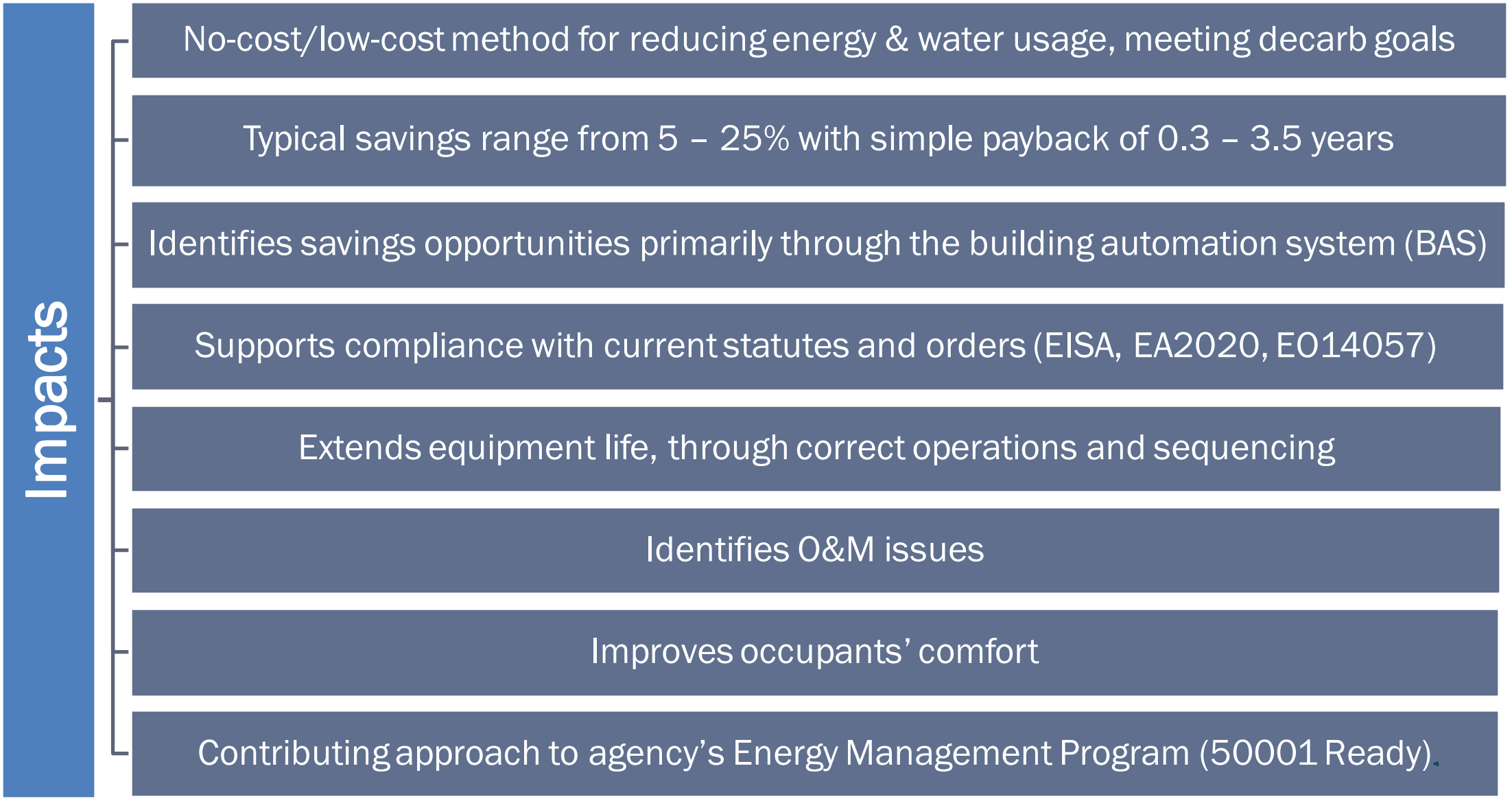


“Mitigate simultaneous heating and cooling”

“Reduce infiltration and outside air”

Re-tuning can meet EISA/EA2020 requirements for ongoing commissioning and agency decarbonization goals.

FEMP Re-tuning

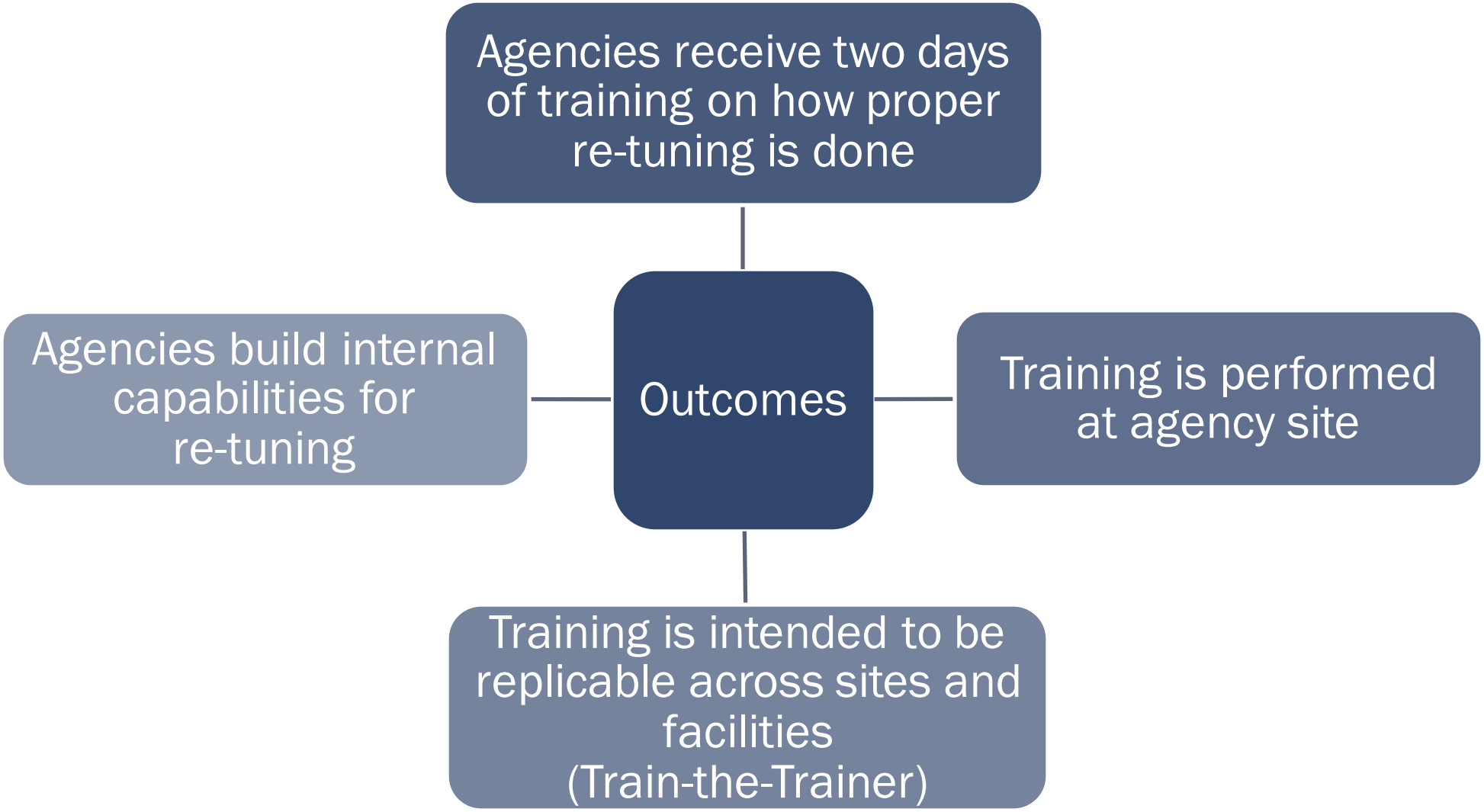


FEMP Re-tuning Challenge

Interested in hosting a Re-tuning Challenge at your site?

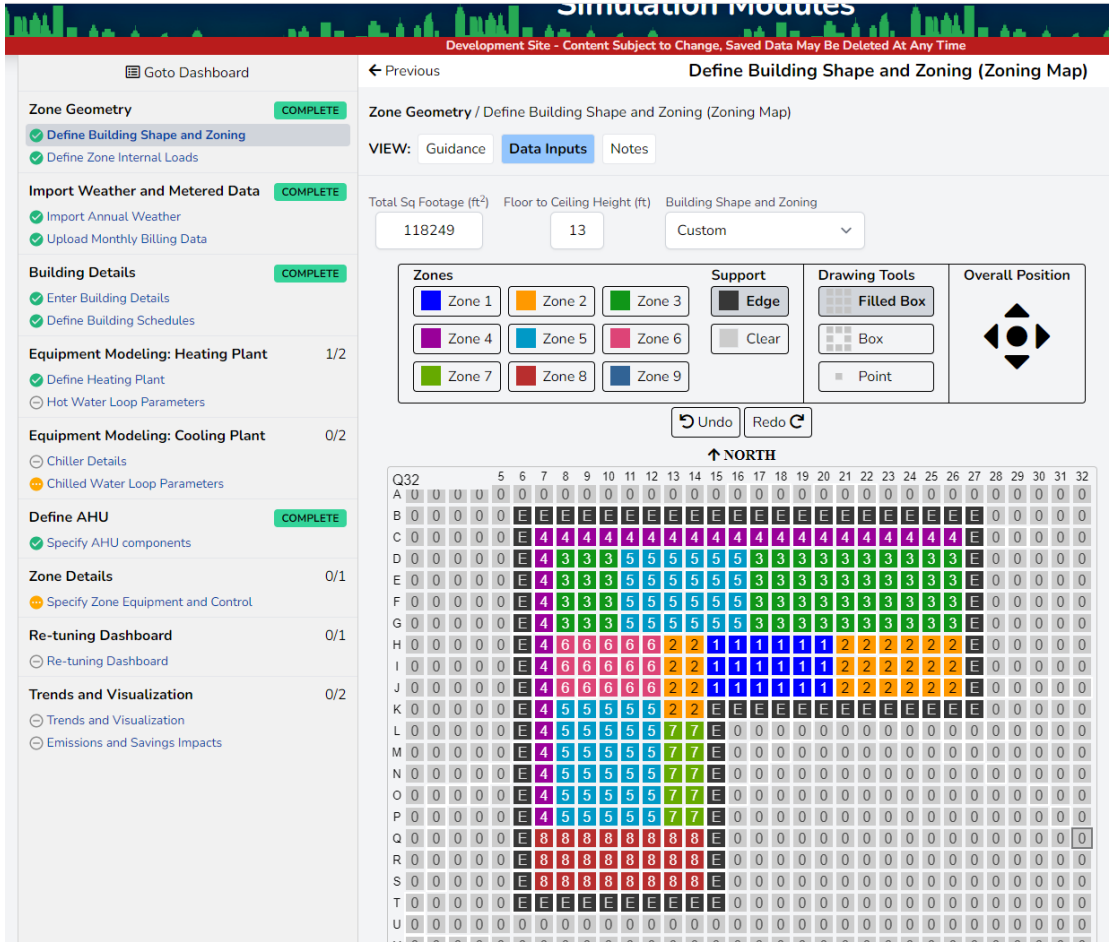
Want to learn more about the training?

Contact us!



Building Re-tuning Simulator (BRS) Tool (coming soon)

- Online tool under development for Federal agencies
  - BRS will be used in Re-tuning Challenge
- Quick creation of building energy models with a focus on the impact of controls and re-tuning
- Accurate estimation of energy, cost and emissions savings for each re-tuning measure



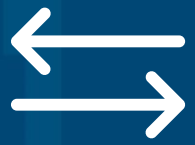
Audit Template

BUILDING ENERGY AUDIT TEMPLATE
U.S. DEPARTMENT OF ENERGY

Federal Audit Template: Key Capabilities Added

Free, secure web-based tool to collect, store, and report building asset data (including ASHRAE Level 2 energy audits, based on Standard 211)

Produces an audit data report including ECMs/WCMs: Supports reporting data meeting EISA 432 requirements



Audit Template can import agency specific building IDs and information that allows the agency admin to manage access control through a Role Based Access Control system

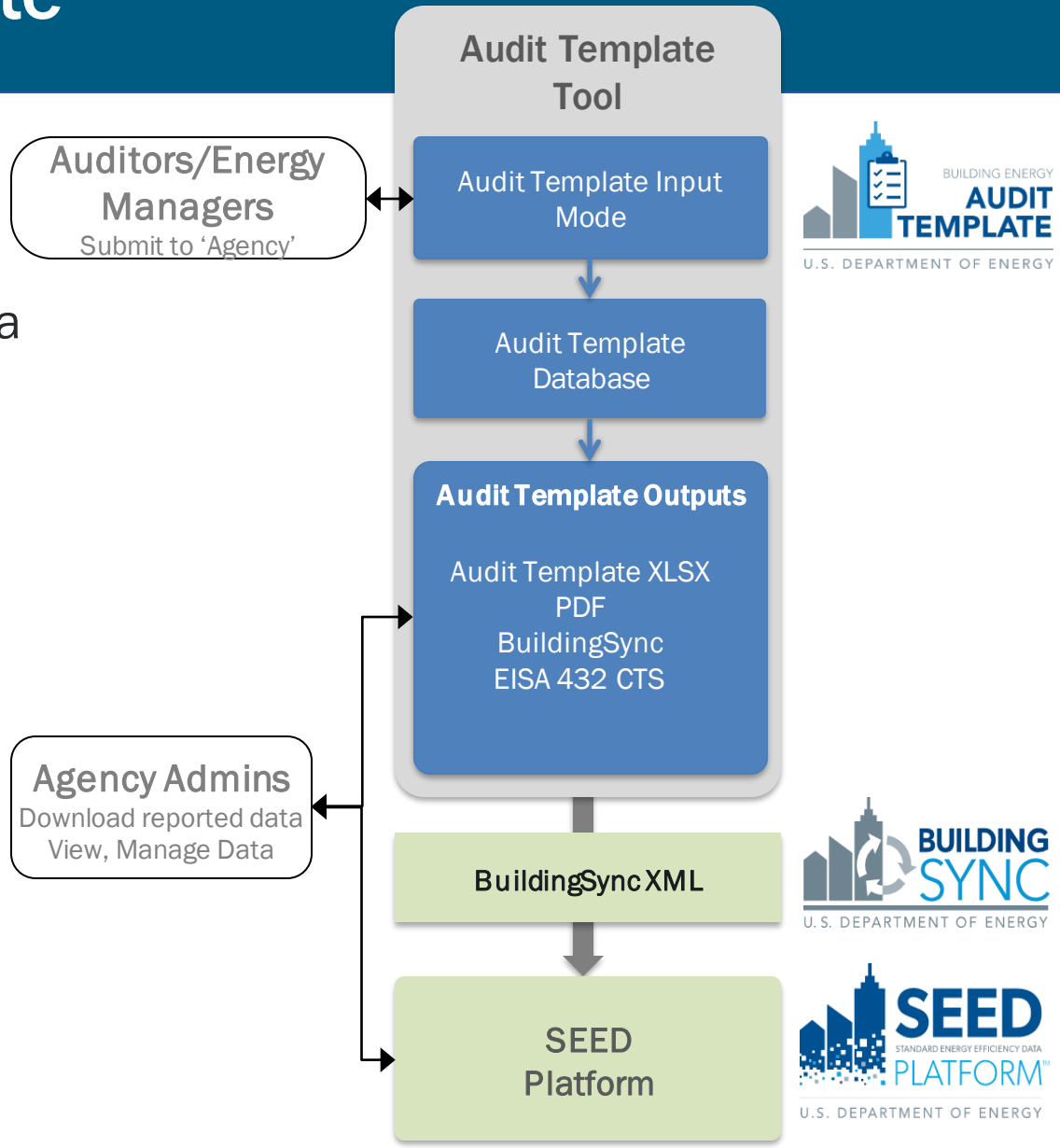
Organizational hierarchy added in Audit Template to support Federal Agencies (Agency > Sub Agency > Facility…)

Offers customized templates to support agency-specific reporting requirements. Data can be exported to CTS at 'System' and 'Facility' level (BuildingSync)

Audit Template: https://buildingdata.energy.gov/#/audit-template

Advantages of using Audit Template

- Provides an integrated data approach can export data to other tools using the BuildingSync format
  - Energy Manager can leverage previous audits, data automatically prepopulated for reporting statute (EISA/EA 2020/BPS)
  - Generates CTS-compliant reports
  - Can be used as basis for project procurement
- Added capabilities to include tracking of ECMs identified, consideration for decarbonization/ electrification, and potential implementation using performance contracting
  - Supports compliance with EA2020
- Can also be used for fleet/EVSE auditing/reporting



Additional Applications of Audit Template

Federal BPS

- ✓ Support identifying equipment with scope 1 emissions
- ✓ Reporting for prescriptive or performance pathway of the Federal BPS
- ✓ Calculating gross square footage which counts towards the Federal BPS; reporting same to agency
- ✓ Assisting agencies in identifying facilities excluded from the Federal BPS

Energy Act 2020

- ✓ Support data collection to identify life-cycle effective measures for implementation within 2 years of evaluation
- ✓ Incorporate the Existing Building Commissioning Tool

Data collection and reporting for decarbonization audits

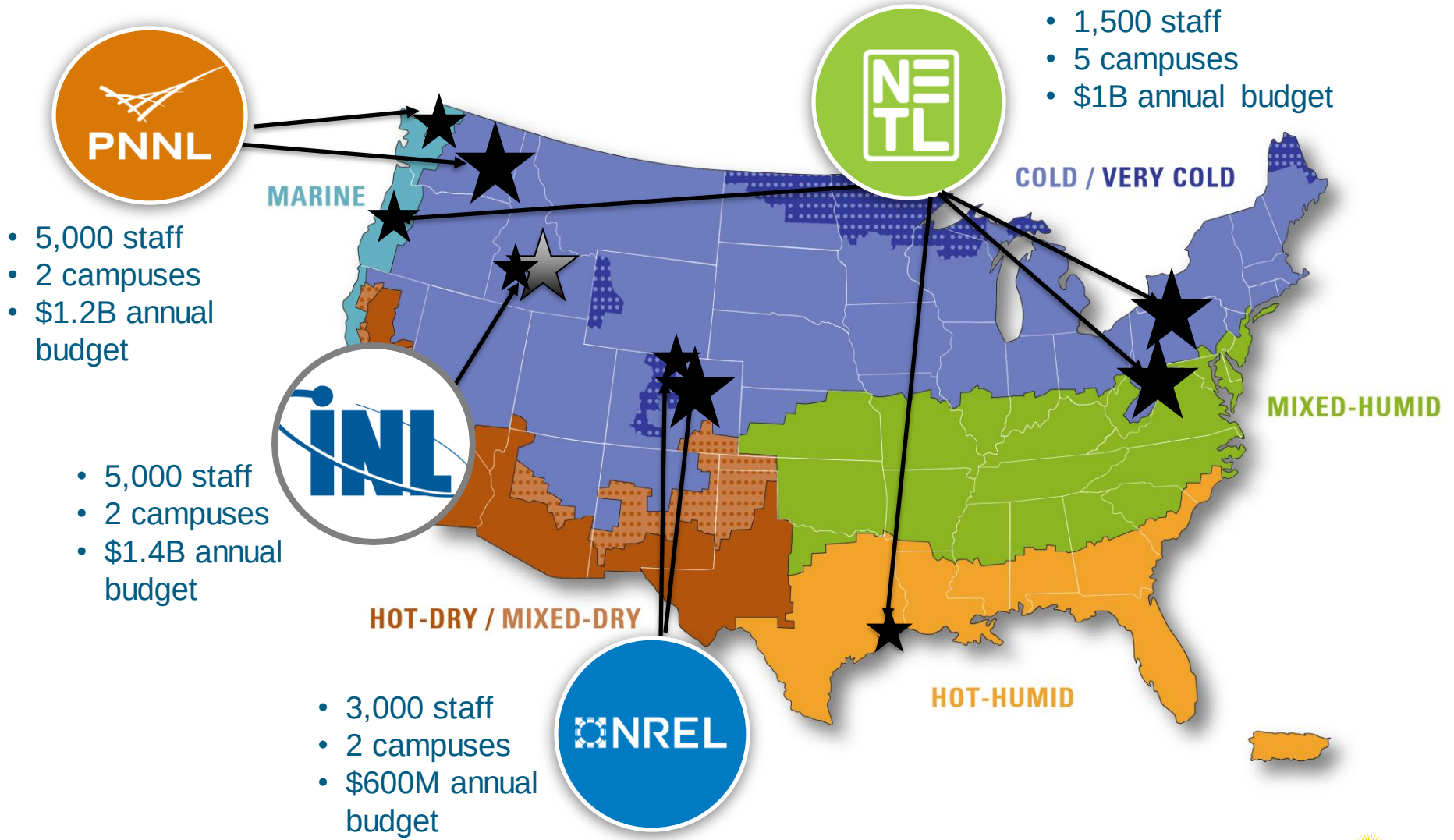
- ✓ Support data collection for decarbonization audits, emissions calculations and identifying electrification opportunities

Audit Template can generate reports for specific statutes and mandates, without requiring data to be collected again.

Net Zero Lab Initiative & Smart Labs

Net-Zero Pilot Labs

Pilot Launch: 4 National Labs, 10 campuses, diverse regions



4 pilot labs - Vision to expand to all 17

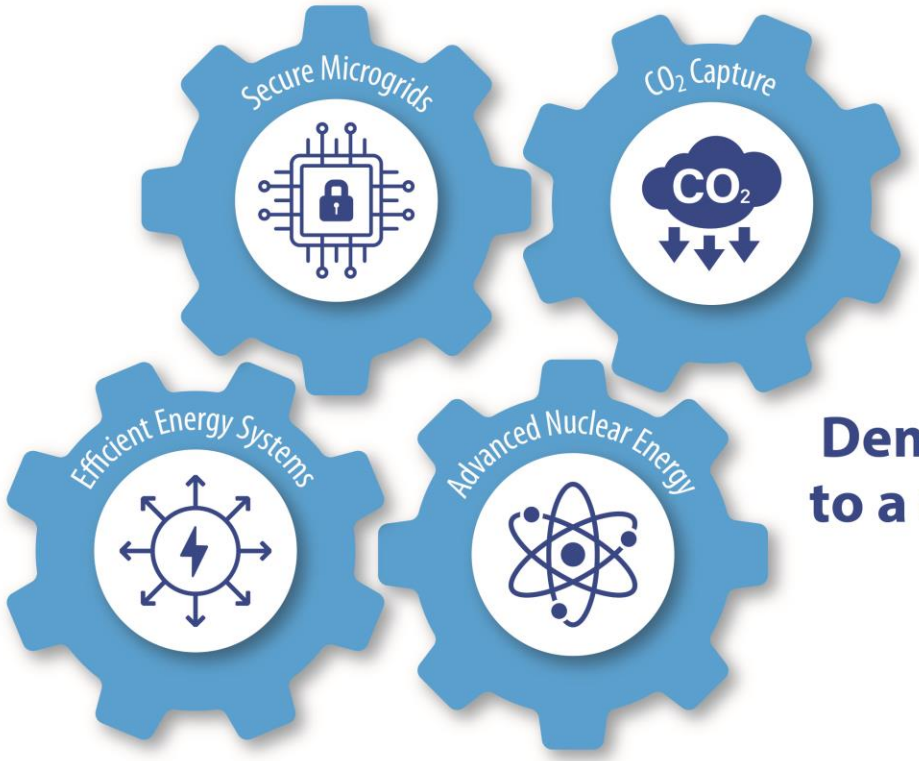
Net-Zero Labs: Leveraging Expertise

Idaho National Laboratory

NATIONAL ENERGY TECHNOLOGY LABORATORY

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Pacific Northwest
NATIONAL LABORATORY



Demonstrating the Path to a Clean Energy Future

Executive Order 14057

DECEMBER 08, 2021

Executive Order on Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability

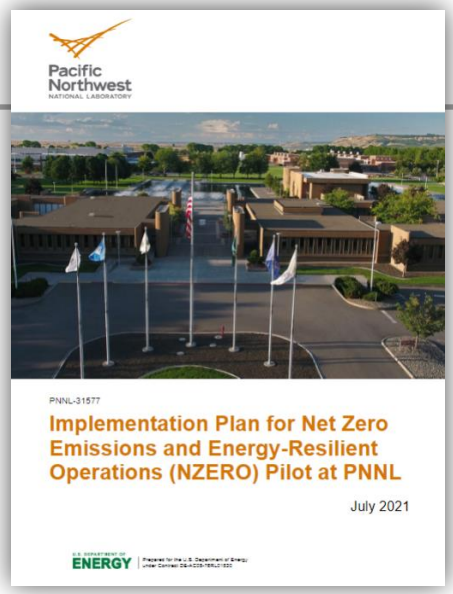
 BRIEFING ROOM ▸ PRESIDENTIAL ACTIONS

By the authority vested in me as President by the Constitution and the laws of the United States of America, and in order to reestablish the Federal Government as a leader in sustainability, it is hereby ordered as follows:

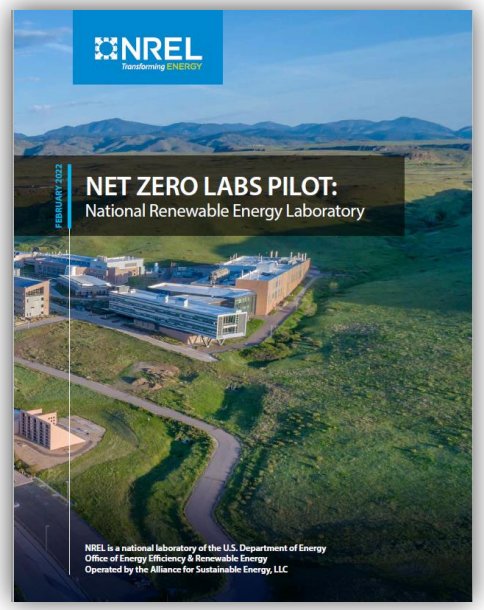
https://www.whitehouse.gov/briefing-room/presidential-actions/2021/12/08/

NZL Implementation Plans

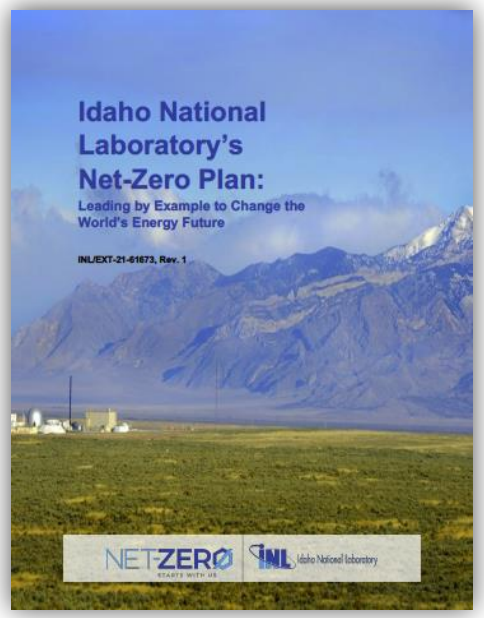
https://netl.doe.gov/node/11790



https://www.pnnl.gov/net-zero



https://www.nrel.gov/about/net-zero-labs



https://inl.gov/net-zero/

NZL Plan Highlights

INL

Planned Energy Source:
Nuclear & Hydrogen

Primary Mitigation Tool:
Nuclear-enabled microgrid

Signature Research:
Advanced nuclear on integrated microgrid

PNNL

Planned Energy Source:
Electricity

Primary Mitigation Tool:
Electrification, efficiency and district energy

Signature Research:
Data-driven, optimized control of diverse energy assets

NREL

Planned Energy Source:
Electricity, Hydrogen

Primary Mitigation:
Efficiency, electrification, and ground source heat pumps

Signature Research:
Advanced distributed energy districts

NETL

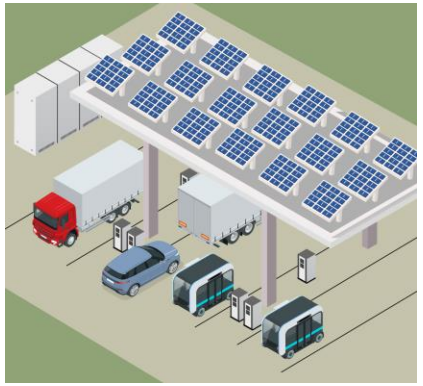
Planned Energy Source:
Biomass, Electricity, and Natural Gas

Primary Mitigation Tool:
Negative Emissions Tech.
Carbon Storage
Net Zero Power Purchase
Combined Heat & Power

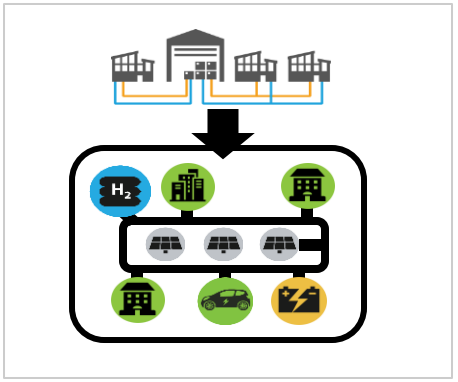
Signature Research:
Integrated Energy System
(Biomass, CCS, H_2)
Direct Air Capture

NREL Major Initiatives / R&D Focus Areas

Fleet Electrification



Distributed Energy District



Renewable Energy

Back-up Power

Next Steps

- ✓ Converting natural gas supply for HVAC equipment to non-carbon resources through an ESPC (2024)
- ✓ Collaborating with NREL's utility provider to create a new green tariff to purchase 100% Carbon pollution-free electricity annually that also provides 50% or greater match on an hourly (24/7) basis (2026)
- ✓ Installation of a hydrogen fuel cell through a 2023 awarded AFFECT grant to replace a diesel generator (2025)
- ✓ Installation of microgrid controller, solar array and energy storage for one facility (2025)
- ✓ Developing Digital Twin for Planning and Investment
- ✓ Contracting Fleet Electrical Vehicles when available from GSA

NET ZERO LABS PILOT:
National Renewable Energy Laboratory

NREL Net Zero Goals

Proposed Decarbonization Targets for NREL's Operational Footprint

End of FY24
Flatirons campus to operate at net zero emissions (Scope 1 and 2 only)

End of FY26
South Table Mountain campus to operate at net zero emissions (Scope 1 and 2 only)

End of FY30
Demonstrate NREL campus operations with 24/7 carbon-free energy (Scope 1, 2 and 3)

STM Campus

- Xcel Energy supplies 31% clean energy for purchased electricity
- 23% clean energy with solar and biomass

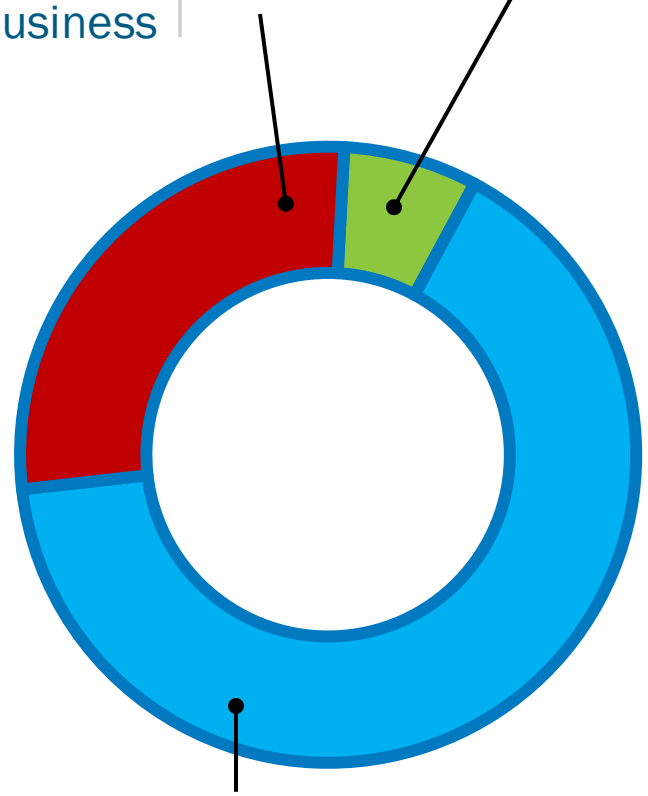
Flatirons Campus

- 33% clean energy with wind and solar
- Net-zero electricity annually

Tools for the biggest reduction

SCOPE 3: Indirect emissions from doing business
9,948 $MTCO_2e$

2,539 $MTCO_2e$
SCOPE 1: Direct emissions from sources NREL owns or controls



23,518 $MTCO_2e$
SCOPE 2: Indirect emissions from purchased electricity and heating

Challenges and Solutions

SCOPE 1:
Challenge: Natural gas supplies central plant
Solution: Conversion to non-carbon fuel sources

SCOPE 2:
Challenge: Xcel Energy 80% clean power by 2030
Solution: On-site and Off-site Renewable Systems

SCOPE 3:
Challenge: Staff Commuting and Business Travel
Solution: Increased staff ownership of electric vehicles, hybrid and remote work, and continuous use of virtual meetings

**Offset purchases only for Scope 3 or research emissions that cannot be mitigated*

NET ZERO LABS PILOT:
National Renewable Energy Laboratory

INL Major Initiatives / R&D Focus Areas

Fleet Electrification

Nuclear-Enabled Microgrids | Hydrogen Production

Value-Added Products

Nuclear-Enabled Microgrids

Next Steps

- ✓ Continue converting LDV fleet to electric and hydrogen, as available, from GSA; R99; hydrogen fuel cell motorcoach testing
- ✓ Microreactor demonstrations on integrated microgrids for CFE
- ✓ HVAC electrification; increase building efficiencies through automated HVAC programs
- ✓ PPAs with energy suppliers
- ✓ Nuclear education workshops with utilities

NET ZERO LABS PILOT:
Idaho National Laboratory

PNNL NZERO: Net Zero Emissions and Energy Resilience Operations

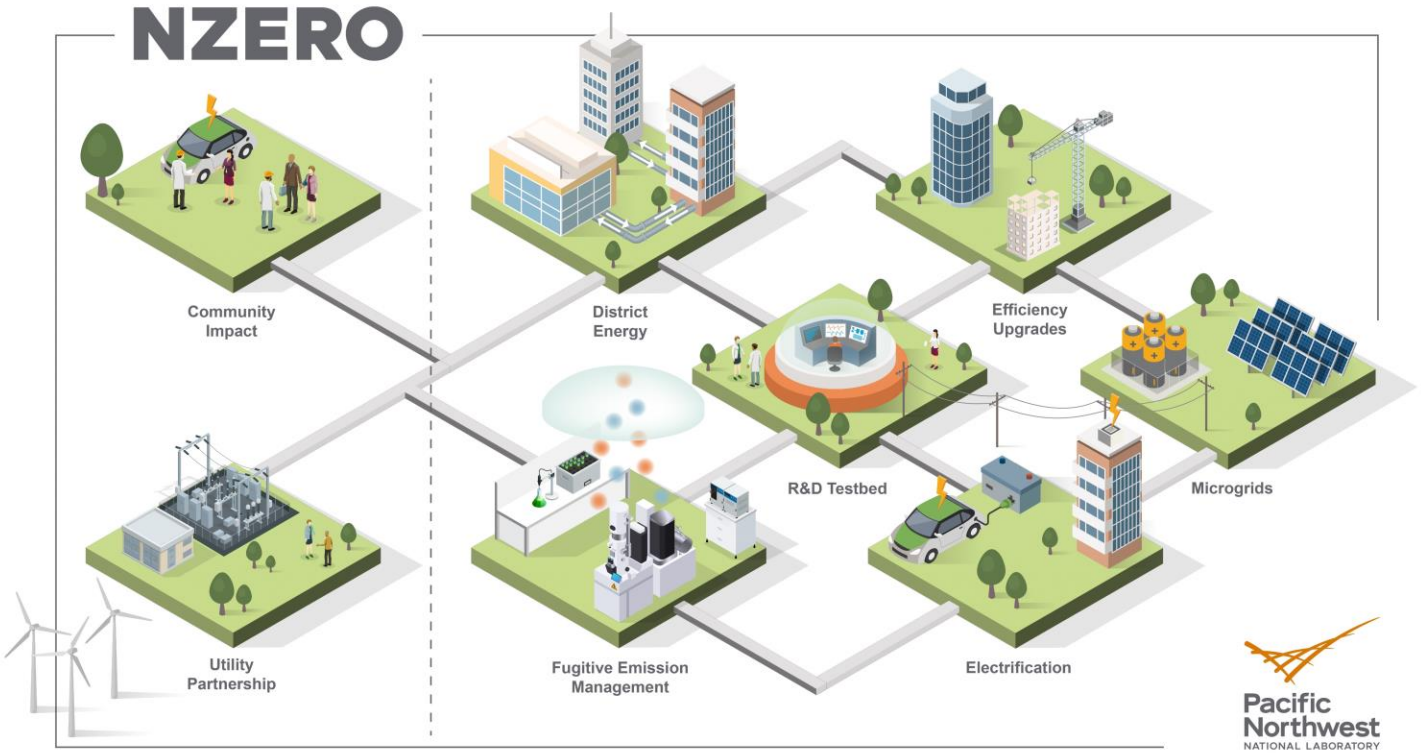
Achieve net zero greenhouse gas emissions with 24/7 carbon-free energy, and demonstrate the role of demand flexibility to support carbon-free energy

Reduce energy use in facilities and vehicles

Replace fossil fuels with cleaner alternatives

Resilience to electric utility disruptions

Research energy system design, integration, and operation



Pacific Northwest NATIONAL LABORATORY

National Energy Technology Laboratory: Direct Air Capture Test Center

NET ZERO LABS PILOT:
National Energy Technology Laboratory

Challenges, Opportunities, & Lessons Learned

Challenges

- Funding
- Timeline
- Moving from competition to collaboration

Opportunities

- Collaborations among all 17 national labs
- Industry partnerships

Lessons Learned

Smart Labs

Strategies for Optimizing Performance, Efficiency, and Safety

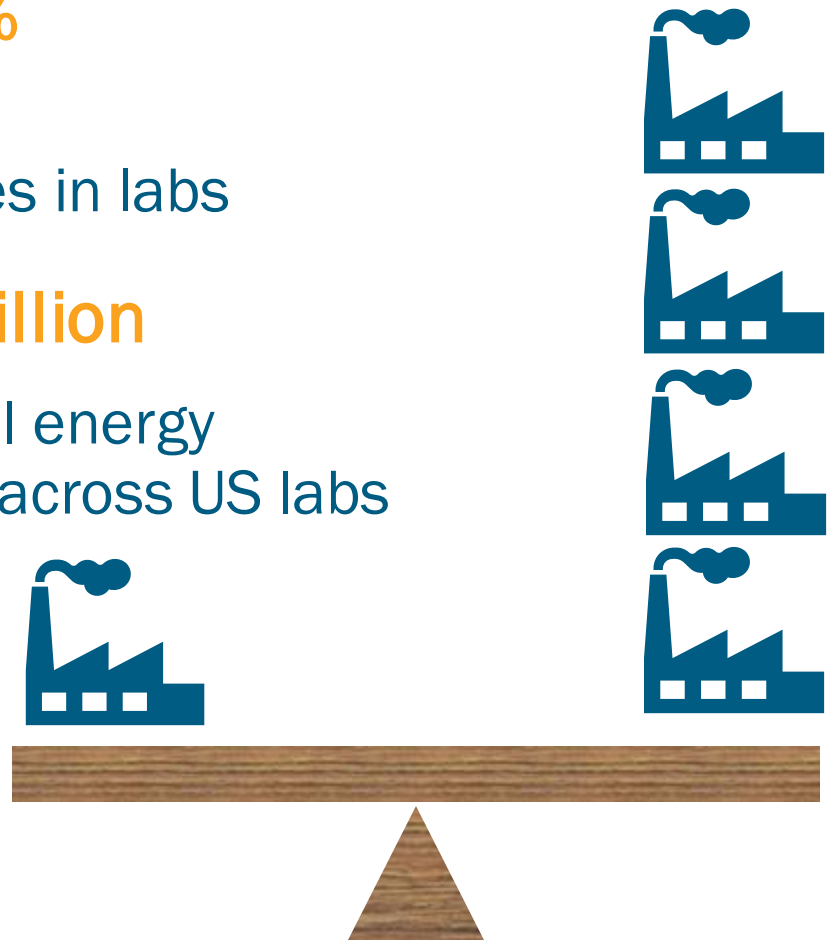
Why Labs?

20% - 40%

Cost-saving opportunities in labs

$1-2 Billion

Potential energy savings across US labs



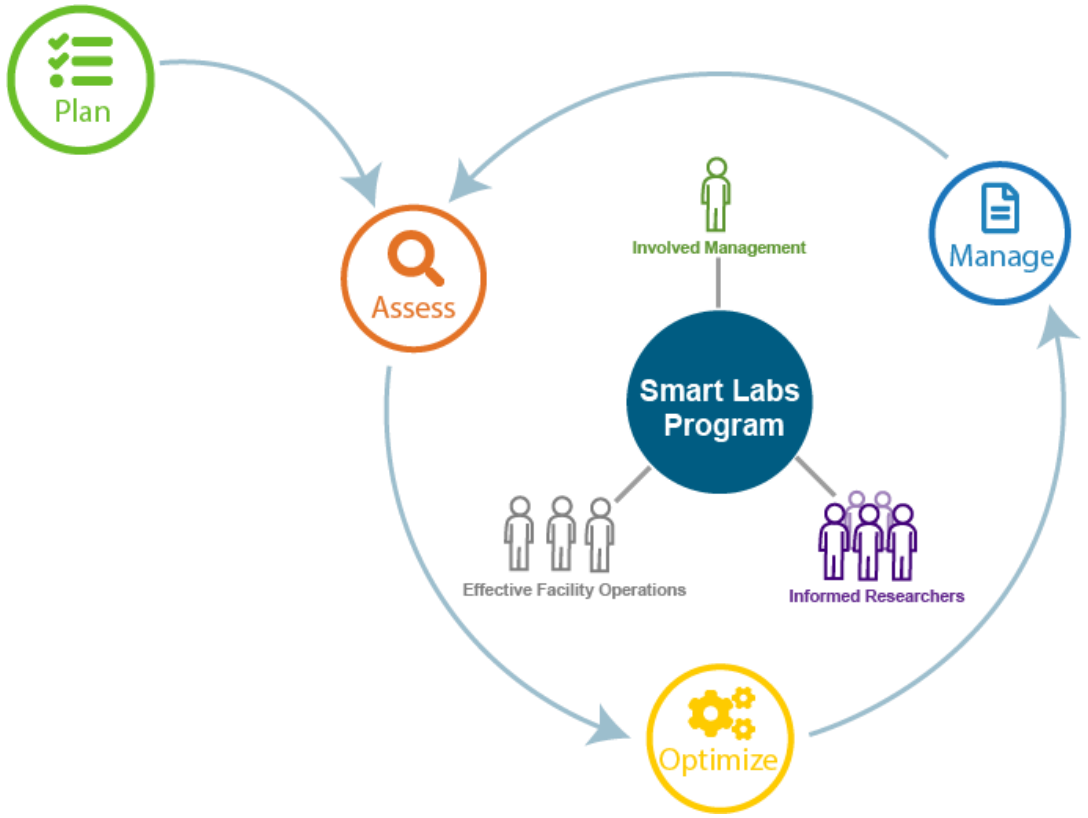
Laboratories typically use 3 - 4 (up to 10) times more energy than an average office building.

Office

Laboratory

* Values estimated based on the Commercial Buildings Energy Consumption Survey (CBECS) and study completed by Lawrence Berkeley National Laboratory entitled, "Characterizing the Laboratory Market"

The Future is...Smart Labs!



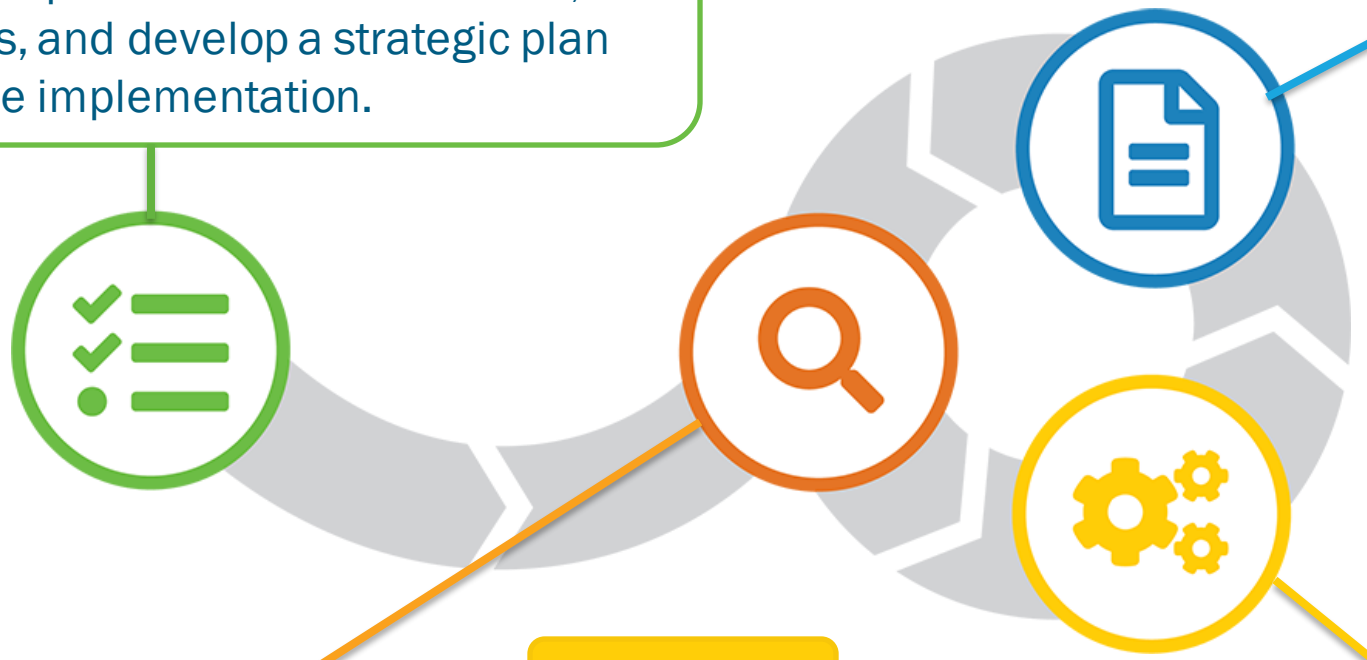
A Smart Labs program enables **world class science** through the design and operation of **safe and efficient** high-performance labs.

- ✓ **Optimize** safety
- ✓ **Reduce** costs
- ✓ **Improve** energy efficiency
- ✓ **Maintain** high-performance laboratories

The Smart Labs Process

Plan

Form a team comprised of lab stakeholders, profile buildings, and develop a strategic plan for cost-effective implementation.



Manage

Implement a performance management plan to continue to achieve safe and efficient labs.

Assess

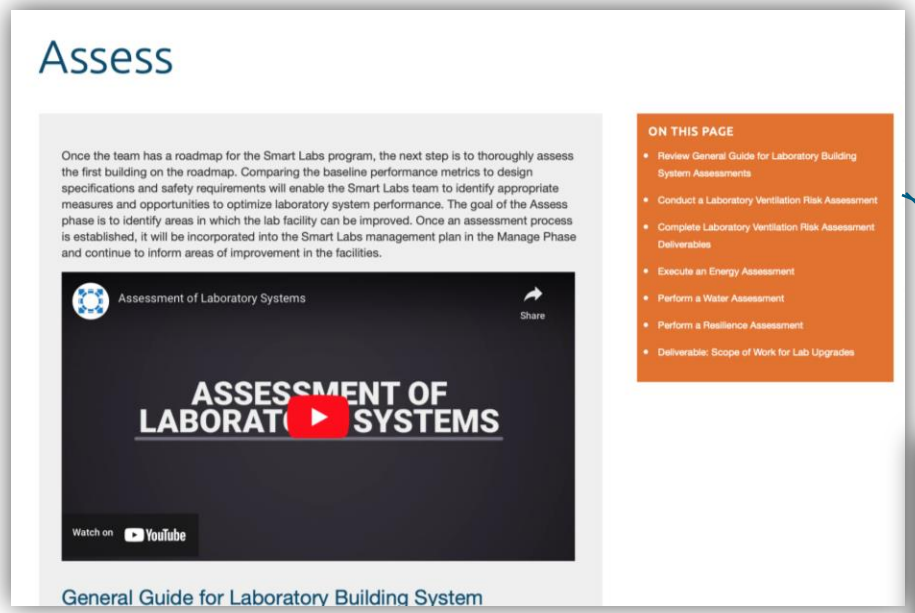
Review the laboratory ventilation system and other building systems to develop a scope of work for optimizing systems.

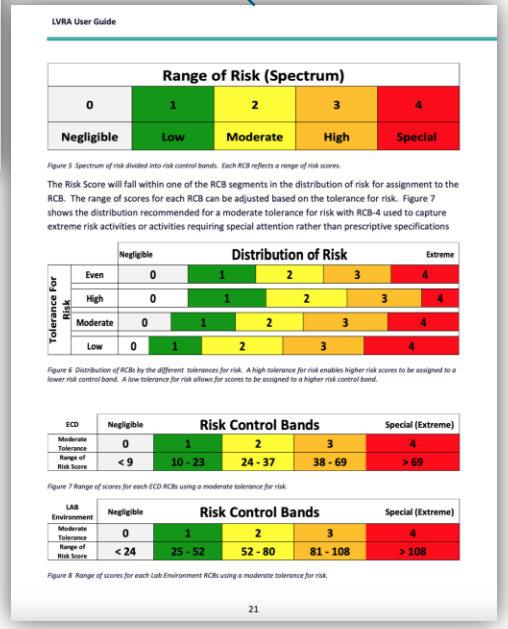
Optimize

Execute meaningful projects to improve building systems in laboratories.

The Smart Lab Toolkit

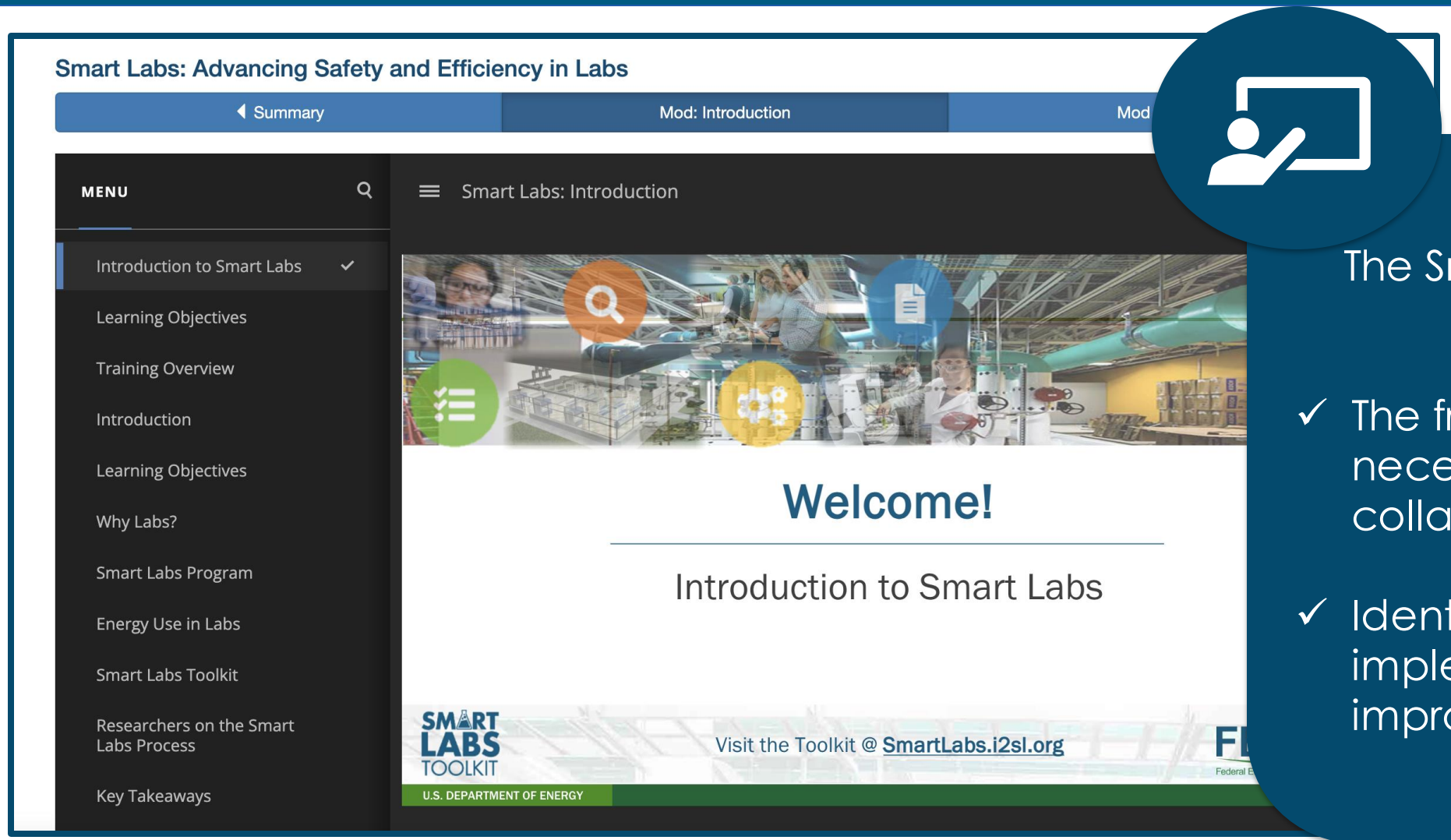
Visit the Toolkit @ **SmartLabs.i2sl.org**





- ✓ Partner Case Studies
- ✓ Step-by-step Guidance
- ✓ User Friendly Tools & Calculators
- ✓ Helpful Resources & Templates
- ✓ Best Practice Guides

Smart Labs Training



The Smart Labs training provides:

- ✓ The framework necessary to assemble a collaborative team
- ✓ Identify and implementing efficiency improvements.

The Smart Labs Training

Decarbonizing Checklist

Visit the Toolkit @ **SmartLabs.i2sl.org**

Get the ventilation right!

- Conduct recurring LVRAs
- Modify setpoints and operating specs to optimize HVAC systems

Consider energy recovery

- Exhaust energy recovery
- Heat recovery chillers
- Other sources of waste heat:
  - Data centers
  - Sewer pipelines

Install heat pump, air-source or ground source

Thank You!

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FEMP 50
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