Healthcare Design & Decarbonization: Can They Coexist?

Presented at ASHE Region 6 Annual Conference

March 30th, 2023

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Presented by:
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AKF Group

Learning Objectives:

This presentation will enable attendees to:

1. Understand the various regulations being adopted throughout the country and how they can affect you.

2. Recognize the financial impacts related to non-compliance of local regulations.

3. Identify strategies to minimize building energy to offset carbon footprints.

4. Examine various benchmarking tools available to aid informed decision-making.

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Healthcare (We are here because we know what Healthcare is)

Today we will be talking about spaces including:

- Hospitals
- Medical Office Buildings
- Ambulatory Surgery Centers
- Medical Lab and Research Centers
- Stand alone Emergency Department

Many similarities between these, Some Differences

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Decarbonization

When you hear Decarbonization this may not mean the same thing to everyone here. For this presentation we are focusing on:

Finding ways to limit or eliminate the release of the by-products of carbon dioxide and other green house gases into the atmosphere.

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Decarbonization

When we talk about Carbon Accounting we can look at:

Operational vs Embodied

Building Energy vs Transportation

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Decarbonization In Buildings

For buildings decarbonization is focused on:

- **Limiting energy use** (to limit carbon created by generating energy)
- **Going all electric (Electrification)**
  (no fossil fuels burned on site + electricity generate CAN be from renewable means)
- **Generating renewable/carbon-free electricity on site**
  (typically solar panels also referred to at Photovoltaic panels or PV)

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Healthcare and Decarbonization

Both aim to help people

But sometimes what is needed for one seems opposed to what is needed for the other.

Healthcare		Decarbonization
Fresh and Filtered Air	→	Uses more energy to temper and filter
Need quick & effective means for sterilizing tools	→	Effective solutions like steam often use fossil fuel energy
Hospitals need to be available 24/7 for patient care – no down time	←	Save Energy/Pollution by turning off systems when not in use
Connections to the outside/nature are important for patient healing	←	Minimize windows to improve building envelope performance

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So Why Try to Decarbonize Healthcare?

- Better For the Environment…
  - Minimize impacts on population health
  - Resiliency

- Is or May Become Required
  - Several Cities and States are now passing policies and codes that will require buildings to take steps to help decarbonize.

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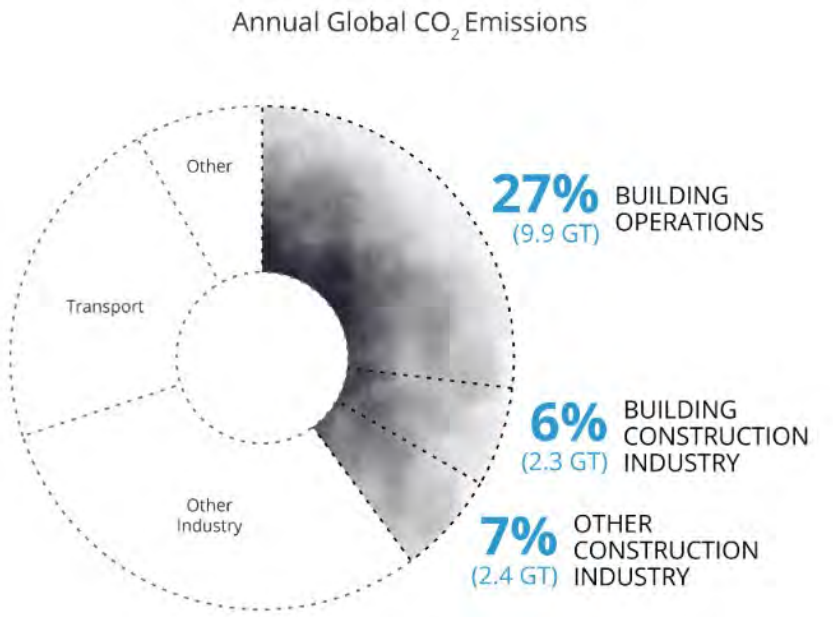
So Why Try to Decarbonize Healthcare?

THE BUILT ENVIRONMENT



Building Construction Industry and Other Construction Industry represent emissions from concrete, steel, and aluminum for buildings and infrastructure respectively.

The built environment generates 40% of annual global CO2 emissions.

Of those total emissions, building operations are responsible for 27% annually, while building and infrastructure materials and construction (typically referred to as embodied carbon) are responsible for an additional 13% annually.

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So Why Try to Decarbonize Healthcare?

EXISTING BUILDINGS

In 2040, **2/3 of the global building stock** will be buildings that exist today.
Without upgrades, they will still be emitting GHGs.

Data Source: IEA Energy Technology Perspectives 2020, February 2021 Revised Edition

In 2040 approximately 2/3 of the global building stock will be buildings that exist today.

Without widespread existing building decarbonization across the globe, these buildings will still be emitting CO2 emissions in 2040 and we will not achieve the Paris Agreement's 1.5°C target.

Achieving zero emissions from the existing building stock will require leveraging building intervention points to accelerate the rate of energy upgrades (increasing energy efficiency, eliminating on-site fossil fuels, and generating and/or procuring 100% renewable energy).

Actions for Existing Building

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Decarbonization and USA/State/City Initiatives

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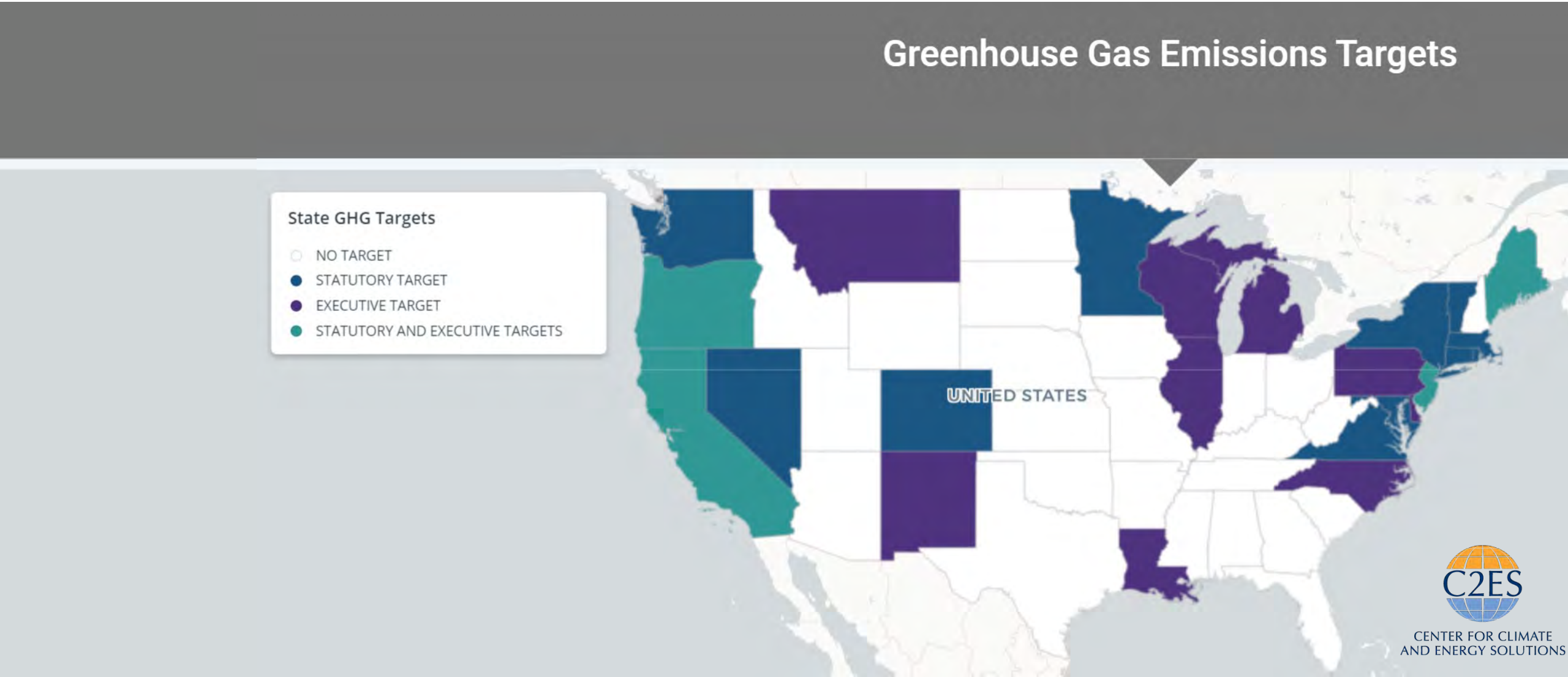
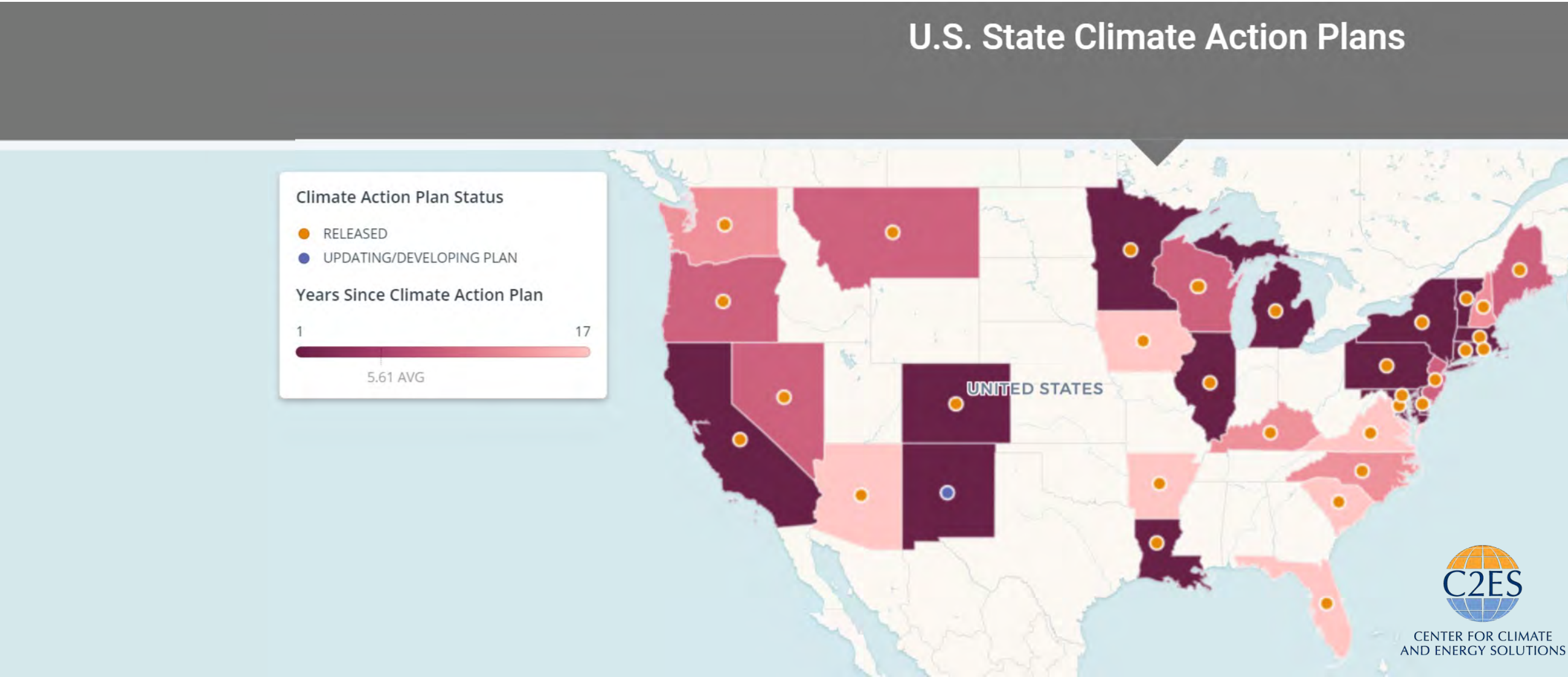
Where Are Decarbonization Policies Happening?

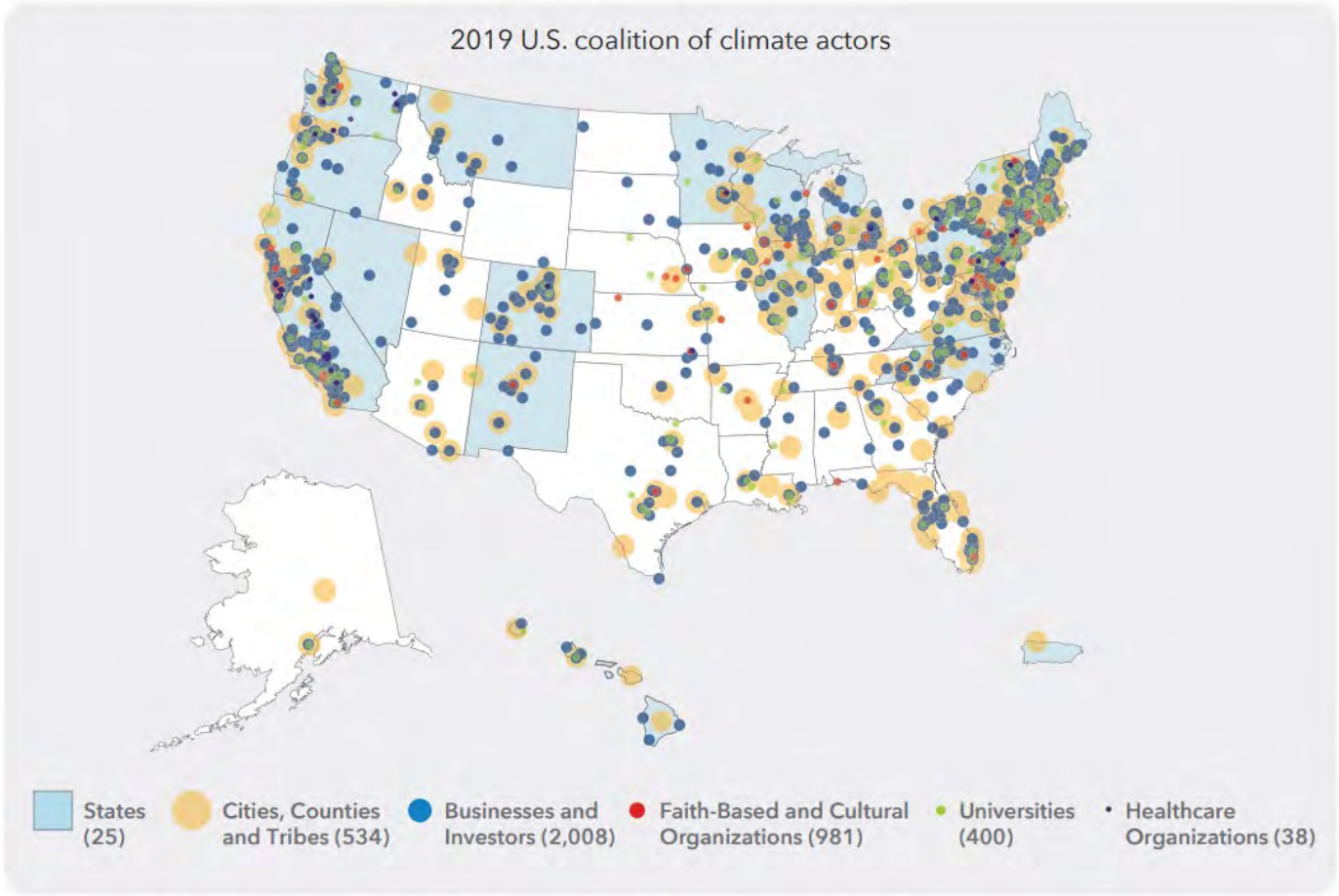


Where Are Decarbonization Policies Happening?



Where Are Decarbonization Policies Happening?

Figure ES-3 | **Actors Supporting the Paris Agreement**



▲ Thousands of leaders, with real policy and financial power across our federal system in the United States, have committed to climate action in their jurisdictions or within their organizations.

From Executive Summary:
https://americaisallin.com/sites/default/files/2022-09/executive-summaryaccelerating-americas-pledge.pdf

Where Are Decarbonization Policies Happening?

The *Clean Energy and Efficient Buildings* goal of Minnesota's Climate Action Framework looks to tackle these challenges, with solutions that will save Minnesotans money and protect our climate.

Some of these solutions include...

- Establishing a standard to achieve 100% carbon-free electricity and 55% renewable electricity by 2040.
- Adapting our grid through transmission upgrades to enable greater reliability and renewable energy access and integration.
- Improving building codes and standards so that all new commercial and large multi-family buildings produce net-zero greenhouse gas emissions by 2036.

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https://climate.state.mn.us/

It is important to the current policies/codes AND key and eye on proposed future changes to these

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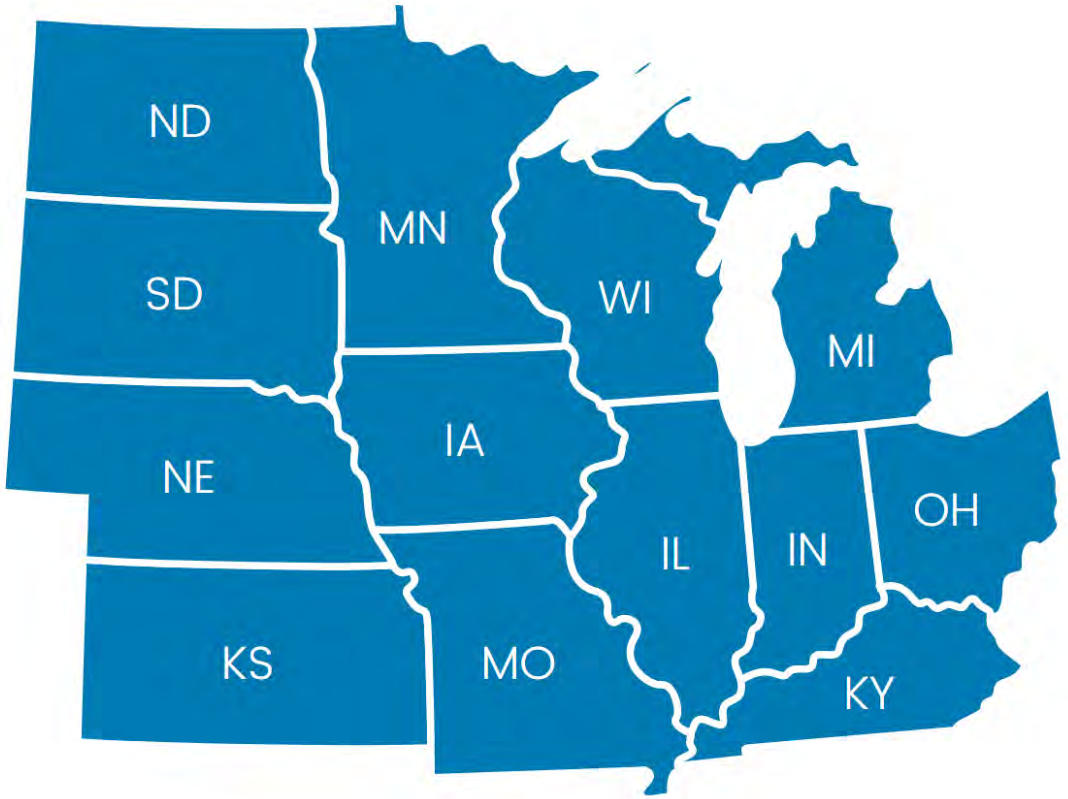
Policy by State

https://www.mwalliance.org/initiatives/policy



Why Care About Policies?

- Can have a significant impact on what will be required
- May mean you have to pay penalties for energy use
- May change the order and magnitude of your future capital projects.

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Example: Boston and Massachusetts

Recent Codes and Policies:

- Statewide:
  - Massachusetts Energy Efficiency Code

Base Code (IECC 2021)	Stretch Code (2023 update)	Specialized Code ("Net-Zero")
• New construction in towns & cities not a green community • **52 communities** Expected from BBRS: **July 2023**	• New construction in towns & cities that are a green or stretch community • **299 communities** **Residential : Jan 2023** **Commercial: July 2023**	• New Construction in towns & cities that vote to opt-in to this code • **Effective date:** Typically 6-11 months after Town/City vote

- City of Boston:
  - BERDO 2.0
  - Zero Net Carbon Building Zoning Initiative

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What buildings must comply?

BERDO 2.0 applies to Boston buildings that are:

- non-residential buildings over 20,000 square feet,
- residential buildings with 15 or more units,
- and/or any parcel with multiple buildings that adds up to 20,000 square feet or 15 units.

Example: Boston and Massachusetts

Statewide Impacts:

- New very stringent building envelope requirements
- Difficult compliance paths that favor all electric buildings
- Mandatory Air Tightness Testing
- Requirements to go all electric if building is more than 50% window to wall ratio

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Example: Boston and Massachusetts

City of Boston Impacts:

- BERDO 2.0: Imposes fines on buildings exceeding energy targets (starting in 2024)
- Healthcare facilities in Boston are facing potential fines of up to $1M per year starting in 2024 if they can't reduce their current energy usage

Building use	Emissions standard ($kgCO_2e/SF/yr.$)					
	2025 - 2029	2030-2034	2035-2039	2040-2044	2045-2049	2050-
Assembly	7.8	4.6	3.3	2.1	1.1	0
College/ University	10.2	5.3	3.8	2.5	1.2	0
Education	3.9	2.4	1.8	1.2	0.6	0
Food Sales & Service	17.4	10.9	8.0	5.4	2.7	0
Healthcare	15.4	10.0	7.4	4.9	2.4	0
Lodging	5.8	3.7	2.7	1.8	0.9	0
Manufacturing/	23.9	15.3	10.9	6.7	3.2	0
Industrial						
Multifamily housing	4.1	2.4	1.8	1.1	0.6	0
Office	5.3	3.2	2.4	1.6	0.8	0
Retail	7.1	3.4	2.4	1.5	0.7	0
Services	7.5	4.5	3.3	2.2	1.1	0
Storage	5.4	2.8	1.8	1.0	0.4	0
Technology/Science	19.2	11.1	7.8	5.1	2.5	0

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BERDO 2.0 Penalty Calculator

https://akf-berdo-calculator.herokuapp.com/

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BERDO 2.0 CALCULATOR

Property Types

Property Type 1

Healthcare

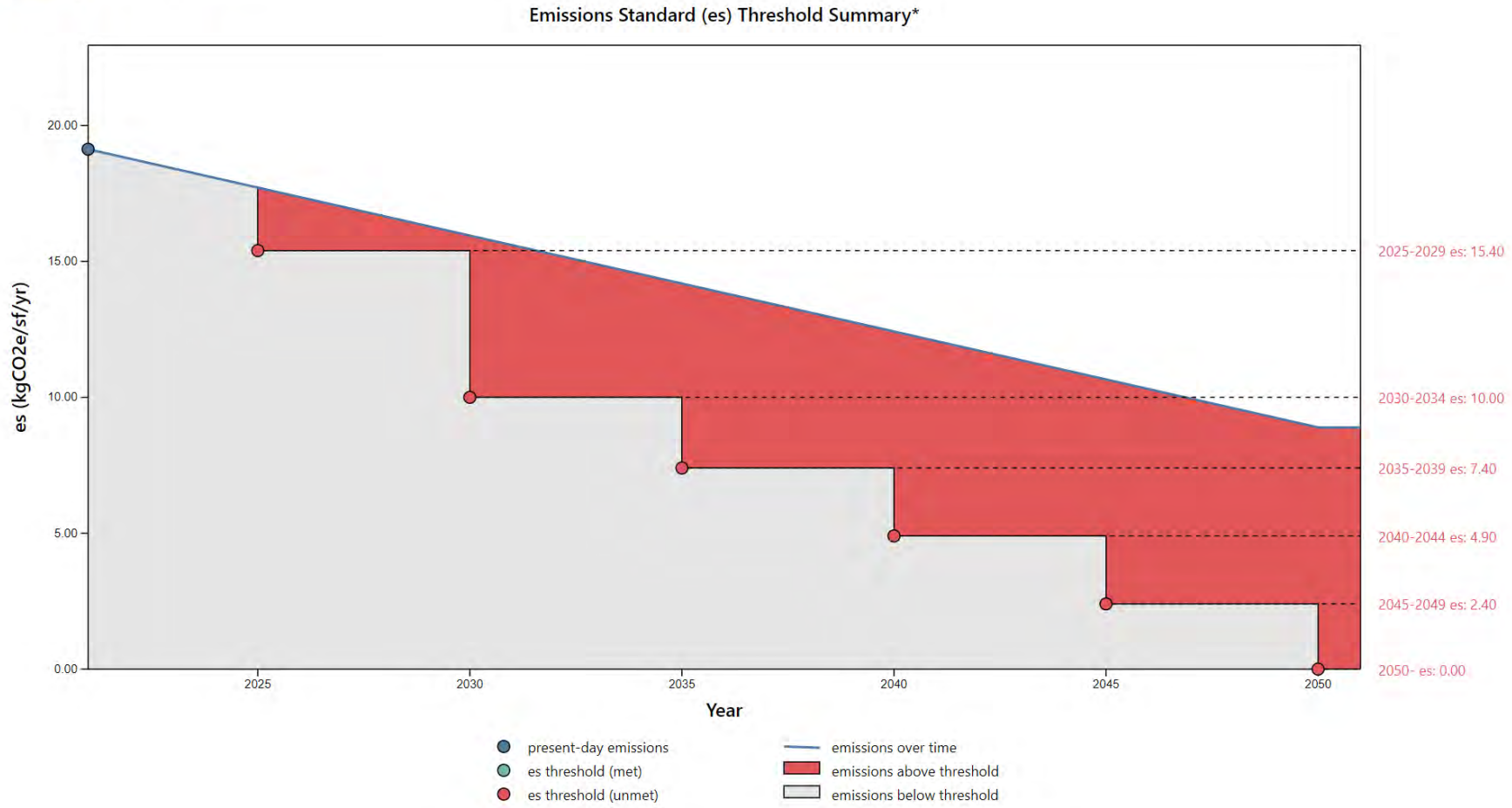
Area (sf)

100,000

ADD BUILDING TYPE

Utility Consumption

Onsite Renewable

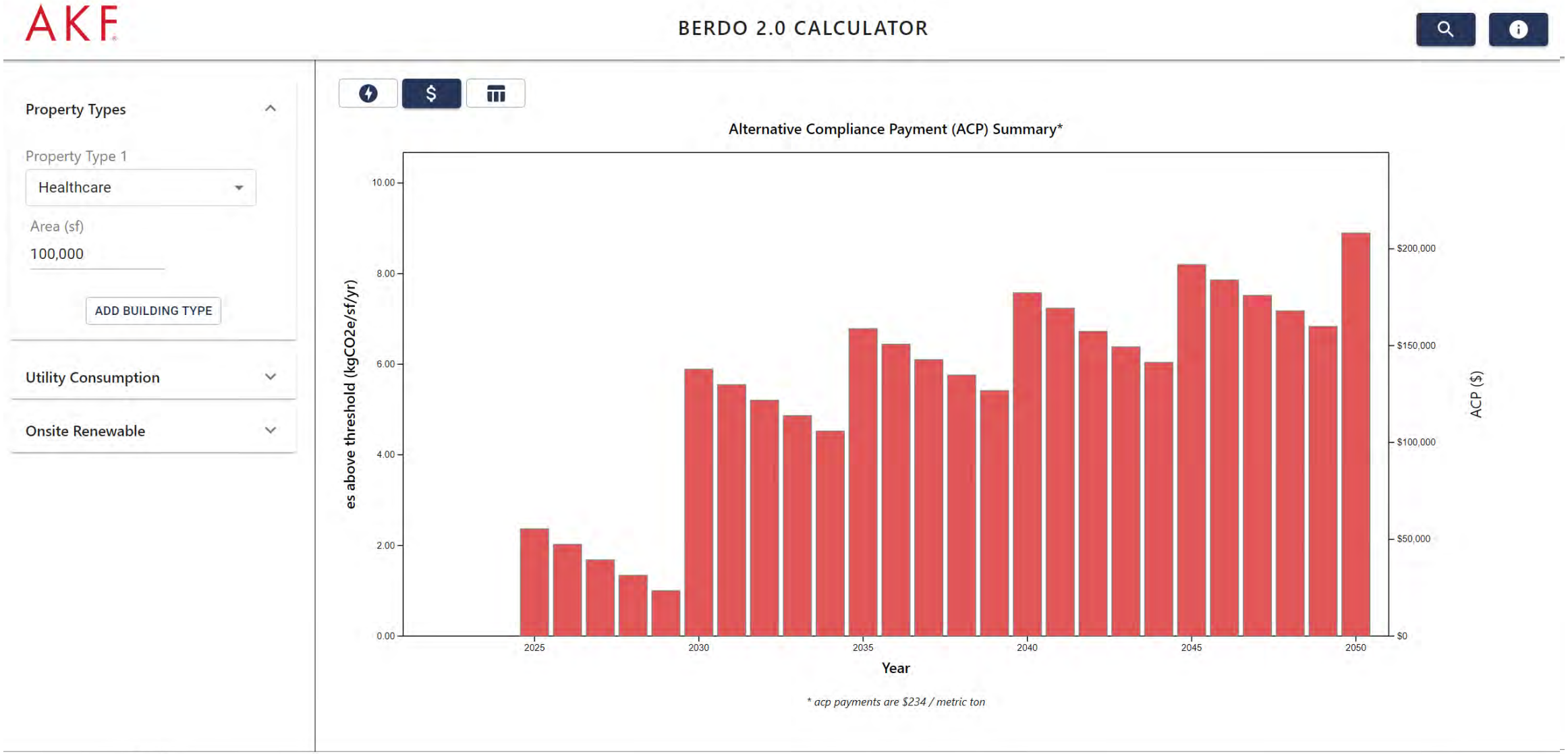


BERDO 2.0 CARBON NEUTRAL BOSTON 2050

CONTACT US

BERDO 2.0 Penalty Calculator

https://akf-berdo-calculator.herokuapp.com/



BERDO 2.0 Penalty Calculator

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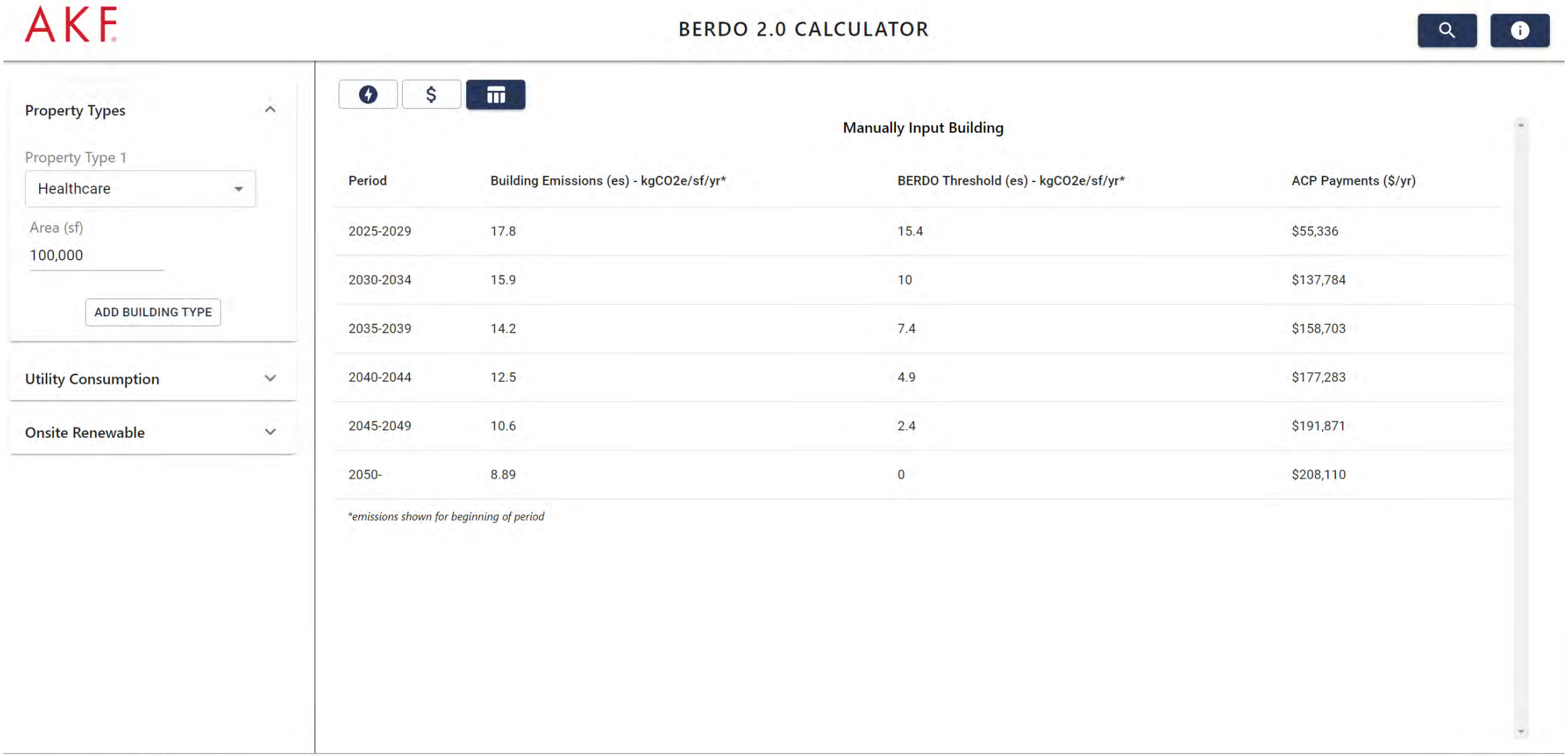


Tracking Your Energy and Setting Targets

ENERGY STAR® PortfolioManager®

The most-used energy measurement and tracking tool for commercial buildings.

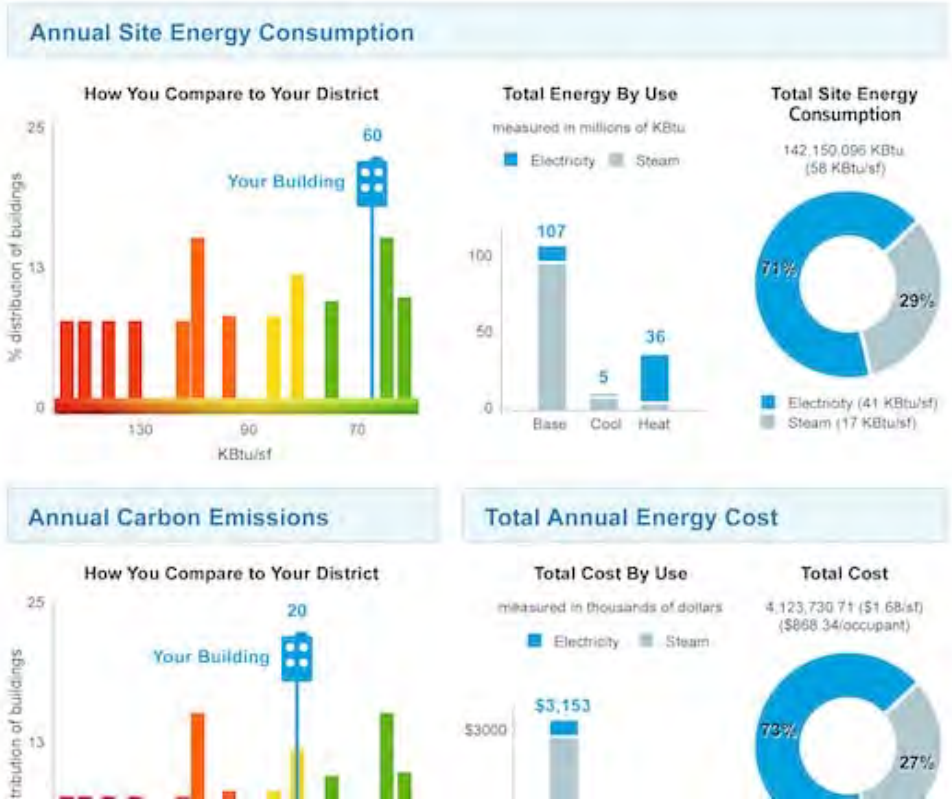
What is Benchmarking?

The first step to saving energy at your building is to benchmark — that is, to measure and compare your building's energy to similar buildings, past consumption, or a reference performance level.

Benchmarking turns the information on your utility bill into knowledge you can act on.

ENERGY STAR Portfolio Manager — the Industry Standard for Benchmarking Commercial Buildings

Portfolio Manager is an interactive resource management tool that enables you to benchmark the energy use of any type of building, all in a secure online environment. Nearly 25% of U.S. commercial building space is already actively benchmarking in Portfolio Manager, making it the industry-leading benchmarking tool. It also serves as the national benchmarking tool in Canada.



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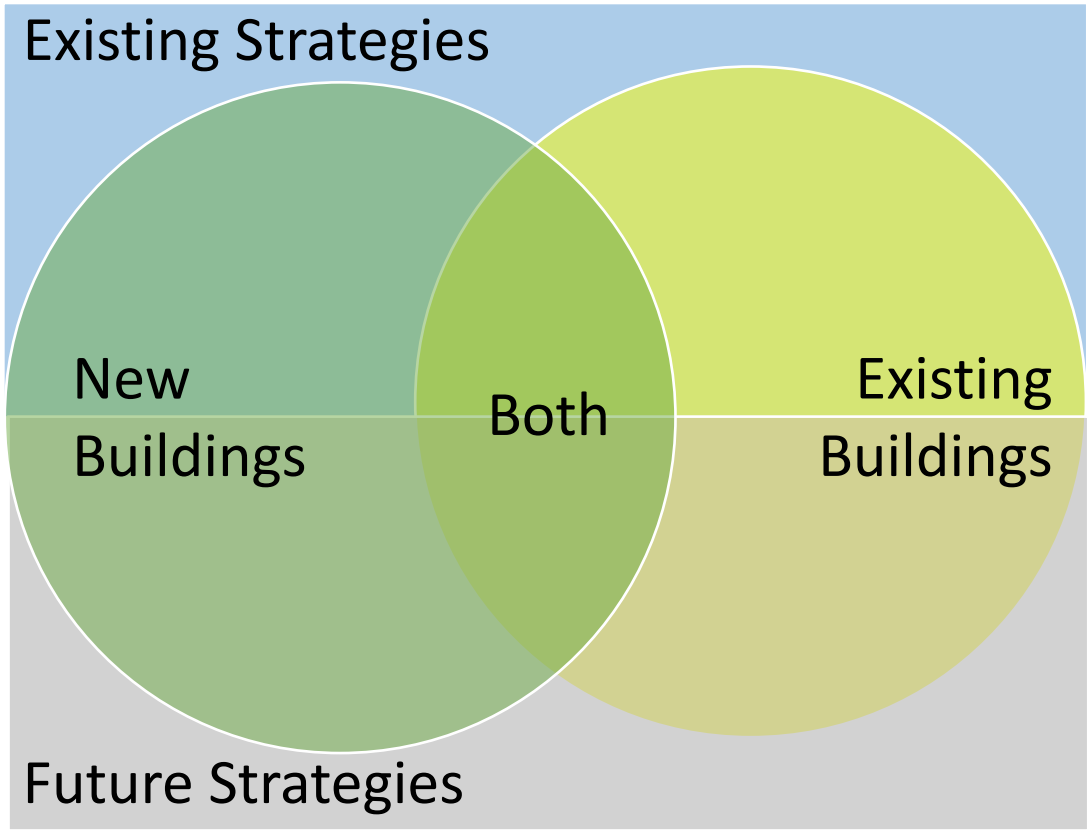
https://portfoliomanager.energystar.gov/pm/login.html

Decarbonization Strategies

- Save Energy
- Go Electric
- Make Energy



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Steps To Decarbonize: Reduce Energy Use

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Why Focus On Reducing Energy First?

Once a building is built, the majority of carbon comes from 2 things:

- By reducing annual energy, we automatically help reduce carbon.
- If we want to go all electric, reducing electric loads frees up capacity on electrical gear to power more energy intensive HVAC and process equipment that traditionally uses fossil fuel.

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Where Is Improvement Needed?

International Energy Agency (IEA) Analysis on Buildings
How are we doing towards Carbon Neutral?

Heating	More efforts needed
Space Cooling	More efforts needed
Lighting	On track
Appliances and Equipment	More efforts needed
Building Envelopes	Not on track
Heat Pumps	More efforts needed

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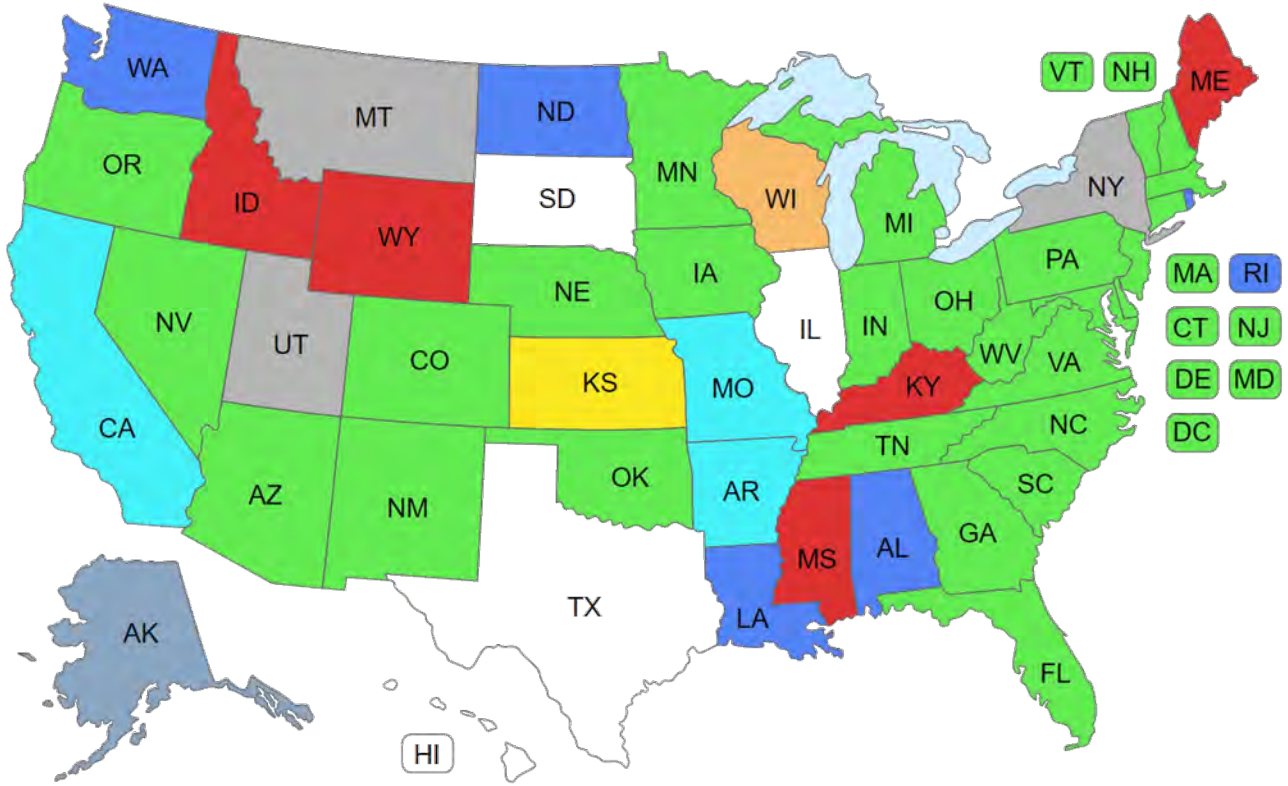
https://www.iea.org/reports/buildings

Additional Challenges in Healthcare:

FGI Guidelines: Adoption Map



Key	
2018	
2014	
2010	
2006	
2001	
1996-97	
Equivalency*	
HVAC Only	

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FGI requirements may impact some potential strategies so be aware!

Existing Strategies: New Buildings

While these updates CAN be done in existing buildings, the costs and impacts are significant

Space Zoning by usage schedule	Building Envelope Improvements
Alternate/Additional adjacencies hierarchy Example: 24-hour vs Limited hours • Allows limited hours areas to drift or shut off • Goal is to zone equipment with schedules • For central plant: use multiple units and stage # of units on based on demand.	Key Considerations: • Window to Wall Ratios • Insulation and Limiting Thermal Bridging • Air Tightness

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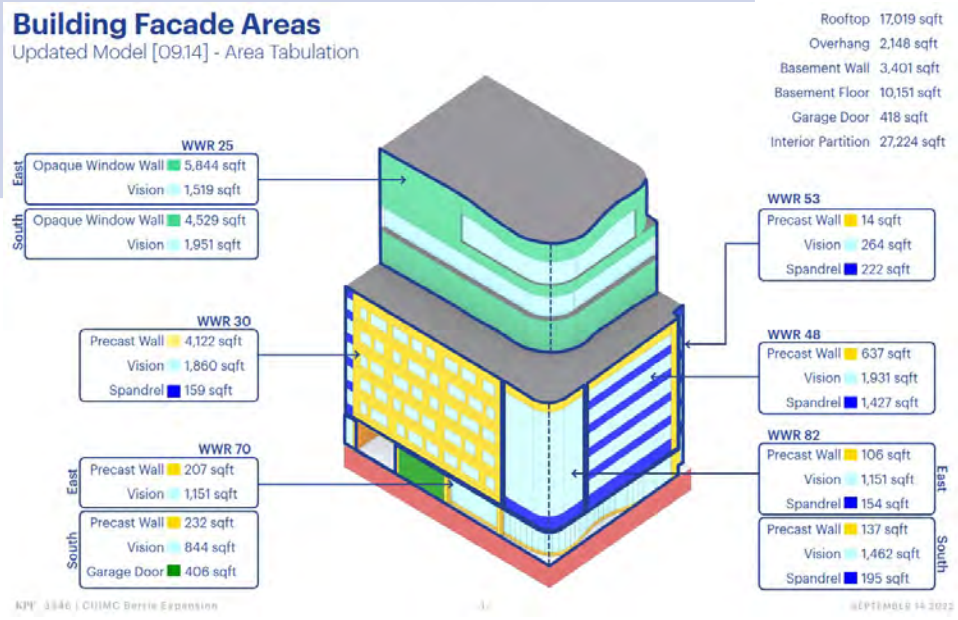
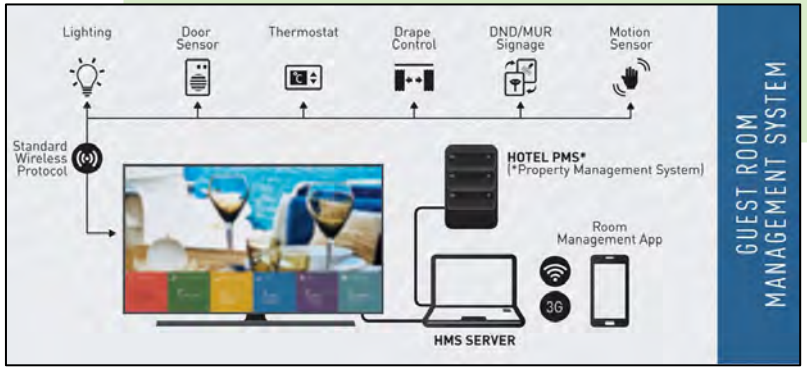
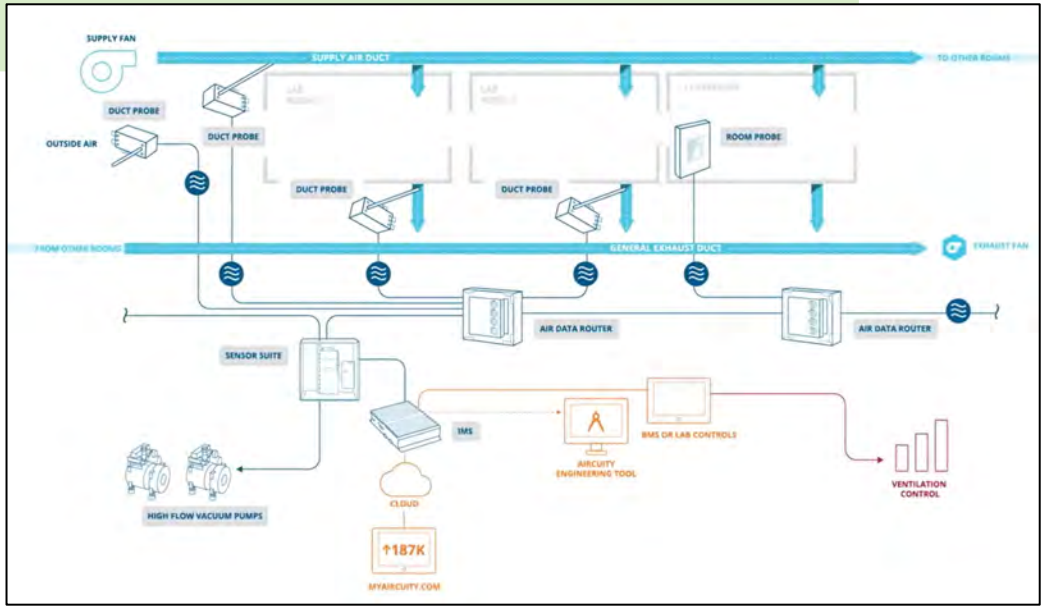


Existing Strategies: Both (New and Existing)

These strategies will be easier in New but possible in existing with a renovation

Take a page from Hotels…	Dynamic Control of Ventilation
Use Guest Room Management System • Shuts off all lights if unoccupied • Sets back ventilation and heat/cool	Monitor space air quality and provide ventilation air as needed (not by default) • Air monitoring such as Aircuity • Example spaces: ORs, Lab, atriums and waiting rooms.





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Existing Strategies: Both (New and Existing) Building Controls

Automated controls for building systems are continuing to grow more import and more sophisticated

New Buildings	Existing Buildings
Consider controls options that may result in more savings: • Additional Metering/Monitoring for more granular understanding of energy • Smart Building Technology such as space usage tracking	Conduct a review of the system and settings • Look for past overrides or temporary adjustments that did not get put back • Add controls or improve controls for systems that didn't have them (lighting) • Conduct testing to see if additional energy savings can be achieved with small setpoint adjustments.

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EERE found that state of the art controls can save buildings as much as 29% energy of building energy

https://www.energy.gov/eere/buildings/building-controls

Existing Strategies: Both (New and Existing) Reheat

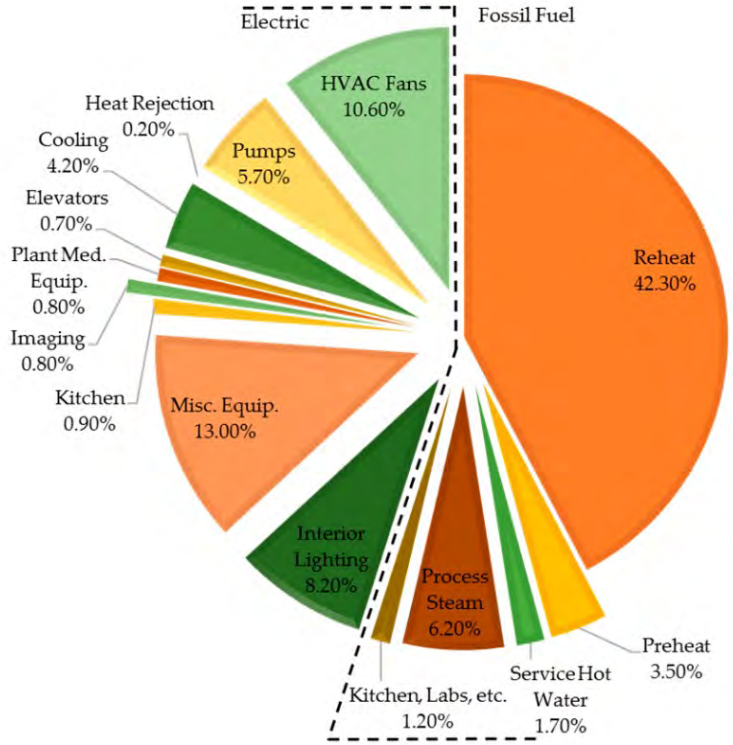

Figure 3. Breakdown of energy consumption in a U.S. hospital.
https://www.mdpi.com/1996-1073/12/19/3775

Air Changes are the largest driver Reheat Loads

Air is delivered at 55°F year-round for cooling but in patient areas the air changes needed over cool the space, so local re-heat is required.

Focus pre-Covid was on strategies to reduce air changes and improve filtration, but that has been challenged post-Covid.

Using 4 pipe heat pumps to create chilled water result in waste heat can be captured and used.

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https://www1.eere.energy.gov/buildings/publications/pdfs/alliances/hea_plugloads.pdf

Existing Strategies: Both (New and Existing) Plug Loads

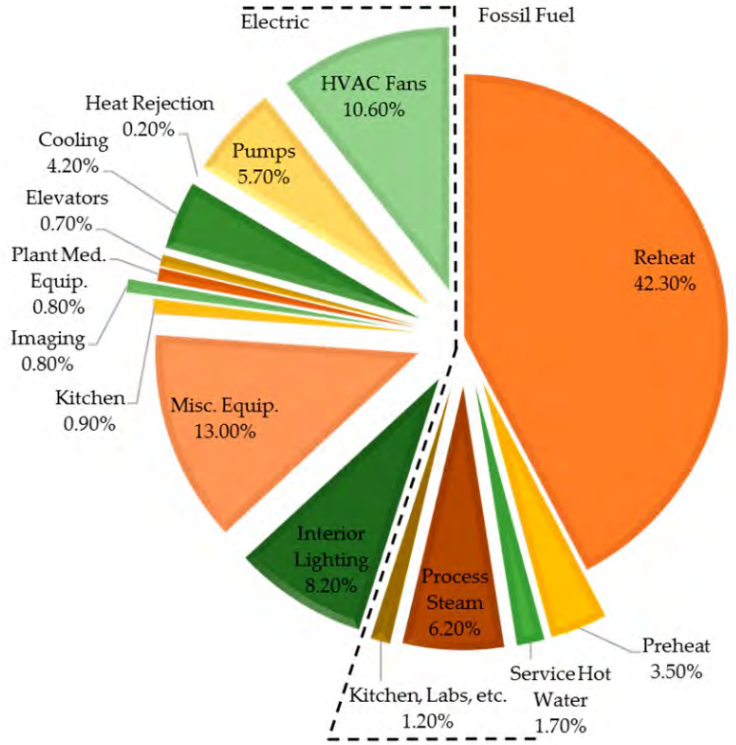

Figure 3. Breakdown of energy consumption in a U.S. hospital.
https://www.mdpi.com/1996-1073/12/19/3775

Patient Care is key in Healthcare. Plug in equipment is a core part of that care.

Plug in equipment accounts for
6 to 18% of total site energy in hospitals.

Strategies to reduce plug load energy:

- Medical Equipment: Look for standby & sleep modes.
- Where possible, buy Energy Star equipment
- Move to laptops (lower energy!)
- Look at what can be de-energized over night

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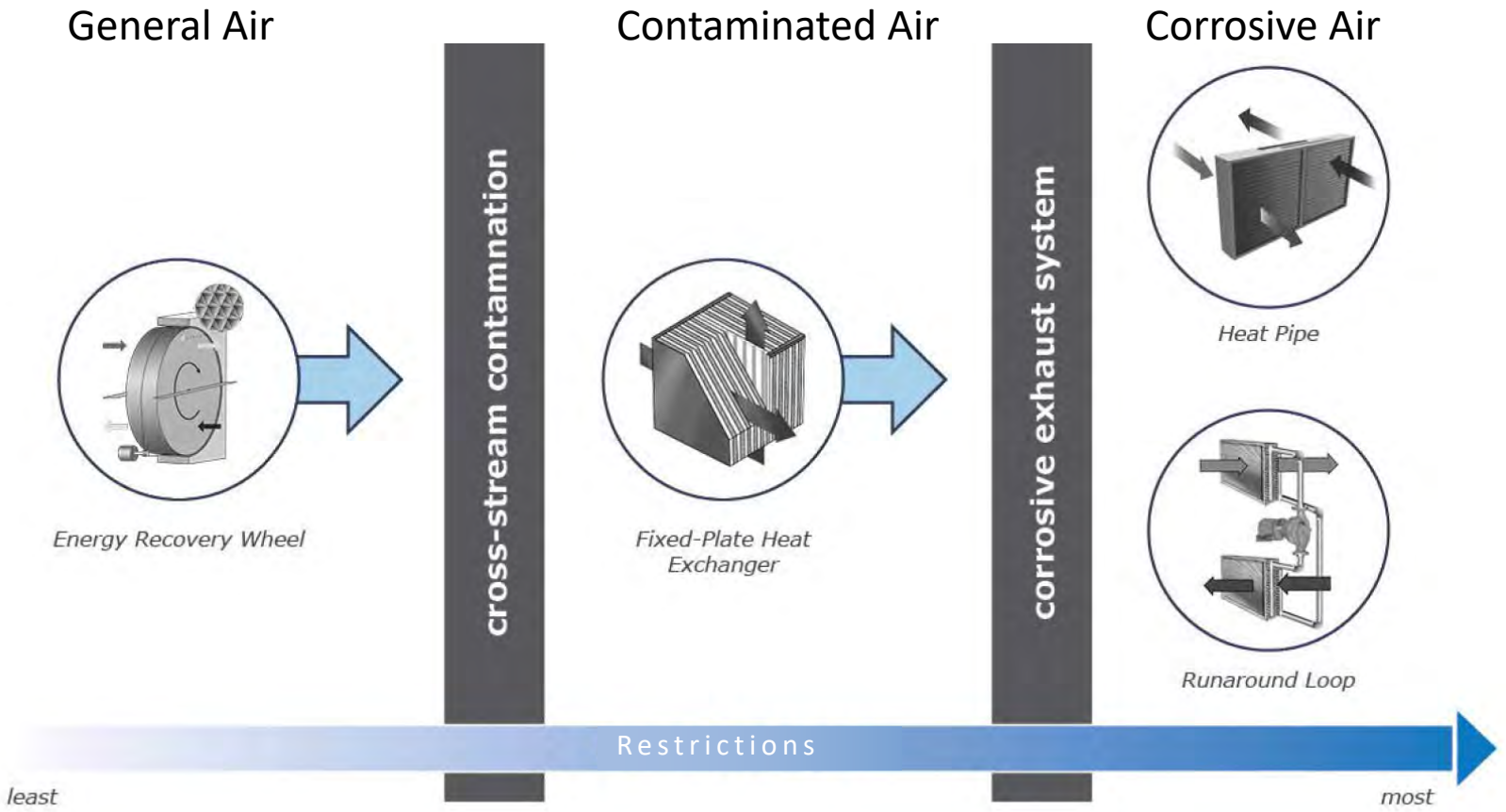
https://www1.eere.energy.gov/buildings/publications/pdfs/alliances/hea_plugloads.pdf

Existing Strategies: Both (New and Existing) Heat Recovery

Case Study:
Memorial Sloan Kettering Cancer Center
New York, NY

Energy Recovered by System:

	Fixed Plate	Runaround Loop	Heat Pipe
Summer % Recovered	59%	46%	33%
Winter % Recovered	64%	49%	55%
Outdoor temp when heating is needed	28 °F	35 °F	30 °F



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https://technologyportal.ashrae.org/papers/paperdetail/11195

Existing Strategies: Both (New and Existing) Occupant Engagement

Engage Staff In Energy Saving

- Invite departments to discuss ways to reduce energy WITHOUT negatively impacting patient care or the needs of their job.
- Celebrate energy savings with everyone (don't compete against, compete together)

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Existing Strategies: Existing Buildings

Maintaining existing buildings helps minimize embodied carbon but existing buildings need care and updates

Energy Audits	Retro Commissioning
If you haven't done this yet, now is the time • Lighting and Controls • Old or poor preforming systems • Replacing filters • Look for air leaks and other issues	More involved than an audit • Meter and measure system performance • Run testing on building systems • Verify set points and performance

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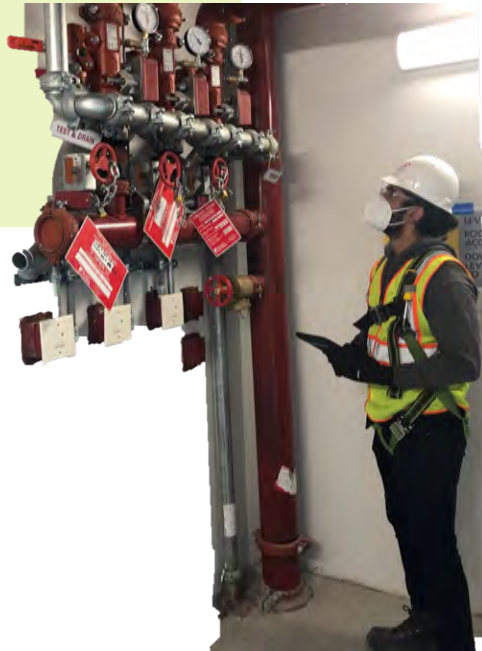

Existing Buildings – Planning

Finding money for changes and upgrades can be a challenge.

It is important to strategize and plan. Studies can be a helpful way to prioritize and strategize for improvements that set the stage for larger changes down the road.

Examples:

- Start replacements with smaller units that can be connected and phased in over time
- Future Expansion? Use this to springboard system changes

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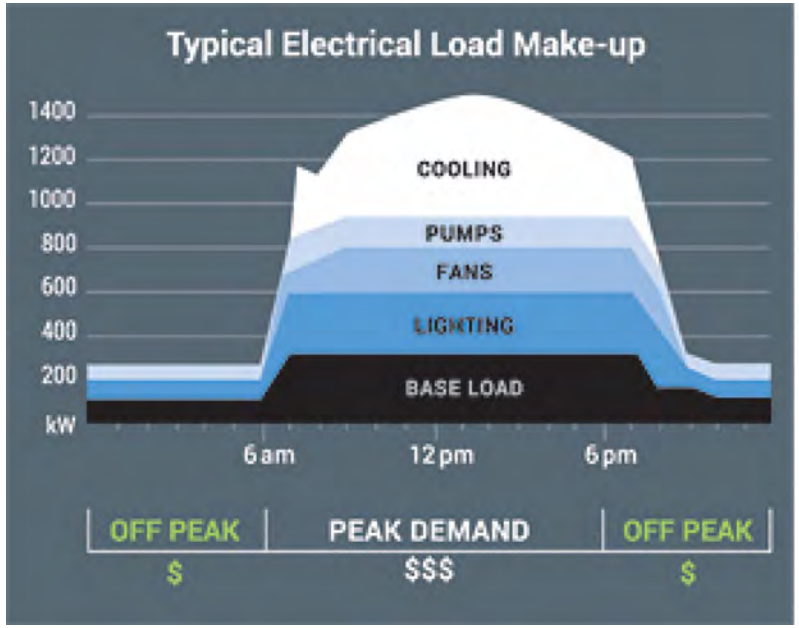
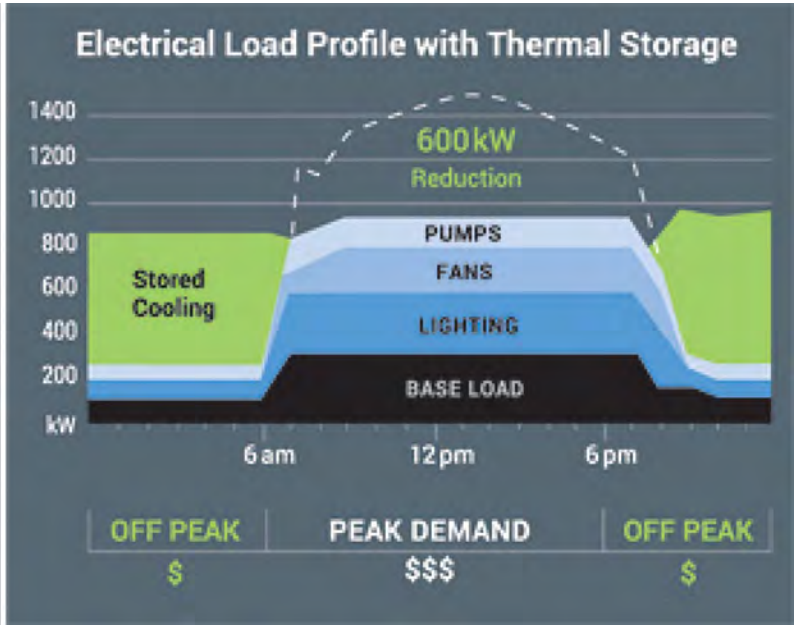
Look for ENERGY savings – Not Cost Savings

Some strategies save money but NOT energy

Example:

Cold Thermal Energy Storage (ice storage)





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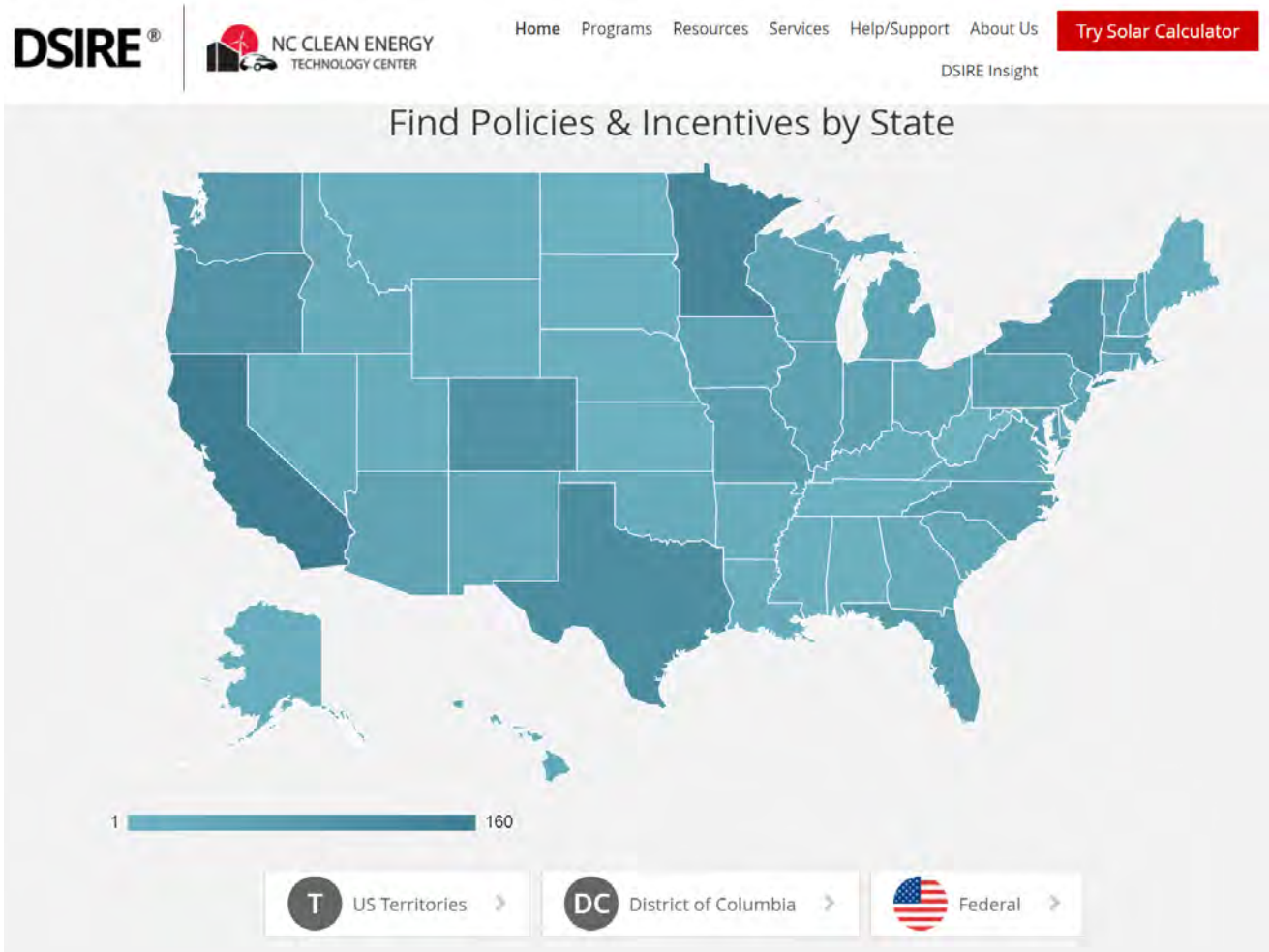
Helping to Fund These Strategies

- Local Utility Rebates
- Federate Programs (Inflation Reduction Act)
- https://www.dsireusa.org



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HOW NON-GOVERNMENT ACTORS CAN ACT

There is something for everyone in the Inflation Reduction Act. Non-government members of *America Is All In* can take advantage of programs that make clean, healthy buildings more affordable upfront and over time.

IRA PROGRAMS

	Sector-specific action	High Efficiency Electric Home Rebate Act (HEEHRA)	Home Energy Performance-Base, Whole-House Rebate program (HOMES)	New Energy Efficient Home Credit (45L)	Energy Efficient Home Improvement Credit (25C)	Energy Efficient Commercial Buildings Deduction (179D)	Energy Credit (48)	Residential Clean Energy Credit (25D)	Low-Embodied Carbon Labeling for Construction Materials	Environmental Production Declaration Assistance	Environmental and Climate Justice Block Grants
Businesses 	Businesses can benchmark their energy use and emissions and use the IRA and local incentives to invest in building electrification. This may lower their operating costs, lead to stabilized electricity prices, improve their ESG (Environmental, Social and Governance) performance and prepare for future regulatory efficiency standards.					✓	✓		✓	✓	✓
Healthcare 	Healthcare facilities should use IRA provisions to electrify systems with appliances such as heat pumps and implement microgrids for on-site energy generation with battery systems to improve power availability and reliability.					✓	✓				
Higher Education 	As academic and cultural stewards in their respective communities, universities can not only electrify their own buildings but also enable other sectors' progress by training the future clean energy workforce and equipping them with intellectual and technical expertise.					✓	✓				

Steps To Decarbonize: Electrification

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Going All Electric

- Easier to achieve in new construction, but still a challenge

- For existing buildings, work in phases. You will likely need existing and new systems running at the same time
  – double systems and more MEP space needed…

For Healthcare going all electric has many challenges – be prepared.

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Electrification Challenges in Healthcare

VERY DIFFICULT:

- Heating in below zero temps
- Emergency power

Less difficult but a challenge:

- Reheat for HVAC (high ventilation and need to reduce humidity)
- Hot water (domestic water load)
- Process Loads (sterilization etc)
- Kitchen/Cooking loads

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Electrification Challenge: General

Electric Service

- Major impact – May need new larger gear or an increased service
- Can the local grid handle it?
- Energy savings in the building MAY help free up space for new higher electric HVAC systems.

Case Study: CUIMC All Electric Lab Building:

Change to all electric mid design resulted in:

- Large upsize in Electrical Service/Gear
- 70% building electrical capacity is for HVAC
- 44% of the HVAC capacity is for Heat Pumps

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Largest Focus for Electrification: Heat Pumps

Recent improvements to heat pump technologies have make them a focus for buildings looking to go all electric

Advantages

- Scalable
- Can do simultaneous heating and cooling
  - For many spaces will only need heat recovery
  - simultaneous are $$$ and larger and often only needed for (process loads)
- Technology is improving, expect get to below 0^{o}F soon

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Largest Focus for Electrification: Heat Pumps

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Side-by-Side Carbon Comparison of Heating Systems Using National Average Emissions and Leakage Rates

Heating Energy	1,000	MMBtu/year

Standard Boiler		
Efficiency	80%	
Fuel Energy	1,250,000,000	Btu/year
Fuel Energy	12,500	Therm/year
Natural Gas CO_2	5.5	kg/therm
Natural Gas Emissions	68,181.8	kg/year
Natural Gas Leakage Rate	2.0%	
Natural Gas Produced	12,755	Therm/year
Natural Gas Leaked	255.1	Therm/year
Natural Gas GWP	30	x CO_2
Natural Gas Energy Density	2.34	kg/therm
Natural Gas Leaked Emissions	17,922.9	kg CO_2e/year
Combined Annual Emissions	**86,104.7**	**kg CO_2e**

Standard Air-Source Heat Pump		
Efficiency	2.05	COP
Electrical Energy	487,804,878	Btu/year
Electrical Energy	142,962	kWh/year
Electricity CO_2	0.374	kg/kWh
Electricity Emissions	53,468	kg/year
% Natural Gas Power	40.5%	
Natural Gas Electricity	57,899	kWh/year
% Grid Efficiency	5.3%	
Natural Gas Power Generated	61,140	kWh/year
Power Plant Efficiency	36%	
Natural Gas Produced	169,833	kWh/year
Natural Gas Produced	5,794.9	Therm/year
Natural Gas Leakage Rate	2.0%	
Natural Gas Produced	5,913.2	Therm/year
Natural Gas Leaked	118.3	Therm/year
Natural Gas GWP	30	x CO_2
Natural Gas Energy Density	2.34	kg/therm
Natural Gas Leaked Emissions	8,308.9	kg CO_2e/year
Heat Pump Capacity	50	Tons
Refrigerant Charge	47.7	kg
Refrigerant Leakage Rate	2.0%	
Refrigerant Leaked	1.0	kg/year
Refrigerant GWP	1,890	x CO_2
Refrigerant Leaked Emissions	1,804.1	kg CO_2e/year
Combined Annual Emissions	**63,580.7**	**kg CO_2e**
Carbon Emissions Savings	**26.2%**	

Figure 1. Side-by-side HVAC carbon analysis.

From ASHE: Health Care Decarbonization Code Overlay Guide
ASHE Catalog Number: P055870

Largest Focus for Electrification: Heat Pumps

The Zero Degree Heat Pumps Do Have Challenges:

- More space required (and more weight)
- More electrical capacity
- Currently only down to 0 to -5 so in ASHE region 6 need backup heat
- For ASHE Region 6winter design temps are as low as -30^{o}F

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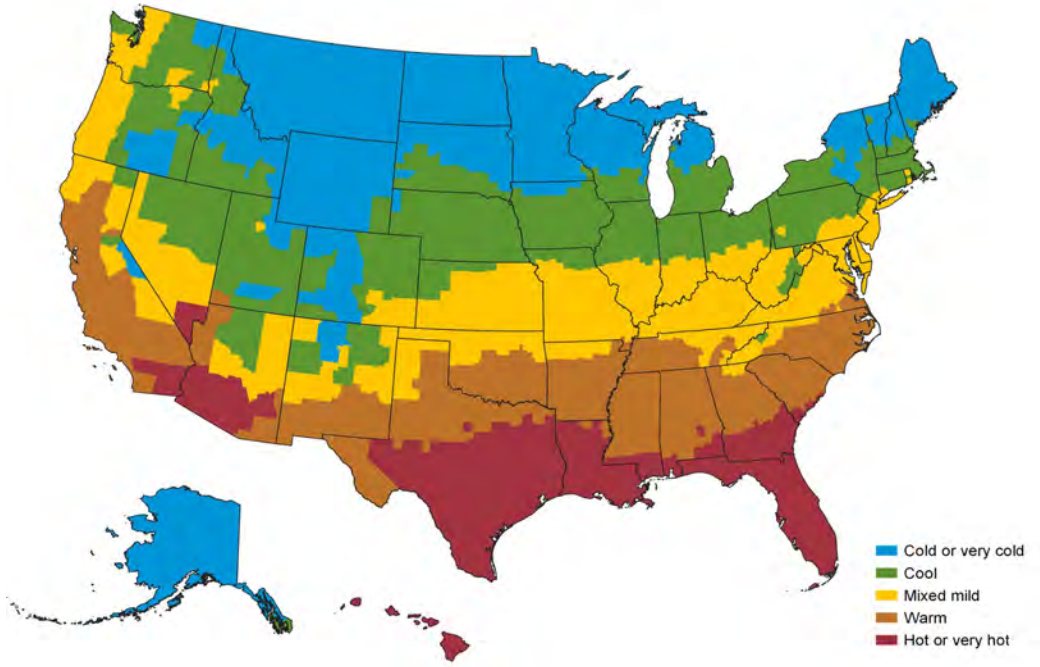


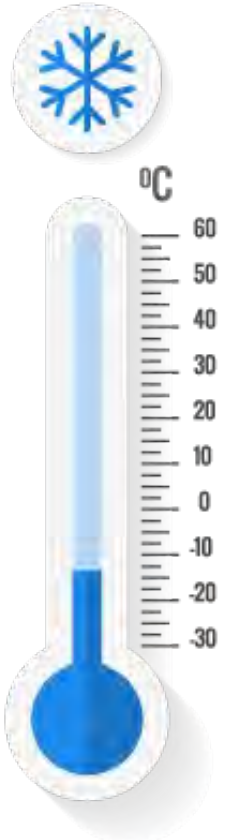
Heating in Below Zero Weather

Current heat pump technology can not keep up with Midwest winters.

FGI guidelines require emergency on site fuel sources for heating.

Some options for back up heating:

- ~~Gas – can save energy but NOT Fossil Fuel Free~~.
- Geothermal hybrid – $$$ charge well field in summer for use in winter
- Electric boiler – $$ (increased electrical equipment sizing/demand)
- Solar thermal evacuated tube collectors – $$$ able to generate 160°F degree water even in the winter



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Heat Pumps: Low Temp Hot Water

While switching to low temperature hot water systems can save energy and help you go all electric there are some challenges:

- In healthcare higher temp water is needed for process loads
- Potential higher losses in transport around building –better to have systems closer to load.
- Low temperature water systems may require larger pipes/more space.
- Perimeter heating issues – not as effective along all glass perimeters

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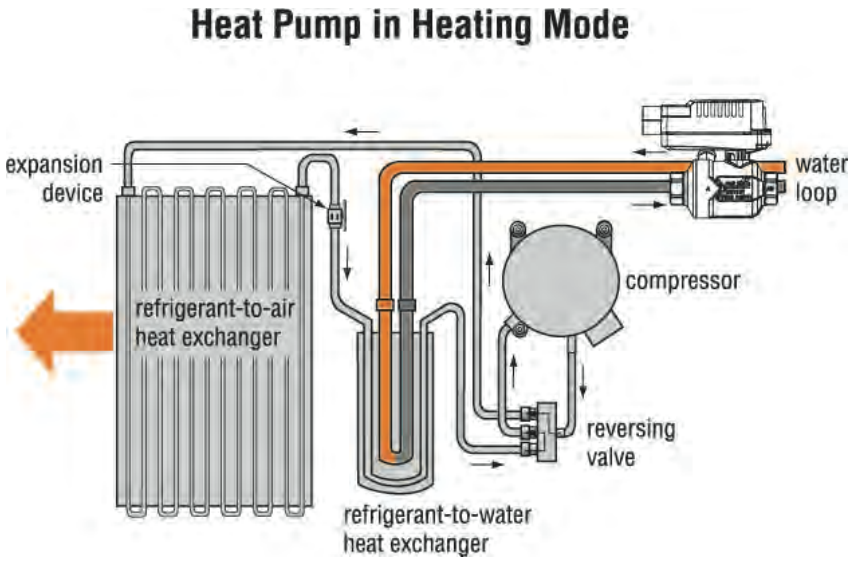

Building Electrification: E-Steam?

Probably a few years out but something to keep an eye on: E-Steam

- Currently generating steam from electric boilers is energy and cost prohibitive.
- Emerging technology: Industrial grade heat pumps which use ammonia to allow for easier generation of higher temps.
- Needs dual heat exchangers to ensure that there is no chemical transfer – need to protect secondary side.

Some healthcare campuses are moving to centralized sterilization facilities which would make generation and use of e-steam easier.

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Steps To Decarbonize: Renewable Energy

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Things to Consider

- What source (PV is easiest and most common)
- Where to locate?
  - Roof? (structural load and other equipment considerations)
  - Parking? (mounting structures, connecting to the building)
- Purchasing
- Interconnecting with the Utility

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Photovoltaics – Basic Overview

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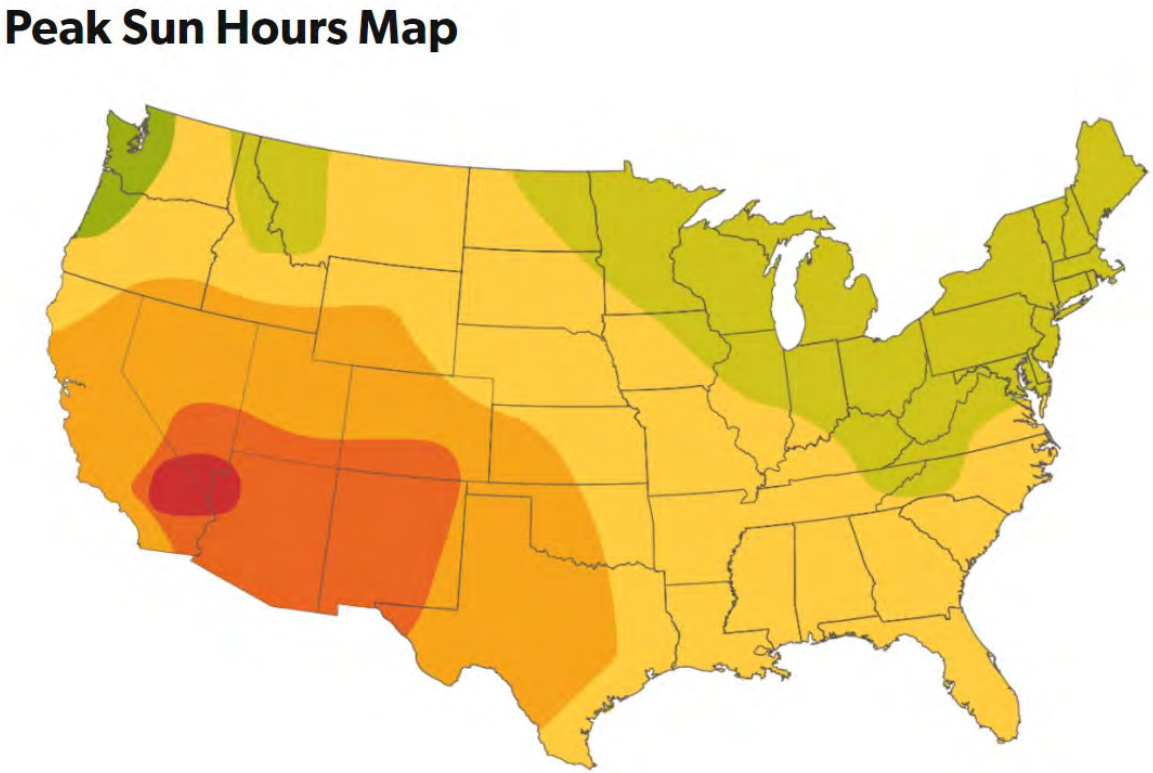

Using Solar Energy

In the Building

- Need larger main electrical panel
- Cost savings from energy made – no need to buy it
- Cannot use solar energy when there is a power outage

Connecting to Utility

- Discuss with Local Utility – will have interconnection information
- Extra solar energy flows into the electric grid for use by others.
- Often Utilities pays for the energy. Need to check with utility on policies and rates.

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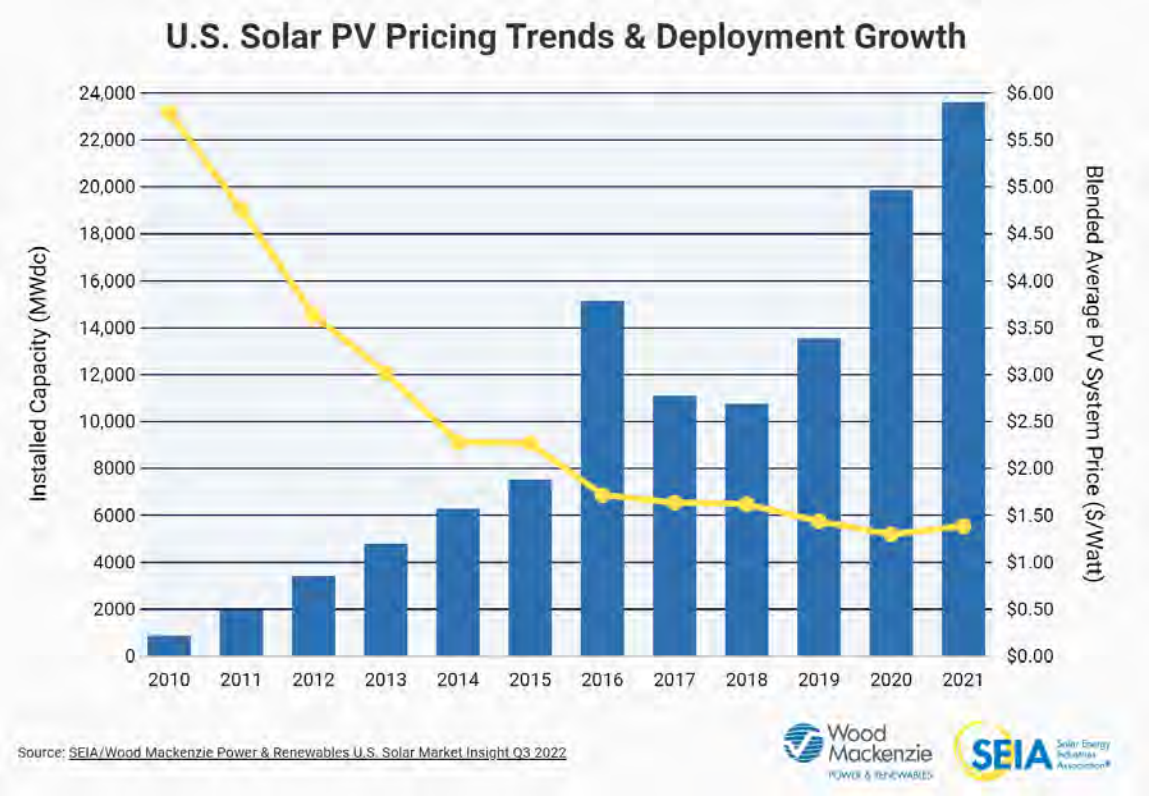
Solar Purchasing Options



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- Buy Yourself AND own the SRECs – you fund, you get benefits
- Buy yourself but sell SRECs – you fund, you get energy savings + more $ for SRECs
- Have a 3rd Party buy and install and you pay them for electricity used, they get SRECs

Closing Thoughts

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Healthcare and Decarbonization - Can they Co-Exist?

- Yes! But not currently to Zero Carbon
- We should be focusing on saving energy now
- Electrification – something to keep an eye on – not there yet
- Renewable Energy – Possible but not likely to get to Zero today

Now is the time to start as it is likely that codes and regulations are only going to focus on this more and it make take years to make some impacts/improvements.

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Thank You!
Questions?

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Connect With Me

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