Addressing the needs of the 99%:
Saving Energy in Existing Buildings

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California Energy Alliance
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Cathy Higgins
Research Director

Kim Cheslak
Director of Codes

Kevin Carbonnier
Project Manager

Stacey Hobart
Communications Director

About NBI and our Program Areas

NBI is responding to increasing urgency to reduce carbon emissions and to the growing demand for improved energy performance and carbon reductions in new and existing buildings.

We shape a new energy future with innovation, research, design guidance, and advanced building policy through three program areas:

- **Getting to Zero Leadership**
  Driving scale in zero energy and zero carbon buildings
- **Building & Program Innovation**
  Best practices in new and existing buildings
- **Advancing Codes & Policy**
  Continuous code and policy innovation

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Today's Key Topics

1. Policy Trends
2. Retrofit Approach and Case Study
3. Value Proposition

1. Policy Trends

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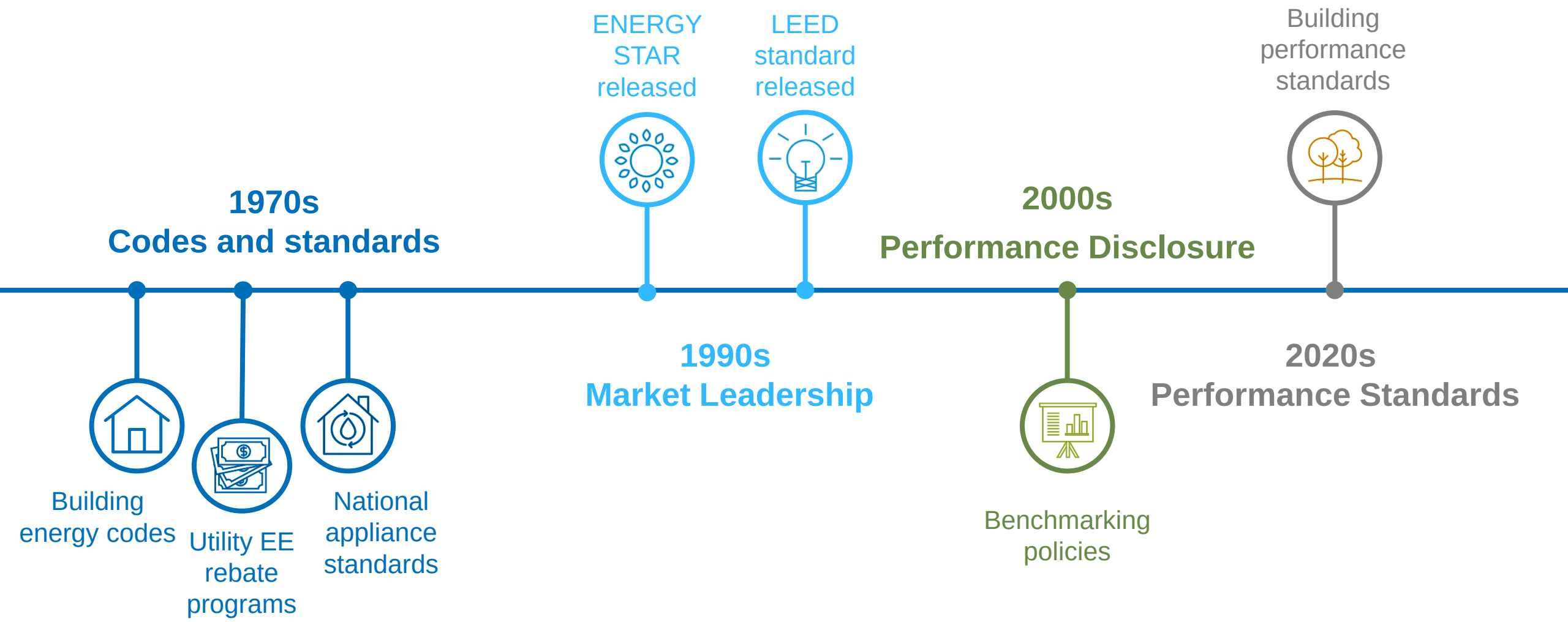
Generational Shift in Building Regulation



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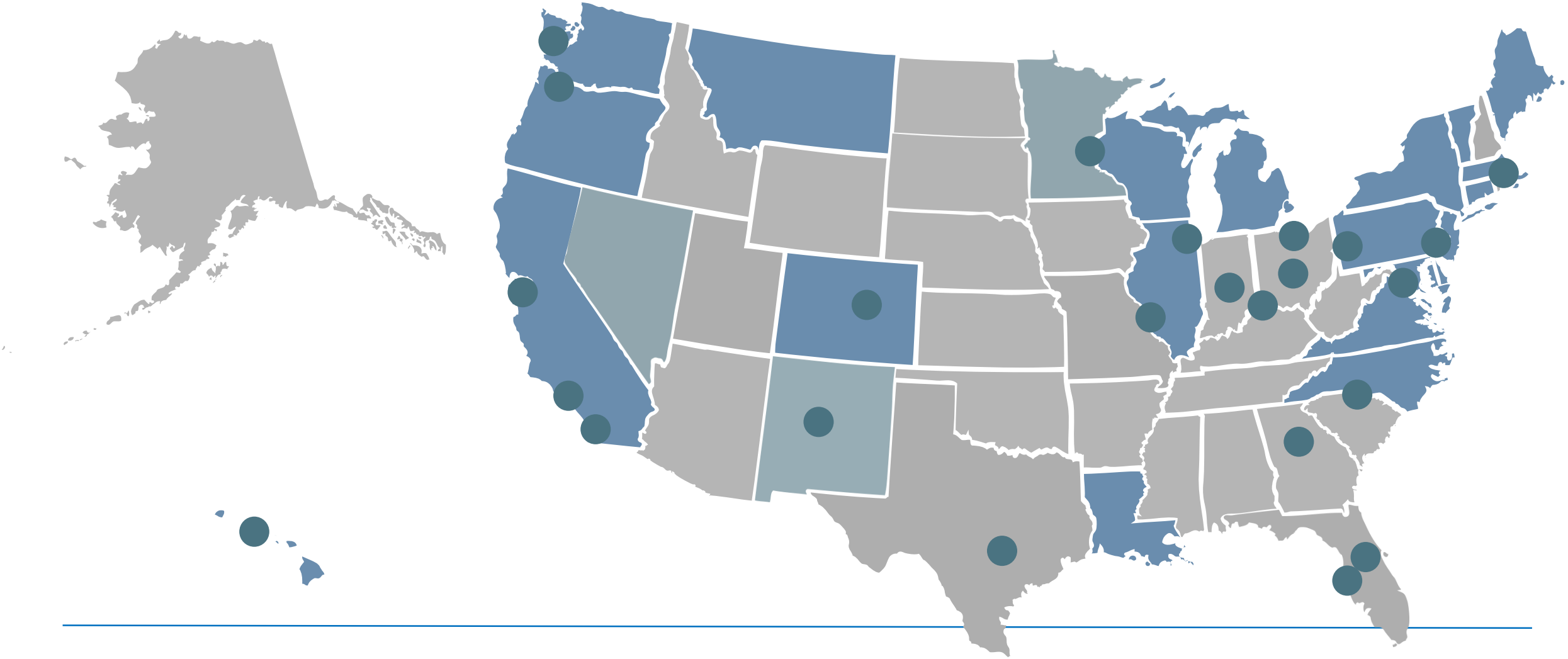
US Leadership*

* Includes USCA, CESA, ACCC Cities



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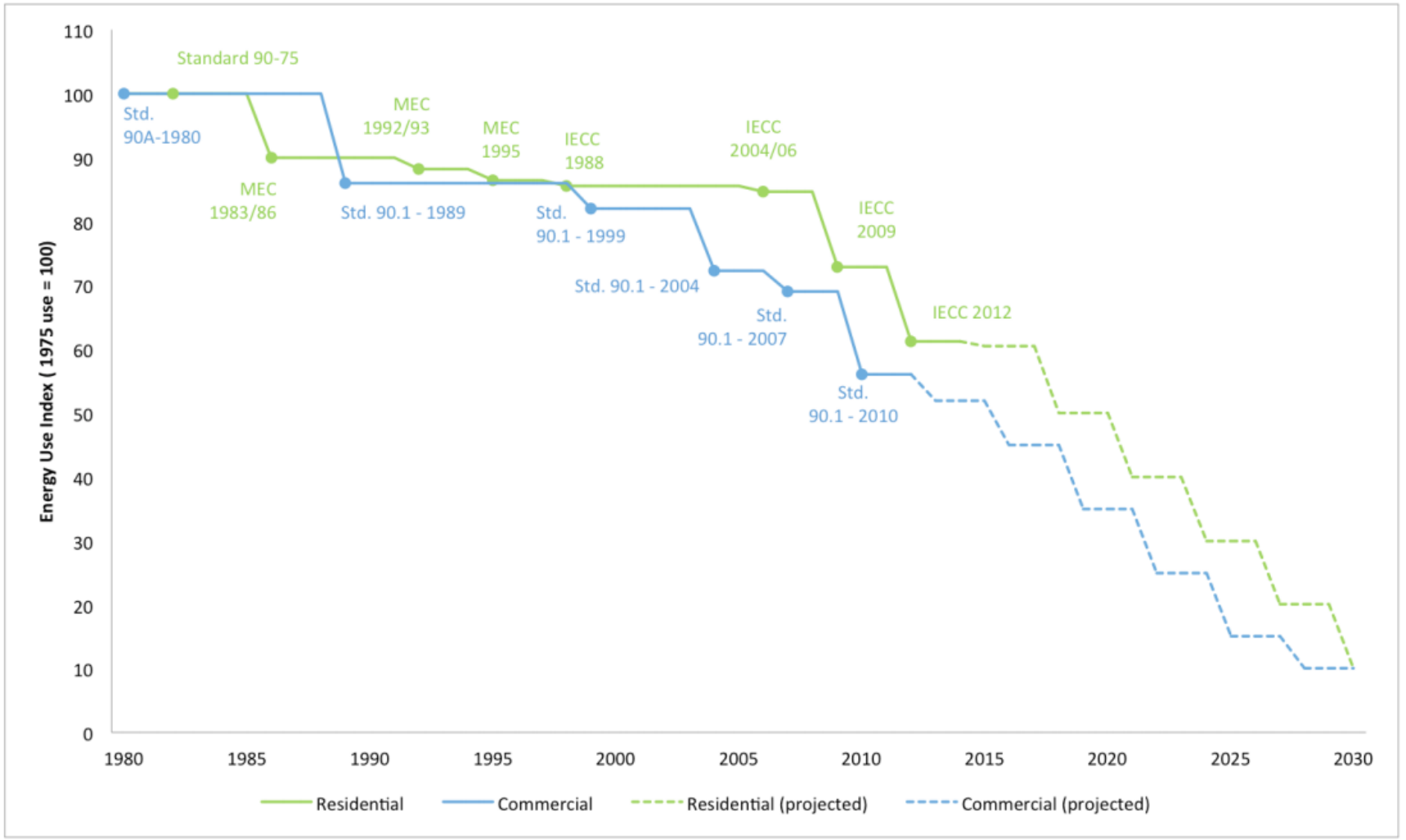
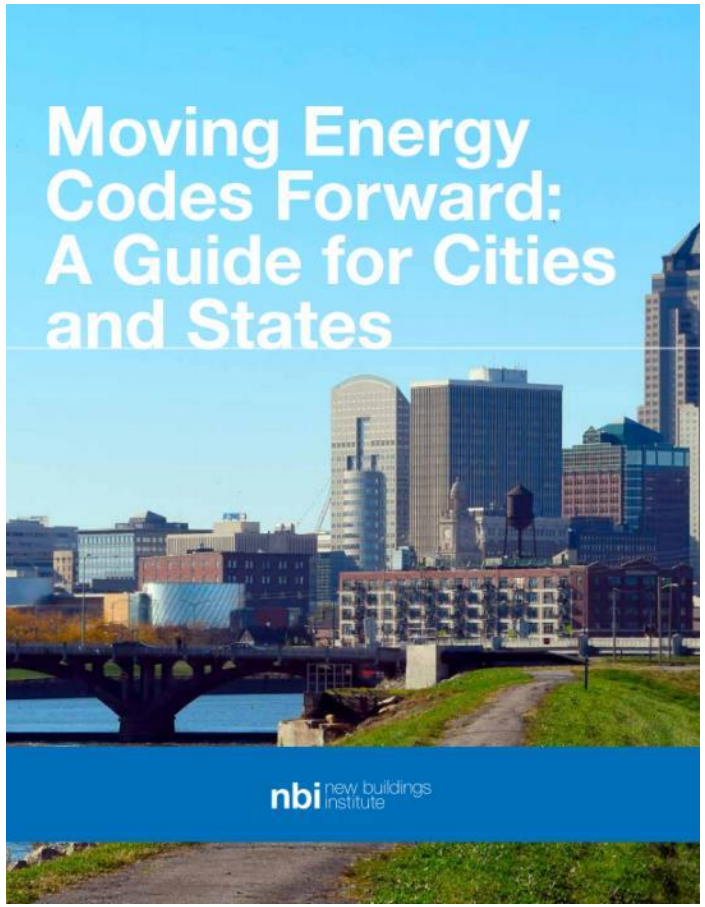
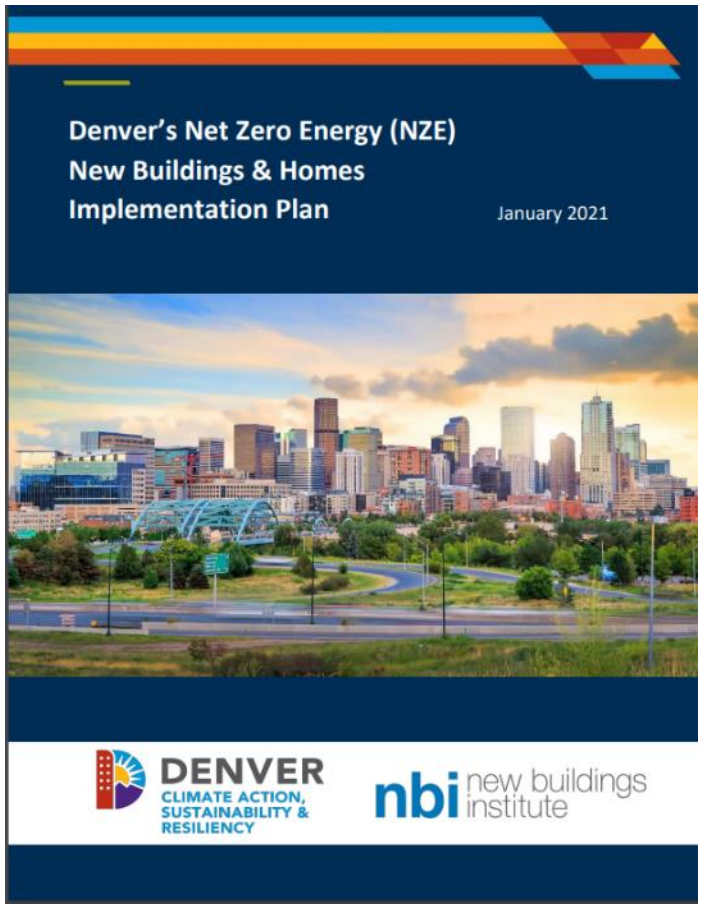
Progress of Model Codes

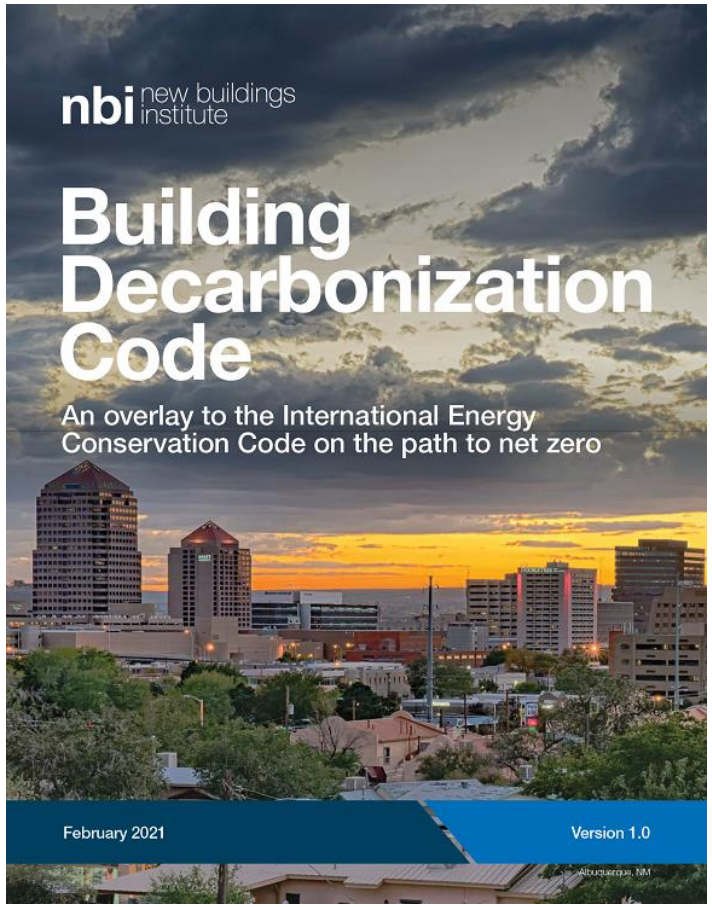


History of US Building Codes 1980-2012.
Source US DOE BECP

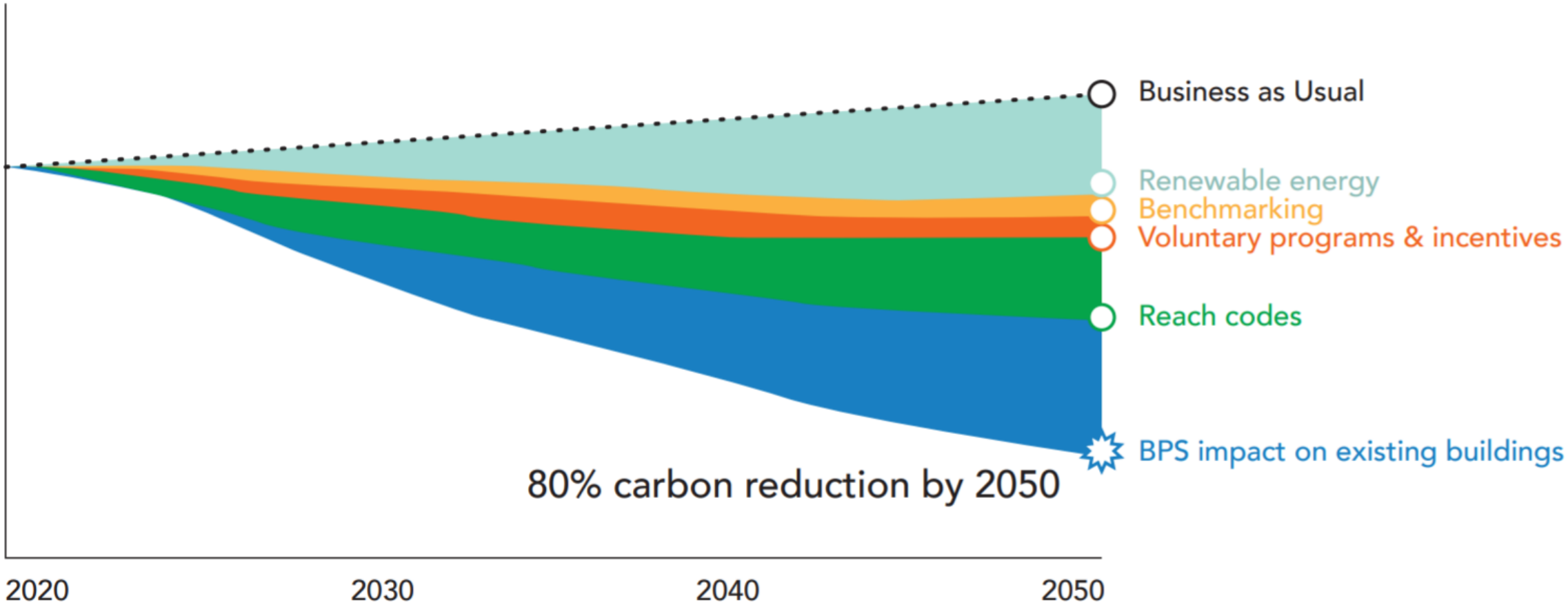
“Beyond” Code







Scale of Impact for EB Policies



What is a Building Performance Standard?

- Establishes targets for building to reduce energy use or GHG emissions
- Over a long-term timeframe, with intermediate reporting and compliance periods
- Requires all buildings to hit a final defined target

Building Performance Standards

Washington DC

Size: 10,000 ft^2
Measuring: Energy

Metric: ENERGY STAR

Standard is recalculated each compliance cycle

New York City

Size: 25,000 ft^2
Measuring: Carbon

Metric: $kgCO_2e/ft^2$

Standard increases in stringency each cycle, those levels have been identified through 2034

St. Louis

Size: 50,000 ft^2
Measuring: Energy

Metric: Site EUI

Standard is recalculated each compliance cycle

Washington State

Size: 50,000 ft^2
Measuring: Energy

Metric: EUI

Targets under development – will be updated in 2029 and every 5 years after

Colorado

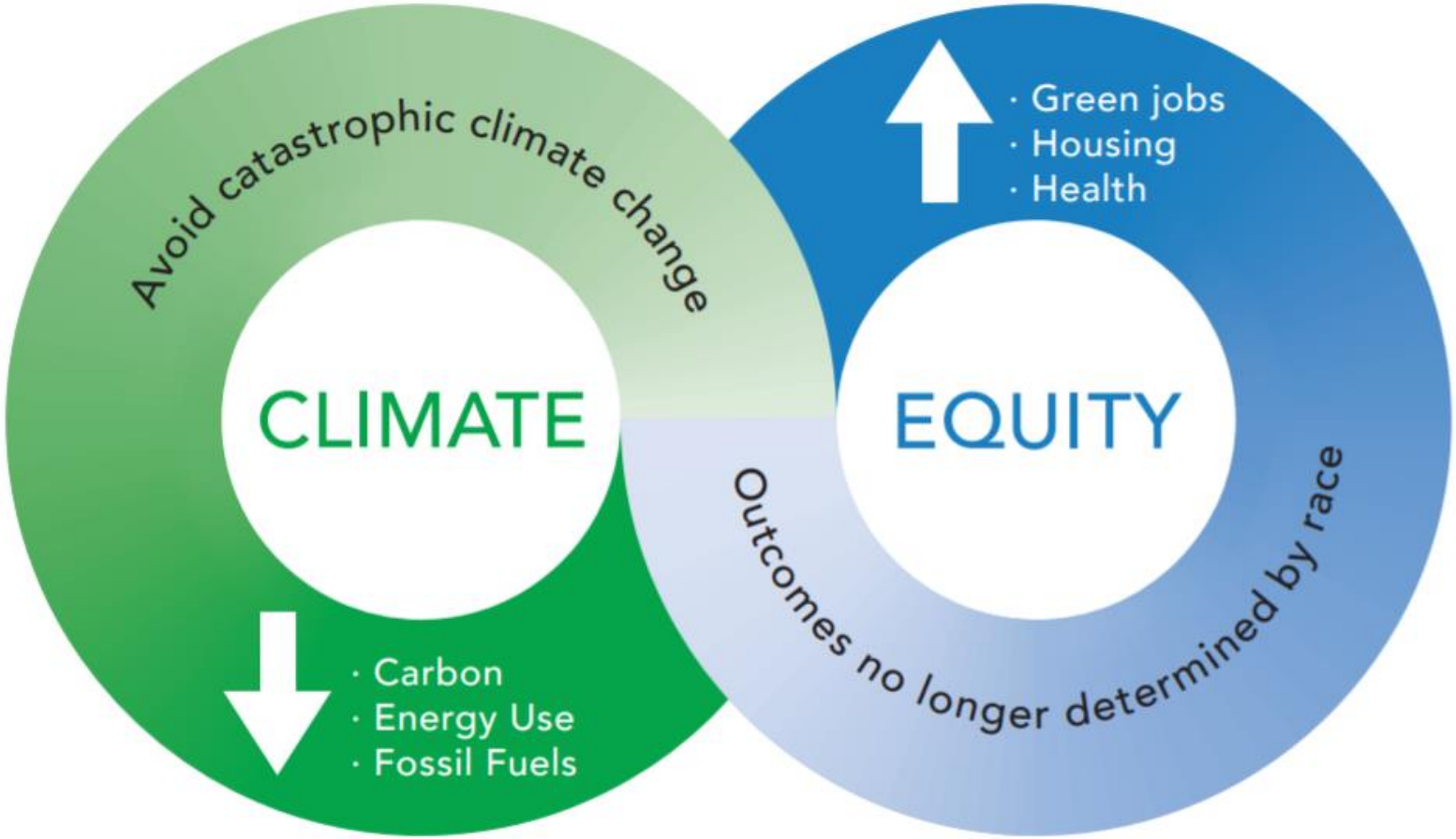
Size: 50,000 ft^2
Measuring: TBD

Metric: TBD

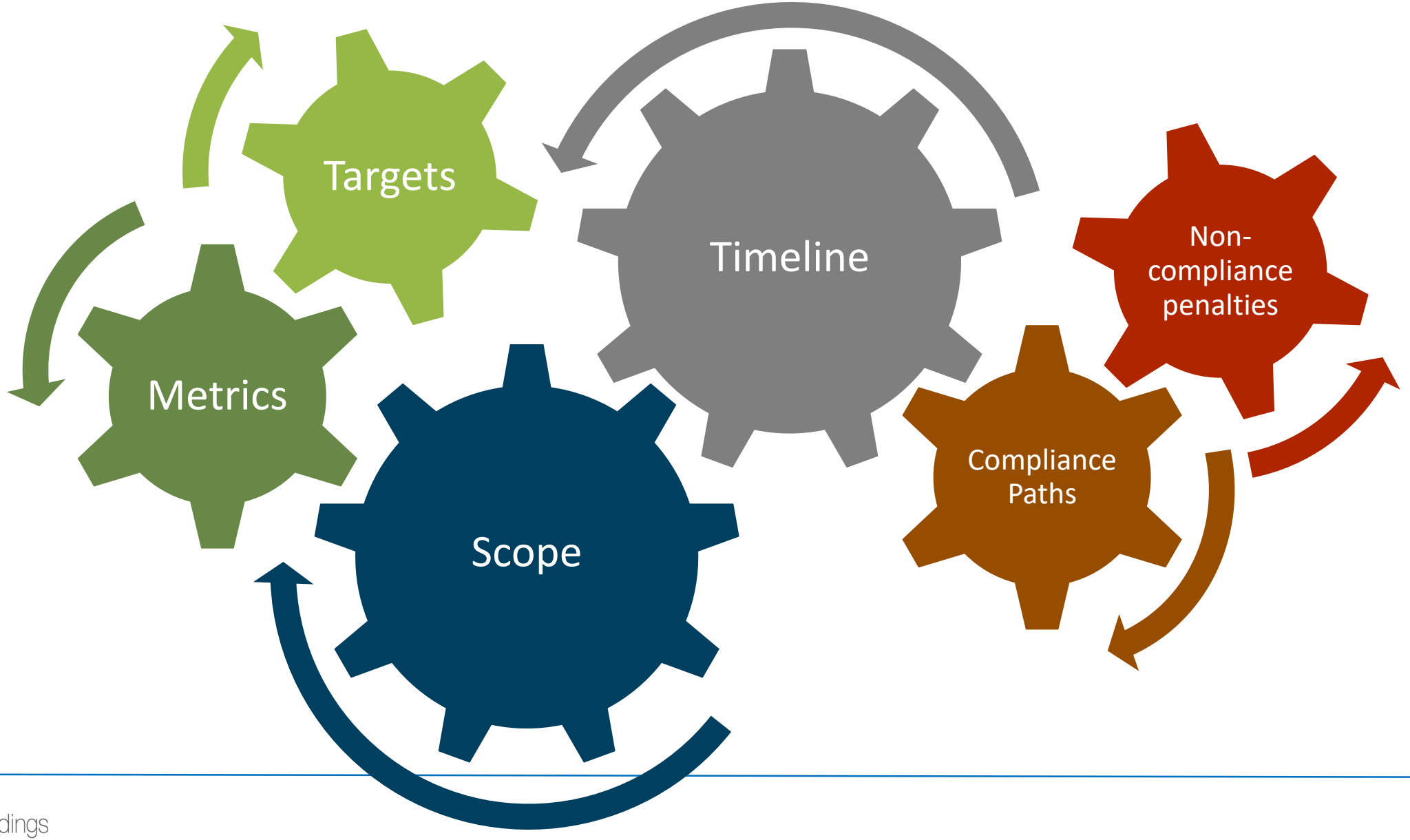
Targets under development

BPS Critical Considerations

Climate and Equity Goals



Nuts and Bolts of a BPS



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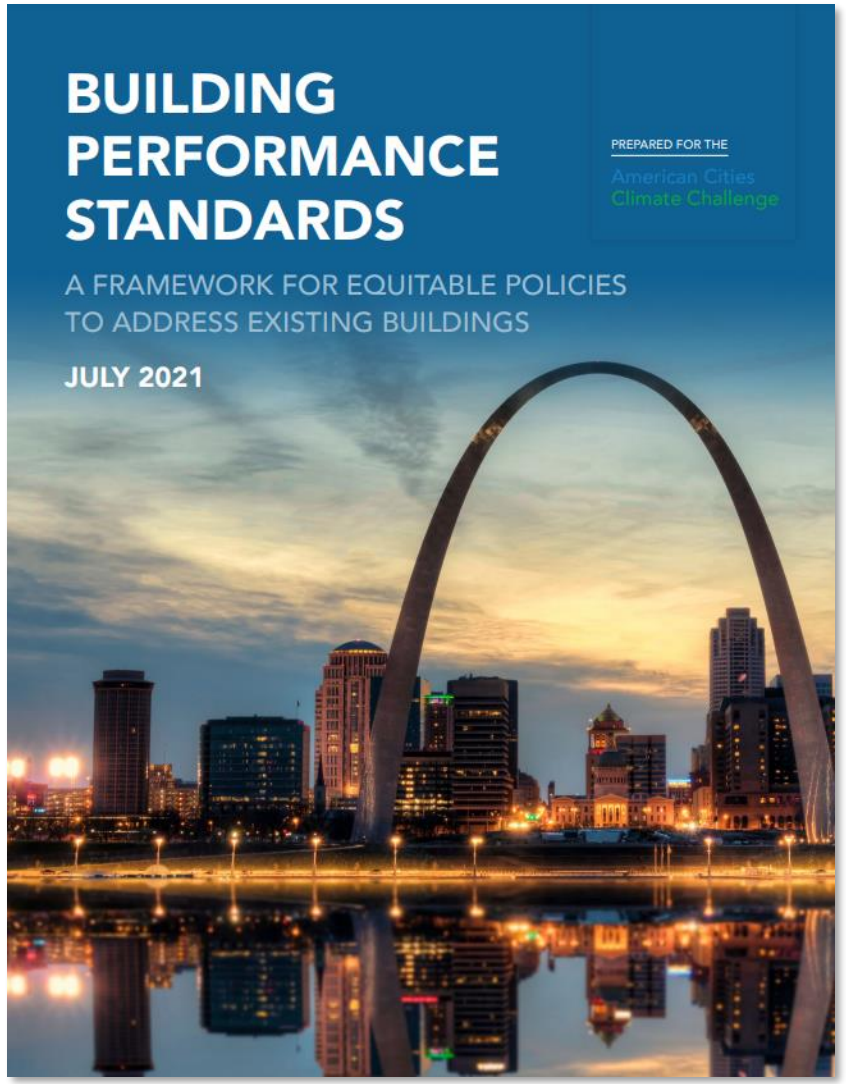
ACCC BPS Cohort

- 12-month collaborative effort
- 8 national partners with 12 cities
- Balance of technical and equity considerations
- Framework to support future work on BPS published July 2021



Other Options for Existing Building Policies

- Equipment Replacement Incentives
- Benchmarking
- Audit/Retro commissioning
- Existing Building and Property Maintenance Codes
- Time of Sale/Lease Disclosure

2. Retrofit Approach and Case Study

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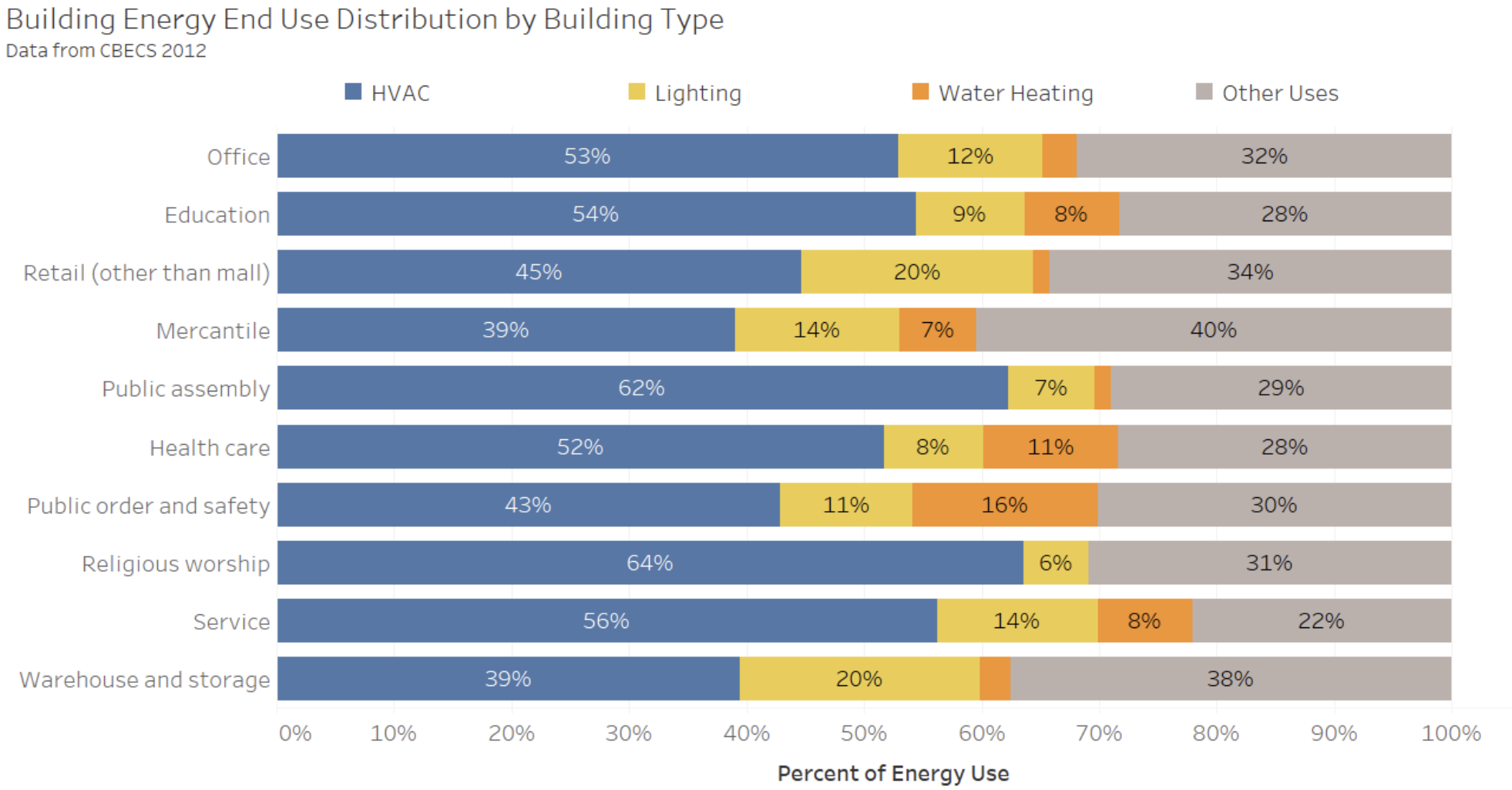
Typical Building End Use



The Future Vision for Retrofits

Business-As-Usual

Widget-based programs

Replace on burnout

Single technology

Strategic Retrofitting

System-based programs

Equipment lifecycle plan

Integrated systems

Leading in Los Angeles: A Retrofit Case Study

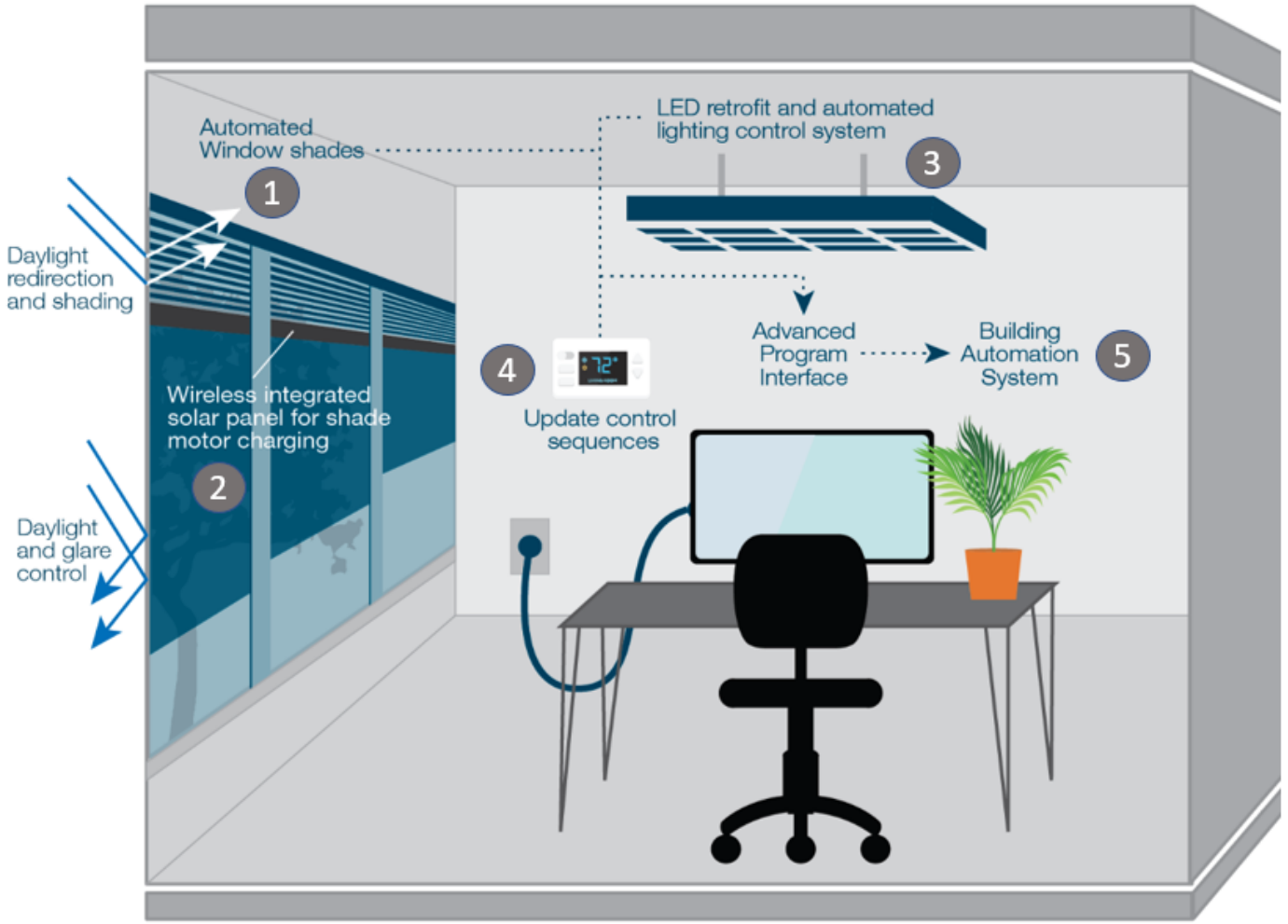
- **Goal:** Support California energy and carbon reduction goals.
- **Project Objectives:**
  1. Validate viability and performance of an **integrated set of technologies** for existing commercial buildings including emerging **self-powered** shades
  2. Demonstrate **20%+** whole building energy savings
  3. Develop and share guidance and resources to **facilitate widespread adoption**
- ***Length:*** *July 2017 – June 2021*

The Technologies

The INTER Solution Set

*Targeting Lighting and HVAC Savings**

1. Self-powered automated shades/blinds with dedicated daylight redirecting
2. Solar panel for wireless automation
3. LED upgrade with Networked Lighting Controls
4. Light HVAC Retro-Commissioning
5. M&V through Building Automatic System



**Nearly 70% of energy use in large CA office buildings (source: CEUS)*

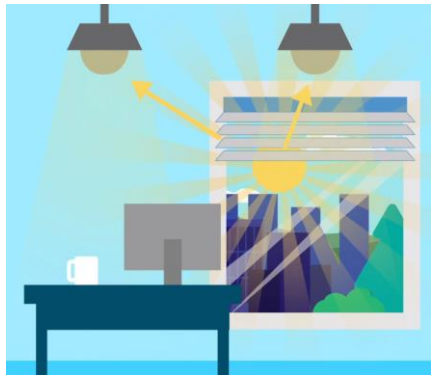
Primary Market Opportunities

California Floor Space and Electricity by Target Market

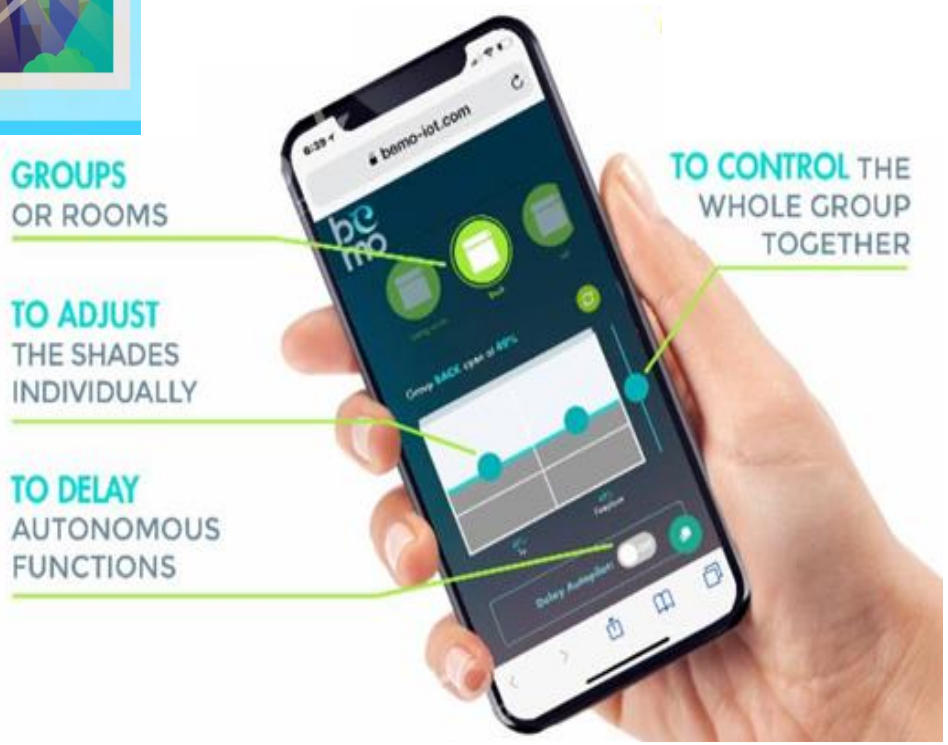
Sector	Floor Space	Electricity
Small Offices (<30,000 sf)	5%	4%
Large Offices (>30,000 sf)	17%	22%
Primary and Secondary School	8%	3%
Post High School Education	4%	3%
Total Market	**34%**	**32%**
Hospitals and Health Care	*4%*	*12%*

Source: CEC 2016, Attachment 12 PIER GFO 16-304

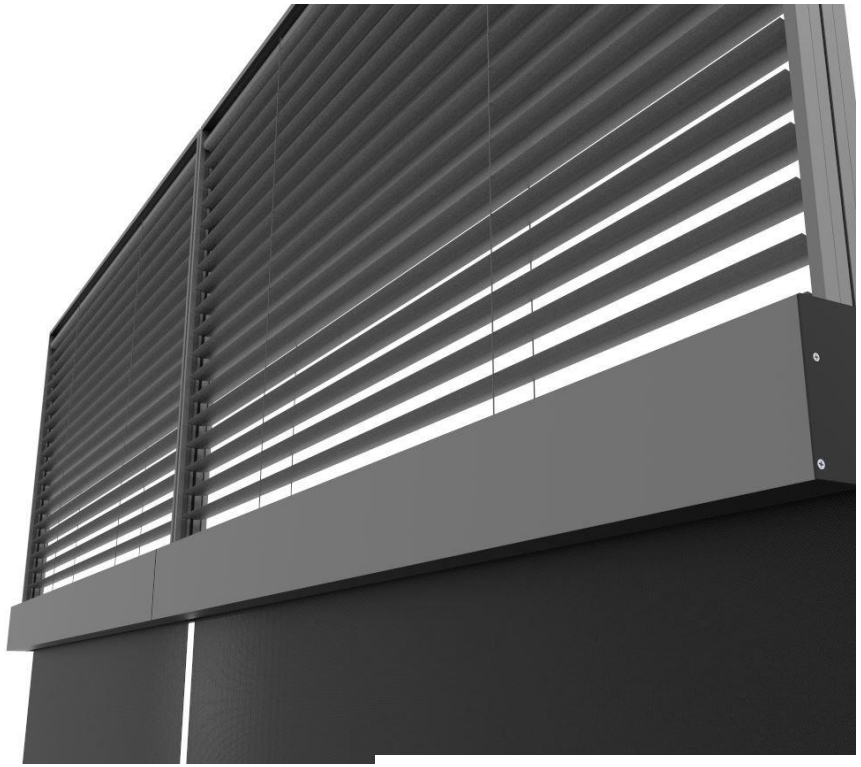
1. Illuminate™ – Self-powered automatic shade/blind combo



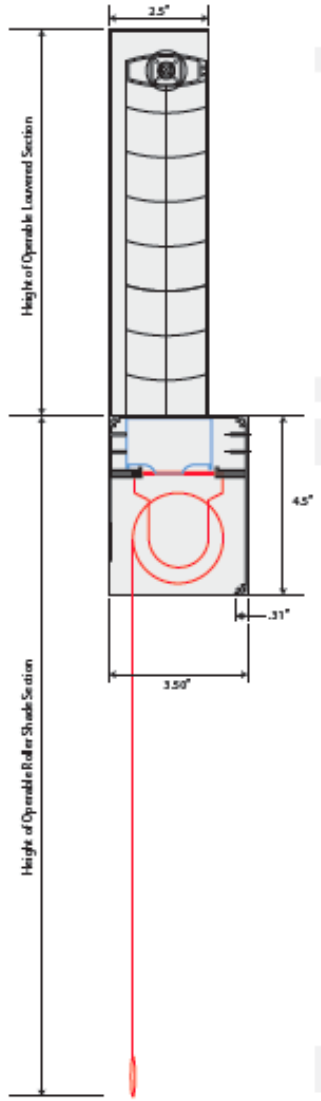
Occupant Control App



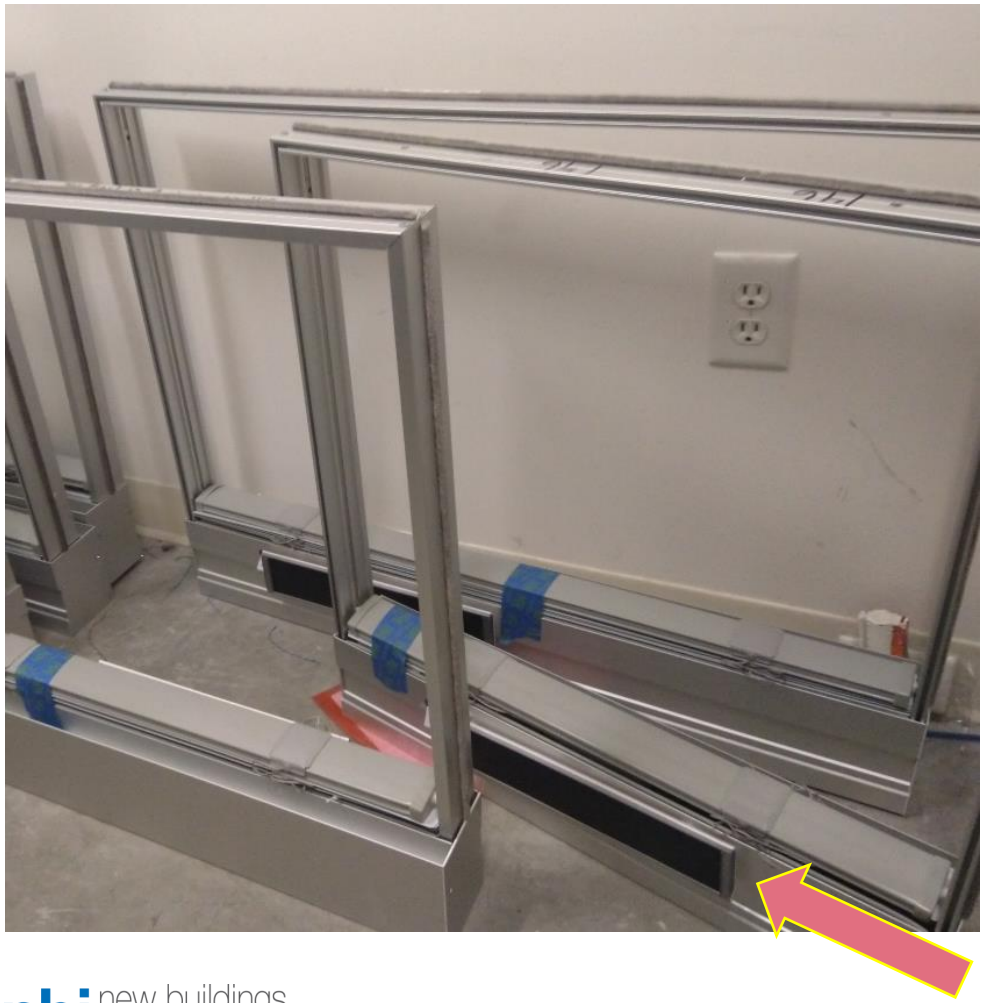
Daylight redirecting louvers



Motorized solar shades



2. Solar PV Powered: Elimination of wiring and disruption, long-term battery solution



3. LED Upgrade: Easy retrofit with dim-to-off controls

3. Networked Lighting Control (NLC) Systems

Luminaire-level lighting controls (LLLC) at one site

- Daylight dimming
- Occupancy controls
- Institutional Tuning
- Timeclock

4. HVAC Retro-commissioning

- Scheduling/sequencing
- Tuning setpoints/setbacks
- Software-only
- Guideline 36 measures where possible

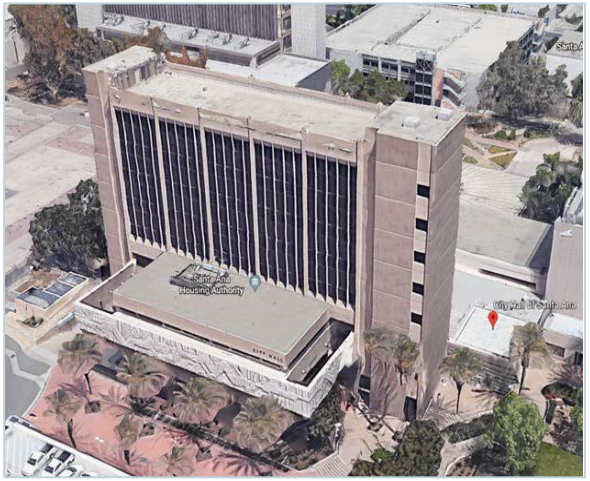
Demonstration Partners and Sites

Building	Yr Built	Size (sf)	Retrofit Area (sf)	Pre-retrofit	Upgrade
Santa Ana City Hall	1972	127,000 8 stories	88,000 (~70%)	• 2-lamp T8 troffers • Daintree lighting controls • Manual Shades	• LEDs replacement kits • NLC upgraded Daintree control • New automated and manual shades
CSU Dominguez Hills Welch Hall	2001	183,000 4 stories	131,000 (~70%)	• 3-lamp T8 troffers • Enlighted lighting controls • Manual Shades	• LEDs replacement kits • LLLC upgraded Enlighted controls • New automated and manual shades

Good applications include offices, schools, universities, hospitals

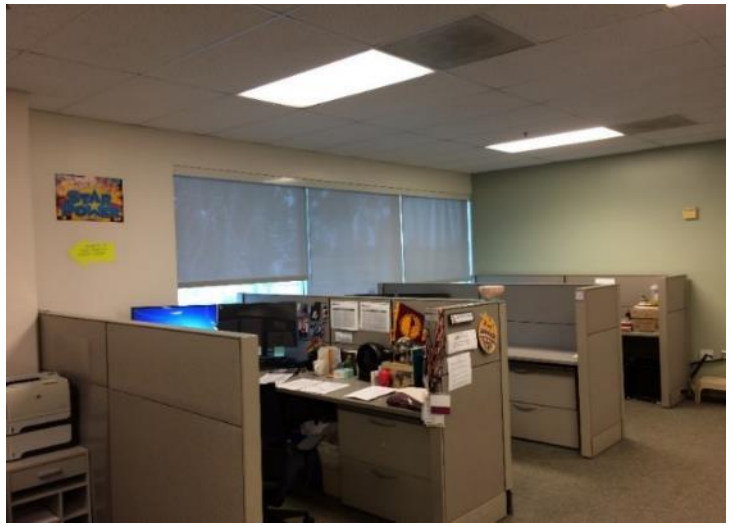
Santa Ana City Hall

- Primarily private offices and small shared open offices
- 18”x36” ceiling grid configuration
- Existing semi-functional Daintree lighting controls system
- Relatively high window-to-wall ratio, Primarily south-north-facing windows, and narrow floorplates
- Significant energy savings opportunities



CSUDH Welch Hall

- Primarily University administrative office building with a mix of private office and open office
- Existing Enlighted controls
- First floor large windowless classrooms with office spaces at perimeter
- Second - fourth floors: offices, conference rooms, and support
- Interior courtyard provides additional daylight access
- Mix of glazing conditions and orientations



Measured Site Energy Savings

Building	Total Site Energy	Electricity	Lights	HVAC
Welch Hall	26%	15%	35%	29%[1]
SACH	15%[2]	19%	42%	6%[2]

[1] Welch Hall HVAC savings include modifications beyond the research RCx scope implemented in parallel by the facility manager.
[2] Santa Ana site total and HVAC savings do not include savings in district steam, due to erroneous data. These figures represent electricity and chilled water savings only, so savings are likely larger.

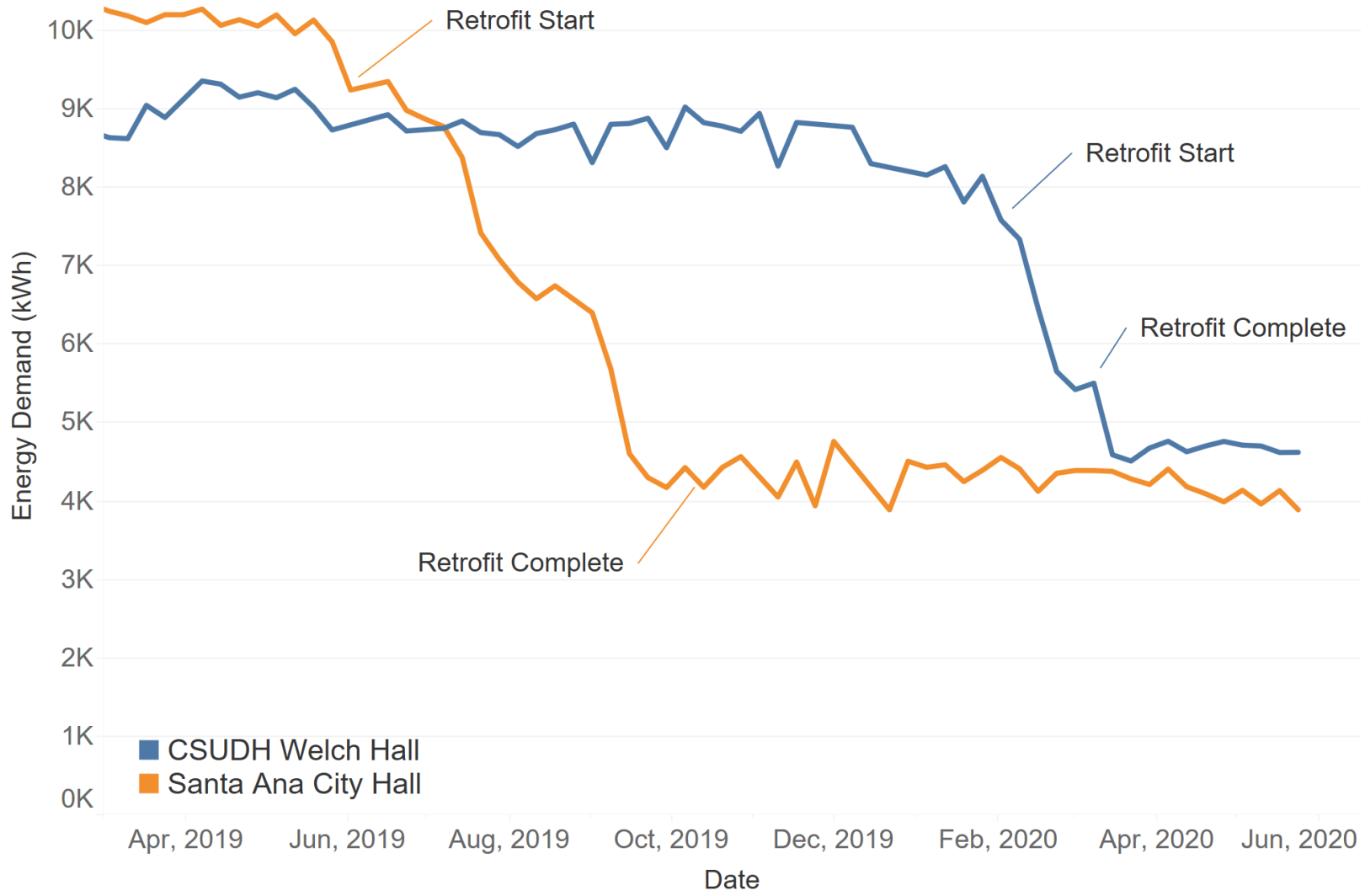
-- Significant lighting energy savings: 35% in Welch Hall, 42% in SACH

-- Significant electricity savings: 15% in Welch Hall, 42% in SACH

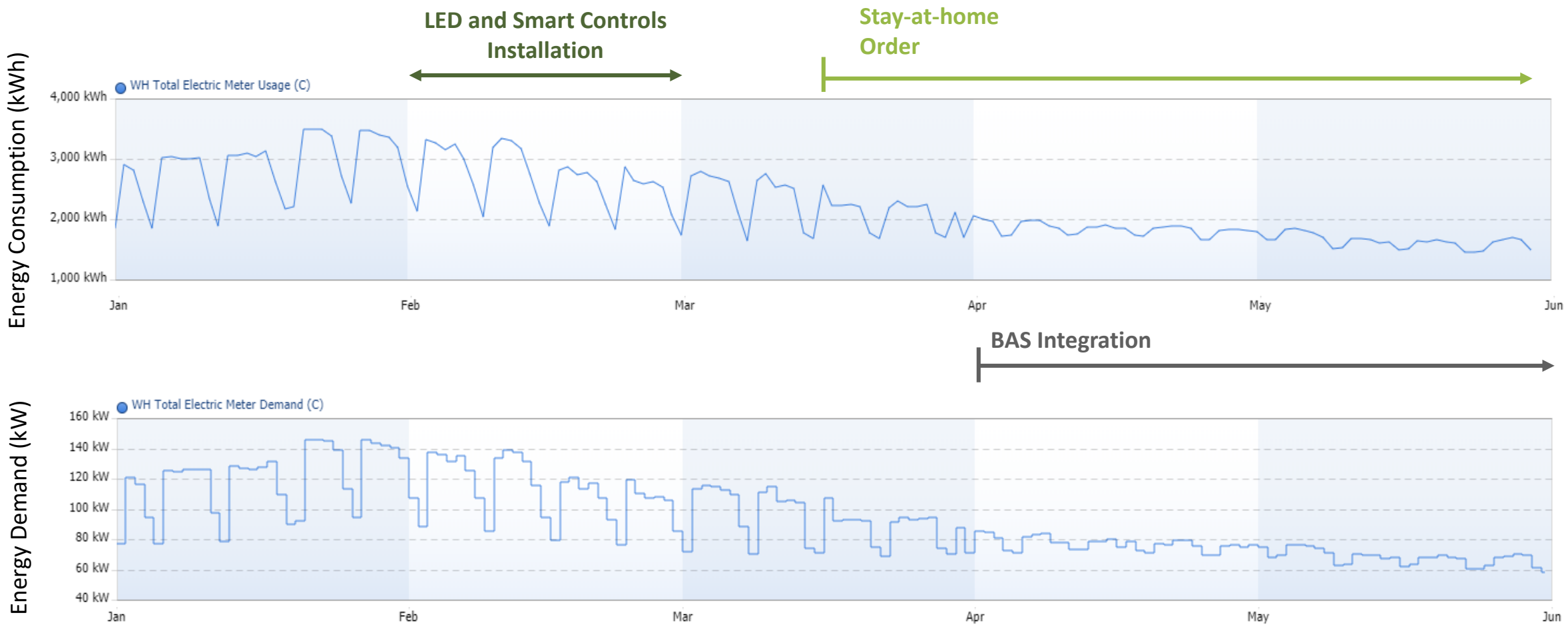
-- Welch Hall shows significant HVAC savings of 29% and site energy savings of 26%

-- **Confident in 20% whole building savings in most buildings**

Results: Retrofit Savings - Pre-retrofit Baseline and Post-retrofit Measured Lighting Energy Use



CSUDH Welch Hall Energy Trends



Results: Clear Non-Energy Benefits

Benefits of Automated Lighting and Shading Systems

Owners
Modernized building
Reduced operating costs
Higher tenant satisfaction

Occupants
Personalized control
Thermal comfort
Elimination of glare
Maintained views

Operators
Centralized data and control
Reduced maintenance of lamp change outs
Reduced comfort complaints

Stakeholder interviews expressed increased satisfaction with the indoor environments and personal control

Project Costs and Savings

- $5-8/ft² for full, **networked** lighting retrofit with BAS integration
- $0.2-0.4/ft² annual lighting energy consumption cost savings
- $10-14/ft² for full retrofit package, including lighting, automated shades, and retro-commissioning

Project Resources

Project website

Kenny Seeton CSUDH Chief Engineer and Buildings Manager Takeaway message

Existing Building Retrofits

An integrated solution set for energy and occupant benefits

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3. The Value Proposition

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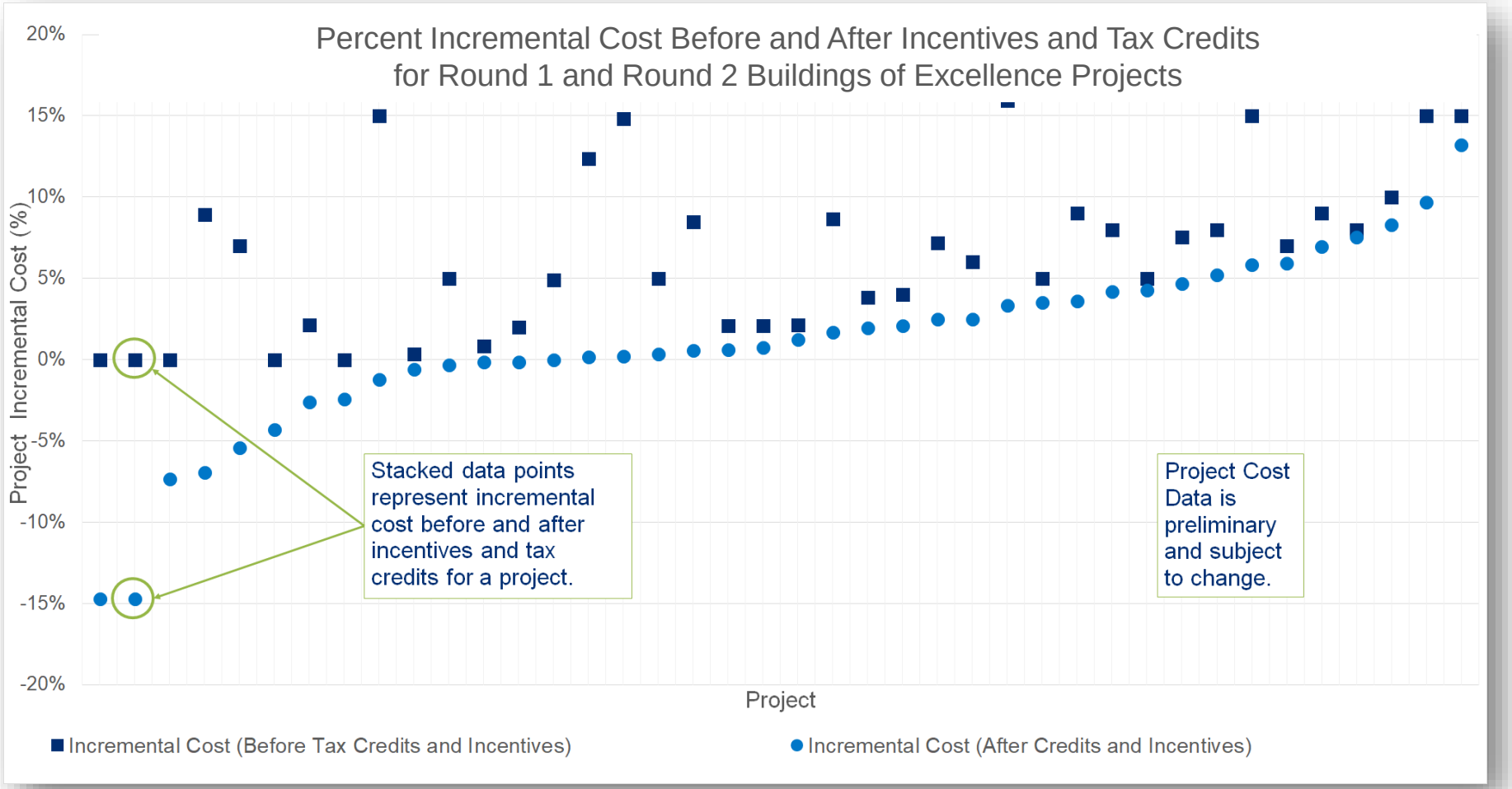
Communicating Value to Drive Scale

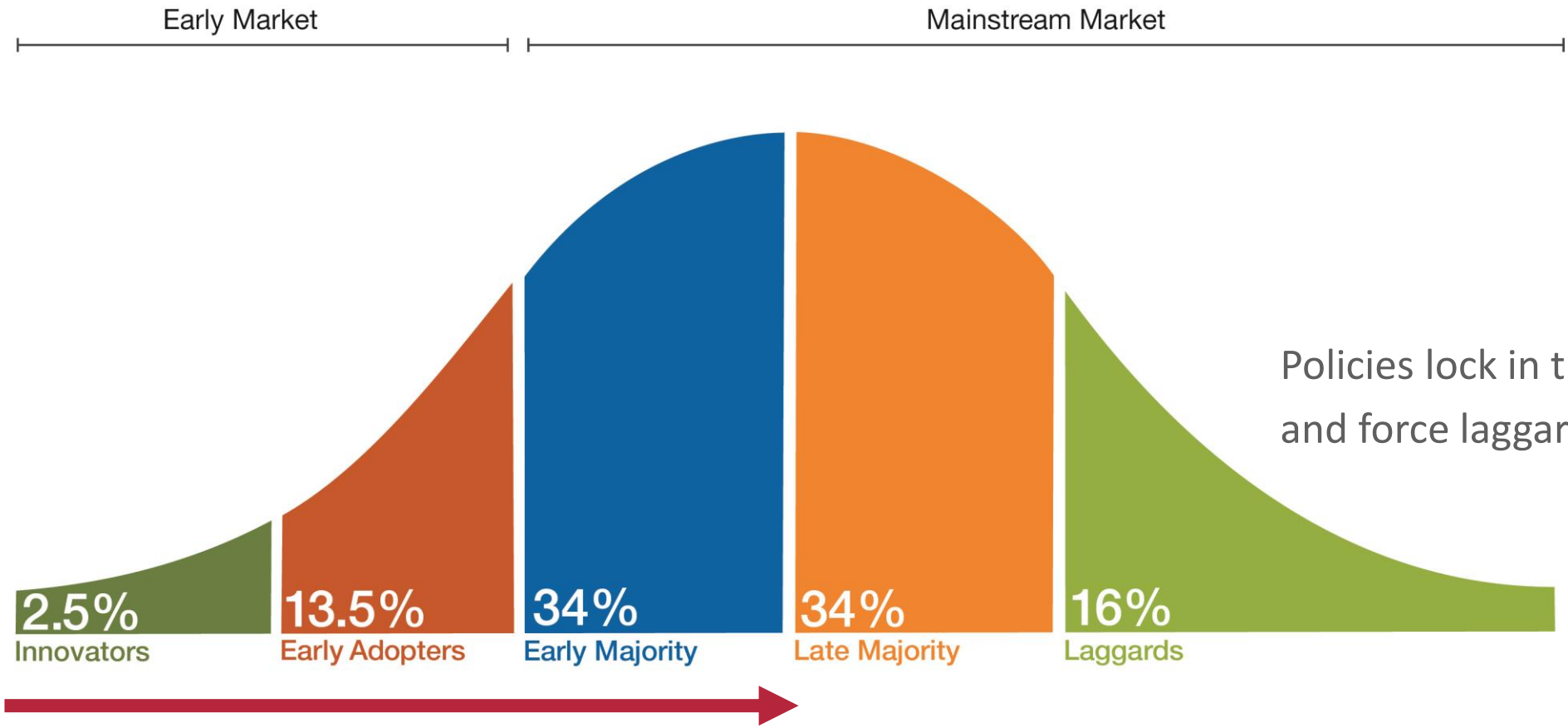
- First **question** on efficiency investments is always: what does it cost?
- **Answer** must be a holistic value proposition: cost savings + co-benefits

Building the Business Case

Actual projects show design and construction teams are exceeding modeled and predicted results, with first cost premium after incentives and tax credits averaging 2%.



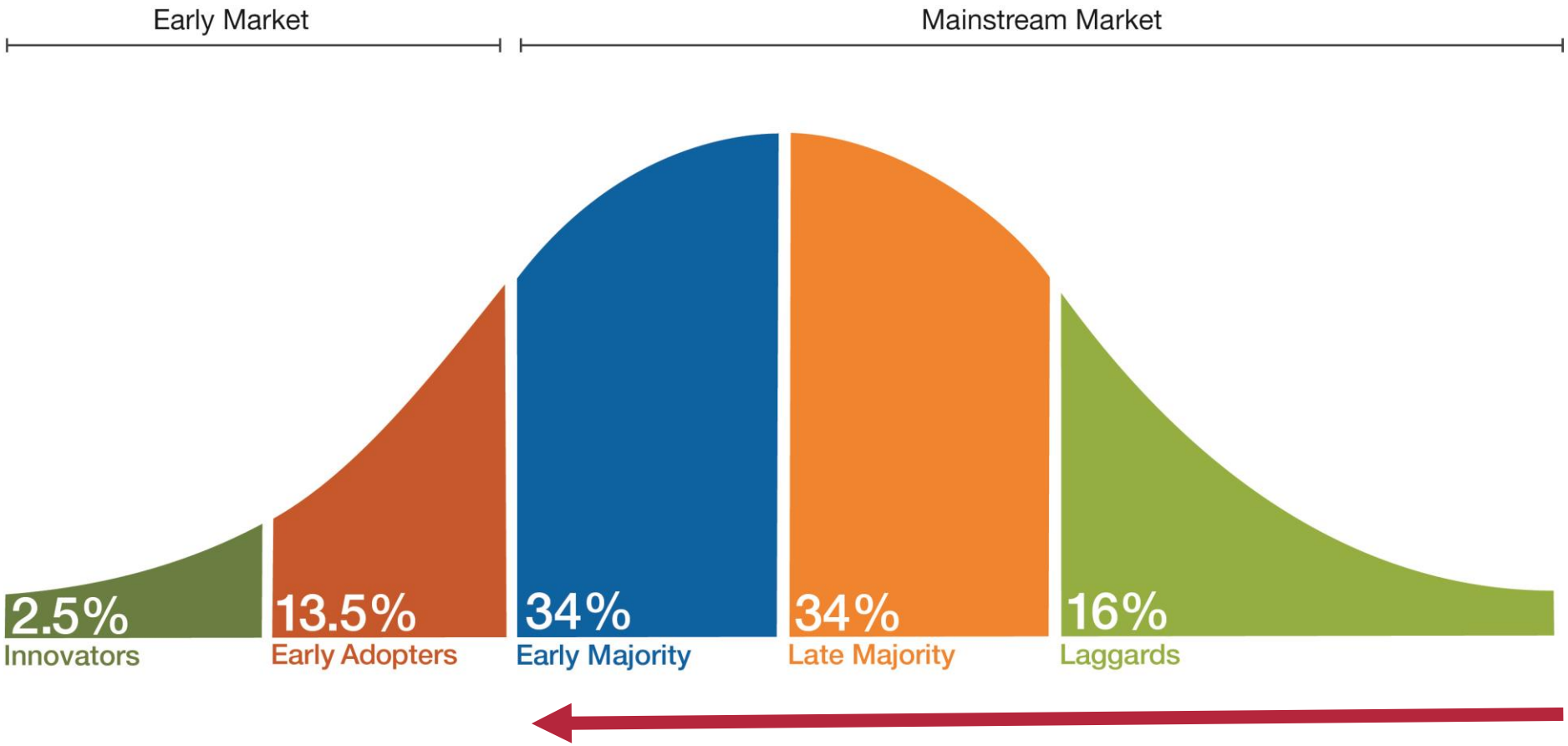
Market Adoption (Diffusion) Curve



Policies lock in the changes and force laggards to comply

Graphic Credit: NBI

Market Adoption (Diffusion) Curve



Graphic Credit: NBI

Clean energy trends in the built environment

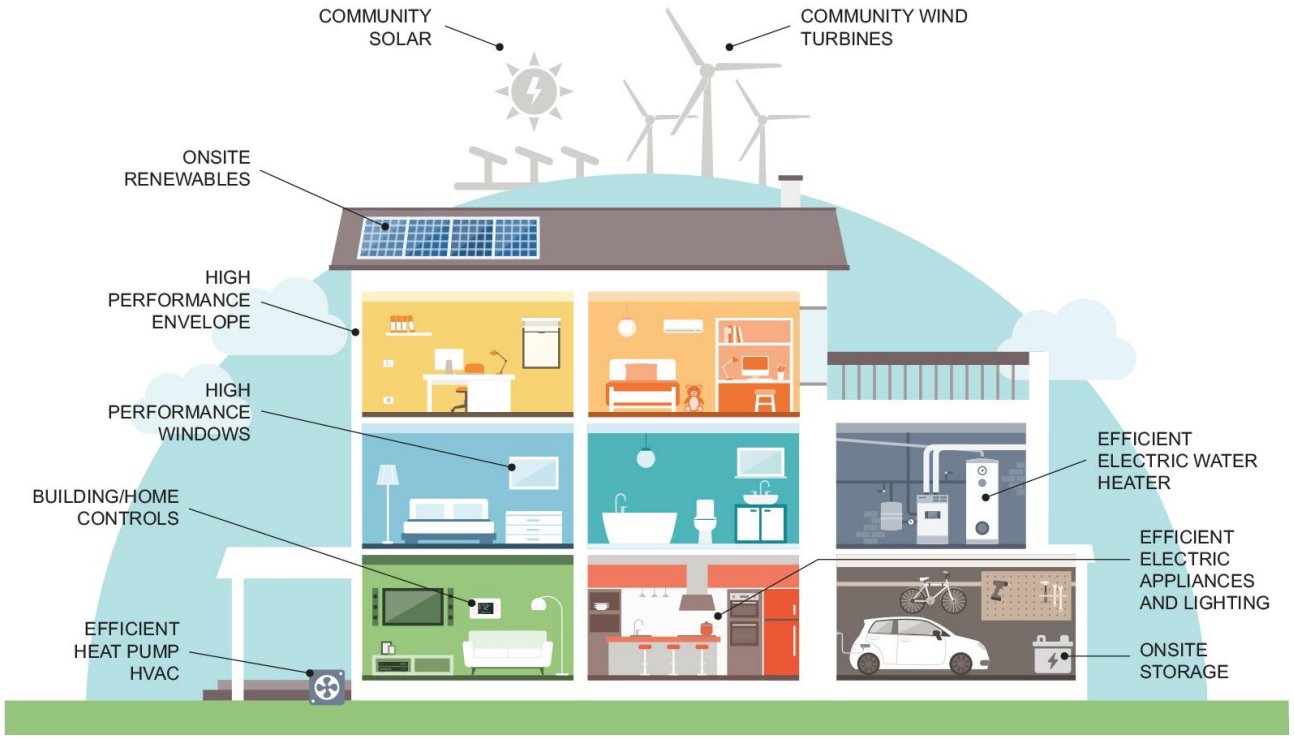
1. **Shift to carbon**. Industry metric historically staked on kWh. That is still an important metric, but not the most important metric.
2. **Embodied carbon.** 11% of building carbon is from the manufacturing of materials.
3. **Electrification.** Must address the greenhouse gas emissions from the burning of fossil fuels onsite.
4. **Grid Interactivity.** Grid interactive tech will help shave and shift load when during peak times of day.

Net zero energy building versus carbon neutral buildings

In addition to the Core Components, **carbon neutral buildings** incorporate the additional components listed below. As grid-supplied resources get cleaner, **building-grid integration** will become necessary to address peak demand and enable load shifting. Reducing onsite GHG emissions through **electrification** and **embodied carbon** will become priorities for driving down the climate changing impacts of the built environment.

Core Components:

- Maximize energy efficiency
- Prioritize on-site renewables
- Utilize off-site renewables
- Measure and manage net zero operations



Credit: NYSERDA

Additional Components:

- Electrification-ready and minimize/eliminate on-site fossil fuels
- Optimize building-grid integration and on-site storage
- Specify low GWP refrigerants
- Select low embodied carbon materials

Co-benefits of carbon neutral buildings

1
Minimize liability & future proof

Safeguard against a changing energy market where gas and other fossil fuels are likely to become less accessible and more expensive over time.

2
Maximize usable square footage

Electric HVAC equipment maximizes available square footage (e.g. heat pump units installed on walls near ceiling vs. steam radiator taking up floor space).

3
Health benefits

All-electric appliances, especially electric stoves and cooktops, reduce indoor air pollutants. Good building envelopes protect against pest infestation and other asthma triggers.

4
Increased resilience

Weatherization and solar + storage help keep the power on and temperatures consistent in the event of a power outage or extreme weather event.

5
Occupant comfort

Improved comfort from increased air-flow/movement, addressing previously unmet cooling needs (through heat pumps), and noise reduction.

6
Safety

Reduced risks associated with aging gas infrastructure leaks; induction cooktops reduce instances of fire and burns.

Co-benefits: Cost and Value

https://blueprintforbetter.org

Co-Benefit	Value
Property values	Every dollar saved in energy costs can increase a building's market value by $18.32 assuming a capitalization rate of 5.5% (Eichholtz 2010).
Operational cost savings from design integration	A cost analysis of a hypothetical six-story, 31,000-square-foot office building in Philadelphia concluded that right-sizing equipment led to a cost savings of $2/sf (doas-radiant.psu.edu/).
Healthier IAQ	By improving the indoor air quality, employee turnover fell by 27% and absenteeism decreased by 58%. Together, these two elements saved the company approximately $275,000 a year (WGBC 2018).

Co-benefits: Cost and Value

https://blueprintforbetter.org

Co-Benefit	Value
Resiliency	FEMA estimates better resiliency in buildings can pay back 6:1 in the case of an emergency.
Productivity	Increased CO_2 concentrations from 550 to 945 ppm resulted in a 15% reduction in cognitive test scores. Changes in concentrations from 550 to 1400 ppm resulted in a 50% decrease in cognitive scores (Allen 2016).
Hiring and employee retention	A Deloitte survey found that 93% of companies that implemented a green retrofit reported an increase in the ability to attract talent, and 81% reported an increase in the ability to retain talent (Deloitte 2008).

Questions and Dialog

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Thank you!

Higgins@newbuildings.org
Kevin@newbuildings.org
Kim@newbuildings.org
Stacey@newbuildings.org

West Berkeley Public Library, Berkeley, CA

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