


Addressing Life-Cycle Energy Performance: A Framework for Cities

Building Codes Advocates Meeting
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National Institute of
BUILDING SCIENCES

*An Authoritative Source of Innovative Solutions
for the Built Environment*

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Public Law 93-383, Sect. 809

Congress directed the Institute to “exercise its functions and responsibilities in four general areas.....”

- **Develop and maintain** performance criteria for maintenance of life, safety, health, and public welfare for the built environment
- **Evaluate and prequalify** building technology and products
- **Conduct** related and needed investigations
- **Assemble, store, and disseminate** technical data and related information



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High-Performance Buildings Defined

High-Performance building means a building that integrates and optimizes on a life-cycle basis all major high-performance attributes, including energy [and water] conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.

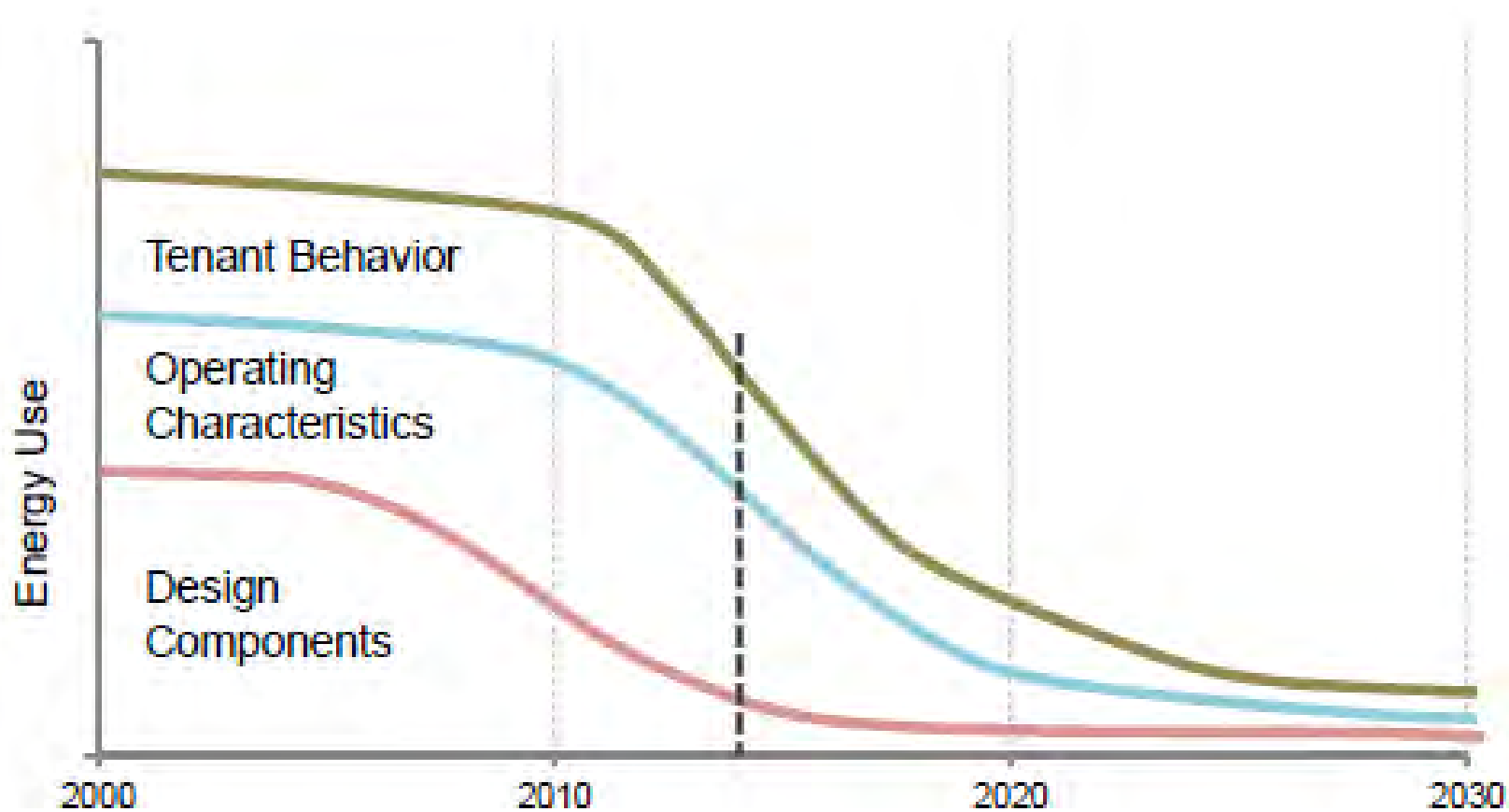
-Energy Independence and Security Act of 2007 §401 (PL 110-140)

Why Life-Cycle Performance?

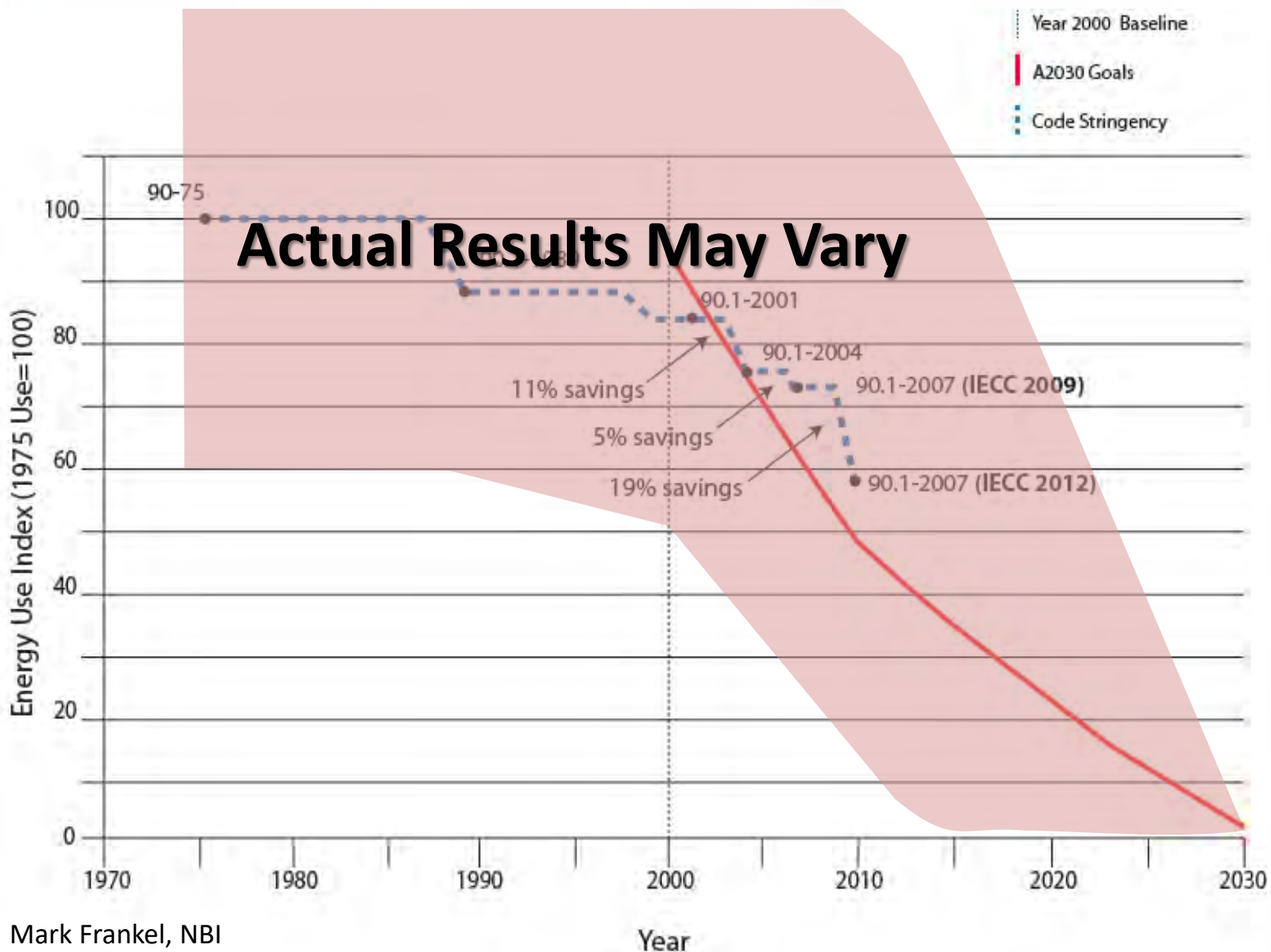
... 'cause that's where the savings is

- Design focused solutions will only get us so far
- Existing building stock represents huge largely untapped opportunity
- Encourages more holistic approach to design, construction and operations
- Cities setting community-wide goals for energy use, greenhouse gas emissions
- The U.S. buildings sector alone accounted for 7% of global primary energy consumption
- U.S. buildings GHG emissions approximately equal the combined carbon emissions of Russia and Canada

The Limits of Design Focused Solutions



Energy Code Stringency



Summary of Energy Efficiency Impact by Market Size, Climate and Employment Categories

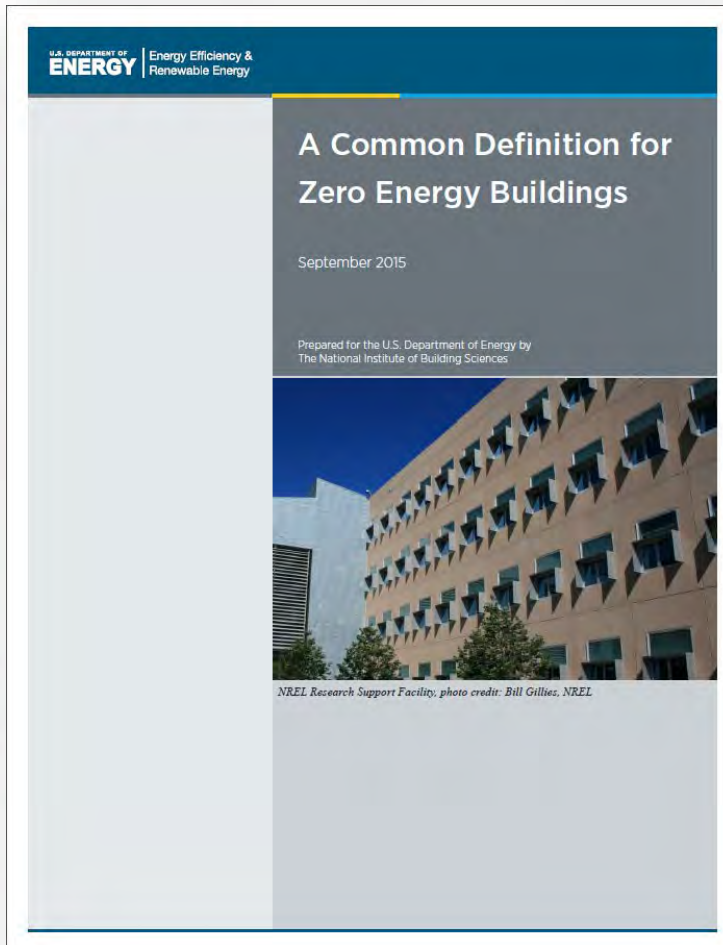
	Residential	Commercial	Institutional	Total
Economic/Financial Impact				
Energy Savings (Trillion Btu)	1,892	848	293	3,033
Total Investment (\$ Bn)	182	72	25	279
Social Impact				
Cumulative Job Years Created (# FTEs over course of investment program, '000s)	2,152	857	296	3,305
Environmental Impact				
Greenhouse Gas Emission Reduction (million metric tons of CO ₂ mitigated per year)	382	175	59	616

Source: Rockefeller Foundation, 2012. McKinsey, *Unlocking Energy Efficiency in the U.S. Economy* (2009); Center for American Progress, *The Economic Benefits of Investing in Clean Energy* (2009); Energy Information Administration *Commercial Building Energy Consumption Survey 2003, Residential Energy Consumption Survey 2000*. Note: Analysis is based on an assumption of 30% energy savings in buildings built before 1980. Category impact information represents an aggregation of the values calculated for the segments associated with that category. TBtu = Trillion Btu.

What is Going to Get us There?



ZEBs are all about Performance



<http://energy.gov/eere/buildings/downloads/common-definition-zero-energy-buildings>

- Zero Energy Building (ZEB):
 - An energy-efficient **building** where, on a **source energy** basis, the **actual annual delivered energy** is less than or equal to the on-site renewable **exported energy**.
- The designation *Zero Energy Building (ZEB)* should be used only for *buildings* that have demonstrated through **actual annual measurements** that the *delivered energy* is less than or equal to the *on-site renewable exported energy*.
- Also similar definitions for **campus**, community, **portfolio**

Fundamental Steps

- Setting Policy Goals
 - Climate action plans, 80x50, C40, Climate Mayors. . .
- Establishing System(s) for Tracking Performance
 - Determine performance relative to goals
- Setting Policy-Level Performance Targets
 - Realistic interim targets, evaluation of progress
- Setting and Implementing Building-Level Performance Targets
 - Individual buildings to achieve city-wide goals

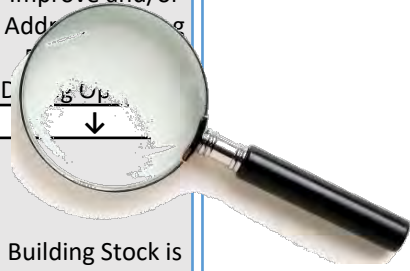
Activities and Mechanisms

- Policies require legislative or regulatory action by city leadership (mayor, city council, etc), or within administrative agencies.
- Actions are steps that should generally be undertaken at an administrative level.
- Resources are either investments or capabilities that support realization of program goals.
- Tools can be developed internally at the city level or at a national level by the Department of Energy or others and provide the mechanism to accomplish a specific strategy.

Elements of A Life-Cycle Performance Strategy

LEADERSHIP		DATA, ANALYSIS, AND APPLICATION			MECHANISMS			ENSURING RESULTS	
Capacity and Commitment		Data	Targets and Benchmarking	Application of Targets	Engagement / Triggers	Design and Construction Code	Operations	Enforcement	City Influence on Market
Description	Administrative Resources, Framework and Commitment to Effectively Implement the Policy and Programs	Information about Building Performance and Mechanisms to Collect It	Where Does the Observed Metric for a Building Fall on a Scale that Includes the Target, the Ultimate Goal and the Performance of Other Buildings	How and When Targets are Applied to the Building Stock	Events that Initiate an Obligation to Take Action	Develop, Adopt and Enforce Energy Codes	Extension and/or Creation of Administrative Structure to Improve and/or Address Building Performance During Operation	Regulatory Mechanisms (and Implementation) to Ensure Compliance with Performance Requirements	Opportunities to Engage the Private Sector to Support Performance Outcome Goals
	↓	↓	↓	↓	↓	↓	↓	↓	↓
Outcome	Consistent Support, Resources and Capabilities to Implement and Manage Building Performance Policies	Data is Collected Consistently and Comprehensively so the City can Track Progress to Goals	Providing a Consistent and Comprehensive Metric for Tracking Progress Toward Goals	Establish Meaningful Targets that can be Adjusted for Specific Building Conditions and are Adjusted Over Time to Meet Goals	Annual Performance Data is Routinely Reported and Required to Manage Building Operation within Targets	Buildings are Designed and Constructed for Energy Efficiency and City Goals, Configured to Operate as Designed and Provide Measurable Outcomes	Building Stock is Operating Optimally up to their Design Potential	Realization of the Community's Goals Based on the Established Metrics	The Market Delivers and Maintains Buildings that Achieve Performance Goals

MECHANISMS			
	Engagement / Triggers	Design and Construction Code	Operations
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MECHANISMS			
	Engagement / Triggers	Design and Construction Code	Operations
Description	Events that Initiate an Obligation to Take Action	Develop, Adopt and Enforce Energy Codes	Extension and/or Creation of Administrative Structure to Improve and/or Address Building Performance During Operation
High Level Policy	Specific Triggers of Policy Application at the Building Level	Enforcement Mechanisms during Design and Construction	Policies and Mechanisms to Influence Building Operation
Administrative Policy	Targeted Events that are the Basis for Administration and Enforcement of Building Performance Policies	Administrative Mechanisms and Policies for New Construction Requirements	Administrative Mechanisms to Influence Building Operations
Actions	Develop Mechanisms to Track and Trigger Performance Requirements	New Construction Code Evolution to Support Policy	Implement Requirements for Improving Operational Performance
City Resources	Staff and Support Resources at City		
Tools	Tools Needed or Available to Support Implementation		
Outcome	Annual Performance Data is Routinely Reported and Required to Manage Building Operation within Targets	Buildings are Designed and Constructed for Energy Efficiency and City Goals, Configured to Operate as Designed and Provide Measurable Outcomes	Building Stock is Operating Optimally up to their Design Potential

MECHANISMS

Engagement / Triggers

Description	Events that Initiate an Obligation to Take Action
High Level Policy	Performance Requirements Applied to Increasing Proportion of Building Stock Over Time Based on Expanding Set of Triggers
	Performance Goals for Municipal Building Stock
	Performance Requirements for New Construction
	Performance Requirements for Major Remodels
	System-Specific Triggers
Administrative Policy	Maintenance / Upgrade
	Point of Sale
	Change of Occupancy
	Time Certain
	Annual Review
Actions	Track Building Events that Trigger Performance Requirements
City Resources	
Tools	Infrastructure for Data Collection and Management
Outcome	Annual Performance Data is Routinely Reported and Required to Manage Building Operation within Targets

Other Triggers

Once a city develops requirements for categories within the fundamental trigger points, there may be a desire for capturing additional savings through a broader set of triggers. These recommended triggers represent further opportunities for engaging building owners.

• Point of Sale

Sale of a property serves as a potential intervention points where buyer and seller may be motivated to take action. Additionally, the city is often notified of the event and has potential mechanisms for engagement including through title records, deed filings and tax filings. Burlington, Vermont has issued a “Time of Sale Energy Efficiency Ordinance” for residential rental housing which could be modified and applied elsewhere

(https://www.burlingtonelectric.com/sites/default/files/Documents/Energy_Eff/time-of-sale-energy-ordinance.pdf).

• Change of Occupancy

When pursuing a change of occupancy, the building owner typically must provide notice to the jurisdiction and be required to comply with provisions of code applicable to the new occupancy type. The city may elect to use this owner initiated activity as an opportunity to implement energy performance focused requirements.

• Time Certain

Once the city establishes its long-term goal, targets for intermediate time periods should be developed to support the long term planning of building owners and building teams. Building owners may be required to report performance and achievement of an energy use target on a regular schedule (e.g., every 3 years). The targets may also be aligned to reflect these periodic requirements (e.g., the target will be decreased by 5 percent every 3 years).

• Annual Review

If city goals are particularly aggressive or the performance requirements apply to a highly regulated segment of the building stock, the city may elect to implement requirements for benchmarking, reporting and improvements that are triggered on an annual basis. The city should be mindful that such annual requirements do not place an undue burden on buildings that are already operating at a high level of efficiency. This may require establishing an absolute target accompanied by a relative target level of improvement for poor performers.

Tracking Progress

Matrix of Policies and Strategies for Building Life Cycle Performance Requirements									
LEADERSHIP	DATA, ANALYSIS, AND APPLICATION			MECHANISMS			ENSURING RESULTS		
	Capacity and Commitment	Data	Targets and Benchmarking	Application of Targets	Engagement / Triggers	Design and Construction Code	Operations	Enforcement	City Influence on Market
Description	Administrative Resources, Framework and Commitment to Effectively Implement the Policy and Programs	Information about Building Performance and Mechanisms to Collect It	Where Does the Observed Metric for a Building Fall on a Scale that Includes the Target, the Ultimate Goal and the Performance of other Buildings	How and When Targets are Applied to the Building Stock	Events that Initiate an Obligation to Take Action	Develop, Adopt and Enforce Energy Codes	Extension and/or Creation of Administrative Structure to Improve and/or Address Building Performance during Operation	Regulatory Mechanisms (and Implementation) to Ensure Compliance with Performance Requirements	Opportunities to Engage the Private Sector to Support Performance Outcome Goals
High Level Policy	High Level City Commitment to Building Policy and Implementation Resources	Policy Commitment to Building Performance and Sharing of Building Performance Data	Adoption of Specific Performance Goals and Metrics	Plan to Systematically Increase Application of Policy to Building Stock	Specific Triggers of Policy Application at the Building Level	Enforcement Mechanisms during Design and Construction	Policies and Mechanisms to Influence Building Operation	Enforcement Mechanisms during Building Life Cycle	Engagement Strategies with Private Sector
	Executive Order Goals and Comprehensive Performance Improvement Strategy through Action Plan	Disclose Requirements through Access to Building Stock	Policy Goals Translated into Long Term Building Sector Performance Targets	New Construction Performance Policies	Performance Requirements Applied to Existing Buildings through a Phased Approach to Building Stock Over Time based on Occupancy, Set of Triggers	Adopt and Enforce Model Based Baseline National Model Code or better	Adopt and Enforce Property Maintenance Code	Incentives to Participate	Performance Incentives
	Administrative Framework Enabled to Adapt and Enforce Policies			Plan to Broaden Application of Performance Policy to Existing Performance Requirements to Increase Percentage of Building Stock	Performance Goals for Municipal Building Stock	Adopt an Energy Benchmark Code on all buildings and with City Performance Goals	Periodic Updates to Code	Consequences for Failure to Participate	Performance Goals through Application of Municipal Policies
				Performance Requirements for New Construction	Performance Requirements for Major Remodels	Performance Requirements Phased in to New Construction	Appliance Standards		Issue Financial Incentives to Support Participation
									Lead and Organize Other Committees
Administrative Policy	City Administrative Policy Adoption Commitments	Data Handling Capabilities at Administrative Level	Administrative Capabilities to Identify Application of Performance Targets	Administrative Capabilities to Identify Broadening Policy Application in Building Sector	Targeted Events that are the Basis for Administration and Enforcement of Building Performance Policies	Administrative Mechanisms and Policies for New Construction Requirements	Administrative Mechanisms to Influence Building Operations	Administrative Mechanisms for Enforcement of Building Performance Requirements in Operations Phase	Administrative Mechanisms to Influence Private Sector Building Performance
	Staff Incentives to Implement, Manage and Review Building Disclosure Requirements Data	Staff Incentives to Implement, Manage and Review Building Disclosure Requirements Data	Calculate Disclosure Results to City Policy Goals	Building Size	System Specific Triggers	Design for Measurability	Enforce Completion of Commissioning	Assignment of Performance Liability to City	Update and Adjust Financial Programs
	Commitment to Energy Code Adoption and Enforcement		Set Utility Performance	Target Worst Performers	Maintenance / Upgrade	End Use Metering	Establish Intra-Commissioning the Commissioning Rules and Metrics Requirements	Public Utility	Zoning
	Department Responsibility for Collection of Building Performance Data		Periodically Update Targets with New Code	Point of Sale		Priority Building Components with Long Service Life		Utility Rates	Annual Certification
	Disclosure Policy		Targets for All Buildings	Change of Occupancy		Set Energy Performance Objectives as Permit Requirements		Tax Structures	
	Regulatory Incentives			Annual Review		Link with Ongoing Inspections		Fee Schedules	
						Develop Incentive and Requirements for Building		Hard-Stop Utility Resource	
Actions	Develop Agency Administrative Responsibilities and Procedures to Support and Implement Policies	Develop Data and Analytics Infrastructure to Support Performance Tracking	Develop Performance Tracking and Management Capabilities for Building Stock	Develop and Implement Evolving Performance Targets Over Time	Develop Mechanisms to Track and Trigger Performance Requirements	New Construction Code Evaluation to Support Policy	Implement Requirements for Improving Operational Performance	Enforce Performance Requirements Across the Building Life-Cycle	Actions to Influence Voluntary Adoption
	Adopt and Enforce Energy Code Requirements	City Building Stock Assessment	Calculate Utility to Energy	Public Building Performance Targets and Evaluation of Applicability in Advance	Track Building Status that Trigger Performance Requirements	Review Scope or Coverage of Codes	Develop Enforcement Capabilities on Building Operational Phase	Enforce Performance Requirements	Build Performance Awareness Across Subsectors
	Engage in National Code Development Process	Assign Diagnostic of Disclosure Data to Building Stock	Include Designers & Owner on Disclosure Reports	Require Public Building Performance		Engage in National Code Development Process			Educate Stakeholders
									Highlight Successful Projects
City Resources	Staff and Support Resources at City								
	City Champion	Staff and Infrastructure for Data Collection and Management	Analytics Capability	Performance Tracking Tools for Policy and Public		Staff to Implement	Staff to Implement		
	Funding Sources for Staff, Tools, Outreach and Implementation		Performance Tracking Tools for Building Stock			Design/Real-Time Diagnostics	Open Reporting / Transparency		
Tools	Tools Needed or Available to Support Implementation								
	Infrastructure for Data Collection and Management	Disclosure and Benchmarking Tools	Infrastructure for Data Collection and Management	Infrastructure for Data Collection and Management	Infrastructure for Data Collection and Management	Standard Tool for Target Setting and Normalization	Disclosure and Benchmarking Tools		Utility Programs
	City Strategy (Internal)	Utility Data Availability	Standard Tool for Target Setting and Normalization	Strategy and Benchmarking		Available Tool for Target Setting and Normalization			Operator Certification
		Other Building Stock Sources							Available Utility Programs
									Utility Rate Structures
Outcome	Consistent Support, Resources and Capabilities to Implement and Manage Building Performance Policies	Data is Collected Consistently and Comprehensively so the City can Track Progress to Goals	Providing a Consistent Admin for Tracking Progress Toward Goals	Establish Meaningful Targets that can be Adjusted for Specific Building Conditions and are Adjusted Over Time to Meet Goals	Annual Performance Data is Routinely Reported and Required to Manage Building Operation within Targets	Buildings are Designed and Constructed for Energy Efficiency and City Goals, Configured to Operate as Designed and Provide Measurable Outcomes	Building Stock is Operating Optimally up to their Design Potential	Realization of the City's Goals Based on the Established Metrics	The Market Delivers and Maintains Buildings that Achieve Performance Goals

- In Place ✓
 - Executive Level Goals and Commitments to Performance Improvements Through Action Plan(s)
- In Process →
 - Performance Tracking Tools for Policy and Public
- In Planning ↔
 - Analysis/Diagnostics of Disclosure Data to Determine Building Stock Performance Characteristics
- In Projections ↗
 - Other Building Data Sources

Next Steps

- Developing web-based tool for cities on Whole Building Design Guide
- Funding to support development
- Publicizing availability
- Soliciting feedback from communities on how using the tool
- Building out supplemental information with examples, case studies


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