

**Energy Efficiency Solutions
Precourt Energy Efficiency Center
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“Getting to Net Zero Energy Buildings” Needs, Challenges, Opportunities

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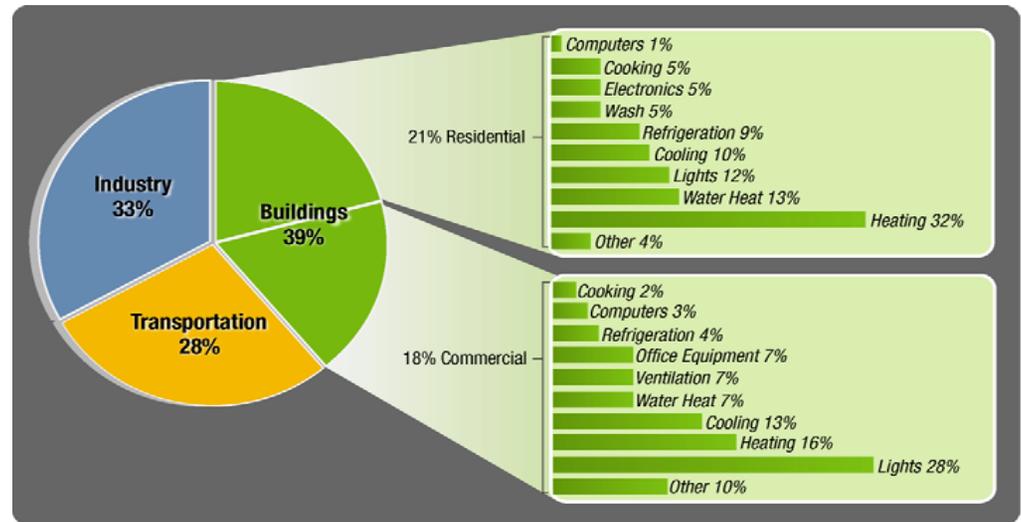
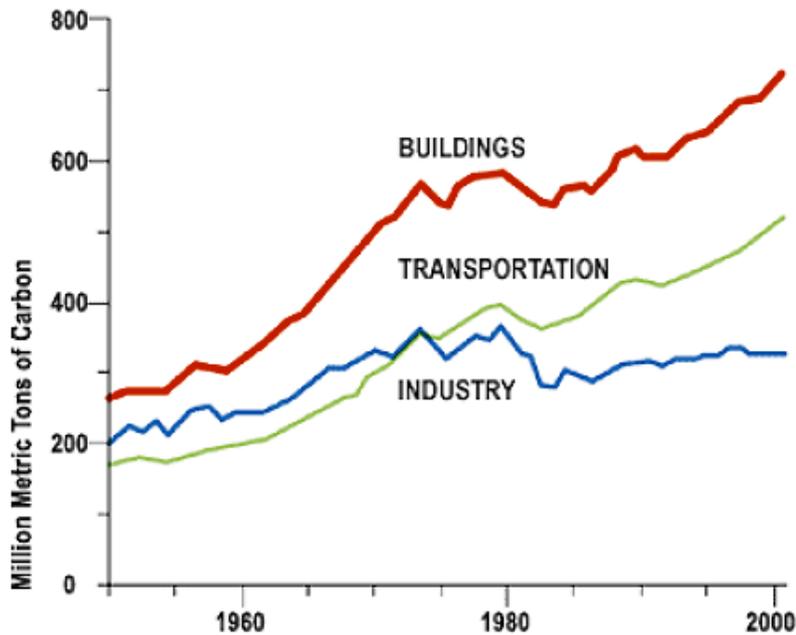
Building End Use Energy Consumption

Building sector has:
Largest Energy Use!
Fastest growth rate!

Buildings consume 40% of total U.S. energy

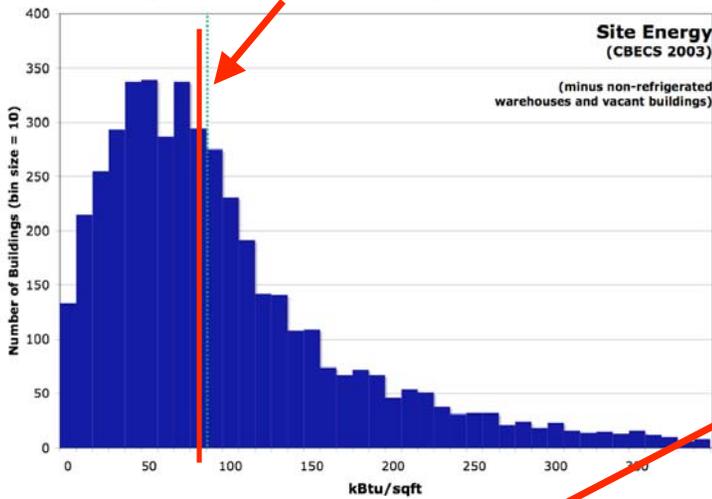
- 71% of electricity
- 54% of natural gas

No Single End Use Dominates

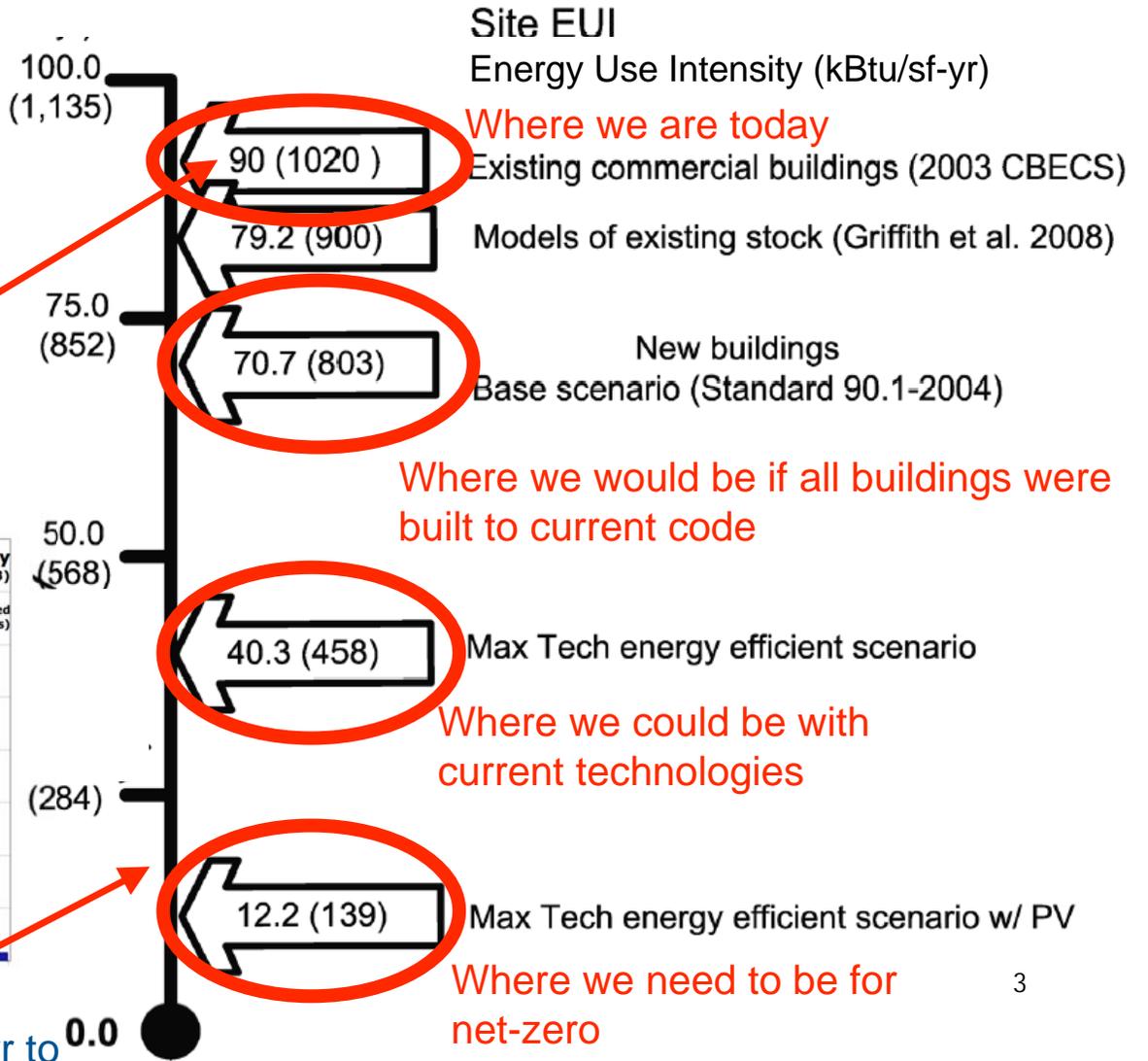


Commercial Building Energy Use

Site Energy Use Intensity (EUI) distribution of Commercial Building Stock
Average is 90kBTu/sf-yr



Must be reduced to 10-20kBTu/sf-yr to achieve ZEB performance levels with cost effective PV



Site EUI
Energy Use Intensity (kBTu/sf-yr)

Where we are today
Existing commercial buildings (2003 CBECS)

Models of existing stock (Griffith et al. 2008)

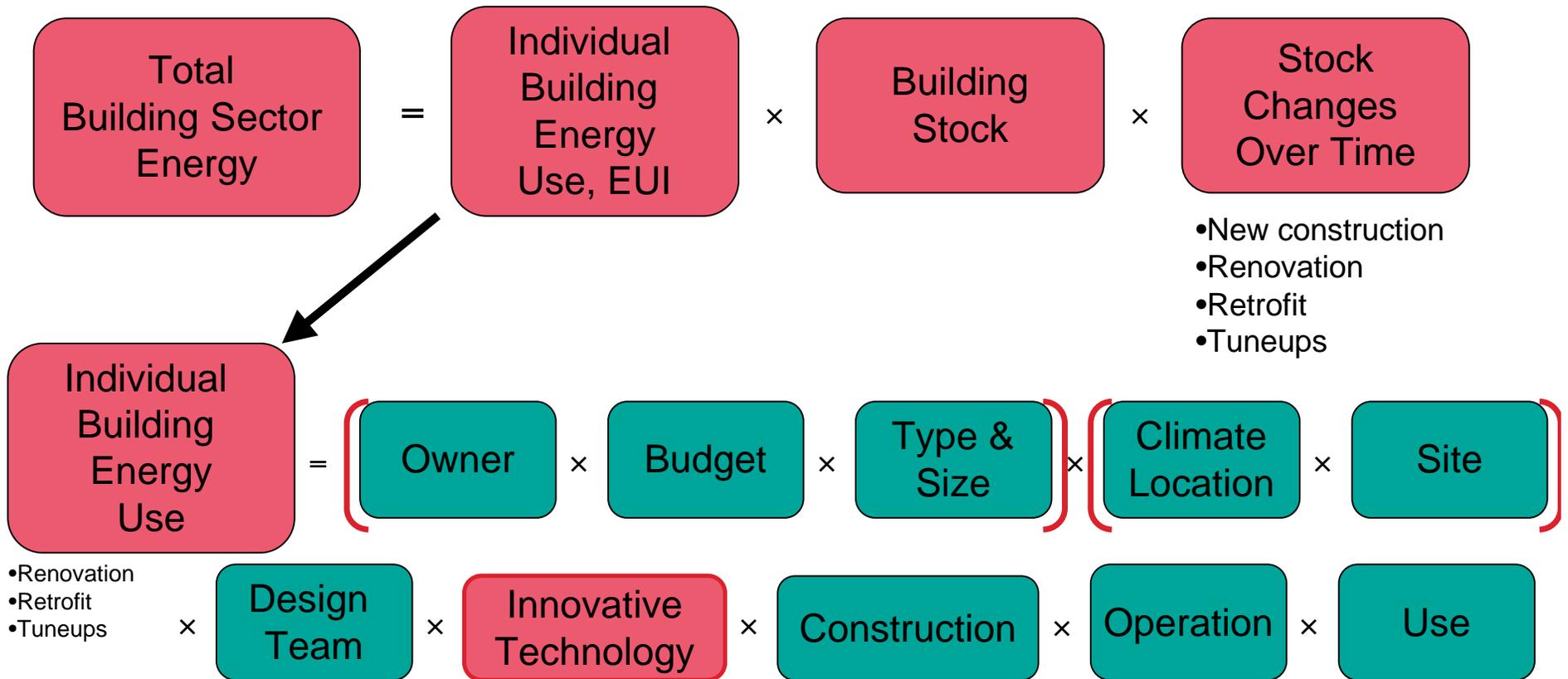
New buildings
Base scenario (Standard 90.1-2004)

Where we would be if all buildings were built to current code

Max Tech energy efficient scenario
Where we could be with current technologies

Max Tech energy efficient scenario w/ PV
Where we need to be for net-zero

“Controllable Parameters” that Impact Building Energy Use (and Carbon)



Building Innovation “Game Changers” for NZEB



MATERIALS AND SYSTEMS

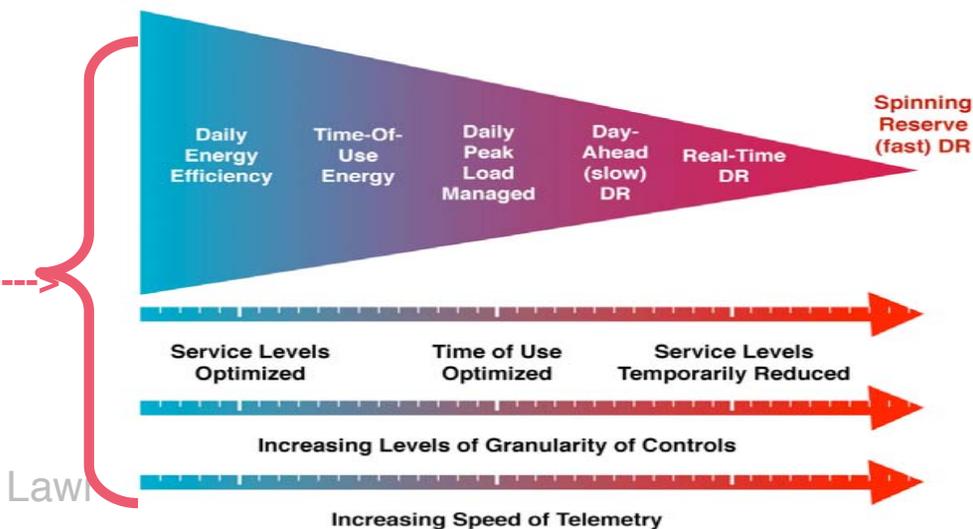
- Smart Glass/Dynamic Facades
- High R Windows, Insulation
- Thermal Storage
- 200 lumen/watt lighting
- Daylight integration
- Dimming, Addressable Lighting Controls
- Task Conditioning HVAC
- Climate Integrated HVAC

LIFE-CYCLE OPERATIONS

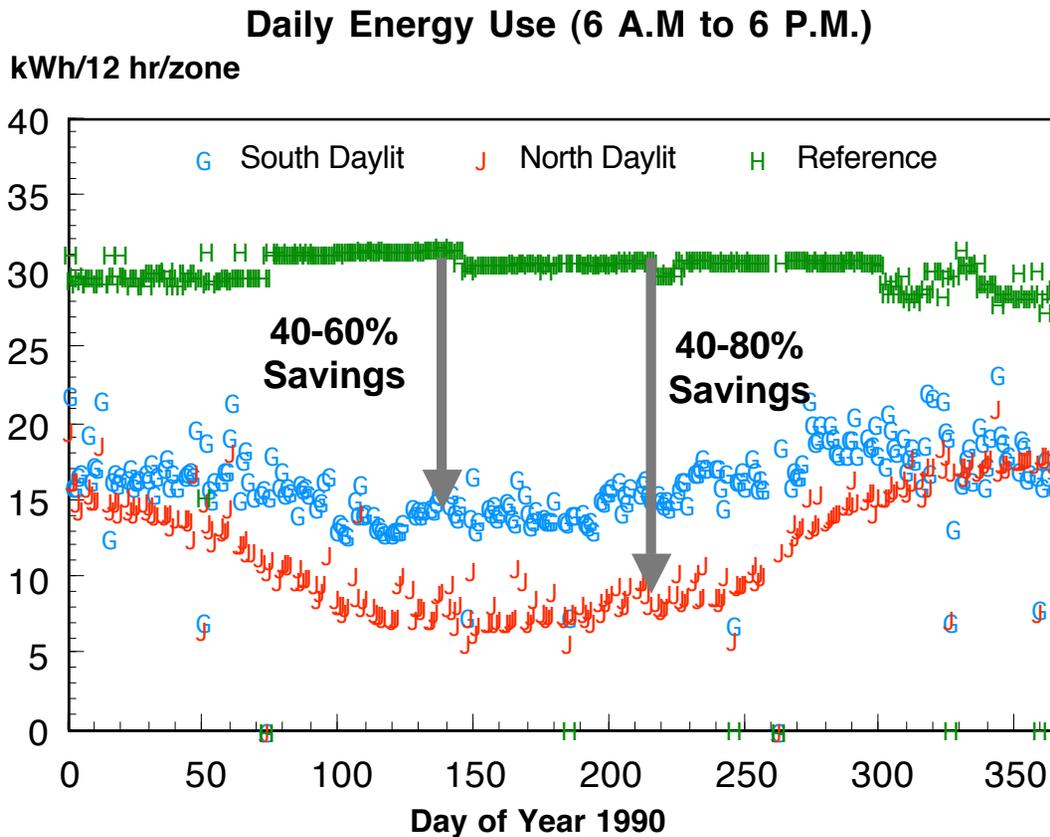
- Building Life Cycle Perspective
- Benchmarks and Metrics
- Building Information Models (BIM)
- Integrated Design Process and Tools
- Building Operating Controls/Platform
- **Building Performance Dashboards**
- Understanding Occupants
- Facility Operations

Buildings and the Grid

- Demand Response <--> Efficiency
 - Time frame for response
- Smart electronics
- Electrical Storage



Good Lighting Controls (Daylight Dimming) Work



Data from advanced lighting controls demonstration in Emeryville, CA (1990) ← !!!

Energy Use before retrofit: █

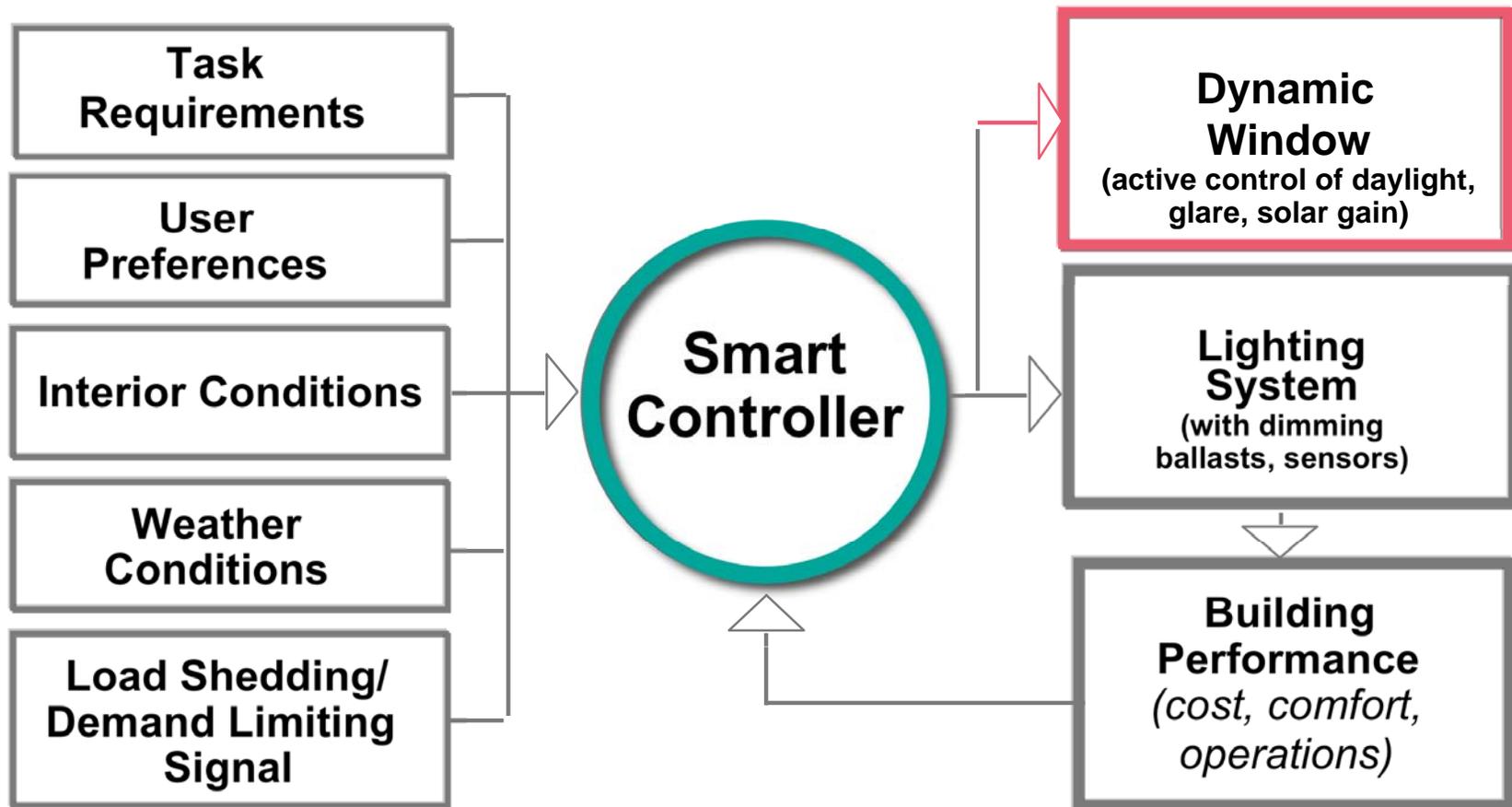
After retrofit:
 South zone: █
 North zone: █

Dimming is only 3% of lighting sales after 20 yrs

Zone savings differences (N vs. S) due to poorly operated shading controls that reduce daylight benefits

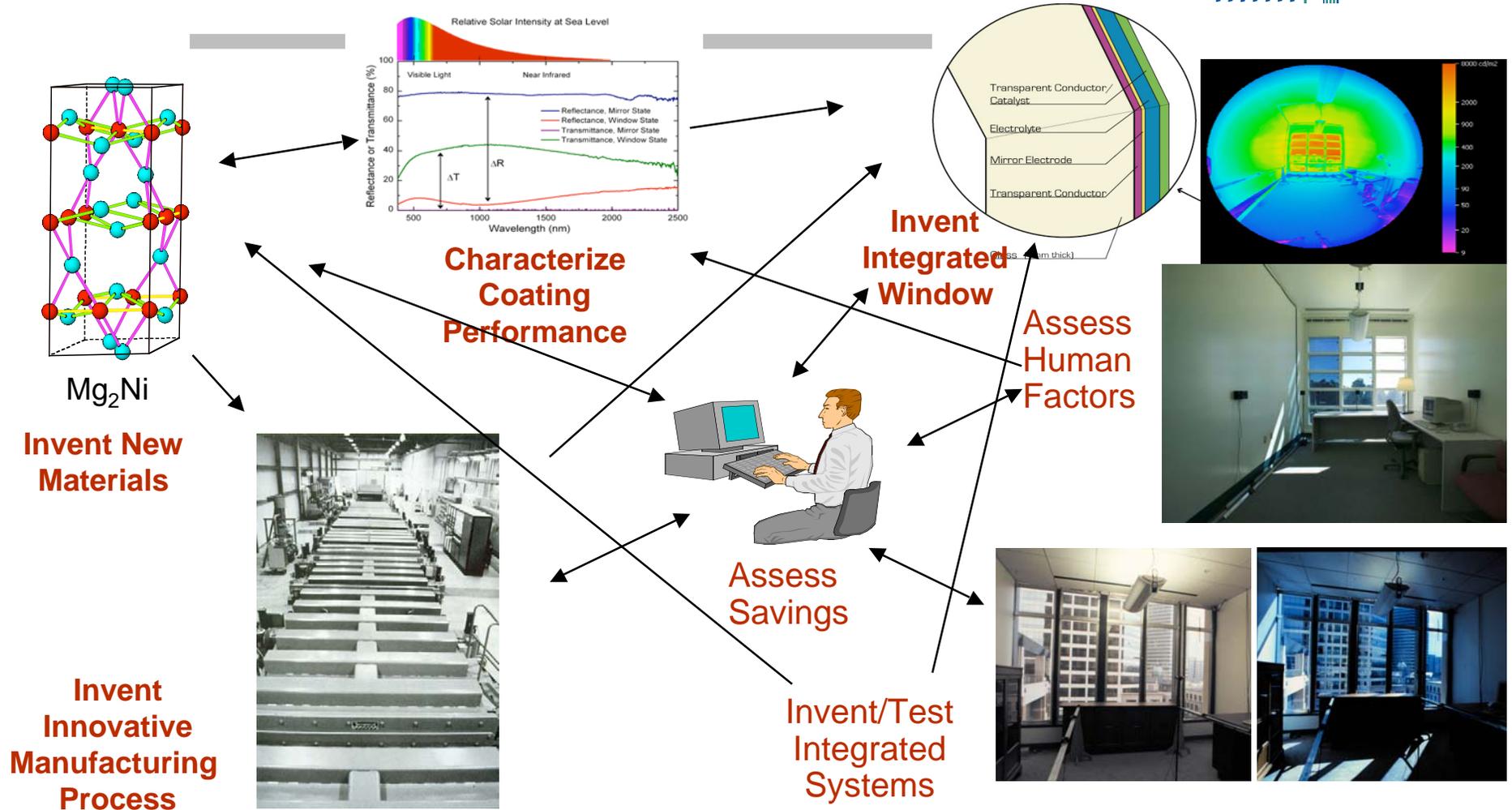
Intelligent Control of Dynamic Systems

(needed for optimal and reliable control of integrated systems)



Integrated R&D Strategy for New Systems

(Needed to guide R&D for maximum success in markets)



Building Owners Need Integrated Programs for Maximum Market Impact with Lowest Cost and Effort

- Owners swamped by yet another “program” approach to building energy improvements; numerous discrete (overlapping) programs:
 - Audit programs
 - Rebate programs
 - Benchmark programs
 - Commissioning programs
 - Retrofit programs
 - Load Management programs
 - DR programs
 - Renewables programs
 - LEED programs
 - EPACT Tax Credit programs
 - Title 24: Codes and standards
 - (+ Life safety, earthquake, disabled access, ...)

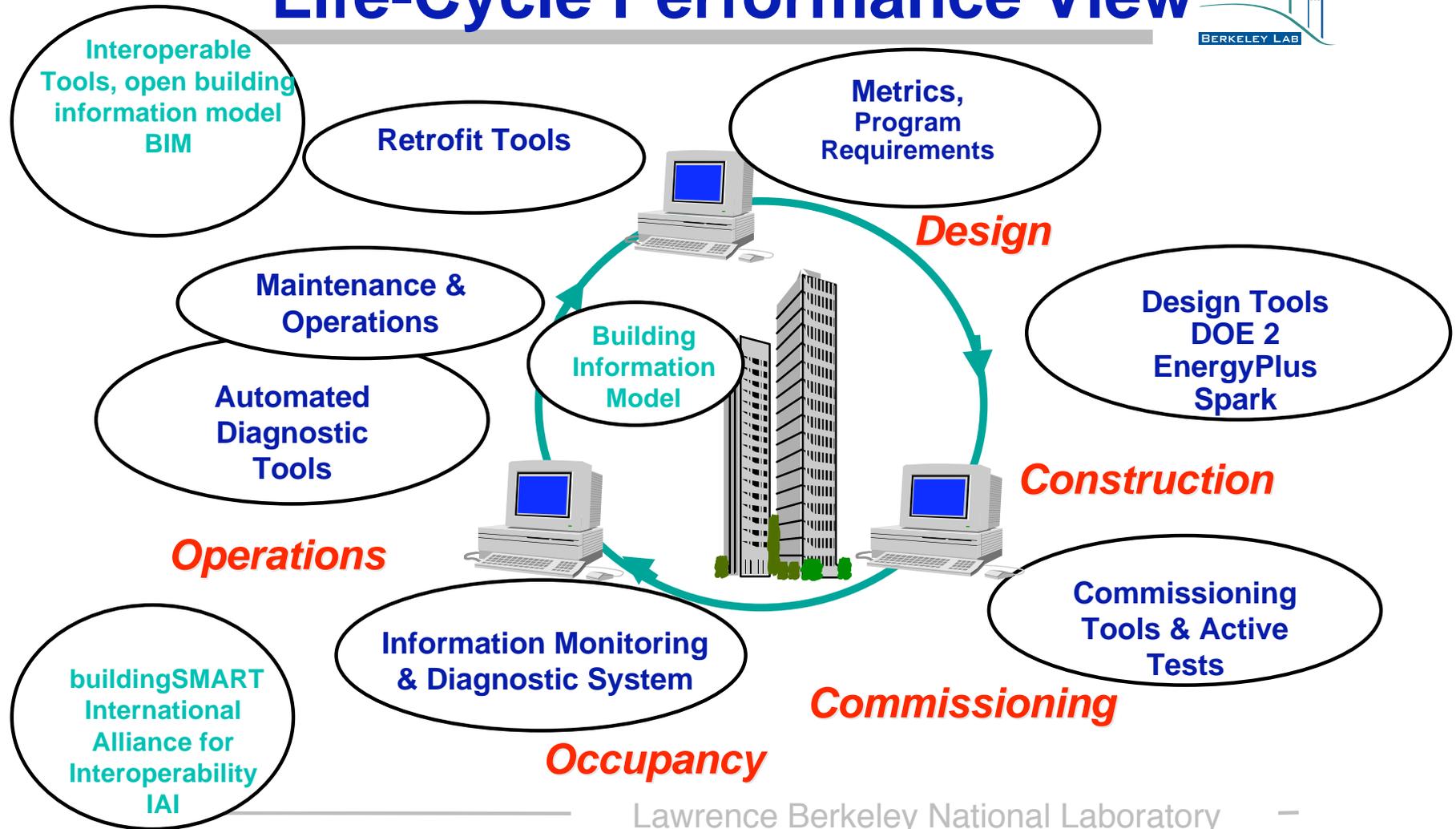
**What
Not To
Do**

-
- For New Buildings:
 - The *“determine performance goals, use integrated design approach with state-of-the-art smart systems, construct and commission, operate to meet targets”* Program
 - For Existing Buildings:
 - The *“benchmark your energy use and set goals, actively monitor end use and indoor environmental quality, diagnose and fix problems as they arise -> take operational and/or investment actions to meet goals, and actively monitor feedback, re-evaluate benchmarks in light of costs...”* Program
 - “IT management” problem; Build these programs around a single shared “life-cycle” Building Information Model (BIM)

**What's
Needed**



Information Technology-based Building Life-Cycle Performance View



Strategy Portfolio for Getting to “Zero Net Energy” or “Carbon Neutral” Buildings

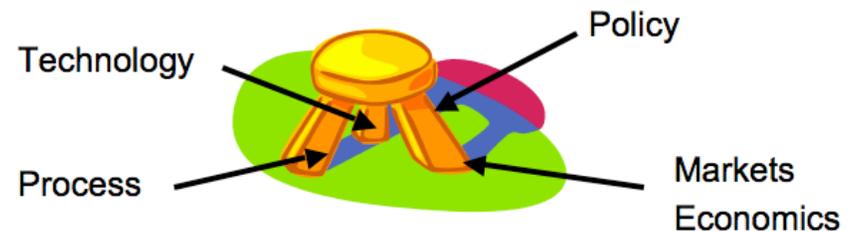
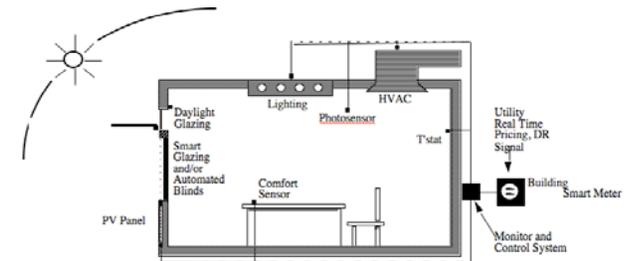
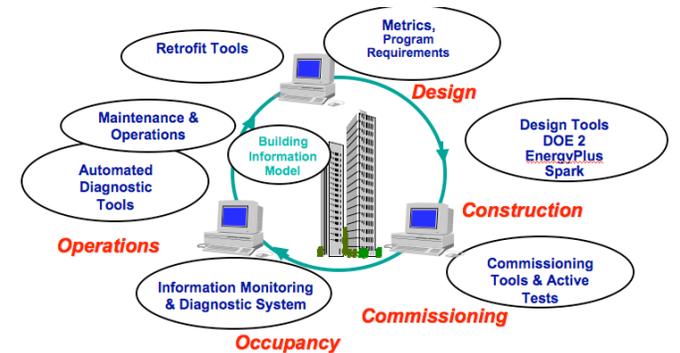


- **Deployment: (5-30% savings)**
 - Identify what works and deploy it widely
 - Applies to all buildings: new and existing
 - Mandatory programs: codes and standards
 - Voluntary programs: incentives
- **Demonstrate Emerging Solutions (20-60% savings)**
 - Find underutilized, unproven technologies and systems
 - R&D to improve, optimize; make them mainstream
- **R&D --> Breakthrough Innovations (50-80% savings plus on-site renewable power)**
 - New, more effective, high performance, integrated systems options
 - Technology, Systems, Process
 - Lower costs, lower risk

Buildings “Grand Challenge”: Getting to “Net Zero”



- **Make Performance Visible, Actionable**
- **Focus on Life Cycle of the Building**
 - Design --> Construction --> Operations
- **Focus on Integrated Building Systems**
 - Materials --> Devices --> Integrated Systems --> Buildings
- **Focus on “intersection” of Technology and Policy**
 - R&D: Innovative, Disruptive technologies and systems
 - +
 - Occupant behavior, satisfaction, comfort, Life style
 - +
 - Policy, Investment and Decision making
- **Proactive, Patient, Persistent, \$\$.....**



LBL Building Energy Efficiency Information Resources



Commercial Buildings projects: --> <http://buildings.lbl.gov>

EETD Division Project Info:

<http://eetd.lbl.gov>

Windows R&D

<http://windows.lbl.gov>

Advanced Facades project

<http://lowenergyfacades.lbl.gov>

<http://gaia.lbl.gov/hpbf>

Commercial Windows Web Site

<http://www.commercialwindows.org>

Residential Windows Web Site

<http://www.efficientwindows.org>

New York Times project

http://windows.lbl.gov/comm_perf/newyorktimes.htm

COMMERCIAL BUILDINGS
research & development

Home >

TECHNOLOGIES & SYSTEMS

- Windows/Façades
- Lighting
- HVAC/CHP
- Demand Response
- Ventilation/IAQ
- Plug & Process Equipment
- Case Studies
- Specialty Buildings

TOOLS & PROCESS

- Modeling & Simulation
- Commissioning/Performance Monitoring
- Benchmarking
- Design Assistance & Assessment

SEARCH

More than one-third of the energy consumed in the United States is used in buildings. The mission of the Environmental Energy Technologies Division at Lawrence Berkeley National Laboratory is to perform research and development leading to better energy technologies that reduce adverse energy-related environmental impacts. Our work increases the efficiency of energy use, reduces its environmental effects, provides the nation with environmental benefits, and helps developing nations achieve similar goals through technical advice.

EETD addresses building energy efficiency issues, including:

- building technologies,
- the indoor environment,
- building codes and standards, and
- end-use energy efficiency issues,

through multidisciplinary research and analysis.

The Building Technologies Department works closely with the building industry to develop, test and deploy advanced technologies, integrated systems and new tools for design and operations that reduce energy bills while improving the comfort, health and safety of building occupants. Research and development efforts focus on windows and daylighting, lighting systems, building simulation tools, commercial building systems, demand response and high-tech buildings.

Indoor Environment Department researchers working in the buildings area focus on infiltration and mechanical ventilation systems, and on human health and productivity in buildings, with an emphasis on indoor chemistry and exposure and on air flow and air quality modeling.

Analysts working in the Energy Analysis Department gather and interpret information to examine the feasibility of different approaches to designing energy-efficient appliance standards and building codes in the U.S., and have worked with developing nations to create programs, codes and standards to reduce greenhouse gas emissions and encourage efficiency.

This website is a portal to more than fifty current and recent projects in commercial buildings. We have organized these projects into two broad areas:

- [Technologies & Systems](#)
- [Tools & Process](#)