EBC

Energy in Buildings and Communities Programme

G-A-P-S in Building Performance

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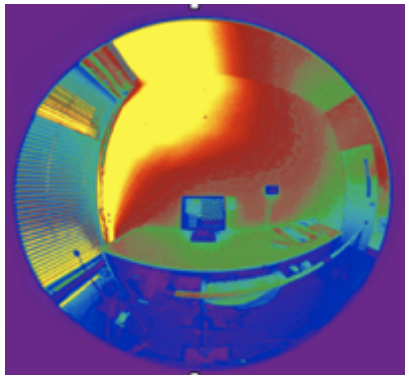

IEA EBC Annex 58 – 7th Expert Meeting

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If you don’t know where you are going, any road will get you there…

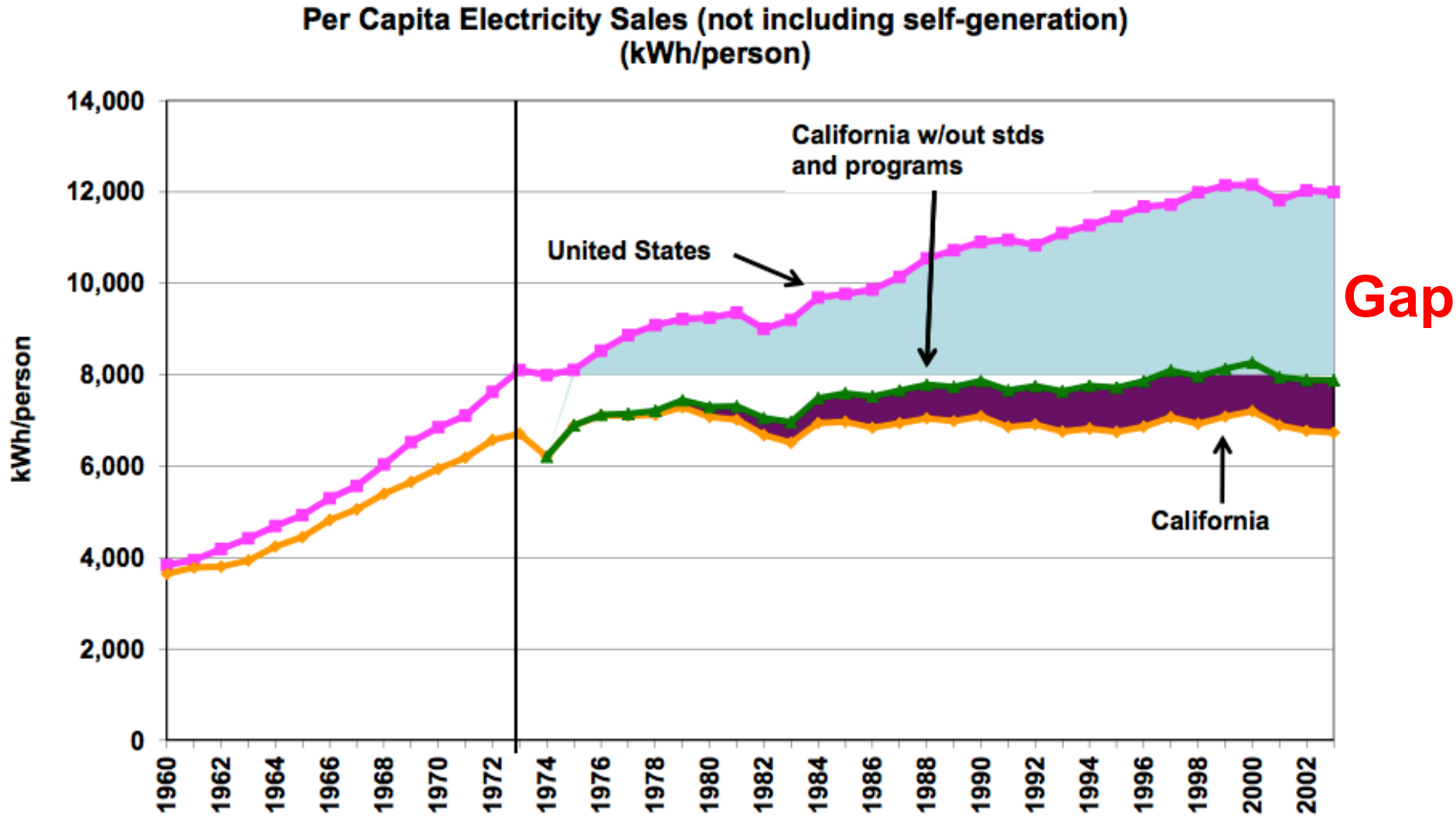
50-80% Reduction in Carbon? Solution is Simple in Concept

1. **Optimize "Lifestyle" to Minimize Energy Services and Needs**
   - Buildings…
   - Make cities walkable, food, …
2. **Optimize Efficient Use of Energy**
   - LED light bulbs,…..
3. **Decarbonize energy sources**
   - Solar energy,…..

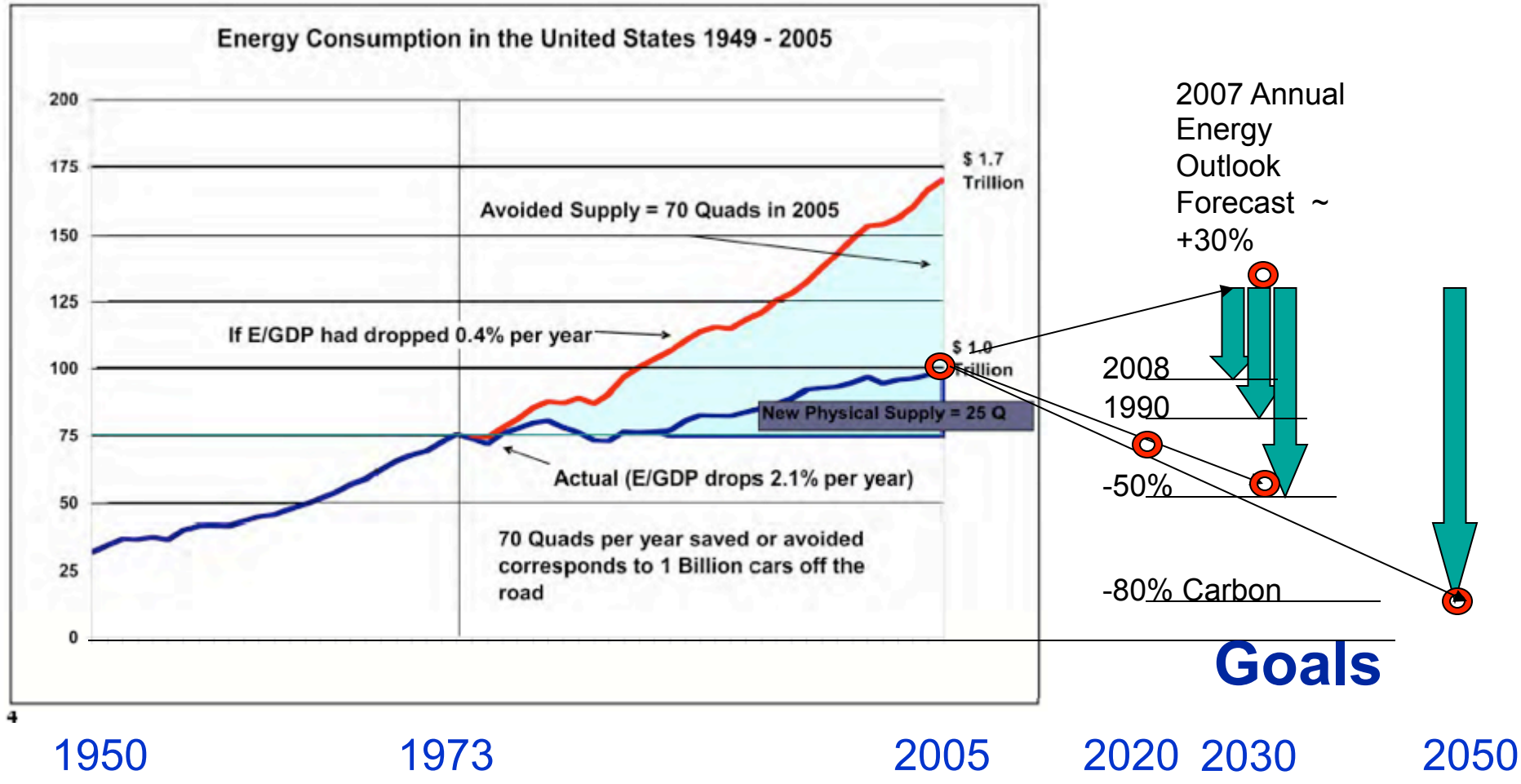
But more difficult to plan, execute and scale

Where are the Gaps?

U.S. Energy Use Grows While California Usage Remains Flat



U.S. Energy Use Gaps: Past and Present Trends vs. Future Goals



Gaps….

- Early Adopters vs Mainstream vs Laggards
- Best in Class vs Business as Usual
- Design Intent vs Skill and Knowledge
- Design Cost -> "Value Engineering" - > Final Cost
- "Reality" vs Speed of impact and scale:
  - "all buildings by 2018…"
  - (Innovation studies: 17 years from concept to practice)

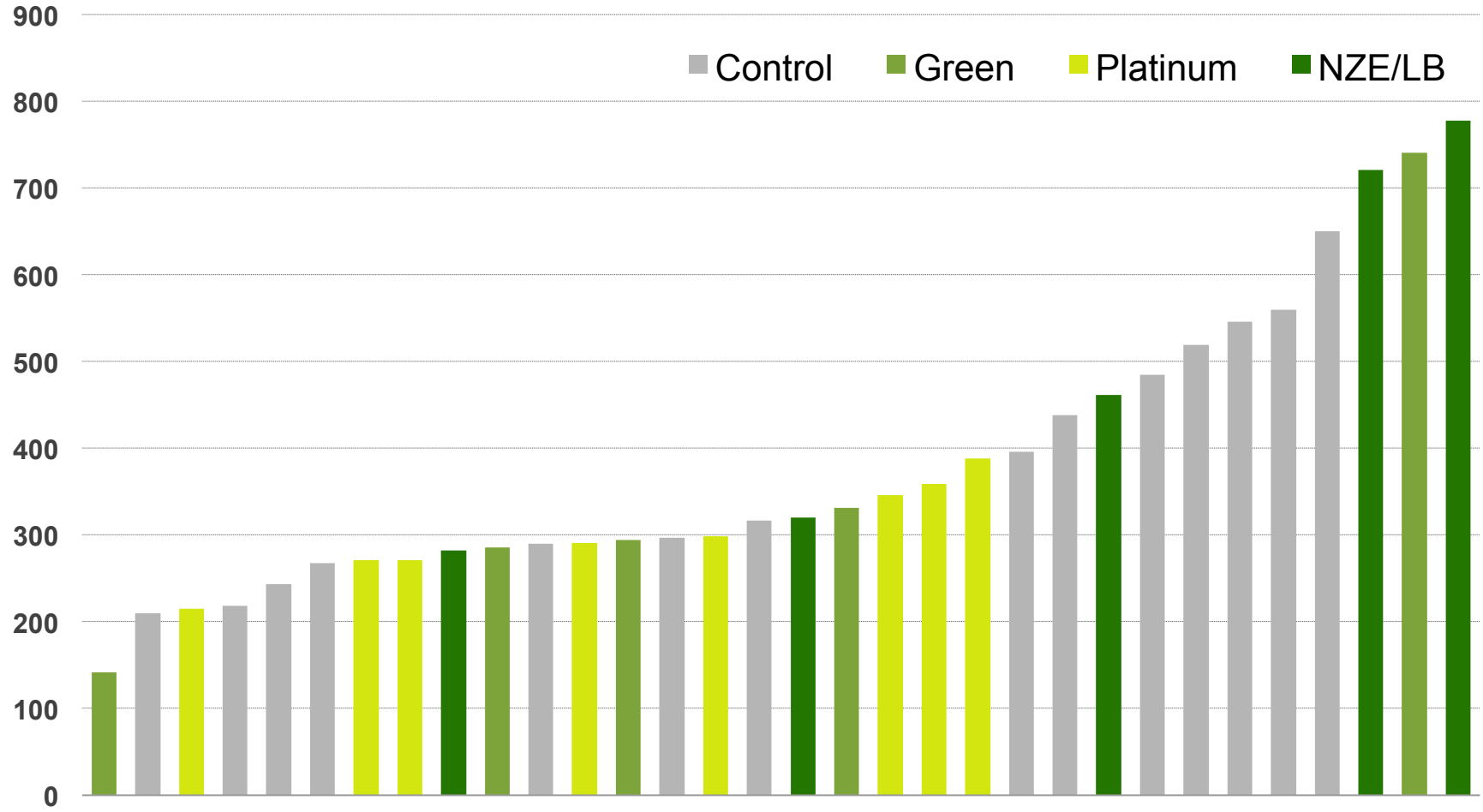
- Tool predictions vs lab test vs field measurements….

Affordability Gap?

Construction Cost of Low Rise Office Buildings

statistical analysis

Cost Premium/Gap for Efficient Buildings



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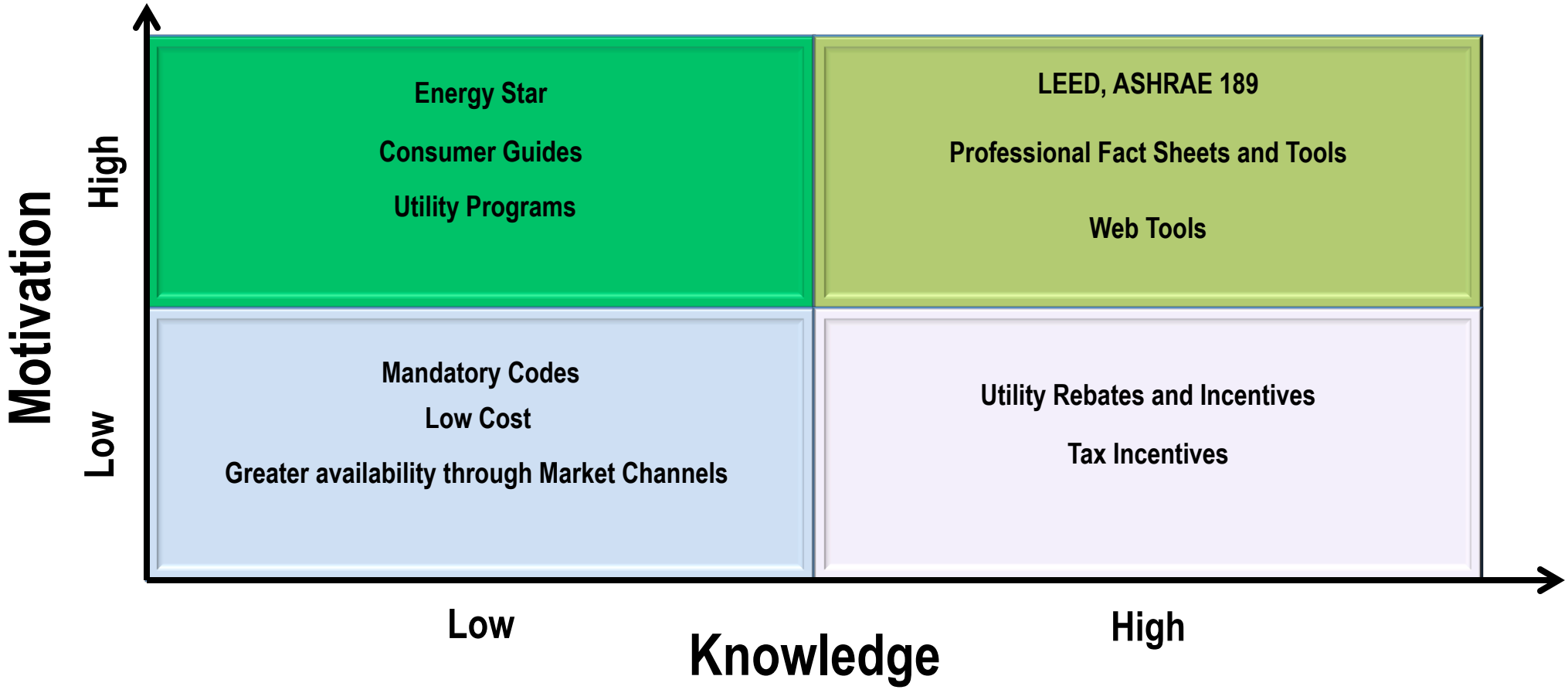
BUILDINGS MEASURED

Lisa Matthiessen, Peter Morris and Laura Lesniewski
Lawrence Berkeley National Laboratory

Gap: Motivation and Knowledge/Skill Level

Portfolio of Strategies to Increase Energy Savings



Gap: "Do the Best You Can Now" vs "Wait and Do It Better Tomorrow"

(Don't Let the Perfect be the Enemy of the Good)

- **Increase Rate of Adoption of Existing/Emerging Technologies**
  - Operational improvements
  - Better Design and Selection Guidance
  - New Market channels
  - New Voluntary and Mandatory Programs
  - Education and training
- **Create Pipeline of New Technology Options and Business Models:**
  - **Incremental improvements** to technology available today
    - Performance enhancements but Cost reductions
    - New features
  - **Breakthrough R&D**
    - Innovation- new products, new applications
  - **Components → Integrated Systems**

A New Framework for Building Performance

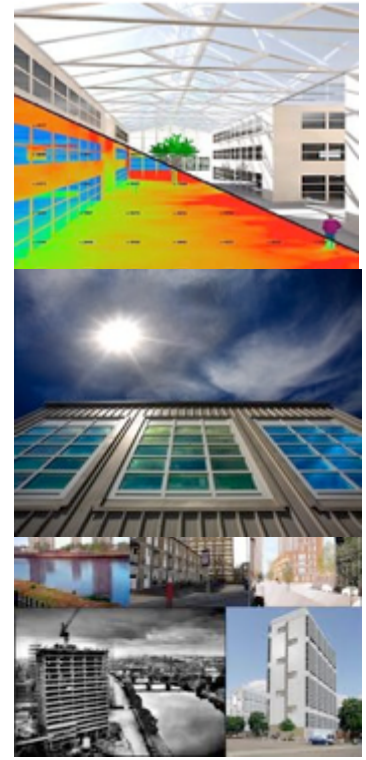
Vision: To design and operate buildings with "***guaranteed***" energy performance.

Goal: To accurately predict and verify energy performance across the building life cycle, from design to operations

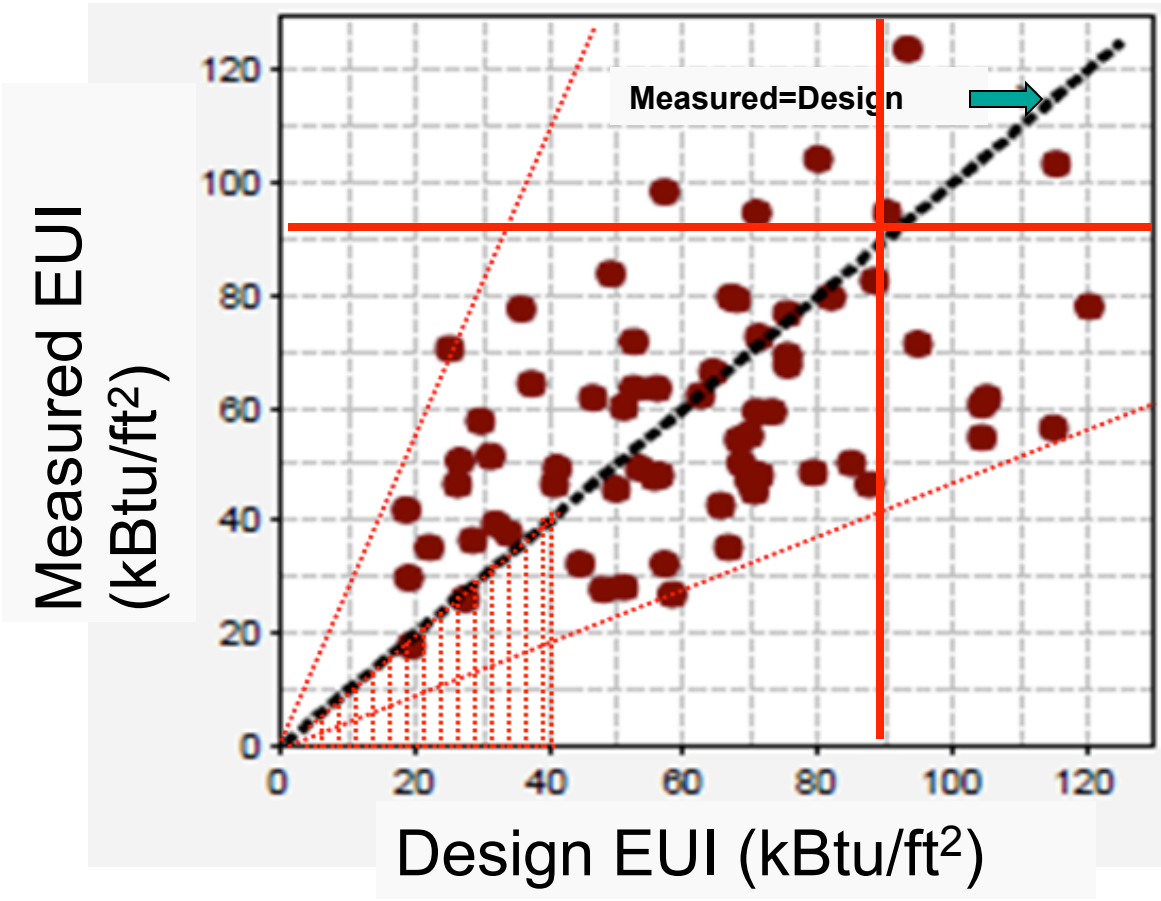
1. **Predict Performance**: Use fully validated simulation models and processes to reliably simulate and optimize a wide range of systems and their interactions.

2. **Ensure Actual Performance**: Validate/integrate simulation with measurements in testbeds and real buildings.

3. **Deploy at Scale**: Implement performance prediction tools and smart operations in routine practice



The Gap and the Challenge: Design Goals vs Measured Performance



Observations:

1. Various building types, ages, locations
2. Average over all projects is not bad
3. Max over-predict by **120%**
4. Max under-predict by **65%**
5. **Almost all under-predicted for low energy designs** (red triangle: EUI <= 40)
6. Uncalibrated simulated results

Source: Energy performance of LEED-NC buildings, NBI, 2008

Can We Guarantee Performance???
Measured Performance vs Design Goals

Measured Performance =

- Design Goals x
- Simulation Tool Accuracy x
- Simulator Skill x
- Value Eng'ing "Aftermath" x
- Construction "Artifacts" x
- Schedule "Adjustments" x
- Facility Operations x
- Occupant "Adjustments x
- Weather "Adjustments"

Design/Construct *A/E Team*

Operate *Facilities Team*

What is the Sensitivity/Uncertainty Associated with Each Factor?

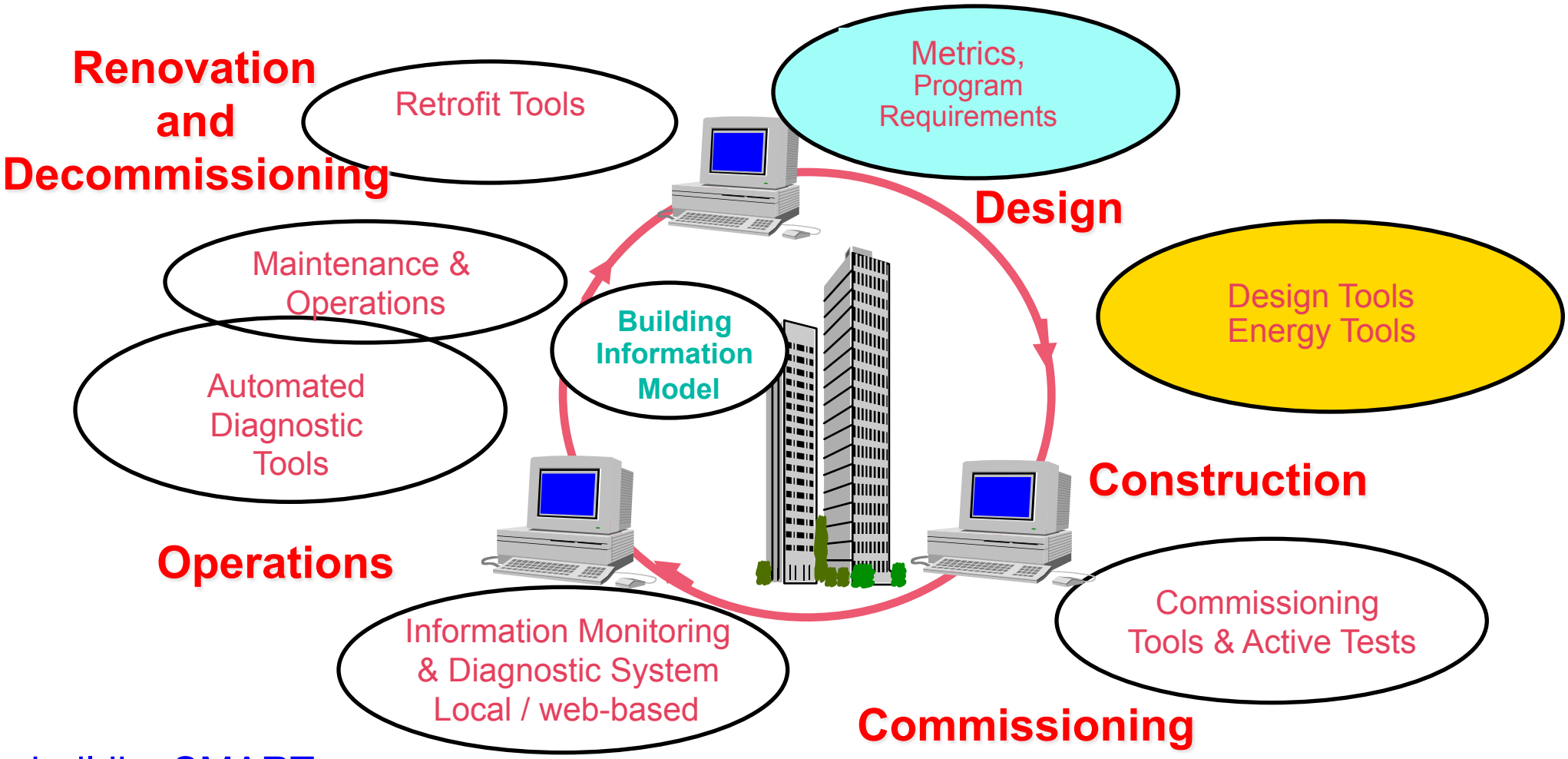
"guaranteed" Energy Performance

- **Can a Design Team Guarantee Energy Use target?**
- **Design – Bid – Build – Operate….??**
- Need new metrics and new business practices

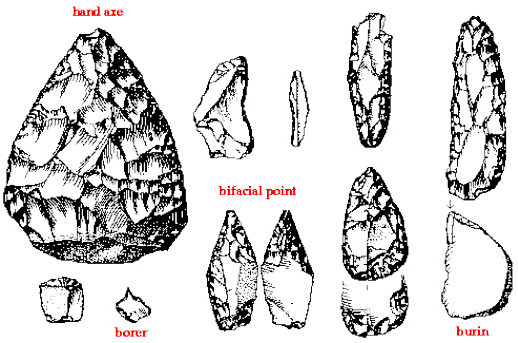
- **New Market Drivers:**
- **Outcome-based codes:**
  - "Build anything you want but prove that the building energy use is lower than target level after occupancy…"

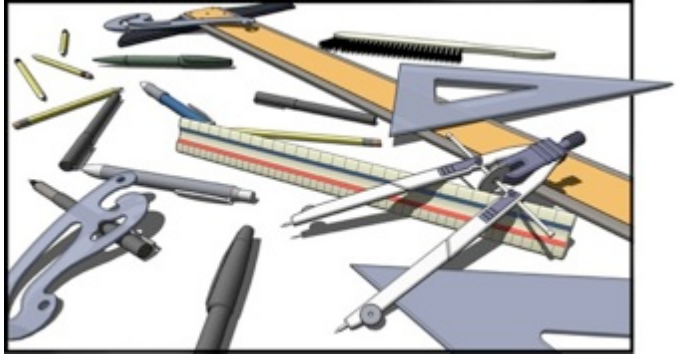
- **More Transparency: Energy Disclosure laws**
  - **"Publicly" disclose your annual energy use!**
  - **European Union implementation**
  - **US: 29 Cities and States now have disclosure laws**

Gap: Data Management Across Building Life-Cycle



buildingSMART
Data model

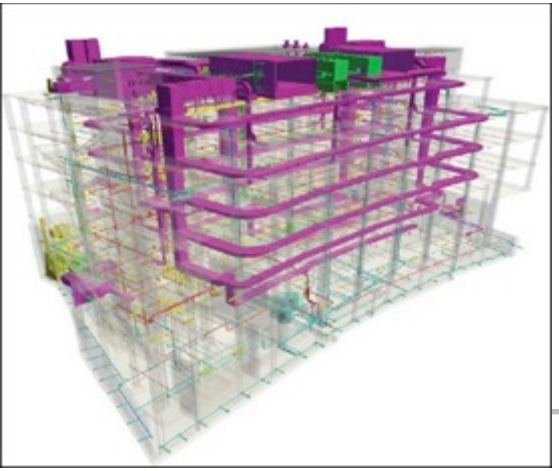


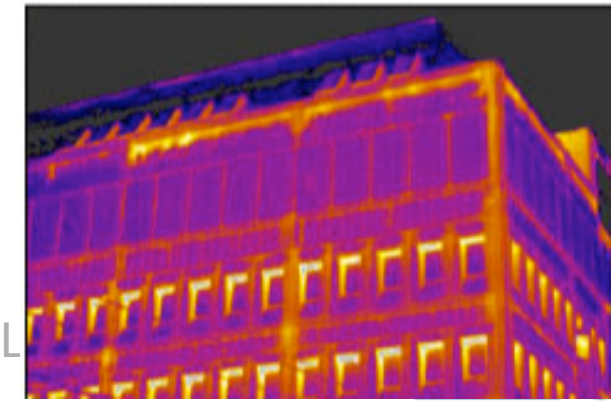


Data, Models and Tools

"All Simulation Models are Wrong, But Some are Useful"

How do we ensure our tools are useful?



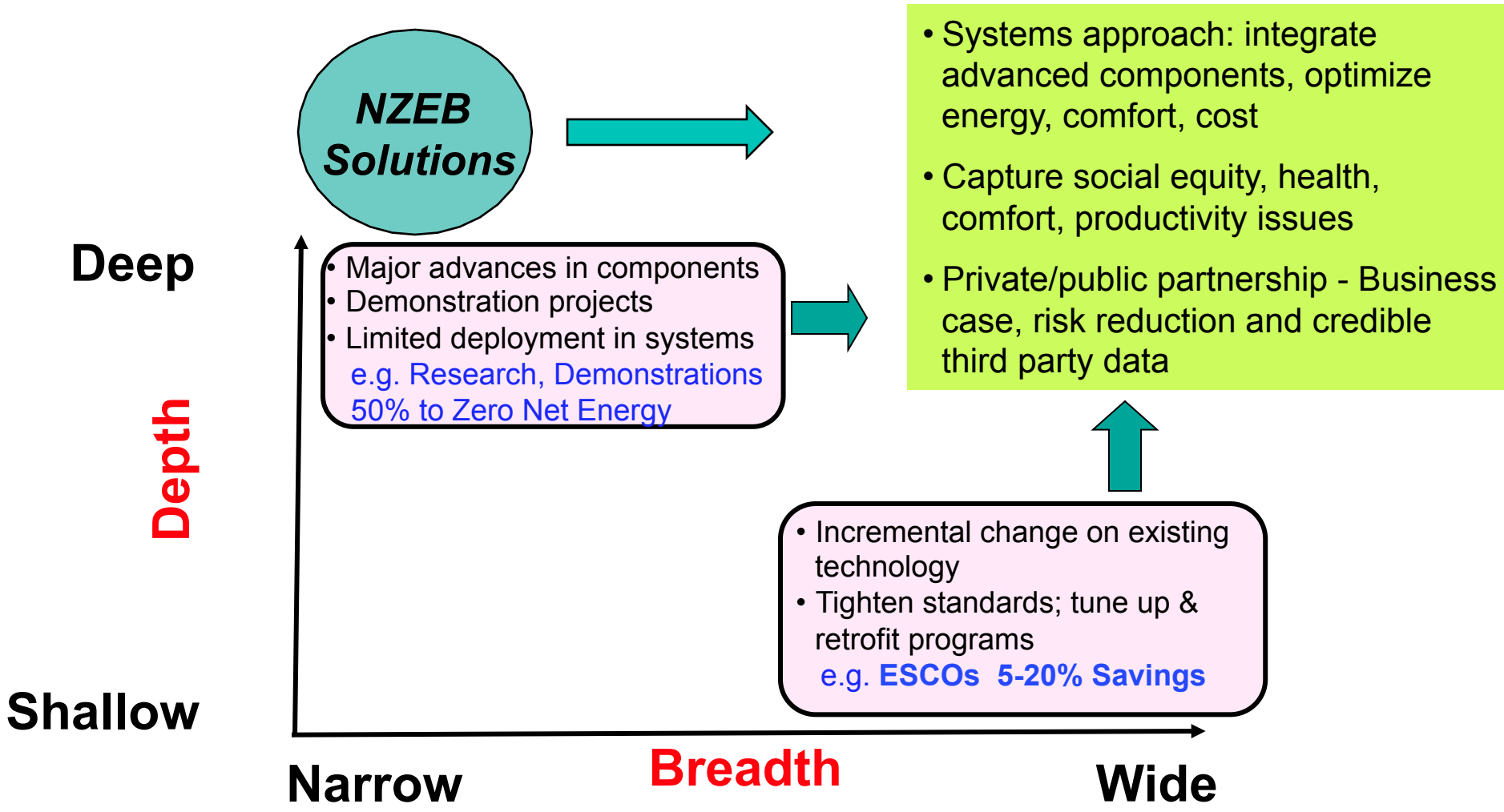


Net Zero Energy Buildings
Status: 2014
Good News – Bad News

~ 147 buildings in 37 states!

But there are 5,000,000 buildings in US
Can we Scale This? How?

Gap: Need Scale to Achieve Impact



NZEB: Net (Nearly) Zero Energy Buildings

The Vision

The Dream

The Reality

- "Net Zero Energy Buildings" is the right goal
- NZEB = 60-80% savings + renewables

- ***Just Do It***
  - *Set a goal - march toward it*
  - *Its easy, if we commit and apply ourselves*
  - *We have the technology and know-how*
- ***Major National Challenge***
  - *Technically attainable - Difficult to achieve in scale*
  - *Shortcomings: Owners? Users? Tools? Construction? Operations?*
  - *Integrated Standards -Deployment-Demonstration-Research*
  - *Issues- Policy, Finance, Design Process, Technology*

Gap: Technology View vs. Operations View

Building Innovation "Game Changers"

MATERIALS AND SYSTEMS

- **Smart Glass/Dynamic solar control**
- **High R Windows, Insulation**
- **Thermal Storage- Envelope, structural**

- **>200 lumen/watt lighting**
- **Daylight integration**
- **Dimmable, Addressable Lighting Controls**

- **Task Conditioning HVAC**
- **Climate Integrated HVAC**
- **HVAC vs comfort and IEQ**

- **Miscellaneous Electrical Loads**

- **Demand Response**
- **Controls infrastructure- sensors, networks**
- **Building- and Grid- Smart electronics**
- **Electrical Storage**

SYSTEMS: IT, 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/Behavior
- Facility Operations

The "Ideal Window"?
Two Contrasting Views of Energy Efficiency

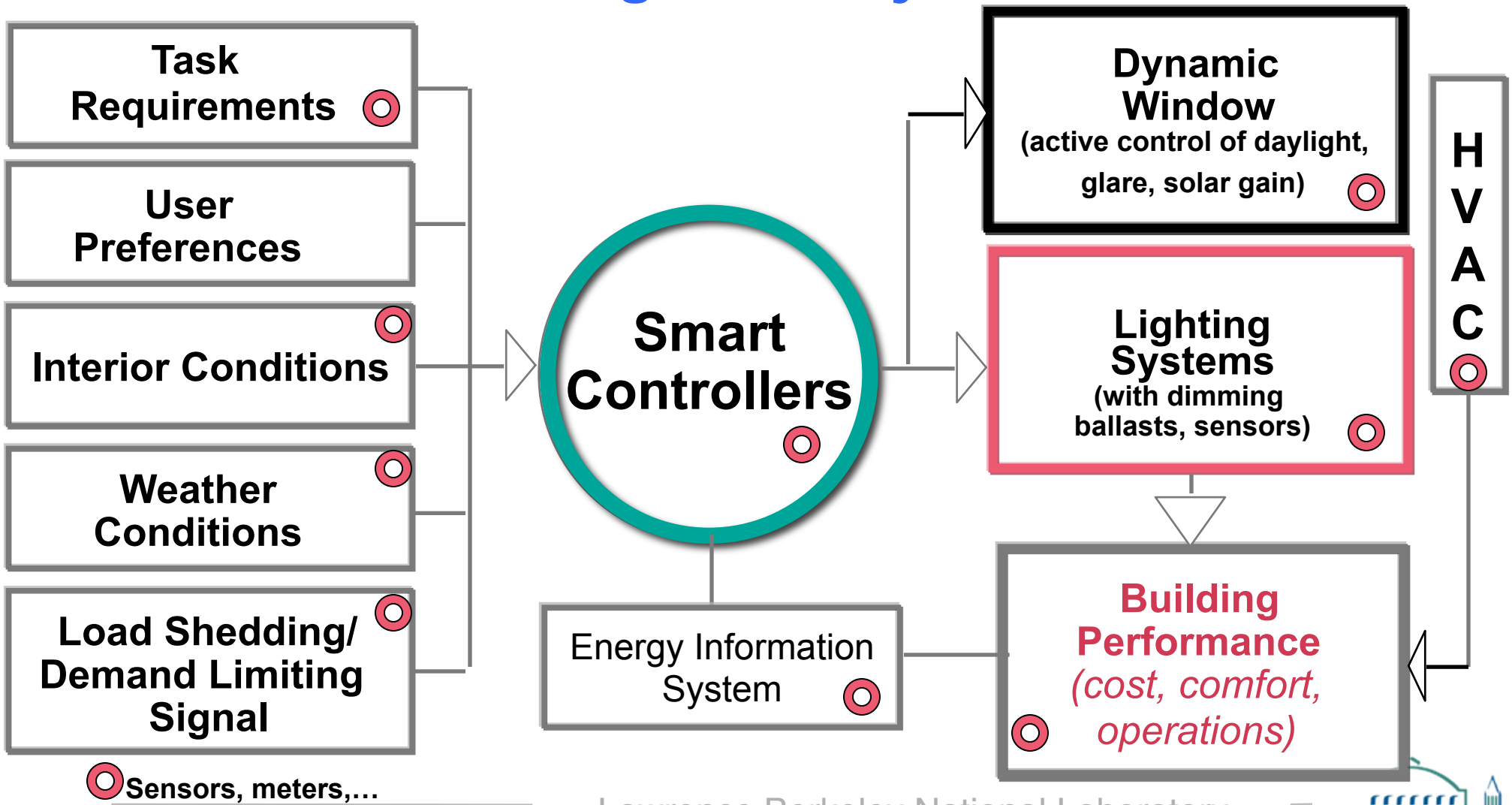
1976 Perspective:
Code Official's View of Ideal Window

2014 Perspective:
Architect's View of Ideal Window

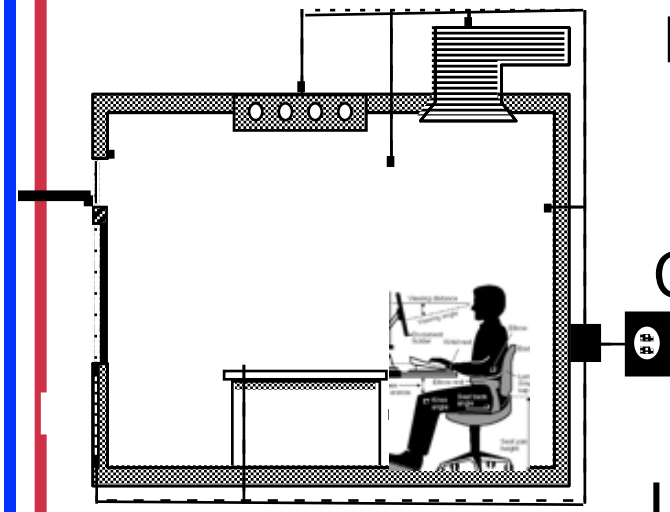
GAP- Static world -> Active, "Smart" world

Gap: Intelligent Building Control Systems:

The "Internet of Things" Collides with the Building Industry…



System Integration Gap → Cost/Risk tradeoffs
People ←→ Buildings ←→ "Smart Grid"



Heating

Cooling

Lighting

Office Eq.

Peak Cooling Load

Lighting Design Strategy

Chiller Size

Energy, Peak Electric Demand, Load Shape

Onsite Power Generation

Central Power Generation

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Initial Cost

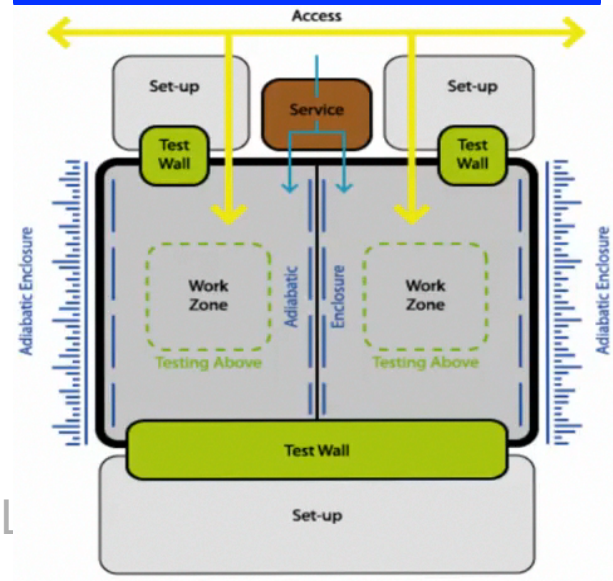
Annual Cost

Closing the Systems Integration Gap: FLEXLAB: Facility for Low Energy EXperiments in Buildings

4 Outdoor Testbeds:
3 1-story
1 2-story

3 Indoor Testbeds
Lighting/Plug Load
Sensors/Controls
Design Lab

Data Acquisition, Monitoring, Control System



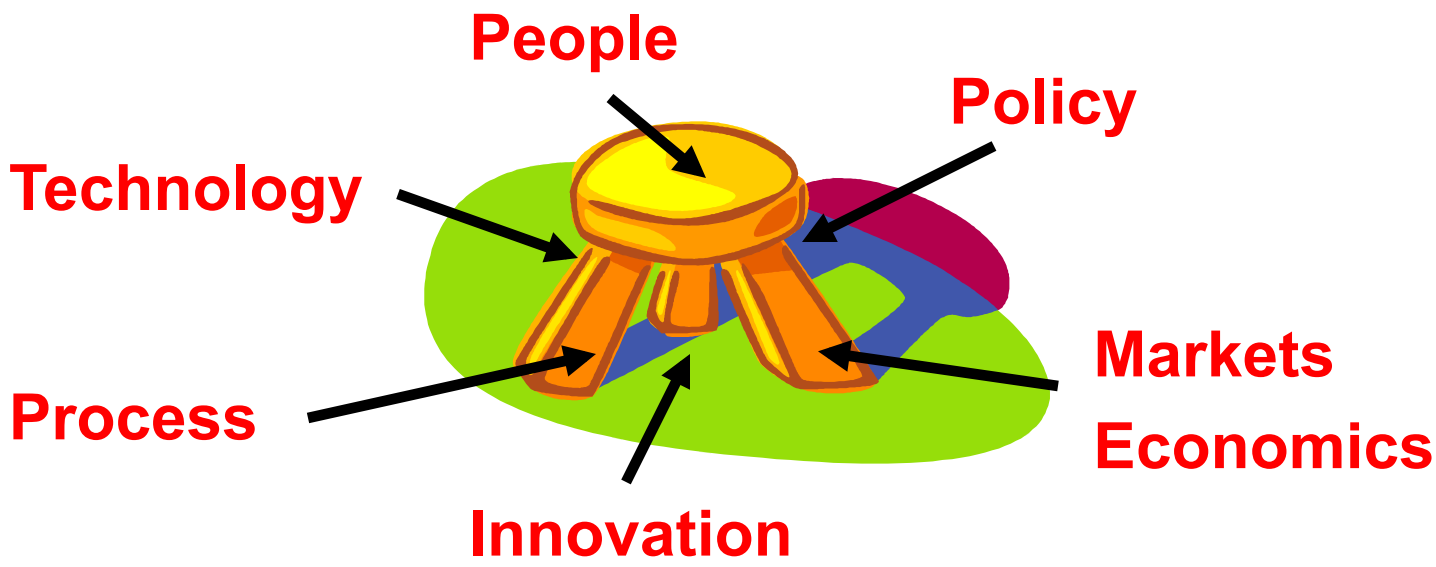
FLEXLAB
FACILITY FOR LOW ENERGY EXPERIMENTS IN BUILDINGS

Gaps to Solve the Building "Grand Challenge"

- Life Cycle of the Building
  - Design → Construction → Operations → Renovation→ Decommissioning
- Measurable, Documented Energy Impacts
  - Make performance visible, understandable, actionable
- Integrated Smart Building Systems
  - Materials → Devices → Integrated Systems → Buildings
- Buildings and the Grid
  - Renewables, Storage, Microgrids, Neighborhoods, "Smart Grid"
- People and Behavior
  - Policy makers, Designers, Investors, Contractors, Occupants,..
  - Occupant behavior, life style, satisfaction, comfort,….
- "Intersection" of Technology and Policy
  - Incremental + Innovative, Disruptive technologies
  - Investment and Decision making

Significant Impact Comes Only from Comprehensive Balanced Program

To routinely deliver high performance, low-energy buildings we must find a balance between:



Solutions fail without this balance

Close the Gap: Everyone Wins….

- NZE Buildings: a necessary and attainable target
- Make high performance and energy efficiency a market advantage, not an extra cost or a risk
- Must Deliver Measurable Savings!
- Opportunity:
  - New Business and Markets → Manufacturer
  - Design freedom and flexibility → Architect
  - Value-added benefits, e.g. better acoustics → Occupant
  - New performance benefits: e.g. comfort
  - Modest/no extra first costs and large annual savings → Owner
  - Lower impact on global environment → Society