Building Energy Efficiency and the Role of Utilities

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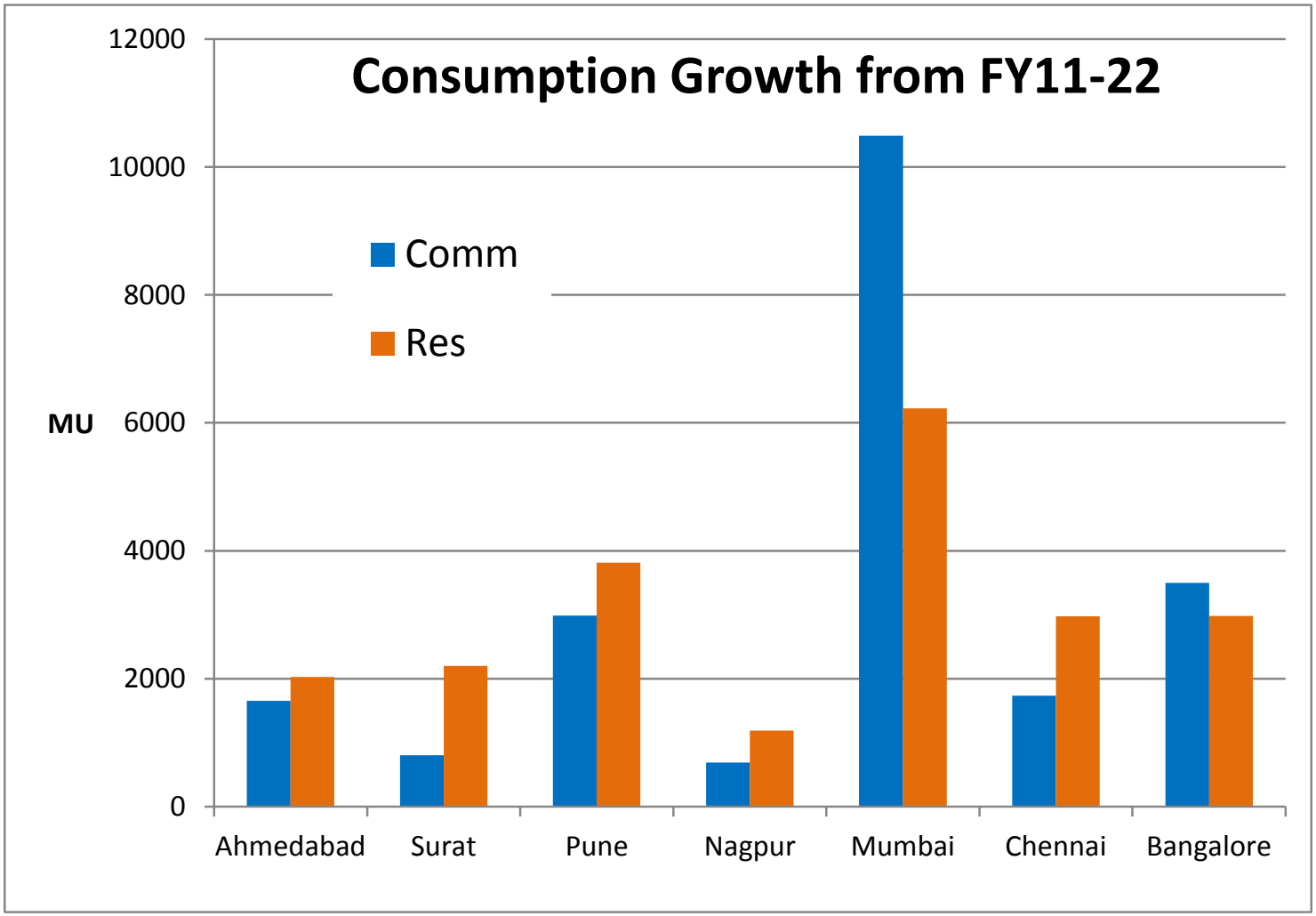
A Building is not a Car

Outline

- Challenges and Opportunities
  - Design
  - Construction
  - Operations
- Intro to Simulation Tool
- Utility Involvement
- Proposed Utility Program for Mumbai
  - Discussion

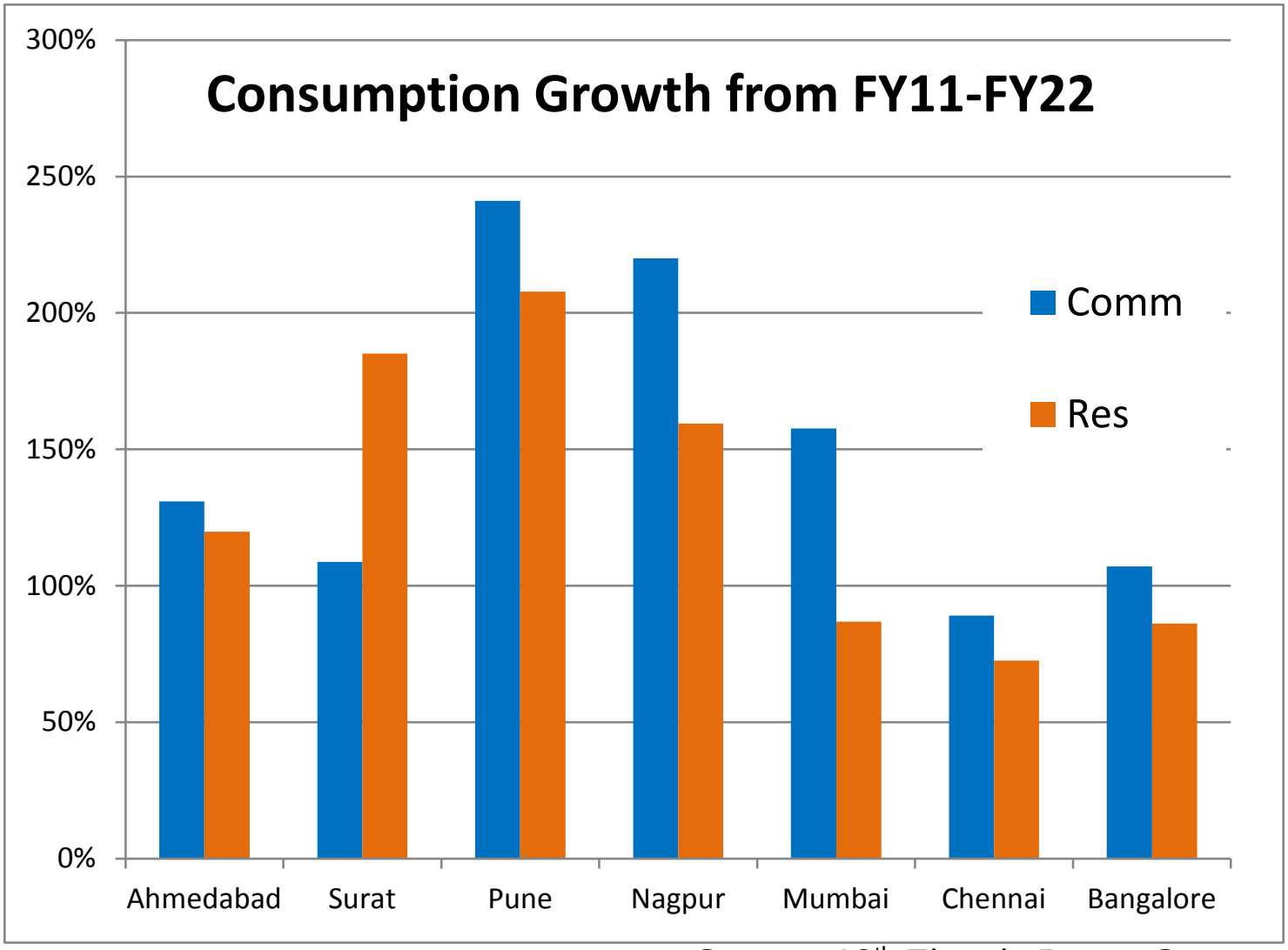
Challenges and Opportunities
Design

Building Energy Consumption Growth



Source: 18th Electric Power Survey

Higher Commercial Consumption Growth



Source: 18th Electric Power Survey

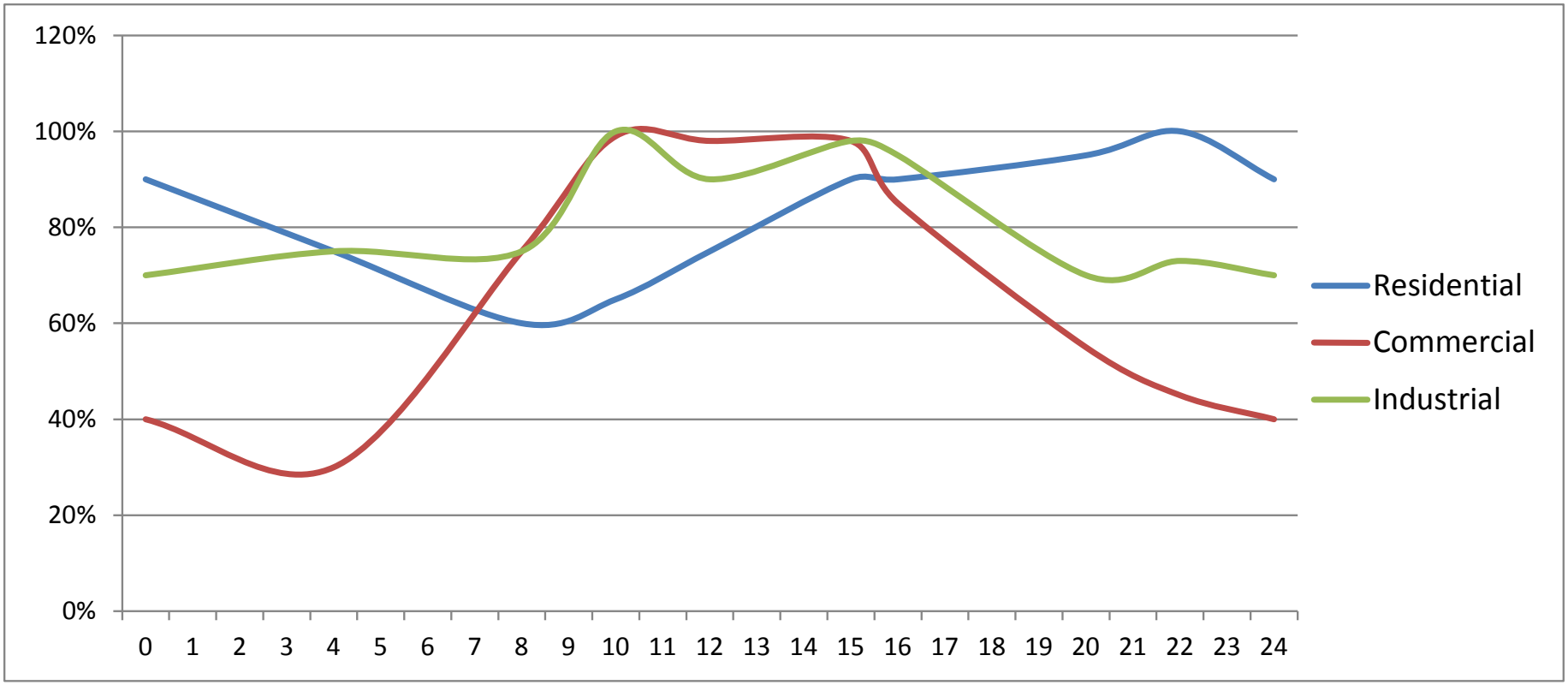
The Need

- Mumbai will add about 32 Million SF of commercial floorspace per year till 2016.
- Typical buildings consume 30% more energy than ECBC levels.
- Less than 1% of new the building stock achieves green building certification.
- Current rating systems do not ensure performance.

The Opportunity

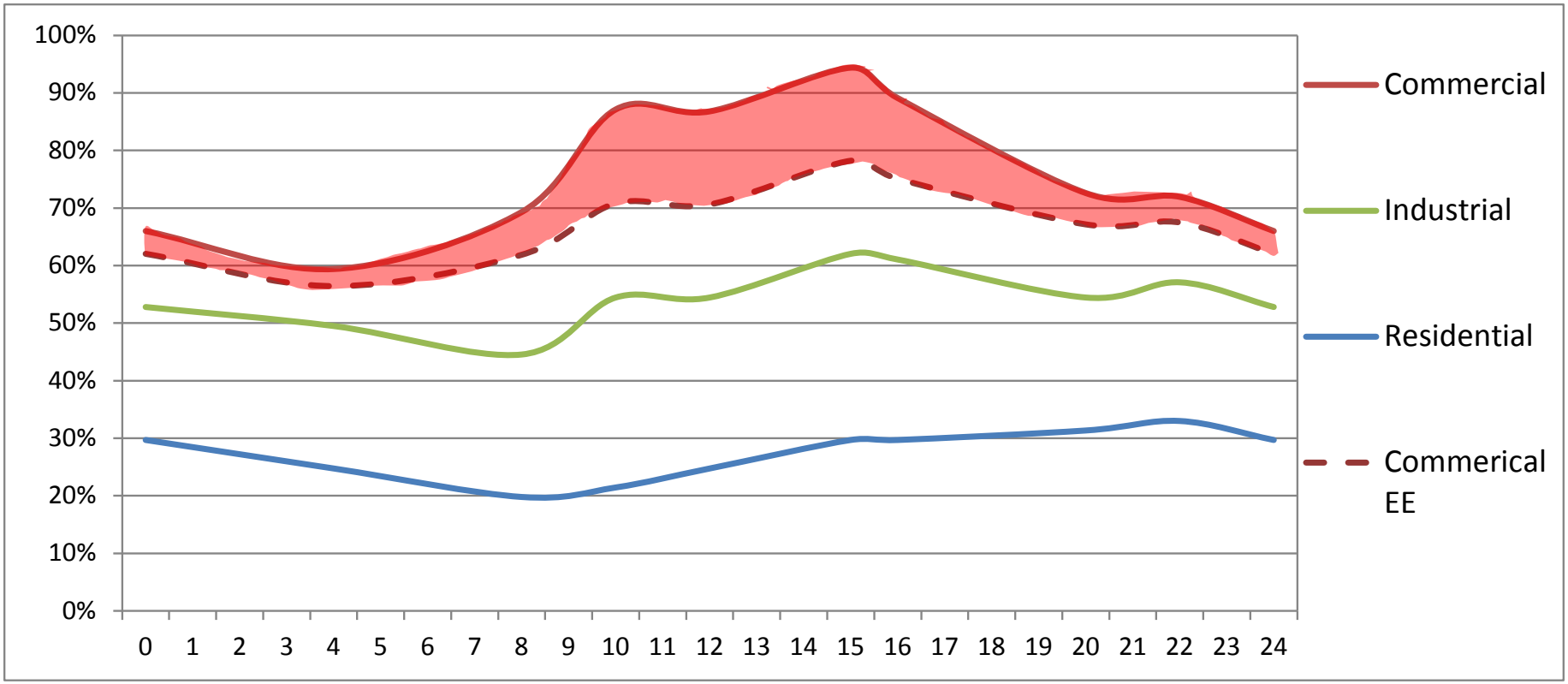
- We already know how to do super-efficient buildings
- New construction allows us to lock in efficiency for the life of the building
- New construction offers the opportunity for design optimization

Typical Weekday Loadshapes



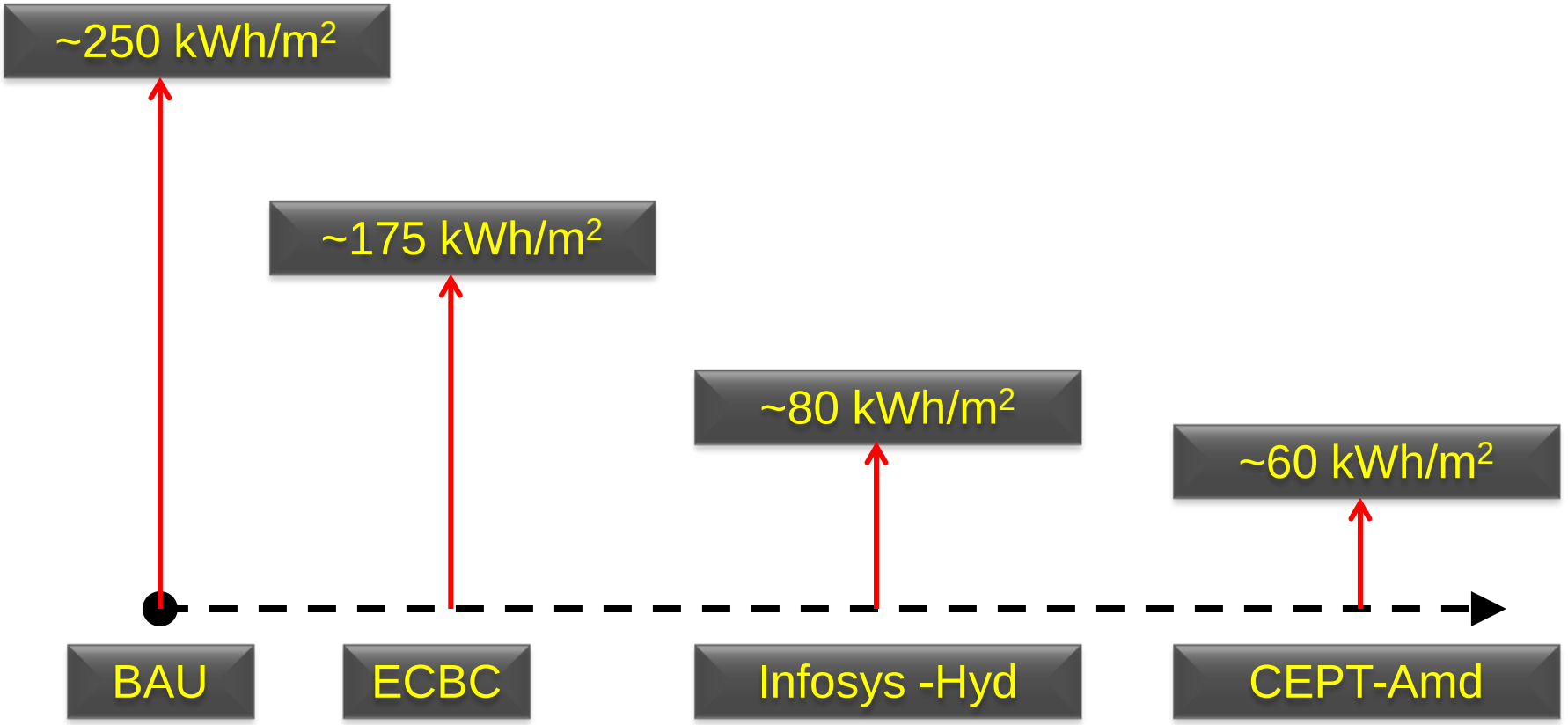
Source: DSM Plans and Reports from Utilities

Loadshapes – Cumulative
and Impact of Commercial Building EE

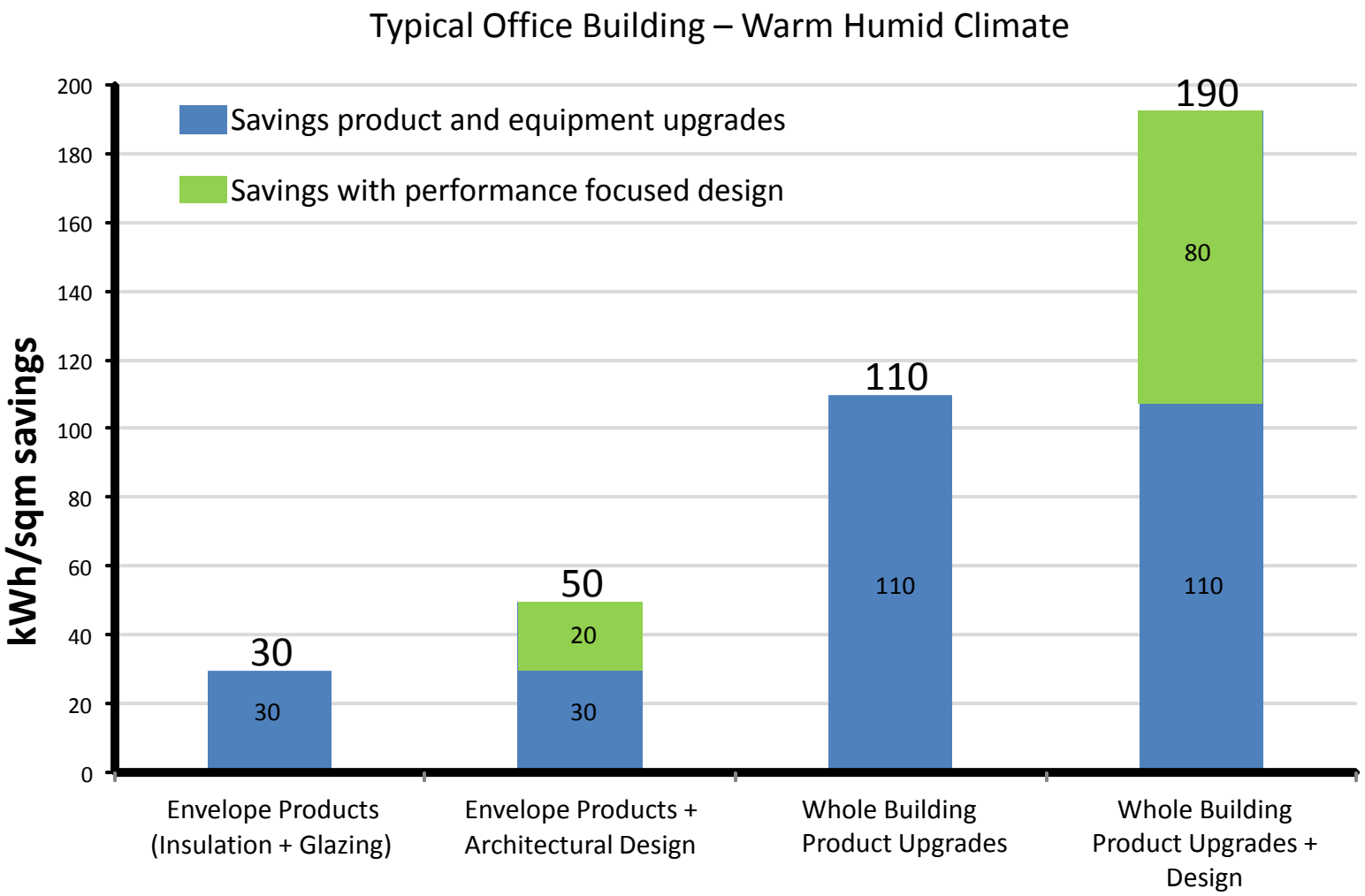


Assumes equal contribution from each consumer type

Whole Building Energy Performance



Savings Opportunity with Design



Note: EPI for BAU ~250 kWH/sqm and EPI for ECBC ~175 kWH/sqm

Infosys - Hyderabad

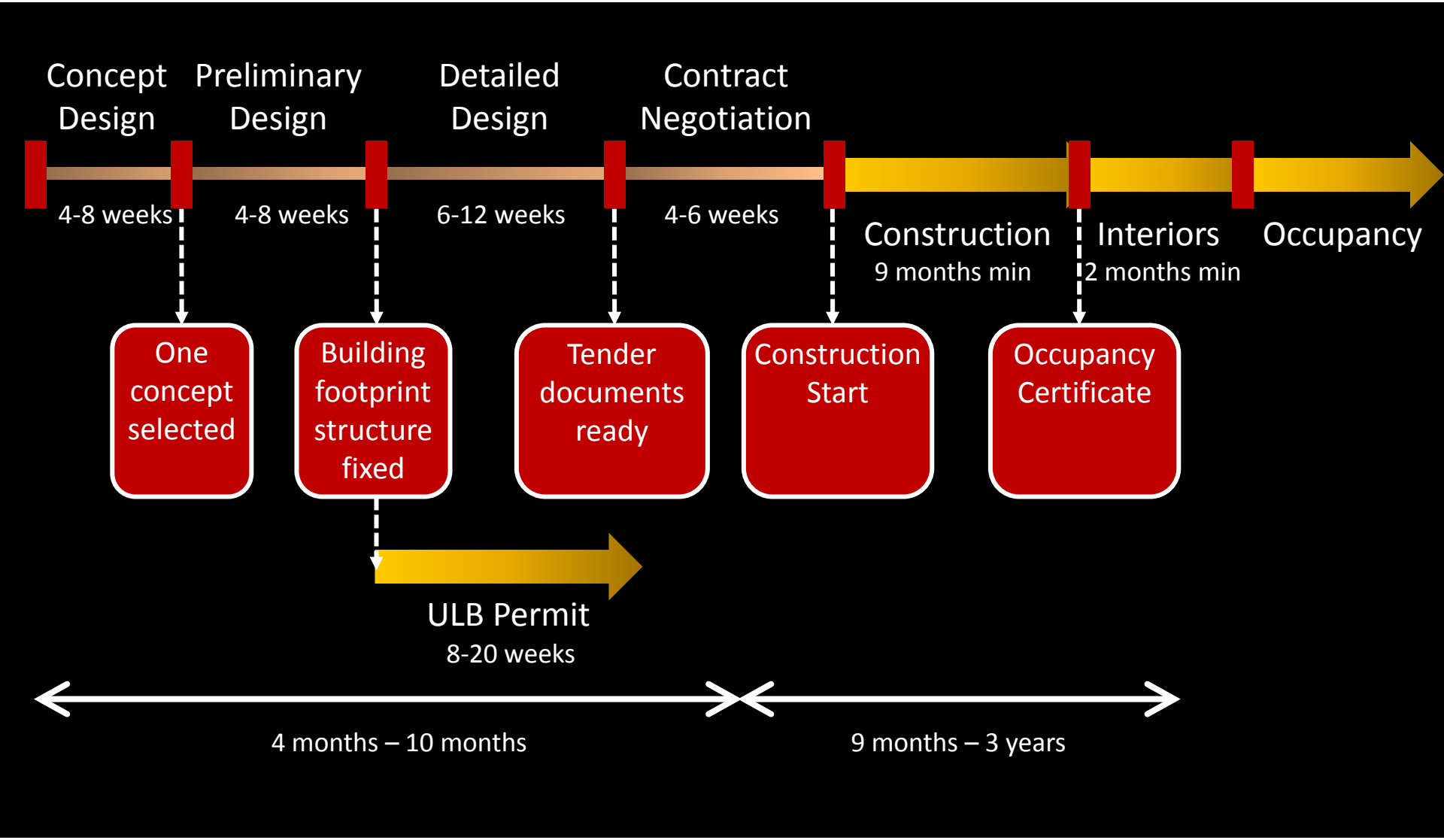
CEPT NZE - Ahmedabad

NZE Features

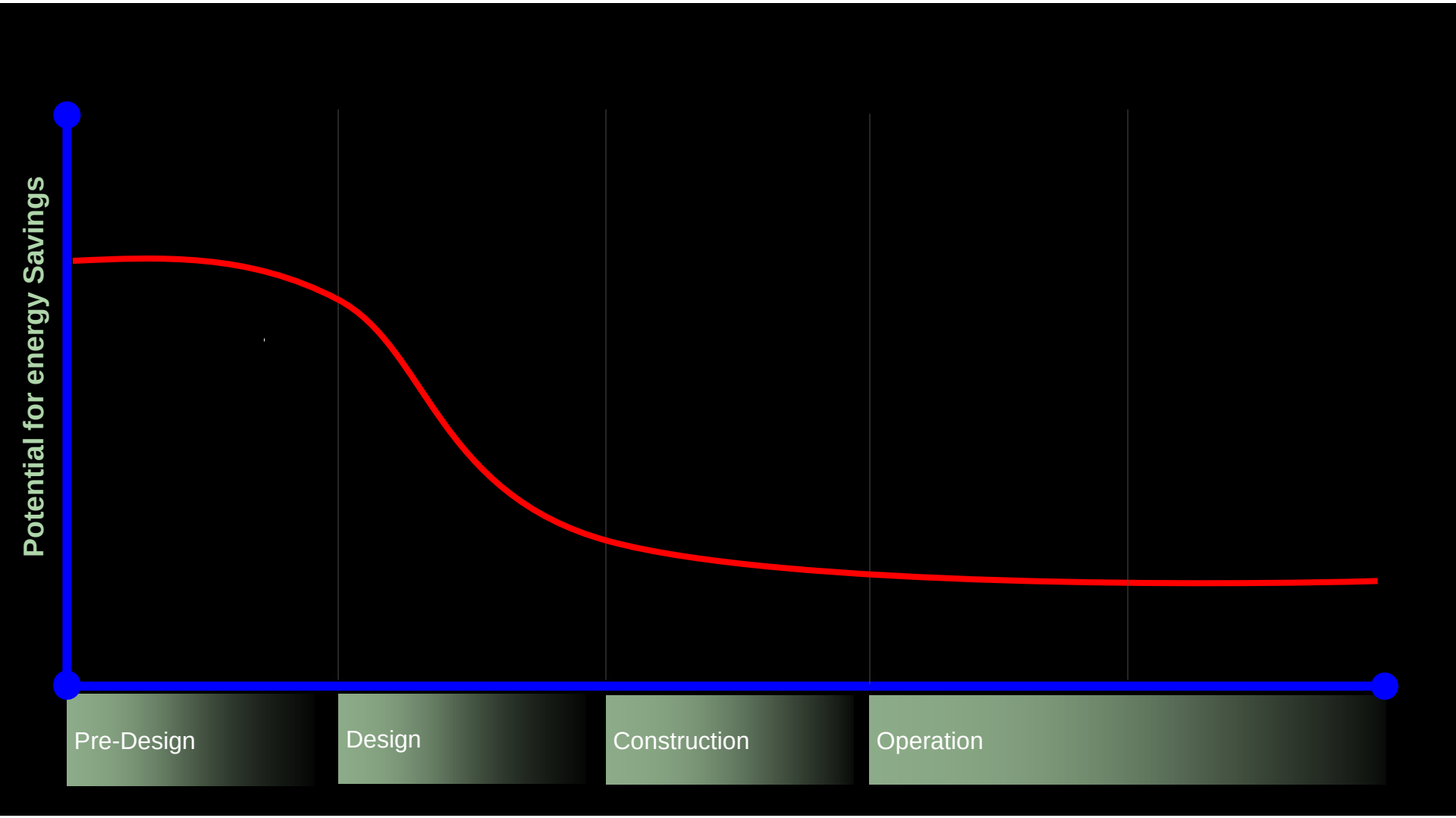
- North-South **Orientation**
- **Daylight Autonomy** for 300 L and 75% time **for over 90% of spaces**
- **Window to Wall Ratio 19%**
- Shading and light shelves on South
- U-factor Wall: 0.78, Roof 0.41
- Glazing: U 1.59, SHGC, 0.31/0.21, VT 0.6/0.41
- **Lighting** at 4.7 W/m^2 with daylighting and vacancy sensor control of lights
- Office equipment control with occupancy sensor control
- **Mixed mode ventilation** and zoning for level of conditioning
- **Radiant cooling** floor and ceiling panels for simulation lab and basement floor
- VRF for Dedicated Outdoor Air System at 3.51 COP with CO_2 control, VRF for equipment rooms 3.51 COP
- Air cooled chiller 3.35 COP (ARI)
- **Passive cooling** in non summer months with underground tank and evaporative fluid cooler
- Premium efficiency pump motors with VFDs
- Rooftop PV 27 kW

What happens in Construction

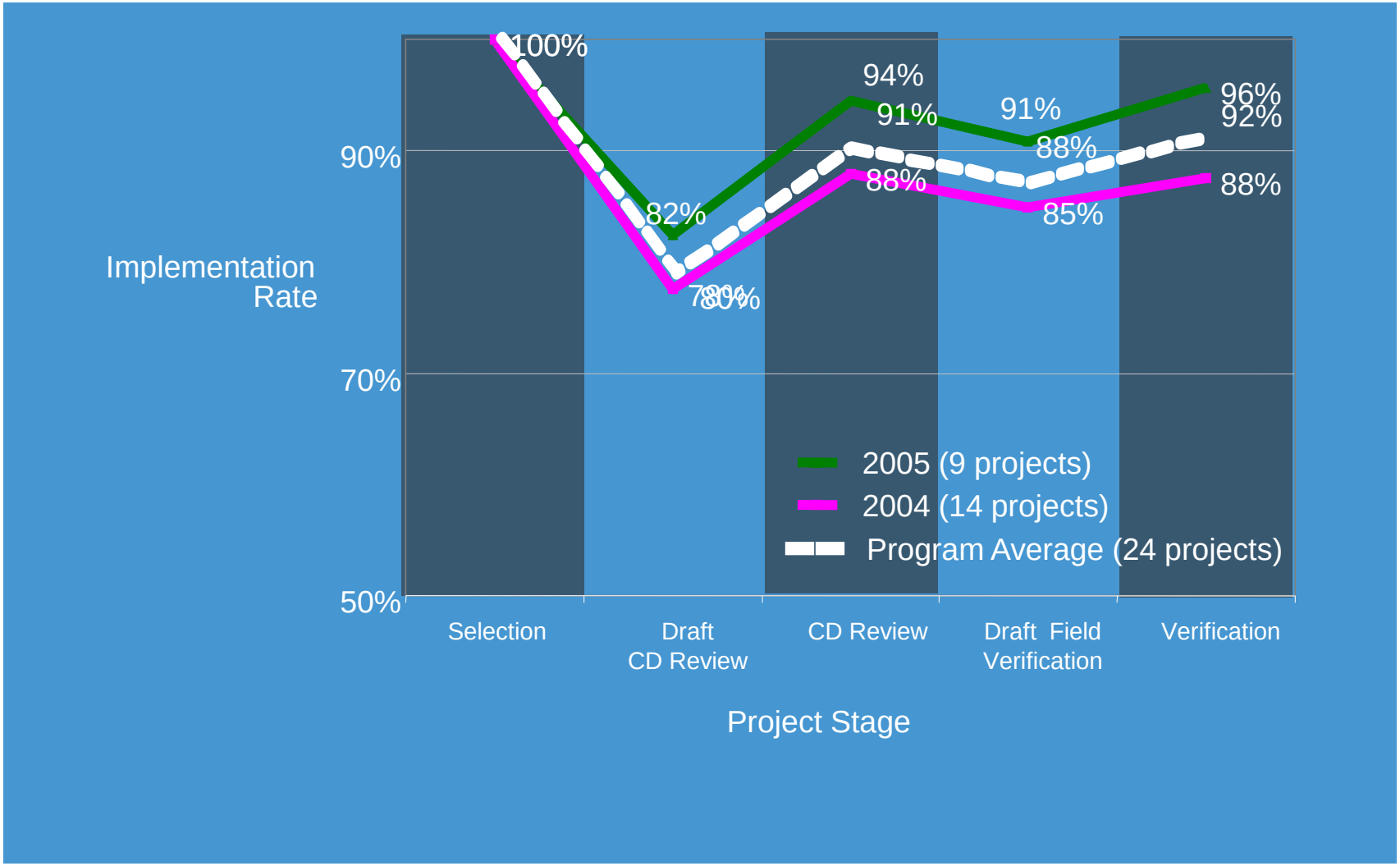
Design Construction Process Map



Energy Efficiency Potential – Timeline

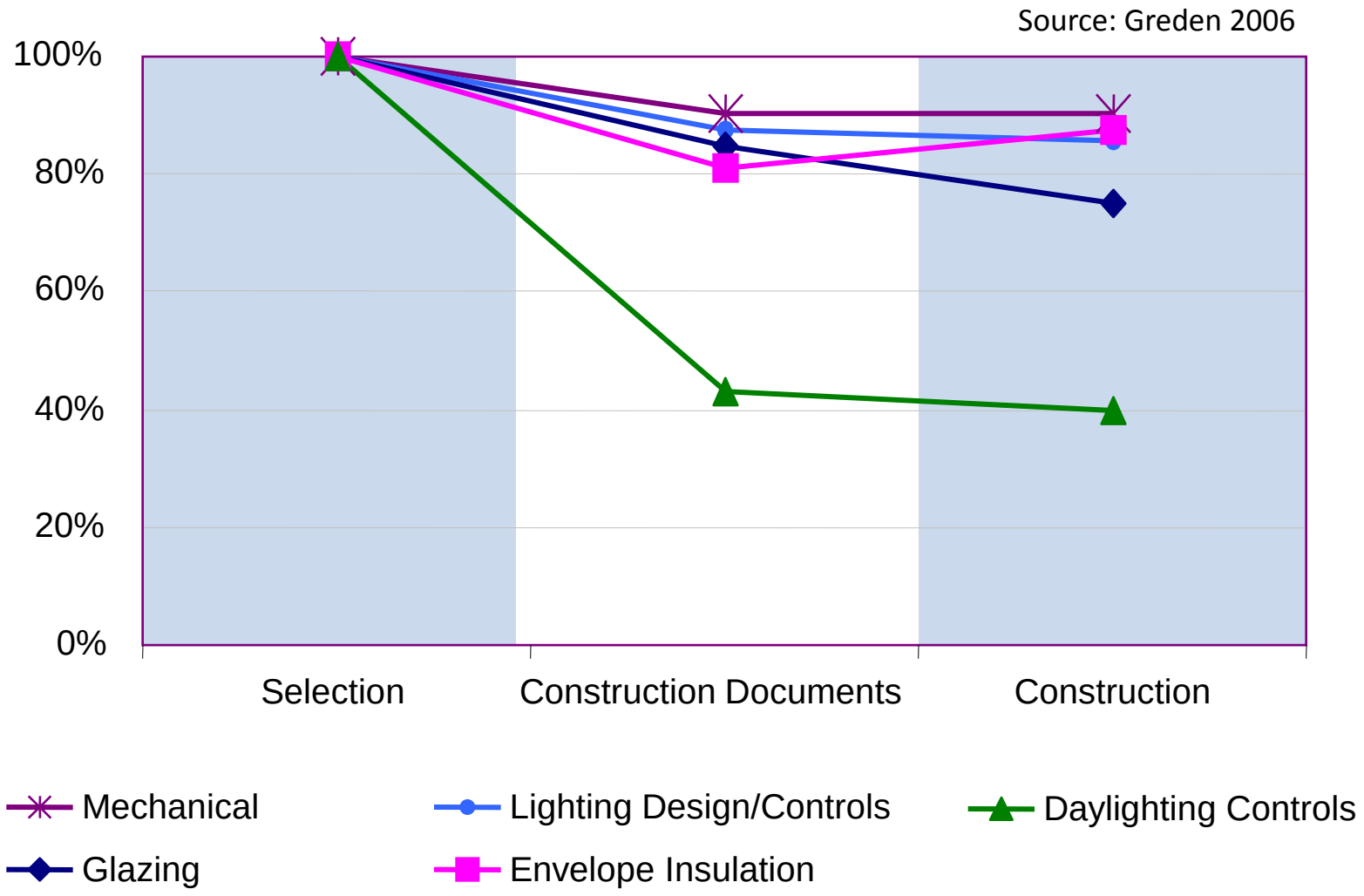


Implementation Success Study



Source: Greden 2006

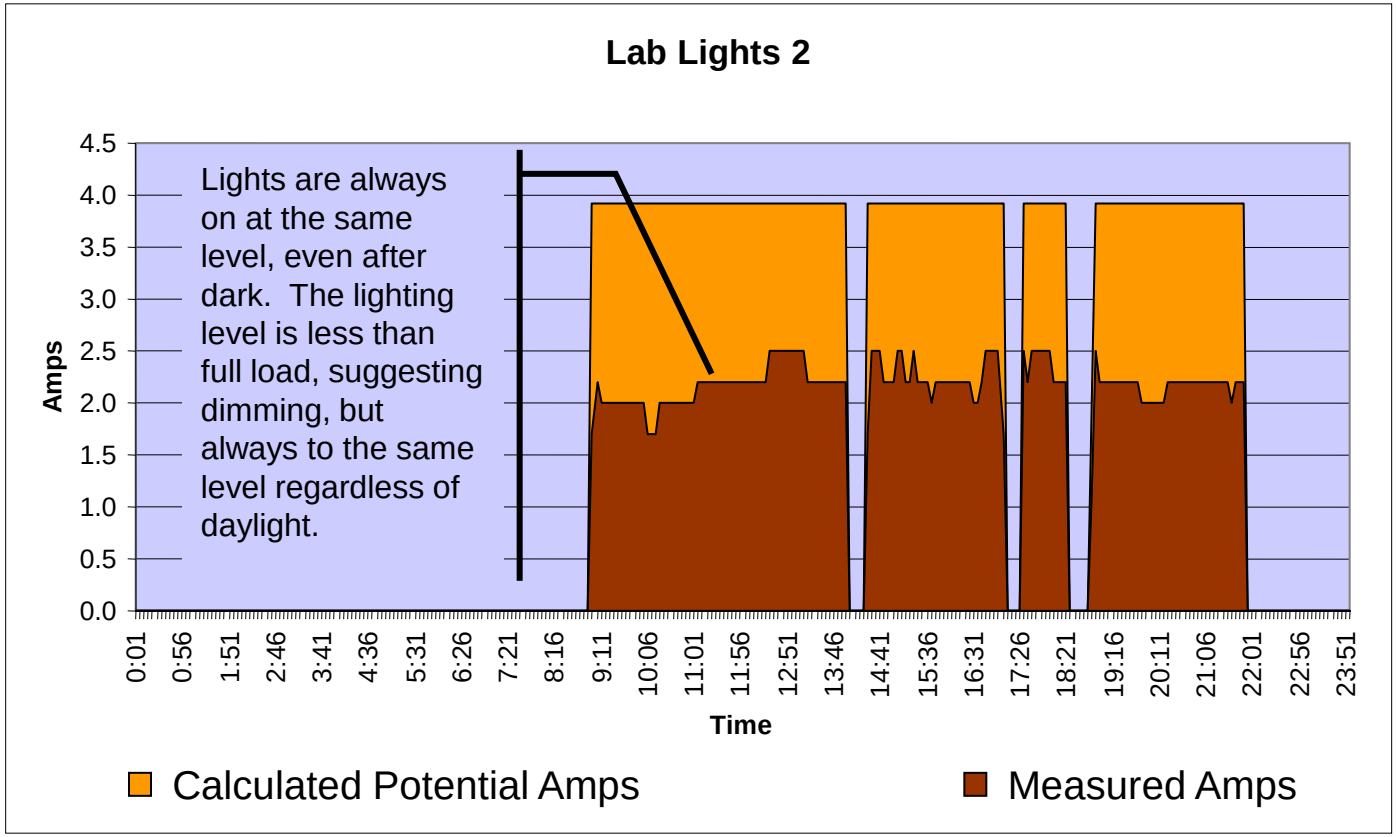
Implementation Success by Measure



Daylighting Controls – No Coordination

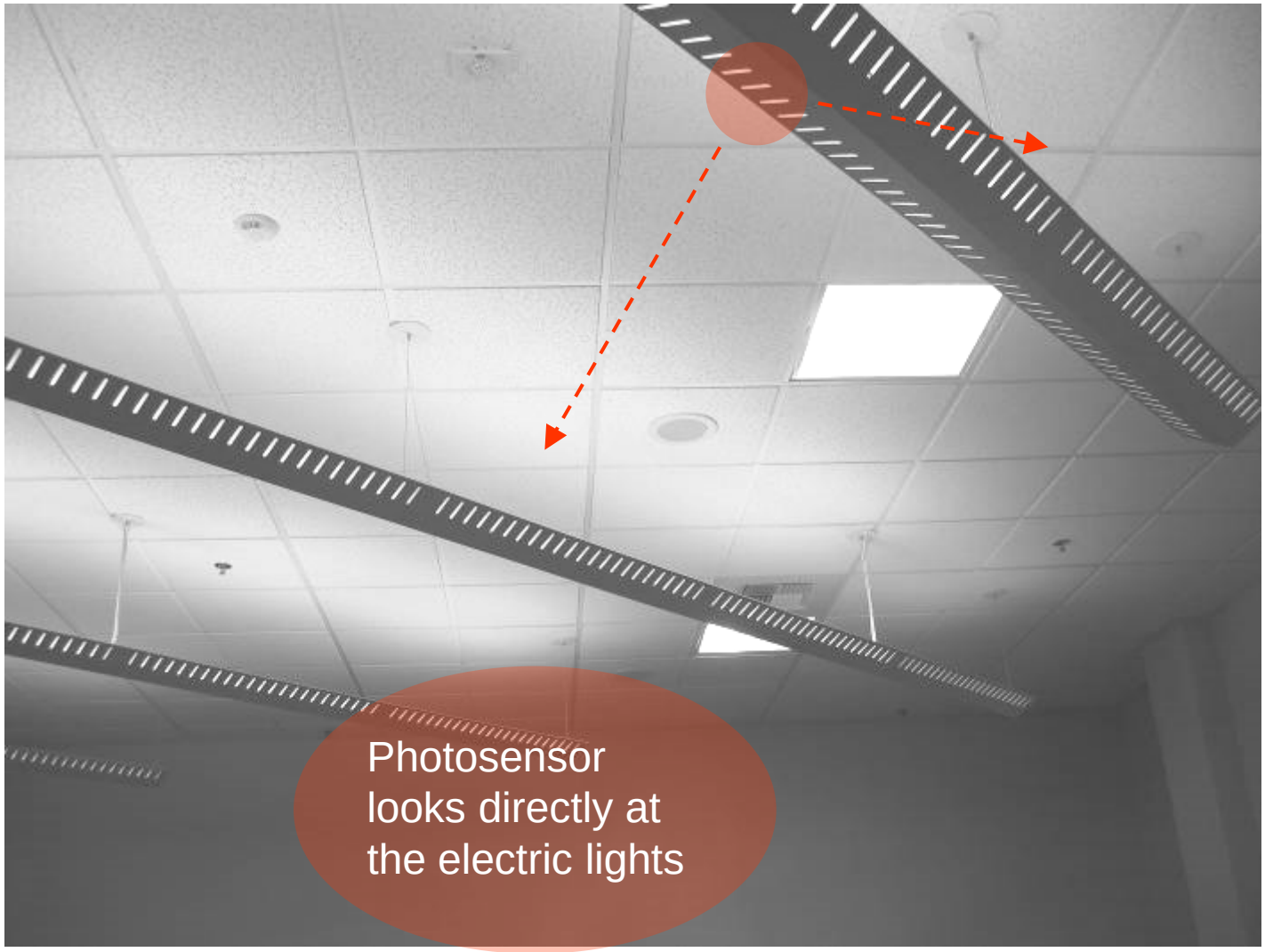
Source: Vaidya 2005

Classroom and Lab Building



Source: The Weidt Group 2005

Classroom and Lab Building

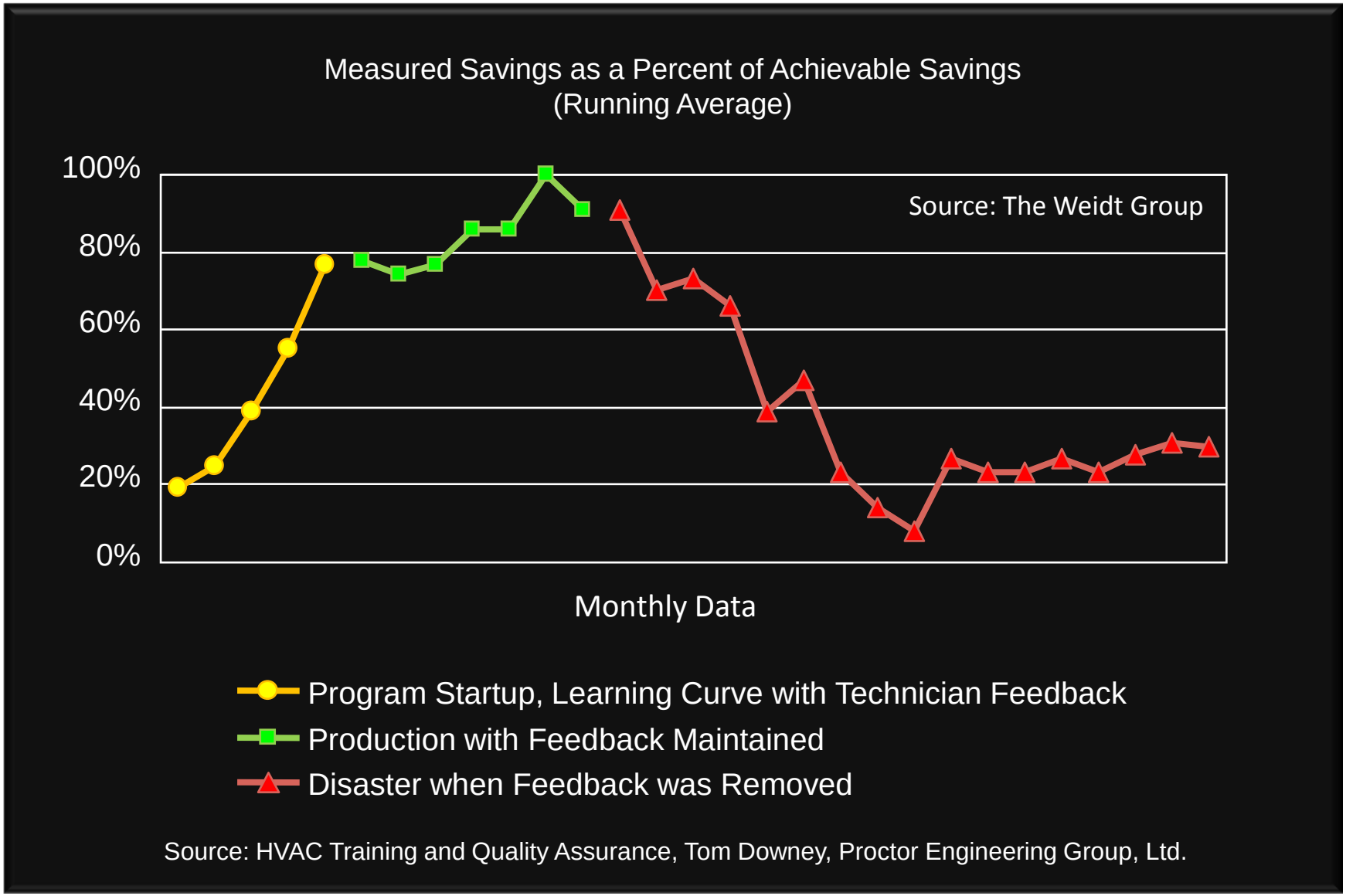


Source: Vaidya 2005

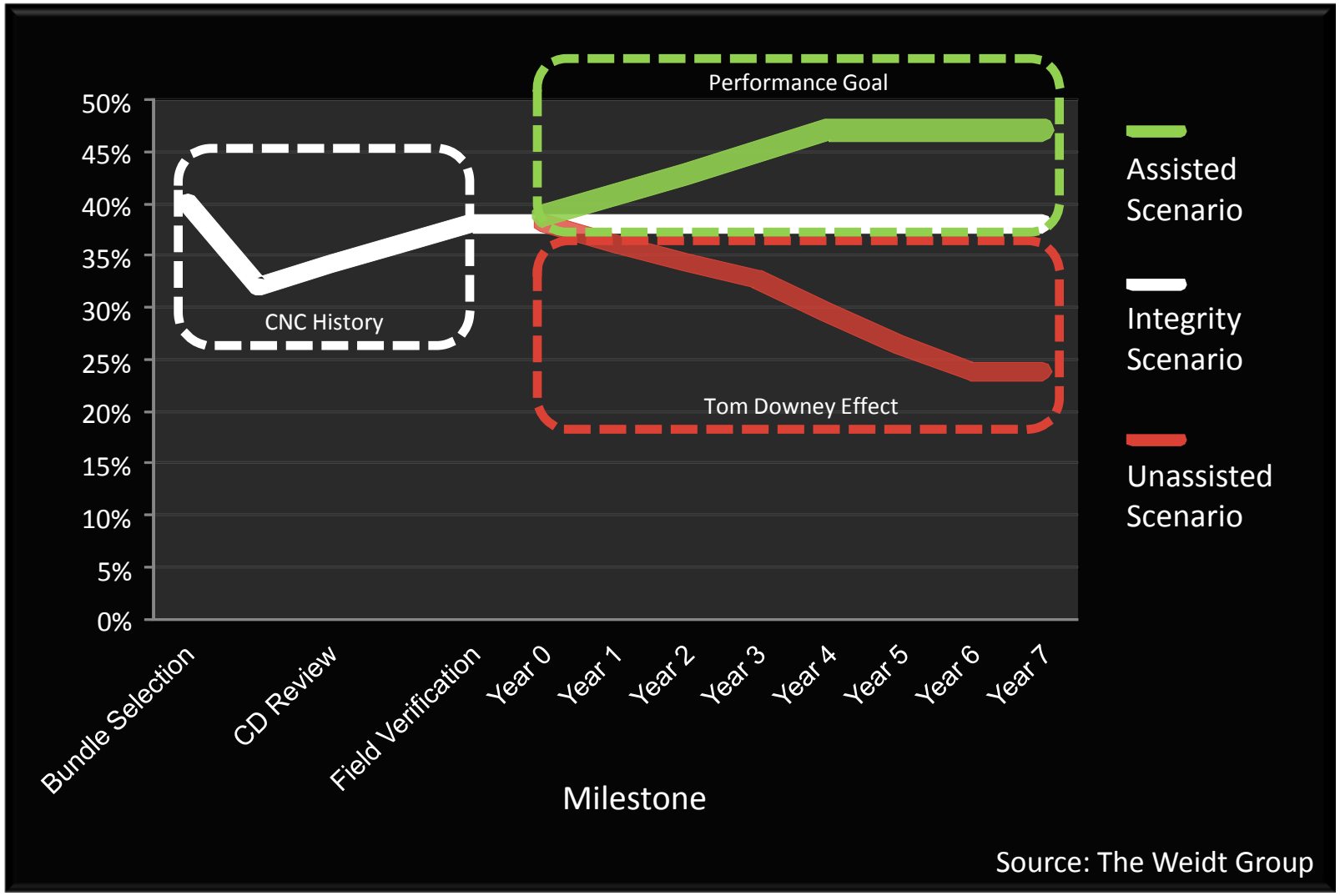
What about

Operations

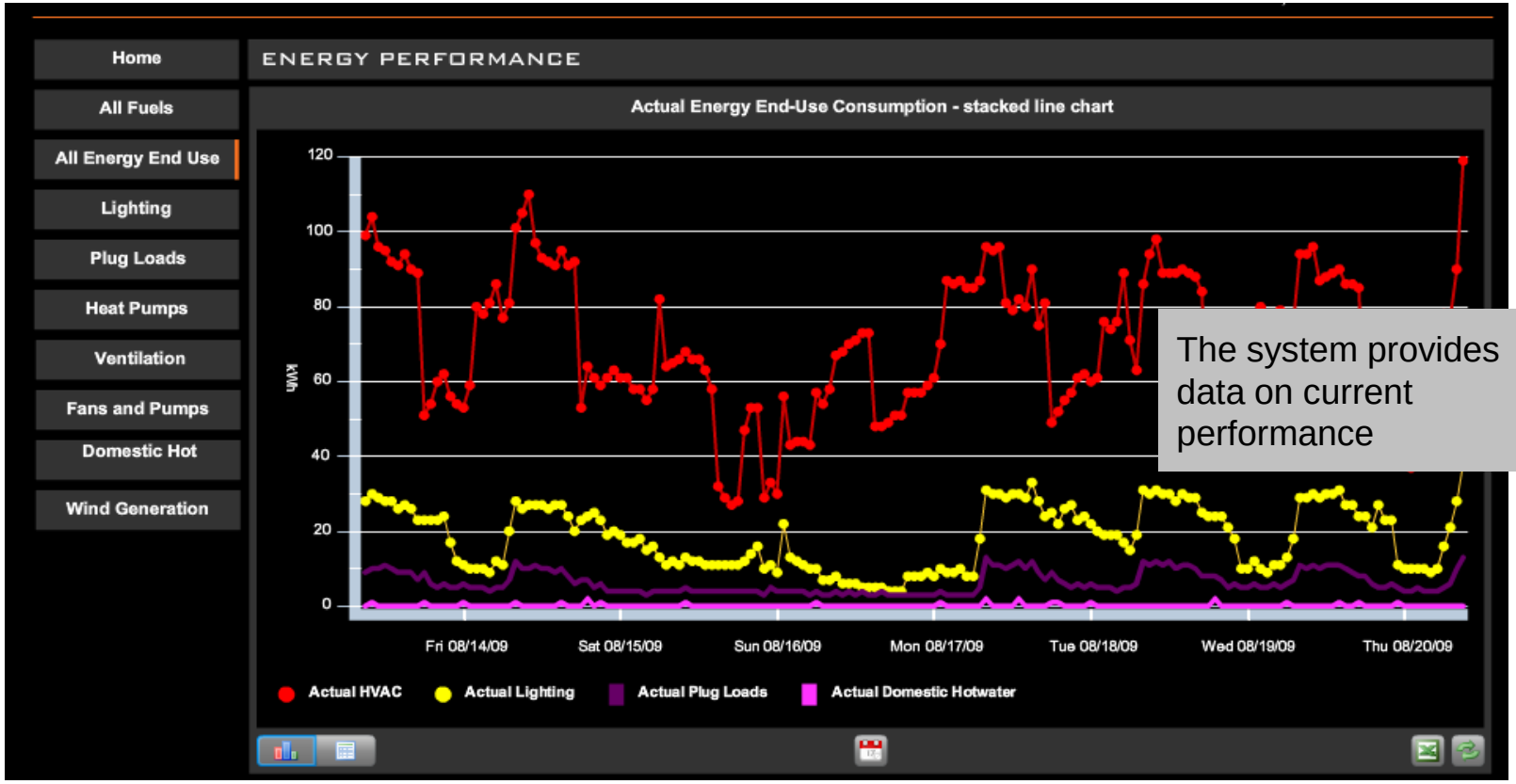
Effect of Training and Monitoring



Long-term Energy Performance



Submetered Energy Use

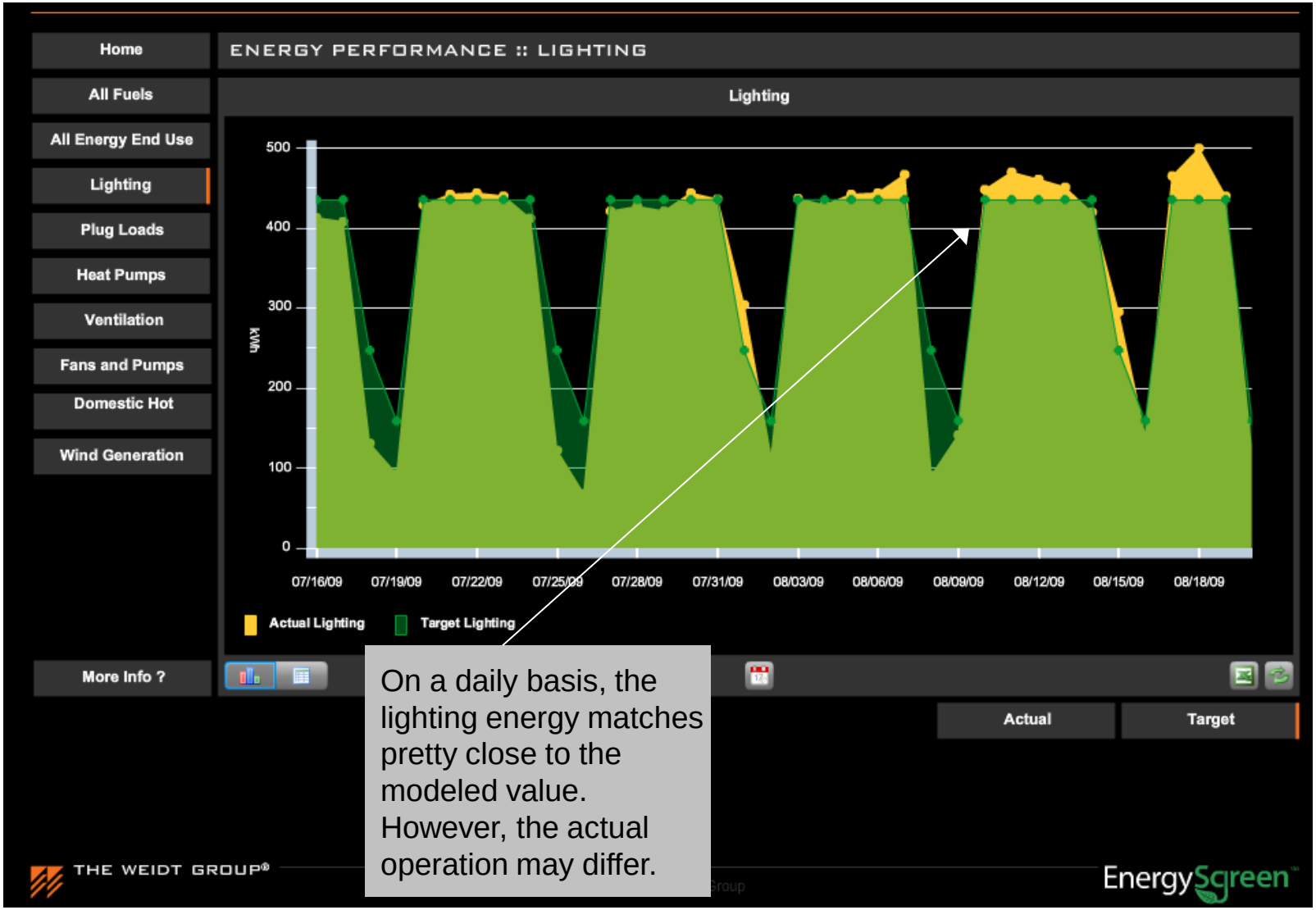


The system provides data on current performance

Source: The Weidt Group

- Monitoring system displays energy enduse data
- It also displays the modeled energy use
- Online web enabled interface to view, compare and download data

Comparing Metered and Modeled



Source: The Weidt Group

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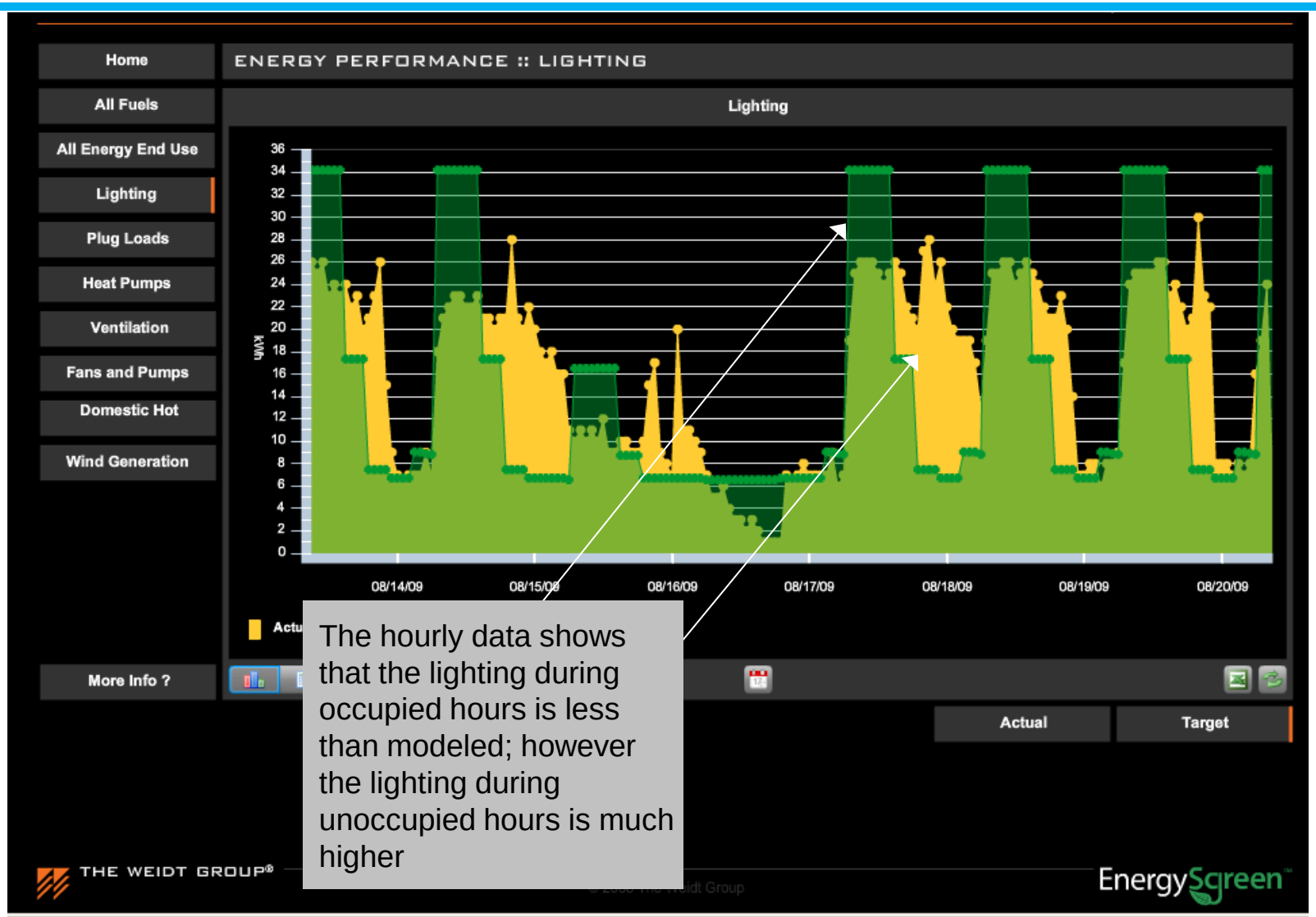
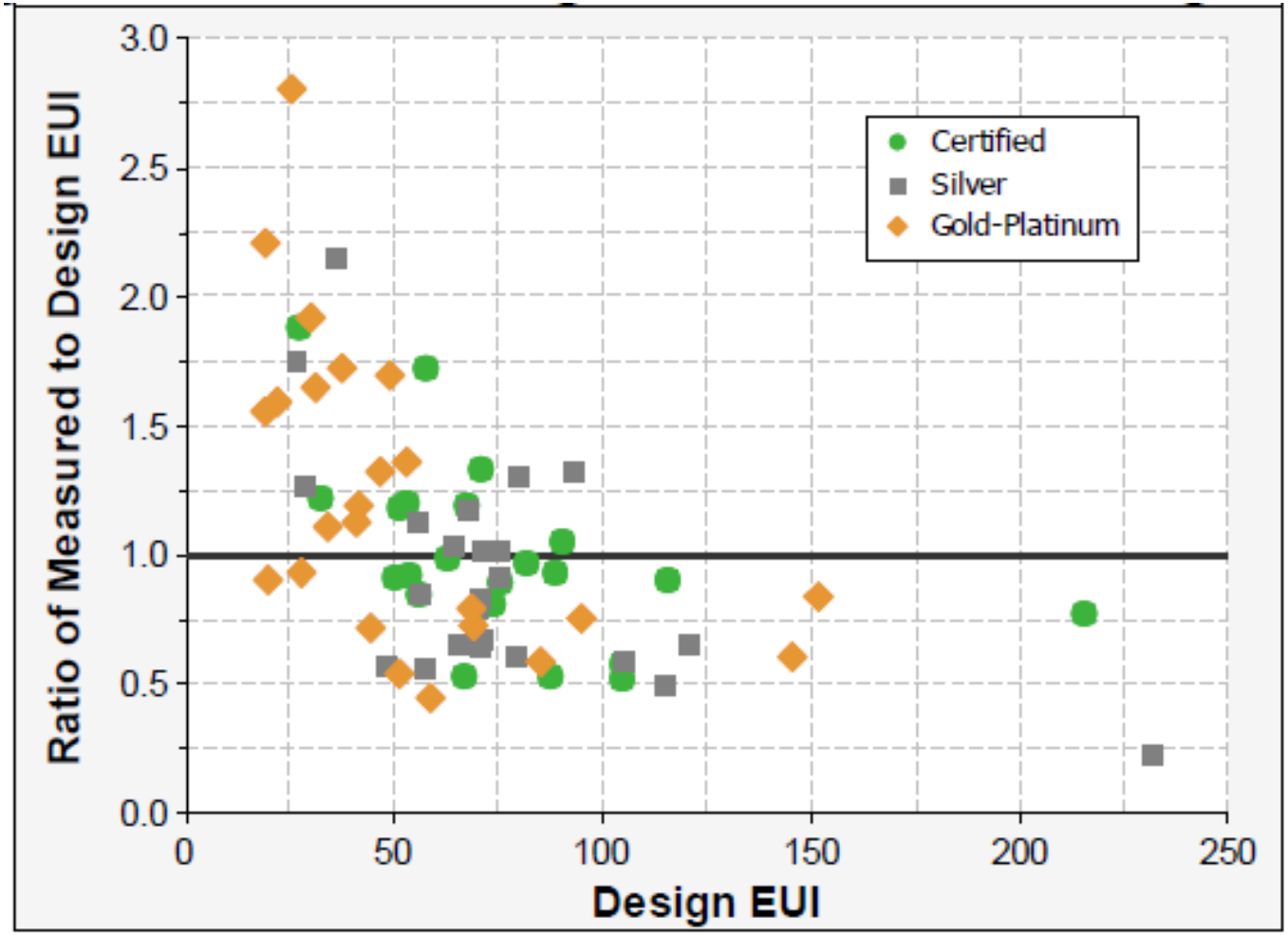


Source: The Weidt Group

Expected vs Actual Performance



Source: Frankel 2008

Is this the right conclusion?

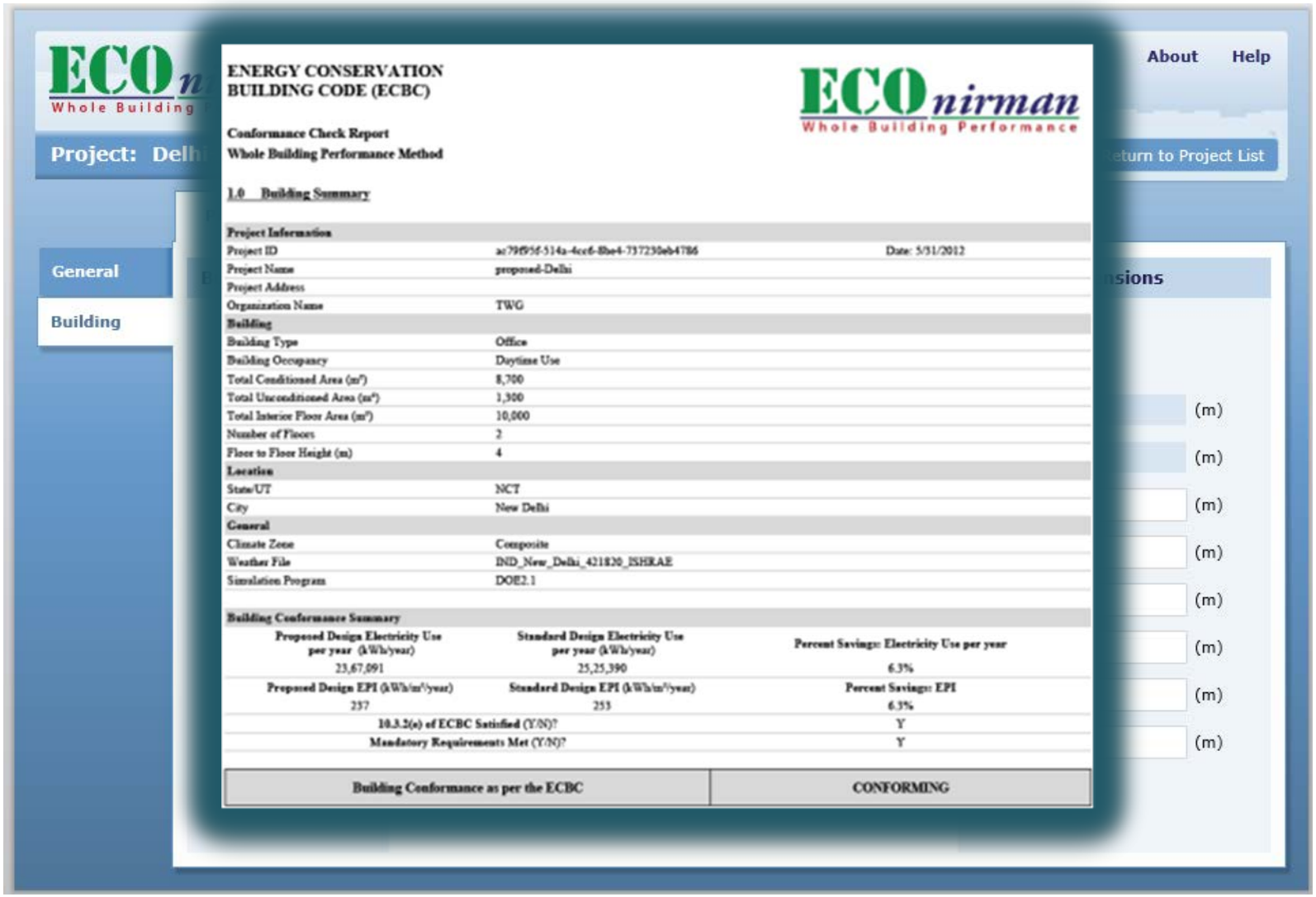
Although in aggregate the energy modeling in the sample above **accurately predicted sample-wide energy savings** (except for high energy buildings), the degree of **variation in predictive accuracy on individual projects was substantial**. It is clear that much work needs to be done to better align energy modeling accuracy with actual building performance outcome if this tool, as currently implemented, is to effectively serve the design community in delivering high performance buildings. The wide variability of energy modeling accuracy on an individual project basis **implies significant flaws in any life-cycle energy savings comparisons undertaken by the affected projects**, and calls into question how effectively this tool is used to predict the performance outcome of any given project. There is a clear need for better data on actual building use characteristics to better correlate modeling inputs with building use characteristics.
–Frankel 2008

Reasons for Variation

- Simulation tool defaults are not appropriate
- Modelers assumptions are not correct
- Building is built differently
- Building is occupied and operated differently
- Actual weather is different

Simulation Tools

ECOnirman WBP Compliance Tool



ENERGY CONSERVATION BUILDING CODE (ECBC)

ECOnirman Whole Building Performance

Conformance Check Report
Whole Building Performance Method

1.0 Building Summary

Project Information		
Project ID	ac79f95f-514a-4cc6-8be4-737230eb4786	Date: 5/31/2012
Project Name	proposed-Delhi	
Project Address		
Organization Name	TWG	
Building		
Building Type	Office	
Building Occupancy	Daytime Use	
Total Conditioned Area (m²)	8,700	
Total Unconditioned Area (m²)	1,300	
Total Interior Floor Area (m²)	10,000	
Number of Floors	2	
Floor to Floor Height (m)	4	
Location		
State/UT	NCT	
City	New Delhi	
General		
Climate Zone	Composite	
Weather File	IND_New_Delhi_421820_ISHRAE	
Simulation Program	DOE2.1	

Building Conformance Summary

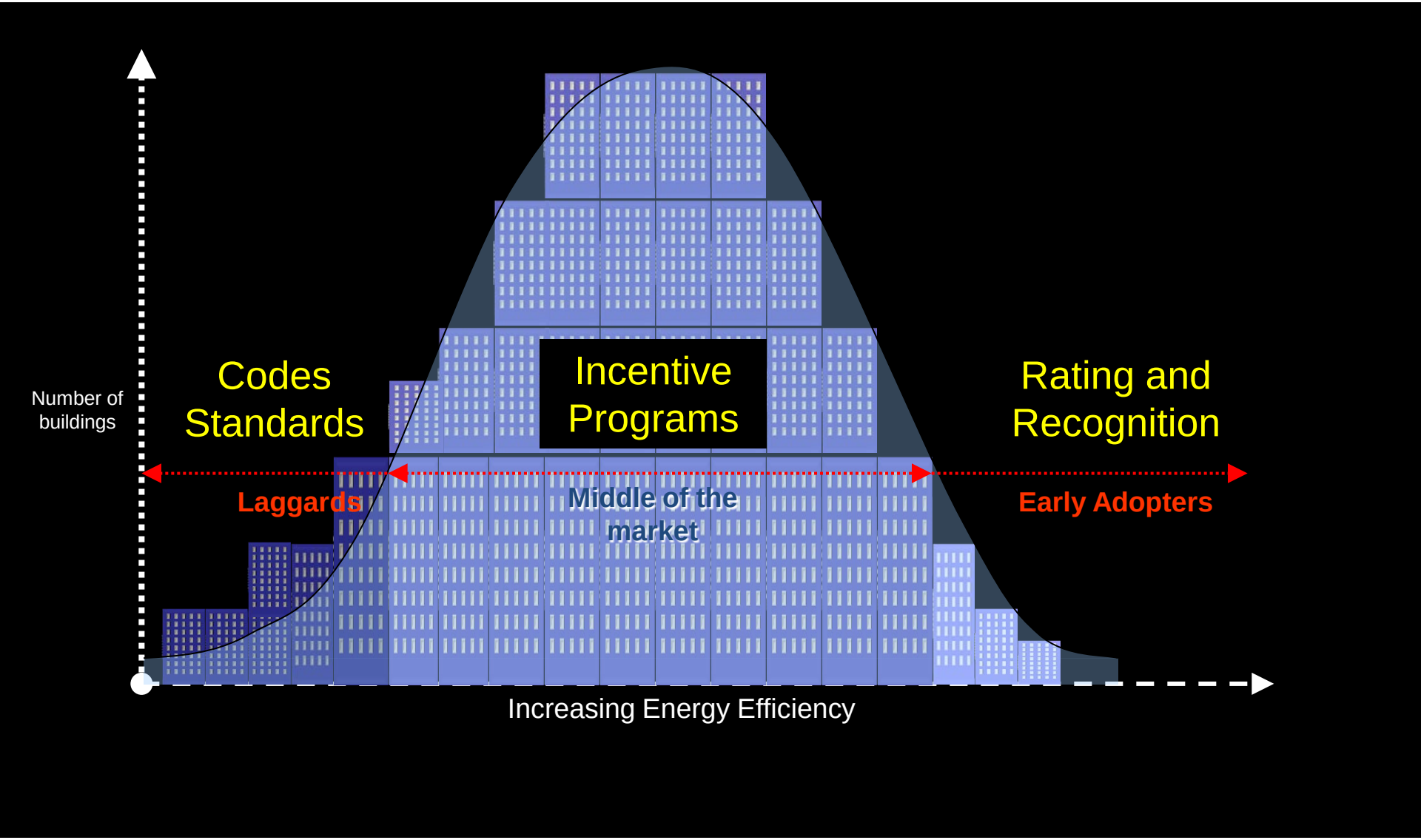
Proposed Design Electricity Use per year (kWh/year)	Standard Design Electricity Use per year (kWh/year)	Percent Savings: Electricity Use per year
23,67,091	25,25,390	6.3%
Proposed Design EPI (kWh/m²/year)	**Standard Design EPI (kWh/m²/year)**	**Percent Savings: EPI**
237	253	6.3%
10.3.2(e) of ECBC Satisfied (Y/N)?		Y
Mandatory Requirements Met (Y/N)?		Y

Building Conformance as per the ECBC	**CONFORMING**

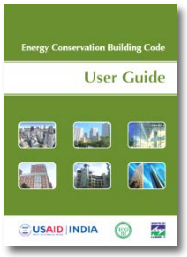
eetools.in

Utility Involvement

Market Transformation



Codes / Incentives / Rating



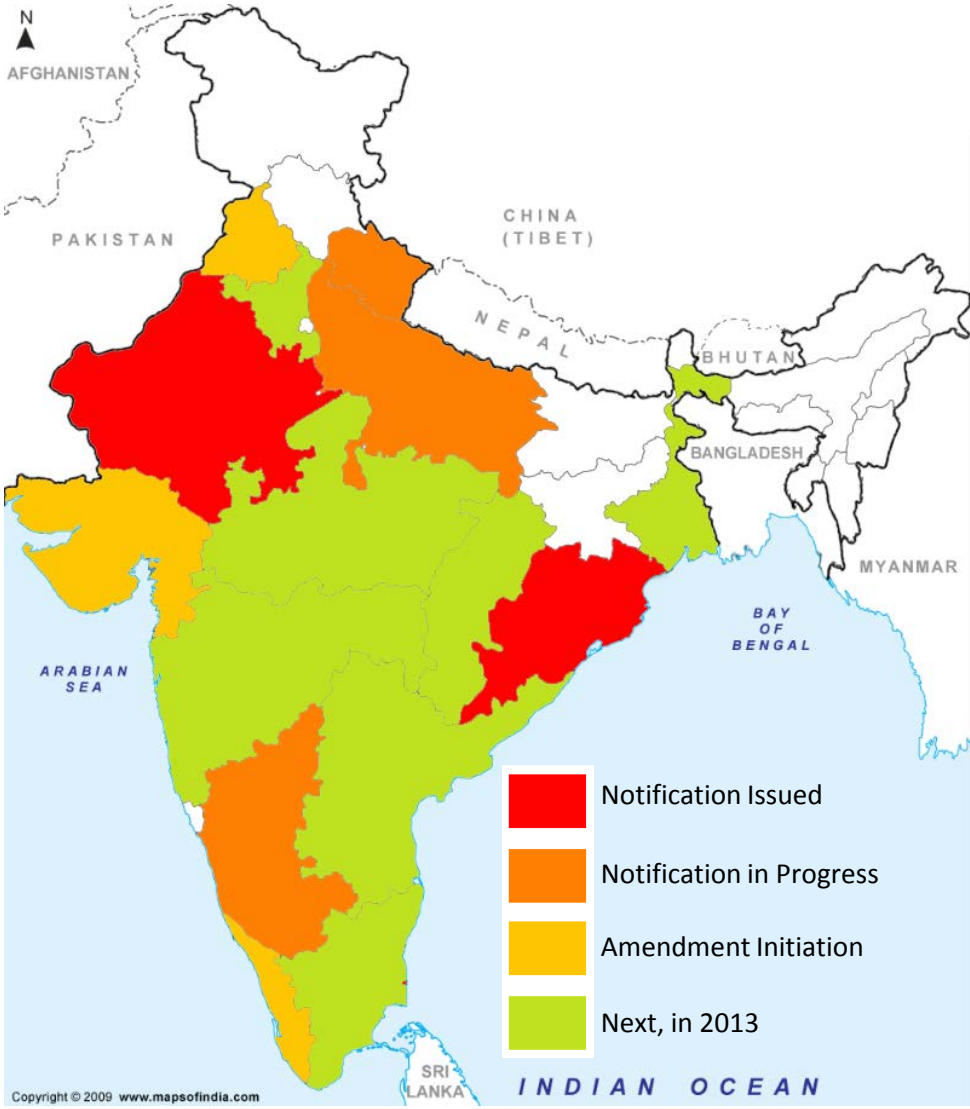
- Energy Conservation Building Code - 2007
  - Sets minimum standard that is enforced by local governments in the building proposal approval

- Incentives offset first costs
  - Tax rebates
  - Utility DSM programs

- Rating, Labeling and Recognition programs
  - LEED
  - GRIHA
  - BEE 5 Star Rating

Status of ECBC at State Level

- Notification Issued
  - Rajasthan, Odisha, & Puducherry
- Notification in progress
  - UP, Karnataka and Uttarakhand
- Amendment Initiation
  - Punjab, Kerala, Gujarat
- Next, in 2013
  - MP, Haryana, Chhattisgarh, AP, Tamil Nadu, West Bengal, Maharashtra

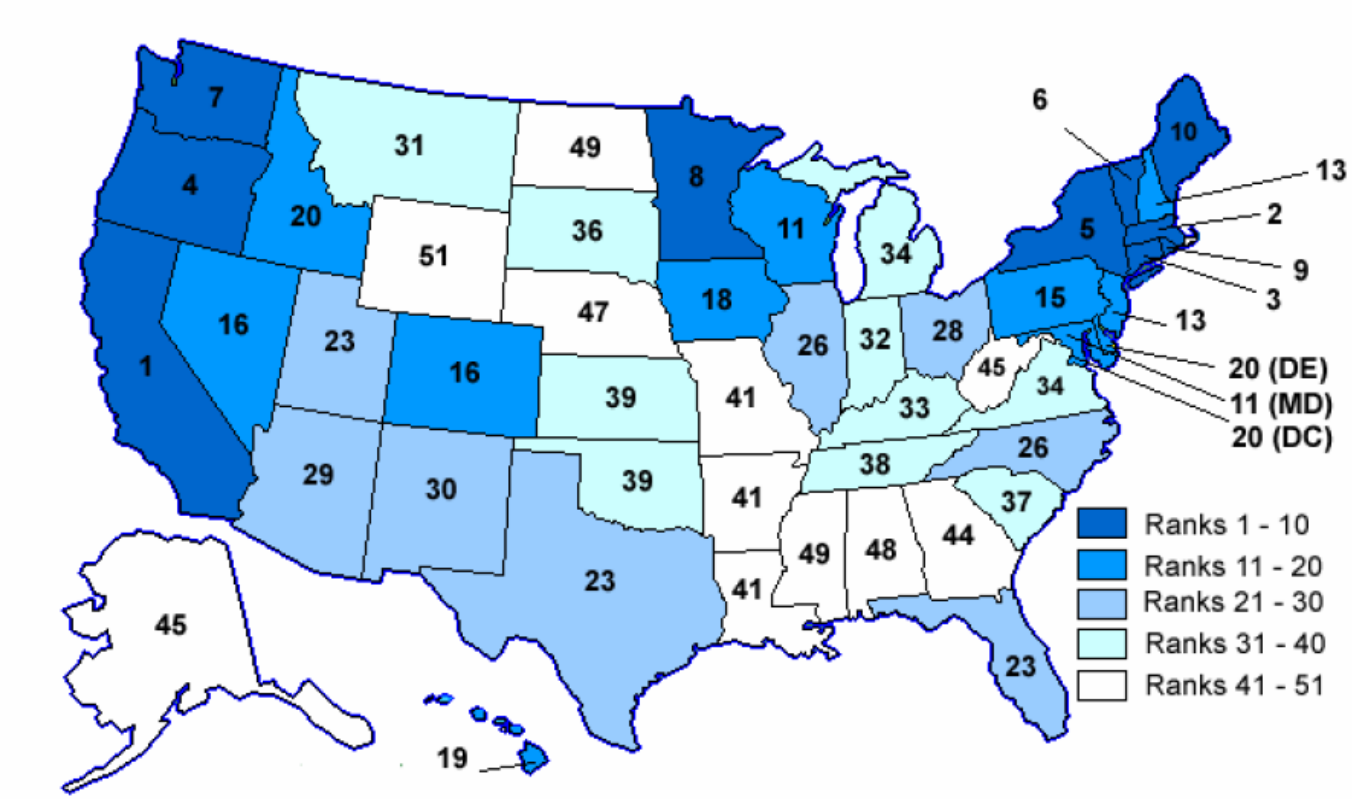


Rating and Recognition Programs As of June 2013

- BEE's Star Rating Program
  - 136 buildings awarded star rating
  - Of these 33 have a 5-star rating
- LEED – India
  - 362 buildings certified
  - 2,111 buildings registered in the program
- GRIHA
  - 17 buildings certified
  - 350 buildings registered in the program

DSM Programs in the USA

Figure ES-1. Map of State Energy Efficiency Scorecard Results



Note: Several states have the same score and are tied for the same ranking.

Cost of Conserved Energy: $0.012 to 0.028 per kWh

Utility Program Examples

Intervention Types	Capacity building potential	Persistence of learning	Utility account-ability to the SERCs	Involvement of utility personnel in program	Specific to a building project
Training and Resource Center	High	Medium[B]	Low	Medium	No
Component Rebates	Low	Low	High	Low with good tools	Yes
Design review with recommendations	Medium	Medium	High	High	Yes
Whole Building performance incentive	Low	Low	High	High	Yes
Design assistance with incentives	High	High	High	Medium	Yes
Codes and Standards	Depends	High	Negotiated	High	No

Proposed Program For Mumbai

The Need

- Mumbai will add about 32 Million SF of commercial floorspace per year till 2016.
- Typical buildings consume 30% more energy than ECBC levels.
- Less than 1% of new the building stock achieves green building certification.
- Current rating systems do not ensure performance.

The Opportunity

- Exceeding ECBC by 10% can save more than 100 kWh/m^2/year, and peak demand by 50% compared to BAU buildings.
- With a mature program we could save 192 MU and 40 MW peak demand over 3 years in Mumbai.
- A pilot program can save 24 MU and 5 MW of peak demand.
- Building Design provides opportunity for much larger savings

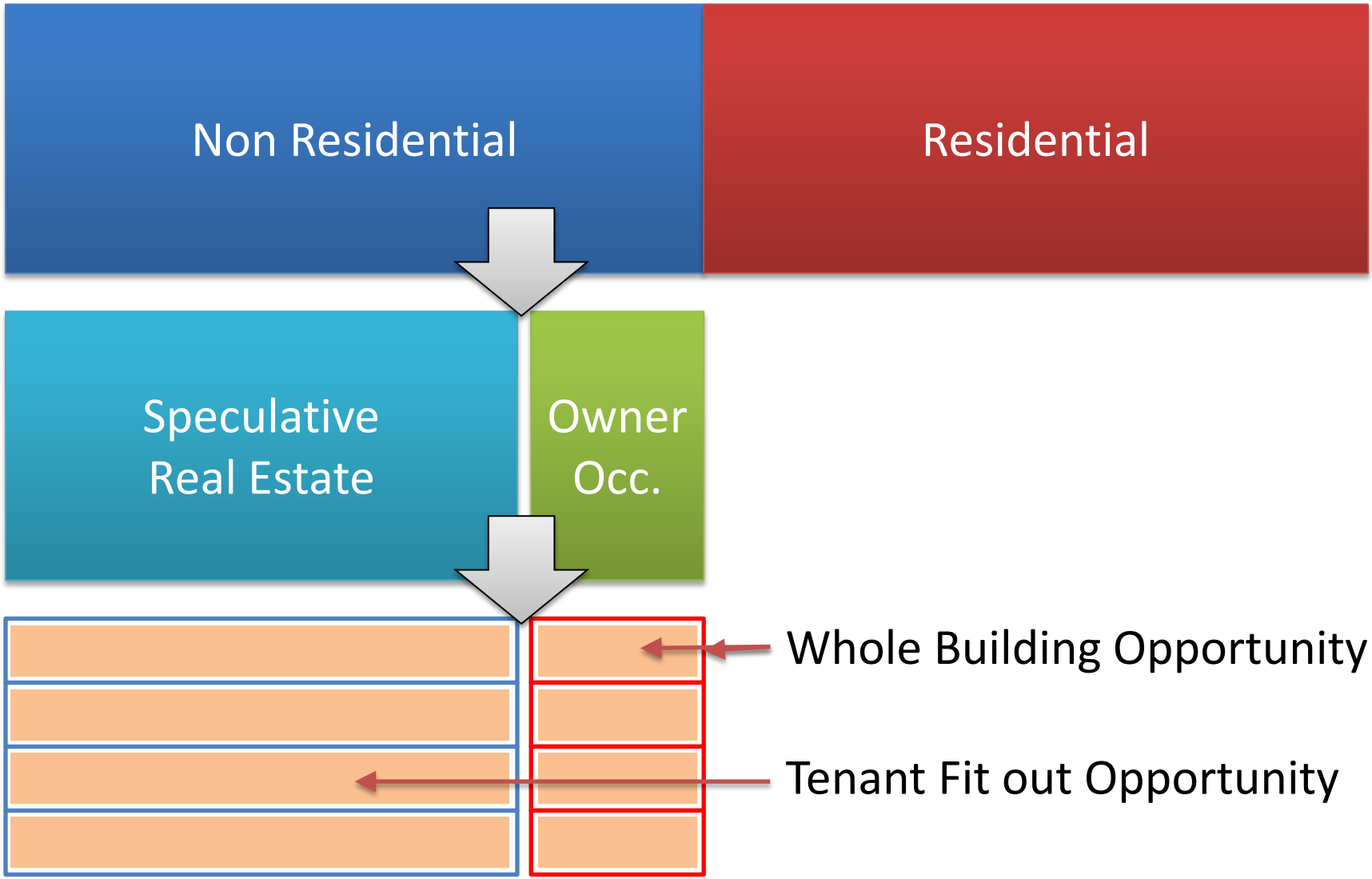
Barriers to EE identified

- Lack of public awareness and thus the absence of a premium for energy efficient real estate
- Cost of energy efficiency technologies and the unwillingness of developers or owners to look beyond a 2-3 year payback
- Owners/ developes do not get reliable ROI information.
- Cost of getting **objective** energy and financial analysis
- Lack of expertise for EE in the larger design industry
- Lack of **easy** design and analysis tools
- Designers experience a 10% increase in effort for EE.

Program Overview

- Program *Baseline is ECBC* performance
- *Savings are Certified* by BEE recognized professionals or institutions
- *Design Assistance to Design Professionals and Customers* provided by empanelled experts
- *Performance Incentive to Design Professionals* for achieving program performance criteria
- *Performance Incentive to Customers* for achieving program performance criteria

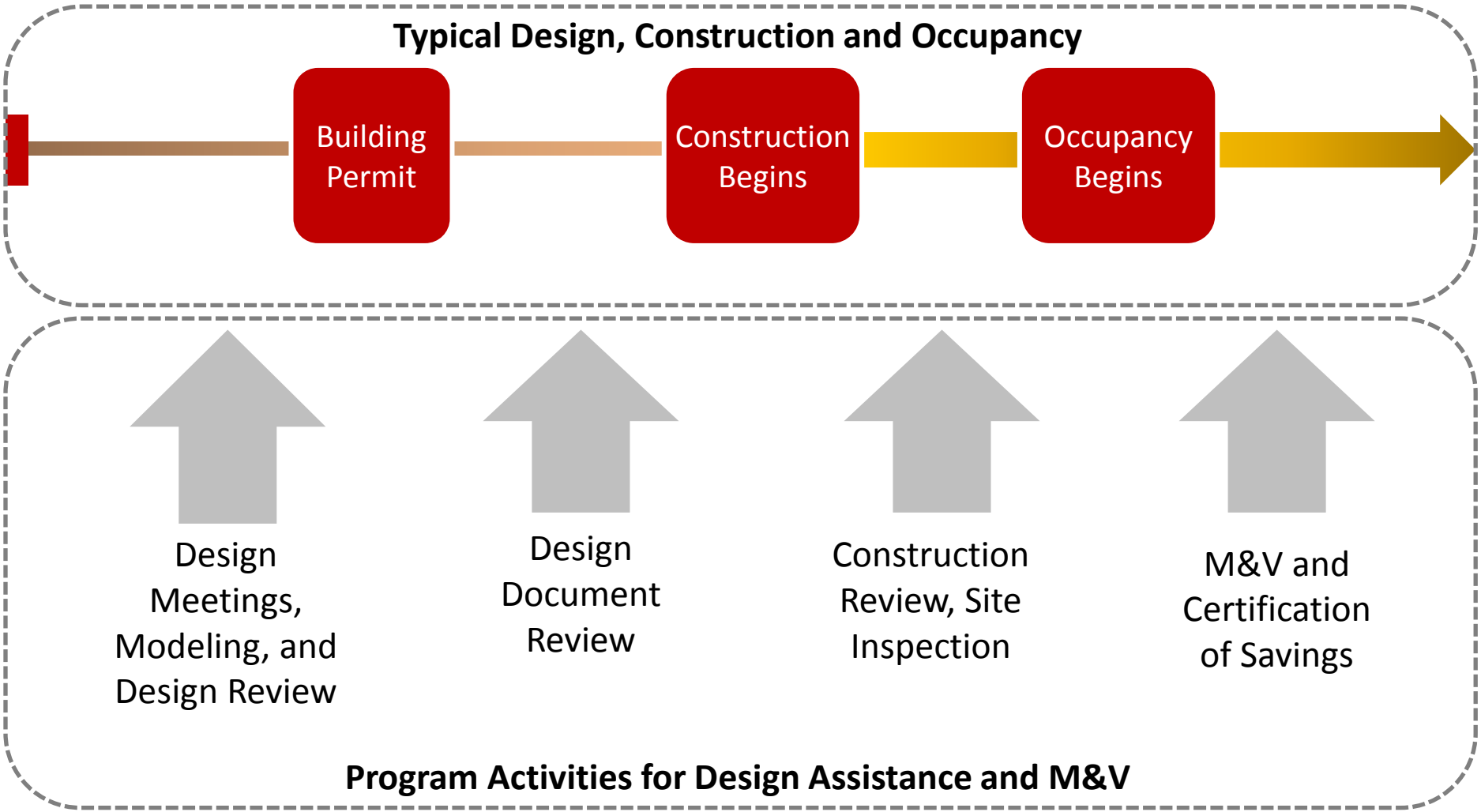
Program Target Market



Program Performance Criteria

- Whole Building Design
  - Exceed ECBC Whole Building performance by 10%
- Lighting System Design
  - Exceed ECBC Lighting System performance by 25%
- HVAC System Design
  - Exceed ECBC HVAC system performance by 25%

Design Assistance Activities



M&V Methodology

- Savings calculations using Appendix B to ECBC and IPMVP Volume III, Option D or Option B.
- The participants install end-use sub-meters for lighting and HVAC energy end uses.
- After Construction: On site verification of measures installed and project savings and incentives.
- After 1 year of Operation: Calibrated energy models to calculate actual savings and incentives.

Pilot Program Benefit Costs

- 1,000,000 SF per year
- Cost of Conserved Energy (CCE)
  - With EUL of 20 years = 1.19
  - With EUL of 10 years = 1.54
  - With EUL of 5 years = 2.37
- CCE is the additional cost that must be invested in order to implement an energy efficiency measure; CCE includes not only the cost of the measure itself but the interest on money borrowed to pay for it.

Stakeholders

- Building Industry Practitioners
- Corporate Owners
- Academic Institutions
- Professional Industry Organizations
- Certification Agency
- Non-profit Advocacy Groups
- Regulatory Commission
- Utilities

Discussion Points

- What are the implementation challenges?
- What's in it for the utility?
- What's in it for the public?
- What are the challenges of selling this?
- Who else could be partners in cost or benefits?
- Which stakeholders have not been listed?

Acknowledgements

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Thank you

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