



 the weidt group

collaboration
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30
YEARS



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HIGH PERFORMANCE BUILDINGS

Risk Calculations for Energy Conservation Technologies

Investigators

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- ▶ Chris Baker
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- ▶ David Eijadi

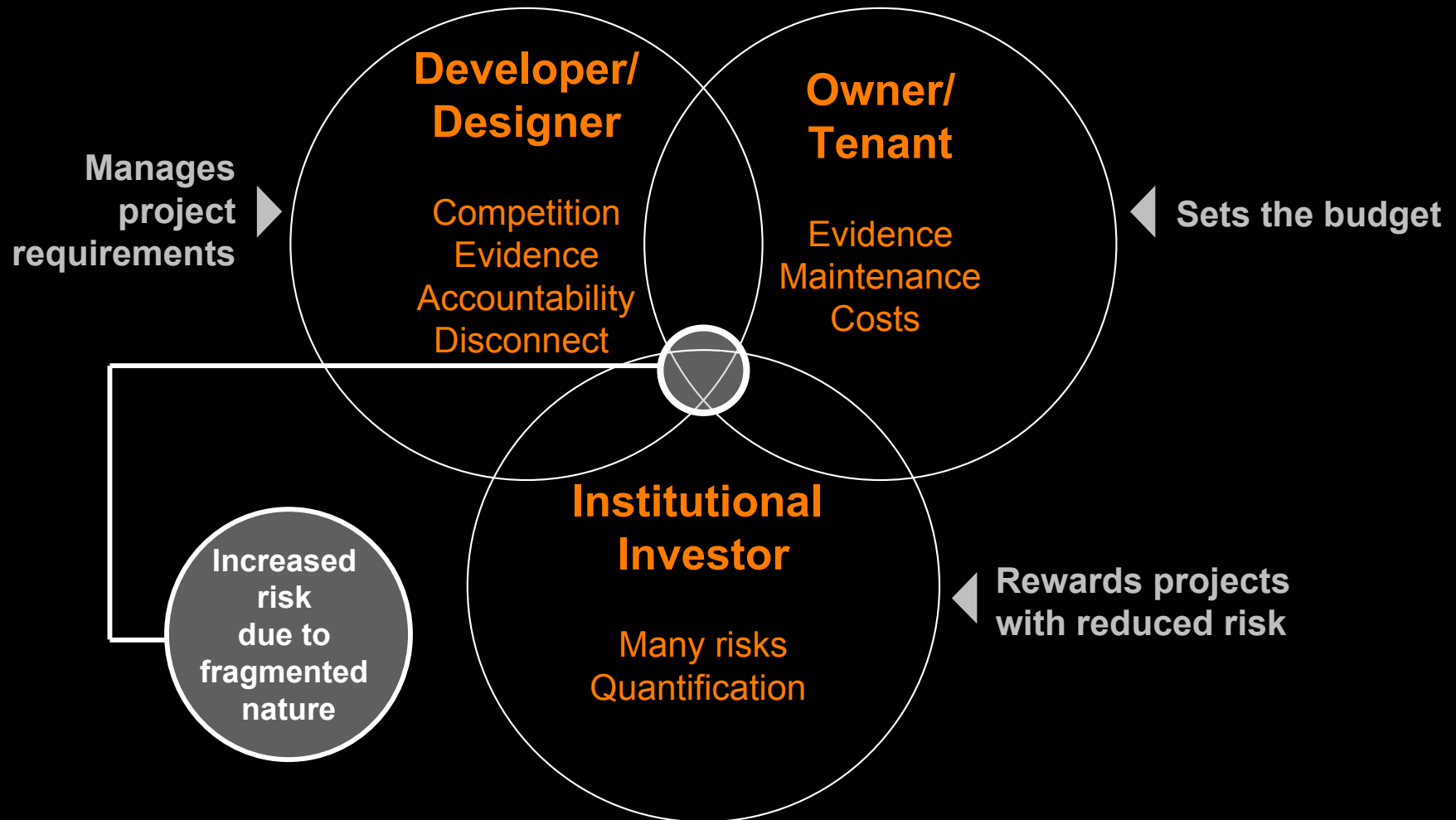
Research questions

- ▶ What is the risk that a building technology will **not be implemented** or functioning correctly?
- ▶ Why are energy conservation technologies lost during the **construction phase**?

Executive Summary

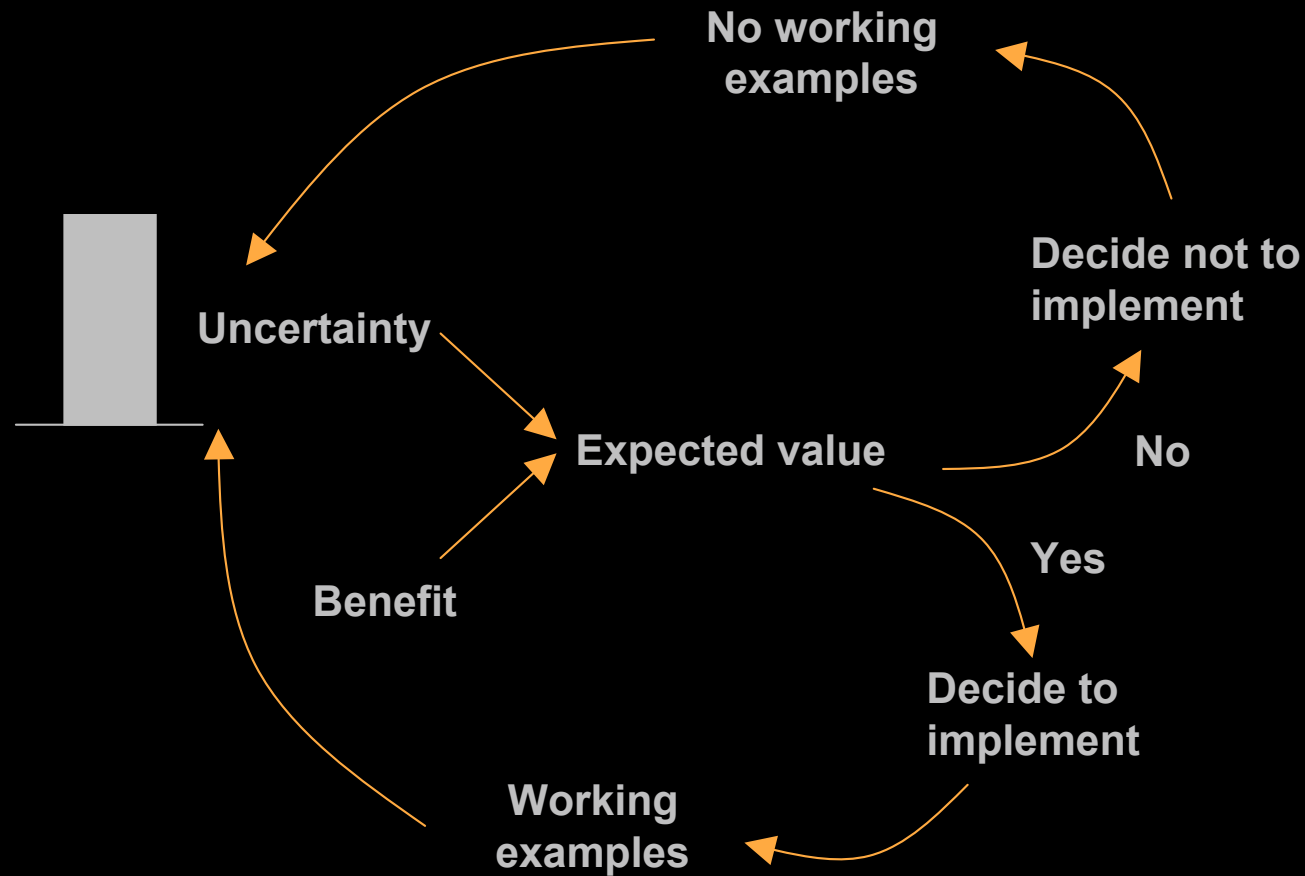
- ▶ Roof insulation
 <0%
- ▶ VFDs
 12%
- ▶ Outside air controls
 37%
- ▶ Daylighting controls
 >50%

Background: Barriers to Adopting Energy Conservation Features



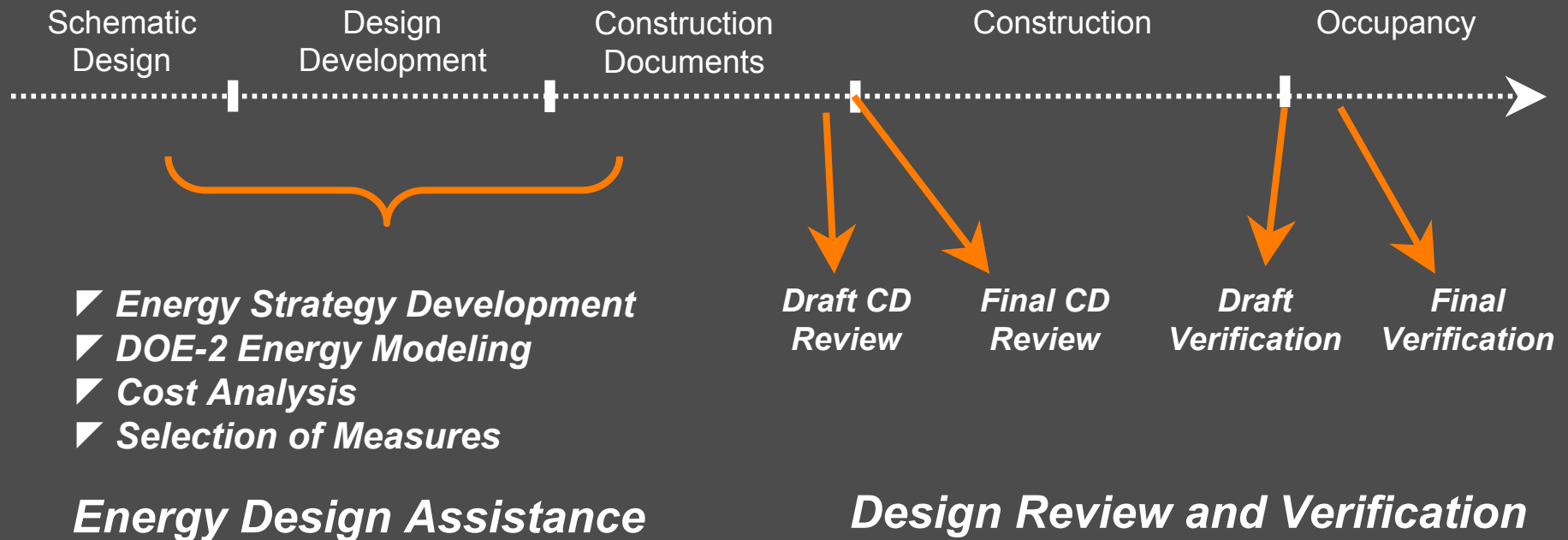
Background: Decision Process

- ▶ “No” decision reinforces uncertainty
- ▶ “Yes” decision reduces uncertainty



Research Methodology: EDA Process

Design Process Timeline



Database Methodology



Data set

- 38 projects (school, hospital, lab, office)
- New construction completed 2003-2005
- Avg. 8,000 m²; total 300,000 m² (3.2 million sq.ft.)
- Based on DOE2.1 modeled energy savings before and after verification



Average savings per project (vs. code base of ASHRAE 90.1-1989)

- 32% annual kWh
- 31% annual energy \$
- 30% annual gas

$$\text{Risk factor} = 1 - \frac{\text{Energy Savings at Verification}}{\text{Energy Savings at Selection}}$$

Interview Methodology



- ▶ Third-party reviewers (9)
 - ▶ All work at same firm
- ▶ Survey
 - ▶ Reasons why a measure not found
 - ▶ Later decision to not implement
 - ▶ Not calibrated/commissioned
 - ▶ Contractor omitted it
- ▶ Focus groups
 - ▶ Explanations from design teams?
 - ▶ Potential solutions for increasing implementation rate?
 - ▶ Biases likely
 - ▶ Tend towards most recent experiences



Results

- ▶ Total 2.2 million kWh lost (annually)
- ▶ EURO 100,000 (\$133,000) savings potential lost annually
 - ▶ Assuming EURO 0.045/kWh

Envelope insulation and glazing



Risk factor

roof
<0%_{±.71}

wall
28%_{±.42}

glazing
12%_{±.80}



Reasons for not achieving

- ▶ Value engineering
- ▶ Documents incomplete
- ▶ Miscommunication
- ▶ Functional risk
- ▶ Lack of specification knowledge
- ▶ Lack of coordination
- ▶ Installation knowledge

Support needed

- ▶ Quantify benefits





Lighting design



r Risk factor

28%
±.50

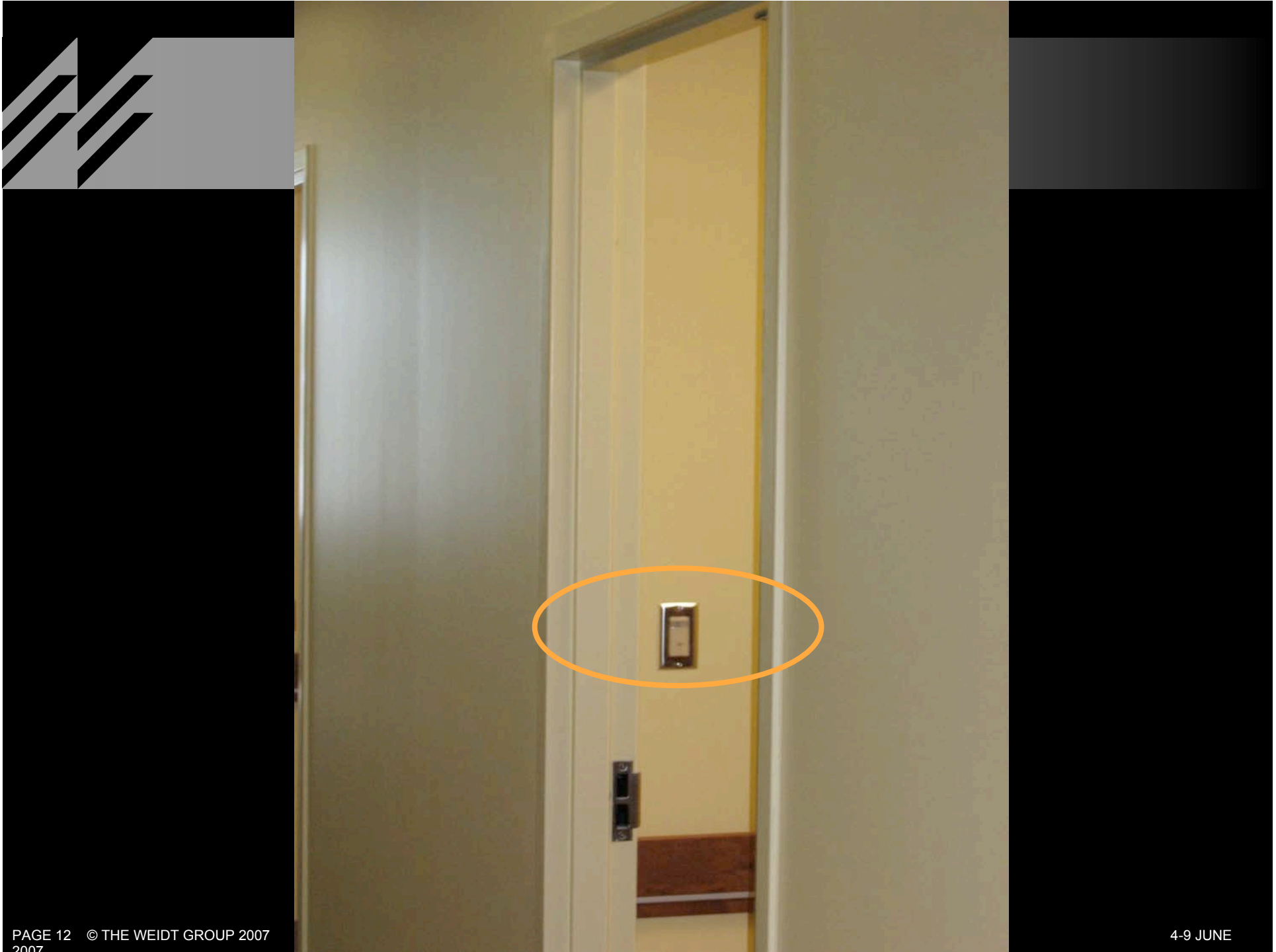


? Reasons for not achieving

- ▶ Value engineering
- ▶ Documents incomplete
- ▶ Miscommunication
- ▶ Functional risk
- ▶ Lack of specification knowledge
- ▶ Lack of coordination
- ▶ Installation knowledge

Support needed

- ▶ Integrated design
- ▶ Sample spec's



Lighting controls



r Risk factor

motion sensor
13% \pm .35

manual control
14% \pm .32

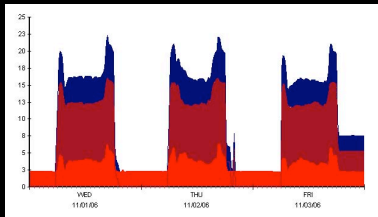
strategic switch
21% \pm .46

? Reasons for not achieving

- Value engineering
- Documents incomplete
- Miscommunication
- Functional risk
- Lack of specification knowledge
- Lack of coordination
- Installation knowledge

Support needed

- Quantify benefits
- Case studies of positive experience





Mechanical equipment

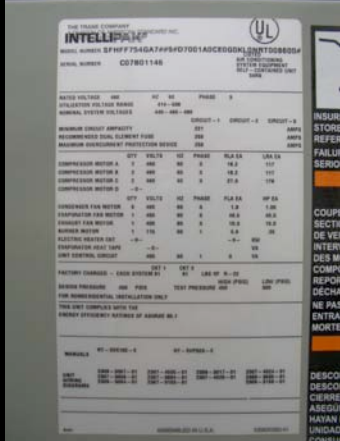
r Risk factor



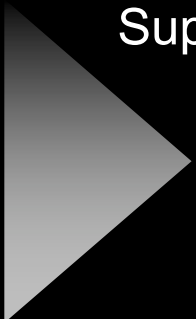
VFDs
12%
±.32

HVAC
equipment
17% ±.36

? Reasons for not achieving



- Value engineering
- Documents incomplete (difficult to find)
- Miscommunication
- Functional risk
- Lack of specification knowledge
- Lack of coordination
- Installation knowledge



Support needed

- Quantify benefits
- Improved document'n



Outside air controls



r Risk factor

37%

±.48



? Reasons for not achieving

- Value engineering
- Documents incomplete
- Miscommunication
- Functional risk
- Lack of specification knowledge
- Lack of coordination
- Installation knowledge

Support needed

- Quantify benefits
- Case studies of positive experience





Daylighting controls



r Risk factor

switching
50%
±.52

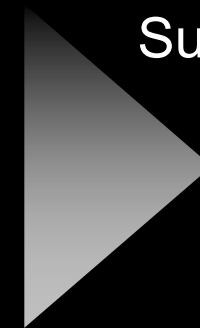
dimming
68%
±.40

strategic
switch
21% ±.46

? Reasons for not achieving



- **Value engineering**
- Documents incomplete
- Miscommunication
- Functional risk
- **Lack of specification knowledge**
- Lack of coordination
- Installation knowledge

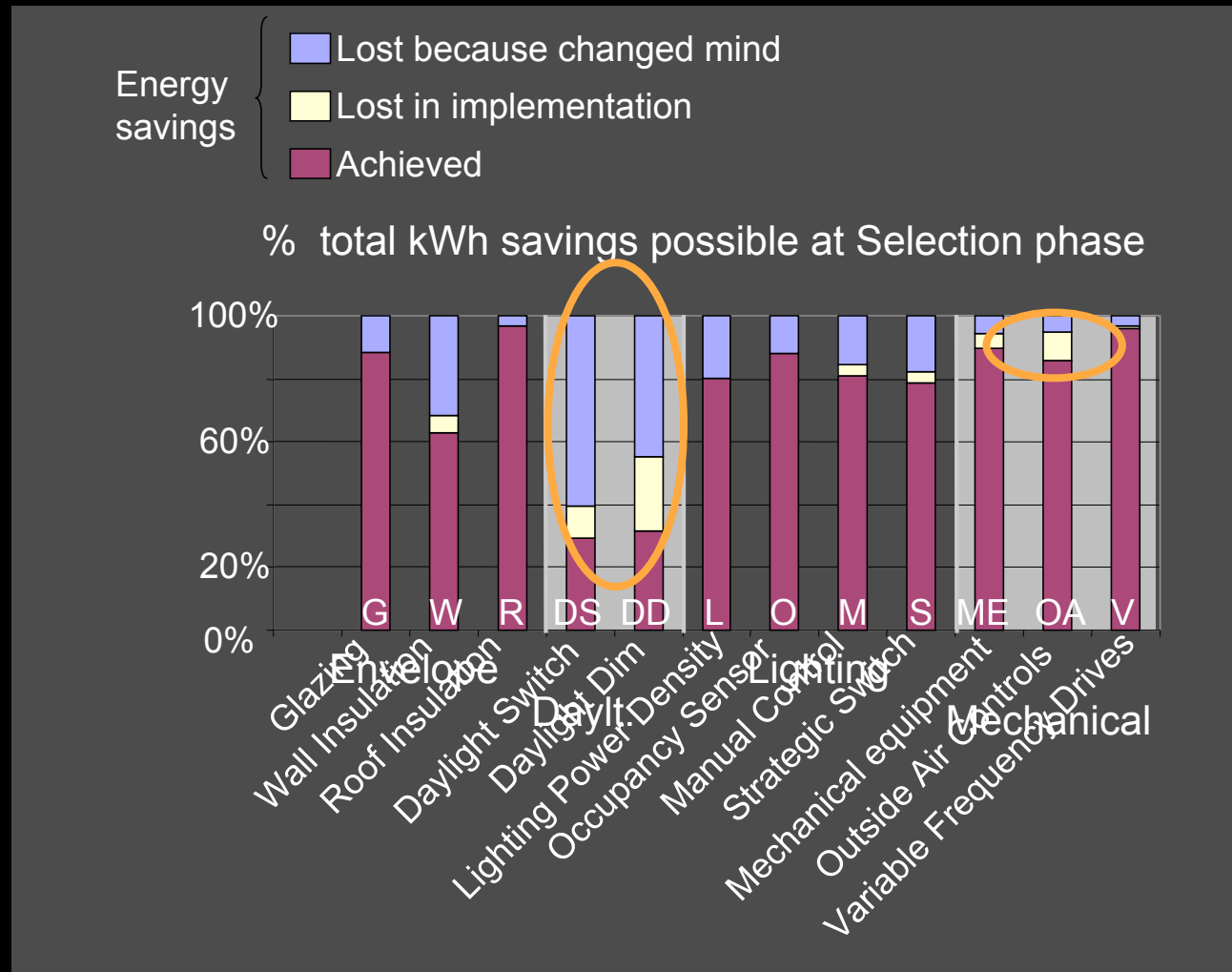


Support needed

- Quantify benefits
- Sample spec's

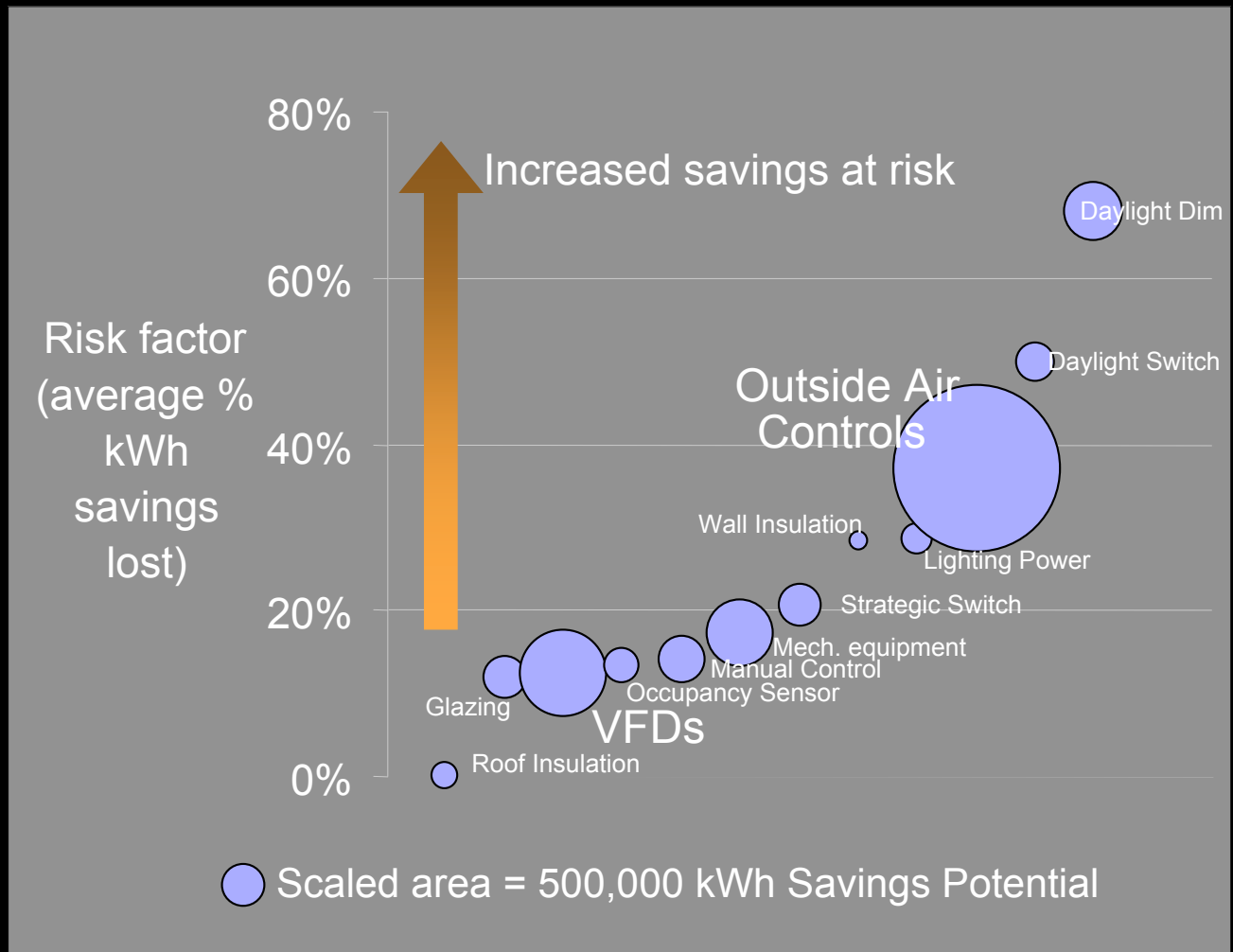
Summary of Results

- Change decision on daylighting controls
- Outside air lost in implementation
- Roof insulation and VFDs achieved to near 100%

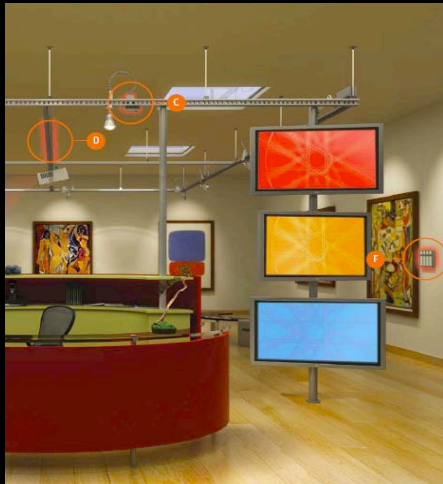


Risk Factor vs. Savings Potential

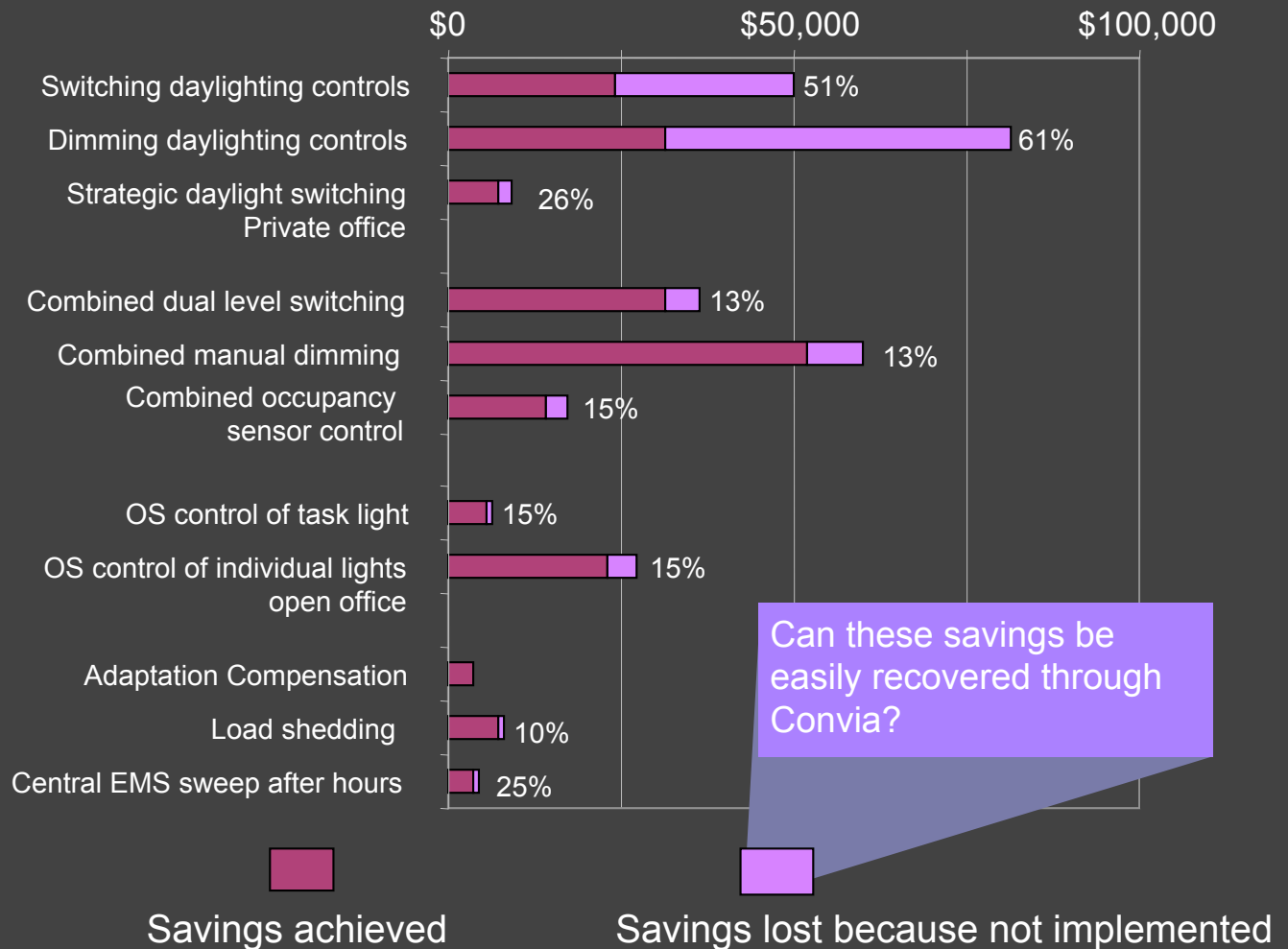
- ▶ Outside air controls have high risk factor and high savings potential
 - ▶ VFDs
 - ▶ Mech equip
 - ▶ Daylighting
- ▶ Total 2.2 million kWh lost
- ▶ Use risk factors to estimate savings that are at risk during construction and operation phase



Apply Risk Factors to Understand Value of Corrective Action



Present Value of 5 Years of Energy Savings at 5%



Value of Corrective Actions

Convia's ability to fix implementation problems

Fixes with Convia compared to Traditional systems										
Issues	Fixes	Add/ change control equipment	Disable control	Add manual override	Move sensor/ control location	Change sensor/ control orientation	Add/ change fixture connections	Change fixture location	Program/ Calibrate the system	Educate building operator
Not implemented (const)		easier					easier		same effort	
Not calibrated									same effort	same effort
Wrong control equipment installed		easier							same effort	same effort
Sensor Location					easier				same effort	easier
Sensor Angle									same effort	same effort
Not enough sensors installed		easier					easier		same effort	easier
Too many sensors installed		easier	easier				easier		same effort	easier
All fixtures not connected							easier		same effort	easier
Wrong fixtures connected							easier		same effort	easier
Window position is different									same effort	easier
Lower surface reflectances									same effort	easier
Higher partitions							easier		same effort	easier
Other obstructions							easier		same effort	easier
Daylight quantity is less		easier	easier			same effort	easier		same effort	easier
Users want more control				easier					same effort	easier

Easier to add or change controls in response to findings in the field

Same effort to adjust orientation of sensor

Same effort to reprogram or calibrate systems, but the effort will differ

Easier to move or change the location of a sensor or fixture in response to spatial realities, building form, and occupant wishes

Easier to educate the building operator, but there will be a learning curve, as with all new technologies. Convia management becomes a new skill set, distinct from that of current electrical

Conclusions



- Roof insulation, glazing, some lighting controls and VFDs have low risk factors
- Dynamic control strategies have high risk factors
 - Daylighting
 - Outdoor air controls
- Top reasons for fall-out
 - Value engineering
 - Functional risk
 - Miscommunication
 - Improper installation
- Need to support - education
 - Quantify benefits
 - Case studies of positive experience
 - Integrated design
 - Sample specifications

Future work

- Apply risk factors to design of incentive structure for utility program
- Build database for other metrics
- Study design-build vs. typical supply chain
- Determine opportunities for BIM (Building Information Modeling) to close gaps



DNR Building, Howard, WI

Thank you



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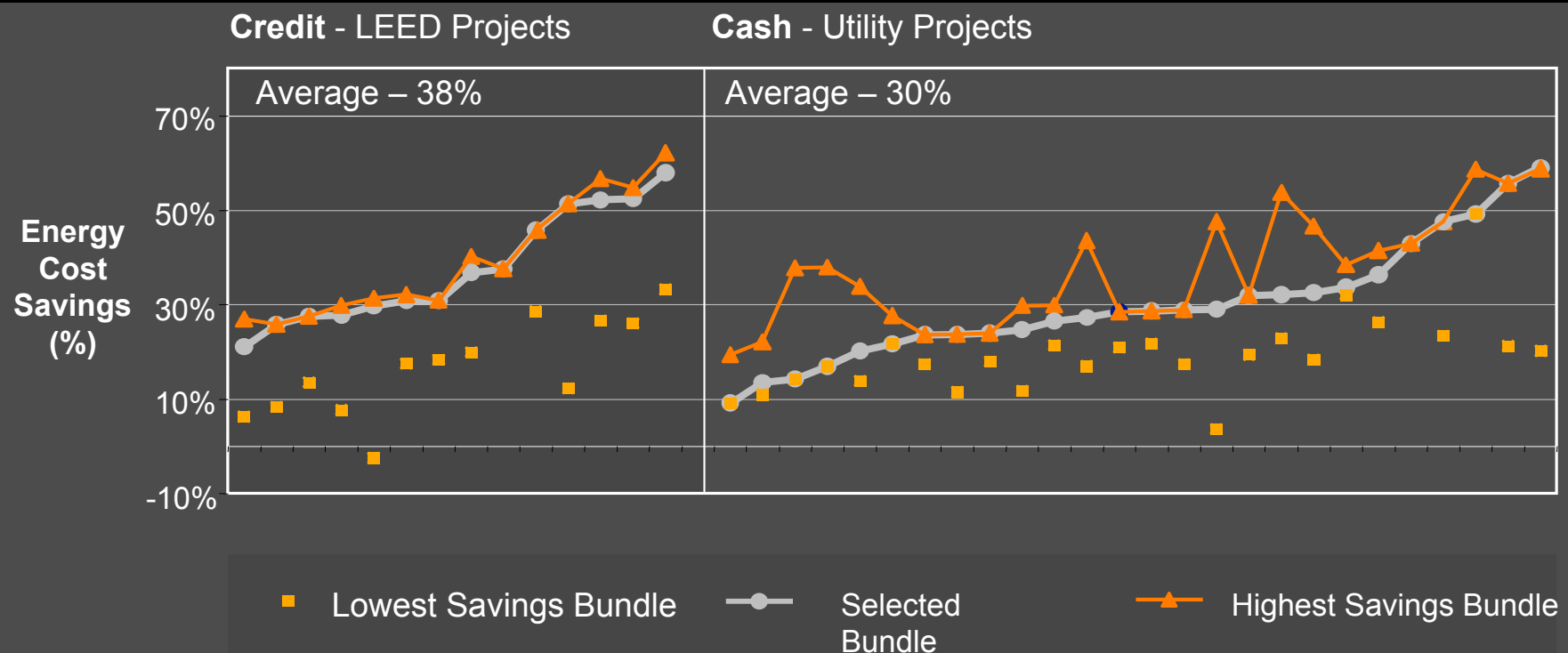
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Results

Energy Cost Savings

- Both types reach 60% savings level for selected bundle
- On average, Credit projects have higher savings than Cash
- Both types have average savings for highest bundle of ~38%





Design Review Process

Construction Documents

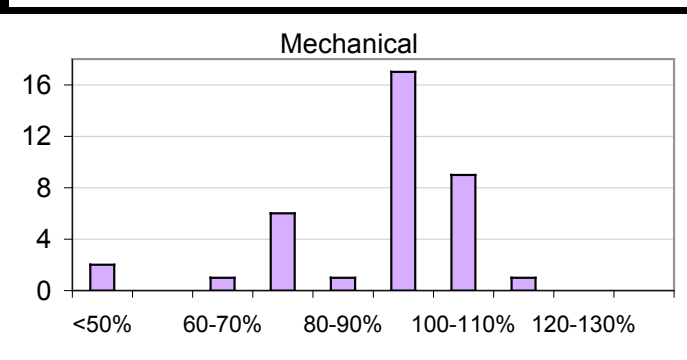
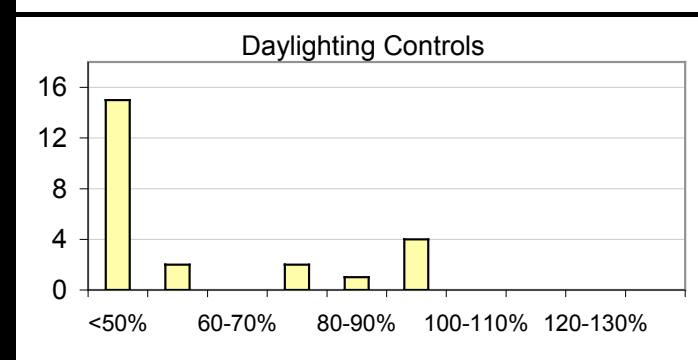
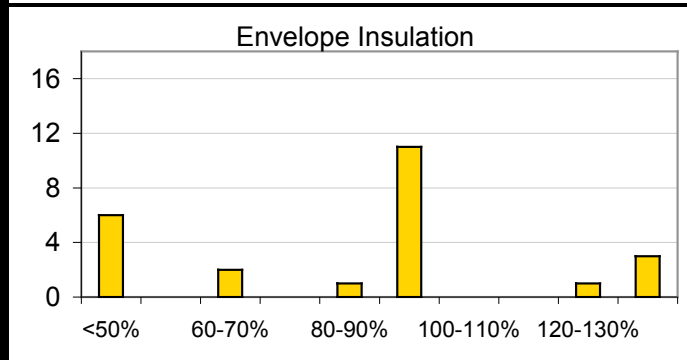
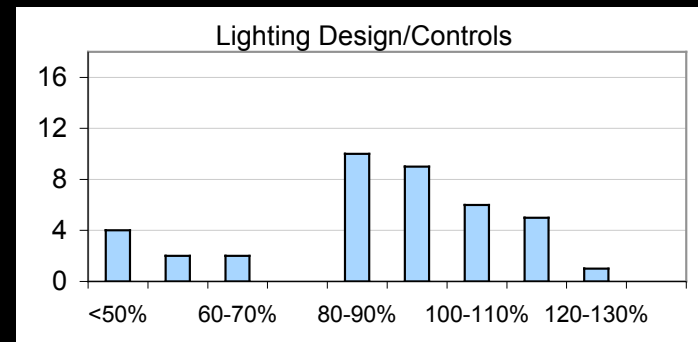
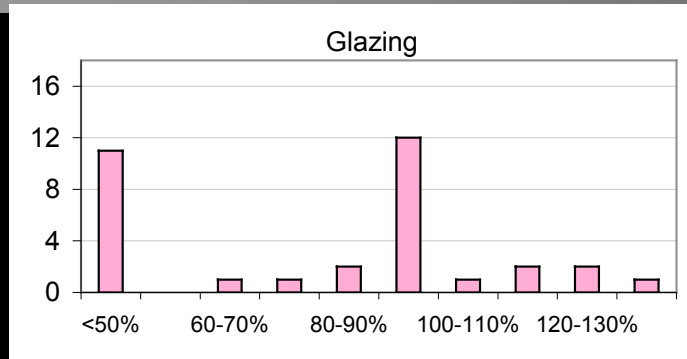
Windows	<ul style="list-style-type: none">✔ Look for specification of glass type✔ Verify key parameters (U, SHGC, VT)
Wall and roof insulation	<ul style="list-style-type: none">✔ Calculate overall U-value and compare with expected values
Daylighting control and other lighting control	<ul style="list-style-type: none">✔ Locate sensors and wiring on plans✔ Review control sequences
Lighting design	<ul style="list-style-type: none">✔ Count fixtures✔ Check lamp and ballast types✔ Check for fixture Watts✔ Calculate W/sq ft
Mechanical equipment	<ul style="list-style-type: none">✔ Check for equipment types and efficiencies
Mechanical controls	<ul style="list-style-type: none">✔ Check plans and schedules for key components✔ Review control sequences

Verification Process

Submittals and Site Visits

Windows	<ul style="list-style-type: none">➤ Look for specification of glass type in Submittals➤ Verify key parameters (U, SHGC, VT)
Wall and roof insulation	<ul style="list-style-type: none">➤ Check construction in Submittals➤ Recalculate overall U-value, if needed
Daylighting control and other lighting control	<ul style="list-style-type: none">➤ Locate sensors in site visit➤ Do functional test➤ Do logging of lighting power to show trends
Lighting design	<ul style="list-style-type: none">➤ Count fixtures on-site; check lamps and ballasts➤ Determine Watts of representative fixtures➤ Calculate W/sq ft
Mechanical equipment	<ul style="list-style-type: none">➤ Locate equipment in submittals and on-site➤ Record nameplate efficiencies
Mechanical controls	<ul style="list-style-type: none">➤ Check Submittals for key components➤ Review control sequences in Submittals➤ Conduct functional test where possible➤ Do logging where possible to verify operation

Frequency distribution of success rates



Number of Strategies

