ENERGY CENTER
OF WISCONSIN

Beyond Code, Beyond Design:
Expanding New Construction Program Impact

September 17, 2013

getting to zero national forum

Today's webinar

…with funding from

The Joyce Foundation

Today's webinar

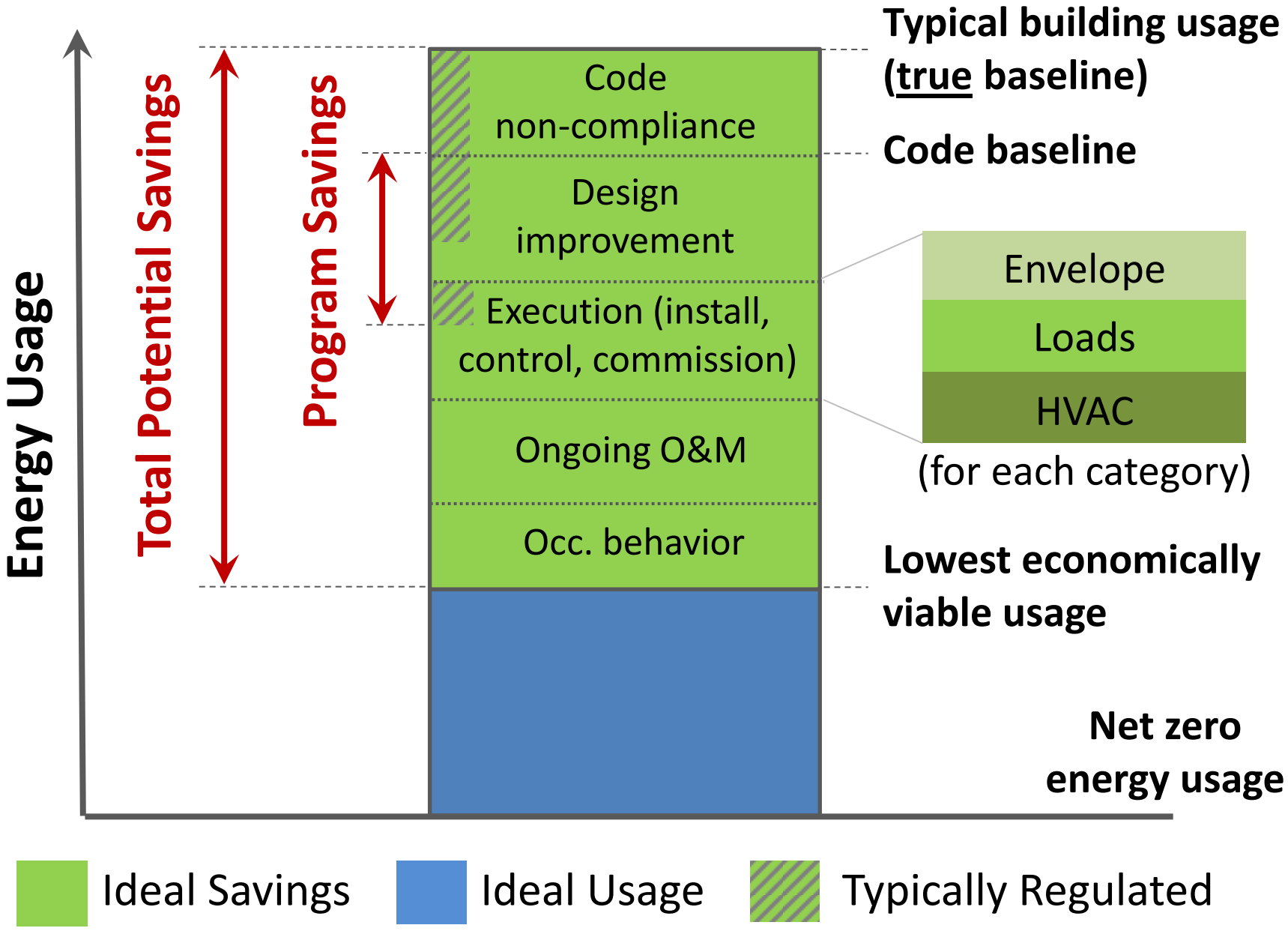
Background

Our study

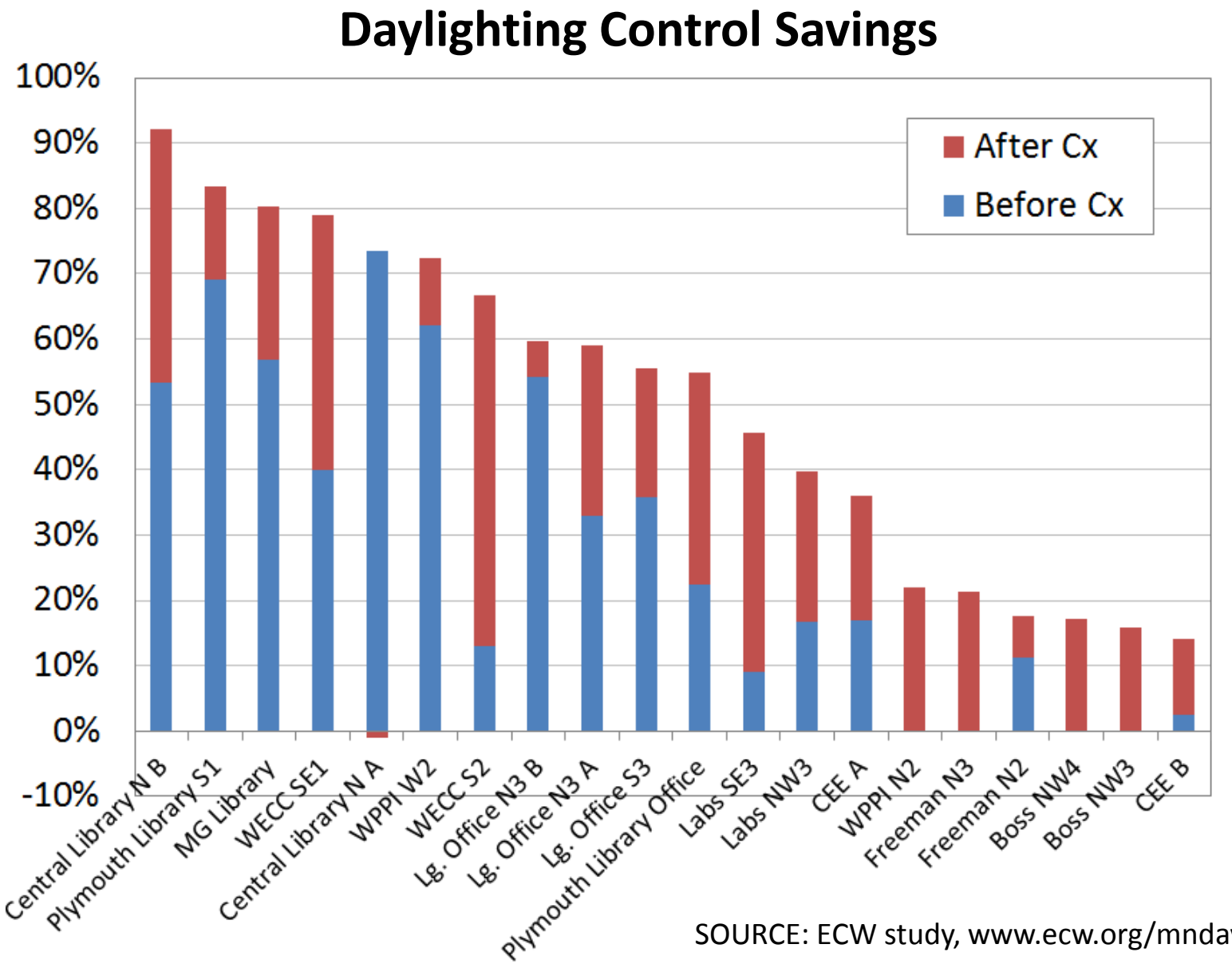
Opportunities and Risks

Program Considerations

Research framework



Evidence from the field…



SOURCE: ECW study, www.ecw.org/mndaylighting

Research hypothesis

Potential for significant additional energy savings are possible in areas not traditionally addressed by utility efficiency programs.

Understanding the magnitude of these different areas is a first step towards achieving them.

Lussier Community Education Center

- 11,000 square foot community center in Madison, WI
- Ground source heat pumps with energy recovery ventilation

OUR STUDY

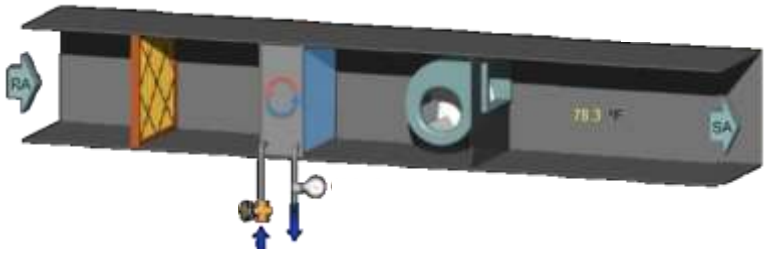
Plymouth Intergenerational Coalition

- 26,000 square foot community center in Plymouth, WI
- Packaged variable air volume systems with DX and boilers

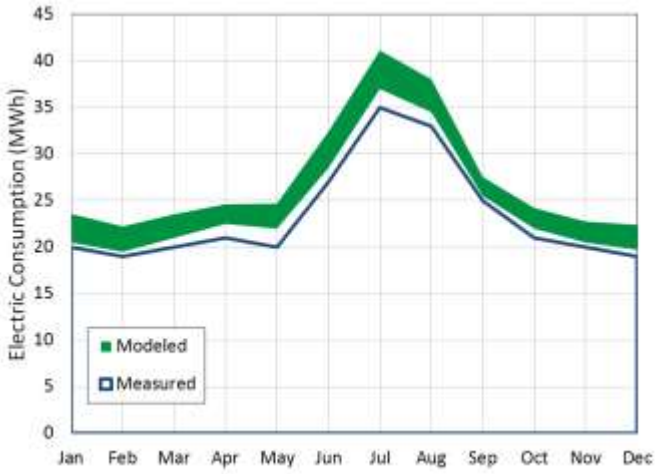
Data collection

- Design documentation
- Utility bills
- Walkthroughs
- Interviews

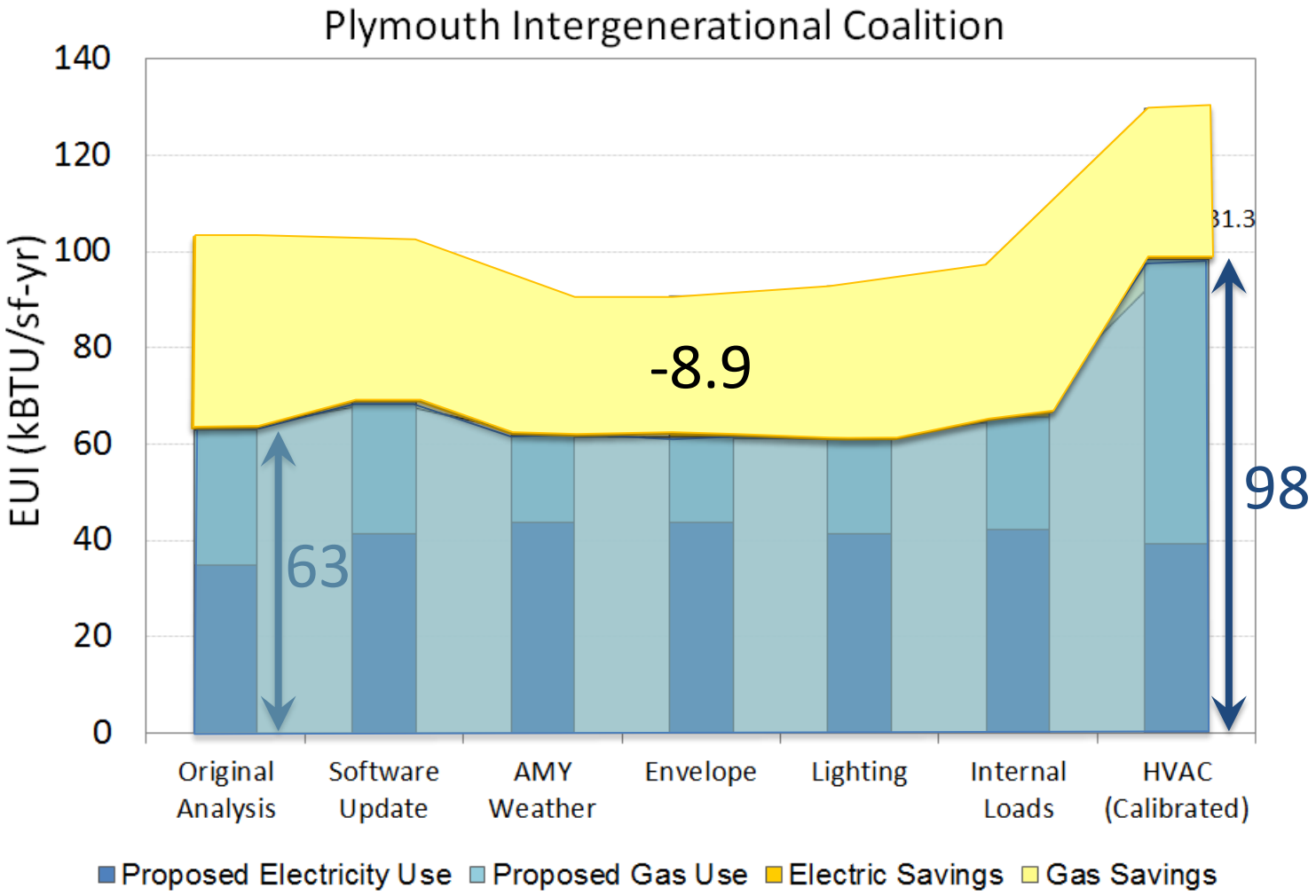
- Data logging
- BAS access and trending



Model Calibration

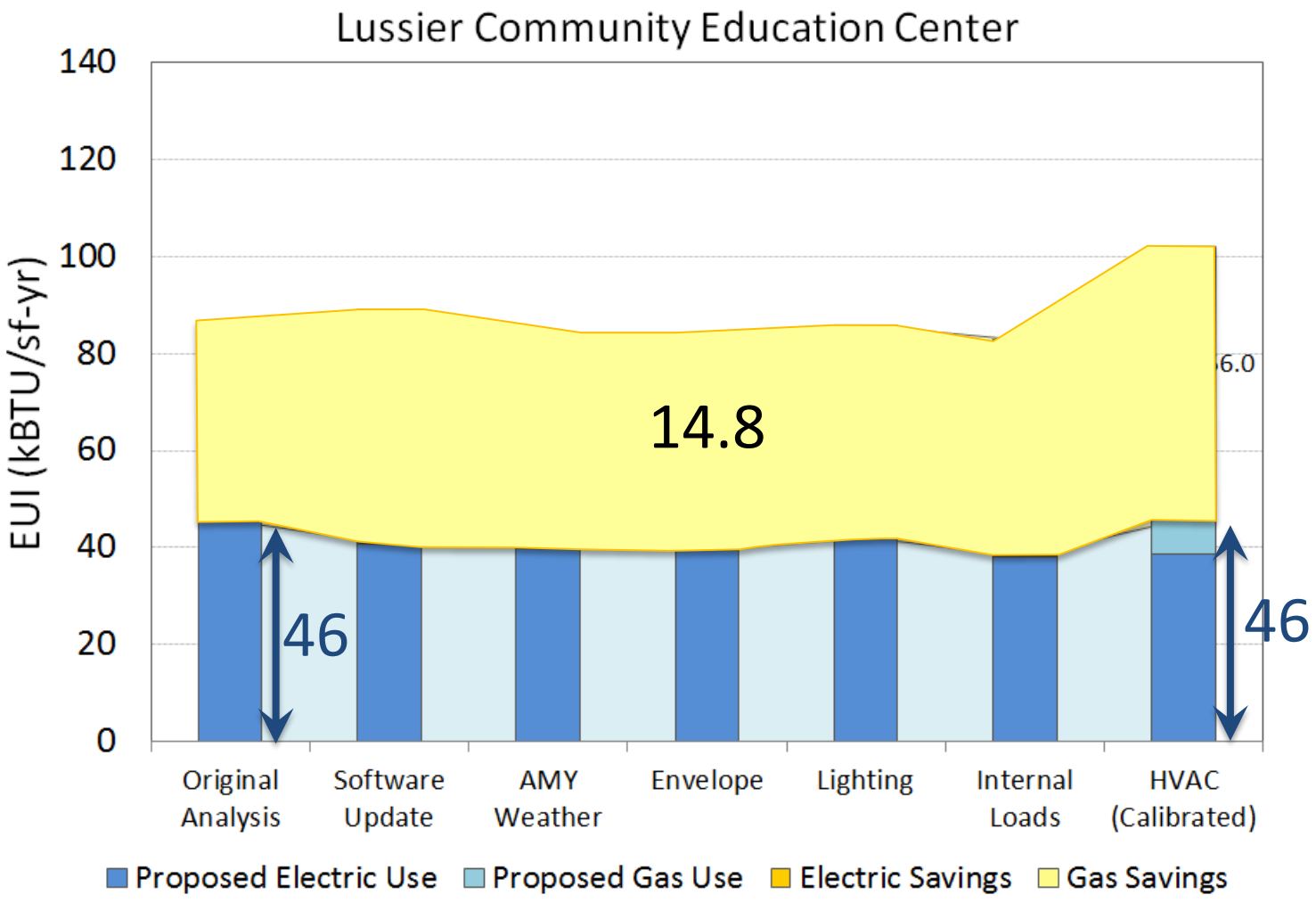


Modeling Savings



Actual measured EUI of 96

Modeling Savings



Actual measured EUI of 46

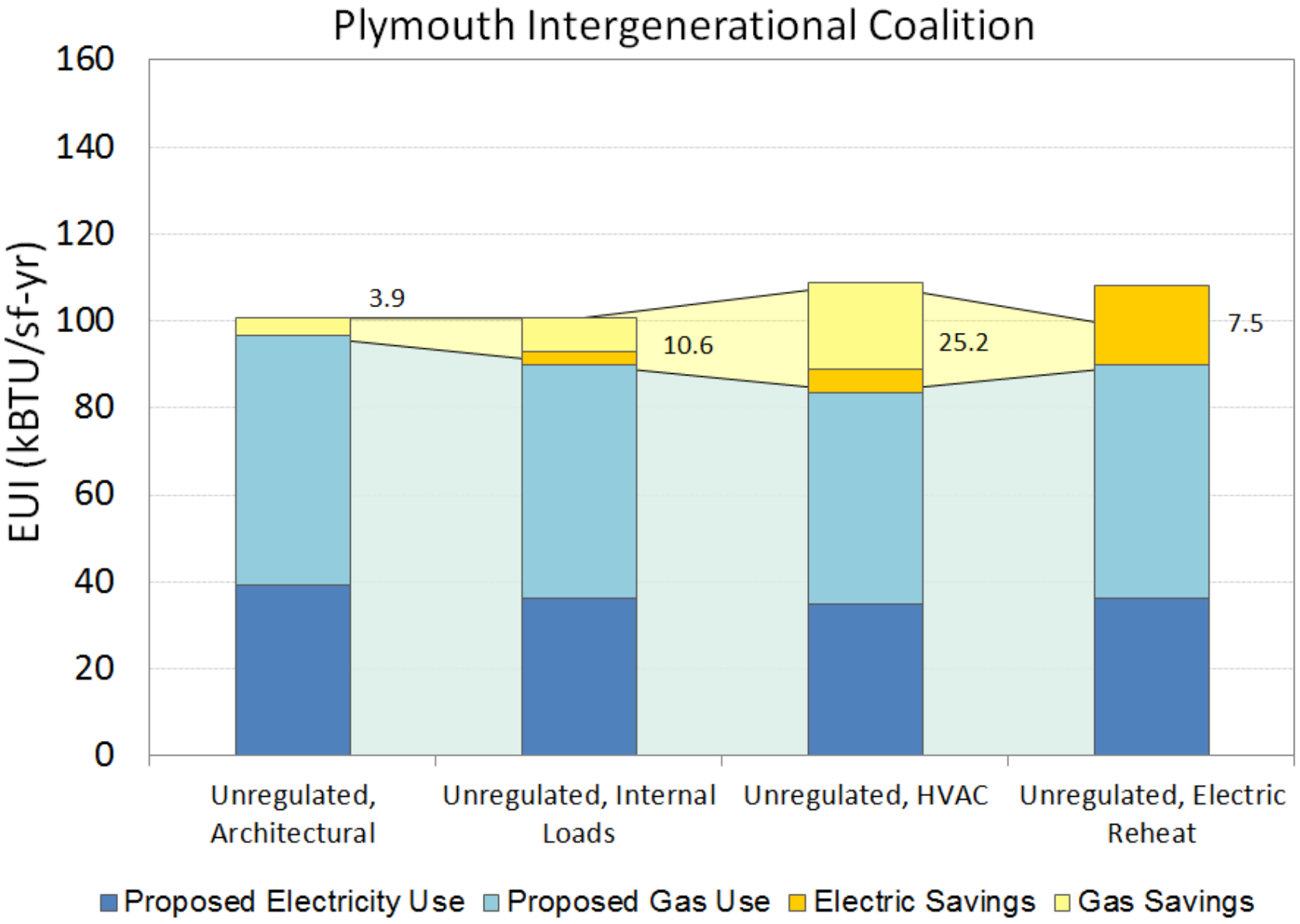
BEYOND CODE, BEYOND DESIGN: SENSITIVITIES

UNREGULATED SENSITIVITY

Unregulated Sensitivity

Category	Component	Description
ARCHITECTURE	Massing design	Use mass walls in place of wood-framed or steel-framed walls
	Infiltration reduction	Reduce infiltration through improved envelope and vestibules
	Glazing placement / size	Configure glazing in optimal configuration, less window area
INTERNAL LOADS	Plug load efficiency	Choose efficient plug-in equipment
	Kitchen	Energy Star kitchen equipment; variable speed exhaust hood; optimally placed hoods to reduce exhaust rates
HVAC	Ventilation rate	Lower design ventilation rates to code minimum
	Heating plant type**	Choose hot water instead of electric reheat
	Ground loop design and construction*	Design ground heat exchanger using best practices; target moderate operating temperatures (35-85 °F)
	Pump control*	Variable speed loop pumps; bypass ground loop optimally
	System Type*	Switch to higher performing system; RTUs to GSHPs
	Pump efficiency	Reduce pump power by selecting efficient pumps, right-sizing, and lowering system static pressure

Unregulated Sensitivity



EXECUTION SENSITIVITY

Execution Sensitivity

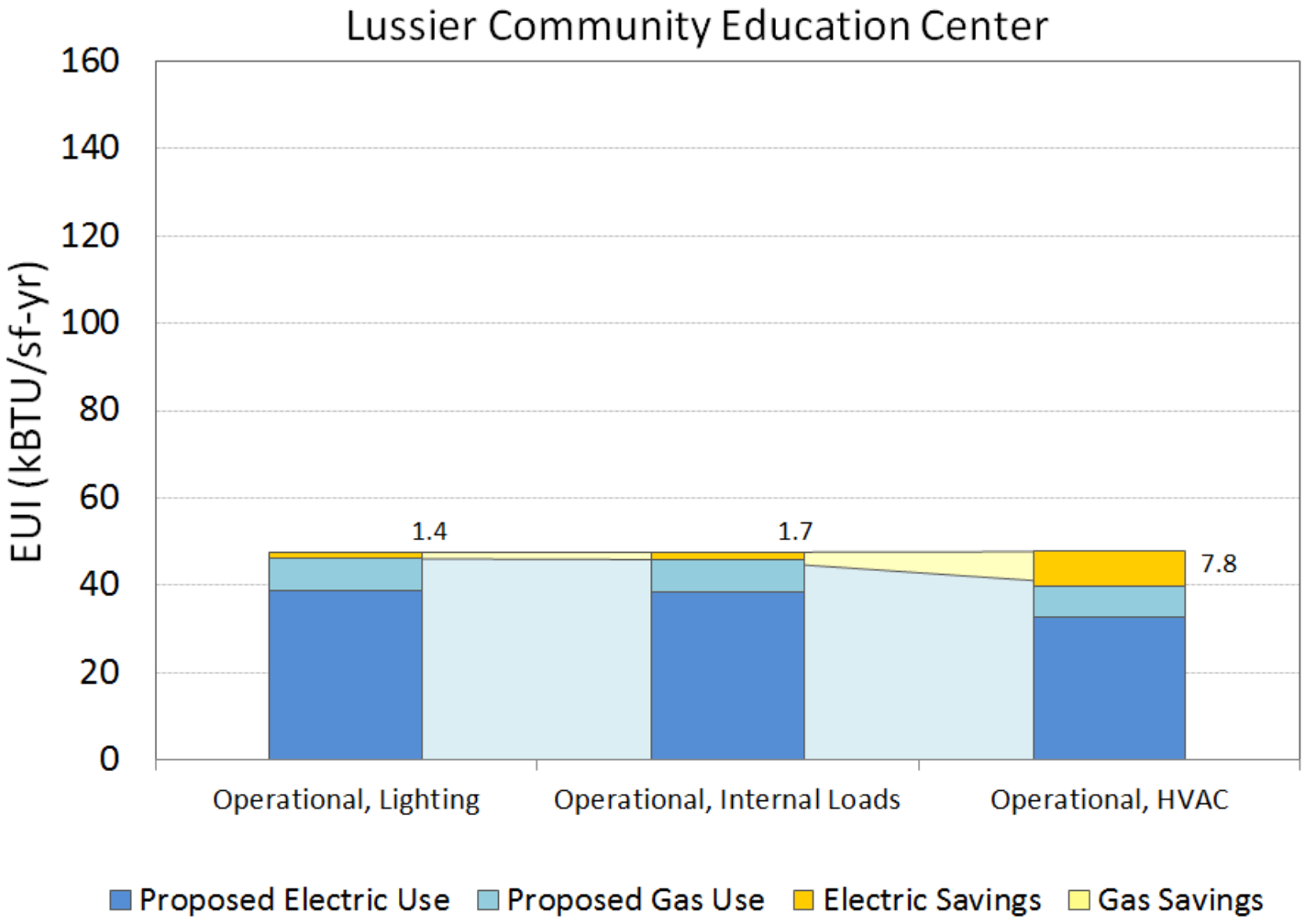
Category	Component	Description
ARCHITECTURE	Infiltration reduction	Reduce infiltration through proper installation
LIGHTING	Occupancy and Daylight Sensors	Properly commission occupancy controls and photosensors
HVAC	Ventilation rate	Commission outdoor air controls to ensure specified rates are delivered
	VAV system control, airflow and temperature**	Reset static pressure; balance system; set VAV box minimums; optimum supply air temperature, proper resets
	Energy Recovery Ventilation	Bypass ERV during economizer; proper modulation
	Heat pump fan operation*	Ensure intermittent fan operation during periods of no load
	Ground loop implementation*	Properly install ground heat exchanger using best practices; target moderate operating temperatures (35-85 °F)
	Demand control ventilation	Properly commission DCV controls to deliver specified rates at given CO2 levels
	Pump control	Ensure variable speed pumps are modulating effectively

OPERATIONAL SENSITIVITY

Operational Sensitivity

Category	Component	Description
LIGHTING	Occupancy sensors and Daylighting control	Maintain installed occupancy sensor and photosensor controls
INTERNAL LOADS	Plug load control	Institute networked computer power settings; maintain other equipment controls to use minimum power when not in use
HVAC	Cleanliness of filters, coils, other equipment	Keep coils, filters, and other equipment clean through proper maintenance
	Radiant heat control**	Avoid simultaneous heating and cooling of spaces
	Pump control	Maintain pump modulation and bypasses are operating effectively
	Heat pump maintenance*	Clean, tune, and check heat pump controls
	HW system operation**	Maintain resets, temperature setpoints, and modulation of flow
	Boiler maintenance**	Clean and tune boiler annually
	RTU maintenance**	Clean, tune, and check economizer operation

Operational Sensitivity

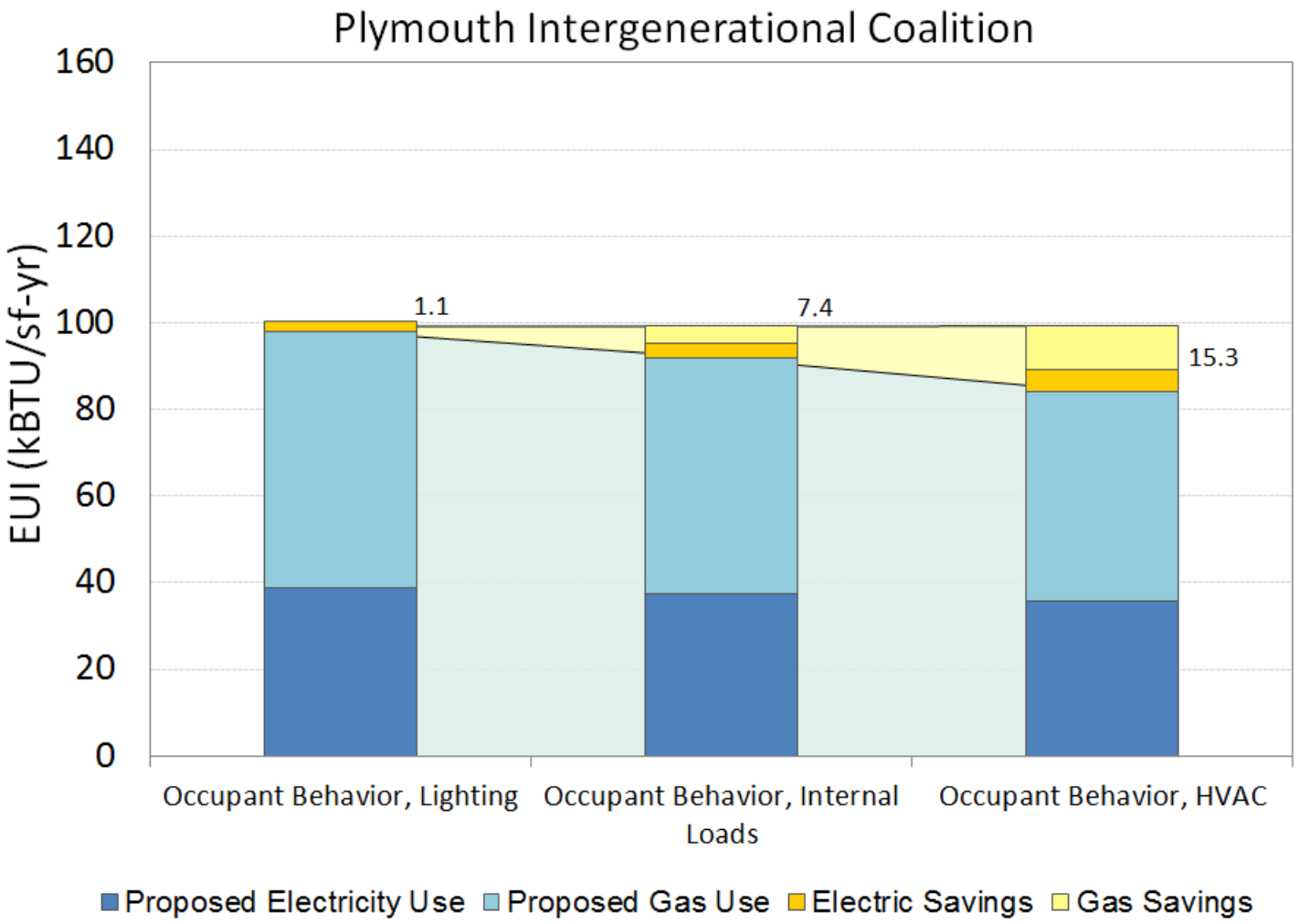


OCCUPANT BEHAVIOR SENSITIVITY

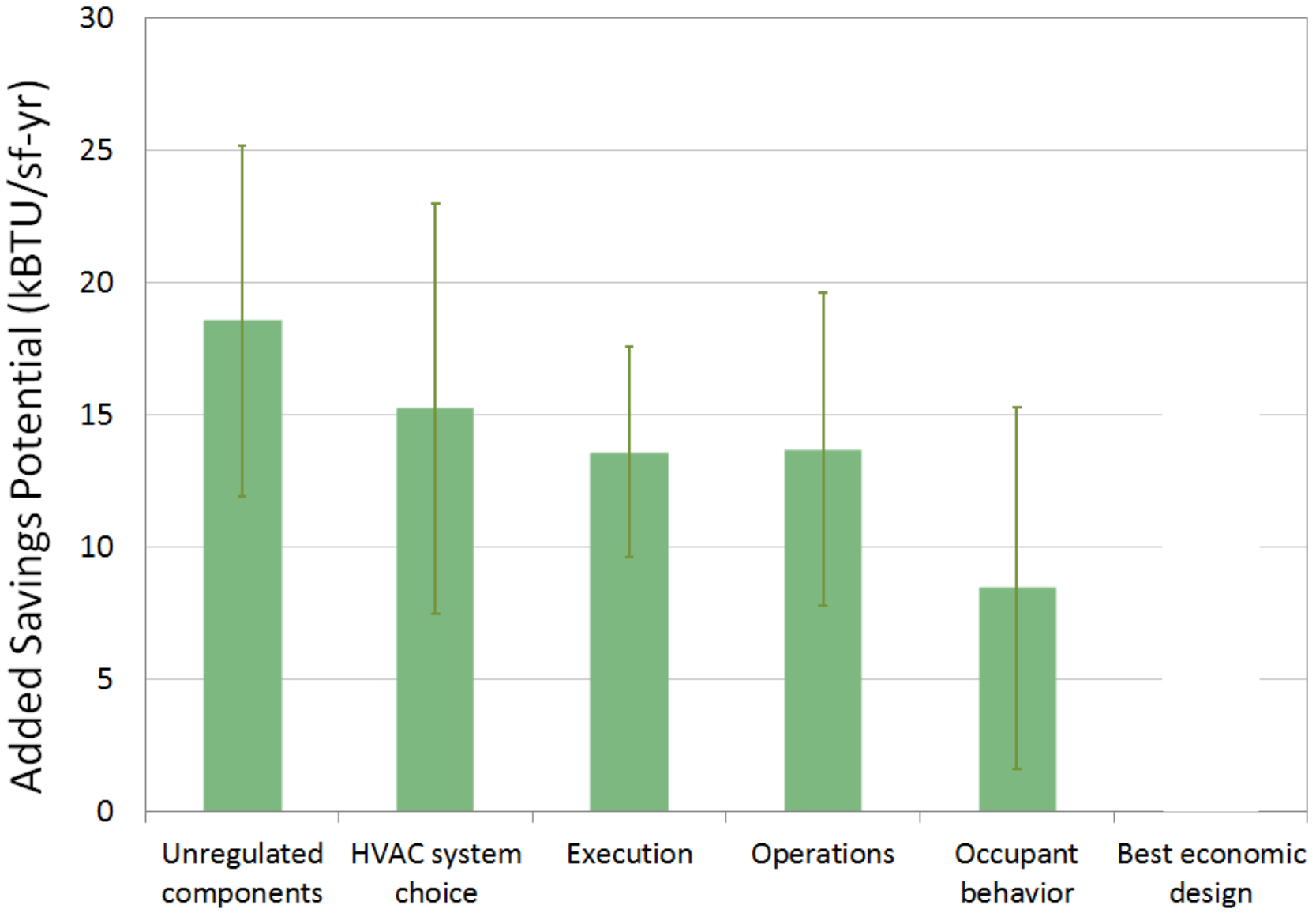
Occupant Behavior Sensitivity

Category	Component	Description
LIGHTING	Occupancy sensors and Daylighting control	Educated occupants do not override occupancy sensoror photosensor controls; manually turn off lights when not occupied or sufficient natural light
INTERNAL LOADS	Plug load control	Educated occupants do not override power settings, manually turn off equipment when not in use
	Kitchen hood	Educated kitchen staff only run hoods when needed
HVAC	Space temperature setpoints	Educated occupants do not override temperature setpoints and setbacks

Occupant Behavior Sensitivity



Results summary



WHAT CAN PROGRAMS OR DESIGN TEAMS DO TO CAPTURE THESE SAVINGS?

Recommendations

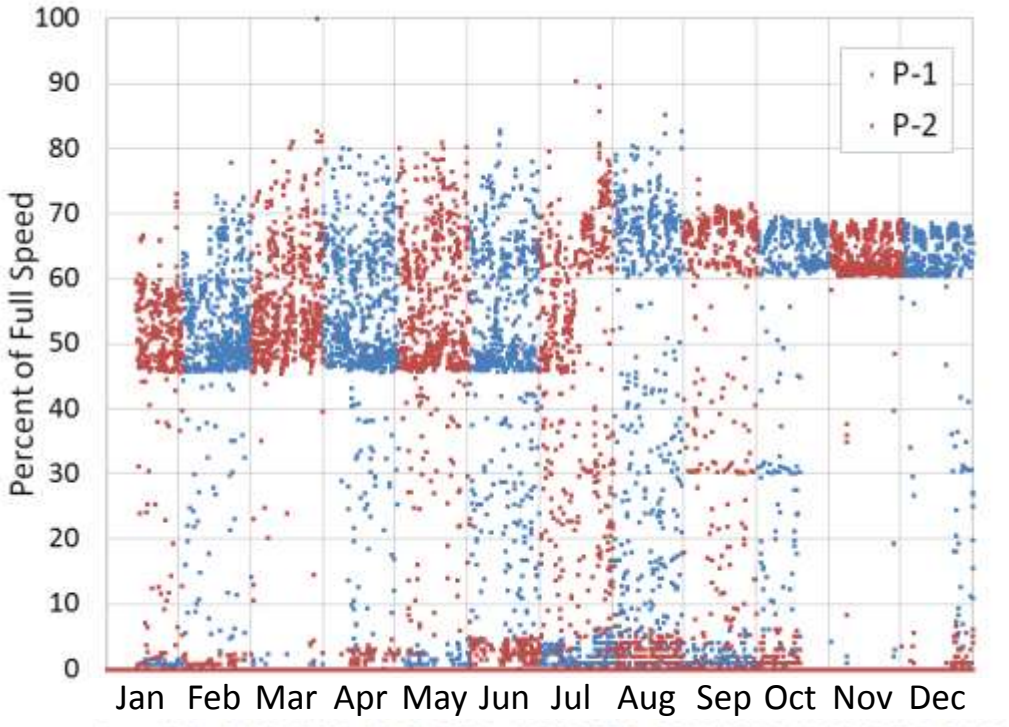
- Model more realistic usage, control, etc.
- Address unregulated components.
- Incorporate quality control in execution.
- Incorporate building operation improvement.
- Influence occupant behavior.

Realistic usage

- Calibration showed generally accurate *models*
  - With consideration for software limitations
- But the inputs…

…could incorporate more realistic building usage

  - Add consideration for imperfect HVAC operation
  - Include estimates where calculations are not available

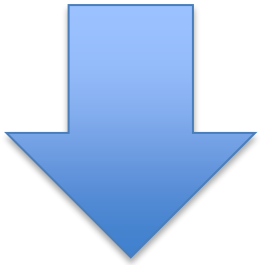


Unregulated components

- Create baselines for key components:
  - Architectural
    - glazing placement, ...
  - Internal loads
    - plug load equip., kitchen design, …
  - HVAC
    - zoning, ventilation rates, temperature setpoints, …
    - **Baseline HVAC system type**

Execution

- Elimination of thermal breaks and air leaks
- Lighting controls calibration
- Proper HVAC programming (e.g. DCV)
- Optimal VAV system balancing



Commissioning

Operation / Behavior

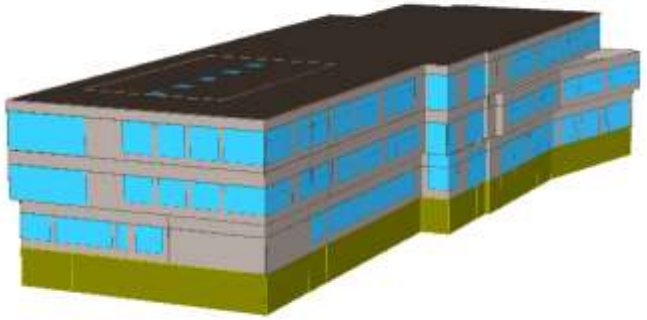
- Significant potential from execution / operation / behavior
- Suggests a second focus point for NC programs: end of construction → occupied
  - Training, provided or required
  - Training focused on HVAC controls
  - Informational materials
    - Maintenance of high performance components
    - How occupants can save energy

Courtesy NREL

- Would require deeming savings for training

Key Takeaways

For substantial savings increases:



Expand program scopes.

1. Expand baseline: HVAC system type, zoning, ventilation rates, etc.

2. Influence beyond design through commissioning, training, etc.

Courtesy NREL

THANK YOU

For more information…

Learn about our work

ecw.org/buildings

Download the study

ecw.org/ecwresults/267-1.pdf

Contact us

shackel@ecw.org · 608.210.7129

sschuetter@ecw.org · 608.210.7149

Energy benchmarking

	Units	Similar	LCEC	PIC
Electricity Usage	kWh/ft^2	12.8	11.4	10.8
Peak Electric Demand	W/ft^2	4.7	4.8	4.5
Natural Gas Usage	$therm/ft^2$	0.55	0.07	0.59
Energy Utilization Index	$kBtu/ft^2$	99	46	96

- Similar building usage derived from CBECS data.
- Represents 2003 building stock

Additional resources

- **Model Calibration:** ASHRAE Guideline 14
- **NC Program Listings:** DSIREUSA.org
- **Energy Policy Research:** New Buildings Institute
- **U.S. Building Energy Information:** Commercial Building Energy Consumption Survey
- **Energy Efficiency Guidance:** Advanced Buildings Core Performance Guide
- **Lussier Center's Energy Stewards:** http://www.energystewards.net/lussier/

Unregulated components

- Baseline HVAC system type**:** a framework, with judgement

With the program involved:

1. Prior to any system decision
2. With multiple options, or VE potential
3. After system type specified

Baseline System

Typical system for region (Appendix G only a starting point)	Least efficient option discussed (repeat for secondary systems)	Chosen system type

Scenario and sensitivity summary

Description		EUI Savings (kBTU/ft^2)	EUI Savings (%)
Scenarios	Adjusted Baseline	12.3	1%
	Best Practice	12.0	10%
Sensitivities	Unregulated	18.6	25%
	Unregulated, System Switch	42.0	37%
	Execution	13.6	19%
	Operational	13.7	18%
	Occupant Behavior	8.4	9%