FEDERAL UTILITY PARTNERSHIP WORKING GROUP SEMINAR

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What We've Learned From a Challenging Efficiency Goal

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Hosted by:

FEMP Federal Energy Management Program

CenterPoint Energy

“And when I challenged colleges to reduce their energy use 20 percent by 2020, UC Irvine went ahead and did it last year. Done! So UC Irvine is ahead of the curve.”

President Barack Obama
UCI Commencement
June 14, 2014

What is a feasible energy efficiency goal?

Facility Type	Goal
Laboratory building systems	50%
Classroom and office buildings	50%
Data centers	50%
Housing/residence halls	40%
Modular buildings	50%
Interior illumination	50%
Parking lots and structures	50%
Other exterior illumination	50%
Central plant/energy infrastructure	15%

Reasons >50% Savings are Possible

- ~~Perhaps UC Irvine was extremely inefficient?~~
- ~~Do universities have buildings that are unusually inefficient?~~
- Buildings' energy systems are designed to waste more energy than we realized
  - Energy is "almost free"
  - Over-design adds a "margin of safety"
  - Building systems are not "smart"

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More Technical Reasons
>50% Savings are Feasible

- Older, non-dynamic systems operated at fixed volumes/levels/speeds/temperatures
- Prior to digital controls and sensors, an extra “margin of safety” was needed
- Energy to pump water and air is non-linear
- Re-heat is excessive when air changes are unnecessarily high
- Building energy systems design practices have enormous momentum!

What is a "smart" energy system?

- Just enough, at just the right time!
- "Information layer" as important as control features themselves

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Results

Where did we start?

Laboratory Building		BEFORE Smart Lab Retrofit		
Name	Type [1]	Estimated Average ACH	VAV or CV	More efficient than code?
Croul Hall	P	6.6	VAV	~ 20%
McGaugh Hall	B	9.4	CV	No
Reines Hall	P	11.3	CV	No
Natural Sciences 2	P,B	9.1	VAV	~20%
Biological Sciences 3	B	9.0	VAV	~30%
Calit2	E	6.0	VAV	~20%
Gillespie Neuroscience Research Facility	M	6.8	CV	~20%
Sprague Hall	M	7.2	VAV	~20%
Hewitt Hall	M	8.7	VAV	~20%
Engineering Hall	E	8.0	VAV	~30%
Averages		**8.2**	**VAV**	**~20%**

Type: P = Physical Sciences, B = Biological Sciences, E = Engineering, M = Medical Sciences

- All of these are existing buildings
- Multiple types of science represented
- Starting air change rates often higher than we expected
- Mix of mechanical system designs
- Most buildings were already very efficient

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Smart Building

Just enough energy at just the right time!

How:

– Challenge all accepted design practices

– Use software and sensors to make building systems dynamic and “smart”

– Whole building retrofits enable energy savings >50%

Smart Lab Key Elements

1. Retrofit constant volume to variable-air volume
2. Optimize safe air-change rates with real-time air quality sensing
3. Improve lighting efficiency and efficacy
4. Optimize exhaust systems including fan discharge airspeed
5. Reduce pressure drops throughout system
6. Optimize fume hood standby ventilation
7. Continuously commission

Smart Labs Resources

- Boston Green Labs Symposium Videos
  http://green.harvard.edu/campaign/green-labs-symposium
- UC Irvine Smart Labs Initiative
  http://www.ehs.uci.edu/programs/energy/

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UC Irvine's Smart Labs Initiative

Laboratory Building		BEFORE Smart Lab Retrofit			AFTER Smart Lab Retrofit		
Name	Type[1]	Estimated Average ACH	VAV or CV	More efficient than code?	kWh Savings	Therm Savings	Total Savings
Croul Hall	P	6.6	VAV	~ 20%	48%	40%	40%
McGaugh Hall	B	9.4	CV	No	57%	66%	59%
Reines Hall	P	11.3	CV	No	67%	77%	69%
Natural Sciences 2	P,B	9.1	VAV	~20%	48%	62%	50%
Biological Sciences 3	B	9.0	VAV	~30%	45%	81%	53%
Calit2	E	6.0	VAV	~20%	46%	78%	58%
Gillespie Neuroscience Research Facility	M	6.8	CV	~20%	58%	81%	70%
Sprague Hall	M	7.2	VAV	~20%	71%	83%	75%
Hewitt Hall	M	8.7	VAV	~20%	58%	77%	62%
Engineering Hall	E	8.0	VAV	~30%	59%	78%	69%
Averages		**8.2**	**VAV**	**~20%**	**57%**	**72%**	**61%**

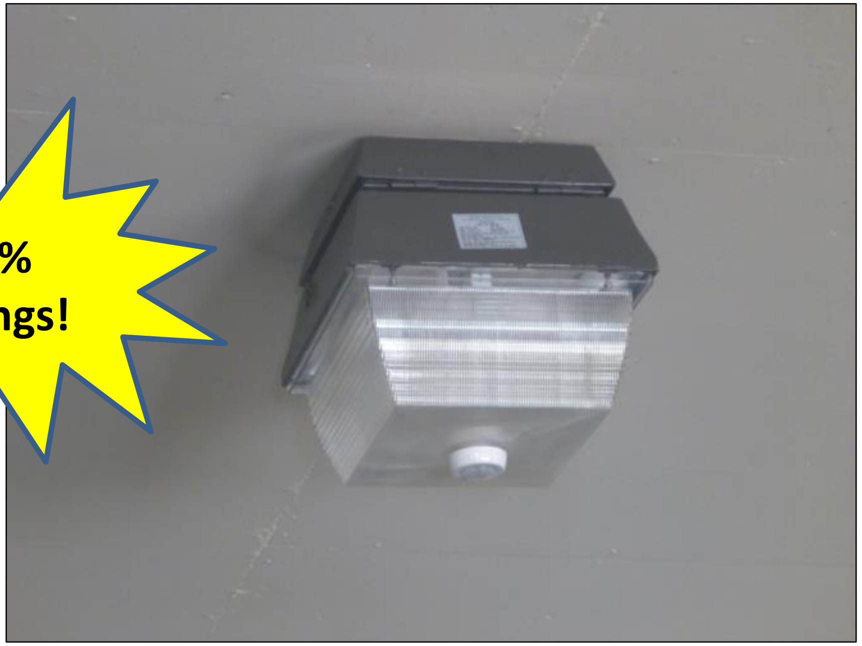
Type: P = Physical Sciences, B = Biological Sciences, E = Engineering, M = Medical Sciences

Parking Structure Lighting

Old = Metal-halide

New = Induction
(magnetic fluorescent)

78% savings!



210 watts x 8,760 hours = 1,840 kWh/per fixture per year

40 watts x 4,984 hours = 199 KWh
85 watts x 2,345 hours = 199 kWh

Total = 398 kWh/per fixture per year

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Street and Parking Lot Lighting

NEW Bi-Level Lighting
Light Emitting Diode (LED)

OLD
High Pressure Sodium (HPS)

62 watts x 1,402 hours = 87 kWh
32 watts x 2,978 hours = 95 kWh

Total = 182 kWh/per fixture per year

295 watts x 4,380 = 1,292 kWh/per fixture per year

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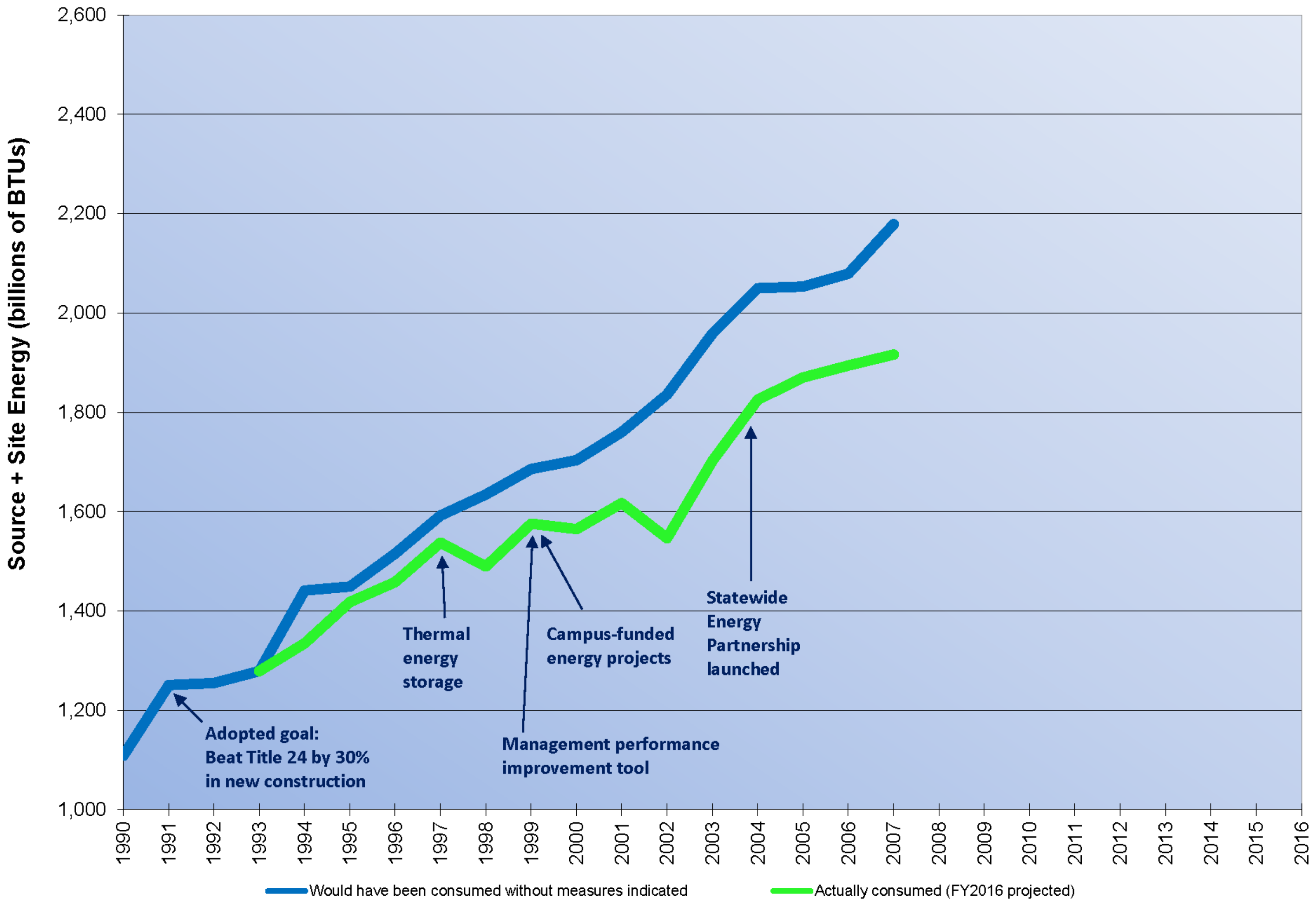
What is a feasible energy efficiency goal?

Facility Type	Goal	Actual
Laboratory building systems	50%	61%
Classroom and office buildings	50%	50% (pilot)
Data centers	50%	TBD 2016
Housing/residence halls	40%	23%
Modular buildings	50%	TBD 2016
Interior illumination	50%	60%
Parking lots and structures	50%	79%
Other exterior illumination	50%	60%
Central plant/energy infrastructure	15%	25% and rising

Plugged In


The cost to a homeowner of
keeping electronic devices
like these plugged in and
ready to use approaches
$600 a year.

Two Decades of Energy Efficiency at UCI



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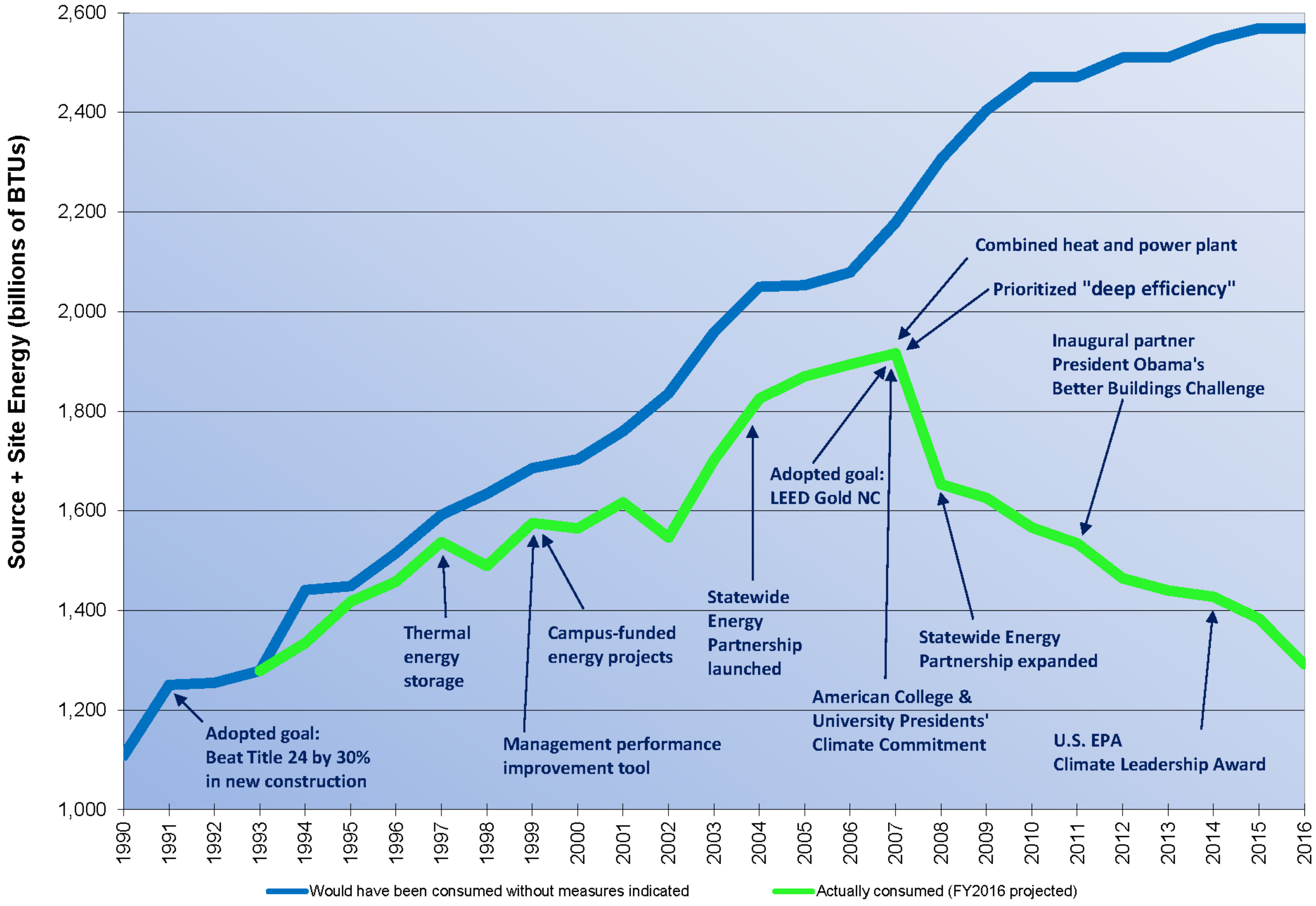
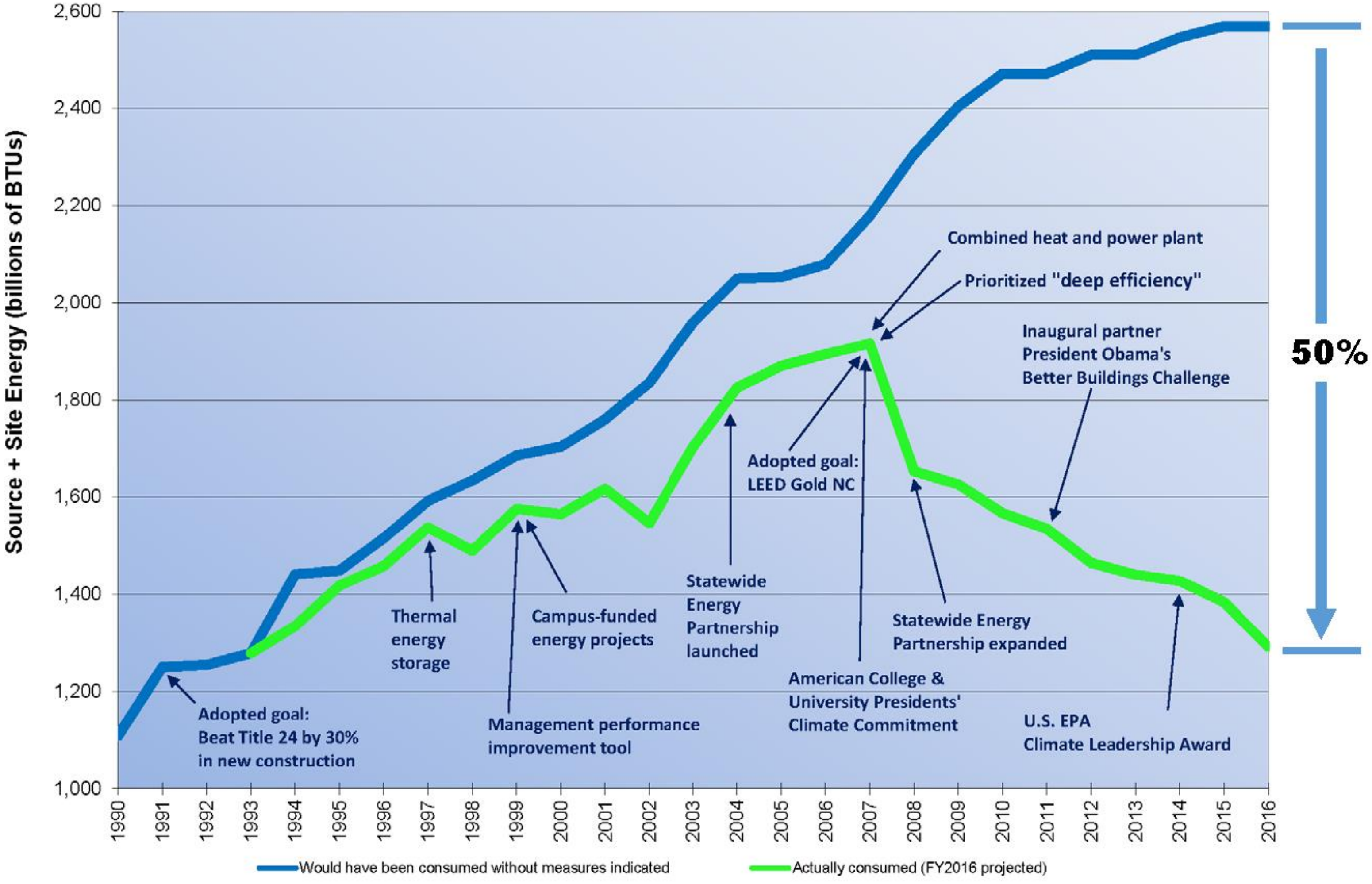
Two Decades of Energy Efficiency at UCI



UC Irvine

Two Decades of Energy Efficiency



Co-Benefits of “Deep” Energy Efficiency Program

- Deferred maintenance
- Better information
  - Air quality longitudinal data
  - No need for periodic commissioning
  - Data to understand and target more opportunities
- Reduced wear and failure rates for fan motors and bearings
- Less re-lamping labor
- Cleaner air in laboratories, classrooms, and offices
- Avoided costs of expanding energy infrastructure, e.g., central plant

Critical Path Steps to Exemplary Performance

1. Get the organizational culture ready
2. Adopt a challenging goal
3. Understand true potential of “smart” buildings
4. Develop a scalable strategy
5. Pilot new concepts initially
6. Use “information layer” to verify and sustain performance
7. Foster breakthrough thinking
    - ✓ Challenge status quo
    - ✓ Question accepted limits
    - ✓ Think comprehensively: re-engineer whole systems
    - ✓ That is, whole building energy retrofits
8. Prioritize “deep” energy efficiency projects (i.e., >50% savings)

Performance Improvement Resources

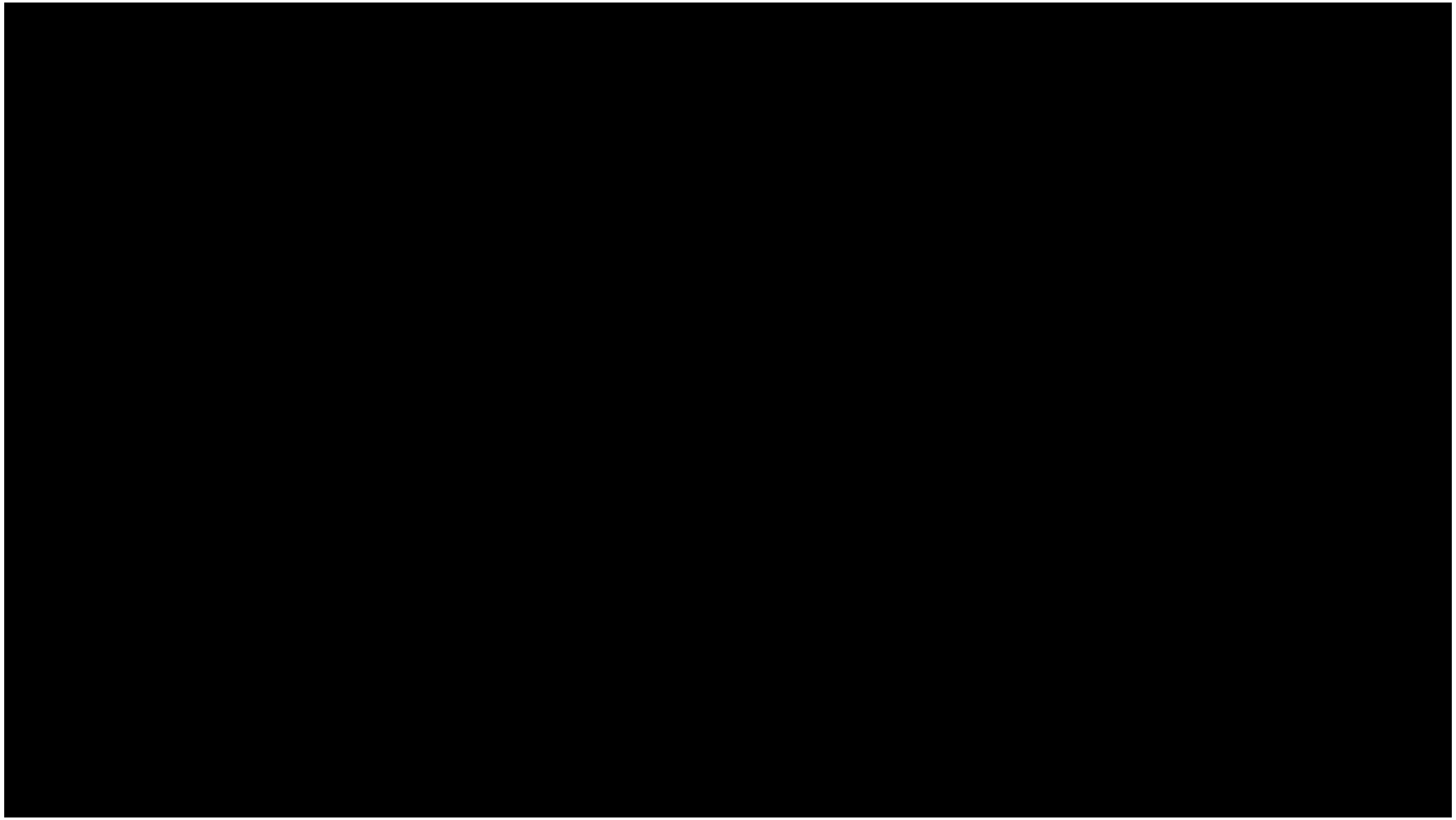
- Sustainable Performance Improvement

  http://www.abs.uci.edu/resources/sustainable.html

- Better Buildings Challenge Implementation Model

  http://betterbuildingssolutioncenter.energy.gov/implementation-models/empowering-managers-help-teams-meet-big-goals

Intelligent Adaptive Street Lighting



Questions?

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