



# Future Proofing Energy Efficiency with Networked Lighting Controls

Levin Nock, PhD

September 6, 2023

# What we are hearing

Lighting incentive programs are going away.

With LED lighting, controls don't save enough additional energy to matter.

Energy efficiency is all about heat pumps now, not lighting

A photograph showing a person's hands reaching up towards a modern, recessed ceiling light fixture. The ceiling is composed of white acoustic tiles with a dark metal grid. The light fixture is a long, narrow, recessed strip light that is illuminated, casting a bright glow. The hands are positioned on either side of the light fixture, with fingers slightly curled as if reaching towards it. The overall scene is brightly lit, emphasizing the efficiency of the lighting fixture.

**Lighting is more efficient.**



**Inexpensive solar energy  
competes with energy efficiency  
in utility budgets.**





# Renewable energy will make energy efficiency more valuable

## ENERGY EFFICIENCY IN A HIGH RENEWABLE ENERGY FUTURE

Mike Specian and  
Aimee Bell-Pasht

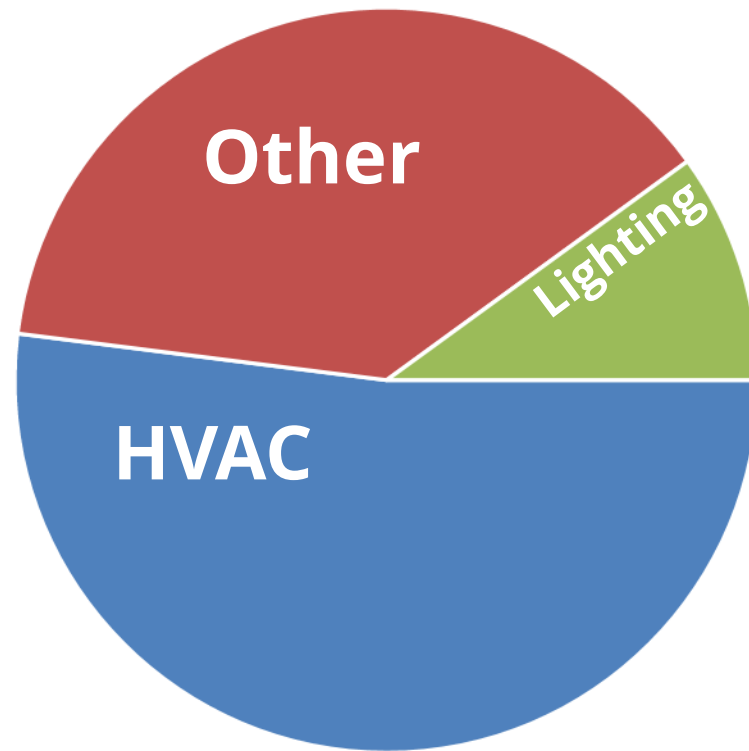
June 2023  
ACEEE Report

**ACEEE**  
Smart Energy. Clean Power. Better Lives.



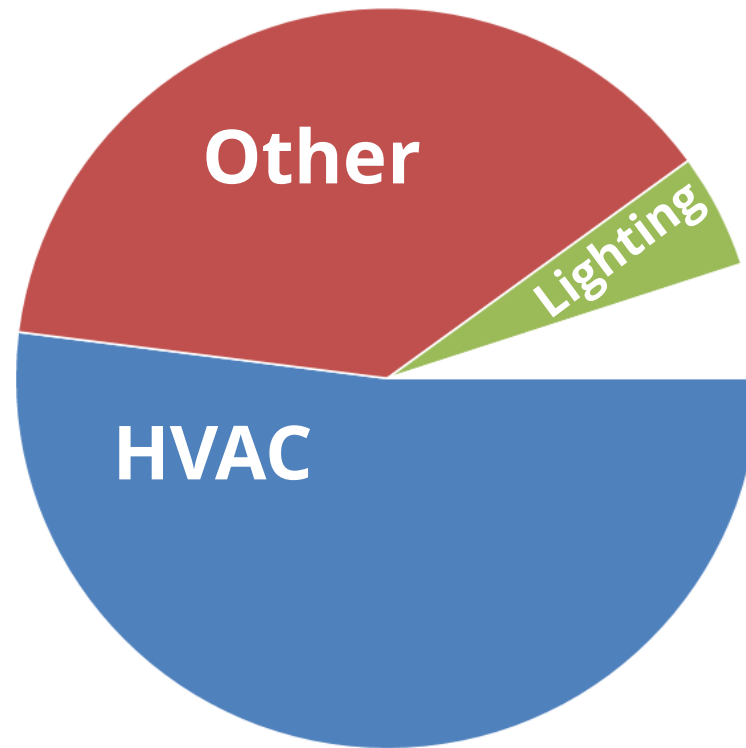
Energy · Quality · Controllability<sup>SM</sup>

# Can Networked Lighting Controls save significant energy?



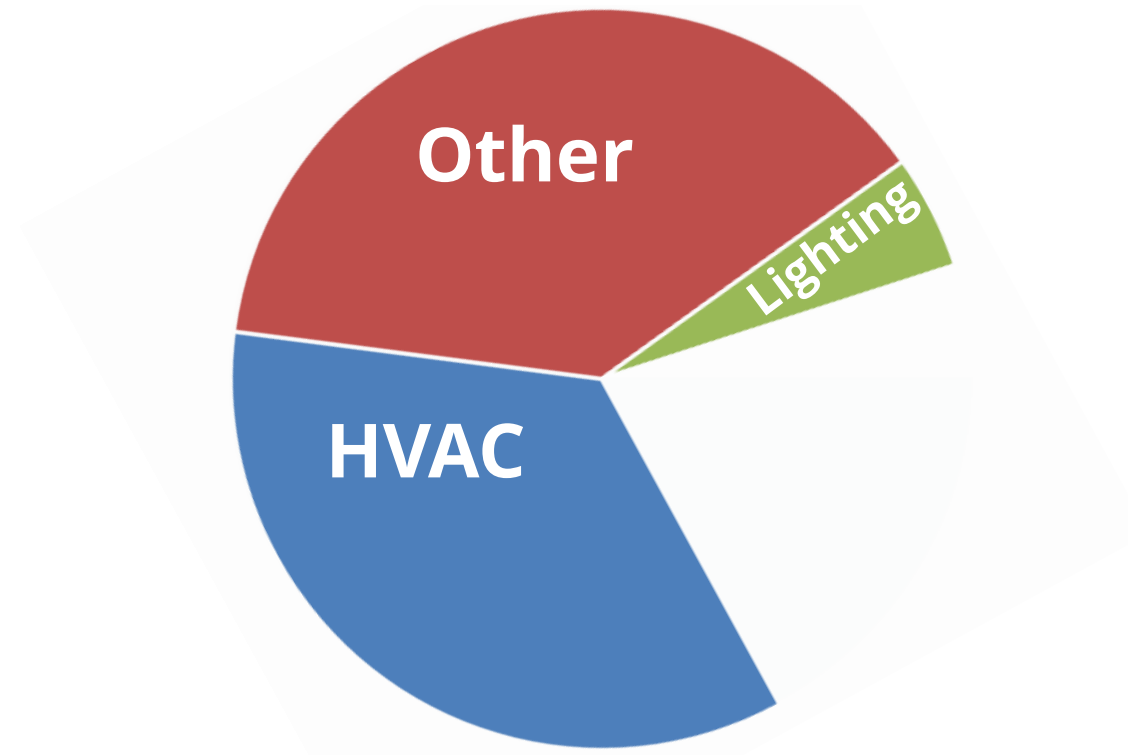
Energy Usage in US Commercial Buildings, 2018

# Can Networked Lighting Controls save significant energy?



When you update the lighting, adding NLC to a typical commercial building can save half of the lighting energy

# Can Networked Lighting Controls save significant energy?



When you update the lighting, adding NLC integrated with HVAC can save half of the lighting energy PLUS 30% of the HVAC energy





**Are NLC incentives good investments for utilities?**

Are NLC's good  
investments  
for building  
owners?

**Out of  
scope**





# Computer model of energy savings potential to 2030



When lighting is updated

- + NLC (S/M/L)
- + Demand Response (S/M/L)
- + Plug Load (M/L)
- + HVAC (L)

LED controls-ready now

- + NLC etc. later



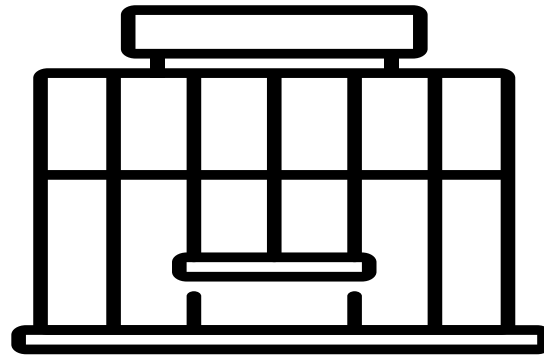
25,000 sq ft

50,000 sq ft

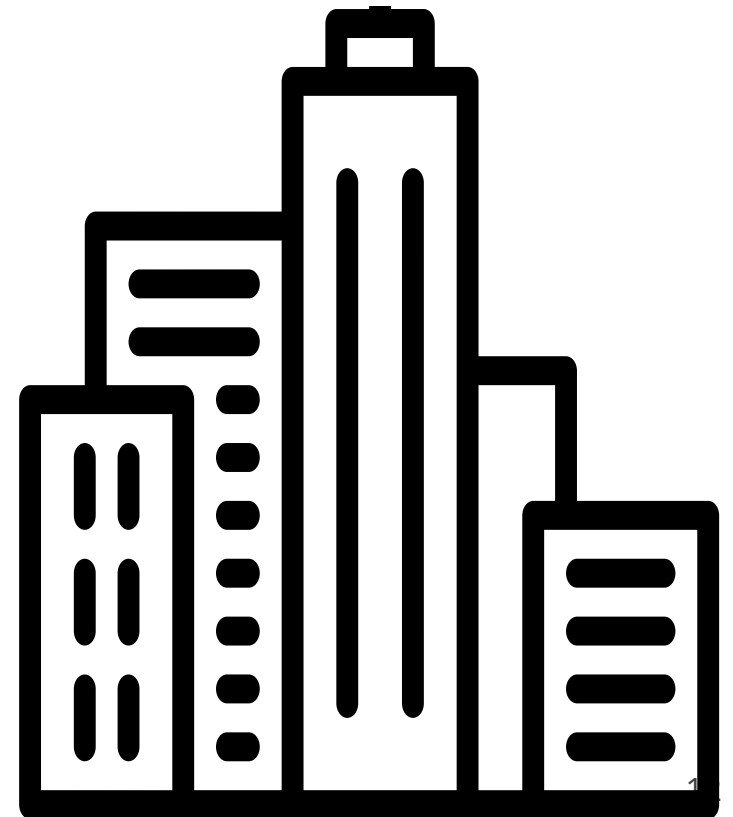
Small



Medium



Large



**Many large buildings are suitable for NLC-HVAC integration; not all.**

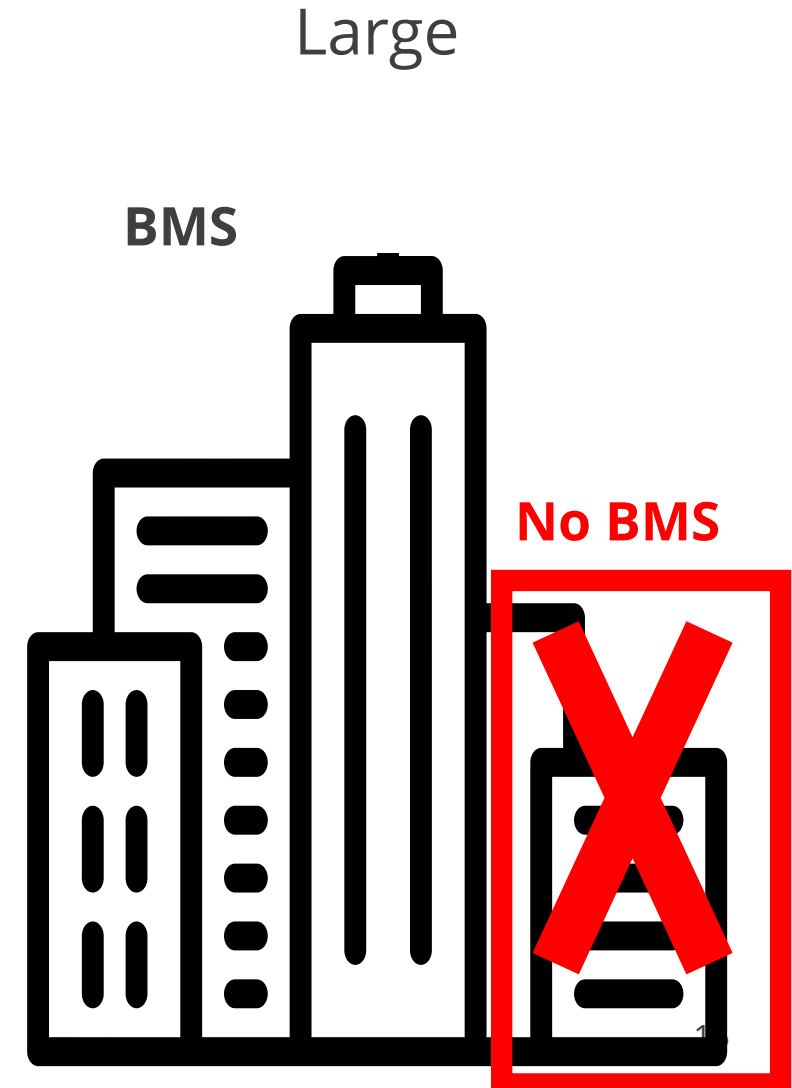
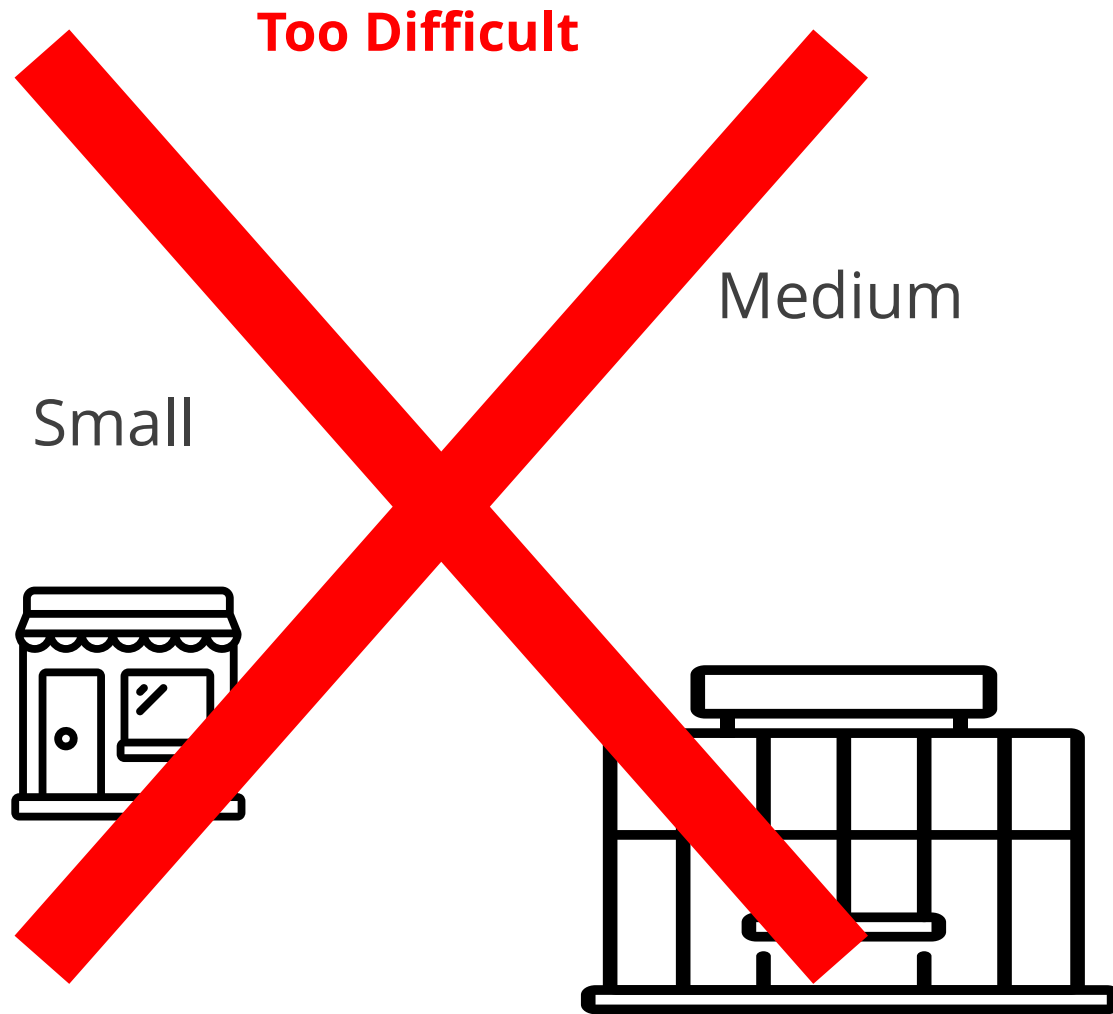


# Suitable Buildings

- Building type
- Variable occupancy
- HVAC zones not too large
- BMS or digital HVAC controls
- Variable Air Volume (VAV) design
- Large enough for customized software



# NLC-HVAC integration



**With additional sponsorship,  
this analysis could be  
applied to other regions.**

Contact: [info@designlights.org](mailto:info@designlights.org)



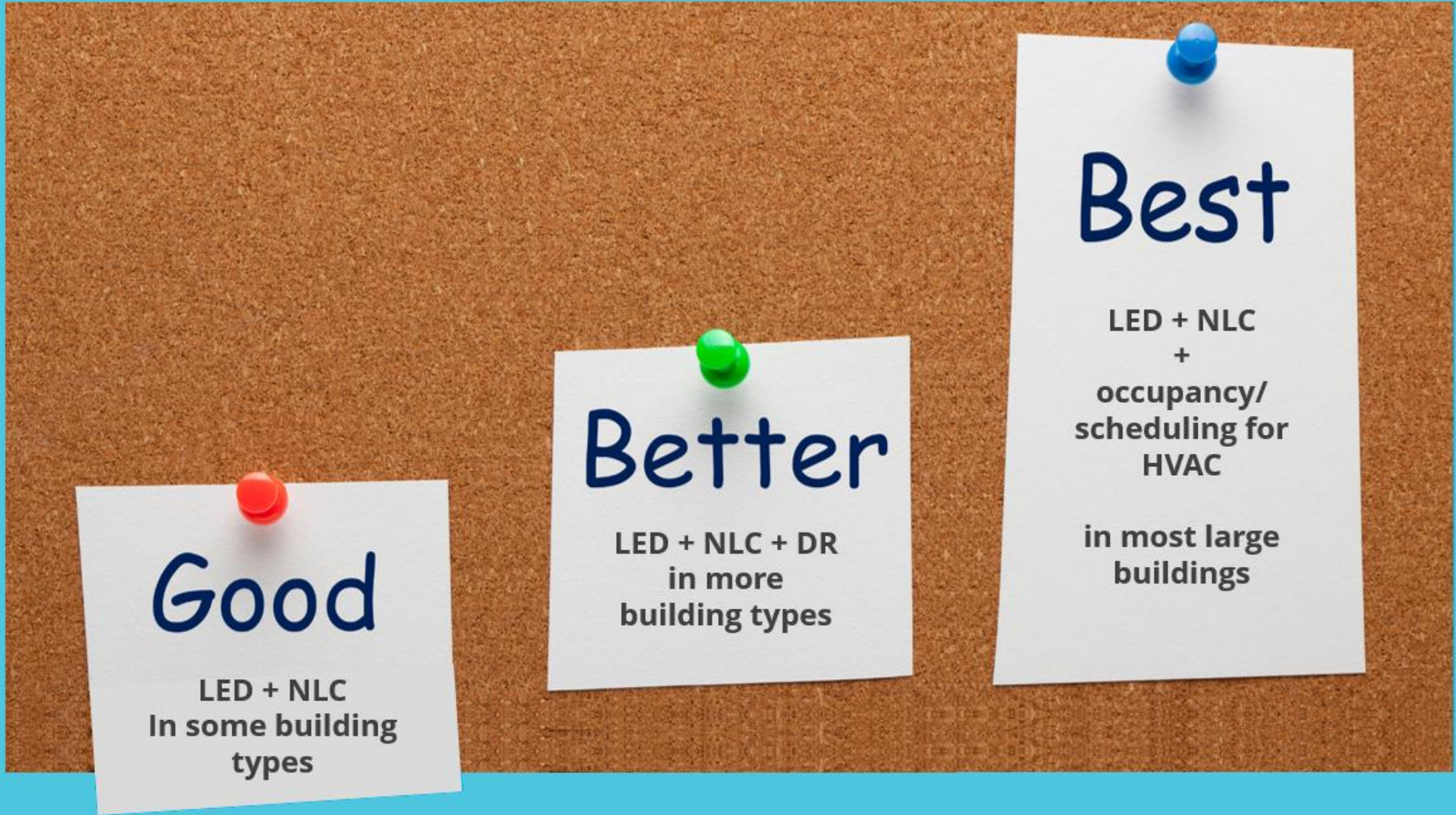
# Results Part 1

**When lighting is updated**

- + NLC (S/M/L)**
- + Demand Response (S/M/L)**
- + Plug Load (M/L)**
- + HVAC (L)**



# What makes incentives for NLC a sound investment?



## Good

LED + NLC  
In some building  
types

## Better

LED + NLC + DR  
in more  
building types

## Best

LED + NLC  
+  
occupancy/  
scheduling for  
HVAC

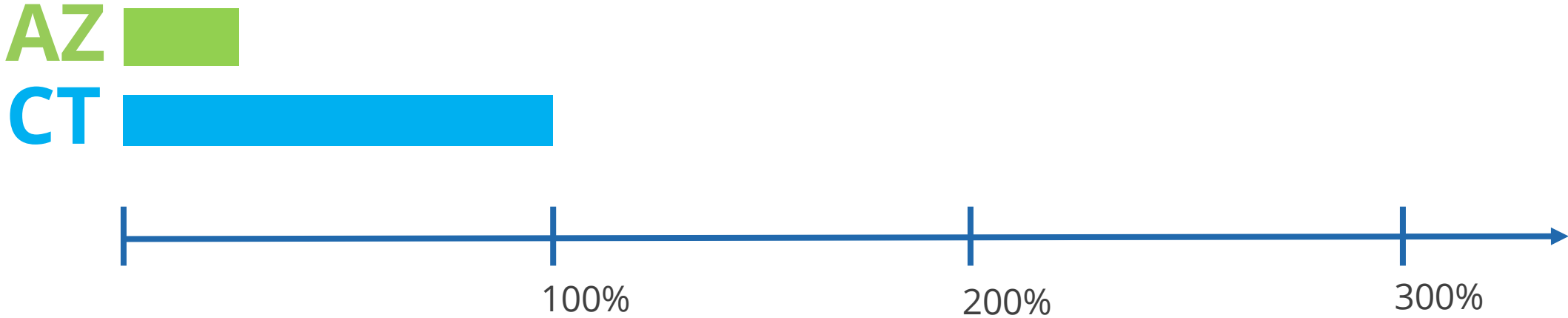
in most large  
buildings

**Plug load was  
disappointing.**

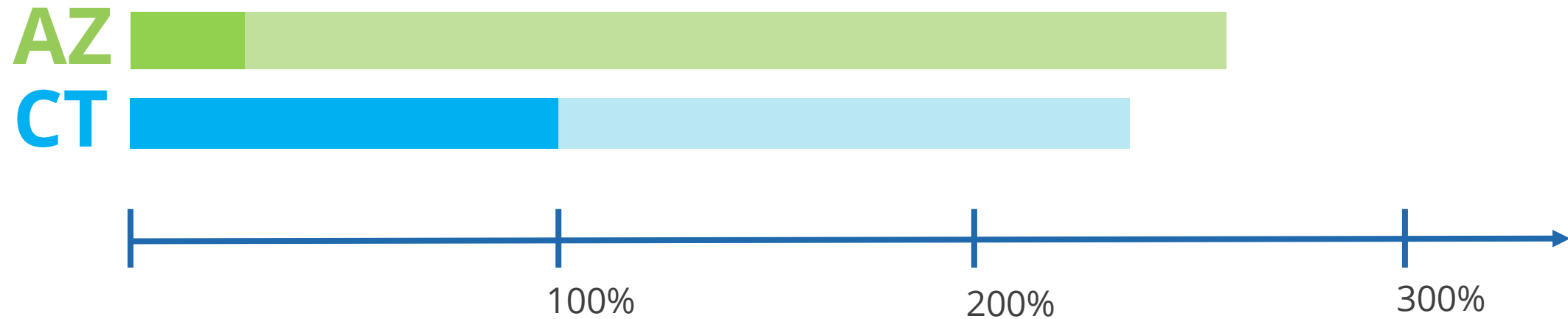




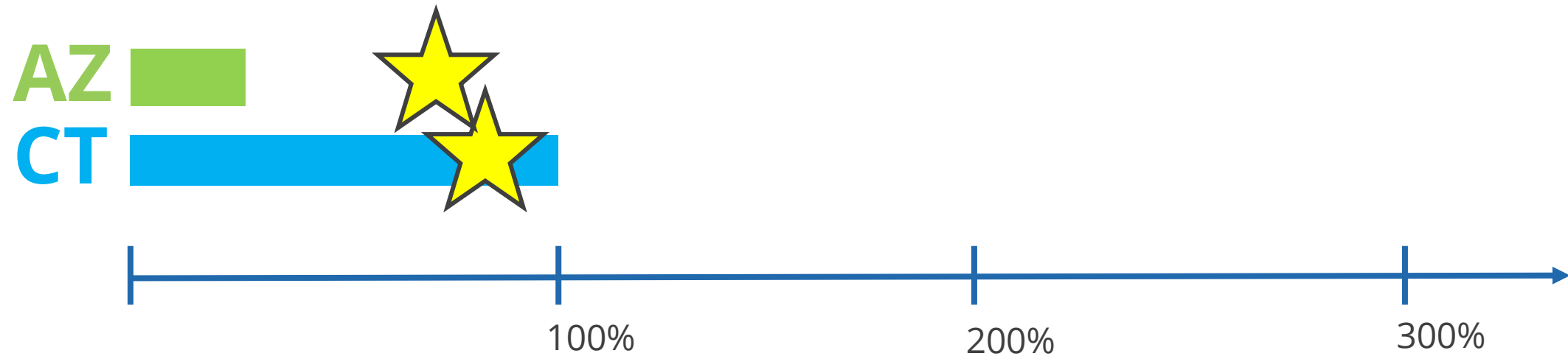
# Average Cost of Energy Savings



# Cost of Energy Savings w/ NLCs + Demand Response

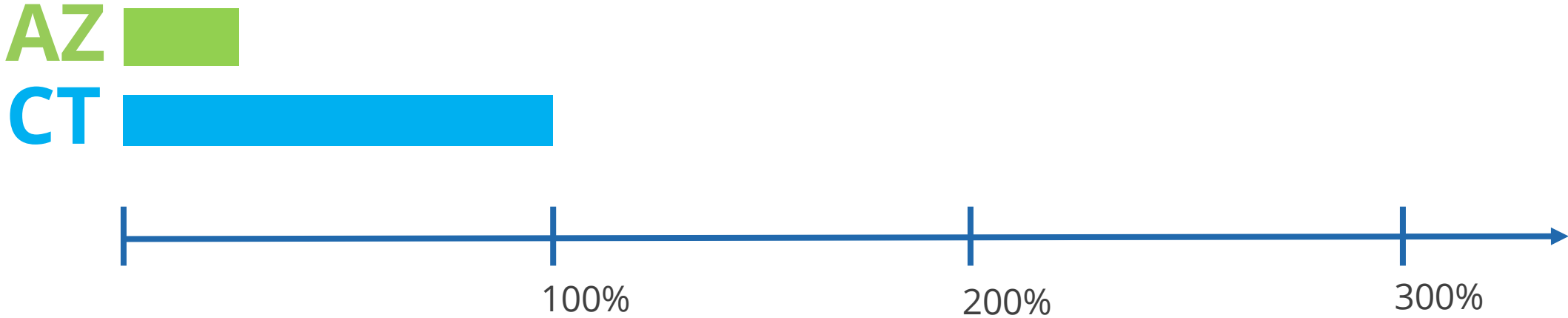


# Cost of Energy Savings w/ NLCs + HVAC



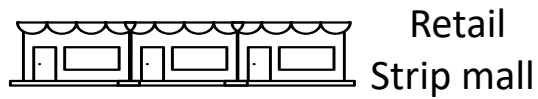
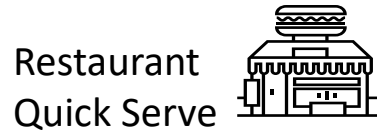
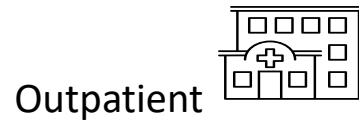


# Average Cost of Energy Savings

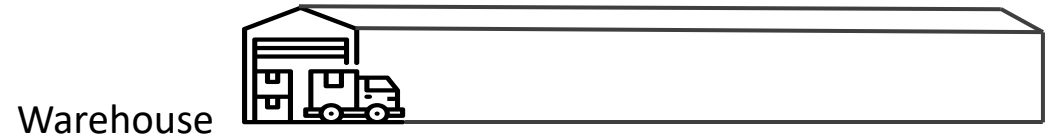
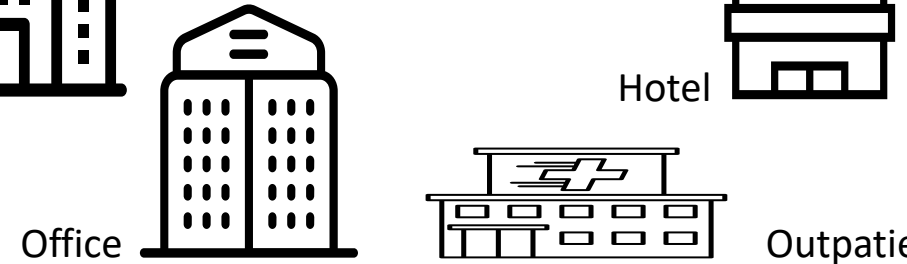


# Building Types

## Small



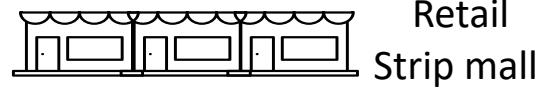
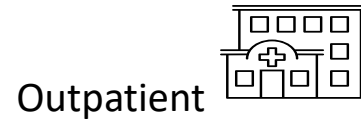
## Large



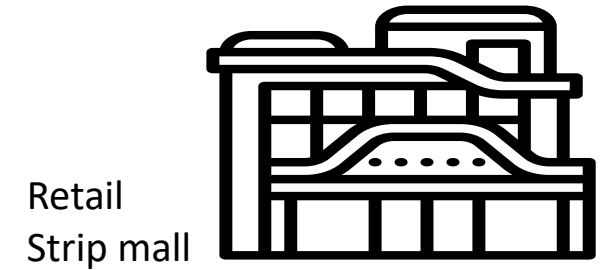
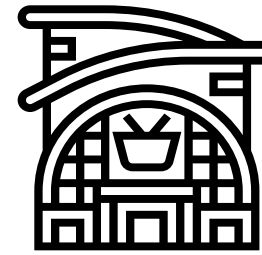
# Connecticut NLC alone

Benefit/Cost Ratio 1 to 3

## Small



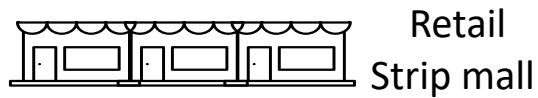
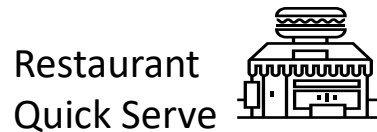
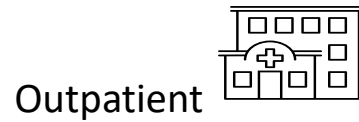
## Large



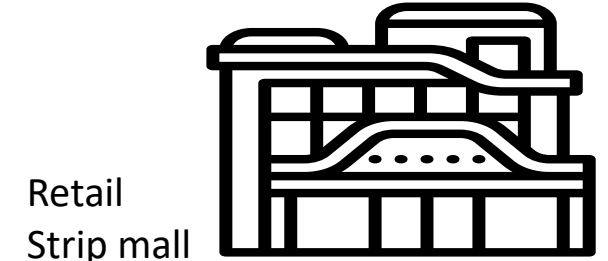
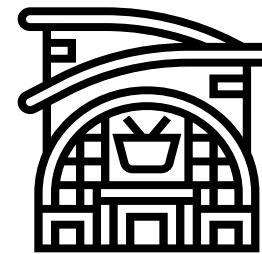
# Connecticut NLC + DR

Benefit/Cost Ratio 1 to 3

## Small



## Large

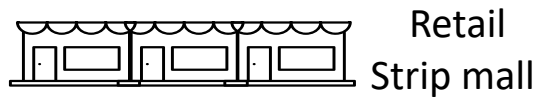
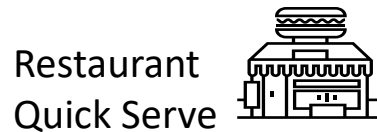
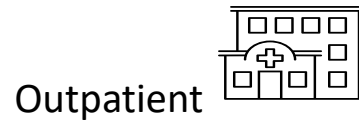




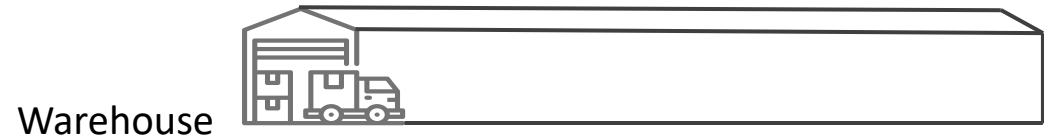
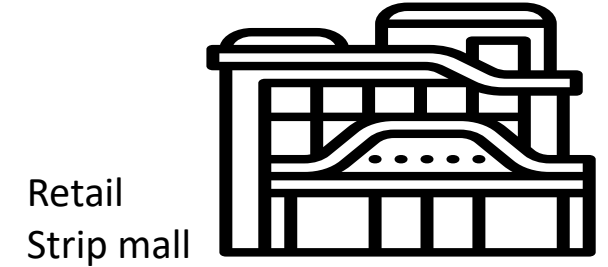
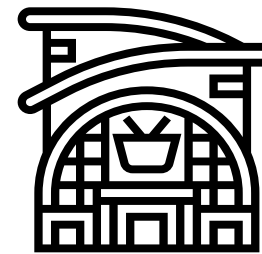
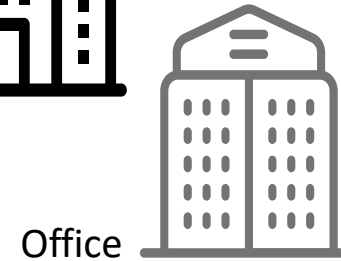
# Connecticut NLC + HVAC

Benefit/Cost Ratio 3 to 6

## Small



## Large



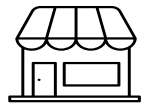


# Arizona NLC alone

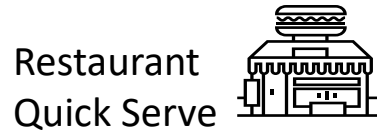
Benefit/Cost Ratio 1 to 3

Small

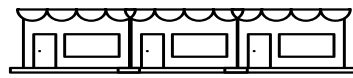
Large



Retail  
Standalone



Restaurant  
Quick Serve



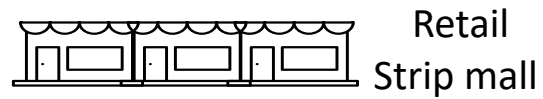
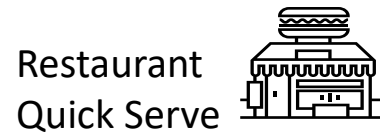
Retail  
Strip mall

# Arizona NLC + DR

Benefit/Cost Ratio 1 to 3

Small

Large

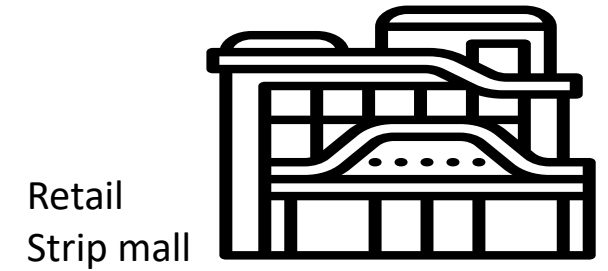
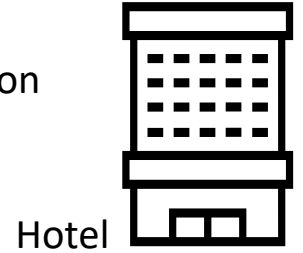
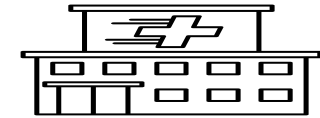
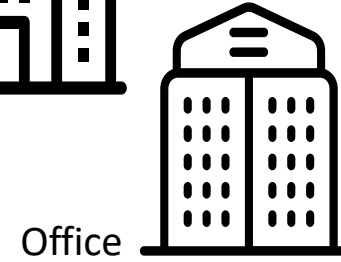
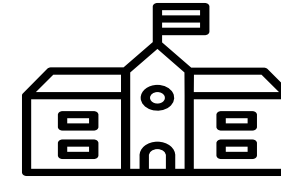
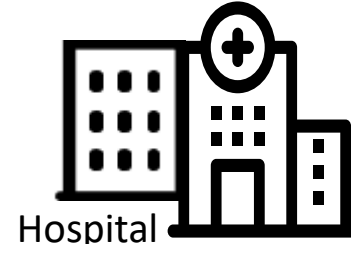
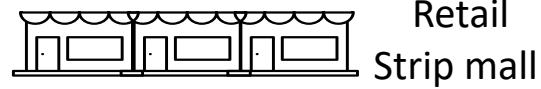
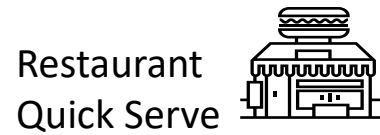




# Arizona NLC + HVAC

Benefit/Cost Ratio 1 to 3

Small

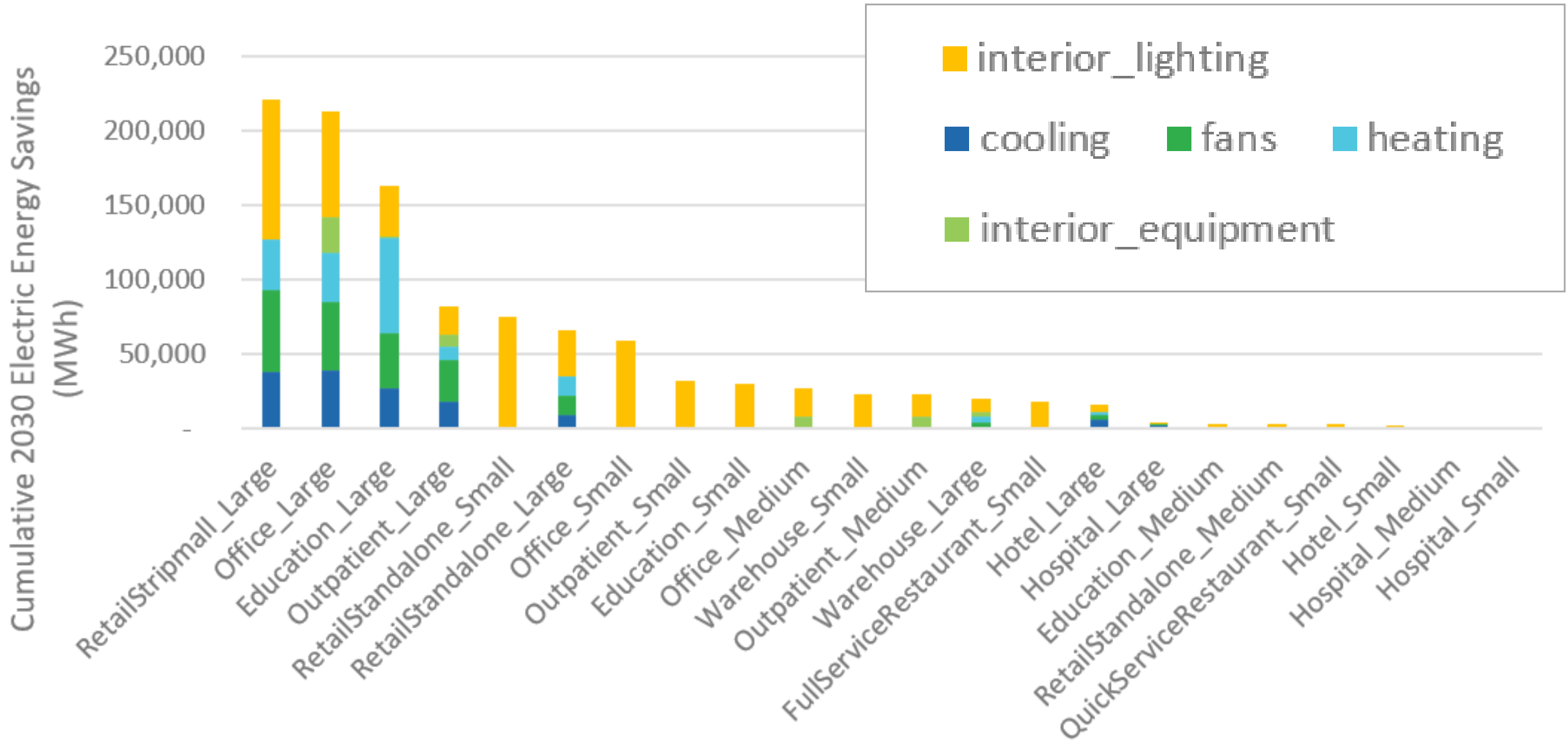


Large

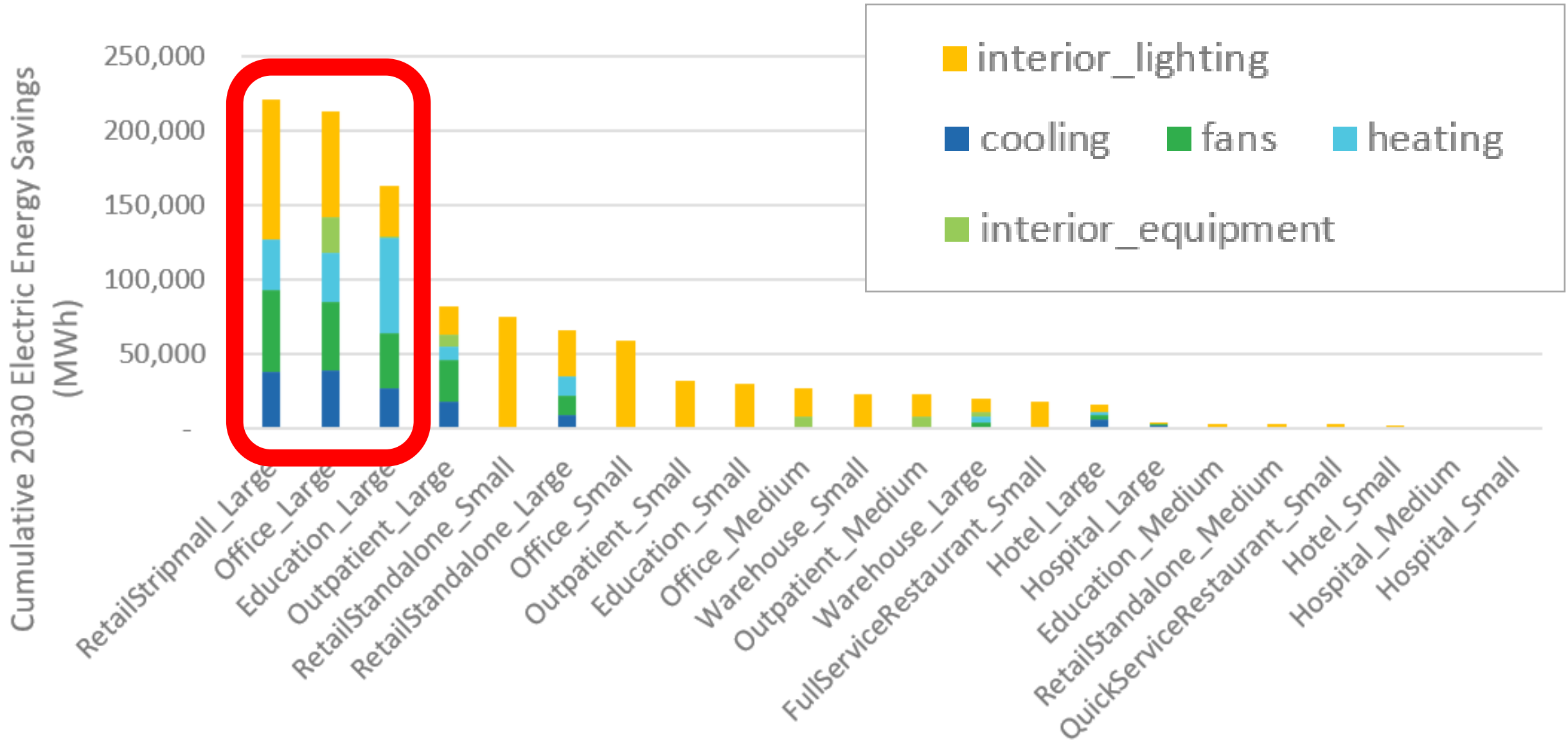
# Serve more customers with NLC-HVAC integration



# Potential Cumulative 2030 Electric Savings (MWh) CT

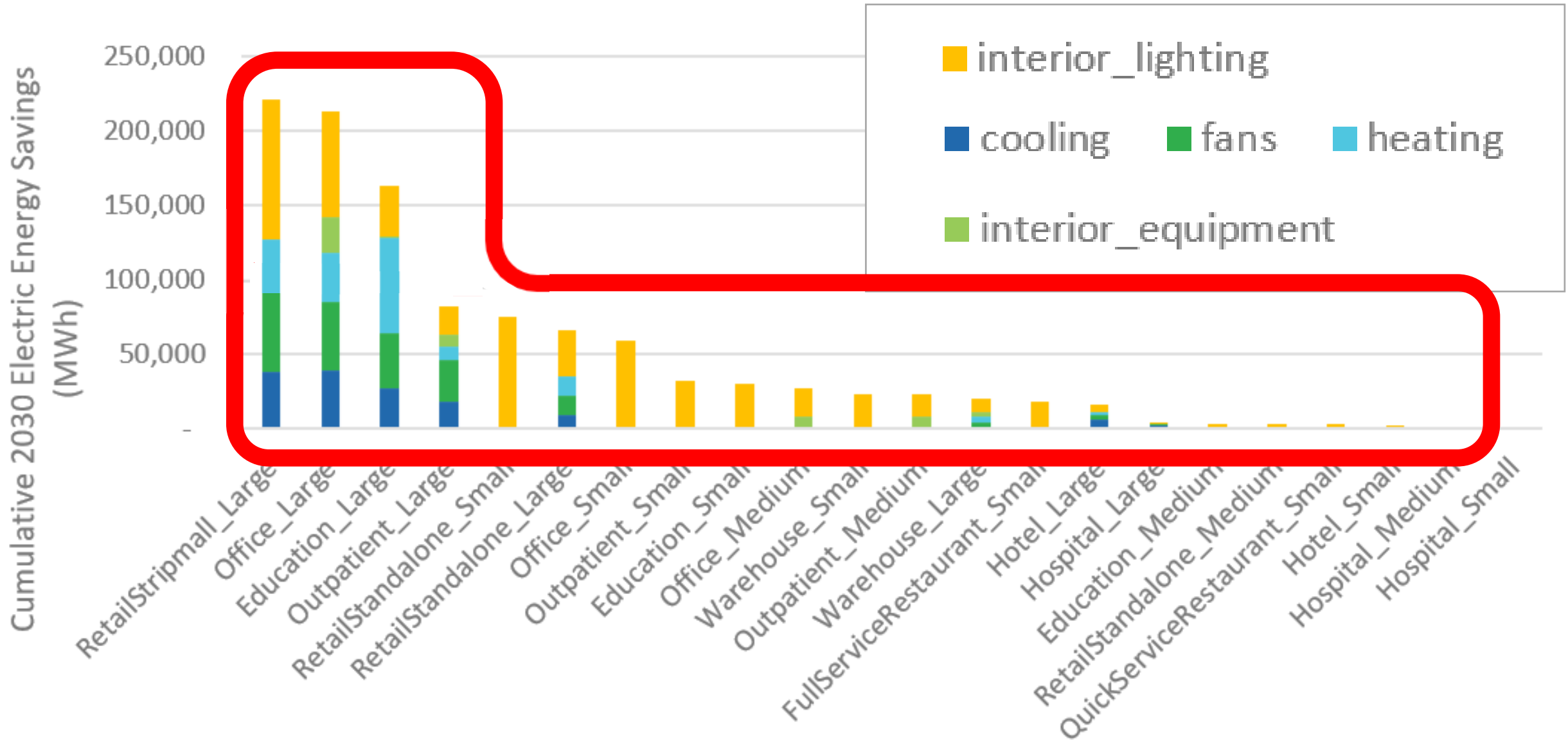


# Potential Cumulative 2030 Electric Savings (MWh) CT

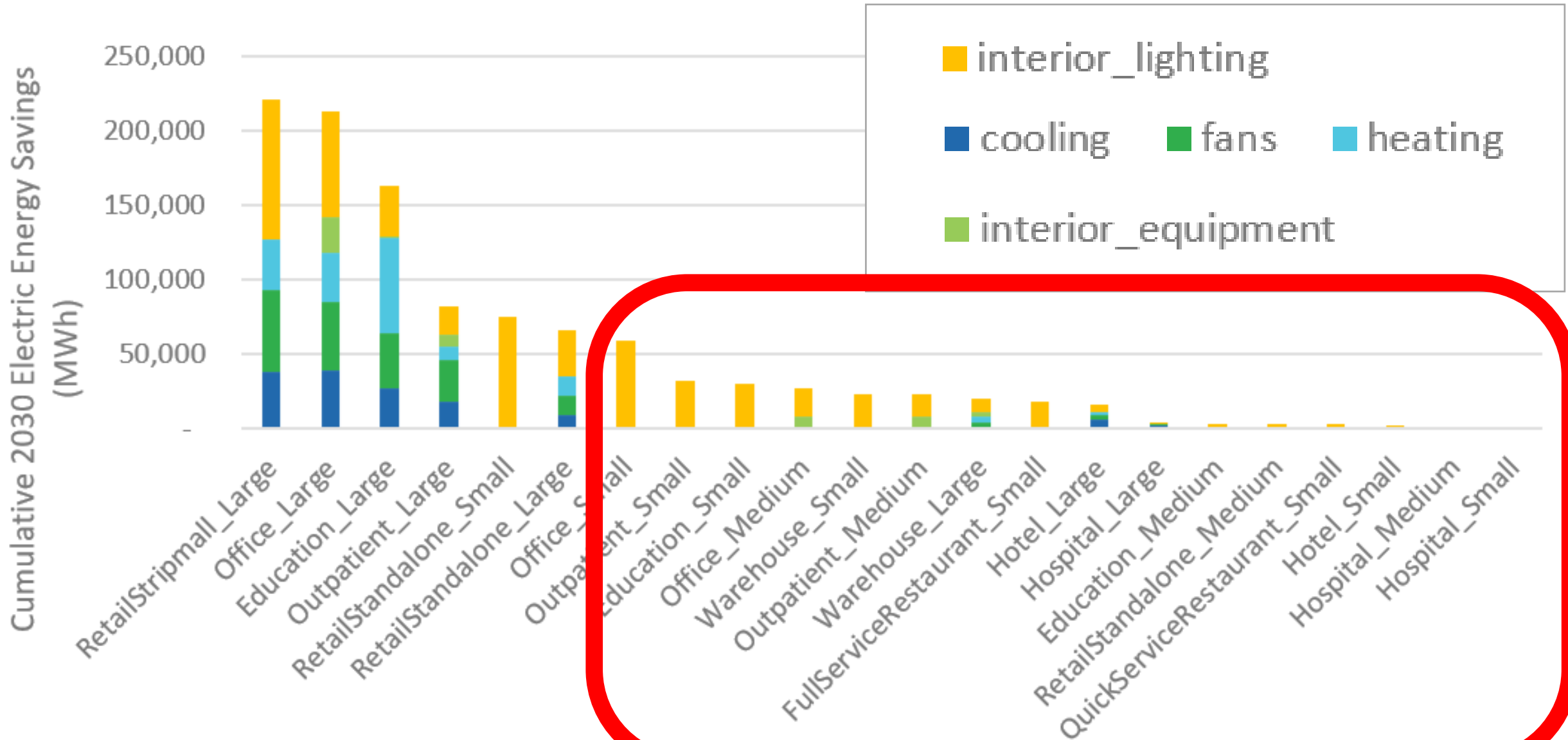




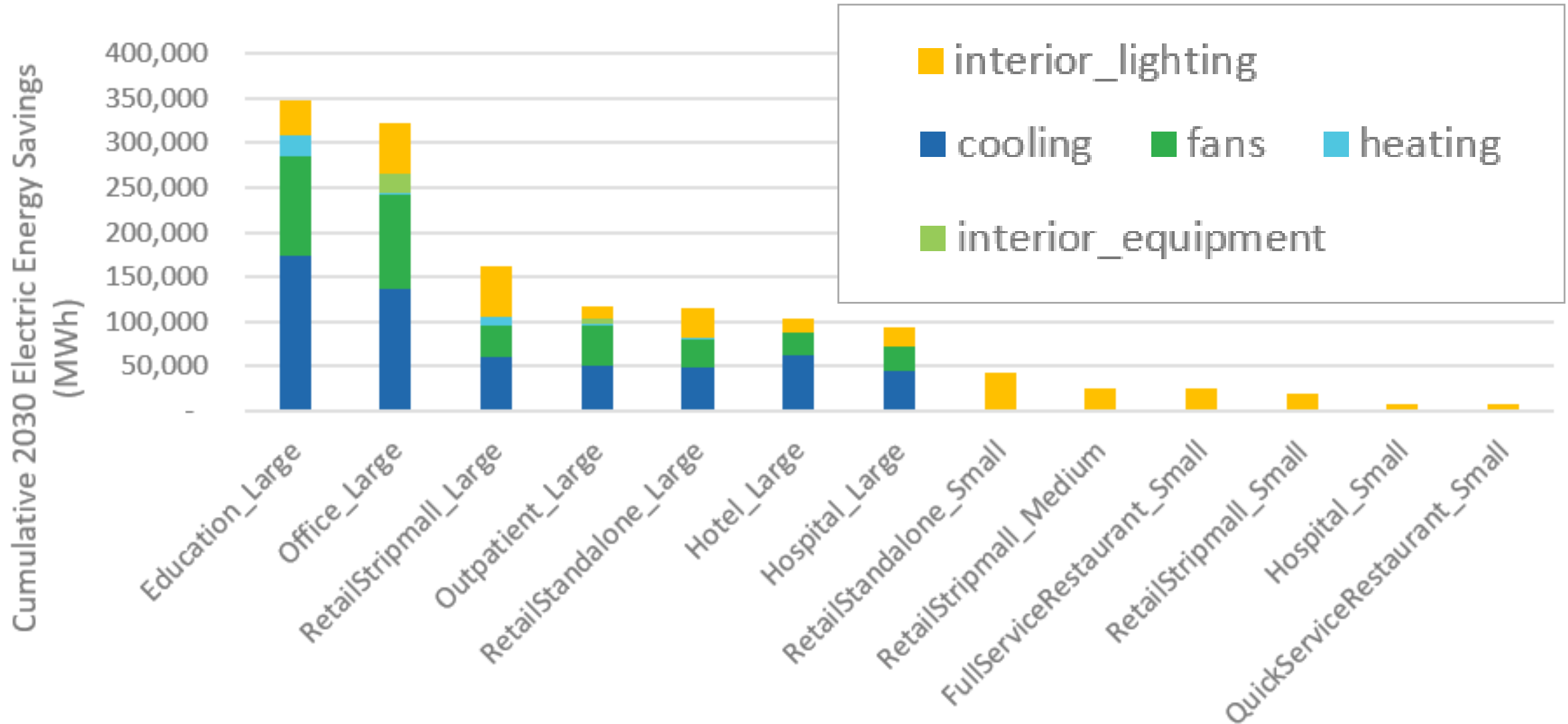
# Potential Cumulative 2030 Electric Savings (MWh) CT



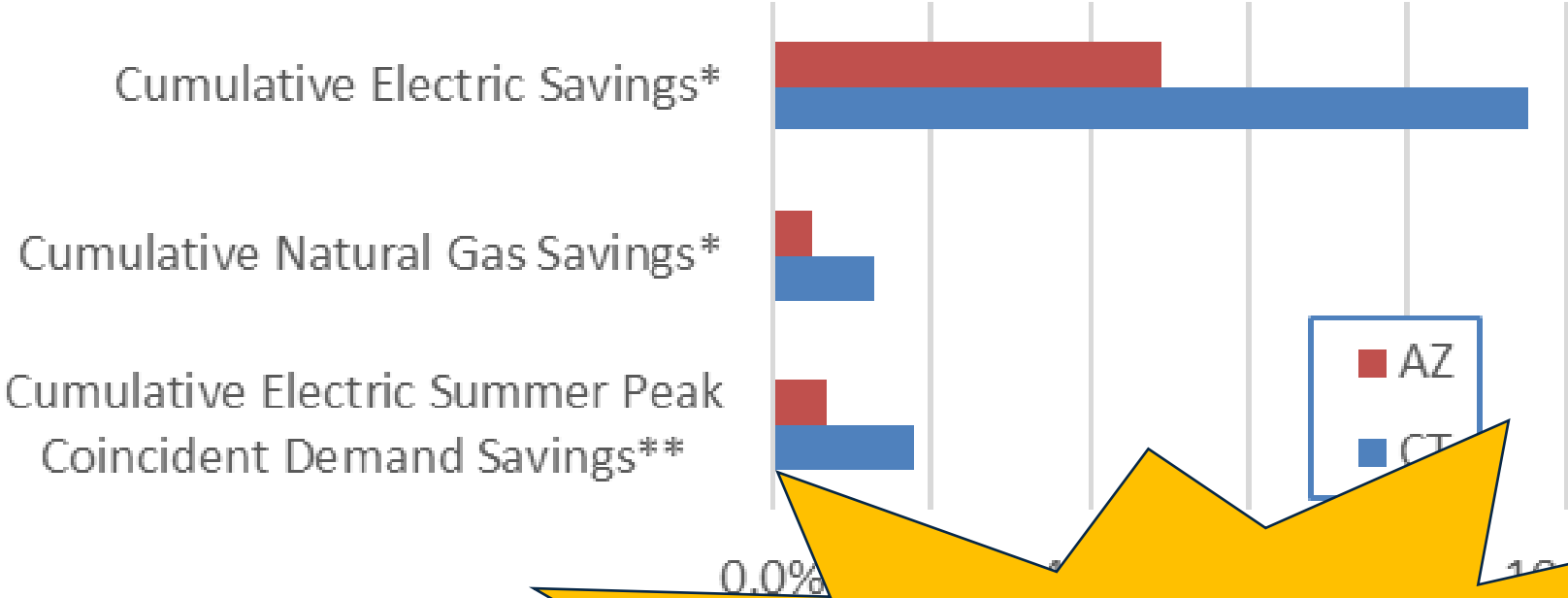
# Potential Cumulative 2030 Electric Savings (MWh) CT



# Potential Cumulative 2030 Electric Savings (MWh) AZ



# NLC Potential Benefits, Cumulative to 2030



\* as % of 2020 Sales

\*\* as % of 2020 Net Summer Capacity

**AZ value: \$217M**  
**CT value: \$1.2B**



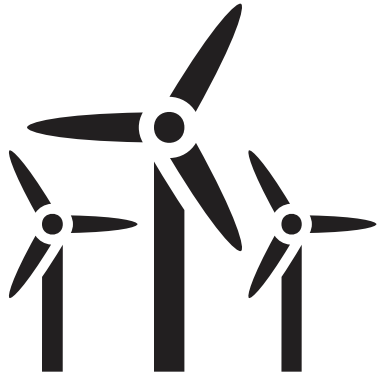
# 35 wind turbines for Connecticut



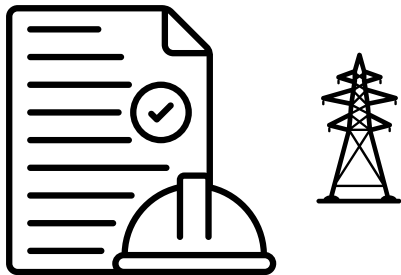
# 47 wind turbines for Arizona



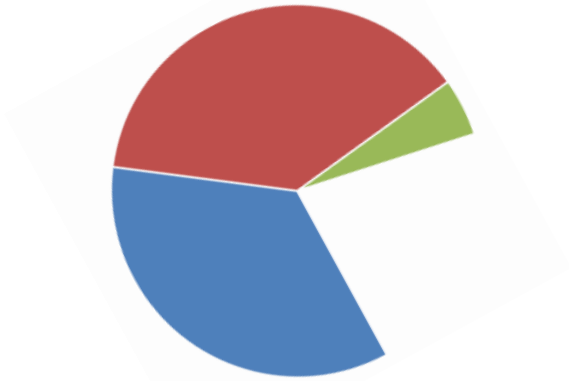
# Wind Turbines



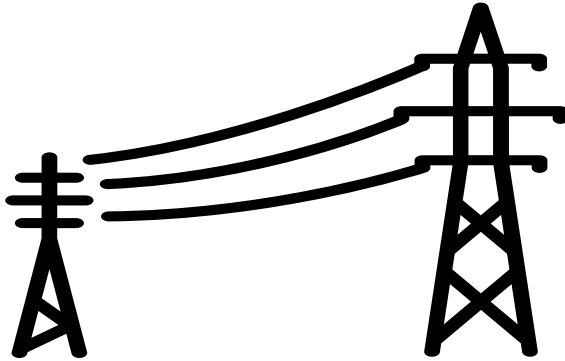
**need new  
transmission**



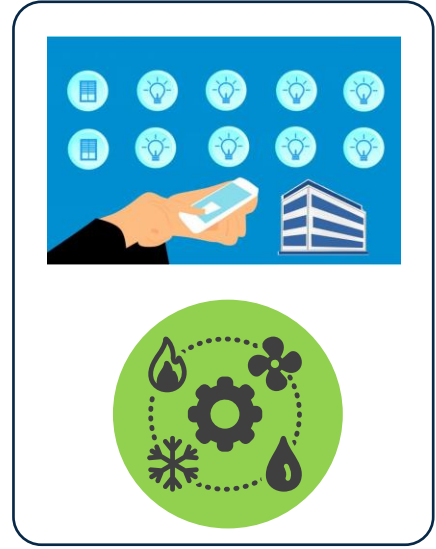
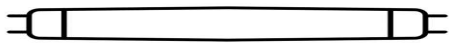
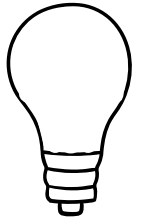
# Energy Efficiency



**frees up  
transmission**



# Energy Savings in Commercial Lighting: Next Chapter?



# Results Part 2

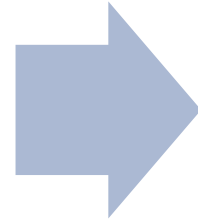


**LED controls-ready now  
+ NLC etc. later (savings to 2035)**



## Controls-Ready Today,

Invest a little now  
for Controls Ready

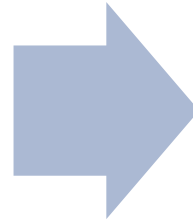
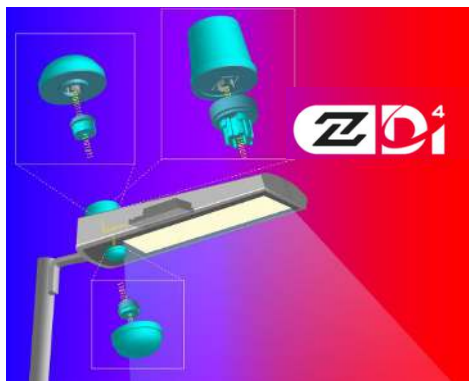


## Controls Tomorrow

Invest in NLC later,  
to save energy

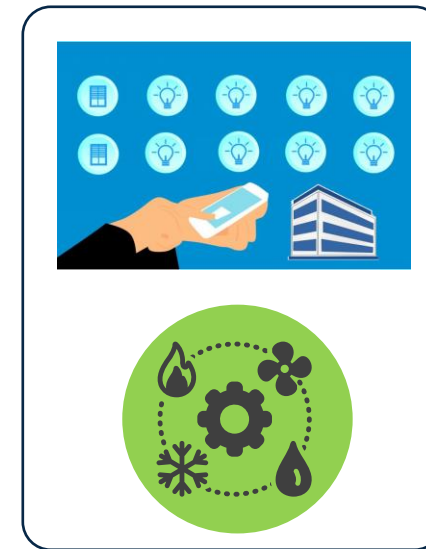
# Controls-Ready Today,

Invest a little now  
for Controls Ready

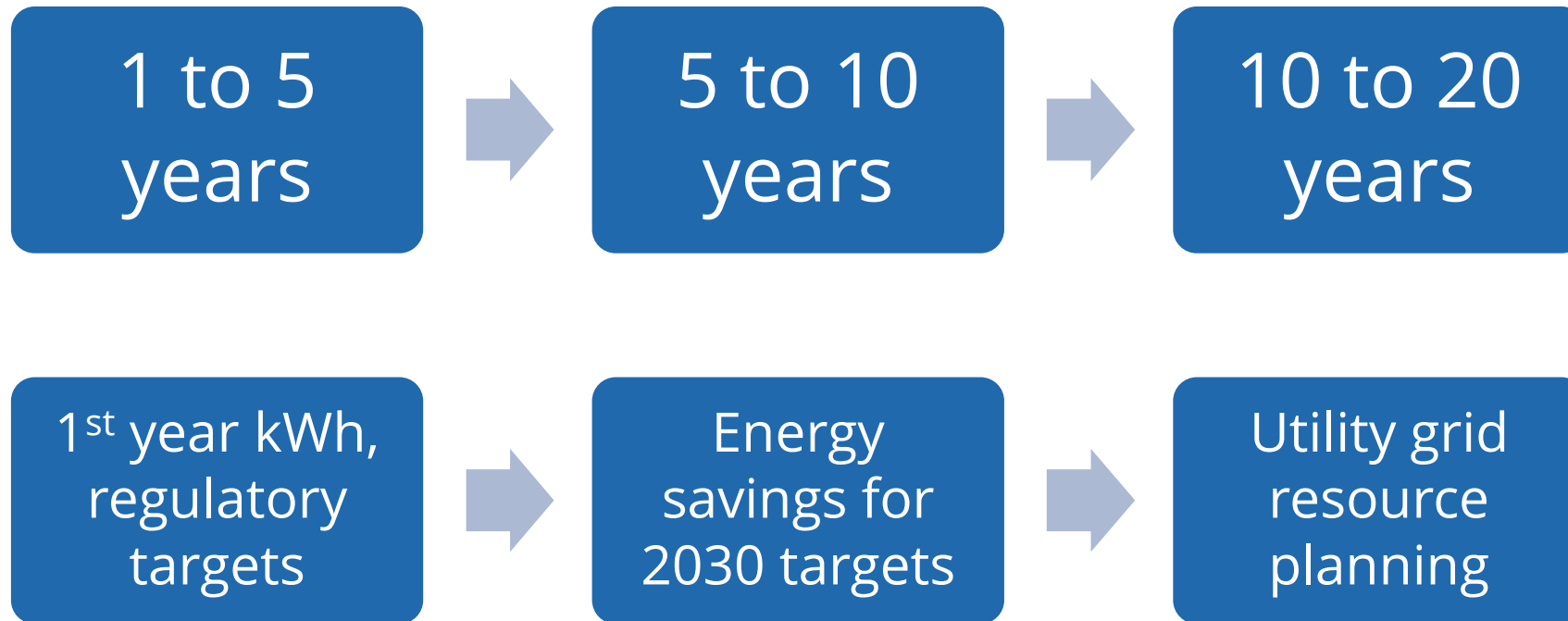


# Controls Tomorrow

Invest in NLC later,  
to save energy



# Controls-Ready requires long term decision making.



# Poll

If you are involved in an efficiency program, what timescale does your program run on?



# Poll

If you are involved in an efficiency program, would the delayed timing of energy savings from controls-ready lighting projects be compatible with your regulations?





**Incentives for  
Uncontrolled Lighting**



**2030  
Savings  
Potential**

# Risk Management





# For Sale Bargain!!!

Imagine, if you will, that some friends of yours have recently purchased a used hot air balloon. They are very excited, because they got a really good deal on it. They have persuaded you to accompany them on their maiden voyage, because they admire your attention to safety, and cautious, careful risk management, which has often saved the three of you from unfortunate circumstances in wild schemes that they've dreamed up.



As you imagine your first trip, you think about a few things you'll need, to be prepared for what you might encounter on this new adventure.



# Controls are essential

A close-up, low-angle shot of a hot air balloon burner firing. The burner is a large, cylindrical metal structure with a wicker basket attached. A large, bright orange flame is visible, extending upwards. The balloon's envelope is partially visible, showing a dark color. A black flag is attached to the balloon's rigging. The background is a dark, clear sky.

First of all, you want to make sure to have foolproof controls on the burner, so you'll be able to make the balloon go higher by running the burner, and lower by turning off the burner.





## Ropes for safety

You realize that for takeoff and landing, you'll need plenty of rope.

As you research the topic, you realize that you could simply take off, and see where the wind blows, but that's probably not the best idea. If you want to choose your direction, you can select a particular altitude with a particular windspeed and direction, but only if...



## Weather

Altitude ft	Wind mph	Direction
10,000	40	S
8,000	5	S
6,000	25	S
4,000	25	SE
2,000	2	E
1,000	10	E
500	4	E

you have a good weather app on your phone, to take advantage of information from nearby weather stations.







After a bit more research, you join a hot air balloon club. After getting helpful suggestions from other members, a few weeks later you and your friends enjoy your first of many successful hot air balloon flights.



Now imagine, if you will, that the whole world has recently bought into the idea that the entire electricity grid needs to be decarbonized rapidly, with emissions cut in half by 2030, at the same time that the space conditioning and transportation sectors are being electrified. Your energy efficiency program has been recruited in this endeavor, especially because you bring attention to safety, and cautious, careful risk management, which has often saved your organization from unfortunate circumstances in wild schemes that other departments have dreamed up.



# Controls are essential

Just as the controls on a hot air balloon prepare you to enjoy a day of fun,

# 1. ALL incentivized lighting projects should require NLC



<https://betterbricks.com/blog/luminaire-level-lighting-control>

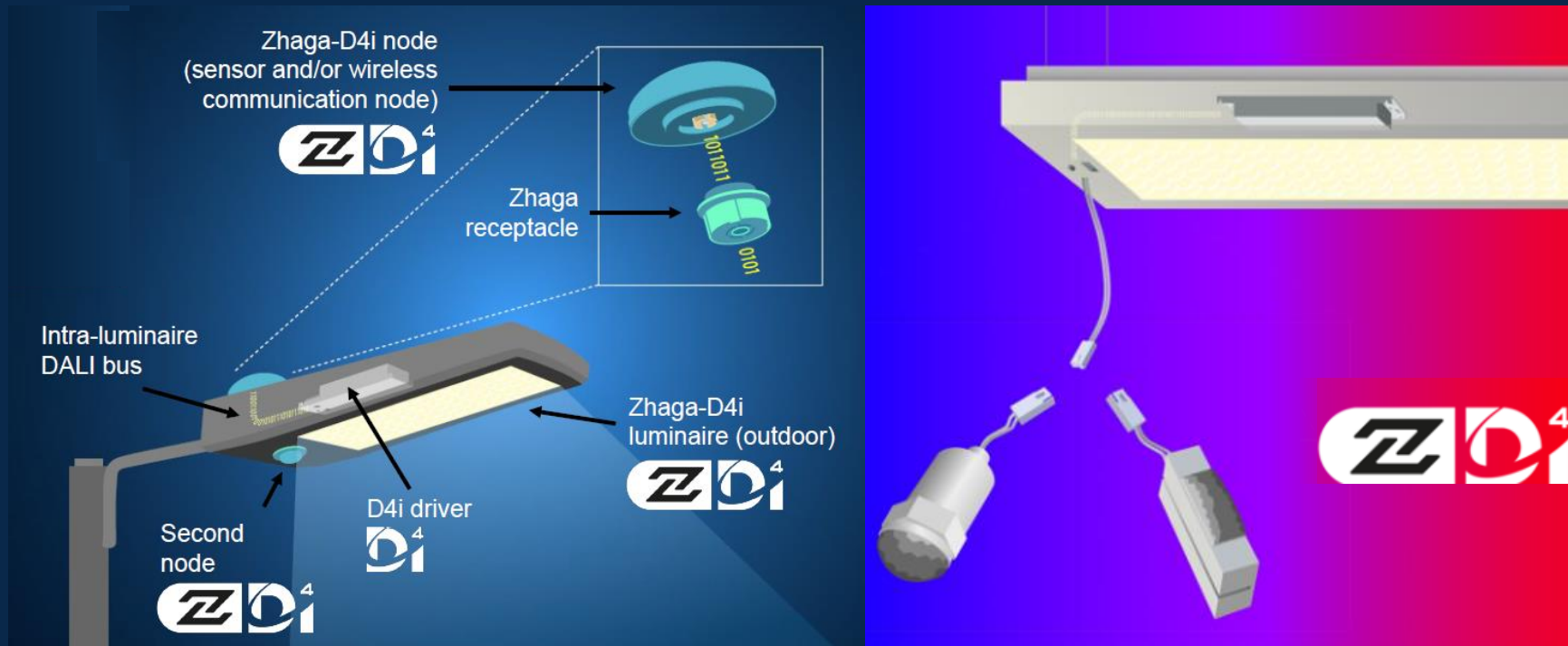
Controls on all incentivized lighting projects will prepare you well for a future of energy savings. To deliver the most energy savings between now and 2030 in an affordable way, ALL incentivized lighting projects today should include networked lighting controls, even though this might increase the cost per kWh saved this year, and thus decrease the volume of first-year energy savings. One straightforward way to require lighting controls on all incentivized lighting, is to only offer lighting incentives for luminaires with Luminaire Level Lighting Control, or LLLC, where an embedded sensor and a wireless network radio is required in every luminaire.



## Ropes for safety

When you first tried out your friends' balloon, you briefly lost control of the burner, and were very grateful to have ropes anchored to the ground, so you could sort things out before taking off.

## 2. If #1 is not feasible in all cases, then require controls-ready luminaires



[DALI-alliance.org](http://DALI-alliance.org) and [Zhagastandard.org](http://Zhagastandard.org)

Likewise, if you find that networked lighting controls are not yet feasible on all of your incentivized lighting projects today, then all of those projects should at least include controls-ready luminaires, to preserve the possibility of adding controls in the future. This may need regulatory updates, to support a relatively small additional cost today that will deliver no additional energy savings unless controls are actually installed, at some point in the future.



## Weather

Altitude ft	Wind mph	Direction
10,000	40	S
8,000	5	S
6,000	25	S
4,000	25	SE
2,000	2	E
1,000	10	E
500	4	E

And finally, how can you connect with powerful external forces, to deliver a higher level of performance and opportunities?





### 3. Support NLC-HVAC integration



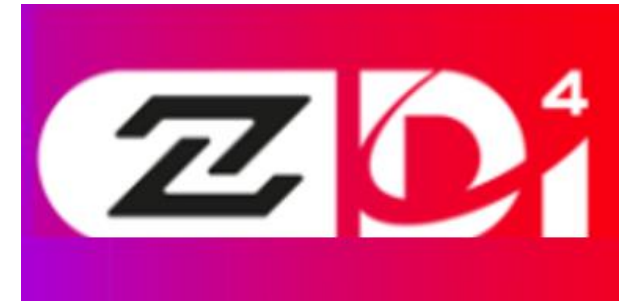
That, of course, would be integration between networked lighting controls and HVAC. For better future-proofing on incentivized Lighting systems and also incentivized HVAC systems, efficiency programs could promote a pathway for occupancy communication from the lighting system to the HVAC system, in buildings where that is feasible. Also, programs could provide incentives for System Integrators to review designs before installation and solve problems after installation.

# Future Proof Lighting Incentives

**1. All lighting projects have NLC**



**2. If not #1, at least controls-ready**



**3. Support NLC-HVAC integration**







If you're wondering what exactly is involved to have lighting controls on all projects and to support NLC-HVAC integration, please consider joining a group of like-minded organizations, to enjoy learning together how to navigate this new world of rapid decarbonization.



# Unlocking the Potential of Networked Lighting Controls

September 26 and 27  
Detroit, MI

Register at [designlights.org](https://designlights.org)





CONFERENCE

# Energy Efficiency as a Resource

October 16 – 18, 2023

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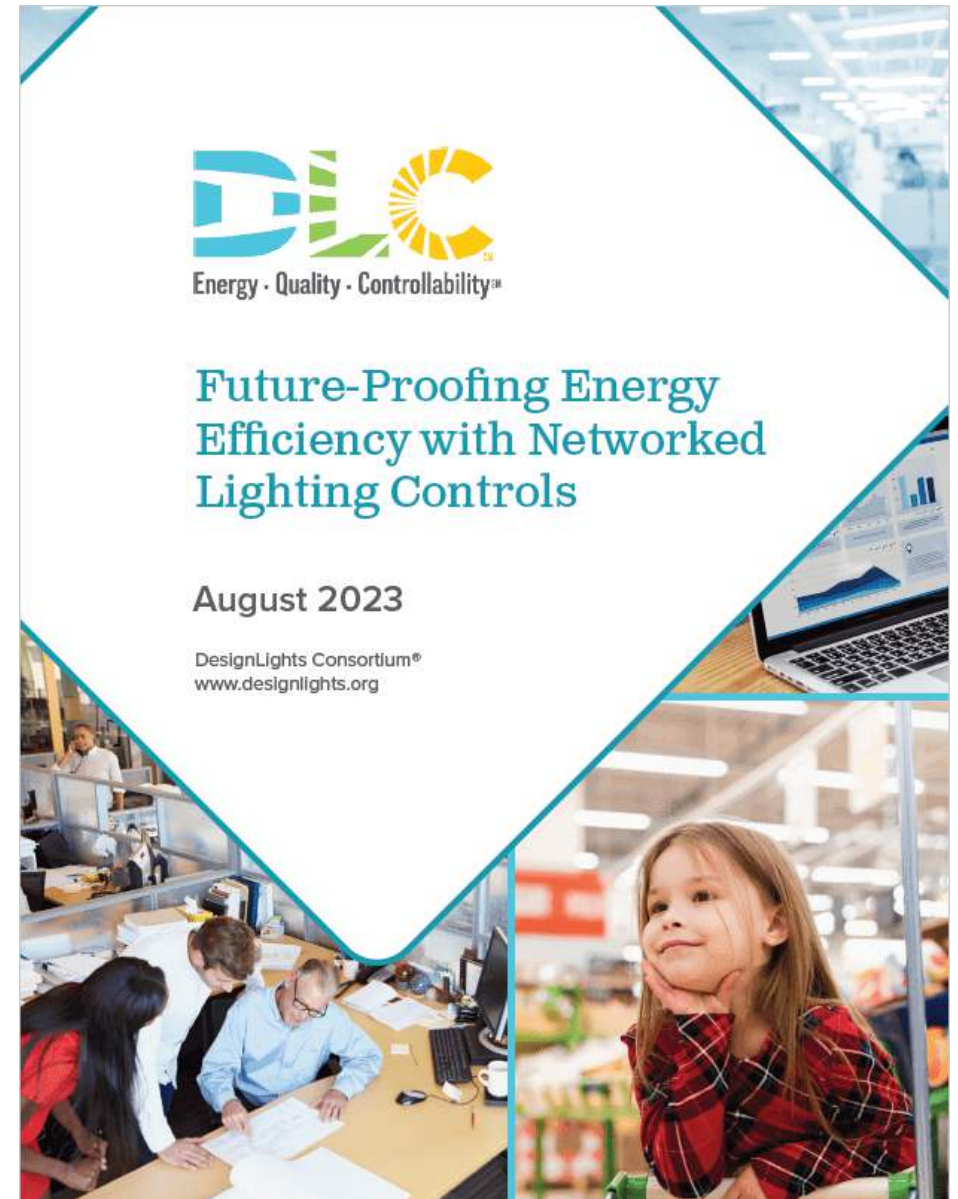
[Accommodations](#)

[DoubleTree by Hilton Philadelphia Center City](#) | Philadelphia, PA



# More Information

- 8 page summary
  - <https://www.designlights.org/resources/reports/future-proofing-energy-efficiency-with-networked-lighting-controls/>
- September 6 webinar recording
  - <https://www.designlights.org/news-events/events/future-proofing-energy-efficiency-with-networked-lighting-controls/>
- Full report for DLC members
  - <https://www.designlights.org/resources/reports/economic-potential-of-networked-lighting-controls/>



# Data Sources

- ComStock: NREL energy model of commercial buildings by location, across the US
- CBECS: US Energy Information Administration (EIA) model of commercial building characteristics by location, across the US
- US DOE reports on SSL
  - “2015 U.S. Lighting Market Characterization” published Nov. 2017
  - “Energy Savings Forecast of Solid-State Lighting in General Illumination Applications” published Dec. 2019.
- State-specific data relevant to utility regulations, as available