ERC
ENERGY RESOURCES CENTER

DCEO Illinois Public Sector & Low Income Energy Efficiency Potential Study: Data Center Addendum

Energy Resources Center
July 29, 2014

Agenda

- Background
- Approach
- Results
- Recommendations

DCEO Energy Efficiency Potential Study

- ELPC staff in docket #13-0499 requested further analysis on data centers
- Excerpt from Final Order:

"DCEO agreed to update its EE Potential Study within the next six months to include the savings potential for public sector data center projects in Illinois and to present the results to the SAG. At that point, DCEO would determine if a data center program is justified."

Data Center Specific Research

- Already had some information on servers in public facilities
- Resending questionnaires not feasible
- Reviewed over 110 case studies & research papers
  - EPA, DOE, Energy Star, Lawrence Berkley National Lab, National Renewable Energy Laboratory, Ebay, Target, Verizon
- Electric Only

Types of Data Centers

Space Type	Typical Size	Typical IT Equipment Characteristics	Typical Site Infrastructure System Characteristics
Server Closet	<200 ft^2	1-2 servers No external storage	Typically conditioned through an office HVAC system. To support VOIP and wireless applications, UPS and DC power systems are sometimes included in server closets. Environmental conditions are not as tightly maintained as for other data center types. HVAC energy efficiency associated with server closets is probably similar to the efficiency of office HVAC systems.
Server Room	<500 ft^2	A few to dozens of servers No external storage	Typically conditioned through an office HVAC system, with additional cooling capacity, probably in the form of a split system specifically designed to condition the room. The cooling system and UPS equipment are typically of average or low efficiency because there is no economy of scale to make efficient systems more first-cost competitive.
Localized Data Center	<1,000 ft^2	Dozens to hundreds of servers Moderate external storage	Typically use under-floor or overhead air distribution systems and a few in-room CRAC units. CRAC units in localized data centers are more likely to be air cooled and have constant-speed fans and are thus relatively low efficiency. Operational staff is likely to be minimal, which makes it likely that equipment orientation and airflow management are not optimized. Air temperature and humidity are tightly monitored. However, power and cooling redundancy reduce overall system efficiency.
Mid-Tier Data Center	<5,000 ft^2	Hundreds of servers Extensive external storage	Typically use under-floor air distribution and in-room CRAC units. The larger size of the center relative to those listed above increases the probability that efficient cooling, e.g., a central chilled water plant and central air handling units with variable speed fans, is used. Staff at this size data center may be aware of equipment orientation and airflow management best practices. However, power and cooling redundancy may reduce overall system efficiency.
Enterprise-Class Data Center	<5,000+ ft^2	Hundreds to thousands of servers Extensive external storage	The most efficient equipment is expected to be found in these large data centers. Along with efficient cooling, these data centers may have energy management systems. Equipment orientation and airflow management best practices are most likely implemented. However, enterprise-class data centers are designed with maximum redundancy, which can reduce the benefits gained from the operational and technological efficiency measures.

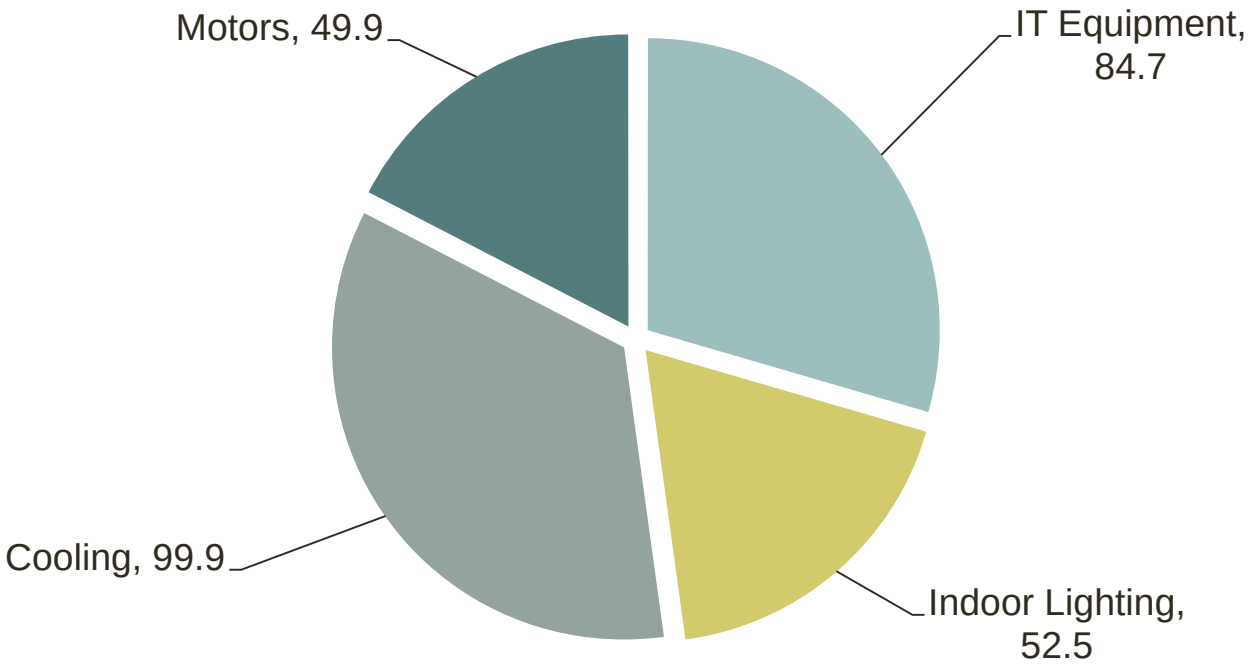
Approach

- Same as primary portion of potential study
  - Technical, Economic, Maximum Achievable, Program Achievable
  - Analysis – Steps as detailed previously
    - Collect data
    - Establish energy consumption of sector
    - Calculate Technical Potential based on highest efficiency available
    - Calculate Economic Potential based on tiers of efficiency available – TRC > 1
    - Maximum/Program Achievable Potential based on adoption rates and funds available

Measures List

HVAC	IT Equipment	Air Flow
Optimize Temperature Setpoints	Power Distribution	Implement Cable Management
Direct Expansion (DX) Systems	Uninterruptible Power Supplies (UPS)	Aisle Separation and Containment
Air Handlers: Central vs. Modular Systems	Power Distribution Units (PDU)	Optimize Supply and Return Air Configuration
Multiple Distributed CRAC Units	Distribution Voltage Options	
Low Pressure Drop Air Delivery	Demand Response	**Others**
High-Efficiency Chilled Water Systems	DC Power	Efficient Pumping
Optimize Plant Design and Operation	Energy-Efficient Servers, Storage and Switches	Variable-Frequency Drives (VFDs)
Efficient Pumping	Server Virtualization	Efficient Lighting
Free Cooling	Desktop Virtualization	Lighting Controls
Air-Side Economizer	Server Refresh	
Water-Side Economizer	Storage Consolidation and Optimization	
Thermal Storage	High-Performance Computing Systems	
Direct Liquid Cooling		
Humidification		
Outside Air Cooling		

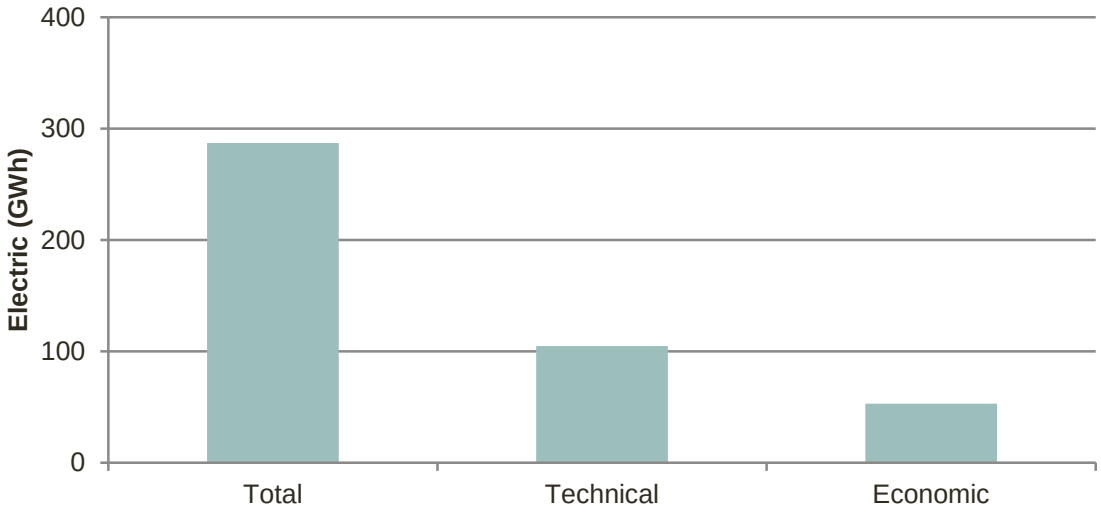
Data Center Electrical Consumption (GWh)



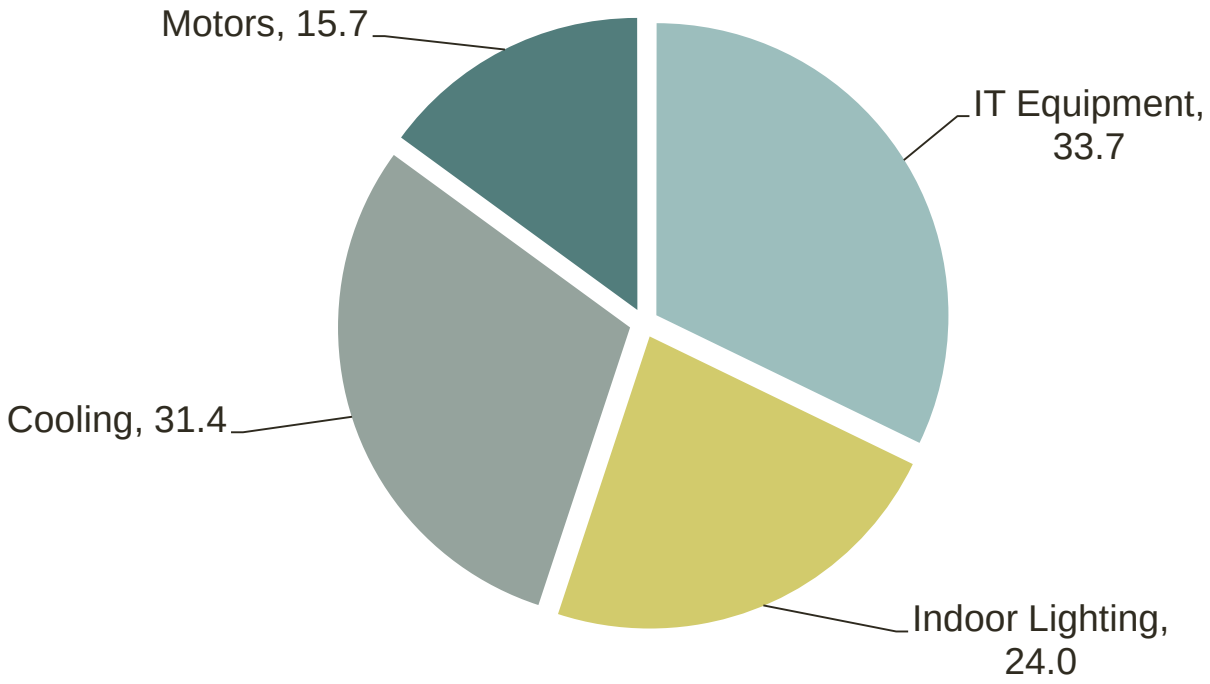
Total Consumption: 287.1 GWh
2.2% of Public Sector Energy Consumption

Data Center Electrical Potential

	Total Consumption	Technical	Technical Potential	Economic	Economic Potential
Electric	287.1 GWh	36.5%	104.8 GWh	18.5%	53.0 GWh

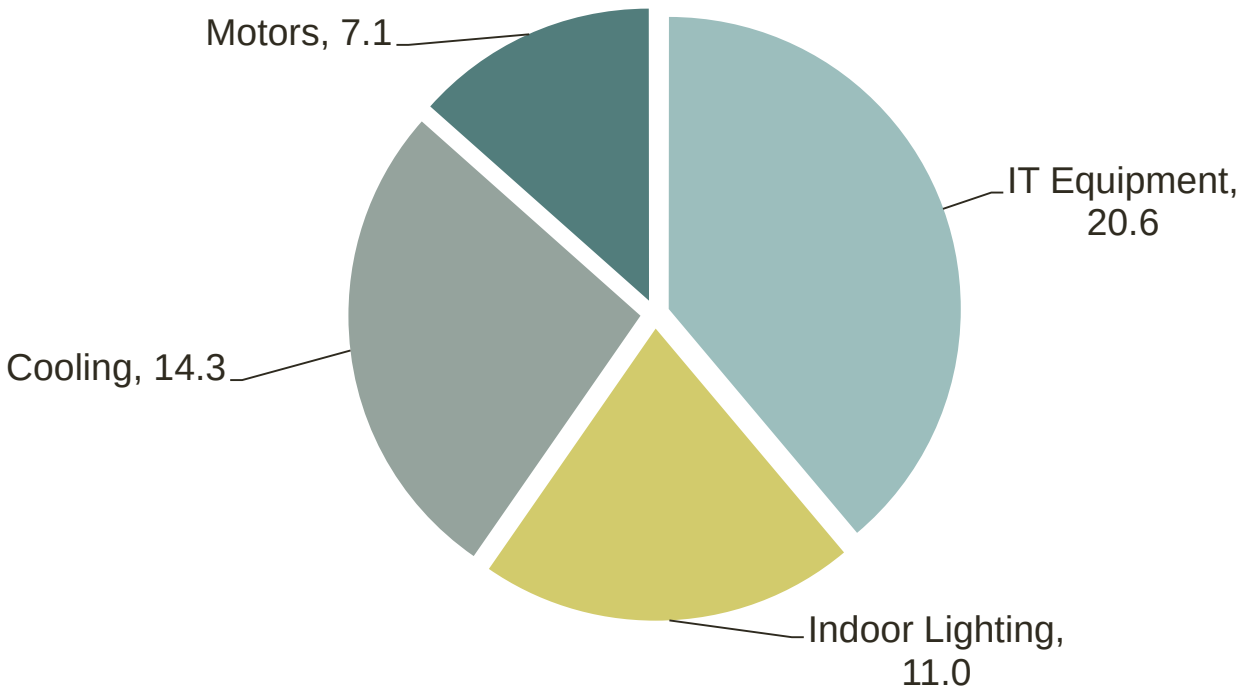


Data Center Electrical Technical Potential (GWh)



Total Potential: 104.8 GWh
36.5% of Data Center Energy Consumption

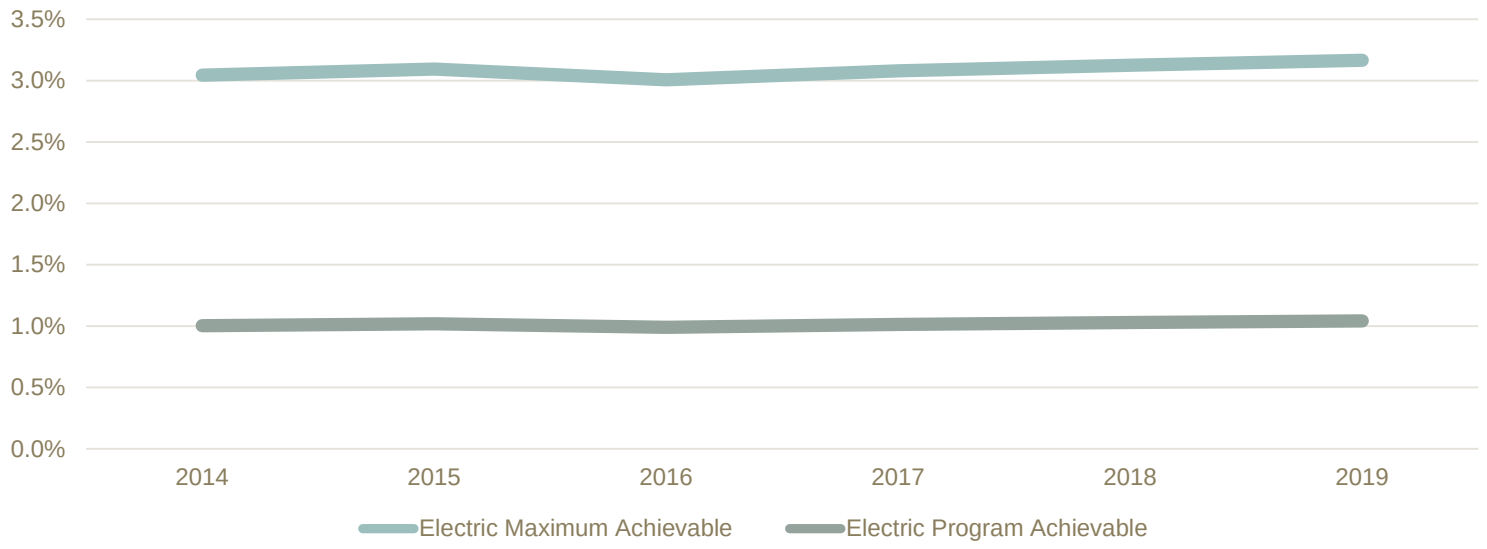
Data Center Electrical Economic Potential (GWh)



Total Potential: 53.0 GWh
18.5% of Data Center Energy Consumption

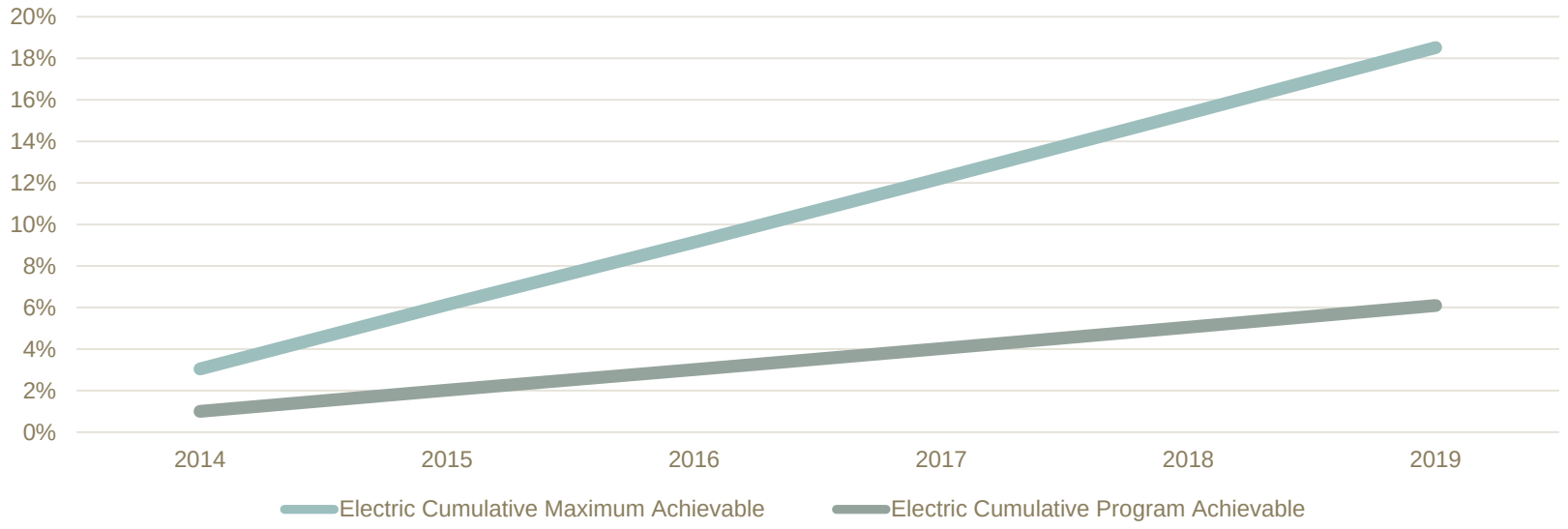
Maximum & Program Achievable

Year	2014	2015	2016	2017	2018	2019
Old Program Electric Achievable Potential %	1.00%	1.02%	0.99%	1.01%	1.03%	1.04%
New Program Electric Achievable Potential % (unchanged)	1.00%	1.02%	0.99%	1.01%	1.03%	1.04%
Old Maximum Electric Achievable Potential %	3.03%	3.08%	2.99%	3.06%	3.11%	3.15%
New Maximum Electric Achievable Potential %	3.04%	3.09%	3.01%	3.08%	3.13%	3.17%



Cumulative Maximum & Program Achievable

Year	2014	2015	2016	2017	2018	2019
Old Cumulative Program Electric Achievable Potential %	1.00%	2.02%	3.01%	4.02%	5.05%	6.10%
New Cumulative Program Electric Achievable Potential % (unchanged)	1.00%	2.02%	3.01%	4.02%	5.05%	6.10%
Old Cumulative Maximum Electric Achievable Potential %	3.03%	6.11%	9.10%	12.16%	15.27%	18.42%
New Cumulative Maximum Electric Achievable Potential %	3.04%	6.14%	9.15%	12.23%	15.35%	18.52%



Recommendations

- Develop pilot data center program
  - Targeted
  - Provide training
  - Standard measures list

- Determine if stand-alone program is effective compared to current standard/custom program structure

Questions?