# Michigan Statewide Commercial and Industrial Lighting Hours-of-Use Study

## Research Results 2014

PRESENTATION

June 17, 2014

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# AGENDA

- Purpose
- Key Findings
- Overview of Study
- Sample
- Methods
- Findings
- Characteristics Data

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# PURPOSE

Collect reliable data on C&I lighting hours-of-use (HOU) and coincidence factors (CFs) for the State of Michigan to validate and calibrate the MEMD to accurately reflect local operating conditions.

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# KEY FINDINGS

## Hours of Use and Coincidence Factor Values

| Variable | Current MEMD Value (a) | Calibrated Value (b) | Ratio (b)/(a) |
|---|---|---|---|
| Hours of Use | 3,680 | 2,744 | 0.755 |
| Coincidence Factor | 0.90 | 0.505 | 0.561 |
| [a.] Current MEMD Value is based on the non-high bay estimates. | | | |

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In general, what did we do?

# OVERVIEW

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# OVERVIEW OF STUDY

- Two waves of metering
  - Wave 1 complete & included in this analysis
  - Wave 2 to be reported in Fall 2014
- Facility type incidence study
- Combined metering data from:
  - Wave 1 from this study (179 sites)
  - Lighting Controls study (377 sites)
- Aggregated logger-level data

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# DATA COLLECTED

| Data Type | Data Collection Method [a] |
|---|---|
| Lighting Hours-of-Use | Metering |
| Peak Coincidence Factors | Metering |
| Facility Operating Hours | Field Technician Report |
| Inventory of Space Types | Field Technician Report |
| Type, Number, and Nominal Wattage of Lighting Equipment | Field Technician Report |
| Heating and Cooling Equipment Specifications and Usage | Field Technician Report |
| Facility Distribution | Incidence Study |

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On what is our analysis based?

# SAMPLE

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# WAVE 1 RECRUITING

- Sample from Population of C&I customers provided by DTE and CE

- Metering contractor called to recruit participants

- $100 incentive (split between visits)

- During recruiting call, team collected data for incidence study

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# WAVE 1 INCIDENCE STUDY

Facility Types as Reported by All Facilities through Incidence Study

| Facility Type | Count | Percent |
|---|---|---|
| Apartments | 53 | 6% |
| Assembly (Churches, etc.) | 61 | 7% |
| Industry | 65 | 7% |
| Lodging | 9 | 1% |
| Medical | 47 | 5% |
| Office | 211 | 24% |
| Other/None of the above | 59 | 7% |
| Restaurant | 47 | 5% |
| Retail | 288 | 33% |
| School (College/University) | 1 | <1% |
| School (K-12) | 20 | 2% |
| Warehouse | 25 | 3% |
| **Total** | **886** | **100%** |
| Refused to Provide | 115 | -- |

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# WAVE 1 RECRUITED FACILITIES

## Participating Facilities by Facility Type and Utility

| Facility Type | CE | | DTE | | Total | |
|---|---|---|---|---|---|---|
| | Count | % | Count | % | Count | % |
| Apartments | 8 | 8% | 1 | 1% | 9 | 5% |
| Assembly | 7 | 7% | 3 | 4% | 10 | 6% |
| Industry | 10 | 9% | 2 | 3% | 12 | 7% |
| Lodging | 1 | 1% | 0 | 0% | 1 | 1% |
| Medical | 5 | 5% | 4 | 5% | 9 | 5% |
| Office | 19 | 18% | 12 | 16% | 31 | 17% |
| Other | 10 | 9% | 7 | 9% | 17 | 9% |
| Restaurant | 6 | 6% | 3 | 4% | 9 | 5% |
| Retail | 29 | 27% | 39 | 53% | 68 | 38% |
| School (K-12) | 5 | 5% | 1 | 1% | 6 | 3% |
| Warehouse | 6 | 6% | 2 | 3% | 8 | 4% |
| **Total** | **106** | **100%** | **74** | **100%** | **180** | **100%** |

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# WAVE 1 RECRUITED FACILITIES

## Locations of Facilities in the Metering Study



Legend:
- Apartments
- Assembly (Churches, etc.)
- Industry
- Lodging
- Medical
- Office
- Other
- Restaurant
- Retail
- School (K-12)
- Warehouse

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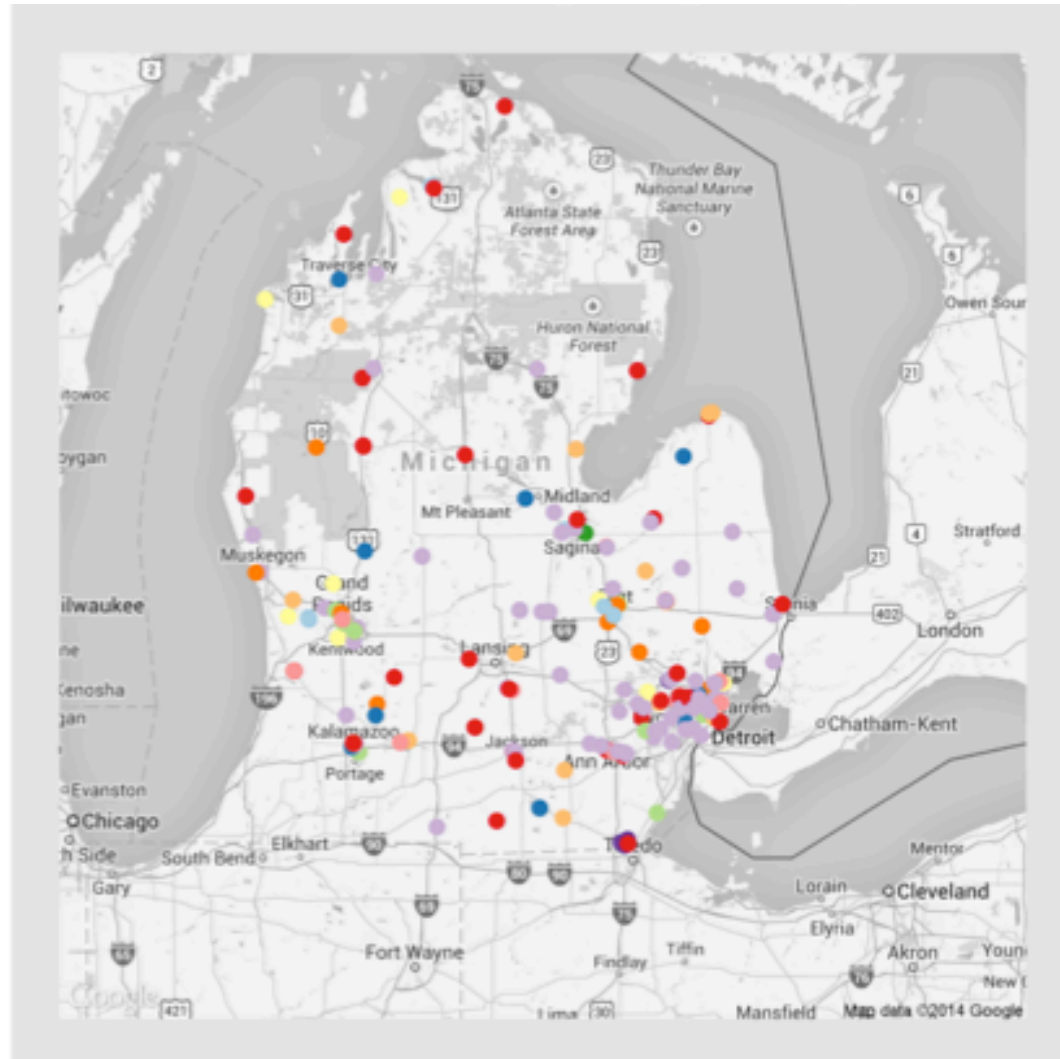
How did we come to our results?

# METHODS

# METHODS – ON-SITE

- Walkthrough of facility

- Interview with on-site representative

- Facility lighting inventory

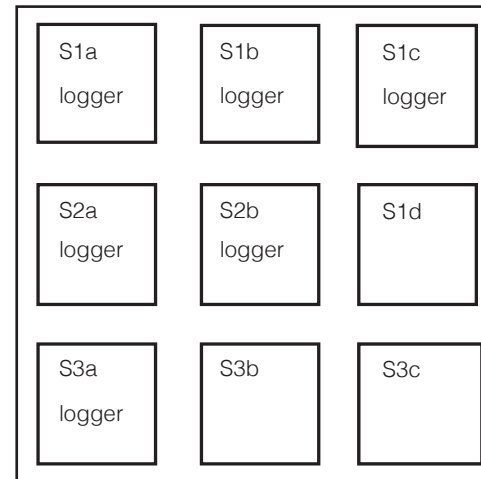- Logger installation

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# METHODS - ANALYSIS

- Cleaned logger data

- Developed daily load profiles for each site

- Converted daily load profiles to annual hours and estimated CF

- Aggregated logger data to spaces and facilities

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# METHODS - AGGREGATION

1. Aggregate to metered value by Space Type by metered space lighting load

2. Aggregate values for metered Space Types to Facility by Space lighting load

3. Aggregate values for Facilities to Facility Type by Facility Lighting Load

4. Aggregate values to C&I overall by incidence study

Facility 1a

| S1a logger | S1b logger | S1c logger |
| S2a logger | S2b logger | S1d |
| S3a logger | S3b | S3c |

Facility 1b

| S4a logger | S4b logger |
| S2a logger | S2b |

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What did we find out?

# FINDINGS

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# LIGHTING HOU

## Hours-of-Use by Facility Type

| Facility Type | HOU | Std. Dev. | Loggers (n) | Relative Precision |
|---|---|---|---|---|
| Apartments | 5,184 | 2325 | 55 | 10% |
| Assembly (Churches, etc.) | 1,686 | 1171 | 99 | 12% |
| Industry | 2,575 | 1205 | 86 | 8% |
| Lodging | 1,515 | NA | 6 | NA |
| Medical | 3,222 | 2276 | 87 | 13% |
| Office | 1,974 | 1113 | 1123 | 3% |
| Other | 1,414 | 690 | 124 | 7% |
| Restaurant | 4,046 | 1444 | 65 | 7% |
| Retail | 2,830 | 1383 | 461 | 4% |
| School (K-12) | 2,239 | 779 | 1276 | 2% |
| Warehouse | 3,587 | 1980 | 1198 | 3% |
| **Weighted Total** | **2,744** | **991.00** | **4,580** | **1%** |

# SPACE HOU BY TYPE

## Hours-of-Use by Space Type by Facility Type

| Space Type | Apartments | Assembly | Industry | Lodging | Medical | Office | Other | Restaurant | Retail | School (K-12) | Warehouse |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Assembly | 4,890 | 1,064 | NA | NA | NA | NA | 899 | NA | NA | NA | NA |
| Break Room | NA | 884 | 1,257 | NA | 1,200 | 1,829 | 1,682 | NA | 1,802 | 1,303 | 2,918 |
| Cafeteria | NA | 375 | NA | NA | NA | NA | NA | NA | NA | 2,356 | 1,775 |
| Classroom | NA | 596 | NA | NA | NA | NA | 172 | NA | 4,842 | 1,429 | NA |
| Conference | 4,035 | 488 | 1,671 | NA | 675 | 971 | 261 | NA | 1,018 | 1,221 | 1,277 |
| Dining | 1,448 | NA | NA | NA | NA | NA | 1,758 | 4,452 | NA | NA | NA |
| Equipment | NA | 707 | 780 | NA | 975 | 2,064 | 1,610 | 1,324 | 2,034 | NA | NA |
| Gym | 563 | 101 | NA | NA | NA | NA | 1,406 | NA | 6,566 | 2,545 | NA |
| Hallway | 8,528 | 1,424 | 2,995 | NA | 3,778 | 1,914 | 2,098 | 4,896 | 2,262 | 3,598 | 2,483 |
| Kitchen | 2,329 | 1,308 | 1,936 | NA | 3,818 | 2,037 | 308 | 5,081 | 1,737 | 1,626 | 1,925 |
| Library/CPU | NA | 1,782 | NA | NA | NA | NA | NA | NA | NA | 1,767 | NA |
| Office (Closed) | 1,929 | 678 | 1,620 | NA | 1,291 | 1,671 | 1,575 | 4,683 | 2,449 | 1,444 | 1,994 |
| Office (Open) | 3,020 | 2,734 | 2,334 | 8,760 | 2,455 | 2,378 | 2,223 | NA | 3,417 | 2,338 | 2,758 |
| Other | 4,366 | 2,213 | 1,215 | NA | 2,523 | 2,550 | 1,853 | NA | 3,263 | 2,111 | 2,202 |
| Production | NA | NA | 2,959 | NA | NA | 1,972 | NA | NA | 2,897 | NA | 3,351 |
| Restroom | 38 | 873 | 431 | 267 | 685 | 1,212 | 1,679 | 3,212 | 587 | 1,515 | 1,140 |
| Retail | NA | 3,184 | 2,632 | NA | 2,716 | 3,558 | NA | NA | 2,825 | NA | NA |
| Storage | 1,904 | 401 | 927 | 17 | 984 | 992 | 1,325 | 3,077 | 1,801 | 1,420 | 1,516 |
| Warehouse | NA | NA | 2,195 | NA | NA | 1,661 | 1,945 | NA | 2,550 | NA | 2,295 |

# PRELIMINARY CF

## Preliminary Coincidence Factors by Facility Type

| Facility Type | CF | Std. Dev. | Loggers (n) | Relative Precision |
|---|---|---|---|---|
| Apartments | 0.71 | 0.27 | 55 | 8% |
| Assembly (Churches, etc.) | 0.28 | 0.22 | 99 | 13% |
| Industry | 0.45 | 0.29 | 86 | 11% |
| Lodging | 0.17 | NA | 6 | NA |
| Medical | 0.59 | 0.26 | 87 | 8% |
| Office | 0.35 | 0.20 | 1123 | 3% |
| Other | 0.27 | 0.18 | 124 | 10% |
| Restaurant | 0.78 | 0.25 | 65 | 6% |
| Retail | 0.61 | 0.29 | 461 | 4% |
| School (K-12) | 0.19 | 0.17 | 1276 | 4% |
| Warehouse | 0.52 | 0.30 | 1198 | 3% |
| **Weighted Total** | **0.51** | **0.18** | **4,580** | **1%** |

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# SPACE CF BY TYPE

## Preliminary Coincidence Factors, by Space Type

| Space Type | Facility Type | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Apartments | Assembly | Industry | Lodging | Medical | Office | Other | Restaurant | Retail | School (K-12) | Warehouse |
| Assembly | 0.62 | 0.14 | NA | NA | NA | NA | 0.18 | NA | NA | NA | NA |
| Break Room | NA | 0.21 | 0.20 | NA | 0.24 | 0.38 | 0.25 | NA | 0.39 | 0.06 | 0.49 |
| Cafeteria | NA | 0.07 | NA | NA | NA | NA | NA | NA | NA | 0.22 | 0.21 |
| Classroom | NA | 0.05 | NA | NA | NA | NA | 0.12 | NA | 0.81 | 0.12 | NA |
| Conference | 0.66 | 0.06 | 0.32 | NA | 0.06 | 0.19 | 0.04 | NA | 0.25 | 0.12 | 0.25 |
| Dining | 0.17 | NA | NA | NA | NA | NA | 0.33 | 0.88 | NA | NA | NA |
| Equipment | NA | 0.06 | 0.09 | NA | 0.26 | 0.36 | 0.33 | 0.09 | 0.37 | NA | NA |
| Gym | 0.18 | 0.00 | NA | NA | NA | NA | 0.88 | NA | 0.89 | 0.21 | NA |
| Hallway | 0.98 | 0.27 | 0.58 | NA | 0.75 | 0.33 | 0.44 | 0.93 | 0.51 | 0.35 | 0.41 |
| Kitchen | 0.37 | 0.21 | 0.44 | NA | 0.86 | 0.32 | 0.03 | 0.99 | 0.42 | 0.12 | 0.35 |
| Library/CPU | NA | 0.20 | NA | NA | NA | NA | NA | NA | NA | 0.12 | NA |
| Office (Closed) | 0.48 | 0.11 | 0.25 | NA | 0.31 | 0.29 | 0.27 | 0.92 | 0.51 | 0.13 | 0.35 |
| Office (Open) | 0.68 | 0.54 | 0.37 | 1.00 | 0.54 | 0.44 | 0.45 | NA | 0.60 | 0.20 | 0.46 |
| Other | 0.56 | 0.44 | 0.31 | NA | 0.48 | 0.44 | 0.16 | NA | 0.67 | 0.28 | 0.41 |
| Production | NA | NA | 0.42 | NA | NA | 0.42 | NA | NA | 0.70 | NA | 0.48 |
| Restroom | 0.01 | 0.16 | 0.06 | 0.03 | 0.15 | 0.21 | 0.29 | 0.60 | 0.11 | 0.12 | 0.21 |
| Retail | NA | 0.35 | 0.36 | NA | 0.42 | 0.70 | NA | NA | 0.66 | NA | NA |
| Storage | 0.49 | 0.06 | 0.10 | 0.00 | 0.15 | 0.13 | 0.26 | 0.51 | 0.40 | 0.12 | 0.24 |
| Warehouse | NA | NA | 0.27 | NA | NA | 0.30 | 0.23 | NA | 0.52 | NA | 0.38 |

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What type of buildings did we meter?

# CHARACTERISTICS

# WAVE 1 FACILITY SIZE

## Square Footage by Facility Type in Wave 1

| Facility Type | Count | Mean | S.D. |
|---|---|---|---|
| Apartments | 9 | 3,644 | 3,880 |
| Assembly (e.g., churches) | 7 | 36,000 | 67,863 |
| Industry | 9 | 14,759 | 18,528 |
| Medical | 7 | 3,986 | 3,040 |
| Office | 24 | 4,337 | 5,700 |
| Other | 11 | 8,059 | 12,816 |
| Restaurant | 6 | 3,029 | 943 |
| Retail | 52 | 5,857 | 8,088 |
| School (K-12) | 1 | 38,000 | NA |
| Warehouse | 8 | 29,288 | 63,371 |
| **Total** | **134** | **14,696** | **23,845** |

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# OFFICE FACILITY SIZE TO HOU



Office Facility Lighting HOU by Facility Size, Wave 1 and LCS
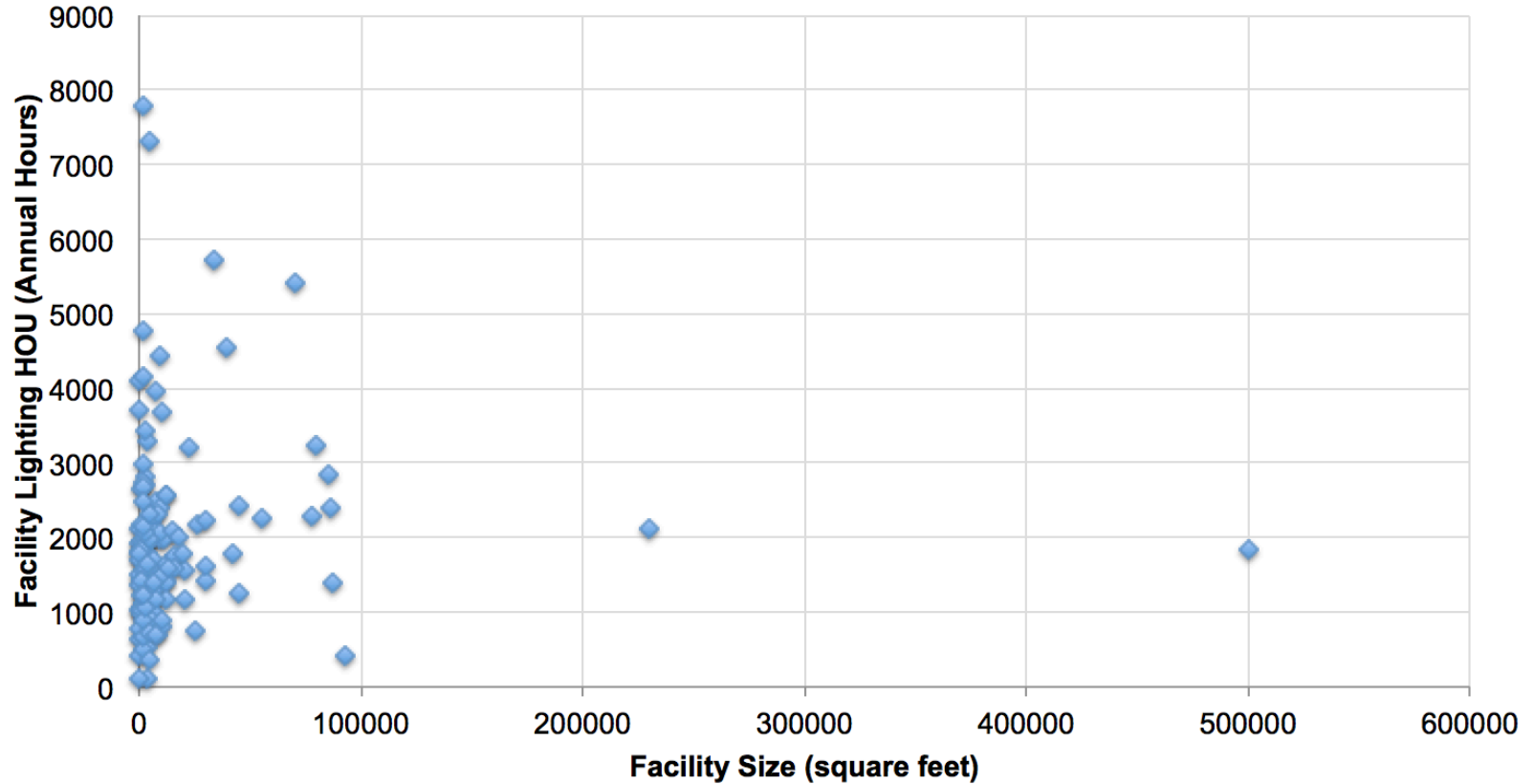
# OFFICE FACILITY SIZE TO HOU CONTINUED



Office Facility Lighting HOU by Facility Size, Wave 1 and LCS
Facilities Less than 100,000 Square Feet
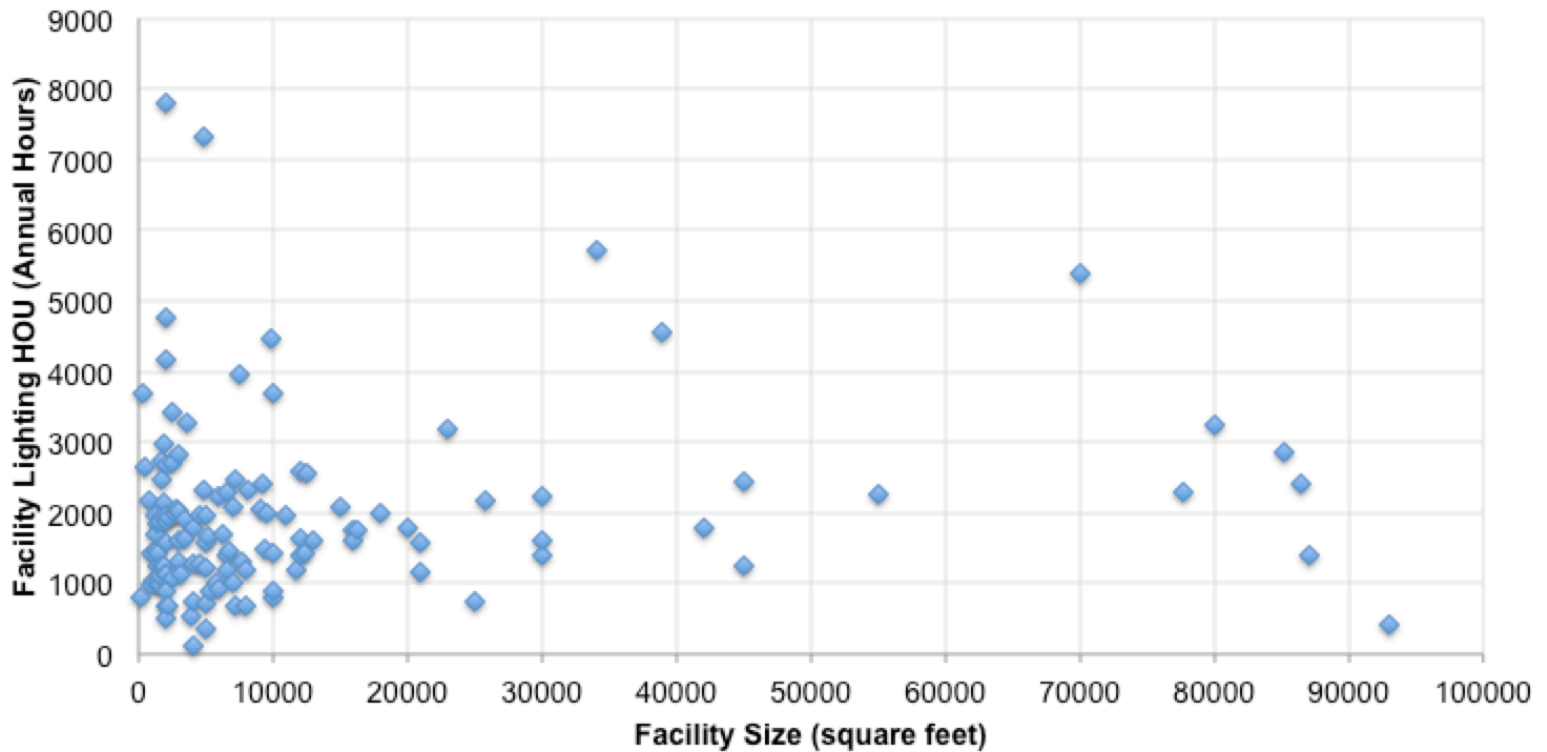
# HEATING EQUIPMENT

## Heating Type Inventory by Space in Wave 1

| Heating Type | Number of Spaces | Percent |
|---|---:|---:|
| Boiler (Hot Water) | 631 | 19.4% |
| Boiler (Steam) | 170 | 5.2% |
| Electric Resistance | 24 | 0.7% |
| Gas Furnace | 1,584 | 48.8% |
| Gas Furnace (Condensing) | 171 | 5.3% |
| Heat Pump (Air) | 3 | 0.1% |
| Heat Pump (Geothermal) | 174 | 5.4% |
| None | 70 | 2.2% |
| Other | 112 | 3.4% |
| Radiant | 11 | 0.3% |
| Unknown | 299 | 9.2% |
| **Total** | **3,249** | **100.0%** |

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# COOLING EQUIPMENT

Cooling Type Inventory by Space

| Cooling Type | Number of Spaces | Percent |
|---|---|---|
| Chiller Air Cooled | 47 | 1.4% |
| Chiller Centrifugal | 123 | 3.8% |
| Chiller Scroll | 38 | 1.2% |
| Direct Expansion | 1,710 | 52.6% |
| Heat Pump Air | 3 | 0.1% |
| Heat Pump Geo | 175 | 5.4% |
| None | 771 | 23.7% |
| Other | 71 | 2.2% |
| Unknown | 311 | 9.6% |
| **Total** | **3,249** | **100.0%** |

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# QUESTIONS?

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# APPENDIX SLIDES

# EXAMPLE LOAD PROFILE