Data Center Energy Efficiency

Assessment Report Template

Version: 2.0

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Purpose

This document is part of [DCEE Toolkit](https://datacenters.lbl.gov/tools). It provides a framework for reporting the results of a data center assessment.

Instructions Provided

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Process

Read the Energy Assessment Process Manual (<https://datacenters.lbl.gov/resources/assessment-resources-energy-training-assessment-process-manual>).

Review the Data Center Energy Efficiency Assessment Workbook v2.0. Determine which data center systems to examine and to what level of detail.

Expand the Assessment Workbook if needed. For example, if you are assessing three chillers instead of two, add a third chiller. Further instructions are provided in the Assessment Workbook.

Determine the data that needs to be collected, and create a workplan for obtaining the data.

In this Template, delete all material that does not apply to your assessment, or hide material that you may wish to return to later.

The Template uses Word’s Captions and Cross-Referencing features, so Tables, Figures, and other items can be renumbered easily. See Formatting, below.

Transfer the information from the Assessment Workbook, and any other Tools exercised, to this Template. Pointers to the source locations are provided in this Template.

Blue highlights throughout document indicate items to be updated to reflect the actual data center facility being assessed. Replace the blue-highlighted text with information that applies to your facility, and then remove the highlighting.

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Agency/Company Logo

**Name of Facility**

Address of facility

**Data Center Energy Efficiency Assessment**

Assessor and affiliation

**Final/Draft Report**

Date

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This report uses preliminary information from vendor data and technical references. The report, by itself, is not intended as a basis for the engineering required to adopt any of the recommendations. Its intent is to inform the site of potential energy saving opportunities and very rough cost savings. The purpose of the recommendations and calculations is to determine whether measures warrant further investigation.

**Authors**

Name - qualified assessor

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# Abbreviations

|  |  |
| --- | --- |
| **AC** | Alternating Current |
| **ACU** | Air Conditioning Unit |
| **AHU** | Air Handling Unit |
| **ASE** | Air Side Economizer |
| **ASHRAE** | American Society of Heating, Refrigerating, and Air-Conditioning Engineers |
| **BAS** | Building Automation System |
| **CRAC** | Computer Room Air-Conditioner (with internal refrigerant compressor) |
| **CRAH** | Computer Room Air Handler (with chilled water coil) |
| **dP** | Differential Pressure |
| **DP** | Dew Point Temperature |
| **EC** | Electronically Commutated |
| **dT** | Differential Temperature |
| **ECM** | Electronically Commutated Motor |
| **EEM** | Energy Efficiency Measure |
| **EER** | Energy Efficiency Ratio |
| **EMCS** | Energy Monitoring and Control System |
| **deg F** | degrees Fahrenheit |
| **FCU** | Fan Coil Unit |
| **HVAC** | Heating, Ventilating, and Air Conditioning |
| **IT** | Information Technology |
| **kW** | kiloWatts of real power |
| **kWh** | kiloWatt hour |
| **MWh/yr** | MegaWatt Hours per year (thousands of kWh/yr) |
| **PDU** | Power Distribution Unit |
| **PF** | Power Factor (ratio of kW/kVA) |
| **PUE** | Power Usage Effectiveness |
| **RAT** | Return Air Temperature |
| **RCI** | Rack Cooling Index |
| **RTI** | Return Temperature Index |
| **RH** | Relative Humidity |
| **SAT** | Supply Air Temperature |
| **sf** | square feet |
| **UPS** | Uninterruptible Power Supply |
| **V** | Volts |
| **VFD** | Variable Frequency Drive (for operating motors at variable speed) |
| **W/sf** | watts per square foot |
| **WSE** | Water Side Economizer |

# Executive Summary

Summarize the basic information: who sponsored the energy assessment, purpose of the assessment, the contractor, site name and region where it is located. Also include a brief description of the site including limitations faced when conducting the energy assessment.

[Sponsor, purpose, contractor, site name, region, description, limitations.]

Based on the assessment described in this report, the estimated total annual energy cost savings, and the reduction in annual average Power Usage Effectiveness (PUE) of the facility, are as shown in **Table 1**.

**Table 1 - Potential Total Savings**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: EEM Summary

Table: Potential Total Savings

|  |  |  |  |
| --- | --- | --- | --- |
|  | Current | Projected | Savings |
| Annual Energy Cost | $xxx,xxx | $xxx,xxx | Xx% |
| PUE | x.xx | x.xx | Xx% |

**Figure 1** is a duplicate of **Figure 4**. After **Figure 4** is finished, copy and paste it over the placeholder chart in **Figure 1**.



**Figure 1 - Current Data Center Energy Use Breakouts**

Figure 2 is a duplicate of Figure 15. After Figure 15 is finished, copy and paste it over the placeholder chart in Figure 2.



**Figure 2 - Projected Data Center Energy Use Breakouts**

## Energy Efficiency Measures (EEMs)

**Table 2** summarizes the energy efficiency measures, potential savings, and estimated payback identified by the assessment. Further details about each EEM are provided in Section 11: Recommended Energy Efficiency Measures.

**Error! Reference source not found.**

Based on an estimated energy cost of $xxx/kWh, energy cost savings of approximately $xx,xxx per year are possible through the EEMs recommended in **Table 2** with an average payback period of xx years. These recommendations represent approximately xx% energy savings in overall data center energy consumption (relative to the xxxx baseline). If all of the recommended EEMs are implemented, the overall power usage effectiveness (PUE) could be improved from the current estimated value of x.x to x.x.

**Table 2 -** **Summary of Recommended EEMs - Savings, Cost and Payback**

Table 2 is a duplicate of Table 164. After Table 164 is finished, copy and paste it over the placeholder table in Table 2.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| EEM Number | EEM Name | Installed Cost | Annual Average Power Demand Savings | Annual Electric Energy Savings | Annual Energy Cost Savings | Simple Payback |
| $ | kW | kWh/yr | $/yr | years |
| EEM 1 |  |  |  |  |  |  |
| EEM 2 |  |  |  |  |  |  |
| EEM 3 |  |  |  |  |  |  |
| EEM 4 |  |  |  |  |  |  |
| EEM 5 |  |  |  |  |  |  |
| All EEMs Combined | |  |  |  |  |  |

Summarize additional high-level findings and relevant updates since the assessment began.

# Facility Overview

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: WholeFacility

Table: Whole Facility: Overview

[Facility overview ]

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: WholeFacility\_Diagram



**Figure 3 - Building Floorplan Showing the Data Centers**

**Table 3 – Whole Facility: Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: Whole Facility

Table: Whole Facility: Observations

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Answer | Date | Notes |
| Year Built |  |  |  |
| State/Region |  |  |  |
| County |  |  |  |
| Climate Zone |  |  |  |
| Is the data center facility is embedded in a larger building? (Yes, No) |  |  |  |
| Is there a central cooling plant? (Yes, No) |  |  |  |
| Is the central cooling plant dedicated to the data center? (Yes, No) |  |  |  |
| What is the floor area of support spaces (UPS, generator,etc)? |  |  |  |
| Data center cooling system type (Air-Cooled DX, Water-Cooled DX, Evaporatively-Cooled DX, Chilled Water) |  |  |  |
| Has an energy audit been conducted within the last two years? (Yes, No) |  |  |  |
| Is there a written energy management plan? (Yes, No) |  |  |  |
| Is there an energy management and calibration program in place? (Yes, No) |  |  |  |
| Is there a preventative maintenance program in place? (Yes, No) |  |  |  |

If you already have a data set that includes annual profiles of outdoor air temperature and humidity for a typical meteorological year at the data center’s location, then you can delete **Table 4**. If you install outdoor air temperature and humidity sensors and record your own data, **Table 4** holds the results.

**Table 4 – Outdoor Temperature and Humidity**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: Whole Facility

Table: Whole Facility: Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| Outdoor Air Drybulb Temperature Annual Profile | deg F vs time | See Appendix X. |  |  |
| Outdoor Air Relative Humidity Annual Profile | % vs time | See Appendix X. |  |  |

**Table 5 - Total IT Equipment Load**

**Table 5** is a duplicate of **Table 36**. After **Table 36** is finished, copy and paste it over the placeholder table in **Table 5**.

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| Total Gross Floor Area | sf |  |  |
| Total Electrically Active Floor Area | sf |  |  |
| Total Rack Quantity |  |  |  |
| Total IT Power Demand, Annual Profile | kW vs time |  |  |
| IT Annual Energy Use | MWh/yr |  |  |
| IT Annual Average Power Demand | kW |  |  |
| IT Peak Power Demand, Actual | kW |  |  |
| IT Average Power Density | W/sf |  |  |
| IT Peak Power Density, Actual | W/sf |  |  |
| IT Peak Power Density, Design | W/sf |  |  |
| IT Average Rack Power Density, Actual | kW/rack |  |  |
| IT Average Rack Power Density, Design | kW/rack |  |  |
| Current Space Usage Factor | % |  |  |

# Facility Energy Use

## Purchased Energy

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: PurchasedEnergy

Table: Overview of Purchased Energy

[Overview of purchased energy]

**Table 6 – Purchased Energy**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: PurchasedEnergy

Table: Purchased Energy

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Electric | | Fuel | | Cooling Water | | Steam | | Notes |
| Units | Answer | Units | Answer | Units | Answer | Units | Answer |
| The data center facility as a whole uses this type of purchased energy. (Yes, No) |  |  |  |  |  |  |  |  |  |
| Does a meter exist that records this type of energy for the entire data center facility being assessed, and no other facilities? (Yes, No) |  |  |  |  |  |  |  |  |  |
| Annual Energy Use | MWh/yr |  | therms/ yr |  | ton-hrs/yr |  | MMBTU/ yr |  |  |
| Peak Demand | kW |  | therms/day |  | tons |  | kBTU |  |  |
| Annual Energy Cost | $/yr |  | $/yr |  | $/yr |  | $/yr |  |  |
| Annual Average Energy Cost | $/kWh |  | $/therm |  | $/ton-hr |  | $/kBTU |  |  |
| Source Factor |  |  |  |  |  |  |  |  |  |

**Table 7 – Site vs Source Energy**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: PurchasedEnergy

Table: Purchased Energy: Calculations

|  |  |  |
| --- | --- | --- |
| Parameter | Units | Value |
| Annual Electric Energy Use, Site | MMBTU/yr |  |
| Annual Electric Energy Use, Source | MMBTU/yr |  |
| Annual Fuel Use, Site | MMBTU/yr |  |
| Annual Fuel Use, Source | MMBTU/yr |  |
| Annual Purchased Cooling Water Use, Site | MMBTU/yr |  |
| Annual Purchased Cooling Water Use, Source | MMBTU/yr |  |
| Annual Purchased Steam Use, Site | MMBTU/yr |  |
| Annual Purchased Steam Use, Source | MMBTU/yr |  |
| Annual Total Energy Use, Site | MMBTU/yr |  |
| Annual Total Energy Use, Source | MMBTU/yr |  |
| Annual Total Energy Use Cost | $/yr |  |
| Site Energy Use Intensity | BTU/yr/sf |  |
| Source Energy Use Intensity | BTU/yr/sf |  |
| Purchased Energy Cost Intensity | $/yr/sf |  |

## Overall Energy Use

The total electrical demand was on average approximately xxx kW with a yearly energy use of approximately x.x GWh/yr. Approximately xx% of this energy use was related to the IT equipment. The data center was [not] separately sub-metered. The assessment team estimated the data center energy use through a combination of [temporary sub-metering, equipment energy use estimates, spot measurements, and spreadsheet calculations].

## IT Equipment Energy Use

**Table 8** summarizes IT equipment energy use.

Some data centers have multiple rooms, or areas within a single room that are significantly different in terms of load density or equipment type. Some data centers are a single, homogenous room. Expand/contract **Table 8** as needed for your situation.

**Table 8 - IT Equipment Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_IT

Table: IT Equipment: Individual Rooms/Areas: Calculations: Energy Use

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| Room/Area 111 | | | |
| IT Annual Energy Use | MWh/yr |  |  |
| IT Annual Average Power Demand | kW |  |  |
| IT Peak Power Demand Actual | kW |  |  |
| Room/Area 222 | | | |
| IT Annual Energy Use | MWh/yr |  |  |
| IT Annual Average Power Demand | kW |  |  |
| IT Peak Power Demand Actual | kW |  |  |

## Power Usage Effectiveness (PUE)

PUE is a metric for how efficiently a data center’s infrastructure delivers power and cooling, and is defined as the ratio of total data center facility energy to the power consumption of the IT equipment itself.

(Eq. 1)

IT equipment consists of servers, switches, and other computing and storage devices, while the non-IT equipment includes everything else serving the data center such as cooling systems, fans, lighting, generators, and electrical transformation and distribution losses. The theoretical PUE limit of 1.0 is not achievable as all data centers require some level of non-IT energy consumption. However, lower PUEs (i.e., closer to 1.0) indicate more efficient data center support systems.

## Data Center Energy End Uses

The electrical end use breakdown associated with the data center space is shown in **Table 9** and illustrated in **Figure 4**. This breakdown is based on data collected during Month/Year site visit. It shows a baseline PUE of approximately x.x, prior to subsequent potential improvements described in Section 11: Recommended Energy Efficiency Measures.

**Table 9 - Summary of Data Center Electrical End Uses**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: FacilityEnergyUse

Table: Current Energy Use Breakout

Delete rows that are not applicable.

|  |  |  |  |
| --- | --- | --- | --- |
| End Use | Average Power Demand (kW) | Percent of Data Center Total (%) | Notes |
| IT Equipment |  |  |  |
| Main Transformer Loss |  |  |  |
| UPS Loss |  |  |  |
| PDU Loss |  |  |  |
| Generator Engine Block Heaters |  |  |  |
| Lighting |  |  |  |
| CRAC/ACU/CRAH/AHUs minus Humidifiers |  |  |  |
| CRAC/ACU/CRAH/AHU Humidifiers |  |  |  |
| Built-Up ASE Fans |  |  |  |
| Condenser/Dry Cooler Fans |  |  |  |
| Chillers |  |  |  |
| Water Side Economizer Pumps |  |  |  |
| Cooling Towers |  |  |  |
| Chilled Water Pumps |  |  |  |
| Condenser Water Pumps |  |  |  |
| Total |  |  |  |
| **PUE (Total Energy Use / IT Energy Use)** |  |  |  |

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: BreakoutChart\_Current

**Figure 4** is constructed from the data in **Table 9**. When it is finished, copy and paste the **Figure 4** chart into **Figure 1**.



**Figure 4 - Current Data Center Energy Use Breakouts**

**(xxx MWh/yr total; PUE = x.x, Month/Year)**

# Electric Distribution System

Energy loss in the data center’s electric distribution system degrades overall data center efficiency, but it is not necessary to isolate and quantify this loss in order to calculate the data center’s overall PUE. If you elect to not assess the distribution system at this time, you can delete this entire Electric Distribution System section.

For the purpose of this data center assessment, “electric distribution system” refers to the

main distribution transformers, the uninterruptible power supply (UPS), the power distribution units (PDUs), and the standby generator engine block heaters. End-use energy (IT Equipment, lights, cooling equipment, etc) is addressed in later sections.

This section quantifies how much energy is being lost as heat in the transformers, UPS, PDUs, and how much energy is being used by the generator engine block heaters.

An evaluation of the electric distribution system’s performance metrics is presented in Section 10.

## Overview

Provide a brief description of the electric distribution system as a whole.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Summary

Table: Electric Distribution System: Overview

[Overview of electric distribution system]

**Figure 5** is a simplified schematic of the data center’s electric system.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Diagram

This example diagram shows the electric system assumed by the Assessment Workbook. Create and insert a diagram that reflects the actual facility. Show the existing electric meter locations.



**Figure 5 - Electric Distribution System Diagram**

**Table 10 - Electric Distribution System: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Summary

Table: Electric Distribution System: Specifications & Observations

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Answer | Date | Notes |
| Is a power analyzer installed at the main feeder panel for critical components? |  |  |  |
| Is an Infra-Red test performed on electrical systems regularly? |  |  |  |

## Energy Loss

**Table 11** summarizes the electric distribution system losses by subsystem.

**Table 11 - Electric Distribution System: Subsystem Energy Loss**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Summary

Table: Electric Distribution System: Subsystem Energy Loss

Delete any subsystems that are not applicable.

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| All Main Transformers Combined | | | |
| Annual Energy Loss | MWh/yr |  |  |
| Annual Average Power Loss | kW |  |  |
| All UPS Units Combined | | | |
| Annual Energy Loss | MWh/yr |  |  |
| Annual Average Power Loss | kW |  |  |
| All PDUs Combined | | | |
| Annual Energy Loss | MWh/yr |  |  |
| Annual Average Power Loss | kW |  |  |
| All Generator Engine Block Heaters Combined | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |

### Main Transformers

If the main transformers are not being assessed, you can delete this entire Main Transformers section. Note that transformer energy loss must still be accounted for when calculating the data center PUE.

#### Overview

Provide a brief description of the main transformers. This report template currently assumes there are five such transformers, as shown in **Figure 5**.

* Whole Facility Transformer
* IT Power Chain Transformer
* Data Center Air Side Cooling System Transformer
* Cooling Plant Transformer
* Lighting System Transformer

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Xformers

Table: Main Transformers: Overview

[Overview of main transformers]

#### All Main Transformers Combined

**Table 12** shows the total energy loss of all main transformers combined. Individual main transformers are addressed in the following section.

**Table 12 - Electric Distribution System: All Main Transformers Combined: Energy Loss**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Xformers

Table: All Transformers Combined: Calculations: Energy Loss

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Annual Energy Loss | MWh/yr |  |  |
| Annual Average Power Loss | kW |  |  |

#### Individual Main Transformers

If the assessment does not include the performance of individual Main Transformers, delete this Individual Transformers section.

**Table 13** presents information collected for each main transformer.

**Table 13 - Electric Distribution System: Individual Main Transformers: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Xformers

Table: Individual Transformers: Specifications & Observations

Delete any transformers that are not applicable.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Units** | **Whole Facility Transformer** | **IT Power Chain Transformer** | **Data Center Air Side Cooling System Transformer** | **Cooling Plant Transformer** | **Lighting System Transformer** | **Notes** |
| Manufacturer |  |  |  |  |  |  |  |
| Model |  |  |  |  |  |  |  |
| Age | years |  |  |  |  |  |  |
| Type (Temp Rise 80C, Temp Rise >80C, TP1, EPACT 2005) |  |  |  |  |  |  |  |
| Serial Number |  |  |  |  |  |  |  |
| Rated Capacity | kVA |  |  |  |  |  |  |
| Input Voltage (208, 480, 600, Other) | V |  |  |  |  |  |  |
| Load imbalance between phases (<=20%, >20%) |  |  |  |  |  |  |  |
| Is there an existing, trusted meter that measures the electric power input to this transformer, only? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |  |  |  |
| Is there an existing, trusted meter that measures the electric power output from this transformer, only? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |  |  |  |
| Is there an existing, trusted meter that measures the Power Factor at the input to this transformer? (None, Instantaneous Only, Average, PF Trends) |  |  |  |  |  |  |  |
| Is there an existing, trusted meter that measures the Total Harmonic Distortion at the input to this transformer? (None, Instantaneous Only, Average, THD Trends) |  |  |  |  |  |  |  |
| Date of Observations |  |  |  |  |  |  |  |
| Transformer Energy Input Total for a Past Year | MWh/yr |  |  |  |  |  |  |
| Transformer Power Input Profile for a Past Year | kW vs time |  |  |  |  |  |  |
| Date Span of Past Year's Data |  |  |  |  |  |  |  |
| Transformer Energy Output Total for a Past Year | MWh/yr |  |  |  |  |  |  |
| Transformer Power Output Profile for a Past Year | kW vs time |  |  |  |  |  |  |
| Date Span of Past Year's Data |  |  |  |  |  |  |  |
| Power Factor Average for a Past Year |  |  |  |  |  |  |  |
| Power Factor Profile for a Past Year | PF vs time |  |  |  |  |  |  |
| Date Span of Past Year's Data |  |  |  |  |  |  |  |
| THD Average for a Past Year |  |  |  |  |  |  |  |
| THD Profile for a Past Year | THD vs time |  |  |  |  |  |  |
| Date Span of Past Year's Data |  |  |  |  |  |  |  |

If all of the meters referred to in **Table 13** exist and have useable data, then measurement instruments will not be needed and **Table 14** can be deleted.

[Existing meters were/meter data was] not available for [transformers]. To establish a complete picture of transformer performance, we installed a [temporary] meter/[temporary] meters and performed the following measurements.

**Table 14 - Electric Distribution System: Individual Main Transformers: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Xformers

Table: Individual Transformers: Measurements

Delete any transformers that are not applicable.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| Whole Facility Transformer | | | | |
| Power Input, Annual Profile | kW vs time |  |  |  |
| Power Output, Annual Profile | kW vs time |  |  |  |
| Power Factor, Annual Profile | PF vs time |  |  |  |
| Total Harmonic Current Distortion, Annual Profile | THD vs time |  |  |  |
| IT Power Chain Transformer | | | | |
| Power Input, Annual Profile | kW vs time |  |  |  |
| Power Output, Annual Profile | kW vs time |  |  |  |
| Data Center Air Side Cooling System Transformer | | | | |
| Power Input, Annual Profile | kW vs time |  |  |  |
| Power Output, Annual Profile | kW vs time |  |  |  |
| Cooling Plant Transformer | | | | |
| Power Input, Annual Profile | kW vs time |  |  |  |
| Power Output, Annual Profile | kW vs time |  |  |  |
| Lighting System Transformer | | | | |
| Power Input, Annual Profile | kW vs time |  |  |  |
| Power Output, Annual Profile | kW vs time |  |  |  |

Annual energy loss for each main transformer is listed in **Table 15**.

**Table 15 - Electric Distribution System: Individual Main Transformers: Energy Loss**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Xformers

Table: Individual Transformers: Calculations: Energy Loss

Delete any transformers that are not applicable.

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Whole Facility Transformer | | | |
| Annual Input Energy | MWh/yr |  |  |
| Annual Average Input Power | kW |  |  |
| Annual Output Energy | MWh/yr |  |  |
| Annual Average Output Power | kW |  |  |
| Annual Energy Loss | MWh/yr |  |  |
| Annual Average Power Loss | kW |  |  |
| IT Power Chain Transformer | | | |
| Annual Input Energy | MWh/yr |  |  |
| Annual Average Input Power | kW |  |  |
| Annual Output Energy | MWh/yr |  |  |
| Annual Average Output Power | kW |  |  |
| Annual Energy Loss | MWh/yr |  |  |
| Annual Average Power Loss | kW |  |  |
| Data Center Air Side Cooling System Transformer | | | |
| Annual Input Energy | MWh/yr |  |  |
| Annual Average Input Power | kW |  |  |
| Annual Output Energy | MWh/yr |  |  |
| Annual Average Output Power | kW |  |  |
| Annual Energy Loss | MWh/yr |  |  |
| Annual Average Power Loss | kW |  |  |
| Cooling Plant Transformer | | | |
| Annual Input Energy | MWh/yr |  |  |
| Annual Average Input Power | kW |  |  |
| Annual Output Energy | MWh/yr |  |  |
| Annual Average Output Power | kW |  |  |
| Annual Energy Loss | MWh/yr |  |  |
| Annual Average Power Loss | kW |  |  |
| Lighting System Transformer | | | |
| Annual Input Energy | MWh/yr |  |  |
| Annual Average Input Power | kW |  |  |
| Annual Output Energy | MWh/yr |  |  |
| Annual Average Output Power | kW |  |  |
| Annual Energy Loss | MWh/yr |  |  |
| Annual Average Power Loss | kW |  |  |

### UPS System

If there are no UPS units, you can delete this entire UPS System section.

If you elect not to assess UPS performance at this time, note that UPS energy loss must still be accounted for when calculating the data center PUE.

#### Overview

Provide a brief description of the UPS system.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_UPS

Table: UPS System: Overview

[Overview of UPS system]

#### All UPS Units Combined

**Table 16** presents information that applies to the UPS system as a whole (all UPS units combined).

**Table 16 - Electric Distribution System: All UPS Units Combined: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_UPS

Table: All UPS Units Combined: Specifications & Observations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Answer | Dates | Notes |
| Is there a UPS? (Yes, No) |  |  |  |  |
| UPS redundancy configuration (N, N+1, 2N) |  |  |  |  |
| What is the power source for non-critical loads? (UPS, Utility Power) |  |  |  |  |
| Is there an existing, trusted meter that measures the total power input to All UPS Units Combined, only? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |
| Total Energy Input for All UPS Units Combined for a Past Year | MWh/yr |  |  |  |
| Power Input Profile for All UPS Units Combined for a Past Year | kW vs time |  |  |  |

If the meter referred to in **Table 16** exists and has useable data, then a measurement instrument will not be needed and **Table 17** can be deleted.

[An existing meter/meter data] was not available for the total UPS system input. We installed a [temporary] meter/[temporary] meters and performed the following measurement.

**Table 17 - Electric Distribution System: All UPS Units Combined: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_UPS

Table: All UPS Units Combined: Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| Power Input Annual Profile for All UPS Units Combined | kW vs time |  |  |  |

**Table 18** shows the total energy loss of all UPS units combined. Energy loss of individual UPS units are addressed in the following section.

**Table 18 - Electric Distribution System: All UPS Units Combined: Energy Loss**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_UPS

Table: All UPS Units Combined: Calculations: Energy Loss

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Total Power Output Profile | kW vs time |  |  |
| Annual Total Energy Input | MWh/yr |  |  |
| Annual Total Energy Output | MWh/yr |  |  |
| Annual Total Energy Loss | MWh/yr |  |  |
| Annual Average Input Power | kW |  |  |
| Annual Average Output Power | kW |  |  |
| Annual Average Power Loss | kW |  |  |

#### Individual UPS Units

If the assessment will not include the performance of individual UPS Units, you can delete this Individual UPS Units section.

**Table 19** presents information collected for each UPS unit.

**Table 19 - Electric Distribution System: Individual UPS Units: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_UPS

Table: Individual UPS Units: Specifications & Observations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | UPS-1 | UPS-2 | Notes |
| Manufacturer |  |  |  |  |
| Model |  |  |  |  |
| Serial Number |  |  |  |  |
| Age | years |  |  |  |
| Rated Capacity | kW |  |  |  |
| Type (Double Conversion, Rotary, etc) |  |  |  |  |
| Input Voltage (208, 480, 600, Other) | V |  |  |  |
| Output Voltage (120/208/480 VAC, Direct Current) | V |  |  |  |
| UPS load imbalance between phases (<=20%, >20%) |  |  |  |  |
| Is the UPS operating in eco-mode? (Yes, No) |  |  |  |  |
| Are the UPS DC capacitors >5 years old? (Yes, No) |  |  |  |  |
| Is there an existing, trusted meter that measures this UPS's power input alone? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |
| Is there an existing, trusted meter that measures this UPS's power output alone? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |
| Date of Observations |  |  |  |  |
| UPS Energy Input Total for a Past Year | MWh/yr |  |  |  |
| UPS Power Input Profile for a Past Year | kW vs time |  |  |  |
| Date Span of Past Year's Data |  |  |  |  |
| UPS Energy Output Total for a Past Year | MWh/yr |  |  |  |
| UPS Power Output Profile for a Past Year | kW vs time |  |  |  |
| Date Span of Past Year's Data |  |  |  |  |

If all of the meters referred to in **Table 19** exist and have useable data, then measurement instruments will not be needed and **Table 20** can be deleted.

[Existing meters were/meter data was] not available for [UPS units]. To establish a complete picture of UPS performance, we installed a [temporary] meter/[temporary] meters and performed the following measurements.

**Table 20 - Electric Distribution System: Individual UPS Units: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_UPS

Table: Individual UPS Units: Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| UPS-1 | | | | |
| Power Input, Annual Profile | kW vs time |  |  |  |
| Power Output, Annual Profile | kW vs time |  |  |  |
| UPS-2 | | | | |
| Power Input, Annual Profile | kW vs time |  |  |  |
| Power Output, Annual Profile | kW vs time |  |  |  |

Annual energy loss for each UPS unit is listed in **Table 21**

**Table 21 - Electric Distribution System: Individual UPS Units: Energy Loss**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_UPS

Table: Individual UPS Units: Calculations: Energy Loss

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| UPS-1 | | | |
| Annual Input Energy | MWh/yr |  |  |
| Annual Output Energy | MWh/yr |  |  |
| Annual Energy Loss | MWh/yr |  |  |
| Annual Average Input Power | kW |  |  |
| Annual Average Output Power | kW |  |  |
| Annual Average Power Loss | kW |  |  |
| UPS-2 | | | |
| Annual Input Energy | MWh/yr |  |  |
| Annual Output Energy | MWh/yr |  |  |
| Annual Energy Loss | MWh/yr |  |  |
| Annual Average Input Power | kW |  |  |
| Annual Average Output Power | kW |  |  |
| Annual Average Power Loss | kW |  |  |

### Power Distribution Units (PDUs)

Include only PDUs that contain transformers. If none of the PDUs have transformers, you can delete this entire PDUs section.

If the PDUs do contain transformers but you elect not to assess their performance at this time, note that PDU energy loss must still be accounted for when calculating the data center PUE.

#### All Rooms/Areas Combined: Overview

Provide a brief description of all the PDUs as a whole. Overviews of PDUS by room/area are entered in later sections.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_PDUs\_Summary

Table: PDUs: All Rooms/Areas Combined: Overview

[Overview of PDUs in all rooms/areas combined]

#### All Rooms/Areas Combined: Energy Loss

**Table 22** shows the total energy loss of all PDUs in all rooms/areas combined. PDU loss for individual rooms/areas is addressed in following sections.

**Table 22 - Electric Distribution System: All Rooms/Areas Combined: All PDUs Combined: Energy Loss**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_PDUs\_Summary

Table: PDUs: All Rooms/Areas Combined: Calculations: Energy Loss

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Annual Total Energy Input | MWh/yr |  |  |
| Annual Total Energy Output | MWh/yr |  |  |
| Annual Total Energy Loss | MWh/yr |  |  |
| Annual Average Power Input | kW |  |  |
| Annual Average Power Output | kW |  |  |
| Annual Average Power Loss | kW |  |  |

#### Room/Area 111: All PDUs Combined

If the assessment will not include a PDU breakout by room/area, you can delete this entire Room/Area 111 section.

Provide a brief description the PDUs in Room/Area 111.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_PDUs\_Room 111

Table: PDUs: Rooms/Area 111: Overview

**Table 23** presents information that applies to the PDUs in Room/Area 111.

**Table 23 - Electric Distribution System: Room/Area 111: All PDUs Combined: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_PDUs\_Room 111

Table: Room/Area 111: All PDUs Combined: Specifications & Observations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Answer | Dates | Notes |
| Is there an existing, trusted meter that measures the input power for All PDUs in this Room/Area Combined, only? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |
| Total Energy Input for All PDUs in this Room/Area Combined for a Past Year | MWh/yr |  |  |  |
| Power Input Profile for All PDUs in this Room/Area Combined for a Past Year | kW vs time |  |  |  |

If the meter referred to in **Table 23** exists and has useable data, then a measurement instrument will not be needed and **Table 24** can be deleted.

[An existing meter/meter data] was not available for the total PDU input for Room/Area 111. We installed a [temporary] meter/[temporary] meters and performed the following measurement.

**Table 24 - Electric Distribution System: Room/Area 111: All PDUs Combined: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_PDUs\_Room 111

Table: Room/Area 111: All PDUs Combined: Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| Power Input Annual Profile for All PDUs in this Room/Area Combined | kW vs time |  |  |  |

**Table 25** shows the total energy loss of all PDUs in Room/Area 111 combined. Energy loss of individual PDUs are addressed in the following section.

**Table 25 - Electric Distribution System: Room/Area 111: All PDUs Combined: Energy Loss**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_PDUs\_Room 111

Table: Room/Area 111: All PDUs Combined: Calculations: Energy Loss

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Total Power Output Profile | kW vs time |  |  |
| Annual Total Energy Input | MWh/yr |  |  |
| Annual Total Energy Output | MWh/yr |  |  |
| Annual Total Energy Loss | MWh/yr |  |  |
| Annual Average Power Input | kW |  |  |
| Annual Average Power Output | kW |  |  |
| Annual Average Power Loss | kW |  |  |

#### Room/Area 111: Individual PDUs

If the assessment will not examine individual PDUs in Room/Area 111, you can delete this entire Individual PDUs section.

**Table 26** presents information collected for each PDU in Room/Area 111.

**Table 26 - Electric Distribution System: Room/Area 111: Individual PDUs: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_PDUs

Table: Room/Area 111: Individual PDUs: Specifications & Observations

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Units | PDU-111-1 | PDU-111-2 | PDU-111-3 | PDU-111-4 | PDU-111-5 | Notes |
| Is this PDU fed by a UPS that serves this room/area? (Yes, No) |  |  |  |  |  |  |  |
| Does this PDU transform voltage? (Yes, No) |  |  |  |  |  |  |  |
| PDU Manufacturer |  |  |  |  |  |  |  |
| PDU Model |  |  |  |  |  |  |  |
| PDU Rated Capacity | kW |  |  |  |  |  |  |
| PDU Transformer Age | years |  |  |  |  |  |  |
| PDU Transformer Type (Temp Rise 80C, Temp Rise >80C, TP1, EPACT 2005) |  |  |  |  |  |  |  |
| PDU Transformer load imbalance between phases (<=20%, >20%) |  |  |  |  |  |  |  |
| Is there an existing, trusted meter that measures this PDU's input power alone? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |  |  |  |
| Is there an existing, trusted meter that measures this PDU's output power alone? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |  |  |  |
| Date of Observations |  |  |  |  |  |  |  |
| PDU Energy Input Total for a Past Year | MWh/yr |  |  |  |  |  |  |
| PDU Power Input Profile for a Past Year | kW vs time |  |  |  |  |  |  |
| Date Span of Past Year's Data |  |  |  |  |  |  |  |
| PDU Energy Output Total for a Past Year | MWh/yr |  |  |  |  |  |  |
| PDU Power Output Profile for a Past Year | kW vs time |  |  |  |  |  |  |
| Date Span of Past Year's Data |  |  |  |  |  |  |  |

If all of the meters referred to in **Table 26** **Table 19**exist and have useable data, then measurement instruments will not be needed and **Table 27** can be deleted.

[Existing meters were/meter data was] not available for [PDUs]. To establish a complete picture of PDU performance, we installed a [temporary] meter/[temporary] meters and performed the following measurements.

**Table 27 - Electric Distribution System: Room/Area 111: Individual PDUs: Measurements**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_PDUs

Table: Room/Area 111: Individual PDUs: Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| PDU-111-1 | | | | |
| Power Input, Annual Profile | kW vs time |  |  |  |
| Power Output, Annual Profile | kW vs time |  |  |  |
| PDU-111-2 | | | | |
| Power Input, Annual Profile | kW vs time |  |  |  |
| Power Output, Annual Profile | kW vs time |  |  |  |
| PDU-111-3 | | | | |
| Power Input, Annual Profile | kW vs time |  |  |  |
| Power Output, Annual Profile | kW vs time |  |  |  |
| PDU-111-4 | | | | |
| Power Input, Annual Profile | kW vs time |  |  |  |
| Power Output, Annual Profile | kW vs time |  |  |  |
| PDU-111-5 | | | | |
| Power Input, Annual Profile | kW vs time |  |  |  |
| Power Output, Annual Profile | kW vs time |  |  |  |

Annual energy loss for each PDU in Room/Area 111 is listed in **Table 28**

**Table 28 - Electric Distribution System: Room/Area 111: Individual PDUs: Energy Loss**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_PDUs

Table: Room/Area 111: Individual PDUs: Calculations: Energy Loss

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| PDU-111-1 | | | |
| Annual Total Energy Input | MWh/yr |  |  |
| Annual Total Energy Output | MWh/yr |  |  |
| Annual Total Energy Loss | MWh/yr |  |  |
| Annual Average Power Input | kW |  |  |
| Annual Average Power Output | kW |  |  |
| Annual Average Power Loss | kW |  |  |
| PDU-111-2 | | | |
| Annual Total Energy Input | MWh/yr |  |  |
| Annual Total Energy Output | MWh/yr |  |  |
| Annual Total Energy Loss | MWh/yr |  |  |
| Annual Average Power Input | kW |  |  |
| Annual Average Power Output | kW |  |  |
| Annual Average Power Loss | kW |  |  |
| PDU-111-3 | | | |
| Annual Total Energy Input | MWh/yr |  |  |
| Annual Total Energy Output | MWh/yr |  |  |
| Annual Total Energy Loss | MWh/yr |  |  |
| Annual Average Power Input | kW |  |  |
| Annual Average Power Output | kW |  |  |
| Annual Average Power Loss | kW |  |  |
| PDU-111-4 | | | |
| Annual Total Energy Input | MWh/yr |  |  |
| Annual Total Energy Output | MWh/yr |  |  |
| Annual Total Energy Loss | MWh/yr |  |  |
| Annual Average Power Input | kW |  |  |
| Annual Average Power Output | kW |  |  |
| Annual Average Power Loss | kW |  |  |
| PDU-111-5 | | | |
| Annual Total Energy Input | MWh/yr |  |  |
| Annual Total Energy Output | MWh/yr |  |  |
| Annual Total Energy Loss | MWh/yr |  |  |
| Annual Average Power Input | kW |  |  |
| Annual Average Power Output | kW |  |  |
| Annual Average Power Loss | kW |  |  |

#### Room/Area 222

If PDUs are being assessed in more than one room/area, replicate the entire Room/Area 111 section and edit as needed.

### Standby Generators

If there are no standby generator engine block heaters, you can delete this entire Standby Generators section.

If there are heaters but you elect not to assess their energy use at this time, note that the heater energy use must still be accounted for when calculating the data center PUE.

#### Overview

Provide a brief description of the standby generator engine block heaters.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Generators

Table: Generators: Overview

[Overview of standby generator engine block heaters]

#### All Generators Combined

**Table 29** presents information that applies to the generator heaters as a whole.

**Table 29 - Electric Distribution System: All Standby Generators Combined: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Generators

Table: All Generators Combined: Specifications & Observations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Answer | Dates | Notes |
| Is there a standby generator (Yes, No) |  |  |  |  |
| Standby generator power configuration (N, N+1, 2N) |  |  |  |  |
| Is there an existing, trusted meter that measures the total generator engine block heater electric power demand for all generators combined, and nothing else? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |
| Total Energy Input for All Generator Engine Block Heaters Combined for a Past Year | MWh/yr |  |  |  |
| Power Input Profile for All Generator Engine Block Heaters Combined for a Past Year | kW vs time |  |  |  |

If the meter referred to in **Table 29** exists and has useable data, then a measurement instrument will not be needed and **Table 30** can be deleted.

[An existing meter/meter data] was not available for the total generator heater power demand. We installed a [temporary] meter/[temporary] meters and performed the following measurement.

**Table 30 - Electric Distribution System: All Standby Generators Combined: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Generators

Table: All Generators Combined: Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| Generator Engine Block Heater Power Demand, Annual Profile | kW vs time |  |  |  |
| Ambient Temperature, Annual Profile | deg F vs time |  |  |  |

**Table 31** shows the total energy use of all standby generator engine block heaters combined. The energy use of individual heaters is addressed in the following section.

**Table 31 - Electric Distribution System: All Standby Generators Combined: Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Generators

Table: All Generators Combined: Calculations: Energy Use

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | **Notes** |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Heater Power Demand | kW |  |  |
| Annual Average Ambient Air Temperature | deg F |  |  |

#### Individual Generators

If the assessment will not examine individual standby generator engine block heaters, you can delete this entire Individual Generators section.

**Table 32** presents information collected for each individual generator.

**Table 32 - Electric Distribution System: Individual Standby Generators: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Generators

Table: Individual Generators: Specifications & Observations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | GEN-1 | GEN-2 | Notes |
| Generator Manufacturer |  |  |  |  |
| Generator Model |  |  |  |  |
| Generator Engine Block Equipped with Electric Heater? (Yes, No) |  |  |  |  |
| What is the power source for the emergency generator block heater(s)? (Utility power, Alternate power source) |  |  |  |  |
| Heater Rated Capacity | kW |  |  |  |
| Heater Equipped with Thermostat? (Yes, No) |  |  |  |  |
| Heater Setpoint Temperature, Currently | deg F |  |  |  |
| Is there an existing, trusted meter that measures the generator engine block heater electric power demand for this generator alone? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |
| Date of Observations |  |  |  |  |
| Generator Engine Block Heater Total Energy Use for a Past Year | MWh/yr |  |  |  |
| Generator Engine Block Heater Power Demand Profile for a Past Year | kW vs time |  |  |  |
| Date Span of Past Year's Data |  |  |  |  |

If all of the meters referred to in **Table 32** **Table 19**exist and have useable data, then measurement instruments will not be needed and **Table 33** can be deleted.

[Existing meters were/meter data was] not available for [generators]. To establish a complete picture of generator engine block heater energy use, we installed a [temporary] meter/[temporary] meters and performed the following measurements.

**Table 33 - Electric Distribution System: Individual Standby Generators: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Generators

Table: Individual Generators: Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| GEN-1 | | | | |
| Radiator Temperature, Annual Profile | deg F vs time |  |  |  |
| Generator Engine Block Heater Power Demand, Annual Profile | kW vs time |  |  |  |
| GEN-2 | | | | |
| Radiator Temperature, Annual Profile | deg F vs time |  |  |  |
| Generator Engine Block Heater Power Demand, Annual Profile | kW vs time |  |  |  |

The annual energy use of each standby generator engine block heater is listed in **Table 34**.

**Table 34 - Electric Distribution System: Individual Standby Generators: Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Generators

Table: Individual Generators: Calculations: Energy Use

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | **Notes** |
| GEN-1 | | | |
| Generator Engine Block Heater Annual Energy Use | MWh/yr |  |  |
| Generator Engine Block Heater Annual Average Power Demand | kW |  |  |
| Generator Radiator Annual Average Temperature | deg F |  |  |
| GEN-2 | | | |
| Generator Engine Block Heater Annual Energy Use | MWh/yr |  |  |
| Generator Engine Block Heater Annual Average Power Demand | kW |  |  |
| Generator Radiator Annual Average Temperature | deg F |  |  |

# IT Equipment

The energy use of the IT equipment must be quantified in order to calculate PUE. Do not delete this section.

In this section we describe the data center’s IT equipment and quantify its energy use. An evaluation of the IT equipment’s performance metrics is presented in Section 10.

## All Rooms/Areas Combined

### Overview

Provide a brief description of all the IT equipment as a whole. Overviews of IT equipment by room/area are entered in later sections.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_IT

Table: IT Equipment: Overview: All Rooms/Areas Combined

[Overview of IT equipment in all rooms/areas combined]

**Table 35** presents information that applies to the IT equipment as a whole.

**Table 35 - IT Equipment: All Rooms/Areas Combined: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_IT

Table: IT Equipment: All Rooms/Areas Combined: Specifications & Observations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Answer | Dates | Notes |
| Do you measure and track IT equipment (storage, server, and network) utilization? (Yes, No) |  |  |  |  |
| Do you have a process for identifying abandoned/unused servers and taking them offline? (Yes, No) |  |  |  |  |
| What is the average age at which you replace your servers? (0-2 years, 3 years, 4 years, 5+ years) |  |  |  |  |
| Are you using virtualization to consolidate your server workloads? (Yes, No) |  |  |  |  |
| How extensive is your storage consolidation? (0%, 1-50%, 51-99%, 100%) |  |  |  |  |
| What storage tiers have you implemented? Mark all that apply. (More than one production tier, Archiving tier, Near-line storage) |  |  |  |  |
| Have you implemented storage optimization techniques such as thin provisioning, incremental snapshots, or de-duplication? (Yes, No) |  |  |  |  |
| IT Peak Power Demand Design | kW |  |  |  |
| What is the IT equipment power factor? (<0.9, >=0.9) |  |  |  |  |
| What is the power source for the IT racks? (AC, DC) |  |  |  |  |

### Total Energy Use

**Table 36** sums the IT equipment energy use from all rooms/areas.

**Table 36 - IT Equipment: All Rooms/Areas Combined: Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_IT

Table: IT Equipment: All Rooms/Areas Combined: Calculations: Energy Use

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Total IT Power Demand, Annual Profile | kW vs time |  |  |
| IT Annual Energy Use | MWh/yr |  |  |
| IT Annual Average Power Demand | kW |  |  |
| IT Peak Power Demand, Actual | kW |  |  |

## Individual Rooms/Areas

**Table 37** presents IT equipment information by room/area.

**Table 37 - IT Equipment: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_IT

Table: IT Equipment: Individual Rooms/Areas: Specifications & Observations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Units** | **Room/Area 111** | **Room/Area 222** | **Notes** |
| Gross Floor Area | sf |  |  |  |
| Electrically Active Floor Area | sf |  |  |  |
| Rack Quantity |  |  |  |  |
| IT Peak Power Demand Design | kW |  |  |  |
| Date of Observations |  |  |  |  |

**Table 38** shows IT equipment energy use by room/area.

**Table 38 - IT Equipment: Individual Rooms/Areas: Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_IT

Table: IT Equipment: Individual Rooms/Areas: Calculations: Energy Use

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Room/Area 111 | | | |
| IT Annual Energy Use | MWh/yr |  |  |
| IT Annual Average Power Demand | kW |  |  |
| IT Peak Power Demand, Actual | kW |  |  |
| Room/Area 222 | | | |
| IT Annual Energy Use | MWh/yr |  |  |
| IT Annual Average Power Demand | kW |  |  |
| IT Peak Power Demand, Actual | kW |  |  |

### Room/Area 111

Provide a brief description of the IT equipment in Room/Area 111.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_IT

Table: IT Equipment: Overview: Room/Area 111

[Overview of IT equipment in Room/Area 111]

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_IT Floor Plan

Replace the floor plan below with a simple sketch that describes your Room/Area 111.

You can include air side cooling units if you like, or present them separately in Section 8.



**Figure 6 - Data Center Room/Area 111 Floor Plan**

### Room/Area 222

If there is more than one data center room/area, replicate the entire Room/Area 111 section and edit as needed.

# Lighting

Lighting energy use impacts overall data center efficiency, but it is not necessary to isolate and quantify this loss in order to calculate the data center’s overall PUE. If you elect to not assess the lighting at this time, you can delete this entire Lighting section.

This section describes the lighting system in general, and its energy use. Evaluation of the lighting system’s performance is presented in Section 10.

### Overview

Provide a brief description of data center lighting as a whole. Overviews of lighting by room/area are entered in later sections.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Lighting

Table: Lighting: Overview

[Overview of data center lighting]

### All Rooms/Areas Combined

This report template currently assumes that the lighting system is the same type in every data center room/area being assessed.

**Table 39** presents information that applies to the lighting system in all data center rooms/areas.

**Table 39 - Lighting: All Rooms/Areas Combined: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Lighting

Table: Lighting: All Rooms/Areas Combined: Specifications & Observations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Answer | Dates | Notes |
| Lighting Type (Fluorescent, LED, Other) |  |  |  |  |
| Type of Lamps (T12, T-8, T-5) |  |  |  |  |
| Type of Ballasts (Magnetic, Electronic) |  |  |  |  |
| How are the lights controlled? (Hard-Wired, Manual Wall Switch, Occupancy Sensor, Timer) |  |  |  |  |
| Is the data center lighting well-designed? (Yes, No) |  |  |  |  |
| Is there an existing, trusted meter that measures the total lighting power demand for all data center rooms/areas combined, and nothing else? (None, Total Energy Only, Power Trends) |  |  |  |  |
| Total Lighting Energy Input for All Rooms/Areas Combined for a Past Year | MWh/yr |  |  |  |
| Lighting Power Input Profile for All Rooms/Areas Combined for a Past Year | kW vs time |  |  |  |

If the meter referred to in **Table 39** exists and has useable data, then a measurement instrument will not be needed and **Table 40** can be deleted.

[An existing meter/meter data] was not available for the total lighting power demand. We installed a [temporary] meter/[temporary] meters and performed the following measurement.

**Table 40 - Lighting: All Rooms/Areas Combined: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Lighting

Table: Lighting: All Rooms/Areas Combined: Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| Lighting System Power Demand, Annual Profile | kW vs time |  |  |  |

**Table 41** sums the lighting energy use for all rooms/areas.

**Table 41 - Lighting: All Rooms/Areas Combined: Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Lighting

Table: Lighting: All Rooms/Areas Combined: Calculations: Energy Use

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | **Notes** |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |

### Individual Rooms/Areas

**Table 42** presents lighting information by room/area.

**Table 42 - Lighting: Individual Rooms/Areas: Specifications & Observations**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Lighting

Table: Lighting: Individual Rooms/Areas: Specifications & Observations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Room/Area 111 | Room/Area 222 | Notes |
| Is there an existing, trusted meter that measures the total lighting electric power demand for this Room/Area, and nothing else? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |
| Date of Observations |  |  |  |  |
| Total Lighting Energy Input for a Past Year | MWh/yr |  |  |  |
| Lighting Power Input Profile for a Past Year | kW vs time |  |  |  |
| Date Span of Past Year's Data |  |  |  |  |

If the meters referred to in **Table 42** exist and have useable data, then measurement instruments will not be needed and **Table 43** can be deleted.

[Existing meters were/meter data was] not available for lighting energy use by [room/area]. To establish a complete picture of lighting energy use, we installed [temporary] meters and performed the following measurements.

**Table 43 - Lighting: Individual Rooms/Areas: Measurements**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Lighting

Table: Lighting: Individual Rooms/Areas: Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| Room/Area 111 | | | | |
| Lighting System Power Demand, Annual Profile | kW vs time |  |  |  |
| Room/Area 222 | | | | |
| Lighting System Power Demand, Annual Profile | kW vs time |  |  |  |

**Table 44** shows IT equipment energy use by room/area.

**Table 44 - Lighting: Individual Rooms/Areas: Energy Use**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Lighting

Table: Lighting: Individual Rooms/Areas: Calculations: Energy Use

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | **Notes** |
| Room/Area 111 | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |
| Room/Area 222 | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |

# Data Center Space: Air Management

Good air management is essential for an energy-efficient data center. Deleting this section is not recommended.

This section presents ASHRAE’s schema for IT inlet air conditions, an overview of the existing data center rooms/areas, the adopted IT inlet air conditions for each room/area, and measurements conducted in each room/area. Evaluation of air management metrics is presented in Section 10, Metrics and Benchmarking.

For air-cooled data centers, the heat generated by IT equipment is removed by passing air through the equipment. Air at a target temperature is introduced to the equipment’s air intakes and then the heated air is collected from the equipment’s exhaust openings and sent back to the cooling units.

Indicators of an effective air-based cooling system:

* Cooling air temperature and humidity is maintained in a range that is appropriate for the given IT equipment.
* Cooling air is delivered directly to the IT equipment intakes, and is not allowed to bypass the equipment.
* Heated air is collected directly from the IT equipment exhaust and sent back to the cooling units without allowing it to mix with cooling air.
* A relatively large temperature rise occurs as the air passes through the IT equipment.

“Air management” is simply the steps taken to promote these conditions. Good air management tends to result in a more energy-efficient cooling system.

## ASHRAE Recommended and Allowable IT Inlet Air Conditions

**Table 45** shows ASHRAE’s recommended and allowable temperature and humidity ranges for IT inlet air. It is important to note that the recommended temperature and humidity ranges are for the *inlet* air to the IT equipment and that the outlet temperatures can be much higher (and the relative humidities correspondingly lower). Also note that the recommended humidity range is much larger than most server-room control set points, with the result that in most cases the humidity control can be turned off and the humidity will still be within the recommended range. The Recommended range is by consensus of all the major IT manufacturers and is intended to ensure reliability when the equipment is operated continuously in this range. The Allowable range is intended to ensure functional operation but reliability may be affected with continuous operation in this expanded range. The Class refers to what level of allowable temperature and humidity is to be maintained; the default is Class A1.

**Table 45** - **ASHRAE Recommended and Allowable Temperature and Humidity Ranges for IT Inlet Air**

**Source:**

ASHRAE Thermal Guidelines for Data Processing Environments

<https://www.ashrae.org/technical-resources/bookstore/datacom-series>

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Class** | **Dry Bulb (°F)** | **Humidity Range** | **Maximum Dew Point (°F)** | **Maximum Elevation (ft)** | **Maximum Rate of Change**  **(°F/hr)** |
| **Recommended** | | | | | |
| A1 to A4 | 64.4 to 80.6 | 15.8°F DP  to 59**°**F DP and 60% RH | N/A | | |
| **Allowable** | | | | | |
| A1 | 59 to 89.6 | 10.4°F DP and 8% RH to 62.6°F DP and 80% RH | 62.6 | 10,000 | 9\*/36 |
| A2 | 50 to 95 | 10.4°F DP and 8% RH to 69.8°F DP and 80% RH | 69.8 | 10,000 | 9\*/36 |
| A3 | 41 to 104 | 10.4°F and 8% RH to 75.2°F DP and 85% RH | 75.2 | 10,000 | 9\*/36 |
| A4 | 41 to 113 | 10.4°F DP and 8% RH to 75.2°F DP and 90% RH | 75.2 | 10,000 | 9\*/36 |
| B | 41 to 95 | 8% to 82.4°F DP and 80% RH | 82.4 | 10,000 | N/A |
| C | 41 to 104 | 8% to 82.4%°F DP and 80% RH | 82.4 | 10,000 | N/A |
| \*More stringent rate of change for tape drives | | | ©ASHRAE 2015 Thermal Guidelines Table I-P Version (updated to errata issued July 25, 2016). Reformatted by LBNL | | |

## Overview

This Overview section provides descriptions of the data center air management scheme(s) that are not necessarily captured by the tables that follow.

### Common to All Rooms/Areas

In this section, describe aspects of the air management scheme that are common to all rooms/areas. Edit the following list of suggestions as needed.

If you are using the Assessment Worbook, these descriptions may have already been provided:

**Sources:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: Air Management

Table: Air Management: Overview: Room/Area 111

and

Table: Air Management: Overview: Room/Area 222

#### Temperature and Humidity Ranges

* Is there a target range of temperature and humidity for the IT equipment?
* What are the factors that led to the adoption of the target range? Is there any particularly sensitive equipment, such as tape drives or printers?
* Where are the temperature and humidity control sensors located?
* Does the climate at the data center’s geographic location pose a challenge (high or low humidity, high temperature?)

#### Air Flow Path

* What is the air flow path in the room/area, from the cooling coils to the racks and back?
* Is there a raised floor for supply air? If so, describe the location of perforated floor tiles, and the size of the perforations. Make particular note of any perforated tiles that are not located in a cold aisle.
* Is there a ceiling return plenum? Describe the return air openings and locations.
* Is there a ceiling supply plenum? Describe the supply diffuser type and locations.
* Is there any ductwork? Where is it located?

#### Level of Containment

* Qualitatively, how well are the supply and return air streams kept separated (good, fair, poor)?
* Are blanking panels installed in empty rack slots?
* Any other means of isolating hot/cold aisles?

#### Humidity Control

* If humidity is controlled, how is it controlled? What type of humidifiers are present? How is dehumidification accomplished?

#### Air Flow Control

* Is the air circulation constant, or does it vary under automatic control?
* If the latter, how is it controlled? Where are the control sensors located?

### Room/Area 111

Following the same list of suggestions from the preceding Common to All Rooms/Areas section, describe any air management details that are unique to Room/Area 111.

[description]

### Room/Area 222

If there is more than one Room/Area, replicate the previous Room/Area 111 section as many times as needed.

[description]

## Air Management Information per Room/Area

**Table 46** presents findings for each data center room/area.

The first row classifies each room/area as per ASHRAE; see **Table 45**.

The ASHRAE section of **Table 46** presents ASHRAE’s Recommended and Allowable temperature and humidity ranges for the given Data Center Class.

The Current Practice section of **Table 46** shows what the IT equipment intake air is currently being controlled to.

If the current air management scheme for the given room/area does not attempt to control the condition of the air entering the IT equipment (for example, it controls cooling unit return air conditions instead), then enter “N/A” in the corresponding cells. Cooling equipment return air conditions are addressed in Section 8.

**Table 46 - Current Air Management Conditions**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: Air Management

Table: Air Management: Overall Specifications & Observations

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Parameter | | | Units | Room/ Area 111 | Room/ Area 222 | Notes |
| Data Center Class (A1, A2, A3, A4, B, C) | | |  |  |  |  |
| ASHRAE | IT Equipment Intake Air Recommended | Temperature, High Limit | deg F |  |  |  |
| Temperature, Low Limit | deg F |  |  |  |
| Relative Humidity, High Limit | % |  |  |  |
| Relative Humidity, Low Limit | % |  |  |  |
| Absolute Humidity, High Limit | deg F dewpoint |  |  |  |
| Absolute Humidity, Low Limit | deg F dewpoint |  |  |  |
| IT Equipment Intake Air Allowable | Temperature, High Limit | deg F |  |  |  |
| Temperature, Low Limit | deg F |  |  |  |
| Relative Humidity, High Limit | % |  |  |  |
| Relative Humidity, Low Limit | % |  |  |  |
| Absolute Humidity, High Limit | deg F dewpoint |  |  |  |
| Absolute Humidity, Low Limit | deg F dewpoint |  |  |  |
| Current Practice | IT Equipment Intake Air Recommended | Temperature, High Limit | deg F |  |  |  |
| Temperature, Low Limit | deg F |  |  |  |
| Relative Humidity, High Limit | % |  |  |  |
| Relative Humidity, Low Limit | % |  |  |  |
| Absolute Humidity, High Limit | deg F dewpoint |  |  |  |
| Absolute Humidity, Low Limit | deg F dewpoint |  |  |  |
| IT Equipment Intake Air Allowable | Temperature, High Limit | deg F |  |  |  |
| Temperature, Low Limit | deg F |  |  |  |
| Relative Humidity, High Limit | % |  |  |  |
| Relative Humidity, Low Limit | % |  |  |  |
| Absolute Humidity, High Limit | deg F dewpoint |  |  |  |
| Absolute Humidity, Low Limit | deg F dewpoint |  |  |  |
| Are the Current Practice Recommended cooling system high and/or low humidity limit setpoints for the IT intake air tighter than the ASHRAE Recommended limits for your data center Class? (Yes, No) | | |  |  |  |  |
| Gross Floor Area | | | sf |  |  |  |
| Total Electrically Active Floor Area | | | sf |  |  |  |
| Can your Current Practice Recommended IT equipment intake air condition be maintained if you turn off one or more selected CRAC/ACU/CRAH/AHUs? (Yes, No) | | |  |  |  |  |
| Is there any supplemental cooling? (In-Row, Modular, Overhead, Rear-Door, Liquid-Cooled Cabinet) | | |  |  |  |  |
| Air supply path (Overhead Ducts, Overhead Plenum, Underfloor Plenum, In-Row, Free) | | |  |  |  |  |
| Is there a floor-tightness (sealing leaks) program in place (Yes, No) | | |  |  |  |  |
| Degree of sealing for cable penetrations? (Poor to None, Fair, Good) | | |  |  |  |  |
| Is the cable build-up in the floor plenum or the overhead plenum more than 1/3 of the plenum height? (Yes, No) | | |  |  |  |  |
| Is there a program in place for regularly managing cables to allow unobstructed air flow? (Yes, No) | | |  |  |  |  |
| Degree that IT equipment is arranged in rows? (Poor to None, Fair, Good) | | |  |  |  |  |
| Do some areas of the data center have load densities that are more than 4 times the average load density? | | |  |  |  |  |
| Is the air-delivery system balanced to ensure correct airflow rates? (Yes, No) | | |  |  |  |  |
| Is there an air-balancing (allow proper airflow distribution) program in place? (Yes, No) | | |  |  |  |  |
| Date of Observations | | |  |  |  |  |

## Data Center Room/Area 111

This report template currently has four options regarding air measurements. Edit to reflect the chosen option(s).

Option 1: Air management is obviously good, no measurements taken.

The air flow management in Room/Area 111 is good. [Cite evidence].

For this reason, we opted to not perform air measurements in this room/area and instead focused on other systems.

Option 2: Air management is obviously poor, no measurements taken.

The air flow management in Room/Area 111 is poor. [Cite evidence - lots of blanking panels missing, etc.].

For this reason, we opted to not perform air measurements in this room/area and instead simply recommend the following energy efficiency measures:

[Air management EEM name xxx]

[Air management EEM name yyy]

See Section 11 for details.

Option 3: Simple approach. The Rack Air Temperatures approach to evaluating air management relies only the Assessment Workbook.

### Rack Air Temperatures

**Table 47** presents a sampling of air temperature readings from the cold and hot aisles between the racks, at three different heights.

A full set of temperature measurements includes rack intake and exhaust, at three positions along each row, at three heights. Less than full coverage is acceptable, depending on circumstances. If less than full coverage was achieved, explain why.

Given limited time and resources, we performed a relatively sparse set of measurements. The results show that [air management appears to be good] [a more thorough set of measurements is recommended].

With good air management:

* The cold aisle temperatures will not be excessively cold or excessively hot relative to the adopted Recommended ranges for IT inlet air as listed in **Table 46**.
* The hot aisle temperatures will be significantly higher than the cold aisle temperatures.

An evaluation of the temperature differences between the cold and hot aisles is presented in **Table 141** in Section 10.

**Table 47 - Data Center Room/Area 111: Rack Air Temperatures Measured on [date]**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: Air Management\_Rack Temps

Table: Rack Intake and Exhaust Temperature Measurements

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | **Row 1** | | | | **Row 2** | | | | **Row 3** | | | **Row 4** | | | **Row 5** | | | **Row 6** | | | **Row 7** | | | **Row 8** | | | **Row 9** | | | **Row 10** | | |
| Posit-ion in Row | Rack Level | Hot Aisle Temp |  | Cold Aisle Temp | | |  | Hot Aisle Temp | | |  | Cold Aisle Temp | |  | Hot Aisle Temp | |  | Cold Aisle Temp | |  | Hot Aisle Temp | |  | Cold Aisle Temp | |  | Hot Aisle Temp | |  | Cold Aisle Temp | |  | Hot Aisle Temp |
| deg F |  | deg F | | |  | deg F | | |  | deg F | |  | deg F | |  | deg F | |  | deg F | |  | deg F | |  | deg F | |  | deg F | |  | deg F |
| Begin-ning | High | 87 |  | 75 | 76 | |  | 97 | 99 | |  | 77 | 90 |  | 88 | 90 |  | 79 | 90 |  | 105 | 84 |  | 70 | 74 |  | 80 | 79 |  | 67 | 65 |  | 75 |
| Middle | 90 |  | 71 | 78 | |  | 98 | 100 | |  | 74 | 95 |  | 94 | 100 |  | 80 | 98 |  | 110 | 84 |  | 68 | 65 |  | 81 | 80 |  | 65 | 62 |  | 72 |
| Low | 92 |  | 74 | 80 | |  | 100 | 103 | |  | 81 | 97 |  | 101 | 102 |  | 85 | 102 |  | 113 | 87 |  | 66 | 60 |  | 79 | 77 |  | 55 | 53 |  | 68 |
| Middle | High |  |  | 79 | 80 | |  | 100 | 105 | |  | 89 | 93 |  | 104 | 108 |  | 95 | 113 |  | 117 | 88 |  | 63 | 55 |  | 78 | 75 |  | 49 | 48 |  | 63 |
| Middle |  |  | 78 | 81 | |  | 102 | 109 | |  | 88 | 90 |  | 105 | 110 |  | 105 | 115 |  | 118 | 90 |  | 64 | 56 |  | 76 | 71 |  | 48 | 40 |  | 59 |
| Low |  |  | 73 | 79 | |  | 99 | 102 | |  | 84 | 87 |  | 102 | 107 |  | 103 | 114 |  | 115 | 87 |  | 64 | 57 |  | 76 | 72 |  | 49 | 45 |  | 61 |
| End | High |  |  |  | 75 | |  | 96 | 100 | |  | 81 | 78 |  | 99 | 103 |  | 96 | 108 |  | 108 | 85 |  | 70 | 58 |  | 77 | 76 |  | 56 | 50 |  | 62 |
| Middle |  |  |  | 77 | |  | 95 | 99 | |  | 93 | 92 |  | 96 | 100 |  | 92 | 103 |  | 104 | 82 |  | 74 | 68 |  | 82 | 80 |  | 66 | 61 |  | 64 |
| Low |  |  |  | 70 | |  | 93 | 96 | |  | 95 | 92 |  | 92 | 97 |  | 80 | 90 |  | 93 | 80 |  | 76 | 71 |  | 85 | 81 |  | 68 | 66 |  | 67 |

|  |  |
| --- | --- |
| **Color Key for Cold Aisle Temperatures** | |
| The ASHRAE Recommended and Allowable ranges refer to the air entering the racks; ie, the cold aisles. | |
|  | Above the Allowable Upper Limit. |
|  | In the high end of the Allowable Range. |
|  | In the Recommended Range. |
|  | In the low end of the Allowable Range. |
|  | Below the Allowable Lower Limit. |
|  | No data. |

|  |  |
| --- | --- |
| **Color Key for Hot Aisle Temperatures** | |
| There are no Recommended or Allowable ranges for the air leaving the racks; ie, the hot aisles. The hot aisle temperatures are simply color-coded on a spectrum from the minimum hot aisle temperature measured, to the maximum hot aisle temperature measured. | |
|  | Minumum hot aisle temperature measured. |
|  | Maximum hot aisle temperature measured. |
|  | No data. |

**Table 48** shows the average, maximum, and minimum rack intake and exhaust temperature for the entire room/area.

**Table 48 - Data Center Room/Area 111: Rack Air Temperature Statistics**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: Air Management\_Rack Temps

Table: Whole-Room Statistics

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | | Avg | Max | Min |
| Rack Intake Temp | deg F | 77 | 115 | 40 |
| Rack Exhaust Temp | deg F | 91 | 118 | 59 |

Option 4: Detailed approach. If you are not doing a detailed air management assessment of this Room/Area, delete the following Air Management section. If you are, the Data Center Air Management Tool v1.18 is required.

### Air Management

#### CRAC/ACU/CRAH/AHU Air Flow and Temperatures

**Table 49** shows measurements of air flow, supply air temperature, and return air temperature for selected CRAC/ACU/CRAH/AHUs.

**Table 49 - Data Center Room/Area 111: CRAC/ACU/CRAH/AHU Air Flow and Temperature Measurements**

**Source:**

Data Center Air Management Tool v1.18

Tab: Step 1 AHU

|  |  |  |  |
| --- | --- | --- | --- |
| CRAC/ACU/CRAH/AHU | Air Flow | Supply Air Temperature | Return Air Temperature |
| cfm | deg F | deg F |
| CRAC/ACU/CRAH/AHU -111-1 |  |  |  |
| CRAC/ACU/CRAH/AHU -111-2 |  |  |  |
| CRAC/ACU/CRAH/AHU -111-3 |  |  |  |
| CRAC/ACU/CRAH/AHU -111-4 |  |  |  |
| CRAC/ACU/CRAH/AHU -111-5 |  |  |  |

#### IT Equipment Measurements

The next set of measurements are from the IT equipment racks.

The Air Management Tool provides three different “Class Options”. Each option requests a different parameter:

* “Similar DT” requests the total rack air flow for all racks in a given rack temperature rise range.
* “Similar V” requests the total number of racks whose air flow is in a given air flow range.
* “Similar DT(P)” requests the total power draw for all racks in a given rack temperature rise range.

**Source:**

Data Center Air Management Tool v1.18

Tab: Step 2 Equip

For our analysis, we selected Class Option Similar DT, Similar V, Similar DT(P)

**Table 50 - Data Center Room/Area 111: Totals by Class**

**Source:**

Data Center Air Management Tool v1.18

Tab: Step 2 Equip

If the Class Option is Similar DT, keep this first table and delete the second and third tables.

|  |  |  |
| --- | --- | --- |
| Class | Measured Temperature Rise (DT) deg F | Estimated Air Flow (V) cfm |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |
| 6 |  |  |
| 7 |  |  |
| 8 |  |  |
| 9 |  |  |
| 10 |  |  |

If the Class Option is Similar V, keep this second table and delete the first and third tables.

|  |  |  |
| --- | --- | --- |
| Class | Estimated Air Flow (V) cfm | Number of Units |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |
| 6 |  |  |
| 7 |  |  |
| 8 |  |  |
| 9 |  |  |
| 10 |  |  |

If the Class Option is Similar DT(P), keep this third table and delete the first and second tables.

|  |  |  |
| --- | --- | --- |
| Class | Measured Temperature Rise (DT) deg F | Measured Power (P) Watts |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |
| 6 |  |  |
| 7 |  |  |
| 8 |  |  |
| 9 |  |  |
| 10 |  |  |

**Table 51** shows the overall totals.

**Table 51 - Data Center Room/Area 111: Class Totals**

**Source:**

Data Center Air Management Tool v1.18

Tab: Step 2 Equip

The third row applies only to Class Option “Similar DT(P)”. If you did not select this Class Option, delete the third row.

|  |  |
| --- | --- |
| Typical (Airflow Weighted) Temperature Rise, deg F |  |
| Total Equipment Air Flow, cfm |  |
| Equipment Power (= CRAC/ACU/CRAH/AHU Cooling), kW |  |

#### Rack Cooling Index Measurements

The following measurements allow the Air Management Tool to calculate the Rack Cooling Index (RCI). The RCI is evaluated in Section 10.

**Table 52 - Data Center Room/Area 111: IT Equipment Intake Air Temperatures**

**Source:**

Data Center Air Management Tool v1.18

Tab: Step 3 RCI

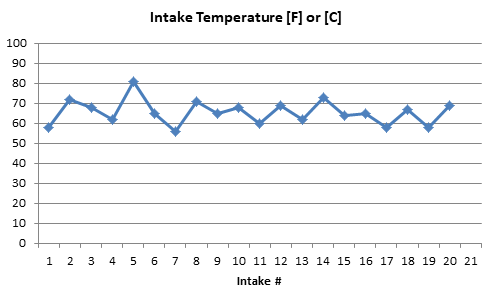
|  |  |
| --- | --- |
| Measurement Number | IT Equipment Intake Air Temperature, deg F |
| 1 |  |
| 2 |  |
| 3 |  |
| 4 |  |
| 5 |  |
| 6 |  |
| 7 |  |
| 8 |  |
| 9 |  |

**Figure 7** is visual representation of **Table 52**.

**Source:**

Data Center Air Management Tool v1.18

Tab: Step 3 RCI



**Figure 7 - Data Center Room/Area 111: IT Equipment Intake Air Temperatures**

The calculation of RCI depends on the minimum and maximum Recommended and Allowable temperatures. **Table 53** shows the values entered in the Air Management Tool.

**Table 53 - Data Center Room/Area 111: IT Equipment Intake Air Min and Max**

**Source:**

Data Center Air Management Tool v1.18

Tab: Step 3 RCI

|  |  |  |
| --- | --- | --- |
|  | Min | Max |
| Recommended |  |  |
| Allowable |  |  |

## Data Center Room/Area 222

If you are reporting on more than one data center room/area, repeat the preceding Data Center Room/Area 111 section as many times as needed.

# Data Center Space: Air Side Cooling System

The energy use of the data center’s air side cooling system affects overall data center efficiency, but it is not necessary to isolate and quantify the energy use of this system alone in order to calculate the data center’s overall PUE. It only needs to be captured in the data center’s overall energy use.

If you elect to not assess the air side cooling system at this time, you can delete this entire Air Side Cooling System section.

Edit the following text to match your air side cooling system.

For the purpose of this assessment, the air side cooling system consists of the following components:

* The CRAC/ACU/CRAH/AHUs that circulate cooling air in the data center rooms/areas. These units include on-board humidifiers. ACU/AHUs include on-board air side economizers. ACUs include on board condensers.
* A separate, built-up air side economizer that serves the entire room/area.
* Separate air-cooled DX condensers that serve the CRAC/ACUs.
* Outdoor “dry coolers” that serve the CRAC/ACUs that contain water-cooled DX condensers.

Systems that produce cold water for direct use by CRAH/AHUs, or for direct use by water-cooled CRAC/ACU condensers, are addressed in Section 9. Pumps that circulate water between water-cooled CRAC/ACU condensers and dry coolers are also addressed in Section 9.

This section reports the energy use of the air side cooling system. Evaluation of air side cooling system performance metrics is presented in Section 10.

## Air Side Economizing

If your data center does not employ are side economizing, or if adding air side economizing is an impractical consideration, you can delete this entire Air Side Economizer section.

Air side economizing refers to the scheme of drawing cool outside air into the data center when available, in order to bypass energy-intensive mechanical cooling.

There are two basic ways to implement this – one air side economizer per each ACU/AHU, or one built-up economizer to serve the whole room.

The Air Side Economizer Utilization Factor refers to the percent of the total annual cooling load that is provided by the economizer. This value depends on several variables:

* Integrated vs non-integrated economizer. Integrated will provide more energy savings, all else held equal.
* The local climate. A cooler climate improves the Utilization Factor.
* The data center supply and return air temperatures. The higher these temperatures are, the higher the Utilization Factor can be, all else held equal.

## All Rooms/Areas and All Cooling System Components Combined

If your assessment is for a single room/area only, you can delete this All Rooms/Areas section and skip to the Room/Area 111 section that follows.

Provide a brief description of the air side cooling system as a whole. Overviews by room/area are entered in later sections.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Summary

Table: All Data Center Rooms/Areas Combined: Overview

[Overview of air side cooling system in all rooms/areas combined]

**Table 54** presents information that applies to all air side cooling system components combined, in all rooms/areas combined.

**Table 54 - All Rooms/Areas Combined: All Air Side Cooling System Components Combined: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Summary

Table: All Data Center Rooms/Areas Combined: Specifications & Observations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Answer | Dates | Notes |
| Is there an existing, trusted meter that measures the electric power demand of All Air Side Cooling System Components Combined for All Rooms/Areas Combined, and nothing else? (None, Total Energy Only, Power Trends) |  |  |  |  |
| Total Energy Input for All Air Side Cooling System Components Combined for All Rooms/Areas Combined for a Past Year | MWh/yr |  |  |  |
| Total Power Input Profile for All Air Side Cooling System Components Combined for All Rooms/Areas Combined for a Past Year | kW vs time |  |  |  |

If the meter referred to in **Table 54** exists and has useable data, then a measurement instrument will not be needed and **Table 55** can be deleted.

[An existing meter/meter data] was not available for the total air side cooling system power demand for all rooms/areas combined. We installed a [temporary] meter/[temporary] meters and performed the following measurement.

**Table 55 - All Rooms/Areas Combined: All Air Side Cooling System Components Combined: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Summary

Table: All Data Center Rooms/Areas Combined: Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| Total Power Demand Annual Profile | kW vs time |  |  |  |

**Table 56** shows the total energy use of all air side cooling system components combined, in all rooms/areas combined. The energy use for individual rooms/areas is addressed in following sections.

**Table 56 - All Rooms/Areas Combined: All Air Side Cooling System Components Combined: Energy Totals**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Summary

Table: All Data Center Rooms/Areas Combined: All Air Side Cooling System Components Combined: Calculations: Energy Use

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Annual Energy Use of All Data Center Air Side Cooling System Components Combined | MWh/yr |  |  |
| Annual Average Power Demand of All Data Center Air Side Cooling System Components Combined | kW |  |  |

**Table 57** provides a breakout of energy use by air side cooling system component, across all rooms/areas.

**Table 57 - All Rooms/Areas Combined: Air Side Cooling System Components: Energy Breakouts**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Summary

Table: All Data Center Rooms/Areas Combined: Air Side Cooling Components: Energy Breakouts

Remove any components that are not applicable.

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| CRAC/ACU/CRAH/AHUs minus Humidifiers | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |
| Humidifiers | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |
| Built-Up ASE Fans | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |
| Condenser/Dry Cooler Fans | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |
| All Data Center Air Side Cooling System Components Combined | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |

The cooling provided by the CRAC/ACU/CRAH/AHUs must be quantified in order to calculate their efficiency. If the assessment is not looking at efficiency, **Table 58** can be deleted.

The total cooling provided by all air side cooling systems in all rooms/areas combined is shown in **Table 58**.

**Table 58 - All Rooms/Areas Combined: All CRAC/ACU/CRAH/AHUs Combined: Cooling Load**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Summary

Table: All Data Center Rooms/Areas Combined: All CRAC/ACU/CRAH/AHUs Combined: Calculations: Cooling Load

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Cooling Load Annual Profile | tons vs time |  |  |
| Annual Average Cooling Load | tons |  |  |

## Data Center Room/Area 111

If your assessment includes multiple rooms/areas, but you are electing to not examine the air side cooling system per individual-room/area, then you can delete this Room/Area 111 section.

Provide a brief description of the air side cooling system in Room/Area 111.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111

Table: Room/Area 111: Overview

[Overview of air side cooling system in Room/Area 111]

Two diagrams are shown for **Figure 8**; one for CRAC/ACUs, one for CRAH/AHUs. Pick the appropriate one and modify it to reflect your facility.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_Floor Plan



**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 222\_Floor Plan



**Figure 8 - Data Center Room/Area 111: CRAC/ACU/CRAH/AHU Floor Plan**

### Room/Area 111: All Air Side Cooling System Components

**Table 59** presents information that applies to all air side cooling system components combined, in Room/Area 111.

**Table 59 - Room/Area 111: All Air Side Cooling System Components Combined: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111

Table: Room/Area 111: All Air Side Cooling Components Combined: Specifications & Observations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Answer | Date | Notes |
| Is there an existing, trusted meter that captures the total electric power demand of all of the air side cooling components combined (CRAC/ACU/CRAH/AHUs, Built-Up Air Side Economizer Fans, Condenser/Dry Cooler Fans) in this room/area, and no other equipment? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |
| Total Annual Energy Use of all Air Side Cooling Components Combined in Room/Area 111 for a Past Year | MWh/yr |  |  |  |
| Total Power Demand Profile of all Air Side Cooling Components Combined in Room/Area 111 for a Past Year | kW vs time |  |  |  |

If the meter referred to in **Table 59** exists and has useable data, then a measurement instrument will not be needed and **Table 60** can be deleted.

[An existing meter/meter data] was not available for the total air side cooling system power demand for Room/Area 111. We installed a [temporary] meter/[temporary] meters and performed the following measurement.

**Table 60 - Room/Area 111: All Air Side Cooling System Components Combined: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111

Table: Room/Area 111: All Air Side Cooling Components Combined: Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| Electric Power Demand of All Air Side Cooling Components Combined Annual Profile | kW vs time |  |  |  |

**Table 61** shows the total energy use of all air side cooling system components combined, in Room/Area 111. The energy use for individual components is addressed in following sections.

**Table 61 - Room/Area 111: All Air Side Cooling System Components Combined: Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111

Table: Room/Area 111: All Air Side Cooling System Components Combined: Calculations: Energy Use

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Annual Energy Use All Room/Area 111 Air Side Cooling System Components Combined | MWh/yr |  |  |
| Annual Average Power Demand All Room/Area 111 Air Side Cooling System Components Combined | kW |  |  |

**Table 62** provides a breakout of energy use by air side cooling system component, for Room/Area 111.

**Table 62 - Room/Area 111: Air Side Cooling System Components: Energy Breakouts**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111

Table: Room/Area 111: Air Side Cooling Components: Energy Breakouts

Remove any components that are not applicable.

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| CRAC/ACU/CRAH/AHUs minus Humidifiers | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |
| Humidifiers | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |
| Built-Up ASE Fans | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |
| Condenser/Dry Cooler Fans | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |
| All Data Center Air Side Cooling System Components Combined | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |

The cooling provided by the CRAC/ACU/CRAH/AHUs must be quantified in order to calculate their efficiency. If the assessment is not looking at CRAC/ACU/CRAH/AHU efficiency, **Table 63** can be deleted.

The total cooling provided by the air side cooling system in Room/Area 111 is shown in **Table 63**.

**Table 63 - Room/Area 111: All CRAC/ACU/CRAH/AHUs Combined: Cooling Load**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111

Table: Room/Area 111: All CRAC/ACU/CRAH/AHUs Combined: Calculations: Cooling Load

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Annual Average CRAC/ACU/CRAH/AHU Return Air Temperature | deg F |  |  |
| Annual Average CRAC/ACU/CRAH/AHU Return Air Relative Humidity | % |  |  |
| Annual Average CRAC/ACU/CRAH/AHU Supply Air Temperature | deg F |  |  |
| Annual Average CRAC/ACU/CRAH/AHU Air Temperature Differential | deg F |  |  |
| Cooling Load Annual Profile | tons vs time |  |  |
| Annual Average Cooling Load | tons |  |  |

### Room/Area 111: CRAC/ACU/CRAH/AHUs

Provide a brief description of the CRAC/ACU/CRAH/AHUs in Room/Area 111.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_Cool Units

Table: Room/Area 111: CRAC/ACU/CRAH/AHUs: Overview

[Overview of CRAC/ACU/CRAH/AHUs in Room/Area 111]

#### Room/Area 111: All CRAC/ACU/CRAH/AHUs Combined

**Table 64** presents information that applies to all CRAC/ACU/CRAH/AHUs combined, in Room/Area 111.

**Table 64 - Room/Area 111: All CRAC/ACU/CRAH/AHUs Combined: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_Cool Units

Table: Room/Area 111: All CRAC/ACU/CRAH/AHUs Combined: Specifications & Observations

Delete any rows that are not applicable.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Answer | Date | Notes |
| Quantity of Enabled, Working CRAC/ACU/CRAH/AHUs |  |  |  |  |
| Type: CRAC, ACU, CRAH, or AHU? |  |  |  |  |
| CRAC/ACU Condenser Type (Air-Cooled, Water-Cooled) |  |  |  |  |
| CRAH/AHU Cooling Coil Valve Type (2-way, 3-way) |  |  |  |  |
| CRAC/ACU/CRAH/AHUs are Equipped with Working, Enabled Humidifiers? (Yes, No) |  |  |  |  |
| Humidifier Type (Electric Resistance Heating/Infrared Lamps, Steam from Boiler, Direct Evaporation, Ultrasonic) |  |  |  |  |
| Do you have active, working de-humidification controls? (Yes, No) |  |  |  |  |
| Are one or more CRAC/ACU/CRAH/AHUs humidifying, while one or more other CRAC/ACU/CRAH/AHUs are simultaneously dehumidifying? (Yes, No) |  |  |  |  |
| Air Side Economizer (None, Each ACU/AHU has its Own ASE, One Built-Up ASE Serves All CRAC/ACU/CRAH/AHUs) |  |  |  |  |
| Do the CRAC/ACUs have a free cooling coil (water side economizer)? |  |  |  |  |
| Temperature & Humidity Control Authority (Each CRAC/ACU/CRAH/AHU Controls Independently, Controlled by Network) |  |  |  |  |
| Air Temperature & Humidity Control Sensor Distribution (CRAC/ACU/CRAH/AHU Return Air Inlets, IT Equipment Air Intakes) |  |  |  |  |
| Is the CRAC/ACU/CRAH/AHU supply fan equipped with a speed control device? (No, 2-Speed Motor, VFD, ECM) |  |  |  |  |
| Is the CRAC/ACU/CRAH/AHU supply fan speed automatically controlled to maintain a static air pressure setpoint? (Yes, No) |  |  |  |  |
| Air Static Pressure Control Type (Set During Manual System Balance, Automatically Controlled to Adjustable Setpoint) |  |  |  |  |
| Air Static Pressure Control Authority (Each CRAC/ACU/CRAH/AHU Controls Independently, Controlled by Network) |  |  |  |  |
| Do controls provide modifiable slope & offset inputs for calibrating all control sensors? (Yes, No) |  |  |  |  |
| Does your air management scheme, your economizing scheme (if present), and your IT equipment allow your data center to operate near the ASHRAE max Recommended and max Allowable intake temperature (per your data center Class) during 100% mechanical cooling? (Yes No) |  |  |  |  |
| Is there a continuous source of outside air admitted to the data center for ventilation? (Yes, No) |  |  |  |  |
| Is there an existing, trusted meter that captures the total electric power demand of all of CRAC/ACU/CRAH/AHUs combined in this room/area, and no other equipment? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |
| Total Annual Energy Use of all CRAC/ACU/CRAH/AHUs Combined in Room/Area 111 for a Past Year | MWh/yr |  |  |  |
| Total Power Demand Profile of all CRAC/ACU/CRAH/AHUs Combined in Room/Area 111 for a Past Year | kW vs time |  |  |  |

If the kW vs time profile referred to in **Table 64** exists and is deemed representative, then the first row of **Table 65** is not needed and can be deleted.

A representative annual kW vs time profile was not available for all CRAC/ACU/CRAH/AHUs combined in Room/Area 111. We installed a [temporary] meter/[temporary] meters and collected sufficient data to extrapolate an annual profile.

If the supply fans are not automatically controlled to maintain a static air pressure setpoint, then the second row of **Table 65** is not needed and can be deleted.

We collected sufficient data from the static air pressure control sensor create an annual profile.

**Table 65 - Room/Area 111: All CRAC/ACU/CRAH/AHUs Combined: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_Cool Units

Table: All Room/Area 111 CRAC/ACU/CRAH/AHUs Combined: Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| Electric Power Demand of All CRAC/ACU/CRAH/AHUs Combined Annual Profile | kW vs time |  |  |  |
| Air Plenum Static Pressure Actual Annual Profile | in of wc vs time |  |  |  |

**Table 66** shows the total energy use of all CRAC/ACU/CRAH/AHUs combined, in Room/Area 111. This includes humidifiers. The energy use of individual CRAC/ACU/CRAH/AHUs is addressed in following sections.

**Table 66 - Room/Area 111: All CRAC/ACU/CRAH/AHUs Combined: Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_Cool Units

Table: Room/Area 111: All CRAC/ACU/CRAH/AHUs Combined: Calculations: Energy Use

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Annual Energy Use CRAC/ACU/CRAH/AHUs | MWh/yr |  |  |
| Annual Average Power Demand CRAC/ACU/CRAH/AHUs | kW |  |  |

**Table 67** sums the energy use of all humidifiers in Room/Area 111, and shows the total CRAC/ACU/CRAH/AHU energy use in Room/Area 111 minus the humidifiers.

**Table 67 - Room/Area 111: All CRAC/ACU/CRAH/AHUs Combined: Humidifier Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_Cool Units

Table: Room/Area 111: All CRAC/ACU/CRAH/AHUs Combined: Calculations: Humidifier Energy Use

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Annual Energy Use Humidifiers | MWh/yr |  |  |
| Annual Average Power Demand Humidifiers | kW |  |  |
| Annual Energy Use CRAC/ACU/CRAH/AHUs minus Humidifiers | MWh/yr |  |  |
| Annual Average Power Demand CRAC/ACU/CRAH/AHUs minus Humidifiers | kW |  |  |

#### Room/Area 111: Individual CRAC/ACU/CRAH/AHUs

If the assessment report will not present findings for individual CRAC/ACU/CRAH/AHUs, you can delete this entire Individual CRAC/ACU/CRAH/AHUs section.

**Table 68** presents information collected for each individual CRAC/ACU/CRAH/AHU in Room/Area 111.

**Table 68 - Room/Area 111: Individual CRAC/ACU/CRAH/AHUs: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_Cool Units

Table: Room/Area 111: Individual CRAC/ACU/CRAH/AHUs: Specifications & Observations

Delete any rows that are not applicable.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Units | CRAC/ ACU/ CRAH/ AHU-111-1 | CRAC/ ACU/ CRAH/ AHU-111-2 | CRAC/ ACU/ CRAH/ AHU-111-3 | CRAC/ ACU/ CRAH/ AHU-111-4 | CRAC/ ACU/ CRAH/ AHU-111-5 | Notes |
| Manufacturer |  |  |  |  |  |  |  |
| Model |  |  |  |  |  |  |  |
| Serial Number |  |  |  |  |  |  |  |
| Age | years |  |  |  |  |  |  |
| Enabled and in Working Order? (Yes,No) |  |  |  |  |  |  |  |
| Currently running? (Yes, No) |  |  |  |  |  |  |  |
| Rated Cooling Capacity | tons |  |  |  |  |  |  |
| Rated Efficiency (COP, EER, SEER, kW/ton) | (none, BTU/W, BTU/W, kW/ton) |  |  |  |  |  |  |
| Rated Supply Air Flow Rate | cfm |  |  |  |  |  |  |
| Rated External Static Pressure (ESP) | in of wc |  |  |  |  |  |  |
| Rated Return Air Temp | deg F |  |  |  |  |  |  |
| Rated Return Air Relative Humidity | % |  |  |  |  |  |  |
| Rated Outside Air Temp | deg F |  |  |  |  |  |  |
| Rated Outside Air Relative Humidity | % |  |  |  |  |  |  |
| Supply Fan Type (Shrouded Centrifugal, Plug Fan) |  |  |  |  |  |  |  |
| Supply Fan Drive (Direct Drive, Belt Drive) |  |  |  |  |  |  |  |
| Quantity of Supply Fan Motors in the CRAC/ACU/CRAH/AHU |  |  |  |  |  |  |  |
| Supply Fan Motor Type (AC, ECM) |  |  |  |  |  |  |  |
| Supply Fan Motor Nominal Size | hp or Watts |  |  |  |  |  |  |
| Supply Fan Motor Efficiency (Nameplate) | % |  |  |  |  |  |  |
| Supply Air Flow Direction (Downflow, Upflow, Horizontal) |  |  |  |  |  |  |  |
| Current speed of supply fan (if variable speed and readout is available)? | rpm or Hz |  |  |  |  |  |  |
| Current position of CRAH/AHU cooling coil valve (if available)? | % |  |  |  |  |  |  |
| Equipped with a Working, Enabled Humidifier? (Yes, No) |  |  |  |  |  |  |  |
| Humidifier Type (Electric Resistance Heating/Infrared Lamps, Steam from Boiler, Direct Evaporation, Ultrasonic) |  |  |  |  |  |  |  |
| Do you have active, working de-humidification controls? (Yes, No) |  |  |  |  |  |  |  |
| Return Air Temperature Setpoint, Currently | deg F |  |  |  |  |  |  |
| Return Air Relative Humidity Setpoint, High Limit, Currently | % |  |  |  |  |  |  |
| Return Air Relative Humidity Setpoint, Low Limit, Currently | % |  |  |  |  |  |  |
| Return Air Absolute Humidity Setpoint, High Limit, Currently | deg F dewpoint |  |  |  |  |  |  |
| Return Air Absolute Humidity Setpoint, Low Limit, Currently | deg F dewpoint |  |  |  |  |  |  |
| Humidity Control Mode, Currently (Humidifying, Dehumidifying, Neither, N/A) |  |  |  |  |  |  |  |
| Date of Observations |  |  |  |  |  |  |  |

This report template assumes there are no pre-existing, representative annual profiles for any of the parameters listed in **Table 69**, and hence measurement instruments must be installed for each (as applicable).

**Table 69 - Room/Area 111: Individual CRAC/ACU/CRAH/AHUs: Measurements: Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_Cool Units

Table: Room/Area 111: Individual CRAC/ACU/CRAH/AHUs: Measurements: Energy Use

If you are assessing more/fewer than five CRAC/ACU/CRAH/AHUs, expand/contract the table as needed. Delete the humidifier rows if they are not applicable.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| CRAC/ACU/CRAH/AHU-111-1 | | | | |
| Whole CRAC/ACU/CRAH/AHU Electric Power Demand Annual Profile | kW vs time |  |  |  |
| CRAC/ACU/CRAH/AHU Humidifier Power Demand Annual Profile | kW vs time |  |  |  |
| CRAC/ACU/CRAH/AHU Supply Fan Power Demand Annual Profile | kW vs time |  |  |  |
| CRAC/ACU/CRAH/AHU-111-2 | | | | |
| Whole CRAC/ACU/CRAH/AHU Electric Power Demand Annual Profile | kW vs time |  |  |  |
| CRAC/ACU/CRAH/AHU Humidifier Power Demand Annual Profile | kW vs time |  |  |  |
| CRAC/ACU/CRAH/AHU Supply Fan Power Demand Annual Profile | kW vs time |  |  |  |
| CRAC/ACU/CRAH/AHU-111-3 | | | | |
| Whole CRAC/ACU/CRAH/AHU Electric Power Demand Annual Profile | kW vs time |  |  |  |
| CRAC/ACU/CRAH/AHU Humidifier Power Demand Annual Profile | kW vs time |  |  |  |
| CRAC/ACU/CRAH/AHU Supply Fan Power Demand Annual Profile | kW vs time |  |  |  |
| CRAC/ACU/CRAH/AHU-111-4 | | | | |
| Whole CRAC/ACU/CRAH/AHU Electric Power Demand Annual Profile | kW vs time |  |  |  |
| CRAC/ACU/CRAH/AHU Humidifier Power Demand Annual Profile | kW vs time |  |  |  |
| CRAC/ACU/CRAH/AHU Supply Fan Power Demand Annual Profile | kW vs time |  |  |  |
| CRAC/ACU/CRAH/AHU-111-5 | | | | |
| Whole CRAC/ACU/CRAH/AHU Electric Power Demand Annual Profile | kW vs time |  |  |  |
| CRAC/ACU/CRAH/AHU Humidifier Power Demand Annual Profile | kW vs time |  |  |  |
| CRAC/ACU/CRAH/AHU Supply Fan Power Demand Annual Profile | kW vs time |  |  |  |

This report template assumes there are no pre-existing, representative annual profiles for any of the parameters listed in **Table 70**, and hence measurement instruments must be installed for each (as applicable).

**Table 70 - Room/Area 111: Individual CRAC/ACU/CRAH/AHUs: Measurements: Air Conditions**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_Cool Units

Table: Room/Area 111: Individual CRAC/ACU/CRAH/AHUs: Measurements: Air Conditions

If you are assessing more/fewer than five CRAC/ACU/CRAH/AHUs, expand/contract the table as needed. Delete the Economizer Mixed Air Temperature rows if they are not applicable.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| CRAC/ACU/CRAH/AHU-111-1 | | | | |
| Return Air Temperature Annual Profile | deg F vs time |  |  |  |
| Return Air Relative Humidity Annual Profile | % vs time |  |  |  |
| Supply Air Temperature Annual Profile | deg F vs time |  |  |  |
| Economizer Mixed Air Temperature Annual Profile | deg F vs time |  |  |  |
| Air Flow Rate Annual Profile | cfm vs time |  |  |  |
| Plenum Static Pressure Annual Profile | in of wc vs time |  |  |  |
| CRAC/ACU/CRAH/AHU-111-2 | | | | |
| Return Air Temperature Annual Profile | deg F vs time |  |  |  |
| Return Air Relative Humidity Annual Profile | % vs time |  |  |  |
| Supply Air Temperature Annual Profile | deg F vs time |  |  |  |
| Economizer Mixed Air Temperature Annual Profile | deg F vs time |  |  |  |
| Air Flow Rate Annual Profile | cfm vs time |  |  |  |
| Plenum Static Pressure Annual Profile | in of wc vs time |  |  |  |
| CRAC/ACU/CRAH/AHU-111-3 | | | | |
| Return Air Temperature Annual Profile | deg F vs time |  |  |  |
| Return Air Relative Humidity Annual Profile | % vs time |  |  |  |
| Supply Air Temperature Annual Profile | deg F vs time |  |  |  |
| Economizer Mixed Air Temperature Annual Profile | deg F vs time |  |  |  |
| Air Flow Rate Annual Profile | cfm vs time |  |  |  |
| Plenum Static Pressure Annual Profile | in of wc vs time |  |  |  |
| CRAC/ACU/CRAH/AHU-111-4 | | | | |
| Return Air Temperature Annual Profile | deg F vs time |  |  |  |
| Return Air Relative Humidity Annual Profile | % vs time |  |  |  |
| Supply Air Temperature Annual Profile | deg F vs time |  |  |  |
| Economizer Mixed Air Temperature Annual Profile | deg F vs time |  |  |  |
| Air Flow Rate Annual Profile | cfm vs time |  |  |  |
| Plenum Static Pressure Annual Profile | in of wc vs time |  |  |  |
| CRAC/ACU/CRAH/AHU-111-5 | | | | |
| Return Air Temperature Annual Profile | deg F vs time |  |  |  |
| Return Air Relative Humidity Annual Profile | % vs time |  |  |  |
| Supply Air Temperature Annual Profile | deg F vs time |  |  |  |
| Economizer Mixed Air Temperature Annual Profile | deg F vs time |  |  |  |
| Air Flow Rate Annual Profile | cfm vs time |  |  |  |
| Plenum Static Pressure Annual Profile | in of wc vs time |  |  |  |

The annual energy use of each CRAC/ACU/CRAH/AHU in Room/Area 111 is listed in **Table 71**. Humidifier energy use is broken out.

**Table 71 - Room/Area 111: Individual CRAC/ACU/CRAH/AHUs: Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_Cool Units

Table: Room/Area 111: Individual CRAC/ACU/CRAH/AHUs: Calculations: Energy Use

If you are assessing more/fewer than five CRAC/ACU/CRAH/AHUs, expand/contract the table as needed.

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| CRAC/ACU/CRAH/AHU-111-1 | | | |
| Annual Energy Use Whole CRAC/ACU/CRAH/AHU | MWh/yr |  |  |
| Annual Energy Use Humidifier | MWh/yr |  |  |
| Annual Energy Use Whole CRAC/ACU/CRAH/AHU minus Humidifier | MWh/yr |  |  |
| CRAC/ACU/CRAH/AHU-111-2 | | | |
| Annual Energy Use Whole CRAC/ACU/CRAH/AHU | MWh/yr |  |  |
| Annual Energy Use Humidifier | MWh/yr |  |  |
| Annual Energy Use Whole CRAC/ACU/CRAH/AHU minus Humidifier | MWh/yr |  |  |
| CRAC/ACU/CRAH/AHU-111-3 | | | |
| Annual Energy Use Whole CRAC/ACU/CRAH/AHU | MWh/yr |  |  |
| Annual Energy Use Humidifier | MWh/yr |  |  |
| Annual Energy Use Whole CRAC/ACU/CRAH/AHU minus Humidifier | MWh/yr |  |  |
| CRAC/ACU/CRAH/AHU-111-4 | | | |
| Annual Energy Use Whole CRAC/ACU/CRAH/AHU | MWh/yr |  |  |
| Annual Energy Use Humidifier | MWh/yr |  |  |
| Annual Energy Use Whole CRAC/ACU/CRAH/AHU minus Humidifier | MWh/yr |  |  |
| CRAC/ACU/CRAH/AHU-111-5 | | | |
| Annual Energy Use Whole CRAC/ACU/CRAH/AHU | MWh/yr |  |  |
| Annual Energy Use Humidifier | MWh/yr |  |  |
| Annual Energy Use Whole CRAC/ACU/CRAH/AHU minus Humidifier | MWh/yr |  |  |

The cooling provided by a CRAC/ACU/CRAH/AHU must be quantified in order to calculate its efficiency. If the assessment is not looking at the efficiency of individual CRAC/ACU/CRAH/AHUs, **Table 72** can be deleted.

The total cooling provided by each CRAC/ACU/CRAH/AHU in Room/Area 111 is shown in **Table 72**.

**Table 72 - Room/Area 111: Individual CRAC/ACU/CRAH/AHUs: Cooling Load**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_Cool Units

Table: Room/Area 111: Individual CRAC/ACU/CRAH/AHUs: Calculations: Cooling Load

If you are assessing more/fewer than five CRAC/ACU/CRAH/AHUs, expand/contract the table as needed.

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| CRAC/ACU/CRAH/AHU-111-1 | | | |
| Annual Average Return Air Temperature | deg F |  |  |
| Annual Average Return Air Relative Humidity | % |  |  |
| Annual Average Supply Air Temperature | deg F |  |  |
| Annual Average Temperature Differential | deg F |  |  |
| Cooling Load Annual Profile | tons vs time |  |  |
| Annual Average Cooling Load | tons |  |  |
| CRAC/ACU/CRAH/AHU-111-2 | | | |
| Annual Average Return Air Temperature | deg F |  |  |
| Annual Average Return Air Relative Humidity | % |  |  |
| Annual Average Supply Air Temperature | deg F |  |  |
| Annual Average Temperature Differential | deg F |  |  |
| Cooling Load Annual Profile | tons vs time |  |  |
| Annual Average Cooling Load | tons |  |  |
| CRAC/ACU/CRAH/AHU-111-3 | | | |
| Annual Average Return Air Temperature | deg F |  |  |
| Annual Average Return Air Relative Humidity | % |  |  |
| Annual Average Supply Air Temperature | deg F |  |  |
| Annual Average Temperature Differential | deg F |  |  |
| Cooling Load Annual Profile | tons vs time |  |  |
| Annual Average Cooling Load | tons |  |  |
| CRAC/ACU/CRAH/AHU-111-4 | | | |
| Annual Average Return Air Temperature | deg F |  |  |
| Annual Average Return Air Relative Humidity | % |  |  |
| Annual Average Supply Air Temperature | deg F |  |  |
| Annual Average Temperature Differential | deg F |  |  |
| Cooling Load Annual Profile | tons vs time |  |  |
| Annual Average Cooling Load | tons |  |  |
| CRAC/ACU/CRAH/AHU-111-5 | | | |
| Annual Average Return Air Temperature | deg F |  |  |
| Annual Average Return Air Relative Humidity | % |  |  |
| Annual Average Supply Air Temperature | deg F |  |  |
| Annual Average Temperature Differential | deg F |  |  |
| Cooling Load Annual Profile | tons vs time |  |  |
| Annual Average Cooling Load | tons |  |  |

### Room/Area 111: Built-Up Air Side Economizer

If there is no built-up air side economizer serving Room/Area 111, delete this Built-Up Air Side Economizer section.

Provide a brief description of the built-up air side economizer serving Room/Area 111.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_ASE

Table: Room/Area 111: Built-Up Air Side Economizer: Overview

[Overview of air side economizer serving Room/Area 111]

**Table 73** presents information about the built-up air side economizer serving Room/Area 111.

**Table 73 - Room/Area 111: Built-Up Air Side Economizer: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_ASE

Table: Room/Area 111: Built-Up Air Side Economizer: Specifications & Observations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Answer | Date | Notes |
| Is there a Built-Up Air Side Economizer that serves the entire room/area? (No, Integrated Control Method, Non-Integrated Control Method) |  |  |  |  |
| Are the economizer mechanicals and controls enabled and in working order? (Yes, No) |  |  |  |  |
| Do the air side economizer controls provide modifiable slope & offset inputs for calibrating all the economizer control sensors? (Yes, No) |  |  |  |  |
| Air Side Economizer Fan Type? (Return, Relief) |  |  |  |  |
| Is the Air Side Economizer Return/Relief Fan equipped with a speed control device? (No, 2-Speed Motor, VFD, ECM, Staged Array) |  |  |  |  |
| Quantity of Return/Relief Fan Motors |  |  |  |  |
| Return/Relief Fan Drive (Direct Drive, Belt Drive) |  |  |  |  |
| Return/Relief Fan Motor Type (AC, ECM) |  |  |  |  |
| Return/Relief Fan Motor Nominal Size | hp or Watts |  |  |  |
| Return/Relief Fan Motor Efficiency (Nameplate) | % |  |  |  |
| Is there an existing, trusted meter that captures the total electric power demand of the Return/Relief Fan, and no other equipment? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |
| Total Annual Energy Use of the Return/Relief Fan in Room/Area 111 for a Past Year | MWh/yr |  |  |  |
| Total Power Demand Profile of the Return/Relief Fan in Room/Area 111 for a Past Year | kW vs time |  |  |  |

If the kW vs time profile referred to in **Table 73** exists and is deemed representative, then the first row of **Table 74** is not needed and can be deleted.

A representative annual kW vs time profile was not available for the built-up air side economizer return/relief fans in Room/Area 111. We installed a [temporary] meter/[temporary] meters and collected sufficient data to extrapolate an annual profile.

This report template assumes there is not a pre-existing, representative annual profile for the economizer mixed air temperature, and hence a MAT sensor must be installed (if there is none), and data collected.

We [installed an air side economizer mixed air temperature sensor and] collected sufficient data to extrapolate a mixed air temperature annual profile.

**Table 74 - Room/Area 111: Built-Up Air Side Economizer: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_ASE

Table: Room/Area 111: Built-Up Air Side Economizer: Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| Return/Relief Fan Power Demand Annual Profile | kW vs time |  |  |  |
| Mixed Air Temperature Annual Profile | deg F vs time |  |  |  |

The annual energy use of the built-up air side economizer return/relief fans in Room/Area 111 is listed in **Table 75**.

**Table 75 - Room/Area 111: Built-Up Air Side Economizer: Fan Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_ASE

Table: Room/Area 111: Built-Up Air Side Economizer: Calculations: Fan Energy Use

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Annual Energy Use Built-Up ASE Return/Relief Fans | MWh/yr |  |  |
| Annual Average Power Demand Built-Up ASE Return/Relief Fans | kW |  |  |

### Room/Area 111: Condenser/Dry Cooler Fans

If Room/Area 111 is not served by air-cooled DX condensers, or water-cooled DX condensers served by a dry cooler, then delete this entire Condenser/Dry Cooler Fans section.

Provide a brief description of the condensers/dry coolers serving Room/Area 111.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_Cond Fans

Table: Room/Area 111: Condensers/Dry Coolers: Overview

[Overview of the condensers/dry coolers serving Room/Area 111]

#### Room/Area 111: All Condenser/Dry Cooler Fans Combined

**Table 76** presents information about all of the air-cooled DX condensers/dry coolers combined, serving Room/Area 111.

**Table 76 - Room/Area 111: All Condenser/Dry Cooler Fans Combined: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_Cond Fans

Table: Room/Area 111: All Condenser/Dry Cooler Fans Combined: Specifications & Observations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Answer | Dates | Notes |
| Is there an existing, trusted meter that captures the total power demand of all condenser/dry cooler fans combined that serve Room Area 111, and no other equipment? (None, Total Energy Only, Power Trends) |  |  |  |  |
| Total Energy Use of all Condenser/Dry Cooler Fans Combined for a Past Year | MWh/yr |  |  |  |
| Total Power Demand Profile of all Condenser/Dry Cooler Fans Combined for a Past Year | kW vs time |  |  |  |

If the kW vs time profile referred to in **Table 76** exists and is deemed representative, then the first row of **Table 77** is not needed and can be deleted.

A representative annual kW vs time profile was not available for all of the condenser/dry cooler fans combined, serving Room/Area 111. We installed a [temporary] meter/[temporary] meters and collected sufficient data to extrapolate an annual profile.

**Table 77 - Room/Area 111: All Condenser/Dry Cooler Fans Combined: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_Cond Fans

Table: Room/Area 111: All Condenser/Dry Cooler Fans Combined: Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| Electric Power Demand Annual Profile | kW vs time |  |  |  |

The annual energy use of all of the condenser/dry cooler fans combined, serving Room/Area 111, is listed in **Table 78**.

**Table 78 - Room/Area 111: All Condenser/Dry Cooler Fans Combined: Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_Cond Fans

Table: Room/Area 111: All Condenser/Dry Cooler Fans Combined: Calculations

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Annual Condenser/Dry Cooler Fan Energy Use | MWh/yr |  |  |
| Annual Average Condenser/Dry Cooler Fan Power Demand | kW |  |  |

#### Room/Area 111: Individual Condenser/Dry Cooler Fans

If the assessment report will not present findings for individual condenser/dry cooler fans, you can delete this entire Individual Condenser/Dry Cooler Fans section.

**Table 79** presents information collected for each individual condenser/dry cooler serving Room/Area 111.

**Table 79 - Room/Area 111: Individual Condenser/Dry Cooler Fans: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_Cond Fans

Table: Room/Area 111: Individual Condenser/Dry Cooler Fans: Specifications & Observations

If you are assessing more/fewer than five condensers/dry coolers, expand/contract the table as needed.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Units | COND-111-1 | COND-111-2 | COND-111-3 | COND-111-4 | COND-111-5 | Notes |
| Manufacturer |  |  |  |  |  |  |  |
| Model |  |  |  |  |  |  |  |
| Serial Number |  |  |  |  |  |  |  |
| Age | years |  |  |  |  |  |  |
| Normally Enabled? (Yes,No) |  |  |  |  |  |  |  |
| Rated Cooling Capacity | tons |  |  |  |  |  |  |
| Rated Outside Air Temp | deg F |  |  |  |  |  |  |
| Rated Outside Air Relative Humidity | % |  |  |  |  |  |  |
| Fan Type |  |  |  |  |  |  |  |
| Fan Drive |  |  |  |  |  |  |  |
| Fan Motor Type |  |  |  |  |  |  |  |
| Fan Motor Nominal Size | hp or Watts |  |  |  |  |  |  |
| Fan Motor Efficiency (Nameplate) | % |  |  |  |  |  |  |
| Date of Observations |  |  |  |  |  |  |  |

This report template assumes there are no pre-existing, representative annual profiles of fan energy use for individual condensers/dry coolers, and hence electric meters must be installed (if there are none), and data collected.

**Table 80 - Room/Area 111: Individual Condenser/Dry Cooler Fans: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_Cond Fans

Table: Room/Area 111: Individual Condenser/Dry Cooler Fans: Measurements

If you are assessing more/fewer than five condensers/dry coolers, expand/contract the table as needed.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| COND-111-1 | | | | |
| Electric Power Demand Annual Profile | kW vs time |  |  |  |
| COND-111-2 | | | | |
| Electric Power Demand Annual Profile | kW vs time |  |  |  |
| COND-111-3 | | | | |
| Electric Power Demand Annual Profile | kW vs time |  |  |  |
| COND-111-4 | | | | |
| Electric Power Demand Annual Profile | kW vs time |  |  |  |
| COND-111-5 | | | | |
| Electric Power Demand Annual Profile | kW vs time |  |  |  |

The annual fan energy use of each condenser/dry cooler serving Room/Area 111 is listed in **Table 81**.

**Table 81 - Room/Area 111: Individual Condenser/Dry Cooler Fans: Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_Cond Fans

Table: Room/Area 111: Individual Condenser/Dry Cooler Fans: Calculations: Energy Use

If you are assessing more/fewer than five condensers/dry coolers, expand/contract the table as needed.

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| COND-111-1 | | | |
| Annual Energy Use | MWh/yr |  |  |
| COND-111-2 | | | |
| Annual Energy Use | MWh/yr |  |  |
| COND-111-3 | | | |
| Annual Energy Use | MWh/yr |  |  |
| COND-111-4 | | | |
| Annual Energy Use | MWh/yr |  |  |
| COND-111-5 | | | |
| Annual Energy Use | MWh/yr |  |  |

## Data Center Room/Area 222

If there is more than one data center room/area, replicate the entire Room/Area 111 section and edit as needed.

# Cooling Plant

If the data center rooms/areas being assessed are not served by a central cooling plant (chillers and/or cooling towers), this entire Cooling Plant section can be deleted.

If a cooling plant serves the data center, the plant is assumed to be:

* Completely electric-driven; ie, not a Combined Heat & Power (CHP) plant.
* Dedicated to the data center. This report template currently does not support pro-rating of cooling plant energy use and cooling load between multiple facilities.

The energy use of the cooling plant affects overall data center efficiency, but it is not necessary to isolate and quantify the energy use of the plant itself in order to calculate the data center’s overall PUE. It only needs to be captured in the data center’s overall energy use. If you elect to not assess the cooling plant at this time, you can delete this entire Cooling Plant section.

Edit the following text to match your cooling plant. Chillers are optional; this report template supports chillerless cooling plants (cooling towers and CW pumps only).

For the purpose of this assessment, the cooling plant consists of the following subsystems:

* Air-cooled/Water-cooled chillers.
* A water side economizer (heat exchanger and pumps).
* Open/Closed cooling towers.
* [Primary and secondary] chilled water pumps.
* Condenser water pumps.

The portion of the overall cooling system that serves the data center space itself (the “air side”) is addressed in Section 8.

Section 9 reports the energy use of the cooling plant. Evaluations of cooling plant’s performance metrics are presented in Section 10.

## Whole Plant

### Overview

Provide a brief description of the whole cooling plant.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Summary

Table: Cooling Plant: Overview

[Overview of whole cooling plant]

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Diagram

Modify this example simple diagram to reflect your cooling plant.



**Figure 9 - Cooling Plant Diagram**

### A Note About Pumps

Pumps are normally installed in pairs, but alternate their duty cycle. This provides backup and allows servicing the pumps without interrupting flow. Throughout this report, the energy use and performance of a given pump refers to the pair as whole.

**Table 82** presents information that applies to the cooling plant as a whole.

**Table 82 - Whole Cooling Plant: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Summary

Table: Whole Cooling Plant: Specifications & Observations

Delete rows that are not applicable. Examples:

* If the assessment will not examine the cooling plant’s efficiency, all rows related to cooling load measurement can be deleted.
* If a trusted BTU meter exists, the water flow rate, supply temperature, and return temperature meters are not needed.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Answer | Dates | Notes |
| Does the plant include electric chillers? (Yes, No) |  |  |  |  |
| Does the plant include cooling towers? (Yes, No) |  |  |  |  |
| Cooling Water Supply Temperature Setpoint | deg F |  |  |  |
| Cooling Plant Design Load | tons |  |  |  |
| Is there an existing, trusted meter that measures the electric power demand of the Whole Cooling Plant, and nothing else? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |
| Is there an existing, trusted BTU meter that measures the cooling load served by the Whole Cooling Plant, and nothing else? (None, Total Ton-Hours Only, Ton Trends) |  |  |  |  |
| Is there an existing, trusted meter that measures the chilled water flow rate provided by the Whole Cooling Plant? (None, GPM Trends) |  |  |  |  |
| Is there an existing, trusted meter that measures the chilled water supply temperature of the Whole Cooling Plant? (None, Temperature Trends) |  |  |  |  |
| Is there an existing, trusted meter that measures the chilled water return temperature of the Whole Cooling Plant? (None, Temperature Trends) |  |  |  |  |
| Whole Cooling Plant Total Energy Use for a Past Year | MWh/yr |  |  |  |
| Whole Cooling Plant Total Power Demand Profile Use for a Past Year | kW vs time |  |  |  |
| Total Cooling Load Served by the Whole Cooling Plant for a Past Year | ton-hrs/yr |  |  |  |
| Cooling Demand Profile for the Whole Cooling Plant for a Past Year | tons vs time |  |  |  |
| Chilled Water Flow Rate Profile for the Whole Cooling Plant for a Past Year | gpm vs time |  |  |  |
| Chilled Water Supply Temperature Profile for the Whole Cooling Plant for a Past Year | deg F vs time |  |  |  |
| Chilled Water Return Temperature Profile for the Whole Cooling Plant for a Past Year | deg F vs time |  |  |  |

If the kW vs time profile referred to in **Table 82** exists and is deemed representative, then the first row of **Table 83** is not needed and can be deleted.

A representative annual kW vs time profile was not available for the cooling plant as a whole. We installed a [temporary] meter/[temporary] meters and collected sufficient data to extrapolate an annual profile.

If the tons vs time profile referred to in **Table 82** exists and is deemed representative, then rows 2 through 5 of **Table 83** are not needed and can be deleted.

A representative annual tons vs time profile was not available for the cooling plant as a whole. We installed a [temporary] BTU meter and collected sufficient data to extrapolate an annual profile.

If the gpm vs time and the two deg F vs time profiles referred to in **Table 82** exist and are deemed representative, then rows 2 through 5 of **Table 83** are not needed and can be deleted.

Representative annual gpm vs time, water supply temperature vs time, and water return temperature vs time profiles were not available for the cooling plant as a whole. We installed [temporary] meters and collected sufficient data to extrapolate annual profiles.

**Table 83 - Whole Cooling Plant: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Summary

Table: Whole Cooling Plant: Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| Whole Cooling Plant Power Demand Annual Profile | kW vs time |  |  |  |
| Whole Cooling Plant Cooling Load Annual Profile | tons vs time |  |  |  |
| Cooling Water Flow Rate Annual Profile | gpm vs time |  |  |  |
| Cooling Water Supply Temperature Annual Profile | deg F vs time |  |  |  |
| Cooling Water Return Temperature Annual Profile | deg F vs time |  |  |  |

**Table 84** shows the total energy use of the cooling plant as a whole. The energy use of cooling plant subsystems is addressed in following sections.

**Table 84 - Whole Cooling Plant: Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Summary

Table: Whole Cooling Plant: Calculations: Energy Use

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |

The cooling provided by the cooling plant must be quantified in order to calculate the plant’s overall efficiency. If the assessment is not looking at cooling plant’s overall efficiency, **Table 85** can be deleted.

**Table 85 - Whole Cooling Plant: Cooling Load**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Summary

Table: Whole Cooling Plant: Calculations: Cooling Load

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Cooling Load Served by the Chillers and WSE Combined Annual Profile | tons vs time |  |  |
| Whole Cooling Plant Annual Total Cooling Load | ton-hrs/yr |  |  |

## Cooling Plant Subsystems

**Table 86** breaks out cooling plant annual energy use by subsystem.

**Table 86 - Cooling Plant Subsystems: Energy Use Totals**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Summary

Table: Cooling Plant Components: Energy Use Totals

Delete rows that are not applicable to your plant.

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| All Chillers Combined | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |
| Water Side Economizer Pumps | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |
| All Cooling Towers Combined | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |
| All Chilled Water Pumps Combined | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |
| All Condenser Water Pumps Combined | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |

If there is no water side economizer, **Table 87** can be deleted. Total chiller cooling is reported in the following Chillers section.

**Table 87** shows how much of the annual cooling provided is by the chillers, and how much by the water side economizer.

**Table 87 - Cooling Plant Subsystems: Cooling Load**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Summary

Table: Cooling Plant Subsystems: Cooling Load Totals

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| All Chillers Combined | | | |
| Total Annual Chiller Cooling Load | ton-hrs/yr |  |  |
| Water Side Economizer | | | |
| Total Annual WSE Cooling Load | ton-hrs/yr |  |  |

## Chillers

If your cooling plant does not contain chillers, you can delete this entire Chillers section.

### Overview

Provide a brief description of the chillers.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Chillers

Table: Overview of Chillers

[Overview of chillers]

### All Chillers Combined

**Table 88** presents information that applies to all chillers combined.

**Table 88 - Cooling Plant: All Chillers Combined: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Chillers

Table: All Chillers Combined: Specifications & Observations

Delete rows that are not applicable. Examples:

* If the assessment will not examine the chillers’ overall efficiency, all rows related to cooling load measurement can be deleted.
* If a trusted BTU meter exists, the water flow rate, supply temperature, and return temperature meters are not needed.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Answer | Dates | Notes |
| Chiller Type (Air-Cooled, Water-Cooled) |  |  |  |  |
| Is there an existing, trusted meter that captures the total electric power demand of All Chillers Combined, and no other equipment? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |
| Is there an existing, trusted BTU meter that measures the cooling load served by all of the chillers combined, and nothing else? (None, Total Ton-Hours Only, Ton Trends) |  |  |  |  |
| Is there an existing, trusted meter that measures the chilled water flow rate of all chillers combined, and nothing else? (None, GPM Trends) |  |  |  |  |
| Is there an existing, trusted meter that measures the chilled water supply temperature for all chillers combined? (None, Temperature Trends) |  |  |  |  |
| Is there an existing, trusted meter that measures the chilled water return temperature for all chillers combined? (None, Temperature Trends) |  |  |  |  |
| Total Energy Use of All Chillers Combined for a Past Year | MWh/yr |  |  |  |
| Power Demand Profile of All Chillers Combined for a Past Year | kW vs time |  |  |  |
| Total Cooling Load Served by All Chillers Combined for a Past Year | ton-hrs/yr |  |  |  |
| Cooling Demand Profile for All Chiller Combined for a Past Year | tons vs time |  |  |  |
| Chilled Water Flow Rate Profile for All Chillers Combined for a Past Year | gpm vs time |  |  |  |
| Chilled Water Supply Temperature Profile for All Chillers Combined for a Past Year | deg F vs time |  |  |  |
| Chilled Water Return Temperature Profile for All Chillers Combined for a Past Year | deg F vs time |  |  |  |

If the kW vs time profile referred to in **Table 88** exists and is deemed representative, then the first row of **Table 89** is not needed and can be deleted.

A representative annual kW vs time profile was not available for all of the chillers combined. We installed a [temporary] meter/[temporary] meters and collected sufficient data to extrapolate an annual profile.

If the tons vs time profile referred to in **Table 88** exists and is deemed representative, then rows 2 through 5 of **Table 89** are not needed and can be deleted.

A representative annual tons vs time profile was not available for all of the chillers combined. We installed a [temporary] BTU meter and collected sufficient data to extrapolate an annual profile.

If the gpm vs time and the two deg F vs time profiles referred to in **Table 88** exist and are deemed representative, then rows 2 through 5 of **Table 89** are not needed and can be deleted.

Representative annual gpm vs time, water supply temperature vs time, and water return temperature vs time profiles were not available for all of the chillers combined. We installed [temporary] meters and collected sufficient data to extrapolate annual profiles.

**Table 89 - Cooling Plant: All Chillers Combined: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Chillers

Table: All Chillers Combined: Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| Chiller Power Demand Annual Profile | kW vs time |  |  |  |
| Cooling Load Served by All Chillers Combined Annual Profile | tons vs time |  |  |  |
| Cooling Water Flow Rate Annual Profile | gpm vs time |  |  |  |
| Cooling Water Supply Temperature Annual Profile | deg F vs time |  |  |  |
| Cooling Water Return Temperature Annual Profile | deg F vs time |  |  |  |

**Table 90** shows the total energy use of all of the chillers combined. The energy use of individual chillers is addressed in following sections.

**Table 90 - Cooling Plant: All Chillers Combined: Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Chillers

Table: All Chillers Combined: Calculations: Energy Use

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Total Annual Chiller Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |

The cooling provided by all of the chillers combined must be quantified in order to calculate the efficiency of all of the chillers combined. If the assessment is not looking at efficiency, **Table 91** can be deleted.

**Table 91** shows the total cooling provided by all of the chillers combined. The cooling provided by individual chillers is addressed in following sections.

**Table 91 - Cooling Plant: All Chillers Combined: Cooling Load**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Chillers

Table: All Chillers Combined: Calculations: Cooling Load

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Cooling Load Served by All Chillers Combined Annual Profile | tons vs time |  |  |
| Total Annual Cooling Load Served by All Chillers Combined | ton-hrs/yr |  |  |

### Individual Chillers

If the assessment report will not present findings for individual chillers, you can delete this entire Individual Chillers section.

**Table 92** presents information collected for each individual chiller

**Table 92 - Cooling Plant: Individual Chillers: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Chillers

Table: Individual Chillers: Specifications & Observations

If you are assessing more than two chillers, expand the table as needed.

Delete rows that are not applicable. Examples:

* If the assessment will not examine the efficiency of individual chillers, all rows related to cooling load measurement can be deleted.
* If a trusted BTU meter exists, the water flow rate, supply temperature, and return temperature meters are not needed.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | CH-1 | CH-2 | Notes |
| Chiller Manufacturer |  |  |  |  |
| Chiller Model |  |  |  |  |
| Chiller Serial Number |  |  |  |  |
| Chiller Age | years |  |  |  |
| Chiller Type (Air-Cooled, Water-Cooled) |  |  |  |  |
| Chiller is Variable Speed? (Yes, No) |  |  |  |  |
| Rated Condition: Cooling Capacity | tons |  |  |  |
| Rated Condition: Efficiency | kW/ton |  |  |  |
| Rated Condition: Cooling Water Supply Temperature | deg F |  |  |  |
| Rated Condition: Condensing Temperature | deg F |  |  |  |
| Is there an existing, trusted meter that captures the total electric power demand of this chiller alone? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |
| Is there an existing, trusted BTU meter that measures the cooling load served by this chiller alone? (None, Total Ton-Hours Only, Ton Trends) |  |  |  |  |
| Is there an existing, trusted meter that measures the chilled water flow rate of this chiller alone? (None, GPM Trends) |  |  |  |  |
| Is there an existing, trusted meter that measures the chilled water supply temperature for this chiller? (None, Temperature Trends) |  |  |  |  |
| Is there an existing, trusted meter that measures the chilled water return temperature for this chiller? (None, Temperature Trends) |  |  |  |  |
| Date of Observations |  |  |  |  |
| Total Energy Use for a Past Year per Chiller | MWh/yr |  |  |  |
| Power Demand Profile for a Past Year per Chiller | kW vs time |  |  |  |
| Date Span of Past Year's Data |  |  |  |  |
| Total Cooling Load Served for a Past Year per Chiller | ton-hrs/yr |  |  |  |
| Cooling Demand Profile for a Past Year per Chiller | tons vs time |  |  |  |
| Date Span of Past Year's Data |  |  |  |  |
| Chilled Water Flow Rate Profile for a Past Year per Chiller | gpm vs time |  |  |  |
| Date Span of Past Year's Data |  |  |  |  |
| Chilled Water Supply Temperature Profile for a Past Year per Chiller | deg F vs time |  |  |  |
| Date Span of Past Year's Data |  |  |  |  |
| Chilled Water Return Temperature Profile for a Past Year per Chiller | deg F vs time |  |  |  |
| Date Span of Past Year's Data |  |  |  |  |

If the kW vs time profiles referred to in **Table 92** exist and are deemed representative, then the first rows in the corresponding sections of **Table 93** are not needed and can be deleted.

Representative annual kW vs time profiles were not available for the individual chillers. We installed [temporary] meters and collected sufficient data to extrapolate annual profiles.

If the tons vs time profiles referred to in **Table 92** exist and are deemed representative, then rows 2 through 5 in the corresponding sections of **Table 93** are not needed and can be deleted.

Representative annual tons vs time profiles were not available for the individual chillers. We installed [temporary] BTU meters and collected sufficient data to extrapolate annual profiles.

If the gpm vs time and the deg F vs time profiles referred to in **Table 92** exist and are deemed representative, then rows 2 through 5 in the corresponding sections of **Table 93** are not needed and can be deleted.

Representative annual gpm vs time, water supply temperature vs time, and water return temperature vs time profiles were not available for the individual chillers. We installed [temporary] meters and collected sufficient data to extrapolate annual profiles.

**Table 93 - Cooling Plant: Individual Chillers: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Chillers

Table: Individual Chillers: Measurements

If you are assessing more than two chillers, expand the table as needed.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| CH-1 | | | | |
| Power Demand Annual Profile | kW vs time |  |  |  |
| Cooling Load Served by Chiller Annual Profile | tons vs time |  |  |  |
| Chilled Water Flow Rate Annual Profile | gpm vs time |  |  |  |
| Chilled Water Supply Temperature Actual Annual Profile | deg F vs time |  |  |  |
| Chilled Water Return Temperature Actual Annual Profile | deg F vs time |  |  |  |
| CH-2 | | | | |
| Power Demand Annual Profile | kW vs time |  |  |  |
| Cooling Load Served by Chiller Annual Profile | tons vs time |  |  |  |
| Chilled Water Flow Rate Annual Profile | gpm vs time |  |  |  |
| Chilled Water Supply Temperature Actual Annual Profile | deg F vs time |  |  |  |
| Chilled Water Return Temperature Actual Annual Profile | deg F vs time |  |  |  |

**Table 94** shows the total energy use of individual chillers.

**Table 94 - Cooling Plant: Individual Chillers: Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Chillers

Table: Individual Chillers: Calculations: Energy Use

If you are assessing more than two chillers, expand the table as needed.

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| CH-1 | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |
| CH-2 | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |

The cooling provided by a chiller must be quantified in order to calculate its efficiency. If the assessment is not looking at the efficiency of individual chillers, **Table 95** can be deleted.

**Table 95** shows the cooling provided by individual chillers.

**Table 95 - Cooling Plant: Individual Chillers: Cooling Load**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Chillers

Table: Individual Chillers: Calculations: Cooling Load

If you are assessing more than two chillers, expand the table as needed.

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| CH-1 | | | |
| Cooling Load Served Annual Profile | tons vs time |  |  |
| Total Annual Cooling Load Served | ton-hrs/yr |  |  |
| CH-2 | | | |
| Cooling Load Served Annual Profile | ton-hrs/yr |  |  |
| Total Annual Cooling Load Served | tons vs time |  |  |

## Water Side Economizer

If your cooling plant does not contain a water side economizer, or if adding one is an impractical consideration, you can delete this entire Water Side Economizer section.

Water side economizing refers to the scheme of using cooling tower water, when it can be produced at a sufficiently low temperature, to offset or entirely remove the cooling load on the energy-intensive chillers.

The Water Side Economizer Utilization Factor refers to the percent of the total annual cooling plant load that is provided by the economizer. This value depends on several variables:

* Integrated vs non-integrated economizer. Integrated will provide more energy savings, all else held equal.
* The local climate. Cooler/dryer climates can improve the Utilization Factor.
* The chilled water supply and return air temperatures. The higher these temperatures are, the higher the Utilization Factor can be, all else held equal.

### Overview

Provide a brief description of the water side economizer.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_WSE

Table: Overview of Water Side Economizer

[Overview of the water side economizer]

There are [quantity > 1] water side economizer heat exchangers. For the purpose of this assessment, we are treated them as a single entity.

There are [quantity > 1] pumps serving the water side heat exchanger. This assessment examines their energy use as a whole; it does not examine the pumps individually.

**Table 96** presents information that applies to the water side economizer.

**Table 96 - Cooling Plant: Water Side Economizer: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_WSE

Table: Water Side Economizer: Specifications & Observations

Delete rows that are not applicable. Examples:

* If the assessment will not examine the cooling provided by the water side economizer, retain only the rows related to electric power and delete the rest.
* If a trusted BTU meter exists, the water flow rate, supply temperature, and return temperature meters are not needed.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Answer | Dates | Notes |
| Is there an existing, trusted meter that measures the electric power demand of All WSE Pumps Combined, and nothing else? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |
| Is there an existing, trusted BTU meter that measures the cooling load served by the WSE? (None, Total Ton-Hours Only, Ton Trends) |  |  |  |  |
| Is there an existing, trusted meter that measures the chilled water flow rate of the WSE? (None, GPM Trends) |  |  |  |  |
| Is there an existing, trusted meter that measures the chilled water supply temperature of the WSE? (None, Temperature Trends) |  |  |  |  |
| Is there an existing, trusted meter that measures the chilled water return temperature of the WSE? (None, Temperature Trends) |  |  |  |  |
| Total Energy Use for All WSE Pumps Combined for a Past Year | MWh/yr |  |  |  |
| Power Demand Profile for All WSE Pumps Combined for a Past Year | kW vs time |  |  |  |
| Total Cooling Load served by the WSE for a Past Year | ton-hrs/yr |  |  |  |
| Cooling Demand Profile for the WSE for a Past Year | tons vs time |  |  |  |
| Chilled Water Flow Rate Profile for the WSE for a Past Year | gpm vs time |  |  |  |
| Chilled Water Supply Temperature Profile for the WSE for a Past Year | deg F vs time |  |  |  |
| Chilled Water Return Temperature Profile for the WSE for a Past Year | deg F vs time |  |  |  |

If the kW vs time profile referred to in **Table 96** exists and is deemed representative, then the first row of **Table 97** is not needed and can be deleted.

A representative annual kW vs time profile was not available for the water side economizer pumps. We installed a [temporary] meter/[temporary] meters and collected sufficient data to extrapolate an annual profile.

If the tons vs time profile referred to in **Table 96** exists and is deemed representative, then rows 2 through 5 of **Table 97** are not needed and can be deleted.

A representative annual tons vs time profile was not available for the water side economizer. We installed a [temporary] BTU meter and collected sufficient data to extrapolate an annual profile.

If the gpm vs time and the deg F vs time profiles referred to in **Table 96** exist and are deemed representative, then rows 2 through 5 in the corresponding sections of **Table 97** are not needed and can be deleted.

Representative annual gpm vs time, water supply temperature vs time, and water return temperature vs time profiles were not available for the water side economizer. We installed [temporary] meters and collected sufficient data to extrapolate annual profiles.

**Table 97 - Cooling Plant: Water Side Economizer: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_WSE

Table: Water Side Economizer: Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| WSE Pump Power Demand Annual Profile | kW vs time |  |  |  |
| Cooling Load Served by the WSE Annual Profile | tons vs time |  |  |  |
| WSE Cooling Water Flow Rate Annual Profile | gpm vs time |  |  |  |
| WSE Cooling Water Supply Temperature Annual Profile | deg F vs time |  |  |  |
| WSE Cooling Water Return Temperature Annual Profile | deg F vs time |  |  |  |

**Table 98** shows the total energy use of individual chillers.

**Table 98 - Cooling Plant: Water Side Economizer: WSE Pump Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_WSE

Table: Water Side Economizer: Calculations: WSE Pump Energy Use

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Annual WSE Pump Energy Use | MWh/yr |  |  |
| Annual Average WSE Pump Power Demand | kW |  |  |

If the assessment is not breaking out the total cooling provided by the whole plant into chiller and WSE portions, then **Table 99** can be deleted.

**Table 99 - Cooling Plant: Water Side Economizer: Cooling Load**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_WSE

Table: Water Side Economizer: Calculations: Cooling Load

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Cooling Load Served by the WSE Annual Profile | tons vs time |  |  |
| Total Annual Cooling Load Served by the WSE | ton-hrs/yr |  |  |
| Annual Average Cooling Load Served by the WSE | tons |  |  |

## Cooling Towers

If your cooling plant does not contain cooling towers, you can delete this entire Cooling Towers section.

### Overview

Provide a brief description of the cooling towers.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Cooling Towers

Table: Overview of Cooling Towers

[Overview of the cooling towers]

For this assessment, the electric energy use of a cooling tower includes all of its components – fans, water circulation pumps (any that are in addition to the condenser water pumps, which are treated separately), and water treatment devices.

### All Cooling Towers Combined

**Table 100** presents information that applies to all cooling towers combined.

**Table 100 - Cooling Plant: All Cooling Towers Combined: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Cooling Towers

Table: All Cooling Towers Combined: Specifications & Observations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Answer | Dates | Notes |
| Is there an existing, trusted meter that captures the total electric power demand of All Cooling Towers Combined, and no other equipment? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |
| Total Energy Use of All Cooling Towers Combined for a Past Year | MWh/yr |  |  |  |
| Power Demand Profile of All Cooling Towers Combined for a Past Year | kW vs time |  |  |  |

If the kW vs time profile referred to in **Table 100** exists and is deemed representative, then **Table 101** is not needed and can be deleted.

A representative annual kW vs time profile was not available for all of the cooling towers combined. We installed a [temporary] meter/[temporary] meters and collected sufficient data to extrapolate an annual profile.

**Table 101 - Cooling Plant: All Cooling Towers Combined: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Cooling Towers

Table: All Cooling Towers Combined: Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| Total Cooling Tower Power Demand Annual Profile | kW vs time |  |  |  |

**Table 102** shows the total energy use of all cooling towers combined. The energy use of individual cooling towers is addressed in following sections.

**Table 102 - Cooling Plant: All Cooling Towers Combined: Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Cooling Towers

Table: All Cooling Towers Combined: Calculations: Energy Use

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |

### Individual Cooling Towers

**Table 103** presents information collected for each individual cooling tower.

**Table 103 - Cooling Plant: Individual Cooling Towers: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Cooling Towers

Table: Individual Cooling Towers: Specifications & Observations

If you are assessing more than two cooling towers, expand the table as needed.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | CT-1 | CT-2 | Notes |
| Tower Manufacturer |  |  |  |  |
| Tower Model |  |  |  |  |
| Tower Serial Number |  |  |  |  |
| Tower Age | years |  |  |  |
| Tower Type (Open Loop, Closed Loop) |  |  |  |  |
| Rated Condition: Cooling Capacity | tons |  |  |  |
| Rated Condition: Tower Water Flow Rate | gpm |  |  |  |
| Rated Condition: Tower Water Entering Temperature | deg F |  |  |  |
| Rated Condition: Ambient Drybulb Temperature | deg F |  |  |  |
| Rated Condition: Ambient Wetbulb Temperature | deg F wetbulb |  |  |  |
| Rated Condition: Approach Temperature | deg F |  |  |  |
| Fan Type (Centrifugal, Propeller) |  |  |  |  |
| Fan Drive Type (Direct Drive, Belt Drive, Gearbox) |  |  |  |  |
| Fan Motor Type (AC, ECM) |  |  |  |  |
| Fan Motor Nominal Size | hp |  |  |  |
| Fan Motor Nominal Efficiency | % |  |  |  |
| Is the motor equipped with a VSD? (None, 2-Speed, VFD, etc) |  |  |  |  |
| Date of Observations |  |  |  |  |
| Is there an existing, trusted meter that captures the total electric power demand of this cooling tower alone? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |
| Total Energy Use for a Past Year | MWh/yr |  |  |  |
| Power Demand Profile for a Past Year | kW vs time |  |  |  |
| Date Span of Past Year's Data |  |  |  |  |

If the kW vs time profiles referred to in **Table 103** exist and are deemed representative, then the **Table 104** is not needed and can be deleted.

Representative annual kW vs time profiles were not available for the individual cooling towers. We installed [temporary] meters and collected sufficient data to extrapolate annual profiles.

**Table 104 - Cooling Plant: Individual Cooling Towers: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Cooling Towers

Table: Individual Cooling Towers: Measurements

If you are assessing more than two cooling towers, expand the table as needed.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| CT-1 | | | | |
| Power Demand Annual Profile | kW vs time |  |  |  |
| CT-2 | | | | |
| Power Demand Annual Profile | kW vs time |  |  |  |

**Table 105** shows the total energy use of individual cooling towers.

**Table 105 - Cooling Plant: Individual Cooling Towers: Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Cooling Towers

Table: Individual Cooling Towers: Calculations

If you are assessing more than two cooling towers, expand the table as needed.

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| CT-1 | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |
| CT-2 | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |

## Chilled Water Pumps

If your cooling plant does not contain chilled water pumps, you can delete this entire Chilled Water Pumps section.

### Overview

Provide a brief description of the chilled water pumping system.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CHW Pumps

Table: Chilled Water Pumps: Overview

[Overview of the chilled water pumping system]

### All Chilled Water Pumps Combined

This report template currently supports primary-only CHW systems, and primary/secondary systems, but not tertiary and beyond.

**Table 106** presents information that applies to all [primary and secondary] chilled water pumps combined.

**Table 106 - Cooling Plant: All Chilled Water Pumps Combined: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CHW Pumps

Table: All Chilled Water Pumps Combined: Specifications & Observations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Answer | Dates | Notes |
| Is there an existing, trusted meter that captures the total electric power demand of All Chilled Water Pumps Combined, and no other equipment? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |
| Total Energy Use of All Chilled Water Pumps Combined for a Past Year | MWh/yr |  |  |  |
| Power Demand Profile of All Chilled Water Pumps Combined for a Past Year | kW vs time |  |  |  |

If the kW vs time profile referred to in **Table 106** exists and is deemed representative, then **Table 107** is not needed and can be deleted.

A representative annual kW vs time profile was not available for all of the chilled water pumps combined. We installed a [temporary] meter/[temporary] meters and collected sufficient data to extrapolate an annual profile.

**Table 107 - Cooling Plant: All Chilled Water Pumps Combined: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CHW Pumps

Table: All Chilled Water Pumps Combined: Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| Total CHW Pump Power Demand Annual Profile | kW vs time |  |  |  |

**Table 108** shows the total energy use of all chilled water pumps combined. The energy use of [the primary pumps vs the secondary pumps, and] the individual chilled water pumps is addressed in following sections.

**Table 108 - Cooling Plant: All Chilled Water Pumps Combined: Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CHW Pumps

Table: All Chilled Water Pumps Combined: Calculations: Energy Use

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |

#### All Primary Chilled Water Pumps Combined

If you do not have a primary/secondary chilled water pumping system, this All Primary Chilled Water Pumps Combined section can be deleted.

**Table 109** presents information that applies to all primary loop chilled water pumps combined.

**Table 109 - Cooling Plant: All Primary Chilled Water Pumps Combined: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CHW Pumps

Table: All Primary Chilled Water Pumps Combined: Specifications & Observations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Answer | Dates | Notes |
| Is there an existing, trusted meter that captures the total electric power demand of All Primary Chilled Water Pumps Combined, and no other equipment? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |
| Total Energy Use of All Primary Chilled Water Pumps Combined for a Past Year | MWh/yr |  |  |  |
| Power Demand Profile of All Primary Chilled Water Pumps Combined for a Past Year | kW vs time |  |  |  |

If the kW vs time profile referred to in **Table 109** exists and is deemed representative, then **Table 110** is not needed and can be deleted.

A representative annual kW vs time profile was not available for all of the primary loop chilled water pumps combined. We installed a [temporary] meter/[temporary] meters and collected sufficient data to extrapolate an annual profile.

**Table 110 - Cooling Plant: All Primary Chilled Water Pumps Combined: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CHW Pumps

Table: All Primary Chilled Water Pumps Combined: Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| Total Primary Loop CHW Pump Power Demand Annual Profile | kW vs time |  |  |  |

**Table 111** shows the total energy use of all primary loop chilled water pumps combined. The energy use of individual primary chilled water pumps is addressed in the following section.

**Table 111 - Cooling Plant: All Primary Chilled Water Pumps Combined: Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CHW Pumps

Table: All Primary Chilled Water Pumps Combined: Calculations: Energy Use

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |

#### Individual [Primary] Chilled Water Pumps

If you have a primary-only chilled water pumping system, you can delete the word “primary” wherever it occurs in this section.

**Table 112** presents information collected for each individual [primary] chilled water pump.

**Table 112 - Cooling Plant: Individual [Primary] Chilled Water Pumps: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CHW Pumps

Table: Individual Primary Chilled Water Pumps: Specifications & Observations

If you are assessing more than two primary chilled water pumps, expand the table as needed.

Delete any rows that are not applicable.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | PCHWP-1 | PCHWP-2 | Notes |
| Pump Manufacturer |  |  |  |  |
| Pump Model |  |  |  |  |
| Age | years |  |  |  |
| Pump Nominal Efficiency | % |  |  |  |
| Pump Nominal Speed | rpm |  |  |  |
| Pump Nominal Flow Rate | gpm |  |  |  |
| Pump Nominal Head | ft of wc |  |  |  |
| Motor Manufacturer |  |  |  |  |
| Motor Model |  |  |  |  |
| Motor Type (AC, ECM, etc) |  |  |  |  |
| Motor Nominal Load | hp |  |  |  |
| Motor Nominal Efficiency | % |  |  |  |
| Motor Nominal Speed | rpm |  |  |  |
| Is the motor equipped with a VSD? (None,VFD, etc) |  |  |  |  |
| VSD Manufacturer |  |  |  |  |
| VSD Model |  |  |  |  |
| VSD Nominal Efficiency at 100% Speed | % |  |  |  |
| Is the motor programmed to vary speed automatically while in operation? (Yes, No) |  |  |  |  |
| CHW Differential Pressure Setpoint for this Pump | ft of wc |  |  |  |
| Is there an existing, trusted meter that captures the electric power demand of this pump alone? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |
| Date of Observations |  |  |  |  |
| Total Energy Use for a Past Year | MWh/yr |  |  |  |
| Power Demand Profile for a Past Year | kW vs time |  |  |  |
| Date Span of Past Year's Data |  |  |  |  |

If the kW vs time profile referred to in **Table 112** exists and is deemed representative, then the first row in each section of **Table 113** is not needed and can be deleted.

A representative annual kW vs time profile was not available for all of the primary chilled water pumps combined. We installed a [temporary] meter/[temporary] meters and collected sufficient data to extrapolate an annual profile.

If the assessment will not examine the pumping efficiency (W/gpm) of individual primary chilled water pumps, the second and third rows in each section of **Table 113** are not needed and can be deleted.

This report template assumes there is not a pre-existing, representative annual profile of the chilled water flow rate for individual pumps, hence a flow sensor must be installed (if there is none), and data collected.

We [installed water flow meters and] collected sufficient data to extrapolate annual chilled water flow profiles.

This report template assumes there is not a pre-existing, representative annual profile of the pumping head pressure for individual pumps, hence a pressure sensor must be installed (if there is none), and data collected.

We [installed water pressure sensors and] collected sufficient data to extrapolate annual chilled water pumping head profiles.

**Table 113 - Cooling Plant: Individual Primary Chilled Water Pumps: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CHW Pumps

Table: Individual Primary Chilled Water Pumps: Measurements

If you are assessing more than two primary chilled water pumps, expand the table as needed.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| PCHWP-1 | | | | |
| Power Demand Annual Profile | kW vs time |  |  |  |
| CHW Flow Rate Annual Profile | gpm vs time |  |  |  |
| Pump Head Annual Profile | ft of wc vs time |  |  |  |
| PCHWP-2 | | | | |
| Power Demand Annual Profile | kW vs time |  |  |  |
| CHW Flow Rate Annual Profile | gpm vs time |  |  |  |
| Pump Head Annual Profile | ft of wc vs time |  |  |  |

**Table 114** shows the total energy use of individual [primary] chilled water pumps.

**Table 114 - Cooling Plant: Individual Primary Chilled Water Pumps: Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CHW Pumps

Table: Individual Primary Chilled Water Pumps: Calculations: Energy Use

If you are assessing more than two primary chilled water pumps, expand the table as needed.

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | **Notes** |
| PCHWP-1 | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |
| PCHWP-2 | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |

#### All Secondary Chilled Water Pumps Combined

If you do not have a primary/secondary chilled water pumping system, this All Secondary Chilled Water Pumps Combined section can be deleted.

**Table 115** presents information collected for all secondary chilled water pumps combined.

**Table 115 - Cooling Plant: All Secondary Chilled Water Pumps Combined: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CHW Pumps

Table: All Secondary Chilled Water Pumps Combined: Specifications & Observations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Answer | Dates | Notes |
| Is there an existing, trusted meter that captures the total electric power demand of All Secondary Chilled Water Pumps Combined, and no other equipment? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |
| Total Energy Use of All Secondary Chilled Water Pumps Combined for a Past Year | MWh/yr |  |  |  |
| Power Demand Profile of All Secondary Chilled Water Pumps Combined for a Past Year | kW vs time |  |  |  |

If the kW vs time profile referred to in **Table 115** exists and is deemed representative, then **Table 116** is not needed and can be deleted.

A representative annual kW vs time profile was not available for all of the secondary loop chilled water pumps combined. We installed a [temporary] meter/[temporary] meters and collected sufficient data to extrapolate an annual profile.

**Table 116 - Cooling Plant: All Secondary Chilled Water Pumps Combined: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CHW Pumps

Table: All Secondary Chilled Water Pumps Combined: Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| Total Secondary Loop CHW Pump Power Demand Annual Profile | kW vs time |  |  |  |

**Table 117** shows the total energy use of all secondary loop chilled water pumps combined. The energy use of individual secondary chilled water pumps is addressed in the following section.

**Table 117 - Cooling Plant: All Secondary Chilled Water Pumps Combined: Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CHW Pumps

Table: All Secondary Chilled Water Pumps Combined: Calculations: Energy Use

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |

#### Individual Secondary Chilled Water Pumps

If you do not have a primary/secondary chilled water pumping system, this Individual Secondary Chilled Water Pumps section can be deleted.

**Table 118** presents information collected for each individual secondary chilled water pump.

**Table 118 - Cooling Plant: Individual Secondary Chilled Water Pumps: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CHW Pumps

Table: Individual Secondary Chilled Water Pumps: Specifications & Observations

If you are assessing more than two secondary chilled water pumps, expand the table as needed.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | SCHWP-1 | SCHWP-2 | Notes |
| Pump Manufacturer |  |  |  |  |
| Pump Model |  |  |  |  |
| Age | years |  |  |  |
| Pump Nominal Efficiency | % |  |  |  |
| Pump Nominal Speed | rpm |  |  |  |
| Pump Nominal Flow Rate | gpm |  |  |  |
| Pump Nominal Head | ft of wc |  |  |  |
| Motor Manufacturer |  |  |  |  |
| Motor Model |  |  |  |  |
| Motor Type (AC, ECM, etc) |  |  |  |  |
| Motor Nominal Load | hp |  |  |  |
| Motor Nominal Efficiency | % |  |  |  |
| Motor Nominal Speed | rpm |  |  |  |
| Is the motor equipped with a VSD? (None,VFD, etc) |  |  |  |  |
| VSD Manufacturer |  |  |  |  |
| VSD Model |  |  |  |  |
| VSD Nominal Efficiency at 100% Speed | % |  |  |  |
| Is the motor programmed to vary speed automatically while in operation? (Yes, No) |  |  |  |  |
| CHW Differential Pressure Setpoint for this Pump | ft of wc |  |  |  |
| Is there an existing, trusted meter that captures the electric power demand of this pump alone? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |
| Date of Observations |  |  |  |  |
| Total Energy Use for a Past Year | MWh/yr |  |  |  |
| Power Demand Profile for a Past Year | kW vs time |  |  |  |
| Date Span of Past Year's Data |  |  |  |  |

If the kW vs time profiles referred to in **Table 118** exist and are deemed representative, then the first row in each section of **Table 119** is not needed and can be deleted.

Representative annual kW vs time profiles were not available for the secondary chilled water pumps. We installed [temporary] meters and collected sufficient data to extrapolate annual profiles.

If the assessment will not examine the pumping efficiency (W/gpm) of individual secondary chilled water pumps, the second and third rows in each section of **Table 119** are not needed and can be deleted.

This report template assumes there is not a pre-existing, representative annual profile of the chilled water flow rate for individual pumps, hence a flow sensor must be installed (if there is none), and data collected.

We [installed water flow meters and] collected sufficient data to extrapolate annual chilled water flow profiles.

This report template assumes there is not a pre-existing, representative annual profile of the pumping head pressure for individual pumps, hence a pressure sensor must be installed (if there is none), and data collected.

We [installed water pressure sensors and] collected sufficient data to extrapolate annual chilled water pumping head profiles.

**Table 119 - Cooling Plant: Individual Secondary Chilled Water Pumps: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CHW Pumps

Table: Individual Secondary Chilled Water Pumps: Measurements

If you are assessing more than two secondary chilled water pumps, expand the table as needed.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| SCHWP-1 | | | | |
| Power Demand Annual Profile | kW vs time |  |  |  |
| CHW Flow Rate Annual Profile | gpm vs time |  |  |  |
| Pump Head Annual Profile | ft of wc vs time |  |  |  |
| SCHWP-2 | | | | |
| Power Demand Annual Profile | kW vs time |  |  |  |
| CHW Flow Rate Annual Profile | gpm vs time |  |  |  |
| Pump Head Annual Profile | ft of wc vs time |  |  |  |

**Table 120** shows the total energy use of individual secondary chilled water pumps.

**Table 120 - Cooling Plant: Individual Secondary Chilled Water Pumps: Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CHW Pumps

Table: Individual Secondary Chilled Water Pumps: Calculations: Energy Use

If you are assessing more than two secondary chilled water pumps, expand the table as needed.

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | **Notes** |
| SCHWP-1 | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |
| SCHWP-2 | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |

## Condenser Water Pumps

If your cooling plant does not contain condenser water pumps, you can delete this entire Condenser Water Pumps section.

### Overview

Provide a brief description of the condenser water pumping system.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CW Pumps

Table: Condenser Water Pumps: Overview

[Overview of the condenser water pumping system]

### All Condenser Water Pumps Combined

**Table 121** presents information that applies to all condenser water pumps combined.

**Table 121 - Cooling Plant: All Condenser Water Pumps Combined: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CW Pumps

Table: All Condenser Water Pumps Combined: Specifications & Observations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Answer | Dates | Notes |
| Is there an existing, trusted meter that captures the total electric power demand of All Condenser Water Pumps Combined, and no other equipment? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |
| Total Energy Use of All Condenser Water Pumps Combined for a Past Year | MWh/yr |  |  |  |
| Power Demand Profile of All Condenser Water Pumps Combined for a Past Year | kW vs time |  |  |  |

If the kW vs time profile referred to in **Table 121** exists and is deemed representative, then **Table 122** is not needed and can be deleted.

A representative annual kW vs time profile was not available for all of the condenser water pumps combined. We installed a [temporary] meter/[temporary] meters and collected sufficient data to extrapolate an annual profile.

**Table 122 - Cooling Plant: All Condenser Water Pumps Combined: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CW Pumps

Table: All Condenser Water Pumps Combined: Measurements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| Total CW Pump Power Demand Annual Profile | kW vs time |  |  |  |

**Table 123** shows the total energy use of all condenser water pumps combined. The energy use of individual condenser water pumps is addressed in the following section.

**Table 123 - Cooling Plant: All Condenser Water Pumps Combined: Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CW Pumps

Table: All Condenser Water Pumps Combined: Calculations: Energy Use

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | Notes |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |

### Individual Condenser Water Pumps

**Table 124** presents information collected for each individual condenser water pump.

**Table 124 - Cooling Plant: Individual Condenser Water Pumps: Specifications & Observations**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CW Pumps

Table: Individual Condenser Water Pumps: Specifications & Observations

If you are assessing more than two condenser water pumps, expand the table as needed.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | CWP-1 | CWP-2 | Notes |
| Pump Manufacturer |  |  |  |  |
| Pump Model |  |  |  |  |
| Age | years |  |  |  |
| Pump Nominal Efficiency | % |  |  |  |
| Pump Nominal Speed | rpm |  |  |  |
| Pump Nominal Flow Rate | gpm |  |  |  |
| Pump Nominal Head | ft of wc |  |  |  |
| Motor Manufacturer |  |  |  |  |
| Motor Model |  |  |  |  |
| Motor Type (AC, ECM, etc) |  |  |  |  |
| Motor Nominal Load | hp |  |  |  |
| Motor Nominal Efficiency | % |  |  |  |
| Motor Nominal Speed | rpm |  |  |  |
| Is the motor equipped with a VSD? (None,VFD, etc) |  |  |  |  |
| VSD Manufacturer |  |  |  |  |
| VSD Model |  |  |  |  |
| VSD Nominal Efficiency at 100% Speed | % |  |  |  |
| Is the motor programmed to vary speed automatically while in operation? (Yes, No) |  |  |  |  |
| CW Differential Pressure Setpoint for this Pump | ft of wc |  |  |  |
| Is there an existing, trusted meter that captures the electric power demand of this pump alone? (None, Power Only, Total Energy, Power Trends) |  |  |  |  |
| Date of Observations |  |  |  |  |
| Total Energy Use for a Past Year | MWh/yr |  |  |  |
| Power Demand Profile for a Past Year | kW vs time |  |  |  |
| Date Span of Past Year's Data |  |  |  |  |

If the kW vs time profiles referred to in **Table 124** exist and are deemed representative, then the first row in each section of **Table 125** is not needed and can be deleted.

Representative annual kW vs time profiles were not available for the condenser water pumps. We installed [temporary] meters and collected sufficient data to extrapolate annual profiles.

If the assessment will not examine the pumping efficiency (W/gpm) of individual condenser water pumps, the second and third rows in each section of **Table 125** are not needed and can be deleted.

This report template assumes there is not a pre-existing, representative annual profile of the condenser water flow rate for individual pumps, hence a flow sensor must be installed (if there is none), and data collected.

We [installed water flow meters and] collected sufficient data to extrapolate annual condenser water flow profiles.

This report template assumes there is not a pre-existing, representative annual profile of the pumping head pressure for individual pumps, hence a pressure sensor must be installed (if there is none), and data collected.

We [installed water pressure sensors and] collected sufficient data to extrapolate annual condenser water pumping head profiles.

**Table 125 - Cooling Plant: Individual Condenser Water Pumps: Measurements**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CW Pumps

Table: Individual Condenser Water Pumps: Measurements

If you are assessing more than two condenser water pumps, expand the table as needed.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | Value | Measurement Dates | Notes |
| CWP-1 | | | | |
| Power Demand Annual Profile | kW vs time |  |  |  |
| CW Flow Rate Actual Annual Profile | gpm vs time |  |  |  |
| Pump Head Actual Annual Profile | ft of wc vs time |  |  |  |
| CWP-2 | | | | |
| Power Demand Annual Profile | kW vs time |  |  |  |
| CW Flow Rate Actual Annual Profile | gpm vs time |  |  |  |
| Pump Head Actual Annual Profile | ft of wc vs time |  |  |  |

**Table 126** shows the total energy use of individual condenser water pumps.

**Table 126 - Cooling Plant: Individual Condenser Water Pumps: Energy Use**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CW Pumps

Table: Individual Condenser Water Pumps: Calculations: Energy Use

If you are assessing more than two condenser water pumps, expand the table as needed.

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Value | **Notes** |
| CWP-1 | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |
| CWP-2 | | | |
| Annual Energy Use | MWh/yr |  |  |
| Annual Average Power Demand | kW |  |  |

# Metrics and Benchmarking

This section presents calculated key metrics by data center system, evaluates them, and compares them to benchmarks from other data centers where available. These evaluations drive the selection of the recommended energy efficiency measures presented in Section 11.

## Overall Efficiency Metric - PUE

Based on the data collected during this assessment, the overall Power Utilization Effectiveness of data center rooms/areas at Name of Facility was found to be approximately x.x, which is better/worse than the majority of the 25 data centers for which PUE data is available in a LBNL database. This is illustrated in **Figure 10**.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: PUE Comparison



**Figure 10 - PUE Comparison between Name of Facility and Other Data Centers**

**Table 127 – Space Usage Factor**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: Whole Facility

Table: Whole Facility: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| Current Space Usage Factor | % |  |  |

## Electric Distribution System Metrics

If no components of the electric power chain were assessed, delete this entire Electric Power Chain Metrics section.

**Table 128** summarizes the electric power chain metrics. Each component is addressed in the following sections.

**Table 128 - Electric Distribution System: Subsystem Efficiency**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Summary

Table: Electric Distribution System: Subsystem Efficiency

If any of the electric distribution subsystems were not assessed, delete them from the table.

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| All Main Transformers Combined | | | |
| Weighted Average Load Factor | % |  |  |
| Weighted Average Operating Efficiency | % |  |  |
| All UPS Units Combined | | | |
| Weighted Average Load Factor | % |  |  |
| Weighted Average Operating Efficiency | % |  |  |
| All PDUs Combined | | | |
| Weighted Average Load Factor | % |  |  |
| Weighted Average Operating Efficiency | % |  |  |

### Main Transformers

Edit the following table to show all the main transformers serving the data center, regardless of whether their operating performance was measured. This report template currently assumes there is only one of each transformer. This table is not copied from elsewhere; this is the only place it appears.

**Table 129 – Main Transformers**

|  |  |  |
| --- | --- | --- |
| Tag | Name | Operating Performance Measured? |
| XX | Whole Facility Transformer | Yes/No |
| XX | IT Power Chain Transformer | Yes/No |
| XX | Data Center Air Side Cooling System Transformer | Yes/No |
| XX | Cooling Plant Transformer | Yes/No |
| XX | Lighting System Transformer | Yes/No |

#### All Main Transformers Combined

If none of the main transformers were assessed, delete this All Main Transformers Combined section, and the following Individual Main Transformers section.

**Table 130 - All Main Transformers Combined: Efficiency**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Xformers

Table: All Transformers Combined: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| Weighted Average Load Factor | % |  |  |
| Weighted Average Operating Efficiency | % |  |  |

Performance data was not obtained for [certain transformers], so these load factor and efficiency values are approximate.

The annual average load factor for all main transformers combined is greater than 50%. No measures are recommended at this time.

The annual average load factor for all main transformers combined is less than 50%. Increasing the overall load factor will result more efficient transformer operation. See Section 11 for recommended EEMs.

The annual average operating efficiency for all main transformers combined is greater than 95%. No measures are recommended at this time.

The annual average operating efficiency for all main transformers combined is less than 95%. See Section 11 for recommended EEMs.

#### Individual Main Transformers

If the Main Transformers were not individually assessed, delete this Individual Main Transformers section.

**Table 131 - Individual Main Transformers: Efficiency**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_Xformers

Table: Individual Main Transformers: Calculations: Efficiency

Delete any transformers not measured.

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| Whole Facility Transformer | | | |
| Annual Average Load Factor | % |  |  |
| Annual Average Operating Efficiency | % |  |  |
| Annual Average Power Factor |  |  |  |
| Annual Average Total Harmonic Distortion |  |  |  |
| IT Power Chain Transformer | | | |
| Annual Average Load Factor | % |  |  |
| Annual Average Operating Efficiency | % |  |  |
| Data Center Air Side Cooling System Transformer | | | |
| Annual Average Load Factor | % |  |  |
| Annual Average Operating Efficiency | % |  |  |
| Cooling Plant Transformer | | | |
| Annual Average Load Factor | % |  |  |
| Annual Average Operating Efficiency | % |  |  |
| Lighting System Transformer | | | |
| Annual Average Load Factor | % |  |  |
| Annual Average Operating Efficiency | % |  |  |

Whole Facility Transformer

The annual average load factor is greater than 50%. No measures are recommended at this time.

The annual average load factor less than 50%. Increasing the load factor will result more efficient transformer operation. See Section 11 for recommended EEMs.

The annual average operating efficiency is greater than 95%. No measures are recommended at this time.

The annual average operating efficiency less than 95%. See Section 11 for recommended EEMs.

The annual average power factor is greater than 0.95. No measures are recommended at this time.

The annual average power factor is less than 0.95. See Section 11 for recommended EEMs.

The annual average THD is less than 5%. No measures are recommended at this time.

The annual average THD is greater than 5%. See Section 11 for recommended EEMs.

IT Power Chain Transformer

The annual average load factor is greater than 50%. No measures are recommended at this time.

The annual average load factor less than 50%. Increasing the load factor will result more efficient transformer operation. See Section 11 for recommended EEMs.

The annual average operating efficiency is greater than 95%. No measures are recommended at this time.

The annual average operating efficiency less than 95%. See Section 11 for recommended EEMs.

Data Center Air Side Cooling System Transformer

The annual average load factor is greater than 50%. No measures are recommended at this time.

The annual average load factor less than 50%. Increasing the load factor will result more efficient transformer operation. See Section 11 for recommended EEMs.

The annual average operating efficiency is greater than 95%. No measures are recommended at this time.

The annual average operating efficiency less than 95%. See Section 11 for recommended EEMs.

Cooling Plant Transformer

The annual average load factor is greater than 50%. No measures are recommended at this time.

The annual average load factor less than 50%. Increasing the load factor will result more efficient transformer operation. See Section 11 for recommended EEMs.

The annual average operating efficiency is greater than 95%. No measures are recommended at this time.

The annual average operating efficiency less than 95%. See Section 11 for recommended EEMs.

Lighting System Transformer

The annual average load factor is greater than 50%. No measures are recommended at this time.

The annual average load factor less than 50%. Increasing the load factor will result more efficient transformer operation. See Section 11 for recommended EEMs.

The annual average operating efficiency is greater than 95%. No measures are recommended at this time.

The annual average operating efficiency less than 95%. See Section 11 for recommended EEMs.

### UPS System

If there is no UPS system, or if none of the UPS units were assessed, delete this entire UPS System section.

This report template currently assumes there is a maximum of two UPS units.

The UPS system typically represents an efficiency opportunity in most data centers.

#### All UPS Units Combined

If only one UPS unit was assessed, or if only one UPS unit exists, replace “All UPS Units Combined” with the name of the single UPS unit, throughout this section.

**Table 132 - All UPS Units Combined: Efficiency**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_UPS

Table: All UPS Units Combined: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| Total UPS Capacity | kW |  |  |
| Annual Average Load Factor | % |  |  |
| Operating Efficiency Annual Profile | % vs time |  |  |
| Annual Average Operating Efficiency | % |  |  |

Performance data was not obtained for [certain UPS units], so these efficiency values are approximate.

Load Factor

The annual average load factor for the UPS system as a whole is xx% of its total rated capacity.

Select one of the following statements based on your UPS system redundancy.

This is a relatively good load factor for a UPS system with [N, N+1, N+2, 2N] redundancy No measures are recommended at this time.

For a UPS system with [N, N+1, N+2, 2N] redundancy, this load factor can be improved. Increasing the load factor will lead to more efficient UPS operation. See Section 11 for recommended EEMs.

**Figure 11** compares the measured overall UPS load factor to other data centers.

**Source:**

Data Center Electrical Power Chain Assessment Tool v2.0

Tab: Peer Comparison



**Figure 11 - UPS Load Factor Comparison**

Efficiency

The annual average operating efficiency for the UPS system as a whole is xx%.

Select one of the following statements based on your UPS system redundancy.

This is relatively good operating efficiency for a UPS system with [N, N+1, N+2, 2N] redundancy. No measures are recommended at this time.

For a UPS system with [N, N+1, N+2, 2N] redundancy, this efficiency can be improved. See Section 11 for recommended EEMs.

**Figure 12** represents a typical double-conversion, 480-volt, modern (2014 to 2017), relatively efficient, UPS of 500 to 600 kW capacity.

**Source:**

Data Center Electrical Power Chain Assessment Tool v2.0

Tab: UPS Efficiency



**Figure 12 - UPS Efficiency Comparison**

#### Individual UPS Units

If only one UPS unit was assessed, or if only one UPS unit exists, you can delete this Individual UPS Units section.

**Table 133 - Individual UPS Units: Efficiency**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_UPS

Table: Individual UPS Units: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| UPS-1 | | | |
| Annual Average Load Factor | % |  |  |
| Operating Efficiency Annual Profile | % vs time |  |  |
| Annual Average Operating Efficiency | % |  |  |
| Manufacturer's Claimed Efficiency at the Calculated Annual Average Load Factor | % |  |  |
| UPS-2 | | | |
| Annual Average Load Factor | % |  |  |
| Operating Efficiency Annual Profile | % vs time |  |  |
| Annual Average Operating Efficiency | % |  |  |
| Manufacturer's Claimed Efficiency at the Calculated Annual Average Load Factor | % |  |  |

UPS-1

This is a relatively good load factor for a UPS module in a UPS system with [N, N+1, N+2, 2N] redundancy No measures are recommended at this time.

For a UPS module in a UPS system with [N, N+1, N+2, 2N] redundancy, this load factor can be improved. Increasing the load factor will lead to more efficient UPS operation. See Section 11 for recommended EEMs.

This is relatively good operating efficiency for a UPS module in a UPS system with [N, N+1, N+2, 2N] redundancy No measures are recommended at this time.

For a UPS module in a UPS system with [N, N+1, N+2, 2N] redundancy, this efficiency can be improved. See Section 11 for recommended EEMs.

UPS-2

This is a relatively good load factor for a UPS module in a UPS system with [N, N+1, N+2, 2N] redundancy No measures are recommended at this time.

For a UPS module in a UPS system with [N, N+1, N+2, 2N] redundancy, this load factor can be improved. Increasing the load factor will lead to more efficient UPS operation. See Section 11 for recommended EEMs.

This is relatively good operating efficiency for a UPS module in a UPS system with [N, N+1, N+2, 2N] redundancy No measures are recommended at this time.

For a UPS module in a UPS system with [N, N+1, N+2, 2N] redundancy, this efficiency can be improved. See Section 11 for recommended EEMs.

### Power Distribution Units (PDUs)

If there are no PDUs with potential significant power loss, or if none of the PDUs were assessed, you can delete this entire PDUs section.

#### All Rooms/Areas Combined

If PDUs were assessed in only one room/area, you can delete this All Rooms/Areas Combined section.

**Table 134 - All Rooms/Areas Combined: All PDUs Combined: Efficiency**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_PDUs\_Summary

Table: PDUs: All Rooms/Areas Combined: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| Total Rated Capacity | kW |  |  |
| Annual Average Load Factor | % |  |  |
| Annual Average Operating Efficiency | % |  |  |

Performance data was not obtained for [certain rooms/areas], so these load factor and efficiency values are approximate.

Load Factor

The annual average load factor for all PDUs in all rooms/areas combined is greater than 50%. No measures are recommended at this time.

The annual average load factor for all PDUs in all rooms/areas combined is less than 50%. Increasing the overall load factor will result more efficient PDU operation. See Section 11 for recommended EEMs.

Efficiency

The annual average operating efficiency for all PDUs in all rooms/areas combined is greater than 95%. No measures are recommended at this time.

The annual average operating efficiency for all PDUs in all rooms/areas combined is less than 95%. See Section 11 for recommended EEMs.

#### Room/Area 111: All PDUs Combined

**Table 135 - Room/Area 111: All PDUs Combined: Efficiency**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_PDUs\_Room 111

Table: All PDUs Combined: Room/Area 111: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| Total PDU Rated Capacity | kW |  |  |
| Annual Average Load Factor | % |  |  |
| Operating Efficiency Annual Profile | % vs time |  |  |
| Annual Average Operating Efficiency | % |  |  |

Performance data was not obtained for [certain PDUs in Room/Area 111], so these load factor and efficiency values are approximate.

Load Factor

The annual average load factor for all PDUs combined in Room/Area 111 is greater than 50%. No measures are recommended at this time.

The annual average load factor for all PDUs combined in Room/Area 111 is less than 50%. Increasing the overall load factor will result more efficient PDU operation. See Section 11 for recommended EEMs.

Efficiency

The annual average operating efficiency for all combined in Room/Area 111 is greater than 95%. No measures are recommended at this time.

The annual average operating efficiency for all PDUs combined in Room/Area 111 is less than 95%. See Section 11 for recommended EEMs.

#### Room/Area 111: Individual PDUs

**Table 136 - Room/Area 111: Individual PDUs: Efficiency**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_PDUs\_Room 111

Table: Individual PDUs: Room/Area 111: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| PDU-111-1 | | | |
| Annual Average Load Factor | % |  |  |
| Operating Efficiency Annual Profile | % vs time |  |  |
| Annual Average Operating Efficiency | % |  |  |
| PDU-111-2 | | | |
| Annual Average Load Factor | % |  |  |
| Operating Efficiency Annual Profile | % vs time |  |  |
| Annual Average Operating Efficiency | % |  |  |
| PDU-111-3 | | | |
| Annual Average Load Factor | % |  |  |
| Operating Efficiency Annual Profile | % vs time |  |  |
| Annual Average Operating Efficiency | % |  |  |
| PDU-111-4 | | | |
| Annual Average Load Factor | % |  |  |
| Operating Efficiency Annual Profile | % vs time |  |  |
| Annual Average Operating Efficiency | % |  |  |
| PDU-111-5 | | | |
| Annual Average Load Factor | % |  |  |
| Operating Efficiency Annual Profile | % vs time |  |  |
| Annual Average Operating Efficiency | % |  |  |

Load Factor

The annual average load factor for [certain PDUs] in Room/Area 111 is less than 50%. Increasing their load factor will result more efficient PDU operation. See Section 11 for recommended EEMs.

Efficiency

The annual average operating efficiency for [certain PDUs] in Room/Area 111 is less than 95%. See Section 11 for recommended EEMs.

#### Room/Area 222: All PDUs Combined

Replicate the Room/Area 111: All PDUs Combined section as needed, for other rooms/areas.

#### Room/Area 222: Individual PDUs

Replicate the Room/Area 111: Individual PDUs section as needed, for other rooms/areas.

## IT Equipment Metrics

If IT equipment metrics were not assessed, you can delete this entire IT Equipment Metrics section.

This report template currently does not support IT equipment computational efficiency, only power density and space usage factors.

### All Rooms/Areas Combined

If IT equipment was assessed in only one room/area, replace “All Rooms/Areas Combined” with the name of the single room/area, throughout this section.

**Table 137 - IT Equipment: All Rooms/Areas Combined: Metrics**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_IT

Table: IT Equipment: All Rooms/Areas Combined: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| Total Gross Floor Area | sf |  |  |
| Total Electrically Active Floor Area | sf |  |  |
| Total Rack Quantity |  |  |  |
| IT Average Power Density | W/sf |  |  |
| IT Peak Power Density, Actual | W/sf |  |  |
| IT Peak Power Density, Design | W/sf |  |  |
| IT Average Rack Power Density, Actual | kW/rack |  |  |
| IT Average Rack Power Density, Design | kW/rack |  |  |
| Current Space Usage Factor | % |  |  |

#### Load (Power) Density

**Figure 13** compares the data center’s overall current, measured IT load density to other data centers.

**Source:**

Data Center Electrical Power Chain Assessment Tool v2.0

Tab: Peer Comparison



**Figure 13 - Measured IT Load Density**

The overall load density of the data center is [average/high] compared to other data centers. The electric distribution system and the cooling system are not overloaded, so no measures are recommended at this time.

The overall load density of the data center is low compared to other data centers. The electric distribution system [and the cooling system] is/are currently underloaded. Increasing the load will allow the support systems to operate more efficiently. See Section 11 for recommended EEMs.

#### Space Usage Factor

The current overall space usage factor of xx% is relatively low. If the support systems (electric distribution, cooling) have sufficient capacity, further populating the data center with IT equipment will help the support systems operate more efficiently.

### Individual Rooms/Areas

If only one room/area was assessed, you can delete this Individual Rooms/Areas section.

**Table 138 - IT Equipment: Individual Rooms/Areas: Metrics**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: ElectricSystem\_IT

Table: IT Equipment: Individual Rooms/Areas: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| Room/Area 111 | | | |
| IT Average Power Density | W/sf |  |  |
| IT Peak Power Density Actual | W/sf |  |  |
| IT Peak Power Density Design | W/sf |  |  |
| IT Average Rack Power Density Actual | kW/rack |  |  |
| IT Average Rack Power Density Design | kW/rack |  |  |
| Current Space Usage Factor | % |  |  |
| Room/Area 222 | | | |
| IT Average Power Density | W/sf |  |  |
| IT Peak Power Density Actual | W/sf |  |  |
| IT Peak Power Density Design | W/sf |  |  |
| IT Average Rack Power Density Actual | kW/rack |  |  |
| IT Average Rack Power Density Design | kW/rack |  |  |
| Current Space Usage Factor | % |  |  |

#### Room/Area 111

The load density of Room/Area 111 is [average/high] compared to other data centers. The electric distribution system and the cooling system that serve this room/area are not overloaded, so no measures are recommended at this time.

The load density of Room/Area 111 is low compared to other data centers. The electric distribution system [and the cooling system] that serve this room/area is/are currently underloaded. Increasing the load will allow the support systems to operate more efficiently. See Section 11 for recommended EEMs.

The current space usage factor of xx% for Room/Area 111 is relatively low. If the support systems (electric distribution, cooling) have sufficient capacity, further populating the data center with IT equipment will help the support systems operate more efficiently.

#### Room/Area 222

The load density of Room/Area 222 is [average/high] compared to other data centers. The electric distribution system and the cooling system that serve this room/area are not overloaded, so no measures are recommended at this time.

The load density of Room/Area 222 is low compared to other data centers. The electric distribution system [and the cooling system] that serve this room/area is/are currently underloaded. Increasing the load will allow the support systems to operate more efficiently. See Section 11 for recommended EEMs.

The current space usage factor of xx% for Room/Area 222 is relatively low. If the support systems (electric distribution, cooling) have sufficient capacity, further populating the data center with IT equipment will help the support systems operate more efficiently.

## Lighting Metrics

If lighting power density was not assessed for any room/area, you can delete this entire Lighting Metrics section.

### All Rooms/Areas Combined

If lighting power density was assessed in only one room/area, replace “All Rooms/Areas Combined” with the name of the single room/area, throughout this section.

**Table 139 - Lighting: All Rooms/Areas Combined: Metrics**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: Lighting

Table: Lighting: All Rooms/Areas Combined: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | **Notes** |
| Gross Floor Area | sf |  |  |
| Annual Average Lighting Power Density | W/sf |  |  |

The overall lighting power density for the assessed spaces is less than 1.0 W/sf. No measures are recommended at this time.

The overall lighting power density for the assessed spaces is greater than 1.0 W/sf. This can be reduced. See Section 11 for recommended EEMs.

### Individual Rooms/Areas

If only one room/area was assessed, you can delete this Individual Rooms/Areas section.

**Table 140 - Lighting: Individual Rooms/Areas: Metrics**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: Lighting

Table: Lighting: Individual Rooms/Areas: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | **Notes** |
| Room/Area 111 | | | |
| Gross Floor Area | sf |  |  |
| Annual Average Lighting Power Density | W/sf |  |  |
| Room/Area 222 | | | |
| Gross Floor Area | sf |  |  |
| Annual Average Lighting Power Density | W/sf |  |  |

#### Room/Area 111

The lighting power density for Room/Area 111 is less than 1.0 W/sf. No measures are recommended at this time.

The lighting power density for Room/Area 111 is greater than 1.0 W/sf. This can be reduced. See Section 11 for recommended EEMs.

#### Room/Area 222

The lighting power density for Room/Area 222 is less than 1.0 W/sf. No measures are recommended at this time.

The lighting power density for Room/Area 222 is greater than 1.0 W/sf. This can be reduced. See Section 11 for recommended EEMs.

## Air Management and Air Distribution Metrics

If air management and air distribution metrics were not assessed for any room/area, you can delete this entire Air Management and Air Distribution Metrics section.

### Room/Area 111: Rack Temperature Rise

If you elected to not fill out the Air Management: Rack Air Temperatures: Room/Area 111 sheet in the Assessment Workbook, you can delete this Room/Area 111: Rack Temperature Rise section.

**Table 141** shows the calculated difference between each pair of aligned cold and hot aisle readings (hot aisle readings subtracted by their counterpart cold aisle readings). Pink-shaded cells are clear indication of by-pass or recirculation problems.

**Table 141 - Data Center Room/Area 111: Rack Temperature Rise**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: Air Management\_Rack Temps

Table: Rack Temperature Rise

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Row Position | Rack Level | **Row 1** | **Row 2** | **Row 3** | **Row 4** | **Row 5** | **Row 6** | **Row 7** | **Row 8** | **Row 9** | **Row 10** |
| Beginning | Top | 12 | 21 | 22 | -2 | 11 | 15 | 14 | 6 | 12 | 10 |
| Middle | 19 | 20 | 26 | -1 | 20 | 12 | 16 | 16 | 15 | 10 |
| Bottom | 18 | 20 | 22 | 4 | 17 | 11 | 21 | 19 | 22 | 15 |
| Middle | Top |  | 20 | 16 | 11 | 13 | 4 | 25 | 23 | 26 | 15 |
| Middle |  | 21 | 21 | 15 | 5 | 3 | 26 | 20 | 23 | 19 |
| Bottom |  | 20 | 18 | 15 | 4 | 1 | 23 | 19 | 23 | 16 |
| End | Top |  | 21 | 19 | 21 | 7 | 0 | 15 | 19 | 20 | 12 |
| Middle |  | 18 | 6 | 4 | 8 | 1 | 8 | 14 | 14 | 3 |
| Bottom |  | 23 | 1 | 0 | 17 | 3 | 4 | 14 | 13 | 1 |

|  |  |
| --- | --- |
| **Color Key for Rack Temperature Rise** | |
|  | Needs Attention (Temp Rise is <1 deg F) |
|  | Marginal (Temp Rise is 1 to 5 deg F) |
|  | Good (Temp Rise is >5 deg F) |
|  | Insufficient Data |

The rack temperature rise in all locations is [good/mostly good with only a few marginal values]. No EEMs are recommended at this time.

The rack temperature rise in most locations is marginal, or definitely needs attention. Correcting this situation will provide the IT equipment with better cooling, and allow the air side cooling system to operate more efficiently. See Section 11 for recommended EEMs.

### Room/Area 222: Rack Temperature Rise

Replicate the Room/Area 111: Rack Temperature Rise section as needed for other rooms/areas.

### Air Management

This Air Management section relies on the Data Center Air Management Tool v1.18. If you elected to not use this tool for any room/area, you can delete this entire Air Management section.

The results presented in this section come from the Data Center Air Management Tool v1.18.

How it works:

Representative IT equipment intake and exhaust temperatures are collected from a sample of IT equipment in a data center room. In addition, measurements of return and supply air temperatures are taken from the CRAC/ACU/CRAH/AHUs and perforated tiles (if a raised floor supply plenum is used). The goal is to establish an understanding of the air management performance and identify any issues such as hot spots or over-cooling. From these temperature measurements a useful index, RCI, is calculated.

#### Rack Cooling Index (RCI)

RCI is a dimensionless measure of how effectively the IT equipment is cooledwithin the desired intake temperature specification range. It provides a measure of the conditions at the high (HI) end and at the low (LO) end of the specified temperature range. RCIHI=100% means that no intake temperature is above the maximum recommended, and RCILO=100% means that no intake temperature is below the minimum recommended. Using ASHRAE’s Class A1 temperature specification, “poor” conditions are ≤90% whereas “good” conditions are ≥96%.

### Room/Area 111

**Table 142** summarizes air management metrics for Room/Area 111, calculated from data taken Month/Year.

**Table 142 - Air Management and Air Distribution Metrics: Room/Area 111**

**Source:**

Data Center Air Management Tool v1.18

Tab: Step 4 Main Input

Table: A: Metrics

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Metric | | Definition | Value | Units |
| dT\_CRAC/ACU/CRAH/AHU |  | Typical (Airflow Weighted) CRAC/ACU/CRAH/AHU Temperature Drop |  | deg F |
| dT\_equip |  | Typical (Airflow Weighted) CRAC/ACU/CRAH/AHU Temperature Drop |  | deg F |
| V\_ CRAC/ACU/CRAH/AHU |  | Total CRAC/ACU/CRAH/AHU Airflow |  | cfm |
| V\_equip |  | Total IT Equipment Airflow |  | cfm |
| RTI |  | Return Temperature Index |  | % |
| RCI\_high | Alt 1 \* | Rack Cooling Index: Measure of absence of over-temperatures |  | % |
| RCI\_low | Alt 1 \* | Rack Cooling Index: Measure of absence of under-temperatures |  | % |
| IAT\_max | Alt 2 \* | Typical (not extreme) Max IT Equipment Intake Temperature |  | deg F |
| IAT\_min | Alt 2 \* | Typical (not extreme) Min IT Equipment Intake Temperature |  | deg F |
| SAT |  | Typical (Airflow Weighted) CRAC/ACU/CRAH/AHU Supply Air Temperature |  | deg F |
| dSAT |  | Maximum Difference Between CRAC/ACU/CRAH/AHU Supply Air Temperatures |  | deg F |

\* Alt 1 has priority over Alt 2.

### Room/Area 222

Replicate the Room/Area 111 air management section as needed for other rooms/areas.

## Data Center Air Side Cooling System Metrics

If air side cooling system metrics were not assessed for any room/area, you can delete this entire Data Center Air Side Cooling System Metrics section.

### All Rooms/Areas and All Cooling System Components Combined

If the air side cooling system was assessed in only one room/area, you can delete this All Rooms/Areas and All Cooling System Components Combined section.

#### Power Density

**Table 143 - Air Side Cooling System: All Rooms/Areas Combined: All Components Combined: Power Density**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Summary

Table: All Data Center Rooms/Areas Combined: All Air Side Cooling System Components Combined: Calculations: Power Density

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| Gross Floor Area | sf |  |  |
| Electrically Active Floor Area | sf |  |  |
| Annual Average Power Density | W/sf |  |  |

#### Efficiency

If you are not assessing the average efficiency of the air side cooling systems in all rooms/areas combined, then you can delete **Table 144**.

**Table 144 - Air Side Cooling System: All Rooms/Areas Combined: All Components Combined: Efficiency**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Summary

Table: All Data Center Rooms/Areas Combined: All Air Side Cooling System Components Combined: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| Cooling Efficiency Annual Profile | kW/ton vs time |  |  |
| Annual Average Cooling Efficiency | kW/ton |  |  |

Air side cooling system performance data was not obtained for [certain rooms/areas], so this annual average efficiency value is approximate.

The annual average efficiency for all air side cooling system components combined in all rooms/areas combined is xx kW/ton.

For [CRAC/ACUs without air side economizing/ACUs with air side economizing/CRAH/AHUs without air side economizing/AHUs with air side economizing] and relatively [low/high] supply and return air temperatures, in the XX climate zone, this is

good efficiency. No EEMs are recommended at this time.

poor efficiency. See Section 11 for recommended EEMs.

### Data Center Room/Area 111

If you are not assessing the performance metrics of the air side cooling system for Room/Area 111, then you can delete this Data Center Room/Area 111 section.

#### All Cooling System Components Combined

Power Density

**Table 145 - Air Side Cooling System: Room/Area 111: All Components Combined: Power Density**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111

Table: Room/Area 111: All Air Side Cooling System Components Combined: Calculations: Power Density

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| Annual Average Power Density | W/sf |  |  |

Efficiency

If you are not assessing the efficiency of the air side cooling system in Room/Area 111, then you can delete **Table 146**.

**Table 146 – Air Side Cooling System: Room/Area 111: All Components Combined: Efficiency**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111

Table: Room/Area 111: All Air Side Cooling System Components Combined: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| Cooling Efficiency Annual Profile | kW/ton vs time |  |  |
| Annual Average Cooling Efficiency | kW/ton |  |  |

Air side cooling system performance data was not obtained for [certain components serving Room/Area 111], so this annual average cooling efficiency value is approximate.

The annual average efficiency for all air side cooling system components combined, serving Room/Area 111, is xx kW/ton.

For [CRAC/ACUs without air side economizing/ACUs with air side economizing/CRAH/AHUs without air side economizing/AHUs with air side economizing] and relatively [low/high] supply and return air temperatures, in the XX climate zone, this is

good efficiency. No EEMs are recommended at this time.

poor efficiency. See Section 11 for recommended EEMs.

#### All CRAC/ACU/CRAH/AHUs Combined

If the performance aspects of just the CRAC/ACU/CRAH/AHUs combined (as opposed to all air side cooling system components combined) is not being assessed for Room/Area 111, then you can delete this All CRAC/ACU/CRAH/AHUs Combined section.

Efficiency

If the average efficiency of just the CRAC/ACU/CRAH/AHUs combined (as opposed to all air side cooling system components combined) is not being assessed for Room/Area 111, then you can delete this Efficiency section.

**Table 147** shows the annual average efficiency all CRAC/ACU/CRAH/AHUs combined, in Room/Area 111.

**Table 147 - Room/Area 111: All CRAC/ACU/CRAH/AHUs Combined: Efficiency**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_Cool Units

Table: Room/Area 111: All CRAC/ACU/CRAH/AHUs Combined: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| Cooling Efficiency Annual Profile | kW/ton vs time |  |  |
| Annual Average Cooling Efficiency | kW/ton |  |  |

Air side cooling system performance data was not obtained for [certain CRAC/ACU/CRAH/AHUs in Room/Area 111], so this annual average cooling efficiency value is approximate.

The annual average efficiency for all CRAC/ACU/CRAH/AHUs combined, serving Room/Area 111, is xx kW/ton.

For [CRAC/ACUs without air side economizing/ACUs with air side economizing/CRAH/AHUs without air side economizing/AHUs with air side economizing] and relatively [low/high] supply and return air temperatures, in the XX climate zone, this is

good efficiency. No EEMs are recommended at this time.

poor efficiency. See Section 11 for recommended EEMs.

Air Side Economizing

Room/Area 111 is currently served by a working, built-up air side economizer. See the following Built-Up Air Side Economizer section.

If the preceding statement is false, delete it. If it is true, you can delete the rest of this section.

The ACU/AHUs serving Room/Area 111 are not currently equipped with air side economizers.

If the preceding statement is false, delete it. If it is true, pick one of the following and then delete the rest of this section.

It appears impractical to add them. [Explain why.]

It appears feasible to add them. See EEM xx in Section 11.

The ACU/AHUs serving Room/Area 111 are equipped with air side economizers, but they were not assessed.

If the preceding statement is false, delete it. If it is true, then the rest of this section can be deleted.

**Table 148** shows the air side economizer utilization factor for all ACU/AHUs combined, in Room/Area 111.

**Table 148 - Room/Area 111: All ACU/AHUs Combined: ASE Utilization**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_Cool Units

Table: Room/Area 111: All ACU/AHUs Combined: Calculations: ASE Utilization

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| Air-Side Economizer Utilization Factor Annual Profile | % vs time |  |  |
| Air-Side Economizer Utilization Factor Annual Average | % |  |  |

The annual average ACU/AHU air side economizer utilization factor for Room/Area 111 is xx%.

For ACU/AHUs equipped with [integrated/non-integrated] economizers, in climate zone XX, and a supply air temperature setpoint of xx deg F, this is

good utilization. No EEMs are recommended at this time.

poor utilization. See Section 11 for recommended EEMs.

The existing air side economizers are non-integrated. The utilization factor can be increased if economizer control is converted from non-integrated to integrated. See EEM xx in Section 11.

The utilization factor can be increased if the supply air temperature setpoint is raised. See EEM xx in Section 11.

#### Individual CRAC/ACU/CRAH/AHUs

If individual CRAC/ACU/CRAH/AHUs in Room/Area 111 were not assessed, then you can delete this Individual CRAC/ACU/CRAH/AHUs section.

Efficiency

**Table 149 - Room/Area 111: Individual CRAC/ACU/CRAH/AHUs: Efficiency**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_Cool Units

Table: Room/Area 111: Individual CRAC/ACU/CRAH/AHUs: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| CRAC/ACU/CRAH/AHU-111-1 | | | |
| Cooling Efficiency Annual Profile | kW/ton vs time |  |  |
| Annual Average Cooling Efficiency | kW/ton |  |  |
| CRAC/ACU/CRAH/AHU-111-2 | | | |
| Cooling Efficiency Annual Profile | kW/ton vs time |  |  |
| Annual Average Cooling Efficiency | kW/ton |  |  |
| CRAC/ACU/CRAH/AHU-111-3 | | | |
| Cooling Efficiency Annual Profile | kW/ton vs time |  |  |
| Annual Average Cooling Efficiency | kW/ton |  |  |
| CRAC/ACU/CRAH/AHU-111-4 | | | |
| Cooling Efficiency Annual Profile | kW/ton vs time |  |  |
| Annual Average Cooling Efficiency | kW/ton |  |  |
| CRAC/ACU/CRAH/AHU-111-5 | | | |
| Cooling Efficiency Annual Profile | kW/ton vs time |  |  |
| Annual Average Cooling Efficiency | kW/ton |  |  |

The annual average cooling efficiency for [certain CRAC/ACU/CRAH/AHUs] in Room/Area 111 is poor. See Section 11 for recommended EEMs.

Air Side Economizing

If the ACU/AHUs serving Room/Area 11 are not equipped with air side economizers, or if they are but the ASEs were not assessed, you can delete this Air Side Economizing section.

**Table 150 - Room/Area 111: Individual ACU/AHUs: ASE Utilization**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_Cool Units

Table: Room/Area 111: Individual ACU/AHUs: Calculations: ASE Utilization

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| ACU/AHU-111-1 | | | |
| Air-Side Economizer Utilization Factor Annual Profile | % vs time |  |  |
| Air-Side Economizer Utilization Factor Annual Average | % |  |  |
| ACU/AHU -111-2 | | | |
| Air-Side Economizer Utilization Factor Annual Profile | % vs time |  |  |
| Air-Side Economizer Utilization Factor Annual Average | % |  |  |
| ACU/AHU -111-3 | | | |
| Air-Side Economizer Utilization Factor Annual Profile | % vs time |  |  |
| Air-Side Economizer Utilization Factor Annual Average | % |  |  |
| ACU/AHU -111-4 | | | |
| Air-Side Economizer Utilization Factor Annual Profile | % vs time |  |  |
| Air-Side Economizer Utilization Factor Annual Average | % |  |  |
| ACU/AHU -111-5 | | | |
| Air-Side Economizer Utilization Factor Annual Profile | % vs time |  |  |
| Air-Side Economizer Utilization Factor Annual Average | % |  |  |

We examined the ACU/AHU air side economizers and discovered that [certain ACU/AHUs] have [operating issues]. See Section 11 for recommended EEMs.

#### Built-Up Air Side Economizer

If Room/Area 111 is currently served by working air side economizers on individual ACU/AHUs, then delete this Built-Up Air Side Economizer section.

Room/Area 111 is not currently served by a built-up air side economizer.

If the preceding statement is false, delete it. If it is true, pick one of the following and then delete the rest of this section.

It appears impractical to add one. [Explain why.]

It appears feasible to add one. See EEM xx in Section 11.

Room/Area 111 is equipped with a built-up air side economizer, but it was not assessed.

If the preceding statement is false, delete it. If it is true, then the rest of this section can be deleted.

**Table 151 - Cooling System: Room/Area 111: Built-Up Air Side Economizer: Utilization Factor**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: AirSide\_Room 111\_ASE

Table: Room/Area 111: Built-Up Air Side Economizer: Calculations: Utilization Factor

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| Built-Up Air-Side Economizer Utilization Factor Annual Profile | % vs time |  |  |
| Built-Up Air-Side Economizer Utilization Factor Annual Average | % |  |  |

The annual average built-up air side economizer utilization factor for Room/Area 111 is xx%.

For an [integrated/non-integrated] economizer, in climate zone XX, and a supply air temperature setpoint of xx deg F, this is

good utilization. No EEMs are recommended at this time.

poor utilization. See Section 11 for recommended EEMs.

The existing built-up air side economizer is currently operated in a non-integrated way. The utilization factor can be increased if economizer control is converted from non-integrated to integrated. See EEM xx in Section 11.

The utilization factor can be increased if the supply air temperature setpoint is raised. See EEM xx in Section 11.

### Data Center Room/Area 222

If you are assessing multiple rooms/areas, replicate the preceding Data Center Room/Area 111 section and edit as needed.

## Cooling Plant Metrics

The “Cooling Plant Metrics” section is relevant only if the data center is served by a cooling plant. If it is not, delete this entire section.

### Whole Plant

**Table 152 - Whole Cooling Plant Efficiency**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Summary

Table: Whole Cooling Plant: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| Annual Average Cooling Plant Wire to Water Efficiency | kW/ton |  |  |

**Figure 14** compares the chiller plant annual average wire-to-water efficiency and chiller rated efficiency to those efficiencies at other data centers. Lower kW/ton values indicate better efficiency.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Comparison



**Figure 14 - Chilled Water Plant and Chiller Rated Efficiency**

**Figure 14** shows that the whole-plant efficiency

is very good compared to other facilities. No EEMs are recommended for the plant at this time.

can be improved. See EEMs xx, xx, xx in Section 11.

### Cooling Plant Subsystems

**Table 153** presents cooling plant metrics by subsystem.

**Table 153 - Cooling Plant Subsystem Efficiency Summary**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Summary

Table: Cooling Plant Subsystems: Efficiency Summary

Delete subsystems that are not applicable.

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| All Chillers Combined | | | |
| Weighted Annual Average Chiller Operating Efficiency | kW/ton |  |  |
| Weighted Annual Average Efficiency Rated Condition | kW/ton |  |  |
| Water Side Economizer | | | |
| Annual Average WSE Utilization | % |  |  |
| All Cooling Towers Combined | | | |
| Weighted Average Fan Motor Efficiency Rated | % |  |  |
| All Primary Chilled Water Pumps Combined | | | |
| Weighted Annual Average Pumping Efficiency | W/gpm |  |  |
| Weighted Average Pump Motor Efficiency Rated | % |  |  |
| All Secondary Chilled Water Pumps Combined | | | |
| Weighted Annual Average Pumping Efficiency | W/gpm |  |  |
| Weighted Average Pump Motor Efficiency Rated | % |  |  |
| All Condenser Water Pumps Combined | | | |
| Weighted Annual Average Pumping Efficiency | W/gpm |  |  |
| Weighted Average Pump Motor Efficiency Rated | % |  |  |

### Chillers

If the plant has no chillers, then you can delete this Chillers section.

#### All Chillers Combined

**Table 154 - All Chillers Combined: Efficiency**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Chillers

Table: All Chillers Combined: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| Annual Average Efficiency Operating | kW/ton |  |  |
| Weighted Average Efficiency Rated Condition | kW/ton |  |  |

The annual average operating and rated efficiencies for all chillers combined are good; no chiller EEMs are recommended at this time.

The annual average operating efficiency for all chillers combined is poor.

The efficiency of individual chillers has not yet been measured. We recommend doing so.

We measured the efficiency of individual chillers; see the next section for further evaluation.

The weighted average rated efficiency for all chillers combined is poor.

See the next section for further evaluation.

#### Individual Chillers

If individual chillers were not assessed, then you can delete this Individual Chillers section.

**Table 155 - Individual Chillers: Efficiency**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_Chillers

Table: Individual Chillers: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| CH-1 | | | |
| Chiller Efficiency Annual Profile | kW/ton vs time |  |  |
| Annual Average Efficiency | kW/ton |  |  |
| CH-2 | | | |
| Chiller Efficiency Annual Profile | kW/ton vs time |  |  |
| Annual Average Efficiency | kW/ton |  |  |

The annual average operating efficiency of [CH-1/CH-2] is

good; no action recommended at this time.

poor; see recommended EEMs xx, xx, xx in Section 11.

### Water Side Economizer

If there is no water side economizer, or if it wasn’t assessed, then you can delete this Water Side Economizer section.

**Table 156 – Water Side Economizer Utilization**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_WSE

Table: Water Side Economizer: Calculations: WSE Utilization

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| WSE Utilization Annual Profile | % vs time |  |  |
| Annual Average WSE Utilization | % |  |  |

The annual average water side economizer utilization factor is xx%.

For an [integrated/non-integrated] water side economizer, in climate zone XX, and a chilled water supply temperature setpoint of xx deg F, this is

[good utilization. No EEMs are recommended at this time.]

[poor utilization. See Section 11 for recommended EEMs.]

The existing water side economizer is currently operated in a non-integrated way. The utilization factor can be increased if economizer control is converted from non-integrated to integrated. See EEM xx in Section 11.

The utilization factor can be increased if the chilled water supply temperature setpoint is raised. See EEM xx in Section 11.

### Chilled Water Pumps

If the plant has no chillers (only cooling towers and condenser water pumps), then there will be no chilled water pumps and this Chilled Water Pumps section can be deleted.

In this template, pumping efficiency is described in units of Watts per gallon per minute (W/gpm). Lower values indicate higher efficiency.

#### All Primary Chilled Water Pumps Combined

If the assessment did not examine any CHW pumps at all, then you can delete this All Primary Chilled Water Pumps Combined section.

If the chilled water distribution system has only a single, primary-pumping-only loop, then delete “primary” throughout this section.

**Table 157 - All Primary Chilled Water Pumps Combined: Efficiency**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CHW Pumps

Table: All Primary Chilled Water Pumps Combined: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| Weighted Annual Average Pumping Efficiency | W/gpm |  |  |

The annual average pumping efficiency for all the primary chilled water pumps combined is less than 20 W/gpm. No EEMs are recommended at this time.

The annual average pumping efficiency for all the primary chilled water pumps combined is greater than 20 W/gpm. This can be reduced. See recommended EEMs in Section 11.

#### Individual Primary Chilled Water Pumps

If individual primary chilled water pumps were not assessed, then you can delete this Individual Primary Chilled Water Pumps section.

**Table 158 - Individual Primary Chilled Water Pumps: Efficiency**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CHW Pumps

Table: Individual Primary Chilled Water Pumps: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| PCHWP-1 | | | |
| Pumping Efficiency Annual Profile | W/gpm vs time |  |  |
| Pumping Efficiency Annual Average | W/gpm |  |  |
| PCHWP-2 | | | |
| Pumping Efficiency Annual Profile | W/gpm vs time |  |  |
| Pumping Efficiency Annual Average | W/gpm |  |  |

The annual average pumping efficiency for each primary chilled water pump station is less than 20 W/gpm. No EEMs are recommended at this time.

The annual average pumping efficiency for [certain primary CHW pumps] is greater than 20 W/gpm. Further investigation showed this is due to [reasons]. See recommended EEMs in Section 11.

#### All Secondary Chilled Water Pumps Combined

If the chilled water distribution system has only a single, primary-pumping-only loop, or if the assessment did not examine any secondary CHW pumps, then you can delete this All Secondary Chilled Water Pumps Combined section.

**Table 159 - All Secondary Chilled Water Pumps Combined: Efficiency**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CHW Pumps

Table: All Secondary Chilled Water Pumps Combined: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| Weighted Annual Average Pumping Efficiency | W/gpm |  |  |

The annual average pumping efficiency for all the secondary chilled water pumps combined is less than 20 W/gpm. No EEMs are recommended at this time.

The annual average pumping efficiency for all the secondary chilled water pumps combined is greater than 20 W/gpm. This can be reduced. See recommended EEMs in Section 11.

#### Individual Secondary Chilled Water Pumps

If individual secondary chilled water pumps were not assessed, then you can delete this Individual Secondary Chilled Water Pumps section.

**Table 160 - Individual Secondary Chilled Water Pumps: Metrics**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CHW Pumps

Table: Individual Secondary Chilled Water Pumps: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| SCHWP-1 | | | |
| Pumping Efficiency Annual Profile | W/gpm vs time |  |  |
| Pumping Efficiency Annual Average | W/gpm |  |  |
| SCHWP-2 | | | |
| Pumping Efficiency Annual Profile | W/gpm vs time |  |  |
| Pumping Efficiency Annual Average | W/gpm |  |  |

The annual average pumping efficiency for each secondary chilled water pump station is less than 20 W/gpm. No EEMs are recommended at this time.

The annual average pumping efficiency for [certain secondary CHW pumps] is greater than 20 W/gpm. Further investigation showed this is due to [reasons]. See recommended EEMs in Section 11.

### Condenser Water Pumps

If there are no condenser water pumps in the cooling plant (for example, the chillers are air-cooled), or if no condenser water pumps were assessed, then you can delete this Condenser Water Pumps section.

In a plant with cooling towers but no chillers, we are calling the pumps that circulate water between cooling towers and the cooling load “condenser water” pumps, even if there are no condensers in the plant.

#### All Condenser Water Pumps Combined

**Table 161 - All Condenser Water Pumps Combined: Efficiency**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CW Pumps

Table: All Condenser Water Pumps Combined: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| Weighted Annual Average Pumping Efficiency | W/gpm |  |  |

The annual average pumping efficiency for all the condenser water pumps combined is less than 20 W/gpm. No EEMs are recommended at this time.

The annual average pumping efficiency for all the condenser water pumps combined is greater than 20 W/gpm. This can be reduced. See recommended EEMs in Section 11.

#### Individual Condenser Water Pumps

If individual condenser water pumps were not assessed, then you can delete this Individual Condenser Water Pumps section.

**Table 162 - Individual Condenser Water Pumps: Efficiency**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: CoolingPlant\_CW Pumps

Table: Individual Condenser Water Pumps: Calculations: Efficiency

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Units | Value | Notes |
| CWP-1 | | | |
| Pumping Efficiency Annual Profile | W/gpm vs time |  |  |
| Pumping Efficiency Annual Average | W/gpm |  |  |
| CWP-2 | | | |
| Pumping Efficiency Annual Profile | W/gpm vs time |  |  |
| Pumping Efficiency Annual Average | W/gpm |  |  |

The annual average pumping efficiency for each condenser water pump station is less than 20 W/gpm. No EEMs are recommended at this time.

The annual average pumping efficiency for [certain condenser water pumps] is greater than 20 W/gpm. Further investigation showed this is due to [reasons]. See recommended EEMs in Section 11.

# Recommended Energy Efficiency Measures

## Current Conditions and Practices

Summarize energy efficiency good practices and other positive management practices observed at the data center during the assessment.

## Energy Efficiency Measure Recommendations by Source

Each of the following tools from the DCEE Toolkit can recommend EEMs.

DC Pro (<https://datacenters.lbl.gov/dcpro>)

Section 4. Recommended Tasks

Section 3. Results (energy savings by percent only).

This information can be exported from DC Pro in PDF or Excel format.

Data Center Electrical Power Chain Assessment Tool v2.0

Tab: Action Results

Tab: Savings Summary

Data Center Air Management Tool v1.18

Tab: Step 5 Main Results

Table 2: Recommended Actions Based on User Input

and

Tab: Step 6 Energy Results

Data Center Air Management Estimator v1.0

Tab: Estimator

Table 2: Step 4 Main Input

and

Tab: Step 6 Energy Results

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: EEM Summary

Table: Proposed Energy Efficiency Measures

For this data center assessment, we used the following tools to obtain EEM recommendations:

Edit this list as needed.

* DC Pro
* Data Center Electrical Power Chain Assessment Tool v2.0
* Data Center Air Management Tool v1.18
* Data Center Air Management Estimator v1.0
* DCEE Actions Master List v2.0
* Other

**Table 163** presents the recommended EEMs by data center system and indicates their source.

**Table 163 - Recommended EEMs by Source**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Recommended Energy Efficiency Measure | DC Pro | Data Center Electrical Power Chain Assessment Tool v2.0 | Data Center Air Management Tool v1.18 | Data Center Air Management Estimator v1.0 | DCEE Actions Master List v2.0 | Other |
| **Whole Facility** |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| **Electric Distribution System** |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| **IT Equipment** |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| **Data Center Space Air Management** |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| **Data Center Space Air Side Cooling System** |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| **Cooling Plant** |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

## Interactive Effects Between Energy Efficiency Measures

The total energy savings accrued when applying multiple EEMs, is not always the sum of the savings due to the individual EEMs applied alone. If the EEMs target the same system, the total savings are likely to be less. On way to think of this, is that the first EEM applied reduces the scale of the energy efficiency opportunity for the next EEM to be applied.

To avoid overstating estimated savings, we bundled some of the proposed EEMs together before performing savings calculations.

## Summary of Estimated Savings

These are estimates only, not investment-grade calculations.

**Table 164** is a summary of the energy efficiency measures (EEMs) recommended for further consideration.

If the following statement applies, include it.

Instructions for **Table 164**:

1. Add/delete rows to match the number of EEMs you are proposing.
2. For each EEM fill in its name, cost, energy and dollar savings, and payback
3. The simple payback is calculated as Implementation Cost / Annual Energy Cost Savings.
4. When it is finished, copy and paste the **Table 164** table into **Table 1**.

**Table 164 - Summary of Recommended EEMs - Savings, Cost and Payback**

Collect the EEM estimated savings from every Tool exercised, and fill out the following table.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| EEM Number | EEM Name | Installed Cost | Annual Average Power Demand Savings | Annual Electric Energy Savings | Annual Energy Cost Savings | Simple Payback |
| $ | kW | kWh/yr | $/yr | years |
| EEM 1 |  |  |  |  |  |  |
| EEM 2 |  |  |  |  |  |  |
| EEM 3 |  |  |  |  |  |  |
| EEM 4 |  |  |  |  |  |  |
| EEM 5 |  |  |  |  |  |  |
| All EEMs Combined | |  |  |  |  |  |

If any EEMs include several parts and their savings are evaluated as a package rather than individually due to their interactive nature, identify them.

Discuss electricity rate used in estimating energy cost savings, whether it is a blended rate or following actual tariff. State all assumptions.

## Projected Power Usage Effectiveness (PUE)

If all of the recommended EEMs are implemented, the new estimated electrical end use breakouts associated with the data center space will be as shown in **Table 165**. As a result, the estimated current PUE of x.x could be improved to approximately x.x as shown in **Figure 15**.

**Table 165 - Summary of Data Center Electrical End Uses - with Recommended EEMs**

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: FacilityEnergyUse

Table: Projected Energy Use Breakout

|  |  |  |  |
| --- | --- | --- | --- |
| End Use | Average Power Demand (kW) | Percent of Data Center Total (%) | Notes |
| IT Equipment | 530 | 45% |  |
| CRAC/ACU/CRAH/AHUs minus Humidifiers | 229 | 20% |  |
| CRAC/ACU/CRAH/AHU Humidifiers | 0 | 0% |  |
| Built-Up ASE Fans | 3 | 0% |  |
| Condenser Fans | 20 | 2% |  |
| Chillers | 235 | 20% |  |
| Water Side Economizer Pumps | 9 | 1% |  |
| Cooling Towers | 18 | 2% |  |
| Chilled Water Pumps | 26 | 2% |  |
| Condenser Water Pumps | 31 | 3% |  |
| Lighting | 10 | 1% |  |
| Generator Engine Block Heaters | 7 | 1% |  |
| UPS Loss | 6 | 1% |  |
| Transformer Loss | 24 | 2% |  |
| PDU Loss | 25 | 2% |  |
| Total | 1,173 | 100% |  |
| **PUE (Total Energy Use / IT Energy Use)** | **2.21** | **2.21** |  |

**Figure 15** is constructed from the data in **Table 165**. When it is finished, copy and paste the **Figure 15** chart into **Figure 2**.

**Source:**

Data Center Energy Efficiency Assessment Workbook v2.0

Tab: BreakoutChart\_Projected



**Figure 15 - Projected Data Center Energy Use Breakouts**

**(xxx MWh/yr total; PUE = x.x, after EEM implementation)**

## Energy Efficiency Measure Detail

Guidance and language for best practice EEMs are outlined in the “Data Center Master List of Energy Efficient Actions” on the Center of Expertise for Energy Efficiency in Data Centers website: datacenters.lbl.gov/tools/8-data-center-master-list-efficiency-actions

### EEM 1 - [name of EEM 1]

#### Observations and Rationale

Describe the current configuration and operation as related to the recommend measure. Explain why it is inefficient now and how the measure can improve it.

#### EEM Details

Provide details about what the recommended measure involves in terms of technology and operation changes required. Describe options if applicable.

#### Energy Savings Estimation

Describe methodology, data source and assumptions used for calculating energy (and maintenance if applicable) cost savings.

#### Implementation Cost Estimation

Provide information that can help decision-making including, but not limited to, the estimated installation cost. For packaged measures, a breakdown of the estimated installation cost will be helpful (see **Table 166**).

**Table 166 - Breakdown of Estimated Implementation Cost for EEM1**

**Source:**

This table is not copied from another tool. It appears only here, in this Report Template.

|  |  |  |
| --- | --- | --- |
| Components of EEM1 | Estimated Cost | Comments |
| Component 1 | $xxxx | comments |
| Component 2 | $xxxx | comments |
| Component 3 | $xxxx | comments |
| Component 4 | $xxxx | comments |
| Component 5 | $xxxx | comments |
| Component 6 | $xxxx | comments |
| Total | $xxxx |  |

### EEM 2 - [name of EEM 2]

Repeat the EEM1 section for every other proposed EEM.

## Other Considered Measures

Often, the assessment team has considered more possible improvement measures than those formalized in the section “Recommended Energy Efficiency Measures”. Some of the considered measures were determined to be not practical or appropriate to be on the EEM list for various reasons. However, sometimes, it may be valuable to document those considered measures and the reasons they were not selected. This can provide reference to the local team for future reference.

## Recommended Metering (and Other) Strategy

PUE monitoring is important for maintaining and improving data center efficiency. However, data centers often do not have existing metering infrastructure capable of such monitoring or their existing systems are not set up to do so. Therefore, recommendations for metering upgrades are often appropriate as part of the assessment result. Mandates and other requirements can sometimes demand such evaluation and recommendation as well.

For further guidance on metering, see [DOE Better Buildings “Data Center Metering and Resource Guide”](https://datacenters.lbl.gov/resources/data-center-metering-and-resource-guide) (February 2017) available at

https://datacenters.lbl.gov/resources/data-center-metering-and-resource-guide

Sometimes, additional best practices such as data center consolidation or moving computing service to the cloud could be appropriate for a data center, but the evaluation of such opportunities may not be part of the assessment scope. Those opportunities can be mentioned here for the organization to consider for further investigation.

## Data Center Infrastructure Management (DCIM) System

In coordination with metering improvements, it is recommended that Name of Facility consider installing a DCIM system. These connected software systems offer a number of benefits for managing data center operations and tracking key metrics to support multiple goals and objectives. Such a system could offer the following functionality:

* Track data in real time, e.g.:
  + power usage vs. capacity
  + cooling requirement vs. capacity
  + PUE (overall plus individual subcomponents)
* Monitor systems for operational performance and alarms:
  + rack inlet and outlet conditions
  + switchgear, UPS, and PDUs
  + cooling plant and CRAH units (e.g., temperatures, flows, power)
* User-friendly and customizable interface and reporting support ease of use for multiple needs

Some components necessary for a DCIM are already in place or are being implemented (e.g., XXX and YYY). However, as described above, it is recommended that meters be added and connected to enable real-time monitoring of systems and PUE, and networked into the DCIM for greatest benefit.

Many DCIM systems also provide for tracking of IT equipment, e.g. what software is running on what hardware and what is the utilization of each piece of hardware. This feature can identify “zombie” servers that take up space, power, and cooling but contribute no computing value, as well as point to virtualization and power-down opportunities.

This assessment does not estimate the savings that could accrue from using a DCIM system, but various energy and non-energy savings would result from a well-implemented system that improves system monitoring, operations, and management.

## Other Resources

There are many information resources available to help inform improvements to data centers. For further information on data center best practices, for example, refer to this guide available from the Center of Expertise for Energy Efficiency in Data Centers:

<https://datacenters.lbl.gov/resources/best-practices-guide-energy-efficient-data-center-design>

From the same source is the Master List of Energy Efficiency Actions:

<https://datacenters.lbl.gov/resources/data-center-master-list-energy>

Appendices are optional to include depending on the scope of the energy assessment. They may be useful for containing:

* Screen shots of inputs and outputs from DCEE Toolkit tools.
* Screen shots from a BAS.
* Large data sets, such as annual profiles of measured parameters.
* Detailed calculations.
* Schematics and diagrams.
* Photos.
* List of measurement instruments used, calibration certificates.
* Specification sheets and service logs for equipment (CRAC/ACU/CRAH/AHUs, UPS, fans, pumps, chillers, etc).

# Appendix A: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Appendix B: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Appendix C: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_