3 Steps to Calculate Total Enterprise IT Energy Consumption Using DCIM

White Paper 100

Version 1

Energy Management Research Center

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Executive summary

Reducing the environmental impact of enterprise IT begins with collecting data and reporting metrics to establish a baseline. But with dozens of potential metrics and complex accounting to consider along with the highly distributed and diverse nature of hybrid IT portfolios, this can be a daunting task. For many CIOs and their IT operations teams, this is also a new task. This paper is a straightforward, "how to get started" guide that identifies energy consumption as the fundamental data point to start with and gives a simple 3-step framework to start measuring the environmental impact of the IT estate.

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Introduction

Measuring, reporting, and managing a company's sustainability performance is starting to drive employee retention, corporate reputation, and contribute to business success. Chief Sustainability Officers (CSOs) will report environmental sustainability metrics for the entire enterprise. However, to track progress against the enterprise's goals and determine where inefficiencies are and improvements can be made, CSOs will need each department or function in the organization to provide more granularity in their measurement of sustainability metrics. IT is one important department where there is much interest in understanding energy consumption and, ultimately, its greenhouse gas (GHG) emissions.

Schneider Electric White Paper 67, *Guide to Environmental Sustainability Metrics for Data Centers*, helps address this challenge specifically for data centers by identifying and explaining the key metrics to track based on their maturity. However, CIO's have an IT estate that goes well beyond just on-premise data centers to also include public cloud, colocation providers, distributed IT sites (i.e., edge computing), and a work-from-home (WFH) end user population.

We recommend that CIOs who are beginning their sustainability journey start with measuring just one metric: total energy consumption. This fundamental metric shows the direct impact of IT operations and is used by CSOs to calculate GHG emissions. Energy consumption is also good to start with because the data sources and collection tools are readily available today, and in many cases, are likely already in use by your IT operations team.

This paper provides a simple framework to measure and track IT energy consumption across the entire enterprise IT portfolio. There are three steps:

Step 1: Assess the coverage of your IT estate
Step 2: Determine metric data sources and deploy metering and software
Step 3: Use data center infrastructure management (DCIM) to aggregate data and report total energy consumption

The paper will explain how to do this across the entire IT estate as summarized in Figure 1.

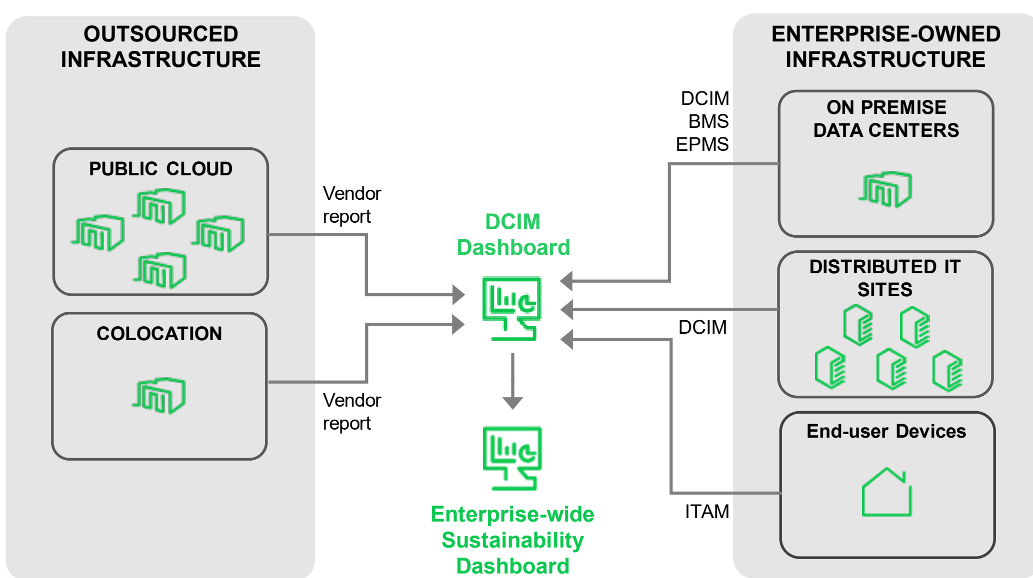


Figure 1

A view of a typical enterprise IT estate showing data flow for the total energy consumption metric and the software management tools that collect and send that data to dashboards.

Following the guidance in this paper creates a solid foundation to collect and report additional metrics (e.g., water use, Scope 3 emissions like embodied carbon, and so on) as the organization's sustainability program matures.

Next, we will explain the total energy consumption metric.

The "total energy consumption" metric

This is the total energy consumed, measured in kilo or mega-watt hours (kWh, MWh), to operate outsourced and enterprise-owned infrastructure. This is typically the electrical energy drawn from the utility grid but would also include any energy production onsite from generators, solar, or wind. Energy imported in the form of natural gas, steam, or chilled water should also be counted, if applicable.

Energy = Power (watts) * Time (hrs)

Ideally, energy is measured in real time using power meters. This could be the utility meter (for core data centers), branch circuit power meters, or meters built-in to an uninterruptable power supply (UPS), power distribution unit (PDU), or rack PDU (rPDU). Power meter data would then be sent to infrastructure management software which aggregates and presents the information for users and stakeholders through its dashboard or report. The infrastructure management software tools referred to in this paper include:

- data center infrastructure management (DCIM)
- building management system (BMS)
- electrical power monitoring system (EPMS)
- IT asset management (ITAM)

Note, devices and meters may report energy and/or power in varying ways in terms of the unit of measure and polling intervals. It is important that the infrastructure management software can normalize this data into a consistent energy consumption metric. This complication is a reason why the the use of simple spreadsheets instead of purpose-built management software untenable.

In cases where there is no meter (e.g., end-user devices), energy consumption is estimated based on the device power rating from the vendor and assumed time duration of use. Note, we recommend taking 60% of the manufacturer's power rating for a given device to more accurately reflect what it actually draws in operation.

In situations where upstream power and cooling infrastructure is shared (e.g., distributed IT sites) or its energy data is not attainable (from a BMS/EPMS), the total IT energy can be multiplied by the site's power usage effectiveness (PUE) value to get a total energy number that accounts for all the power losses of the supporting power and cooling infrastructure. Schneider Electric provides an easy way to quickly estimate PUE for a given location through this freely-available online tool called the Data Center Efficiency & PUE Calculator. Note some DCIM software tools will calculate PUE in real time for the monitored site assuming power data is being collected from the infrastructure. For more information about calculating PUE for data centers, see Schneider Electric White Paper 113, "Electrical Efficiency Modeling for Data Centers".

Next, we will explain the 3-step framework for calculating and reporting the total energy consumption metric.

Step 1: Assess the coverage of your IT estate

With **Figure 1** in mind, this step is about ensuring you're accounting for everything that consumes energy across your portfolio of sites and that you understand where gaps exist. Having as full of an accounting as possible ensures the metric is meaningful and represents reality. This means that end user devices and outsourced infrastructure should be included, as well. Energy consumption, and sometimes even the GHG emissions data, for public cloud and colocation services is typically provided by the vendor which makes this portion of your IT estate easier to account for.

For enterprise-owned infrastructure, however, you need to assess whether power meters are in place and software management tools are in use. Power meters and management software is what gives visibility to on premise data center and distributed IT site and device energy consumption. End user device energy consumption, on the other hand, would ultimately be derived from data in the ITAM tool. Note, the next section of this paper, "Determine metric data sources and deploy metering and software", will explain your energy data source options.

This inventorying and assessment process may expose gaps in visibility to your IT and/or its supporting infrastructure. This is most common at smaller distributed, edge IT sites. Asset management and monitoring software is always recommended for complete accounting of your estate to ensure system reliability, security, and a full accounting of the sustainability impact of IT operations. Your organization will need to come up with a plan and budget to address the gaps. Enlisting the support of corporate-level sustainability officers and teams, if they exist, would likely be helpful.

The following sub-sections explain further what infrastructure should be included and how energy consumption can be calculated.

On-premise data centers

An on-premise data center may be an entire standalone building dedicated to IT operations, or it may be a data center inside a mixed-use building. For standalone, dedicated data centers, 100% of the energy consumption for each site should be accounted for. For data centers in mixed-use buildings, assessing energy consumption may be more challenging. In a mixed-use facility, the data center share of the overall energy consumption must be estimated or derived. One option in this mixed-use scenario is to use the UPS output power and multiply by the PUE to account for upstream infrastructure power losses.

Systems to be accounted for in data centers include:

- Servers, storage, and networking devices (i.e., the IT equipment)
- Electrical & mechanical (HVAC) systems
- UPSs & generators
- Lighting, security systems

Distributed IT sites

These sites are typified by having a small number (<10) of IT rack enclosures and distributed non-racked IT equipment. Edge compute sites often involve shared infrastructure systems. The simplest approach would be to only use the energy consumption of the UPS supplying the IT load plus the estimated energy consumption of any non-racked IT equipment dispersed at the site. A more accurate accounting would involve taking the UPS output and multiplying by the estimated PUE and then adding in the non-racked IT power consumption.

Systems to be accounted for in edge compute sites include:

- Racked IT equipment
- Non-racked IT equipment dispersed at site

End-user devices

For many enterprise companies a significant percentage of their workforce now works from home (WFH) using enterprise-owned devices like laptops, monitors, printers, and cell phones. The McKinsey Institute estimated that these enterprise end-user devices can consume almost half as much energy as on-premise data centers[1]. Given their significance in terms of energy consumption and emissions, they should be counted in the total energy consumption metric.

While we believe it is best to track actual energy consumption, this may not always be feasible, particularly for end user devices and WFH IT equipment where metering is not practical. In those cases, the metric data source would be an estimate of energy use based on device power draw and how much time it is in use to arrive at an energy figure.

Note, there are small residential, cloud-connected UPSs available on the market which can report energy data about the connected load that could be collected and added into reported sustainability metrics. For enterprises who choose to help ensure power availability for WFH users with small UPSs, this could be an option for collecting actual energy consumption data.

Outsourced infrastructure

Outsourced infrastructure includes the company's use of public cloud services and colocation data centers. In the case of the public cloud, service providers should issue energy consumption and emissions data accounting for the use of cloud services and workloads. This may be in the form of a report, dashboard, or as part of the billing invoice.

For colocation data centers, assuming you do not monitor and manage your own infrastructure via your own DCIM, the colocation provider should offer a vendor report to show energy consumption and emissions data for your enterprise IT deployed in their data center(s). Like the cloud provider, this data could also be given via a dashboard or perhaps be attached to the billing invoice. Also, some colocation providers use commercial DCIM software that gives their customers a "tenant portal". This provides tenants real-time visibility into their asset status including their total energy use.

Step 2: Determine metric data sources and deploy metering and software

The next step is to identify your sources of energy data across your entire estate and make sure that data is being reported to management software or, in the case of end user devices, is available in your ITAM tools. Gaps in visibility identified in Step 1 should be filled by deploying power metering and/or management software where needed.

Our recommended data sources for energy consumption across your enterprise IT estate are summarized in Table 1.

[1] McKinsey, *The green IT revolution: A blueprint for CIOs to combat climate change*, 9/2022

Table 1

Recommended data sources for energy consumption

Enterprise IT infrastructure	Recommended Energy Consumption Data Sources *
On-premise Data Centers	Utility meter at site or utility energy invoices
Edge Computing Sites	Built-in power meter of UPS**
End User Devices	Estimation based on power ratings and time used, either manually collected or provided by ITAM software
Outsourced Infrastructure	Vendor provided via sustainability report, online dashboard, billing invoice, or DCIM "tenant portal"

*There are more advanced, granular methods for measuring energy consumption in each area, but for simplicity we have focused on the simplest method to get started.

**Note, some UPSs will report actual energy vs. just power.

Deploy electric power meters where absent

For the purposes of measuring energy consumption for sustainability tracking, general power meters – either permanently installed as a standalone meter or the ones found built into UPSs – provide a cost-effective means for collecting the data for calculating the total energy consumption metric. For power meters built into a UPS or rack power distribution unit, there is no extra cost for that functionality. Standalone power meters used at the service entrance mains or PDUs, for example, are lower cost than power quality sensors and tend to be very simple to use.

Table 1 above gives the basic, minimum requirement to capture the data needed for overall energy consumption related to IT operations. Users may decide to add additional meters to increase the granularity of the energy data being collected to understand, for example, the difference in energy consumption between various subsystems including IT, power, and cooling to calculate a more accurate PUE, for example. Meters could also be added to PDUs in the IT space to be able to track energy consumption at a department level for charge backs within the organization.

Deploy infrastructure management software where absent

Power meter-sourced data needs to be collected by infrastructure management software tools to calculate and ultimately present the total energy consumption metric to stakeholders. So, wherever there is a gap in data collection, monitoring software should be deployed. However, procuring and deploying software systems may not be feasible. In these cases, energy consumption must be estimated and recorded manually.

For example, in shared use facilities, energy data for electrical and mechanical systems upstream of the IT room may have to be estimated by multiplying the IT energy use (from UPS output power meter) times an estimated PUE. This would account for the IT's share of the cooling and electrical distribution's power losses yielding a more complete accounting of energy use. The site's Facilities team may or may not have a BMS and if they do, it may not be practical for the IT Ops team to get that data from Facilities.

The following describes the primary types of data each software tool collects/monitors. Note, that tools that embrace standard open communication protocols and APIs are able to share data with each other.

DCIM – for UPS & rPDU power meters and IT whitespace infrastructure visibility at on-premise data centers and distributed IT sites

ITAM – for estimating energy use of non-racked IT, WFH, and end user devices

BMS – for HVAC system energy of larger buildings; otherwise rely on PUE or estimation using data supplied by facilities team

EPMS – for more granular PDU and branch circuit power meter data collection

Ensure asset power dependencies are accurately defined

For tools like DCIM to be able to aggregate power and energy consumption accurately in data centers and distributed IT sites, it is important that equipment power dependencies are understood and represented correctly in the software tool. You want to avoid, for example, double counting power by including the power reading from both a UPS and its downstream rack PDU which is feeding the servers.

With metric data sources identified and metering and infrastructure management software in place – and/or plans in place to use estimations or billing data – the next step is aggregating the data and reporting the metrics using DCIM.

Step 3: Use DCIM to aggregate data and report total energy consumption

Choosing software to use for data aggregation & dashboarding

Modern BMS, EPMS, DCIM and ITAM software platforms all tend to be designed for data sharing and system integration with other platforms. However, we believe that modern DCIM tools are best positioned to provide CIOs and their IT operations teams with environmental sustainability metric tracking and reporting as they are beginning to address these needs out of the box. There are DCIM offers available today that can aggregate data and report PUE, total energy consumption with breakdowns by subsystem, and even GHG emissions.

The ease of data collection into one dashboard depends on the specific attributes of the software tool used and the capabilities of the vendor. Some more traditional DCIM tools, for example, are architected for single sites, lacking the out-of-box ability to give an aggregate view of resources and status across multiple, distributed sites.

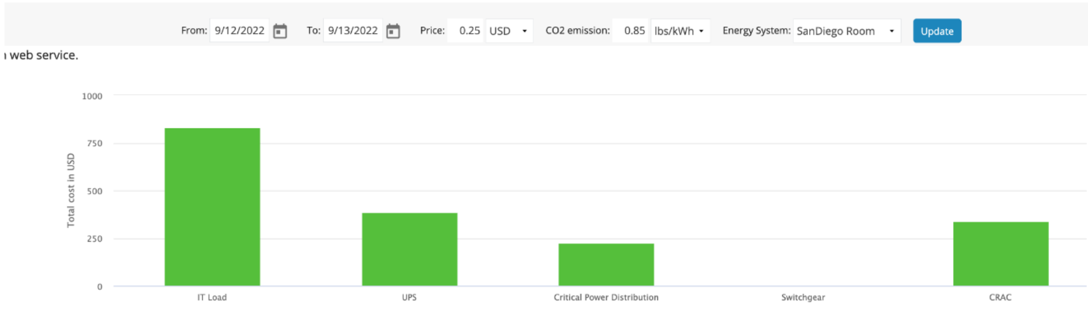
For environmental metrics to be meaningful, as said before, it is important the software tool used to aggregate all the data can communicate with and normalize data from all data sources. This ensures a more complete picture of environmental impact. Software system attributes that help make this easier to accomplish include:

- Being designed for multi-site portfolios with one login giving view to all sites' data at a site-by-site level or in aggregate
- Supporting standard, open communications protocols (e.g., SNMP, BACnet, Modbus, etc.)
- Providing APIs/web services for data sharing and integration with other 3rd party software tools, devices, databases, and files
- Offering customizable dashboards and reporting that accommodates data sources from outside the software tool providing the dashboard
- Offering additional custom services to build bespoke dashboards, reports, connections to meet a variety of customer-specific needs*

*Figures 2 and 3 show examples of custom dashboards made to show energy consumption, cost, carbon emissions, PUE, power losses, and capacity utilization.

Figure 2

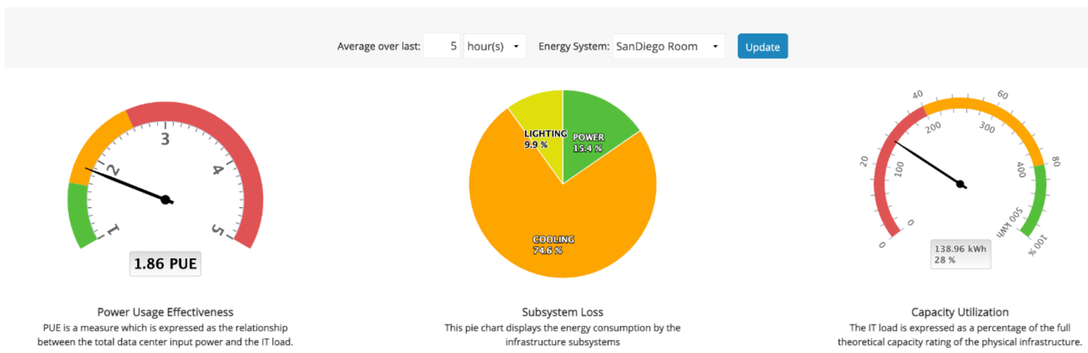
This screenshot shows an example custom dashboard from Schneider Electric's IT Advisor planning and modeling software that shows energy consumption, cost, and carbon emissions for various infrastructure systems of a data center.



	IT Load	UPS	Critical Power Distribution	Switchgear	CRAC	Total
Usage (kWh)	3328.01	1542.09	900.11	8.46	1354.53	7133.2
Cost (USD)	832	385.52	225.03	2.11	338.63	1783.29
CO2 (lbs)	2828.81	1310.78	765.1	7.19	1151.35	6063.23

Figure 3

This screenshot shows an example custom dashboard from Schneider Electric's IT Advisor planning and modeling software that shows the current, real-time PUE, power losses by subsystem and capacity utilization.



This reporting gives CIOs and their operations teams an ideal starting point to track and report the impact of their IT estate on environmental sustainability. It will raise awareness, provide a basis for setting goals, and identify opportunities to enrich the measurement data in line with the CSO's priorities. Benchmarking becomes possible to help the organization know where to improve, what to prioritize, and how to show progress year over year.

Going beyond the 3 steps described in this paper, the final step would be to incorporate the IT estate energy consumption data with enterprise wide ESG reporting. The CSO and their team can take this data and calculate Scope 2 GHG emissions. Since emissions are driven by the local energy mix of the utility grid, providing the CSO with location data along with the energy data would be helpful in generating a more accurate emissions metric. Otherwise averages have to be used perhaps at a country or region basis. See the Appendix for more information about calculating GHG emissions.

For those enterprises who are using an environmental sustainability management (ESM) platform, energy data from your on-premise data centers and edge computing IT sites can be sent from your DCIM software to the ESM tool via an API. This provides enterprise sustainability teams with a consolidated view of the impact of your on-premise IT portfolio.

Conclusion

Measuring, reporting, and managing a company's sustainability performance is starting to drive employee retention, corporate reputation, and contribute to business success. We recommend that CIOs who are beginning their sustainability journey start with measuring just one metric: total energy consumption. This fundamental metric shows the direct impact of IT operations and is used by CSOs to calculate GHG emissions. Energy consumption is also good to start with because the data sources and collection tools are readily available today, and in many cases, are likely already in use by your IT operations team.

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About the authors

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Resources

[Guide to Environmental Sustainability Metrics for Data Centers](#)
White Paper 67

Electrical Efficiency Modeling for Data Centers
White Paper 113

Environmental Sustainability Management (ESM) Software for Colocation Data Centers
White Paper 231

Recommended Inventory for Data Center Scope 3 GHG Emissions Reporting
White Paper 53

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Appendix

Energy-related GHG emissions

Greenhouse gas emissions are calculated from the energy consumption data. For enterprise-owned infrastructure, DCIM[2] and Environmental Sustainability Management (ESM) platforms can do this calculation automatically. And cloud and colocation providers will typically give this data to their customers and tenants through a report or dashboard. The energy-related GHG emissions calculation is the energy consumed times an emission factor which yields the total amount of emissions, usually measured in metric tons, resulting from a given amount of energy consumption. The emission factor (in units of tCO2/MWh) is a coefficient that represents the amount of GHG that is released into the atmosphere per MWh of electricity generated. Since the energy fuel mix (e.g., coal, oil, solar) varies between power plants, each local grid has its own unique emission factor. Those emission factors also vary over time as the generation mix itself varies.

Therefore, to get a more accurate energy-related GHG emissions value, it is important to know the local emission factor. In the absence of that, national, regional, or state/province averages can be used. Some DCIM and ESM platforms have built-in emission factor libraries to automate and simplify GHG emissions calculations. Using management software to aggregate the data is discussed later in the paper.

We recommend that CIOs and their teams who are just getting started focus on location-based emissions. Market-based emissions, if tracked, would be done at the enterprise-wide level.

Finally, the reader will have heard emissions being categorized as Scope 1, 2, and 3. While this paper is largely concerned with Scope 2, we provide a summary of the 3 scopes from Schneider Electric White Paper 53:

- Scope 1 - Direct GHG emissions: All direct emissions within the operational control of an organization (e.g., operating diesel generators onsite).
- Scope 2 - Indirect energy GHG emissions: Indirect emissions generated from purchased or acquired electricity, heat, steam, or cooling.
- Scope 3 - Other indirect GHG emissions: All other indirect emissions from sources such as business travel, waste management, manufacture of the products you buy across the value chain.

[2] Note, many of today's modern DCIM platforms have this capability. Sometimes it is a standard feature, other times it is provided through a custom engineering service.