White Paper

Fundamental Measures of Data Center Sustainability

As digital transformation continues to accelerate across the globe, the rising demand for data centers inevitably leads to increased energy consumption, carbon emissions, and water usage. Simultaneously, global awareness regarding sustainability is on the rise, prompting the emergence of key regulatory frameworks, such as the EU Energy Efficiency Directive (EED), California Title 24 in the USA, Singapore's Data Centre Energy Efficiency Scheme (DCS), Australia's National Built Environment Rating System (NABERS), and United States SEC Climate Risk Disclosures. These directives, designed to manage environmental impacts, have highlighted the importance of sustainability in data center management. This whitepaper explores critical sustainability measures of data centers as outlined by various regulatory bodies, seeking to empower readers with a comprehensive understanding of data center sustainability in the light of these international directives. It delves into metrics like Average Delta T, Cooling Efficiency, Energy Consumption, Power Usage Effectiveness (PUE), Total CO2, Carbon Usage Effectiveness (CUE), Server Utilization, and Water Usage Effectiveness (WUE). By understanding and applying these measures, data centers can optimize their performance while reducing their environmental impact in an effective, compliant manner.

Nlyte Software

Nlyte Software is a part of Carrier Global Corporation, the leading global provider of healthy, safe, sustainable, and intelligent building and cold chain solutions.

Table of Contents

Introduction

In the evolving landscape of data center management, an increasing emphasis is placed on the intersection of sustainability and compliance with government regulations. As the pace of digital transformation continues to accelerate, it fuels an increasing demand for data centers, culminating in heightened energy consumption, carbon emissions, and water usage. However, in the face of these challenges, various government directives around the world, such as the EU Energy Efficiency Directive (EED), California Title 24 in the USA, Singapore's Data Centre Energy Efficiency Scheme (DCS), Australia's National Built Environment Rating System (NABERS), and United States SEC Climate Risk Disclosures, have come to the forefront as key regulatory frameworks designed to manage these environmental impacts.

Adhering to these regulations is more than a compliance issue—it presents an opportunity to drive data center sustainability to new heights. This whitepaper provides a comprehensive overview of these crucial measures from various regulatory bodies, aiming to equip the reader with a robust understanding of data center sustainability within the context of these international directives. The insights provided herein will not only help optimize performance but also aid in reducing environmental impact in a compliant and effective manner.

Average Delta T

Average Delta T (ΔT) is the difference in temperature between two sensors, which varies depending on position, especially vertical position, and time. As IT equipment consumes power, this energy in kilowatts (kW) is converted to heat, absorbed into environmental airflow. Comprehending the average ΔT across critical cooling devices is essential for understanding the effectiveness of the current cooling infrastructure and airflow configuration.

The Average Delta T (ΔT) measure is crucial to data center sustainability for several reasons:

1. **Energy Efficiency**: By monitoring the difference in temperature between the inlet and outlet of IT equipment, you can assess how effectively that equipment is cooled. High ΔT

values indicate efficient heat exchange and effective cooling, which directly impacts energy efficiency. When cooling is optimized, data centers consume less energy, making operations more sustainable.

2. **Thermal Performance**: ΔT helps identify potential hotspots within the data center. Hotspots can lead to equipment failure, which not only impacts uptime and performance but also can lead to excessive energy use if cooling systems are ramped up in response. By identifying and addressing hotspots, data centers can improve their overall thermal performance, leading to increased sustainability.
3. **Cooling Infrastructure Management**: Understanding average ΔT across critical cooling devices can provide insights into the current effectiveness of the cooling infrastructure. If the ΔT is lower than the design specification, it could suggest that cooling units are not working efficiently or that airflows are poorly configured. Correcting these issues can result in significant energy savings and improved sustainability.
4. **Capacity Planning**: ΔT can provide valuable information for capacity planning. Knowing how much heat is being generated and needs to be dissipated can inform decisions on cooling capacity requirements and infrastructure upgrades. Proper capacity planning can prevent over-provisioning, a common practice that often leads to energy waste and increased operating costs.

Cooling Efficiency

Cooling Efficiency evaluates the amount of energy required to cool the IT resources. It utilizes cooling capacity and cooling power data to ascertain the amount of power needed to cool the IT infrastructure.

1. **Greenhouse Gas Emissions**: The more energy a data center consumes for cooling, the more greenhouse gas emissions it potentially contributes to the environment, particularly if the energy is sourced from fossil fuels. By improving cooling efficiency, a data center can reduce its carbon footprint and contribute less to global warming, enhancing its sustainability credentials.

2. **Water Use**: Many data center cooling solutions rely on water for heat transfer. Inefficient systems could result in excessive water consumption. By improving cooling efficiency, data centers can also reduce their water usage, contributing to water conservation and thus overall environmental sustainability.
3. **Equipment Lifespan**: Overheating can damage IT equipment and shorten its lifespan, leading to more frequent replacement and an increase in electronic waste. Efficient cooling systems ensure that IT equipment operates within optimal temperature ranges, prolonging equipment lifespan and reducing e-waste.
4. **Performance and Reliability**: Inefficient cooling can lead to overheating, which may cause performance issues or even failures in IT equipment. By optimizing cooling efficiency, data centers can improve the reliability and performance of IT equipment, ensuring continuous service provision and reducing the likelihood of costly downtime.

The common formulae in Imperial Tons (when measuring water in gallons and temperature in Fahrenheit) and in SI units (measuring water consumption in liters and temperature in Celsius) are respectively as follows:

Common Formula: Tons (refrigeration load) = {GPM x (CHWRT - CHWST)}/24

Where:

- GPM = gallons per minute chilled water leaving the chilled water plant and delivered to the facility.
- CHWRT = chilled water return temperature.
- CHWST = chilled water supply temperature.

24 is a conversion constant.

Common Formula: SI units calculation: {(liters per second x (CHWRT °C - CHWST °C)} * 1.19

Energy Consumption

Energy Consumption is the amount of power required to operate the data center, a crucial aspect of sustaining infrastructure capacity. It comprises energy associated with all IT equipment, power delivery components, cooling system components, and other miscellaneous component loads.

Energy Consumption is a fundamental measure for data center sustainability, as it serves as a cornerstone for several other sustainability measures and is integral to regulatory compliance.

1. **Key to Other Sustainability Measures**: The energy consumption of a data center is central to many other sustainability metrics, including:
    - **Power Usage Effectiveness (PUE)**: This widely used metric is a ratio of the total energy used by the data center to the energy consumed by IT equipment. Hence, having an accurate understanding of total energy consumption is crucial for calculating PUE.
    - **Carbon Usage Effectiveness (CUE)**: This metric calculates the data center's carbon emissions per kilowatt-hour of IT energy usage. Energy consumption data is integral to determining CUE.
    - **Energy Reuse Effectiveness (ERE)**: ERE measures the proportion of energy that is reused outside the data center. To calculate ERE, you need to know how much energy the data center is consuming.
2. **Regulatory Compliance**: Governments worldwide are increasing scrutiny on the environmental impact of data centers, with regulations often focusing on energy consumption and efficiency. Accurately measuring and reporting energy consumption is critical for data centers to comply with these regulatory requirements. Here are a few examples:
    - **Energy Efficiency Directive - European Union**: The Energy Efficiency Directive 2012/27/EU (Union, October 25, 2012) establishes a common framework of measures for the promotion of energy efficiency within the European Union. It requires mandatory energy audits for large enterprises, which include data centers, to identify opportunities to reduce energy consumption.
    - **The Green Grid Association**: While not a government regulatory body, The Green Grid Association (Association, February 26, 2007), an industry consortium dedicated to advancing energy efficiency in data centers, has set industry standards for energy

consumption measurement. Many companies voluntarily adhere to these guidelines and in some cases, these have served as a model for regulations. It encourages the use of the Power Usage Effectiveness (PUE) metric to measure energy efficiency.

- **California Title 24 - USA**: Title 24 is part of the California Code of Regulations (Commission, January 1, 2023) that establishes standards for energy efficiency in buildings, including data centers. It mandates regular reporting of energy consumption and adherence to energy efficiency standards.
- **Data Centre Energy Efficiency Scheme (DCS) - Singapore**: This program by the Infocomm Media Development Authority (IMDA) ((IMDA), June 8, 2023) encourages data center operators in Singapore to adopt greater energy-efficient technologies and practices. It rates data centers based on their energy efficiency, for which energy consumption measurement is necessary.
- **NABERS - Australia**: The National Australian Built Environment Rating System (NABERS) ((NABERS), March 8, 2003) includes a specific rating for data center energy efficiency. This system requires detailed measurement of energy consumption to provide a star rating that reflects the data center's energy performance.
- **ISO 50001 - International**: ISO 50001 ((ISO), September 15, 2018) is an international standard for energy management systems. It provides a framework for data centers to establish the systems and processes necessary to improve energy performance, including energy efficiency, use, and consumption.

These are just a few examples of regulations that require data centers to measure and report energy consumption. Given the growing global emphasis on sustainability, such requirements are becoming increasingly common and stringent.

By accurately measuring energy consumption, data centers can identify inefficiencies, find opportunities for improvement, calculate other sustainability measures accurately, and ensure they comply with relevant regulations.

Common Formula: **Sum of MWh**

Power Usage Effectiveness (PUE)

Power Usage Effectiveness, or PUE, is a metric that measures the total amount of power that your data center consumes. PUE was developed by the Green Grid and introduced in 2006 to calculate data center energy efficiency and is the standard measuring stick upon which the data center industry continues to rely on.

Data centers consume a massive amount of energy. In the US alone, data centers account for 2% of all electricity use. That figure will only continue to rise as demand for processing power increases.

Underutilized servers not only waste resources but also take up valuable floor space. Likewise, hardware that uses more power than necessary places heavier demands on cooling systems.

In both cases, you have assets that are providing less value than they should and driving up costs. Addressing these issues is essential to ensure your data center is running as efficiently as possible.

Calculating PUE is accomplished by dividing the total facility power by the IT equipment power consumption.

Total facility power refers to the amount of power that the facility uses. It includes all hardware inside the data center, as well as cooling systems, power delivery components, and lighting systems.

IT equipment usage refers to the amount of energy that's used to power the storage and networking equipment. Control equipment like workstations and monitors ae also included.

Let's look at an example.

A data center uses 100,000 kilowatts of total energy and the IT equipment uses 55,000 kilowatts of energy. Based on the formula above, that gives us a PUE of 1.81 for this data center.

The closer the number moves down to 1, the more efficient the data center. PUE alerts data center management on how close they are to their efficiency goals. Measuring PUE over time can help determine the most effective energy saving initiatives.

A data center with a high PUE score is using more energy than it should, meaning it's less efficient and costing more money.

Common Formula: FACILITY_LOAD / IT_LOAD

Total CO_2

The Total CO_2 measure is an estimate of the total greenhouse gas emissions produced by a data center. It's usually measured in metric tons of carbon dioxide equivalent (CO_2e), a standard unit for measuring carbon footprints. This measure includes direct emissions from burning fossil fuels (Scope 1 emissions), indirect emissions from purchased electricity (Scope 2 emissions), and other indirect emissions, such as those resulting from the extraction and production of purchased materials and fuels, transport-related activities, and emissions from outsourced activities (Scope 3 emissions).

While Scope 1 and Scope 2 emissions can be relatively straightforward to calculate, Scope 3 emissions require more detailed data collection and calculation, as they account for all other indirect emissions that occur in a company's value chain.

Understanding the Total CO_2 measure is crucial for multiple reasons. Firstly, it provides a clear insight into the environmental impact of a data center's operations. By understanding how much carbon dioxide a data center is responsible for, operators can prioritize efforts to reduce the largest sources of emissions.

Secondly, measuring Total CO_2 enables data centers to track their progress towards sustainability goals. With growing pressure from governments, investors, customers, and society at large to reduce carbon footprints, data centers can use this measure as a key performance indicator (KPI) in their sustainability reports.

Finally, by quantifying their carbon footprints, data centers can identify opportunities for cost savings. Energy efficiency measures that reduce carbon emissions often also reduce energy costs, resulting in a win-win situation for both the environment and the bottom line.

Calculating Total CO2 measure involves the collection of detailed data on energy consumption and other sources of emissions. Here is a simplified version of how this calculation can be done:

Scope 1 Emissions: To calculate Scope 1 emissions ((WBCSD), 2004), you first need to identify all the sources of direct emissions in your data center, such as generators or cooling systems that burn fossil fuels. Then, you need to measure or estimate the amount of fuel used by each of these sources over a given time. Finally, you multiply the amount of fuel used by its specific emission factor, which is a value representing the amount of CO_2e released per unit of fuel burned.

Scope 2 Emissions: Scope 2 emissions ((WBCSD), 2004) result from the electricity used by the data center. To calculate these emissions, you need to multiply the amount of electricity consumed over a given time by the emission factor of your electricity supplier, which should be available in their annual sustainability report or on their website.

Scope 3 Emissions: Scope 3 emissions ((WBCSD), 2004) are the most complex to calculate, as they require a detailed understanding of your supply chain and the lifecycle of your products. One common method is to use lifecycle analysis techniques to estimate the emissions associated with each stage of the product's life, from production to end-of-life disposal.

It's important to remember that this is a simplified explanation of the calculation process, and the actual calculations can be quite complex. Various tools and methodologies, such as the Greenhouse Gas Protocol ((WBCSD), 2004), have been developed to aid businesses in accurately quantifying their emissions. They offer comprehensive guidelines and calculators that account for the intricacies of various emission sources, both direct and indirect. By leveraging these tools, data centers can not only streamline the process of calculating their Total CO2 measure but also make it more precise and reliable.

Common Formula: Summation of "equivalent to CO_2" emissions.

Units: kt(CO_2e)

Carbon Usage Effectiveness (CUE)

Carbon Usage Effectiveness (CUE) is a performance measurement that helps determine the amount of greenhouse gas (GHG) emissions produced per unit of IT energy consumed within a data center. It provides an effective way to measure the carbon footprint and thus the environmental impact of data center operations.

CUE was introduced by The Green Grid (Association, February 26, 2007), a global consortium dedicated to advancing energy efficiency in data centers and business computing ecosystems. This measurement complements the Power Usage Effectiveness (PUE) metric, another Green Grid creation that indicates the energy efficiency of a data center.

CUE is a ratio of Total CO_2 emissions (kg) divided by Total IT Energy (kWh). This ratio gives a clear view of the carbon emissions associated with the IT load of a data center.

The total CO_2 emissions are calculated based on the source of energy and the quantity consumed. Different sources of energy (coal, gas, oil, renewable, etc.) have different carbon emission factors, which need to be considered when calculating total emissions. These factors are often expressed as the amount of CO_2 emitted per unit of energy produced and can be found in public databases or provided by utility companies.

The total IT energy represents the energy consumed by the IT equipment inside the data center, such as servers, storage devices, and network equipment.

Interpreting CUE

A lower CUE indicates a lower carbon footprint, meaning the data center is more carbon efficient. The minimum value of CUE can be 0, indicating a data center that operates entirely on carbon-free energy sources.

It's important to consider that CUE can vary significantly based on the energy sources a data center relies on. A data center powered by renewable energy will typically have a lower CUE compared to one powered by fossil fuels, even if they have the same PUE.

Common Formula: Total CO_2 Equivalent Emissions / IT Equipment Energy in kWh

Units: kg(CO_2e) / kWh

Server Utilization

Server Utilization is a vital measure for data center sustainability for several reasons:

1. **Energy Efficiency**: Underutilized servers consume energy without delivering proportionate computational output, leading to energy wastage. By maximizing server utilization, data centers can get the most computational power per unit of energy consumed, enhancing their energy efficiency and overall sustainability.
2. **Reduced E-Waste**: High server utilization reduces the need for additional servers, which in turn minimizes the amount of electronic waste when these servers reach their end of life. This contributes to overall environmental sustainability.
3. **Cost Efficiency**: Higher server utilization can lead to significant cost savings. It can reduce the need for additional hardware, lowering capital expenditures. Operational costs, such as energy for power and cooling, can also be minimized, contributing to a more sustainable cost structure.

4. **Space Efficiency**: Data centers have a finite amount of space. Maximizing server utilization allows data centers to make the most of this limited resource, reducing the need for physical expansion and the environmental impact associated with construction.
5. **Performance Optimization**: Monitoring server utilization can help identify inefficiencies in resource allocation and application performance. This can guide necessary adjustments to improve operational efficiency and service quality.
6. **Regulatory Compliance**: As governments and industries move towards greener practices, there might be regulatory requirements or incentives tied to efficient use of resources, including server utilization.
7. **Enhanced Lifespan of Data Center**: By optimizing server utilization, the lifespan of a data center can be extended as it can support greater computational demand over time without needing substantial additional resources.

Server Utilization is determined by measuring CPU usage. Both excessively low or high CPU usage rates can indicate problems.

Common Formula: Average CPU utilization of all active servers

Units: %

Water Usage Effectiveness

The Green Grid (Association, February 26, 2007), a global consortium dedicated to promoting resource efficiency in information technology and data centers, introduced the concept of Water Usage Effectiveness (WUE) in 2011. WUE is a performance indicator for water used by a data center. It specifically measures the overhead or efficiency of a facility's water usage.

This metric is becoming increasingly important as water scarcity becomes a significant concern worldwide. For many regions, cooling large data centers necessitates vast amounts of water, exacerbating existing water stress. By effectively measuring and managing WUE, data center operators can make more informed decisions about water use and decrease their environmental footprint.

Importance of WUE in Data Center Sustainability

Improving WUE is crucial to the sustainability goals of a data center for several reasons.

1. **Water Conservation**: Water is a precious resource, and its usage needs to be reduced wherever possible. By monitoring and striving to improve WUE, data centers can contribute to significant water savings.
2. **Energy Efficiency**: Lowering WUE often involves improving cooling efficiency, which also reduces energy use. This dual benefit can lead to substantial cost savings and decrease the environmental footprint of the data center.
3. **Compliance and Reputation**: Increasingly, businesses are being held accountable for their environmental impact. A good WUE can help a data center comply with regulations, earn green certifications, and improve their reputation with customers who prioritize sustainability.

How to Calculate WUE?

The calculation of WUE is straightforward. It is the ratio of the annual site water usage in liters to the IT equipment energy usage in kilowatt-hours (kWh) during the same period.

The "total site water usage" includes all water used in the operation of the data center, including cooling towers, humidification, and facilities' operational processes. The IT equipment energy refers to the energy consumed by computing and storage equipment, networking gear, and other IT-related hardware.

Common Formula: Water in liters / kWh

Unit: L / kWh

Lower WUE values indicate greater water efficiency. An ideal scenario would have a WUE close to zero, indicating negligible or no water use.

Summary

Data center sustainability is a matter of pressing concern, given the significant environmental footprint of these facilities. As the demand for data storage and processing continues to skyrocket, so too does the need for comprehensive measures to gauge and enhance data center sustainability. In this paper, we have delved into several key metrics that offer valuable insights into a data center's environmental impact, exploring their meaning, relevance, and how they are calculated.

The Average Delta T (ΔT) signifies the temperature difference between two sensors within the data center, reflecting the effectiveness of the cooling infrastructure and airflow configuration. A higher ΔT value denotes efficient heat exchange, thus underscoring enhanced energy efficiency, improved thermal performance, and effective cooling infrastructure management. The measure also aids in precise capacity planning, reducing energy wastage and operational costs.

Cooling Efficiency is another essential measure, assessing the energy required to cool the IT resources. An efficient cooling system optimizes energy use, reduces greenhouse gas emissions and water consumption, extends the lifespan of the equipment, and bolsters performance and reliability. The formulas to calculate cooling efficiency are presented for both Imperial Tons (for measurements in gallons and Fahrenheit) and SI units (for measurements in liters and Celsius).

Energy Consumption indicates the power required to run the data center, encompassing energy used by all IT equipment, power delivery components, cooling system components, and other auxiliary loads. This measure forms the foundation of several other sustainability metrics like Power Usage Effectiveness (PUE), Carbon Usage Effectiveness (CUE), and Energy Reuse Effectiveness (ERE). Accurate energy consumption measurement ensures compliance with regulatory requirements and helps in identifying operational inefficiencies and areas for improvement.

Power Usage Effectiveness (PUE) reflects the total facility energy against the energy consumed by IT equipment, providing a clear indicator of a data center's energy efficiency. Lower PUE values signify higher efficiency in use of resources that support the IT space, thereby reducing energy wastage and driving down costs.

Total CO2 estimates the greenhouse gas emissions generated by a data center, encompassing direct emissions from burning fossil fuels (Scope 1), indirect emissions from purchased electricity (Scope 2), and other indirect emissions (Scope 3). This metric provides insights into the data center's environmental impact, progress towards sustainability goals, and identifies opportunities for cost savings.

Carbon Usage Effectiveness (CUE) measures greenhouse gas emissions per unit of IT energy consumed, signifying the carbon footprint of the data center operations. Lower CUE values indicate lower carbon footprint and hence a more carbon-efficient data center.

Server Utilization measures the CPU usage, the balance of which is critical for optimal performance and cost management. Optimal server utilization enhances energy efficiency, reduces e-waste, improves cost efficiency, optimizes space usage, and aids in regulatory compliance.

Water Usage Effectiveness (WUE) analyzes the efficiency of water usage to support and cool the IT infrastructure. As water scarcity becomes a growing concern, monitoring WUE helps data centers make informed decisions about water use and reduce their environmental footprint. It plays a crucial role in water conservation, energy efficiency, compliance with regulations, and improving a data center's reputation.

In conclusion, these fundamental sustainability measures provide a comprehensive overview of a data center's environmental footprint, informing strategies for improvement. Implementing these metrics is not only an ethical necessity but also a means to optimize operational performance, reduce costs, and meet regulatory requirements, driving towards a future of greener and more sustainable data centers.

Referenced Regulations Related to Data Center Sustainability

The EU Energy Efficiency Directive (EED)

https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficiency-targets-directive-and-rules/energy-efficiency-directive_en

The EU Energy Efficiency Directive (EED) is a European Union directive which mandates energy efficiency improvements within the European Union. The EU Energy Efficiency Directive (EED) is a European Union directive which mandates energy efficiency improvements within the European Union. The revision of the EED is still under negotiation between the European Parliament and the Council of the European Union. However, it is expected to be finalized in 2023.

The EED sets several targets for energy efficiency, including:

- A 20% reduction in final energy consumption by 2020, compared to 2007 levels.
- A 32.5% reduction in primary energy consumption by 2030, compared to 2007 levels.
- A 30% improvement in energy efficiency in data centers by 2030.

The EED also requires EU countries to implement several measures to improve energy efficiency, including:

- Mandatory energy audits for large energy users.
- Labeling schemes for energy-consuming products.
- Public awareness campaigns on energy efficiency.

The EED is part of the EU's broader efforts to reduce greenhouse gas emissions and improve energy security. It is estimated that the EED could save the EU up to €600 billion by 2030.

The EED has been amended several times since it was first adopted. The most recent amendment, which was adopted in 2018, strengthens the directive's requirements and sets more ambitious targets.

The EED is a significant piece of legislation that is having a major impact on energy efficiency in the European Union. It is expected to play a key role in helping the EU achieve its climate and energy goals.

Here are some of the key benefits of the EU EED:

- It will help to reduce greenhouse gas emissions and improve air quality.
- It will save businesses and consumers money on their energy bills.
- It will create jobs in the energy efficiency sector.
- It will make the EU more competitive in the global economy.

The EU EED is a complex piece of legislation, but it is an important step towards a more sustainable future. It is expected to have a significant impact on the way we use energy in the years to come.

United States SEC Climate Risk Disclosure

https://www.sec.gov/news/press-release/2022-46
https://www.sec.gov/rules/proposed.shtml

The United States Securities and Exchange Commission (SEC) is proposing new rules that would require public companies to disclose climate-related risks, including those related to data centers. The proposed rules would require companies to disclose information about their direct greenhouse gas (GHG) emissions (Scope 1 emissions), indirect emissions from purchased electricity or other forms of energy (Scope 2 emissions), and certain types of GHG emissions " (LLP, 2022)"

The proposed rules would also require companies to disclose information about the climate-related risks that they face, including risks related to:

- The physical impacts of climate change, such as extreme weather events and sea level rise.
- The transition to a low-carbon economy, such as changes in regulations or market conditions.
- The reputational risks associated with climate change.

The proposed rules would have a significant impact on data center operators. Data centers are major consumers of electricity, and they are responsible for a significant amount of greenhouse gas emissions. The proposed rules would require data center operators to disclose their GHG emissions and to assess the climate-related risks that they face. This information would be important for investors, as it would help them to understand the financial risks associated with data center operators.

The proposed rules are still under consideration by the SEC, and they have not yet been finalized. However, if the rules are finalized, they would represent a significant step forward in the SEC's efforts to promote climate-related disclosure by public companies.

Here are some of the key benefits of the SEC's proposed climate risk disclosures related to data centers:

- It would help investors to understand the financial risks associated with data center operators.
- It would encourage data center operators to take steps to reduce their GHG emissions.
- It would help to promote a more sustainable data center industry.

The SEC's proposed climate risk disclosures are a positive step towards a more sustainable future. They would help investors to make informed decisions about their investments, and they would encourage data center operators to take steps to reduce their environmental impact.

California Title 24 in the USA

https://www.library.ca.gov/wp-content/uploads/2021/08/GuideToTitle24.pdf

California Title 24 is a set of building energy efficiency standards that applies to all newly constructed and existing buildings in the state. The standards are designed to reduce energy consumption and greenhouse gas emissions.

Title 24 includes several specific requirements for data centers, including:

- Computer room energy efficiency: Data centers must meet specific energy efficiency requirements for their computer rooms. These requirements are based on the size and design of the computer room.
- PUE monitoring: Data centers must install and maintain a PUE monitoring system. PUE is a measure of the efficiency of a data center's cooling system.
- Water use: Data centers must use water efficiently. This includes using water-efficient cooling systems and fixtures.
- Lighting: Data centers must use energy-efficient lighting. This includes using LED lighting and occupancy sensors.

The requirements for data centers in Title 24 are constantly being updated to reflect the latest advances in technology and energy efficiency. The latest version of Title 24, which went into effect on January 1, 2023, includes several new requirements for data centers, such as:

- Power usage effectiveness (PUE): The minimum PUE requirement for data centers has been tightened from 1.2 to 1.1.
- Water use: The maximum water use allowance for data centers has been reduced.

- Lighting: The minimum efficiency requirements for lighting have been tightened.

The requirements in Title 24 are designed to help data centers reduce their energy consumption and greenhouse gas emissions. By complying with these requirements, data centers can help to protect the environment and reduce their operating costs.

Here are some of the benefits of complying with California Title 24 for data centers:

- Reduced energy consumption: Complying with Title 24 can help data centers to reduce their energy consumption by up to 30%. This can save data centers money on their energy bills.
- Reduced greenhouse gas emissions: Reduced energy consumption also leads to reduced greenhouse gas emissions. This can help data centers to reduce their environmental impact.
- Improved efficiency: Complying with Title 24 can help data centers to improve their efficiency. This can make data centers more reliable and less likely to experience outages.
- Increased compliance: Complying with Title 24 can help data centers to comply with other regulations, such as the EU Energy Efficiency Directive.

Overall, complying with California Title 24 is a good way for data centers to reduce their energy consumption, greenhouse gas emissions, and operating costs. It can also help data centers to improve their efficiency and compliance with other regulations.

Singapore's Data Centre Energy Efficiency Scheme (DCS)

https://www.imda.gov.sg/resources/press-releases-factsheets-and-speeches/press-releases/2023/imda-introduces-sustainability-standard-for-data-centres-operating-in-tropical-climates

Singapore's Data Centre Energy Efficiency Scheme (DCS) is a government-led initiative to promote energy efficiency in data centers in Singapore. The DCS was launched in 2015 and is administered by the Infocomm Media Development Authority (IMDA).

The DCS has two main components:

- A labelling scheme that helps data center operators to compare the energy efficiency of their facilities.
- A performance-based incentive scheme that rewards data center operators for improving the energy efficiency of their facilities.

The labelling scheme is based on the PUE (Power Usage Effectiveness) metric, which is a measure of the efficiency of a data center's cooling system. The PUE is calculated by dividing the total power consumed by the data center by the power consumed by the IT equipment. A lower PUE indicates a more efficient data center.

The performance-based incentive scheme rewards data center operators for improving their PUE by up to 20%. The incentives are based on the amount of energy saved and the number of years that the data center has been operating.

The DCS has been successful in promoting energy efficiency in data centers in Singapore. Since the DCS was launched, the PUE of data centers in Singapore has improved by an average of 10%. This has resulted in significant energy savings and reduced greenhouse gas emissions.

The DCS is a good example of how government-led initiatives can help to promote energy efficiency in the IT sector. The DCS has shown that it is possible to improve the energy efficiency of data centers without compromising on performance.

Here are some of the benefits of the DCS:

- It helps to reduce energy consumption and greenhouse gas emissions.
- It saves data center operators money on their energy bills.
- It makes data centers more sustainable.
- It sets a good example for other countries to follow.

The DCS is a valuable tool for promoting energy efficiency in data centers. It is a win-win for data center operators, the environment, and the country.

Australia's National Built Environment Rating System (NABERS)

https://www.nabers.gov.au/about/what-nabers

The National Australian Built Environment Rating System (NABERS) is a government-led initiative to measure the environmental performance of Australian buildings and tenancies. NABERS has a specific rating system for data centers, which is designed to assess the energy efficiency and environmental impact of data centers in Australia.

The NABERS rating for data centers is based on a facility's actual operational data, not design. The rating is calculated using several factors, including:

- The Power Usage Effectiveness (PUE) of the data center.
- The energy efficiency of the data center's cooling system.
- The amount of water consumed by the data center.
- The amount of waste generated by the data center.

The NABERS rating for data centers is on a scale of 1 to 6 stars, with 1 star being the least efficient and 6 stars being the most efficient. A data center with a NABERS rating of 4 or 5 stars is energy efficient.

The NABERS rating for data centers can be used to:

- Identify areas for operational improvements and cost savings.
- Promote the environmental credentials of a data center.
- Comply with environmental regulations.

The NABERS rating for data centers is a valuable tool for improving the environmental performance of data centers in Australia. The rating provides data center operators with a clear roadmap for improving the efficiency of their facilities and reducing their environmental impact.

Here are some of the benefits of NABERS for data centers:

- It helps to reduce energy consumption and greenhouse gas emissions.
- It saves data center operators money on their energy bills.
- It makes data centers more sustainable.
- It helps to improve the reputation of data center operators.

NABERS is a valuable tool for promoting energy efficiency and environmental sustainability in the data center industry. It is a win-win for data center operators, the environment, and the country.

The Green Grid Association

https://www.thegreengrid.org/

The Green Grid Association is a non-profit organization that works to promote energy efficiency in data centers. The Green Grid was founded in 2007 by a group of data center professionals who were concerned about the environmental impact of data centers.

The Green Grid has developed several tools and resources to help data centers reduce their energy consumption. These tools include:

- The Power Usage Effectiveness (PUE) metric: PUE is a measure of the efficiency of a data center's cooling system. The Green Grid has developed a standard for PUE that data centers can use to measure their efficiency.
- The Data Center Maturity Model (DCMM): The DCMM is a framework that data centers can use to assess their energy efficiency. The DCMM has five levels, from "Ad hoc" to "Optimized."
- The Green Grid Best Practices: The Green Grid has developed a number of best practices for data center energy efficiency. These best practices cover a wide range of topics, such as cooling, power, and IT equipment.

The Green Grid also provides several other resources to help data centers reduce their energy consumption. These resources include:

- Training: The Green Grid offers several training courses on data center energy efficiency.
- Certification: The Green Grid offers a certification program for data center professionals.
- Publications: The Green Grid publishes several white papers, case studies, and other publications on data center energy efficiency.

The Green Grid is a valuable resource for data centers that are looking to reduce their energy consumption. The Green Grid's tools, resources, and training can help data centers to improve their efficiency and save money on their energy bills.

Here are some of the benefits of working with The Green Grid Association for data centers:

- Access to tools and resources: The Green Grid Association provides data centers with access to several tools and resources that can help them to reduce their energy consumption. These tools include the PUE metric, the DCMM, and the Green Grid Best Practices.

- Training and certification: The Green Grid Association offers training courses and certification programs for data center professionals. This training can help data center professionals to learn about the latest energy efficiency technologies and practices.
- Networking opportunities: The Green Grid Association provides data centers with networking opportunities with other data centers and with industry experts. This networking can help data centers to share best practices and to learn about new technologies.

Overall, working with The Green Grid Association can be a valuable way for data centers to reduce their energy consumption and improve their efficiency.

Works Cited

(IMDA), I. M. (June 8, 2023). *Data Centre Energy Efficiency Scheme (DCS) - Singapore.* IMDA website https://www.imda.gov.sg/resources/press-releases-factsheets-and-speeches/press-releases/2023/imda-introduces-sustainability-standard-for-data-centres-operating-in-tropical-climates.

(ISO), I. O. (September 15, 2018). *ISO 50001:2018 Energy management systems — Requirements with guidance for use.* ISO website - https://www.iso.org/standard/69426.html.

(NABERS), N. A. (March 8, 2003). *NABERS: The National Australian Built Environment Rating System.* NABERS website https://www.nabers.gov.au/.

(WBCSD), W. R. (2004). *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard.* WRI and WBCSD website https://ghgprotocol.org/.

Association, T. G. (February 26, 2007). *The Green Grid: Industry Consortium fordvancing energy efficiency in data centers.* The Green Grid website https://www.thegreengrid.org/.

Commission, C. E. (January 1, 2023). *Title 24, Part 6: Energy Efficiency Standards for Buildings.* California Code of Regulations https://www.energy.ca.gov/title24/.

LLP, B. &. (2022). *SEC Proposes New Rules to Standardize Climate-Related Disclosures.* BTLaw Insights, April 21, 2022. https://btlaw.com/insights/alerts/2022/sec-proposes-new-rules-to-standardize-climate-related-disclosures.

Union, E. P. (October 25, 2012). *Directive 2012/27/EU on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC.* Official Journal of the European Union https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32012L0027.

Table of Acronyms

CHWST - chilled water supply temperature. The chilled water supply temperature is the temperature of the chilled water that is supplied to the cooling coils in a building. The chilled water supply temperature is typically 5-10 degrees Fahrenheit lower than the chilled water return temperature. For example, if the chilled water return temperature is 50 degrees Fahrenheit, the chilled water supply temperature would be 45-40 degrees Fahrenheit.

The chilled water supply temperature is important because it affects the efficiency of the cooling coils. If the chilled water supply temperature is too low, the cooling coils will not be able to remove enough heat from the air, which will reduce the cooling capacity of the system.

CHWRT - chilled water return temperature. The chilled water return temperature is the temperature of the chilled water that is returned to the chiller after it has been used to cool the air in a building. The chilled water return temperature is typically 5-10 degrees Fahrenheit higher than the chilled water supply temperature. For example, if the chilled water supply temperature is 45 degrees Fahrenheit, the chilled water return temperature would be 50-55 degrees Fahrenheit.

The chilled water return temperature is important because it affects the efficiency of the chiller. If the chilled water return temperature is too high, the chiller will have to work harder to cool the water, which will reduce its efficiency.

The chilled water return temperature is an important factor in the efficiency of a chiller. By monitoring the chilled water return temperature and taking steps to reduce it, you can improve the efficiency of your chiller and save energy.

GPM - stands for gallons per minute. It is a unit of measurement used to measure the flow rate of water.

1 gallon is equal to 3.785 liters, so 1 GPM is equal to 3.785 liters per minute.

GPM is a common unit for measuring the flow rate of water in plumbing and irrigation systems. It is also used to measure the flow rate of water in swimming pools and other water features.

The GPM is a useful unit for comparing the flow rates of different water sources and for tracking the flow rate of a water system over time.

GWh - stands for gigawatt-hour. It is a unit of energy equal to one gigawatt of power for one hour. It is a non-SI unit of energy, but it is widely used in the United States and other countries.

1 gigawatt-hour is equal to 1,000 megawatt-hours or 3.6 gigajoules. It is also equal to the energy consumed by a 1,000-megawatt appliance operating for one hour.

GWh is a common unit for measuring the energy consumption of large facilities, such as data centers, power plants, and industrial plants. It is also used to measure the energy output of large-scale energy projects, such as hydroelectric dams and wind farms.

The GWh is a useful unit for comparing the energy consumption of different facilities and projects. It is also a useful unit for tracking the energy consumption of a facility or project over time.

kg(CO_2e) - stands for kilograms of carbon dioxide equivalent. It is a unit of measurement used to quantify the total amount of greenhouse gases emitted into the atmosphere.

CO2e is a measure of the global warming potential of a greenhouse gas, considering its lifespan in the atmosphere and its ability to trap heat. For example, 1 kg of methane is equivalent to 25 kg of CO2e, because methane has a much higher global warming potential than CO2.

kg(CO2e) is a useful unit for comparing the emissions of different activities and for tracking emissions over time. It is also a useful unit for setting emissions targets and for measuring progress towards those targets.

kWh - stands for kilowatt-hour. It is a unit of energy equal to one kilowatt of power for one hour. It is a non-SI unit of energy, but it is widely used in the United States and other countries.

1 kilowatt-hour is equal to 3,600 kilojoules or 3.6 megajoules. It is also equal to the energy consumed by a 1,000-watt appliance operating for one hour.

L (or l) - is the symbol for liter, a unit of volume in the metric system. It is equal to the volume of a cube with sides of 10 centimeters.

MWh - stands for megawatt-hour. It is a unit of energy equal to one megawatt of power for one hour. It is a non-SI unit of energy, but it is widely used in the United States and other countries.

1 megawatt-hour is equal to 3,600,000 watt-hours or 3.6 megajoules. It is also equal to the energy consumed by a 1,000-kilowatt appliance operating for one hour.

MWh is a common unit for measuring the energy consumption of homes, businesses, and other organizations. It is also used to measure the energy output of power plants and other energy-generating facilities.

The MWh is a useful unit for comparing the energy consumption of different appliances and devices. It is also a useful unit for tracking the energy consumption of a home or business over time.

SI units, or the International System of Units - is the modern form of the metric system. It is the most widely used system of measurement in the world.

The SI system is based on seven base units:

1. Length: meter (m)
2. Mass: kilogram (kg)
3. Time: second (s)
4. Electric current: ampere (A)
5. Thermodynamic temperature: kelvin (K)
6. Amount of substance: mole (mol)
7. Luminous intensity: candela (cd)