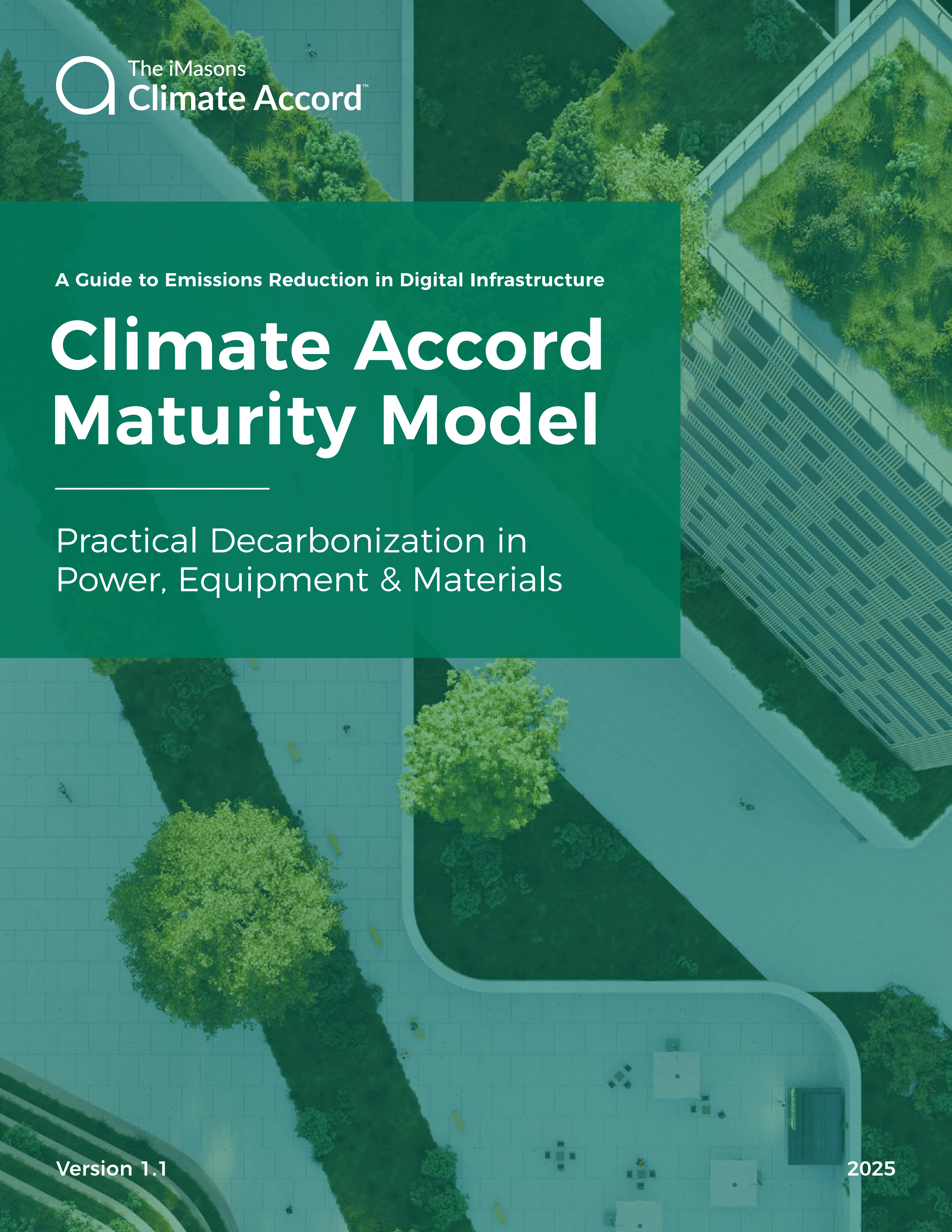

The iMasons
Climate Accord™

A Guide to Emissions Reduction in Digital Infrastructure

Climate Accord Maturity Model

Practical Decarbonization in Power, Equipment & Materials

Version 1.1

2025

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Introduction

The Digital Age necessitates more digital infrastructure. As such, it's fueling exponential growth of data centers and increasing global carbon emissions. Measuring and reducing the associated impacts is critical.

In recent years, we have increasingly relied on digital services. Inefficient facilities and software force servers to run longer and hotter, and creates challenges with storing information and basic processing functions. Facilities and operating systems draw on critical, finite, global resources (energy, water, and raw materials), contributing to an untold number of gigatons of greenhouse gas emissions each year.

Data centers globally consumed around 460TWh of electricity in 2022 alone, almost 2% of global electricity demand (Çam, 2024). This translates to the equivalent carbon emissions of 25 million homes' energy use for one year (Greenhouse Gas Equivalencies Calculator, 2024a). Based on the current rate of construction, this use is expected to more than double by 2026 (Synergy Research Group, 2024). Over the past few decades, our industry has driven energy efficiency through Power Usage Effectiveness (PUE) and IT work output improvements, as well as significant investments in energy infrastructure for clean or renewable energy.

Additionally, material use contributes significantly to the industry's embodied carbon emissions. Progress in the transparency of the embodied impacts has led to reductions throughout products' supply chains. However, with the projected growth of hyperscale data centers alone, the digital infrastructure industry needs a more impactful, scalable plan to decarbonize while meeting consumer demand (Yadav, 2024).

Significant portions of the embodied carbon emissions, in particular those of equipment (both IT and MEP systems), are not completely studied. Various supply chains that comprise just one piece of equipment can be incredibly complex, and therefore time-intensive to measure the life cycle impacts. However, where studied, equipment (including servers, mechanical, electrical, and plumbing [MEP] equipment) and on-site, backup power sources are estimated to be carbon intensive.

It is increasingly common for a company to report on impacts through frameworks including measuring and disclosing scope 1, scope 2, and sometimes scope 3 emissions. Existing and emerging regulations such as the EU Energy Efficiency Directive, Corporate Sustainability Reporting Directive (CSRD), and SEC Climate Disclosure Rules are furthering a focus on public reporting of impacts. While these frameworks and regulatory requirements touch various aspects of decarbonization, there is a need to coalesce this information into a consistent document for our industry.

Even with growth predictions inclusive of Artificial Intelligence (AI), these environmental challenges are resolvable with existing systems and today's technology, provided we mature the building and management of digital infrastructure. For this purpose, the iCA is pleased to offer a Maturity Model addressing greenhouse gas emissions in three categories: power, materials, and equipment.

As such, the iMasons Climate Accord (iCA) has convened its Governing Body and three working groups of independent industry experts (in the areas of Materials, Power, and Equipment) to create this roadmap on the decarbonization of digital infrastructure. This standardized framework outlines opportunities for progress in reducing:

- Embodied carbon in the materials used to build data centers;
- Embodied carbon of the equipment deployed in data centers; and
- The carbon intensity of source power used to operate data centers.

This first edition of the iCA Maturity Model is intended to provide clarity on the requirements for the digital infrastructure sector to achieve sustainable growth while protecting our planet. The focus is carbon accounting for each unique data center location over its lifetime, with the ultimate goal of net zero carbon emissions (as aligned with the Paris Climate Accord) for our industry.

About the iMasons Climate Accord (iCA)

The iMasons Climate Accord is a coalition united on carbon reduction in digital infrastructure. Launched by the Infrastructure Masons in 2022, the organization has mobilized a community of 250+ member organizations spanning data centers, networks, cloud computing, energy, and cybersecurity.

At the time of publication, the Climate Accord Governing Body includes AWS, Digital Realty, Google, iMasons, Meta, Microsoft, and Schneider Electric. Alongside the entire iCA member community, these leading organizations are working toward industry-wide adoption of an open standard to report carbon power, materials, and equipment to create a common maturity model to report progress.

Acknowledgments

The Maturity Model and levels were determined by a broad range of industry experts from the iCA Governing Body and Working Groups, feedback from the overall iCA membership and key subject matter experts, iMasons Global Partners, and the iMasons Sustainability Committee. As such, the iCA recognizes the following individuals and respective organizations for their contributions.

Brightworks Sustainability

A longstanding, trusted partner of the iMasons Climate Accord and Infrastructure Masons, Brightworks Sustainability was invaluable to the development and delivery of this Maturity Model. Additional thanks to the following team members: Dejana Harris, Joshua Hatch, Colleen Large, Jessie Templeton, and Sunni Wissmer.

Founded in 2001, Brightworks Sustainability offers expertise in ESG & Corporate Sustainability, Government Sector Sustainability, Sustainable and Healthier Built Environments, Carbon, Energy, and Materials.

Infrastructure Masons

The iCA and iMasons are partners in our respective efforts in supporting the digital infrastructure industry. Thank you to the iMasons team for your ongoing collaboration and leadership: Santiago Suinaga (CEO), Gina Bonatti, Jen Franklin, Rudolf Gordon-Seymour, Jeff Omelcheck, Courtney Popp, Rachell Robson, Emma Stevens, and Aissa Wise.

Infrastructure Masons (iMasons) is a non-profit, professional association of technology and business leaders who represent over $150Bn in infrastructure projects in over 130 countries. The organization is guided by an Advisory Council composed of global leaders who manage some of the largest digital infrastructure portfolios in the world. iMasons has four strategic industry priorities—increase Awareness, enhance Education opportunities, champion Diversity & Inclusion, and inspire Sustainability through deep member engagement.

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Christian Belady for hosting the inaugural meeting of the iMasons Climate Accord at "Chez Belady," spearheading the foundation of the organization.

Andrew Schaap and **Aligned Data Centers**. The iCA's first Mover organization and key thought leaders in driving the initial maturity model concept.

Maturity Model

Overview

The Maturity Model is a framework and opportunity for companies to evaluate its progress on their pathway toward net zero emissions for their data center portfolio, including owner-operated facilities and/or colocation centers.

Maturity levels provide an incremental roadmap toward optimal, low-carbon data center operations and were formulated in reverse from optimized carbon emissions and practices in each category. The model enables the evaluation of a company's digital infrastructure portfolio, including their portfolio of owned and/or leased assets. Individual exemplary data centers may also be highlighted through the model. While the methods and background data to reach the highest maturity levels are still progressing throughout the industry, the model initiates distinct market pressure along the entire supply chain to materialize the necessary solutions. It is not prescriptive, providing flexibility in reduction pathways to the owner and a changing carbon landscape.

There are also several models and standards referenced in this iMasons model, cited here for brevity:

- France's National Methodological Standard for the environmental assessment of Datacenter IT hosting services and cloud services
- CLC/TS 50600-5-1 on maturity model for the environmental sustainability of data centres
- ISO/IEC 30134-7:2023, Information technology, Data centres, key performance indicators, Part 7: Cooling efficiency ratio (CER)
- ISO/IEC 23544:2021, Information Technology, Data centres, Application Platform Energy Effectiveness (APEE)
- ISO/IEC 21836:2020, Information technology, Data centres, Server energy effectiveness metric
- Forthcoming energy guidance from the European Commission

Application

The Maturity Model is designed to support responsible data center owners and operators seeking to mitigate and reverse the greenhouse gas emissions associated with their business. It is a comprehensive, voluntary framework to empower data center service buyers to request comparable and summarized information for informed decision-making while incentivizing service providers to offer higher performance aligned with customer demand. It communicates critical gaps to those outside of data center procurement to enable collaboration and faster progress across private, public, and other market sectors.

By understanding where their own decarbonization program stands, organizations will be able to guide clear and actionable next steps, such as sustainable purchasing, capital investments, and/or operational changes.

Use cases for the Maturity Model include but are not limited to:

- **Evaluation of Digital Footprint**
  Assessing the maturity of a company's digital and data center footprint, as comprised of owned/operated data centers, leased colocation data centers, and/or cloud provision via service providers, will enhance current Environmental, Social, and Governance (ESG) reporting efforts by data center companies.

- **Informed Procurement**
  Buyers of data center services have an inconsistent and incomparable view into the sustainability impacts and performance of options in the market. To date, available performance metrics are limited to Power Usage Effectiveness (PUE), Water Usage Effectiveness (WUE), and renewable energy procurement. Use of the Maturity Model will allow for more informed purchasing across more categories to drive sustainable facilities. It will inform companies on how to act with their values, choose further advanced options, and to allow for cost premiums to be valued for their achievement.

- **Highlight Achievements of Facility or Campus**
  Evaluating an individual data center or campus will better communicate and earn the trust of communities and other stakeholders.

- **Regional Limitations**
  Different regions are constrained by technical and regulatory factors for their electric grid and markets, as well as the availability of embodied carbon data. Progress can be expedited by illuminating what is possible, and where concerted and collaborative effort is needed to create the more sustainable reality needed for data center development.

- **Leadership and Clarity**
  This maturity model is focused on data centers. However, the framework could be referenced by other sectors and advance aspects of corporate ESG reporting through a consistent and clear format for communicating progress towards decarbonization. This is especially needed where the market is still less mature in measuring progress (for example, scope 2 emissions still utilizing a "100% on an annual basis, either location- or market-based" approach).

- **Supply Chain Visibility**
  The impacts from equipment and materials range beyond greenhouse gas emissions. There are known risks of commonly used critical minerals in IT equipment (use of artisanal miners for cobalt as perhaps the most well-known). Successfully addressing these ethical and social considerations will require increased visibility into the supply chain. While environmental disclosures do not specifically investigate social impacts throughout the supply chain, they do provide increased transparency around where and how a material is manufactured, which is an important first step.

Under Development

Additional, supplemental resources will be forthcoming, such as an evaluation tool for owners to map/compare their data center(s) to the iCA Maturity Model.

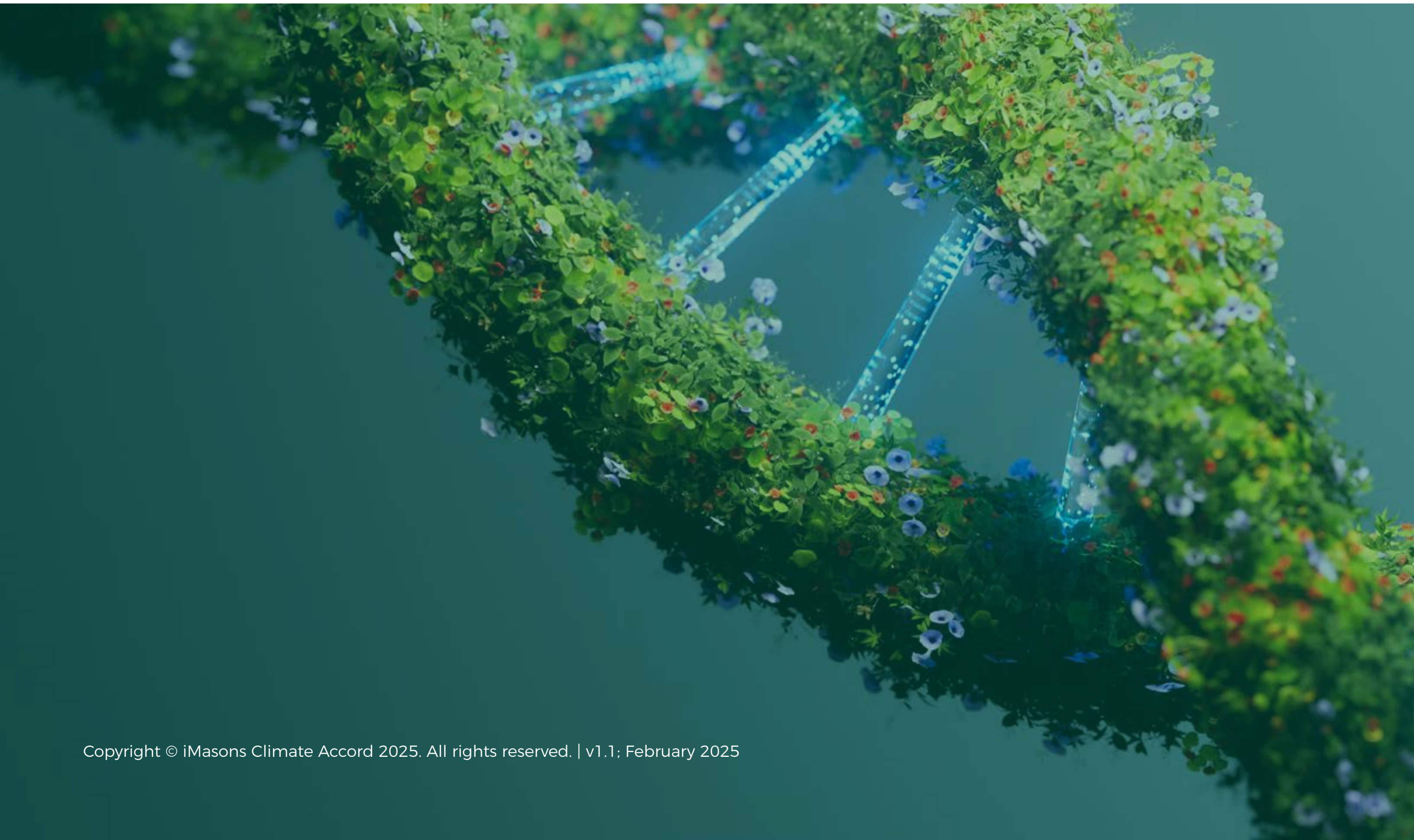
If an organization decides to voluntarily share their insights from utilizing the Maturity Model, the iCA may use this information in a variety of aggregated and anonymized ways, including trend summaries and graphics, to understand the industry's progress on our decarbonization journey.

Goal / Intent

The Maturity Model is the first cornerstone publication of the iCA, with the initial intent of linking our emissions reductions through our three primary focus categories of Materials, Equipment, and Power.

The iCA is committed to providing resources to our member organizations and the broader industry to support this publication and a continuous improvement cycle to ensure it adapts and drives as we mature along our collective journey. By engaging with this document, we aim to comprehensively understand our current state, breakdown the barriers toward progress, and support collaborative, effective solutions for carbon emissions reductions.

This document is for our members, by our members.



Maturity Model Graphic

The Maturity Model is composed of three sub-models to address different aspects of emissions: Power, Materials, and Equipment. In Figure 1, Level 0 maturity is the center of each circle, progressing outward with corresponding maturity levels and critical aspects for progress towards decarbonization.

Data quality for activity-based data looks at only where carbon analyses (e.g.., whole building life cycle analysis) have been performed and does not include spend-based measurement. Industry-wide environmental product declarations (EPDs) or proxy data does not contribute towards the supplier-specific data. In Figure 1 – Power, Equipment & Materials Maturity Model (Example Company), the color of the associated sections demonstrates the data quality and indicates:

- **Low Data Quality**
  1 – 49% of total global warming potential (GWP) measured in carbon analysis uses supplier-specific data (i.e., product-specific LCAs or EPDs). Proxy analysis using supplier-specific bill-of-materials (BOMs), such as CIBSE TM65, is permitted for MEP and IT equipment.
- **High Data Quality**
  50 – 100% of total global warming potential (GWP) measured in carbon analysis uses supplier-specific data (i.e., product-specific LCAs or EPDs). Proxy analysis using supplier-specific bill-of-materials (BOMs), such as CIBSE TM65, are not permitted for MEP and IT equipment.

NOTE: The industry baselines continue to develop and future versions of the Maturity Model will be updated in alignment. As such, the iCA is working in collaboration with industry partners to support increased accuracy of referenced data.

Key

- Low Data Quality
- High Data Quality

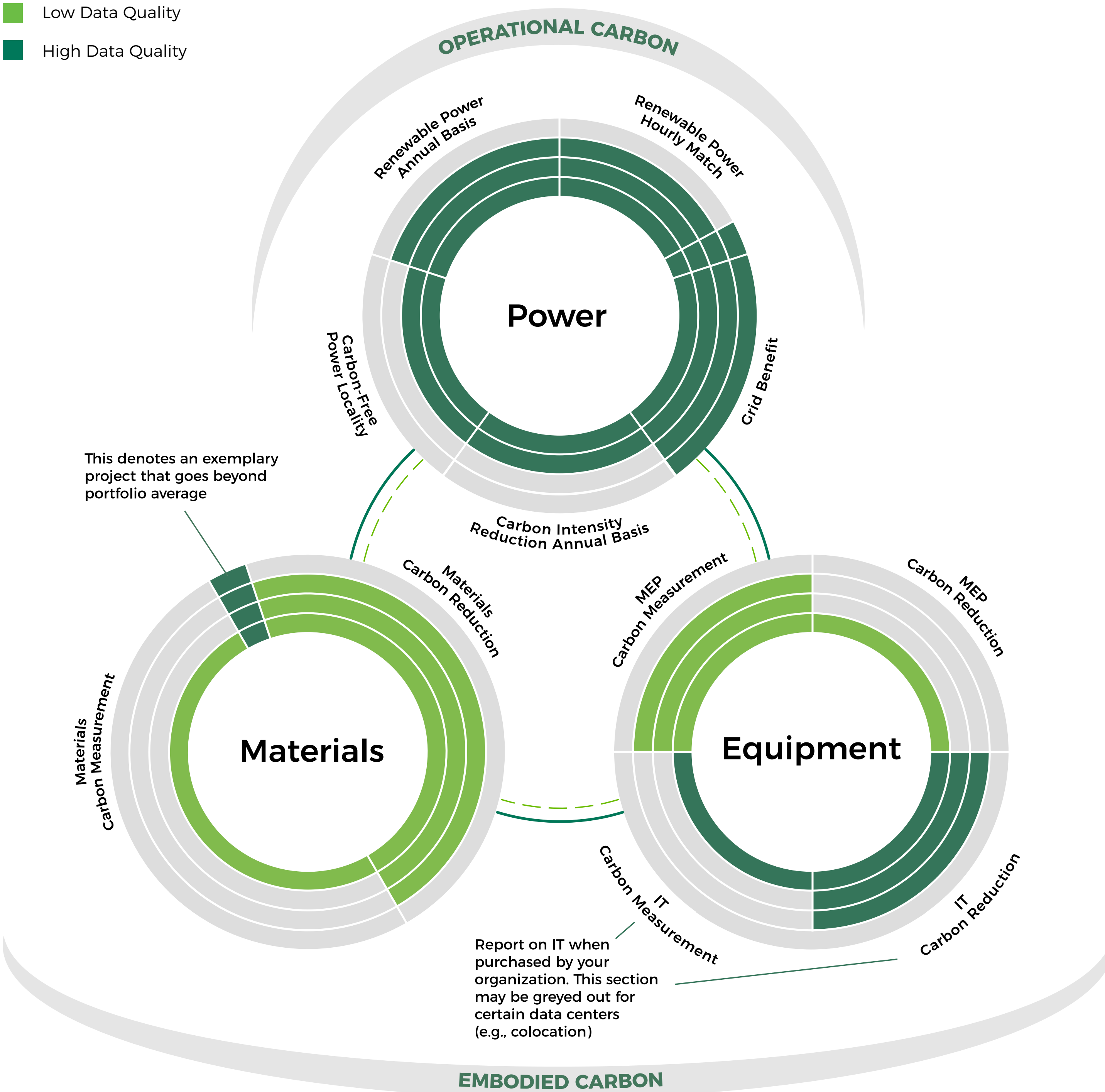


Figure 1 – Power, Equipment & Materials Maturity Model (Example Company)

Power Maturity Levels

In envisioning what a net zero future would entail, the Working Group considered both solutions available today and the pathway towards a net zero future. While much focus has been given historically to criteria such as renewable power supply, this criterion looks beyond use of renewable power and considers other important factors such as when and where power is supplied, and how it impacts the grid.

NOTE: Maturity levels are based on inclusion of any/all power purchased in the prior calendar year by the entity evaluating themselves against the model. For colocation data centers, power includes customer consumption, given the significant contribution of IT loads to a data center's overall power use.

Criteria	Definition	Maturity Level				
		0	1	2	3	4
Renewable Power – Annual Basis	Annual power usage covered by renewable energy market-based procurement on a kWh basis	Grid-source power	40-59% renewable supply	60-79% renewable supply	80-99% renewable supply	100% renewable supply
Renewable Power – Hourly Match	Annual power usage coinciding with location-based renewable energy supply on an hourly basis by kWh	Not considered	20-39% hourly match	40-59% hourly match	60-79% hourly match	≥80% hourly match
Carbon-Free Power Locality	Location of carbon-free energy supply relative to data center facility	Not considered	Same region	Same interconneted grid	Within 100 miles	Collocated
Carbon Intensity Reduction – Annual Basis	Carbon intensity of overall power usage compared to grid as measured on an annual basis (excluding offsets)	Not considered	40-59% lower carbon intensity than grid	60-79% lower carbon intensity than grid	80-99% lower carbon intensity than grid	Carbon-free operation
Grid Benefit Refer to Appendix B: Definitions for qualifying grid benefit measures	Proportion of overall energy use exported to grid, captured and reused waste heat, or curtailed as part of demand response	No grid benefit	1-2%	3-5%	6-9%	≥10%

Materials & Equipment Maturity Levels

To drive decarbonization of materials and equipment, two key criteria were identified: quality of measurement (i.e., scope and precision) and level of reductions. The Working Groups evaluated the various methodologies used in the market today to measure and reduce embodied carbon, both by their own organizations and by their peers. The associated maturity levels were determined based on an understanding of where the market is today and consideration for what a net zero future will require.

NOTE: Maturity levels are based on inclusion of any/all embodied carbon associated with the materials and equipment purchased in the prior calendar year by the entity evaluating themselves against the model. Given variations in the market's maturity for materials, mechanical, electrical, and plumbing (MEP) and IT equipment, these categories have been separated to establish reasonable levels and evaluate progress in each subcategory (defined as Product Category).

For Product Categories, see Appendix A – Definitions.

Criteria	Definition	Product Category	Maturity Level				
			0	1	2	3	4
Embodied Carbon Measurement	Scope & quality of portfolio embodied carbon measurement	Materials	Not measured	Spend-Based	20% Measured (not via spend)	80% Measured (not via spend)	100% Measured (not via spend)
		MEP Equipment	Not measured	Spend-Based	20% Measured (not via spend)	80% Measured (not via spend)	100% Measured (not via spend)
		IT Equipment	Not measured	Spend-Based	20% Measured	80% Measured	100% Measured
Embodied Carbon Reduction	Reduction of embodied carbon relative to industry baseline	Materials	Set public goals, establish reduction strategy	1-15%	16-30%	30-45%	≥45%
		MEP Equipment	Set public goals, establish reduction strategy	1-10%	11-20%	21-30%	≥30%
		IT Equipment	Set public goals, establish reduction strategy	1-10%	11-20%	21-30%	≥30%

Power

Power refers to the energy which enables the data center facility to operate. Existing power transmission networks are constrained, and new renewable energy sites near major grid connections are dwindling. It is unclear whether additional power and required transmission networks will be able to support expected demand growth, and whether renewable energy and decarbonization goals will be able to keep up. Communities where data centers are located have concerns related to power, water, and land uses, as well as noise and traffic.

The Power Maturity Model provides a roadmap for protecting our climate while powering data centers. Collaboration between developers, operators, utilities, regulators, and communities will help that success and provide opportunities to overcome the obstacles. The solution will require the transition to—and eventual operation of —a dynamic power grid including generation, transmission, storage, and active management.

Why a Power Maturity Model for Data Centers is Essential

- **Scale Demands Sophistication**
  Data centers require significant amounts of power, consuming as much power as tens of thousands of homes. Their immense scale and unique load profiles require a nuanced approach to energy procurement and management that goes beyond simple metrics.

- **Leading the Renewable Charge**
  The data center industry has set ambitious renewable energy goals. Yet current practices, like relying solely on annual renewable energy matching, are insufficient for a truly sustainable power grid. We need a roadmap that guides us towards a future where renewable energy matches demand every hour of every day and data centers are located where renewable energy resources are strong, to reduce the need for transmission upgrades.

- **Carbon-Free Future Now**
  Commitments to carbon neutrality are commendable, but the path to a carbon-free future needs to be accelerated. This model will guide the shift towards strategies like utilizing lower-carbon fuels and nuclear power, while prioritizing grid decarbonization efforts.

- **Clarity Cuts Confusion**
  Existing frameworks oversimplify the complexities of sustainable power. This has led to confusion and setbacks. This model aims to provide clarity by addressing nuances like hourly energy matching, the origin of renewable energy credits (RECs), and the need for more precise carbon intensity tracking.

- **Reimagining Backup Power**
  Diesel generators are a relic of the past. This model envisions a future where backup power systems are cleaner, carbon-free, and actively contribute to grid resilience by exporting energy and services.

- **Trust Through Transparency**
  Claims of 100% renewable energy often lack context and erode public trust. This model embraces the complexity of achieving truly sustainable power, rebuilding trust by providing a transparent roadmap towards a fully renewable or carbon-free future.

- **Blueprint for a Broader Impact**
  While urgently needed for the rapidly growing data center sector, this model serves as a blueprint for other industries as well. It aims to elevate the “E” in ESG reporting standards by offering a more comprehensive and actionable approach to scope 1 (backup power such as generators) and scope 2 emissions reduction.

Key Components

- **Renewable Power: Annual Basis**
  To reach net zero emissions, data centers need to be powered by 100% renewable energy. A great starting point is to procure a quantity of renewable energy on an annual basis that matches the total energy consumption on an annual basis. This is an important and valuable milestone, generally accepted as best practice currently in the market, and how greenhouse gas accounting for scope 2 is structured.

- **Renewable Power: Hourly Match**
  Eventually, renewable energy supply needs to be available to match demand within the same energy grid and for every hour of the year.

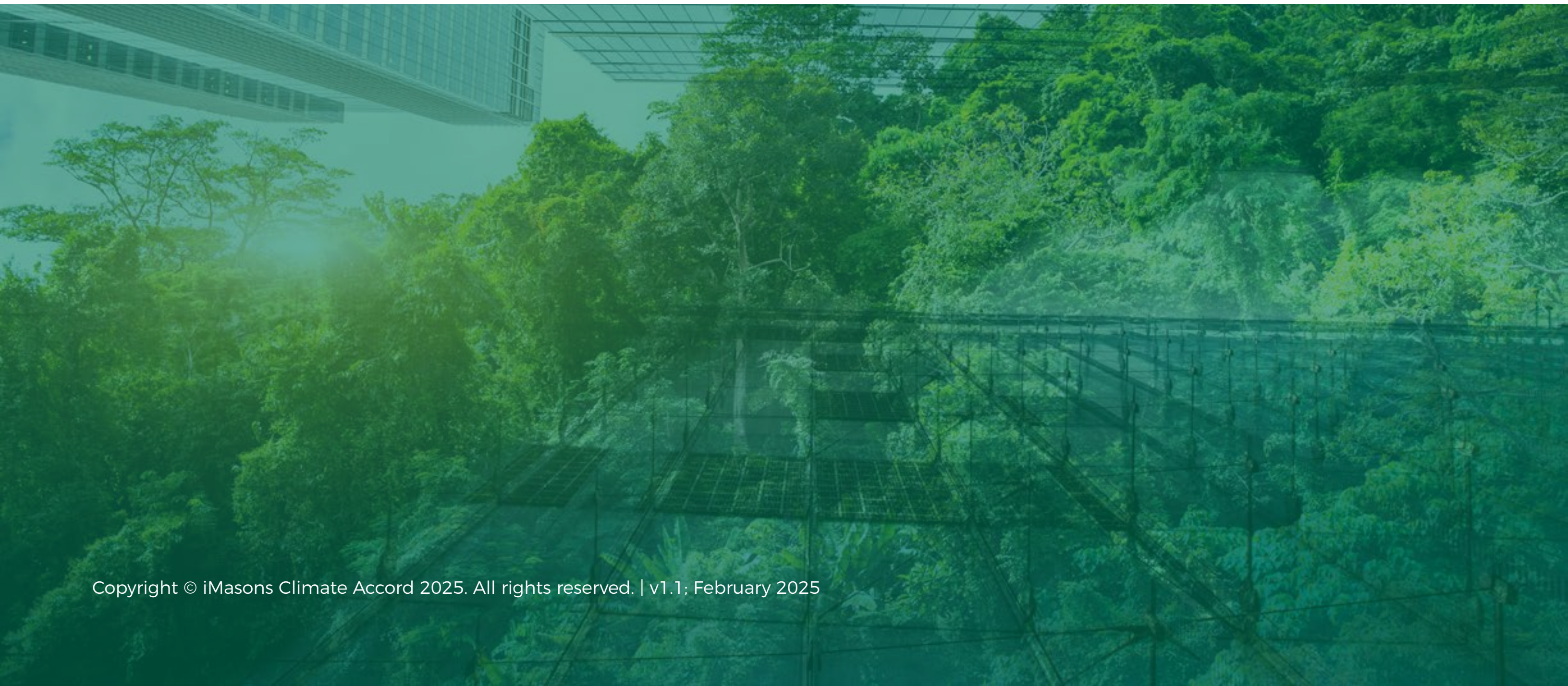
  - Given the scale of data center power use, there is great potential for data center loads to be managed differently to coincide with renewable power supply more closely. Planning and shifting loads across a large geographic portfolio of data centers to follow renewable energy availability, combined with utilizing energy storage to shift from a time where renewable energy supply exceeds demand to when demand exceeds supply, will improve grid reliability for both digital infrastructure and the public.

  - Data center loads are geographically distributed and uniquely movable to follow abundant supplies of renewable energy. Portability of data center work is not easy, but it is much less location-dependent than other energy loads.

  - Monitoring and control systems that allow supply and demand to be aligned and anticipated, and the use of artificial intelligence to generate digital twins that enable forecasts, again improve grid reliability.

- **Carbon-Free Power Locality**
  - While we strive for 100% sustainably powered data centers, there is also urgency to fast-track progress towards a carbon-free electrical grid. To accelerate the shift towards carbon-free energy, there are instances where low-carbon strategies will make sense, such as using generators that utilize natural gas and can transition to biofuels and green hydrogen, especially where natural gas is already lower-carbon than the grid supply. Where possible, we can hasten the pace of carbon reduction and provide flexibility for further reductions and carbon-free energy down the road.
  - Selective use of on-site nuclear energy for data centers, given the magnitude of their power use, can provide data center services where it is difficult to increase transmission and distribution upgrades, and allow upgrades to focus on connecting new renewable supply and interconnecting across regions to help match supply and demand during all hours.
  - Over the past decade, renewable energy penetration into the market was less than 20-40%, and any renewable energy development anywhere was helpful to offset traditional fossil fuel and carbon-intensive sources. As renewable energy penetration moves beyond 20-40%, it will need to be more closely and carefully managed to match the loads it is serving.
  - Since the challenge of new transmission is greater than the challenge of new fiber, one compelling solution is for data centers to be developed where renewable energy is most abundant and economic, and be paired with storage and on-site generation to maintain supply during low points of renewable production.
- **Carbon Intensity Reduction: Annual Basis**
  - Grid power in different utility service areas varies widely in carbon intensity (depending on the mix of fossil fuel sources) and renewable energy penetration. Measuring the overall carbon intensity of power that serves data centers is an important indicator of progress.
  - Separate from the renewable energy metrics, tracking carbon intensity rewards transition paths and supports flexible, multi-fuel options. This is especially true for locations where grid power is carbon intensive or unreliable, and where solutions using on-site natural gas provide meaningful progress towards an eventual 100% renewable grid. It also allows for selective use of nuclear power where politically viable, advantageous relative to transmission constraints, and where it complements and supports an increasingly renewable-powered grid.

- **Grid Benefit**
  - Data centers can participate in demand response by curtailing load by load-shifting temporally and geographically, storing excess energy they do not use, and then providing this energy to the grid and increasing the resilience of the local energy system. This will require new approaches and methods in managing and categorizing loads, such as tiered service level agreements (SLA). In this way, data centers can provide an important public service.
  - Ideally, renewable energy should be on the same grid and as close to data centers as possible to limit impacts on transmission and to better connect load with supply for large volumes.
  - Data centers uniquely produce large quantities of low-grade waste heat, ideal for injecting into existing heat loops, space heating for other buildings, industrial drying processes, and other applications requiring low-grade heat.
  - Traditionally, backup power via diesel generators provided the reliability required for mission-critical data center operation. These have been single-purpose and stranded resources for the sole purpose of providing supply during power outages. Shifting backup power away from a 100% on-call power outage resource and from carbon-intensive fossil fuels towards low-carbon alternatives (e.g., Hydrotreated Vegetable Oil (HVO) generators, biomass, green hydrogen, small modular nuclear reactors, etc.) could transform this to a shared asset for multiple benefits. Backup power should shift towards a lower-carbon and eventually carbon-free generation source and be reimagined as a resource for the grid for generation and other services, such as frequency regulation and power quality—in some cases even serving as primary power. This could improve economics and reliability while reducing carbon as compared to the current model of a stranded asset on site only providing backup power.



Materials & Equipment

The rapid expansion of data centers, fueled by increasing demand for digital services and emerging data storage regulations, necessitates significant procurement of both building materials and equipment. Materials refers to all permanently installed building materials used to construct the data center campus including the building's core, shell, and interiors, in addition to site infrastructure. Equipment refers to equipment used to operate the building, including mechanical, electrical, and plumbing equipment, IT (e.g., servers), and backup power sources.

Historically, construction of the built environment has relied on carbon-intensive materials such as concrete, steel, and copper. These contribute to a significant portion of an annual greenhouse gas emissions footprint and need to be addressed to achieve net zero emissions. To transition towards low-carbon alternatives, transparent and reliable data on the embodied carbon of available materials and equipment is needed.

The Materials Maturity Model and Equipment Maturity Model provide a roadmap for minimizing the Capital Goods and Purchased Goods and Services categories of scope 3 greenhouse gas emissions while constructing and refurbishing data centers. Scope 4 emissions, or "avoided emissions," is outside of this purview given there is not a widespread, standardized practice for reporting, and it is not currently recognized by industry frameworks like the Greenhouse Gas Protocol.

Procurement decisions made today, and their associated life cycle impacts, cannot be undone. To minimize the potentially negative impacts, swift progress is needed to equip purchasers with clear, comparable embodied carbon data and advanced low-carbon solutions.

Why Materials & Equipment Maturity Models for Data Centers are Essential

- **Time-Sensitive**
  Unlike operational emissions, which are ongoing over the life of a facility, the upfront embodied carbon of a data center has already been released throughout the supply chain of a product by the time it becomes available for purchase. Embodied carbon cannot be amortized over time, as with financial debts, given that the upfront supply chain impacts on our climate will have already occurred.

- **Consistent Market Signals**
  The life cycle of a product involves many stakeholders, from the raw material suppliers to contractors installing the material on site. A consistent understanding and rapid education of relevant stakeholders is required to reach our decarbonization goals.

- **Justification of Capital Costs**
  For a manufacturer to decarbonize their supply chain, changes to their sourcing and manufacturing may be required, which often necessitates significant capital investment. To incentivize manufacturers to invest this time and capital, a clear and consistent market signal is needed from purchasers.

- **Design and Procurement**
  Procurement is a critical window of opportunity for an owner to select optimized, low-carbon solutions. Even before specifying low-carbon products, designers and owners should first explore minimizing new materials through prioritizing existing building facilities, maximizing space utilization, and leveraging hyper-efficient design methods.

- **Accurate and Transparent Data**
  For owners to make low-carbon selections, manufacturers must measure and disclose the embodied carbon associated with the life cycle of the material or equipment through a public Environmental Product Declaration (EPD). While development timelines vary by product type, at best, the development of an EPD may take as little as 10 months from initiation to final publication; it will be longer if they need to establish the processes necessary to ensure accurate data collection and invest in internal support or external service providers. This limitation increases the urgency of requiring EPDs and further transparency to enable lower carbon procurement.

- **Varied Data Availability**
  While some industries have grown accustomed to developing EPDs (e.g., concrete), others for complex materials and equipment still require time and support in developing EPDs and LCAs (e.g., MEP equipment and servers, which are estimated to have a high carbon impact). Availability of EPDs currently varies by geographic region. Without data on the embodied carbon associated with products or equipment, it is challenging to make low-carbon procurement decisions.

- **Partial Measurement**
  Given limitations in data availability, owners have focused measurement efforts on a fraction of high-impact product types such as materials used in the building's structure and enclosure. Not measuring other high-impact product types, which are complex or difficult to measure, will delay carbon reductions.

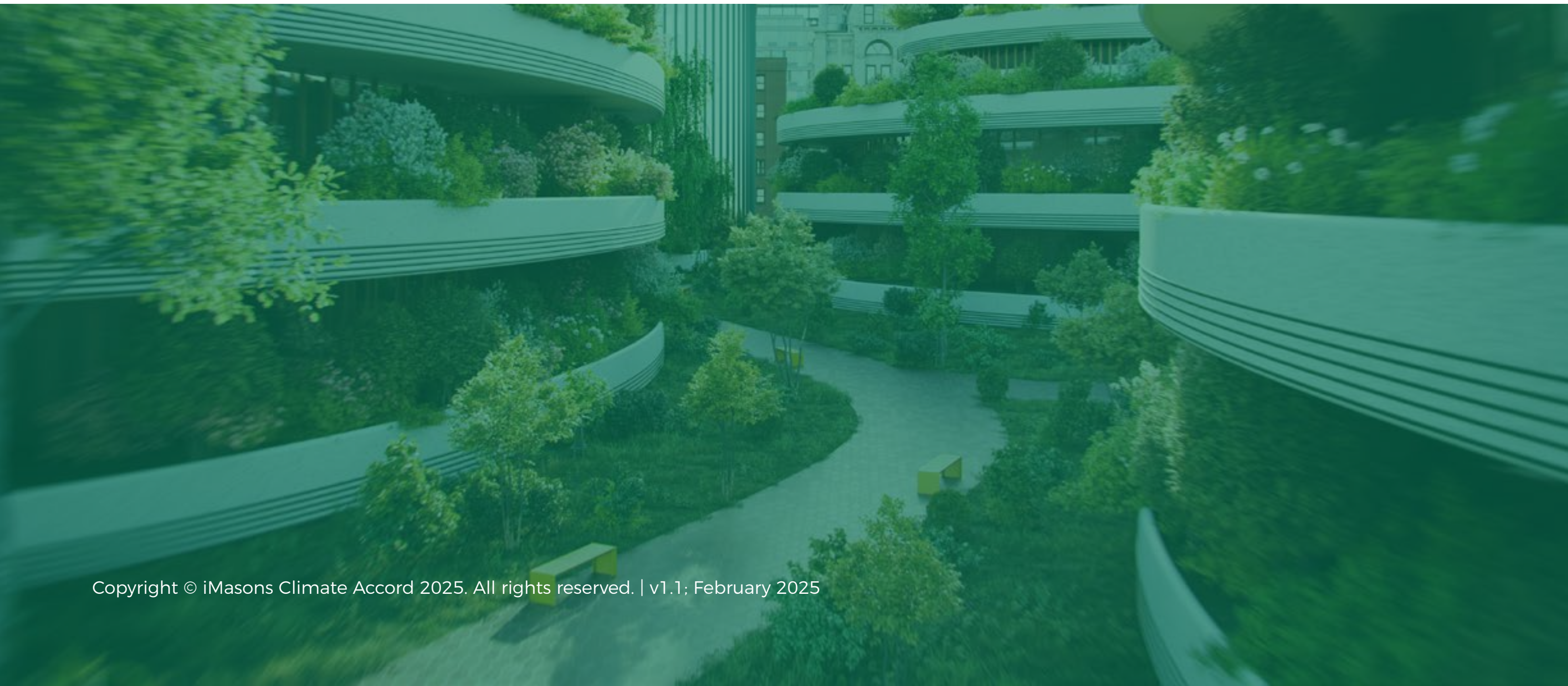
- **Methodology Estimations**
  Various alternative estimation methodologies fill data gaps, including spend-based accounting or Chartered Institution of Building Services Engineers (CIBSE) TM65. While these help owners estimate the magnitude of their overall impact, they do not help manufacturers decarbonize, as they are conducted through a less rigorous process and with less precision than EPDs. Further, when leveraging this information with inconsistent data quality, we risk making misinformed decisions. It is important that accuracy of data quality be understood and accounted for in decarbonization conversations.

Key Components

- **Embodied Carbon Measurement**
  A crucial first step is to understand a data center's embodied carbon footprint, identify hot spots in the design, and inform reduction strategies.
  - Currently, much of scope 3 emissions measurement utilizes spend-based accounting. While measurement of any kind is important, spend-based accounting is both imprecise and corners owners into only one method for demonstrating emissions reduction—spending less. Activity-based accounting, measuring the actual embodied carbon associated with the supply chain of materials and equipment purchased through methods such as whole building life cycle assessment (WBLCA), rewards actual carbon reduction measures.
  - Many building or site-level embodied carbon analyses conducted today focus only on a few high-impact materials where data is available, such as structure and enclosure materials. To achieve net zero carbon emissions, the industry must measure the embodied carbon associated with all products procured to support an individual data center or campus.
- **Data Quality**
  The methods to estimate the embodied carbon associated with the life cycle of a material or piece of equipment vary widely in precision. Measurement is a key first step and if the accuracy level is understood, even measurement with lower data quality provides informed decision-making. To evaluate and compare owners' decarbonization progress, the level of data quality must be understood.
  - Product-specific EPDs with external verification remain the leading standard for a manufacturer to measure and publicly disclose the embodied carbon, among other environmental indicators associated with the product or equipment. To empower data center owners to make informed, low-carbon choices, manufacturers are strongly encouraged to prioritize the development of EPDs for their materials and equipment. The availability of EPDs will be a key factor in procurement decisions, giving preference to those manufacturers who have invested in transparency and demonstrated their commitment to reducing embodied carbon.
  - Product category rules (PCRs) are critical documents that define certain assumptions or rules that should be followed in the development of an EPD for a particular product category. Where product category rules do not currently exist, the data center industry can support the production of new PCRs in conjunction with relevant industry associations to enable further EPD development.
  - When used to compare products, EPDs should be closely reviewed to consider the scope boundary of the analysis, factors that may impact results (e.g., PCR, assumptions, datasets used) and the complex nature of each product's use, installation, and effect on other systems and products. Beyond reported A1-A3 emissions, products of the same type may have different replacement rates, maintenance requirements, and end-of-life processing which affect the total cradle-to-grave emissions.

- While in certain industries many manufacturers have developed EPDs, others such as the MEP equipment industry have limited data. To quickly address data gaps, methodologies like CIBSE TM65 embodied carbon in building services help coarsely estimate the embodied carbon associated with equipment. While less precise than EPDs, estimation methodologies like TM65 enable measurement, and if the accuracy level is understood, measurement methodologies with lower data quality provide a starting point for decision-making. These estimation methodologies are recognized at lower levels of maturity where significant data gaps exist.

- **Carbon Reduction**
  - The industry currently lacks a clear, consistent baseline against which data center projects can measure embodied carbon reductions. While many data center owners conduct analyses to measure the embodied carbon associated with their data center projects or campuses, it is difficult to interpret that owner's progress relative to the rest of the market without an industry baseline. The iCA is seeking to support the publication of the first industry embodied carbon baseline for data center projects.
  - The industry needs to achieve drastic reductions in the embodied carbon associated with building materials and equipment. Reductions can be realized via various methods including design strategies, densification of data centers through increases in server efficiency, and procurement strategies such as:
    - Procurement strategies that focus on engagement with suppliers and play a crucial role in decarbonization. These strategies can include education and training, setting short- and long-term goals for suppliers' scope 1 and 2 emissions reductions, as well as roadmaps for decarbonizing product design.
    - Equipment design strategies aimed at dematerialization and increased use of circular materials that foster decarbonization by allowing for the same functional performance with less need for raw materials.



Appendix A. Definitions

Carbon-Free Energy
Inclusive of all forms of renewable energy and also nuclear energy. Does not include any use or consideration of carbon offsets (which would be carbon neutral, not carbon-free).

Clean Energy
Defined by the US DOE (United States Department of Energy), is inclusive of solar wind, water, geothermal, bioenergy, and nuclear.

Data Center
A building that houses IT infrastructure, including a network of computers which store and process data.

Demand Response
Schemes to adjust data center power demand according to the needs of the electricity grid. This includes agreements with the utility that extend beyond load shedding to other schemes such as load shifting (Ansett, 2022a).

Digital Infrastructure
A collection of data center locations that delivers electronic services to people and machines.

Embodied Carbon
Greenhouse gasses released into the atmosphere during a product's life, from extraction of raw materials and manufacturing (A1-A3), transportation to the site and installation (A4-A5), use and maintenance (B1-B2), Repair and Refurbishment (B3-B5), deconstruction and demolition, to end of life waste transport and processing and disposal (C2-C4), expressed in Global Warming Potential (kgCO2e per declared unit). Refer to the Maturity Model evaluation template for specifics around the phases of life intended to be measured and reduced.

Enclosure
The exterior plus semi-exterior portions of the building. Exterior consists of the elements of a building that separate conditioned spaces from the outside (e.g., the wall assembly). Semi-exterior consists of the elements of a building that separate conditioned space from unconditioned space or that encloses semi-heated space through which thermal energy may be transferred to or from the exterior or conditioned or unconditioned spaces (e.g., attic, crawl space, basement) (Glossary, n.d.-b).

Environmental Product Declaration (EPD)
A standardized report that summarizes a product's environmental impact (Glossary, n.d.-b).

Grid Benefit
Measures that benefit the electricity grid by providing energy to the grid to increase the resilience of the local energy system. Benefits must meet at least one other criteria outlined in the Power Maturity Levels such as Renewable Power, Carbon-Free Power Locality, and/or Carbon Intensity Reduction.

Hardscape
The inanimate elements of the building landscaping. It includes pavement, roadways, stonewalls, wood and synthetic decking, concrete paths and sidewalks, and concrete, brick, and tile patios.

IT Equipment
Equipment used to operate the data center equipment. This may include servers and racks.

Life Cycle Assessment (LCA)
Systematic way of analyzing and compiling the environmental impact of a product throughout its entire life cycle, expressed in impact categories including greenhouse gas emissions, also referred to as a product's embodied carbon.

Materials

All building materials used to construct the data center building, ancillary buildings, and site. This includes all structure, enclosure, and hardscape materials in accordance with the "Reduced Embodied Carbon" credit per LEEDv5.

MEP Equipment

All mechanical, electrical, and plumbing equipment used to operate the base building systems, inclusive of backup power solutions.

Net Zero

The iCA recognizes net zero carbon as cutting carbon emissions to a small amount of residual emissions that can be absorbed and durably stored by nature and other carbon dioxide removal measures, leaving zero in the atmosphere.

Power Usage Effectiveness

The ratio of total facility energy to IT equipment energy used in a data center, which is commonly used as a standard efficiency metric for power consumption in data centers.

Renewable Energy

Defined by the United Nations (UN) and US DOE (United States Department of Energy) to be inclusive of solar, wind, hydropower, biomass, and tidal. Excludes fossil fuels, nuclear, and hydrogen (except for green hydrogen produced by renewable sources).

Scope 1 Emissions

Direct emissions from sources owned or controlled by a company. This includes any fuel source burned on site such as gas-fired appliances or gas in company cars. For data centers, this includes emissions from backup power sources such as generators.

Scope 2 Emissions

Indirect emissions from purchased energy.

Scope 3 Emissions

Indirect emissions from an organization's upstream and downstream activities such as the embodied carbon of purchased construction materials, leased assets, and fossil fuels burned from employee travel.

Scope 4 Emissions

Avoided emissions because of using companies' products. Although a company may emit GHGs to produce a product (scopes 1 and 2), the product itself can help reduce emissions that otherwise would have occurred (Draucker, 2013b).

In our industry, Scope 4 impacts have been showcased and presented with empirical data on numerous occasions by our colleagues at Compass Datacenters (Compass Datacenters, 2023; Novak, 2023; Nelson, 2024).

Spend-Based Method

Estimates emissions for goods and services by collecting data on the economic value of goods and services purchased and multiplying it by relevant secondary (e.g., industry average) emission factors (e.g., average emissions per monetary value of goods) (World Resources Institute & World Business Council for Sustainable Development).

Structure

Elements carrying either vertical or horizontal loads (e.g., walls, roofs, and floors) that are considered structurally sound and nonhazardous (Glossary, n.d.-b).

Whole Building Life Cycle Assessment (WBLCA)

An LCA for an entire building which compiles environmental impact data from all the individual building components, including the embodied carbon impact of a whole building.

Appendix B. References

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Appendix C. Standards

CIBSE TM65, Embodied carbon in building services

CLC/TS 50600-5-1 on maturity model for the environmental sustainability of data centres

France’s National Methodological Standard for the environmental assessment of Datacenter IT hosting services and cloud services

ISO/IEC 21836:2020, Information technology, Data centres, Server energy effectiveness metric

ISO/IEC 23544:2021, Information Technology, Data centres, Application Platform Energy Effectiveness (APEE)

ISO/IEC 30134-7:2023, Information technology, Data centres, key performance indicators, Part 7: Cooling efficiency ratio (CER)