Data Center Maturity Model

Data Center Efficiency & Sustainability

Facility

Power

		Level 0 Minimal/No Progress	Level 1 Part Best Practice	Level 2 Best Practice	Level 3	Level 4	Level 5 Visionary - 5 Years Away
1.1	Critical Power Path Efficiency - Building Entrance to IT load	• Mid to low efficiency <90% based on your typical utilization	• 90% efficiency based on your typical utilization	• 92% efficiency based on your typical utilization	• 94% efficiency based on your typical utilization	• 95% efficiency based on your typical utilization	• 96% efficiency based on your typical utilization
1.2	Architecture	• Low efficiency power infrastructure and inefficient UPS use • Greater redundancy than required • Numerous isolation transformers	• Eco Mode UPS if applicable to business type • Fewer and higher efficiency transformers (NEMA TP1 or equivalent) • Verify the product's efficiency curve is highest for the load range used vs. highest overall	• Consolidate transformers (use fewer series isolation transformers, consider autotransformers) • Select power (and backup) technologies based on TCO, Materials & Sustainability	• Eco Mode UPS that works for all business types • Scalable power infrastructure • Use products with flat, high efficiency at all loads • Review and capture waste heat (for example, to augment generator block heaters)	• Move to higher IT load voltage, either AC or DC	
1.3	Operations	• Maintained inefficiently/unbalanced	• Monitor equipment and performance in real time • Document and participate in the recycling plans for batteries and other consumables	• Provision power quality based on the equipment type • Align rack power sizing with typical uses	• Placement of large power equipment outside of the conditioned space to reduce cooling load (e.g. Switchgear, Transformer, UPS) • Use monitoring software data and other tools to implement real time changes (phase balancing, load changes, etc)		• Power infrastructure automatically adapts while maintaining required availability and redundancy
1.4	Generation				• Alternative method of backup power for the data center based on TCO, environmental and sustainability considerations • Use of onsite or offsite (require proof of "additionality") low carbon power generation - 5%	• Use of onsite or offsite (require proof of "additionality") low carbon power generation - 15%	• Use of onsite or offsite (require proof of "additionality") low carbon power generation - 35% • Implementation of new, currently undiscovered or undefined energy storage techniques

Cooling

		Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
2.1	PUE - Cooling Contribution	• Annual average of 1	• Annual average of 0.5	• Annual average of 0.35	• Annual average of 0.2	• Annual average of 0.1	• Annual average of 0.05
2.2	RCI (hi) & RCI (lo) - if applicable	• Not measured	• One as low as 50%	• One as low as 75%	• 100% for both		
2.3	Mechanical/Refrigerant Cooling reduction	• Inefficient cooling infrastructure	• Variable speed fans, motors, pumps, compressors etc. • Optimize current infrastructure to take advantage of economization available based on local climate data (e.g. local BIN weather data & The Green Grid Economization Maps)	• No mechanical/refrigerant cooling (e.g. economization) for 50% of annual hours - 4,380 hours	• No mechanical/refrigerant cooling (e.g. economization) for 75% of annual hours - 6,570 hours	• No mechanical/refrigerant cooling (e.g. economization) for 90% of annual hours - 7,884 hours	• No mechanical/refrigerant cooling (e.g. economization) for 100% of annual hours - 8,760 hours
2.4	Environmental - set point range at inlet conditions to IT equipment	• Temperature and humidity unnecessarily controlled		• Humidity parameters widened to ASHRAE guideline • Increase temperature to higher limits of ASHRAE guideline taking into account server fan power energy change	• Increase temperature of coolant in step with the computer room change to maximize the hours of no mechanical/refrigerant cooling (e.g. economization) achieved • Increase temperature and humidity ranges to the higher end of equipment supplier specifications taking into account server fan power energy changes	• Increase temperature and humidity ranges in order to achieve Level 4 on the Mechanical/refrigerant cooling reduction	• Increase temperature and humidity ranges in order to achieve Level 5 on the Mechanical/refrigerant cooling reduction
2.5	Environmental - monitoring and control	• Temperature and humidity unnecessarily controlled	• Move temperature control point AWAY from CRAC return, begin controlling at CRAC supply	• Use rack level (average) reported temperature data to monitor and control the room cooling systems	• Use IT (server, storage, network) reported temperature data to monitor and control the room cooling systems		
2.6	Operations	• Overcooled areas • Mixing of hot and cold air • Leaking floor • Minimal maintenance and monitoring • Minimal control over air	• Align CRAC (Computer Room Air Conditioning)/CRAH (Computer Room Air Handling) output • Match cooling to heat emitted and need of servers - periodic manual review • Tile optimization • Line up equipment to have air movement from front to back • Hot/Cold aisle configuration • Remove gaps/holes in the floors and racks to reduce leakage between hot/cold aisles • Blanking panels to fill the gaps in the cabinets • Proactively remove redundant cabling • Intentional air flow segregation • Variable control of airflow (e.g. at the CRAC, floor tile) - manual	• Proactive air management studies (possibly including CFD modelling) to identify and execute on further optimization activities • Hot/Cold aisle physical segregation/containment • Separate Data Center temperature and air/water flow controls • Variable control of airflow (e.g. at the CRAC) - automated	• Matching cooling to heat emitted and need of servers - through automated controls • Full containment of supply or return air		• Dynamic changes to improve environment based on continuous monitoring

Other - Facility

		Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
3.1	Operational Resilience	• Unclear mapping of resilience	• Clear mapping and understanding of resilient M&E components	• Standardize approach to mapping resilience across the data centers and IT component - M&E, Data Cabling, Network, IT etc.	• Centralized view of resilience across all M&E and IT components including understanding of all upstream and downstream relationships		• Automated updates on resilience based on changes made in the data center (e.g. if a component was to fail, components being maintained etc.) including full understanding of all impacts upstream and downstream
3.2	Resilience vs. Need	• Business requirements 'unknown' - data center resilience not matched	• Business requirements 'known' - data center resilience not matched	• Matching data center resilience to SLA between Operations and Business Units		• Matching resilience to actual business need	• Matching resilience to the individual platform service
3.3	Lighting	• Inefficient lighting - 24 x 7	• Optimize Lighting • Move to lighter color cabinets to minimize lighting requirement	• Intelligent high efficiency lighting including sensor technology • Reduce dependency on electrical lighting systems by using natural lighting	• Reduce dependency on electrical lighting systems by 15% e.g. Natural lighting, Daylighting, Lightpipes, etc.	• Daylighting and/or lightpipes/tubes used to augment and reduce dependency on electrical lighting systems by 40%	• Maximize natural light, where lighting technologies are installed use components with a lower energy consumption, greater quality of light, longer lifespan and from recyclable components
3.4	Building/Shell		• Data center building/shell in accordance with local sustainability standard (e.g. LEED in the US, BREEAM in the UK or similar) - Bronze standard	• Data center building/shell in accordance with local sustainability standard (e.g. LEED in the US, BREEAM in the UK or similar) - Silver standard	• Data center building/shell in accordance with local sustainability standard (e.g. LEED in the US, BREEAM in the UK or similar) - Gold standard	• Data center building/shell in accordance with local sustainability standard (e.g. LEED in the US, BREEAM in the UK or similar) - Platinum standard	• Data center building/shell to exceed Platinum ratings by 15% in terms of reduce, reuse, recycling, land/environmental impact, and consumption of natural resources in the design and build process
3.5	M&E Waste	• M&E waste strategy not in place	• Reuse policy for components across the organization	• M&E waste vendor in place to deal with all equipment aligned to local/national mandatory regulations		• Supplier and supply chain evaluated for waste management and environmental protection practices	• Supplier and supply chain waste & environmental compliance programs included as part of procurement/sourcing decision process
3.6	Procurement	• Energy & sustainability aspects not considered as part of procurement	• Procure assets that comply with reducing hazardous substances and are recyclable	• Purchase only equipment required - rightsize equipment to need • Reduction in waste by minimizing packaging from supplier • Procure energy efficient equipment that comply with Energy Star or similar standards and metrics • Purchasing decision based on TCO modelling	• Components in the data center to be operable at higher temperatures in alignment with Other IT Level 3 - "All IT equipment for the data center available to be operated continuously and warrantied at air inlets temperatures between 15°C/59°F and 32°C/89.6°F and 20% - 80% Relative Humidity, non-condensing respectively."	• TCO modelling includes power consumption of the component at the expected/actual utilization levels • Smart technology components - energized on demand	• Components in the data center to be operable at higher temperatures in alignment with Other IT Level 5 - "All IT equipment for the data center available to be operated continuously and warrantied at air inlets temperatures between 5°C/41°F and 40°C/104°F (and under exceptional conditions up to +45°C/113°F) and 10% - 80% Relative Humidity, non-condensing respectively." • Cradle to cradle lifecycle view on all M&E equipment - looking at embedded carbon, ease of recycling of the product, etc. • Carbon intensity of different M&E options considered

Management

		Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
4.1	Monitoring	• Monitoring or Manual monitoring not in place	• Automated monitoring of key components in the data center	• Centralized and automated monitoring system inclusive of all mechanical, electrical and facility systems.	• Centralized and automated monitoring system inclusive of all mechanical, electrical, facility and key IT systems.	• "Holistic" monitoring capability across the data center - from source of power to chip performance	• "Holistic" monitoring capability across the data center - from source of power to business benefit of data center
4.2	PUE	• PUE not measured	• PUE Level 1 measured, plan and actions in place for improvements	• PUE Level 2 measured, plan and actions in place for improvements	• PUE Level 3 (including Source Energy implications) measured, plan and actions in place for improvements	• PUE Level 3 measured, plan and actions in place for improvements. Manual analysis/reporting of data to identify energy saving opportunities	• PUE Level 3 measured, plan and actions in place for improvements. Automated analysis/reporting of data to identify energy saving opportunities
4.3	Waste heat reuse (as measured by ERF/ERE)	• No reuse of heat, ERF = 0	• Plan for reuse of heat	• Reuse of heat, ERF not measured	• ERF = 0.1	• ERF = 0.25	• ERF = 0.5
4.4	CUE	• CUE not measured	• CUE measured, plan and actions in place for improvements	• CUE - Scope I and II calculated as part of carbon emissions	• Scope III emissions step 1 included as part of carbon emissions (business and employee travel)	• Scope III emissions step 2 included as part of carbon emissions (outsourced corporate support services, upstream - supply chain and downstream - customers use of product/service)	• Embedded carbon considered as part of calculated carbon emissions
4.5	WUE	• WUE not measured	• WUE measured, plan and actions in place for improvements	• WUE_{source} measured, plan and actions in place for improvements		• WUE_{source} to include water quality	• Embedded water considered as part of calculated usage
4.6	xUE/additional metrics	• xUE not measured	• Basic xUE measured	• Basic xUE measured, plan and actions in place for improvements	• Advanced xUE measured, plan and actions in place for improvements	• Advanced xUE measured, plan and actions in place for improvements. Manual analysis/reporting of data to identify energy saving opportunities	• Advanced xUE measured, plan and actions in place for improvements. Automated analysis/reporting of data to identify energy saving opportunities

IT

Compute

		Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
5.1	Utilization	• Utilization not measured	• Tracking average monthly and peak utilization across the data center	• Average monthly CPU utilization is greater than 20% in the data center	• Average monthly CPU utilization is greater than 35% in the data center	• Average monthly CPU utilization is greater than 50% in the data center • Clearly understand applications use of compute power	• Average monthly CPU utilization is greater than 60% across the data center • Manage spare compute capacity to maintain utilization target (e.g. selling spare capacity)
5.2	Workload Management	• Policy or strategy for management of workloads not in place • Rationalization initiatives not in place • Unclear as to number & location of servers	• CMDB adoption (understanding assets and associated applications) - enabling an understanding of workload • Rationalization of applications	• CMDB (assets, applications & dependencies) - enabling an understanding of workload - 95%+ accuracy across the data center • Rationalize applications according to TCO and business need • Rationalize workload (virtualization/consolidation)	• Minimize compute workload • Automated provisioning based on resource need • Ability to shift some of the workload in an automated manner within a data center to optimize demand taking into account business priorities, availability of resource and TCO	• Ability to shift all of the workload in an automated manner across to another single data center and some workload across different data centers to optimize demand taking into account business priorities, external drivers, availability of resource and TCO • Dynamic provisioning and commissioning of applications	• Ability to shift all of the workload in an automated manner across many other data centers to optimize demand taking into account business priorities, external drivers, availability of resource and TCO - "Follow the Moon" strategy • Future applications - reviewing TCO of different architectures, implementations and design
5.3	Operations	• Application installed on servers not visible	• Perform audits/infrastructure reviews to decommission unutilized servers	• Decommissioning servers based on compute characteristics (e.g. CPU utilization, Memory I/O) • Understand performance per watt metric of compute resources through the use of standard benchmarks (SPECpower or others related to the workload used)	• Optimize server configuration based on resource usage	• Clearly understand usage and demand for compute resource (based on business need and historical data)	• Improve application use of processor, memory and major power consuming components
5.4	Power Management	• Power management not enabled • Lack of Power Monitoring • Onboard sensors (Power, Temperature, Utilization) not utilized	• Basic power monitoring and measurement (estimate server power consumption through power distribution equipment) • Some servers have embedded power management enabled where there is no business impact	• Obtaining power information directly from the server - understand utilization on each server (Power, Temperature, Utilization) • All servers have embedded power management enabled where there is no business impact • Data Center and business level power management enabled for some servers (e.g. power capping for protection at rack level) where there is no business impact	• Understand power-performance metric based on actual usage • Data Center and business level power management enabled for all servers (e.g. power capping for protection at rack level) where there is no business impact • Power management enabled on servers driven by external policies (outside of the data center e.g. demand response) where there is no business impact	• Power management of all servers driven by external policies (outside of the data center e.g. demand response) where there is no business impact	• Power Management that has no impact on performance or application
5.5	Server population	• Policy for hardware refresh not in place	• Policy for hardware refresh based on years of service • Exception allowed for business or operational reasons	• Policy set based on TCO model including typical operating cost, capital cost, depreciation costs and value of new technology	• Technology refresh - analysis of TCO and ROI on a server model basis • Energy proportionality - power consumption scales directly with workload at typical usage patterns for major power consuming units	• Technology refresh - analysis of TCO and ROI on a server by server basis across the data center	• Technology refresh - real time analysis of TCO and ROI on a server by server basis across the data center • Energy proportionality - power consumption scales directly with workload • Smart components - energized on demand

Storage

		Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
6.1	Workload	• Duplicated and unnecessary data	• Deduplication (backup data)		• Deduplication (rest of data)		
6.2	Architecture	• Data held on high availability/high cost storage	• Classifying data/tiering	• Tiering according to business need	• Auto-tiering		
6.3	Operations	• Redundancy not matched to business need • Inefficient capacity management – requests & allocations	• Storage decommissioning/repurpose - aligned to other decommissioning initiatives (e.g. server, application) • Share resources between similar types of business units	• Storage consolidation • Assess estate against data management policy and business need • Power down hot spares • Demand Management - challenge business requests for storage	• Minimize data to business and application need • Implement user changes to reduce total data volume	• Operational media choice (solid state vs. tape vs. DVD vs. disk vs. MAID vs. Cloud, etc.) based on TCO model, energy usage, operational carbon footprint and business need	• Improve application use and creation of data • Operational media choice (solid state vs. tape vs. DVD vs. disk vs. MAID vs. Cloud, etc.) based on TCO model, energy usage, embedded carbon footprint and business need
6.4	Technology	• Inefficient storage hardware	• Utilize low power drive technology. Use small form factor drives	• Utilize low power consuming technology (e.g. solid state drive technology)		• Use variable speed mechanical components such as drives and fans - many spin at a constant speed	• Use/enablement of low power states for storage
6.5	Provisioning	• Shared storage not utilized (dedicated systems)	• Shared storage (hardware - SAN, iSCSI, etc.) without robust capacity control	• Thin provisioning		• Dynamic capacity provisioning	• Ability to shift storage - abstract from hardware and linked to application - "Follow the Moon" strategy

Network

		Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
7.1	Utilization	• Utilization not measured	• Understand network infrastructure and port utilization • Manual port switching capability - e.g. turn off unused ports	• Average monthly utilization (bandwidth usage divided by bandwidth capacity) is greater than 40% in the data center • V-LAN implementation	• Average monthly utilization (bandwidth usage divided by bandwidth capacity) is greater than 65% in the data center • Virtualized Network Infrastructure - routing, forwarding, load balancers and firewalls	• Average monthly utilization (bandwidth usage divided by bandwidth capacity) is greater than 75% in the data center	• Average monthly utilization (bandwidth usage divided by bandwidth capacity) is greater than 90% in the data center • Manage spare network capacity to maintain utilization target (e.g. selling spare capacity)
7.2	Workload	• Data volume not measured	• Identify data volumes	• Identify data flows • Optimize data volumes to reduce bandwidth requirements - e.g. data compression technologies	• Minimize data movement	• Prioritize data volumes and flows • Compute optimizes data flows (calls) to minimize movement, network consumption and energy consumption • Improve application use of network resource bandwidth	• Ability to adapt network configuration/IP details - abstract from hardware and linked to application - "Follow the Moon" strategy
7.3	Operations	• Dedicated network links • Disparate complex networks	• Consolidate and simplify multiple networks	• Application and hardware decommissioning – identify hardware that has no or minimal input/output as strong candidates for decommissioning		• Centralized simplified network built at resilience needed by business	
7.4	Technology	• Inefficient components • All network infrastructure and ports enabled and powered		• Automated port switching capability - turning off unused ports	• Energy proportionality of major power consuming components (Processor, Fans, PSU)	• Energy proportionality of all components	• Energy proportionality - based on application requirements • Smart components - energized on demand
7.5	Base performance	• Performance not measured	• Understand bits per watt for network equipment		• Measure actual bits per watt for all future designs and majority of actual deployments		
7.6	Provisioning	• Capacity Management not in place	• Inefficient capacity management (peak, average, total capacity) - overprovisioned bandwidth	• Tracking and managing to utilization targets	• Provision capacity on usage not reserved capacity (understand peak and average utilization)	• Dynamic provisioning of bandwidth based on actual usage	• Automated provisioning

Other IT

		Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
8.1	Overall		• Systems designed for optimal cooling with front to rear air flow to provide hot and cold aisle separation	• Manual alignment of M&E infrastructure to IT demand • IT and Facilities collaboration on unified energy efficiency goals	• IT systems to communicate with data center M&E infrastructure in term of required need in order to optimize data center energy and cooling efficiency	• IT systems and data center M&E infrastructure to communicate (bi directionally) to operate using minimal energy at an overall level	• Automated relational changes to infrastructure based on application demand
8.2	Utilization	• Utilization unknown	• Gathering information on server, storage, network, M&E utilization for key data centers - e.g. using TGG Indicators	• Automated information on server, storage, network, M&E utilization for key data centers - e.g. using TGG Indicators and proactively reviewing data to identify opportunities for improvement		• Gathering information on server, storage, network, M&E utilization for all data centers - e.g. using TGG Indicators	• Automated information on server, storage, network, M&E utilization for all data centers - e.g. using TGG Indicators and proactively reviewing data to identify opportunities for improvement
8.3	IT sizing	• IT resource sized based on requested resource	• IT resource sized based on validated requests	• IT resource sized based on actual usage		• IT resource optimized to ensure minimal resource consumed	
8.4	Internal Power Supply Efficiency	• 30% of IT PSUs - certified by Climate Savers Computing Initiative (CSCI) - Bronze or above	• 45% of IT PSUs - certified by Climate Savers Computing Initiative (CSCI) - Bronze or above	• 90% of IT PSUs - certified by Climate Savers Computing Initiative (CSCI) - Bronze or above	• 100% of PSUs certified by Climate Savers Computing Initiative (CSCI) - 50% above Gold standard	• 100% of PSUs certified by Climate Savers Computing Initiative (CSCI) - 85% above Gold standard • IT power supplies implement an eco or rapid wake up mode	• 100% of PSUs certified by Climate Savers Computing Initiative (CSCI) - greater than 80% at Platinum
8.5	Service Catalogue/SLA's	• Centralized service catalogue not in place	• Centralized service catalogue	• Service catalogue strategy based on effectiveness and TCO per business need: 1. Internal service / External service 2. Infrastructure as a service, Platform as a service, Software as a service, Cloud services		• Service catalogue strategy based on effectiveness, TCO, energy efficiency, and sustainability per business need	
8.6	Incentivizing change for efficient behaviour (e.g. chargeback and or cost awareness)	• Incentive for efficient behaviour not in place	• Incentive for efficient behaviour at an organizational level	• Incentive for efficient behaviour at a service level	• Incentive for efficient behaviour based on usage	• Incentive for efficient behaviour based on usage and energy consumed	• Incentive for efficient behaviour based on usage at a user level
8.7	E-Waste	• E-Waste Strategy not in place	• Reuse policy for assets across the organization	• E-Waste vendor in place to deal with all data center equipment aligned to local/national mandatory regulations	• E-Waste strategy in place to promote reselling, recycling, donating and disposal of IT assets based on cost, legislation, ethical and sustainable implications across all data centers	• Supplier and supply chain evaluated for waste management and environmental protection practices	• Supplier and supply chain waste & environmental compliance programs included as part of procurement/sourcing decision process
8.8	Procurement	• Energy & sustainability aspects not considered as part of procurement	• Procure assets that comply with reducing hazardous substances and recycling such as RoHS/WEEE or equivalent local standard	• Procure energy efficient equipment that comply with Energy Star or similar standards and metrics • Reduction in waste by minimizing packaging from supplier • Purchase only equipment required - rightsize equipment to need	• All IT equipment for the data center available to be operated continuously and warrantied at air inlets temperatures between 15°C/59°F and 32°C/89.6°F and 20% - 80% Relative Humidity, non-condensing respectively.	• Purchasing decision based on TCO modelling including power consumption of the devices at the expected/actual utilization levels • Smart technology components - energized on demand	• Cradle to cradle lifecycle view on all IT equipment - looking at embedded carbon, ease of recycling of the product (e.g. RoHS/WEEE), etc. • Carbon intensity of different IT options • All IT equipment for the data center available to be operated continuously and warrantied at air inlets temperatures between 5°C/41°F and 40°C/104°F (and under exceptional conditions up to +45°C/113°F) and 10% - 80% Relative Humidity, non-condensing respectively.

Investment (Financial, Time & Resource)