Office of the
Government Chief Information Officer

GREEN DATA CENTRE PRACTICES

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1. INTRODUCTION

The Government of the HKSAR is well aware of the benefit of green ICT to reduce the energy consumption and carbon footprint of Government data centres. Since 2010, the Office of the Government Chief Information Officer has prepared the Green Data Centre Practices ("the Practices") as a quick reference for Bureaux and Departments (B/Ds) in achieving a green data centre environment.

The Practices summarise a set of recommended practices applicable to B/Ds for achieving energy efficiency and minimising environmental impacts in data centre operations by making reference to relevant guidelines and code of practices listed in the **Appendix**. Readers are recommended to read the full article in these documents for detailed recommendations.

The Practices are categorised under the four lifecycle stages of data centre management: design, procurement, operations and disposal.

The purpose of the Practices is for reference by B/Ds of the Government of the HKSAR only. The Practices should not be regarded as exhaustive or applicable to all circumstances in Hong Kong. Consultation should be sought from qualified professionals when necessary.

2. GREEN DESIGN

2.1 FOR IT SYSTEMS:

2.1.1 Deployment of new or replaced IT systems

(a) Server virtualisation should be considered for deployment of new or replaced IT systems. Virtualisation technology enables multiple systems to run in a single physical server. It helps reduce the number of physical servers and in turn reduce the power required for server operations as well as for cooling of the physical accommodation space that may otherwise be required.

(b) Energy and temperature reporting hardware should be considered whenever possible so as to assist in the implementation of temperature and energy monitoring across data centres.

2.1.2 Data management

(a) A framework for data life cycle management should be developed, defining which data should be kept, for how long and at what level of security protection. Data life cycle management helps manage the flow of system data throughout its life cycle – from creation and initial storage to the time when it becomes obsolete and is deleted. A clear framework can help ensure the minimal set of information is kept to support business needs and avoid wastage of storage resources at the same time.

(b) Redundant files or data should be reduced or eliminated to save data storage. Technologies such as de-duplication, compression, snapshots, and thin provisioning can be used to improve storage efficiency.

2.2 FOR DATA CENTRE FACILITIES:

2.2.1 Air-flow management

(a) A design of hot and cold aisles should be adopted. Hot aisle layout means the equipment racks installed back-to-back whereas cold aisle layout means the equipment racks installed front-to-front. Such a design avoids mixing of hot air and cold air, and thus optimises airflow in data centres.

(b) A design of containing hot or cold air should be adopted. This design is to separate hot and cold air by installing physical partitions (e.g. vinyl plastic sheeting) for better uniformity of air temperature from the top to the bottom of equipment racks.

(c) A structured cabling system (means a standardised wiring infrastructure or system such as using a centralised patch panel or cable tray for cable laying etc.) for improving air-flow should be used. A structured cabling system provides more room within racks to improve air-flow.

(d) Groups of equipment with substantially different environmental requirements should be deployed in a separate zone. Separate environmental controls for each zone should be adopted for optimising cooling efficiency.

(e) Equipment should be selected with heat dissipation matching the airflow design for the rack to be installed.

2.2.2 Cooling management

(a) A design separating the chilled water system of human comfort cooling with that of data centres should be adopted. This separation could ensure the efficiency of the data centre cooling system.

(b) Humidity control should be centralised at the fresh make-up air coming into the building and to avoid the control at the computer room air conditioners/air handlers (CRAC/CRAH) units on the re-circulation air within the data centre. This will reduce both capital and on-going maintenance expense of CRAC/CRAH units.

2.2.3 Measurement of power consumption

(a) Power meters of measuring total energy in kWh* of data centres including all power conditioning, distribution and cooling systems should be installed. The total energy, including all power system, power distribution and cooling system, is measured at the utility meter of the data centre. This measurement should not include any non-data centre building loads.

(b) Power meters of measuring total IT equipment energy in kWh, including uninterruptible power supply (UPS) and non-UPS outputs for IT equipment should be installed. The total equipment energy includes all IT equipment, such as server, storage, networking equipment and peripheral equipment (for example, KVM switches, monitors and workstations).

* **kWh**, Kilowatt hour, is a unit of energy.

3. GREEN PROCUREMENT

3.1 FOR IT SYSTEMS:

3.1.1 Procurement of IT equipment

(a) Procurement of IT equipment should follow the green procurement requirements stipulated in Environment Bureau Circular Memorandum No. 6/2015.

(b) Energy efficiency performance requirements (e.g. Energy Star, Grading Type Energy Label under the Energy Efficiency Labelling Scheme of Electrical and Mechanical Services Department) and environmental friendly requirements (e.g. restrictions of hazardous substance (RoHS)) should be included in procurement of IT equipment as far as possible.

(c) The full ranges of 10^{o}C to 35^{o}C intake temperature and relative humidity of 20% to 80% (ASHRAE Class A2) should be considered in procurement of IT equipment for saving cooling energy. ASHRAE Class A2 is a fairly typical environmental specification of most current available IT equipment since 2011.

(d) Power management features should be included in the procurement specification of IT equipment, if applicable. Power management features would facilitate optimal use of energy according to the workload of IT equipment. A typical example is the low-power "sleep" mode of IT equipment, which will be activated after a period of inactivity. Some servers may be shut down automatically when there is no workload running on the hardware.

3.2 FOR DATA CENTRE FACILITIES:

3.2.1 Procurement of chillers

(a) A minimum Coefficient Of Performance (COP) complying with Code of Practice for Energy Efficiency of Building Services Installation should be specified when procuring chillers. COP means the ratio of the rate of heat removal to the rate of energy input, in consistent units, for an air-conditioning equipment. The higher COP, the higher efficiency of an air-conditioning installation is.

3.2.2 Procurement of computer room air conditioners/air handlers (CRAC/CRAH)

(a) A minimum Coefficient Of Performance (COP) complying with Code of Practice for Energy Efficiency of Building Services Installation should be specified in procuring CRAC/CRAH.

(b) Variable speed fans should be deployed. Variable speed fans optimise power consumption as they adjust air speed and air flow according to the surrounding temperature.

3.2.3 Procurement of uninterruptible power supply (UPS)

(a) High efficiency UPS systems complying with Code of Conduct on Energy Efficiency and Quality of AC Uninterruptible Power Systems should be deployed.

(b) Line-interactive instead of double-conversion UPS should be deployed for IT equipment that does not require a higher power quality requirement. The higher power quality requirement induces lower UPS efficiency.

3.2.4 Procurement of emergency generator

(a) Sufficient power sizing of generator-set should be conducted to cater for the power requirements of the installed systems, the expected inrush currents during operations and harmonics returning from the connected installation.

3.2.5 Procurement of data centre lighting

(a) Energy efficient lighting systems should be used.

4. GREEN OPERATIONS

4.1 METRICS

(a) Carbon footprints of data centres based on energy consumption should be measured / estimated.

Carbon footprint = Electricity(kWh) × 0.7 (kg/kWh)[‡] *÷ 1000 (kg/ tonne)*

(b) Power usage effectiveness (PUE) of data centres should be measured / estimated. PUE measures the energy-efficiency of a data centre by comparing the total energy consumed (in kWh) by a data centre to the amount of energy (in kWh) that is effectively consumed by IT equipment, showing how effectively the energy is gainfully deployed for operating the IT equipment and the extent that is required for operating the supporting facilities such as cooling systems.

(c) Servers' processor utilisations should be measured to identify underutilised servers for consideration of consolidation or virtualisation.

(d) Storage utilisation should be reported for consideration of consolidation, such as de-duplication, or virtualisation.

(e) Network utilisation should be measured to identify inefficient data transmission.

4.2 ENERGY USE AND ENVIRONMENTAL REPORTING

(a) Energy consumption and environmental ranges should be reported periodically, preferably by an automated system.

(b) The water usage of data centres, such as evaporation of water in cooling tower, humidification by CRAC/CRAH, and chilled water, should be measured and reported regularly.

(c) The inlet temperature of IT equipment should be measured and reported periodically. The inlet temperature is the temperature measured at the point of entering IT equipment for cooling. Measuring the inlet temperature could improve visibility and understand how well the cooling system is working.

[‡] **0.7 (kg/kWh)** is a territory-wide default value adopted in *Guidelines to Account for and Report on Greenhouse Gas Emissions and Removals for Buildings in Hong Kong*, EMSD and EPD, HKSARG

(d) The outlet temperature of IT equipment should be monitored. Monitoring both inlet and outlet temperature could assist in improving airflow to prevent over-cooling and under-cooling of IT equipment.

(e) The power costs of significant IT systems and overhead systems should be reported regularly.

4.3 SERVICE MANAGEMENT

(a) The relationship of existing physical assets and their delivered services should be assessed. Installed equipment should be regularly examined to ensure that it is required and delivering active services. The implementation of an Information Technology Infrastructure Library (ITIL) type Configuration Management Database and Service Catalogue should be considered.

(b) The allowable intake temperature and humidity ranges for IT equipment should be identified and recorded.

4.4 FOR IT SYSTEMS:

4.4.1 Management of existing IT equipment and systems

(a) Unused IT systems should be decommissioned and removed within a reasonable period.

(b) IT equipment that is idle for a prolonged period should be virtualised, shut down or put into low power state.

(c) Power management features on IT equipment should be enabled, if such features are available.

(d) Unmanned monitors in data centre should be switched off.

4.5 FOR DATA CENTRE FACILITIES:

4.5.1 Airflow management

For existing data centres:

(a) The airflow direction of IT equipment should match the airflow design for that area, commonly front to rear or front to top. Otherwise, a correction mechanism such as ducts, or special racks that divert the airflow to the defined direction, should be used.

(b) Placement and opening factors of vented tiles should be reviewed regularly to avoid unwanted apertures in the raised floor.

(c) Any clutter under the data centre floor, including cabling that might impede airflow, should be cleaned up whenever possible.

(d) Cables in equipment racks should not impede airflow.

(e) Thermal imaging camera is useful in capturing small temperature gradients. This information should be used for identifying hot spots as the basis for improving cooling efficiency and removing causes of faults.

For equipment racks:

(f) Gaps where there is no equipment should be covered (e.g. by installing blanking plates) to reduce cold air passing through gaps in the racks and hot air being ingested by other equipment.

(g) Cable cut-out tiles should be covered (e.g. by installing aperture brushes) to avoid any anticipated air leakage opportunities.

(h) If doors are necessary, perforated rack doors should be used whenever possible. Perforated rack doors allow efficient in-take of cold air and dissipation of hot air when the racks are arranged in hot and cold aisles.

4.5.2 Cooling management

(a) Unnecessary cooling equipment should be shut down to save energy.

(b) Cooling air should be moved closer to the IT load to reduce cooling demands whenever possible.

(c) Cooling load should be reviewed before any change/replacement of IT equipment (e.g. review placement and flow of vented tiles before change/replacement of each IT equipment).

(d) The thermal load of IT equipment and the deployment of cooling equipment should be reviewed periodically.

4.5.3 Temperature and humidity settings

(a) Reduction of cooling requirement in data centre should be explored by increasing the target intake temperature of IT equipment within the temperature range of 10ºC to 35ºC (ASHRAE Class A2). Note that some IT equipment may consume more energy in fan power as intake temperature increases. Validate that the IT equipment will not consume more energy than that is saved in the cooling system.

(b) Humidity range should be reviewed to widen the relative humidity set point of the cooling system within the range of 20% to 80% (ASHRAE Class A2) to decrease the humidification and dehumidification loads within the facility.

(c) The cooling system set-points should be dictated by IT equipment only. Other non IT equipment requires a more restrictive temperature or humidity range should be avoided.

(d) Chilled water temperature setting should be reviewed to reduce the compressor energy consumption.

(e) Cooling system operating temperatures should be reviewed to improve efficiency (e.g. evaluate the opportunity to decrease condensing temperature[§] or increase evaporating temperature[**] in order to reduce delta temperature between these temperatures so that less work is required in cooling cycle, hence improved efficiency).

[§] **Condensing temperature** is the set point in chiller controlling the target condensing pressure in heat rejecting process. Heat rejection is the excess heat from a cooling system which is removed by the condenser/cooling tower.

[**] **Evaporating temperature** is the set point in chiller controlling the target evaporating pressure in heat absorption process. The evaporating refrigerant absorbs energy from fluid to reduce its temperature and the fluid is then used for cooling.

(f) Part load operation, which is in use for most of the operational time, should be optimised to improve efficiency instead of maximum load (e.g. sequence chillers, operate cooling towers with a shared load for increased heat exchange area).

4.5.4 UPS management

(a) Three phase power circuits should be balanced to minimise power loss. Ensuring that three phase power circuits are balanced should be a routine maintenance task. This requires planning (e.g. before any change of IT equipment) and monitoring.

4.5.5 Management of data centre lighting

(a) Lights should be switched off whenever areas are unoccupied, preferably automatically.

5. GREEN DISPOSAL

5.1 DISPOSAL OF OBSOLETE IT EQUIPMENT AND DATA CENTRE FACILITIES

(a) Equipment should be refurbished or dismantled for reuse as far as practicable, while disposal of obsolete equipment should comply with relevant environmental legislations/regulation such as Waste Disposal Ordinance.

APPENDIX – REFERENCES

1. ***Australian Government Data Centre Strategy 2010-2025 Better Practice Guide: Data Centre Cooling,*** Department of Finance, Australian Government (2014)

2. ***Australian Government Data Centre Strategy 2010-2025 Better Practice Guide: Data Centre Power,*** Department of Finance, Australian Government (2014)

3. ***Code of Practice for Energy Efficiency of Building Services Installation 2015,*** Electrical & Mechanical Services Department, The Government of HKSAR (2015)

4. ***Code of Conduct on Energy Efficiency and Quality of AC Uninterruptible Power Systems,*** Joint Research Centre , European Commission, (2011)

5. ***Environment Bureau Circular Memorandum No. 6/2015,*** Environment Bureau, The Government of HKSAR (2015)

6. ***EU code of conduct on data centres - 2015 best practices,*** European Commission, (2015)

7. ***Guidelines To Account For And Report On Greenhouse Gas Emissions And Removals For Buildings In Hong Kong,*** Electrical & Mechanical Services Department and Environmental Protection Department, The Government of HKSAR (2010)

8. ***Information Technology Infrastructure Library Version 3 (ITILv3),*** AXELOS (2011)

9. ***L.1300 Best practices for green data centres,*** Telecommunication Standardization Section, International Telecommunication Union (2014)

10. ***PUE^{TM}: A Comprehensive Examination of the Metric,*** Green Grid (2012)

11. ***Technical Guidelines on Code of Practice for Energy Efficiency of Building Services Installation 2015,*** Electrical & Mechanical Services Department, The Government of HKSAR (2015)

12. ***Thermal Guidelines for Data Processing Environments, Third Edition,*** American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) (2012)