SUSTAINABLE ENERGY AUTHORITY OF IRELAND

GUIDE TO ICT – SERVER ROOM ENERGY EFFICIENCY

Public Sector ICT Special Working Group

SERVER ROOM ENERGY EFFICIENCY

This guide is one of a suite of documents that aims to provide guidance on ICT energy efficiency. The guide provides information and techniques to improve the energy efficiency of communication/ server rooms. Use this guidance to:

- **reduce the electrical power consumption of the server room by 30% to 50%**
- **increase the life span of the IT equipment**
- **reduce the fault rates which result from over temperature.**

CONTENTS

Abbreviations

ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
C/H	Cold/Hot side of rack
CFD	Computational Fluid Dynamics
CRAC	Computer Room Air-Conditioning
ICT	Information and communication technology
PDU	Power Distribution Unit
PUE	Power Usage Effectiveness
SEAI	Sustainable Energy Authority of Ireland
UPS	Uninterruptible Power Supply/ies
VSD	Variable Speed Control

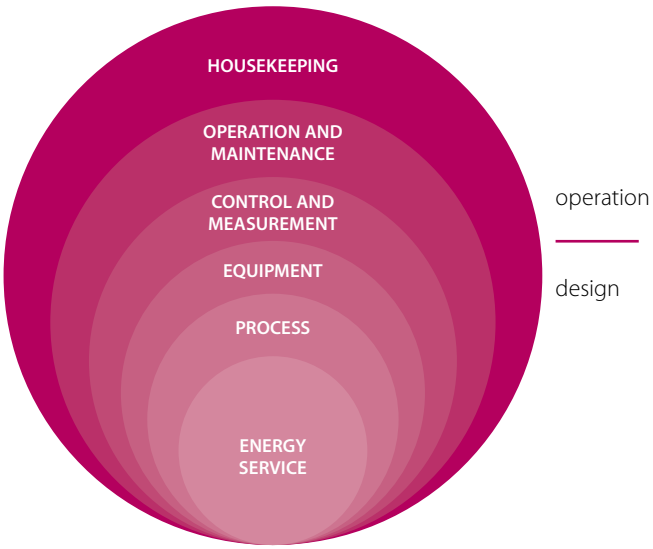
Line drawings courtesy of Vincent Byrne (www.vincent-byrne.com)

OVERVIEW

ICT equipment rooms vary in size based on the number of racks they contain. Guidance in this document is developed for three room sizes:

- Small: ICT Closet which can house 1–2 racks
- Medium: ICT Room which can house 3–10 racks
- Large: ICT Room which can house 11+ racks

While each room will have its own design characteristics, there are some generic principles that can be applied to improve energy efficiency, in a systematic way. This is illustrated in the Venn diagram on the right. By starting with the provision of the core energy service required, all the ancillary and supporting services to deliver this can be reviewed for energy saving opportunities.



ENERGY SERVICE	The core energy service required from ICT rooms is data storage and processing
PROCESS	ICT software and hardware
EQUIPMENT	Cooling and electrical systems and their application
CONTROL AND MEASUREMENT	Controlling temperature and humidity in server rooms and measuring overall room efficiency
OPERATION AND MAINTENANCE	Utility equipment should be operated and maintained in accordance with manufacturers' guidelines, by competent service engineers
HOUSEKEEPING	Carrying out equipment and room condition checks

APPLICATIONS

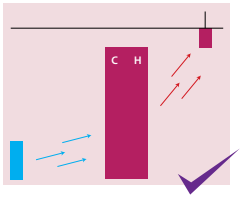
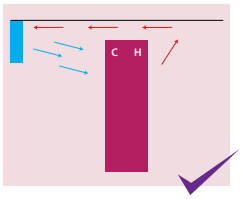
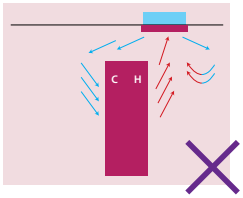
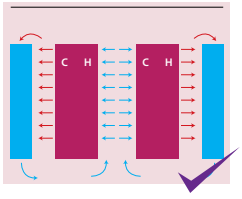
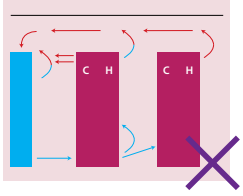
PROCESS

ICT Software and Hardware

The selection of ICT software and hardware has the greatest potential to reduce the energy consumption of a server room.

- **Virtualisation software can reduce the number of machines required**
- **Server management software can reduce the ICT power load**
- **Select equipment with internal temperature controlled variable-speed fans (VSDs).**
- **ICT equipment can offer internal/external power management to optimise energy consumption**
- **Consider reporting systems that can send temperature and power/energy consumption data to a Building Energy Management System**
- ICT equipment should be selected with common airflow direction requirements to allow implementation of hot aisle/cold aisle containment. The hot aisle/cold aisle approach involves lining up server racks in alternating rows with cold air intakes facing one way and hot air exhausts facing the other. The rows composed of rack fronts are called cold aisles. Typically, cold aisles face air-conditioner output ducts. The rows the heated exhausts pour into are called hot aisles. Typically, hot aisles face air-conditioner return ducts.
- Current industry guidance on server air intake temperatures, states a minimum of 18°C to 27°C (with an allowable temperature at the air inlet of up to 32°C) and 5.5°C up to 15°C dew-point and 60% RH. (ASHRAE, 2008).

EQUIPMENT

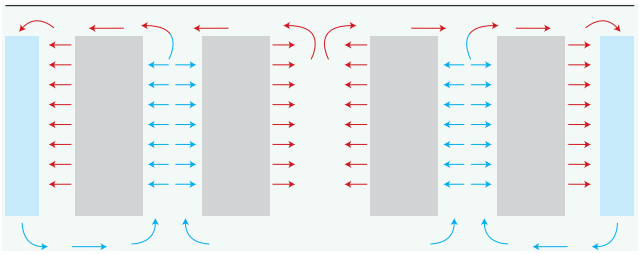
COOLING AND AIR DISTRIBUTION DESIGN		
If the ICT equipment selection is effective, the cooling system can be optimised. Depending on the size, scale and the physical characteristics of the space available for ICT operations, there are a number of recommended design and layout choices, that when applied in practice will reduce energy consumption.		
Small ICT equipment rooms		
ICT Closets up to 6kW	It is recommended to use the existing office air-conditioning system to supply and extract air to and from the server environment. This can be achieved by installing dedicated ductwork or by using wall grilles to the office spaces.	*Hot exhaust air is extracted from above the rear of the racks and reused to provide heat or dumped to atmosphere (Fire dampers installed as necessary)* 
ICT Closets over 6kW	For loads above 6kW it is recommended that a dedicated cooling system is installed. Wall mounted cooling units are suitable as they provide a natural supply and return path for the cold and hot air streams.	*Hot exhaust air is extracted from above the rear of the racks and reused to provide heat or dumped to atmosphere (Fire dampers installed as necessary)* 
	Ceiling mounted split units are not recommended.	*Ceiling mounted split units are not recommended, as the hot and cold air streams mix together* 
Medium size ICT rooms		
	For medium size ICT Rooms, underfloor air supply is recommended (Floor depth 300mm+). Air is discharged into the room through perforated panel floor registers. The air is returned directly to the air-conditioning system or by means of a ceiling return system.	*In underfloor air distribution, the space between the regular building floor and the raised floor is used as a means to supply air for equipment cooling* 
	Cooling units which deliver the air above the floor are not recommended.	*Cooling units which deliver the air above the floor are not recommended as it creates mixing of hot and cold air streams* 

Large ICT rooms

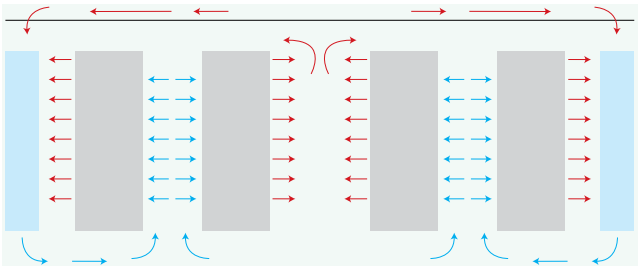
Fundamental to the efficient operation of an ICT Room is the segregation of the hot and cold air flows to and from the IT equipment. This segregation can be provided purely by correct rack layout for rooms with higher rack power loads, or by augmenting the layout by installing a physical containment system to either the hot or cold aisles.

The goal of a hot aisle/cold aisle configuration is to conserve energy and lower cooling costs by managing air flow. Blanking plates are used in cabinets where future server space is allocated; otherwise short-circuiting would occur. There are a number of recommended configurations.

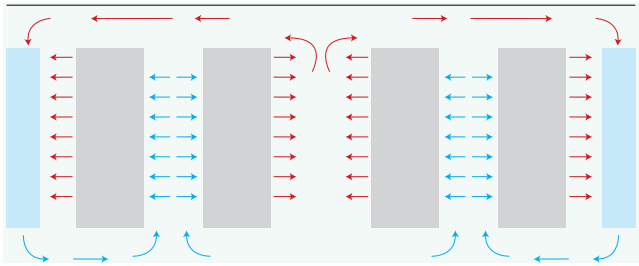
Hot aisle/cold aisle layout. This is the minimum level of design which should be installed for all server rooms and data centres (Floor depth 400-600mm).



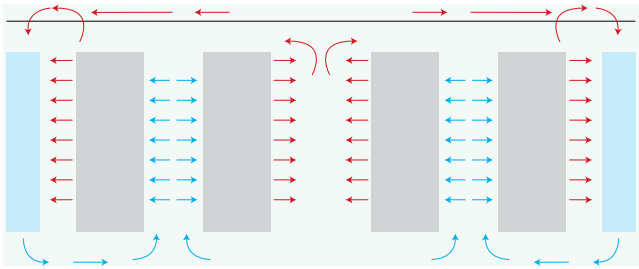
Cold aisle containment with hot air return through the ceiling to the Computer Room Air-Conditioning unit (CRAC). Outside aisles must be hot aisles (Floor depth 400-600mm). *Note: Very low cost to install.*



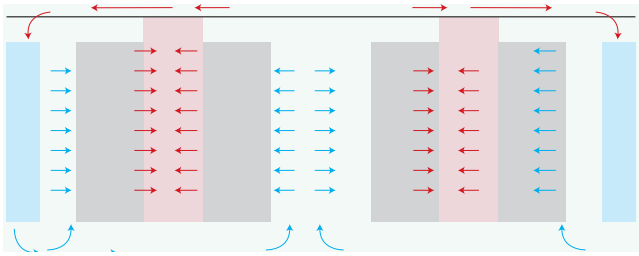
Cold aisle containment with open hot air return to CRAC unit. Outside aisles must be hot aisles (Floor depth 400-600mm).



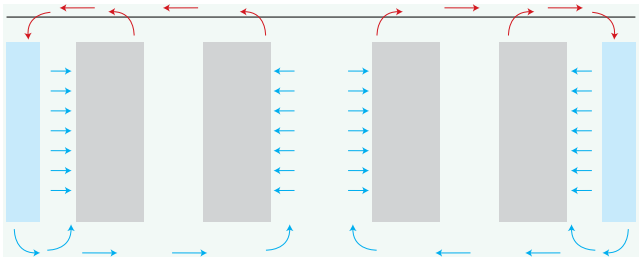
Cold aisle containment with hot air return through the ceiling. This helps to keep the room temperature down while maintaining the high return air temperature to the CRAC units thereby ensuring higher CRAC unit efficiency (Floor depth 400-600mm).



Hot aisle containment with hot air return to CRAC unit through the ceiling (Floor depth 400-600mm). *Note: low cost to install.*



Hot air chimney containment with hot air returning to the CRAC units through the ceiling. This requires new 1200mm deep racks and extra space in the data centre (Floor depth 400-600mm).



CONTROL AND MEASUREMENT

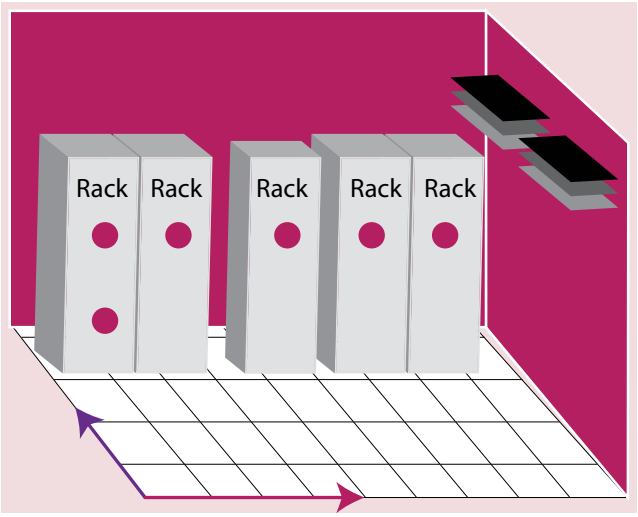
CONTROL OF TEMPERATURE

The aim of the cooling system within the ICT Room is to ensure that the server equipment is kept within the manufacturers' operating parameters and the recommended industry guidelines as set out in ASHRAE Environmental Guidelines for Data Centre Equipment (2008). This guideline has expanded the recommended operational bands from the earlier 2004 guidelines in recognition of the now proven ability of IT equipment to operate in higher temperature environments and the benefits of reducing cooling demands.

Temperature	20°C to 25°C	18°C to 27°C
Humidity	40% RH to 55% RH	5.5°C DP to 60% RH & 15°C DP

It is not sufficient to just know what temperature you want the room to operate at, it is also necessary to know where you want that room temperature to be measured. Room temperature should be measured at the front of the racks in the cold aisle.

Measure temperatures at server intakes



MEASUREMENT

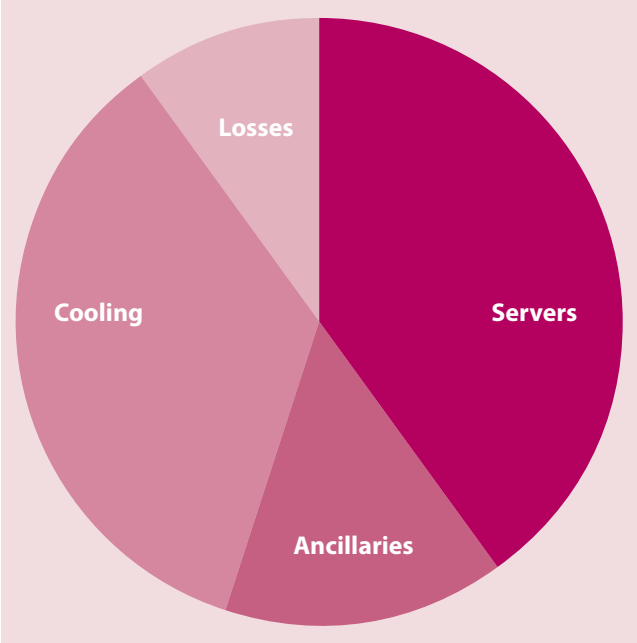
The electrical power load in a data centre can be broken down into three principal categories:

- **IT process power**
  (servers, switches, routers, storage)
- **Ancillary power**
  (lighting, protective services, uninterruptible power supply/ies)
- **Cooling power**
  (air-conditioning units, chillers, fans, motors)

The current industry standard for measurement of data centre efficiency of an ICT Room is Power Usage Effectiveness (PUE). PUE is a measure of how efficiently a data center uses its power; specifically, how much of the power is actually used by the computing equipment.

- Power Usage Effectiveness (PUE) = Total Data Centre Power/Server Power
- A PUE of 1.5 or lower is recognised as efficient

Total data centre power requirements



Total Data Centre Power includes:

- Server power
- Cooling power
- Ancillary power
- Losses

PUE Scoring

- Poor = > 2.0
- Fair = 1.5 – 2.0
- Good = 1.0 – 1.5

OPERATION AND MAINTENANCE

Facility designers should be involved in the compilation of maintenance and servicing manuals for the installed equipment to ensure there is a full set of guidelines available to the end user. Utility equipment should be maintained, as per the recommendations of the manufacturers, by competent service engineers. Timely maintenance and servicing will keep equipment operating at optimum efficiencies and prolong its lifespan.

HOUSEKEEPING

Good housekeeping consists of carrying out regular walk-round checks of systems and equipment, and generally keeping systems and equipment clean and air paths free of obstructions.

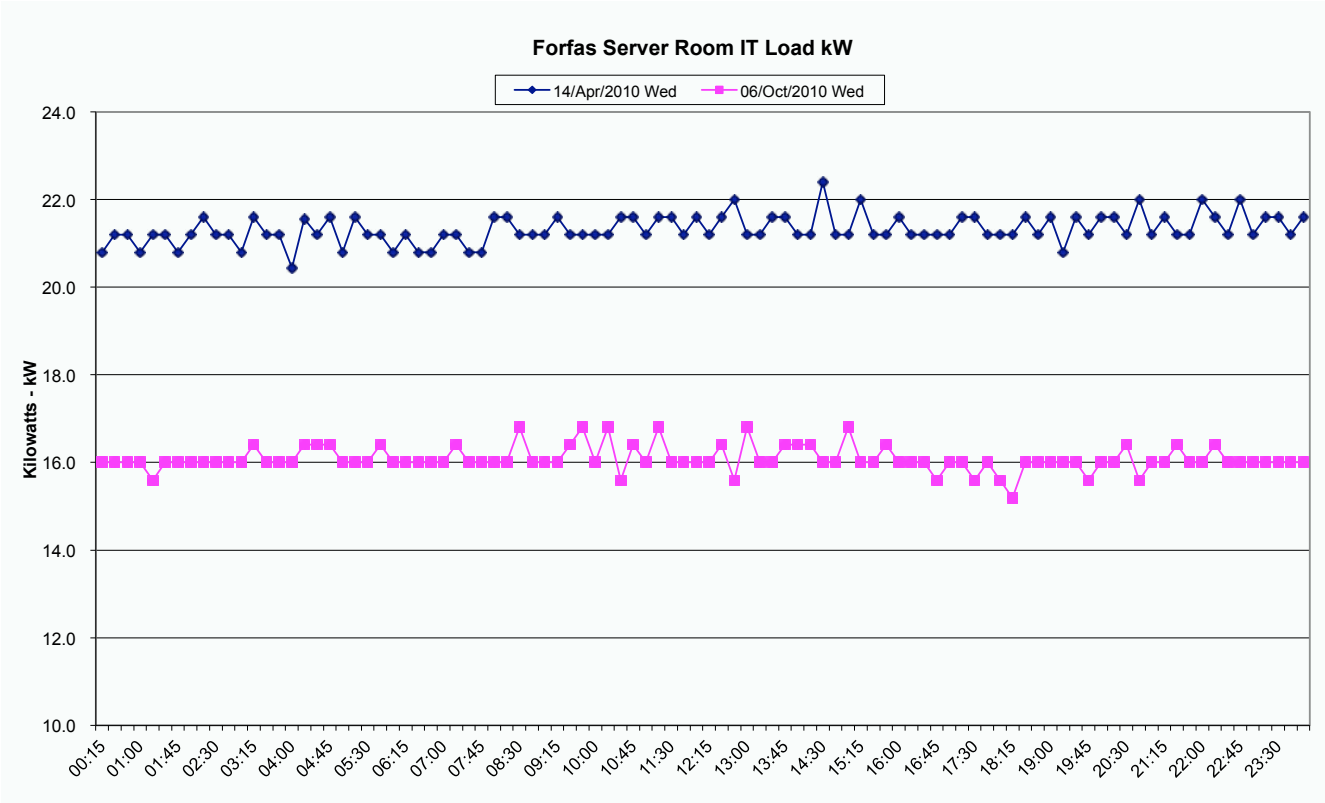
IN PRACTICE

Forfás is Ireland's policy advisory board for enterprise, trade, science, technology and innovation. It was represented on the Public Sector ICT Working Group and achieved significant energy savings in its server room operation at Wilton House by:

- removing idle, unused software applications
- reducing the number of servers
- increasing the server room temperature by 1 °C

Estimated annual energy savings:

- Mean IT load reduction of 4 kW
- Mean cooling load reduction of 1 kW
- Annual consumption reduced by 43,800 kWh
- Emissions reduced by 23,302kgCO2



Sample reports from Forfás showing the reduction in base load as changes were implemented

Sample reports from Forfás showing the reduction in base load as changes were implemented

PROCUREMENT

Procurement policies for ICT hardware and ancillary equipment should include energy efficiency criteria.

For example: Purchase certified energy efficient hardware, e.g. equipment on the SEAI Triple E list.

TRIPLE E AND PUBLIC PROCUREMENT

The new public procurement procedures and guidelines require 'green' criteria to be at the centre of all State procurement.

The European Communities (Energy Efficient Public Procurement) Regulations S.I. 151 2011 oblige public bodies when purchasing or leasing products to only procure products that:

- are specifically listed on the Triple E Register, or
- satisfy the energy efficiency criteria published by SEAI for the relevant product categories.

Therefore all* public sector tenders must include reference to Triple E compliance and suppliers must be able to demonstrate that their product offering is either on the register or complies with the relevant criteria.

**Some exemptions exist relating to competition issues and Register criteria.*

More information on Triple E products is available from:

http://www.seai.ie/Your_Business/Triple_E_Product_Register/

Innovative licensing, pricing and service models are now becoming available from established vendors; consult with your suppliers as to what new services are available to reduce the energy usage of existing ICT infrastructure.

SERVER ROOM ENERGY MANAGEMENT CHECKLIST

The table below summarises the actions which have been found to generate savings in ICT Server Room electricity usage and cooling demand.

✓	Action Checklist	*Tips and findings from SEAI's Public Sector ICT Working Group*
	Energy Management Structure	
	Have senior management made a commitment to ICT energy efficiency?	*to ensure resources are made available and an appropriate policy is adopted*
	Is there an ICT Energy co-ordinator appointed?	*with necessary time and resources*
	Are sufficient resources allocated to energy management within the ICT team?	*allocation of time to ICT projects*
	Has an ICT Energy Management Team been established?	*a small team of enthusiastic volunteers*
	Is there a standard operating procedure to control power settings centrally?	
	Is a system of energy use reporting in place (ICT energy consumption estimates/ metered/reported)?	*estimate based on rules of thumb e.g. 300W per server*
	Are energy/power management review dates set up?	
	Operations & Maintenance	
	Simplify ICT processes to reduce the demands on server resources	
	Raise server intake temperature to 23°C in 1°C steps	*ASHRAE Guidance allows up to 27°C*
	Vent the server exhaust heated air to other areas	*To office or other areas*
	Carry out a CFD thermal modelling analysis of possible cooling options to guide energy efficient design solutions	*CFD = Computational fluid dynamics*
	Use free- cooling air when outdoor conditions are suitable	
	Turn off duplicate cooling units where possible	*Ireland is a temperate country, cooling is often superfluous*
	Install blanking panels between servers in racks	
	Remove cable arms, to clear air flows	*Replace with velcro fasteners or similar*
	Remodel server room to reduce cooling load	
	Establish hot aisle/cold aisle arrangements	
	Install hot/cold aisle containment	
	Choose appropriate screens, default fonts, etc., to reduce printing demand	
	Install temperature monitoring in cold aisles	
	Use the ceiling void as a return plenum	
	Retrofit variable speed electronically commutated fans to air-handling units	
	Virtualise the server environment	*80% increase in computing capacity for a 20% increase in energy use*
	Housekeeping	
	Deploy script power management automation and reporting tools	
	Survey for and remove idle applications and their servers	*Reduces computing and cooling demand*
	Ensure air paths are clear of obstructions and set temperatures are being maintained	*Estimate based on rules of thumb e.g. 300W per server*
	Keep the server environment dust free	
	Ensure lights are turned off when leaving the room, or install occupancy controls	

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