Green Data Centers

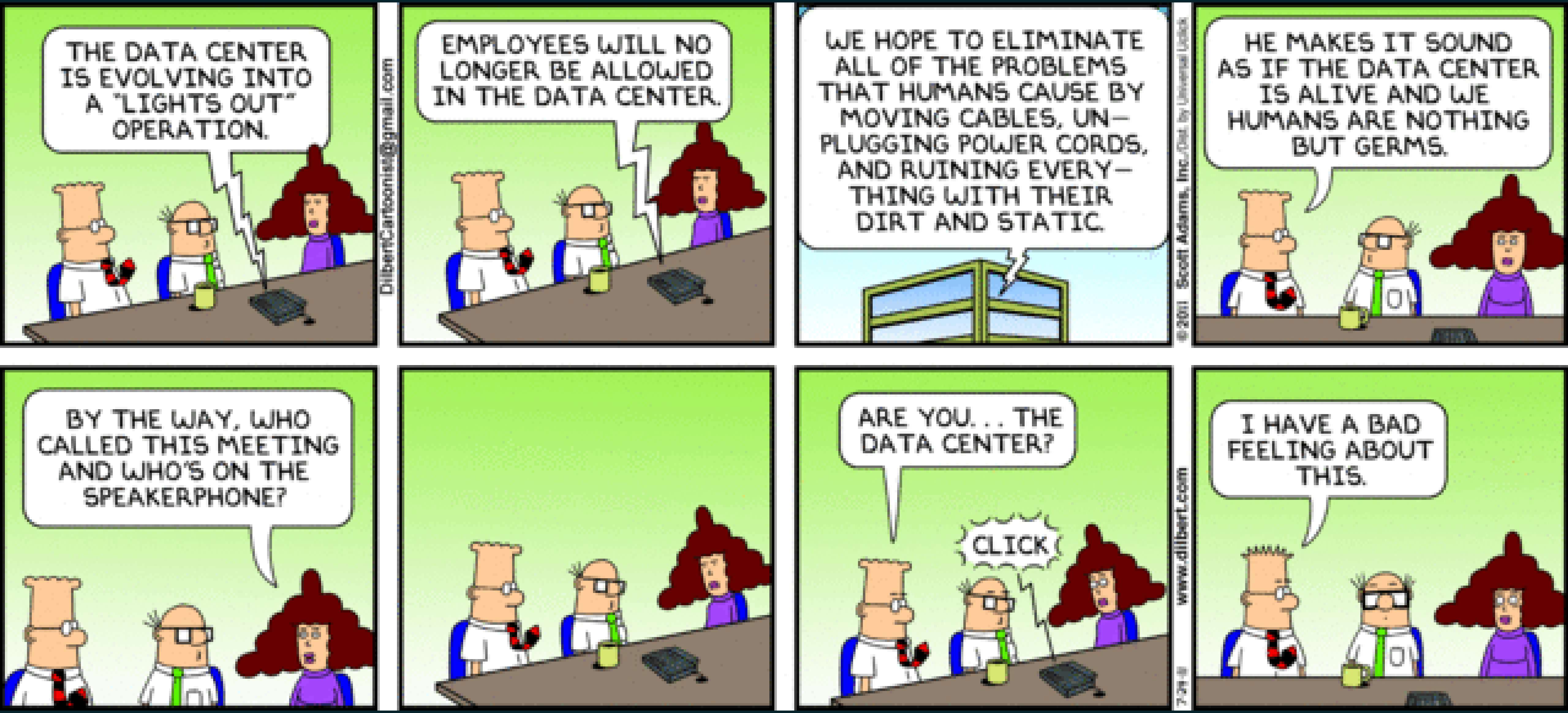
A Guideline

Sekhar Kondepudi Ph.D

Associate Professor
Smart Buildings & Smart Cities

Vice Chair
Focus Group on Smart Sustainable Cities

ITU-TRCSL Workshop on Greening the Future: Bridging the Standardization Gap on Environmental Sustainability, Colombo Sri Lanka Oct 03-04 2013.



* Source: Dilbert United Features Syndicate

Agenda

1. Background
2. Data Centers & Energy Use
3. Energy Efficiency
4. Metrics & Best Practices
5. ITU Efforts

1 Background

2 Data Centers & Energy Use

3 Energy Efficiency

4 Metrics & Best Practices

5 ITU Efforts

ICT Policy in Sri Lanka

- **Sri Lanka's Information and Communication Technology Agency (ICTA)**

  Information Infrastructure/Digital Divide—connecting Sri Lanka's villages and towns to the world.

  E-Laws—guiding necessary regulatory reform to enable e-commerce and e-government.

  ICT Skills—developing necessary IT skills to support ICT industry development.

  E-Government—under the re-engineering Government initiative, applying ICT to modernise the public sector and deliver e-services.

  ICT Industry promotion—promoting Sri Lanka as an ICT destination

- **Sri Lanka Government Cloud (2012)**

  Provides infrastructure, platform and applications as a service to government, for hosting any government system, application, content or service, with-out the government organization having to spend on the infrastructure, themselves.

Energy Crisis in Sri Lanka

the SUNDAY TIMES

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BUSINESS TIMES

Long-term solutions needed for power crisis

View(s):

Sri Lanka's electricity crisis has in recent days, gripped the attention of the public with the Ceylon Electricity Board's (CEB) decision to dramatically raise electricity tariffs, triggering a public outcry.

On Wednesday President Mahinda Rajapaksa, during a May Day rally, announced concessions for lower end users of power. The current power crisis climate is surprisingly similar to a situation in 2008. The CEB in March 2008 increased its tariff rates for the supply of electricity by imposing a mandatory 30 per cent fuel surcharge on consumers using over 90 units of electricity per month, in a move to raise revenue and hopefully depress its colossal loss-making.

In the wake of public anger at the time the Institute of Human Rights (IHR) filed a fundamental rights petition in the Supreme Court on May 2008 requesting the court to order the establishment of an independent electricity price-regulator and for a switch to more cost effective power generation methods.

The petitioners in the 2008 case clearly highlighted that the root cause of Sri Lanka's electricity issue lay in its power-generation mix with a heavy reliance on thermal power generation being completely unfeasible.

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Sri Lanka's massive power and energy crisis: No easy answers, no immediate relief for consumers

20 Mar, 2012 · Groundviews · Colombo, Development, Economy, Environment, Politics and Governance

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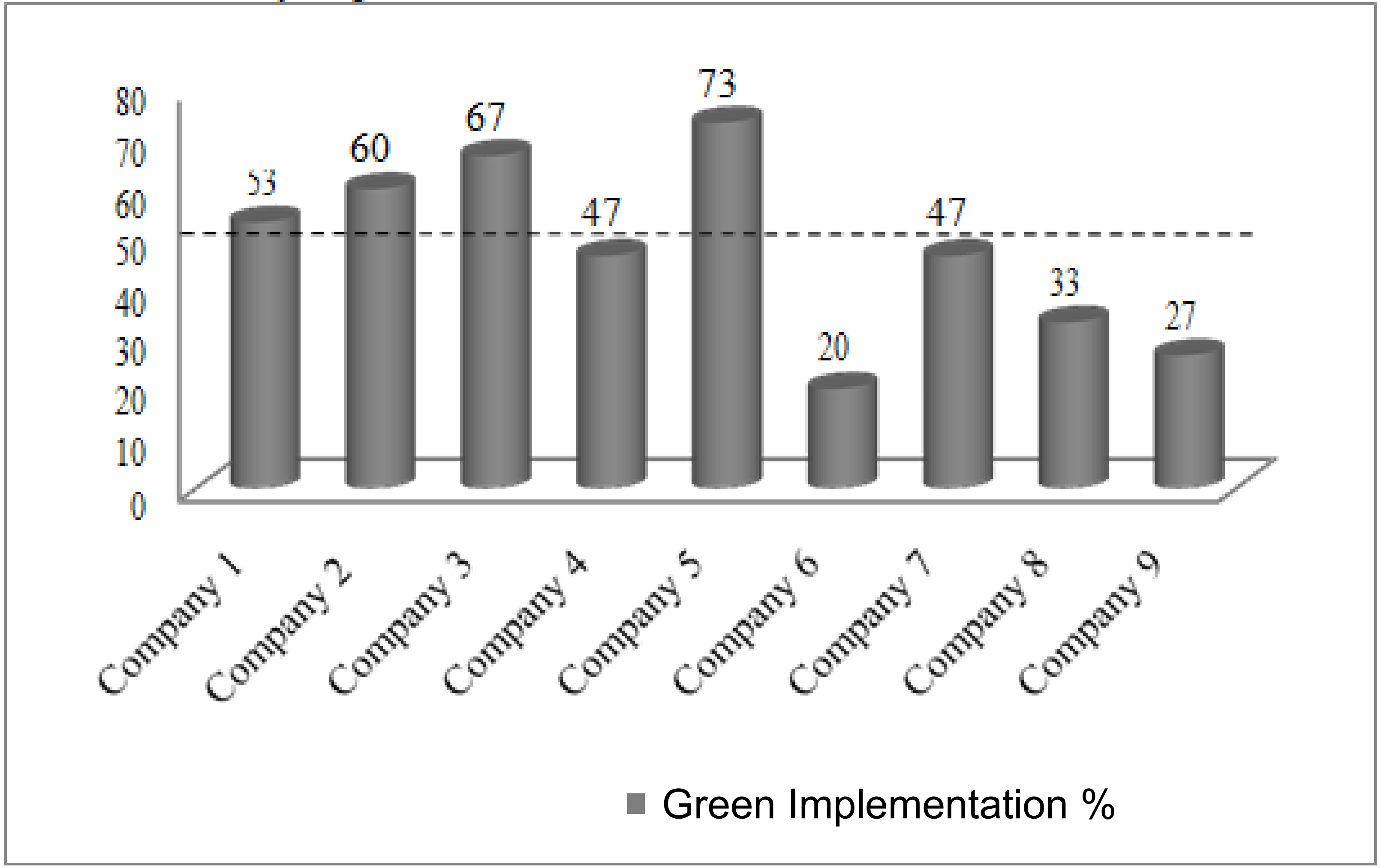
Sri Lanka IT Sector (2011)

	2007	2008	2009	2010	2011	2012	2013	2014	2015
IT Market	212	254	277	327	386	456	538	629	**742**
IT Market as % GDP	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7	**0.7**
Hardware Sales	151	180	194	227	265	310	362	419	**489**
Services	37	45	50	61	74	89	107	128	**155**
Software	24	29	32	39	47	57	68	82	**98**
PCs (including notebooks)	120	144	157	184	216	254	300	347	**405**
Servers	**14**	**16**	**17**	**20**	**24**	**28**	**33**	**38**	**44**

Source : 2011 IT/ITES Report by ICRA

All Figures in USD Million

How Green are Data Centers in Sri Lanka ?



Cumulative score-percentage of different green practices implemented by companies

Ahangama & Gunawardana (2012)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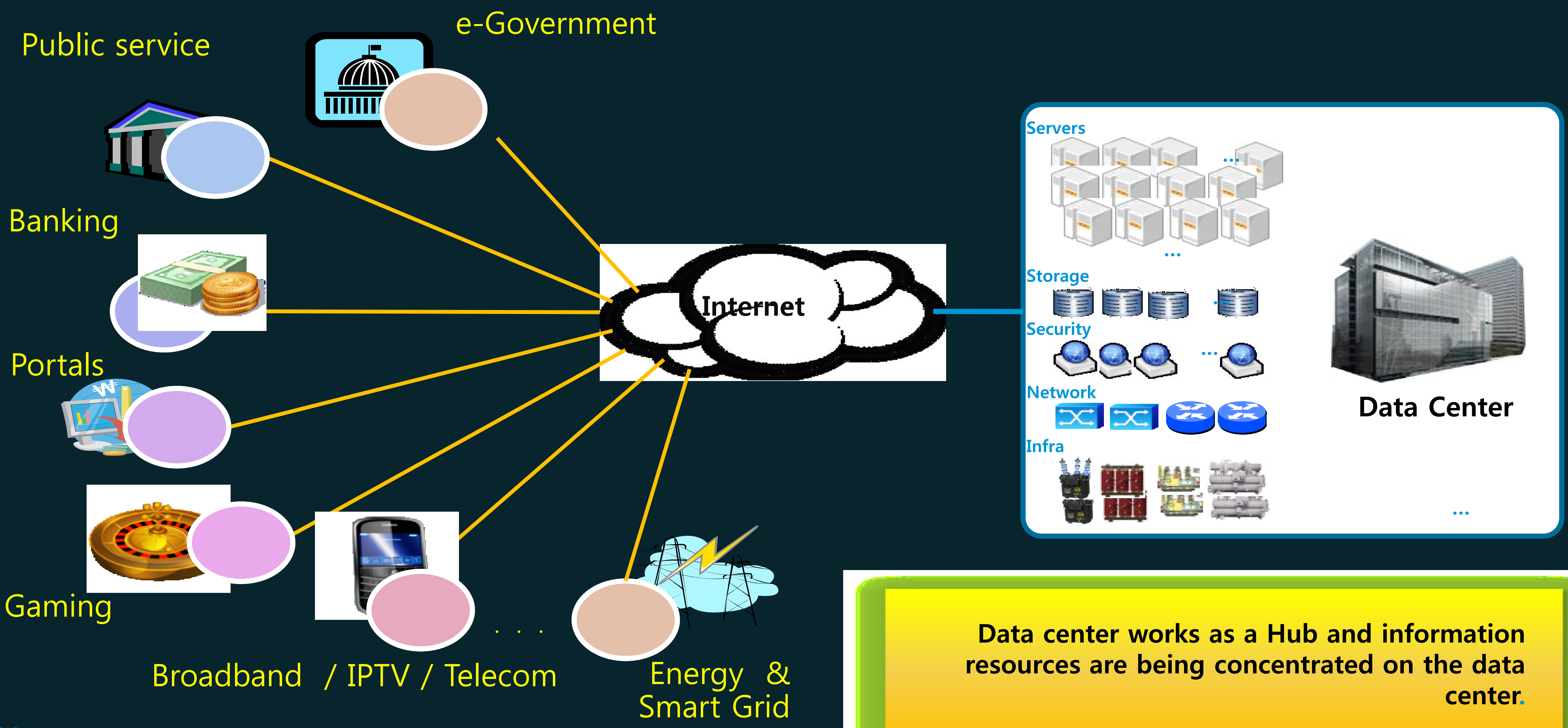
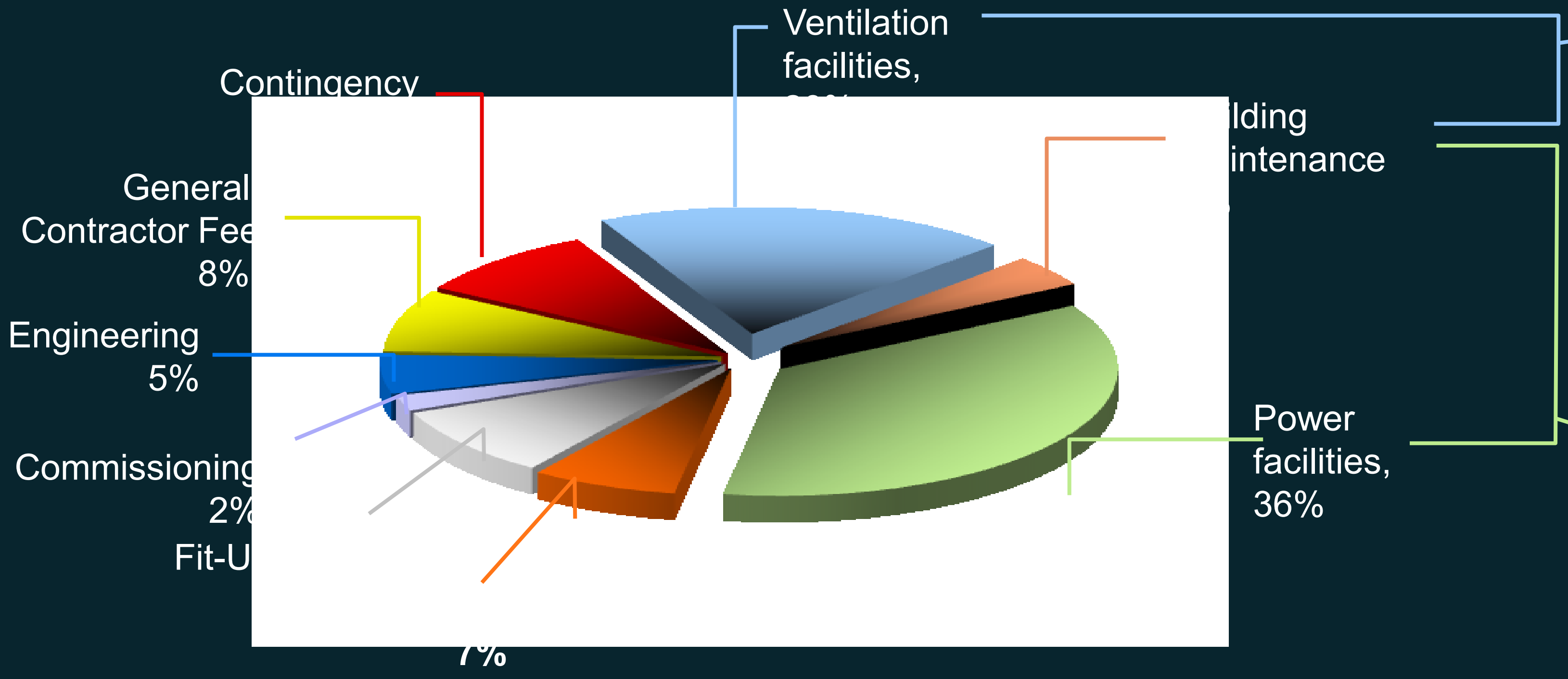
Roles of Data Centers



Data center works as a Hub and information resources are being concentrated on the data center.

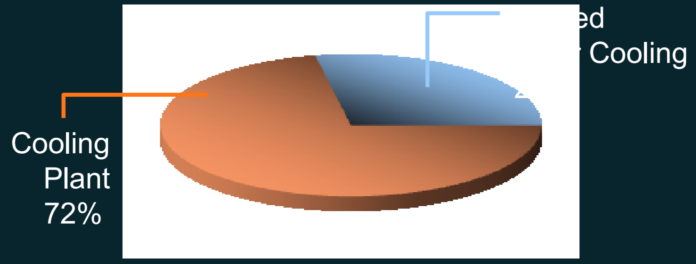
Costs of Establishing a Data Center

"60% of total establishment cost of data center is caused by energy-relevant facilities."

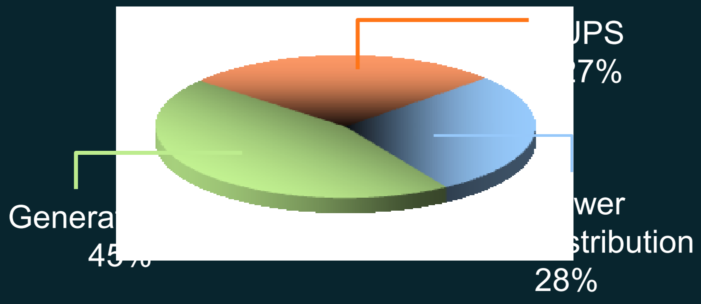


Total cost of data center establishment

Cost of ventilation-relevant facilities

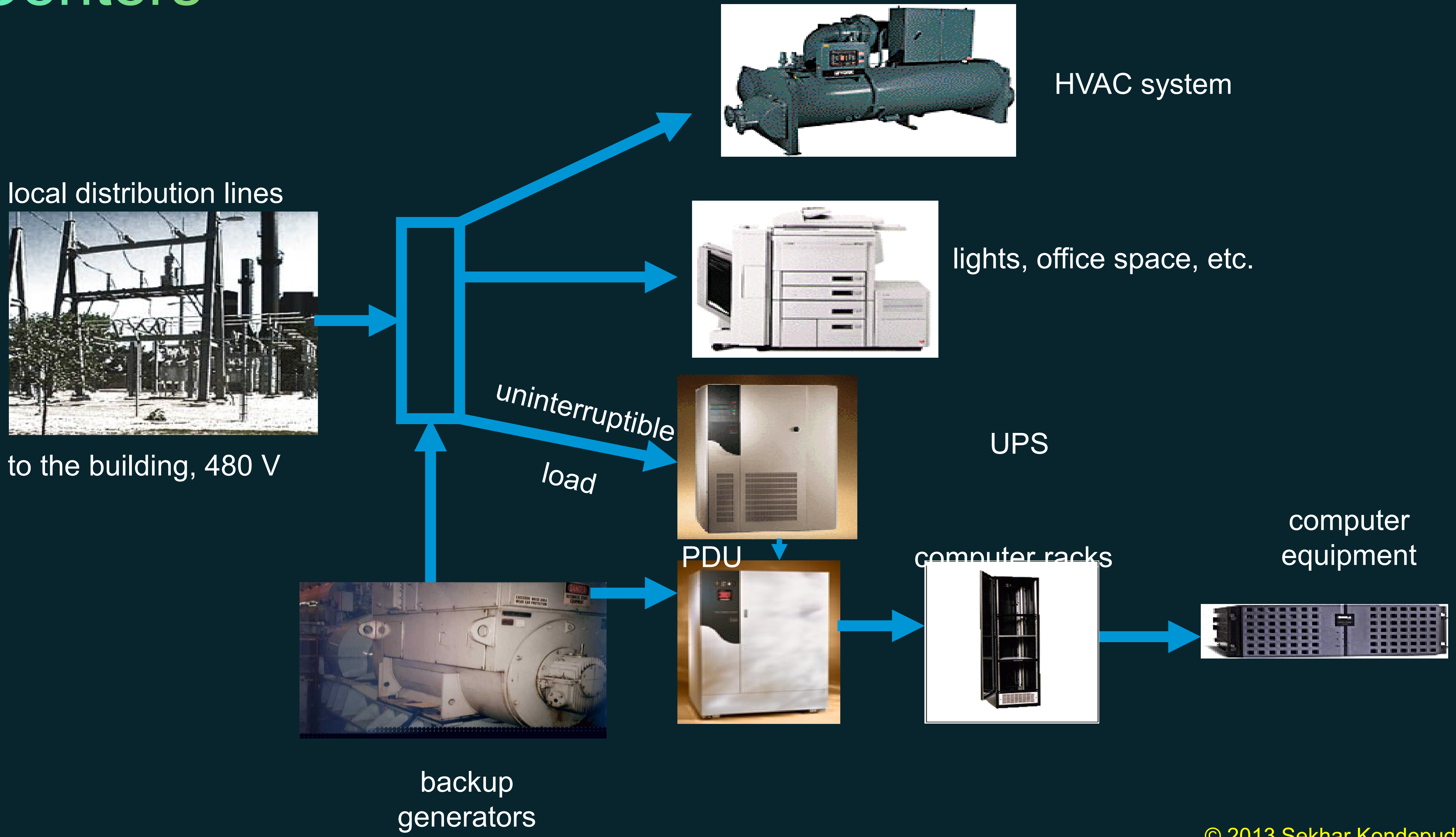


Cost of power-relevant facilities

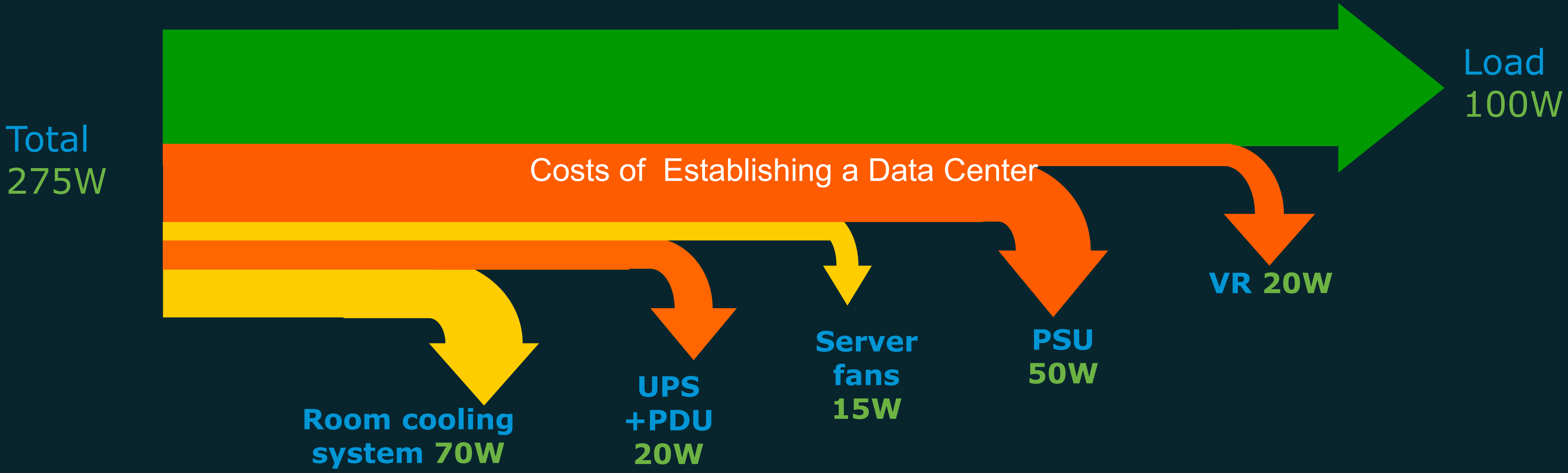


* Source: IBM engineering estimates, 2008

Electricity Flows In Data Centers

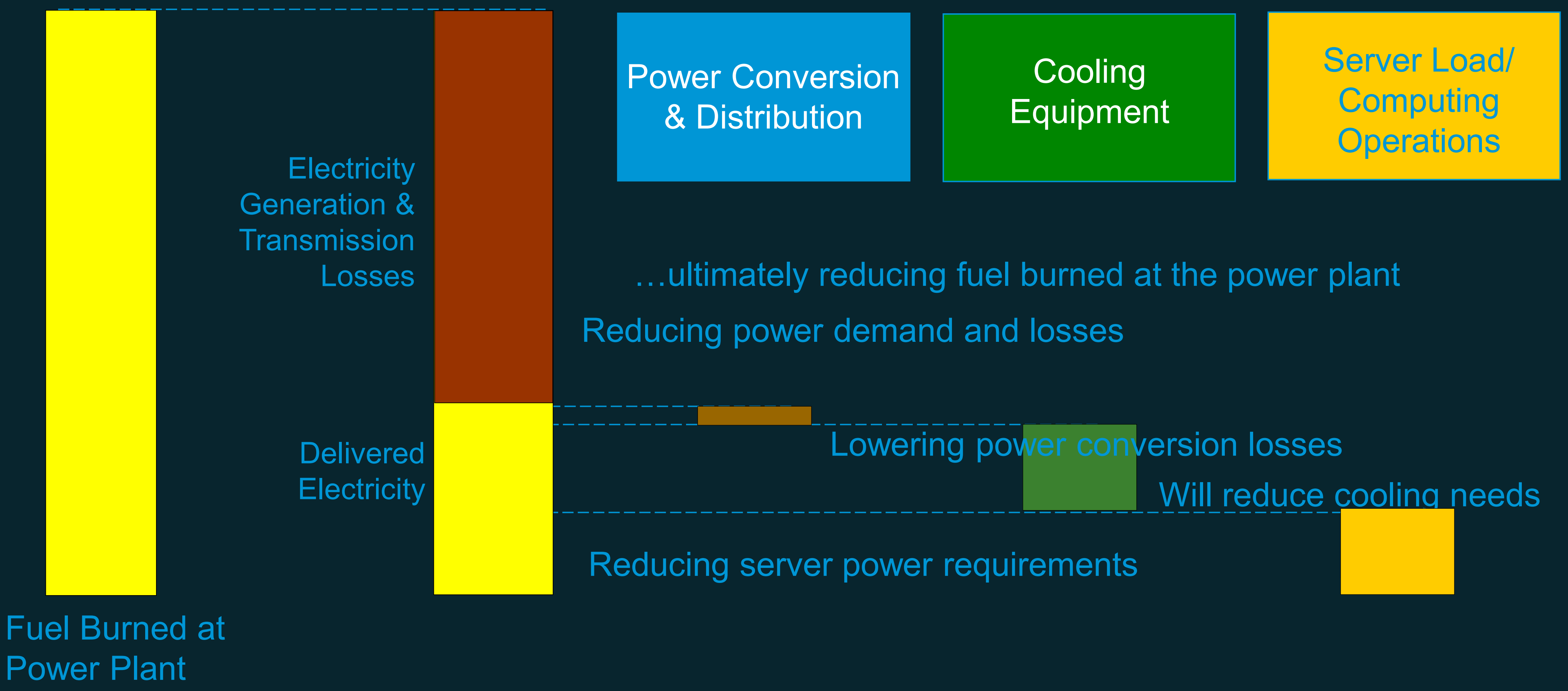


Power Consumption: 100 W System Load



source: Intel Corporation

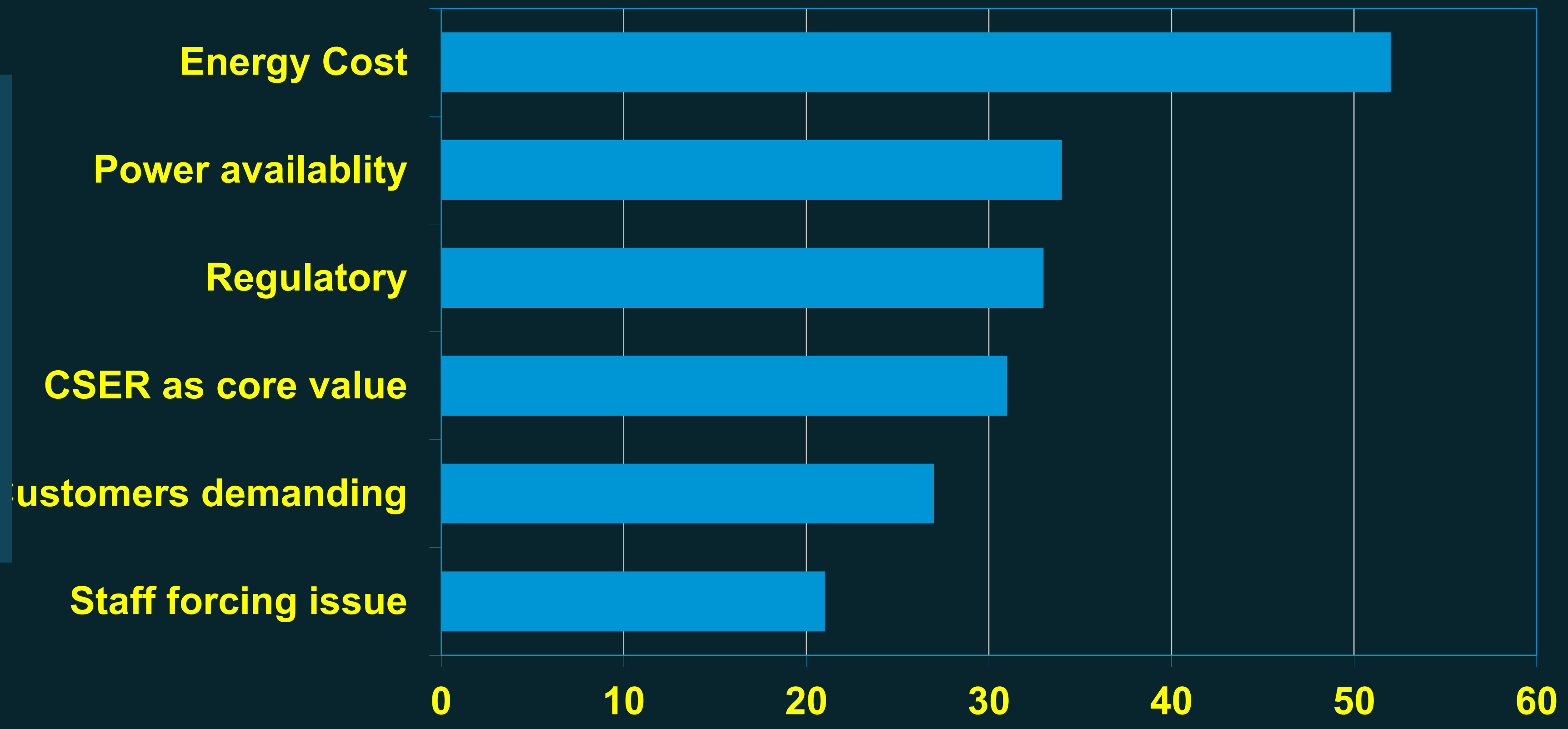
Typical Data Center Energy Flow/Use



Key Issues for Data Center Managers / Experts

Survey result for data center experts

- Improved monitoring
- Power-handling efficiency
- Cooling is a limiting factor
- Power is also a constraining factor:



Source: Bathwick Energy Efficiency Benchmark Tool

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1 Background

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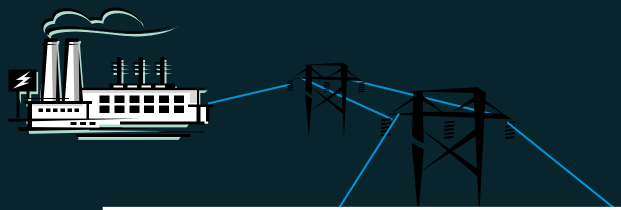
3 **Energy Efficiency**

4 Metrics & Best Practices

5 ITU Efforts

Energy Efficiency Opportunities



& Distribution

Equipment

- On-site generation
- CHP applications
- Waste heat for cooling
- Use of renewable energy
- Fuel cells

- Load
- Server innovatio

- High voltage d
- Use of DC power
- Highly efficient UPS systems
- Efficient redundancy strategies

- Move to liquid cooling
- Optimized chilled-water plants
- Use of free cooling

ative
r Generation

Power Delivery Cost Savings

Power Path Efficiency		Power (kW)	MW-h	Cost ($k)
	Load cooling	3.1	113	8.5
Loads	Systems (x100) (not including dc/dc & ac/dc)	9.8		
x 85%	Dc/dc	2.1	109 → 62	8.2 → 4.7
x 70% → 85%	Power supply	5.1 → 2.1		
x 90% → 94%	UPS	1.9 → 0.9		
x 98%	Distribution	0.4 → 0.3		
x 76%	Delivery Cooling	3.0 → 1.7		
Total = 40% → 51%	Total		222 → 175	16.7 → 13.2

Original efficiency ≈ 40%
Original Cost of power delivery = $8,200 / 100
Annual cost reduced by $3,500 / 100

Source: EPRI PEAC

Energy Savings Impact

Approach	Savings	Description
Virtualize servers	10 - 40%	Consolidation of applications onto fewer servers, typically blade servers
Right-size NCPI	10 - 30%	Using a modular, scalable power and cooling architecture
More efficient air conditioner architecture	7 – 15%	Row-oriented cooling and shorter air paths
Economizer modes of air conditioners	4 – 15%	Choosing economizer options-offered air conditioners
More efficient floor layout	5 – 12%	hot-aisle / cold-aisle arrangement with suitable air conditioner locations
More efficient power equipment	4 – 10%	Best-in-class UPS, & light load efficiency rather than full load efficiency
Coordinate air conditioners	0 – 10%	One air conditioner may actually heat while another cools; and One may dehumidify while another humidifies.

(1) APC White paper #114 " Implementing Energy Efficient Data Centers", 2006

(2) NCPI : network critical physical infrastructure

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Summary of Energy Savings Measures

- Air management
- Right-sizing
- Central plant optimization
- Efficient air handling
- Free cooling
- Humidity control
- UPSs and power supplies
- On-site generation
- Liquid cooling
- Design and M&O processes

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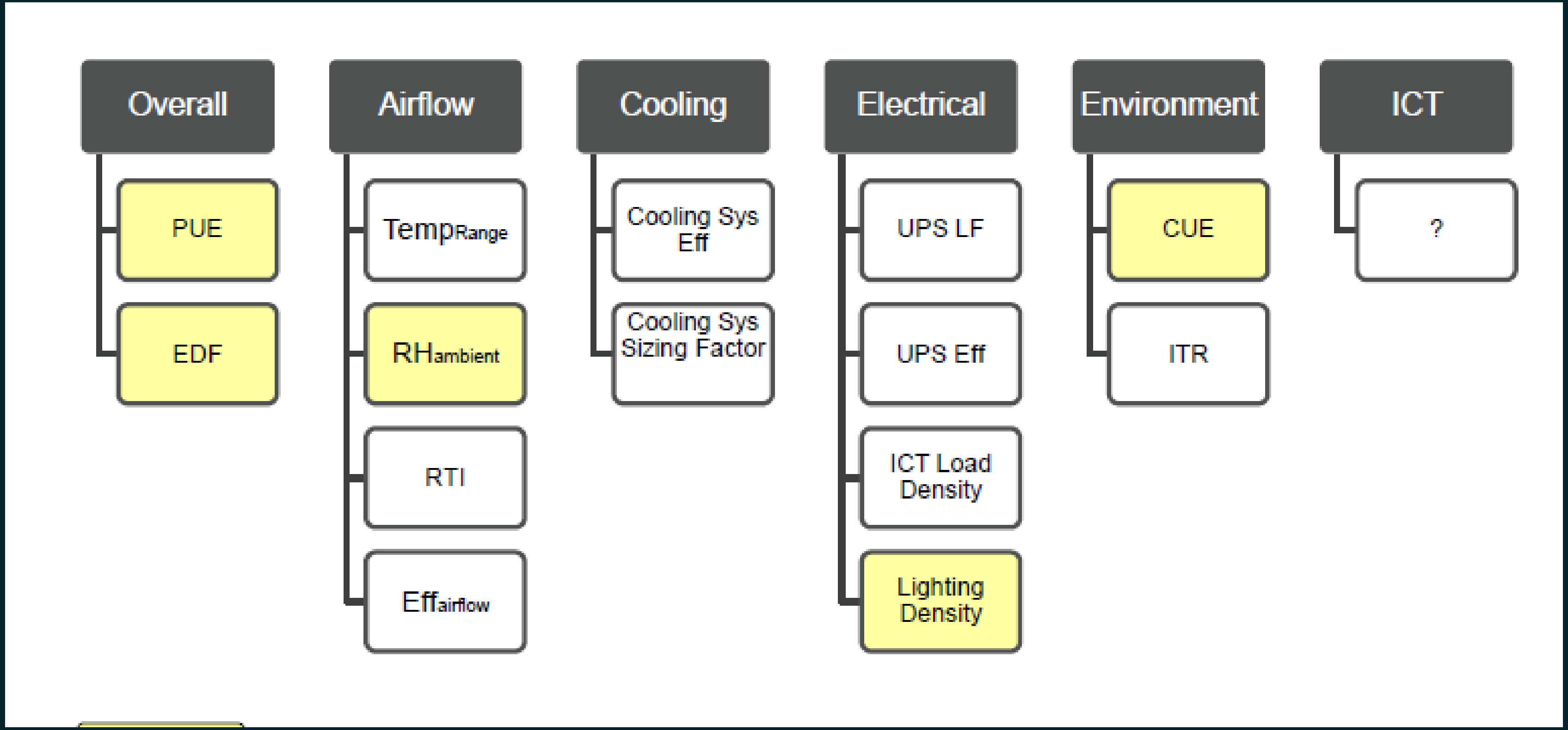
Important Items to Measure



SS 564 : Singapore Standards for Green Data Centers

Common Data Center Metrics

- PUE – Power Usage Effectiveness
- DPPE - Datacenter Performance Per Energy
- WUE - Water Usage Effectiveness

  Annual water usage divided by IT equipment energy, and expressed in liters/kilowatt-hour;
- CUE - Carbon Usage Effectiveness

  To address carbon emissions associated with data centers
- DCMM - Data Center Maturity Model

  Clear goals & direction for improving energy efficiency & sustainability across all aspects of the data center.

  Parameters include power, cooling, compute, storage, and network.

PUE
(Power Usage Effectiveness)

- Indicator Commonly agreed to by industry bodies and governments
- In practice, a data center consumes more energy that what its IT resources use. Additional energy is needed to feed the cooling systems, lighting and power delivery.
- If a data center has a PUE of 2.0 it means that for every 100 W of power needed by the IT Infrastructure, the data center needs 200 W from the utility grid.
- PUE = Cooling Load Factor (CLF) + Power Load Factor (PLF) + 1.0

  - 1.0 represents the normalized IT load
  - CLF is the total power consumed by chillers, cooling towers, computer rooms air conditioning, pumps, etc., divided by the IT load
  - PLF is the total power dissipated by switch gear, UPSs, power distribution units, etc., divided by the IT load.

PUE	Indication of Efficiency
3.0	Very Inefficient
2.5	Inefficient
2.0	Average
1.5	Efficient
1.0	Very Efficient

DPPE (Datacenter Performance Per Energy)

DPPE is defined as a function of four sub-metrics.

Metric:

$$DPPE = ITEU \times ITEE \times \frac{1}{PUE} \times \frac{1}{1 - GEC}$$

Comment:
- The purpose of expressing DPPE as a product of each sub-metric is to calculate DC capacity per non-green power.
- Because DPPE becomes infinite when GEC=1, the maximum value for GEC should be limited to 0.8 when calculating DPPE.

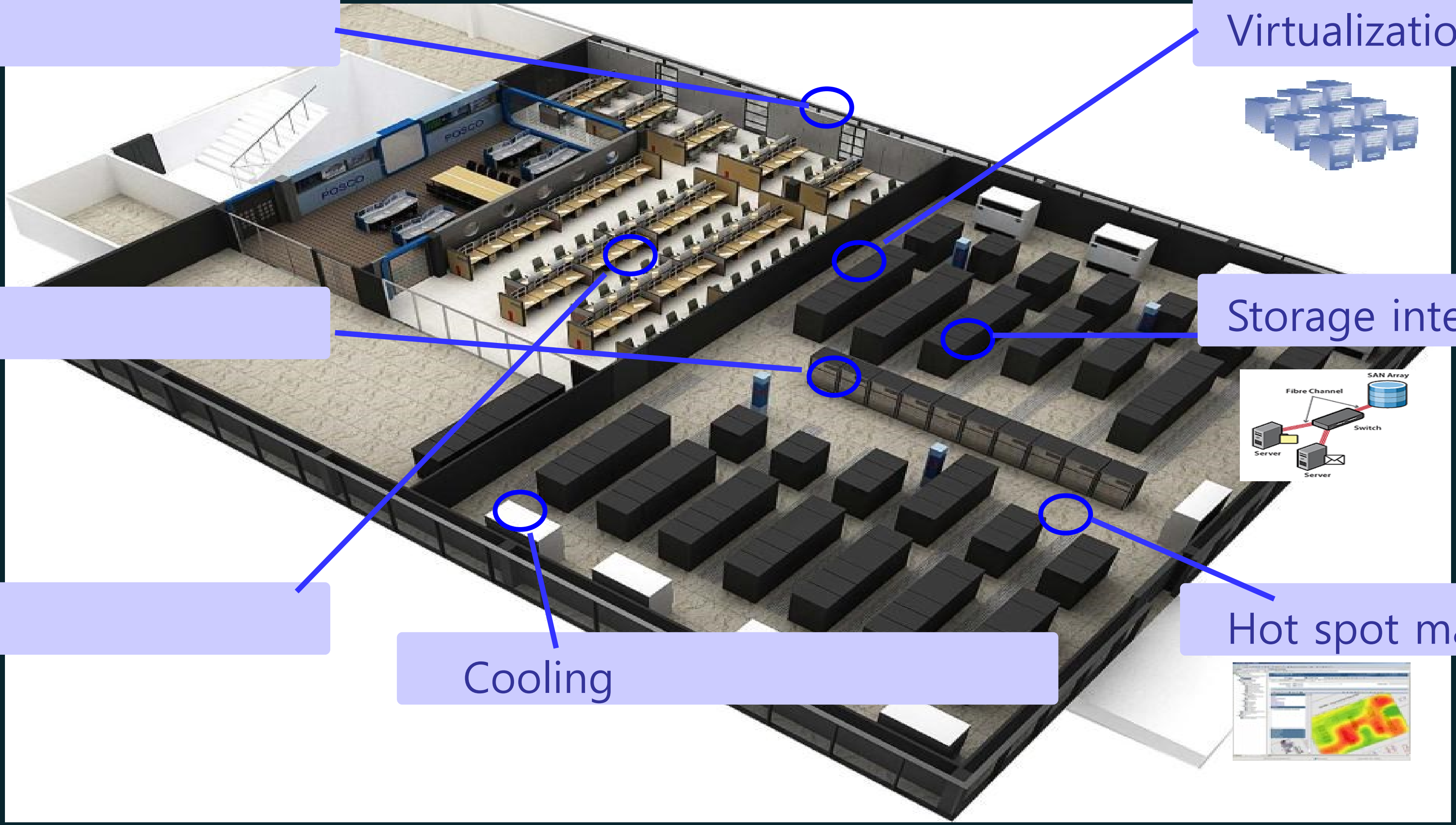
Sub-metric Name	Basic Definition	Corresponding action
IT Equipment Utilization (ITEU)	= IT equipment usage in DC	• Effective operation of IT equipment
IT Equipment Energy Efficiency (ITEE)	$= \frac{\Sigma \text{(IT equipment rated capacity)}}{\Sigma \text{(Rated Energy Consumption of IT equipment)}}$	• Installation of energy efficient IT equipment
Power Usage Effectiveness (PUE)	$= \frac{\text{DC Total Energy Consumption}}{\Sigma \text{(Energy Consumption of IT Equipment)}}$	• Energy saving in facility
Green Energy Coefficient (GEC)	$= \frac{\text{Green energy}}{\text{DC Total Energy Consumption}}$	• Use of Green Energy

DPPE is developed by the Green IT Promotion Council (GIPC) of Japan

Performance Metrics

Parameters used in the metrics	Type of information	PUE	ITEU	ITEE	GEC	DPPE
Total energy consumption of data center	Dynamic	✓			✓	✓
Energy consumption of ICT equipment	Dynamic	✓	✓			✓
Green energy produced and used in data center	Dynamic				✓	✓
Rated power of ICT equipment	Static		✓	✓		✓
Server capacity	Static			✓		✓
NW equipment capacity	Static			✓		✓
Storage capacity	Static			✓		✓

Best Practices



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Energy Star Guidelines

Action	Summary
Server virtualization	Consolidating multiple servers to a single physical server reduces energy consumption by 10-40%
Shut down unused servers	Save 15-30% by simply shutting down comatose servers
Server consolidation	Bring lightly used servers tasks to a single server
Storage consolidation	Storage typically averages 30% utilization, yet companies typically hold the same information 20 times
Invest in energy efficiency	An Energy Star server draws around 30% less energy than a conventional one
Hot aisle/cold aisle layout	Physical arrangement of servers can reduce mixing of hot and cold air, improving efficiency
Aisle enclosures	Further reduction in mixing cold supply air with hot exhaust air
Airflow improvements	Decrease server inlet air temperatures and increase temperature of exhaust air to CRAC
Seal off ducts	Use grommets to reduce air leakage
Adjust the temperature and humidity range	Most data centers run cool and dry. They can save 4-5% in energy costs for every 1° F increase in server inlet temperature
Air-side economizer	Bring cooler evening and winter outside air into the data center
Water-side economizer	Cooling tower to evaporate heat and produce chilled water during winter

Greenmark (Singapore) for Data Centers

Energy Related Requirements (83 points)
(Minimum 35 points to be scored)

		Pts
Part 1 - Energy Efficiency		
1-1 Overall Energy Efficiency		*25*
Maximum Design PUE	10	
PUE Improvements over Reference model (Full Load and Part Load)	15	
1-2 Systems Energy Efficiency		*28*
Cooling System (based on specified eqmt)	12	
Electrical System (by design)	8	
IT Equipment (by design)	8	
1-3 Energy Efficiency and Performance Verification		*10*
Commissioning of Energy Systems	4	
Measurement and Verification Plan	3	
Energy Metering and Reporting of PUE	3	
1-3 Data Centre Design & Energy Management		*10*
Data Centre Planning and Design	5	
Data Centre Operations and Energy Mgmt	5	
1-5 Energy Efficient Features and Innovations		10

Other Green Requirements (42 points)
(Minimum 10 points to be scores)

		Pts
Part 2 - Water Efficiency		*12*
2-1 Water Use Efficiency	3	
2-2 Alternative Water Sources	3	
2-3 Cooling Towers Water Use	6	
Part 3 – Sustainable Operation & Management		*12*
3.1 Refrigerants and Fire Suppressants	4	
3.2 Sustainable Construction	5	
3.3 Sustainability Policy	3	
Sustainable Purchasing		
Waste Management		
Part 4 - Indoor Environmental Quality		*8*
4-1 Indoor Air Quality Performance	3	
4-2 Lighting Quality and Management	3	
4-3 Thermal Comfort and Noise Level	2	
Part 5 – Other Green Features and Innovations		10

LEED like rating schema for Data Centers

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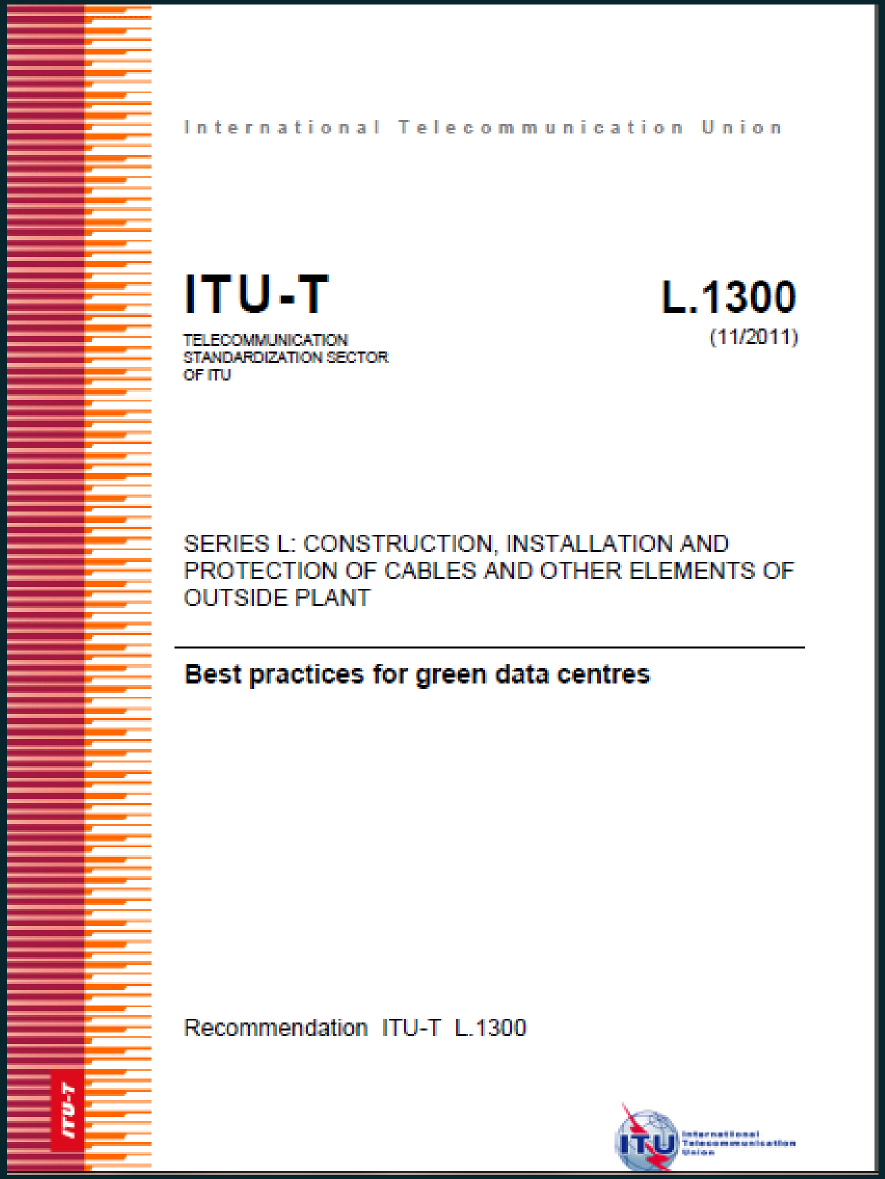
ITU L.1300 Best Practices for Green Data Centers (1)

- This Recomendation contains requirements for data center realization as selection of equipment, cooling, powering, and some suggestions to realize and conduct a data center with reduced impact.
- **Recommendation ITU-T L.1300** states that reducing energy consumption and GHG emissions should be considered in the design and construction of data centres, and that constant monitoring will be required to consistently manage and improve energy consumption while the data centre is in operation. **(Approved in January 2012)**
- Best practices are outlined for the use, management and planning of data centres, for cooling and power equipment, for the optimum design of data centre buildings, and for the monitoring of data centres after construction.

  For example, applying best practice to cooling could reduce the energy consumption of a typical data centre by more than 50 per cent.



International Telecommunication Union

ITU-T

TELECOMMUNICATION STANDARDIZATION SECTOR OF ITU

L.1300

(11/2011)

SERIES L: CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

Best practices for green data centres

Recommendation ITU-T L.1300

ITU L.1300 Best Practices for Green Data Centers (2)

Issue	Notes
Data center utilization and management	Effective communications between different departments; resilience level and provisioning
ICT equipment	Selection, deployment and management of new and existing IT and telecom equipment
Cooling	Airflow design, cooling, free and economized cooling, cooling plant, CRAC units, reuse of waste heat
Data center power	Selection, deployment and management of data center power equipment
Other data center equipment	General practices
Data center building	Building physical layout and geographic location
Monitoring	Energy use and environmental measurement, data logging, reporting
Design of network	Requirements to connect equipment in the data center as well between data centers

L.metrinfra

Metrics for infrastructure and data center

Recomendation that will contains definition of metrics for Data centers and Telecom Infrastructure

L.measinfra

Measurement method for Infrastructure and Data Center

Recomendation that will establish measurement methods for the power/energy consumption of Data Centers and Telecom Infrastructure

THANK YOU

Sekhar Kondepudi Ph.D.
Smart Buildings & Smart Cities
National University of Singapore
Sekhar.Kondepudi@nus.edu.sg
+65 9856 6472