University of Coimbra

Energy Efficient IT-Technology for Data Centers and Server Rooms

PrimeEnergyIT European project

Aníbal De Almeida, Carlos Patrão – ISR-University of Coimbra
Bernd Schaeppi , Thomas Bogner – Austrian Energy Agency
Andrea Roscetti, Lorenzo Pagliano – Politecnico de Milano
Philipp Tepper – ICLEI Local Governments for Sustainability
Alexander Schloesser – Technical University Berlin
Laurent Lefevre – INRIA

Data Centers Footprint – More & larger

ISR-UC

- According to one forecast, the number of servers in the world will increase from 18 million in 2007 to 122 million in 2020 (Climate Group and GeSI 2008);
- The servers will also have much greater processing capacity than current models. The historic trend of rising total power consumption per server is therefore likely to continue:

Server class	US			World		
	2000	2003	2005	2000	2003	2005
Low-end	186	207	217	183	214	218
Mid-range	424	524	641	423	522	638
High-end	5534	6428	10673	4874	5815	12682

Weighted average power (Watts) of top 6 servers, by sales class
(Source: Koomey, 2007)

Data Centers Footprint

ISR-UC

- It is forecasted that the global data center footprint, including equipment use and embodied carbon, will more than **triple** from **76 million tonnes CO2 equivalent emissions in 2002, to 259 million tonnes in 2020** (Climate Group and GeSI 2008).

- The study assumed that 75% of these emissions were related to use;

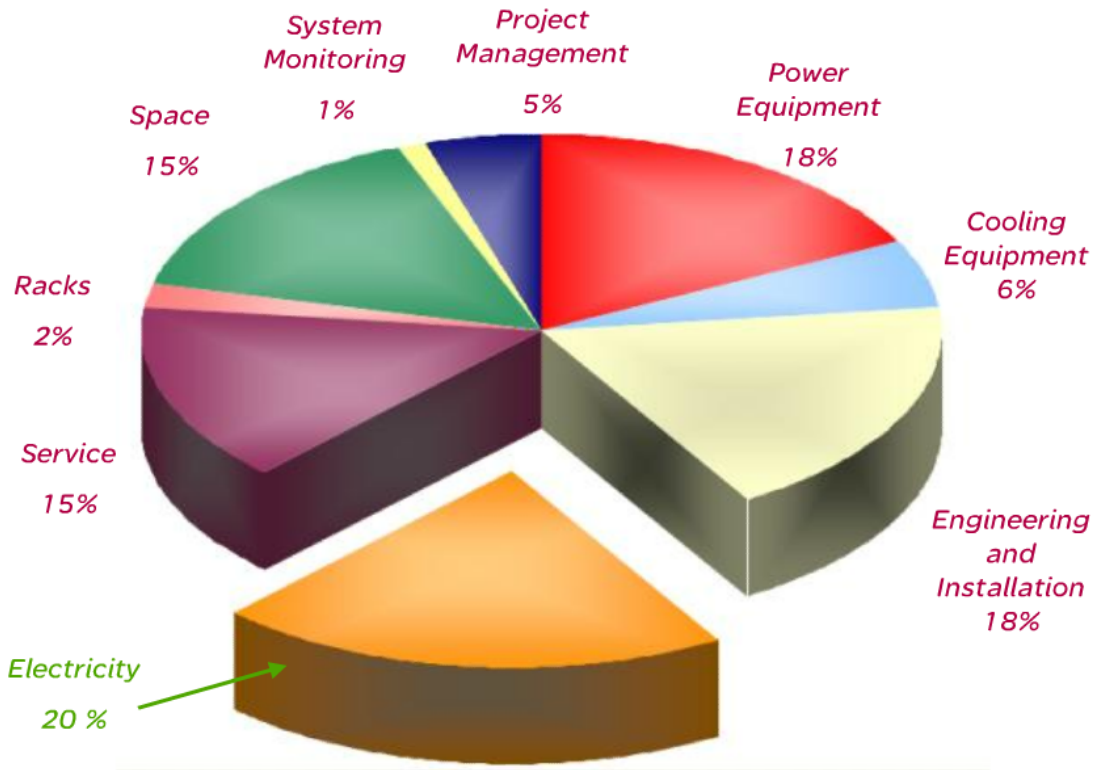
- The totals represent about 14% and 18% respectively of total ICT-related emissions;

- ICT-related CO2 equivalent emissions are said to be about **2% of the global total** (Climate Group and GeSI 2008). Hence, data centers account for around **0.3% of global CO2 equivalent emissions**.

Total Data Center Cost Disaggregation

ISR-UC

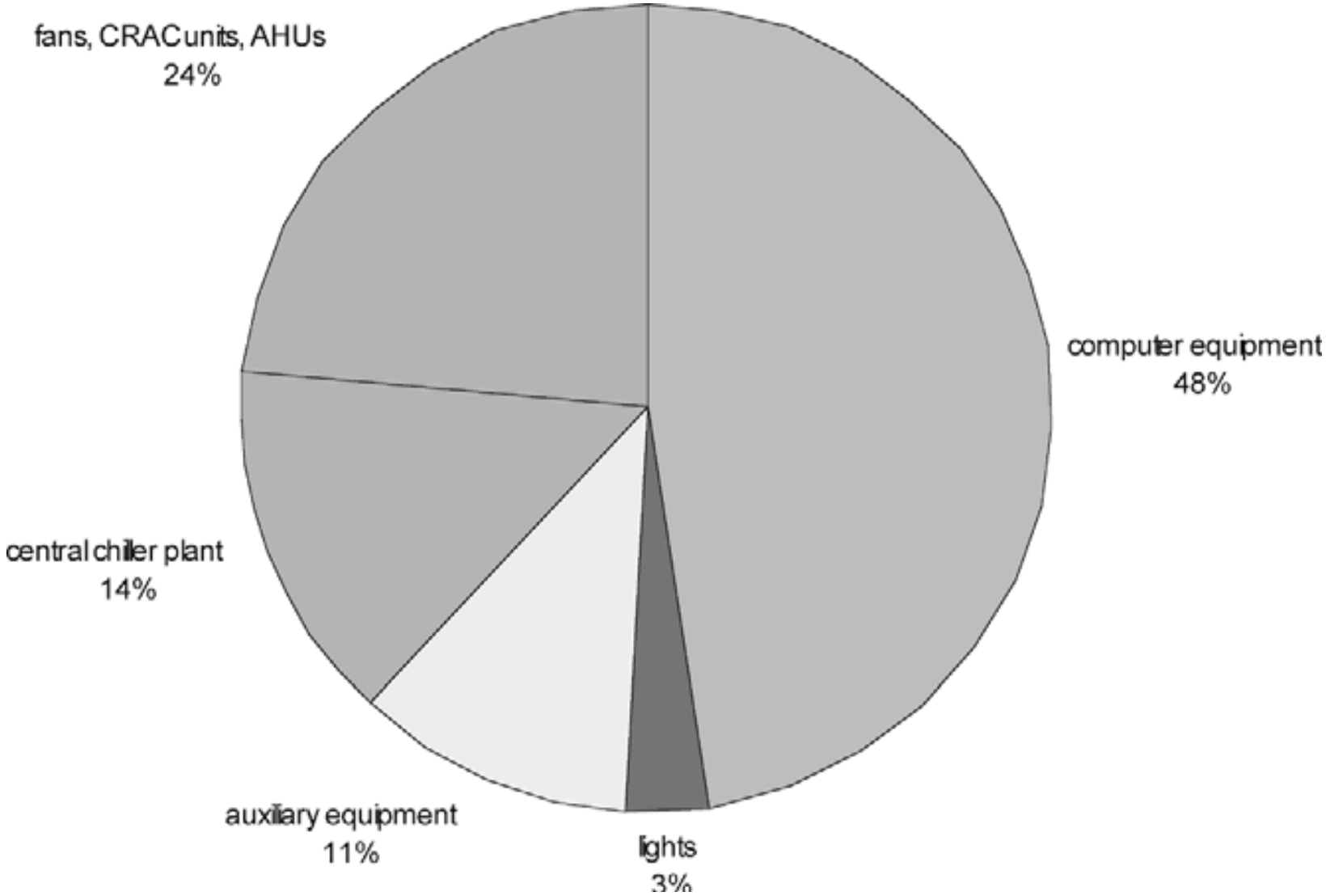
The typical 10-year total cost of ownership (TCO) for a Network Critical Physical Infrastructure (NCPI) in a typical data center can be from $80,000 to $150,000 per rack (Schneider Electric).



Total Data Center Cost Disaggregation (Source: Schneider Electric)

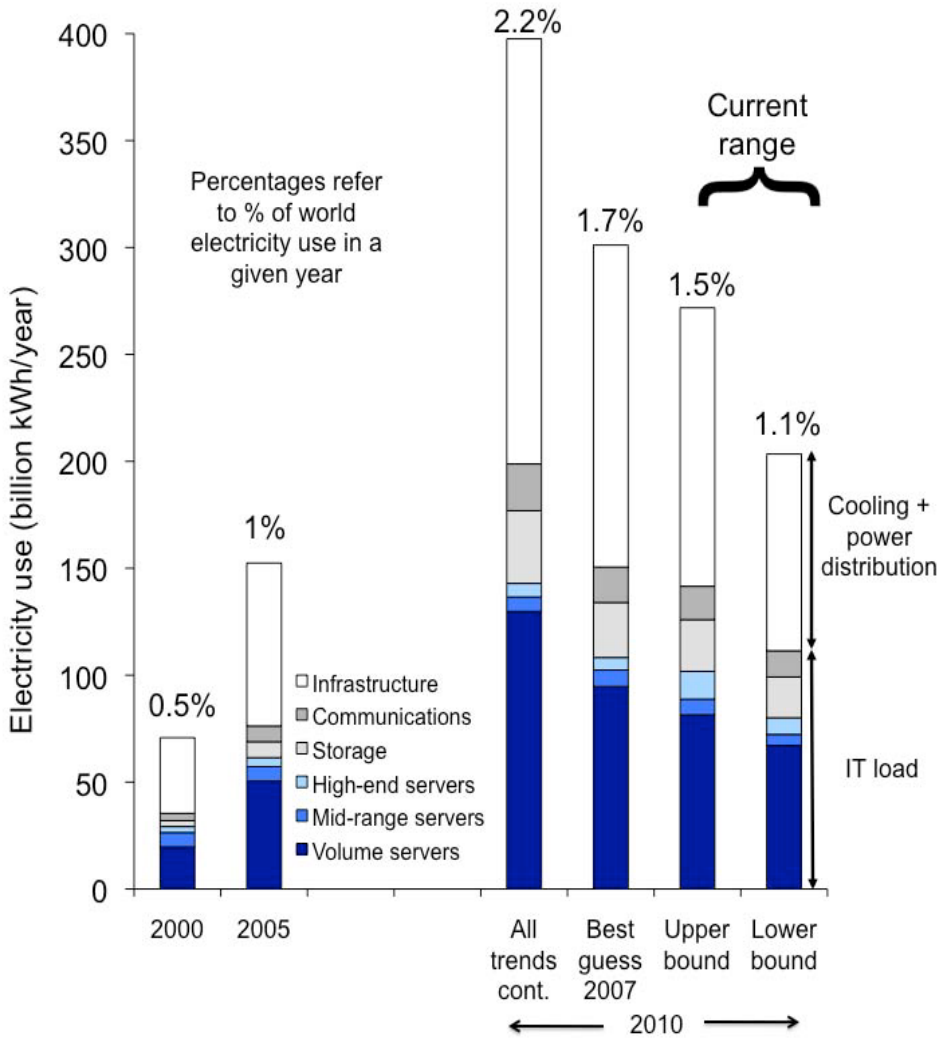
Electrical power breakdown in a Data Center

ISR-UC



World Data Center Total Electricity Consumption

ISR-UC



- Electricity used by data centers worldwide increased by about 56% from 2005 to 2010 instead of doubling (as it did from 2000 to 2005)
- Global data centers in 2010 likely accounted in EU for between 1.1% and 1.5% of total electricity use, respectively. For the US that number was between 1.7 and 2.2%;

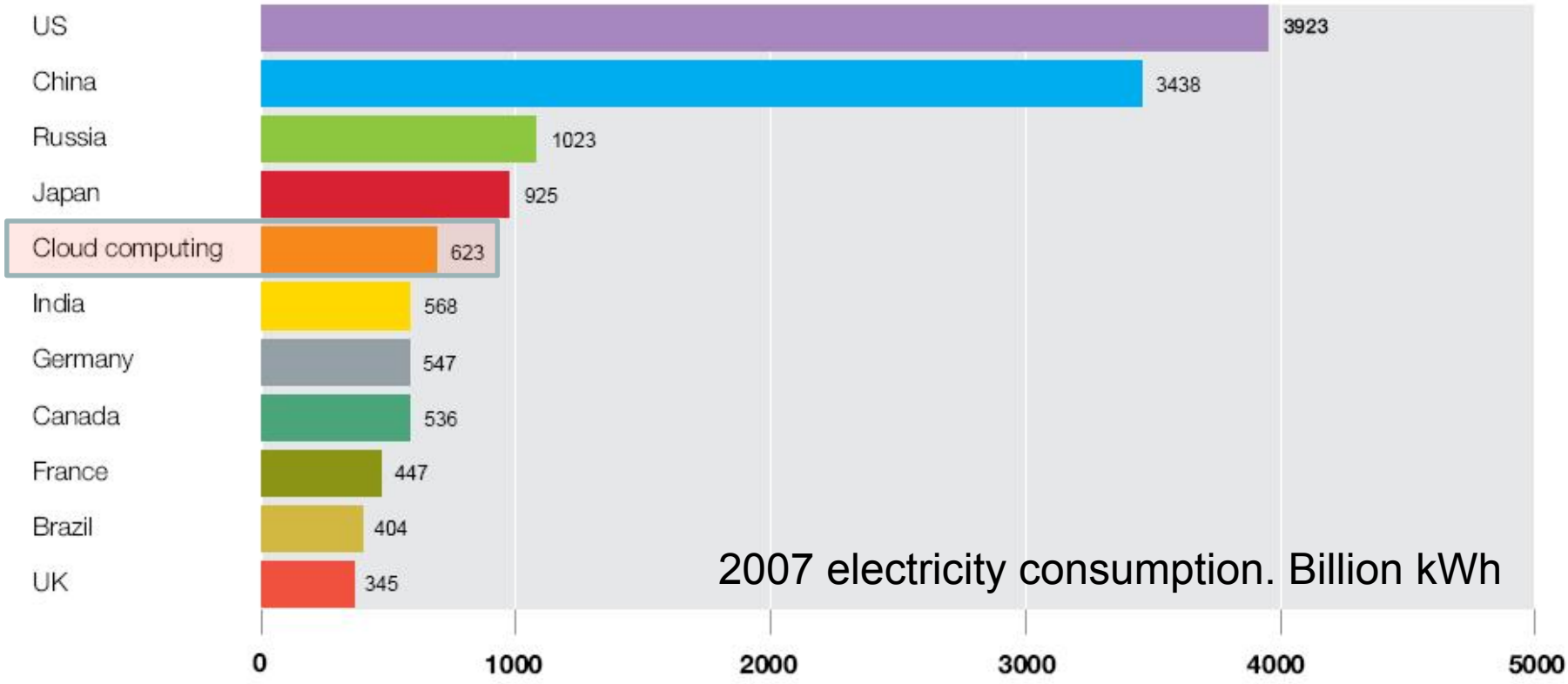
- While Google is a high profile user of computer servers, less than 1% of electricity used by data centers worldwide was attributable to that company's data center operations.

- **Europe -> 56 TWh/year in 2007 and is projected to increase to 104 TWh/year by 2020**

How Clean is your Cloud?

ISR-UC

- Greenpeace study of April 2012) makes a cloud computing assessmment;
- If "Cloud Computing" was a country, it would be the 5th bigger electricity consumption in the World.



IT Services Energy Consumption

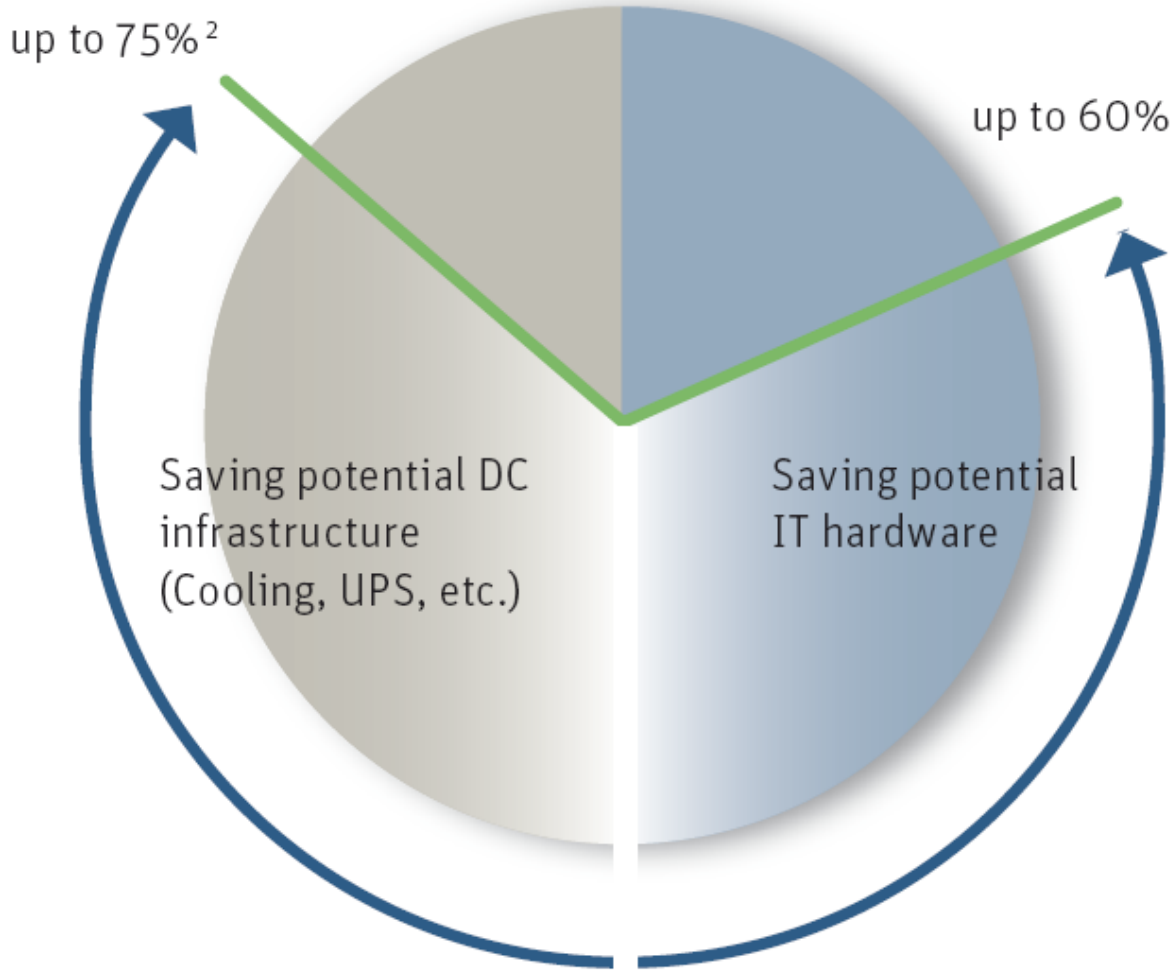
ISR-UC

- A broad implementation of energy efficient technology and system optimization however would allow a reduction of energy demand of about 60% compared to the business as usual scenario;

- Energy efficient technology is available but needs to be broadly implemented in the demand side market.

Energy Savings Potential

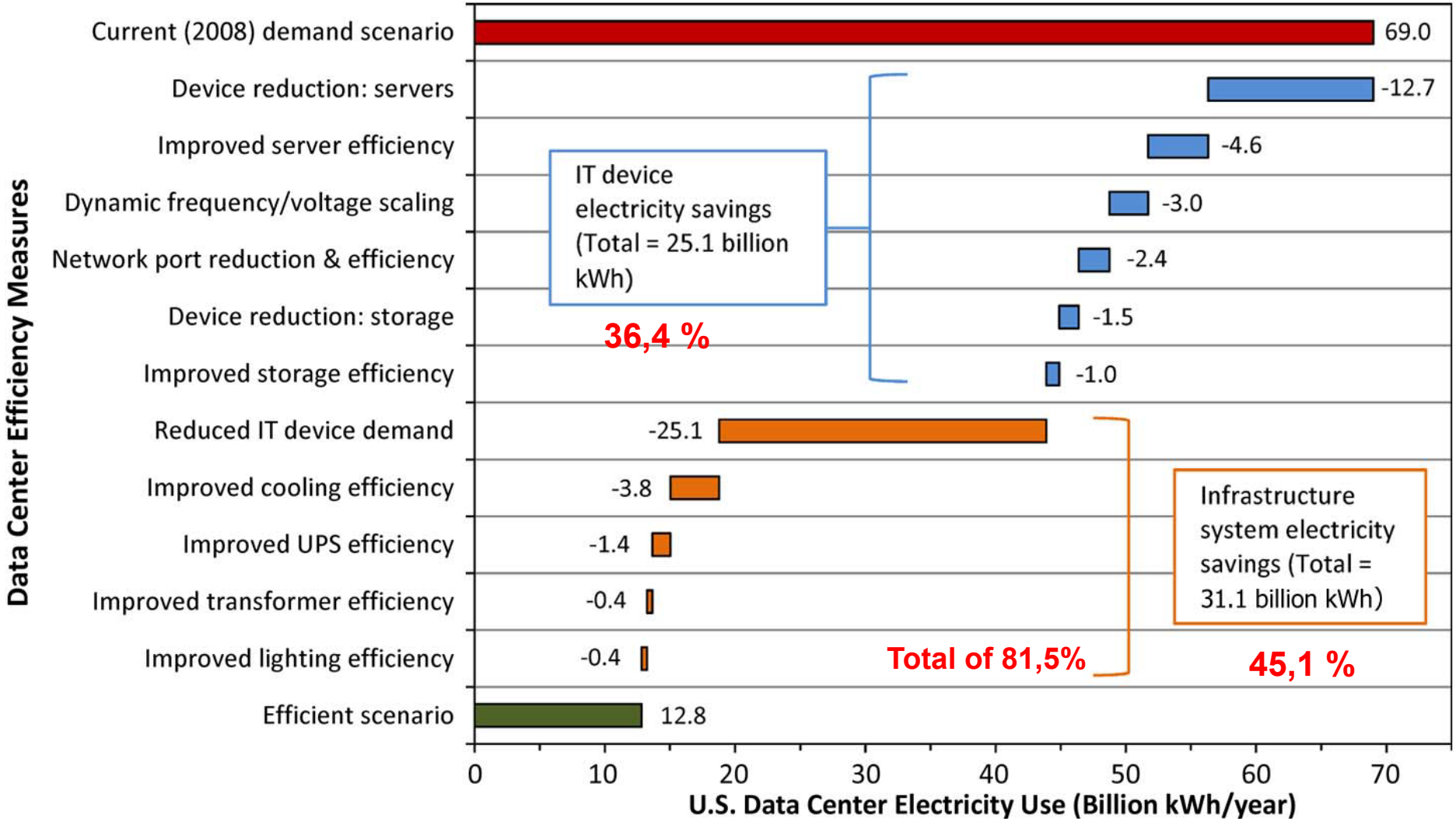
ISR-UC



1 Schäppi et al. (2007), E-Server-Consortium, www. efficient-servers.eu
2 Aebischer (2009), CEPE, ETH-Zürich

Maximum Saving potentials - USA

ISR-UC



(Source: Koomey, Growth in data center electricity use 2005 to 2010)

PUE – Power Usage Effectiveness

ISR-UC

- Power usage effectiveness (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 (in contrast to cooling and other overhead).

$$PUE = Total\ facility\ power / IT\ equipment\ power$$

PrimeEnergyIT – Case Study
Politecnico di Milano

ISR-UC

- **Summary of characteristics for the two data center rooms**

Data center Zone 1 (Main site)	Data center Zone 2 (Disaster Recovery)
Floor area: 84 m^2	Floor area: 63 m^2
Number of physical and virtual servers: **119 / 470**	Number of physical and virtual servers: 119 / 470
Related electrical load: 45 A	Related electrical load: 30 A
Set-point temp: 24 °C	Set-point temp: 23,5 °C
PUE: 1,5 (excluding switchboards)	PUE: 1,5 (excluding switchboards)

PrimeEnergyIT – Case Study
Politecnico di Milano

ISR-UC

- **Evolution of virtualized services in PoliMi data center, 2005-2011**

No. Services / Year	2005	2006	2007	2008	2009	2010	2011
Total servers	232	256	380	325	373	425	471
Physical servers	144	142	217	145	119	119	119
Virtualized servers	88	114	163	180	254	306	352
% virtualization	39%	46%	44%	58%	71%	76%	79%

PrimeEnergyIT – Case Study

Politecnico di Milano

ISR-UC

- **Success factors:**
  - Both rooms' facilities are controlled via a management system tool that provides information on power distribution system, building mechanical and cooling, IT room, and security;
  - Introduction of efficient blade systems and the virtualization process.

- **Average power consumption, years 2005-2011, in kW**

Year	2005	2006	2007	2008	2009	2010	2011
Zone 1 – Main site	30,9	30,3	32,3	30,3	29,3	29,6	29,6
Zone 2 – Disaster recovery	21,1	20,4	22,4	21,7	20,1	20,4	19,7

PrimeEnergyIT – Case Study

City of Marburg high tech cooling

ISR-UC

- The municipality of Marburg (Germany) invested in 2011 into a new highly efficient cooling technology for their existing server room;
- Combined heat, power (CHP) and cooling system provides the cooling power as well as the required electricity for the IT-equipment;
- Turning from standard cooling solutions towards a new integrated energy solution enables the municipality to save more than 70% of total server room energy;
- This allowed energy-cost savings up to 15.000 € per year;
- The micro-cogeneration plant is capable of 5,5 kW electric power and 12,5 kW heating power output (integrated condenser);
- The absorption chiller has a 9 kW cooling power, and is connected with a cold water buffer storage of 500 liters.

PrimeEnergyIT – Case Study

City of Marburg high tech cooling

ISR-UC

➢ Efficient cooling results- energy and cost savings

	Initial situation		CHP with cooling adsorption	
	Energy (kWh)	Expenses	Energy (kWh)	Expenses
Gas consumption for building	335000	18458 €	402871	22198 €
Electricity procurement for building	177000	37878 €	92000	19688 €
Maintenance and repair costs		400 €		2512 €
Revenues for CHPR bonus		--		- 2248 €
Revenues for tax on oil and gas		--		- 999 €
Total costs p.a.		56736 €		41150 €
Energy cost savings p.a.				+ 15585 €
One-off funding of from state of Hessen				32000 €
Static amortization of CHPR system				3,08 years

The PrimeEnergyIT project

ISR-UC

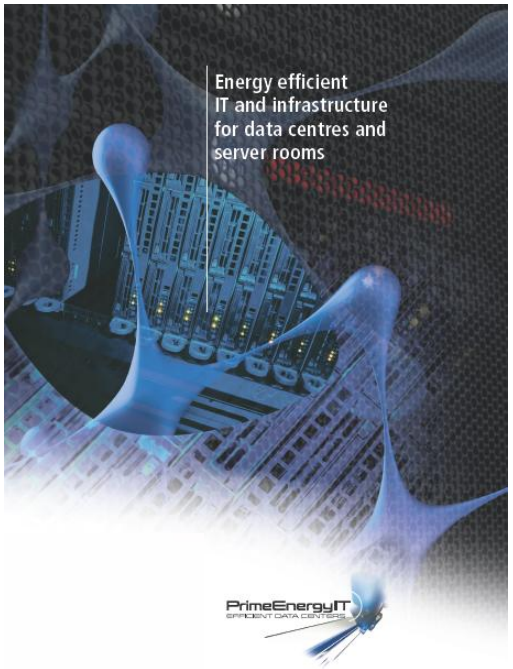
- **The European initiative PrimeEnergyIT supported the market development and demand for energy efficient central IT hardware and infrastructure;**

- **The project outcomes included tools and services for IT and infrastructure managers, consultants and other experts, covering:**
  - Hardware and service based energy efficiency criteria and metrics;
  - Guidelines on energy efficient equipment and best practice;
  - Education and training of IT and infrastructure managers and experts;
  - Guidelines and criteria for procurement and management.

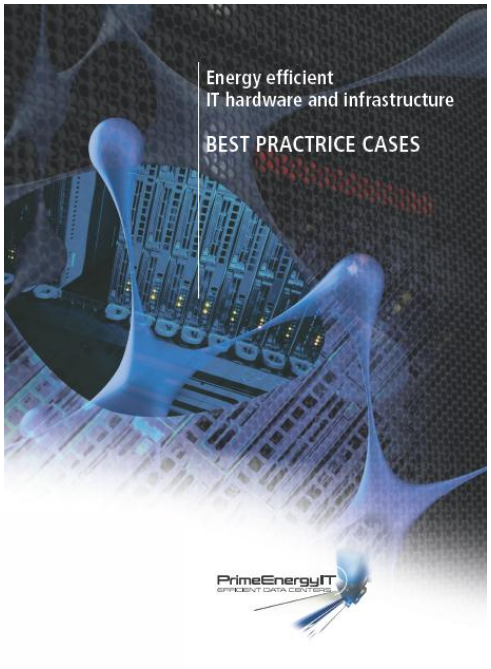
The PrimeEnergyIT project

ISR-UC

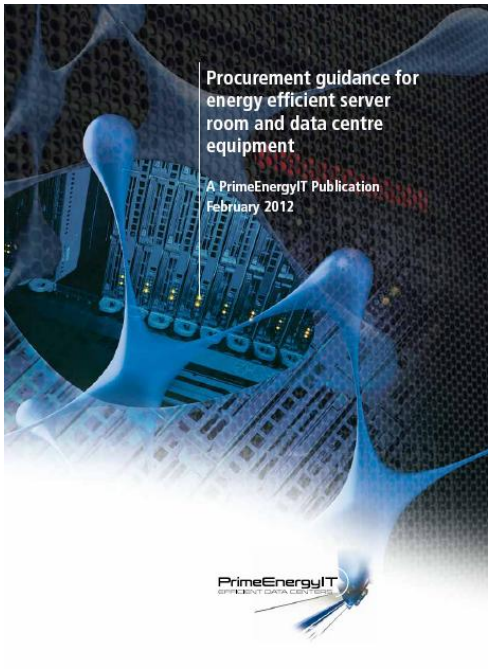
Technical Guidelines



Best Practice Guidelines



Public Procurement Guidelines



PrimeEnergyIT – Procurement Guidelines

ISR-UC

- The guideline **"Procurement guidance for energy efficient server room and data center equipment"** provides purchasing recommendations for public authorities and data center requisitioners in the European Union;

- The core elements focus the replacement and refurbishment of server room
  - Servers
  - Storage devices
  - Network equipment (network access equipment, gateways, switches and routers)
  - Cooling equipment
  - Monitoring equipment

PrimeEnergyIT – Education Events

ISR-UC

- **The main objective of the Education/Training events was to educate and motivate all chain of professionals involved in the ICT systems, into alter their decisions towards improved energy efficiency;**

- **After successful completion of the events, participants should have consciousness about:**
  - Development of energy efficient ICT systems;
  - Energy-efficient procurement;
  - Energy life-cycle analysis of an ICT system;
  - Analysing energy gaps of existing ICT hardware and infrastructures and develop plans aiming their improvement;
  - Responsibility towards improvement of energy performance.

PrimeEnergyIT – Education Events

ISR-UC

➢ Training modules developed

- **M1** •Introduction and Energy and Environmental Impacts of Data Centers and IT facilities
- **M2** •Energy consumption monitoring and cost analysis
- **M3** •Server equipment
- **M4** •Data storage equipment
- **M5** •Network Equipment
- **M6** •Design of energy efficient cooling systems
- **M7** •Free cooling and waste heat recovery (potencials and design)

PrimeEnergyIT – Education Events

ISR-UC

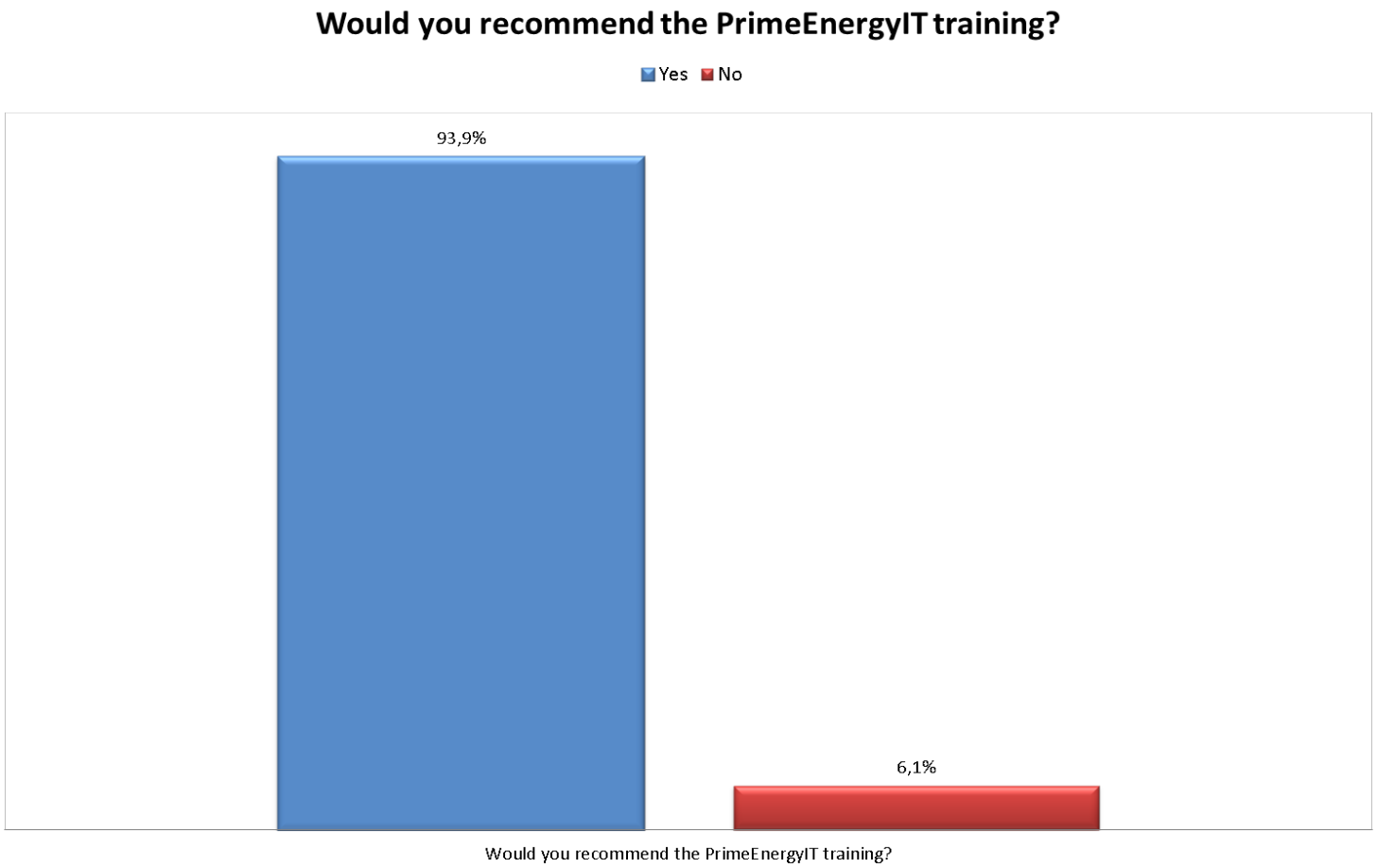
➢ Event summary

Partner	Country	Total Nº of training events	Total Nº of trainees	Questionnaires collected	Followed approach
ISR-UC	Portugal	3	149	104	Full day training workshops with all modules (except M5)
BEA	Germany	4	74	24	3 hours events, all together covering all modules
GAIA	Spain	3	28	28	Full day events with all modules
Seven	Czech Republic	2	37	14	8h30 to 15h00 event covering all modules
TUB	Germany	2	40	10	Half day events, covering all the modules after completing all 2 events
AEA	Austria	4	82	15	Half day events, covering all the modules
eERG	Italy	1	63	31	Full day events with all modules
BIOS	France	2	24	21	One event of 3 days with all modules and another event of one day with M1 and M2
Total		**21**	**497**	**247**	

PrimeEnergyIT – Education Events

ISR-UC

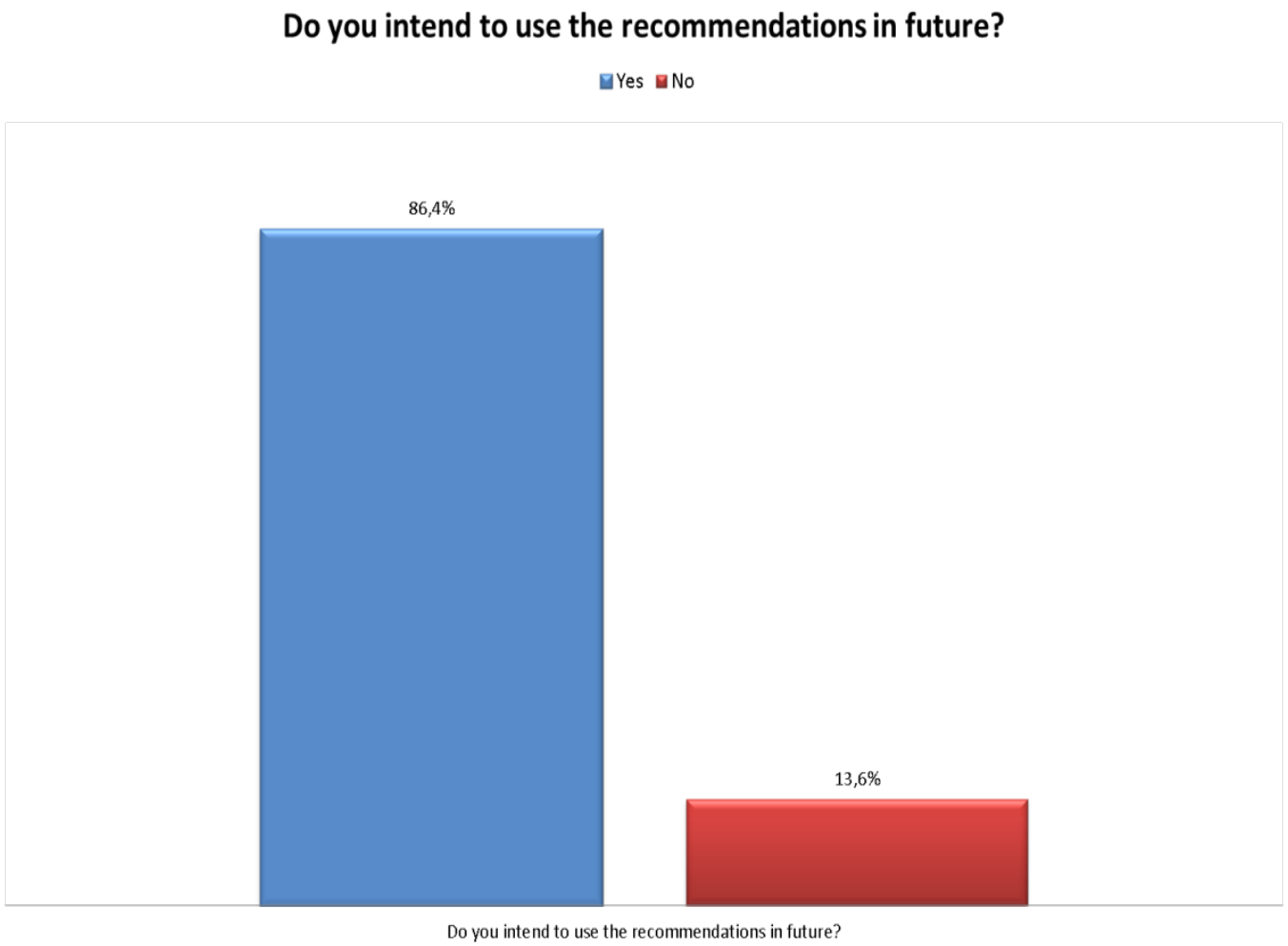
➢ Questionnaire evaluation



PrimeEnergyIT – Education Events

ISR-UC

➢ Evaluation of usefulness by trainees?



Thanks for your attention !

ISR-UC

www.efficient-datacenter.eu

INTELLIGENT ENERGY EUROPE