Green Computing and Sustainability

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Green Computing: a ”hot” topic

Energy efficiency is at the heart of the EU’s effort to tackle the problems of climate change (global warming) (EC Com 2009)

Europe’s targets for 2020:
• saving 20% of primary energy consumption;
• reducing greenhouse gas emissions by 20%;
• raising the share of renewable energy to 20%.

ICT has a key role to play in this challenge

• Using ICT to reduce environmental impact:
  – ICT industry can be a key player in creating a low carbon society
  – ICTs can enable energy efficiency improvements (ICT-enabled improvements in other sectors could save about 15% of total carbon emissions by 2020)

• Reducing the environmental impact of ICT (The ICT footprint): ICT sector is responsible for 2% of global carbon emissions (Gardner report, 2007)
Policies & Tools at European level

2005
**Green Paper** on Energy Efficiency: Set the goal of reducing 20% of energy consumption by 2020.

2006
April: **EC DIRECTIVE** on *Energy end-use efficiency and energy services*: Calls for “National Energy efficiency Action plans from Member States”

2008
May: **EC Communication** on *Addressing the challenge of energy efficiency through ICTs*: Recognition of the potential of ICTs to provide a cost-effective means of improving energy efficiency across industry and broader civil society.

2009
March: **EC Communication** on *Mobilizing ICTs to facilitate the transition to an energy-efficient, low-carbon economy*:

- ICT can enable energy efficiency improvements by reducing the amount of energy required to deliver a given service (by monitoring and directly managing energy consumption; by providing the tools for more energy-efficient business models, working practices and lifestyles; by delivering innovative technologies, etc.)
- ICT can provide the quantitative basis on which energy-efficient strategies can be devised, implemented and evaluated (quantity energy consumption, measuring energy performance at a system level, etc.)

  - ICT sector must measure and quantify the energy performance of its own process
  - ICT sector must reduce the energy consumption of its own process (including operations, manufacturing, service delivery and the supply chain)

October: **EC recommendation** on *Mobilizing ICTs to facilitate the transition to an energy-efficient, low-carbon economy*. Sets a few recommendations for the ICT sector and MS to facilitate the transition to an energy efficient and low-carbon economy

Other tools:

- **FP7**: ICT Work Programme (ICT for a low carbon economy) & Research Infrastructures WP (data infrastructures)
- **Cohesion Policy 2007-2013**: Funds to support the development of ICT solutions that improve energy performance
The Global ICT Footprint

ICT sector represents 7.8% of the EU electricity consumption, and the figure is likely to grow to 10.5% in 2020!

Source: Smart 2020 report
The Global ICT footprint by subsectors

Source of carbon emissions by subsectors (%)

- PCs (workstations, desktops and laptops) will continue to remain the largest pollutants in the future, despite technological improvements, due to the increasing demand in the developing world.

- Telecoms infrastructure and devices demand will also increase significantly, but their relative contribution to the global footprint is expected to decrease due to power consumption reduction from smart chargers and stand-by modes.

- Despite first-generation virtualization and other efficiency measures, data centers share will grow faster than any other ICT technology, driven by the need for storage, computing and other IT services.

Source: Smart 2020 report
The challenge: better environment, smaller costs and better performance

- Behaviours are still mainly driven by costs savings (how much money will I save?) rather than energy savings (How much CO2 will I save?)

- Instead of waiting for a change in priorities, Green IT must seek solutions that are both cost- and energy-saving, without losing efficiency
The case for greener data centers

- Due to their enormous energy consumption, data centers have a large and growing carbon footprint;
- Virtualization and cloud computing are major trends driving down the global footprint but ultimately rely on big data centers;
- There is much room for energy efficiency improvements in data centers that can reduce this footprint;
- Data centers are an area where improved environmental performance can result in significant costs savings.
Where does the energy go and how to measure data center efficiency?

**INFRASTRUCTURE SUPPORTING IT EQUIPMENT**

**Power delivery components**
- Uninterruptible power supply (UPS)
- Switch gear
- Generators, power distribution units (PDUs)
- Batteries, etc.

**Cooling system components**
- Chillers
- Computer room air conditioning units (CRACs)
- Direct expansion air handler (DX) units
- Pumps
- Cooling towers

Computer, network, and storage nodes, data center lighting, etc.

**Power Usage Effectiveness (PUE)**

\[
PUE = \frac{\text{Total Facility Power}}{\text{IT Equipment Power}}
\]

PUE = 2: for every watt of IT power, an additional watt is consumed to cool and distribute power to the IT equipment.

Most of today’s data centers have a PUE between 1.8 and 3.0. The most energy efficient can achieve 1.2
Focusing on improving energy efficiency = saving costs

Average energy consumption and costs of running operations for 1MW IT equipment according to different PUE (based on Finnish Electricity costs for Industry)
How to improve energy efficiency? Take advantage of the climate using external free cooling

Air vs Water cooling
CSC Roadmap for data centers

**2005**
- **DC I**
  - 500kW
  - Critical load, security
  - Energy from national grid
  - Free cooling (air)
  - €/MWh high

**2008**
- **DC II**
  - 800kW
  - Scientific computing, showroom
  - Green energy from national grid
  - Free cooling (air)
  - €/MWh mid

**2012-2015**
- **DC III, IV, V**
  - 4 - 16MW
  - Computing, Hosting
  - Modular capacity and service levels
  - Local Green energy
  - Free cooling (water)
  - €/MWh very low
  - Finnish flagship datacenter (public sector)
  - Fostering Finnish competitiveness on Green IT / datacenter business
The Finnish Roadmap: transforming old paper mills into data centers

Kajaani paper mill (Central Finland)

Voikkaa paper mill (Southern Finland)
Transforming old paper mills into data centers

**Technical**
- Finnish paper mill environments are basically well equipped for future proof data centers and server farms
- Technical infrastructure is built according to demanding specifications for process industry, robust and redundant power sources (high reliability)
- Redundant water supply
- Redundant energy supply
- Located nearby rivers and lakes, thus enabling water cooling
- Local green energy production without transmission loss
- Existing equipment to be utilized
  - Pump stations
  - Pipelines
  - Cooling water tanks
  - Transformers for electricity
- Solid buildings for heavy modules and space for large server farms that can host more than one Data center
- Well functioning network and data communications

**Business**
- Existing infrastructure — less investment needs
- Less investments for facilities — more resources for advanced green technology
- Part of bigger industrial campus: Lower energy cost without transmission fee + Option to monetize excess heat
- Managed environment
- Free cooling

**Environment**
- Existing infrastructure increases ecological efficiency
- Economy of scale creates better platform for both to utilize green technology and national skills in energy efficiency
- Centralizing supercomputing and server farms will increase cost efficiency
- Centralized infrastructure enables to avoid CO2 footprint
- Local green energy and water cooling options
Google’s new data center in Hamina

In 2009, Google bought an empty Finnish paper mill in Hamina (Eastern Finland) from Stora Enso, to house a server center.

Google’s criteria for selecting DC locations

- Large volumes of cheap electricity.
- Green energy. Focus on renewable power sources.
- Proximity to rivers and lakes. Datacenters use a large amount of water for cooling purposes.
- Large areas of land. Allows for more privacy and security.
- The distance to other Google data centers (for fast connections between data centers).

*source: www.datacenterknowledge.com
CSC’s new machine room plans

- Proposal for a new datacenter and updated supercomputing and data handling capacity submitted to the relevant ministries;
- Expected decision / funding in May-June 2010;
- If successful, site selection during summer 2010
- New datacenter available 2011

- Extension to the CSC machine room possible, available capacity to others
- Modular concept in paper-mills or other factories: possibility to add full independent data centers next to CSC (synergy benefits)
- Infrastructure available (for example fiber networks etc.)
Collaboration opportunities in Green computing

• Sharing best practices and expertise in Green computing and Green data centers

• Developing joint activities within FP7 Work Programmes and creating a task force to shape policies and the future FP8

• Making the case for European data centers compatible with research communities’ requirements

• Developing collaborations for centralised data centers facilities that are eco- and cost-efficient
Thank you for your attention!