ICT and Energy

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Content

1. Energy demand of ICT today and tomorrow
2. Impact of ICT on energy demand
3. Concluding remarks
4. References, literature
1. Energy demand of ICT today and tomorrow

- What is included in ICT?
- B.U. methodology, data, results
- EU? -> indicators information society
- Importance of infrastructure

What is included in ICT?

- There could be as many as 10,000 telemetric devices per person in the industrialized countries by 2010.
- Within a decade more things will be using the Internet than people (Michel Mayer, head of IBM Pervasive Computing)
**B.U. methodology, data, results**

Energy(t) = \( \sum_{ijk} n_i(t) \cdot e_{ijk}(t) \cdot u_{ijk}(t) \)

with
- \( n \): number of type \( i \)
- \( e \): power in functional state \( j \)
- \( u \): intensity of use by user \( k \)

Computers, office equipment, entertainment electronics, internet, telecom, …
- About 5% of total electricity

Plus 85% of other microprocessors used elsewhere ->
- About 10% of total electricity, or
- About 1 MWh per person and year (CH -> USA, EU?)

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**Total electricity demand per capita in different countries and electricity for ICT per capita in CH and USA**

![Graph showing MWh/capita.year for different countries and MWh_el per capita and year for ICT](image-url)
EU? -> indicators information society

Households (%) with at least 1 PC

People (%) with fast internet access

Source: www.bfs.admin.ch/bfs/portal/de/index/themen/16/04/key/approche_globale.approach.301.html

Importance of infrastructure (1)

Electricity demand 2001 et 2010 in Germany of ICT, by "end-use" in households and offices and by "infrastructure" in households, offices and public infrastructure. Source: Cremer, Aebischer et al., 2003
Importance of infrastructure (2)

Mobile telecommunication, in kWh/Gbit (Faist et al., 2003)

Importance of infrastructure (3)

Figure ES-1: Total electricity use for servers in the U.S. and the world in 2000 and 2005, including the associated cooling and auxiliary equipment

Source: Koomey, 2007
Importance of infrastructure (3)

<table>
<thead>
<tr>
<th>Region</th>
<th>TWh/a 2000</th>
<th>TWh/a 2005</th>
<th>Growth</th>
<th>Growth rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>US</td>
<td>23.3</td>
<td>45.1</td>
<td>94%</td>
<td>14%</td>
</tr>
<tr>
<td>Western Europe</td>
<td>15.1</td>
<td>33.3</td>
<td>121%</td>
<td>17%</td>
</tr>
<tr>
<td>Japan</td>
<td>6.7</td>
<td>12.9</td>
<td>93%</td>
<td>14%</td>
</tr>
<tr>
<td>Asian Pacific</td>
<td>5.8</td>
<td>16.0</td>
<td>176%</td>
<td>23%</td>
</tr>
<tr>
<td>Rest of World</td>
<td>7.6</td>
<td>15.5</td>
<td>104%</td>
<td>15%</td>
</tr>
</tbody>
</table>

Electricity demand of servers (including infrastructure to run the servers) in five world regions. Source: Koomey, 2007/2

More → Aebischer/Roturier, 2007; Souchon et al., 2007

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2. Impact of ICT on energy demand

- What has to be considered?
- Micro, case studies
  - some examples...
- Macro
  - E-business w@tch: desk research (Madlener, 2008)
  - A recent article about impact on US economy

Energy = (Energy/Service) × Service

Energy = (Energy/GDP) × GDP
What has to be considered?

1. Direct energy demand -> increasing electricity demand (1\textsuperscript{st} part)
2. Indirect energy demand
   • Energy over life cycle (embodied/grey energy)
   • Efficiency improvements of technical and economic processes, of vehicles/mobility, buildings
   • Structural changes / substitutions, dematerialisation
   • Faster economic growth (faster increase of productivity)

Micro analysis, case studies

• Processes: control, regulation, adjustment (Spreng, Berkhout, …)
• Building automation, intelligent homes (Aebischer/Huser, …)
• Transport: cars, traffic management
• E-economy: e-commerce, e-work, e-government, … (Heiskanen, …)
Macro analyses (1)

• Collard et al., 2005: Electricity consumption and ICT in the French service sector.
  Key findings: electricity intensity of production has increased (decreased) with diffusion of computers/software (comm. devices)
• Takase/Murota, 2004: Impact of IT investments on energy demand in Japan and US.
  Key findings: by promoting IT, Japan could conserve energy, while the US would likely increase its energy use!
• Laitner, 2003: Is the information economy an energy hog, productivity tool or both?
  Key findings: interrelated trend will likely generate small decreases in energy intensity

Source: E-business w@tch: desk research (Madlener, 2008)

Macro analyses (2)

A recent article about impact of ICT on US economy
Laitner and Ehrhardt-Martinez, 2008: Information and communication technologies: the power of productivity. How ICT sectors are transforming the economy while driving gains in energy productivity.

Key findings: “For every extra kilowatt-hour of electricity that has been demanded by ICT, the U.S. Economy increased its overall energy savings by a factor of about 10 ?!?!!??!
3. Concluding remarks (1)

• Investments or capital stock in ICT = major indicator in “macro analysis”, but not specified what ICT is used for.

• ICT usually used to increase (labor) productivity only and not or a more rational use of energy → Spreng’s triangle: substitution of time and energy (Spreng, 1993)

3. Concluding remarks (2)

• ICT for development
  • WSIS → action plan, but hardly considered infrastructure need and know-how and …
  • 100 USD laptop …
  • Common Service Centres (CSC) scheme of the Indian Government
4. References, literature


http://www.cepe.ethz.ch/publications/Aebischer_haushaltsvernetzung_00_english.pdf


- Cremer et al., 2003. Energy Consumption of Information and Communication Technology (ICT) in Germany up to 2010. Summary of the final report to the German Federal Ministry of Economics and Labour, FhG-ISI and CEPE, Karlsruhe/Zürich


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4. References, literature (2)


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