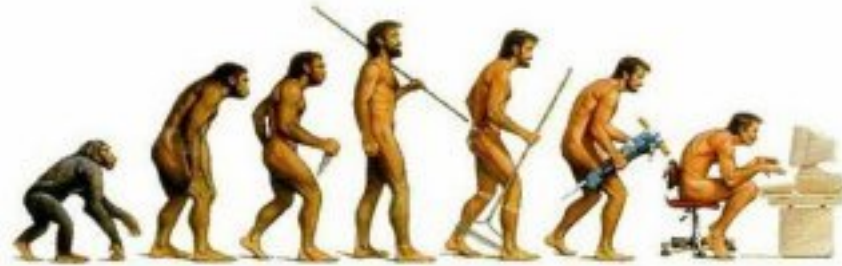




Green IT: Making Access to the World's Information Sustainable

Urs Hölzle
March 2009

Information Evolution: Better technology, lower C02



30,000 years ago

Cave paintings

3,000 years ago

Portable documents: maps and scrolls

400 years ago

Centralized public documents: public libraries

300 years ago

Organized data: encyclopedia

35 years ago

Network for efficient data transfer: TCP/IP "internet"

17 years ago

Interconnected documents: CERN World Wide Web

10 years ago

Organized interconnected data: search engines

Today

Moving electrons, not atoms

Carbon Accounting: CO₂ of everyday activities

- 0.2g Answering one **Google query**
- 20g Using a **Laptop** for one hour
- 75g Using a **PC & monitor** for one hour
- 173g One weekday **newspaper** (physical copy)
- 209g Producing a single glass of **orange juice**
- 280g Washing one load of **laundry** in an efficient machine
- 532g Drinking one **beer**
- 890g Running one load in an efficient **dishwasher**



Travel from Paris to Geneva:

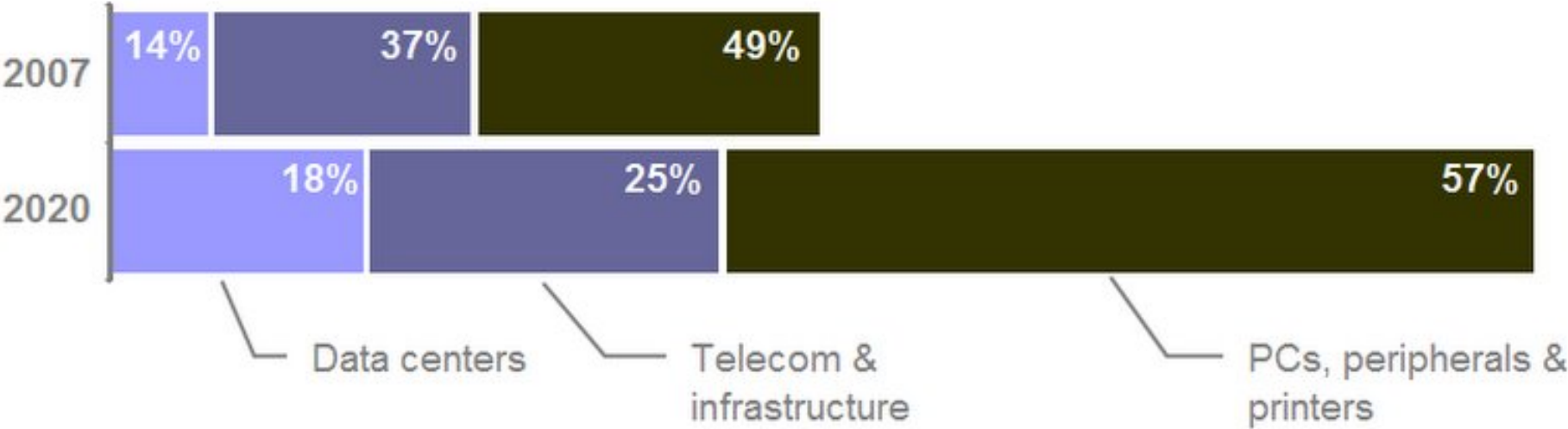
- TGV: 13 kg
- Flying: 56 kg (Economy Class, flight only)
- Driving: 73 kg (EU mandate, not yet met)

80g CO₂ Emissions to research and compute this data

ICT Footprint: 2% of GHG emissions and growing



Global ICT GHG Footprint*



*source: GeSI/The Climate Group: SMART 2020: Enabling the low carbon economy in the information age

Biggest Potential: PCs and peripherals

Fact: The typical PC wastes half the electricity it uses

Fact: Over 60% of all corporate PCs are left on overnight

- End-user devices are the largest portion of IT footprint
- Power efficiency is central to minimizing carbon impact as billions of devices are deployed
- The technology exists **today** to save energy and money

Cutting Waste: Smarter computing

- **Buy power efficient laptops / PCs / servers**
Google saves \$30 per server every year



- **Enable power management**
Power management suites: ROI < 1 year




- **Transition to lightweight devices**
Reduce power from 150W to less than 5W



Potential: 50% emissions reduction

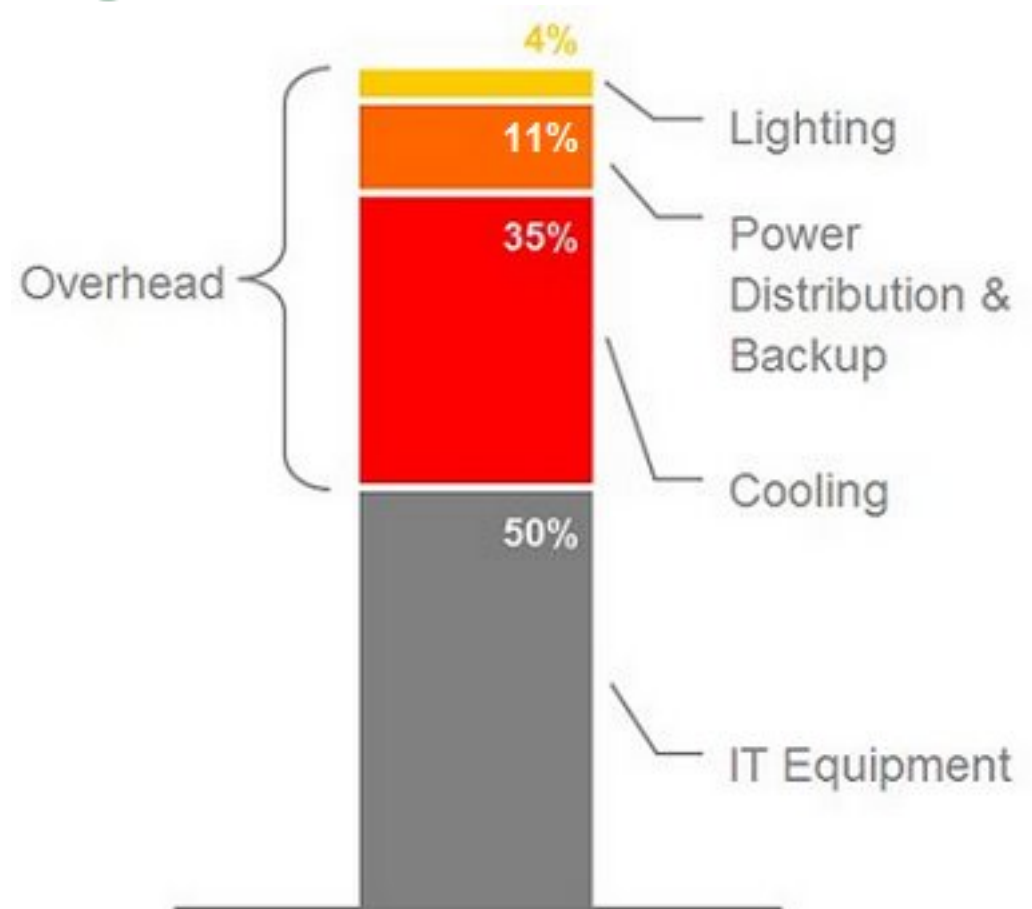
More Opportunity: Data centers

Overhead: A typical data center wastes one unit of energy for every unit delivered to the IT equipment inside

 Typical data center energy use*

Areas to Improve:

- Cooling
- Power distribution
- Server utilization
- Water footprint



*source: Silicon Valley Leadership Group, Data Center Energy Forecast, Final Report July, 2008

Google's Approach: Efficient from chip to cooling tower

Start with metrics & measurements

- Google's annual PUE: 1.19

Better thermal management

- Manage airflow, raise thermostat
- Use evaporative cooling
- Ex: St. Ghislain uses no chillers

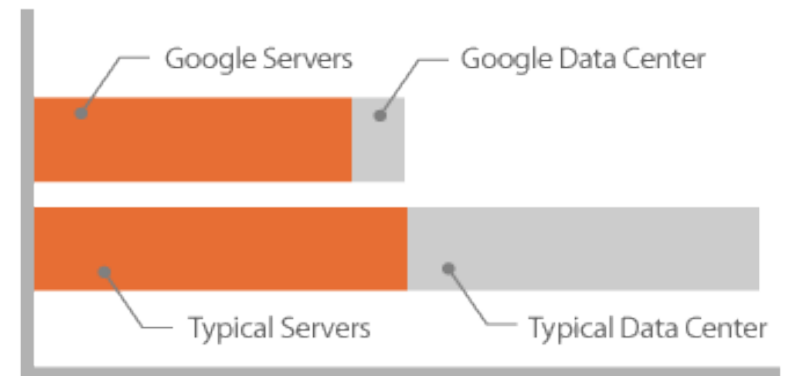
Optimize power distribution & backup

- Minimize energy losses

Result: 50% emissions reduction



Google's energy use*



Water Recycling: Our data center in St. Ghislain, Belgium



Google's data center in Belgium uses **100% reclaimed water** from an industrial canal

We Can Double IT Efficiency

- We can achieve well over **2x efficiency improvement** in PCs and data centers with proven technologies and no reduction in functionality
- Based on our experience, these efficiency improvements have **high ROI**
- Instead of almost doubling IT energy use by 2020, we may be able to reduce it instead!
- This is an **industry choice**, not a research problem

Net IT Carbon Footprint: Much less than zero

The carbon footprint of information pays for itself...and then some



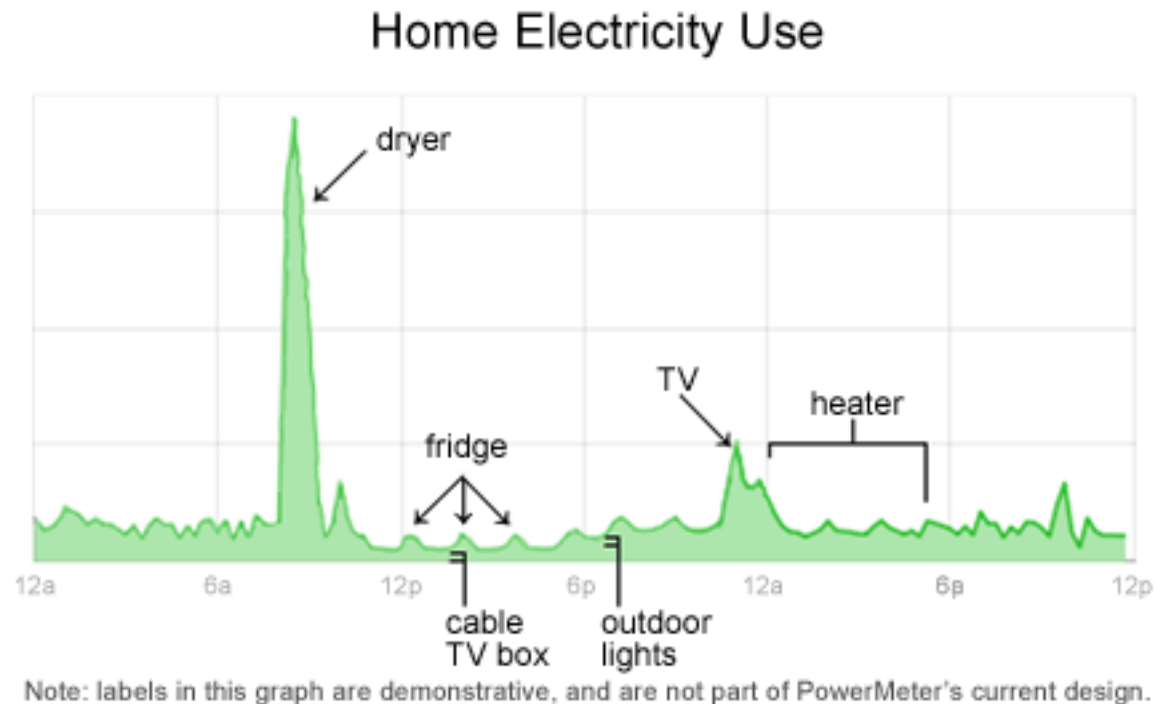
ICT Footprint & Enabling Effect, GtCO₂e*



*source: GeSI/The Climate Group: SMART 2020: Enabling the low carbon economy in the information age

Google PowerMeter: Empower users with energy information

- Near real-time data on home electricity use
- Consumers save 5-15% on their electricity use when given data
- Open standards promote innovation and drive competition



RechargeIT: Accelerate the adoption of plug-in vehicles

- Plug-in vehicles can cut oil use, reduce CO2 emissions, and help stabilize the electrical grid
- Our fleet of converted plug-ins average 93 MPG
- Smart charging will allow plug-ins to charge when electricity is least expensive



RE<C: Developing renewable energy cheaper than coal

- Low-cost, clean, renewable energy is necessary to avoid devastating climate change
- Google is advancing clean energy technologies through development, investment, policy & advocacy

Solar Thermal



EGS



High Altitude Wind



The Power of Green IT: Information creates sustainability

- We can double IT energy efficiency
- We can use IT to make many other products more efficient
- It's our choice--not a technology problem



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