Accounting for the Energy Consumption of Personal Computing including Portable Devices

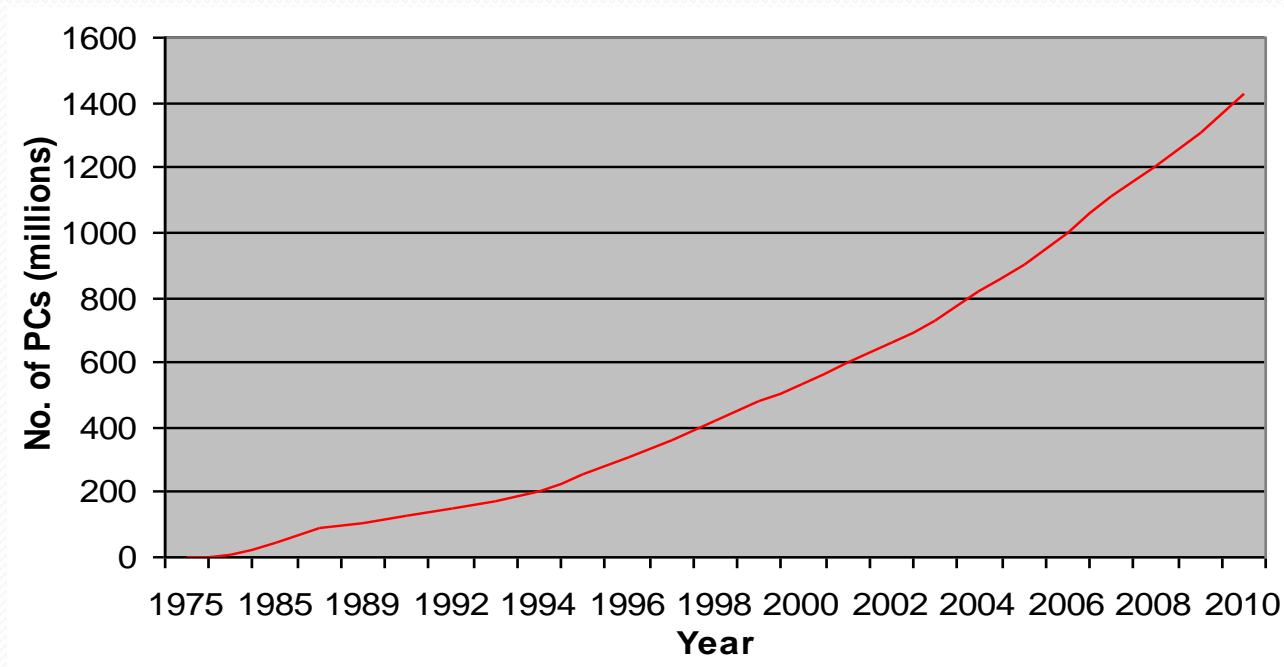Pavel Somavat, Shraddha Jadhav, Vinod Namboodiri

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"I believe that the world has reached a critical stage in its efforts to exercise responsible environmental stewardship."
UN Secretary General Ban Ki-Moon

Projected Computing Growth

- Figure includes desktops, laptops, handhelds, and servers
- BRIC nations set to add 775 million computers by 2015

What should an energy-aware planet know about computing?

- Energy consumed due to various information and computing (ICT) technologies
  - Useful to know what percent of global consumption, and comparison to other sectors

- Amount of CO_2 emissions from ICT
  - Useful to know what percent of global emissions, and comparison to other sectors

Goal of this work

- Account for energy consumed due to the personal computing segment
  - Includes portable devices, desktops, servers/data centers, and mobile infrastructure

- Recent growth in portable devices like laptops and mobile phones warrant specific attention
  - No prior work in accounting of energy consumed in relation to broader computing and global numbers

Targeted Area
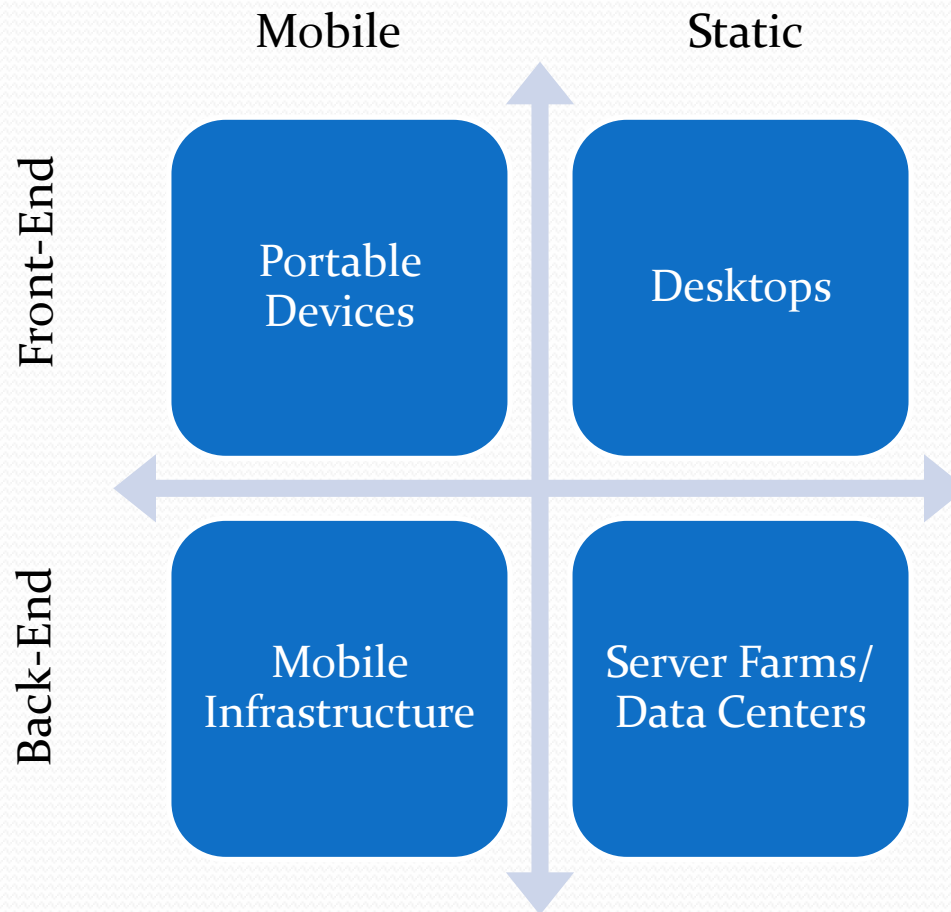
Accounting Methodology

- Energy Consumption
  - Portable Devices
    - Laptops
    - Mobile Phones
  - Desktops
 - Data Centers
  - Mobile Infrastructure

Based on quantity in use, and per unit energy usage

Based on previous accounting and our projections

Energy Consumption - Laptops

Model	Specification	Power consumption when WNIC off (W)	Power consumption Idling with WNIC on (W)	Power consumption when video streaming through WNIC (W)
HP pavilion dv4t	4GB RAM, 2GHz processor	30	31	32
Dell Inspiron 1525	3GB RAM, 2GHz processor	21	24	36
Compaq Presario C300	2GB RAM, 2GHz processor	28	30	34
Dell Inspiron 1440	4GB RAM, 2.2GHz processor	18	19	24
Aspire 4730Z	2GB RAM, 2GHz processor	27	29	31
Dell Inspiron XPS M1310	2GB RAM, 1.6GHz processor	36	39	48
Hp pavilion dv 2000	2GB RAM, 2GHz processor	64	71	72
Fujitsu Siemens AMILO M7440	512 MB RAM, 1.73GHz processor	29	31	35
Lenovo ThinkPad X60	512 MB RAM, 1.6 GHz processor	21	25	28

Wireless Interface Share
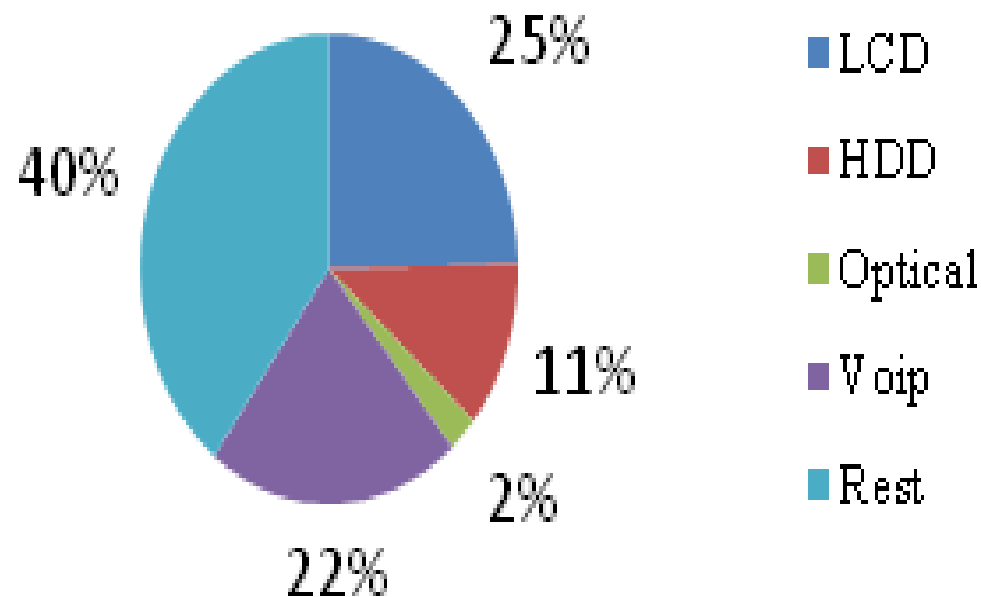
Energy Consumption – Mobile Phones

- Samsung Blackjack smartphone
  - Has no Wi-Fi
  - Bluetooth switched off

- 1W when Idle
- 3W during a Call
- Active communication consumes 2/3rd power !

- Nokia study shows on average a mobile phone consumes 1.2W
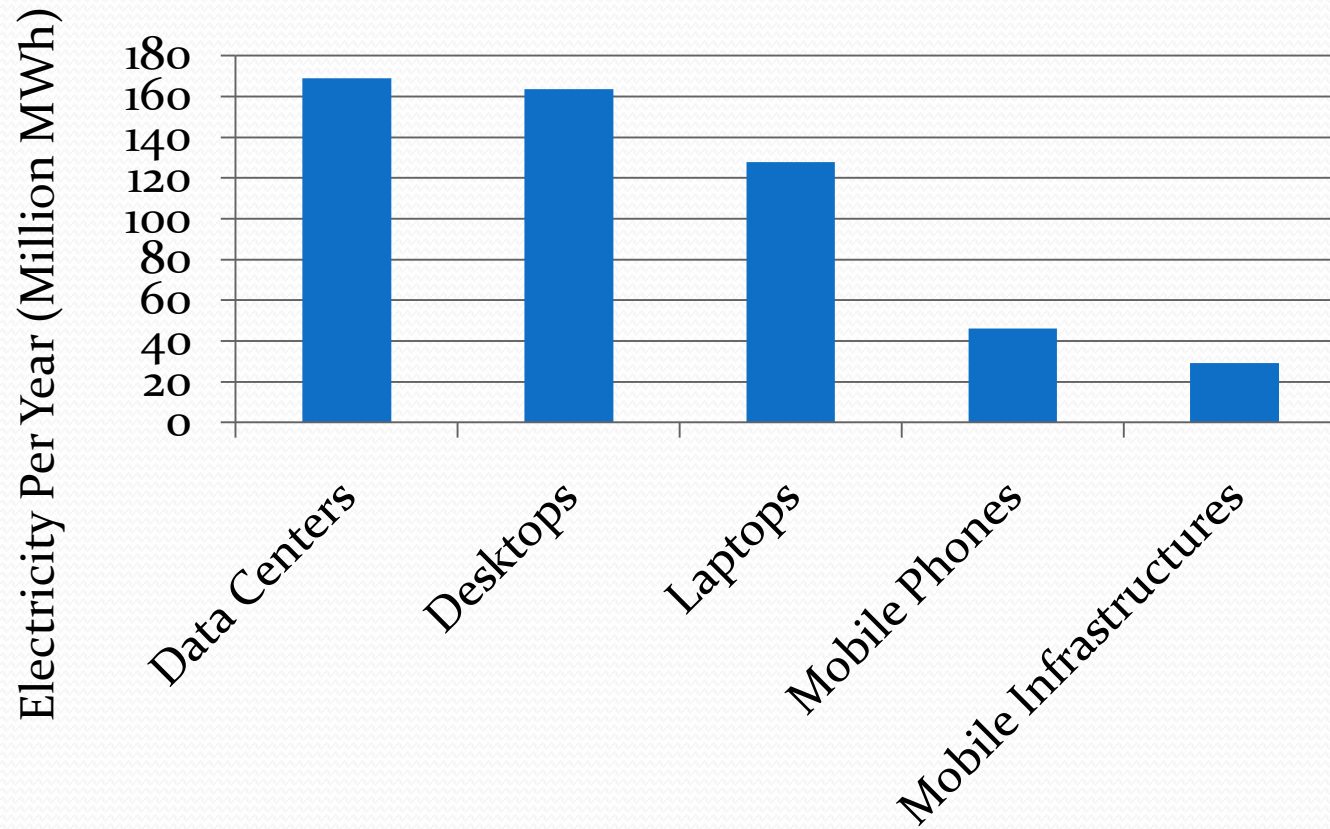
Portable Device Numbers

- Laptops
  - 350 million
  - 35 W, used 10 hours a day

- Mobile Phones
  - 4.2 billion
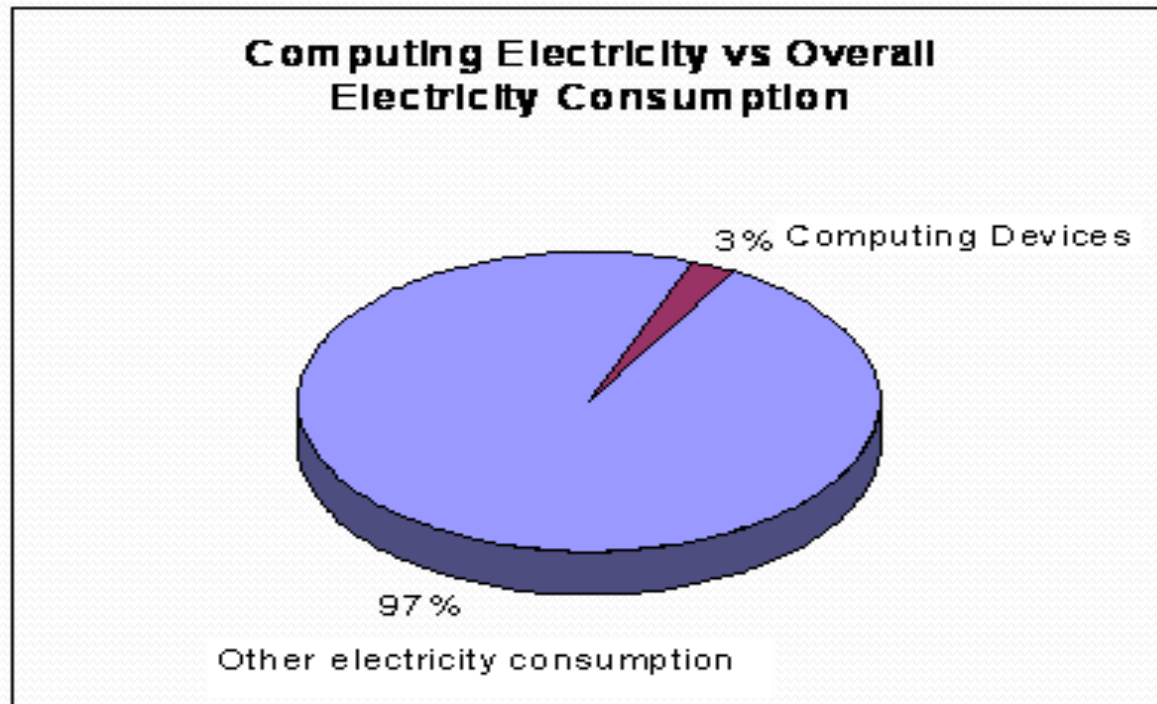 - 1.2 W
  - 11 kWh per year based on a Nokia study

Desktop Numbers and Energy Consumption

- 950 million desktop computers
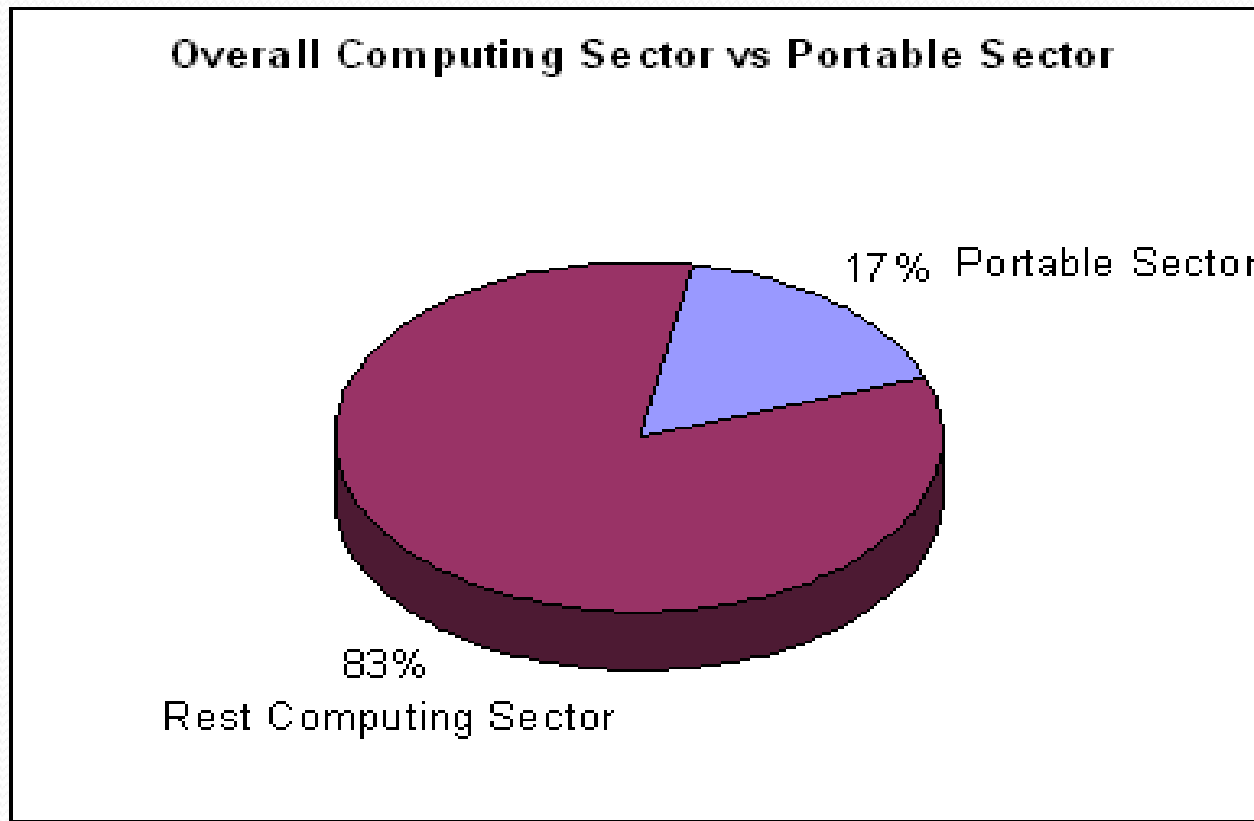- Avg. power consumed is 60 W

- Used 8 hours a day

Global Perspective - Electricity

Share due to Portable Devices

Environmental Impact – CO2

- Electricity consumption only 12% of global energy consumption
  - Personal computing consumes only 0.31% of global energy

- Electricity consumption responsible for 40% of global CO_2 emissions
  - Personal computing responsible for 1% of global emissions
  - Coal, a major source of electricity generation
  - Equivalent to emissions by 4.5 million vehicle s driving 10,000 miles per year with average mpg of 21.

- Thus computing responsible for a larger share of emissions than what is expected based on share of global energy consumption

Individual Consumer Perspective

- What share of a household's electricity consumption is due to personal computing?
  - Assume each household has 2 mobile phones, 1 laptop, and 1 desktop

- This question asked for households of two countries
  - U.S: Large, developed country
  - India: Large, developing country

- Methodology
  - Compute average household electricity consumption
  - Compute Personal computing and portable devices share

Computing Share in Residential Consumption
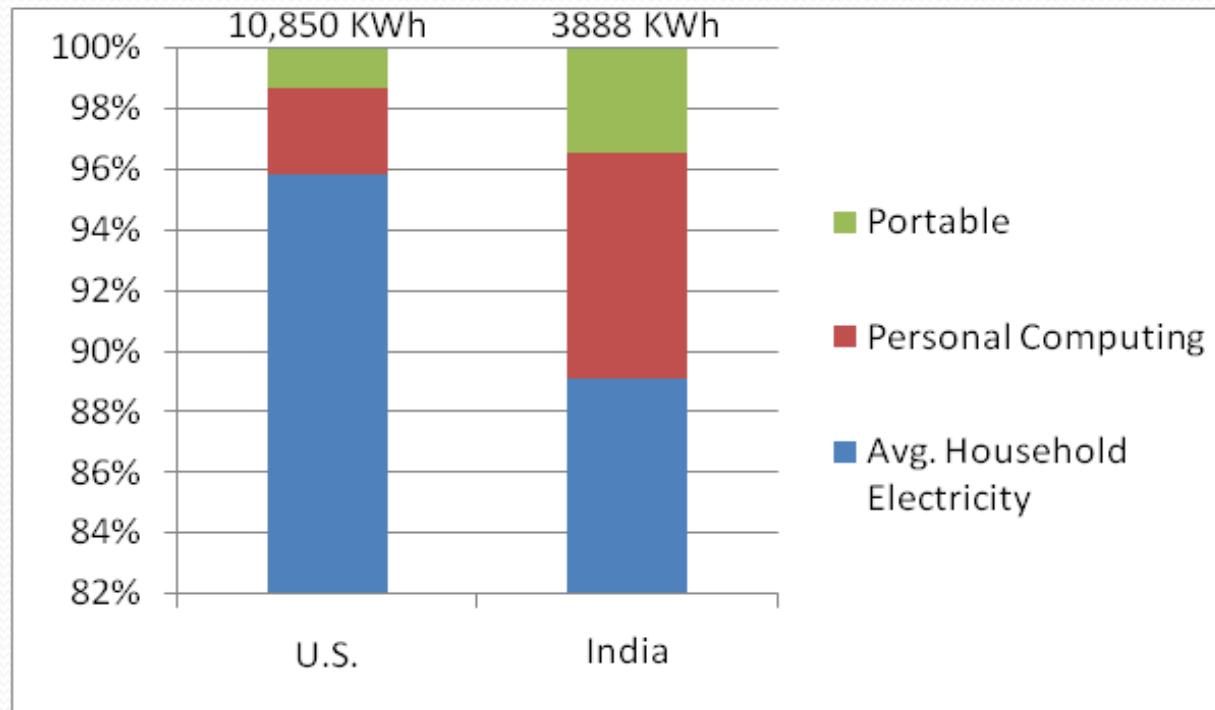
Recommendations to Networking Community

- Employ Power Management
  - More informed users, enable more tunable energy-performance tradeoffs
- Improve Battery Management
  - Utilize recharge effect better to reduce frequency at which power outlet used for charging
- Adjust Optimization Metrics
  - Emphasize total power of a collective network instead of individual power
- Utilize Energy Harvesting
  - Now possible to find laptop solar panels for $350, phone solar panels for $120

Conclusions

- Personal computing 3% of overall global electricity usage

- Portable devices consume 17% of electricity share of personal computing segment!

- Usage of electricity results in higher CO_2 emissions than expected based on energy consumption share

- Personal computing will be a large share of residential consumption in many countries of the world which are smaller in terms of per-capita energy consumption