CANARIE

How the Optical Networks and Cyber-infrastructure can be more significant than carbon taxes or cap and trade in reducing Global Warming

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The Climate Change Imperative

- One of , if not, the greatest threat to our future society and economy is global warming.
- 15-30% cut in greenhouse gas emissions by 2020 will be needed to keep the temperature increase under 2 °C, and a deeper reduction by 60-80% may be needed by 2050.*
- It will be necessary to go beyond incremental improvements in energy efficiency, current life-styles and business practices. Significantly more drastic measures will need to be undertaken

*International Panel on Climate Change

An inefficient truth- ICT impact on CO2 emissions*

- It is estimated that the ICT industry alone produces CO2 emissions that is equivalent to the carbon output of the entire aviation industry.
- ICT is now 5th largest industry in terms of consumption of power
- ICT emissions growth fastest of any sector in society, doubling every 4 years
- One small computer server generates as much carbon dioxide as a SUV with a fuel efficiency of 15 miles per gallon
- Nearly 40% of servers at universities and businesses are under utilized by more than 50%.

*An Inefficient Tuth: http://www.globalactionplan.org.uk/event_detail.aspx?eid=2696e0e0-28fe-4121-bd36-3670c02eda49

Cyber-infrastructure: the scary facts

- By 2008, 50% of today's Data Centers and major science facilities in the US will have insufficient power and cooling;*
- By 2009, energy costs will become the 2nd highest cost of a Data Center or science facility*
- By 2010, half of all Data Centers will have to relocate or outsource applications to another facility.*
- During the next 5 years, 90% of all companies and universities will experience some kind of power disruption. In that same period one in four companies will experience a significant business disruption*
- Cyber-infrastructure is often the 2nd largest consumer of electricity after basic heat and power on university campuses

*Sourcce: http://www.nanog.org/mtg-0802/levy.html

Universities to be carbon neutral by 2010 in BC

- **British Columbia was first government to introduce carbon tax in Western Hemisphere**
- **Provincial Government in province of British Columbia has mandated all public sector institutions to be carbon neutral by 2010**
- **This will have big impact on universities as Cyber-Infrastructure is very energy intensive**
- **Major planning underway to explore how to move computation and Cyber-Infrastructure off campus**
- **CANARIE has deployed a 2.5 Terabit optical network that will enable connecting computers and instruments at remote sites to universities**

UK – JISC study

- **Why the future's green for IT at universities**
  - http://education.guardian.co.uk/link/story/0,,2278356,00.html
- **Green IT is best achieved through the collaboration of IT and campus facilities management – power, heat and real estate**
  - Most researchers are not aware of true costs of computation such as power, cooling, and specialized buildings.
- **Increased energy and computing costs can be offset by technologies such as grid computing and virtualisation.**
  - "Eighty to 90% of a computer's capacity is wasted.
- **Cardiff University solution to the cost of running super computers for research projects by centralizing departments' IT budgets and transferring byte-hungry number-crunching to clusters of smaller high-performance computers.**

What does Carbon Neutral mean for universities?

- Still a hotly debated issue
- In Canada most university electricity comes from hydro – which is zero carbon
- But heating is major carbon producer – often oil or gas
- All research travel, all campus vehicles and transportation also must be counted in
- So how do you balance out carbon costs of heating, research travel and campus vehicles??
- Universities could end up paying substantial carbon offset fees in order to stay carbon neutral

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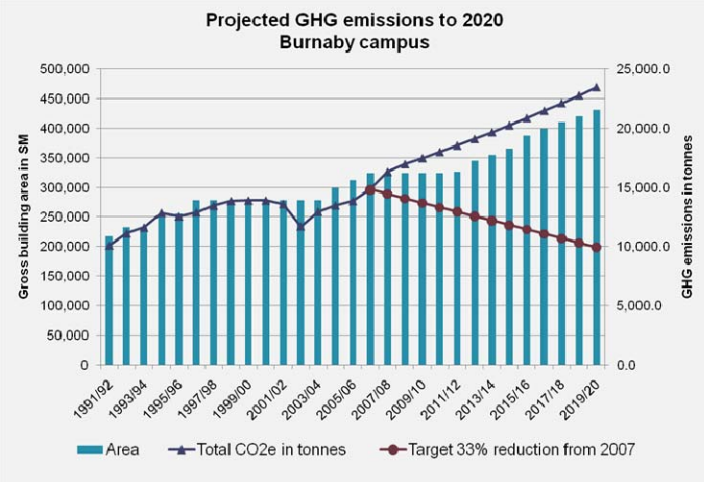
University GHG emissions

➢ Projected GHGs are based on Planned Growth in Ten Year Capital Plan



Source: SFU Facilities Services

ENERGY MANAGEMENT 1965 - 2008

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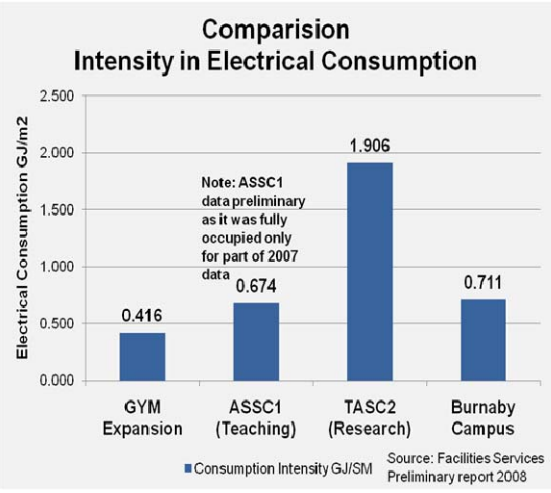
eScience major producer of GHG emissions

TASC2 Research Building



Zero Carbon Strategy for R&E networks

1. **More efficient computers and network equipment**
   - Marginal gains due to Khazzoom-Brookes postulate
2. **Virtualization of laboratories, computer and networks into data centers**
3. **Deployment of data centers at renewable energy sites for business continuity and carbon reduction linked by optical networks**
4. **New network and computer architectures that take advantage of remote zero carbon data centers linked by optical R&E networks**

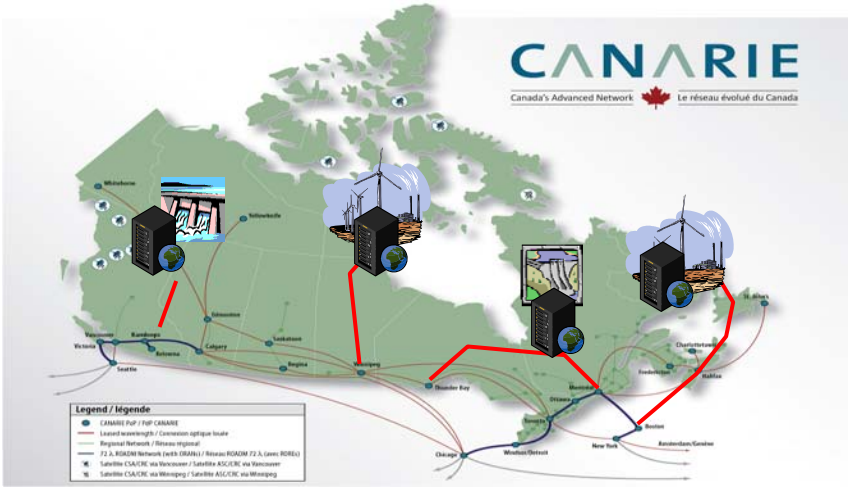
Optical networks and cyber-infrastructure virtualization the solution

- Optical networks (as opposed to electronic routed networks) have much smaller carbon footprint and allow relocating cyber-infrastructure equipment to zero carbon data centers
- Significant reduced CO2 impacts are possible through use of cyber-infrastructure tools like virtualization, clouds, SOA, grids, Web 2.0, etc.
- New "zero carbon" computer and network architectures needed to connect remote computers, databases and instruments will be essential

Optical network essential for zero carbon data centers

- Purchasing green power locally is expensive with significant transmission line losses
- Demand for green power within cities expected to grow dramatically
- Cyber-infrastructure and data centers DON'T NEED TO BE LOCATED IN CITIES or at UNIVERSITIES
  - -Cooling also a major problem in cities
- Most renewable energy sites are very remote and impractical to connect to electrical grid.
  - But can be easily reached by an optical network
- Locating cyber-infrastructure and data centers at remote renewable energy sites connected by optical networks will provide access to cheap green power not practical to use by other industry sectors

“Zero Carbon” data centers connected by optical networks



“The best place in North America for Data Center”- CIO Magazine

- Partnership between IBM and Rackforce
- $100m investment – 85,000 sq ft
- Cheap renewable power, well educated community, geological stability
- Hydro electric power as low as 2 cents per kilowatt, versus 20 cents in other jurisdiction

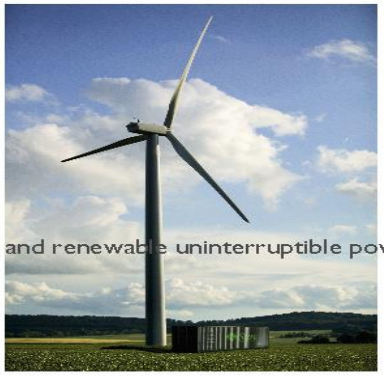
Kelowna BC

http://www.cio.com/article/183256/The_Best_Place_to_Build_a_Data_Center_in_North_America

Grid in a Box at windmill

Green Power is the Future

-wind
-solar
-hydrogen



Sustainable and renewable uninterruptible power supply

BASTIONHOST

Source: www.Bastionhost.com

Financial Incentives

- Many utilities offer incentives to reduce consumption
- PGE Incentives for energy-efficient computing equipment (Rip & Replace only)
- PGE Incentives for virtualization/consolidation
- IBM “Big Green” earn up to $1 million through carbon offsets by virtualizing your computers
- Undertake carbon offset audits and sell carbon offsets to power plants or carbon offset exchange
  - Chicago Climate Exchange
- Carbon Offset Credits can be earned by network provider or cyber-infrastructure provider

The Falsehood of Energy Efficiency

- **Most current approaches to reduce carbon footprint are focused on increased energy efficiency of equipment and processes**
- **This approach is doomed to failure because of Khazzoom-Brookes postulate (aka Jevons paradox)**
  - Greater energy efficiency reduces overall cost and therefore promotes increased usage
- **We need a "zero carbon" strategy because increased usage will not change emission equation**
  - Anything times zero is zero
- **Internet networks and broadband architecture are the answer**

Next Generation Internet to reduce Global Warming

- **PROMPT: New $50m research consortium made up of Bell Canada, Nortel, Ericsson, McGill, UoT etc**
- **Any future internet network, project, program or application must have as its primary objective of a zero carbon footprint**
- **Zero carbon condition applies to**
  - all optical, wireless and last mile networks
  - all routers, switches, and web servers
  - all applications, computers
  - and all customer devices such as PCs, mobile phones, PDAs etc
  - Remote laboratories and instrumentation

Novel licensing approach

- Instead of complicated licensing agreements and royalties payment for IP will be made through carbon offsets
- PROMPT plans to set up a number of testbeds to develop CO2 reduction protocols, verification and audit systems to measure networks and ICT ability to reduce CO2
- PROMPT will work with various carbon offset brokerage firms to aggregate and sell carbon offsets
- Many companies like Cisco, Google, IBM, etc will purchase carbon offsets if you use their technology top reduce Co2

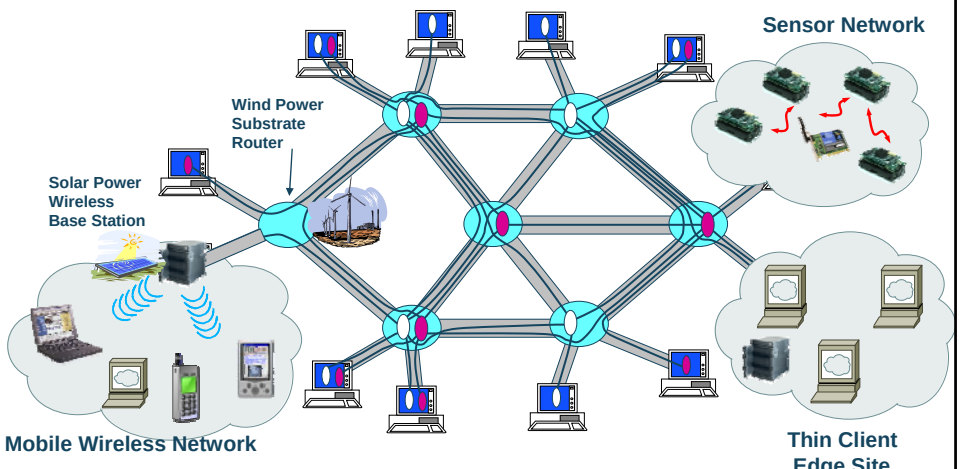
Possible research areas

- Dynamic all optical networks with solar or wind powered optical repeaters
- Wireless mesh ad-hoc networks with mini-solar panels at nodes
- New Internet architectures with servers, computers and storage collocated at remote renewable energy sites such as hydro dams, windmill farms, etc
- New routing and resiliency architectures for wired and wireless networks for massively disruptive topology changes due to setting sun or waning winds that power routers and servers
- New grid and data storage architectures with distributed replication and virtual machines (VM turntables, Hadoop) for “follow the sun” and “follow the wind” grids
- New Cyber-infrastructure and virtual laboratories

CANARIE's UCLP foundation for zero carbon Internet

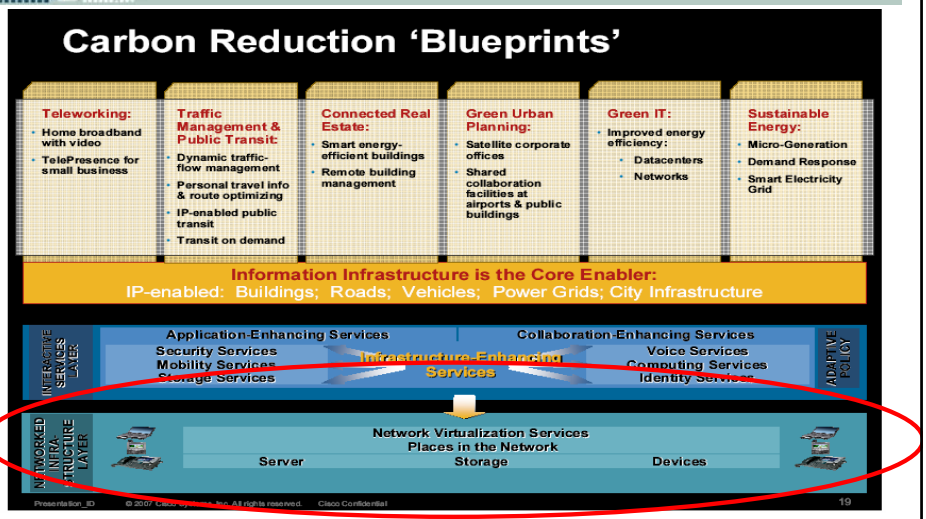
- **UCLP allows creation of virtual networks, application, instruments and services under user control**
- **Foundation for Next Generation Internet initiatives in Europe**
  - Federica
  - 4Ward
  - Phosphorous
- **"Virtualization" is foundation of US Next Generation Internet initiative – GENI**
  - Instead of one common network – many parallel virtual networks

GENI with Zero Carbon Footprint

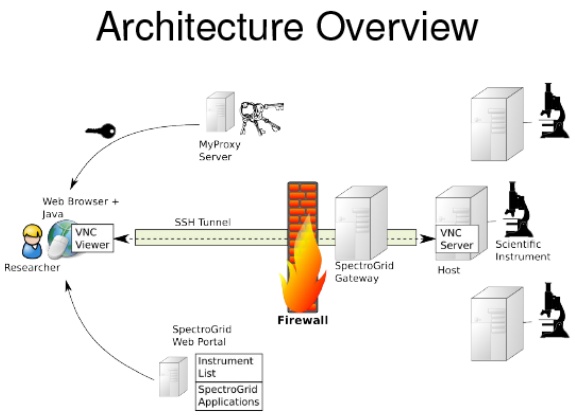


Source: Peter Freeman NSF

Cisco ICT Carbon reduction blueprint



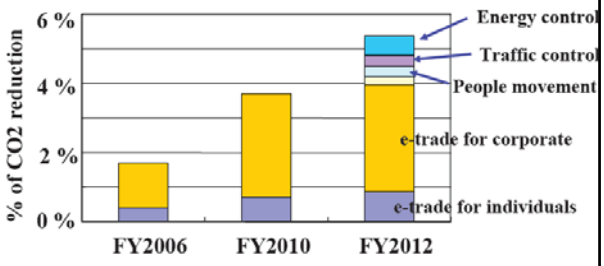
Remote Laboratory SpectroGrid - NRC



ICT and Virtualization may allow us to achieve Kyoto targets

In 2012 application of ICTs to other sectors will contribute to reduction of 68 million tons of CO2, which is equivalent to 5.4% of CO2 emission in 1990in Japan.

90% of Kyoto commitments by Japan

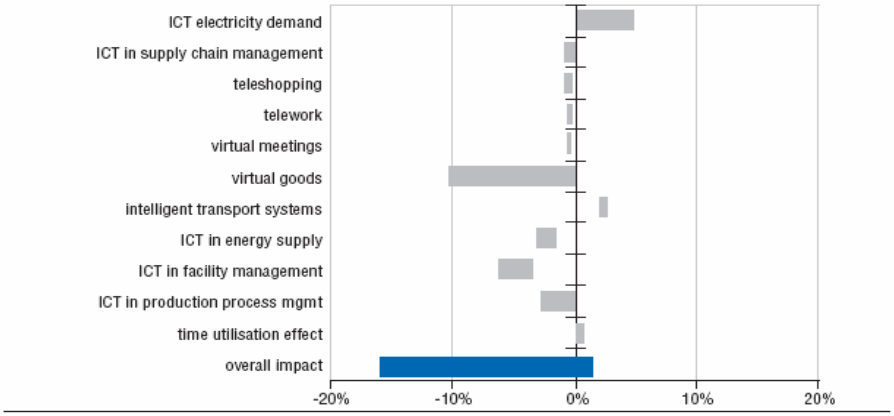


Reference is the FY1990 according to Kyoto Protocol: Japan expected to reduce 6%.

Dr Yuji INOUE's presentation http://www.itu.int/dms_pub/itu-t/oth/06/0F/T060F0060080025PDFE.pdf

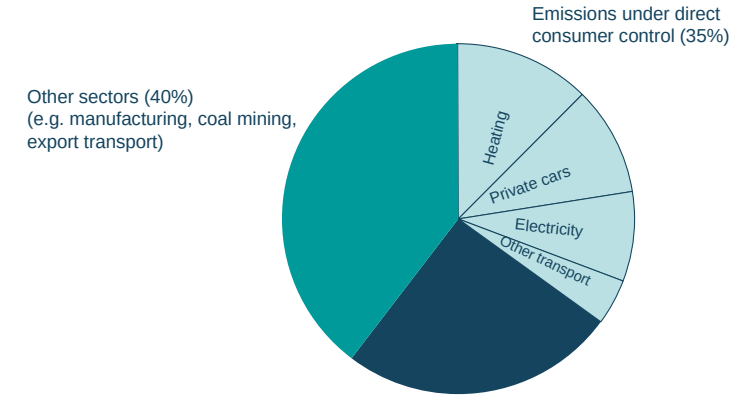
Step 3: Virtualization and De-materialization

Direct replacement of physical goods – 10% impact



Source: European Commission Joint Research Centre, "The Future Impact of ICTs on Environmental Sustainability", August 2004

Consumers control or influence 60 per cent of emissions



http://www.cbi.org.uk/pdf/climatereport2007full.pdf

Carbon Rewards rather than Carbon Taxes

- **Rather than penalize consumers and businesses for carbon emissions, can we reward them for reducing their carbon emissions?**
- **Using Internet and ICT to provide "virtual" products and services directly as a replacement for real equivalents, but also as incentive to "reward" consumers to reduce their own carbon footprint in other activities**
  - Virtual networks and computers for business
  - Cloud computing, Web 2.0 applications
  - Next generation solar powered PDAs and cell phones for access to the Internet
  - eMusic, eFilm, eBooks for consumer
- **Bits and bandwidth are virtually carbon free**
  - especially if we use zero carbon data centers and optical networks

Universities can lead the way to zero carbon society

- **Bits and optical bandwidth are virtually carbon free (especially if we use zero carbon data centers and optical networks)**

Examples:

- Providing free download music, video, electronic textbooks, and campus wide advanced tele-presence systems in exchange for carbon fees assessed on student parking, researcher's travel, and inefficient high energy consuming computer systems, etc.
- Provide remote laboratories and instrumentation instead of travel

Problem: No business case for FTTh

- **Broadband networks, whether wireless or FTTx, overbuilders, municipal, requires huge capital outlay. In addition:**
  - Low takeup – "Tyranny of the takeup"
  - Revenues declining as more and more applications are free
  - Over the top providers are capturing most of the value
- **Many companies starting to offer free broadband, both wired and wireless**
  - Inuk, Sky, TalkTalk, Google, Microsoft, Cable and Wireless etc
  - Cable TV services are moving to the Internet
- **Business case for closed networks like Verizon FiOS are uncertain**

Carbon Reward Strategy for last mile infrastructure

- **Provide free high speed Internet and fiber to the home with resale of electrical and gas power**
- **Customer pays a premium on their gas and electric bill**
- **Customers encouraged to save money through reduced energy consumption and reduced carbon output**
- **Customer NOT penalized if they reduce energy consumption**
  - May end up paying substantially less then they do now for gas + electricity + broadband + telephone + cable
- **Network operator gets guaranteed revenue based on energy consumption rather than fickle triple play**

Thank you

- **More information**
- **http://green-broadband.blogspot.com**
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