Grid TALK GridBriefings
Grid computing in five minutes

A Greener Way? Grids and Green Computing

Climate change is one of the biggest challenges facing us in the 21st century and, across Europe, efforts are being made to cut down on energy usage and carbon emissions. The EU has set a target of a 20% reduction in greenhouse gas emissions by 2020 compared to levels in 1990[1] and decisive action is needed to meet this goal.

As sectors across the economy search for ways to make themselves greener, the European Commission has identified Information and Communication Technologies (ICTs) as a major player in helping to cut down on carbon emissions. The EU hopes to exploit technologies such as virtualisation, and to invest in ICT research - which together promise to reduce energy consumption and increase our knowledge of the changing climate. By harnessing ICT we have the potential to cut emissions, not only in the ICT industry, but in all sectors of the economy.

How green is our ICT?

ICT is responsible for 2% of carbon emissions in Europe, a figure equal to that produced by the aviation industry, and emissions are set to increase by 6% a year.[2]

In order to reach the ambitious targets set by the EU for 2020, the ICT sector needs to act now to cut down on carbon emissions that result from both the use of ICTs and their production.

However the biggest savings in energy and emissions are not likely to be through cuts in the ICT sector itself. Today ICTs are embedded into our society and clever utilisation of technology, as well as investment in ICT research, can decrease our energy use and carbon output in many other sectors of the economy.

ICTs have the potential to reduce total carbon emissions by some 15% by 2020[3] and, according to the Commission, the amount of energy they can save could outweigh the energy they consume by five to ten times.

The EU's actions so far

On 12 March 2009 the Commission adopted a Communication entitled 'Mobilising Information and Communication Technologies to facilitate the transition to an energy-efficient, low-carbon economy', which stated how ICTs could be employed throughout Europe to improve energy efficiency and reduce our carbon footprint.

The Commission has called on the ICT sector to set concrete targets and to identify measures to become more energy efficient. It is also holding a public consultation to gather further information and opinions.

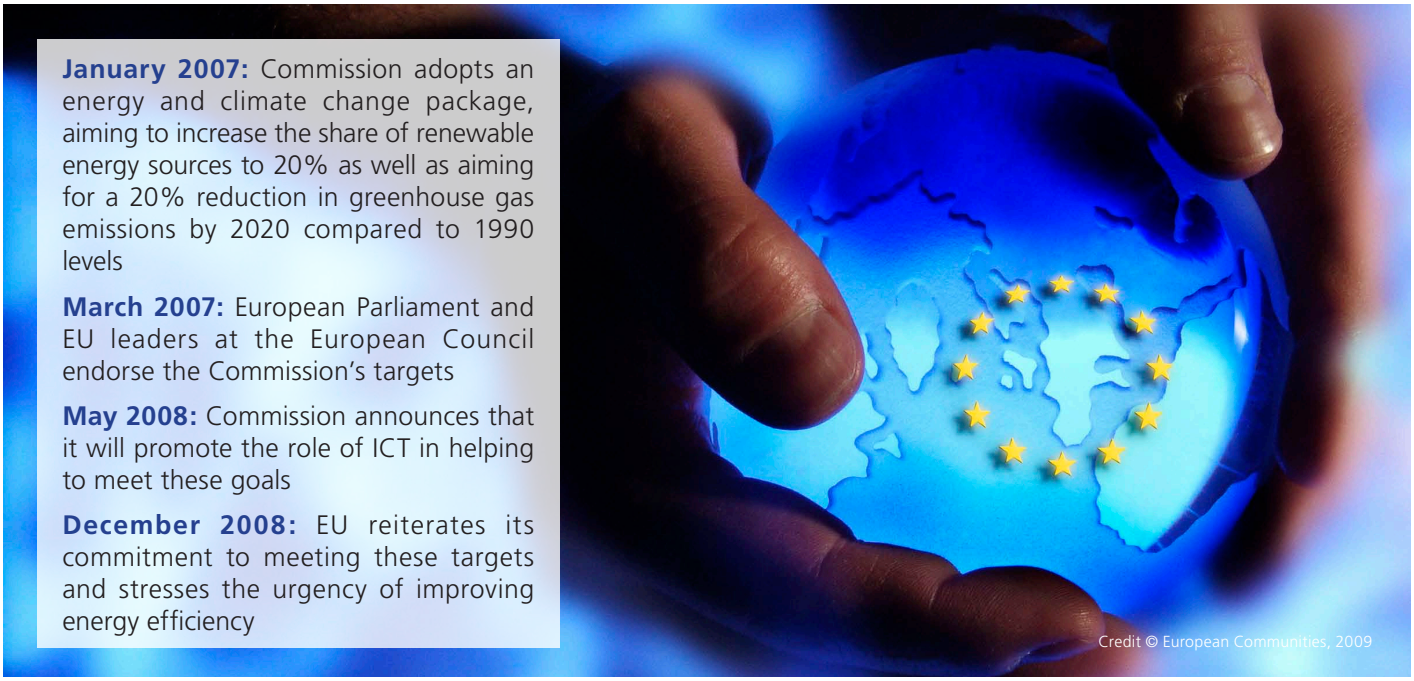
These results will be used to form a Recommendation, to be adopted in the second half of 2009, which sets firm aims for stakeholders and Member States in an effort to 'green' ICT and other sectors of the economy.

January 2007: Commission adopts an energy and climate change package, aiming to increase the share of renewable energy sources to 20% as well as aiming for a 20% reduction in greenhouse gas emissions by 2020 compared to 1990 levels

March 2007: European Parliament and EU leaders at the European Council endorse the Commission's targets

May 2008: Commission announces that it will promote the role of ICT in helping to meet these goals

December 2008: EU reiterates its commitment to meeting these targets and stresses the urgency of improving energy efficiency



Using ICT to reduce energy usage

The March Communication suggests that ICTs can be used both to *enable* energy efficiency improvements and *quantify* energy consumption:

ICTs can be used to **provide technological solutions** that help all sectors of the economy to reduce their energy usage. Recent studies suggest that ICTs could reduce energy consumption in buildings by up to 17% through savings in areas such as lighting systems. ICTs could also increase the efficiency of travel, through logistics, realising a reduction in emissions of up to 27%.[3]

ICTs can help people precisely **measure their energy consumption**, so they can make informed decisions on whether and how to change their lifestyle. For example smart metering can provide consumers with detailed information about their energy usage patterns, allowing them to control their power needs and save money.

Sven van den Berghe, Services and Solutions, Fujitsu Laboratories of Europe - "Carbon efficiency in IT, as in all aspects of carbon efficiency, is maximised with complete solutions that fully engage users in the consequences of their actions. Open publication of carbon use as an additional constraint when selecting services should help to close this loop and make consumers more aware of their carbon footprint."

Computing against climate change

Thousands of volunteers worldwide are joining in the largest climate experiment ever and helping to generate a clearer picture of how the climate of our Earth is changing.

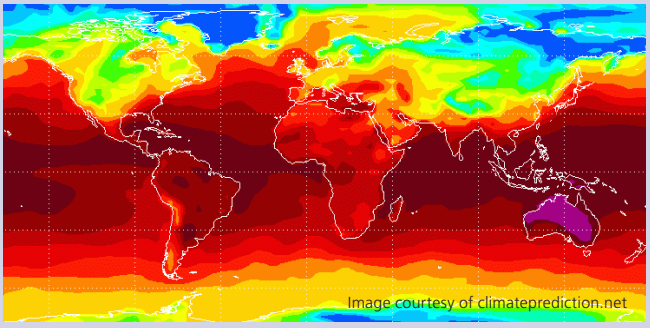


Image courtesy of climateprediction.net

By using the idle cycles of home computers, climateprediction.net can test the world's best climate models to find out how accurate they really are. Whenever a computer is switched on but is not being used to full capacity climateprediction.net can use the extra processing power to run simulations and produce predictions of the climate all the way up to 2080.

With the help of its volunteers, climateprediction.net has calculated over 40 million years of climate model data, and is giving decision makers a better scientific understanding of how to tackle one of the biggest global problems today.

A greener way to email

Image courtesy of GridTalk

UK-founded company Mimecast is paving the way to greener communications with its software-as-a-service approach to email.

By offering companies the opportunity to manage and store their emails "in the cloud", Mimecast have eliminated more than 8,300 power-intensive servers worldwide, saving enough energy to power more than 3,700 households in the US for a year.

The role of distributed computing

Innovative technologies such as grid computing and virtualisation can play a key role in this enabling process – helping to reduce redundancy, and therefore, energy, in a given service.

Grid computing gives users access to distributed computing resources at multiple locations, using the power of thousands of smaller computers to act as one much larger and more powerful processor. Cloud computing, says John Lamb of IBM, is simply "a new label for the subset of grid computing that includes utility computing and other approaches to the use of shared computing resources." Utility computing refers to the packaging of computing resources, such as computation and storage, as a metered service similar to a public utility such as electricity, water, or gas.

For small or medium sized companies, using distributed computing such as the 'cloud' can offer savings in greenhouse gas emissions. While it is important to ensure emissions are not simply offloaded to an outside source, dedicated server hosts often make more efficient use of a processor's computing power, and so lead to an overall decrease in energy use.

Companies such as Memset and Mimecast (see box above) show how utility computing can result in real reductions in carbon footprints, while distributed computing has also proved an essential tool for projects working to further our understanding of climate change.

Kate Craig-Wood, Memset Ltd. - "My company, Memset, [which provides dedicated server hosting] is leading Britain's green hosting movement, and we are living proof that, in ICT, green means efficient, means lower cost. Grid is a key part of that; using virtualisation, we provide "cloud" or utility resources on our grid. Cloud computing is by far the most efficient method of utilising servers."

The reality of virtualisation

Many organisations are now going virtual in an effort to reduce energy consumption. Moving to virtual servers can also cut costs and increase flexibility, so is increasingly attractive. But what exactly is virtualisation?

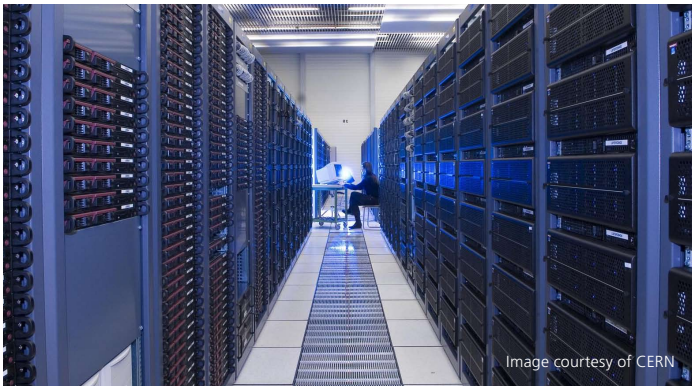


Image courtesy of CERN

Today's computers are designed to run one operating system at a time, but this can leave more than 90% of the computing power unused. Instead of wasting electricity on an underutilised machine, virtualisation allows us to use this spare computing power.

By creating 'virtual machines', computers (or servers) are able to run multiple operating systems and applications on the same piece of physical kit. So, for example, the same computer could run Windows, Linux and OS-X all at the same time, making much better use of its computing capacity.

Moving to virtual servers cuts down on the equipment needed – not just computers, but also cooling systems – and decreases the amount of power used. Virtualisation has already helped firms such as Merril Lynch, who for every 18 servers they used to use, have now cut down to just one.

Open-ing the door to eco-virtualisation

Not content with simply tackling virtualisation, the OpenNebula project is now working towards a more eco-friendly way to place virtual machines on distributed infrastructures.

"Energy efficiency is a critical issue for research infrastructures today," says Ignacio M. Llorente of Complutense University of Madrid, who is co-leading the OpenNebula initiative. "The application of cloud computing and virtualisation technologies to grids can contribute to reducing the energy demands of grid infrastructure. Our new consolidation scheduler software allows grid services to be dynamically consolidated on a lower number of physical resources. We can reduce the number of active physical systems and so power consumption and cooling requirements, without affecting applications or users."

John Lamb, IBM and Author of 'The Greening of IT' - "The most-significant step most organisations can make in moving to green IT is to implement virtualisation for their Information Technology data centre devices. There is also a virtual IT world of the future - via grid or cloud computing. Together these technologies will help drive energy efficiency for our green data centres of the future."

A greener grid?

When researchers of the GREEN-NET research project designed software to help distribute computing jobs in a way that cut down on energy use they realised they were up against a tough challenge.

This collaborative research project, supported by INRIA, the French national institute for research in computer science and control, didn't just have to measure power consumption and determine how it could be decreased. It also had to find a way to visualise and apply energy usage models to the system.

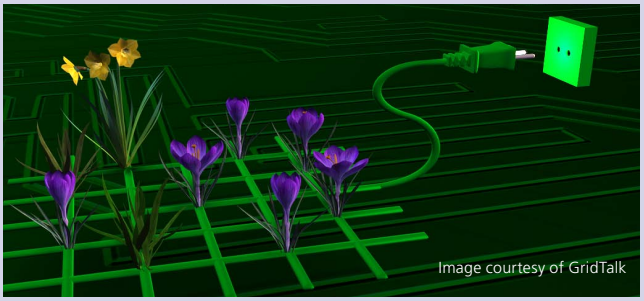


Image courtesy of GridTalk

By deploying sensors, the GREEN-NET team were able to measure the real-time energy consumption of 160 computational nodes belonging to the large scale experimental French Grid'5000 platform. They found that scheduling more jobs at quiet times, to even out demand on computing facilities, decreased energy usage dramatically.

GREEN-NET's methods - asking users to agree to postpone jobs for quieter times and following green policies provided by GREEN-NET software components - could produce substantial savings says Laurent Lefèvre, GREEN-NET's coordinator: "For a platform like Grid'5000, we can obtain a 30-35% energy savings for a year, which is equivalent to the consumption of a village of 600 residents over that same period of time!"

The data centre challenge

One of the biggest challenges the ICT sector faces today is how to cope with the ever increasing power consumption of data centres.

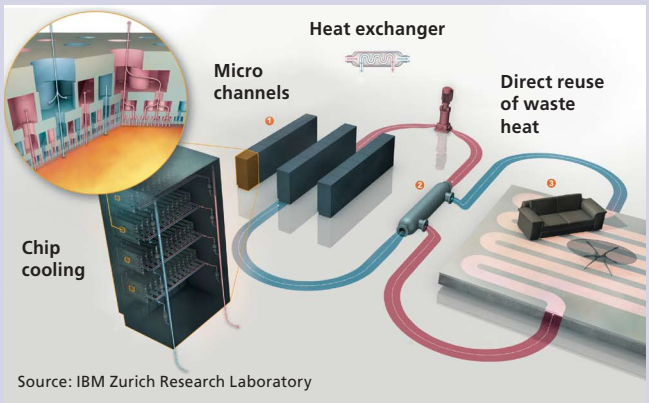
The EU have released a Code of Conduct in response to this problem while IT consortiums such as the Green Grid are working together to tackle the issue. And, for smaller organisations, distributed computing solutions such as the cloud may provide an energy efficient answer.

"Data centres are currently estimated to account for three percent of the world's energy consumption, so it is essential that steps are taken now to reduce that," says Alan Priestly of the Green Grid's European Communications Group. "Our consortium has taken up the challenge of developing standards and guidelines to measure data centre efficiency. This will make it easier for IT managers to understand their current environment and develop plans to manage their facilities and equipment – they can achieve optimal energy efficiency whilst still meeting the demands placed on them."

New research in this area is also vital to ensure our data centres don't continue to use such large amounts of energy. Initiatives such as reusing the heat energy generated by servers are already underway and being trialled at institutes such as ETH Zurich in partnership with IBM.

Recycling the heat from supercomputers

IBM and ETH Zurich, the Swiss Federal Institute of Technology, are planning to build a new kind of water-cooled supercomputer, which puts excess heat to good use by using it to warm nearby university buildings.



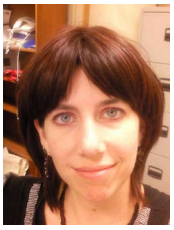
Source: IBM Zurich Research Laboratory

In a first-of-a-kind trial, the planned Aquasar system will use water to cool the supercomputer's processors. Through a network that emulates the human vascular system, and highly efficient chip-level coolers, 60°C water will be used to cool the processor's chips and transport excess heat away. This will be directed towards the heating system of ETH Zurich where the energy can be reused (see diagram). The system could potentially save up to 30 tons of CO2 per year compared with a similar system using current cooling technologies.

By using water as a coolant, the team from ETH Zurich and IBM hope to reduce energy consumption by up to 40%. And, as cooling down processors usually accounts for a large proportion of a system's energy footprint, other institutes are likely to follow in their footsteps. CERN already purchases energy efficient processors for its 2.5 megawatt computer centre but plans are underway for a new energy efficient centre which could make use of water cooling and energy reuse.

A wasteful issue: reduce, reuse, recycle

ICT production accounts for a quarter of the ICT industry's emissions, and waste electrical and electronic equipment, known as WEEE, is one of the fastest growing waste streams in the EU. The European Community WEEE Directive, agreed in 2003, aims to tackle these issues by making environmentally-sound disposal a legal responsibility. The Directive reduces the amount of electrical and electronic equipment being produced by encouraging reusing, recycling and recovering. It also aims to improve the environmental performance of businesses that manufacture, supply, use, recycle and recover this equipment.



Elizabeth Van der Meer, UK National e-Science Centre - "Proponents of green ICT must seriously consider the impact of current practices, addressing issues such as energy use, electronics waste disposal and materials recycling as well as the way in which ICT can help to mitigate global environmental problems such as climate change and biodiversity loss. The ICT sector is in a position to "green itself" and can also become a tool for greening other sectors. Over the last decade, the use of ICT worldwide has increased dramatically so that users and developers of these technologies have a responsibility to locate their activities within the context of global environmental concerns."

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3. Bio Intelligence Impacts of Information and Communication Technologies on Energy Efficiency **http://cordis.europa.eu/fp7/ict/sustainable-growth/studies_en.html**

For more information:

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Grid Computing Now! - http://tr.im/sLDh

GreenerComputing.com - www.greenercomputing.com

GREEN-NET
www.ens-lyon.fr/LIP/RESO/Projects/GREEN-NET/

Green IT at the British Computer Society
www.bcs.org/server.php?show=nav.10698

Climateprediction.net - www.climateprediction.net

OpenNebula - www.OpenNebula.org

EGEE (Enabling Grids for E-sciencE) - www.eu-egee.org/

GridTalk - www.gridtalk-project.eu

iSGTW - www.isgtw.org

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