HP Eco Solutions Program

Low Carbon IT Solutions

Contributing to the first billion tonnes of global CO_2 reduction with smart IT solutions

June 2008

This white paper outlines existing HP innovations and solutions that can contribute to the reduction of greenhouse gas emissions (GHGs) in different parts of the economy. The selection of HP solutions reported on with in the paper correspond to the solution areas identified in the report titled "The potential global CO_2 reductions from ICT use: Identifying and assessing the opportunities to reduce the first billion tonnes of CO_2,"developed by Dennis Pamlin, Global Policy Advisor, WWF-Sweden. The report identifies and assesses the opportunities to reduce the first billion tonnes of CO_2.

Quantifying the CO_2 reduction potential for IT solutions is a new science, and this paper does not aim to present specific quantified savings. It does however show the potential for currently available IT solutions to contribute to climate change mitigation.

More information about HP's joint initiative with WWF to combat climate change can be found at www.hp.eu/wwf

Introduction

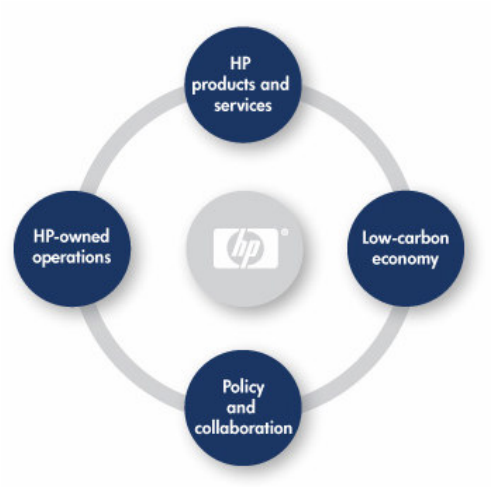
Background

Recently, the role of IT in combating climate change has received significant attention. The "first billion tonnes report examines some of the academic literature on the topic. The American Electronics Association[1] and EICTA (the European ICT Industry Association)[2] have both published reports in the last year that examine the potential for IT solutions to help reduce climate change.

In April 2007, Gartner estimated that the Information and Communication Technology (ICT) sector was responsible for around two percent of global CO_2 emissions,[3] approximately the same as fuel consumption from the airline industry. Many also recognise that IT has a significant opportunity to enable CO_2 reductions across other sectors. In fact, according to WWF's Dennis Pamlin there may be no other industry sector where the opportunities hold such a reduction potential for the rest of the economy. *"Realizing this potential is not simple, what is needed is a long-term, strategic approach where we re-define not only business and the way business is made, but the societies businesses exist in – today and in the future – and how they help shape it. A fundamental part of this equation will be IT, not only as a sector with the potential to become one of the winners in a low carbon economy, but also through the deployment of IT services which could fundamentally impact the way we view buildings, motion, light, heat, food and other services."* Dennis Pamlin - Global Policy Advisor, WWF-Sweden.

HP is committed to reducing our contribution to climate change and we have developed a comprehensive climate strategy to enable this[4]. Our climate strategy framework includes developing products and services to enable a transformation towards a low-carbon economy.

HP Climate and Energy Strategy Framework



[1] Advanced Electronics and Information Technologies: The Innovation-Led Climate Change Solution, September 2007 http://www.aeanet.org/AeACouncils/AeAEurope_Energy_Efficiency_Report_17Sep07.pdf
[2] High Tech: Low Carbon: The role of the European digital technology industry in tackling climate change, April 2008. http://www.eicta.org/web/news/telecharger.php?iddoc=762
[3] http://www.gartner.com/it/page.jsp?id=503867
[4] For more details visit http://www.hp.com/hpinfo/globalcitisenship/gcreport/energy.html

HP's approach to low carbon IT solutions

HP has developed IT solutions that can help lower or reduce the release of greenhouse gases (GHG) such as carbon dioxide (CO_2) into the atmosphere. These low-carbon solutions fall into three broad areas and are described below.

- Solutions which help *reduce* energy intensity and carbon footprint
- Solutions which help *substitute* carbon-intensive processes by low-carbon ones
- Solutions which help *enable* low-carbon economy management

REDUCE

The first area of opportunity focuses on improving the efficiency of existing products and services. Advances in IT are enabling energy-intelligent appliances and systems that require less power. As an example, HP's Dynamic Smart Cooling solution provides a comprehensive approach to reducing the power needed to cool data centres. We are also researching large-scale sensor networks to improve energy efficiency in broader areas such as construction and agriculture. New technologies can also prompt important shifts in consumer behaviour. Solutions providing real-time energy monitoring and reporting, described later in this white paper, make consumption more transparent. By seeing the impact of their energy use – in terms of both its cost and its associated GHG emissions – consumers can make more informed choices when using household appliances and devices, heating and cooling their homes, and purchasing new products.

SUBSTITUTE

The second area of opportunity is in replacing carbon-intensive activities with low-carbon alternatives. For example, HP's Halo telepresence and videoconferencing solutions reduce the need for business travel, a significant source of GHG emissions, by replicating the meeting environment virtually. In addition, the web services and client devices we are developing to help power the Internet economy and replace physical processes, are making commerce and information sharing increasingly more efficient. Shifting purchases online, for instance, lessens the need for complex logistics and store infrastructure to serve customers, and in doing so, conserves energy and limits GHG emissions.

ENABLE

Facilitating the world's transition to a low-carbon economy is a third area of opportunity for HP. This shift will require technologies to support emerging carbon markets, and sophisticated monitoring and reporting of carbon emissions. HP is developing software and services to help assess, manage and report energy use and GHG emissions generated by our customers' businesses, including their supply chains.

LOW CARBON IT INFRASTRUCTURE

In order to realise the potential of many of the innovations described in this catalogue, an appropriate IT infrastructure is needed. As part of our climate strategy framework, HP has invested considerably in the development of low energy IT solutions including energy efficient printing and computing devices, tools and calculators for monitoring energy and paper efficiency, services that optimise printing and computing infrastructure networks. Although not the subject of this paper, efforts to reduce the environmental impacts caused by the use of IT are clearly important to the successful growth of IT as part of the solution to transform to a low carbon economy.

Low Carbon IT Solutions

Overview

WWF developed an approach for classifying different IT solutions and their beneficial impact on GHG emissions. The following areas of IT application (amongst others) emerged from that work and form the basis of the structure of this white paper.

- Smart Buildings
- Smart Transportation/Communication
- Smart Commerce & Services
- Smart Industrial Production
- Knowledge and Behaviour

In order to get a sense of the magnitude of GHG reduction potential from these areas, the estimated potential for GHG emission reductions enabled by ICT is summarised in Table 1 and is taken from the work done by WWF[5]. Each area will then be explored in more detail.

Table 1	**Estimated Incremental Potential for GHG Emissions Reductions Enabled by IT by 2030 $MtCO_2$**		
	low	**medium**	**High**
Smart buildings – ICT in existing buildings	121	545	969
Smart buildings – ICT for planning and operating new buildings	46	439	832
Transport mode switching enabled by smart urban planning	38	190	380
Telecommuting and virtual meetings (smart work)	68	159	404
In vehicle ICT and intelligent transport infrastructures (smart vehicles and intelligent transport)	581	1,486	2,646
E-commerce and dematerialisation	198	927	1,822
ICT for energy efficiency in Industry (improving day by day operations: smart industry and plant and process design: I-optimisation)	100	815	1,530
ICT in Energy supply systems (Removal of network constraints – 2020)	17	59	128
Estimated total potential for CO_2 emission reductions	**1,168**	**4,620**	**8,711**

Smart Buildings

In most countries, buildings are the largest driver for both energy use and CO_2 emissions. The 160 million buildings of the EU, for example, are estimated to use over 40 percent of Europe's energy and to drive over 40 percent of its carbon dioxide emissions. According to the US Energy Information Administration (EIA) the share of energy and green house gas emissions associated with buildings is even larger in the US, with 48 percent of the total[6].

[5] Outline for the first global IT strategy for CO_2 reductions: A billion tonnes of CO_2 reductions and beyond through transformative change, WWF 2008, www.panda.org/ict

[6] The potential global CO_2 reductions from ICT use: Identifying and assessing the opportunities to reduce the first billion tonnes of CO_2,Dennis Pamlin, Global Policy Advisor, WWF-Sweden 2008, http://www.wwf.se/source.php?id=1183710

SMART ENERGY SYSTEMS IN THE DATA CENTRE

Increasingly, in commercial organisations, a significant proportion of electricity is consumed by "data centres". Data centres house the computing and communications equipment that businesses use to manage and organise their corporate data.

It is estimated that data centres in the U.S. consumed about 61 billion kilowatt-hours (kWh) in 2006 (1.5 percent of total U.S. electricity consumption). This is more than the electricity consumed by the nation's colour televisions and similar to the amount of electricity consumed by approximately 5.8 million average U.S. households (or about five percent of the total U.S. housing stock)[7]. In Western Europe (EU 15 plus Switzerland) in 2006, power consumption amounted to 14.7 TWh/a (6.2 MT CO_2) for servers and 36.9 TWh/a (15.5 MT CO_2) for data centres including storage, network components and infrastructure (cooling, UPS, lighting)[8].

A study by HP and the Uptime Institute suggests that in the majority of the world's data centres, 60-70 percent of a data centre's power consumption is associated with cooling the IT equipment[9]. HP realised that the air-conditioning needed to cool data centres was growing and that with the expected growth and investment in data centres something was needed to reduce the costs and energy consumption required. After years of research HP introduced Dynamic Smart Cooling (DSC).

For the first time, Dynamic Smart Cooling enables the equipment to interact with the facilities that support the data centre, driving maximum efficiency. DSC is the industry's first solution that integrates data centre-wide sensors, intelligent control, and automated provisioning that can reduce energy consumption related to cooling by as much as 40 percent[10].

Intelligent cooling is just one of the ways that energy consumption can be reduced in the data centre. EYP Mission Critical Facilities (EYP MCF) – an HP company – provides end-to-end facilities management capabilities that help customers design, build and operate their data centre environments. EYP MCF utilises computer modelling to validate design alternatives for data centres. Their software suite encompasses advanced fluid dynamics modelling, probabilistic reliability analysis and proprietary programmes. EYP MCF design enabled the first data centre to be certified to the U.S. Green Building Council's LEED certification (Leadership in Energy and Environmental Design) in 2005. The experience and capabilities of EYP MCF can be extended to the design of other critical facilities such as command and control centres and stock exchanges.

SMART ENERGY METERING

Energy consumption of domestic dwellings is also considerable. In the UK, for example, it represents 29 percent of the UK total CO_2 emissions[11]. Smart metering is one way that utility companies can help domestic users reduce their consumption through increased awareness. HP is currently developing an "Advanced Meter Infrastructure" (AMI) solution for utility companies to be able to offer real-time metering of domestic premises. The solution is an adaptation of real-time telecommunication billing solutions currently in place. Real-time metering will enable consumers to see real and immediate benefit from their energy saving actions, which is likely to increase behaviour change and corresponding emission reductions.

[7] Report to Congress on Server and Data Centre Energy Efficiency Public Law 109-431
[8] High Tech: Low Carbon: The role of the European digital technology industry in tackling climate change, April 2008, http://www.eicta.org/web/news/telecharger.php?iddoc=762
[9] HP, Christopher Malone, PhD, Christian Belady, P.E., "Metrics to Characterise Data Centre & IT Equipment Energy Use", Digital Power Forum, Richardson, TX (September 2006) & "How to Minimise Data Centre Utility Bills", HP C. Belady, P.E., September 2
[10] http://h71028.www7.hp.com/ERC/cache/438048-0-0-0-121.html?ERL=true
[11] http://www.dtistats.net/energystats/ecuk1_4.xls

Smart Transportation/Communication

Information technologies can play a major role in reducing GHG emissions from transportation sources in a number of ways, outlined comprehensively in the "first billion tonnes" report[12]. One significant way is the substitution of digital solutions for physical business travel. Telepresence and videoconferencing are becoming more popular and a more acceptable means of working across geographic boundaries than has previously been possible due to recent technology innovations and cost reductions.

TELEPRESENCE AND VIDECONFERENCING

HP Halo Telepresence and Video conferencing solutions include distinct product offerings that are designed to meet specific communication and infrastructure requirements. The solutions bring people from across the globe into an environment that looks, sounds, and feels as if they are just across the table. HP launched the first Halo telepresence solution in December 2005 in partnership with DreamWorks. In August 2007, HP extended its commitment to widening the reach by partnering with Tandberg to connect Halo solutions to other standards-based videoconferencing systems located anywhere in the world.

A typical Halo studio uses 2.43 kilowatts of electricity per hour over a 24-hour period[13]. Total consumption is 58 kilowatt-hours per day of electricity. One round trip flight for three passengers from London to Tokyo generates the same level of greenhouse gas emissions as a Halo Studio located in Europe for an entire year[14]. HP is using this advanced technology itself to reduce business travel across the company. Some rooms log up to 250 hours a month. As of December 2007, HP had 34 Halo studios and plans to quadruple that number by 2010. This effort is expected to significantly reduce HP travel, saving around 20,000 international trips and, we estimate, at least 32,000 tonnes of carbon dioxide equivalent (CO_2e) per year. Based on an HP internal study[15], the average roundtrip business flight generates more than 0.91 tonnes of CO_2e emissions per person for the air travel portion only. We estimate that each internal Halo studio at HP currently eliminates at least one roundtrip flight per business day, which amounts to a savings of more than 237 tonnes of CO_2e per studio per year. When employees request travel arrangements to and from destinations with Halo Studios through HP's travel system, they are now prompted to consider booking a Halo Studio instead.

In March 2008, HP announced an innovative partnership with the Marriott Hotel Group to make HP Halo Telepresence Solutions available for public use at select Marriott locations in major business centres around the world. This will allow the public to take advantage of all the business benefits that Halo offers reducing the need for business travel and corresponding impact on the environment.

In addition to Halo, HP has other solutions to enable virtual collaboration. The HP Remote Graphics Software enables remote, real-time collaboration for graphics-intensive industries. It allows customers in graphics-intensive fields such as engineering and graphic design to collaborate with teams in real time across locations, avoiding the need to travel. HP Remote Graphics is an interactive 3D graphics software application that can be used with workstations, notebooks and commercial desktop PCs. With visual image quality true to the original, it provides users with an easy to use, secure and efficient collaboration solution.

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[12] The potential global CO_2 reductions from ICT use: Identifying and assessing the opportunities to reduce the first billion tonnes of CO_2,Dennis Pamlin, Global Policy Advisor, WWF-Sweden 2008, http://www.wwf.se/source.php?id=1183710

[13] Assuming 8 hours of use and 16 hours in standby mode

[14] Calculated using HP Corporate and Brand Marketing Carbon Calculator Assumptions: Air Travel: 0.447 pounds CO_2 per passenger air mile. This is an average for short haul and long haul flights. Electricity: Varies by region based on how electricity is generated. Average for US is 1.27 pounds CO_2/kWhr. Average for Europe is 0.386 kg CO_2/kWhr. Average for Latin America is 0.189 kg CO_2/kWhr. Average for Canada is 0.224 kg CO_2/kWhr. Average for Asia Pacific is 0.710 kg CO_2/kWhr. RT Flight from NY to London is 6,888 miles. RT flight from London to Tokyo 11,986 miles.

[15] http://h71028.www7.hp.com/enterprise/downloads/Enviro_CsStdyUS_5_16_LR.pdf

VIRTUAL OFFICES

Using the latest HP computing technology, HP has undergone a workplace transformation. Upgraded offices were equipped with the latest energy-efficient HP technology. For example, we replaced cathode ray tube monitors with flat panel displays and used more notebook PCs in temporary office spaces. Increasing the use of HP notebook PCs by our workforce is encouraging us to become more mobile. HP currently has nearly 13,000 employees worldwide who work exclusively from home offices. While some are sales representatives who use their cars for customer visits, the HP Telework programme saves many roundtrip commutes to the office, reducing road travel and associated GHG emissions. In addition, many HP employees divide their work time between an HP site and their home office, further reducing travel and emissions. Other employees use the flexibility of HP mobile computing technology to travel outside of peak traffic hours, reducing congestion and corresponding emissions. Some notebook models now include built in web-cameras, enabling further savings through virtual meetings.

OPTIMISING TRAVEL

A further way that IT can help reduce GHG emissions from transportation sources is to use devices and systems to optimise travel networks. HP has been exploring how hand-held devices can be used to optimise distributed transportation networks, and avoid the need for travel by using digital information transfer. As an example, in a test project for a police force in Europe community officers and youth-management officers were issued a mobile solution designed by HP, allowing them access to national databases. The policeman had an HP iPAQ handheld computer, or PDA, which combined a GPS receiver and a secure wireless data link to his back-office systems. The system provided officers with the latest information about stolen cars, addresses, or potentially armed suspects, allowing them to perform their duties more efficiently and contributing greatly to the safety of both the police and the general public. This kind of mobile solution, which reduces the need for support from a "headquarter" or "base station" improves productivity and effectiveness and can reduce occasions for travelling back to the base station to log incidents and gather information, thereby reducing carbon dioxide emissions from transport.

Smart Commerce & Services

In the "first billion tonnes" report, IT solutions are identified that, when applied, can make carbon dioxide reductions in commerce and services. In particular concepts such as performing commercial trades electronically, dematerialisation and the process of substituting physical products with digital ones are described. One of the physical items that can be substituted digitally is paper. Unlike consumption trends in other mature commodity sectors, paper consumption shows little sign of decoupling from economic growth[16]. Any efforts to reduce paper consumption have a "win-win" in terms of climate change mitigation. To produce one tonne of paper, requires three and a half tonnes of wood and produces three tonnes of CO_2. In addition, when paper is sourced from forests which are not managed sustainably, reducing paper consumption can reduce deforestation which results in more forests being available to absorb CO_2 from other CO_2 producers[17].

E-SERVICES

E-services can have a benefit on CO_2 mitigation from the substitution of physical products with digital ones. This results from either avoided transportation, printing, storage or distribution. Research commissioned by the Department for Communities and Local Government in the UK found the web services of Sunderland City Council (population circa 280,000) save around 80 tonnes of CO_2 per

[16] http://earthtrends.wri.org/features/view_feature.php?theme=6&fid=19
[17] See http://sustainablepractices.ning.com/pages/page/show?id=1037707%3APage%3A3601 for more details

year from reductions in staff time, distance travelled by service users, and printing[18]. The research estimates that if this figure was matched by the UK as a whole it would reduce CO_2 emissions by around 14,000 tonnes per year. If we extrapolate this to the EU level (500 million inhabitants) the potential CO_2 emission reductions could reach 160,000 tonnes. Regardless of the accuracy of this extrapolation, it shows there is a potential of e-Government services to contribute to a reduction of CO_2 emissions, in particular with the introduction of more citizen centric e-services.

In a printing example, HP has developed a solution that enables governments and educational institutions to move from costly pre-printed forms and processes to automated, enhanced secure delivery of on-demand electronic forms and document creation. The HP Forms and Document Automation solution allows users to create professional documents on-demand and distribute them electronically to the point of need. Additionally, the solution eliminates high costs and environmental impacts associated with warehousing, distribution logistics and processing of pre-printed forms.

Similarly, designed for institutions of higher education, HP Campus Advantage Solution can help universities, colleges and schools to significantly reduce costs and wastage. One of the features of this service includes Mobile Printing. This enables students and faculty staff to print from any PC or laptop to any networked printer on the campus, allowing anytime, "on-demand" document retrieval. After sending the print job, users just need to authenticate with their ID card at the printing device of their choice – e.g. in the laboratory, library or even in their room – and initiate and retrieve the print job. This solution reduces the wastage of printing and ensures that only those documents are printed which are actually retrieved from the printer.

DIGITIZING WORKFLOW / INFORMATION MANAGEMENT

HP is working with its customers to help automate workflows and change the way business is conducted. With the ability to capture and deliver documents digitally it is possible to virtually eliminate the need for faxing, and lower the amount of paper used in an organisation.

As an example, HP Output Management solutions are a family of infrastructure products and services that are improving the way enterprise customers manage, distribute and share information. The solutions provide simple print serving capabilities that make network printing easier and automate delivery capabilities that enable the reliable distribution of application generated documents across printer, fax, web and e-mail destinations. This type of workflow management, e.g. HP Output Server, has environmental benefits. For example, one customer using HP Output Server reduced the need for printed pages by up to 70 percent, amounting to paper and material savings measured in millions of pages.

HP is going further and is investigating low-cost, lightweight, portable displays that could one day match paper – or possibly even replace it. Besides enabling devices that are lighter than laptops and provide a more user-friendly browsing experience, these have the potential to reduce both paper use and waste because it is possible to 'print' many images to a single paper-like display. Such displays could one day be used to display newspapers, documents, books, billboards and other types of printed materials.

[18] http://www.communities.gov.uk/publications/localgovernment/carbonefficiencies

Smart Industrial Production

Globally, industry emits directly and indirectly about 37 percent of all CO_2 emissions. The contribution to the emissions in individual countries can vary from around 30 percent of the total (this is the case in advanced economies where the service sectors represent the largest proportion of the economy) to over 80 percent (as in the case of rapidly industrializing countries such as China)[19].

CONTROL

IT solutions can play a big role in managing and reducing the environmental impact of production (or manufacturing). HP Integrated Site Management solution, which was designed by an HP team in Hungary, is a tool which allows customers to monitor and control parameters such as energy use, water consumption and sewage as well as air pollution at production sites or in office buildings. The aim of the tool is to help customers bring down costs, e.g. on energy bills and sewage handling charges, but also to increase effectiveness of production and to prevent unexpected events which might lead to a disruption of the production process. This solution was deployed at a Hungarian company that produces wooden furniture for the leading consumer furniture company in EMEA. Through the monitoring and the calculations provided by the HP tool, the customer was able to cut energy consumption and its corresponding contribution to greenhouse gas emissions by 11.3 percent.

ON-DEMAND PRODUCTION

Dematerialisation processes in production have similar dynamics to e-commerce or other digital delivery with GHG benefits that depend on the reduction in physical materials used and the corresponding reduction in storage and transportation needs. We believe that HP's focus on digital printing can help with society's dependency on physical material flows in manufacturing, as the examples below describe.

HP is helping companies from a range of sectors including operations, marketing and manufacturing to improve their printing efficiency. This includes printing in the manufacturing process (labels etc.), customer collateral (log books, instruction manuals, warranty material etc.), marketing material (product guides, sales tools, direct mail, in-store signage, outdoor advertising etc.) as well as document management and process flow within the company operations described earlier.

Digital print production processes, such as those enabled by HP's Graphic Arts portfolio are potentially more efficient than conventional offset printing. This is due to traditional offset printing requiring large batches to absorb setup overhead costs leading to wasteful over printing, warehousing and transport logistics. The additional make-ready (plate preparation etc.) of offset compared to digital printing discourages networked "Distribute and Print" production models.

Retail Marketing Automation[20] is a comprehensive workflow solution that can help customers to reduce the environmental impact of printing. This solution helps eliminate the waste and costs associated with printed materials by printing on demand, when and in the location they are needed as opposed to being printed at a central location and then distributed, either by road or air in some cases. Assessments conducted by HP solution experts found that retailers could reduce wasted signage and other printed marketing materials by up to 90 percent by implementing the solution. One leading supermarket company with outlets across Europe deployed an online system that streamlined

[19] The potential global CO_2 reductions from ICT use: Identifying and assessing the opportunities to reduce the first billion tonnes of CO_2,Dennis Pamlin, Global Policy Advisor, WWF-Sweden 2008, http://www.wwf.se/source.php?id=1183710

[20] http://h71028.www7.hp.com/enterprise/cache/529724-0-0-225-121.html?jumpid=reg_R1002_USEN

the creation of materials and enabled integrated promotion campaign management. The solution improved business results such as reduced promotion set up time, but also reduced wasted signage by 30 percent.

Digital printing enables printing to be driven "on-demand", reducing the need for unnecessary storage and distribution. HP's Graphic Arts portfolio has enabled Amazon[21] to print and bind low volume books and post them out as they are ordered, as opposed to stocking every book ever published, with subsequent greenhouse gas reductions in logistics, storage, offset printing, etc. The books-on-demand market is expected to grow from approximately 20 billion book pages in 2006 to approximately 38 billion book pages by 2009[22]. This is due chiefly to the increasing demand for small-volume, rare and self-published books. In a similar, way HP is transforming the way that DVDs and other digital media is produced. This has transformed into HP's DVD Manufactured on Demand service, which HP launched together with Sony[23] to give people access to back catalogues without un-necessary production of materials that may never be sold. The service is a component of HP Digital Content Services designed to transform the workflows, processes and tools used to create, manage, distribute and enjoy digital content.

Applications for digital printing can be extended to cover more of the printed pages in society. Newspapers for example, are produced in very large regional factories on web offset presses. A study of newspaper production in 2006 reveals that for a national daily the print run typically begins at 11 pm and must be finished by 3 am, ready for trucking to wholesalers and onward distribution to retailers by 5 am. The print factory must be built to handle this peak rate of production yet runs at less than capacity the rest of the time (or pads to capacity with lower value product). The transport system is very spiky and at an inconvenient time of day leading to many trucks making empty return journeys. The physical distribution of the newspaper product is the highest day-to-day operational cost associated with the newspaper publishing business[24]. This process could be radically upgraded by a move to digital press-based Distribute and Print on Demand production. HP is starting to quantify the greenhouse gas reductions of these types of on-demand production and marketing processes, but is confident that significant transportation and dematerialisation can be achieved.

SUPPLY CHAIN MANAGEMENT

Today's manufacturing supply chains have become much more complex – requiring greater agility, more collaboration, and a higher degree of response than ever before. A sound supply chain strategy and business framework enables organisations to flex and respond to business changes. One aspect of an efficient supply chain is operational efficiency and logistics optimisation, which have the potential to reduce GHG emissions. Logistics can be optimised to make the most of different forms of transport or the distances between different members of the chain. HP estimates that every tonne of freight transported by air for one kilometre results in 0.6 Kg of CO_2 emissions, compared to just 0.003 Kg for ocean transport. Supply chains that can be optimised to make the most of ocean transportation could have significant benefits. In an HP internal example, HP was able to shift more than 250 containers of notebook computers last year from air to ocean saving approximately 4,000 tonnes of carbon dioxide equivalent.

HP offers supply chain and enterprise resource planning (ERP) solutions that can help customers in many sectors to streamline their operations. As an example, The HP/Microsoft Supply Chain Visibility Solution delivers a foundation for capturing and analysing supply chain data that supports informed decision making, mitigates risk, and improved processes. In the consumer products sector for example, supply chain visibility can enable greater demand led supply chains, eliminating the need for unnecessary warehousing and ensuring that products are only shipped when needed.

[21] http://www.hp.com/hpinfo/newsroom/press/2006/061204a.html?jumpid=reg_R1002_USEN
[22] INTERQUEST, Ltd., "The Digital Book Printing Opportunity," 2006, page 42
[23] http://www.hp.com/hpinfo/newsroom/press/2008/080124c.html?jumpid=reg_R1002_USEN
[24] Integrating multi-product production and distribution in newspaper logistics, Russella,, Chianga & Zepeda (2006).

Knowledge & Behaviour

As enabler of information management and exchange, and provider of superior analytical tools, ICT can play a significant role in the creation of the knowledge needed to identify and implement effective policies and strategies. Moreover when context relevant information is provided to end users and consumers, behavioural changes can occur, which can lead to changes, also dramatic, in GHG emissions[25].

SENSORS FOR MONITORING THE ENVIRONMENT[26]

HP Labs are working to develop very low-cost self-powered sensors that can be embedded in large numbers in many different types of infrastructure, from buildings, to roads, bridges, vehicles and even agricultural fields.

- In buildings, real-time temperature and humidity monitoring will enable heating and cooling optimisation, in a similar way that Dynamic Smart Cooling is currently working in data centres.
- In roads and bridges, sensors will listen for stress noises, alerting maintenance crews at the right time, avoiding accidents as well as unnecessary control visits and early maintenance (and resultant carbon intensive traffic jams).
- In agricultural fields, and industrial greenhouses sensors will allow optimal delivery of water, fertilisers and heating, conserving water, reducing fertiliser use, heating bills and associated greenhouse gas footprint, and increasing crop yields.

These networks of billions of sensors will monitor specific conditions and report them to central applications, enabling real-time operational optimisation for energy efficiency and performance. This will have dramatic applications for energy efficiency throughout the economy. Large networks of smart, cheap sensors will make it possible to use many resources more efficiently. HP's nano-crossbar memory is designed to enable these distributed devices to operate in the most efficient way – they will wake up, take a measurement, make a decision, communicate if necessary, store the result, and go back to a zero-power sleep. Power requirements will be small enough to enable on-chip batteries to last a lifetime.

ANALYTICAL TECHNOLOGIES

When a new information system is commissioned, specifying, designing and delivering that system in isolation from the wider environment in which it will operate is short-sighted and ultimately wasteful. In contrast, analysis of the 'complete system' – the people, the processes, political and environmental contexts and infrastructure – enables solutions that really transform existing services and infrastructure. Such systems can be optimised for cost, for environmental footprint, and for agility. HP labs conducted some exploratory work on the analytic technologies for designing information services and the systems that they support. Experimental work with large public and commercial services showed clear benefits of a holistic approach to services design, improving all aspects of delivery including cost, flexibility, environmental footprint and the quality of life for people delivering the services. One example demonstrated to all of the stakeholders of a regional ambulance service that their complete system could be re-engineered to deliver an estimated 30 percent reduction in carbon footprint through the more effective distribution of ambulances across the region whilst improving survivability by up to 23 percent[27].

[25] The potential global CO_2 reductions from ICT use: Identifying and assessing the opportunities to reduce the first billion tonnes of CO_2,Dennis Pamlin, Global Policy Advisor, WWF-Sweden 2008, http://www.wwf.se/source.php?id=1183710

[26] http://www.hpl.hp.com/environment/nanotechnology.html

[27] A systems approach to carbon footprint management (Taylor & Tofts 2008). HP paper for Tech Con 08.

This catalogue, probably the world's first collection of low carbon IT solutions by a world leading company, is a welcome and important contribution in response to the urgent climate challenge. Most IT solutions are not sold because they reduce CO2 emissions, still this is an important aspect and more companies and governments should ask themselves if they can use IT solutions to provide the same or better services compared to what they already have today but with less carbon emissions. We need IT companies and users of IT to engage in dialogues about how they together can become winners in a low carbon economy. The next 25 years will see investments of the magnitude of 40 trillion dollars in urban infrastructure by governments and companies. The question is how much of this will be directed in fossil and energy intensive solutions and how much that will be invested in low carbon and highly efficient IT solutions? Hopefully this catalogue and those that will follow can help to show that a low carbon future is not only possible, it is attractive. As with all IT solutions it is important to think before they are implemented, many times it is possible to start a transition towards a low carbon economy by providing the right framework for the IT solutions.

Dennis Pamlin (Global Policy Advisor, WWF-Sweden) on this white paper.

Concluding Remarks

The research to map the first billion tonnes of CO_2 reductions from IT solutions has shown the potential for significant environmental benefit. Table 1 demonstrates the scale of opportunity that is available for IT solutions to address. The HP solutions described in this paper represent existing IT solutions that can be implemented in order to enable reductions of GHG emissions. Further work is being done by HP and WWF to quantify these emissions and develop further understanding of the way that IT eco systems can have environmental benefit.

It is important to note that these opportunities are not limited to developed economies. In fact, as the work from the "first billion tonnes" points out, the key to creating a low carbon future is developing IT solutions that enable smarter growth in emerging and developing economies. As countries build their infrastructure from the ground up, we have an opportunity to help them bypass more energy-intensive approaches in favour of solutions such as web services and electronic commerce with a lower greenhouse gas impact. We are working to capitalise on these opportunities and intend for HP to be a leader in providing the technological solutions that give countries, businesses and individuals an advantage in a low carbon world.

For more information

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