

Information Technologies and Telecoms Industry Partnership

THE CONTRIBUTION OF ICT TO CLIMATE CHANGE MITIGATION

The wide-spread adoption of Information and Communications Technologies (ICT) solutions in all parts of society in the last 25 years has led to tremendous productivity improvement while reducing energy consumption. The application of ICT solutions can enable a transformation towards a resource efficient and services-based society, and deliver CO₂ reduction emissions in particular in those sectors where the opportunities are largest: buildings, transport, and manufacturing. The ICT sector holds great potential for mitigating climate change through the decoupling of economic growth from energy consumption. We have shown that in the past with the introduction of the PC, the Internet, and mobile telecommunications.

From the national and macro perspectives, as market- and policy-based approaches to reduce greenhouse gas (GHG) emissions are implemented, the market will demand new, innovative, and large responses in the form of new technologies and social approaches. These responses will spur new markets, R&D, and industries, (whether energy-management, bio-based, geo-based, or behaviour-based) and serve as significant economic drivers for countries and innovation hubs throughout the 21st Century.

*“The ICT industry is responsible for approximately 2% of global CO₂ emissions. ICT solutions have the potential to be an **Enabler** to reduce a significant part of the remaining 98% of total CO₂ emitted by non-ICT industries.”*

Source: Gartner/HP/McKinsey/WWF

Introduction

There is significant need for the ICT sector to collaborate with leading think tanks and NGOs on elucidating a clear message on the role of ICT in mitigating climate change. There remains no single, unified message that is being delivered to senior-most decision makers from governments and in other industries.

This work will have significant value to these decision makers at a time when positive action needs to be taken and when winners in a low-carbon economy need to step forward.

The World Economic Forum is delighted to have partnered with so many much respected institutions to synthesise the leading thinking on the role of ICT. The work is focused on the role of ICT in mitigating climate change as an enabler within many other sectors and industries, and is not primarily focused on the carbon footprint of the ICT industry. While the carbon footprint is not the focus of this work, it is obviously an important issue that also needs to be addressed, as any serious actor taking steps forward will have to put its own “house in order”.

The following work represents the synthesis of feedback from a large number of institutions on the most impactful contributions of ICT to mitigating climate change. This impact may be measured in absolute terms (reduction in energy usage) in the short-term and/or long term, or indirectly through strategic results (visible and symbolic impact on people’s lives/ corporations’ behaviour supporting wider, positive behavioural change and improved regulatory frameworks).

Summary of structure

Seven contributions of ICT to mitigating climate change are laid out in this paper and can be grouped into the following three logical categories:

- 1. Infrastructure innovation:** This section addresses the area where many of the most significant and immediate impact can be made on energy savings and reductions of Green House gases (GHGs)¹. This includes the large scale physical environment consuming the most energy, which includes buildings, public utilities & infrastructure, and manufacturing. It also captures opportunities for innovation within the energy grid and efficiencies for energy distribution.
- 2. Behavioural change & green enablement:** This section focuses on the need for global measurement and tracking of carbon reduction, as well as tools that impact positive behavioural change. This includes software tools for carbon impact measurement, and the use of innovative technologies and opportunities that reduce travel and transportation, such as those for virtual meetings, telecommuting, and on-line services (e.g. eHealth, eTaxation, and eBanking).
- 3. Energy efficiency of ICT products and solutions:** This section covers energy efficiency of data centres, electronic devices and solutions. Even if ICT products themselves have only a marginal environmental impact, there is a great risk that the public will judge the whole sector as environmentally unfriendly if the sector does not address its own carbon footprint. First, this would impact ICT's credibility, making it difficult to deliver on the points above. Second, the rapid increase and penetration of ICT products can, if no action is taken, result in increased energy demand.

Project overview

Problem statement

Whilst significant opportunity exists for ICT products and services to enable climate change mitigation, the opportunity is far from realising its potential. With climate change now being one of the top issues at global, intergovernmental level, a unified, clear message on the role of ICT is urgently required. This message needs to be delivered outside of the ICT sector. Otherwise, uninformed legislation and investment decisions would probably only focus on ICTs direct climate change impact and thereby limit both the overall positive impact of ICT, as well as reduce the total green technology market opportunity for the ICT sector.

A unified and clear message would allow the ICT sector to establish itself as a leading contributor that sees reduction of CO₂ as a driver for innovation and profit. It would also allow the sector to claim a leadership role as a winner in a low carbon economy.

The status quo is determined by a number of factors:

- 1. The contribution by the ICT sector has up until now focused on the sector's own carbon footprint.** The approach of business, policy makers, media and NGOs have all contributed to this situation (as business has traditionally been seen as part of the problem, not the solution). This is now changing as the understanding of the ICT sector's potential role is slowly gaining acceptance.
- 2. Industry messaging has largely been internally focused.** Many leading experts and organizations have spent significant time and resources in developing clear views on the role of ICT in climate change mitigation. These efforts have in most cases aimed at regional and ICT industry audiences.
- 3. External messaging by the ICT sector remains fragmented as a whole.** The ICT industries have thus far focused on reducing their own footprint, and are relatively new to the broader global debate

¹ Approximately 45% of final consumer energy is used for low-temperature heat (cooking, water and space heating, drying), 10% for high-temperature industrial process heat, 15% for electric motors, lighting and electronics and 30% for transport. The CO₂ emissions from meeting this energy demand using mainly fossil fuels account for around 80% of total global emissions. (IPCC AR4, WG3, Chapter 4, p.256)

on climate change. They have just recently shifted from the internal problems, to the external opportunities, and are still optimizing their positions and perspectives, something the automotive and energy sectors have long ago achieved.

4. **ICT is still positioned only as a productivity enhancer, not as an energy efficiency driver.** ICT solutions are generally positioned in the market as enablers of productivity improvements and cost reductions (doing more with less). The link between productivity improvements and energy savings is new, and is a message which the ICT industry is not yet clearly quantifying and communicating.
5. **Policy makers lack information on the potential contribution of ICT.** Largely as a result of the above, policy makers and decision makers outside of the ICT sector are only slowly becoming aware of the potential contribution of ICT, and are currently more likely than not to create approaches that do not fully leverage this potential.

Question to be resolved:

How can the ICT sector unify its messaging and create the first clear, global statement on the role of ICT in mitigating climate change - in order to better inform regulatory and investment decisions globally over the next five years?

Aims of this work:

The aims of this work are to:

1. **Formalise a clear set of statements on the contribution of ICT to climate change mitigation.**
This will synthesize the best thinking by leading global ICT companies and independent experts on the role of ICT in climate change mitigation, and act as the unifying effort needed and asked for by the ICT sector.
2. **Provide the basis for a 2-page executive summary for review and approval by CEOs and ICT ministers in Davos, 2008.** This will serve as a tool to gain agreement at the highest level of decision making with the ICT industry globally.
3. **Elevate any ICT Industry-wide consensus as a message to the highest decision makers globally.**
This will clarify the role of ICT within the broader context of climate change and sustainability initiatives, strengthen global dialogue and understanding, as well as promote more focused public policy action.

Collaborators

The role of the World Economic Forum is one of neutral orchestrator of collaboration. This work has been achieved in collaboration with the following organisations:

- **The IT & Telecoms Industry Partners of the World Economic Forum:** *Accenture, Akamai Technologies, Alcatel-Lucent, AMD, Amdocs, Applied Materials, AT&T, Autodesk, Avaya, BMC Software, BT, CA, China Mobile, Cisco, Deutsche Telecom, EMC, France Telecom, Freescale Semiconductor, Google, HCL, HP, HTC-VIA, Huawei, Infosys, Intel, Lenovo, Liberty Global, Microsoft Corporation, Motorola, Pitney Bowes, Qualcomm, Salesforce.com, SAP, SAS, Satyam, SK Telecom, Silver Lake, Telia Sonera, Telstra, Vimpelcom, Vodafone, Wipro, & Fujitsu (non-partner).*
- **Expert organisations:** *American Electronics Association (AeA), Business for Social Responsibility (BSR), The Climate Group Gartner, Global e-Sustainability Initiative (GeSI), Information Technology Industry Council (ITIC), ITU, and the World Wide Fund for Nature (WWF).*

Further intellectual content for this work comes from the synthesis of other work from:

- *ABB, Arup, BP, EMPA, European Network Operators (ETNO), European Commission, Forum for the Future, GE, IKEA, International Energy Agency (IEA), McKinsey & Co. Ltd, Ministries of Commerce in China & India, Toyota, Pew Centre on Global Climate Change, United Nations Foundation, UNDP, United Nations Information and Communication Technologies Task Force, UNCTAD, United States Environmental Protection Agency, Vattenfall, Volvo, and World Business Council on Sustainable Development (WBCSD).*

Audience

It is important to note that this document is written to be read by ICT industry insiders. It assumes clear understanding of the scale and urgency of the climate change challenge, as well as the extent to which further enhancement and deployment of ICT and other advanced technologies can provide the foundation for the many new innovations that can set a trajectory for a low-carbon path to the future.

Definitions

The relevance of ICT to discussions on a low carbon future is regarded as significant by many. It is important to clarify what this work is concerned with and what it is not:

1. Focus on climate change, not broader environmental sustainability:

Our focus here is on climate change, not the broader issue of environmental sustainability. The scope covers actions and contributions that reduce GHG emissions. While tackling many of the sources of GHG emissions also have implications for other environmental issues such as bio-diversity, waste management, sustainable use of resources, this report only relates to those issues in so far as they are connected to climate change. It does however take into account the economic sustainability as it is built on the understanding that the ICT sector can be a winner in a low-carbon economy.

2. The role of ICT as an enabler to impact a low carbon future, not the ICT industry's efforts to reduce its own carbon footprint

On one hand, the expansion of new devices and appliances in our homes and businesses has increased energy consumption – and especially the use of electricity. Gartner estimates ICT Industry accounts for approximately 2% of global CO₂ emissions, and this is expected to increase. On the other hand, the potential for ICT to address the other 98% is striking. Most of the studies so far have based their assumptions on business-as-usual scenarios developed by experts focusing on the supply side¹. While the potential is significant even under a business-as-usual scenario, it is a shift towards a low carbon economy with focus on the demand side that will allow for ICT's truly important contribution (See studies by IPCC, EMPA, WWF, Booz Allen Hamilton, ACEEE, EuroACE, and Vattenfall internal papers).

Next steps:

In order for this message to be truly impactful, it should be adopted by ICT industry CEOs and Ministers of ICT in Davos 2008.

Once approved by the CEOs and Ministers, this work would be delivered into broader cross-industry climate change dialogue, and will support submissions put before ministers of energy and environment as part of the Gleneagles Dialogue on Climate Change, Clean Energy and Sustainable Development at their meeting in Chiba, Japan in March 2008. It would then form part of a business policy statement to be delivered to the G8 in Japan 2008. ICT would thus have a powerful and resonant voice at the highest political table.

Summary of the contributions of ICT to mitigating climate change

Infrastructure innovation

1. Increase energy efficiency of Buildings/infrastructure through intelligent systems & design
2. Reduce the energy use of the manufacturing sector through intelligent systems, design and business models
3. Enable smarter management of energy supply and demand
4. Sustainable energy production

Behavioural change & green enablement

5. Enable carbon accounting and the tracking of Green House Gas emissions through the Supply Chain
6. Enable virtual meetings

Energy efficiency of ICT products and solutions

7. Increase energy efficiency of data centres and electronic devices

Contribution #1: Increase energy efficiency of buildings through intelligent systems and design

Description:

Rapid urbanisation in emerging economies is set to increase the population of the world's cities by almost two billion over the next 25 years. In this context, there is significant demand on urban planners to maximise energy efficiency of buildings. Within the EU, buildings are responsible for 40% of greenhouse gas emissions. This is approximately 48% in the USA. The majority of energy inefficient features in buildings are designed into them. Two key areas of focus to generate greater energy efficiency in buildings are:

1. Existing buildings: Greater smart management of energy use through Building Energy Management Systems (BEMS). These schedule the operations of major equipment including chillers, boilers, packaged air conditioners, heat pumps, and lights according to need, reducing unnecessary use, and minimizing wear and tear on equipment. Features could include demand limiting, load shifting, advanced meters that record and communicate actual electricity use and will then adjust electricity use based on time-of-day, on peak/off peak or other billing rates.
2. New buildings: Built-in energy supply and improved and ICT-enabled energy efficient design in buildings, including greater use of efficiency principles in position and shape of the building as well as designing windows, lighting, shading and insulation. New buildings can also be linked and deliver integrated solutions where energy production and energy use are optimized.

Potential impact:

The potential carbon savings provided through the adoption of BEMS have been estimated to be as high as 20 percent². When it comes to new buildings it is possible to turn many buildings from large energy consumers to net producers, and with approximately 50% of CO₂ emission coming from buildings this might be the single biggest opportunity towards a low carbon economy.³

Today's situation:

Data from the US Energy Information Administration illustrates that buildings are responsible for almost half (48%) of all energy consumption and GHG emissions annually; globally the percentage is even greater. Seventy-six percent (76%) of all power plant-generated electricity is used just to operate buildings⁴. Technology and knowledge exists to enable buildings to be zero carbon or even net producers of electricity⁵.

In order to deliver significant reductions of GHG emissions it is important to start from the planning phase and include the surroundings into the equation⁶. Energy savings potential from water heating, cooling, or hot water production, can be up to 10%, which represents up to 7% of the total energy consumption of the domestic residential and commercial sectors.⁷

Office buildings and hotels have begun integrating sensors and wireless technology to monitor and control lighting and electronics in unoccupied hotel rooms and offices. For example, after learning that hotel rooms were left unoccupied for an average of 11.5 hours per day, some hotels began installing small infrared sensors to detect when no one is in the room. After 30 minutes, the temperature is automatically reduced by 3 degrees; these technologies have saved as much as 37 percent of hotel heating costs⁸.

Heating - examples⁹

- Temperature control: protection against freezing or frost protection generally involves running heating system pumps and boilers when external temperature reaches a set level (0°C).
- Compensated systems: control flow temperature in the heating circuit relative to external temperature. This raises the circuit flow temperature when outside temperature drops.
- Thermostatic radiator valves: these sense space temperature in a room and throttle the flow accordingly through the radiator or convector to which they are fitted.
- Proportional control: involves switching equipment on and off automatically to regulate output.
- Other methods can include thermostats, occupancy sensing passive infra-red sensors (PIRs), and manual user controls.

Lighting - examples¹⁰

Different control systems exist, enabling time-based and parameter-based control (where a level of luminance or particular use of lighting is required). Energy savings can be up to 75% of the original circuit load, which represents 5% of the total energy consumption of residential and commercial sectors. Examples are:

- Zones: lights are switched on corresponding to the use and layout of the lit areas, in order to avoid lighting a large area if only a small part needs light.
- Time control: to switch on and off automatically in each zone to a preset schedule for light use.
- Passive Infra-Red (PIR) Occupancy sensing: In areas which are occupied intermittently, occupancy sensors can be used to indicate whether or not anybody is present and switch the light on or off accordingly.
- Light level monitoring: this consists of switching or dimming artificial lighting to maintain a light level measured by a photocell.

Role of government:

1. Develop and implement policy measures, e.g. financial incentives, efficiency-related tax legislation, low interest loans, or performance standards (e.g. California's Building Standards Title 24) to mobilize efforts to increase energy efficiency in buildings (home and office).

2. Encourage manufacturers and suppliers of equipment and services to make their products visibly display information about their real time environmental behaviour¹¹.
3. Ensure that sustainable solutions are developed with the global need in mind and support technology transfer and technology exchange between nations.
4. Support innovative solutions that allow buildings to become net supporters.
5. Launch global competitions where cities compete towards the first zero carbon city on the planet
6. Support information sharing that allows entrepreneurs to engage in sustainable building solutions¹².
7. Adopt greater design efficiency measures in all public buildings, including increased focus on energy efficient public procurement decisions (e.g. fixtures and fittings).

ICT Industry next steps:

1. BEMS: Design easy to install systems that optimise energy usage; partner with building developers to ensure the longer term financial benefits of these systems.
2. Efficient design: Building design (software) tools incorporating energy efficiency (e.g. LEED) at design stage.
3. Support integrated building solutions with focus on the demand side.
4. Develop solutions that allow commercial and residential buildings to become net producers of electricity.
5. Develop solutions that allow trading between buildings and cities possible.
6. Use expansion of offices, server parks and suppliers to develop new innovative solutions that can be integrated into new business opportunities.
7. Develop standards and benchmarks allowing for easy comparison of energy efficient data centres.
8. Collaborate more closely with all decision makers involved in urban planning to ensure greater awareness and optimal use of technology solutions.
9. Develop voluntary, open standards to allow interoperability of end devices and management controls.

Contribution #2: Reduce the energy use of the manufacturing sector through intelligent systems, design and change of business models

Description:

Carbon dioxide emissions from industrial energy use have been rising as a consequence of increasing product demand and look to be on a growing pathway. However, this trend can be reversed through energy efficiency measures. Contrary to common belief, industry is not always efficient in its energy use¹³.

ICT can provide more and better information as well as tools to design teams and product managers to improve the energy impact of products we consume. It can also support a shift in business models where companies can for example dematerialise their services (such as in the entertainment industry) or move from product to service¹⁴.

1. Enabling easier design of products with lower energy requirements, reduced emissions, improved recyclability/reuse, longer life, lower maintenance or support needs.
2. Enabling “dematerialisation” of any products or services that may be delivered virtually, especially those with high “embedded energy”. Dematerialization refers to the absolute or relative reduction in the quantity of materials required to serve economic functions.
3. Product lifecycle management (PLM); manufacturing process controls (MPC) - Integrated measurement devices linked to intelligent control systems and process automation to improve plant energy efficiency while also boosting productivity by increasing throughput, yield, and product quality.
4. Sensors and controls to significantly improve energy efficiency providing significant reductions in total energy consumption.
5. ICT support for decentralised, on demand production systems.
6. The development of systems that can help companies to move from a product approach to a service approach.

Potential impact:

A new study by the IEA, *Tracking Industrial Energy Efficiency and CO₂ Emissions*, suggests a technical efficiency improvement potential of 18 to 26% for the manufacturing industry worldwide if best available technology were applied. These savings would equal 5 to 7% of total energy use and reduce carbon dioxide emissions by 8 to 12% worldwide. These are conservative estimates based on proven technology¹⁵.

Today's situation:

Globally, approximately 36% of all carbon dioxide emissions are from the manufacturing industry, 40% from buildings and appliances and 24% from transport. Approximately half of the transport sector emissions are from freight haulage. On a global scale, manufacturing is buoyed by the gross domestic product (GDP) growth that is concentrated in emerging economies, notably China, where the rising middle classes are just starting to buy cars, and increasing their consumption of manufactured items commonly found in the developed world. Last year China's car production overtook that of Germany. Over the last 25 years, China has accounted for four-fifths of the growth in industrial energy use and carbon dioxide emissions. Today China accounts for more than half of world cement production, and is the largest producer of key energy intensive commodities such as aluminium, ammonia and steel¹⁶.

With few energy efficiency programmes in this sector aside from notable individual approaches, there is significant room for improvement.

Role of government:

1. Support and fund energy-(and carbon) labelling on manufactured products that rewards lower impact products. Adopt complementary approaches to incentivise rapid adoption of superior solutions.
2. Sponsor R&D into building energy toolsets and simulations into product lifecycle management tools.
3. Use public procurement to support innovation and energy efficiency measures by including CO2 footprint and energy use over the life cycle in procurement criteria for manufactured goods. It is important that these criteria also include the positive contribution of products such as meters, servers, video conference equipment on energy usage behaviour.
4. Review the taxation system in order to promote dematerialisation and a shift from product to service where this is delivering a reduction of GHG emissions.

ICT Industry next steps:

1. Demonstrate existing and invest in new product lifecycle management tool (PLM) functionality that enables enterprises to analyse, simulate, model and design lower energy products (throughout the lifecycle) and products (and packaging) with lower environmental impact.
2. Continue focus on enabling “dematerialisation” of any products or services that may be delivered virtually, especially those with high “embedded energy”.
3. Continue development and application of MPCs and other ICT-based manufacturing technologies, such as automated, self-correcting production systems (smart sensors and machine-to-machine communications).
4. Develop of communication systems between all required devices that incorporate technical capability to adapt to a renewable energy resource (such as photovoltaics or wind resources).
5. (Link to Contribution #3: ICT to provide information on energy consumption and saving).
6. Support the development of software that enables measurement of GHG emissions for procurement purposes.
7. Collaborate more closely with all decision makers in the manufacturing supply chain to ensure greater awareness and optimal use of technology solutions.

Contribution #3: Enable smarter management of energy supply and demand

Description:

Many of today's energy systems were built during a time when oversupply was the only way to ensure that enough power was available. Years of under-investment in the electric grids of many nations have resulted in aged, inefficient, and environmentally wasteful energy systems. In the USA, for example, the result is a very inefficient electricity generation and distribution system that converts only 1/3 of the total energy it consumes into useful electricity¹⁷.

Recognizing these inefficiencies, the energy community is starting to marry Information Technology with Renewable Energy to significantly improve how electric power is generated, delivered and consumed. Technology allows the electric grid to become 'smart'. Near-real-time information allows utilities to manage the entire electricity grid as an integrated system - actively sensing and responding to changes in power demand, supply, costs, and emissions across various locations and devices. Similarly, better information allows consumers to better manage their energy use to best meet their needs. "Just as a robust information economy was triggered by the introduction of the Internet, a dynamic new renewable energy economy can be stimulated by the development of an electrified or *Smart Grid*", noted Nobel Prize winner Al Gore¹⁸.

The main principles include:

- **Demand management:** Reducing electricity consumption in homes, offices & factories

Demand response: Alerting consumers during periods of peak usage to reduce consumption¹⁹.

Smart meters and variable pricing: Replacement of traditional meters with "smart" meters that charge variable rates based upon demand²⁰.

Smart buildings with smart appliances: Use of IT systems to coordinate energy consumption by key appliances (heating, ventilation, air, etc)²¹.

Energy dashboards: Online energy dashboards offering real-time visibility into individual's energy consumption, while offering suggestions on how to reduce consumption²².

- **Distributed energy generation:** Encouraging home and business-owners to install their own renewable sources of energy

"Micro" generation: Cost-effective production of electricity locally using small renewable devices designed for home or office such as wind generators, photo-voltaics, and solar thermal, as well as non-renewable devices such as natural gas generators with heat reclamation. Micro-generation technologies are becoming affordable for residential, commercial and industrial customers²³.

Storage and hybrid electric vehicles: Plug-in hybrid vehicles offering the ability to buy energy when it is inexpensive, store it in their batteries, and sell it back to the grid when the price goes up. Drivers see these vehicles as a viable means to arbitrage the cost of power while some utilities may envision fleets of these vehicles supplying power to reduce peaks in electricity demand.

- **Supply-side efficiency:** Utility companies use information technology to provide near-real time monitoring and control of the electric grid. These solutions prolong the useful life of the existing grid, delaying major investments to replace its infrastructure.

Grid monitoring & control: Power outages are very expensive, but some can be avoided if proper action is taken immediately to isolate the fault. Utilities are installing sensors to monitor and control the grid in near-real time (milliseconds or nanoseconds), to detect faults early to provide time to respond. These systems are increasingly being automated into utility's existing SCADA control systems.

Potential impact:

A technology-enabled electric grid will be more efficient, reduce greenhouse gas emissions, and improve power reliability. The potential environmental and economic benefits of smart grid are significant²⁴. Specifically, smarter electricity grids would:

- Reduce peaks in power usage by automatically turning down appliances in homes & offices
- Reduce waste by providing instant feedback on how much energy is being consumed
- Encourage home and business-owners to install their own renewable sources of energy
- Encourage manufacturers to produce 'smart' appliances to reduce energy use
- Sense and prevent power blackouts before they occur

Enhancing the role of technology to make electricity grids "smart" could help offset some of the expected increases in CO2 emissions in three ways:

1. Reduce growth in demand for electricity for:

Electricity consumers:

- Inform consumers and enable them to better monitor their own energy consumption to be more efficient and promote energy efficiency.
- Provide more accurate and timely information to consumers on electricity variable pricing signals, allowing them to invest in load shedding and load shifting solutions.
- Provide more accurate information to consumers on electricity variable pricing signals, allowing them to dynamically shift among several competing energy providers based on price, greenhouse gas or social goals

Power utility companies & regulators:

- Broadcast demand response alerts to reduce peak energy demand and reduce need to start up dirty, inefficient reserve generators
- Provide remote energy-management services and energy control operations to advise consumers and remotely reach into their homes to reduce their energy usage
- Enable utilities to increase their focus on creating "Save-a-Watts" instead of only on producing Kilowatts. That is, offsetting a watt of demand through energy efficiency measures is more cost effective than by generating an extra watt of electricity. In fact, some utilities believe they can earn more profit by selling "Save-a-Watts" instead of Kilowatts²⁵.

Equipment manufacturers:

- Incentivise building control systems companies to standardize data communications protocols across building systems --- eliminating proprietary and non-standard protocols that inhibit integration and management
- Incentivise manufacturers to produce goods (air conditioners, freezers, washer/dryers) that better monitor and manage their power usage and that are able to communicate and coordinate among themselves. For example, a refrigerator and air conditioner compressor could "talk among themselves" to ensure they don't start up at same time, thus reducing peak electricity demand.
- Enable and encourage electrical equipment manufacturers to build energy efficiency, management & data integration capabilities and interfaces into their equipment.

Building architects & owners:

- Accelerate construction of new buildings that are built with an integrated approach, incorporating smart, connected building communication technologies to manage and synchronize operations of appliances, turn off lighting in rooms not in use, turn on reserve generation when price effective, and manager overall energy use

2. Accelerate adoption of renewable sources of electricity generation:

- Provide local energy grid infrastructure that accepts distributed power production, and thus accelerates the growth of opportunities for micro-generation.
- (See Contribution 4 for more details on the contribution of ICT companies here)

3. Delay construction of new electricity generating and transmission infrastructure:

- It is estimated that the cost to renew the world's aging transmission & distribution grid will exceed \$6 trillion over next 25 years²⁶. Utility companies that implement electronic monitoring and management technologies will prolong the useful life of the electric grid and delay this investment. This delay could reduce new construction and installation costs for the grid and accompanying carbon emissions.

Today's situation:

Practically speaking, most of the technologies required to create smarter electric grids are already available today.

Forward-looking utilities are already offering demand response technologies to customers. Such technologies detect the need for load shedding, communicate the demand to participating users, automate load shedding, and verify compliance with demand-response programs.

Many utilities are implementing large numbers of smart electric meters to offer variable pricing to consumers and to reduce manual meter reading costs²⁷. However, several competing communication protocols²⁸ are still vying to become the standard to which all building devices can intercommunicate. Delay in agreeing a common industry standard has delayed the vision of having every electric device connected and has spawned several middleware and gateway companies. As expected, many white-goods manufacturers are making appliances that can connect to the building network.

Many public and private organizations have implemented energy consumption dashboards. Typically these are custom designed internally or provided by small software integrators²⁹.

IT systems integration is provided by several large technology firms. A host of other technology companies provide network communications required to make the smart grid, smart.

Role of government:

While the technologies for smart grid solutions are mainly available today, the real challenge to accelerating adoption stems from the various industries that need to work together to create a viable, integrated system. For example, smart grid requires utility companies to work with technology companies, and building owners to work with energy technology companies. Bringing together their various perspectives to design and build complex systems often proves challenging.

Given this complexity, the role of Government is to create the working organizations and policies to incentivise open partnerships. Five of the most important steps for Government to accelerate smart grid would be:

1. Financial incentives to drive smart grid adoption. This includes electric regulatory policy that decouples utility sales from profits and protects utilities from high initial investment costs. California, for example, has led regulation to encourage utilities to help consumers reduce the amount of electricity they consume by basing utility profits on energy savings, not on electricity sold or generating capacity.
2. Quickly develop critical communication standards. The connected building industry, in particular, has been battling among several standards for the past 10 years.
3. Encourage utilities offer variable-time-based pricing for electricity tariffs to their customers.
4. Allow increased competition among utilities, giving consumers the ability to choose among several energy providers using the smart meter to purchase electricity from the most efficient provider

ICT Industry next steps:

The ICT sector can help accelerate the smart grid in the following ways:

- Partnering for systems integration: From an ICT perspective, building the smart grid is a fairly straightforward technical challenge - most of the core technologies already exist and have been proven. However, the real challenge in smart grid is integrating the various technologies together into a single, working solution - it is a significant systems integration challenge to tie various devices, constituencies, telecommunication protocols together to operate in a seamless manner. No single company has all the capabilities to implement smart grid, rather, each industry brings a piece of the solution. The challenge, especially for ICT companies, is to build the alliances and partnerships needed to ensure their technology fits into the larger cross-industry ecosystem that will become the smart grid.
- Increase risk taking: In a recent discussion with technology companies, Jim Rogers, CEO of Duke Energy said that because smart grid ideas are evolving so quickly, technology companies need to become more comfortable taking risks and applying their technologies to new applications. Rather than wait for the perfect IT solution or comprehensive standard to be developed, companies need to rapidly get their solutions into the marketplace to be tested and vetted³⁰.
- Companies make markets – markets don't make companies: Technology companies need to make a return on their investments. Large, successful, established companies often pursue a 'fast follower' strategy, waiting for the market to be proven and large numbers of customers to be identified. This often makes sense before investing significant R&D resources; however, the smart grid may evolve in a way that makes fast follower strategy sub-optimal. The core technology and communications standards that will enable widespread smart grid are currently being established. Once open protocols are established, they will be built into a capital infrastructure (power plants, substations, buildings, power lines) which have a useful life of 20+ years.

Contribution #4: Sustainable energy production

Description:

According to the International Energy Administration's (IEA) *World Energy Outlook 2007*, the world's primary energy needs are projected to grow by 55 percent between 2005 and 2030 at an average annual rate of 1.8 percent³¹.

This rising global energy demand poses real and growing threats not only to the world's energy security, but also to strategies to limit rising CO₂ and other greenhouse gas emissions and mitigate climate change. To meet this growing demand, an estimated \$22 trillion of investment in supply infrastructure is required. The ICT sector can impact most directly the electricity generating sector, which the IEA projects to double in usage by 2030 and rising to 22 percent of total energy consumption (up from its current 17-percent level). The ICT sector can make more modest contributions to other areas as well.

ICT solutions are:

- Electricity generation: in addition to ICT's contribution to better grid management (see Contribution on energy supply and demand), ICT companies are increasingly entering the alternative energy production sector, bringing R&D capital, technical skills, and production economies of silicon to this potential market.
- Transport: Hybrid vehicles. Using materials, battery technology and other ICT-derived innovations, hybrid vehicles can contribute to limiting the growth of oil for transportation...

Potential impact:

- Reduction of need for fossil fuels, with attendant benefits to both energy security and climate change mitigation.
- Creation of potential for economic development from distributed power generation (analogy to countries bypassing land lines and installing wireless telephony to bring modern communications capabilities – and the resulting economic opportunities – to regions previously excluded).
- Home and building owners invest in high efficient and low emissions micro-generation technologies to supply some of their own energy needs and offset the peak demand on the electric grid - to offset the need for some new large-scale power plants.
- Creation of virtual power plants that include both distributed power production and energy efficiency measures.
- Acceleration of the introduction of Plug-in Hybrid Vehicles to act as temporary electricity storage, as well as provide incremental energy generation to offset peak demand on the grid

Today's situation:

The IEA estimates that the bulk (84 percent) of the world's growing energy appetite up until 2030 will be met by fossil fuels. Despite its great promise, non-hydro renewable electricity today supplies less than 5% of global electricity and its share is dropping as new coal-fired generating capacity is being developed worldwide. The major reason for this situation is the cost of renewable electricity – with photovoltaic (PV) generated electricity, for example, roughly five times the cost of coal-fired power, geothermal about two to three times more expensive, and wind at least 50% more.

Alternative energy solutions offer a game-changing scenario if the price can be reduced. This is only possible through greater investment and the construction of a proper policy framework. Today, alternative energy production is a checkerboard of policy initiatives that often hinder as much as help.

Role of government:

- Create supportive policy frameworks to encourage adoption of sustainable energy production systems and remove artificial barriers to integration into existing energy networks and grids. In particular,

governments should agree on realistic cost/pricing structures and factor in externalities when comparing all types of energy production systems (fossil fuels, nuclear, solar, wind, *etc.*).

- Provide long-term incentives for sustainable energy production that will decline as technologies mature and become commercially viable.
- Accelerate investment and research into new materials, technologies and infrastructure improvements for increased and more efficient sustainable energy production.

ICT Industry next steps:

- Develop technology that can lower the cost of critical renewable electricity sources, e.g. advanced semiconductors for photo-voltaics and improved generators and inverters for wind turbines.
- Advance “smart grid” technology that can enable more significant penetration of renewable electricity – both central station and distributed generation - into the electricity grid without destabilizing effects.
- Be a test-bed for new renewable technologies through demonstration projects and power purchase agreements to meet facility electricity needs.

Contribution #5: Enable carbon accounting and the tracking of Green House Gas emissions through the supply chain

Description: Provide systems to measure and report Greenhouse Gas (GHG) emissions, and to track these through the supply chain down to the individual product's use. This includes accounting on the carbon footprint of:

- An organisation's operations
- A product (from production through to distribution at point of sale).

This includes software tools, reporting standards and enhanced public awareness of the relative carbon efficiency of products.

Potential impact: Consistent calculation and visibility of carbon impact would give investors, management teams, buyers and consumers the ability to make more informed choices about activities, processes, products and services. This would allow investors to set benchmark targets, government to drive informed public procurement, and customers to choose lower carbon lifestyles. For example:

- Greater consumer information on the carbon footprint of foods would reduce the climate impact of dietary choices. Cattle-rearing generates more global warming greenhouse gases, as measured in CO₂ equivalent, than transportation³². The indirect effect of enhancing consumer awareness here is even more important with its broader impact on behaviour and markets in general.
- The impact on manufactured product purchases is described in chapter four.

Today's situation: CO₂ footprints are mostly invisible to investors, management teams, buyers and consumers. Whilst there has been some progress in the development of carbon accounting protocols, there are no consistently applied standards and systems for tracking and reporting carbon footprints. Software tools are appearing on the market, however the lack of agreement on measurement and reporting standards are slowing progress. Further research is needed on what specifically must be measured, and how differences between consumption by individuals and by industries can be recognized.

Role of government:

1. Working with existing bodies such as World Resources Institute and the World Business Council for Sustainable Development, and Global Reporting Initiative (GRI) to establish appropriate guidance and regulation on measuring, tracking, reporting and accounting for GHG emissions at an enterprise and eventually at a product and service level.
2. Support initiatives that make the CO₂-emissions visible throughout the supply chain.
3. Fund greater research into what the scope of carbon accounting might be and into technologies that can help track GHG emissions.
4. Introduce the need for carbon impact reporting for publicly procured goods and services.

ICT Industry next steps:

1. Collaborate with governments and NGOs (World Business Council for Sustainable Development, Carbon Disclosure Standards Board, GRI and Carbon Disclosure Project) on creating widely acceptable and implementable standards.
2. Provide business with easy-to-use measurement and reporting systems that comply with existing (Green House Gas Protocol) and new standards.

- a. Create (software) tools for measuring and converting CO2 emissions using the GHG protocol, to allow for reporting, tracking and managing of CO2 emissions (i.e. user friendly tools such as “Quicken” for CO2 measurement and management)
 - b. Automate the CO2 accounting rules and processes as per financial reporting and accounting (i.e. more powerful software such as “TurboTax” for CO2 financial report)
 - c. Support development of software that makes it possible to distinguish between a high carbon service and a low-carbon service as well as the shift from using a product to using a service
 - d. Collaborate with sectors that are interested in helping their customers to choose low carbon services, e.g. the retail sector, transportation sector, the restaurant sector, energy sector.
3. Champion better carbon accounting and reporting, raising the importance of this issue with all stakeholders

Contribution #6: Enable virtual meetings

Description:

Travel Substitution: remote collaboration and telecommuting (home to office, inter-office travels); the use of ICT to enable and encourage remote collaborations as a substitute for some travel activities. In many cases, the value of these virtual meetings far exceeds what would be possible without ICT. For example, the latest reports of the Intergovernmental Panel on Climate Change were the work of 450 lead authors, 800 contributing authors and 2,500 scientific expert reviewers from 130 countries—an undertaking impossible to imagine without the collaboration and communication tools provided by the ICT sector.

Potential impact:

- Reduction in the number of total kilometres travelled
- Reduction in traffic congestion (and therefore time spent idling in traffic)
- Reduction in the amount of building-related energy used by reducing the amount of office space required to house employees
- A study completed by the European Telecommunications Network Operators Association (ETNO) and the World Wildlife Fund concluded that if 20 percent of business travel in the EU were replaced by non-travel means through audio-conferencing, videoconferencing or tele-presence, then by 2010 around 25 million tonnes of CO₂ might be saved annually. That same study also noted that if just 10 percent of EU employees became telecommuters or flexi-workers, another 22 million tonnes of CO₂ might be saved annually³³.

Today's situation:

Whilst some organisations have embraced distributed working models, there are still significant barriers to adoption preventing widespread adoption. Greater effort is required to maximise the social and environmental benefits of tele-work, and, where possible, increase productivity.

Role of government:

- Use incentives to encourage the use of remote collaboration technologies. Adjust tax schemes that encourage travel (deductions on travel costs, company car allowances) to reward and encourage travel displacement.
- Encourage video-capable broadband deployments to all areas, especially emerging markets where the infrastructure is being shaped.
- Favourable tax treatment for investments in conferencing technologies for companies which agree to use them to displace travel
- Encourage the public sector to adopt tele-presence and similar technologies to reduce the need for work-based travel, and lead the way in allowing staff to work from home.
- Use virtual meetings at high level conferences and meetings when possible to set the example.
- Fund research into cultural, management and behavioural issue, resistance and barriers that get in the way of or reduce the efficacy of remote working.
- Continue to promote and deploy broadband infrastructure to better enable technologies that enable virtual meetings and collaboration technologies.

ICT Industry next steps:

The potential to save energy and reduce traffic congestion will only be realized when employees can work flexibly.

- Introduce and encourage flexible working models, such as flexible hours and work from home options to employees.
- Encourage greater understanding by managers of the benefits of distributed working practices,
- Enable and enhance mobile working environments through interoperability of devices over networks
- Collaborate in creating cross-industry value with key stakeholders such as travel agencies, airlines, airports, hotels and event organisers.
- Enhance general awareness of key decision makers by demonstrating virtual meeting tools at key events such as climate meetings, Davos, WTO meetings.
- Increase investment in making technology attractive as an alternative to individual travel: publicise best practices in getting people to use the technology; improve ease of use and address privacy issues; reduce infrastructure resources needed to deploy VoIP and video.
- Improve the efficiency and effectiveness of citizen-centric services.

Contribution #7: Increase energy efficiency of data-centre technologies and electronic devices

Description

The ICT industry has for a long time been focused on delivering productivity enhancements in and through its products and solutions. Energy efficiency has only recently become a critical issue. There continue to be improvements that can be made to individual devices; however it is important to note that individual parts of a total solution may actually increase in energy intensiveness as they combine to produce more value (e.g. one device doing the job of two). As such, two important areas of focus exist here: 1. Increasing the energy efficiency of the products and services offered by ICT companies; 2. Progress in educating society on the economic & environmental value that ICT solutions such as data centres provide. Thus, energy efficiency of any device providing a stated value (perhaps measured in bits per watt) should be reduced.

Potential impact:

1. Prove commitment to providing leadership on climate change mitigation by investing time and resources in improving the energy efficiency of the ICT sector's own products and services.
2. Increase of thought leadership and commitment to GHG reduction by the ICT industry through the investment in time and resources to increase electrical efficiency.
3. Improved distribution of technology resources by other industries and government through increased awareness of efficient data centre technologies and efficient practices.

Today's situation:

The use of electronic devices from mobile phones to laptops is exploding globally. This is a function of many new users in emerging and developing economies, as well as an increase in the number of devices being owned by individuals. Parallel to this rise is the increase in use of the internet, and thus data centres by businesses and governments. The increasing demands made by society to provide greater productivity of ICT devices and data centres naturally lead to rising energy cost of these tools (for example the growing demand in video, voice communications via the internet). Individual companies are doing much to increase the overall energy efficiency of individual devices; however the greatest impact will be achieved through greater ICT sector collaboration to ensure that the total energy cost of connected systems is reduced.

Commercial use of Energy Management Systems is increasing and is expected to significantly increase in the next few years. It is important that these are increasingly installed. In addition to optimising device and system energy efficiency in this way, human processes provide an important additional improvement in energy efficiency. Increasing implementation of best practices here will continue to be an important factor.

Significant progress is being made on the development of standardized metrics for data-centres and the energy efficiency of electronic devices; however, it is important to note that this progress must be intensified if the ICT sector is to adopt a leadership role in climate change mitigation. Even if ICT products themselves have only a marginal environmental impact (when compared to overall statistics), there is a great risk that the public will judge the whole sector as environmentally-unfriendly if the sector does not address its overall carbon footprint.

First, this would impact ICT's credibility, making it difficult to deliver on the points above. Second, the rapid increase and penetration of ICT products may, if no action is taken, result in increased energy demand.

Role of government:

1. Collaborate with industry to develop measurement and efficiency metrics.
2. Collaborate with industry on promoting efficient technologies, applications and practices, particularly in power provisioning, compute and cooling resources of data centres.
3. Encourage industry partnerships to address vendor-neutral solutions to enhance data centre productivity.

4. Collaborate with industry to define future objectives for data centre optimization.
5. Facilitate regulatory changes in depreciation allowance. This will provide an incentive to remove inefficient legacy equipment and install new energy efficient equipment. .
6. Identify and promote best regulatory standards globally to increase device efficiency, such as US Energy Star
7. Stimulate greater research and development in electrical efficiency

ICT Industry's next steps:

1. Define and promote the value of a holistic approach, rather than component-level efficiency, to improving the efficiency of data centres.
2. Lead development of reporting efforts on environmental impact of data centres.
3. Continue to create new products and services to enhance energy efficiency, and share those improvements to a broader audience.
4. Collaborate with data centre users to develop efficiency models best practices and ICT management applications.

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FOOTNOTES

¹ Furthermore:

- International Energy Agency (IEA) estimates the world economy will need to invest \$20 trillion (in 2005 US dollars) between now and 2030 in order to maintain current energy-related infrastructure as well as build new supply facilities to meet growing energy demands.
- McKinsey Global Institute suggests that the right set of investments in the development and application of new technologies could increase energy productivity by 25 percent or more over standard projections during the next two decades. In addition to reducing energy use and CO2 emissions, the estimated productivity gains would generate a 10 percent or better net positive return on investment.
- Vattenfall, the Swedish electric utility, suggests that cost-effective efficiency investments could reduce overall greenhouse gas emissions by 25 percent.
- The United Nations Foundation now refers to energy efficiency as “the resource of first choice” and called on the G-8 to double the historical rate of energy efficiency improvements by 2012 through 2030.

² Paul Ashford, Caleb Management Services, *Assessment of Potential for the Saving of Carbon Dioxide Emissions in European Building Stock*, Prepared for EUROACE – Building Energy Efficiency Alliance, 1998.

³ Many different projects exists and many construction companies and architects have initiatives:

- <http://www.toolbase.org/ToolbaseResources/level3.aspx?BucketID=2&CategoryID=58>, <http://www.zerocarbonhouse.com/>,
- <http://www.arup.com/europe/newsitem.cfm?pageid=10639>,
- <http://uk.ihf.com/news/earthships-building-zero-carbon-future-for-homes.htm>,

⁴ http://www.architecture2030.org/current_situation/building_sector.html

⁵ <http://www.zerocarbonhouse.com/>

⁶ <http://www.architect-vzy.au.com/Free/climate.htm>

⁷ <http://www.businessballs.com/intelligentbuildingsdesign.htm>

⁸ AeA Report “Advanced Electronics and Information Technologies: The Innovation-Led Climate Change Solution”, September 2007, P. 13

⁹ <http://www.businessballs.com/intelligentbuildingsdesign.htm>

¹⁰ <http://www.businessballs.com/intelligentbuildingsdesign.htm>

¹¹ <http://www.fatspaniel.com/>

¹² <http://www.sf.solarmap.org/>

¹³ <http://environmentalresearchweb.org/cws/article/opinion/30580>

¹⁴ For example white ware producers transitioning from selling washing machines and fridges to providing clean clothing and cold food services.

¹⁵ <http://environmentalresearchweb.org/cws/article/opinion/30580>

¹⁶ <http://environmentalresearchweb.org/cws/article/opinion/30580>

¹⁷ In more detail:

- That equates to 1,500 teragrams of CO₂ emissions wasted during the production and delivery of electricity in the US each year (Environmental Protection Agency, Inventory of US Greenhouse Gas Emissions & Sinks, 1990 to 2005, Page 45. "in 2005, the electricity generation in US resulted in 2,381 Tg of CO₂ equivalent" (a Tg = teragram = 10¹²)
<http://www.epa.gov/climatechange/emissions/downloads06/07CR.pdf>
- Energy Information Administration, US Dept. of Energy, Annual Energy Review, 2006, Page 221 (Page 2 of Section 8) "41 quadrillion BTU's of raw energy are consumed to generate 13 quadrillion BTU's of usable electricity"
<http://www.eia.doe.gov/emeu/aer/pdf/pages/sec8.pdf>
- In fact, most of the existing infrastructure (wires, transformers, substations and switches) that make up the US electric grid have been in use 25 years or more (National Electric Delivery Technologies Roadmap, US Dept. of Energy, Office of Electric Transmission & Distribution, Jan 2004, Page 5).

¹⁸ Al Gore speech at NYU Law School, Sept. 2006, <http://thinkprogress.org/gore-nyu>

¹⁹ During emergency periods of peak energy usage, utility companies could send electronic messages to alert consumers to reduce their energy consumption by turning off or down non-essential appliances. Often, alert signals automatically pass directly to the end-appliance, eliminating the consumer's need for manual intervention. If enough consumers comply, the utilities may not need to start up a reserve generator (which is typically inefficient with high CO₂ emissions). In return, consumers may receive cash payments above and beyond their energy savings.

²⁰ In many areas, electricity pricing is dynamic, rising and falling based on the demand at that moment. Utilities are replacing traditional mechanical electric meters outside buildings with 'smart meters' that charge the variable rate based on the time the electricity is used. Consumers respond accordingly, shifting their energy consumption from high price times (days) to low price times (nights), called *load shifting*, or by turning off appliances altogether, called *load shedding*. This reduces consumer costs while reducing peak demand on utilities.

²¹ Buildings are becoming smarter in their ability to reduce energy usage. Traditional standalone, complex systems that manage the various appliances (heating, ventilation, air conditioning, lighting, etc.) are now converging onto a common IT infrastructure that allows these devices to "talk" to each other, coordinating their actions and reducing waste. For example, a manager of 500 commercial buildings was able to reduce energy consumption nearly 20% simply by ensuring heaters and air conditioners were not running simultaneously (State of Missouri, Mr. Dave Mosby, Director of Facilities, Dec. 2007). Individual appliances will include passive displays and single pixel interfaces, such as the ambient orb, which exploit pre-attentive processing to display subtle hints to consumers.

²² Recent university studies have found that simple dashboards can encourage occupants to reduce building energy usage by up to 30% (2005 Dormitory Energy Competition at Oberlin College, Cleveland, OH. "On average, dorms reduced electricity use by 32% during the competition. The two dorms with real-time feedback won with 56% reductions in electricity")

<http://www.oberlin.edu/dormenergy/news.htm>

²³ Analysis by Dept of Energy NREL found that many micro-generation technologies cost about the same per KWH as the local power company while producing less greenhouse gases. Furthermore, using new ICT solutions the smart grid allows consumers to sell back any surplus energy for a profit, reducing investment cost and accelerating adoption. These distributed technologies can help consumers to become an "active part of the grid" rather than "go off the grid", and may integrate with, not replace centralized generation.

²⁴ A recent PNNL study provided homeowners smart grid technologies to monitor and adjust the energy consumption in their homes. The average household in the US reduced their annual electric bill by 10%. This could reduce peak loads on utility grids up to 15% annually, avoiding need to build 30 large coal-fired power plant over next 20 years in the US alone. This could save \$70 billion in capital expenditures (CAPEX) on new plant investments, and take the equivalent of 30 million autos off the road (Department of Energy putting power in the hands of consumers through technology, Pacific Northwest National Laboratory, Jan. 2008),

<http://www.pnl.gov/topstory.asp?id=285>

²⁵ Jim Rogers, CEO of Duke Energy, briefing to Gridwise Alliance meeting, Charlotte, NC, Dec. 2007

²⁶ World Energy Outlook, 2006

²⁷ In more detail:

- European utilities, in particular, are leading in implementing this technology. For example, ENEL the Italian utility, has already installed 33 million smart meters at a cost of €2 billion. Total power consumption from households has decreased 5% since installing smart meters, and ENEL is saving €500 million annually on reduced operational costs (Website Low Carbon Life <http://www.lowcarbonlife.net/default.asp?page=79>).
- In 2006, California approved a PG&E plan to roll out smart meters to 9 million residents in northern California over 5 years (Website Wikipedia http://en.wikipedia.org/wiki/Smart_meter).
- The major building automation companies, all have smart building solutions that integrate their various HVAC systems.

²⁸ BACnet, LONnet, oBIX, etc

²⁹ Oberlin College has an interesting example of an on-line energy dashboard showing energy consumption at its college dormitories (2005 Dormitory Energy Competition at Oberlin College, Cleveland, OH. "On average, dorms reduced electricity use by 32% during the competition. The two dorms with real-time feedback won with 56% reductions in electricity" <http://www.oberlin.edu/dormenergy/>).

³⁰ Jim Rogers, CEO of Duke Energy, briefing to Gridwise Alliance meeting, Charlotte, NC, Dec. 2007

³¹ Worldwide demand for electric energy is estimated to rise 82% by 2030. Unless revolutionary new fuels are developed, this demand will primarily be met by building many new coal and natural gas electricity generation plants. Not surprisingly, world carbon dioxide emissions are estimated to rise by 59% by 2030 as a result (International Energy Outlook 2007, Energy Information Administration, US Dept. of Energy, Figure 6, "World carbon dioxide emissions continue to increase steadily in the IEO2007 reference case, from

26.9 billion metric tons in 2004 to 33.9 billion metric tons in 2015 and 42.9 billion metric tons in 2030, an increase of 59 percent over the projection period” <http://www.eia.doe.gov/oiaf/ieo/highlights.html>).

³² <http://www.un.org/apps/news/story.asp?NewsID=20772&Cr=global&Cr1=environment>

³³ AeA Report “Advanced Electronics and Information Technologies: The Innovation-Led Climate Change Solution”, September 2007, P. 10