



Green IT

Energy efficiency: the silent killer & enabler - data centres, semis & the smart grid

- **The IT sector's environmental credentials have long been neglected by investors** – both from risk and opportunity perspectives. The sector's CO2 emissions already account for 1.3% of global emissions and are set to overtake the aviation sector by 2020. **Data centres need to be singled out for particular scrutiny**, with their energy use projected to increase significantly as their numbers grow to over 120m by 2020. Data centres are expected to account for up to 50% of IT budgets for some companies – meaning that companies are starting to feel the cost pressure, regulators are considering taking action and the industry is waking up.
- **Green IT makes good business sense** both in terms of tens of billions in potential cost savings for data centre-reliant companies, with every €1 in energy savings driving up to €3 to €8 in operational savings (Source: IBM). **Green data centre companies should be a major beneficiary**. Companies developing software and hardware to green data centres – including companies involved in consolidation, data centre design, data de-duplication, infrastructure management, thin provisioning, virtualisation, as well as heating, cooling and power management – should all benefit.
- **IT companies can play a critical role as an enabler for others sectors**, notably buildings, industry, logistics, power and transport with the GeSI estimating that it could “enable” cost savings of over €625bn by 2020. **Semiconductors will be key to doing more using less**. Despite the current decline in the market, semis look likely to be vital to efficiency developments for consumer electronics and appliances (standby power), IT (data centres), industry (automation) and transport (fuel efficiency, PHEVs), among other sectors.
- **IT will be key for the development of the potential \$20 billion/year smart grid market** – intelligent energy networks that connect suppliers and consumers through ICT. The sector should be a key area for stimulus funding and energy efficiency in the coming years – and the market is potentially huge with over 90% of the world's electricity, gas and water meters using antiquated 1970s-era technology.

SG Green IT Watchlist

	Cur.	SGEE**	Reco	Price 17/03	Target 12m	P/E 09e (x)	EV/EBIT 09e (x)	Div. yld 08e (%)	Energy efficiency	Comments
Accenture	USD	<10%	Buy	30.48	35.0	13.6	6.6	1.3	Green data centres, Green Technology Suite, consulting	
Cisco*	USD	>50%	NR	15.45	NA	12.35	6.97	1.07	Efficiency of networks, big new push on data centres	
Comverge*	USD	100%	NR	5.54	NA	NA	NA	0	Largest provider of demand response systems to utilities	
EMC*	USD	>95%	NR	10.61	NA	NA	NA	3.58	Efficient storage platforms, green data centres	
Fairchild Semiconductor*	USD	75%	NR	3.52	NA	NA	NA	0.57	Smart power management & systems: 70% sales	
Google*	USD	<5%	NR	319.7	NA	15.48	10.14	3.61	Focus on end customer/household: PowerMeter, smart grid	
IBM	USD	<10%	Sell	92.91	80.0	10.6	7	2	2,000 green It client projects: data centres, smart grid	
International Rectifier*	USD	100%	NR	13.08	NA	NA	NA	1.38	Key enabler for efficiency across sectors: power management	
Itron*	USD	100%	NR	44.3	NA	12.86	NA	0	Global leader in smart meters: ~30% global mkt. share	
STMicroelectronics	USD	25%	Sell	4.51	4.2	NA	NA	6.7	Auto, residential & LED lighting efficiency	
VMWare *	USD	100%	NR	22.5	NA	22.78	14.96	5.78	Global leader in virtualisation technologies	
Wipro	INR	<10%	Sell	227.8	180	9.6	7.3	1.6	One of the most comprehensive green It offerings	



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* Consensus data from Datastream. ** SGe of approximate current sales exposure to energy efficiency theme

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Green IT, the silent killer and enabler

SG Green IT watchlist

Accenture
Cisco*
Comverge*
EMC*
Fairchild Semiconductor*
Google
IBM
International Rectifier
Itron*
StMicroelectronics
Vmware*
Wipro

* Not covered by SG, no reco, no TP

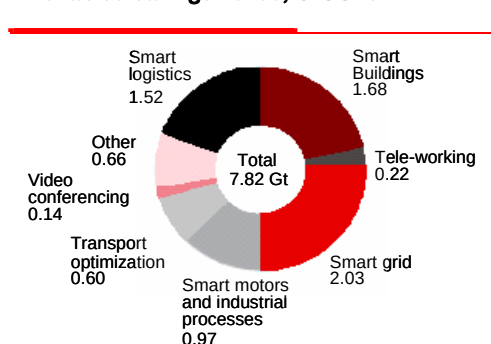
The IT sector has consistently delivered innovative products and services which have systematically increased productivity and supported economic growth across the world. However, **the sector's environmental credentials – both from risk and opportunity perspectives – have long been neglected by investors.** The UN estimates over 2% of total worldwide CO2 emissions are currently generated by ICT (information & communications technologies) – and that the sector could overtake the aviation sector by 2020. Data centres need to be singled out for particular scrutiny with their energy use projected to increase significantly as the number of centres is expected to grow to over 120m by 2020. As IT emission concerns rise, the energy efficiency of the sector is being targeted by stakeholders and both EU and US regulators. Additionally, energy price increases and availability constraints are also on the agenda – with data centres expected to account for up to 50% of IT budgets for some companies – meaning that companies are starting to feel the pressure and the industry is waking up.

We believe that Green IT initiatives are a significant answer to these issues and will help companies to both reduce their energy use and CO2 emissions simultaneously.

Green IT makes good business sense both in terms of tens of billions in potential cost savings for data centre-reliant companies with every €1 in energy savings driving up to €3 to 8 in operational savings (Source: IBM). The biggest beneficiaries should be companies developing software and hardware for green data centres – including companies involved in consolidation, data centre design, data de-duplication, infrastructure management, thin provisioning, virtualisation, as well as heating, cooling and power management.

We also believe that IT companies can play a critical role as an enabler for others sectors, notably buildings, logistics, power and transport with GeSI estimating that it could “enable” cost savings of over €625bn by 2020. We are particularly positive on IT's long-term role vis-à-vis semiconductors on a range of industries and the potential \$20 billion/year smart grid – which we believe will be a key area for stimulus funding and energy efficiency in the coming years – and believe that a number of companies are positioned to benefit.

IT-enabled savings 2020e, GtCO2e



Source: GeSI (Global e-Sustainability Initiative), SG Equity Research

Green IT – companies that could benefit

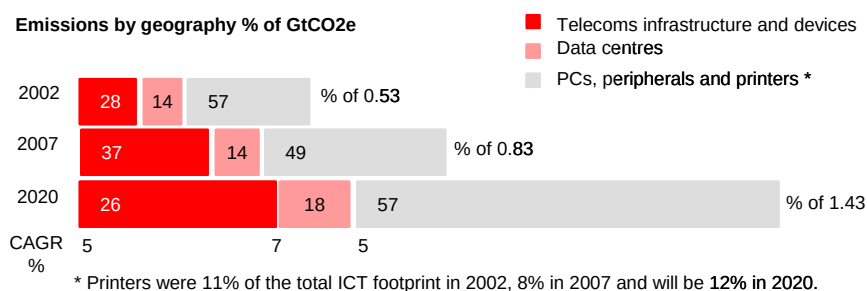
Theme	Impacted sub-sectors	Companies
GREEN DATA CENTRES	Cooling, data-deduplication, power supply, powering down, thin provisioning, virtualisation	Business software & services, data storage devices, diversified computer systems, hardware, internet providers, IT Services, technical & system software
CONSULTING	Business software & services, Management services	Cassatt Corp, Cisco, CSC, Dell, EDS, EMC, Getronics, IBM, Rackable Systems, Sun Microsystems, Spraycool*, Sun, Synapsense, VMware
SEMICONDUCTORS	Power semiconductors (power conversion, motor control)	Semiconductors
SMART GRID	Smart meters, Intelligent electricity networks	Business services, internet information providers, scientific & technical instruments, technology, utilities

Source: SG Equity Research

ICT emissions are set to outpace the airline sector

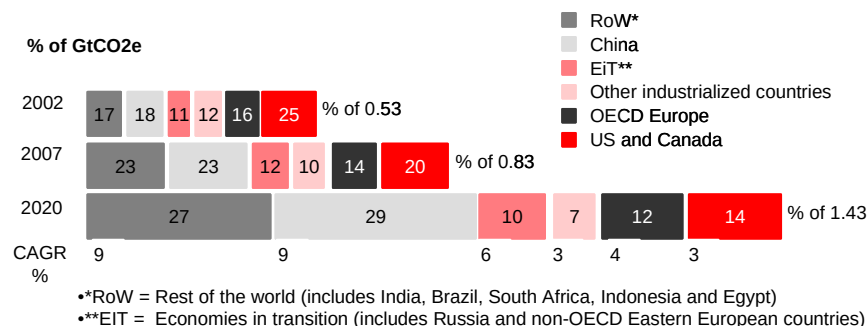
Despite common stereotypes of CO₂ emissions being a non-issue for ICT companies, the ICT sector was responsible for 1.3% of global primary energy use and 1.4% of CO₂ emissions in 2006. These figures increase to close to 2% of global totals if telecoms-related emissions are also taken into account (c.830 MtCO₂e). Materials and manufacture account for about one quarter of the sector's footprint with the bulk of CO₂ emissions impacts coming from usage.

Global ICT* footprint by sub-sector



Source: GeSI, * Information & Communications Technologies

Global ICT footprint by sub-sector



Source: GeSI, SG Equity Research

ICT emissions are set to grow at around 6% p.a. to 2020

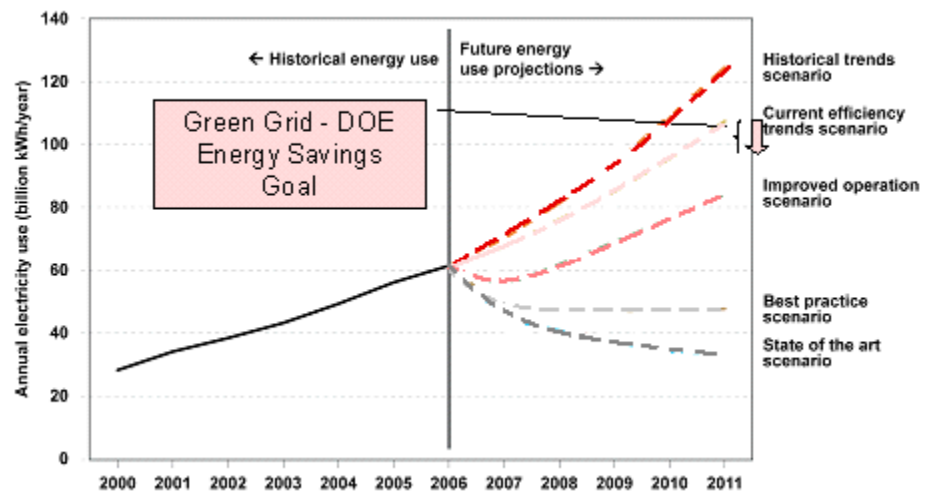
Global ICT emissions are set to rise at a rate of 6% p.a. and could reach 1.43Gt CO₂e by 2020 (Source: GeSI): Among the factors driving the increase in emissions are booming demand for ICT in developing countries: according to GeSI rising incomes and increasing affordability should mean that by 2020, one-third of the global population will own a PC (vs. 1/50 today), 50% will own a mobile phone and 1/20 will have broadband connection – with the bulk of the growth coming from China and India.

Data centre's power consumption becoming a major concern

The number of data centres is increasing as business demands increase and each facility is housing more powerful IT equipment. From 18m servers today, the market could grow to 120m+ servers by 2020 with the average data centre consuming as much energy as 25,000 households (i.e. 259 MTCO₂e – Source: US Congress). In addition to the electricity needed to run IT devices at data centres (i.e. load associated with all of the IT equipment, such as

compute, storage, and network equipment, along with supplemental equipment such as KVM switches, monitors, and workstations/ laptops used to monitor or otherwise control the data centre) – the largest sources of power consumption lies with Total Facility Power, which includes everything that supports the IT equipment load such as power delivery and cooling systems.

World's data centers projected to surpass airline industry as a greenhouse gas polluter by 2020



Source: Report to Congress on Server and Data Center Energy Efficiency Public Law 109-431" US EPA, August 2, 2007, SG Equity Research

Data centres, a silent problem with serious consequences

Data centre power consumption has been compared to the corporate version of high blood pressure, a relatively silent problem with serious consequences. The problem with data centre power consumption is that it is close to invisible – and, on the whole, neither corporations nor stakeholders adequately take into consideration the impacts of the fastest growing IT segment with 20m servers operating today and an estimated 120m servers expected by 2020. Data centre power consumption is on the rise and the cost and CO2 implications are becoming major cost and opportunity issues which could reshape the economics of many businesses, in a negative or positive way.

The changing picture of the data centre

A data centre is a facility that houses electronic equipment used for data processing, data storage, and communications networking. It houses server, network, and computer equipment, may have environmental controls, may contain or link to an uninterruptible, redundant and/or backup power supply, may be protected by physical security and protection devices or systems (e.g., fire suppression) and may be built for redundancy. Data centres have undergone significant changes in the last two decades with evolutions in IT seeing it become the critical nerve center of today's companies. The number of data center facilities has increased over time as business demands increase, and each facility houses a rising amount of more powerful IT equipment.

Global data centres are increasingly running into walls in terms of power, cooling, and space. They are also having a noticeable impact on the world's power grids with their energy efficiency becoming an important challenge for end-users, policy-makers, technology providers, facility architects, and utilities.

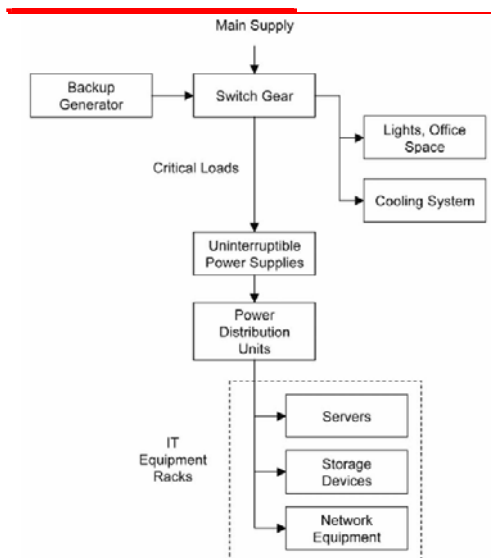
Growing needs for storage, computing & IT services

Until recently, electricity usage was not a major IT concern – with the electricity costs for running and cooling computers often not even part of the IT budget. However, the past decade has seen a vast increase in the number of data centres – the facilities used to house computer systems and associated components, such as telecommunications, storage systems environmental controls and security devices. The boom in needs for storage, computing and IT services should see data centres growing faster than any other ICT technology. From 18m servers today, the market could grow to some 122m servers by 2020.

Rampant inefficiencies are easy to find

In addition, inefficiencies within data centers are also easy to find. The majority of hardware devices have been designed to provide maximum performance and functionality with only

Data centre elements



Source: Report to Congress on Server and Data Center Energy Efficiency, SG Equity Research

limited regard for energy efficiency. A particular concern is the lack of power conversion and cooling systems that scale better with the load. Among the inefficiencies at play are energy wastage in cooling (c.60%), power conversion (burning more power in power conversion and cooling at light loads than the computer systems themselves are using) and the perverse incentive that pervades design and operation of data centres (vendors commonly put inefficient power supplies in high volume servers because buyers have traditionally shown a greater interest in the initial cost of a server rather than on lifetime energy savings).

Booming power consumption

Today's high performing data centres are huge consumers of power, with the average data centre consuming as much energy as 25,000 households. In 2000, they consumed about 0.5% of the world's electricity. By 2005, that had doubled to about 1%, a level equivalent to about 17 1,000-MW power plants (Source: Stanford). In addition to the electricity needed to run IT devices at data centres (i.e. load associated with all of the IT equipment, such as compute, storage, and network equipment, along with supplemental equipment such as KVM switches, monitors, and workstations/ laptops used to monitor or otherwise control the data centre), the largest sources of power consumption lies with Total Facility Power, which includes everything that supports the IT equipment load such as:

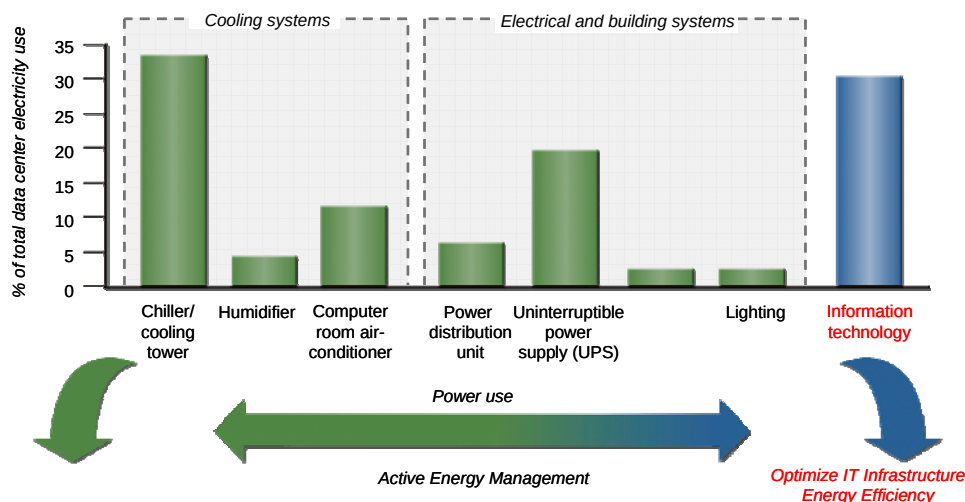
Average data centre power consumption

Equipment	Power consumption
Chiller	33%
IT Equipment	30%
Uninterruptible power supply (UPS)	18%
Computer room air conditioner (CRAC)	9%
Power distribution units (PDUs)	5%
Humidifiers	3%
Switch / generator	1%
Lighting	1%

Source: The Green Grid, SG Equity Research

- **Power delivery components** (UPS, switch gear, generators, PDUs, batteries, and distribution losses external to the IT equipment)
- **Cooling system components** such as chillers, computer room air conditioning units (CRACs), direct expansion air handler (DX) units, pumps, and cooling towers.
- **Compute, network, and storage nodes.**
- **Decreased efficiency of UPS equipment** when run at low loads.
- **Miscellaneous component loads** such as data centre lighting.

Optimising data centre energy efficiency



Source: American Power Conversion Corporation, SG Equity Research

Skyrocketing CO2 emissions

Data centers already consume a considerable amount of the world's total supply of electricity – and are set to become a larger cause for carbon emissions than the airline industry. Global data-centre related CO2 emissions are set to triple from 76 MTCO2e to 259 MTCO2e by 2020, making it the fastest growing contributor to ICT emissions growth (c. 7% p.a.) (Source: GeSI). In the US alone, data centers consumed 1.5% of all electricity in 2006 – the equivalent to the electricity consumed by 5.8 million average U.S. households – with their electricity usage growing at 12% p.a.

Old solutions no longer work

Growing storage system capacity is the time-honored method for housing more data. However, energy and cooling costs grow right along with capacity, making for unacceptably high energy costs and data centers that have reached the limit of their expansion. Instead of merely adding storage capacity, IT must optimize usable capacity on its existing storage systems. According to InfoStor this alone will provide the data reduction needed to control storage-related energy issues--a significant offender when it comes to data-center energy costs.

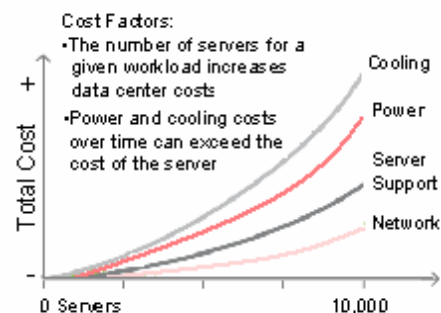
Cost is forcing companies to act

The increase in computing demand, IT equipment power density, energy costs – and their subsequent importance as a significant part of the total cost of ownership is forcing companies to act on Green IT. Data centre costs have risen to account for 25% of IT budgets and data centres are growing twice as fast as IT revenues.

By 2015, the costs to operate servers are expected to exceed the costs to purchase server hardware and while energy bills traditionally have accounted for less than 10% of an overall IT budget, they could soon could account for more than half (Source: Gartner):

- 100 KWatt in IT power = up to \$1m in infrastructure costs
- \$1 in equipment = up to \$1 in energy costs
- \$ in energy = up to 1\$ for energy for HVAC

Data centre cost factors



Source: Intel, SG Equity Research

Energy budgets are swelling as companies use more energy to keep their systems running. In a worst case scenario, without radical changes in operations, the world's data centres could run out of power and many companies with large data centres could face significantly reduced profitability. The slowing economy will not derail efforts to make IT operations more energy efficient for the simple reason that green IT saves companies money. According to the latest Forrester report surveying 1,500 IT practitioners from 1,022 companies in October 2008, 67% cite energy-related cost savings as the main driver for corporate IT decisions.

Growing regulatory pressure

Regulators are becoming increasingly vocal on IT energy use in the EU, and the European Commission is taking a lead role in ensuring that the IT sector leads efforts to attain climate change targets. To date, the focus has been on voluntary mechanisms but stronger actions may be on the agenda with the EC's Information Society Commissioner hinting at the possible

introduction of mandatory public-procurement standards to improve energy-efficiency standards for ICT – and the EC set to publish shortly policies and proposals to boost the use of smart technologies to combat climate change.

In the U.S. a number of standards are in place or being developed on energy efficiency, power supply, power measurement and virtualisation capability and EPA power/performance benchmarks should be in place by 2010.

Recession is driving companies to act

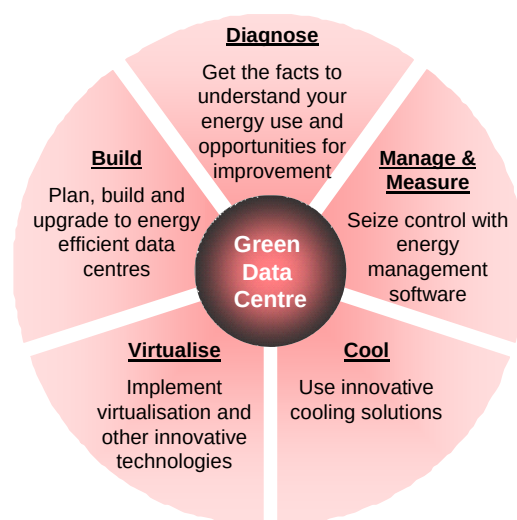
The slowing economy will not derail efforts to make IT operations more energy efficient for the simple reason that green IT saves companies money. According to an October 2008 Forrester report surveying 1,500 IT practitioners from 1,022 companies, reducing energy-related operating expenses will continue to drive take-up of Green IT:

- 67% cite energy-related cost savings as the main driver for corporate IT decisions
- 25% of companies are already implementing green IT plans
- >33% will maintain the pace of green IT plans while 10% will accelerate plans
- 48% are very aware of green marketing by IT vendors.

Greening data centres

Energy usage and energy costs are have spurred both challenges and advances across the IT continuum of servers, storage, networks, and facilities. Energy budgets are swelling as companies use more energy to keep their systems running. This is a large-scale problem and without radical changes in operations, the world's data centres could in a worst case scenario, run out of power and many companies with large data centres could face reduced profitability.

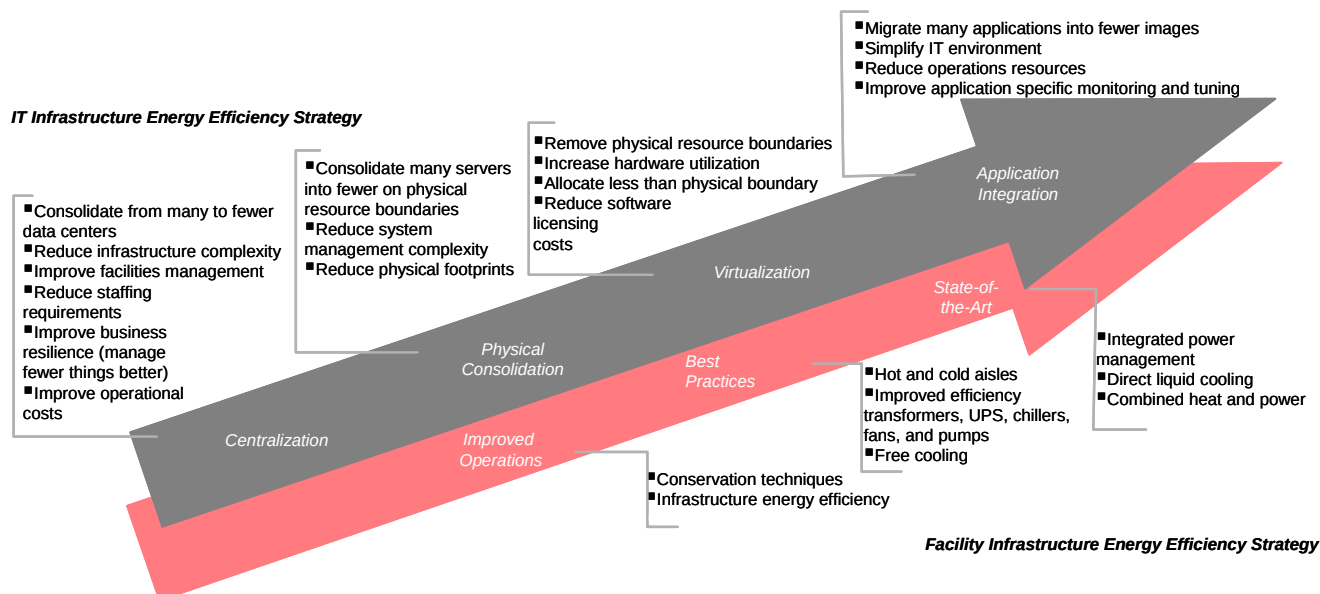
Green data centre



Source: IBM, SG Equity Research

As a result, the green data centre movement has developed to promote and enact more energy efficient technology to better manage increased computing, network, and storage demands on a large scale. The central tenet is that less data requires less energy. In practice, this involves acting on a series of integrated measures including best practices in terms of software-based technologies (data de-duplication, thin provisioning, primary data compression, and virtualisation) and on operations (transformers, UPS, HVAC, coolers,, fans, and pumps etc.). We believe that these areas will create increasing opportunities for companies involved in providing such technologies and services.

Energy efficiency for IT infrastructure and facility infrastructure



Source: IBM, SG Equity Research

Greening the data centre

Greening technique	Overview of energy efficiency benefits
Data compression	Most established energy savings technology and has long helped to save disk space, speeds up data recovery using fewer backup sources, and saves on storage system and media purchases. Usually takes place at the secondary storage (nearline) level – with data compression using less disk and thus cutting down on ongoing energy costs from constantly spinning disks, but is being looked into for primary production environments / storage (assuming costs can be reduced)
Virtualisation	<40% energy savings by applications and servers working in a non-dedicated manner, pooling assets where utilisation is low, making it possible to run multiple operating systems and multiple applications on the same computer simultaneously, thus increasing the utilisation and flexibility of hardware (rather than a traditional vision of a number of standalone computers performing dedicated functions for individual applications). Methods include: server consolidation; orchestration (moving around virtual machines); storage virtualization (presenting virtualised storage pools as separate devices to the applications (rather than having a plethora of storage devices, each requiring its own energy source and generating significant heat); best practices around managing large virtual storage pools, such as wide striping across multiple spindles for improved performance).
Data de-duplication	Reduces storage needs and boosts efficiency for file-based data by optimising storage systems to eliminate the inherent data redundancies that exist in many traditional storage and data protection processes, such as backup (>25x reduction in backup data as its highly optimised storage systems house less data, which means less power use and less heat generation)
Thin provisioning	Deals with the problem of over-allocation /provisioning (i.e. users and applications requesting more storage than the application will actually use in the short- to mid-term: utilization rates of <20% with 80% of usable power capacity using up energy) by allowing IT systems to allocate a larger virtual amount of capacity than the actual physical amount available (e.g. virtually provisioning 100GB to an application while only physically provisioning 10GB in the physical storage pool). As capacity requirements grow, thin provisioning can automatically release physical storage via capacity alerts
Information lifecycle management	ILM uses automatic intelligence to store information in the most appropriate and energy-efficient storage device at every point in its lifecycle (i.e. migrating less critical information to storage that requires less energy)
Adopting cooling technologies	Hardware and software need to work hand-in-hand to address power surges, “hot spots” in facilities, wasted energy, overheating and overuse of power by applications and air conditioning. <30% savings via modular, scalable power and cooling architecture (e.g. detect when temperatures are running high & providing direct cooling to those areas)
Air conditioning	<30% savings via more efficient AC architecture (row-oriented cooling, shorter air paths), economizer modes of AC, directing external air into the data centre
Power use	Best in class UPS systems have <70% less losses than legacy UPS. ~10% energy savings by directing low voltage DC into the data centre (eliminating the need for mechanical back up, uninterruptible power supply units)
Floor layout	<12% savings via hot/cold aisle arrangements with suitable AC arrangements
Distributed generation	Use of renewables or locally generated energy: solar, wind, hydro, geothermal, fuel cells etc.

Source: SG Equity Research

Overview of company data centre energy efficiency capabilities

	Intel	Dell	HP	Getronics	Sun	Wipro	IBM	EDS	CSC	Accenture	EMC	VMware	Cisco
Virtualisation & consolidation	●	●	●	●	●	●	●	●	●	●	●	●	●
Data centre/ power & cooling	●	●	●	●	●	●	●	●	●	●	●	○	●
Desktop & PC systems	●	●	○	●	●	●	●	●	●	●	●	●	●
Data centre design & architecture	●	●	●	●	●	●	●	●	●	●	●	●	●
Power management software	●	●	●	●	●	●	●	●	●	●	○	○	●
IT infrastructure management software	○	●	●	●	●	●	●	●	●	●	●	●	●

Source: Company data, Forrester, SG Equity Research

Huge Potential for CO2 savings

The potential savings from improvements in energy efficiency are huge with the improved operational management of IT equipment offering potential electricity savings of more than 20%. For a typical 25,000-square-foot data center that spends \$2.6million in power annually, this would mean potential savings of more than 4million kWh (Source: EPA Report to Congress on Server and Data Center Efficiency). This reduction would be the equivalent of an abatement of 3,714t of CO2 annually, annual GHG emissions of 617 care, carbon sequestered by 86,325 tree seedlings grown for 10years – and a potential savings of \$1.2M in energy costs over four years (assuming a 5% per year improvement over that period) (Source IBM).

Energy efficiency is not just about power use

Energy-Efficient Systems	Cooling, UPS, power supplies, servers, and non-IT equipment
Asset Procurement	Equipment is selected considering full lifecycle environmental impact, from technology providers with appropriate environmental policies and controls
Building Construction	The physical building, its fixtures and fittings are designed and selected to be energy efficient and to make use of relatively low impact materials and construction techniques (LEED certification)
Energy-Efficient Operations	The systems are monitored and operated to maximize energy efficiency
Energy Source	Appropriate use of renewable or locally generated energy; solar, wind, hydro, geothermal, fuel cell, etc.
Support Services	Selected and managed to minimize the environmental footprint
Waste Management	Waste products and emissions are reduced, recycled, or reused

Source: SG Equity Research

The Green Grid initiative, companies taking the lead

The Green Grid is a global, non-profit consortium dedicated to advancing energy efficiency in datacenters and business computing ecosystems. The scope of The Green Grid is broad in the context of energy and power efficiency. It includes the:

- Defining meaningful, end-user-centric models and metrics agencies to evaluate the performance-per-watt of the datacenter and their components (including islands or sub-components of the datacenter);
- Developing standards, measurement methods, processes and technologies to improve performance against the defined efficiency metrics; and the
- Promoting energy-efficient standards, processes, measurements, and technologies.

In February 2009, the Green Grid announced its most ambitious plans yet to create a “top-to-bottom” design guide for building energy-efficient data centres, as well as new metrics for estimating data centre productivity. The “Data Center 2.0” design guide will offer ways to minimize energy use for both new facilities and those being retrofitted –and will be released in 2010. Long-term objectives for The Green Grid include defining a new datacenter power efficiency architecture to implement energy-efficiency policies natively through the instrumentation of devices. This architecture will include automatic control of datacenter components via policy-based management geared toward IT objectives for power efficiency.

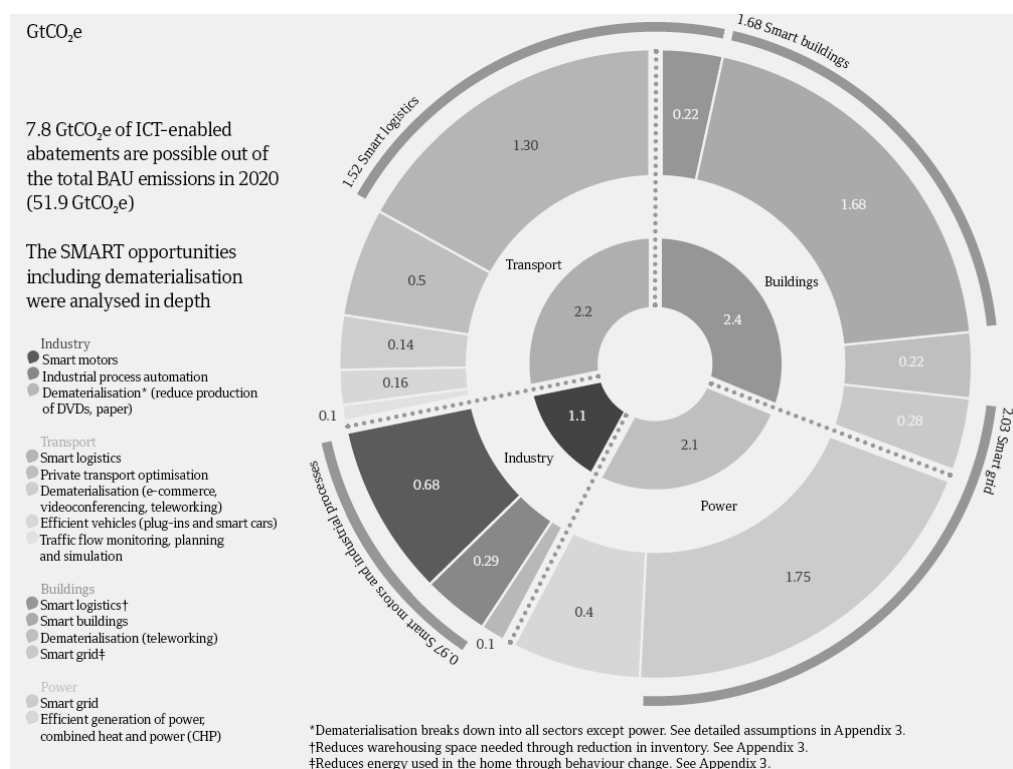
Need for better data centre metrics

Energy efficiency in the data center depends on being able to clearly measure, monitor and manage energy consumption. Conventional models for estimating the electrical efficiency of datacenters are grossly inaccurate for real-world installations – for example, DCD (data center density) is a good metric for absolute performance but fails to capture whether the deployment is being done effectively. Fair comparisons for datacenter energy efficiency (and the components that comprise it) will require a standardised set of performance and energy efficiency metrics (a la miles-per-gallon for cars). Recent innovations such as the Green Grid’s introduction of the PUE (power usage effectiveness) ratio, which provides a way to measure overall datacenter efficiency, have been taken up by Microsoft and Google. Such metrics will be key to understanding the efficiency of their datacenters, improving the performance-per-watt of their IT equipment, and making smarter IT purchases. In addition, these metrics will provide a common way to benchmark against existing or legacy datacenters as well as other organisations and industry norms.

IT's enabling effect, hundreds of billions in savings

The IT sector has an increasingly important role to play in creating a low carbon society. In particular, it is set to be a key actor in enabling other sectors such as buildings, power, transport and industry to become more energy efficient. IT should help to radically transform the way these sectors operate and the IT sector's "enabling effect" role could help to deliver up to a 15% reduction in global BAU emissions by 2020 (7.8 GtCO₂e out of 51.9 GtCO₂e). Savings could reach well over €600bn (\$946.5bn) including up to €553 billion (\$872.3bn) in energy and fuel saved and an additional €91 billion (\$143.5bn) in carbon saved (Source GeSI). These assumptions are based on a forecast of a CO₂ cost of €20/t for 2012. In the following sections, we focus on two areas which show IT's enabling abilities vis-à-vis other sectors – semiconductors and the smart grid.

IT's enabling effect: up to 7.8 GtCO₂ abatements by 2020



Source: GeSI, SG Equity Research

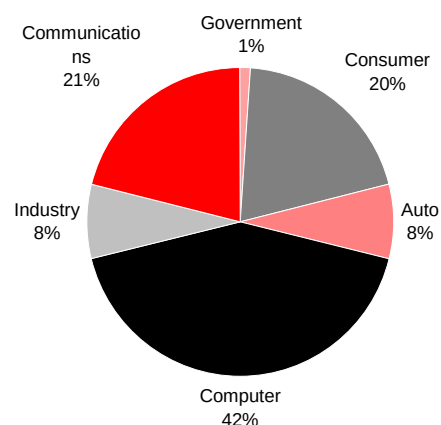
Semiconductors, doing more using less

Semiconductor devices play a vital but nearly invisible role in achieving the goal of energy efficiency. They are one of the best examples of IT as an enabling industry with huge economic impacts downstream on a number of sectors – consumer appliances and electronics, data centres, industrial manufacturing, infrastructure, lighting and transport – and thus essential for energy savings across the economy.

Due to its vast applicability the semiconductor industry both drives the market and is driven by it so the industry's performance is often considered cyclical – and will be hit hard by the current economic climate – but long-term will be essential to the global drive on energy efficiency.

This should benefit a number of companies who are essentially pure plays on the energy efficiency theme such as Fairchild Semiconductor and International rectifier as well as larger semi companies such as AMD, Infineon and STMicroelectronics, among others.

Power efficiency solutions



Source: World Semiconductor Council, SG Equity Research

Power efficiency solutions



Source: International Rectifier, SG Equity Research

Semiconductors' key role in electronic technology & energy and data transfer

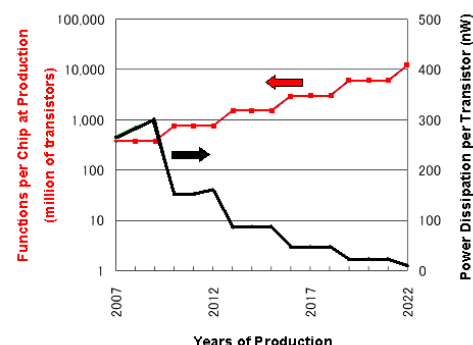
Semiconductors are a materials product, often made of silicon, which play an essential role in electronic technology and are a key component in energy and data transfer. The primary characteristic of all semiconductors is that they are capable of electrical conductivity between a conductor, such as copper or aluminum, and an insulator. They are very small and incredibly complex and are used in an impressively large number of diverse markets including communications infrastructure, automotive technology, personal computers, appliances and consumer products. The semiconductor industry broadly consists of four main categories:

- **Memory** – act as temporary data storage units and pass information to and from sources and receivers.
- **Microprocessors** – central processing units capable of performing basic tasks.
- **Commodity Integrated Circuit** – Also known as 'standard chips' these are basic processing circuits which are often produced in large batches and have a very small profit margin.
- **Complex SOC** – An SOC, or 'system on a chip' semiconductor has integrated technology with the capability of a whole system.

Performance and miniaturisation – smaller, faster, cheaper

As a result of the industry's "smaller, faster, cheaper" mantra, semiconductor companies are under constant pressure from consumers and competitors to develop better and cheaper products. Miniaturisation is key in advancing semi technology and realizing more functions without increasing power. The smaller the semiconductor, the more transistors can be packed onto a chip, which results in faster transmission and superior technology and efficiency. The power consumption to activate one transistor has decreased one ten thousandth since the first transistor was made 50 years ago. Superior semiconductor technology has the ability to boost the efficiency of the IT industry as a whole and, due to its downstream impacts in other non-IT markets, semiconductors can reduce the energy use and emissions of countless other products and industries.

Integration and power dissipation



Source: WSC, SG Equity Research

Green cap goods – motors, automation and lighting

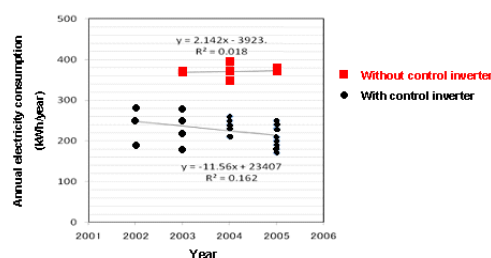
Semiconductors enable variable speed motors, which consume 1/8 of the energy as a constant speed drive. Two-thirds of the world's industrial electricity runs electric motors and only 5% of these use variable speed drives. The 5% of electric motors that do use variable speed drives are estimated to save the energy produced by 10 power plants and annually prevent the emission of 68 million tons of greenhouse gases. It is estimated that industrial applications of new energy-saving chip technologies could improve energy efficiency by up to 88% due to more efficient motor control and power management.

Semis are also essential to solid State Lighting (SSL) – the new, energy saving lighting solution that uses high brightness Light Emitting Diodes (LEDs) and can be applied to traffic lights, portable consumer devices, automotive and in-outdoor lighting. Currently lighting is responsible for 19% worldwide electricity use and integrating SSL solutions which consume less overall power could lead to a potential savings of 25 – 40%. This savings in electricity use could equal a savings of more than 500 million tons of CO2 emissions per year. (See SG's *Green Capital Goods* report also dated 19 March 2009).

Green consumer goods – energy and cost savings on power loss

Semiconductors can help to manage power in consumer electronics and household appliances by reducing power loss and optimising energy efficiency. Ranking among the most inefficient household energy consumers are lighting, air conditioning systems and electrical appliances or devices operating in standby mode. The standby mode is highly inefficient and a major culprit in wasting electricity. Studies in the USA have shown the unproductive standby mode as accounting for about 1.5 % of the entire power consumption in the USA. A 90% reduction in power loss is already technically possible

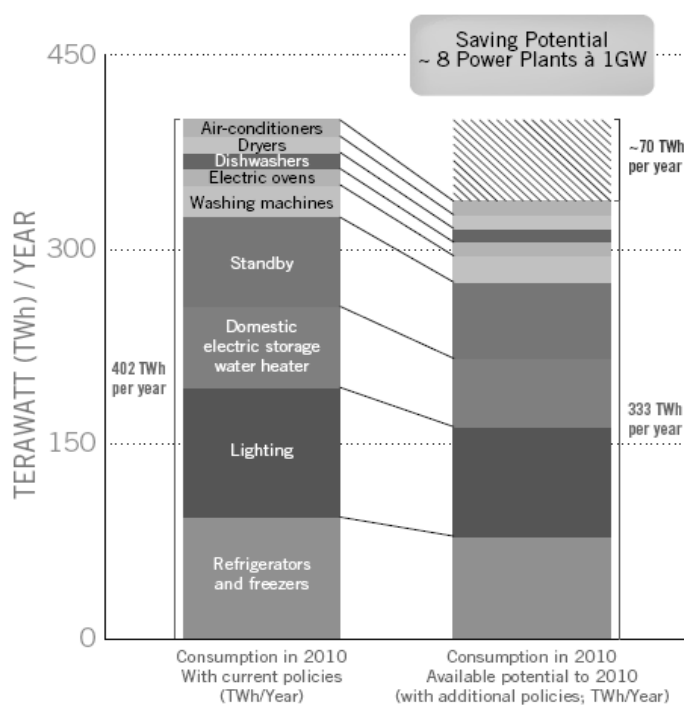
Electricity consumption of a household fridge (pa)



Source: WSC, SG Equity Research

and could save some 3-4 billion US dollars in the USA alone. A study by the International Energy Agency (IEA) found that the capacity of all the wind power stations in the world falls far short of that required to cover the energy demand from the standby mode of household appliances in the 30 member states of the OECD.

Potential European energy savings in the home



Source: European Semiconductor Industry Association (ESIA), SG Equity Research

Green IT – data centres & SSDs

Semis can reduce energy and emissions in all areas of data centre operations by increasing efficiency via improvements of up to 80% in the performance of chillers, fans, pumps and use of direct liquid cooling. During computations (c. 35% of a server's energy draw), new chip technologies allow those parts of the processor not fully engaged in an application to draw reduced amounts of energy. Meanwhile, new chips can also reduce the energy use by up to 40%, even in the less energy-intensive memory arena. Chips also improve the efficiency of the data center cooling systems and enable intelligent sensing, control and communication capabilities that further reduce energy usage via improvements of up to 80% in the performance of chillers, fans, pumps and use of direct liquid cooling.

Semis are key to the roll-out of solid-state drive (SSDs) – data storage devices that uses solid-state memory to store persistent data – and which emulate and replace hard disk drives. Although costlier, SSDs provide solid power efficiency, requiring less than half the energy of a conventional hard drive. And with almost no heat emissions, the SSD does not need a fan to keep its cool, thus further reducing energy costs.

SSD power use advantages over HDD

Power use	2.5" SSD	2.5" HDD
Active	1W	2.1W
Idle	0.1W	1.5W
Stand by	0.06W	0.2W

Source: Semiconductor Industry Association, Korea

Green transport - automobile fuel efficiency

Semis' role in engine control electronics has been a key to dramatic improvements in fuel efficiency and emissions over the last 20 years. Today's vehicles can feature over 100 chip-enabled features such as gasoline direct injection, knock detection, oxygen sensors, exhaust gas recirculation, evaporative emission control systems, misfire detection, electronic steering, and secondary air systems. These chip-based features both reduce energy consumption and improve vehicle performance and safety. For instance, in terms of car wiring, semis allow for multiple systems to be placed on the same cable, resulting in a huge reduction of car wiring. The average weight saved per car in wiring alone is about 30 kg which according to the Semis industry globally saves 15Mt CO₂ per year. Chips will likely play an increasingly important fuel efficiency role in terms of electronic throttle control, variable valve timing, cylinder deactivation, camless engines and in-cylinder combustion control – as well as being critical to the development of plug-in electric vehicles (PEV) by significantly extending their performance and range, making them more attractive to consumers as well as more efficient.

Renewables, solar could pick up the economic slack

Due to their role in storing and transmitting energy advanced semiconductor technology will also likely be instrumental in making renewable energy more efficient and cost effective. Chips play a key role in the electronics used in both solar and wind generated power systems, including solar inverters and wind turbines, which convert direct current from solar panels or turbines into usable household alternating current. With the latest chip technologies, system efficiency is maximised so it can be productive even on cloudy and low wind days. Chips are also being researched to better use solar power — both natural sunlight and indoor ambient — in recharging the batteries of portable devices. A number of companies are putting a stronger emphasis on solar energy in particular:

- Hemlock Semiconductor announced a \$3 billion expansion of polysilicon production,
- IBM formed a partnership with a Japanese company to produce thin film solar panels,
- Intel introduced its solar startup SpectraWatt,
- National Semiconductor introduced its SolarMagic line.

The smart grid, intelligent energy systems

Smart grids are intelligent electricity networks that connect energy suppliers and consumers through the use of sophisticated technologies. They use advanced two-way ICT technologies and sophisticated sensing and monitoring technologies which can monitor and control the flow of power between utilities and their customers to avoid blackouts, incorporate distributed power generation and even use plug-in electric vehicles as grid storage batteries. The smart grid has huge potential to improve industrial efficiency, promote the use of cleaner energy resources, ensure the security of infrastructure and improve stakeholders' everyday lives. However, significant progress needs to be made on a number of fronts including introducing AMI (advanced metering infrastructure or "smart meters") as an enabler.

For companies competing for a piece of the emerging smart grid market it is something of a Wild West story with a variety of competing technologies and communication standards at play. However, the prospect of lucrative utility contracts and growing governmental support means that there is significant room in an industry that's still in its infancy. But as utilities start installing smart meters and demand response systems, as well as Home Area Networks, we anticipate short to medium-term opportunities for a number of small, pure play smart networks and smart meter companies such as current market leader Itron as well as Comverge, Echelon and EnerNoc. Longer-term, we believe that global players such as Accenture, Cap Gemini, Cisco, General Electric, Google or IBM might buy-out many of the smaller players with risk-averse utilities preferring to buy equipment and services from large companies.

Drivers for updating the electricity grid

Expected change	Impact
Shift in centralised power structure from coal and petrol to natural gas	Power plants to be constructed close to harbours and pipelines rather than demand sides, in order to reduce costs
Extension of renewable energy systems	Reduced regional flexibility. Intermittent production is a challenge to match supply and demand in real-time
maximum integration of decentralised energy resources	E.g. renewables - because of their efficiency potential and quick response potential to fluctuating demand
Use of dynamic pricing models with ICT functionality	High levels of automation and device-specific automation to ensure user awareness and capacity building
Countries are looking to isolate energy grid disturbances	Changing climate patterns/uncertainty

Source: SG Equity Research

Traditional grid is not positioned for future realities

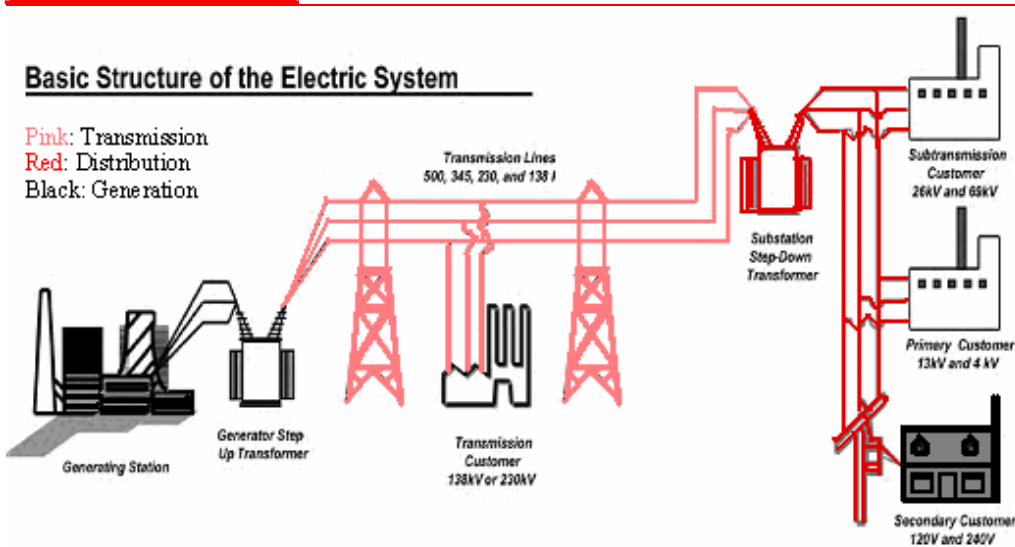
The traditional model of electric power generation and delivery is based on the construction of large, centrally located power plants – (i.e. hubs surrounded by major electrical load centres). The electricity grid brings power from the plant to users and consists of two infrastructures:

- 1) High-voltage transmission systems, which carry electricity from the power plants and transmit it hundreds of miles away, and
- 2) Lower-voltage distribution systems, which draw electricity from the transmission lines and distribute it to individual customers.

High voltage is used for transmission lines to minimize electrical losses; however, high voltage is impractical for distribution lines. The interface between the two is the electrical substation,

which features transformers that "step down" the transmission voltages—from 138kV to 765kV—to lower voltages for the distribution systems. Transformers located along the distribution lines further step down the voltage to 120V or 240V for household use. Substations also include electrical switchgear and circuit breakers to protect the transformers and the transmission system from electrical failures on the distribution lines. Circuit breakers are also located along the distribution lines to locally isolate electrical problems (such as short circuits caused by downed power lines).

Basic structure of the electric system



Source: SG Equity Research

Drivers for updating the electricity grid

Beyond distributed generation pilot projects there have been no major changes in the electricity grid in recent years. The current grid, dominated by centralised generation, is antiquated, non-ICT compatible and not very well positioned to deal with the biggest challenge going forward to 2020 and beyond; the transition away from today's demand side management to dynamic demand scenarios. Drivers for updating the existing electricity grid include:

- **Shift in centralised power structure** from coal and petrol to natural gas: power plants will be constructed close to harbours and pipelines rather than demand sides, in order to reduce costs;
- **Extension of renewable energy systems** with reduced regional flexibility: intermittent production is a challenge to match supply and demand in real-time
- **Need for maximum integration of distributed energy resources** because of their efficiency potential and quick response potential to fluctuating demand
- **Countries are looking to isolate energy grid disturbances** because of changing climate patterns/uncertainty

The traditional model of electric power generation and delivery is based on the construction of large, centrally located power plants – i.e. hubs surrounded by major electrical load centres. The electricity grid brings power from the plant to users and consists of two infrastructures: high-voltage and low voltage transmission systems. Beyond distributed generation pilot projects, there have been no major changes in the electricity grid in many years. The current

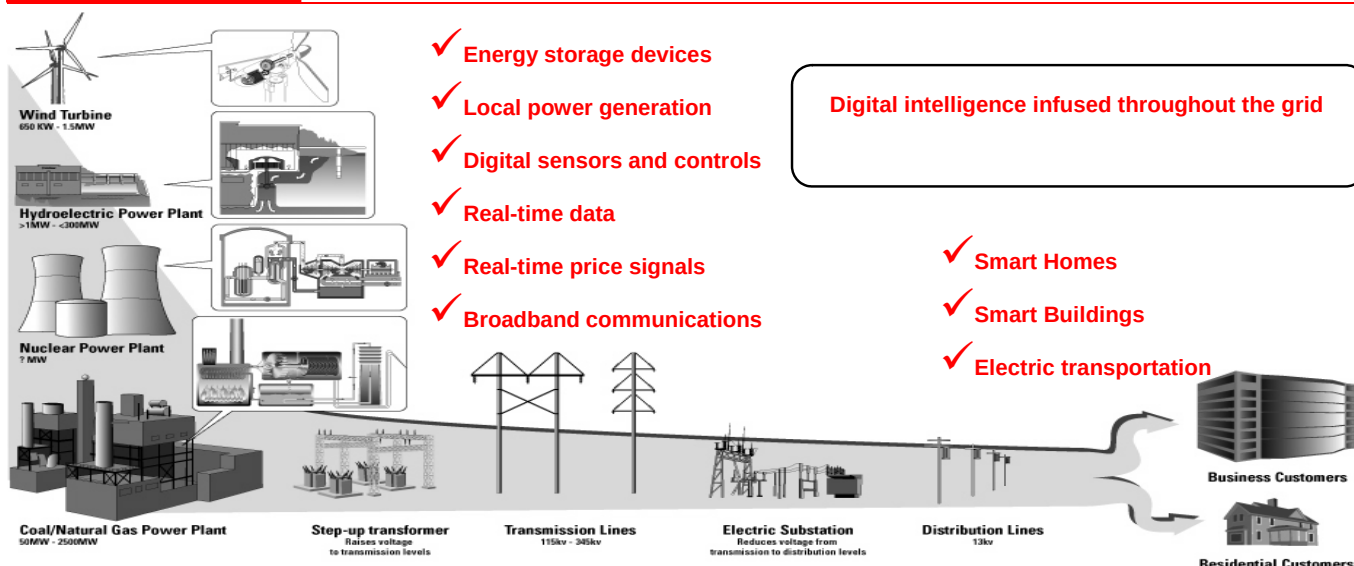
grid is antiquated, non-ICT compatible and not positioned to deal with the biggest challenge going forward: the transition away from today's demand side management to dynamic demand scenarios. It is in major need of a revamp – new transmission lines and a massive upgrade of the analogue grid that directs the energy from place to place, with new computers, sensors, and communication gear to manage the network.

EU-27 energy grid: challenges

Factor	Situation / overview
Infrastructure	c.50 years old; hierarchical, top-down flow & distribution of power
ICT integration	Poor
Energy efficiency	Not designed / optimised for it
Power generation	Fossil fuels
Demand structure	Centralised power stations: heavy industries in agglomeration areas
Supply structure	Oriented to regional demand; guarantee redundancy

Source: SG Equity Research

Smart grid



Source: Xcel Energy, SG Equity Research

Smart grids save energy and costs

Smart grids save energy and reduce carbon emissions by developing an interactive network that links multiple energy providers with numerous energy users using advanced technologies such as advanced metering infrastructure (AMI) and services (smart meters). Unlike traditional systems in which energy flows from utility to consumer, AMI / smart grid systems allow both information and energy to flow in either direction. Data on energy production, energy costs, energy sources, and energy consumption is made available to producers and consumers. These data can then be used as inputs into automated or managed decision-making processes to manage energy demand, choose energy providers, or schedule energy use for off-peak periods. Under an optimistic scenario – the implementation of a smart-grid enabled supply and demand management system could reduce power sector emissions by 2.03 GTCO₂e and save up to €79 billion by 2020.

Smart grid's cost savings potential

Functions / benefits	Cost savings	Cost savings potential
Automated and remote meter reading	Collections	15-25%
Remote connection and disconnection	Standards & constructions	15-20%
Monitoring of power quality	Demand management	2-22%
Consumer information about utilities (i.e. current & historic consumption, costs, GHGs, current tariff & demand)	Asset management	4-19%
Misc. safety; field work management, settlement, system control, billing & customer care, tariff & regulatory, outage & restoration	Load forecasting	9-14%

Source: Cap Gemini, European Commission, SG Equity Research

Smart grid as an enabler

Supply and demand management (SDM) is the core element of a smart grid and will require technology, consumer awareness/acceptance and policy frameworks vis-à-vis these enabling factors:

- **Growing share of distributed energy resources (DERs)** – based on the growing proportion of renewables, control energy capacities have to be expended so that an optimized grid can communicate with demand side loads that offer a number of options to make the grid load predictable via – shiftable loads, interruptible loads, loads that can be schedule, highly inertial loads. This will require important changes in technical functions of energy grids i.e. frequency stability, power balancing, voltage stability, system management).
- **Advanced metering infrastructure (AMI) and services (smart meters)** SDM needs intelligent end use devices and a local infrastructure which is available on all demand sides. AMI allows 2-way communication within an integrated communication system

Overview of smart grid technologies

technology	Overview	Equipment / Innovations / improvements
Integrated communications	Real-time control, information and data exchange to optimize system reliability, asset utilization, and security (eg via direct network connection)	Substation automation, demand response, distribution automation, supervisory control and data acquisition (SCADA), energy management systems, wireless mesh networks and other technologies, power-line carrier communications, and fiber-optics
Sensing and measurement	Evaluating congestion & grid stability, monitoring equipment health, energy theft prevention, and control strategies support	Advanced microprocessor meters (smart meter) & meter reading equipment, wide-area monitoring systems, dynamic line rating, electromagnetic signature measurement/analysis, time-of-use and real-time pricing tools, advanced switches and cables, backscatter radio technology, and digital relays.
Smart meters	A smart grid replaces analog mechanical meters with digital meters that record usage in real time	Provide a communication path extending from generation plants to electrical outlets (smart socket) and other smart grid-enabled devices
Phasor measurement units	High speed sensors called PMUs distributed throughout their network can be used to monitor power quality and in some cases respond automatically to them.	With large numbers of PMUs and the ability to compare shapes from alternating current readings everywhere on the grid, research suggests that automated systems will be able to revolutionize the management of power systems by responding to system conditions in a rapid, dynamic fashion
	Wide-Area Measurement Systems (WAMS) is a network of PMUs that perform can provide real-time monitoring on a regional and national scale. M	May be able to contain blackouts to much smaller areas
Advanced Components	Innovations in superconductivity, fault tolerance, storage, power electronics, and diagnostics components	Flexible alternating current transmission system devices, high voltage direct current, first and second generation superconducting wire, high temperature superconducting cable, distributed energy generation and storage devices, composite conductors, and "intelligent" appliances
Advanced controls	Power system automation enables rapid diagnosis of & precise solutions to specific grid disruptions or outages	Distributed intelligent agents (control systems), analytical tools (software algorithms and high-speed computers), and operational applications (SCADA, substation automation, demand response, etc
Improved interfaces and decision support	Information systems that reduce complexity so that operators and managers have tools to effectively and efficiently operate a grid with an increasing number of variables	Visualization techniques that reduce large quantities of data into easily understood visual formats, software systems that provide multiple options when systems operator actions are required, and simulators for operational training and "what-if" analysis

Source: SG Equity Research

The implementation of a supply and demand management system (SDM) could save the equivalent of 433 TWh of primary energy by 2020 (vs. a BAU scenario). This is the equivalent of 37.2Mtoe / 2.3% of projected BAU primary energy consumption in 2020 for EU-27 (European Commission). Smart grid could reduce power sector emissions by 2.03 GTCO₂e and save up to €79 billion by 2020.

Will allow for dynamic pricing models

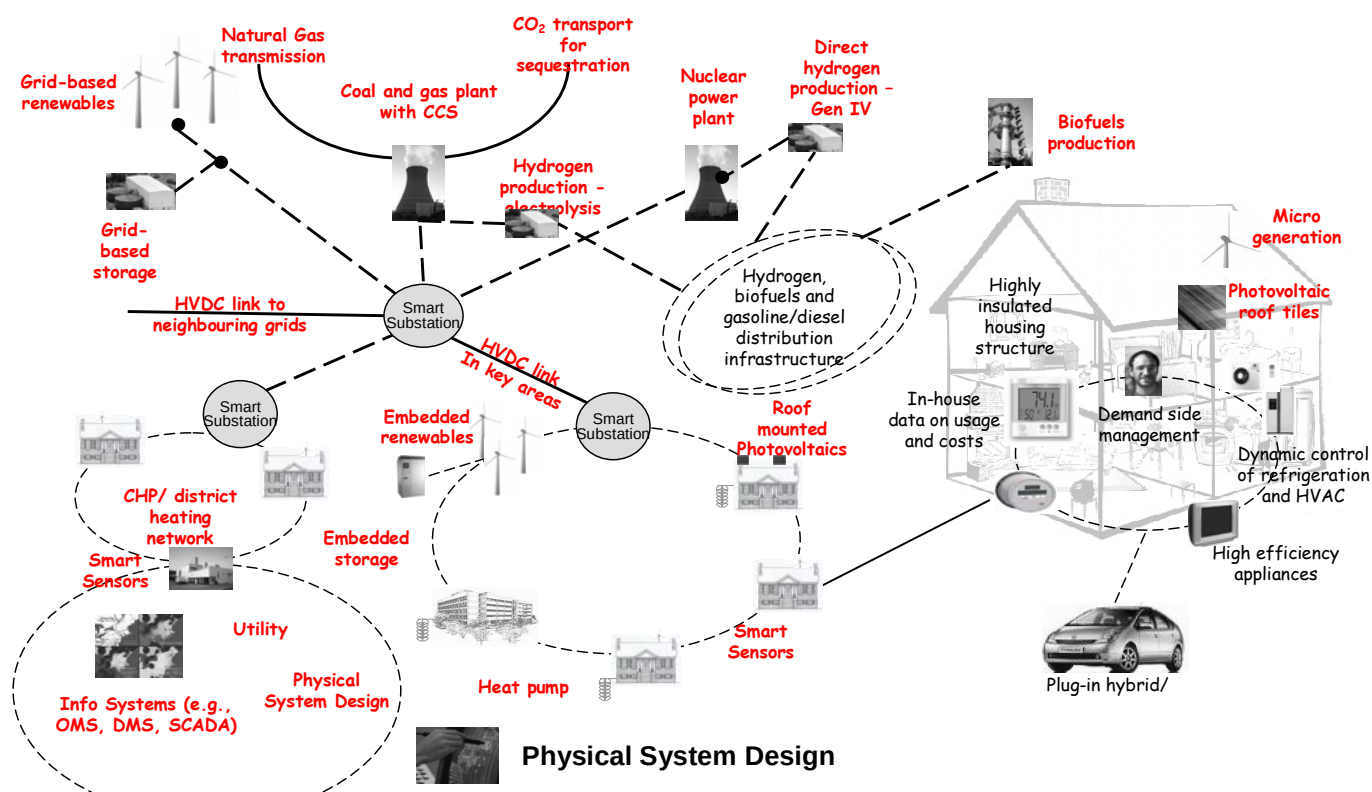
Current power pricing models are usually flat rate systems with no real ICT involvement or demand. Dynamic price models combined with ICT such as AMIs to ensure user awareness and capacity building – are key to a future smart grid / SDM process chain. In particular we need to move to dynamic price models with ICT functionality with high levels of automation and device-specific automation: central status information in households: LED traffic light display system – high / middle / low price times, AMI with detailed information like actual load profiles & historic data; grid sensitive devices which switch off in critical peaks, remote switches as part of a direct load control. To date there are a number of pilot projects with proprietary ICT but no real efforts to enhance the standardized use of existing dynamic tariffs

Overview of dynamic tariff/pricing models

	Tariff	Standing charge	Working charge	ICT demands	Use & comments
Current standard tariffs	Flat rate	Low	Fixed	None	In typical household installations
	Reduced rate off peak	Higher than flat rates	Reduced at night time	Ripple control: switch between different tariff metering	Small industries and office buildings
Dynamic tariffs	Time of Use (TOU)	Higher than standard tariffs	Variable with day-ahead signal	Home control box or utilities website	Combination of day-ahead can be combined with reduced rate off peak
	Fixed critical peak pricing (CPP-F)	NA	NA	Day-ahead notification (time to response)	Pilot projects
	Variable critical peak pricing (CPP-V)	NA	Super-peak prices	Smart thermostats	Pilot projects
	Direct load control (DLC)	NA	NA	Equipment automation to switch off with short notice	Can interrupt electricity supply to a customer's individual appliance
Long-term	Real-time fixed pricing (RTP)	Higher than TOU tariff	Real-time	Price condition info. Available in AMI	User interface with price information
	Virtual energy market with electronic auctions	None	Real-time	Multi-asset system (AMI/SDL prices chain)	No real tariff because actual costs are based on on-line pricing (<1 min)

Source: SG Equity Research

Long-term smart grid vision: a collection of transformational technologies that reduce costs while improving outcomes



Source: Accenture, SG Equity Research

A potential \$20bn a year market

The global market for smart grid components and software is estimated at US\$20 billion a year – with changes in behaviour associated with smarter metering reducing energy consumption by between 3% and 15%. There are currently close to 1.5B installed meters in the world but over 90% are based on 1970s designs and their replacement will see utilities spending hundreds of billions in the coming years on new smart meters, infrastructure improvements, including computers, sensors, and networking systems. The installed base of smart electricity meters in Europe is projected to grow by over 15% CAGR between 2008 and 2013e – and the market is expected to reach 81.2M by 2013 (Source: Berg Insight). Italy and the Nordic countries have already seen rapid roll-out – and France, Spain and the Netherlands are all in the processing of adopting smart meters (with an expected 11M units p.a. by 2013). The US is also seeing significant take-up particularly in California.

Major beneficiary of regulation and stimulus spending

As part of the Green New Deal, many countries are setting aside funds to invest in smart grids including Canada and China as well as \$11 billion under the US economic stimulus to modernise the grid including \$4.5 billion to convert the low-voltage part of the system into a so-called smart-grid, introducing digital-age efficiencies into the system, reducing waste and negating the need for expensive and polluting new power plants. According to a US DOE report power outages and interruptions cost Americans at least \$150 billion every year, despite the current system being rated as more than 99% reliable. That means that initial investments in a smart grid could ultimately save \$150 billion per year in the US alone with

significant savings to be had in other developed and developing economies as well as increased reliability and access to electricity in a more environmentally friendly framework.

Smart meter roll out is here and now

There are several examples of utilities having pioneered smart grid projects with Enel in Italy undertaking the largest project to date – the €2.1 billion Telegestore system which involved 27m smart meters – and which delivers annual savings of €500m/year.

Overview of smart meter roll-out and planned roll-out (to date)

Country	Smart meters	Companies involved	Actions undertaken
Italy	27m+	Enel SpA, Cap Gemini, echemlon	World's largest smart meter deployment whereby Enel deployed smart meters for its entire customer base from 2000-2005. The system provides a wide range of advanced features, including the ability to remotely turn power on or off to a customer, read usage information from a meter, detect a service outage, detect the unauthorized use of electricity, change the maximum amount of electricity that a customer can demand at any time; and remotely change the meters billing plan from credit to prepay as well as from flat-rate to multi-tariff. Enel has estimated the cost of the project at approximately €2.1 billion and the savings they are receiving in operation of €500 million/yr □ 4-year payback
Canada	<1m	NA	Ontario government set a target of deploying smart meters to 800,000 homes and small businesses throughout the province by the end of 2010
Turkey	>1.5m	Elektromed	Prepayment smart gas/water/electric meters implemented including 1m gas meters. Prepayment water meters approached 500.000 units at end 2008, close to a world record.
New Zealand	112,000	Meridian Energy, Arc Innovations	Introduced the usage of smart meters in 2005 and there are plans to install over 112,000 smart meters by January 2009
Netherlands	NA	Oxxio	In September 2007, the Dutch government proposed that all 7 million households should have a smart meter by 2013, as part of a national energy reduction plan.
Ireland	NA	NA	In 2007, the Minister for Communications, Energy and Natural Resources, pledged to introduce smart meters for every home in the country within a five year period
Nordic countries	8m	Vattenfall, Fortum, E.ON	As of 2008, almost all of the DSOs in Sweden had signed contracts for AMM solutions. In Finland and Denmark, the share of metering points under contract was 23% and 15% respectively with Norway at 6% (Source: Berg Insight)
Australia	1m	NA	Essential Service Commission of Victoria, Australia (ESC): planned rollout timetable requiring interval meters to be installed by 2013 for all small businesses and residences with new and replacement installation commencing in 2006. The ESC forecasts that within 7 years of the start of the rollout up to 1 million large customers and other customers will have existing meters upgraded to interval meters.
USA	9m	PG&E	Jurisdictions such as California are actively pursuing the same technology. On July 20, 2006, California's energy regulators approved a program to roll out of communications co-processor electronics to 9m gas & electric household customers in the Northern California territory of PG&E. These meters report electricity consumption on an hourly basis. This enables PG&E to set pricing that varies by season and time of the day, rewarding customers who shift energy use to off-peak periods. The peak pricing program will start out on a voluntary basis, and the full rollout is expected to take five years. The smart grid also allows PG&E to give customers timing and pricing options for upload to the grid (see vehicle-to-grid). The largest municipal utility in the U.S., the Los Angeles Department of Water and Power (LADWP), has chosen to expand its advanced metering infrastructure (AMI) serving its commercial and industrial (C&I) customers.

Source: SG Equity Research

Key obstacles to smart meter roll-out

Lack of consumer demand on AMI & limited engagement in innovation

No EU-wide mass implementation of AMI

No real-time efficiency-oriented pricing

Lack of harmonized standards

Unbalanced power (influence) structure of energy market actors

Global unified standard production of end devices

Broadband internet connection

Infrastructure owners are not supporting rapid implementation

Lack of ICT experts in the energy sector

Lack of investment support incl. for SMEs

Need for regulatory support to harmonise the EU energy market

Source: SG Equity Research

Green IT - companies that stand to benefit

Based on their current exposure to energy efficiency and our long-term forecasts for future development, we believe the following themes and companies constitute a good matrix for those considering investing in Green IT through global equities:

- **Green data centre** long-term
- **Smart meter / grid companies** long-term
- **Semiconductor companies** long-term

Accenture is a global management consulting, technology services and outsourcing company with 187,000 employees serving clients in 120 countries. It has a range of Green IT solutions including data centre technology & operations (DCT&O). In 2008, it launched its Green Technology Suite – IT-based assessment and monitoring tools to reduce carbon footprint – to capture a larger part of the estimated \$4.8B Green IT consulting services industry (2013e). The Suite fully complements the product focused strategies launched by big IT vendors by centring on power use, quantifying the benefits of changes, analysing side effects, and looking at greener product procurement and disposal strategies. Its three-part offer covers the key user issues: a datacentre estimator recommends energy reduction strategies based on power use, performance and expected changes in demand; a workplace estimator helps companies look at how green IT strategies, such as thin clients and telepresence, can affect the organisation in other ways; and a green maturity model assesses the overall environmental efficiency of IT and, in particular, the impact that IT can have to improve environmental efficiency across the entire organization. The company's Q109 results as well as contacts by SG's IT analysts would suggest that management is confident in its capacity to outperform peers and continue to increase profitability in the downturn.

Cisco Systems Inc. is the worldwide leader in networking for the Internet. It is a major Green IT infrastructure actor, catering to customers looking for a network platform through which to conduct business (i.e. supporting business applications while decreasing the total cost of ownership). Its Green IT strategy focusing on 1) efficiency of network infrastructure (improved switching, routing, collaboration solutions, 2009 launch of EnergyWise power management software that will run on top of its network to help businesses reduce energy use for phones, computers, building HVAC and lighting systems); 2) energy efficient data centres (virtualisation); 3) efficient work practices (secure networking, IP telephony, virtual meetings vis-à-vis Unified Communications, TelePresence, and WebEx); and 4) smart buildings and work spaces (intelligent power management and IT infrastructure). In March 2009, it publicly announced its intention to significantly step up its efforts in the data centre market with the launch of Cisco Unified Computing Architecture which the company estimates can reduce capex costs by up to 20% & opex costs by 30%. There has been-on going speculation that Cisco – with \$29.5 billion cash – may be interested in acquiring EMC or VMWare, either of which would add to its energy efficiency credentials as could its move into the smart grid via Energywise (Source: WSJ et al). Cisco continues to post good top and bottom line numbers, topping consensus Q2 08/09 estimates after embarking on \$1B cost cutting plan.

Comverge is the largest provider of demand response services to utilities and boasts over 500 utility clients and 5 million devices delivered or installed (>2200 MW of energy). Its bread and butter business has been installing its own hardware and software in homes to help utilities curtail residential power use via the use of 1-way pager networks. These older

generation devices are seen as stranded assets and in February 2009, the company launched its "Apollo Platform" 2-way communication software to get a piece of the demand-response market from utility customers (with its strong existing customer base giving it a strong positioning). The new platform is regarded as a key element of the Progress Energy Carolina EnergyWise(TM) demand response system and will also be deployed by PEPCO Holdings – and which has helped its future contracted revenues surpass the \$500 million mark for the first time. Comverge could be a major beneficiary of the \$4.5bn in US stimulus spending for the smart grid. While the company's Q408 profits fell 19% as revenues declined, its results still topped analysts expectations.

Echelon specialises in smart metering and energy-consumption related automation technologies for lighting, HVACs and appliances. It recently launched a new version of its LonWorks technology for building automation which could beef up its smart grid credentials (via its Networked Energy Services business). ELON has installed 1.5m meters in Europe and continues to work with Enel – providing power line networking for a 27m meter roll-out – as well as the public utility of Hassfurt in Germany. However, smart grid take-up has been slower in the US where most utilities have opted for radio mesh or wireless communications to connect smart metering rather than higher cost power line networking. 2008 revenues fell slightly to \$134m as the recession has slowed some smart grid projects. The company expects to see continued growth in 2009 from utilities in western Europe and North America..

EMC is one of the world's top-10 technology companies and the #1 data storage infrastructure company. It has been the market leader in energy efficient storage platforms since the 1990s including on virtualisation (it is the majority shareholder of VMware – see below), data and file mobility (efficiency tiered storage) and back-up, recovery and archiving. Maor brands include Clariion, RSA, Symmetrix and VMWare and nearly every major product announcement in the last two years including some element of energy improvement (consolidation, disk spin-down, larger capacity/lower power disk drives, SSDs, dynamic cache partitioning) such as its announcement that it will enter the primary data de-duplication market in 2009. EMC has also created a cross-functional Green Team bringing together 18 departments to focus on developing new integrated efficiencies for hardware and software such as its "Design for Environment" program and EMC Consulting works with clients on energy efficiency from data centres to remote sites. EMC posted record Q408 profits and total revenues which saw a 12% increase YoY, its 6th straight year of double-digit revenue growth. But the company – which was hit hard by the 2000 bubble – is bracing itself for slowed growth and is engaging in major cost cutting.

Fairchild Semiconductor FCS is a leading global supplier of high performance semiconductors that enable smart power management and reduced energy consumption. It is the #1 global supplier for optimising system power and generates over 70% of its annual revenues from its power business including motors (variable speed motors and inverter-controlled drives being energy savings of up to 40%), power supplies (high efficiency power supplies and reducing consumption in stand-by mode) and lighting (move to CFLs). It also stands to benefit from the consumer market with its power franchise including a portfolio of products that ensure maximum efficiency for a variety of consumer electronic goods, from cell phones to plasma screens. In 2008, it also formed a global Energy and Environmental Design Team to identify energy-conservation projects at its major manufacturing sites worldwide. Following a Q408 loss, the company has said that order rates are beginning to stabilise and FCS is now building backlog.

Google Inc has taken a vocal position on energy efficiency via its involvement in Renewable Energy Cleaner than Coal, RechargeIT, Climate Savers Computing Initiative, and in going Carbon Neutral. We see it emerging as a possible leader on emerging issues like the smart grid. Following investments in two leading start-ups (Current Group and Silver Spring Networks), collaborating with GE on smart meters and the launch of its Clean Energy 2030 vision – it is looking to transform antiquated energy infrastructure in the image of the internet: decentralized, distributed, disembodied. It recently announced plans to use its software skills to help consumers track their home energy usage to lower demand. It is developing a smart grid software tool called Google PowerMeter that will show smart-meter enabled home energy consumption almost in real time on a user's computer (which could help consumers reduce electricity bills by 5-15%). The company hopes to develop partnerships with utilities and start-ups for roll out in the next few months – and the potential scope is enormous (e.g. a utility could create an application that runs consumer appliances when power demand is at its lowest). Google's focus on the consumer could serve as a major competitive advantage with most energy efficiency initiatives focused only on utilities – and long-term could play a major role in the power sector and in giving ordinary households more power to control their electricity use. The company reported stronger than expected Q408 results that suggested its search-advertising business and cost-cutting efforts have enabled it to weather the recession better than rivals.

International Business Machines IBM develops and manufactures IT, including computer systems, software, networking systems, storage devices, and microelectronics worldwide. It has been active on Green IT for over 15 years and it is now one of the company's core growth drivers – with IBM spending \$1 billion per year on new products and services for energy efficiency and dedicating a “Green Team” of 850 specialists. IBM has pioneered data centre efficiency at its own operations. These initiatives, along with the company's other energy conservation actions, have avoided CO2 emissions from 1990 to 2007 by an amount equal to 45% of its 1990 emissions. Cutting emissions by 40% from 1990-2005 and IBM is now looking to double its centres compute capacity by 2010, without increasing power consumption, thus avoiding 5B kWh/ year. This expertise has been successfully rolled over to customers and IBM has over 2,000 green IT client projects focused on data centres offering energy efficient servers and technology (System z and x), storage virtualization (>80% energy savings) and services (storage and servers, site and facilities, integrated communications, business objectives, end users). The company is also well-positioned on the smart grid – giving utilities end-to-end support in upgrading their transmission systems, helping them set standards, develop software, and order the right components – and says that it is one of its fastest-growing business categories. IBM's less is more approach to IT continues to pay dividends with the company performing well in a difficult environment - reporting record annual revenue and Q408 profit up 12%.

International Rectifier IRF is a market leader in advanced power management technology, from analog and mixed signal ICs to advanced circuit devices, power systems, and components for consumer and industrial applications. It is a key enabler for energy efficiency across the green deal spectrum including for cars (advanced power management systems for fuel efficiency solutions), motor controls (integrated design platform for variable speed motor control), data centres (scalable multiphase architecture, dual-sided MOSFETS and real-time power monitoring ICs) and lighting (dimming and non-dimming high voltage ICs). Market demand significantly deteriorated in Q408 and the company is expecting a 13-35% industry fall in Q109e – but IRF considers itself well-positioned in terms of its balance sheet and capital and cost control discipline.

Itron is the global leader in smart meters with a ~30% global market share in meters (#1 electric smart meters, #2 gas meters and #4 waters), ~5% share in North America, automated meter reading and advanced metering infrastructure. It is battling with GE for large utility deployments and currently works with 3,000 utilities including recent deals with Southern California Edison (5.3m meter deployment) - and had 2007 revenues of US\$1.46 billion. Its acquisition of European rival Actaris (ex-Schlumberger Smart Metering) for €1.7bn gave it global reach with 65% of revenues coming from outside North America and a #1 position in the EU market. ITRI saw 2008 revenues increase to \$1.9bn in 2008 (+30%). The 30-year-old Washington state-based company is also aggressively partnering with innovative startups and should be a major beneficiary of the \$4.5bn in US stimulus spending for the smart grid.

Rackable Systems, Inc. is a leading provider of energy efficient rack-mount and hybrid blade servers and storage ("Eco-Logical") for large- and mid-sized data centers as well as associated storage solutions for a wide range of sectors. The company has developed a range of product solutions on "physicalisation" (hardware-based virtualisation which does not require software), virtualisation, storage systems and modular data centres. The company is also tackling the sub-\$500 server and cloud computing markets through its new MicroSlice architecture which does away with the need for virtualisation software (by housing up to 264 servers in server cabinets & server racks). Despite a tough 2008 which saw a strong fall in revenues in Q408 and a 21% fall from its two largest customers, RACK plans to use its balance sheet to make investments in 2009.

STMicroelectronics STM is the world's #5 semiconductor company and at the forefront of System-on-Chip (SoC) technology and its products play a key role in enabling convergence markets. ST has been committed to developing products and technologies that enable an increasingly efficient power-supply chain in microelectronics applications for industrial, consumer and computer markets since the early 1990s - with #1 market positions in the auto and industrial sectors and in power conversion semiconductors. Its efficiency solutions focus both on reducing energy consumption in the chip itself and contributing to energy savings in end applications, such as home appliances (ST internal analysis shows its energy-saving power electronics technologies can cut residential energy consumption by a third), low-power stand-by systems and lighting (complete solutions with smart lamp management, electronic ballasts, dimming solutions). ST is also looking to step up its activity in LED lighting where it is a market leader. At the chip level, ST has made major advances with its MDmeshpower MOSFET technology and in using alternative materials and technologies such as Silicon Carbide (SiC). We currently anticipate that the slowdown in end markets for STM's products is likely to last at least until Q2 and that the slowdown in handsets and automotive industries (50% of STM's turnover) could last longer.

VMware - which is majority owned by storage giant EMC - is the global trailblazer in virtualisation solutions. Its advanced resource and memory management features enable consolidation ratios of 15:1 or more which increase hardware utilisation to as much as 85%. Once virtualised, it can also monitor utilisation across the datacenter and intelligently power off unneeded physical servers without impacting applications and users. Its solutions enable customers to reduce energy consumption and costs by up to 80%. Virtualisation software, has been one of the fastest-growing technologies of recent years, thanks largely to VMware's efforts and the company has over 30,000 customers, including 90% of the Fortune 500, in just over a decade. It has made such inroads that Dell, Fujitsu, HP, IBM, Fujitsu and Siemens servers come pre-loaded with VMware. It recently launched its first open source virtual desktop client which will enable IT managers to host their companies' users desktops in the

data centre with the ability to provision power and storage space as needed. The company beat revenue estimates with its Q408 results (+25% YoY) as did its year end results which increased by 42% YoY – with customers likely to continue to opt for its server and desktop consolidation cost-saving projects.

Wipro Technologies is the No.1 provider of integrated business, technology and process solutions on a global delivery platform. It's a strong player o, helping clients go green by adopting eco-friendly product designs, green data centres, energy efficiency solutions and virtualization. It has helped clients build over 75 green data centres (APC-MGE, AMD, Hitachi) and operates a global command centre to monitor and provide real-time input on load and server utilisation. The acquisition of Infocrossing has helped it further its offer. Wipro also has one of the most comprehensive green IT business offers covering everything from consulting (Wipro Eco Energy), smart devices, green lighting solutions, industrial water treatment, renewables, carbon accounting, paperless office solutions, freight management, virtual workspaces, to green testing and green computer peripherals. Wipro is a member of the Green Grid and has gone carbon neutral. Despite Wipro's long-term fundamentals and a valuation at historic lows, SG's IT analysts remain cautious on the share.

Noteworthy unlisted smart meter / grid companies

Company	Overview
eMeter	It claims 20 million meters under contract and has raised \$12.5 million in a round led by Siemens, Foundation Capital and DBL Investors.
Greenbox Technologies	Start-up founded by the team that developed Flash technology for the web, and is using its experience to build a web-based software dashboard to help energy consumers cut household consumption. The company is working with Silver Spring on a pilot with an Oklahoma utility.
GainSpan	Planning to use low-powered WiFi rather than Zigbee to connect home energy monitoring systems.
GridPoint	Helps utilities balance energy loads through hardware and software on the power grid via WiMax. It believes that the growing WiMax network being put in place by Sprint and Clearwire would be a ready-made communications system for a future smart grid. The company has raised over \$200 million from Goldman Sachs Group (GS), Susquehanna Private Equity Investments, The Quercus Trust, Altira Group and Standard Renewable Energy Group. It also has links to Intel and General Electric. Purchased V2Green, a company working on ways to use plug-in electric vehicles for grid power storage.
Positive Energy	Software and research startup develops research reports that utilities can offer to customers to help them reduce their energy consumption and receive more transparent energy bills. Positive Energy recently raised a \$14 million round from New Enterprise Associates.
Silver Spring Networks	Its Smart Energy Network IP suite connects utilities and customers across the power grid - and is now being deployed by utilities including Pacific Gas & Electric Co., Florida Power & Light, American Electric Power and others. Its smart meter interface cards with frequency-hopping radios that mesh together in a 900-megahertz frequency range stand apart in that the Internet protocol is used throughout the stages of its network.
Tendril	Makes Zigbee-based home energy management software and hardware including smart plugs, smart meters, energy displays to software for utilities. The company raised \$40 million and has signed deals with 29 utilities to test and/or deploy its technology.
Trilliant	Makes hardware and software to allow for time-of-use metering and two-way communication. The company uses open standards and raised \$40 million from Mission Point Capital Partners and Zouk Ventures. It deals with about 100 utilities, including Ontario, Canada's Hydro One and has installed >750,000 meters.

Source: Companies, SG Equity Research

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