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GREEN SCREEN

How does IT contribute to sustainability?

A discussion paper supported by Tata Consulting Services (TCS)
and written by Carnstone Partners LLP

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EXECUTIVE SUMMARY

Introduction

In sustainable development the IT sector is usually seen as a force for good. The direct impacts of the sector itself – energy, waste, pollution – are small, especially when compared with others. Moreover, these small impacts are offset by big indirect benefits as IT enables social advances, and offers routes to lower environmental impacts. By bringing together existing research we hoped to assess those impacts and offer a view on the central question: *How does IT contribute to sustainability?*

Main findings

IT has enormous potential for good, but we cannot assume that will just happen automatically. IT companies that want to maximise their sustainability contribution must play an active role. Yes, they must stay on top of their direct impacts, but more important is to help their customers get the biggest benefits possible from their products, and to start working in earnest on understanding the long-term societal changes which will likely make or break IT's contribution to sustainability.

There is a mass of existing insight into the direct and indirect impacts of IT, but there is remarkably little certainty about the profound ways which society might respond to advances in IT in the long-term. Our research suggests that the societal effects of IT could change the most fundamental of societal and business activities: how we travel, how we work, how we consume and how we communicate. Technology companies could play a very important role in convening discussions and supporting research to shed light on these huge social questions.

Focus areas

This paper has four distinctive foci:

Focus on business - we concentrated on the way IT is changing business practice and the consequent impacts from that.

Focus on meta-analysis - we have compared the papers on IT and sustainability looking for patterns in their outputs.

Focus on environment - we have included social impacts in our analysis, but our principal attention has been on the environmental impacts.

Focus on action - we have tried to propose a clear agenda for the sector to debate and act upon.

Summary of the research

The interaction between IT, business and sustainability is a well-researched area. Significant works on this topic have already been published and we have reviewed 45 of them. Despite their differences, many papers use the same model when discussing sustainability: *'direct', 'indirect'* and *'societal'* effects. This distinction was first made by Forum for the Future in 2002 and is useful in summarising the conclusions of the very diverse papers.

- Direct effects are on average negative. This is particularly true for environmental effects; making and running IT requires electricity, resources and materials.
- Indirect effects are much more beneficial. The biggest benefits come from IT driving efficiency in high impact processes *(such as energy generation and intelligent transport systems)*. Another big benefit is from alternative options to physical products through dematerialisation.
- Societal effects are both positive and negative, or – more likely – inconclusive. The vast majority of the societal effects we identified were not conclusive due to lack of research or heavy reliance on assumptions.

Seven key insights

01 **The sustainability benefits of IT are in the indirect effects:** The sustainability benefits come from the changes which IT enables - the indirect effects - particularly where IT enables efficiency gains in other high-impact sectors.

02 **Indirect benefits are much larger than direct costs:** It is this fact which is at the root of the sector's positive sustainability claims.

03 **This is a well-investigated topic:** The conclusions are already clear enough to allow action.

04 **The references tend to agree:** The references which cover similar topics broadly agree – at least qualitatively.

05 **Current activity focuses on reducing the direct effects:** Reducing the direct environmental impacts of IT is the most frequent objective of governments and businesses.

06 **Who is responsible for the indirect benefits?** The indirect and societal benefits are largely outside the direct control of the sector, relying on the take up and use of technology in other sectors.

07 **We know little about the rebound effects:** The rebound effects refer to the counterbalancing impacts that reduce positive benefits. Some sources discuss the societal effects but there are very few numbers, presumably owing to the difficulty of modelling such nebulous change.

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1.0 How does IT contribute to sustainability?

This discussion paper asks one simple question: *How does IT contribute to sustainability?* By exploring the possible answers to this question we establish a sustainability agenda for responsible IT companies.

In sustainable development the IT sector is usually seen as a force for good. Compared with other resource and energy intensive industries, the impacts of the sector itself – energy, waste, pollution – are small. Moreover, these limited impacts are offset by big benefits as information technology *(IT)* enables social advances, and offers routes to lower environmental impacts *(See the 'Positive IT' hypothesis on the following page).*

Is this justified? How much of a positive contribution does the sector really make? And are there any negative aspects *(either explicit or hidden)* which require more careful attention?

These were the questions which this project set out to explore via an analysis of existing research and opinion. We studied a wide range of sources to find future projections for the IT sector. The results were grouped together by theme, allowing us to offer a view on the sustainability impacts. By bringing together existing research in this way, we set out to identify patterns and blank spots in the data. This also enabled us to offer a view on the central question: How does IT contribute to sustainability?

We established four distinctive foci to guide our analysis:

1. **Focus on business.** The transformative nature of IT is practically limitless, ranging from automated invoices to sexting. To keep the project focussed, we concentrated on the way IT is changing business practice and the impacts resulting from that.

2. **Focus on environment.** We focussed primarily on environmental rather than social impacts. Many of the sources consider both, but the social issues associated with IT are hard to quantify and would create a more speculative research agenda.

3. **Focus on meta-analysis.** Many of the papers we reviewed have attempted to model the environmental impacts of IT, often employing very detailed and large-scale studies. We have not sourced primary data, instead we have compared the papers looking for patterns in their outputs.

4. **Focus on action.** Our ultimate aim was to produce findings that are actionable; results which the IT sector can use to plot its course towards a more sustainable future. We have tried to issue a clear agenda for the sector to act upon.

The future of IT

Predicting the future of IT is an uncertain business, but most of the papers identify five major, overlapping trends:

1. *Dematerialisation and move to the cloud*
2. *The Internet of Things*
3. *The collation and use of big data*
4. *The advancement of networks, content and the internet*
5. *The development of more sophisticated multiuse devices and applications*

The 'Positive IT' hypothesis

Many argue that the IT sector has a positive role to play in creating a sustainable economy. New technologies solve problems and allow new practices to emerge: applied in the right way and these could foster sustainable behaviour. IT can also enable new business models for companies to generate value in alternative ways.

Well-known examples of improved sustainability due to the application of IT include the digitisation of magazines and books, moving from print to online and e-reading: no more paper mills, no more bookshops, no more landfilled books. Or, replacing business travel with tele-conferencing: thousands of avoided air miles and no company cars, and so on.

Set against this are opposing factors, for example the impact of the technology sector itself. It is estimated that US data centres now consume 100 terrawatt hours per year and that data centres account for 1.5% of global electricity use.

The second factor is the very powerful ripple effects of technology. The 'rebound effect' *(or 'take-back effect')* is well known in energy and resource conservation studies. An innovation might theoretically cut fuel consumption by 10% but in reality only a 2% saving is recorded with the balance unrealised as drivers go further and faster because they now can. This may well be in play on a grand scale as new technology enables society to do new things. For example, the most recent statistics are that 100 hours of video is uploaded to YouTube every minute – a wholly new activity, enabled by technology, with a very significant environmental impact.

So how positive is positive? And are these offsetting factors properly understood?

2.0 Review of existing research and opinion

The interaction between IT, business and sustainability is a well-researched area. Significant works on this topic have already been published by institutions and organisations such as the *European Commission*, the *International Institute on Sustainable Development (IISD)*, the *Organisation for Economic Co-operation and Development (OECD)*, and the *Global e-Sustainability Initiative (GeSI)*.

During our research we grouped 44 documents into the following five categories:

Future IT predictions for businesses
This group of papers discusses specifically how business will change as a result of IT developments. They embrace topics from structural developments in sectors *(new entrants, reduced barriers to entry, new business models)* to changes to business processes *(wireless, tele and mobile working, robotics).*

Future IT predictions more generally
These papers focus on the future of IT in general, covering topics such as the cloud, the 'internet of things', big data, and the move to dematerialisation. They also discuss the impact this may have on data security and online privacy.

The future of the internet and networks
A number of sources focus specifically on the internet. They explore scenarios such as a free but dangerous internet, abundant with viruses; an expensive security protected internet; or multiple bespoke internet networks created at a local or national scale.

IT and sustainability
Among the more general sources some are looking specifically at the sector's contribution to environmental sustainability. They explore positive issues such as energy efficiency, optimising existing processes, better environmental management and dematerialisation. Others adopt a more critical stance, highlighting growing electronic waste or increasing energy used directly by the sector.

The state of knowledge
The final group of papers are more agnostic in their attitude towards IT and sustainability. They point out gaps in the current knowledge and examine how much confidence we can have in future scenarios.

2.1	2.2	2.3	2.4	2.5
Future IT predictions for businesses	**Future IT predictions more generally**	**The future of the internet and networks**	**IT and sustainability**	**The state of knowledge**
Agent of Change *(EIU, 2012)*	Internet Economy Outlook *(OECD, 2012)*	After Broadband *(Wharton, Mack Centre, Institute for the Future, 2012)*	Measuring the relationship between ICT and the environment *(OECD, 2009)*	Changing our Understanding of Sustainability: The impact of ICTs and the Internet *(IISD, 2012)*
Information and communication technology, work and employment *(Beyond Current Horizons, 2009)*	Digital Agenda *(European Commission, 2010)* and Digital Agenda 2 *(European Commission, 2012)*	The Evolving Internet *(Cisco and GBN, 2010)*	Addressing the challenge of energy efficiency through Information and Communication Technologies *(European Commission, 2008)*	The impact of ICT on sustainable development *(Forum for the Future and EITO, 2002)*
Disruptive technologies: Advances that will transform life, business, and the global economy *(McKinsey Global Institute, 2013)*	Scenarios for the Future of Technology and International Development *(The Rockefeller Foundation and GBN, 2010).*	Project 2020 -Scenarios for the Future of Cybercrime *(ICSPA, 2012)*	Impacts of Information and Communication Technologies on Energy Efficiency *(Bio Intelligence Service, 2008)*	The Future Impacts of ICTs on Environmental Sustainability *(IPTS, 2004)*
How digital technologies will revolutionize the way businesses are run *(Accenture Outlook 2013)*	Cisco Visual Networking Index *(Cisco, 2014)*	Internet Futures Scenarios *(Internet Society, 2009)*	How Green is the Cloud *(Alliance Trust Investments, 2013)*	A Framework for Modelling ICT and Environmental Challenges Using Future Scenarios *(OECD and IISD, 2008)*
The Digital Guest List Expands: Driving Digital Transformation Across Lines of Business *(TCS, 2012)*	Exploring the Future of Cloud Computing *(WEF, 2010a)*	Telco 2015 *(IBM, 2010)*	Future Lifestyles and Opportunities for the ICT Industry *(GeSI, 2012)*	Towards Green ICT Strategies *(OECD, 2009)*
The Digital Enterprise and Changing Role of ICT *(TCS, 2012)*	Digital Ecosystem *(WEF, 2010b)*	The Theory of Peak Advertising and the Future of the Web *(Nesson Center for Internet Geophysics, 2013)*	GeSI SMARTer 2020: The Role of ICT in Driving a Sustainable Future *(GeSI and BCG, 2012)*	Greener and Smarter *(OECD, 2010)*
Creating Eco-Corporations of the Future *(TCS, 2010)*	Advancing Cloud Computing *(WEF, 2011)*	SMART 2020 *(GeSI, 2008)*	Connect, Collaborate, Change *(Forum for the Future, 2011)*	
Measuring the Digital Economy *(OECD, 2014)*		Empowered Consumers *(TCS, 2012)*	How Clean is Your Cloud? *(Greenpeace, 2012)*	
		Low Carbon Living *(TCS, 2011)*	To Save Everything, Click Here: Technology, Solutionism, and the Urge to Fix Problems that Don't Exist *(Morozov, 2013)*	
		High Tech: Low Carbon *(intellect, 2008)*		
		Low Carbon, High Growth *(TCS, 2011)*		
		The Enabling Technologies of a Low-Carbon Economy *(Enabling Technology, 2013)*		
		Workshop on ICTs and Environmental Challenges *(OECD and NITA, 2008)*		
		ICT Innovations for Sustainability *(Hilty and Aebischer, 2015)*		
		Exploring the Macroeconomic Impacts of Information and Communication Technologies on Greenhouse Gas Emissions *(Erdmann and Hilty, 2010)*		

3.0 Describing sustainability impacts

Despite their differences, many papers use the same model when discussing the relationship between IT and sustainability. They talk about *'direct'*, *'indirect'* and *'societal'* effects. This distinction was first made by Forum for the Future in 2002 and remains useful in ordering the conclusions of the diverse body of research.

The three definitions are:

Direct effects *(or 'First Order effects')*
These result from the processes involved in manufacturing and operating IT. For example, the jobs directly created in IT manufacturing and services, or the carbon emitted from operating a network of servers.

Indirect effects *(or 'Second Order effects')*
These arise from the ways in which IT changes businesses practices, industrial processes or content delivery. For example, the jobs lost in sectors replaced by internet-enabled businesses, such as music retail, or the carbon savings from smart management of the electricity grid.

Societal effects *(or 'Third Order effects')*
These are the aggregated outcomes of large numbers of people using IT over the medium-to-long term in ways that alter how economies and societies work. For example, changes in the nature of work and working relationships, the relationships between diasporas and home communities, or in patterns of consumption and human settlement.

Within this final category of effects, we find the concept of the **'rebound effect'**. This refers to the counterbalancing impacts that reduce positive benefits. For example, the likelihood that the reduction in vehicle usage resulting from telecommuting will be accompanied by more driving for leisure activities.

THE CHANGING ROLE OF THE CONSUMER

What are 'societal effects'? They can often be very subtle, but powerful long-term changes. For example, a study by the Economist Intelligence Unit suggests that the role of the consumer within product design is set to change significantly by 2020. Through the development of powerful personalisation technologies, traditional in-house research and design departments will be replaced with customer 'co-creation' methods. If so, it is the consumer who will lead the design process in the future. How will this affect the kind of products we get? Or the careers of designers?

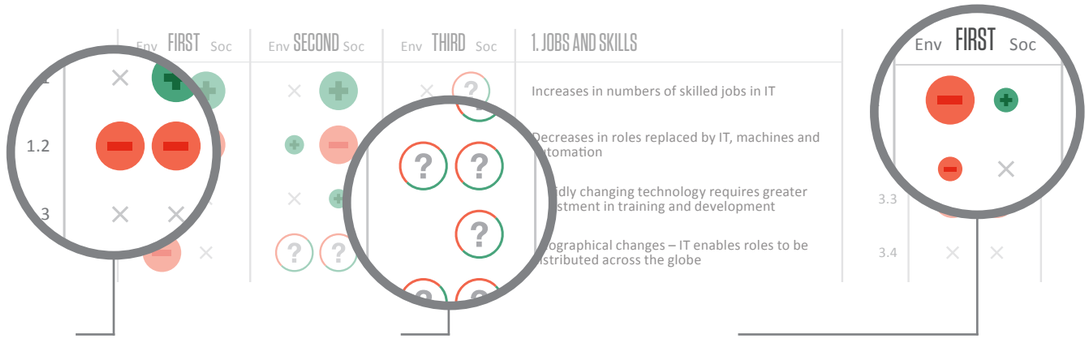
EIU, 2012

4.0 Summary of the research

So how can we draw patterns from this huge volume of research? Is the IT sector a positive contributor to sustainability or is it part of the problem?

To help make sense of this, we have summarised the data graphically in the table on the following pages. It allows us to quickly see patterns and draw conclusions visually.

It works as follows:



Each row represents one of the forecast IT developments from the papers we reviewed. We have grouped them into themes.

The columns then show the **direct** *(first column)*, **indirect** *(second column)* and **societal** *(third column)* sustainability effects for each row.

The circle shows if the effect is **positive or negative** *(red/green)*, **both** *(red and green)* or **inconclusive** *(question mark)* and the **scale** *(large/small)*.

The visual representation of our meta-analysis enables us to see the following patterns:

Direct effects are often negative – the first column has more red circles than green. This is particularly true for environmental effects. Making and running IT requires electricity, resources and materials. The biggest direct effects *(the largest circles)* are developments that require the production and use of a significant amount of hardware. We found that direct social effects are both positive and negative. Principally, they relate to employment: the creation of new jobs as a result of increased IT manufacturing or the loss of jobs from process automation.

Indirect effects are much more beneficial – the second column has more green circles. The biggest benefits come from IT driving efficiency in high impact processes *(such as energy generation and intelligent transport systems)*. Another big benefit is from alternative options to physical products through dematerialisation. Negative environmental impacts are fewer. They include, for example, embedding products with technology, which in turn makes objects less recyclable. A number of developments were identified as both positive and negative, such as the move to new networks and increased bandwidth. On the one hand, this may encourage new types of online activity causing bigger environmental impacts. On the other, it may also enable new, more efficient types of data transfer.

We found the predictions for **societal effects** to be both positive, negative and, more than anything else, inconclusive, reflecting high levels of uncertainty of what the effects will actually be. This uncertainty stems from the complexity of predicting rebound effects. For example, although teleconferencing can reduce the need to travel, mobile working can actually enable more travel, swallowing up much of the benefit.

Finally, we note that **societal effects** are usually harder to determine than environmental ones. There are two reasons for this. Firstly, social impacts are often less quantifiable, occurring as they do over a range of measures which cannot easily be compared *(for example, a technology may cost jobs but enable better social cohesion)*. Secondly, many social effects may be positive or negative depending on other factors: technology which allows a sales force to be 'always available' professionally may drive productivity, but increase stress and damage family life.

4.1 Future sustainability effects

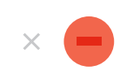
SUMMARY OF THE EXISTING RESEARCH

	Env FIRST Soc	Env SECOND Soc	Env THIRD Soc	1. JOBS AND SKILLS
1.1				Increases in numbers of skilled jobs in IT
1.2				Decreases in roles replaced by IT, machines and automation
1.3				Rapidly changing technology requires greater investment in training and development
1.4				Geographical changes – IT enables roles to be distributed across the globe
1.5				Automated decision making and knowledge creation takes these tasks away from managers
1.6				IT enables devolved decision making, allowing decisions closer to those affected by them
1.7				Sociological implications for workers of increased machine/human interaction
	Env FIRST Soc	**Env SECOND Soc**	**Env THIRD Soc**	**2. TELECOMMUNICATIONS**
2.1				Wireless replaces wired networks
2.2				Networks may become more bespoke
2.3				Increased bandwidth and storage will enable full media content on internet
2.4				Social interaction and working practices change due to increased network bandwidth
2.5				Security and privacy more of a focus as wireless companies become reality
2.6				New networks and bandwidth create opportunities for new businesses and apps
2.7				New networks and bandwidth threaten existing telecommunications models
2.8				Mobile technology supports mobile working/ teleconferencing
2.9				Mobile technology creates changes in travel behaviour and use
2.10				Increased number and distribution of devices affects work and personal relationships
2.11				Changes in needs for physical offices

	Env FIRST Soc	Env SECOND Soc	Env THIRD Soc	3. BUSINESS PROCESSES
3.1				Wider use of IT marketing tools (e.g. Big Data, social media) drives new business practice
3.2				Gains in R&D efficiency from consumer interaction and consequent rapid prototyping
3.3				Gains in R&D efficiency from direct use of IT (3D printing, cloud, and rapid prototyping)
3.4				Customer feedback becomes more extensive as barriers to interaction are reduced
3.5				Analytics allow pre-emptive analysis of customer feedback
3.6				More efficient sales processes through better data analytics
3.7				Better targeting of customers
3.8				More mobility among sales forces enabled by better communications
3.9				Better employee engagement through IT and social media (two-way)
3.10				Real-time data on employee indicators leads to better management and governance
3.11				IT developments challenge existing laws and processes to protect Intellectual Property
3.12				Information security becomes more difficult as data moves online
3.13				IT enables dynamic pricing of energy and commodities saving money and resources
	Env FIRST Soc	**Env SECOND Soc**	**Env THIRD Soc**	**4. CITIZENS' DATA**
4.1				Increased personal data online raises new issues for consumers and citizens
4.2				Diminishing returns from advertising drive new models based on the use of personal data
4.3				Future internet is either more interconnected with reduced barriers, or increasingly bespoke
4.4				Better public policy making based on insights from huge consumer data sets (Big Data)
4.5				Consumer data becomes increasingly valuable, creating new business opportunities

4.1 Future sustainability effects (continued)

SUMMARY OF THE EXISTING RESEARCH

	Env FIRST Soc	Env SECOND Soc	Env THIRD Soc	5. INTERNET OF THINGS (IoT)
5.1				IoT reduces human interaction with devices and systems as control becomes automated
5.2				IoT increases energy efficiency of processes and systems (e.g. domestic heating)
5.3				Automated connection between machines/ products/devices replaces current job roles
	Env FIRST Soc	Env SECOND Soc	Env THIRD Soc	6. TRANSPORT, UTILITIES, ENVIRONMENT
6.1				Intelligent transport management systems improve efficiency
6.2				Driverless vehicles improve safety and efficiency
6.3				IT enables alternative energy generation – localised, new entrants, new generation sources
6.4				IT enabled energy efficiency technology drives savings
6.5				IT used to monitor energy use and change behaviours leading to savings
6.6				Developments in IT improve efficiency and co-ordination of energy distribution networks
6.7				IT enables new and innovative technologies for environmental protection
	Env FIRST Soc	Env SECOND Soc	Env THIRD Soc	7. INDUSTRY CHANGES
7.1				IT drives industry convergence as multiple services are delivered from common platforms
7.2				IT challenges existing business models (e.g. banking, retailing)
7.3				Intermediary sectors of industry (agents, financial intermediaries etc) diminish
7.4				New business and sectors will emerge enabled by IT and e-commerce
7.5				Alternative payment methods and internet-based exchange and currency
7.6				Pace of technology and business model change increases importance of business resilience
7.7				IT reduces barriers to entry, putting pressure particularly on mid-sized companies

	Env FIRST Soc	Env SECOND Soc	Env THIRD Soc	8. DEMATERIALISATION
8.1				IT may enable the replacement of material goods and services with non-material substitutes
8.2				The ease of online purchasing may drive greater consumption of physical goods
8.3				IT improves manufacturing efficiency thereby reducing waste
8.4				IT enables smaller and lighter products, reducing material requirements
8.5				Embedding technology into products may increase obsolescence and replacement rates
8.6				Existing services are delivered through digital platforms (e.g. e-health)
8.7				Services delivered on-line may have lower cost
	Env FIRST Soc	Env SECOND Soc	Env THIRD Soc	9. SUPPLY CHAIN
9.1				Better information exchange up and down supply chains improves supply efficiency
9.2				Better product traceability for companies (enabling greener procurement) and consumers
	Env FIRST Soc	Env SECOND Soc	Env THIRD Soc	10. WASTE
10.1				Multi-purpose devices may reduce numbers of overall products
10.2				Managing and reclaiming e-waste creates new business opportunities
10.3				Embedding technology into products makes their recycling harder

5.0 Seven key insights

01 **The sustainability benefits of IT are in the indirect effects.**
The direct effects of the sector are environmentally negative. At the moment and when compared with other sectors the scale is limited, but rising quickly driven mainly by energy demand. However, most sources agree that key sustainability benefits come from the changes which IT enables – the indirect effects – particularly where IT enables efficiency gains in other high-impact sectors.

02 **Indirect benefits are much larger than direct costs**.
Many sources suggest that the indirect benefits are much larger than the direct negative impacts. This fact fuels the sector's positive sustainability claims. The model below, *The future impact of IT on Greenhouse Gas Emissions by 2020 in EU 15 countries,* shows how the potential benefits of IT *(green)* more than offsets the negative impacts *(red)*.

03 **This is a well-investigated topic.**
The references include everything from speculative opinion pieces to detailed quantified models of IT's impact. They cover national policy, effects on business and general commentary. Many of them are carefully analysed, although some of the papers are a few years old.

04 **References tend to agree**.
The references which cover similar topics broadly agree – at least qualitatively. There are no obvious 'camps' of differing opinions.

Model of the future impact of IT on Greenhouse Gas Emissions by 2020 in EU 15 countries, taken from *Erdmann and Hilty (2010)*.

Note the larger benefits in second- and third-order effects, and negative impact from physical use of ICT.

The enormous efficiency potential of IT

A study produced by the Climate Group and GeSI *(Global e-Sustainability Initiative)* demonstrates IT's role in creating a low carbon economy. The SMART2020 study *(2008)*, explores how IT can improve energy efficiency first within its own products and then in other sectors. It is this latter influence that the study states will have the most positive environmental impact in the future, predicted at five times larger than the total emissions from the IT sector in 2020 *(7.8 GtCO2e in total)*. This would be delivered through dematerialisation, smart motor systems, logistics, buildings and grids. Similarly, intellect's *(now techUK)* 2008-report, High Tech: Low Carbon, makes the point that IT's most material contribution is in its ability to enhance, enable and transform what technology does in other sectors.

The follow on report, SMARTer 2020 *(2012)*, quantifies even higher savings from IT *(9.1 GtCO2e by 2020)*. This report builds on the SMART2020 study, by including IT's potential to reduce emissions from agriculture and farming, increase efficiencies within manufacturing, and enable reductions in the consumer and service sectors. The largest savings are predicted to come from smarter power generation and transportation *(estimated at 3.9 GtCO2e in total)*.
GeSI SMART 2020, 2008 / intellect 2008
GeSI SMARTer 2020, 2012

The rising direct impacts of the IT industry

The direct environmental impacts of the IT industry continue to rise, according to a report by the IISD *(2012)*. The sector currently represents 8% of global energy consumption, predicted to increase to 10-12% in the next decade. Broadband-internet alone is expected to consume 5% of all electricity. 50% of the IT energy consumption and greenhouse gas *(GHG)* emissions are from domestic, business and personal devices, such as mobile phones. IT in homes now contributes more GHG than traditional appliances such as fridges.
IISD, 2012

05 **Current activity focuses on reducing the direct effects.**
The main focus has been on tackling the rapidly rising direct impacts. For example, the OECD (2009) points out: *"Governments and businesses have a wide range of initiatives dealing with the impacts of information and communication technologies (ICTs) on the environment and climate change. Initiatives concentrate on greening ICTs rather than tackling global warming and environmental degradation through the use of ICT applications. Reducing the direct environmental impacts of ICTs is the most frequent objective of governments and businesses. Of 92 initiatives surveyed for this report, over two thirds focus on greening ICTs."*

06 **Who is responsible for the indirect benefits?**
The indirect and societal benefits are largely outside the direct control of the sector, relying as they do on the take-up and use of technology in other sectors. Furthermore, the uncertainties around the predicted benefits are much larger. So the IT sector is in a position of justifying a very visible environmental cost by reference to a much less tangible – or as yet unrealised – benefit elsewhere.

To quote the IISD, *"while the negative first order impacts resulting from increased usage are effectively certain to occur, the second order effects described above are merely potential impacts: whether they are achieved will depend on decisions that are taken [...] outside the ICT sector." (IISD, 2012)*

07 **We know little about the rebound effects.**
A small number of papers discuss the societal effects, but they rarely offer quantitative insights and generally lack rigour. Yet given that these societal effects are potentially larger still, they are a very important part of the case for the IT sector.

'... the IT sector is in a position of justifying a very visible environmental cost by reference to a much less tangible – or as yet unrealised – benefit elsewhere.'

6.0 What are the largest impacts?

We have already described the difficulties of quantifying the future sustainability impacts of IT, but we can use the sources to pick some of the potentially most significant. While not a precise list, it does provide a good indication of the most relevant issues for the sector.

We estimate that the most significant potential DIRECT IMPACTS are:

DIRECT

Power demands in new physical IT assets and the resulting greenhouse gas emissions. This is clearly the largest of the negative direct environmental impacts.

Materials and environmental impact from the manufacture and disposal of the new enabling hardware, which is a significant negative environmental impact.

Changes in employment resulting from the physical manufacture and use of IT. This social effect is both positive and negative since manufacturing creates many jobs, but other technologies directly replace human roles.

Environmental gains from smaller, lighter, more efficient technology products; less to carry, less materials to manufacture and less to dispose of.

We see the most important potential INDIRECT EFFECTS as:

INDIRECT

Energy efficiency technology drives resource and cost savings in other sectors. For example, improvements to building energy management systems, intelligent sensors and decentralised controls all reduce building energy demands.

The dematerialisation of value chains in film, music, books and imagery has many potential sustainability benefits. Taken further, 3D printing may bring similar efficiencies to the manufacture and transport of physical products. However, the rebound effects of dematerialisation in the media sector are unknown, with potentially negative environmental impacts.

Gains in process efficiency from automation as improved sensors and control systems enable manufacturers to make more with less.

Infrastructure improvements through 'smart' solutions, including intelligent transport systems and energy efficient utilities networks

Environmental and social benefits of wireless and mobile working. Leads to better social connections and reduces travel.

Multi-use devices offer the chance to combine functions and reduce the total need for devices. On the other hand, embedding IT into everyday items *(e.g. fridges, TVs)* increases obsolescence.

Transportation and teleworking

Greener and Smarter *(a study by the OECD)* suggests that IT applications could save 13% of GHG emissions from transport through a combination of changed vehicle behaviour and reduced travel needs. It states that automotive systems can improve fuel efficiency by 20%.

However, the study comments particularly on the rebound effect: intelligent transport systems are predicted to *increase* travel by 4% since they incentivise more travel. E-commerce, telework and teleconferencing may limit this growth but only a limited part of business travel can be replaced by teleconferences, and not all jobs can adopt telework. Telework could also result in greater commuting distances as employees settle further from main offices. The study also states that mobile working, enabled by IT applications, may result in more travel as work on the move becomes possible *OECD, 2010*

The Internet of Things

The Internet of Things refers to the embedding of everyday objects with sensors, monitors and timers, connecting them to a data network or the internet. In a recent report, McKinsey states there has been a 300% increase in connected machine-to-machine devices over the past five years. Potential benefits are large: power grids can be controlled more efficiently by continuously monitoring their operations - customer meters will be automated resulting in a 2-4% reduction in demand peaks in the grid. The cities of Doha, Sao Paulo and Beijing all use sensors on their water pipes and pumps to manage water usage and loss, reducing water leaks by up to 50%.
McKinsey Global Institute, 2013

SOCIETAL EFFECTS

It is much more difficult to highlight individual societal effects, but notable points are:

- Although IT with transformational potential is available, decisions around implementation and uptake rest with businesses and governments. Whether it is actually used, and how effectively, is therefore an important question. Much has been written on barriers to technology uptake, which we will not reproduce here. But we do note that this is perhaps the key sustainability question for the IT sector.
- Online products and services will only be environmentally beneficial in so far as they actually replace the physical alternative. Online offerings are often just an addition to the physical, or are transferred to a physical version resulting in little or no environmental benefit. Similarly, multi-use devices may be simply added to the repertoire of existing devices.
- Wireless and mobile working offer better social connections and the promise of avoided travel, but both of these positive concepts drive rebound effects. Firstly, there are real doubts over whether electronic communication can substitute face-to-face meetings. Secondly, the ability to send and receive data anywhere may, in the long term, encourage people to adopt hyper-mobile lifestyles, driving up physical travel and the associated environmental impacts. Indeed there is an argument that we are already observing this in the upper tiers of businesses.

7.0 An agenda for the sector

Based on the findings on the previous pages we can now ask: what are the implications for the IT sector? How can responsible IT companies play a part in securing the maximum sustainability benefit?

The answer is in three parts, following the three types of impacts. The direct impacts of the sector are very real. While they may be modest at the moment, they are growing fast. It is important for all companies to have a plan in place to measure and control them. For the IT sector to truly realise its huge positive contribution to sustainability, it must engage with its indirect and societal impacts. This is where the real benefit lies and – as we note above – securing this benefit is largely in the hands of IT users and policymakers.

This creates an imperative for responsible IT companies to:

1. Work to control direct impacts;
2. Act positively to secure the indirect benefits, working with others where necessary; and
3. Explore and research the big societal changes, enabling them to have a voice in social policy.

7.1 Work to control direct impacts

There are many technological and behavioural approaches for reducing direct impacts in the IT sector. We do not propose to repeat them all here. We suggest that responsible IT companies should have an active programme in place to identify and reduce direct impacts as a necessary first step. This is already business as usual.

Reducing energy impacts – Facebook

Facebook's energy consumption is significant and growing as their social media platform and associated apps continue to expand. The energy use of its data centres has come into focus, and Facebook now has a data centre siting policy that prioritises access to renewable energy. As such, Facebook's third data centre was located in Luleå, Sweden, since it can be almost entirely powered by renewable energy. Facebook is assessing not just the energy efficiency of their data centres, but the sources of their energy also. *Greenpeace, 2012*

Tips for tackling direct impacts

Your impacts

- Be aware of what your environmental impacts are and where they are most significant – conduct a basic environmental impact analysis including the manufacture and use of your products.
- Set policies and targets to reduce them. Monitor your progress.
- Be aware of the energy mix of the electricity you use. Could you incorporate more renewable energy, or produce energy locally on site?
- If your impact is highest in the use phase, engage your customers and consumers about how best to use your IT most efficiently.

Your workforce

- Do your people understand how their behaviours affect your impacts? Ensure they know how to play their part.
- Are accountabilities clear? Set clear responsibilities for the topic and try to avoid unempowered 'champion' roles.

Your own IT equipment

- Be aware of how you use your IT. Could you use fewer or alternative devices or run them for less time?
- Are you specifying the most up to date and efficient equipment in your operations?
- Ensure you use energy efficient technology to its full potential. Are those using the technology fully trained and aware of how it should work?
- At a minimum, comply with legislation for the disposal of electronic equipment. If you can, think about reusing and recycling equipment, or reducing the total waste produced.

Your supply chain

- Investigate where efficiencies can be made. Can you engage suppliers to cut their own impacts?
- Consider the use of scarce resources in your supply chain, their sourcing and potential reclamation.
- Consider where you locate your supply chain and data centres in particular. The energy mix in these countries, as well as distance and transport options, all have an effect.

7.2 Act positively to secure indirect benefits

This research has demonstrated that the IT sector can be a real force for good in sustainability. It has also shown that realising these benefits does not lie in the direct control of the companies in the sector.

Our most important finding is this: responsible IT companies will play an active role in ensuring their customers and others adopt their technologies, and that these are securing the best possible sustainability benefits. This will almost certainly involve partnering with other companies – whether peers or somewhere else in the value chain – to ensure that these sector-wide benefits are understood and realised. Each company must explore for itself what this means, and it will vary depending on the products and services it offers. Responsible companies might do the following:

- **Support technology transfer** generically as well as individually. If a company is offering a product or service leading to an indirect environmental benefit, the bigger the uptake, the bigger the benefit. So it may well be the best option to try and promote the uptake of the technology generically *(i.e. including competitors' versions)* as well as selling one's own. This may make commercial sense as widespread adoption of new platforms or ideas can help secure their place in society more generally. In practice, the sector might collaborate to promote intelligent travel planning or telepresence systems in general as well as each company offering its own distinctive solution.
- **Promote responsible use** of technology by customers. For example, by being clear with customers and citizens on how IT should be used, the scale of the impact it can have, and then checking whether it is being applied appropriately.
- **Measure uptake and benefit** by researching how often their technologies have been adopted and collecting quantified data on the savings they achieve. When offering a solution with an indirect benefit it is tempting just to stop once the sale has been made, but it may well be valuable to remain close to the customer, encouraging and enabling them to measure the savings or impact of the product. In this way companies can learn and optimise environmental benefits in the next generation. It also puts them in a position to argue convincingly about the benefits they are already producing.
- **Steward their technology.** For example, ensuring that dematerialisation is a transition, not an addition, to what is existing, or ensuring old servers are genuinely switched off when transitioning to the cloud. Consider whether issues like built-in obsolescence and product replacement can be tackled to try and enable the maximum environmental benefits for customers. As the IISD wryly observes *"we cannot assume that the existing trajectory of IT innovation is 'fit for purpose' just because it exists." (IISD, 2012)*

7.3 Explore and research the big changes

There is a mass of existing insight into direct and indirect impacts, but there is remarkably little certainty about the profound ways in which society might respond to advances in IT in the medium to long term. Importantly, our research suggests that third order effects of IT are the only category that have the potential for systemic changes to the most fundamental of societal and business activities: how we travel, how we work, how we consume and how we communicate. If IT companies can harness the opportunities that third order effects offer, then they may be able to provide products and services that make the greatest strides towards a sustainable society.

We believe that it is in the interests of the sector to challenge and explore this critically. In an ultra-networked world, what role does IT play in shaping how people live and work? What is IT's role in creating thriving, prosperous societies, now and in the future? How can businesses understand the second and third order impacts *(negative or positive)* that their use of IT is having? Is it possible for IT companies to drive sustainability collaboratively while maintaining healthy, competitive relationships with their peers?

Technology companies could play a very important role in convening discussions and supporting research to shed light on these huge social questions. In the words of Neil Armstrong, the first man to stand on the surface of the moon: *"Science has not yet mastered prophecy. We predict too much for the next year and yet far too little for the next 10."*

APPENDIX 1

List of reports used in meta-analysis

1. **Accenture Outlook (2013)**. *How digital technologies are changing the way we work.* Available at: http://www.accenture.com/us-en/outlook/Pages/outlook-journal-2013-how-digital-technologies-are-changing-the-way-we-work.aspx

2. **Alliance Trust Investments (2013)**. *Clements, S. How green is the cloud?* Available at: http://www.alliancetrustinvestments.com/sri-hub/posts/2013/november/cloud-computing

3. **Beyond Current Horizons (2009)**. *Dixon, M. Information and communication technology, work and employment*. Available at: http://www.beyondcurrenthorizons.org.uk/information-and-communication-technology-work-and-employment/

4. **Bio Intelligence Service (2008)**. *Impacts of Information and Communication Technologies on Energy Efficiency*. Available at: ftp://ftp.cordis.europa.eu/pub/fp7/ict/docs/sustainable-growth/ict4ee-final-report_en.pdf

5. **Cisco (2014)**. *Cisco Visual Networking Index: Forecast and Methodology, 2013–2018.* Available at: http://www.cisco.com/c/en/us/solutions/collateral/service-provider/ip-ngn-ip-next-generation-network/white_paper_c11-481360.pdf

6. **Cisco and GBN (2010)**. *The Evolving Internet.* Available at: http://newsroom.cisco.com/dlls/2010/prod_082510b.html

7. **Economist Intelligence Unit (2012)**. *Agent of Change, The future of technology disruption in business.* Available at: http://www.economistinsights.com/sites/default/files/downloads/EIU_Agent%20of%20change_WEB_FINAL.pdf

8. **Enabling Technology (2013)**. *Thomond, P. The Enabling Technologies of a Low-Carbon Economy.* Available at: http://gesi.org/assets/js/lib/tinymce/jscripts/tiny_mce/plugins/ajaxfilemanager/uploaded/Cloud%20Study%20-%20FINAL%20report_2.pdf

9. **Erdmann, L. and Hilty, L. (2010)**. *Exploring the Macroeconomic Impacts of Information and Communication Technologies on Greenhouse Gas Emissions. Journal of Industrial Ecology. Volume 14, Number 5.* Available at: http://publicationslist.org/data/lorenz.hilty/ref-59/2010-10%20Erdmann%20Hilty%20Scenario%20Analysis%20Impacts%20of%20ICT%20on%20GHG.pdf

10. **European Commission (2008)**. *Addressing the challenge of energy efficiency through Information and Communication Technologies.* Available at: http://ec.europa.eu/information_society/activities/sustainable_growth/docs/com_2008_241_all_lang/com_2008_241_1_en.pdf

11. **European Commission (2010)**. *A Digital Agenda for Europe.* Available at: http://www.kowi.de/Portaldata/2/Resources/fp/2010-com-digital-agenda.pdf

12. **European Commission (2012)**. *The Digital Agenda for Europe - Driving European growth digitally.* Available at: http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?doc_id=1381

13. **Forum for the Future (2011)**. *Connect, Collaborate, Change.* Available at: http://www.forumforthefuture.org/sites/default/files/project/downloads/j11-5064-lr-o2-future-report-booklet_0.pdf

14. **Forum for the Future and EITO (2002)**. *The impact of ICT on sustainable development.* Available at: http://homepage.cs.latrobe.edu.au/sloke/greenIT/eito_forum_2002.pdf

15. **GeSI (2008)**. *SMART 2020: Enabling the low carbon economy in the information age.* Available at: http://www.smart2020.org/_assets/files/02_Smart2020Report.pdf

16. **GeSI (2012)**. *Future Lifestyles and Opportunities for the ICT Industry.* Available at: http://gesi.org/files/Reports/ReportWorkstudio_Berlin120626print.pdf

17. **GeSI and BCG (2012)**. *GeSI SMARTer 2020: The Role of ICT in Driving a Sustainable Future.* Available at: http://gesi.org/assets/js/lib/tinymce/jscripts/tiny_mce/plugins/ajaxfilemanager/uploaded/SMARTer%202020%20-%20The%20Role%20of%20ICT%20in%20Driving%20a%20Sustainable%20Future%20-%20December%202012.pdf

18. **Greenpeace (2012)**. *How clean is your cloud?* Available at: http://www.greenpeace.org/international/Global/international/publications/climate/2012/iCoal/HowCleanisYourCloud.pdf

19. **Hilty, L. and Aebischer, B. (2015)**. *ICT Innovations for Sustainability.* Table of Contents available at: http://www.springer.com/engineering/computational+intelligence+and+complexity/book/978-3-319-09227-0

20. **IBM (2010)**. *Telco 2015.* Available at: http://www-01.ibm.com/common/ssi/cgi-bin/ssialias?infotype=PM&subtype=XB&appname=GBSE_GB_TI_USEN&htmlfid=GBE03304USEN&attachment=GBE03304USEN.PDF#loaded

21. **ICSPA (2012)**. *Project 2020 - Scenarios for the Future of Cybercrime.* Available at: https://www.icspa.org/wp-content/uploads/2014/12/ICSPA_Project_2020_-_Scenarios_for_the_Future_of_Cybercrime.pdf

22. **IISD (2012)**. *Changing our Understanding of Sustainability: The impact of ICTs and the Internet.* Available at: http://www.iisd.org/pdf/2012/changing_our_understanding_of_sustainability.pdf

23. **IISD and OECD (2008)**. *MacLean, D. A. Framework for Modelling ICT and Environmental Challenges Using Future Scenarios. Workshop on ICTs and Environmental Challenges.* Available at: http://www.oecd.org/sti/ieconomy/40832836.pdf

24. **intellect [now TechUK] (2008).** *High Tech, Low Carbon: The role of technology in tackling climate change.* Available at: https://www.techuk.org/insights/reports/item/457-high-tech-low-carbon

25. **Internet Society (2009)**. *Internet Future Scenarios.* Available at: https://www.internetsociety.org/sites/default/files/pdf/report-internetfutures-20091006-en.pdf

26. **McKinsey Global Institute (2013)**. *Disruptive technologies: Advances that will transform life, business, and the global economy.* Available at: http://www.mckinsey.com/insights/business_technology/disruptive_technologies

27. **Morozov, E. (2013)**. *To Save Everything, Click Here: Technology, Solutionism, and the Urge to Fix Problems that Don't Exist. Allen Lane*

28. **Nesson Center for Internet Geophysics (2013)**. *Hwang, T. and Kamdar, A. The Theory of Peak Advertising and the Future of the Web.* Available at: http://peakads.org/images/Peak_Ads.pdf

29. **OECD (2009)**. *Measuring the Relationship between ICT and the Environment.* Available at: http://www.oecd.org/sti/43539507.pdf

30. **OECD (2009)**. *Towards Green ICT Strategies: Assessing Policies and Programmes on ICT and the Environment.* Available at: http://www.oecd.org/sti/ieconomy/42825130.pdf

31. **OECD (2010)**. *Greener and Smarter: ICTs, the Environment and Climate Change.* Available at: http://www.oecd.org/site/stitff/45983022.pdf

32. **OECD (2012)**. *OECD Internet Economy Outlook 2012. OECD Publishing.* Available at: http://dx.doi.org/10.1787/9789264086463-en

33. **OECD (2014)**. *Measuring the Digital Economy.* Available at: http://www.oecd-ilibrary.org/science-and-technology/measuring-the-digital-economy_9789264221796-en

34. **OECD and NITA (2008)**. *Workshop on ICTs and Environmental Challenges.* Available at: http://www.oecd.org/sti/ieconomy/40808014.pdf

35. **Tata Consultancy Services (2010)**. *Kripalani, D. and Pandit, A. Creating Eco-corporations for a Sustainable Future.* Available at: http://www.tcs.com/SiteCollectionDocuments/White%20Papers/Eco-white-paper-Eco-corporations_05-2010.pdf

36. **Tata Consultancy Services (2012)**. *McKinney, T. and Quinn, W. The Digital Guest List Expands: Driving Digital Transformation Across Lines of Business.* Available at: http://www.tcs.com/SiteCollectionDocuments/Perspectives/Perspectives_vol5_Driving_Digital_Transformation.pdf

37. **Tata Consultancy Services (2013)**. *Rameshkumar, S. The Digital Enterprise and the Changing Role of IT.* Available at: http://www.tcs.com/SiteCollectionDocuments/Perspectives/Digital-Enterprise-Changing-Role-IT-0613-1.pdf

38. **TCS (2011a)**. *Low Carbon Living.* Available at: http://www.tcs.com/SiteCollectionDocuments/White%20Papers/ESU_Whitepaper_Low-Carbon-Retail_020112.pdf

39. **TCS (2011b)**. *Low Carbon, High Growth.* Available at: http://www.tcs.com/SiteCollectionDocuments/White%20Papers/ESU_Whitepaper_Electric_Utility_Services_1212-1.pdf

40. **TCS (2012)**. *Empowered consumers: The next wave of electric utility services.* Available at: http://www.tcs.com/SiteCollectionDocuments/White%20Papers/ESU_Whitepaper_Electric_Utility_Services_1212-1.pdf

41. **The Rockefeller Foundation and Global Business Network (2010)**. *Scenarios for the Future of Technology and International Development.* Available at: http://www.rockefellerfoundation.org/uploads/files/bba493f7-cc97-4da3-add6-3deb007cc719.pdf

42. **WEF (2010a)**. *Exploring the Future of Cloud Computing: Riding the Next Wave of Technology-Driven Transformation.* Available at: http://www.weforum.org/reports/exploring-future-cloud-computing-riding-next-wave-technology-driven-transformation (accessed 19 January 2015)

43. **WEF (2010b)**. *Digital Ecosystem Convergence between IT, Telecoms, Media and Entertainment: Scenarios to 2015.* Available at: http://www.weforum.org/reports/digital-ecosystem-convergence-between-it-telecoms-media-and-entertainment-scenarios-2015 (accessed 19 January 2015)

44. **WEF (2011)**. *Advancing Cloud Computing: What To Do Now?* Available at: http://www.weforum.org/reports/advancing-cloud-computing-what-do-now (accessed 19 January 2015)

45. **Wharton School of the University of Pennsylvania, The Mack Center and Institute for the Future (2012)**. *After Broadband: Imagining Hyper-connected Futures.* Available at: http://afterbroadband.com/report/AfterBroadband.pdf (accessed 19 January 2015)

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