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OUTLINE FOR THE FIRST GLOBAL IT STRATEGY FOR CO_2 REDUCTIONS

A BILLION TONNES OF CO_2 REDUCTIONS AND BEYOND THROUGH TRANSFORMATIVE CHANGE

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THE FUTURE OF THE INTERNET ECONOMY

ICT'S AND ENVIRONMENTAL CHALLENGES

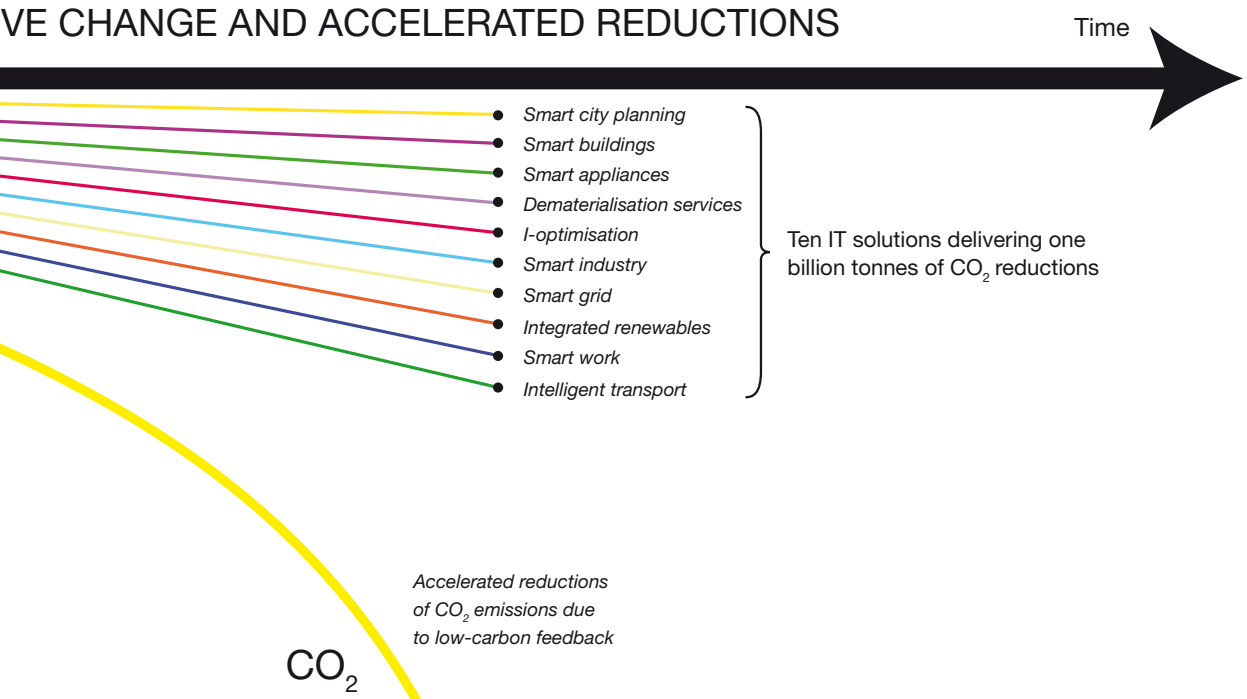
THE FIRST BILLION TONNES OF CO_2 REDUCTIONS TO ACHIEVE TRANSFORMATI

THIS REPORT presents ten strategic Information and Communication Technology (ICT or IT, hereafter written only as IT) solutions that can help accelerate the reduction of CO_2 emissions. The solutions come from another WWF report "The potential global CO_2 emission reductions from ICT use: identifying and assessing the opportunities to reduce the first billion tonnes of CO_2 emissions".[1]

The solutions in this report have been included based on their potential to provide "low-carbon feedback", i.e. solutions that not only reduce CO_2 directly when they are used, but also strengthen structures that support further emission reductions.[2]

The direct emission reductions of one billion tonnes of CO_2 which could be achieved through these ten IT solutions is equivalent to approximately a quarter of EU's current CO_2 emissions and, thus, very significant. Hopefully their significant direct contribution will be acknowledged and ensure that IT will become an integrated part in all key climate polices around the world to fight climate change. Even more important however is their further reduction potential due to the fact that they have been selected for their likely contribution to a "low-carbon feedback". Building on existing discussions on "rebound effects" (the possible "side effects" from implementing a solution that could potentially undermine it and lead to counter-productive results), this paper discusses "high- and low-carbon feedback" as well as a set of questions to differentiate between different kinds of low-carbon feedback.

Analysing feedback can help to avoid solutions that could look like "low



hanging fruits", but in fact only contribute to short-term reductions as well as contribute to unsustainable investments that make larger and necessary reductions more difficult. Looking at feedback helps to avoid solutions that result in "high-carbon feedback", i.e. solutions that will strengthen structures that support increased emissions.

Instead of a reactive approach where the focus is on incremental reductions on the supply-side (the dominating approach to CO_2 reductions so far) evaluating and promoting low carbon feedback would encourage innovation on the demand-side. With a focus on innovation, companies and parts of government, which both have so far played a marginal role in the climate debate, would be encouraged to show necessary leadership.[3]

What is needed is a long-term, strategic approach where we re-define not only business and the way business is made, but the societies businesses exist in – today and in the future – and how they help shape it. A fundamental part of this equation will be IT, not only through the IT sector with the potential to provide solutions that can help those who want to be winners in a low carbon economy, but also through new networks. New constellations should work together to ensure incentive structures support the deployment of IT services that could fundamentally impact the way we view buildings, motion, light, heat, food and other services.

This approach is particularly important to enable a fruitful collaboration between countries with the big emissions per capita, OECD, and those growing very fast, such as China and India.

"The effects of climate on companies' operations are now so tangible that the issue is best addressed with the tools of the strategist, not the philanthropist. […] strategic approaches could involve reconfiguring the activity entirely: In outbound logistics, firms might replace physical books or manuals with electronic versions, and in after-sales service, they could supplant physical visits by service technicians with remote diagnostics and treatment programmes."

Michael E. Porter and Forest L. Reinhardt
Harvard Business Review, October 2007

RE-THINKING **GREEN IT**

IN RECENT YEARS, the role of IT in combating climate change has received significant attention in different types of international fora, ranging from the political discourse to business fora and conferences.[4] All the while events and discussions on the topic of "Green IT" have become more frequent and numerous, the current backdrop of the scale of IT's potential often fails to get the attention it deserves to reflect solutions instead of problems. The notion of "Green IT" has rather become synonymous with energy labelling schemes, green procurement of energy efficient equipment, consolidation of server parks and virtualisation of office environments.

So far, being "green" has mainly been connected to traditional reactive environmental work and "doing something good"; a philanthropic or risk minimising/compliance effort. Dealing with the environment has been something a company approaches in an "end of pipe" manner when everything else is already in place – resulting in a situation when "green" has been far away from the core business development and KPI's. To become a leader in a low carbon economy, companies, both providers and users, need to rethink the entire notion of "Green IT". Green IT of the 21st Century is not only green in terms of a healthy planet but green in terms of cash – not just in savings to be made, but future markets to be won – and should be part of core business strategy and planning.

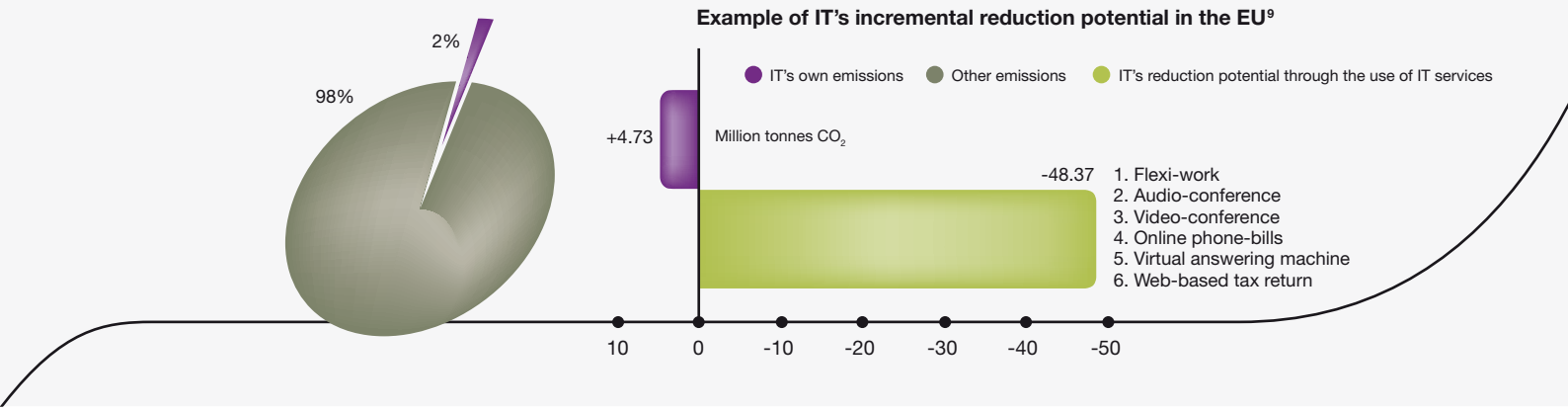
From products to services: from 2% to 98%

In 2007, Gartner released a study which showed that the total amount of CO_2 emissions from the IT industry could amount to 2% of global carbon emissions.[5] Even if many media outlets used this number only to continue discussing the IT products themselves, the study provided a language to discuss the remaining percentage of CO_2 gains to be made where IT solutions could play an important role for transformative change – a part that now could be called "the 98%".[6] Faced with the contrast between 2% and 98% has made it difficult to ignore the role IT solutions can play in society to combat climate change. There is probably no other sector where the opportunities through the services provided holds such a reduction potential as for the IT industry. Obviously emissions from the IT sector should not be ignored, but the emphasis on reducing the emissions from the sector itself should be proportional to the potential for reductions through services provided.

A better understanding of impact: Direct, Indirect & Systemic effects[7]

What is easy to see and measure is not always the most important. In order to understand the impact of a product or service it is important to understand different consequences. The division of impact into "direct", "indirect" and "systemic" can allow for a better understanding of the impact ranging from 1) impact from the product itself, 2) the immediate impact on the surroundings due to a product's use and the 3) the socio-economic/ structural changes that potential use could result in. The latter is particularly important over time and will be further discussed in the next section.

IT'S OWN EMISSIONS AND THE 98% WINDOW OF OPPORTUNITY[8]



"'Green IT' is an oxymoron, until you consider use of IT to 'green' business and society."

Simon Mingay, Gartner[10]

DIRECT EFFECTS

Relate to the actual product:

Depending on how it is measured this includes anything from only the emissions during use to the emissions from production to disposal. These emissions refer to those caused by IT infrastructure and equipment, e.g. the resource consumption (including materials and energy) when producing IT equipment, the energy consumption when using IT, and the effects of the resulting electronic waste. In order to have a credible strategy resulting in an overall increased use of IT, the direct effects must be addressed.

These impacts are the least important in terms of CO_2 emissions but are the easiest to measure and also have institutional structures in place in the shape of labels/legislations and public procurement criteria, therefore much of the discussions keep drifting back to the energy use in IT equipment. Addressing direct emissions is however important for a number of reasons ranging from credibility of the IT sector to support of new innovative solutions.

INDIRECT EFFECTS

Relate to the service provided:

Depending on how they are measured they can include anything from the substitution effects (e.g. that you save CO_2 when you use videoconferencing instead of flying) to also include the supporting infrastructure and which can be reduced (that the fibre optic cables and other supporting infrastructure for videoconferencing need less resources than the airports and other infrastructure necessary for flying).

The emissions derive from the use and habits through communication-based applications. These can be both positive and negative. For example, the reduced need for transportation as a result of teleconferencing, or the increased need for transportation as a result of just-in-time deliveries (due to B2B applications) are examples of indirect effects.

The indirect effects are more complicated to measure than direct ones, but some work has been done to develop methodologies and ways to collect relevant data.[11]

SYSTEMIC EFFECTS

Relate to technological and institutional structures:

The systemic effects are the most significant, but also the most difficult to assess. They stem from new habits, social structures and consumption patterns that arise from communication products, applications and services when they are used in society.[12]

Even if, in the near future, it is not possible to put exact numbers on these effects, it is important to at least explore if they are positive or negative and their approximate magnitude.[13]

The key reason for the importance of the systemic effects is that the changes in institutional structures provides feedback that is dynamic (it can make the feedback increase or decrease over time). The system can provide low-carbon feedback (enabling further reductions of CO_2 emissions) or high-carbon feedback (instead supporting increases of CO_2 emissions). This requires us to take feedback into special account when IT solutions are implemented.[14]

"If you do not change direction, you may end up where you are heading."

老子 *Laozi*

UNDERSTANDING CHANGES OVER TIME: **SUPPO**

APPLYING THE SPATIAL filter of direct, indirect and systemic effects by IT applications only provides a snapshot of the world – and the consequences over time are often forgotten. Such a static model can work when not much change in a system is expected, but as we need rapid reductions on a large scale, this will transform societies and we need to understand the services that strengthen further investments to increase emission reductions – and avoid the opposite. If we combine the previous description of direct, indirect and systemic effects with the concept of "low- or high- carbon feedback" we can gain a better understanding of what strategic IT services we should focus on implementing.

Otherwise, if systemic effects over time are ignored, solutions that might seem as important in a linear model could turn out to be counterproductive. A good product which is delivering direct CO_2 reductions can contribute to a system that results in a high-carbon feedback and therefore be responsible for an unsustainable development in society.[15]

Similarly, a service that might not provide much direct or indirect effect in terms of emission reductions might still result in a significant low-carbon feedback when looking at the systemic effects of the same service.

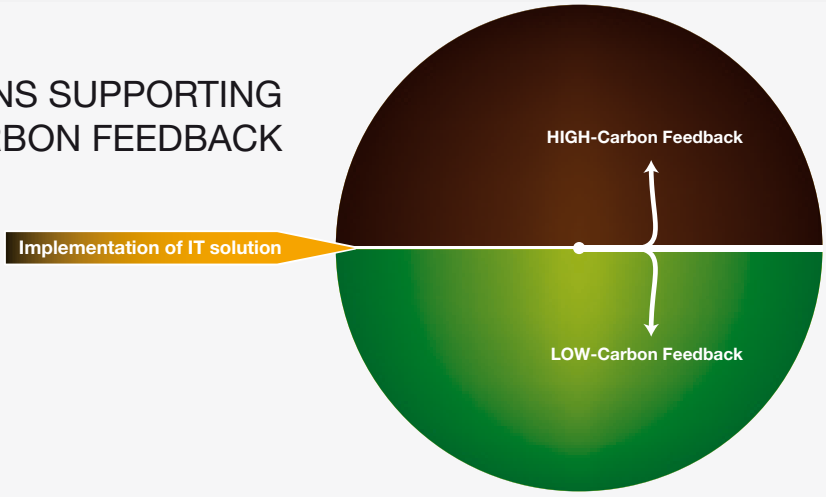
Most models today assume that everything stays the same when we introduce a change to the system. This is obviously not true. A product or service is not an isolated island and will affect the surroundings when they are being used. In many cases these changes are so small (only affect the system on the margin) that they can be ignored. If we are looking for rapid CO_2 reductions and exponential uptake of solutions that can reduce CO_2 however, the changes to a system that can encourage further reductions become vital.

An IT solution that makes it possible to switch off the lights in a building is for many economic models easier to calculate than a switch from air transport to videoconferencing. The effects by substitution often require more sophisticated approaches that move beyond linear models. Linear models can still provide interesting information, but action based on these must be taken with great care as we risk both a lock-in with existing structures, and focus on incremental reductions instead of the solutions that can contribute to necessary emission cuts.

When implementing different IT services, a society's structures will be affected and different processes and stakeholders will be strengthened while others weakened. Exactly how society will be affected by new solutions is determined by a number of factors, all of these can never be taken into account by any model. To totally disregard them, like most models do today, is however not a sustainable approach. Some changes will trigger further use of low-carbon solutions and contribute to increased CO_2 reductions; this will create a "low-carbon feedback" to a system.

Other changes will result in situation where emissions increase and/or lock us into an infrastructure dependant on fossil fuel, creating a "high-carbon feedback".

IT SOLUTIONS SUPPORTING
HIGH- OR LOW-CARBON FEEDBACK



ORTING HIGH- OR LOW-CARBON FEEDBACK

TWO GENERAL TYPES OF FEEDBACK CAN BE IDENTIFIED:

1 HIGH-CARBON FEEDBACK

A situation where an IT service encourages new services, behavior and institutional structures that result in increased CO_2 emissions.

Some IT investments can, even if they help reduce CO_2 emisisons in the short term, support higher emissions over time, resulting in a high-carbon feedback and a high-carbon "lock-in".

2 LOW-CARBON FEEDBACK

A situation where an IT service encourages new services, behavior and institutional structures that result in reduced CO_2 emissions.

Some IT investments can support a system that provides a low-carbon feedback that helps support an accelerated reduction of CO_2 emissions. These solutions are crucial if we are to achieve a transformative change and reach the significant emission reductions necessary to avoid dangerous climate change.

Some IT services can help to reduce CO_2 emissions but not create any particular feedback. These services might not be counterproductive per se, but a single minded focus on them (since they might become visible in simple linear economic models) could be counterproductive as then, the most important reductions are ignored. The next section will look in more detail at different types of low-carbon feedback.

"To tackle climate change we must stop relying on 'quick fix' technological solutions and start adopting new low-carbon ways of working and living."

Dr Michael Harris, The disruptive approach to low-carbon innovation, 2008

THREE TYPES OF **LOW-CARBON FEEDBACK**

WITH A GROWING gap between the understanding of the scale of CO_2 reductions that are needed to avoid catastrophic climate change and the close to insignificant actions being taken to reduce emissions, the need to find new ways forward is urgent. The IT sector could play an important role in redefining the way we approach the climate challenge and turn the need to reduce CO_2 into an opportunity by helping to implement strategic IT solutions.

In order to deliver real change it is important that significant resources are invested to ensure that solutions that can deliver accelerated reductions of CO_2 emissions are identified. For more than 100 years there has been an almost exponential growth in carbon emissions, the challenge to turn this trend around should not be underestimated, but neither should the potential of already existing solutions.

Achieving a common focus to implement IT solutions to ensure low carbon feedback to society will be one of the most important tasks ahead.

Selecting IT solutions that deliver low-carbon feedback

As any system is dynamic when seen over time the systemic effects when introducing solutions that are transformative in nature will increase as society changes. With IT solutions often working as powerful catalysts, influencing all parts of the economy, it is important to focus on their most strategic applications. When an IT service can contribute not only to an accelerated reduction of CO_2 emissions but also a transformative change of the economy, we will see significant low carbon feedback to a system.

Looking closer, this (systemic) feedback can be of three different types:

1 LOW-CARBON SERVICE FEEDBACK

This will take place if implementation/use of a low-carbon service makes it easier for more of the same service to be deployed.

Key questions:

— Will more users use a service and/or make it more attractive to other users (network economy)?

— Will more users of the service accelerate reductions of CO_2?

EXAMPLE OF VIDEOCONFERENCING:

Increased access and use will make videoconferencing a more attractive solution enabling communication with more people. The more videoconferencing services that exist will create a higher value for those who have one. It will become more attractive to have one and the more places that are connected the more it can be used as a means of replacing unnecessary travels.

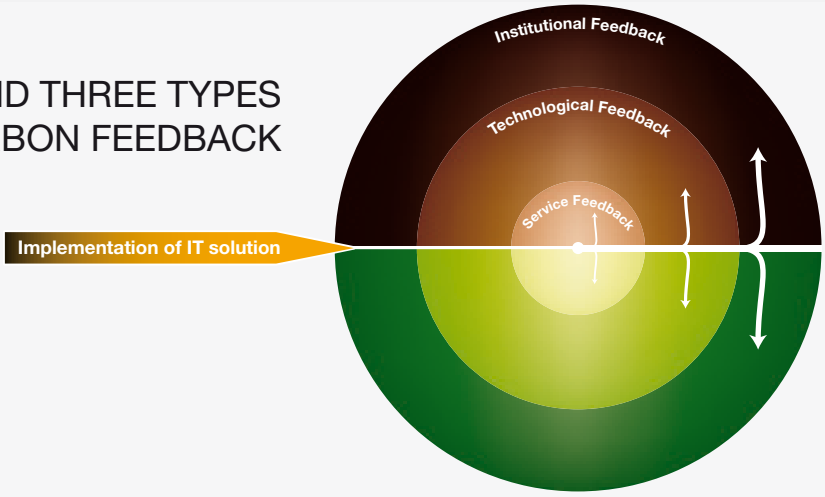
2 LOW-CARBON TECHNOLOGICAL (STRUCTURAL) FEEDBACK

This will take place if the implementation/use of a low-carbon service supports a technological structure which, in turn, will enable and strengthen potential growth/increased use of other low-carbon services.

Key questions:

— Will the service support an infrastructure which would support other sustainable services/increase connectivity to enable CO_2 reductions?

IT SOLUTIONS AND THREE TYPES OF LOW-CARBON FEEDBACK



— Will the service help to develop technology that can also be used in other sustainable solutions to reduce CO_2?

Example of videoconferencing:
More videoconferencing would, for example, trigger investments in high-quality broadband and thereby contribute to an infrastructure that allows laptops and mobiles to be connected for virtual meetings as well. This would support a situation where not only the transport saved by using videoconferencing will lead to CO_2 reductions but this could also deliver emission reductions from flexible working, as people could reduce commuting and work from where ever they liked. Investments in videoconferencing could also help to develop technologies to compress and transfer data that, in turn, can be used to dematerialise other parts of the economy.

3 LOW-CARBON INSTITUTIONAL (STRUCTURAL) FEEDBACK
This will take place if the implementation/use of a low-carbon service supports or enhances an institutional structure which, in turn, will enable the uptake of other low carbon services.

KEY QUESTIONS:
— Will the service support a shift from goods to service?
— Will the service help to create interest groups that support a low-carbon development path?

Example of videoconferencing:
If videoconferencing services are implemented in a company, this could support a change in strategy to shift from a product perspective of buying "travels" to a service approach buying "meetings". Such a change in strategy could then be applied to other parts of the company resulting in a shift from products to services in other areas as well. More business opportunities around different services linked to virtual meetings and more deployment will also increase the likelihood of a stronger united voice in policy discussions. This is key as legislators often want input from different stakeholders and one of the challenges is that few or no representatives from low-carbon business models have been present in discussions so far. In many cases this is because they are busy trying to survive and lack lobby organisations in the world's capital cities. For example, if representatives from the airline industry are the only ones present when incentives for companies to reduce CO_2 from flying are being developed, it is likely that we will only see offsetting and more efficient engines on the agenda. Investments and rules to ensure higher bandwidth and incentive structures for virtual meetings will probably not gain equal support.

THE FIRST BILLIO

IDENTIFYING IT SOLUTIONS that can deliver one billion tonnes of CO_2 emissions is a significant challenge, yet only the first step. To ensure that the IT solutions are also implemented in the right context is fundamental to minimise negative rebound effects and promote low-carbon feedback. Inside, a matrix presents ten strategic IT solutions that given the right circumstances, will help to not only reduce one billion tonnes of CO_2 emissions, but also support accelerated reductions due to low-carbon feedback. The same solutions could, however, contribute to high-carbon scenarios as well (also presented in the matrix), and caution is needed as the positive or negative outcome depends on how a solution is implemented.

N TONNES OF CO_2

IMPLEMENTING TEN IT SOLUTIONS TH

LOW-CARBON FEEDBACK
HIGH-CARBON FEEDBACK

SOLUTION	ACTION	100 MT CO_2 EMISSION REDUCTIONS	SERVICE FEEDBACK • Will more users use a service or make it more attractive to other users (network economy)? • Will more users of the service accelerate reductions of CO_2?
1 Smart City Planning	*Deploy modern simulation and analysis software to improve urban design and planning to optimise energy efficiency.*	*Reduce the CO_2 emissions from buildings and infrastructure by 2.3%.*	More design software for smart buildings could help reduce prices of such software. If the software is very expensive and/or difficult to use only a few will probably use it and they will be seen as "alternative" while most others will instead use software that will result in carbon-intensive buildings.
2 Smart Buildings	*Use sensors and controls in buildings to improve efficiency and tailor energy use to energy needs.*	*Reduce the CO_2 emissions from buildings being built by 4.5% in the coming decade.*	More use of sensors and controls could reduce their cost and enable further uptake. Unique sensors and controls without a standardised interface would not allow for an increased spread and use in other applications.
3 Smart Appliances	*Utilise IT components (Microprocessors and ASICs) within appliances to improve efficiency and tailor appliances use with actual needs.*	*Reduce about 1% of average CO_2 emissions from energy use in existing buildings.*	As more connected appliances are sold, the cheaper they can become and allow for wider uptake. If smart appliances are sold only as exclusive top end products without a mainstreaming strategy, this could result in isolated use and continued sales of unintelligent appliances.
4 Dematerialisation Services	*Use IT as a form of "service delivery", substituting physical products and interactions – i.e. 'use bits instead of bricks'.*	*Reduce current paper use by 13%.*	The more e-governance with e-taxation and online access to key documents and corporate services (such as online billing) that are implemented, the better economy of scale and lower administration costs can be achieved. If the dematerialised services are not as good as (or better than) their paper equivalent, a high-carbon feedback can happen where people use both the dematerialised service and then also the physical version. Printing of an email is a good example of this.
5 I-optimisation	*Use IT-based controls and knowledge management systems within individual production processes to improve operations, save energy and increase efficiency.*	*Reduce 1% of total CO_2 emissions generated by industry.*	More use of IT-based controls and knowledge management systems could reduce prices of these solutions. Increased use within individual production processes allow for connections between different processes (part of the same system) which can create added value. The same software also enables optimisation of investments i.e. low investment costs, at the cost of increased energy use.

IAT WILL REDUCE ONE BILLION TONNES O

LOW VS. HIGH-CARBON FEEDBACK SCENARIOS[16]

TECHNOLOGICAL FEEDBACK • Will the service support an infrastructure which would support other sustainable services/increase connectivity to enable CO_2 reductions? • Will the service help to develop technology that can also be used in other sustainable solutions to reduce CO_2?	INSTITUTIONAL FEEDBACK • Will the service support a shift from goods to service? • Will the service help to create interest groups that support a low-carbon development path?
Software development that targets high-carbon areas becomes mainstream among software developers and the interface between different software allows for integrated solutions. Only a few companies develop software for low-carbon solutions as a "nice" product but not as part of their core business portfolio.	Lobby groups promote rules and regulations that will support the uptake of low-carbon software and can also support open source and freeware in areas where the result contributes to CO_2 reductions. Most software developers focus on helping high-emitting companies to become more efficient and thereby run the risk of contributing to increased emissions instead.
A strategic implementation of sensors would contribute to an increased connectivity and thereby also enable the uptake for appliances to become "smart". Sensors and controls can also be used to support a smart grid (see below) to make the grid even "smarter". Different interfaces and protocols that require different kinds of supporting infrastructure would be used, creating a system that would not support other use of low-carbon solutions in need of connectivity.	Groups that deliver solutions for smart buildings work together to provide low-carbon solutions in ways that the current power companies have been unable to do as their business models are based on selling as much electricity as possible instead of ensuring optimal energy use. Traditional construction companies and power companies keep on providing high-carbon solutions in new buildings being built so that most houses remain energy inefficient and continue to require a lot of external energy supply.
A wide spread use of smart appliances could result in increased connectivity that could support further use of smart appliances and also support smart buildings. Even "smart use" during peak hours could lead to more or the same electricity consumption unless appliances are connected to each other as well as to a smart grid to ensure optimal use.	An increased number of companies ask for service-based regulations (instead of product-based). This could contribute to a significant shift towards a low-carbon economy. If smart appliances are only provided by a small group of companies as isolated products, those with business models based on increasing sales of inefficient products will profit instead and could lobby for smart appliances to be seen as useless.
Uptake of one type of online service to minimise paper use will spur further social acceptance of virtual services (governmental or corporate) and allow for accelerated uptake and acceptance of substituting physical products. Implementation of services will create a more resource inefficient society if they require more IT goods and a supporting infrastructure that is more resource intense than the products that are replaced (including their production line and seen over time). Implementation of dematerialisation can also result in new opportunities for high-carbon consumption that can increase CO_2 emissions. For example, more people getting computers for e-billing might also start looking on the web for cheap flights and thereby achieve a high-carbon lifestyle instead.	The more governments, companies and citizens that promote resource-efficient living in a global economy, the stronger support for a dematerialised economy we are likely to see. If companies that have their core business in high-carbon areas are the main providers of solutions for dematerialisation it is likely that these will only be marginal. These companies have strong incentives to protect their existing core business and therefore support an overall high-carbon agenda.
Modern IT developments enable improved controls that not only optimise energy use in individual processes, but also across a site or plant. Improved controls and better understanding of complex processes and operations could also help to develop more low-carbon solutions and help to spread the use of these to processes/sites of all capacities. Improved controls will reduce production and energy costs. This could lead to (although very unlikely) products becoming cheaper and hence consumption may increase. This could also lead to a situation where outdated plants are kept open longer.	Properly operating controls in complex processes can increase the profit among those using them and make these companies more influential in policy development. They could then support regulations that favour smart industry solutions rather than those provided by traditional heavy industries that focus on lower energy prices. If a few software solutions would be market leaders, this may generate more dependence on a few suppliers. This could negatively impact the speed of innovation in further developing these solutions.

F CO_2 AND BEGIN THE TRANSFORMATION

LOW-CARBON FEEDBACK
HIGH-CARBON FEEDBACK

SOLUTION	ACTION	100 MT CO_2 EMISSION REDUCTIONS	SERVICE FEEDBACK • Will more users use a service or make it more attractive to other users (network economy)? • Will more users of the service accelerate reductions of CO_2?
6 Smart Industry	*Deploy design tools and software to forecast, simulate and analyse energy use in production processes to ensure low carbon design of plants and processes.*	*Reduce 1% of total CO_2 emissions generated by industry.*	More use of IT-based design tools and software to forecast, simulate and analyse energy use could reduce prices of these solutions. Increased use of single systems allow for connections between systems that can create added value when a new generation of companies can work in similar ways. If sub-optimisation continues to occur despite having installed modern control systems this will impair process operation.
7 Smart Grid	*Deploy smart meters and communication technologies within electricity networks to enable two way communication between energy users and energy producers and to deliver advanced services such as "time of use metering" or "remote demand management".*	*Reduce about 1.25% of the CO_2 emissions associated with electricity use in buildings within a decade.*	More use of systems that use intelligent meters could allow connections between different systems and make them more efficient. If smart meters are introduced that only allow for energy use to be linked to price fluctuation over time, and without also controlling the energy consumption, this could lead to users keeping the same emissions and only adjusting to cost optimisation.
8 Integrated Renewable Solutions	*Utilise simulation, analytical and management tools to enable a wide deployment of renewable energy, for example removing existing bottlenecks present in transmission infrastructure or enabling a wider use of distributed generation.*	*Add 75 GW renewable energy capacity to the global energy system.*	IT tools can be created for those looking for energy efficiency solutions, these can be solutions for markets that are expanding fast, such as urban construction in emerging markets, and could enable accelerated uptake of smart renewable solutions. If the IT tools supporting new renewable energy solutions are only sold as an "add-on" feature, they are likely to be sold as expensive solutions for a small target group.
9 Smart Work	*Leverage the internet and other advanced communication tools to work remotely and avoid business trips or physical commuting.*	*About 5% of car commuters become tele-commuters and 15% of airplane business trips are substituted by virtual meetings.*	The more people who become tele-workers and telecommute the more socially acceptable it will become, services are also bound to be improved as more people are connected and better equipment installed. Unless remote workers and those conducting virtual meetings are properly connected, the level of complication will hamper a continued spread.
10 Intelligent Transport	*Deploy advanced sensors and controls, analytical models, management tools, and ubiquitous telecommunications to provide relevant information to enable less polluting forms of transport (such as public transport).*	*Substitute less than 6% of all km travelled by 'light-duty vehicles' with public transport.*	Better understanding of how public transport can be planned makes it easier for continued uptake and cities to follow each other (and quick implementation). If implemented against public opinion, or if the system does not work well, a backlash is likely with commuters boycotting use.

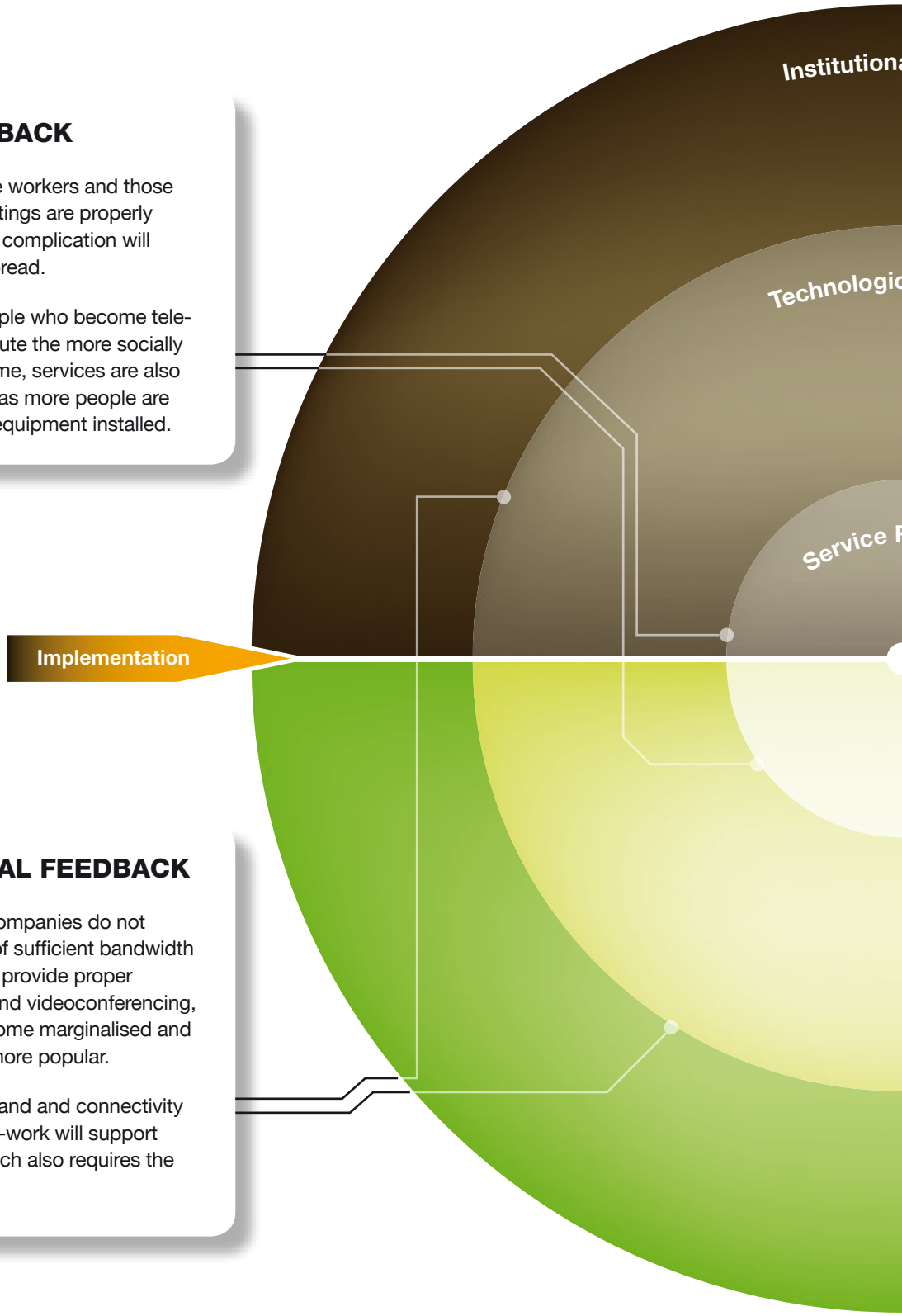
TOWARDS A LOW-CARBON SOCIETY[17]

LOW VS. HIGH-CARBON FEEDBACK SCENARIOS[18]

TECHNOLOGICAL FEEDBACK	INSTITUTIONAL FEEDBACK
• Will the service support an infrastructure which would support other sustainable services/increase connectivity to enable CO_2 reductions? • Will the service help to develop technology that can also be used in other sustainable solutions to reduce CO_2?	• Will the service support a shift from goods to service? • Will the service help to create interest groups that support a low-carbon development path?
Increased experience with design tools will lead to new applications in and beyond industry. Further integration of processes, may make the control and start-up of these processes more complex and more vulnerable for failures in some part of the system. Hence, improved process integration will also demand more sophisticated controls to avoid this scenario.	Companies that from the beginning can design their production from a service perspective (and with a full "lifecycle" perspective) could grow strong and establish networks that can deliver innovative solutions. Together, they could influence policy makers in order to ensure that rules and regulations support this development. If the new smart solutions are primarily used by the old industries there is a risk that oil companies, car companies, power companies, etc will only change marginally and use their already strong position to lobby against policy changes that would encourage innovative low-carbon solutions.
Improving the intelligence of buildings with smart meters require them to be better connected and would encourage key appliances to also include smart controls, thereby ensuring that larger parts of the buildings' energy needs can be managed. If this development is driven by power companies, focusing on the supply side, this development could result in a situation where the focus is on optimisation of the current system instead of supporting new decentralised energy solutions.	Smart grids would shift power away from high-carbon stakeholders with interests in a fossil infrastructure. To support this, rules and regulations for a less carbon intensive, and also less vulnerable, electricity grid would need to be put in place. Power companies could work against this transition to keep a centralised structure as it lies in their vested interest.
Adding renewable energy to a smart grid/decentralised energy system will support both further use of renewable energy solutions as well as energy efficiency (which is inherent in such a grid structure). Renewable solutions that are only sold as additional features to the traditional energy system could strengthen the current centralised infrastructure. With companies investing only to make the energy system "look" cleaner, no investments will be done to really move away from a centralised fossil fuel infrastructure.	If IT tools are used to launch and support integrated renewable energy systems, and if these are used by influential companies such as architects and construction companies, this could enable a creation of both national and international rules to support sustainable energy solutions. If traditional power companies use IT tools to launch renewables as a marginalised power option and use the profits to invest further in fossil fuel extraction (as is the case today by many power companies) this will spur further high-carbon lock-in.
Better broadband and connectivity available to enable telework will support videoconferencing (which also requires the same infrastructure). If telephone companies do not ensure the availability of sufficient bandwidth and related services to provide proper support for telework and videoconferencing, these services will become marginalised and high-carbon services more popular.	Less use of cars and air travel will reduce the need for not just the vehicles needed (cars and airplanes) but also the related infrastructure such as factories to build the vehicles, roads, fuel extraction and so on. If governments and employers fail to support the spread of these new services to allow them to be used with proper regulations and incentive structures in place, powerful lobby groups could work against this transition in self-interest.
More intelligent transport systems make it easier for people to use flexible ways of communication, from bikes to electric plug-in cars in car pools. If only poor parts of a population will use the system, most new research and product development will focus on those who are not using the public transport.	With more people engaged in public transport and significant resources invested in the interest of those who are using it, the better institutionalised public transport will become. Rules and regulations will support a move towards more resource efficient societies. If the transition is not happening in dialogue with traditional vested interests, such as the car lobby, these groups could begin campaigning against public transport.

THE FIRST BILLIO

VIRTUAL MEETINGS: ONE OF THE SOLUTIONS THAT WILL REDUCE ONE BILLION TONNE



SERVICE FEEDBACK

HIGH Unless remote workers and those conducting virtual meetings are properly connected, the level of complication will hamper a continued spread.

LOW The more people who become tele-workers and telecommute the more socially acceptable it will become, services are also bound to be improved as more people are connected and better equipment installed.

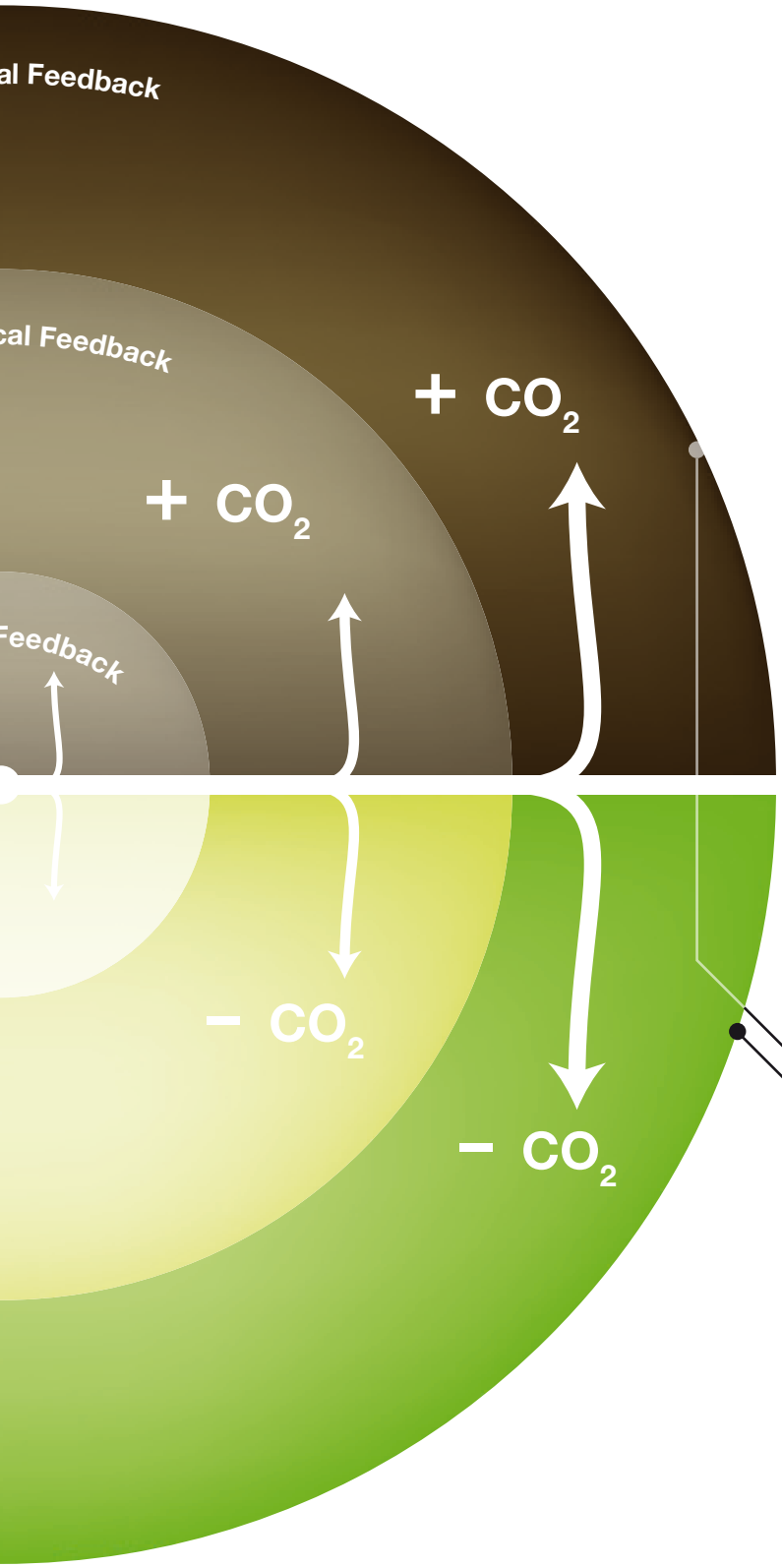
TECHNOLOGICAL FEEDBACK

HIGH If telephone companies do not ensure the availability of sufficient bandwidth and related services to provide proper support for tele-work and videoconferencing, these services will become marginalised and high-carbon services more popular.

LOW Better broadband and connectivity available to enable tele-work will support videoconferencing (which also requires the same infrastructure).

N TONNES OF CO_2

S OF CO_2 AND BEGIN **THE TRANSFORMATION TOWARDS A LOW-CARBON SOCIETY**



HIGH-Carbon Feedback

Solutions that will strengthen structures that support increased emissions.

INSTITUTIONAL FEEDBACK

HIGH If governments and employers fail to support the spread of these new services to allow them to be used with proper regulations and incentive structures in place, powerful lobby groups could work against this transition in self-interest.

LOW Less use of cars and air travel will reduce the need for not just the vehicles needed (cars and airplanes) but also the related infrastructure such as factories to build the vehicles, roads, fuel extraction and so on.

LOW-Carbon Feedback

Solutions that not only reduce CO_2 directly when they are used, but also strengthen structures that support further emission reductions.

"This era won't be about efficiency – although there are still lots of gains to be made there – but about increasing revenues and inventing entirely new businesses. [...] Transitioning to a low-carbon economy will require new ways to generate power, run our cars, grow our food, and design, build, heat and cool our homes and offices."

Fortune, April 2nd 2007

THE WORLD **IS CHANGING**

IN ONLY A few years, the discussions about climate change and use of natural resources have changed both focus and arenas. Scenarios from all major institutions and experts point towards disaster if the emerging economies continue on the same development path as the West. With China and India emerging as two of the world's leading economies in the coming decades, the responsibility to support a sustainable development falls hard on the developed world exporting their "solutions" and lifestyles. The good news is that things are changing.

Only ten years ago most climate discussions took place among a few environmental groups, government officials representing the Ministry of Environment and within the academic community. The language was technical and the emphasis was on uncertainties. Today, we see a different picture. The need to find low-carbon solutions is being explored everywhere from articles in lifestyle and business magazines to financial and economic legislation. Still there is more talk than action, but the understanding that action is needed is widespread and the willingness to use investment, innovation, profit, and legal frameworks as drivers for new sustainable solutions has probably never been greater.

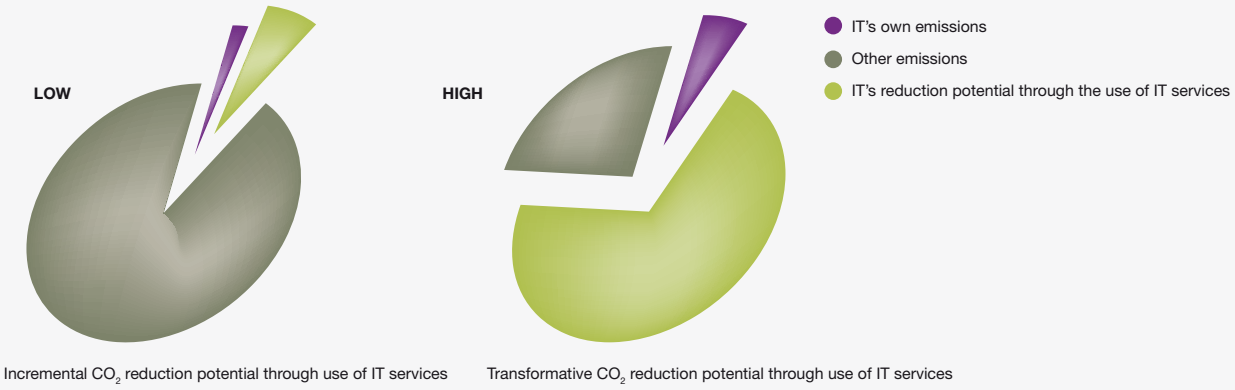
Even if we know what the problem is, and what the solutions are, the question of how to get there still remains. A transition to a low-carbon and resource efficient economy will not be simple, no "obvious" choices are readily at hand and the dominating reactive approach to reduce emissions on the margin will not enable us to reach reductions of the scales that are needed. The approach to the climate and resource challenge has to be one of transformative change. While the reductions needed might sound daunting to achieve within current systems, it is rather a change of thinking that is needed than anything else.

A shift from Academia to Business

In the past, most discussions regarding our global climate were focused on the scale of impact if emissions continued to increase. Gradually, however, the scope of the challenge became evident and groups like the re-insurance community started to calculate the impacts of the consequences from a monetary perspective.[19] The shift away from an environmental perspective to an economic perspective made the business community start to open its eyes to an evident future and progressive actors started thinking about how to incorporate it into corporate strategies, despite uncertainties.

The early academic language that was used did not reach a general public and the media's overall polarised way of reporting made the climate challenge seem much debated and questioned in a way that it was not. This created a general disbelief and questioning amongst a large number of policy makers and the public. Over the last few years, however, the focus has shifted. Numbers are being presented more easily, solutions highlighted and business involved. The work with IPCC's fourth assessment report, and studies such as the Stern Review on the Economics of Climate Change, triggered a number of studies and activity amongst the business community.

FROM INCREMENTAL TO TRANSFORMATIVE REDUCTION POTENTIAL WITH LOW-CARBON FEEDBACK[20]



Incremental CO_2 reduction potential through use of IT services

Transformative CO_2 reduction potential through use of IT services

These days the question is not if climate change will impact business, but how much and in what way.[21]

Whilst most companies and governments still have a very long way to go, environmental groups and scientists are no longer alone, alongside a few government representatives, to get the general public to understand how important the climate challenge is. While there is still room for further education, a growing number of people, especially business leaders and government representatives are looking for suggestions for ways forward.

A shift from West to East

One of the major trends, that will become even more key over the coming years, is a shift in focus from OECD countries to the emerging economies – particularly China and India.

Every year 2,000,000,000 m^2 of new building space is added in China.[22] In twenty years time, the country's cities and towns are expected to absorb about 300 million more people from rural areas.[23] This is equivalent to the entire US population or more than twice the population of Japan to be moving into cities. Looking an additional twenty years ahead, India, which has 10 of the 30 fastest growing urban areas in the world, will have about the equivalent of the entire population of Europe move into its cities – 700 million people – if current trends continue.[24]

Already the trend is evident when the winners and losers amongst the largest companies on the planet are listed depending on country of origin – Western companies dominate the losers and emerging economies dominate the winners.[25] All this suggests a new geographic lens must be added to fully explore opportunities of implementing IT solutions to reduce CO_2 emissions. A shift from problems in Western societies and previous urban development, to solutions in the emerging economies in the East will prove pivotal in achieving the necessary transformative change.

From Incremental to transformative

A third changing perspective that is shaping the climate discourse is the growing understanding of the need to move beyond incremental changes to achieve transformative change.[26] This implies inevitable clashes between old and new stakeholders, as well as a new legislative approach. It also requires new and innovative business constellations.

In the short term, IT solutions can contribute to making current systems more efficient and reduce resource consumption through the so called "dematerialisation" of goods.[27] To deliver sufficient emissions reductions however, a linear thinking within existing systems aiming only at "low hanging fruits", would not allow IT solutions to contribute to a low-carbon economy in the way it can. With a focus on transformative changes it becomes obvious that IT can help to transform the very infrastructure, incentive structure and even values in today's society.[28]

"China is now the world's fourth largest economy and growing very fast. India's economic salience is also on the rise. Together these two countries will profoundly influence the pace and nature of global economic change."

Dancing with Giants: China, India and the Global Economy, World Bank, 2007

RE-FOCUS FOR **THE FUTURE**

THERE IS MUCH that can and must be done when it comes to sustainable IT solutions. Implementing a joint strategy to focus on strategic IT solutions that can deliver low-carbon feedback is probably among the most important things. To support solutions that can provide low-carbon feedback there are a number of flanking measures that are necessary.

Four areas in need of a re-focus

ACADEMIA

Re-focus from ad-hoc studies to a common methodology and transparent numbers

Over the next few years there will most certainly be a number of studies exploring the possibilities of reducing greenhouse gases with IT solutions. On the one hand new and innovative studies should be encouraged, but long-term it is also important to establish methodology standards that can be followed to ensure that the different studies can build on each other's findings.

In many studies the level of transparency rigor and the complexity of calculation and analysis are kept relatively low as no standards exist. To ensure higher quality and the possibility for different research to build on earlier work the following should be considered:[29]

- Elaborated and clear definitions of key concepts
- Addressing double counting problems due to the fact that the impact of some applications may overlap with the impact of others
- Include transparent calculation methods, clear target years and uncertainties
- Discuss both the direct, indirect and systemic impacts of IT as well as their potential rebound effects
- Discuss the IT service contribution to low- or high-carbon feedback. Plus also divide this feedback into service, technological and institutional feedback.

GOVERNMENTS

Re-focus legislation and regulations from problems with IT's own emissions to opportunities that low-carbon IT solutions can provide

The challenge for most governments is to identify a place within the government where policies that focus on the opportunities can be coordinated and a sustainable e-strategy can be overseen. Progressive governments could set three goals:

- IT will be recognised as an important part of the solution for combating climate change
- Key players within the government will have a climate change strategy for IT
- Concrete "IT Climate change programmes" that focus on the 98% window of opportunity will be initiated

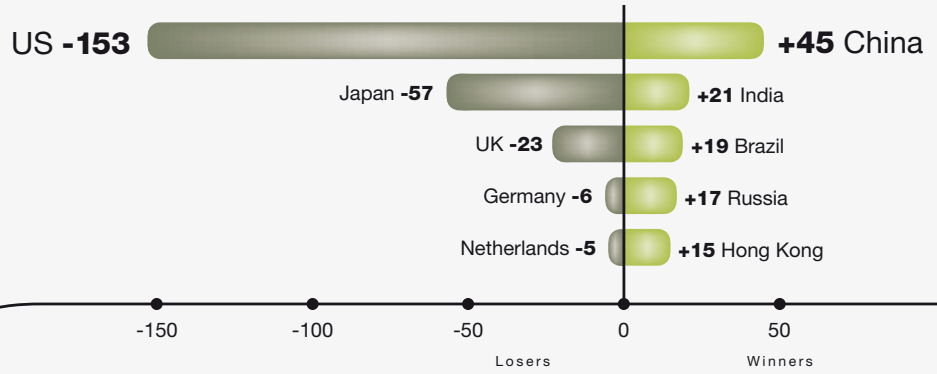
Leading governmental organisations should explore opportunities to exchange ideas. Bodies like ITU and OECD could play an important role in coordinating efforts to ensure that different methodologies and definitions are standardised on a global level in a way that make comparison between studies possible.

BUSINESS

Re-focus from incremental improvements and the purchasing of 'IT products' to transformative change and buying 'low-carbon services'

WINNERS AND LOSERS

Gain/loss in companies 2004 vs. 2008, Forbes global 2000 companies[30]



IT generates new solutions that allow for existing needs to be met in completely new ways, and these new environmentally friendly solutions should be encouraged. Procurements and contracts should be reviewed, both generally and especially in particularly relevant areas, since this change in perspective will cause the focus to shift from physical space and products to the web and services.

It is important to go as far back as possible in the value chain. For example, once a building is built there are only a limited amount of measures that are possible to improve design features like energy efficiency, optimal lighting and so on. Going all the way back to the software that is used to design the buildings or even city planning allows for much more significant improvements if services instead of products are in focus.

Using a transformative and service perspective instead of an incremental and product perspective will result in investment shifts of different kinds, e.g. shifting perspective from 'travel' to 'meetings' could result in a shift from 'airplanes' to 'videoconferencing equipment'. A shift in perspective from 'office work with a fixed amount of hours' to 'delivery of results' could result in a shift from 'office space' to 'laptops' and IT solutions that allow people to work wherever they are, as long as they can deliver.

A shift away from looking at 'constructing buildings' to 'provide smart living' could result in a shift from 'cement and coal' to 'servers and smart appliances' so that people instead get the right services, such as comfortable in-door temperature, adequate light, and delivery of fresh air in the most resource efficient way.

ALL

Re-focus geographical priorities

So far, all studies around the possibility of IT reducing carbon emissions are almost exclusively focused on OECD countries. For the US, EU and Japan there are now a significant number of studies. The almost total lack of work in the emerging economies is an indicator of the current inability of the developed world to think and act globally. Too much activity is still driven by short-term concerns and funding constraints.

The need to include emerging economies is obvious as:

- The reference scenario of EIA's world energy outlook projects that between 2005 and 2030 almost 50% of the increase in world primary energy demand will come from China and India alone
- The dramatic changes occurring in developing countries offer the opportunity to leapfrog the "CO_2-heavy IT-poor solutions" in use in the OECD and instead implement innovative IT technologies that can provide the same or better service with much lower energy use and CO_2 emissions

In developing countries, public policies or corporate strategies that do not consider the opportunities offered by modern IT to reduce CO_2 emissions, and instead pursue approaches based on copycatting the CO_2-intensive development patterns of Western countries, will squander an historic opportunity unless a re-focus happens soon.

THREE LAWS FOR GREEN

As we need to move forward to implementation and action it might be worth remembering Sir Isaac Newton and his three laws of m
The three "laws" are meant as reminders of some fundamental

§1 *THE FIRST LAW: Sustainable IT solutions need to be purposely used for CO_2 reductions to take place*

"Every object in a state of uniform motion tends to remain in that state of motion unless an external force is applied to it."

No change will take place unless people actually start to use sustainable IT solutions. A force is needed to set something in motion and governments must ensure that they use IT solutions to pursue CO_2 reductions and not just talk about them. Companies, in turn, need to ask for these solutions and effectively use sustainable IT if they are to be part of the solution and not the problem when it comes to combating climate change and creating a successful low-carbon economy.

§2 *THE SECOND LAW: The amount of support that is needed to implement sustainable IT solutions depends on how much old companies and policy makers are obstructing necessary change (due to fear of losing influence and money)*

"The relationship between an object's mass m, its acceleration a, and the applied force F is F = ma."

A society heavily influenced by companies that do not want to see anything beyond incremental change (as they see the transition to a low-carbon economy as a threat) becomes more resistant to change. These companies can become a very powerful force against sustainable IT for transformative change. The more conservative a system is, the more structural support for sustainable IT solutions will be needed. Demonstrating use and the creation of structures to support low-carbon solutions in society will be critical to make these forces move. In order to achieve substantial CO_2 reductions with IT, a critical mass of stakeholders to push these solutions forward must be created to balance out heavy influence from old and opposing stakeholders.

otion. In this section, these laws have been used to illustrate a rough guide outlining a way forward for Green IT in the 21st century. issues that all too often get lost in today's "Green IT" debate.[31]

§3 *THE THIRD LAW: For each IT solution used, there is a counter effect that can either strengthen or weaken the momentum towards a low-carbon society*

"For every action there is an equal and opposite reaction."

In order to ensure accelerated reductions of CO_2 emissions, those IT solutions that enable further reductions are the most important to implement. To treat IT solutions as if they exist in a vacuum is not realistic when engaging in discussions on solutions for climate change. All climate policies and strategies implemented by governments and companies must include a thorough assessment of feedback effects.

Endnotes

[1] The full report "The potential global CO_2 emission reductions from ICT use: identifying and assessing the opportunities to reduce the first billion tonnes of CO_2 emissions" can be downloaded from www.panda.org/ict

[2] The concept "carbon feedback" is detailed in a separate section in this paper.

[3] Already we are seeing several examples of leadership:
- The Government in Japan has produced a report about ICT and climate change: http://www.itu.int/dms_pub/itu-t/oth/06/0F/T060F0060080004PDFE.pdf
- The European Commission will explore how to promote the use of ICT to improve energy efficiency starting with buildings, lighting and the power grid: http://europa.eu/rapid/pressReleasesAction.do?reference=IP/08/733&format=HTML&aged=0&language=EN&guiLanguage=en
- The World Economic Forum in Davos 2008 promoted an initiative where IT companies show leadership, showcase innovative technologies, provide the solutions needed and clarify what others can do to support this development to realise the potential of sustainable IT use:
http://pamlin.net/blog/2008/01/historic-event-in-davos-when-world.html
- HP, one of the world's leading IT companies, is publishing the world's first customer catalogue with low-carbon IT solutions.

[4] See for example http://www.itu.int/themes/climate/, http://www.euractiv.com/en/infosociety/eu-plans-mandatory-energy-efficiency-standards-ict/article-170472, www.pamlin.net/written/documents/Contribution%20of%20ICT-%20detailed%20paper.pdf

[5] http://www.gartner.com/it/page.jsp?id=503867

[6] In presentations and material WWF has for example used the "98% window of opportunity" as a way to highlight the "other part". The Gartner study also inspired the joint project between WWF and Gartner where leading IT companies' climate performance is measured, both with regards to the 2% and the contribution to reductions of the 98%.

[7] This terminology was developed in the work with GRI and the sector reporting guidelines for the telecom sector where WWF participated. These are similar to 1st Order (direct result of its existence), 2nd Order (Applications of IT that reduce or increase environmental impacts) and 3rd Order (long-term socio-economic structural changes that impact the energy productivity).

[8] For a more detailed discussion on IT's own emissions and the 98% window of opportunity see WWF's paper "From fossil to future with innovative ICT solutions", available for download on www.panda.org/ict.

[9] http://assets.panda.org/downloads/road_map_speed_of_light_wwf_etno.pdf

[10] Presentation in Las Vegas during Gartner Expo April, 2008

[11] Recent reports indicate that most models, especially economic ones, seem to be able to identify efficiency effects better than dematerialisation effects. The reason is probably that energy efficiency often happens within the system, so that incremental improvements can be calculated using linear models, compared to disruptive changes that shift how the service is provided between sectors and technologies.

[12] Examples would include changes in commuting distances and times due to potential mobile communication, access to information and the speed of technological development.

[13] At a glance, the systemic effects are often small and difficult to trace to individual services, but increased use of a certain solution when seen over time, will in many cases show that systemic effects are the most important.

[14] This paper has not attempted to give a quantitative estimation of the systemic effects, but it focuses on solutions which are strategic and can help accelerated reductions of CO_2 emissions.

[15] Obvious examples include IT solutions that reduce the need for travel and increase productivity, which is beneficial in most cases. However, when these solutions are used to open up and explore new oil fields, they instead become part of the problem and not the overall solution.

[16] The "green" examples describe scenarios that would contribute to a low-carbon feedback, whereas the "brown" examples describe scenarios that would contribute to a high-carbon feedback.

[17] For more details see the WWF report: "The potential global CO_2 emission reductions from ICT use: identifying and assessing the opportunities to reduce the first billion tonnes of CO_2 emissions".

[18] The "green" examples describe scenarios that would contribute to a low-carbon feedback, whereas the "brown" examples describe scenarios that would contribute to a high-carbon feedback.

[19] http://www.munichre.com/en/ts/geo_risks/climate_change_and_insurance/the_economic_sector_and_climate_change/default.aspx

[20] For a more detailed discussion on IT's potential through transformative change vs. incremental reductions through energy efficiency, see WWF's paper "From fossil to future with innovative ICT solutions", available for download on www.panda.org/ict.

[21] "It's hard to argue anymore with the proposition that greenhouse gas emissions are causing the Earth to become dangerously warm. The debate is virtually over. What policy makers and businesses are focusing on now is how to rectify the problem." wrote Ronald Henkoff, Editor of Bloomberg Markets, in the December 2007 issue.
"Moral and economic pressures have become intertwined" was also written in a special report on business and climate change in The Economist on June 2nd 2007.
It is interesting to note that not much changed with regard to the available facts between 1988, when the climate meeting in Toronto was held and a target for 20% reduction in greenhouse gas emissions by 2005 was set by people that few took notice of (even if this was the first global conference and many participating at that time felt that it brought the issue to the very top of the global agenda), and 2007 (when those highlighting climate change, IPCC and Al Gore, were rewarded the Nobel Peace prize).

[22] WEO 2007, p. 283

[23] http://www.chinadaily.com.cn/china/2006-03/21/content_547967.htm

[24] http://business.guardian.co.uk/story/0,,2002796,00.html
Note that it is Europe not EU that this refer to: http://en.wikipedia.org/wiki/Demographics_of_Europe

[25] http://www.forbes.com/2008/04/02/worlds-largest-companies-biz-2000global08-cx_sd_0402global_land.html

[26] http://www.ipsnews.net/news.asp?idnews=39922

[27] Dematerialisation refers to the absolute or relative reduction in the quantity of materials required to serve economic functions in society.

[28] http://www.leonardo-energy.org/drupal/book/export/html/2321

[29] For more details see the WWF report: "The potential global CO_2 emission reductions from ICT use: identifying and assessing the opportunities to reduce the first billion tonnes of CO_2 emissions".

[30] http://www.forbes.com/2008/04/02/worlds-largest-companies-biz-2000global08-cx_sd_0402global_land.html

[31] For specific recommendations regarding the ten solutions see the WWF report: "The potential global CO_2 emission reductions from ICT use: identifying and assessing the opportunities to reduce the first billion tonnes of CO_2 emissions".

IT for transformative change with the first billion tonnes of strategic CO_2 reductions

www.panda.org/ict

This paper is based on WWF's work with IT/ICT, particularly a joint initiative with HP where the key objective is to identify the first billion tonnes of CO_2 reductions through the use of IT. The paper is also a contribution to the collaboration between WWF and the World Economic Forum. The ten solutions in this paper come from "The potential global CO_2 emission reductions from ICT use: identifying and assessing the opportunities to reduce the first billion tonnes of CO_2 emissions", the first global study with the aim to identify strategic IT solutions that can deliver one billion tonnes of CO_2 reductions. The text is written by Dennis Pamlin, Global Policy Advisor, WWF and Suzanne Pahlman, Strategy and Innovation Consultant (www.spahlman.com).

WWF is the world's largest and most experienced independent conservation organisation, with almost 5 million supporters and a global network active in more than 90 countries.

WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by:
- conserving the world's biological diversity
- ensuring that the use of renewable natural resources is sustainable
- promoting the reduction of pollution and wasteful consumption.

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For further information about WWF's work please contact:

Dennis Pamlin,
Global Policy Advisor,
dennis.pamlin@wwf.se