

# DIGITAL GREEN REVOLU- TION



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## ABSTRACT

While technology has impaired mankind and the environment for many centuries, it is today's digital technology and ICT systems that can solve the climate crisis. Change is necessary not only to preserve our environment but also to maintain the economic and financial system that businesses and global commerce depends on. Through a host of different technologies this change can be facilitated by creating sustainable solutions for the future. Dematerialization and use of the Cloud through digital devices eliminates waste and increases efficiency, thus drastically reducing the carbon footprint. Intelligent processes and energy leverage technology to create an efficient and transparent flow of energy from utilities to appliances, monitoring and controlling themselves for efficiency and sustainability. Sustainable practices need to be at the core of every business and government to maintain the environment and the economy for future generations.

## INTRODUCTION

Can the technology that has alienated us from nature bring us back in harmony with it?

Today we use a computer almost every day, whether you use it to write an essay, go on Facebook or develop software. It makes our life easier by providing us with efficient mechanisms of communication, problem solving, task management, creation - a virtual extension of our human capabilities. As such it has become an increasingly important asset to be able to use and manage. The computer and its corresponding digital technology makes not only us more efficient in what we do, but also enables us to be more efficient, careful, and responsible with the resources around us. On the other hand, nature with all its resources has existed before mankind, and is also the base of our existence. Living in harmony with nature by using resources responsibly is not only desirable but crucial for mankind's prolonged existence. This is evident in climate change and every sustainability initiative. Managing nature's limited resources and digital technology goes hand in hand, and as we master both we live in the prospects of harmony.

## THE ENVIRONMENT

In a recent trend the environment has seen a resurgence as more institutions and governments start to see its significance on future health, business, economics and the general living conditions of the future. It is therefore essential to understand how mankind has created the current environment and how to eliminate today's environmental problems.

### HISTORICALLY

Environmental issues date back to ancient civilizations. Ancient Rome already faced problems of air pollution caused by the rise of industry. However, many ancient religions show a strong emphasis on the connection to nature and compassion for all beings. Especially Greek philosophers such as Aristotle and Indian religions put nature in the center of their ideologies. Also, managing resources such as timber posed a major contribution to the rise and fall of ancient civilizations. As a result, deforestation plagued many of these civilizations.

Throughout the next millennia up to our present time many environmental issues gain and lose momentum, but the state of our ecosystem continually worsens with the introduction of new industries and technologies, and an ever growing world population. Only after serious effects on the environment does an awakening take place that calls for reform. In the middle ages the first public health system is established after the devastating effects of the plague in Europe. Water and air pollution remain at the center of environmental hazards for centuries. The continual introduction of new technologies such as coal plants, leaded gasoline, chemical plants and nuclear plants keep creating new hazards. It takes until the 1970s that the Environmental Protection Agency and the United Nations Environmental Program are created, which pave the way for cleaner air and water.

Most of the environmental issues created throughout history are still visible today. Earth's environment is a limited resource and the effects of the ozone depletion for example, will still last many decades. Similarly the source of climate change is the cumulative sum of many different kinds of environmental pollution conducted throughout the years.

## SUSTAINABILITY

In order to live in harmony with nature, without destroying the environment and depleting natural resources, mankind's actions have to be sustainable. Sustainability means that the resources we use in order to carry out any given task are used responsibly with respect to the environment and nature itself. Renewable energy is a great example of a sustainable resource, usually referring to energy harvested from the sun, wind, or water, but actually applies to any resource where the inputs and outputs can be sustained.



The unsustainable and also most used resource today is fossil fuel. It comes in many forms such as oil and coal and powers most cars, heats homes and generates electricity. During the industrial revolution oil and coal were the drivers behind much of the techno-

logical progress that shaped industries and mass production to where they are today. It is also the main cause of climate change through the release of CO<sub>2</sub>.

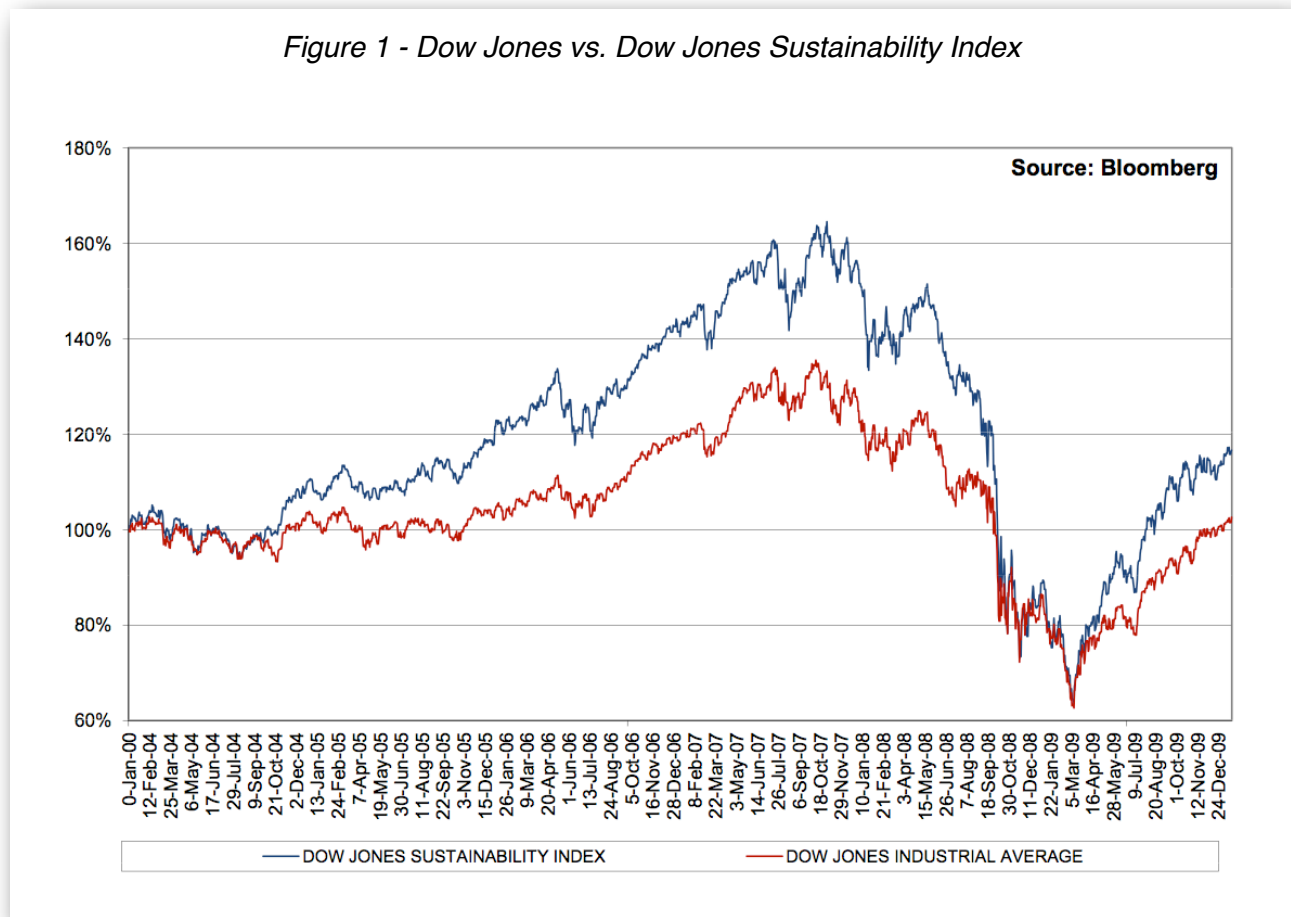
Energy creation is only one side of the story, namely the inputs, but the processes and products (the outputs) that are created using these resources are equally important. Inefficiencies and waste creation must be eliminated to create sustainability. The 'Cradle to Cradle' model developed by William McDonough & Michael Braungart is important to understand the significance of inefficiencies and waste. According to the model a products life-cycle should be such that at the end the product can be recycled into other products of the same quality or be reused in the same quality as the originating product. For example a glass bottle can be reused for the same product of same quality. It can also be recycled into another product with a glass component of same quality. However, a bottle made from regular plastic cannot be reused or recycled for a product of same quality. Plastic is 'down-cycled' into products of lower quality or mostly not recycled at all. There are reservoirs of plastic waste all over the world, sometimes in the shape of underground dumping, waste hill or island.

Inefficiencies in using resources is as crucial as avoiding waste to achieve sustainability. Using inefficient outdated technology or processes in production leads to more expenses and the deterioration of competitive advantages. For example, more efficient technologies and methods for harvesting increases a farmers production and also reduces costs. Using advanced computing systems can enable products better developed with longer life-cycle.

By being more efficient and creating less waste companies also have an economic incentive in addition to being more environmentally friendly. A simple comparison of the Dow Jones Industrial Average with the Dow Jones Sustainability Index (DJSI) shows that companies embracing sustainable practices have constantly outperformed their not sustain-

able counterparts for the past decade, as shown in Figure 1. The DJSI is based on SAMs internationally recognized assessment methodology and has been identified as the most accurate sustainability measurement. This highlights that companies acting in favor of the environment help the planet and are also more profitable while doing so.

Figure 1 - Dow Jones vs. Dow Jones Sustainability Index



Ignoring these signs for sustainability and the warnings for climate change will lead to less economic performance but also, for the industry as a whole, quickly outweigh the costs of sustainability. It is estimated that a loss of 5% of annual GDP can be accounted to the costs and risks of climate change if the warnings for reductions carbon emissions are ignored.<sup>1</sup>

<sup>1</sup> The Climate Group p.12, Lovins

## TECHNOLOGY

For a long time technology and the environment have been on opposite ends of the spectrum. As outlined, technology has caused an ever changing array of environmental pollutants as byproducts. Since the introduction of the first electronic computer in the 1940s and the transistor in the 1950s the utility of computers has exponentially increased while requiring fewer and fewer resources. The computer was intended to store and process data faster and in ways not possible by mankind. And with such mission the first computers had their purpose as wartime devices to aid ballistic calculations and crack military code. It took until the 1980s for development on semiconductors and the start of the rise of the personal computer. With the start of the Internet and the widespread use of computers at the end of the 20th century and the beginning of the 21st the amount of information available to mankind is unprecedented. With this new flow of information and tools and services that are available to every user it becomes easier to communicate, share and work together on common goals by being virtually connected. Also new digital technology creates more efficient ways to organize and process data and simplify many aspects of our lives.<sup>2</sup>

Digital technology has created the virtual space, in which some find an extension to their physical life, while others are able to be someone they don't dare in the physical world. However, the virtual space has also created an environment that is used everyday to the advantage of the physical environment. In this virtual environment we write letters without using paper and ink, send them without requiring a parcel service, and make calculations without knowing mathematics. By doing this we protect the environment every day and are more efficient than their physical counterpart.

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<sup>2</sup> Butler

## THE REVOLUTION

Initiatives such as the Kyoto Protocol, Europe 2020 and the UNEP have already sparked change towards a sustainable future. Using and leveraging digital technology this spark can be transformed into a revolution. Revolutionizing and rethinking the way we do things today will bring the results necessary to sustain our climate and our economy. In the future it will be even more important for a business to pursue sustainable practices because of a growing consciousness for nature's environment, increasing competition of firms that do leverage more efficient sustainable practices and increasing stakeholder pressure. It will not be enough to make money, but to make money while using as little resources as possible. This will maximize profits because it means efficiency comes first but also because the cost of producing the same amount of waste and consumption of fossil fuels will dramatically increase.

It is estimated that by leveraging the ICT sector savings in green house gas emissions can be achieved equal to 5 times the total footprint of the ICT sector, or in other words a 15% decrease in total emissions. This reduction comes from technologies directly impacting emissions such as 'smart motor-systems', 'smart logistics', 'smart buildings', and 'smart grids'.<sup>3</sup> Additionally there are other industries and processes indirectly affected by the use of ICT that can reduce emissions. The Stern Review predicts that the failure to act immediately can cause irreversible economic conditions comparable to the great depression of the first half of the 20th century.<sup>4</sup>

Some countries and political leaders have already taken this information seriously and indicated change for the future. The European Union has committed to a 20% reduction of

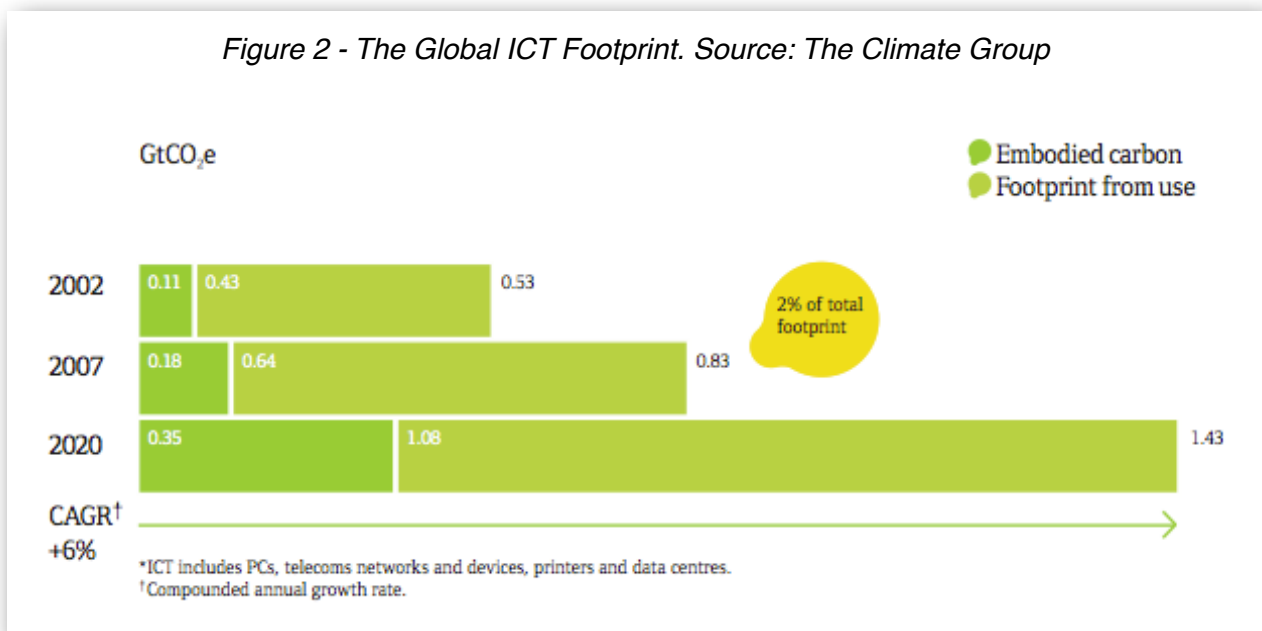
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<sup>3</sup> The Climate Group

<sup>4</sup> Stern

emissions compared to 1990 levels by the year 2020 <sup>5</sup>, while Germany targets 40% by 2020. The UK has targeted a reduction of 60% by the year 2050. Norway aims to be carbon-neutral by then. California has committed to reduction of 80% of emissions by 2050. Governments around the world are becoming aware of the implications of climate change and are increasing their pressure on businesses to reduce emissions.<sup>6</sup>

Although the environmental impact of sending an email is only a fraction of sending a letter through a parcel service, it is still relevant to consider the impact of the information and communication technology (ICT) industry.



As shown in Figure 2 from research conducted by The Climate Group in 2008, the global footprint of ICT represents 2% of the total global footprint. As growth and adoption of digital technologies in developed countries is increasing and more and more people world wide enter the digital age, the ICT footprint will increase. This is due to new and cheaper devices entering the markets of undeveloped countries, and at the same time a

<sup>5</sup> EU Spring Summit 2007

<sup>6</sup> The Climate Group

growing proportion of the population that is able to afford ICT devices. For this reason, the estimated increase in emissions for the US and Canada is at 20% of 2007 levels. At the same time this is estimated to be increasing by 102% for undeveloped countries and by 117% for China alone. However, this rapid adoption of digital technology in undeveloped countries also signifies the entry of technology that is more efficient and versatile than manual machinery that will be replaced by their digital counterparts.

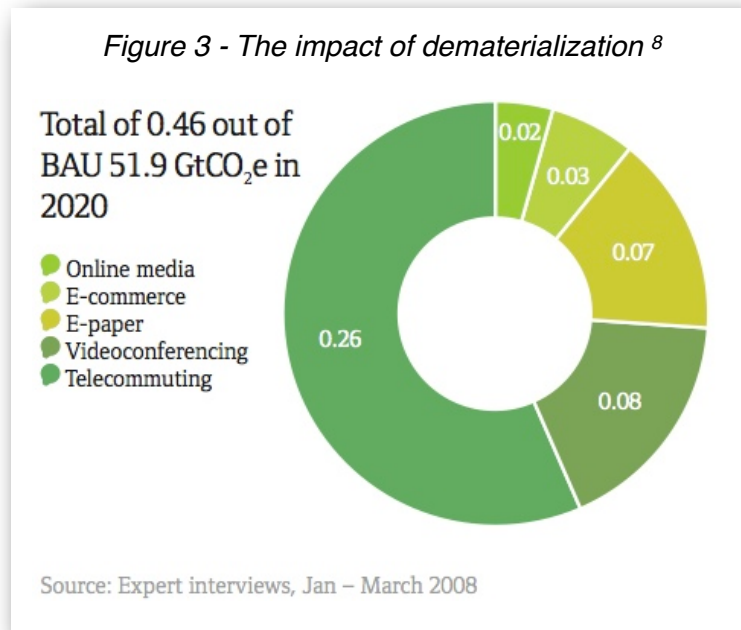
The Australian Information Industry Association (AIIA) predicts that the utilization of smart ICT would benefit the Australian economy by boosting it with \$35 to \$80 billion, create 70,000 jobs and cut Australia's carbon footprint by one fifth annually.<sup>7</sup> By now it should be clear that the ICT's involvement in solving the climate and economic crises is mandatory. The following sections will analyze the technologies that can revolutionize the way we do things today and bring the necessary change.

## DEMATERIALIZATION AND THE CLOUD

Dematerialization refers to the ability of ICT to replace material goods and processes, and similarly, cloud computing enables the user to replace local ICT with access to centralized ICT. A simple example is the email versus traditional mail comparison. The email is delivered electronically in an instant, does not require transport and generates no waste. The development of new ICT devices that enable us to interact with technology in many ways also creates new ways of dematerialization.

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<sup>7</sup> AIIA



Based on historic trends, Figure 3 shows the impact dematerialization can have and what technologies are used. The emission reductions possible almost equal the total emissions of Australia in 2005. However, these numbers reflect the low adoption of dematerialization techniques such as the ‘paperless’ office and video conferencing in the past, and therefore might be overshadowed by a quicker adoption of technologies in the future. Telecommuting, which represents the single biggest reduction, saves time and resources used to commute by working from home. Today’s digital home in developed countries is more than capable of extending the office through broadband internet connections. Videoconferencing replaces business meetings and 5-20% of business travel.<sup>8</sup> Other technologies that replace paper and commerce depend heavily on their adoption rates. Devices such as the iPad have seen numerous applications for them to replace books, textbooks, magazines, restaurant menus, and more. The iPad’s intuitive use has attracted big firms like amazon and start ups like Kno to create new offerings such as textbook rentals for students. Given the iPad’s many different applications to replace and dematerialize various

<sup>8</sup> The Climate Group, p.31

traditional products and processes the potential benefits in efficiency, including waste and less resources, the resulting reductions in emissions and the ability to replace a multitude of products and processes with one device, showcases the possibilities of digital technology. With the continuous introduction of new technology on the software level, which can be used without the production and merchandise of a new physical product, more efficient products and processes can be created efficiently. Several companies have shown that the distribution channels of the future are digital. Google has recently launched a new service that easily lets up to 10 people vide chat for free.<sup>9</sup> Apples has released it's latest operating system exclusively through it's digital distribution channel and saved the equivalent of over 1 million DVDs worth of emissions within 24 hours.<sup>10</sup> Considering that most customers also did not have to commute to their local Apple Store, digital distribution shows far reaching benefits for the environment.

On the other hand, cloud computing can be seen as the dematerialization of ICT department. As a study by Accenture suggests, the reductions possible through increased efficiency can be particularly dramatic for small businesses. Cloud-based applications can in these cases reduce the amount of CO<sub>2</sub> by more then 90%, as seen in Figure 4.<sup>11</sup> Microsoft has compared their on-premise solutions, comprised of their software and the corresponding hardware necessary to run a particular service, with Microsoft's own cloud-based solution, which essentially is access their data centers.

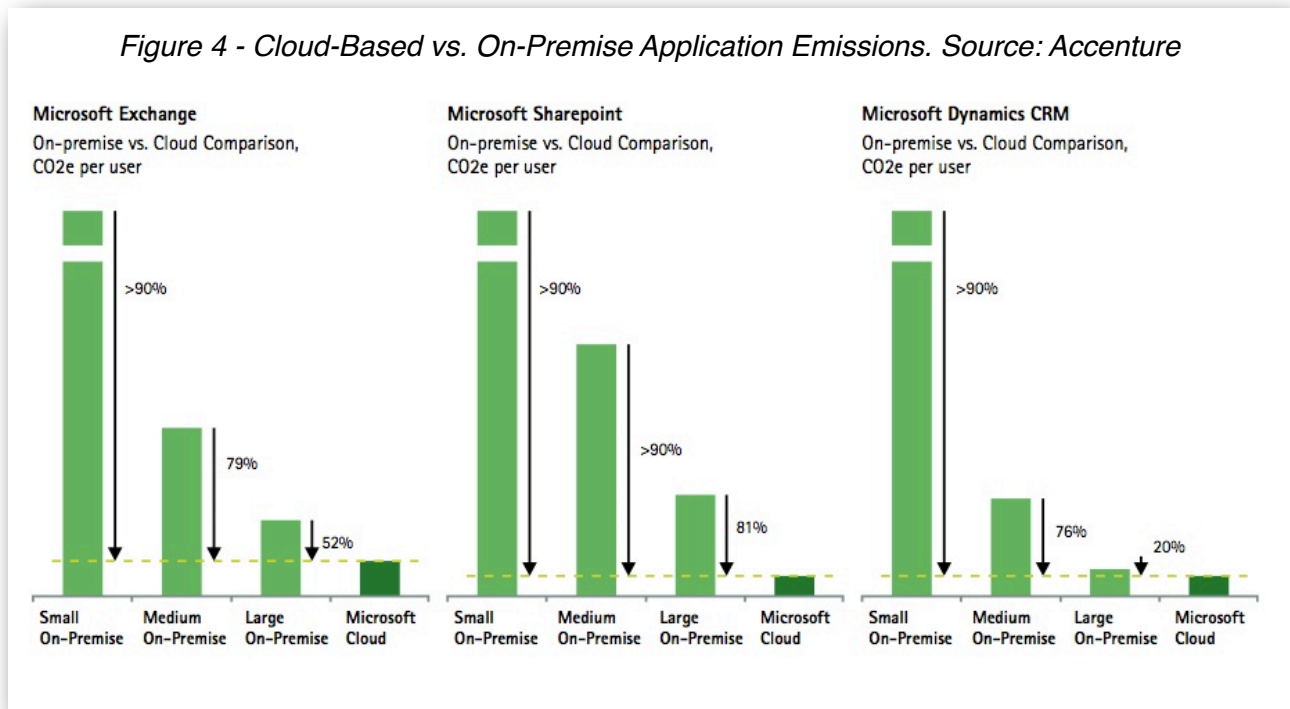
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<sup>9</sup> Google Hangouts, [plus.google.com](https://plus.google.com)

<sup>10</sup> Apple Inc. [www.apple.com/pr/](http://www.apple.com/pr/)

<sup>11</sup> Accenture

Figure 4 - Cloud-Based vs. On-Premise Application Emissions. Source: Accenture



By nature data centers are more efficient, since they allow a very high and permanent rate of utilization, compared to on-premise solutions that are utilized only locally. Taking an individual car versus mass transportation is a nice analogy for this. While a reduction in emissions of more than 90% is possible for small businesses with, on average, less than 100 employees, the possible reductions for large enterprises with more than 10,000 employees is still significant with reductions in the 30-60% range.

### INTELLIGENT PROCESSES

The next step is to rethink today's processes, make them use, waste, and take up less energy to create. How can a data center itself become more efficient while providing the same benefits to its users. The Open Compute Project was the first of its kind to radically rethink the way servers are used today and managed to create the world's most energy efficient data center. What started out of the basement of the Facebook headquarters has become an open project shared with the world. Open Compute's specifications are available

freely and can revolutionize every data to achieve a 1.07 energy efficiency, which means that 93% of the energy from the grid makes it into the data center.<sup>12</sup> The EPA has released information showing that the energy efficiency of US data centers is on average 1.91. This is a significant boost in unnecessary energy used for lighting, cooling and other related devices<sup>13</sup>. Microsoft's Chief Environmental Strategist, Rob Bernard, even suggested that cooling a data center at all might be unnecessary, since it is not meant to be 'comfortable to walk in'.<sup>14</sup>

In 2002 industrial processes as a whole amounted to 23% of total emissions, one of the largest contributors<sup>15</sup>. Revolutionizing data centers is one process amongst many, and as such, companies are finding new ways to leverage digital technology and rethink existing industrial processes. Hewlett-Packard (HP) has announced a new suite of services to help businesses do just that. HP's Energy and Sustainability Management suits offers customers an integrated view of their business, deriving from consulting services, workshops and partnerships to HP's technical expertise, resulting in a 'holistic corporate sustainability initiative'.<sup>16</sup>

'Smart' motor systems, products from careful analysis and improved by ICT, are great examples of the possibilities of intelligent processes. Motors are at the core of most industrial processes and like data centers, they operate at full capacity. By utilizing intelligent ICT, these motors can be made 'smart', automatically reducing the capacity when not needed. A dramatic cut in power consumption and insight into the efficiency of operations are the result. Wireless communication technologies can create a network of 'smart' de-

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<sup>12</sup> Open Compute Project, [opencompute.org/about](http://opencompute.org/about)

<sup>13</sup> EPA

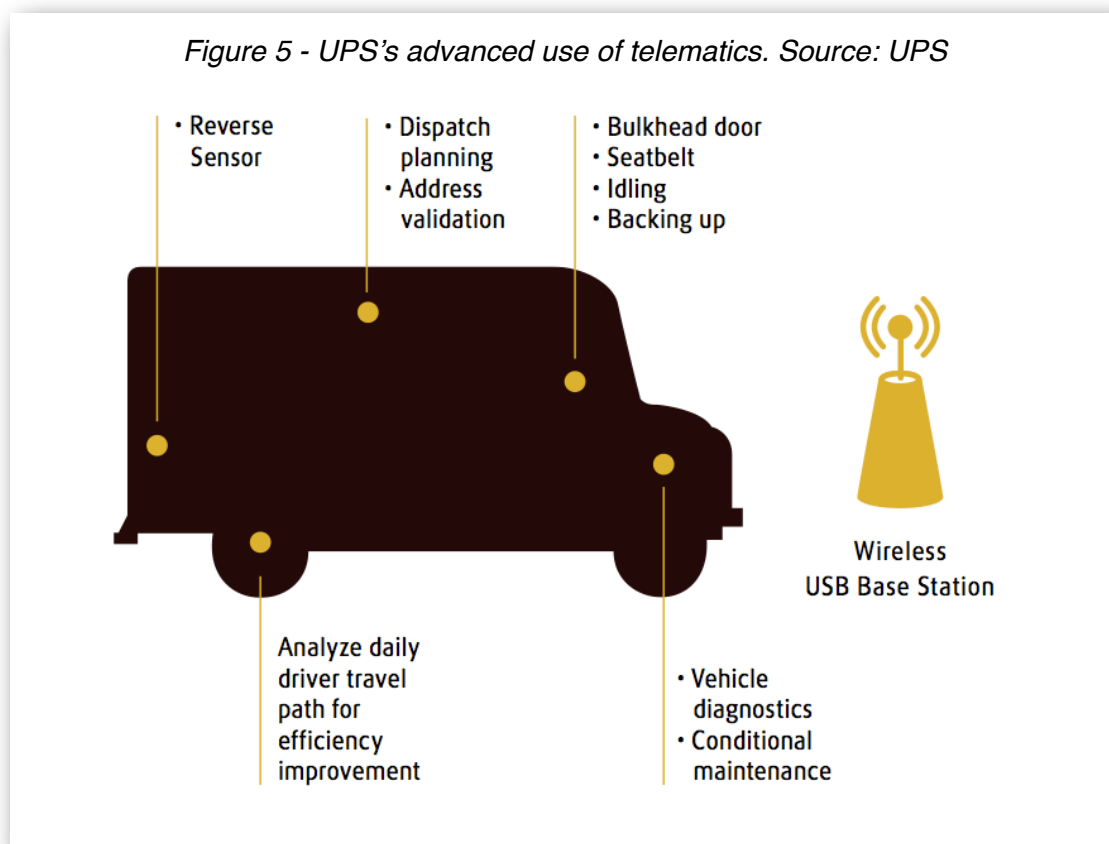
<sup>14</sup> Wheeland: Microsoft

<sup>15</sup> The Climate Group

<sup>16</sup> Wheeland: HP

vices that can not only automatically turn on and off devices not in use, or reduce their power, but also generate direct control over costs. Costs thought of as fixed can become variable costs.<sup>17</sup>

Making today's processes 'intelligent' can be achieved in virtually any industry. UPS, one of the world biggest logistics companies, has contributed extensively, making itself an example of what is possible through intelligent processes and the pursue of sustainability. Scott Wicker, the Chief Sustainability Officer of UPS, oversees \$50 billion worth of sustainability strategy and practices. He is the latest example of large corporations taking sustainability to the highest level.<sup>18</sup> FORTUNE magazine has ranked UPS number 1 in 'Social Responsibility in the world.' UPS employs ICT and software to calculate the most efficient routes for it's telematics equipped fleet of almost 25,000 vehicles. As Figure 5 shows, ad-



<sup>17</sup> The Climate Group

<sup>18</sup> Aston

vanced use of telematics enables the collection of vehicle data and GPS coordinates, giving UPS more information of driver and vehicle. Analyzing this data lets UPS not only choose the most efficient routes with the least amount of breaking, left turns, and least mileage, but also lets the company give informations to drivers on how to drive most efficiently, allocating different drivers based on their behavior on different routes. As a result in 2010 the telematics equipped fleet saved 260,000 gallons from eliminating idling time and 1.8 million miles, which translates into total carbon savings of more than 3,500 metric tones of CO<sub>2</sub>.<sup>19</sup>

In a different approach, Delhi, India, based company Digital Green educates farmers through short videos of new techniques and sustainable measures. By teaching and equipping farmers with video cameras and screening them in local environments, over 16,000 farmers have been able to participate and learn, spreading sustainable practices across farms. Without the technology, none of this would be possible.

In Germany alone, the gains from utilizing intelligent processes and therefore also reducing industrial waste is estimated at 100 billion euro annually.<sup>20</sup>

## INTELLIGENT ENERGY

In contrast to intelligent processes, intelligent energy focuses on the use of the energy itself and not the process that it powers. In combination with ICT hardware and software, energy use can be monitored and transformed from a one way channel from the power supplier to the end user into a two way channel that enables communication between the two, ultimately making energy 'intelligent'. Two of the most promising applications of intelligent energy are 'smart grids' and 'smart buildings'.

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<sup>19</sup> UPS

<sup>20</sup> WirtschaftsWoche

According to The Climate Group, the power sector accounted for 24% of total global emissions in 2002. In 2020, the smart grid could create substantial savings of almost 15% of estimated emissions. Both Europe and the US have shown government participation in creating a common standard, merging technology and regulation, through their *SmartGrid* and *The Modern Grid* initiatives, respectively, to achieve widespread adoption of smart grid technologies<sup>21</sup>.

Devices such as smart meters that allow the user to see not only how much electricity he is consuming but also which applications, and at what time, consume the electricity. Dynamic feedback in appliances such as refrigerators will automatically reduce their electricity consumption in peak and off-peak times or even shut down during unused hours, saving costs for the end user and making the use of energy more efficient. The power suppliers also benefit from less wasted electricity and a transparent consumption pattern, enabling better power distribution and elimination of inefficiencies. In a study conducted by IBM and the Pacific Northwest National Laboratory, utilizing and leveraging only existing technology, reductions in total home energy consumption of 15% and a 10% reduction on electricity bills was achieved.<sup>22</sup> The smart grid is also particularly important in undeveloped countries with poorer infrastructure, such as India, where up to 57% of total emissions stem from the power sector. It is estimated that in 2007 32% of India's electricity generation was lost due to a lack of transparency and inefficiencies.<sup>23</sup>

IBM and Cisco have launched two prominent initiatives leveraging their ICT expertise. IBM's *Intelligent Utility Network Solution* provides technology and sophisticated analytics to

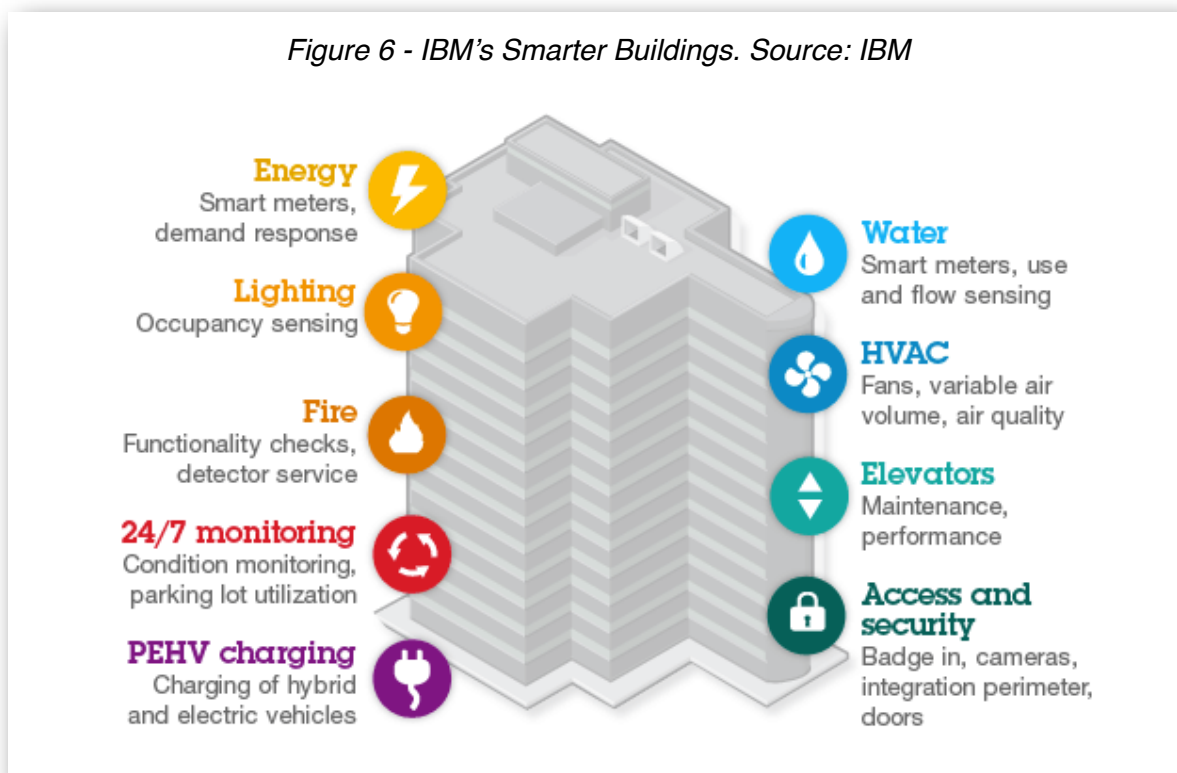
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<sup>21, 21</sup> The Climate Group, p.47

<sup>22</sup> IBM: Pacific Northwest National Laboratory

utilities to make their energy grid 'intelligent'.<sup>24</sup> Cisco's *EnergyWise* platform on the other hand leverages existing Cisco infrastructures, as seen in many corporations and large companies, and adds a layer of transparency that enables monitoring, measuring and managing the way devices consume energy on the network.<sup>25</sup>

Similar to the smart grid, smarter buildings focus on reducing the carbon footprint by becoming more energy efficient, adapting to the environment and being more transparent from creation to utilization. By using sensors and control systems every aspect of a building can be monitored and analyzed, as seen in Figure 6. For example gathering data from the weather forecast can automatically adjust the cooling or heating systems of a smart building in a pre-emptive action.<sup>26</sup>



<sup>24</sup> IBM Intelligent Utility Network Solution, [www.ibm.com/smarterplanet](http://www.ibm.com/smarterplanet)

<sup>25</sup> Cisco

<sup>26</sup> IBM Green Buildings, [www.ibm.com/smarterplanet](http://www.ibm.com/smarterplanet)

In the Netherlands a new housing development project has started using these technologies to create energy-neutral homes and apartments equipped with solar panels and intelligent energy ICT. This allows the homes not only to take advantage of the smart grid but also gives them multiple energy sources. According to preference the home can source from the cheapest or from the most sustainable source of energy. The aim of this project, to see how people will use smart buildings, shows that whether it be for economic or environmental reasons are the future.<sup>27</sup>

In an effort to facilitate this change companies such as EnOcean are creating the sensors necessary for monitoring and analyzing. EnOcean has created self-powered wireless technology that can be implemented in devices to make the energy flow transparent and also make the process of doing so energy efficient as possible with the exclusive use of solar panels and thermal converters.<sup>28</sup>

An estimated \$295 billion could be captured from energy savings by utilizing only minimum energy efficiencies standards in new and existing homes globally. At the same time \$45 billion can be saved in carbon costs. As fossil fuel prices increase in the future intelligent energy practices will become more and more valuable, fueling the change towards ICT enabled smart grids and smart buildings.

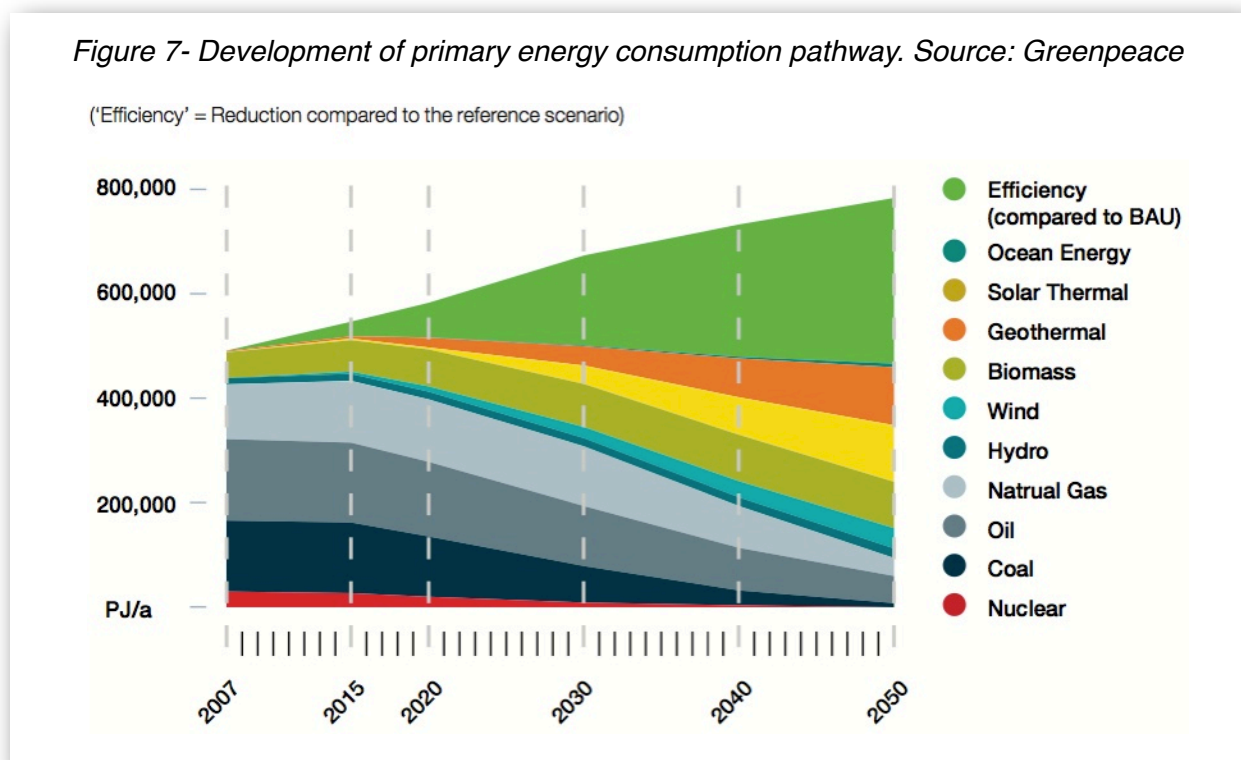
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<sup>27</sup> Lombardi

<sup>28</sup> EnOcean, [www.enocean.com/en/company-profile](http://www.enocean.com/en/company-profile)

## THE FUTURE AND BEYOND

Technology has revolutionized the way mankind lives, engages, travels, works and prospers countless times, however, usually at the cost of the environment and the planet that we inhabit. Today's generations carry this burden and today's generations will be the ones that need to show the necessary change. Today's technology can show us how to achieve the necessary change. Nano technology research promises a 10 fold increase in capacity of batteries through lithium air technology. Better batteries will create better electric cars that are less fossil fuel dependent as they can be charged from numerous sources of electricity.<sup>29</sup> Greenpeace has created a pathway, shown in Figure 7, in collaboration with international specialists that shows how the global energy consumption can be shifted away from fossil fuels and reducing CO<sub>2</sub> emissions while maintaining energy security.<sup>30</sup>



<sup>29</sup> IBM: Battery 500 Project

<sup>30</sup> Greenpeace

Digital technology has enabled us to see the change that is necessary to maintain the environment and solve the economic crisis. Mankind's inability to act could have drastic and irreversible consequences. As the world moves on and we go on about our daily tasks, it is essential that stop for a second and rethink whether this process is at its best, whether the environmental impacts simply occurs out of our reach, and whether doing this is worth it at all. It is up to the individual, whether he adopts the digital technological inventions, advancements and changes that enable sustainability, and transforms them into a revolution.

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