Sustainability

Chapter 2 in Alänge, S. & Lundqvist, M. eds. (2014) *Sustainable Business Development: Frameworks for Idea Evaluation and Cases of Realized Ideas*. Chalmers University Press, Gothenburg ISBN 978-91-87463-03-7

2 SUSTAINABILITY

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This chapter derives our current understandings of the concept of Sustainability. Sustainability has only recently been clearly linked to business development. Its history dates back to the Sixties and is today largely affected by concerns about climate change. The aim of this chapter is to introduce you to the concept of Sustainability and give it sufficient background for you to subsequently explore the promises of sustainable business development.

TOWARDS A FOCUS ON SUSTAINABILITY

In the first decades of the 21st Century it seems that a common understanding is evolving among scientists, industrialists and politicians about the need for the world to deeply consider sustainability. However, from this to potent political action on a global scale seems still to be a step to dream about, as indicated by the watered-down summit texts from the recent UN conferences on sustainability in Copenhagen 2009, Cancún 2010, Durban 2011, Doha 2012 and Warsaw 2013.

However, there are actions taken by individual companies both to act as a good citizen and increasingly also to develop 'green' business opportunities, there are customer groups creating new sustainable demand, and there are legal systems being modified (e.g. the use of energy-wasting traditional lamp-bulbs is being banned in the EU). But of course, there have been important steps taken by pioneers much earlier. And more recently the strength of the movements towards a sustainable perspective has been greatly reinforced by the fact that many strong opinion-builders in industry, among researchers, politicians and in media have joined. First, we will look back to some important input, starting in the 1960s and rapidly moving towards the end of the 1980s until now.

WHAT HAS INFLUENCED PUTTING THE ISSUE OF SUSTAINABILITY ON THE AGENDA?

Rachel Carson's (1962) book '**Silent Spring'**, proposing that DDT could cause cancer in humans, made a strong impression on many individuals and started a debate concerning modern society's negative impact on nature. The realization arose that scientific/technological developments that had been seen as valuable for humanity also had negative impacts on humans, such as mercury to protect seeds and DDT to fight mosquitoes carrying malaria. She was not alone; there were others who actively discussed the future of the globe from a sustainability perspective, including Georg Borgström who in the 1950-60s pointed at the **Earth's biological limitations** (e.g. Borgström 1965). In 1973 the British economist E.F. Schumacher published an influential collection of essays called **Small Is Beautiful: Economics As If People Mattered**, which focused on decentralization and small-scale production as a way of satisfying both human and ecological needs.

The Club of Rome published in 1972 a book by a group of MIT researchers titled **The Limits to Growth** (Meadows et al. 1972). Based on a system dynamics model, the MIT researchers concluded that

> "If the present growth trends in world population, industrialization, pollution, food production, and resource depletion continue unchanged, **the limits to growth** on this planet **will be reached** sometime within the next one hundred years. The most probable result will be a rather sudden and uncontrollable decline in both population and industrial capacity." However, they also added that "**It is possible to alter these growth trends** and to **establish** a condition of **ecological and economic stability that is sustainable** far into the future. The state of global equilibrium could be designed so that the basic material needs of each person on earth are satisfied and each person has an equal opportunity to realize his individual human potential". (Abstract of The Limits to Growth, compiled by Eduard Pestel)

This book provided an important input into the debate about whether the modern economic model has a limit or not. The researchers' argument that in any closed system, such as the Earth, exponential growth is impossible without sooner or later collapsing, was supported by computer generated "stunning graphs, (of) what our fate was to be if we did not slow down" (Bishop 2006). The MIT team has since continued by publishing two more books providing additional data to support their argument of unsustainability, introducing the concept of **'overshoot'**, which means that we first exceed the limits, using up our resources in order to sustain growth, followed by collapse when there are no resources left, even to sustain on the previous levels (Meadows et al. 1992, 2002). In their most recent book they also utilize the 1990s concept '**ecological footprint'** (see Wackernagel & Rees, 1998) in order to make their point concerning overuse of resources by human civilization as compared to the carrying capacity of the planet. The ecological footprint is defined as the land (and water) area that would be required to support a defined human population and material standard indefinitely.

In 1972, on a Swedish initiative, the **first UN Conference on the Human Environment** was held in Stockholm. One major result was the Stockholm declaration with 26 common principles "to inspire and guide people of the world in the preservation and enhancement of the human environment" (UN 1972). Principle 1 stated that:

> "Man has the fundamental right to freedom, equality and adequate conditions of life, in an environment of a quality that permits a life of dignity and well-being, and he

> bears a solemn responsibility to protect and improve the environment for present and future generations. In this respect, policies promoting or perpetuating apartheid, racial segregation, discrimination, colonial and other forms of oppression and foreign domination stand condemned and must be eliminated."

Another important principle was no. 21 that has become a basic legal principle for international cooperation concerning environmental issues crossing national borders:

> "States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction."

Other outcomes of this first UN conference were an action plan for continued international environmental cooperation and the establishment of the UNEP (United Nations Environment Program). However, although being an important early step, the impact on international cooperation concerning global environmental issues was limited in practice.

Hence, the starting point for the modern sustainability movement can be traced back to the more recent UN **Brundtland Commission's** (1987) report 'Our Common Future'. The following quote from the report, *"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"*, has been widely spread and has influenced the definition and direction of the sustainability movement. Another important statement in the report was that "*Humanity has the ability to make development sustainable".*

On a global scale the UN has been an organizing actor for other important landmarks in the development towards sustainability through a series of UN conferences.

- The **Rio Conference** in 1992 stated that "Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature." In connection with this conference, also the Agenda 21 was launched as an action program. While most program points were societal, there was also one section on improvement of industry, covering the "improvement of production systems through technologies and processes that utilize resources more efficiently and at the same time produce less wastes" However, it was also a short comment on the need for innovation and entrepreneurship: "Similarly, facilitating and encouraging inventiveness, competitiveness and voluntary initiatives are necessary for stimulating more varied, efficient and effective options." One program area suggested the support of 'Responsible Entrepreneurship', by encouraging the concept of stewardship in the management and utilization of natural resources by entrepreneurs, and by increasing the number of entrepreneurs engaged in enterprises that subscribe to and implement sustainable development policies. The rationale was that:

  > "Entrepreneurship is one of the most important driving forces for innovations, increasing market efficiencies and responding to challenges and opportunities. Small and medium-sized entrepreneurs, in particular, play a very important role in the social and economic development of a country. Often, they are the major means for rural development, increasing off-farm employment and providing the transitional means for improving the livelihoods of women. Responsible entrepreneurship can play a major role in improving the efficiency of resource use, reducing risks and hazards, minimizing wastes and safeguarding environmental qualities." (Agenda 21, 30.17)

- The **Kyoto Protocol** from 1997 provides a means for establishing environmental goals that individual countries can agree upon to follow. By November 2009 there were 189 countries that had ratified and followed the Kyoto protocol – although the world's major polluters, China and the USA, were not among them. The Kyoto protocol also introduced the Clean Development Mechanism (CDM) which stimulates sustainable development and emission reductions, by letting an industrialized country implement emission-reduction projects in developing countries and earn saleable certified emission reduction credits, each equivalent to one tonne of CO_2, which can be counted towards meeting the Kyoto targets. For example, a CDM project activity might involve a rural electrification project using solar panels.

- The **Johannesburg World Summit on Sustainable Development** in 2002 was one further step of developing the consciousness in the international community. The understanding of sustainable development was broadened and strengthened as a result of the Summit, particularly the important linkages between poverty, the environment and the use of natural resources. Governments agreed to and reaffirmed a wide range of concrete commitments and targets for action to achieve more effective implementation of sustainable development objectives. Energy and sanitation issues were critical elements of the negotiations and outcomes to a greater degree than in previous international meetings on sustainable development. One contribution to this conference from Chalmers was a paper by Christian Azar and John Holmberg analyzing what happens when a national economy gets richer. They found that some common sustainability-related issues are taken care of through self-organization in local communities, e.g. water and sanitation. Other sustainability issues, however, get worse when a community becomes better off, such as polluting the environment through increased CO2 emissions, due to a tendency to buy more and larger cars.

- The UN **'Intergovernmental Panel on Climate Change'** (IPCC) in 2007 was a major initiative to involve a very large number of scientists from many countries for the purpose of reviewing and assessing the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change. Thousands of scientists contributed on a voluntary basis; one of them was Chalmers professor Christian Azar. IPCC published its very influential report on climate change in 2007 and was also rewarded with the Nobel Peace Prize that year. In this report it was made clear that human activities during the past 150 years have had major impact on climate change and estimations were made of future impact if no action is taken (see further below).

- In 2009 there were high hopes for a global agreement on limiting environmental impact during the UN **Climate Change Conference in Copenhagen** in December 2009. The immediate result was, however, very meagre as the world's two major polluters, China and the USA, were reluctant to put their signatures on a document and make major commitments.

- The UN **Climate Change Summit in Cancún 2010** aimed to reach an agreement on a global level. However, at the conference there was a clear divide between rich and poor

countries and a threat that even countries who have signed the Kyoto Protocol would leave it, because some of the major polluters have still not signed the accord, such as China, India and the US. After considerable disagreement, the conference ended in a compromise agreement which makes the next step, the UN Climate Change Summit in Durban in 2011, even more challenging. However, for the first time, the Cancún Agreement commits both rich and developing nations to curbing greenhouse gas emissions. There is also an agreement on establishing a Green Climate Fund to provide financial aid to poorer countries for their contributions to remedy climate change.

- The UN **Climate Change Conference in Durban 2011** did not succeed to reach a global agreement on how to limit the impact on nature, but an agreement, the **Durban platform**, including **all countries** was reached to start **a process of developing a legally binding agreement**, which should be prepared by 2015 and is supposed to **take effect in 2020**. This means that the time-table to get all countries in the world involved in taking active measures has been postponed for 8 years, which according to Stern (2006) will substantially increase global costs to remedy climate effects. According to Rockström (2011) this delay will most probably result in a substantial increase in the Earth's global average temperature – instead of the Kyoto Protocol goal of a maximum increase of 2 degrees, this might result in somewhere between 3-4 degrees, which might have devastating effects on the global economy. One reason that no immediate step could be taken to include all countries in a developed version of the Kyoto Protocol was that the conference was characterized by a divide between the industrialized countries and the large rapidly industrializing countries. China, India and Brazil were of the opinion that the industrialized countries should limit their emissions immediately while they as industrializing countries should be allowed to increase their emissions in order to develop their economies further before they assume a more strict control of their emission increase. The Kyoto Protocol, which terminates in 2013, was further weakened by Canada making a decision to leave the agreement. However, until 2020 the EU countries keep their goal of lowering the CO_2 emissions by 20%. Another outcome of the conference was the launching of the **Green Climate Fund** to provide support to **developing countries** to limit or reduce their greenhouse gas emissions and to adapt to the impacts of climate change. The goal for the fund is to distribute US$ 100 billion per year.

- In the **2012** UN **Climate Change Conference in Doha** no agreement seemed possible. However, the delegates continued negotiating after the planned closure of the conference and an agreement was reached to **extend** the life of the **Kyoto Protocol**, which had been due to expire at the end of 2012, **until 2020**. The conference also **reified the 2011 Durban Platform**, i.e. the process of developing a successor the Kyoto Protocol. Another step forward was the 'Loss and Damage mechanism' that regulates richer nations' financial responsibility for damage in developing countries, caused by the richer nations' failure to reduce carbon emissions and thus contributing to climate change.

- The main contribution of the **2013** UN **Climate Change Conference in Warsaw** was a decision to establish an international branch (the Warsaw mechanism) to help poorer

countries deal with **loss and damage** caused by extreme weather events and slow onset events such as rising sea levels (UN 2013). The conference was otherwise characterized by substantial disagreements between participants and difficulties in reaching agreements on how to proceed towards a global agreement scheduled for 2015 in Paris. The Warsaw conference concluded, by urging individual nations to take steps towards the climate goal of limiting the temperature increase to 2 degrees above the current levels and to bring their experiences and transparent plans to the table ahead of the planned Paris conference.

Hurricane Katrina in 2005 destroyed large parts of New Orleans and raised the awareness of climate change, not least because of intensive coverage on television. Other major natural catastrophes, e.g. the South Asian floods in 2007, also contributed to a growing awareness that the climate might have changed.

Former vice president Al Gore's 'An Inconvenient Truth: The planetary emergency of global warming and what we can do about it', published in 2006, also received considerable media coverage in combination with Gore's intensive touring the world to deliver his message. His work to raise the awareness of global warming provided him with the Nobel Peace Prize in 2007, shared with the UN IPCC.

In 2006 the **Stern Review on the Economics of Climate Change** was presented by the economist Nicholas Stern for the UK government. This became a very important document because it quantified the impact of climate change and it pointed at the economic rationale for changing now instead of in many years to come. According to Stern:

> ***There is still time to avoid the worst impacts of climate change, if we take strong action now.*** The scientific evidence is now overwhelming: climate change is a serious global threat, and it demands an urgent global response. … Hundreds of millions of people could suffer hunger, water shortages and coastal flooding as the world warms. Using the results from formal economic models, the Review estimates that if we don't act, the **overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year, now and forever.** If a wider range of risks and impacts is taken into account, the estimates of **damage could rise to 20% of GDP or more**. **In contrast, the costs of action** – reducing greenhouse gas emissions to avoid the worst impacts of climate change – **can be limited to around 1% of global GDP each year.**
>
> The investment that takes place in the next 10-20 years will have a profound effect on the climate in the second half of this century and in the next. Our actions now and over the coming decades could create risks of major disruption to economic and social activity, on a scale similar to those associated with the great wars and the economic depression of the first half of the 20th century. And it will be difficult or impossible to reverse these changes. … Because climate change is a global problem, the response to it must be international.
>
> ***The costs of stabilising the climate are significant but manageable; delay would be dangerous and much more costly.*** The risks of the worst impacts of climate change can be substantially reduced if greenhouse gas levels in the atmosphere can be stabilised between 450 and 550 ppm CO2 equivalent (CO2e). …This is a major challenge, but sustained long-term action can achieve it at costs that are low in comparison to the risks of inaction. Central estimates of the annual costs of achieving stabilisation between 500 and 550 ppm CO2e are around 1% of global GDP, if we start to take strong action now."

In June 2008 Nicholas Stern increased the estimate of cost to reduce the CO_2 to 2% of GDP to account for faster than expected climate change. Stern's quantifications supplemented earlier indicator-based argumentation and helped politicians to realize its importance by pointing directly to the effects on economic development.

So what were the major findings from the **UN (2007) 'Intergovernmental Panel on Climate Change' (IPCC)** that was published one year after the Stern Review and was the result of input from more than 1,000 scientists around the world?

Observed changes in climate and their effects

Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level.

Observational evidence[1] from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases. {1.2}

Global GHG emissions due to human activities have grown since pre-industrial times, with an increase of 70% between 1970 and 2004 (Figure SPM.3).[5] {2.1}

Carbon dioxide (CO_2) is the most important anthropogenic GHG. Its annual emissions grew by about 80% between 1970 and 2004. The long-term trend of declining CO_2 emissions per unit of energy supplied reversed after 2000. {2.1}

Global atmospheric concentrations of CO_2, methane (CH_4) and nitrous oxide (N_2O) have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years. {2.2}

Advances since the TAR (Third Assessment Report) **show that discernible human influences extend beyond average temperature to other aspects of climate.** {2.4}

Human influences have: {2.4} *very likely* contributed to sea level rise during the latter half of the 20th century; *likely* contributed to changes in wind patterns, affecting extra-tropical storm tracks and temperature patterns; *likely* increased temperatures of extreme hot nights, cold nights and cold days; *more likely than not* increased risk of heat waves, areas affected by drought since the 1970s and frequency of heavy precipitation events.

There is high agreement and much evidence that with current climate change mitigation policies and related sustainable development practices, global GHG emissions will continue to grow over the next few decades. {3.1}

The IPCC Special Report on Emissions Scenarios (SRES, 2000) projects an increase of global GHG emissions by 25 to 90% (CO_2-eq) between 2000 and 2030 (Figure SPM.5), with fossil fuels maintaining their dominant position in the global energy mix to 2030 and beyond. More recent scenarios without additional emissions mitigation are comparable in range.[8,9] {3.1}

Continued GHG emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century (Table SPM.1, Figure SPM.5). {3.2.1}

There is high confidence that neither adaptation nor mitigation alone can avoid all climate change impacts; however, they can complement each other and together can significantly reduce the risks of climate change. {5.3}

Risks to unique and threatened systems. There is new and stronger evidence of observed impacts of climate change on unique and vulnerable systems (such as polar and high mountain communities and ecosystems), with increasing levels of adverse impacts as temperatures increase further. An increasing risk of species extinction and coral reef damage is projected with higher confidence than in the TAR as warming proceeds. There is *medium confidence* that approximately 20 to 30% of plant and animal species assessed so far are *likely* to be at increased risk of extinction if increases in global average temperature exceed 1.5 to 2.5°C over 1980-1999 levels. Confidence has increased that a 1 to 2°C increase in global mean temperature above 1990 levels (about 1.5 to 2.5°C above preindustrial) poses significant risks to many unique and threatened systems including many biodiversity hotspots. Corals are vulnerable to thermal stress and have low adaptive capacity. Increases in sea surface temperature of about 1 to 3°C are projected to result in more frequent coral bleaching events and widespread mortality, unless there is thermal adaptation or acclimatisation by corals. Increasing vulnerability of indigenous communities in the Arctic and small island communities to warming is projected. {5.2}

> **Risks of extreme weather events.** Responses to some recent extreme events reveal higher levels of vulnerability than the TAR. There is now higher confidence in the projected increases in droughts, heat waves and floods, as well as their adverse impacts. {5.2}
>
> **Distribution of impacts and vulnerabilities.** There are sharp differences across regions and those in the weakest economic position are often the most vulnerable to climate change. There is increasing evidence of greater vulnerability of specific groups such as the poor and elderly not only in developing but also in developed countries. Moreover, there is increased evidence that low-latitude and less developed areas generally face greater risk, for example in dry areas and megadeltas. {5.2}
>
> ***Aggregate impacts.*** Compared to the TAR, initial net market-based benefits from climate change are projected to peak at a lower magnitude of warming, while damages would be higher for larger magnitudes of warming. The net costs of impacts of increased warming are projected to increase over time. {5.2}
>
> **Risks of large-scale singularities.** There is high confidence that global warming over many centuries would lead to a sea level rise contribution from thermal expansion alone that is projected to be much larger than observed over the 20th century, with loss of coastal area and associated impacts. There is better understanding than in the TAR that the risk of additional contributions to sea level rise from both the Greenland and possibly Antarctic ice sheets may be larger than projected by ice sheet models and could occur on century time scales. This is because ice dynamical processes seen in recent observations but not fully included in ice sheet models assessed in the AR4 could increase the rate of ice loss. {5.2}
>
> **Many impacts can be reduced, delayed or avoided by mitigation. Mitigation efforts and investments over the next two to three decades will have a large impact on opportunities to achieve lower stabilisation levels. Delayed emission reductions significantly constrain the opportunities to achieve lower stabilisation levels and increase the risk of more severe climate change impacts. {5.3, 5.4, 5.7}**
>
> **There is high agreement and much evidence that all stabilisation levels assessed can be achieved by deployment of a portfolio of technologies that are either currently available or expected to be commercialized in coming decades, assuming appropriate and effective incentives are in place for their development, acquisition, deployment and diffusion and addressing related barriers.** {5.5}

Finally, the IPCC (2007) presents a relatively vague estimate of economic impact, but with estimates of impact on GDP in 2030 and 2050. The main significance of the IPCC (2007) was that the UN and policy makers all over the world now had a report where a large majority of influential scientists had participated and agreed upon climate impact. It also expressed the belief that "many impacts can be reduced, delayed or avoided by mitigation … to achieve lower stabilisation levels".

These reports and conferences were also further reinforced by **media**. In interviews conducted at Swedish large companies in 2004-2007, managers commented that they were aware of the Stern review (2006) and the IPCC (2007), but also that television programs such as the BBC Series "**Planet Earth**" (2006) had made a major impact on their view of sustainability.

In 2013-14, work groups of scientists within the **UN 'Intergovernmental Panel on Climate Change' (IPCC)** have published new data and new analyses of the world situation. Once again scientists have focused on establishing what they can agree upon with high confidence looking at the data from different disciplines and from all continents on Earth. IPCC (2013) to a large extent confirmed the previous report's findings and added further details and confidence to the on-going process of climate change influenced by human activities.

> **Human influence on the climate system is clear**. This is evident from the increasing greenhouse gas concentrations in the atmosphere, positive radiative forcing, observed warming, and understanding of the climate system (2-14).

> Human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea level rise, and in changes in some climate extremes. This evidence for human influence has grown since AR4 (IPCC 2007). It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century. (10.3-10.6, 10.9)
>
> Cumulative emissions of CO_2 largely determine global mean surface warming by the late 21st century and beyond. Most aspects of climate change will persist for many centuries even if emissions of CO_2 are stopped. This represents a substantial multi-century climate change commitment created by past, present and future emissions of CO_2. (12.5)

One major difference in relation to the IPCC (2007) is that the IPCC (2014a) puts a major emphasis on management through adaptation (and mitigation) and that it focuses on risk in order to support decision-making in the context of climate change. It also stresses that people and societies may perceive or rank risks and potential benefits differently, given diverse values and goals. The earlier emphasis on providing firm climate data in order to establish rules and regulation on a global scale has, partly due to the meagre results of recent UN Climate Conferences, been replaced by a belief that national laws and regulation can be important steps forward. The importance of local actors, including companies in the private sector and NGOs, is also emphasized to a larger extent, in comparison to the earlier IPCC (2007).

The IPCC (2014a) summarizes that:

> Human interference with the climate system is occurring and climate change poses risks for human and natural systems. The assessment … evaluates how patterns of **risks and potential benefits** are shifting due to climate change. It considers how impacts and risks related to climate change can be reduced and **managed through adaptation and mitigation**. The report assesses needs, options, opportunities, constraints, resilience, limits, and other aspects associated with adaptation.

The IPCC (2014a) presents the following Principles for Effective Adaptation:

> **Adaptation is place and context specific, with no single approach for reducing risks appropriate across all settings** ***(high confidence).***
>
> **Adaptation planning and implementation can be enhanced through complementary actions across levels, from individuals to governments** ***(high confidence).*** National government can coordinate adaptation efforts of local and subnational governments … Local government and the private sector are increasingly recognized as critical to progress in adaptation, given their roles in scaling up adaptation of communities, households, and civil society and in managing risk information and financing *(medium evidence, high agreement).*
>
> **A first step towards adaptation to future climate change is reducing vulnerability and exposure to present climate variability** ***(high confidence).***
>
> **Adaptation planning and implementation at all levels of governance are contingent on societal values, objectives, and risk perceptions** ***(high confidence).***
>
> **Decision support is most effective when it is sensitive to context and the diversity of decision types, decision processes, and constituencies** ***(robust evidence, high agreement).***
>
> **Existing and emerging economic instruments can foster adaptation by providing incentives for anticipating and reducing impacts** ***(medium confidence).***
>
> **Constraints can interact to impede adaptation planning and implementation** ***(high confidence).***
>
> **Poor planning, overemphasizing short-term outcomes, or failing to sufficiently anticipate consequences can result in maladaptation** ***(medium evidence, high agreement).***
>
> **Limited evidence indicates a gap between global adaptation needs and the funds available for adaptation** ***(medium confidence).***

> **Significant co-benefits, synergies, and tradeoffs exist between mitigation and adaptation and among different adaptation responses; interactions occur both within and across regions** ***(very high confidence).***

The IPCC (2014a) presents the key risks for each continent, the polar regions, small islands and the Ocean followed by adaptation issues & prospects. It also provides an estimate for risk & potential for adaptation for three time frames: present, near-term (2030-2040), and long-term (2080-2100) with two different estimates of temperature increase: 2 and 4 degrees. Here, long-term risk levels even with high level of adaptation seems to become critical if the temperature increases by 4 degrees: for Africa in terms of reduced crop productivity associated with heat and drought stress, for Asia in terms of increased risk of heat-related mortality, for Australasia in terms of composition and structure of coral reef systems, for North America in terms of wildfire-induced loss of ecosystem integrity, and for the Ocean a reduced biodiversity, fishery abundance and coastal protection.

The IPCC (2014b) focuses on mitigation which is defined as "…the human intervention to reduce the sources or enhance the sinks of greenhouse gases". IPCC (2014b) assesses literature on the scientific, technological, environmental, economic and social aspects of mitigation of climate change. It also assesses mitigation options at different level of governance and in different economic sectors, and the societal implications of different mitigation policies, but does not recommend any particular option for mitigation.

> "The ultimate objective … is to achieve … stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."

IPCC (2014b) point out that effective mitigation depends on various factors, including finding ways to deal with issues of justice and fairness, value judgements and ethical considerations, conflicting societal goals, risk and uncertainty:

> **Effective mitigation will not be achieved if individual agents advance their own interests independently.** … **Issues of equity, justice, and fairness arise with respect to mitigation and adaptation**. Countries' past and future contributions to the accumulation of GHGs in the atmosphere are different, and countries also face varying challenges and circumstances, and have different capacities to address mitigation and adaptation. The evidence suggests that outcomes seen as equitable can lead to more effective cooperation.
>
> **Many areas of climate policy making involve value judgements and ethical considerations.** … Social, economic and ethical analyses may be used to inform value judgements and may take into account values of various sorts, including human wellbeing, cultural values and non-human values.
>
> **Climate policy intersects with other societal goals** such as those related to human health, food security, biodiversity, local environmental quality, energy access, livelihoods, and equitable sustainable development, **creating the possibility of co-benefits or adverse side-effects.**
>
> **Climate policy may be informed by a consideration of a diverse array of risks and uncertainties, some of which are difficult to measure.** … **The design of climate policy is influenced by how individuals and organizations perceive risks and uncertainties and take them into account.** People often utilize simplified decision rules such as a preference for the status quo. Individuals and organizations differ in their degree of risk aversion and the relative importance placed on near-term versus long-term ramifications of specific actions.

However, IPCC (2014b) points out what will happen without any mitigation and what is needed in terms of changes in energy systems and land use in order to keep the temperature increase to less than 2°C, and also highlights the urgency of not delaying mitigation efforts:

> **Without additional efforts to reduce GHG emissions beyond those in place today, emissions growth is expected to persist driven by growth in global population and economic activities. Baseline scenarios, those without additional mitigation, result in global mean surface temperature increases in 2100 from 3.7 to 4.8°C compared to pre-industrial levels.** *(high confidence)*
>
> **Mitigation scenarios in which it is likely that the temperature change caused by anthropogenic GHG emissions can be kept to less than 2°C relative to pre-industrial levels are characterized by atmospheric concentrations in 2100 of about 450 ppm CO2eq** *(high confidence).*
>
> **Scenarios reaching atmospheric concentration levels of about 450 ppm CO2eq by 2100 (consistent with a likely chance to keep temperature change below 2°C relative to pre-industrial levels) include substantial cuts in anthropogenic GHG emissions by mid-century through large-scale changes in energy systems and potentially land use** *(high confidence).*
>
> **Delaying mitigation efforts beyond those in place today through 2030 is estimated to substantially increase the difficulty of the transition to low longer-term emissions levels and narrow the range of options consistent with maintaining temperature change below 2°C relative to pre-industrial levels** *(high confidence).*

The IPCC (2014b) states that both efficiency enhancements and behavioral changes are key mitigation strategies. However, a comment is also made about the importance of technology policy as a complement to mitigation, i.e. to stimulate innovation through either publicly funded R&D or procurement. In line with IPCC (2014a) the report also emphasizes that the private sector can play an important role, adding that it also can take part in financing mitigation efforts.

> **Efficiency enhancements and behavioural changes, in order to reduce energy demand compared to baseline scenarios without compromising development, are a key mitigation strategy in scenarios reaching atmospheric CO2eq concentrations of about 450 or 500 ppm by 2100** (robust evidence, high agreement). Near-term reductions in energy demand are an important element of cost-effective mitigation strategies, provide more flexibility for reducing carbon intensity in the energy supply sector, hedge against related supply-side risks, avoid lock-in to carbon-intensive infrastructures, and are associated with important co-benefits.
>
> **Behaviour, lifestyle and culture have a considerable influence on energy use and associated emissions, with high mitigation potential in some sectors, in particular when complementing technological and structural change** *(medium evidence, medium agreement).* Emissions can be substantially lowered through changes in consumption patterns (e.g., mobility demand and mode, energy use in households, choice of longer-lasting products) and dietary change and reduction in food wastes. A number of options including monetary and non-monetary incentives as well as information measures may facilitate behavioural changes.
>
> **Technology policy complements other mitigation policies** (*high confidence*)**.** Technology policy includes technology-push (e.g., publicly funded R&D) and demand-pull (e.g., governmental procurement programmes).
>
> **In many countries, the private sector plays central roles in the processes that lead to emissions as well as to mitigation.** Within appropriate enabling environments, the private sector, along with the public sector, can play an important role in financing mitigation *(medium evidence, high agreement).*

BUSINESS STRATEGIES FOR SUSTAINABILITY

At least since the Brundtland Commission's (1987) report 'Our Common Future', the issue of sustainability has been on the public agenda, but not always on the corporate agendas. However, what industrial and service firms do 'matters' for sustainability. This can be observed in terms of the *direct* impact of their production processes, including raw materials' use and distribution/transportation of products, as well as the firms' *indirect* influence on the use and later

destruction/recycling of their products in society. In addition, firms as actors in society impact the social domain including health, child labor and social equity.

Inspired by the Brundtland Commission, there have been several attempts to develop approaches to analyze the needs of, and to envision strategies towards, a future sustainable society. Several sustainability approaches have focused on the societal level, e.g. in the Netherlands where the sustainability demands for technological, cultural and structural changes in society were addressed from different stakeholder perspectives. However, in a paper looking back on 10 years of development, Vergragt (2001) commented that while the involvement of private companies in innovation processes is essential, the bulk of Dutch industrial companies is still in the earlier stages of development towards sustainability (i.e. primarily focusing on cleaning up production processes and not on eco-design of products and services).

Nonetheless, today there are examples from various countries of industrial firms taking corporate social responsibility and sustainability seriously. For example, based on an empirical study of Canadian firms in the oil, mining and forestry industries, Bansal (2005) found that the commitment to a sustainable development had increased over time, fuelled primarily by a greater concern for social equity. Recent natural disasters (e.g. Hurricane Katrina) have contributed to an increased general interest in global warming, in combination with specific efforts to influence the public domain. One such example is former vice president Al Gore's (2006) 'An Inconvenient Truth: The planetary emergency of global warming and what we can do about it', which has had considerable impact reaching many individuals and groups in several countries, through television, seminars and a book. This mass-media exposure has, according to Gore, a major purpose of influencing politicians through the general public, but of course also managers in industrial firms develop new insights.

There were fewer approaches that directly addressed the need for corporations to develop strategies in line with the demands of a future sustainable society. The **Natural Step** was one such approach that from the early 1990s succeeded in having an impact on the way business firms develop their undertakings (Holmberg & Robert 2000, Nattrass & Altomare 1999). Holmberg (1998) outlines the steps for a **backcasting** approach to strategy development in business firms, based on system conditions for sustainability. Other researchers focused on **ecological auditing** as a way to develop sustainable businesses (e.g. Callenbach et al. 1993), or on **Corporate Social Responsibility** (e.g. Garriga & Melé 2004). Probably the most commonly used tool in order to estimate ecological impact is **Life Cycle Analysis**, which in many companies has become a standard methodology used in connection with product development in order to identify ecological impact (e.g. Rex 2008).

A major breakthrough in the academic business/strategy discipline took place in 2006 when the doyen of strategy research, Harvard Business School professor Michael Porter, received the 2006 McKinsey Award for the most significant HBR article during the year – an article in which he and his co-author Mark Kramer are arguing for companies to create competitive advantage by **integrating social and environmental issues into their core strategy**, i.e. making sustainability a natural part of strategy. They stated that NGOs, governments, and companies must stop thinking in terms of 'corporate social responsibility' and start thinking in terms of 'corporate social integration' in order to find shared values between society and corporations. To

analyze this potential for shared value, Porter & Kramer (2006) developed a framework based on Porter's well-established strategy analysis tools: mapping the social impact of the 'value chain' and using the 'diamond framework' to analyze the social influences on competitiveness. Hence, to put these principles into practice, a company must integrate a social perspective into the core frameworks it already uses to understand competition and guide its business strategy. According to Porter & Kramer the essential test of CSR is not whether a cause is worthy, but whether it presents an opportunity to create shared value – that is, a meaningful benefit for society that is also valuable to the business.

However, there are also other strategy development tools that can be used, and which also to some extent have been used, to include sustainability issues in strategy development. Not least, the tools developed to cope with discontinuous or disruptive change can be useful, i.e. to help strategizing when there is a high degree of uncertainty concerning the conditions for the future. **System Dynamics** has been used to analyze complex interactions in the market and learning processes on different system levels (de Geuss 1988, 1996; Senge 1990). Another starting point has been to focus on disruptive technologies and observe the difficulty that previously successful firms have had when there is a major **technology shift** (Christensen 1997), and to develop tools and approaches for firms to analyze such shifts (Christensen et al. 2003, 2004). Because of the difficulty of knowing what the future has in store, one approach that has been advocated is to keep strategy alternatives open as long as possible by developing an understanding of the uncertainty and managing a **portfolio of real options** on the contingent elements of alternative optimal strategies (Raynor 2007).

Scenario Planning is an approach that has been relatively widely used by industrial firms, most notably in the oil industry (Van der Heijden 1996) in order to create pictures of plausible futures for decision-makers. There are several variants of scenario planning – the most common way is a deductive approach where four equally possible developments are outlined to form the basis for strategy processes (Van der Heijden 1996). Based on this understanding, a strategy which is working and **robust** under all four scenarios is developed. It has been argued that "robust strategies tend to result in mediocre, if acceptable, results under most circumstances and standout performance in none." (Raynor 2007, p.231.) However, scenarios should be seen as an input for **strategic conversation** which can both expand and focus the thinking of decision-makers in corporations, and the concept of equally possible developments and robustness has a role in this conversation. While primarily used for corporate strategy development, scenario planning has been used for several other applications and in creative combinations. For example, Carlsson-Kanyama et al. (2003) integrated the participative approach from scenario planning into a back-casting exercise in five European cities, i.e. for society's development (see further the section on Scenarios).

Recently a growing number of prominent researchers have repositioned themselves into addressing central issues connected with sustainability. Senge et al. (2008) point at the "Necessary Revolution: how individuals and organizations are working together to create a sustainable world". C.K. Prahalad and co-authors (Nidumolu et al. 2009) ask "Why sustainability is now the key driver of innovation" indicating that there is no alternative to sustainable development: "In the future, only companies that make sustainability a goal will achieve competitive advantage. That means rethinking business models, as well as products, technologies, and processes." They

develop a 5-stage model of sustainability challenges, competences and opportunities starting from (1) viewing compliance as opportunity, (2) making value chains sustainable, (3) designing sustainable products and services, (4) developing new business models, and finally (5) creating next-practice platforms. They conclude their article by stating "That will happen only when executives recognize a simple truth: Sustainability = Innovation."

Porter & Reinhardt (2007) further emphasize the direct link between climate change and business strategy: "Companies that persist in treating climate change solely as a corporate social responsibility issue, rather than a business problem, will risk the greatest consequences. …the effects of climate on companies' operations are now so tangible and certain that the issue is best addressed with the tools of the strategist, not the philanthropist."

DEVELOPMENT OF TECHNOLOGY AND MARKETS FOR PRODUCTS THAT ARE ENVIRONMENTAL

Another clear indicator of a major change can be seen in the marketplace. Even in the traditionally conservative automobile industry a major change is occurring, where innovation has become central for business success. Toyota Prius III was no.1 in Japan, and Honda's hybrid was no.4 on the Japanese market in 2009. The 2010 Car of the Year in the US, Ford Fusion, is also available in a hybrid version, as well as in diesel versions. During the past year almost all manufacturers have launched cars consuming 4.5 liters per 100 km, and Volkswagen – which has been leading this development – is once again launching a diesel model that uses less than 3 liters per 100 km (they launched their first 3-liter diesel Polo in 1998, although with an advanced gearbox that has been a constant headache).

Sustainability is increasingly being used as a starting principle for innovation and development. Jeffrey Immelt, the CEO of GE, has made it very clear: whatever is being developed at GE is based on or stimulated by a sustainability vision. "At GE, we are taking a new approach to solving some of our customers' toughest environmental challenges. We call it ecomagination." (GE homepage.) GE is also changing the way it innovates in the world. "Rather than follow its historical path of developing high-end products and adapting them for emerging markets, GE is developing local technologies in these regions and then distributing them globally." (See Immelt et al. 2009.)

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