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Comments on this paper are invited and may be addressed to the author, c/o the Publications Assistant, Macroeconomic and Development Policies Branch (MDPB), Division on Globalization and Development Strategies (DGDS), United Nations Conference on Trade and Development (UNCTAD), Palais des Nations, CH-1211 Geneva 10, Switzerland (Telefax no: +41 (0)22 917 0274/Telephone no: +41 (0)22 917 5896). Copies of Discussion Papers may also be obtained from this address.

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Ulrich Hoffmann

United Nations Conference on Trade and Development (UNCTAD)

Abstract

Many economists and policy makers advocate a fundamental shift towards "green growth" as the new, qualitatively-different growth paradigm, based on enhanced material/resource/energy efficiency and drastic changes in the energy mix. "Green growth" may work well in creating new growth impulses with reduced environmental load and facilitating related technological and structural change. But can it also mitigate climate change at the required scale (i.e. significant, absolute and permanent decline of GHG emissions at global level) and pace? This paper argues that growth, technological, population-expansion and governance constraints as well as some key systemic issues cast a very long shadow on the "green growth" hopes. One should not deceive oneself into believing that such evolutionary (and often reductionist) approach will be sufficient to cope with the complexities of climate change. It may rather give much false hope and excuses to do nothing really fundamental that can bring about a U-turn of global GHG emissions. The proponents of a resource efficiency revolution and a drastic change in the energy mix need to scrutinize the historical evidence, in particular the arithmetic of economic and population growth. Furthermore, they need to realize that the required transformation goes beyond innovation and structural changes to include democratization of the economy and cultural change. Climate change calls into question the global equality of opportunity for prosperity (i.e. ecological justice and development space) and is thus a huge developmental challenge for the South and a question of life and death for some developing countries (who increasingly resist the framing of climate protection versus equity).

I. INTRODUCTION

According to the International Energy Agency (IEA), global growth of CO_2 emissions from fuel combustion increased by a record 5.3 per cent in 2010 after a slight dip of 1.5 per cent in 2009, caused by the global financial crisis. Total GHG emissions for 2010 are estimated to have increased by more than 6 per cent, a historical record (The Guardian, 2011; and IEA, 2011a: 7). Also, according to estimates of analysts at Pricewaterhouse Coopers (PwC), global carbon intensity (i.e. carbon emissions per unit of GDP) has increased for the first time in many years. "Instead of moving too slowly in the right direction, we are now moving in the wrong direction", said one of the PwC analysts (Financial Times, 2011: 1). Initially, the IEA had hoped that crisis-caused emission reductions were higher and that they could be maintained, helping to give the world a breathing space to set countries on a low-carbon path of development.

When in December 2010 at the UNFCCC climate-change summit in Cancun, after years of debate, governments finally agreed to limiting global warming to 2°C by 2050, quite a number of scientists cautioned that based on current and realistically predictable GHG emission trends that target was beyond reach, rather a 3–5 degree warming scenario would be very likely (see *inter alia* UNEP, 2010; the IEA now projects 3.5 degrees, not excluding even 6 degrees, IEA, 2011b). To illustrate the devastating implications of such situation, one should recall that the last time the earth's temperature was 3° above average in the Pliocene period, some 3 million years ago, the sea levels were up to 25m higher than at present. The last time our planet saw 4° warming, some 55 million years ago, at the beginning of the Eocene, the average sea level was some 75m higher than now (HRH The Prince of Wales et al., 2010: 44). And this is just one major risk factor among many others that are also very daunting.

Against this background, many economists and policy makers advocate a fundamental shift towards "green, low-carbon growth" in the next few decades, based on increased material/resource/energy (MRE) efficiency and a shift of the energy mix towards renewable sources (see *inter alia* UNEP, 2011a). However, given the colossal scale required for global GHG emission reductions (i.e. 50 per cent for developing and 85 per cent for developed countries) and the commensurate contraction of MRE consumption, the question arises as to whether such an approach is realistic: can "green growth" indeed be of sufficiently low-carbon nature and thus also guarantee "equal development opportunity" and the regeneration of the atmosphere?

II. GREEN GROWTH MYTHS

Conceptually, "green growth" implies a decoupling of economic growth from material throughput and conventional energy use. This should be achieved by a qualitatively different growth model, where the scale effect of growth (also reflecting population growth) is overridden by structural and technological change. What is required, however, is not a relative, but an absolute decoupling of economic growth from MRE throughput,[1] and that at an unprecedented scale in a historically very short period of time (i.e. the next two decades). In order not to exceed the 2° warming limit, the remaining maximum tolerable global GHG emission load is estimated at about 750 Gt CO_2-eq, which is the equivalent of not more than some 25 years if emissions were frozen at current levels (Hansen et al., 2008).[2]

According to "green growth" proponents, an MRE efficiency revolution and a completely changing energy mix towards renewable energy should bring about the U-turn. Such approaches might work at some enterprise or national industry level, based on very advanced technologies, far-going restructuring and drastic changes in consumption behaviour. A transition to "green growth" may indeed be successful in creating new growth impulses with reduced environmental load, facilitating technological and structural change, and in addressing a number of inter-related economic, social and environmental challenges (as amply illustrated in UNCTAD, 2010a). This paper does however not try to evaluate the effectiveness of "green stimulus packages" as anti-cyclical or economic/financial-crisis-mitigation tool,[3] but rather attempts to analyse whether "green growth" can mitigate climate change at the required scale (i.e. significant, absolute and permanent decline of GHG emissions at global level) and pace. And in this regard, there is reason for doubt that "green growth" can really bring about the colossal changes required under the given time constraint. What are the main reasons for being skeptical?

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[1] "Relative" decoupling means that the rate of MRE consumption (and GHG emission) growth is lower than GDP growth. Conversely, "absolute" uncoupling implies that MRE consumption (and GHG emissions) decline, whereas GDP continues to grow.

[2] The period of 25 years takes into account carbon sequestration in soil, biomass and oceans.

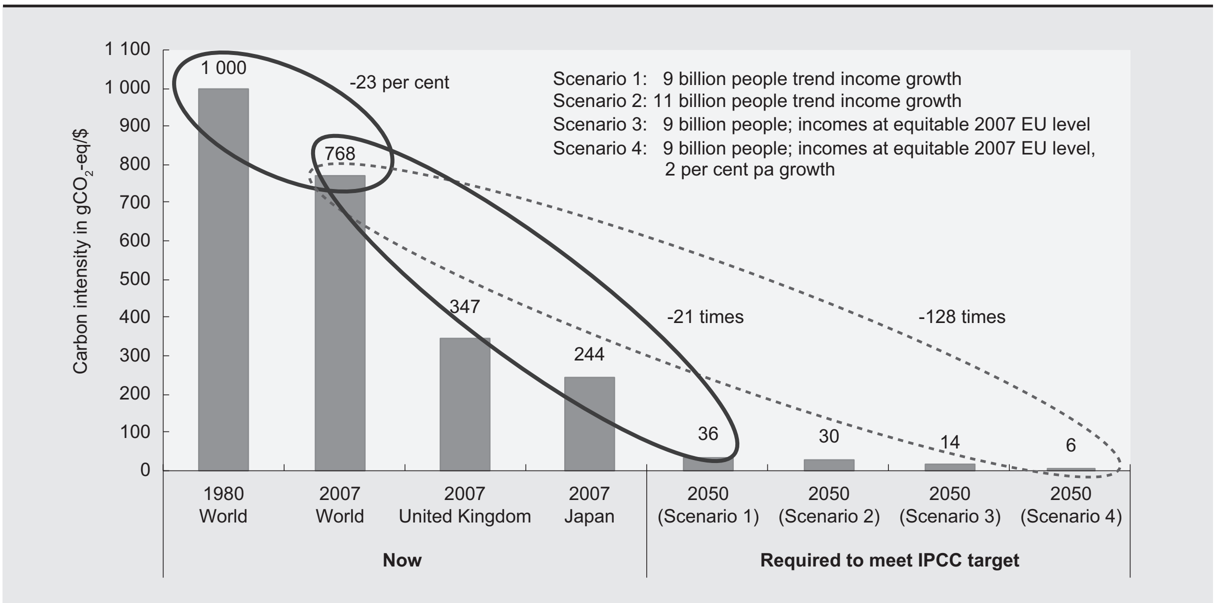
[3] For a critical analysis in this regard, see Tienhaara (2009).

A. Arithmetic of growth and efficiency limits

Firstly, it is questionable whether the required changes are really achievable under the prevailing growth paradigm. By way of illustration, global carbon intensity of production fell from around 1kg/$ of economic activity to just 770g/$ (i.e. by 23 per cent) in the 28 years between 1980 and 2008 (a drop of about 0.7 per cent per annum). In a world of more than 9 billion people by 2050, however, and, in addition, assuming an annual GDP growth of 2 per cent till then as well as an appropriate catching up of developing countries in terms of GDP per capita (to the EU average of 2007),[4] carbon intensity would have to fall to just 6g/$ of production, almost 130 times lower than it is today (requiring an average annual fall in carbon intensity of 11 per cent) to limit global warming to 2°. Even if recent trends of global population (at 0.7 per cent per annum) and income growth (at 1.4 per cent per year) were just extrapolated to 2050, carbon intensity would have to be reduced to 36gCO_2/$ – a 21-fold improvement on the current global average (see figure 1).[5]

Figure 1

RECENT CARBON INTENSITY OF GDP AND THE LEVEL REQUIRED TO LIMIT GLOBAL WARMING TO 2 DEGREES



Source: Jackson, T (2009: 81) and additions by the author.

In retrospect, apart from Germany just for a short period after reunification in the 1990s, the Russian Federation is the only large economy that reduced emissions substantially since 1990, mostly caused by a breakdown of its heavy industry. The country's carbon emissions fell by almost 3 per cent annually in 1990–2005 (IEA, 2010a). The world (not only a handful of technologically very advanced countries) would have to repeat the Russian experience at roughly a 3 times more drastic extent (and even that would only result in limiting global warming to about 3°).[6] Does this sound feasible?

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4 Even if one modified the across-the-board catching up scenario of developing countries (i.e. bringing rapidly industrializing developing countries to the EU per capita GDP level of 2007 and letting the other developing countries achieve current GDP per capita of the rapidly industrializing developing countries), the required reduction in carbon intensity would not be much lower as the rapidly industrializing developing countries account for about 60 per cent of the current population of the South, and 50 per cent in 2050. In scenario 1, Jackson de facto follows that approach by assuming a very high income growth of 5–10 per cent for rapidly industrializing countries (Jackson, 2009: 80).

5 For more information, see Jackson (2009).

6 For more information, see Minqi Li (2008).

It is often also overlooked that the drastic reductions in GHG intensity have to happen in a historically very short period of time, i.e. the next 20 years. According to McKinsey researchers, the "carbon revolution" needs to be three times faster than industrial labour productivity rise in the industrial revolution. "During the Industrial Revolution, the United States achieved an increase in labour productivity of ten times between 1830 and 1955. The key difference is the timeframe. The tenfold increase in labour productivity was achieved over 125 years; the 'carbon revolution' needs to happen in only 2–3 decades" (McKinsey Global Institute, 2008: 12–13).

Secondly, enhanced MRE efficiency and ample availability of cheap renewable energy will encourage a certain "rebound effect", i.e. physical consumption is likely to increase as a result of lower prices and the shifting of thus saved consumer money or investment funds (often neutralizing 10–50 per cent of the MRE saving gain);[7] this will be particularly pronounced in developing countries.[8] As a result, relative decoupling of GHG emission growth from GDP dynamics can be achieved, but it is doubtful whether the massive absolute decline in MRE use is indeed feasible.[9] The rebound effect could theoretically be neutralized by carbon taxes and market-based instruments, but this has hardly been done in practice at the required scale.

There is also a tendency of too much linear thinking and approaches to enhancing MRE efficiency, often resulting in an outcome that only shifts the problem. For instance, instead of taking a systemic and new view towards transport, reducing the need for mobility and favouring public and multimodal transport networks, the current predominance and dependence on individual (mostly car) transport[10] and globalized maritime and air shipments are cemented by isolated technical improvements for those modes of transport, for instance in forms such as light-weight and electrical vehicles or the use of biofuels in car and jet engines. It is often overlooked that some of these technical advances rely on material, which is either scarce or very energy intensive to produce or difficult to re-use, recycle or safely dispose of.

According to Bleischwitz et al. (2012: 21), "the upswing for eco-industries in the North may have a dark side in the South: resource-rich countries being moved into rapid extraction paths exceeding the eco-systems and socio-economic institutions of those regions and fuelling civil wars with resource rents".

Furthermore, any technical improvement should indeed ultimately result in less absolute MRE consumption per unit of output along the supply chain, which seems to be the exception rather than the rule.[11] Based on an extensive study of global material use trends, Fischer-Kowalski (2010) comes to the conclusion that relative decoupling of MRE consumption from economic growth has largely been business as usual and a

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[7] Efficiency savings may thus be eroded at national level, but also at international level, where savings of one group of countries may be overcompensated by additional consumption in others. There is also the risk that energy efficiency gains, in combination with greater deployment of renewable energy, might encourage conventional fuel producers to step up their production level to forestall losses from a future weakening of conventional fuel prices.

[8] For more information, see Weizsäcker et al. (2009: 301–311).

[9] For an in-depth analysis of this issue, see Dauvergne (2008: 35–47) and Foster (2003).

[10] The global vehicle population is estimated to double from the current 1 billion cars to 2 billion by 2030. Currently, average GHG emissions per vehicle are about 5.5 t CO_2-eq, amounting to 5.5 Gt CO_2-eq globally. Even an ambitious 40 per cent increase in fuel efficiency per vehicle will be insufficient to neutralize the increase in the global car fleet. Under such efficiency scenario, GHG emissions would still soar to 6.8 billion tons CO_2-eq till 2030 (Kohlmaier, Beemicker, 2011). In India, today there are 30 cars per 1,000 inhabitants; in China that ratio is 120, in OECD countries it is 750. If India and China ever reached a ratio similar to that currently in OECD, these two countries alone would be home to 1.5 billion vehicles, consuming all of the current OPEC oil production. Nobody should assume that such escalating scale can be checked by "green cars" (Nair, 2011). The IEA's World Energy Outlook 2010 projects that transport fuel demand will grow by about 40 per cent by 2035 (IEA, 2010b: 10).

[11] To give but one example, the Beetle car model of Volkswagen had a weight of 730kg and a fuel efficiency of 7.5 l/100km in 1955. 50 years later, in 2005, the same car model had a weight of 1,200kg and a fuel efficiency of 7.1 l/100km (i.e. an almost two-thirds higher material consumption at a fuel efficiency improvement of just 5 per cent) (Paech, 2010).

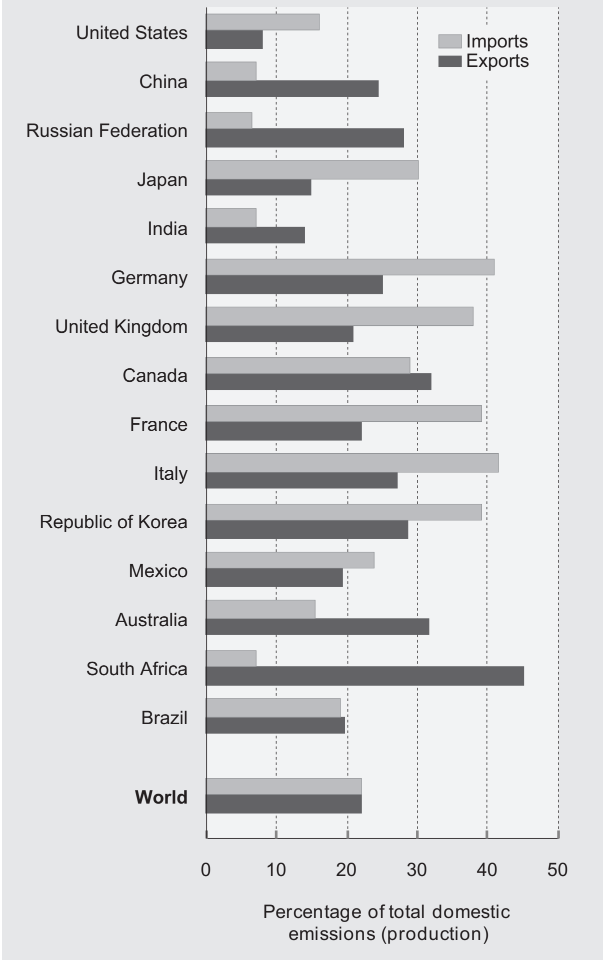
driver of growth. Absolute decoupling has rarely happened and so far only at very low rates of economic growth. As Sarkar and Kern (2008: 16) put it, "we cannot wish away the laws of physics, chemistry and biology. In short, also in the matter of resource productivity there are limits to growth".

Thirdly, a considerable part of MRE efficiency gains in developed countries has been achieved not by "real physical savings" resulting from changes in production and consumption patterns/modes, but by "outsourcing" very MRE-intensive production to developing countries (almost a quarter of GHG emissions related to goods consumed in developed countries has been outsourced).[12] According to the United Kingdom Department for Environment, Food and Rural Affairs, between 1990 and 2008, GHG emissions from United Kingdom production decreased by 14 per cent; whereas GHG emissions from United Kingdom consumption increased by almost 20 per cent.[13] A team of scientists at Oxford even estimate that under a correct account, allowing for imports and exports, Britain's carbon footprint is nearly twice as high as the official figure (i.e. 21 t CO_2eq/person/year instead of 11) (cited in MacKay, 2009: 93). The share of CO_2 net imports to total carbon emissions of individual developed countries has recently ranged from about 15 per cent for Greece to almost 60 per cent for Switzerland (Aichele and Felbermayr, 2011: 13). Germany, one of the most resource efficient and engineering-wise sophisticated economies, increased its domestic resource/material efficiency by almost 14 per cent in the period 2000–2007. However, when calculated as total material requirement, including indirect material flows through the "ecological rucksack of international trade", material efficiency only improved by 4 per cent and the physical volume of total material/resource consumption actually grew by 134 million tons (Simon and Dosch, 2010; and Center for Resource Efficiency and Climate Protection, 2010). A comparison of material productivity (i.e. GDP generated per unit of physical material consumption) between the Republic of Korea and Chile, done by Dittrich et al. (2011), shows that the former was more than seven times as productive as the latter in 2005. However, after including indirect material flows both countries were almost equally material productive (at around US$250 per ton). The authors therefore warn that "comprehensive material flow-based indicators are a precondition for a comprehensive evaluation of the productivity of resource consumption in a country, which avoids producing artifacts due to international trade and outsourcing of industrial production" (Dittrich et al., 2011: 30). Figure 2 summarizes in a self-explanatory way the carbon

Figure 2

SHARE OF CARBON EMISSIONS INCORPORATED IN TRADED GOODS

(Percentage of total domestic emissions of key developed and developing countries in 2001)



Source: Peters and Hertwich (2008: 1401–1407).

[12] According to Peters et al. (2011), in terms of consumption-based inventories, 11 per cent of the growth in global CO_2 emissions between 1990 and 2008 can be attributed to consumption in Annex B (i.e. developed) countries, instead of a per cent reduction for territorial emissions.

[13] See www.defra.gov.uk/statistics/environment/green-economy/scptb01-ems/.

emissions incorporated in exported and imported goods as share in total domestic emissions of a number of countries for the year 2001.

Fourth, it will be technically extremely challenging to completely replace fossil fuel by renewable energy (RE). Wind and solar, the two most promising RE sources, are variable and intermittent, and therefore cannot serve as "base-load" electricity, requiring substantial conventional electricity capacity as backup. They also require significant material input into the production of solar panels and wind turbines and a major upgrading of storage capacity, transmission lines and the creation of intelligent grids, all set to drive up material consumption (and related costs), in some cases completely exhausting supply of strategic materials (for more information, see Achzet et al., 2011).[14] Furthermore, two-thirds of fossil fuel is used as transport fuel, for which there is no real substitute within sight (biofuels cannot meet more than a small faction of the world's transport fuel demand).[15]

Hänggi (2011) in a recent book cautions that a change in the energy mix does often not lead to a straightforward replacement of fossil by renewable fuel. Rather, the new energy is likely to be used in parallel with the old one for quite some time (a phenomenon that applies to many social innovations), both for technical reasons, but also linked to the above-mentioned rebound effect. For instance, the present global consumption of coal is higher than that before the oil age, so is the current consumption of fuel wood compared to what was used before the coal age. Also, to assure reliable electricity supply, gas-reliant power stations are likely to play an important role in backing up wind and solar power facilities (Röpke and Lippelt, 2011).

It should also not be overlooked that, unlike conventional fuel, renewable energy is usually only available in non-concentrated form; it has to be "compacted" to generate sufficient power. This "compaction" or, in technical terms, the reduction of entropy of a system,[16] can only be achieved by increasing the entropy in other parts. In practical terms of renewable energy, this means that one can only compact wind, solar, bio or hydro energy by increasing the use of conventional fuel or raw materials.[17]

As a result, the Energy Return on Energy Invested (EREI) is low and sometimes even negative (in fact, even for conventional fuels the EREI has dramatically declined in recent decades).[18] According to Hall

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[14] Just one illustration: to meet global electricity consumption by (solar) photovoltaic panels in 2030 would require a consumption of copper of 100–200 million tons; this compares to a recent global copper production level of 15 million tons per annum. If the some 900 million four-wheel vehicles currently in use worldwide were to be converted to fuel-cell propulsion technology, the resulting consumption of platinum would be about 27 thousand tons, with an annual renewal of 2,600 tons. However, the currently known platinum resources are only 29,000 tons. Even under the assumption that the recycling rates were 50 per cent, global platinum resources would be exhausted in two years. Similar scenarios apply to rear earths and some heavy metals. What is more, their production is highly environmentally problematic (Exner et al., 2008: 68, 69, 72). For more information, also see Bleischwitz et al. (2012).

[15] Estimates of land requirements for biofuels vary widely, but mainly depend on type of feedstock, geographical location, and level of input and yield increase. The massive scale of land requirements for meeting biofuel blending targets however poses a serious competitive challenge for land for food-crop production. To replace 10 per cent of global transport fuel demand by first generation biofuels in 2030 would require the equivalent of no less than 8 to 36 per cent of current global cropland, including permanent cultures (UNEP, 2009). This contrasts with recent estimates that only about 5 per cent of the arable land on the planet remains unused (Kluger, 2010: 34–39). Furthermore, a recent study of the Institute for European Environmental Policy on the effects of indirect land-use change associated with the increased use of conventional biofuels that EU Member States have planned for within their National Renewable Energy Action Plans till 2020 (i.e. 10 per cent of consumed transport fuel should come from renewable resources) concludes that meeting this target would lead to between 80.5 and 167 per cent more GHG emissions than meeting the same need through fossil fuel use (Bowyer, 2010).

[16] In classical thermodynamics, the concept of entropy is defined by the second law of thermodynamics, which states that the entropy of an isolated system always increases or remains constant. Entropy is the unit of measurement for the unavailability of a given volume of energy.

[17] For more information, see Sarkar (2009: 316–318) and Rundgren (2012: chapter 6).

[18] For more information, see Exner et al. (2008: 60–79).

et al. (2009: 25–47), it is not important to have renewable energy alternatives per se, but that they have (i) a sufficient energy density; (ii) transportability; (iii) relatively low environmental impact per net unit delivered to society; (iv) a relatively high EREI; and (v) are obtainable on a scale that society demands. The authors stress that "we must remember that usually what we want is energy services, not energy itself, which usually has little intrinsic economic utility". MacKay (2009: 103–104) adds that "for a sustainable energy plan to add up, we need both the forms and amounts of energy consumption and production to match up. Converting energy from one form to another ... usually involves substantial losses of useful energy ... Conversion losses (in the United Kingdom, for example – added by the author) account for about 22 per cent of total national energy consumption".

Fifth, there are clear signs of scarcity of oil and uranium that are likely to drive up their future price levels. Yet, "peak oil" is unlikely to provoke extreme price explosions of conventional fuel, which might trigger significant leaps in global energy efficiency. The reason is simple; oil can relatively easily be replaced by coal (and "unconventional" gas[19]), the supplies of which have a geological reach of some additional 200 years. Coal liquefaction, using classical technology, would allow mass production of oil at prices of US$60–80 per barrel, assuming even high coal prices at US$100 per short ton (von Weizsäcker et al., 2009: 318). The global warming potential of coal is twice as high as that of natural gas and 50 per cent higher than that of oil. 80 per cent of global coal demand till 2030 is projected to come from China and India alone (IEA, 2007: 43). The Carbon Capture and Storage (CCS) technology is at early experimental stage and thus still largely unproven, absorbs at least 20 per cent of energy generated by the concerned power plants, reduces the efficiency rate of the whole plant by at least a quarter and might never be available at sufficient scale in the not too distant future.[20] Yet, as further elaborated on below, given current and future trends in the strong domination of coal-fired power plants in energy-related carbon emissions, notably in China and India, global research and technology efforts need to focus on neutralizing these emissions.

Sixth, direct and indirect GHG emissions from agriculture, which are higher than from the key energy-intensive industrial sectors (such as iron and steel, cement, chemicals or non-ferrous metals) and even surpass those of the global energy sector (i.e. generation of electricity, heat and other fuel combustion),[21] are projected to rise by almost 40 per cent till 2030, at a time when a drop of the same order of magnitude is required. Land-use changes, primarily deforestation, land-degradation, mono-cropping-based industrial agricultural practices, large-scale biofuel and factory-like livestock (and associated animal feed) production that all rely on significant external (fuel-related) inputs are the major causes and driving forces of agricultural GHG emissions. This prompted Albert Bartlett to say: "Modern agriculture is the use of land to convert petroleum into food" (cited in MacKay, 2009: 76). The prevailing trend is accelerating in the light of population growth and dietary changes. Alternative production methods exist, but require

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[19] "Unconventional gas" or rather gas from unconventional, difficult-to-access deposits (in sand stone – "tight gas" – or in clay or shale stone – "shale gas") is increasingly being seen as promising oil substitute. Huge deposits of "unconventional gas" are believed to exist in the United States, Australia, China, India and Indonesia. Apart from the low EREI, "unconventional gas" has significant environmental impact, in particular on ground water contamination, methane leakage and the likelihood of causing earthquakes (for more information, see Franken and Kriener, 2011; and Financial Times, 2011: 2). According to a recent study of the US National Center for Atmospheric Research (Wigley, 2011), switching from coal to "unconventional gas" as an energy source could result in more, not less global warming.

[20] According to Rundgren, the EREI for CCS is very low: "it will produce only 50 per cent more energy than it consumes, making it one of the most inefficient ways of producing energy, and therefore also increase energy consumption tremendously contributing to an escalating depletion of fuel resources" (Rundgren, 2012: chapter 7). Besides absorbing at least one fifth of energy generated at power plant level, CCS will additionally require construction of pipelines to underground CO_2 storage facilities and the proper preparation and sealing of the storage facilities. At the moment, the costs of a ton of CCS-removed CO_2 are estimated at about 50 Euro (Tenbrock, 2011: 35). Recent evidence suggests that total power plant investment costs almost double by adding CCS devices (Herold and von Hirschhausen, 2010: 4).

[21] If GHG emissions from agricultural production, related land-use changes, and emissions from food processing, packaging, transport and retail, as well as food wastage are aggregated, the total emissions are estimated to account for almost half of all global GHG emissions (GRAIN, 2012).

a radical transformation that goes much beyond simply tweaking the existing industrial agricultural systems. Yet, how likely is such U-turn?

In theory, what would be required is to transform the uniform, high-external-input-dependent model of quick-fix industrial agriculture into a flexible approach of sustainable (regenerative) agricultural systems that continuously recreate the resources they use and achieve higher productivity and profitability of the system (not necessarily of individual products) with minimal external inputs (including energy). Such production methods focus on recreating and maintaining soil fertility and related soil organic matter. They could thus, on the one hand, drastically reduce GHG emissions, and, on the other hand, lead to the uptake of huge volumes of carbon in soils in the form of soil organic matter, that, on its own, could mark a quantum leap for climate mitigation[22] and adaptation.

However, the sheer scale at which modified production methods would have to be adopted, the significant governance and market-structure challenges, in particular at international level, pose considerable challenges to implement the required far-reaching transformation. To name but one, there are very powerful vested interests of large globally active companies that currently dominate the agricultural input markets to keep the status quo of high external input dependent agricultural production methods.[23]

Seventh, the rise of global population by about 35 per cent, from 6.9 billion in 2010 to about 9.3 billion by 2050 (UN/DESA, 2010), will drive the scale effect of production and consumption, significantly increasing the pressure on structural change, technological progress and changing consumption patterns to neutralize it. The 35 per cent rise, combined with a four-fold increase in output per capita (and even assuming that the rich world grows no more) would jack up the size of the world economy by six times (Sachs, 2009). While it is a fact that the countries with the highest population growth have contributed least to GHG emissions thus far, this is only because their populations continue to live in extreme poverty. In other words, population growth does not matter for resource consumption and GHG emissions as long as one accepts that people remain poor, with minimal levels of consumption. But it begins to matter a great deal if the international community has the ambition to reduce poverty amidst rapidly growing populations.

Eighth, colossal de-carbonization of the economy and human life will only be achievable if current consumption patterns, methods and lifestyles are also subject to profound change. Consumption in general needs to become more de-materialized and de-carbonized, as well as determined by appropriate and more conscious purchasing decisions. According to a recent UNEP global survey on sustainable lifestyles, "creating sustainable lifestyles means rethinking our ways of living, how we buy and what we consume but, it is not only that. It also means rethinking how we organize our daily life, altering the way we socialize, exchange, share, educate and build identities. It is about transforming our societies towards more equity and living in balance with our natural environment" (UNEP, 2011b: 6). However, real, far-going and lasting changes will be very difficult to bring about.[24] The globalization of unsustainable Western consumption trends and patterns, the tendency towards higher animal protein content of food,

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[22] According to a survey of field trials by Leu (2012), organic agriculture, for instance, leads to the absorption of between 0.5–8 tons of CO_2 per hectare on average, but higher levels of up to 30 tons can be achieved with more extensive compost utilization (the extensive use of compost would however not be self-sustaining). If organic agriculture were applied globally, it could lead to CO_2 absorption through soil organic matter at up to 110–120Gt of CO_2 per year, more than double the world's current annual GHG emissions of 49Gt CO_2-eq (it should not go without comment that higher soil fertility and related biological activity might increase emissions of some non-CO_2 GHGs; sufficient compost availability might also be a problem). A safe assumption is that if globally applied, organic agriculture could be at least carbon neutral.

[23] For more information, see Hoffmann (2011) and Daño (2012).

[24] Limiting global warming to about 2 degrees would require a reduction in global per capita CO_2-eq emissions to not more than 2.2 tons per annum. That is the equivalent to about 6 kg of CO_2-eq per day. Based on current levels of carbon intensity, a person would have to limit its total consumption to a 40 km car ride or a day of air conditioning or to buying two new T-shirts (without driving to the shop) or to eating two meals. For more information, see McKinsey Global Institute (2008: 12).

and the high mobility obtained through modern, but carbon-intensive transport systems are but three examples of the very hard nuts to crack on the consumption front.

What is often underestimated by the advocates of "green growth" is the fact that changing consumption and concomitant lifestyles need to be understood as a social issue, factoring in equity, not just as environmental issue. As Vermeulen (2009: 25) summed it up, "in seeking solutions to over-consumption, we need to concentrate on societies and structures as a whole, rather than their individual actions. Short-term solutions may rely on improving efficiencies within existing modes of production and consumption (reformist changes). In the longer term, however, what is needed is a re-think of how and what we consume (transformist changes)".

Furthermore, Khor (2011: 23) correctly emphasizes that consumption patterns will not significantly change unless income distribution changes as well. "While there is more potential to increase the productivity per unit of natural resources used, this is done within the same or worse income distribution pattern; thus the rich may consume the same luxury products and services and in larger numbers though each unit may be more energy-efficient. Because of the same distribution pattern, the poor still do not have access to basics. Thus, an improvement in the pattern of income distribution is required if sustainable development objectives are to be met. The equitable distribution of income as a goal becomes more urgent as resources are being depleted to critical levels, and as the 'atmospheric' space for greenhouse gases is fast vanishing. In this situation of environmental crisis, the irrationality of existing consumption patterns becomes even more evident."

To sum up all factors enumerated above, in a carbon and resource-constraint world one is left with the policy options of (i) limiting population growth; (ii) reducing per-capita income growth in developed countries and giving up developmental catching-up of the South; or (iii) drastically changing consumption patterns. While in theory progress would have to be made on all three fronts, in reality, as pointed out above, it is highly unlikely that this materializes, apart from the fact that it would cement gross injustices.

B. Governance and market constraints

No doubt, the drastic and quick changes required for achieving the unprecedented absolute, permanent and global GHG emission reductions require a clear vision, a sound strategy and consistent implementation. Yet, in practice we remain far away from that.

The international climate regime (although without alternative) is not providing a coherent and sufficiently effective approach yet. The gap between the claims and the reality of international climate policy is widening. No truly assertive climate pioneer alliances exist to accelerate the establishment of post-fossil, transnational structures (WBGU, 2011). The much-praised outcome of the United Nations Climate Change Conference in Durban in December 2011 might have been a victory of *Realpolitik* and almost the last chance of rescuing the survival of international climate dialogue, but it has done little to come to effective mitigation measures so that global GHG emissions peak by 2020, which is imperative for staying within the 2^{o} warming limit. Once again, decisions on effective mitigation action were postponed.[25] According to Fatih Birol, the chief economist of IEA, "potentially, we are already with our feet in water, reaching the level of our knees. Yet we make decisions and keep promising that our toes will remain dry" (cited in Kriener, 2011).

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[25] For an in-depth evaluation of the outcome of the Durban conference, see IISD (2011) and Sterk et al. (2011).

Also, the recent financial and economic crisis has hardly been seized as an opportunity for the much-required ecological U-turn. In fact, even during the crisis global MRE consumption has increased and GHG emissions did not fall, mainly driven by growth in rapidly industrializing developing countries.[26]

Moreover, the current public debt and financial crisis in numerous countries in Europe, the United States and Japan is likely to complicate the much required structural and technological change. On the one hand, it shows that the debt-driven growth of capitalist accumulation linked to a decoupling of the financial from the real economy is unsustainable (the sub-prime crisis in the United States and Spanish housing markets are just two prominent examples[27]). On the other hand, under capitalism, periods of severe economic crisis are also when economic distortions and asymmetries between supply and demand are temporarily overcome, when radically new economic structures emerge and breakthrough technologies are adopted.[28] Yet, this would require a particularly pro-active role of governments in supporting and stimulating S&T development, accelerating and smoothening structural change (including in the energy mix) and encouraging a drastic change in consumption patterns and lifestyles.[29] Governments in the crisis-stricken developed countries however find themselves in a budgetary straightjacket, being obliged to drastically cut back public expenses and investment in the next few years, increasing deflationary and recessionary tendencies in the concerned economies.[30] Most of these countries will be unable to launch big economic or re-structuring stimulus packages as done in the wake of the 2008–2009 crisis.[31]

It is also important to appreciate that GDP is not an adequate indicator of progress of human society. To set correct and effective incentives for drastically reducing the environmental impact of economic growth, a modification of the measurement of economic performance and resulting prosperity or well–being is imperative, as highlighted by the recent report of the Commission on the Measurement of Economic Performance and Social Progress, convened by the French President. The report states that "what we measure affects what we do; and if our measurements are flawed, decisions may be distorted. Choices between promoting GDP and protecting the environment may be false choices, once environmental degradation is appropriately included in our measurement of economic performance. So too, we often draw inferences about what are good policies by looking at what policies have promoted economic growth; but if our metrics of performance are flawed, so too may be the inferences that we draw" (Stiglitz et al., 2009: 7).

The key message of the report is that the time is ripe for our measurement system to shift emphasis from measuring economic production to measuring people's well–being. In this regard, the report makes some specific recommendations:

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[26] As mentioned at the outset, global energy-related CO_2 emissions decreased by a tiny 1.5 per cent in 2009, being however overcompensated by growth in other GHGs, in particular from agriculture.

[27] In the United States, the mortgage-to-GDP ration has climbed from 61 per cent of GDP in 1994–1997 to 101–103 per cent in 2007–2008. Only 4 per cent of new houses are bought for cash. For more information, see Rundgren (2011: chapter 26).

[28] For a more elaborate analysis, see Hoffmann (2010).

[29] According to WBGU (2011: 15), "the most important precondition for investments into low-carbon technologies and infrastructures are long-term, stable climate and energy policy framework conditions with ambitious targets, for example within the scope of climate protection legislation or a decarbonisation strategy. Apart from carbon pricing and phasing out of subsidies for fossil energy carriers, technology-specific funding should be granted, and binding efficiency standards for buildings, vehicles and energy consuming products should be introduced, or become more stringent. In the interim, tax incentives".

[30] Low-cost public efforts to encourage and support a change in consumption patterns would therefore be more promising. However, apart from some sporadic activities, this is also not happening.

[31] As put by Mueller and Bullard (2011: 12), "current economic conditions – of bust in the North and boom in the South – make it difficult for either developed and developing countries to take effective action on climate change as, under conditions of largely fossil-fuel-driven growth, there is an effective trade-off between mitigation and development-understood-as-growth".

- When evaluating material well-being, one should look at income and consumption rather than at production.
- The household perspective needs to be emphasized.
- Income and consumption should be jointly considered with wealth.
- More prominence needs to be given to the distribution of income, consumption and wealth.
- Income measures to non-market activities should be broadened.
- Measures of people's health, education, personal activities and environmental conditions must be improved.
- Quality-of-life indicators in all the dimensions covered should assess inequalities in a comprehensive way.

Some alternative indicators already exist, such as the Genuine Progress Indicator (GPI), the Happy Planet Index (HPI) or the Index of Sustainable Economic Welfare (ISEW).[32] The latter calculated for Germany for the period 2000 to 2006, for instance, shows a decline of 7 per cent, whereas conventional GDP increased by 6 per cent in the same period (Zieschank and Diefenbacher, 2009: 789). The United Nations System of Environmental-Economic Accounts (SEEA) will be launched as an international statistical accounting framework in 2012. The SEEA is a satellite system of the existing System of National Accounts (SNA) that applies the SNA definitions, guidelines and practical approaches to the SEEA.[33]

It goes without saying that reforming the system of measurement of economic performance and social progress along these lines will be a tall order. It would be simplistic to assume that such exercise is a pure cosmetic, technical or statistical change in the gathering and calculation of data. Rather, it will be a power struggle against those who are economically, politically or ideologically benefiting from the current accounting system, which does not reflect numerous environmental and social costs and benefits. What is more, one should not lose sight of the fact that "companies are not trying to grow the GDP, they try to increase their profit or simply survive the competition … And this will remain the same even if societies trash GDP as a measure" (Rundgren, 2012: chapter 31).

Existing market structures are also complicating the "green" transformation of economies. For instance, from a systemic point of view, a considerable part of renewable energy can (and should) be deployed in a local, decentralized way, avoiding much of the required investment in new grids, transmission losses and matching supply with demand.[34] Yet, the market domination of few energy companies leads to a preference being given to central, grid-based approaches that retain their market power (off shore wind parks and project proposals for huge solar power generation facilities, for instance, in the Sahara are cases in point). Similarly, a few globally active agri-food companies that dominate the world's seed, agro-chemicals and bio-technology markets have an interest in maintaining high external-input-dependent agricultural production methods (for more information, see Daño, 2012).

The externalization of environmental costs and massive subsidization of fossil-fuel dependent industries and industrialization approaches[35] have become a fundamental part of the capitalist market economy. More generally, there is a systemic problem of free riding of "conventional producers" that take advantage of all kinds of "perverse" subsidies and misguided incentives. Conversely, sustainable producers, who want to distinguish themselves, have to provide (and pay for) the evidence that they are indeed meeting specific sustainability criteria (usually partly reflected in voluntary sustainability standards). They are like

[32] For an overview, see Lawn (2003: 105–118).

[33] For more information, see http://unstats.un.org/unsd/envaccounting/seea.asp.

[34] For more information, see Robert et al. (2010).

[35] Annual consumption subsidies for fossil-based energies are estimated at US$300–500 billion (WBGU, 2011). According to the Potsdam Institute for Climate Impact Research, G-20 countries subsidize every ton of CO_2 with about US$9, which is higher than the current price in emission trading markets (Edenhofer, 2011).

Box 1

KEY FINDINGS OF AN EVALUATION OF THE EU EMISSIONS TRADING SYSTEM

1. The ETS has failed to reduce emissions. Companies have consistently received generous allocations of permits to pollute, meaning they have no obligation to cut their carbon dioxide emissions. A surplus of around 970 million of these allowances from the second phase of the scheme (2008–2012), which can be used in the third phase, means that polluters do not need to take any action domestically until 2017. Proposals to curtail this surplus were discussed in the context of the EU's 2050 Roadmap, but have been watered down in response to lobbying from energy-intensive industries.
2. Companies can use 1.6 billion offset credits in phases II and III, mostly derived from the United Nations Clean Development Mechanism. Over 80 per cent of the offsets used to date come from industrial gas projects, which EU Climate Action Commissioner Connie Hedegaard admits have a "total lack of environmental integrity". The Commission delayed a ban in the use of these industrial gas offsets to April 2013.
3. The ETS is a subsidy scheme for polluters, with the allocation of permits to pollute more closely reflecting competition policy than environmental concerns. Power companies gained windfall profits estimated at €19 billion in phase I, and look set to rake in up to €71 billion in phase II. Subsidies to energy-intensive industry through the two phases could amount to a further €20 billion. This has mostly resulted in higher shareholder dividends, with very little of the windfall invested in transformational energy infrastructure.
4. The third phase of the ETS will still see significant subsidies paid to industry, despite the auctioning of permits in the power sector. Industry lobbying has resulted in over three-quarters of manufacturing receiving free permits, which could yield at least €7 billion in windfall revenues annually. Energy companies successfully lobbied for an estimated €4.8 billion in subsidies for Carbon Capture and Storage (CCS), with a smaller amount for "clean" energy that includes agrofuels. In addition, the Commission is undertaking a review of its "state aid" rules which could see the granting of direct financial subsidies to companies claiming that the ETS damages their competitiveness.
5. Aviation will be included in the scheme from 2012. The sector will receive 85 per cent of permits for free, and the projected carbon cost is far lower than the equivalent tax breaks for aviation fuel. Inclusion in the ETS applies only to CO_2 emissions, which obscures the greater impact of contrails and other gases.

Source: Carbon Trade Watch and Corporate Europe Observatory (2011).

sheep in a lions' cage. In the absence of systemic change, this prisoners' dilemma can only be countered by price premiums for sustainably produced goods and services or public subsidies in recognition of (still externalized) environmental benefits, because the cost savings through sustainable production methods are often insufficient or come too late to compensate for the significant inspection, auditing and certification costs in connection with sustainability standards. Yet the present situation as regards price premiums, subsidies and payments for environmental services is far from satisfactory and many actions remain sporadic.[36]

A systemic change would have to logically start with removing "perverse" incentives and channeling part of the savings into support systems for sustainable production. In the absence of such steps, the

[36] According to Rundgren (2012: chapter 26 and 27), "most externalities are part of the business plan of industrial capitalism … To try to shift the burden to someone else, other people or future generations, to buy cheap and sell dearly (be it labour, raw materials or ready made goods), to appropriate common resources for exploitation or for dumping ground are just normal business … To believe that prices could include all external social and environmental costs is just not realistic".

only alternative to pursue is the creation of international commodity-related environmental agreements (ICREAs) that form an international governance system, where "polluters or non-performers" get charged for freeing "supportive" funds to facilitate the promotion of sustainable production.[37] Though so much required, correcting these "failures" will remain illusory, at least within the short time frame required for checking climate change.

The much-vaunted market-based instruments for internalizing GHG emission costs, in particular emissions trading, have so far also fallen far short of expectations. A recent review of the EU Emissions Trading System (ETS) draws very sobering conclusions: "Emissions trading is the European Union's flagship measure for tackling climate change, and it is failing badly. In theory, it provides a cheap and efficient means to reduce greenhouse gases within an ever-tightening cap,[38] but in practice it has rewarded major polluters with windfall profits, while undermining efforts to reduce pollution and achieve a more equitable and sustainable economy". The in-built serious flaws and shortcomings of the third phase of the ETS till 2017 will thus not result in the required drastic GHG emission cuts (see box 1).

Many environmentalists argue that what is urgently required to reverse the resource and environmental-impact intensity of capitalist growth is to duly reflect the value of stocks of natural capital, by introducing a spate of regulatory and market instruments such as mandatory limits, pollution taxes, fees on resource use, cap and trade on pollution. While well intentioned at first sight, such measures run the risk that they perpetuate the systemic flaws of the system (as illustrated on cap and trade above).[39]

C. Systemic limits

If the growth, technological and governance constraints were not already enough, some systemic issues are also casting a very long shadow on the "green growth" hopes. Their essence is that the capitalist economic system cannot operate without growth, or, more precisely, in a contracting economy (with the exception of short cyclical crises). Moreover, "the introduction of fossil fuel made it possible to cut the chains of in-built bio-physical limits, limits that, in any case made growth impossible" (Rundgren, 2012: chapter 30).

"Expand or perish" is an inexorable force in a capitalist economic system. The constant accumulation of capital has inherent expansionist features, i.e. all economic agents are under competitive pressure to either undercut the costs of their competitors, generally by improving the economies of scale, or by creating new products and markets. Increases in labour productivity and the permanent creation of new consumer needs generally lead to more, not less production and consumption (i.e. the principal of capitalist accumulation). This increase in growth can bring, but does not necessarily mean, additional benefits to society. Capitalist actors are not interested per se in growth of societal benefits, but in sales' increases so that profits rise. As correctly put by Lockwood (2011), "capitalism is about investing capital to increase productivity, earn profits and then re-invest those profits in turn. Crucially, it is this process that underlies economic growth. Growth is inherent in capitalism, which means you can't have capitalism without growth, and you can't have a capitalist steady state economy", as advocated by Herman Daly (see, for instance, 2011: 11–15) and others.[40] Rather, as nicely described by Green (2011), "growth is like a bicycle – if it stops, you fall off".

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[37] For more information, see Kox (1993).

[38] What is often overlooked in this regard is that emission rights and eco-system services are adapted to the markets, which, according to Rundgren (2012: chapter 27) "is an euphemism for privatization … to let entrepreneurs and speculators earn money on the damage caused by capitalism itself; to give them concessions and access to the resources, a 'property' they later can sell on to someone else".

[39] For more information, see Rundgren (2012: chapter 27).

[40] For an elaborate discussion on "sustainable de-growth", see Martinez-Alier et al. (2010).

But what can be done, if, as shown above, the "qualitatively-different green growth" strategy is insufficient to check climate change, thus jeopardizing future development prospects and even the very existence of some developing countries?

The pivotal future challenge for achieving real sustainable and equitable growth is to couch the growth imperative within the societal benefits and prosperity objective and thus de-link it from the private motive of creating financial (instead of desirable social) profit/benefit (by way of illustration, without fossil fuel, we will have to drastically change methods of food production and consumption, but that does not mean that we will have to starve; likewise, without oil, we will not be able to keep the current level of motorized individual transport, but that does not mean that our level of mobility will have to be drastically reduced[41]). As Rundgren correctly put it for many developed countries, economic growth and expanding consumption have "made us healthier, wiser, more beautiful and happier to begin with, but it has long crossed a line after which more things do not mean more wellbeing" (Rundgren, 2012: Introduction). There is also the need to re-define "progress". Its old pillars – growth, ecological over-exploitation and infinite belief into techno-fixes for all key challenges we face – are crumbling (Hennicke et al., 2011). Against this background, governments need to regain the sovereignty of shaping policies according to real societal needs, rather than being turned into hostages or rubber stamps of stock markets or chased victims of rating agencies. In addition, there is the need for more effective and much broader forms of public participation and pressure on governments and the business community to make the required changes.

Even under very optimistic assumptions that global GHG emission intensity fell by 1 per cent per annum till 2050 (some 1.5 times higher than the historical trend for 1973–2005) and global energy intensity declined by 1.5 per cent annually (50 per cent faster than the historical trend), global economic activity would still have to stagnate till 2050 and yet our planet would be 3^{o} warmer (Minqui Li, 2008). However, an increase of global population by about 35 per cent would suggest that GDP growth should exceed historical labour productivity growth of 1.5 per cent annually, if serious social disruptions caused by mass-unemployment are to be avoided.[42] Likewise, government revenues are mainly derived from taxes, which tend to come under pressure when the economy stagnates, let alone contracts. And also borrowing and even holding of shares would become difficult without growth and profit gain. As Jackson correctly put it, "growth is functional in maintaining economic and social stability" (Jackson, 2009: 64).[43] And yet, Kenneth Boulding, President Kennedy's environmental adviser some 45 years ago, said something along the following lines: "Anyone who believes in indefinite growth in anything physical, on a physically finite planet, is either mad – or an economist" (New Statesman, 2011).

To avoid any misunderstanding, our analysis is far from scaremongering and doomsday prophetism. No doubt, "green" growth is better than a "brown" one and any step to check GHG emission growth is better than continuing with business as usual. However, one should not deceive oneself into believing that such evolutionary (and often reductionist) approach will be sufficient to cope with the complexities of climate change. It may rather give much false hope and, even more important, excuses to do nothing really fundamental that can bring about a U-turn of global GHG emissions in a historically extremely short period of time.

"Green growth" naively postulates that technological progress and structural change would be sufficient to uncouple economic from GHG and resources/material consumption growth, without questioning the existing asymmetrical market structures, related supply-chain governance, and economic driving forces (dematerialized growth will remain an illusion under the prevailing capitalist accumulation imperative).

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[41] For further elaboration, see Hänggi (2011).

[42] What in theory would be required is a shift in emphasis away from increasing labour to improving the "scarcest factors", i.e. energy, material and resource efficiency. With an increasing global population, labour productivity should even be allowed to decrease, yet that raises systemic issues.

[43] Jackson also qualifies that "the capitalist model has no easy route to a steady state position. Its natural dynamics push it towards one of two states: expansion or collapse" (2009: 64).

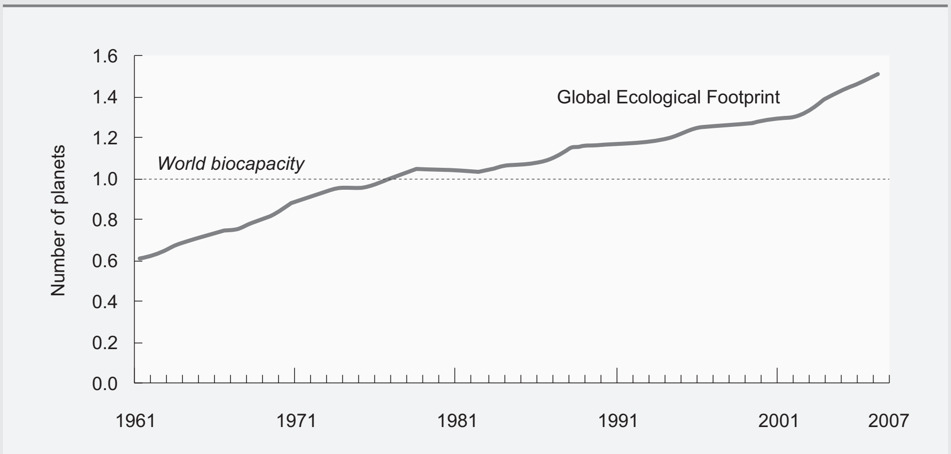
Box 2

THE MIND-BOGGLING GLOBAL ECOLOGICAL FOOTPRINT

The Global Ecological Footprint (GEF), as estimated by WWF, tracks the area of biologically productive land and water required to provide the renewable resources people use, and includes the space needed for infrastructure and vegetation to absorb waste carbon dioxide.

In 2007, the most recent year for which data is available, the GEF exceeded the Earth's biocapacity – the area actually available to produce renewable resources and absorb CO_2 – by 50 per cent. Overall, the GEF has doubled since 1966. This growth in ecological overshoot is largely attributable to the carbon footprint, which has increased 11-fold since 1961.

If the current trend continues, and no ecological tipping points are reached soon, the GEF will reach a factor of 2 by 2030, meaning that we would need two planets to sustain our population and consumption levels.[a]



Source: WWF (2010).

[a] A new study of researchers at the University of Hawaii even claims that a projected population of 10 billion people by 2050 with unchanged consumption patterns would require a cumulative natural resource use equivalent to the productivity of up to 27 planets Earth. According to the authors, the pressures on the planet's resources are escalating so quickly that the problem is running away from the solution (Mora and Sale, 2011: 251–266).

Without democratization of economies and changes in income-distribution and culture related to consumption behaviour, the required fundamental transformation will remain illusory. Moreover, those who advocate a decoupling of MRE use from economic growth and a drastic change in the energy mix need to scrutinize the historical evidence, in particular the arithmetic of economic and population growth. Furthermore, it should not be overlooked that there are natural-science and technical limits to growth, which cannot be circumvented by green technology alone. According to Tienhaara, "an overemphasis on technology … tends to displace solutions to problems that are simple, yet effective, and reinforces the belief that changes in lifestyle (or in ways of doing business) are not necessary in order to reduce humanity's impact on the planet" (Tienhaara, 2009: 18).

"Green stimulus packages" undoubtedly make sense as an anti-cyclical or anti-crisis strategy. They can also facilitate or accelerate much needed structural and technological change and expand the share of particular countries in global markets for green products and services. But, as Jackson correctly puts it, "the default assumption of even the 'greenest' stimulus package is to return the economy to a condition of continuing consumption growth. Since this condition is unsustainable, it is difficult to escape the conclusion that in the longer term something more is needed" (Jackson, 2009: 104). How serious the situation already is can be seen in box 2.

The climate problem (and associated with it the fuel, water[44] and soil fertility constraints[45]) are all too often only perceived as a management or technocratic problem, overlooking their socio-economic dimension and the deep-routed systemic problems that cause and drive them. As put by Hänggi (2011), "efficiency gains are insufficient for resolving resource scarcity; in fact, they are often bought through higher material consumption. They are thus representing nothing more than a slower growth in the depletion of natural resources. This is why green growth systematically destroys the foundations on which it is based … Regaining future developmental space and the re-introduction of sustainable forms of economic and social life is not a technical, but a social task, which will only be successful if it can overcome tremendous hurdles and resistance".

III. DEVELOPMENTAL CHALLENGES AND IMPLICATIONS

As pointed out by Rundgren (2012: chapter 7), "climate change has brought new credibility to perspectives such as ecological footprint and development space; and ultimately to that there are bio-physical limits for the economy". The analysis above calls into question the global equality of opportunity for prosperity (i.e. ecological justice and development space). Climate change is a huge developmental challenge because:

(i) it tends to reinforce social inequality and injustice as it affects first and foremost the poorest countries and segments of world population, who did not cause the atmospheric GHG overload, and thereby aggravates social tensions and conflict, both nationally and internationally;

(ii) it undermines and jeopardizes the prospects for economic prosperity in the poorest parts of the world; and

(iii) it is likely to threaten the physical existence of several poor countries, in particular small island states threatened by sea level rise and countries inflicted by draughts and desertification (against this background, these countries increasingly resist the framing of climate protection versus equity).

Against this background, what are the key developmental challenges and what is the development space for developing countries in the next two to three decades?

First of all, to avoid an apocalyptic future, developing countries can no longer follow, but will have to "tunnel" the so-called Environmental Kuznets Curve.[46] In other words, there is insufficient atmospheric carbon space in the future, which will no longer allow developing countries to have unabated economic growth till GDP per capita reaches a level, where environmental pollution and GHG emission intensity of growth start falling. By way of illustration, the targeted 20 per cent GHG emission reduction volume of all EU Member countries till 2020 would be offset by emissions resulting from just one year of China's economic growth (Minqui Li, 2008). As a result, "developmental space and justice" and "historical climate debt" will become very contentious issues in North-South relations and international climate change negotiations.[47]

Often arguments are made that developed countries should drastically cut their GHG emissions to make sufficient atmospheric carbon space for development in the South.[48] As analysed above, however,

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[44] Under a business-as-usual scenario, by 2025, 1.8 billion people will be in countries or regions with absolute water scarcity and two-thirds of the global population may suffer from water stress (UNEP, 2007).

[45] It is estimated that about one quarter of all usable land (excluding mountains and deserts) has been affected by degradation to a degree sufficient to reduce its productivity. More than half of the extremely degraded soils are in Africa (UNEP, 2002).

[46] According to this theory, there exists an inverted U-shape between pollution and economic growth. For more detail, see Stern (2003).

[47] For an in-depth analysis, see Khor (2010) and WBGU (2009).

[48] See, for instance, World People's Conference on Climate Change and the Right to Mother Earth, 2010.

significant absolute declines of Northern GHG emissions will remain illusory. What is more, it is simplistic to assume that a drastic reduction of growth (or even a decline) in developed countries could make sufficient “development and carbon space” for developing countries in the future (for more information, see Sakai, 2011). One cannot deny the reality that much of developing country growth will continue to be dependent on unsustainable consumption in the North.[49]

Apart from a higher frequency and severity of climate-change-induced disasters (such as draughts, floods, tropical storms or forest fires)[50] it can also not be ruled out that one or the other environmental tipping point is reached in the next few decades (the weakening of the monsoon in South Asia or the disappearance of large parts of the glaciers in the Himalaya, to give but two examples). Such unprecedented events will imply unimaginable human loss and suffering, for which neither national governments nor the international community are appropriately prepared. Consequently, significant parts of the concerned population are likely to get disillusioned and frustrated, which may well lead to political instability. Even worse, some countries, such as a number of island developing countries in the Pacific, the Indian Ocean and the Caribbean as well as large, lower-laying parts of a few countries, such as Bangladesh, are threatened in their physical existence by rising sea and ground water levels.

As highlighted in a recent DESA report (UN/DESA, 2011: 21), “developing countries tend to suffer more from the adverse consequences of natural hazards through multiple vulnerabilities associated with lower levels of development and inadequate resources, which constrain their efforts to build more adequate and resilient infrastructure and implement adequate disaster risk management strategies”. The report stresses that “disaster risk management and adaptation to climate change … have not been mainstreamed into broader decision-making processes. In practice, responses are most often largely event-driven … Investment and technology decisions related to disaster risk reduction and adaptation to climate change should be embedded in national development strategies”.

Against this background, while climate-change mitigation efforts remain important, developing countries need to prioritize investment and supportive policy action to step up effective climate-change adaptation in forms that optimize poverty-eradication. The most pressing and promising areas in this regard are a fundamental transformation of agriculture towards sustainable production methods; harnessing the use of renewable energy, in particular for sustainable rural development; and energy-efficient and climate-resilient construction and renovation of buildings (including urbanization in low-carbon cities).

Particularly dramatic will be the climate change impact on agricultural production, water and food security in developing countries, with the poorest of them in sub-Saharan Africa and South Asia being at the forefront (although food shortages might be overcome by imports from temperate zone countries, massive imports are unlikely to be affordable).[51] This is likely to provoke foot riots and political de-stabilization. It will also fuel large-scale migration from climate-change-distressed countries at regional and international level. There is an increased risk of conflicts over water and productive land. A dangerous geopolitics of food scarcity is thus likely to emerge, which may well seriously endanger international security.

Effective adaptation measures will become an issue of “survival” for agricultural and food systems (and politically for many governments). This can only be effectively addressed through a fundamental transformation of agriculture. The sector, being one of the biggest sources of global GHG emissions, can be turned from a cause into part of the solution to climate change. Given that more than 70 per cent of the agricultural mitigation potential is in developing countries, a far-going transformation of developing country agriculture is a key global issue.[52] Such transformation will have many catalytic and economic

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[49] For an analysis of rebalancing of growth between developed and developing countries, see UNCTAD (2010b: chapter II).

[50] For an overview of recent climate-change-caused extreme anomalies, see Tirado and Cotter (2010).

[51] For an in-depth analysis of the climate-change impact, see Hoffmann (2011: 3–5).

[52] For a more elaborate analysis of the required transformation, see Hoffmann (2011).

spin-off effects. Its linchpin has to be enhanced soil fertility, which, through building up of soil organic matter, can sequester huge amounts of CO_2, reduce the requirements for (fuel-derived) synthetic fertilizers and pesticides, improve water retention capacity of the soil, and significantly enhance adaptation capacity and climate resilience. The advantage of that approach is that it is based on tested and readily available technology and practices and that it also is one of the cheapest adaptation and mitigation tools. Moreover, it has many economic and social catalytic benefits.[53]

A fundamental transformation of agricultural production methods in developing countries will require considerable national and international efforts to scale up existing and appropriate technologies and knowledge that would assist notably small-scale farmers to widely use agro-ecological practices, linked to local and indigenous knowledge, which results in eco-functional intensification of agricultural production to assure food security, mitigate and adapt to climate change. By being more labour, local skills and local input intensive, these forms of agriculture offer more employment opportunities and distinct profitability advantages. If combined with renewable energy, sustainable agriculture could become the cornerstone of self-sustained rural development through the creation of income, markets and supportive service sectors.[54]

The much larger use of renewable energy in developing countries can make a significant contribution to climate-change mitigation, on the one hand, and enhanced energy security and affordable access to energy and thus spur local development, on the other. Large projects, such as solar and wind parks, but sustainably produced bio-fuels too, may also offer considerable export potential. Particularly important will be the symbiosis between sustainable agriculture and renewable energy, in particular as off-grid, local solutions (for more information, see UNCTAD, 2009).

Buildings account for almost 38 per cent of global final energy use, around 46 per cent of which is consumed in developing countries (IEA, 2008). Buildings are also very vulnerable to extreme weather events and inundation. Population in urban areas will double to 6 billion by 2050. The thus existing demand and market is huge and can relatively easily be catered for by the local construction sector, including many small and medium-sized enterprises. Most construction and energy-efficiency-enhancing renovation is labour intensive, uses locally available material and appliances and thus has multiple catalytic effects.[55]

Large parts of the trade infrastructure are in coastal zones of developing countries. In fact, these tend to be the economically richest parts of most countries. They are particularly vulnerable to rising sea levels and floods. Their climate proofing and adaptation will have to become a priority issue and will thus also provide plenty of opportunities for the construction sector.

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[53] All too often the impression is created that sustainable production in smallholder farming systems is bound to be less productive than industrial agriculture and thus cannot feed a rising population on our globe (conventional farms outperform small farmers only as regards productivity per unit of labour, because of the fuel-dependent mechanization and chemicalization; for more information, see De Schutter and Vanloqueren, 2011). Yet several studies have shown that if yields and economic returns are not expressed per product, but for the whole farming system, smallholder farming based on an integrated crop and livestock farming approach can produce 3–14 times as much per acre (i.e. 0.4 ha) as large scale industrial farms and can be considerably more profitable given the input cost savings (Altieri and Nicholls, 2008; Van der Ploeg, 2008; and Sachs and Santarius et al., 2007). The superiority of yields is particularly apparent during seasons with below-normal rainfall (for more information, see Herren et al., 2011). In the most comprehensive study to date, a group of scientists under the lead of Jules Pretty studied 286 completed and on-going farm projects in 57 developing countries, concluding that small-scale farmers increased their crop yields by an average of 79 per cent by using environmentally sustainable techniques (Pretty et al., 2006). The findings of the most recent comprehensive study, commissioned by the United Kingdom Government's Foresight Global Food and Farming Futures project that reviewed 40 sustainable intensification programmes in 20 African countries, confirm these results. Crop yields on average more than doubled over a period of 3–10 years (Pretty et al., 2011).

[54] For an in-dept discussion, see UNCTAD (2009); UNCTAD (2010a: chapter 4) and Mae-Wan Ho (2012).

[55] For an in-depth analysis, see UNEP (2011c) and UNCTAD (2010a: chapter 2).

The calamities caused by climate change are likely to increase the vulnerability of long international supply chains. As the Fukushima nuclear incident illustrated, supply chains can be severely affected, even in highly developed countries, leading to supply disruptions. To increase resilience, developing countries should place greater emphasis on safe local, national or regional supply chains as well as on national food sovereignty.[56] This will undoubtedly also require fundamental changes in the current governance of trade, which has been created to facilitate the globalization of supply chains discouraging reliance on domestic or regional sourcing.

Peak oil, as already mentioned above, is likely to make coal much more competitive as a fuel for base-load electricity generation, but also for coal liquefaction to meet rapidly rising transport fuel needs, in particular in China and India. According to IEA projections, China and India, which already account for 45 per cent of world coal use, are likely to drive over four-fifths of the increase in global coal consumption to 2030 (IEA, 2007: 43). The lion's share of the required coal demand of these countries can be met by abundant indigenous deposits. In the last 2–3 decades, global carbon emissions have risen more slowly than primary energy demand, because the shares of nuclear power, natural gas and renewable energy expanded. Driven by a greater reliance on coal in China and India and the weight of these two countries in total primary energy production and consumption, the carbon-emission intensity of primary energy generation is now however going to increase (IEA, 2007: 194). China and India are estimated to contribute between 55 and 70 per cent to the global increase in energy-related CO_2 emissions in the period to 2030 (IEA, 2007: 196).

As the dynamics of increasing coal-dependence for primary energy generation is unlikely to be checked by enhanced energy efficiency only, China and India will need to significantly step up their own efforts and require effective international support for mitigating coal-combustion-caused carbon emissions. Given the infancy of and uncertainty associated with the carbon-capture-and-storage technology, a concerted and massive international R&D effort and related investment is required to develop adequate technological, ecologically and economically sound solutions that reverse the very disturbing trend of coal-combustion-caused carbon emissions in China and India.

Emergency funds and contingency plans for climate-induced droughts and extreme weather events as well as provision of full costs for adaptation to those adverse effects need to be set up by national governments (in the context of National Adaptation Plans of Action) and the international community. Likewise, emergency funds and contingency plans for market volatility associated with the adverse effects of climate change on food production, which may affect the availability or affordability of food in developing countries, need to be created.[57]

Given the level of urgency and the time constraint, freeing sufficient national and obtaining adequate external funding for the above-mentioned adaptation measures is of pivotal importance.[58] Appropriate

[56] Curtis (2009: 432 and 433) argues that "changes in natural capital are beginning to erode the economic logic of one major aspect of economic globalization, an international division of labor and production based on global supply chains ... The strong implication is that production and trade will need to become more local or regional, although this will not occur easily, cheaply or quickly".

[57] For more information, see Third World Network Agriculture Info (2011).

[58] Decision 1/CP.16 of the Climate Change Conference in Bonn on 6–17 June 2011 created the Green Climate Fund (formally endorsed by the COP in Durban in December 2011), which is designated as the new operating entity of the Convention's financial mechanisms. The decision recognized the commitments by developed countries to provide US$30 billion of fast-start finance in 2011–2012, and to jointly mobilize US$100 billion per year by 2020.

international adaptation funding should reflect (i) the full costs of avoiding harm; (ii) actual harm and damage; and (iii) lost opportunities for development in developing countries.[59]

Taken together, the adaptation and mitigation measures outlined above for developing countries are unlikely to sufficiently check global warming, yet they have the potential to make economic development more climate-change resilient. They also offer ample development space for real prosperity gain. It should however be remembered that, as the Fukushima incident, the recent floods in Thailand or the earlier catastrophic floods in Pakistan[60] harshly illustrated, major climate-change-caused disasters may role back development gains, in particular when certain environmental tipping points are reached. Yet, the irony is that under the conventional system of measurement of economic performance, GDP may increase through remedial and corrective measures related to such environmental and human loss.[61]

[59] Currently, most multilateral public transfers are largely aimed at mitigating climate change rather than supporting adaptation: 79 per cent of dedicated multi- and bilateral funds were approved for mitigation projects (84 per cent when including REDD activities), and only 14 per cent for adaptation projects (www.climatefundsupdate.org). Bilateral ODA shows a slightly different pattern with a distribution of 70 per cent for mitigation and 30 per cent for adaptation. At the same time, most activities and funds focus on reducing emissions and increasing efficiency in the energy and transport sectors, while adaptation and mitigation in agriculture are still under-funded. Looking at bilateral ODA again, agriculture received only 1 per cent of all funds dedicated to mitigation in 2009, while this figure was 10 per cent for adaptation activities (Kaplan et al., 2011).

[60] Almost 20 million people (about 13 per cent of Pakistan's population) were affected by the floods. Preliminary estimates of the damage are as high as 15 per cent of the country's GDP. For more information, see Mufti (2011).

[61] As Rundgren (2012: chapter 21) duly points out "sometimes it is discussed that 'fixing' the problem with green house gases will 'cost' so and so many per cent of the GDP, but the reality is that it will increase the GDP. The final and in the long run interesting discussion about growth is if it will increase our well-being". And Rundgren continues "all in all, the ironic thing is that what capitalism can to a large extent be blamed for, to destroy the environment, becomes a new and lucrative field of expansion for capitalism. And the more destruction, the bigger the business" (chapter 26).

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