The EU Climate Policy: Expensive and Ineffective

Manuel Frondel, RWI and Ruhr-University Bochum

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1. Introduction

So-called “climate warming” has for some considerable time been one of the most discussed themes worldwide. Climate warming is generally understood to involve an increase in the average global temperature. In fact, the average temperature of the earth over the past century has increased by about 0.8 degrees Celsius (IPCC 2008). A good part of this increase occurred in the last two decades of the previous century.

Anthropogenic emissions of greenhouse gases, especially of carbon dioxide (CO2), have been made (largely) responsible for global warming. CO2 is a greenhouse gas created largely by the combustion of fossil fuels. To what extent this contributes to global warming is still controversial, as well as the strength of the associated threat it poses to so-called climate change. Therefore, the spectrum of positions on and assessments of climate change includes views which hold that the contribution of human-generated CO2 to global warming is negligibly small and insignificant (Lüdecke 2008:163), as well as statements that global warming causes greater havoc than any war (Stiglitz 2006:1) and could be accompanied by, for example, a substantial rise in sea levels, an increase in the frequency and intensity of storms or the expansion of deserts.

Notwithstanding the necessity of an intervention in this discussion, the current article deals with the efficiency and cost effectiveness of the European Commission’s climate policy which has largely concentrated on reducing greenhouse gas emissions, so far mainly on the reduction of CO2, while measures to adapt to climate change such as the strengthening and improvement of dykes to protect against a rise in sea levels, have taken more of a background role.

Section 2 explains the leading role that the European Commission -hereinafter referred to as the Commission- has played since the conclusion of the world-renowned international climate change agreement, the Kyoto Protocol, further strengthened by the announcement of an unconditional and ambitious greenhouse gas reduction target for the year 2020. Here, the goal is independent of whether other major emitting countries like China or the U.S. also undertake reduction efforts. Recent greenhouse gas reduction efforts by the European Union (EU) and its member states will also be compared to those of other leading industrial and emerging countries in this section

Section 3 explains the internationally counter-productive repercussions of ambitious but unilateral efforts by the Commission towards greenhouse gas reduction.

Section 4 raises the question of cost effectiveness of unilateral EU policy which is dubious for various reasons.

Section 5 explains the reasons why the chances for the materialization of a global climate agreement to reduce greenhouse gas are poor, even though highly desirable, as independent cooperation or even unilateral actions both tend to be unhelpfully over-exaggerated, or even counterproductive.

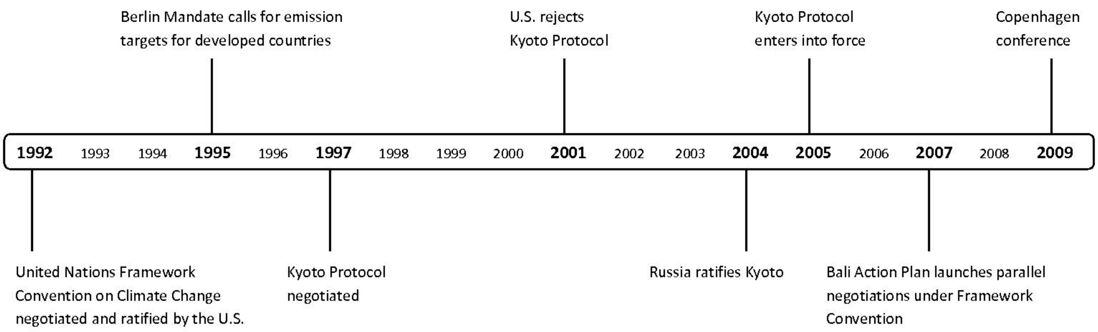
Section 6 discusses promising policy alternatives to the imposition of emissions restrictions by which in the first instance, individual countries would themselves benefit from challenging measures and therefore have a high vested interest in their implementation. This would encourage a worldwide accord on gradually increasing expenditure on research and development (R&D) in energy conversion and storage technologies, which without being directly beneficial, could achieve greenhouse gas reductions and have a realistic chance of realization within a few decades.

Section 7 deals with the advantages of measures to adapt to global warming which, among others, could include targeting flood-areas, as well as the relocation of populations at risk to less threatened land areas. A strategy for the implementation of adaptation measures has particular importance as efforts towards global emissions reduction are extremely unlikely to have any chance of success. The final section presents a resume of the Commissions chosen climate policy strategy and argues for a major strategy change.

2. The Limited Effects of the EU Greenhouse Gas Reduction Policy

Since the beginning of the 1990s, the Commission has been active in establishing measures to reduce greenhouse gas emissions at an international level (Fig 1). With the ratification and implementation of the Kyoto Protocol, the Commission effectively took on a leading role. Without the explicit and comparatively high reduction targets set by the EU, The Kyoto Protocol would hardly have been adopted in 1997 and without the strategic acumen of the Commission, the Kyoto process would probably have been aborted after the USA's rejection of the Protocol in 2001 (Böhringer 2010:60). Only with the ratification of the Kyoto Protocol by Russia, the country that tipped the balance on specific diplomatic awareness as well as numerous concessions granted to the Commission (Requate 2010:1), could the Protocol come into force as a binding contract under international law in 2005. Penalties for non-compliance with agreed targets were however, not incorporated.

Figure 1: Important Cornerstones in Climate Policy since 1990



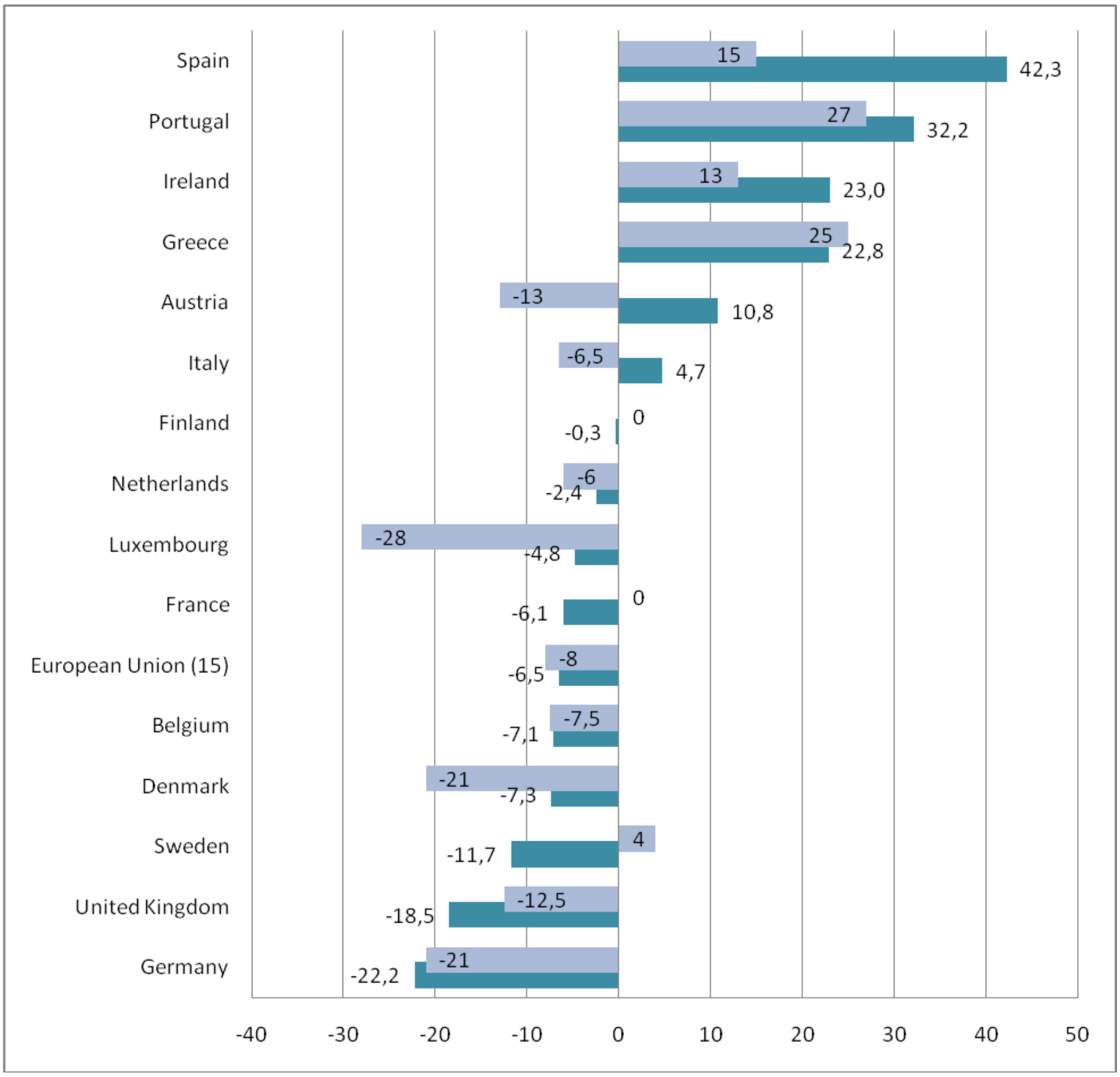
With the ratification of the Kyoto Protocol, the EU was required to ensure that greenhouse gas emissions for the years 2008-2012 are on average, 8% lower than in 1990. To achieve this objective for the whole EU, the EU Burden-Sharing Agreement was established in 1998 which laid out the burdens that individual members have to shoulder. With the goal of reducing greenhouse gas emissions by 21% as compared to 1990 (Fig 2), Germany bears by far the highest burden of reduction. Germany's reduction commitment accounts for around three quarters of the total reduction for the EU set under the Kyoto Protocol.

With a reduction of 6.5% in greenhouse gas emissions compared to 1990, the EU-15 countries were already close to their Kyoto target of 8% in 2008 even though some countries such as Denmark, Austria, Luxembourg, Italy and Spain clearly were experiencing significant difficulties (Fig 2). Other member states including France, Sweden, the United Kingdom and Germany had however already achieved their reduction targets.

The observance of individual Kyoto obligations is clearly a prerequisite for the credibility of unilateral and ambitious reduction targets set by the Commission for the year 2020. Accordingly, in the Commission's energy and climate packet agreed in early 2009, European-wide gas emissions should decrease by a minimum of 20% by 2020 compared to 1990 levels. Taking comparable efforts on behalf of other major industrial nations into consideration, even a reduction of 30% is contemplated. The EU has therefore taken on the leading role in the battle against greenhouse gas emissions. Other states have not set such ambitious targets for the Kyoto compliance period 2008-2012 and there is currently no comparable internationally agreed climate change agreement.

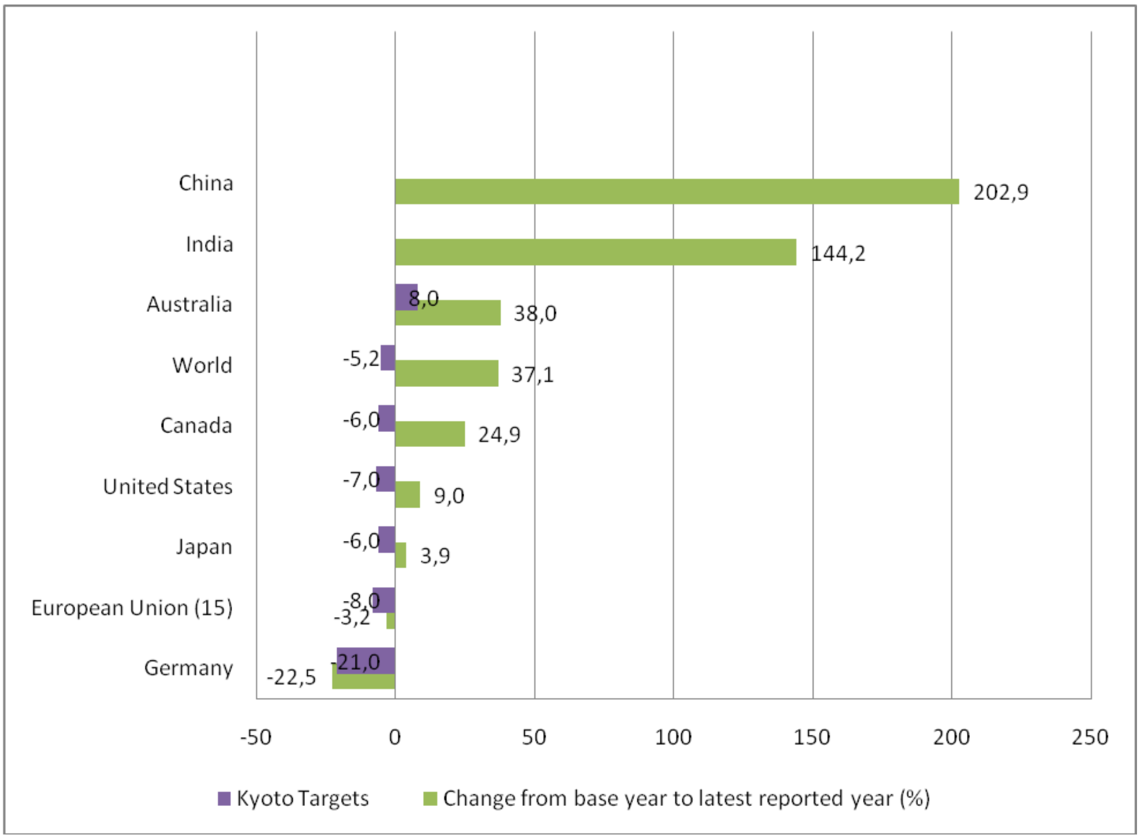
In view of its climate protection ambitions for 2020, the Commission would be advised to consider the fact that recent reduction success is less to be accredited to stringent policy but rather to the considerable influence of unique historical events. These include the economic collapse of former Eastern Bloc countries resulting in political upheaval, the economic renewal of East Germany after German reunification as well as the deep recession after the banking and financial crisis at the end of the first decade of this century. According to a study commissioned by the European Parliament in 2009, roughly half of the emissions reductions in the EU since 1990 can alone be traced back to the impact of historical political developments (Böhringer 2010:63).

Figure 2: EU Burden-Sharing and Changes in Greenhouse Gas Emissions in Percentage Terms



Furthermore, the Commission cannot ignore the fact that, as well as several European countries, numerous other industrial countries which signed and ratified the Kyoto Protocol are some considerable distance from their targets (Fig.3). Australia for example, with an emissions increase of 38% between 1990 and 2008 is impossibly far away from its Kyoto target. In the USA, Canada and Japan, emissions have likewise risen to the extent that anticipated emissions reductions in Kyoto obligations for these countries hardly seem reachable, above all for Canada. Even a turnaround in hitherto increasing emissions trends would be seen as a success by these countries; compliance with Kyoto targets on the other hand seems almost impossible.

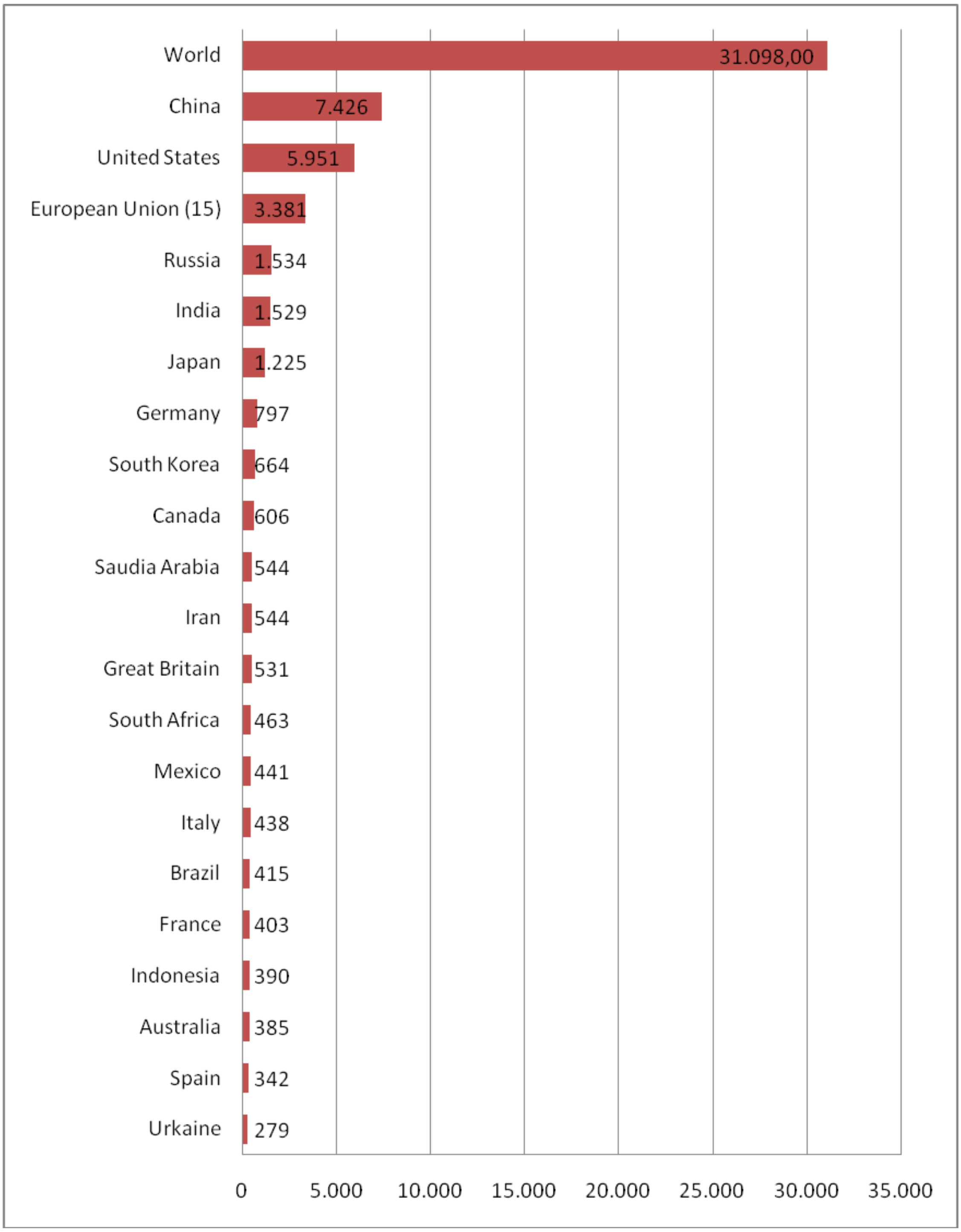
Figure 3: Changes in CO2 Emissions for Leading Emitters in Percentage Terms (1990- 2009) Source: Cerina (2010)



This should be taken together with the substantial costs involved in the drive towards climate protection where there is clear evidence that even states such as Canada, who are contractually bound by the Kyoto protocol, have backed away from it (Böhringer, Rutherford 2010). This also applies to the failure to establish workable sanctions (Böhringer 2010:60). Overall, worldwide CO2 emissions rose by around 37% between 1990 and 2008 (Figure 3) in spite of successful reduction efforts by the EU, as opposed to falling by 5.2% as anticipated by the Kyoto Protocol.

All efforts by the Commission are in the end limited by the fact that the EU-15 share in worldwide CO2 emissions is relatively small and stood at just 12% in the year 2008 (Fig 4). Without cooperation from China and the USA, the two leading emissions countries, whose emission shares in 2008 lay at 21.4% and 19.1% respectively, global emissions cannot be significantly reduced. Recent history clearly demonstrates this.

Figure 4: CO2 Emissions by Leading Emissions Countries in the year 2009

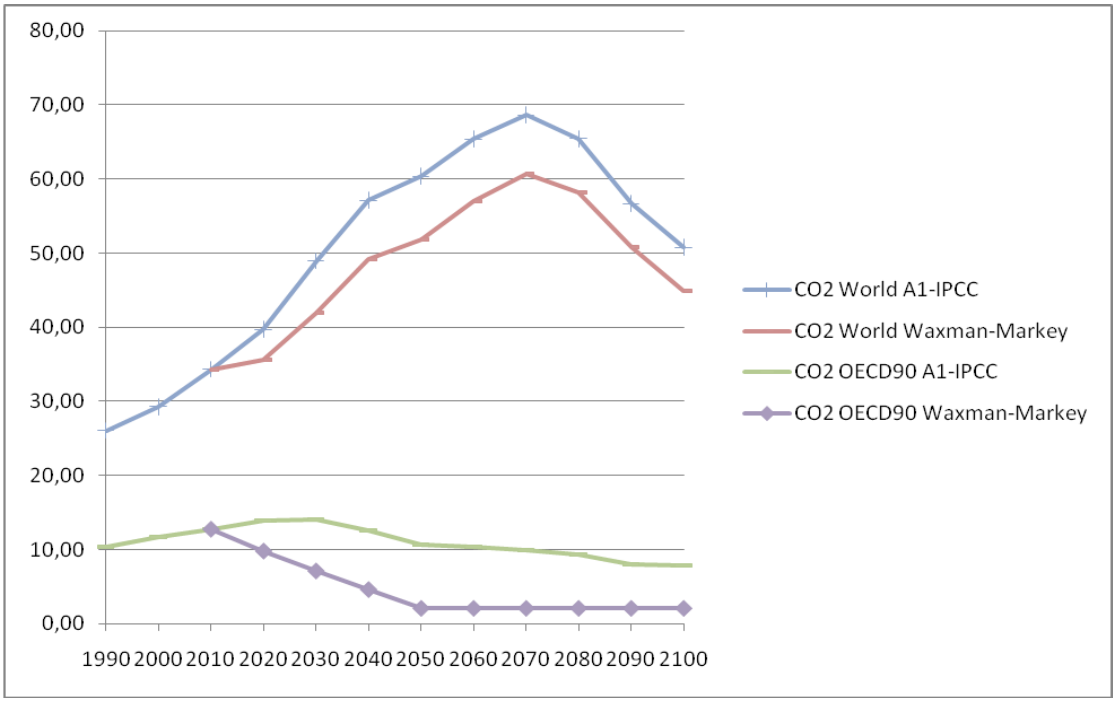


In reality, the uncomfortable truth is that the reduction of greenhouse gases in the EU in a global context could have entirely secondary consequences (Böhringer 2010:56). CO2 emissions in China more than trebled between 1990 and 2009 (Fig 3) and rose from 2.45 to 7.43 billion tons whereas CO2 emissions by EU-15 states decreased by 3.49 to 3.38 billion tons (Cerina 2010). The reduction by the EU-15 by 0.11 billion tons effectively means a comparative almost fifty-fold rise in China's emissions. Also, in the context of expected emissions increases in developing and emerging countries such as China, Russia and India, emissions developments in the EU and other industrial countries will have a further secondary role as shown in Fig 5.

Even if CO2 emissions in OECD countries really decrease by 83% by 2050 as foreseen in the plan named after US Congressmen Waxman and Markey, future rise in global emissions could only be moderately attenuated as Fig 5 shows. The emissions trend without reductions in OCED countries, as foreseen by the Waxman-Markey Plan, corresponds to the economic-oriented A1 Scenario by the Inter-Governmental Panel on Climate Change (IPCC 2010) which implies increasing globalization. According to the A1 Scenario, the trend towards higher emissions will reverse only in the year 2070. The main reason for this is a predicted fall in world population.

In short: even if the EU, together with all other OECD countries reduced their CO2 emissions to zero over the next decade, this would in effect have very little impact. To put it even more clearly: without a drastic reduction in emissions per-head in prosperous emerging countries, which have to date dropped very slowly relatively speaking, the future rise in worldwide emissions could not even be forestalled let alone decreased.

Figure 5: Future CO2 Emissions on Implementation of Waxman-Markey Plan in Billions of Tons CO2



3. Counter-productive International Repercussions

Unilateral efforts by the Commission to reduce greenhouse gases can in the last resort do little to mitigate worldwide emissions as they have counter-productive international repercussions (Böhringer 2010:58). This means that after gaining insights from environmental-economic literature, countries decrease their reduction efforts when a nation or confederation of states like the EU is widely recognized as having a higher credibility when it comes to intensified efforts towards emissions reductions (Beirat BMF 2010:14).

As a consequence, the more a confederation of states such as the EU attempts to mitigate or even reduce worldwide emissions, the less advantage there is to be gained for other states from their own reduction efforts (Beirat BMF 2010:16). In other words: the marginal benefit to other states wanes with increasing EU efforts. Given the reduced marginal benefits, it is extremely appealing to non EU states to restrain their own efforts in view of EU ambitions.

Other countries profit therefore from EU efforts in two respects. Firstly their "feel good" factor is immediately raised by heightened emissions reductions in EU countries if these measures have a positive effect on the world climate. Secondly, heightened prevention efforts by the EU reduce climate protection costs for other states as they cut back on their own emissions reduction measures.

In short: changes in their cost-benefit calculations mean that non-EU countries' greenhouse gas reduction policies tend to be less restrictive and less ambitiously developed than without EU efforts, so they are able to reduce their own greenhouse gas reduction costs (Hoel 1991, Warr 1993). The effect of the voluntary agreement imposed by the Commission when setting the 20% target results in a so called "crowding out" or avoidance of prevention efforts by other countries. Effective EU emissions reductions could quite plausibly lead to a partial or almost total compensation (Beirat BMF 2010:14).

In adopting a unilateral voluntary agreement on higher emissions reduction, they may well hope to establish a positive example for other countries to follow. In the real world however, where emissions by all countries are determined by individual cost-benefit calculations, this is a forlorn hope (Beirat BMF 2010:14). Moreover, the great danger that other countries will devote less, rather than more, has an impact on the reduction of global emissions given the strong leading role played by the EU. The short-term "feel good" effects of such a pioneering policy are clear: welfare in the voluntarily obligated EU will decrease whereas the welfare in all other countries - at least in the short term- will rise (Beirat BMF 2010:14).

Via its unilateral reductions policy, the EU expressly displaces emissions in countries without emissions reductions (Hoel 1991, Felder, Rutherford 1993), an effect known as Emissions- or Carbon-Leakage. This means that unilateral efforts by energy-intensive European industries leads to increased emissions in non EU countries where there are no comparable climate protection costs. In this way, emissions reductions in Europe lead conversely to raised emissions in other countries (Oliveira-Martins et al. 1992).

There are three reasons for this: firstly, location shifts of environmentally and energy-intensive industries to non EU countries may occur. Critics point out that environmental regulations are only one location factor, but admit the possibility of location shifts (Hentrich, Matschoss 2006:51). Secondly, imports of environmentally-intensive products could suppress European production. According to an empirical study by Demailly and Quirion (2006), this would apply to a considerable degree to cement. Thirdly, a substantial downturn in demand in countries with strict emission reductions could lead to lower energy prices worldwide, so that the demand for fossil energy sources would immediately increase in other countries (Böhringer 2010:58).

To mitigate these counter-productive repercussions, it could be reasonable to charge energy and trade-intensive industries to a lesser degree, as Böhringer and Schwager state (2003:13), as for example in the levying of power taxes in Germany. The Commission has also realised the relevance of the leakage effect and will at least partially exclude enterprises from industrial sectors that are both trade- and energy-intensive from purchasing required certificates from the year 2013 onwards. Excluded are those sectors where costs caused by emissions trading amount to at least 5% of the gross value added and whose trade volume[1] likewise exceeds 10%. Sectors where only one of these criteria exceeds 30% are considered to be especially affected by carbon leakage and are therefore also excluded.

However, it has to be considered that these exemptions do not completely relieve such enterprises of C02 costs. Rather, energy-intensive companies which evidentially must remain competitive in the face of international competition are given an allowance that is defined by a sector-specific benchmark (BMU 2008). For the determination of benchmarks standardised within the EU, the most efficient investments by branch in the EU are taken into consideration. Those enterprises however that are not included in the most efficient 10% of a branch

1 Trade volume is the sum of imports and exports divided by the sum of imports and exports generated in the EU (BMU 2008).

could, in spite of the free allowance, be faced with substantial costs in purchasing further necessary certificates.

An overly ambitious unilateral climate policy that pursues increasingly stricter climate protection aims can finally also lead to intensified mining of fossil energy sources as suppliers of raw materials could fear that as a result of prospective reinforced climate protection efforts, the demand, and thereby the prices for raw energy, materials could decrease. According to the “green paradox” (Sinn 2008) worldwide emissions of greenhouse gases could paradoxically be precipitated more quickly with, rather than without, climate protection efforts.

4. The Lack of Cost Efficiency in the EU's Greenhouse Gas Reduction Policy

Even though, as stated above, the Commission's climate policy has only minimal or even counter-productive effects on a global scale, there is still a question on the EU's unilateral policy cost efficiency. Cost efficiency can be especially doubted for the following reasons (Böhringer 2010:63):

Firstly, additional costs are unavoidable because alongside the climate protection tool of C02 emission certificate trading, established specifically for the purpose of greenhouse gas reduction, several other restrictive regulation tools are deployed, even though, according to environmental economic literature, the reduction of greenhouse gasses can only be reached by emission trading at the lowest costs. Only in this case can emission reduction aims be achieved not only ecologically accurately, but also with economic efficiency (Bonus 1998:7).

Secondly, considerable additional costs also arise because emission trading is so far restricted to the EU. An expansion of the EU emission trading system to further regions which particularly include major emitters such as the USA and China, would allow a reduction of the same amount of emissions at a favourable cost because with the help of this instrument, emissions could be reduced where it is cheapest (Böhringer 2010:64). With an international expansion of emission trading, the number of available cheap reduction options should increase. This should lead to reduced costs in achieving specific emission reductions.
However, there is little hope for an expansion of the EU emissions trading system to global trade as this demands a worldwide climate policy agreement. The prospect of negotiating an effective international climate agreement with reduction aims that are both part of international law and legally binding is very poor (Beirat BMF 2010:7), as will be explained in the following section. One of the main reasons for this is that there is no world government and there will never be one.

Thirdly, in spite of the establishment and development of emissions trading, which has to be emphasized as positive, the EU is still a long way from a coherent climate policy (Böhringer 2010:66). This is mainly due to the fact that, so far, only the power generation sectors and energy-intensive production facilities are included in emissions trading, which together are responsible for about 40 % of the EU-wide C02 output. By contrast, other fields like the traffic sector, private households, business sectors, trade and services companies, are not integrated into emission trading. Instead of expanding emission trading to other fields, there is a tendency in the EU to regulate each sector specifically to achieve the EU-wide reduction aim. This results in a considerable loss of efficiency (Böhringer et al. 2005).

Therefore, in future, there will be a specific emissions standard for private car traffic under the Commissions preferred regulation tool (Frondel, Schmidt 2008:330). Under EU ordinance 443/2009, an upper limit of specific C02 emissions per kilometre is mandatory for new cars, which increases with the vehicles weight. C02 reduction costs of between €475 and €950 per ton of C02 are connected to this type of regulation whereas the C02 certificate price in the context of emission trading has not so far exceeded €30 per ton.

The economic advantages of emission trading notwithstanding, there are a number of further measures and political instruments which the EU Commission defends in the reduction of the greenhouse gas emissions as one of several approaches. Firstly, there are guidelines to increase energy efficiency and to develop the use of renewable energies. By this, the 20-20-20 aims listed in the energy- and climate-protection package should be achieved. Thus, the reduction of greenhouse gasses by 20% compared to 1990 represents one of the aims for the year 2020, while the expansion of the contributions of renewable energies by 20% to cover primary energy needs by 2020, as well as an increase in energy efficiency of 20%, constitute further goals.

Part of this bundle of regulations is also the gradual ban on selling proprietary light bulbs issued on 1 September 2009, which prohibits the sale of different kinds of light bulbs in the EU by latest 31 August 2012 (EU ordinance 244/2009) and therefore goes under the name “light bulb ban”. This ban is basically justified by the Commission on two grounds (Frondel, Lohmann 2010). Firstly, energy-saving bulbs would help private households and other power consumers to save electricity and thereby money, so that electricity bills would significantly decrease. Frondel and Lohmann (2010) hold that the use of energy-saving bulbs provides substantial cost benefits under frequent use. Under rare usage however, as is the case in lighting in cellars and attics, consumers suffer economically. For this reason alone, the EU Commission's general light bulb ban is inappropriate and should be withdrawn.

Secondly, according to the Commission, the emission of greenhouse gasses connected with conventional power generation using fossil fuels such as coal or gas can be reduced with the electricity savings achieved with the light bulb ban. In fact, the net effect of this ban tends to be zero when coexisting with emission trading established in 2005, as well as all other measures aiming at a reduction in power usage and connected C02 emissions. As the emission trade dictates a mandatory cap on C02 emissions, no further savings can be achieved in Germany by measures such as the Renewable Energies Act (Erneuerbare-Energien-Gesetz, EEG) to encourage alternative power generating technologies (Frondel, Ritter, Schmidt 2008:4201).

Power generation support via the EEG does cause lower emissions in the German power sector which is why certificate prices are in effect lower than without the EEG. However, reductions efforts are not taken-on in other sectors involved in emission trading because it is cheaper to buy certificates. Other power generation sectors in the EU as well as the industrial sectors involved in emission trading accordingly show higher emissions and thereby completely offset any savings achieved by the EEG in the German power generation sector.

As a result, there is merely an emission shift; the savings effect achieved by the EEG is however, de facto, zero (BMWA 2004:8, Morthorst 2003). This can lead to the situation that in the event of a strong expansion of renewable energy and the significant effects of a decreasing C02 price connected to it, it could be more profitable for operators of old coal power stations to keep their barely efficient, emission-intensive facilities running, as if the (percentage) share of renewable energy had not indeed been increased. Consequently, the restrictiveness of regulations can even lead to paradoxical results (Böhringer 2010:69).

Ultimately, comparatively inexpensive measures have not been taken, even though they would have been implemented in a hypothetical situation without a German EEG and support tools for renewable energy existing in the other EU states. Instead, solar power production, the most expensive of all discussed technologies for avoiding C02 emissions, has been implemented. Frondel, Ritter, Schmidt, Vance estimate the reduction costs resulting from the promotion of photovoltaics at more than €600 per ton C02 (2010a:119). The International Energy Agency assumes an even higher value of about €1000 per ton (IEA 2007:74).

As a result, the net costs for all photovoltaic modules installed in Germany between 2000 and 2009 amount to about 52,3 billion €. (Frondel, Ritter, Schnmidt, Vance 2010b:4051). This counteracts the principle of emission trading to reduce greenhouse gas emissions where it is most inexpensive - i.e. to reduce greenhouse gasses with the most cost-efficient technology.

This theoretical argument is underpinned by a statistical analysis for Germany by Traber and Kemfert (2009) which demonstrates that C02 output has hardly changed on a European level, even though emissions in the German power generation sector have been reduced by 11% by the EEG. The reason for this is that power production based on renewable technologies in Germany reduces the urgency of emission reduction in the other EU countries as the EU-wide effective prices for C02-certificates are in effect 15% lower compared to the situation without a German EEG (Traber, Kemfert 2009:169).

It is often argued that the ecological ineffectiveness of the EEG in terms of the the EU-wide expansion of renewable energy can be remedied by reducing the emission budget of the emission trade using C02 reduction shares that can be expected to result from the expansion of renewable power production (Diekmann, Kemfert 2005; Kemfert, Diekmann 2009). Therefore, it is claimed that the C02-reducing influence of renewable power production technologies was considered in the EU-wide binding emission cap for 2020 (COM 2008) and therefore, the expansion of renewable energies did indeed have a C02-reducing effect. This argument is incorrect because it is solely the instrument of emission trading itself that guarantees keeping within the emission cap. This limit would be maintained even if the expansion of renewable energies were completely abandoned; admittedly, an unlikely development.

In fact, this analysis illustrates that it is only the tool of emission trading that causes a decrease in greenhouse gas emissions (Häder 2010:14). This hardly disputable fact is often contested by claiming that it is merely the subsidy of renewable energies that allows for lower caps in EU future emissions trading than would otherwise be the case. This argument is unsound because EU countries would be able to keep within upcoming lower caps with far lower subsidies than involved in the promotion of renewable energy.

The continued operation of nuclear power plants in Germany, which under existing law should be shut down after 32 years when in fact the technical duration period is 60 years or more, is only one example of how stricter emission limits could be applied in a less expensive manner. In this example, the national economic costs could even be negative and prosperity in the EU and especially in Germany would undoubtedly be increased (Energieprognose 2009). By contrast, additional policies for promoting renewable energies have proven to be especially expensive. Böhringer et al. (2009a) pointed out that the costs for greenhouse gas reduction in the EU could even double through such political measures.

A further example of a tool impacting emission trading is power taxation. One such example was implemented under the name “eco tax” in Germany in 1999. Companies that pay power taxes as well as participating in emission trading, effectively lose out (Böhringer 2010:68). They indirectly subsidise companies in countries that also are involved in emission trading but are not subjected to a power tax. Here too, the following applies: as total emissions are capped in the EU emission trading, additional power or C02 taxation has no C02-reducing effect (Böhringer 2010:68).

This similarly applies to all further tools aimed at a reduction of power consumption in the EU countries. In Germany for example, the energy consumption labelling law that promotes the sale of energy-efficient electric devices, the CHP promotion via the Act on Combined Heat and Power Generation or the Energy-using Products Act (Energiebetriebene-Produkte-Gesetz, EBPG), exclude energy-inefficient devices from the market. As a result of the co-existing emissions trade, these laws are ineffective in regard to greenhouse gas reductions (Häder 2010:17) as is the trade with so-called “white certificates” established in Great Britain and Italy, which is meant to achieve a reduction in power consumption.

Even if there were no C02 emissions trade, white certificate systems would not be the tool of first choice: any policy that sets across-the board energy demands to minimise environmental externalities without taking environmental effects into consideration, is inefficient (Mennel, Strum 2010:27).

In fact, instruments that are based on emission trading as well as technology-specific support, with the subsidisation of renewable energy leading the way, are not only ineffective (i.e. ecologically superfluous), but also counterproductive from an economic standpoint as they make climate protection un-necessarily expensive (Häder 2010:15). The promotion of alternative technologies to produce “green” power, which is subsidised in Europe to the tune of several billion Euros each year - in Germany alone feed-in compensation for “green” electricity amounted to ca. 10 bill. Euros in 2009 (Schiffer 2010:38) – has therefore to be justified in other ways.

Unfortunately, positive effects on the employment rate can not be expected because of the massive financial burden applied by the Commission's renewable energy policy (Frondel, Ritter, Schmidt, Vance 1010b:4055). Because of this, there is a loss of purchasing power in private households along with increased power prices induced by the promotion of renewable energies, e.g. the German Renewable Energies Act (Erneuerbare-Energien-Gesetz, EEG). Combined with a withdrawal of investment capital by industrial power consumers, this causes negative employment effects in other sectors. As budgets of industrial consumers are reduced by higher power prices, there are fewer funds available for alternative and more profitable investments. Therefore it is highly doubtful that the net employment effects of the German EEG will turn out to be positive (Frondel, Ritter, Schmidt, Vance 2010a:123).

Accordingly, it is unsurprising that there have been several studies which are sceptical with regard to positive net employment effects. The Institute for Economic Research in Halle states that considering the investment costs, i.e. the displacement of the private use of investment funds, “practically no employment effects could be detected“ (IWH 2004:72). Fahl, Küster und Ellersdorfer (2005), Pfaffenberger (2006) and the RWI (2004) resp. Hillebrand et al. (2006) commented similarly.

Overall, jobs created by promotion/subsidy of renewable energy are bought dearly. In Spain, the creation of 50,000 “green jobs” cost 28.7 bill. Euros (Álvarez et al. 2009:24). This works out at €574,000 per job. Similarly high subsidies are paid in Germany for every job in the photovoltaic sector. On the basis of net costs of around 17.4 billion € for all facilities set up in 2009 (Frondel, Ritter, Schmidt, Vance 2010b:4051), subsidies per head work out at about €290,000, assuming 60,000 employees in the German photovoltaic sector (BSW 2009).

These results are not really surprising. After all, political comparative advantage is not necessarily expected to result in the immediate creation of jobs. One would perhaps expect that a market that favours competitively viable conventional power production technologies would be more capable of creating more jobs and thus higher prosperity, than policies which promote inefficient “green” technologies.

Indeed, policies should concentrate not on creating jobs but on creating favourable business conditions that allow for the production of goods and services at the lowest possible costs. The support for developing new production methods which use less energy resources, environment, capital or work to produce the same output as existing technologies, is part of these conditions. By utilising freely available resources for other purposes, the population's standard of living can be increased. The technology support planned by the Commission to promote the increase of renewable energy is not very successful in this respect, as will be shown in section 7.

5. Poor Chances for a Global Climate Agreement for Greenhouse Gas Reduction

National climate policies to decrease greenhouse gasses are faced with a fundamental dilemma[2]: the citizens of a single country who are burdened with the full costs of a unilateral reduction policy profit only to a small degree from this climate policy; indeed, if these reductions of greenhouse gasses can significantly influence global warming at all. Beneficiaries of these emission reduction efforts are the citizens of other countries; as a result, the main benefits of such a policy lay abroad (Beirat BMF 2010:8).

For this reason, single countries usually have only small incentives[3] to spend substantially on greenhouse gas reductions, as while these benefit everyone because of global effects, they bring about little on a worldwide scale. On the contrary: a single country is rather tempted to act as a "free rider" (Weimann 1994:73) and do nothing in order to benefit from other countries efforts.

Therefore, the main challenge is to find a way to stop states from "free riding" and to raise the likelihood of the realization of a climate agreement on a global level by which nearly all states, or at least all major emitters, agree to self-impose greenhouse gas restrictions. Due to the lack of a world government however, which will certainly never exist, the result could effectively sanction "free riding" (Weimann 1994:73) as international climate policy consists solely of voluntary agreements. This raises the question of what role partnerships of single countries could play in influencing other countries' readiness to participate in a global climate agreement.

Partnerships of a group of countries, like for example the 27 EU member states, could indeed be attractive and economically rational for single members, as explained in the following example. Let us suppose, for arguments sake, that the 27 EU states agree on the same level of emissions reduction. This agreement pays off for a single EU member if and only if its emission reduction costs are lower than the benefits for this country achieved by the 27th highest emission reduction effort to which the partner countries contractually agreed.[4] One would presume that the participation of a country in such a cooperation contract is the

2 Hardin called this dilemma the "tragedy of commons". This states that common and public goods that are available for everyone have therefore no price and suffer from overexploitation.

3 Only few countries contribute to the reduction of emissions on a voluntary basis (Beirat BMF 2010:11). It is more probable that a country belongs to this group as the bigger, more densely populated and more prosperous the country is, the more dramatic the effects of climate change, the more prominent and politically influential the ecology movement within the country, the lower the costs of emission reductions are for the country.

4 The hypothetical assumption that all countries pledge to the same amount of reduction is irrelevant. In fact, the cost-benefit calculation of a country pledging to a certain emission reduction obviously does not matter as long as the reduction quantity as a whole remains the same.

more attractive the more partners commit themselves to reductions efforts as their own efforts are rewarded with respective many-fold emission reductions.

At a first glance one would therefore expect that such a cooperation by a group of countries would raise the chances for the realization of a global agreement, as one could hope for a cumulative effect from this cooperation and that the pioneering role taken on in the cooperation would positively influence the expansion of this partial agreement to a global level.

The evidence from environment-economical literature on the question of the significance of partial agreements for the chances of a global climate agreement is however highly sobering: For the same reasons outlined in section 3 which state that excessive engagement of a single country or a group of states like the EU reduces other states willingness to reduce emissions, the willingness of the other states to cooperate is reduced by the cooperation of a group of states, and therefore, the realization of a global climate agreement is even less likely.

Indeed, the more a country or group of countries is prepared to do in the context of a cooperative contract, the more attractive it is for other countries to undertake less prevention themselves and to keep their distance from an agreement that commits them to considerable efforts because marginal benefits from their own efforts decrease in the light of efforts by leading countries, whilst marginal prevention costs, remain the same.[5]

An agreement by a subgroup of states, such as the voluntary agreement by EU states on a 20% reduction in greenhouse gases compared to 1990, can thus have a negative influence on the negotiation of a worldwide climate agreement (Beirat BMF 2010:17). "Pioneering by a subgroup of countries and agreement on higher emission reduction targets is, in policy terms perhaps, a moral victory. When it comes however to saving the world climate in the framework of a global environmental agreement, this form of moral deal is misguided. It can prevent an effective solution which would have been within the bounds of possibility without the pioneering."

Cooperation by a subgroup of countries is however, not only of limited use in the realization of a global climate agreement. According to environmental economic literature, it even builds the risk of increasing redistribution of cost

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[5] In economic literature, rational cost benefit calculations preponderate as the basis for individual decisions. In other social scientific as well as economic areas, decisions made on the basis of incomplete information or a limited rationality are more typically considered. Even if, for example countries identified their mitigation efforts with an evolutionary process rather than an overly welfare-maximising one, concessions made by individual countries would be just as ineffective. In an evolutionary process, countries imitate the successful strategies of other countries and here, countries making only limited mitigation efforts are most successful. Even in an evolutionary process, inefficient, low mitigation comes to the fore.

burdens for countries which have already declared they are ready to cooperate (Buchholz, Haslbeck, Sandler 1998, Konrad 2003). The Commission should therefore consider this associated effect mechanism when it comes to the question of whether climate policy should lie in the hands of individual EU countries all be centrally co-ordinated from Brussels. Whilst a co-ordinated EU climate policy itself can only have a small influence on global emissions reduction (figure 2) the chances for a worldwide coordinated climate policy are minimized as the burden for emissions reduction falls on member states rather than other OECD states who tend to be relieved from their burden (Beirat BMF 2010:14).

Given that the Commission's climate policy has counterproductive effects, the chances for a global agreement that leads to an appreciable reduction in global emissions or at least a widespread stagnation are poor, as this agreement would most impact the countries with the most extensive greenhouse gas emissions. China, the largest worldwide greenhouse gas emitter will with certainty, absolutely not want to bring about emissions reductions if they damage the growing prosperity of the country.

For good reason, China instead first wants substantial extended compensation from countries which were largely responsible for greenhouse gas concentration in the past. Further reported evidence on limited effectiveness is that the USA, the second largest emitter according to current reduction figures, refuses to conspicuously reduce its emissions as emerging countries such as China and India are not bound by similar reduction efforts. One possible way out of this dilemma, not only directly applicable to emissions mitigation, is presented in the following section.

6. Alternative Strategies for Success

Promising alternatives to the imposition of emissions restrictions consist of those strategies by which individual countries profit in the first instance from instigating measures and therefore have a high degree of self interest in their implementation. These include adaptation measures on climate change such as the construction of dykes to protect against a rise in sea levels, with the aim of reducing follow-up costs for global warming to the considerable benefit of the populations of countries who adopt these measures.

In addition to such policies, whose degree of implementation is above all individually assessed by single countries, countries could commit themselves to a worldwide agreement on the gradual increase of expenditure on research and development (R&D) on energy conversion and storage technology. This type of R&D will admittedly not immediately lead to greenhouse gas reductions but over a period of several decades, R&D investment in revolutionary technologies could nevertheless have a substantial positive effect on greenhouse gas emissions.

One example of such technology is atomic fusion. This offers a CO2-free power generating technology that has a wide potential to contribute long-term to a clean, secure and hazard free power supply (DPG 2010:122). As opposed to nuclear power, fusion power would produce no radioactive waste. In the event of successful practical application, predicted by the German Physics Association for the middle of the century (DPG 2010:122) based on comparatively low current research funding, European power generation could be emissions free by 2100 solely on the basis of this technology. In combination with renewable energy technologies, a widespread de-carbonisation of the power generating sector could be a reality by the middle of this century, as is currently the case in Germany, albeit only on the basis of renewable energy technology.

The example of the construction of the ITER experimental reactor in the South of France in a worldwide cooperative venture, demonstrates that a global agreement with commitments to growing R&D investment in the context of countries respective gross domestic product is within the bounds of possibility. With a similar agreement on quotas for R&D expenditure on energy conservation and storage technology, negative external environmental effects could be decreased in the long-term, as well as benefit from typical positive spill-over-effects from R&D activities (Jaffe, Newell, Stavins 2002). Consequently, R&D-expenditure pays a double dividend that proves advantageous to all countries but to a large degree, those countries who finance it. In the event of success, a wide ranging diffusion of technologies would profit and particularly those enterprises that market these technologies.

Furthermore, given the gradual increase in its R&D expenditure, a country could redress a chronic shortage of private research funding. For this, research activities financed by private market players tend to be inadequate (Nelson 1959). From a political economy point of view, 'inadequate' is when expenditure falls short of previously expected income. Above all, private companies show limited interest in financing basic research, as the probability of an immediate market economy benefit from research results is relatively low and, as a rule, benefit everyone equally. In such a case of market failure, it is the duty of the state to further drive support for research and technology.

State support for R&D should certainly be randomly driven, as policies on successful future technologies cannot be identified decades in advance (Karl, Wink 2006:275-276). Von Hayek (1978) mainly traces this back to the information deficit of states who, as a rule, do not take necessary information into consideration. The state should aim to support several different technologies at once, not least because the preference for one technology, perhaps for industrial-political reasons, always at the same time discriminates against the development of other technologies (Kronberger Kreis 2009:34).

Given the high prioritisation of EEG financing for photovoltaic technology which has been excessively funded to the tune of several million Euros in Germany, the opposite applies as the state does not take existing knowledge into consideration. Photovoltaic technology receives by far the highest subsidies in relation to its actual power output (Frondel, Ritter, Schmidt, Vance 2010a:116). For all photovoltaic modules installed in Germany between 2000 and 2009, the net cost was around €52.3 billion (2007 prices).

With its renewable energy policy, the European Commission violates against the principle of technological openness in effective R&D support in important ways. Via symbolic goals whose target is not the result of rational optimisation deliberations but rather those overtly related to yearly targets (as is the case with the 20% share of renewable energy in the year 2020) even though prioritising renewable energy with co-existing emissions trading cannot be justified by the removal of negative external climate effects.

If the Commission's renewable energy goal has technological support in mind, the selection of promoting instruments should not be left to member states. Particularly ineffective in this respect is the feed-in-compensation system used in Germany where R&D are only indirectly supported. In Germany in Germany, this has not in practice lead to increased research efforts on behalf of EEG supported companies even though EEG subsidies between 2000 and 2009 increased more than tenfold and rose from nought €9 to around €10 billion (BDEW 2001, 2009), whereas expenditure by private industry in power generation in Germany generally declined. While business investment in energy support was around €503 million in 1991, it was only €139 million in 2007 (BMWi 2010). In comparison to subsidies for renewable energy of €7.6 billion in 2007, €139 million is a small amount, particularly as it not only applies to regenerative technology, but also to research support for other energy technologies.

Expenditure on research and development in the area of renewable energy has in real terms, as well as in relation to posted turnover, slightly fallen as figures for research expenditure from photovoltaic companies confirm. The two largest German companies Q-Cells and Solarworld, respectively allocated in 2009 €26.5 million and €12 million, only around 1.2% and 3.3% of their turnover, to research (Breyer 2010). Here, these comparatively new companies are way behind R&D expenditure by traditional companies. Siemens in 2008 invested around €3.8 billion, around 4.9% of turnover in research and development while companies in the health sector usually have an extremely high level of research expenditure. Roche invested €5.6 billion, 19.4% of its turnover in RND in 2008 (Booz & Company 2009).

The German Physics Association is also critical in a study from June 2010, that despite massive market support from the EEG, the intensity of RND in the photovoltaic industry has sunk from 2% to under 1.5% of turnover in the last few years, whereas research intensive companies such as large pharmaceutical concerns, demonstrate research intensity of 15 to 20%; Intel 15%, or Microsoft 13.8%. Moreover, the limited RND activities in the solar branch are mainly concentrated on ready-to-use aspects (DPG 2010:102).

Unlike technological support, for which financing of prototypes is sufficient (Kronberger Kreis 2009:34), incentives for renewables are used to a large extent in the distribution of surface covering installations. From such distribution, foreign countries benefit as well as domestic companies. For example, the Chinese company Suntech Power rose to first place in worldwide photovoltaic manufacturers in 2001, mainly as a result of German feed-in-compensation whereas China, up to now, has no similar system worthy of note. Feed-in-compensation systems such as EEG patently offer the competition the same opportunities for technological development and export as domestic companies. Even though this is not necessarily negative from a welfare perspective, it is certainly not the aim behind the scheme.

In order to improve its companies' competitiveness, each state would be well advised to directly establish R&D support instead of the watering-can method offered by feed-in-compensation from which foreign companies can also benefit and which does not necessarily lead to increased research expenditure by private companies. The offer of targeted incentives is decisive in obtaining real competitive advantage which leads to the development of better technologies. In this respect, the feed in compensation system fails almost all along the line as incentives for innovation stifled as each technology is subsidised according to its competitive disadvantage.[6]

The International Energy Agency (IEA 2007:74,77) proposes the use of instruments other than feed-in compensation to support photovoltaic technology which should above all lead to the development of this technology rather than the distribution of surface covering. The commission should follow this advice and move towards full energy transformation and storage technology instead of setting symbolic goals for the share of renewables in the energy-mix only to accelerate the distribution of renewable energy installations. This does not push technologies towards a decisive international competitive advantage as the negative example of German support for photovoltaic technology shows.

There should be a more promising way in which the Commission sets member countries energy support for R&D expenditure quotas in relation to GDP. This would result in much stronger research support than in the case of renewable energy sectors. The way forward is a gradual increase in R&D expenditure on energy technology and the spill over effects involved, which could together be all the more effective in long-term reduction of global greenhouse gas emissions, the more this example is taken up on a worldwide basis. The path to a global agreement with energy research support targets would not then seem so distant.

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[6] This also applies to the often repeated but erroneous argument of First-Mover-Advantage from countries which "get their foot in early" and allegedly achieve long-term advantages. That this argument is hardly sustainable is demonstrated by the current situation in Germany where photovoltaic technology has been subsidised for a decade via feed- in -compensation, and to an extreme degree since 2005, yet has to fight in the world market against the increasing dominance of Asian manufacturers, especially China. Although Chinese companies do not enjoy the same benefit of exorbitant national support\subsidy as do German companies, this is not a significant advantage over Asian manufacturers. The opposite applies: it is probable that higher EEG subsidies for solar power are partly responsible for the efficiency disadvantages borne by German companies given a lack of inducement/incentive for corresponding efficiency efforts.

7. Adaptation to global warming

In addition to emissions mitigation, there is the possibility of tackling the consequences of global warming by adaptation. For example, if consequences consisted in a rise in the quantity and intensity of storms - an assumption lacking any scientific proof so far (Bouwer 2010)- an adaptation reaction on behalf of the state could consist of measures in building regulations, urban-planning development, agriculture and forestry.

Adaptation processes can consist of many further measures such as the reclamation of land and settlement areas in regions that are currently still too cold, should they become less inhospitable as a result of global warming, changes in agricultural production, resettlement of inhabitants of islands that are threatened by a rise in sea level, and improved malaria prevention.

Of course, emissions mitigation and adaptation are no substitute for emission reduction.[7] However, the strategies are both alternatives when it comes to minimising the follow-on costs of global warming. Follow-up costs can either be reduced by emitting less CO2 or by better adapting to the consequences of CO2 output (Beirat BMF 2010:26).

The adaptation strategy was already discussed very seriously by authors like Nordhaus (1994) at the beginning of the climate debate. Even though this strategy has stood in the background during the recent climate debate, Germany has taken the first important steps towards a comprehensive adaptation strategy (Beirat BMF 2010:25). The "German Adaptation Strategy on Climate Change", enacted in December 2008, has identified several sectors including agriculture and health, for which the federal and state governments will present a detailed action plan by 2011

This should sensibly operate on several different levels, including national, federal, municipal or even individual levels. For example, it could be the sole responsibility of house owners to protect their property against storm damage with suitable constructional measures.

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[7] There is a connection between mitigation and adaptation strategies that have received little attention so far both in political debate or economic literature (Tol 2005). If the country focuses intensely on adaptation measures and accordingly reduces its reduction efforts this could, in an inversion of the argument in paragraph 3, lead to other countries making higher reduction efforts and bearing higher costs. In an inversion of the arguments in paragraph 5, such a strategy could lead to improved chances for the realisation of a global climate agreement: "should there be unrealistically high or exaggerated expectations on behalf of less-developed and poor countries with respect to the willingness of industrial countries to make sacrifices, a visible and consequent adaptation strategy on the part of developed industrial countries can help to t correct these and contribute to international consensus building" (Beirat BMF 2010:27)

Insurance could be taken out as an alternative or a supplement. This example demonstrates that with many adaptation measures, individual decisions are socially optimal and that government intervention is unnecessary because individual and collective cost benefit calculations coincide.

"Whoever protect his house against increasing imminent storm damage, considers basically all relevant advantages and disadvantages of respective measures. Here, the government does not have to and should not intervene. The state is responsible only when the individual cost benefit calculations differ from the collective one (Beirat BMF 2010:28). An example here is the raising of dykes to protect all inhabitants of a region from climate change

Compared to emissions mitigation efforts, adaptation measures have several advantages. Firstly, whoever bears the cost of the measure, i.e. a house owner who reinforces his roof against storms, has the sole, or at least the main, benefit. In contrast, whoever takes mitigation measures bears the full costs but benefits only partially, if at all, whereas the main benefit applies to everyone who suffers a little less from global warming if the measure proves to be effective.

There is indeed a preponderance of potential beneficiaries, while only a few have to bear the costs. As a result, incentives for mitigation efforts should be expectedly less as those for carrying out adaptation measures. Also, the fundamental dilemma of "free riding" that drives the chances of an effective reduction in greenhouse gases towards zero, does not apply in the case of a strategy that focuses on adaptation measures.

Secondly, there is a great divergence in the timing of costs and potential benefits as the benefits of such measures will only manifest themselves much later, perhaps decades ahead, while costs immediately incur today (Nordhaus 2007, Weitzman 2007, Stern 2007). Economically speaking, the only thing beyond doubt is the fact that an expenditure of €1 billion on greenhouse gas reduction and adaptation measures mean higher costs today then €1 billion for the same purpose 20 years in the future.

In the case of adaptation measures, the divergence in timing between costs and benefits is much smaller. Measures to raise dykes will only be taken when it is foreseeable that current dyke height might not be sufficient given a further raise in sea levels. Accordingly, it is an important advantage of adaptation strategies that they do not require a decade long lead-in-time in the same way that mitigation policies do (Beirat BMF 2010:30) and adaptation measures can rather be taken over a short time period and react to environmental changes that are relatively clear in their extent.

Thirdly, the extent of damage accompanying global warming is currently still very uncertain. Due to the potentially irreversible consequences of CO2 output, policies have to act as early as possible and take measures to reduce CO2 emissions. If a too high level of CO2 emissions is permitted (although it is currently very unclear what "too high" means exactly) potentially severe subsequent damage could not be avoided. As a consequence, policies should be prepared to take on relatively high mitigation efforts early on.

This however, could turn out to be a mistake if subsequent damage is less than expected. To wait until the uncertainty over subsequent damage is reduced would save costs in this case. From a policy point of view, it could be profitable to delay climate policy measures until a future date, if the uncertainty surrounding subsequent damage could be gradually reduced by means of further research.

An adaptation strategy is one solution to this dilemma because it allows, at least partially, for a cost-saving option of delaying countermeasures, as severe consequences can still be reduced by adaptation measures in the future (Beirat BMF 2010:29). This option saves costs because it allows policies to waive expensive mitigation measures today in order to combat severe damage, should it occur, with more comprehensive adaptation measures in the future.

Fourthly, there is a scientific consensus that global warming produces both winners and losers (Tol, 2010). Adaptation measures will only be adopted by those negatively affected by global warming. Those regions which profit from global warming still retain the advantage of an adaptation strategy. In contrast, mitigation strategies could reduce not only negative but also the positive effects of global warming.

Whilst it is still unclear whether ultimately it is not significantly more expensive to rely on adaptation measures alone rather than exclusively make emission mitigation efforts, an adaptation strategy could be advantageous in two distinct cases. If for example, it became apparent that greenhouse gases and the anthropogenic influence on their concentration in the atmosphere have only a minimal influence on global warming (contrary to current, unverified opinion) and that the latter is largely affected by non-anthropogenic causes, it could happen that there will be a significantly smaller impact on the climate than recent climate models predict. In this situation, only few or no adaptation measures at all would be necessary and costs would be accordingly low. On the other hand, non-anthropogenic causes could lead to similar or even more severe effects than predicted by recent climate models. In this case, adaptation measures would be the most appropriate solution as mitigation measures would be largely ineffective and even superfluous.

8. Summary and Conclusion

Climate change is clearly a matter of economics. Böhringer et al (2010) estimate that the Commission's climate policy could cost EU states between 1% and 4% of their prosperity. An effective climate policy is always guided by the principle of rational use of funds. For this reason, an aim such as the prevention of negative global warming impact should be achieved with as little national economic costs as possible. As a rule, this principle should comprise of a mix of cost-efficient measures including both efforts to reduce greenhouse gas emissions and adaptation measures on global warming.

Excessive efforts to reduce greenhouse gases could in fact be inefficient if only a few of the most important states take them on (Nordhaus 2009:51). Cost benefit analyses of greenhouse gas reduction measures show that in fact these should be taken only to a limited degree. Nordhaus (1993) argues that the optimal emission reduction rate stands between 10% and 15% compared to a scenario without any climate policy. Following this, the EU Commission's climate policy is not ideal because it sets the EU states a goal to reduce emissions by 20% by 2020 compared to 1990. If other major industrial countries commit themselves to similarly substantial efforts, the Commission would even raise the reduction target for 2020 to 30%.

Such a pioneering role by the Commission on greenhouse gas reductions measures would therefore not only be inefficient but also counterproductive. Firstly, Western and Eastern Europe are considered to be the winners in global warming (Tol 2010:16). Maddison (2003) estimates that as a result, GDP in Western Europe could rise by 2.5%.

Secondly, high self-determined emission reduction aims could cause other countries to reduce their climate policy efforts instead of reinforcing them. The more the EU is willing to do, the more attractive it is for other countries to mitigate less themselves, because marginal benefits of their own efforts diminish in the light of the EU's efforts, whereas marginal reduction costs remain the same. Therefore, the pioneering role taken by the EU on climate policy tends to lead to higher costs without a distinct reduction in global emission levels.

Thirdly, the EU's special efforts worsen the chances of realizing a global agreement as the reduction of existing advantages for a global climate agreement make its realisation less probable. Preferably however, climate agreements should be geared to include all countries. In contrast, partial agreements between countries such as the EU member states, lead to a reduction of efforts in remaining countries. If important countries do not participate, it could in effect be more sensible to rescind the agreement even though a subgroup of countries agreed to it (Beirat BMF 2010:16), as is the case with the member states of the EU.

All these arguments speak against the EU acting alone, but in no way against negotiations on an effective worldwide treaty. However, the chances for a global agreement on greenhouse gas reduction are rather poor. China, the biggest global greenhouse gas emitter, will certainly not submit itself to any emission limitations if these have a negative bearing on the country's growing prosperity.

Instead, China could with good reason claim substantial compensation from those countries that were mainly responsible for the rise of greenhouse gas concentrations in the past. With similar reported evidence on limited effectiveness the USA, the second biggest emitter, refuses to commit itself to drastic reduction measures if emerging countries like China or India do not also commit themselves to reduction measures that will significantly curb the future increase in their emissions.

A possible solution to this dilemma consists in policy alternatives to the imposition of emissions restrictions by which individual countries themselves benefit initially from the measures taken and therefore have a high degree of self interest in their implementation. Thus, a worldwide agreement on a gradual increase in expenditure on R&D in energy conservation and storage technology could have a realistic chance of success. Having said this, greenhouse gas reductions could not be achieved immediately but rather within a few decades- and possibly substantially as the example of fusion technology shows.

In the case of adaptation measures such as the construction or enlargement of dykes it is again those who bear the costs who primarily benefit. A strategy for the implementation of adaptation measures is of great importance because on one hand, emission reduction measures ultimately have little chance of success, and on the other hand, this strategy allows, at least partially, the cost saving option to delay mitigation measures and rely instead on an R&D support strategy. Severe consequences could still be reduced by adaptation measures in the future. This option saves costs because it allows for the policy of waiving expensive mitigation measures today in order to combat any eventual damage in the future via adaptation measures, the extent of which could be directly determined by emerging consequences.

Goklany (2009:35) is of the same opinion and shows that a focused adaptation strategy which directly combats for example malaria rather than climate change mitigation measures, which indirectly seek to limit the spread of the disease, has a much greater benefit and a far lower cost of only one fifth of the charges that have come about through the implementation of the ineffective

Kyoto Protocol (Goklany 2009:30). As the benefits of mitigation measures are highly dubious due to the uncertainty of effects connected to climate change, and will only become evident over decades, there is no doubt that focused adaptation measures to combat immediate, serious, current problems such as malaria, famine and the flooding of whole coastal regions, result over a very short time and with great certainty in far higher benefits (Goklany 2009:25) as these human catastrophes cause far more damage than climate change which is often incorrectly given paramount importance.