The Honest Broker - Stuck Half Way Through

Comment on Pielke et al. in *Nature* 452, 531-532 (2008)

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Introduction

Pielke et al. argue that the IPCC ”seriously” underestimated the scale of the technology changes required to stabilize greenhouse gas concentrations, and hence has failed to convey the appropriate message to policy makers on the policies required for mitigation. We reject this argument, which is based on a flawed analysis and indeed repeats the work carried out in IPCC WG3.

The authors use a frozen technology scenario to show that if there is no autonomous improvement in technology over the next century the required emission reductions to reach any of the assessed stabilisation levels of greenhouse gases far exceeds the mitigation effort computed by any of the mitigation scenarios reviewed in the IPCC fourth assessment report (AR4). This is a trivial result already shown by the IPCC itself. The implications of autonomous technological change in the future emission scenarios were shown by way of a hypothetical frozen technology calculation. Chapter 3 of IPCC WG3 states on page 219 that “[t]o illustrate the importance of technological change, actual projected scenario values in the original SRES no-climate policy scenarios are compared with a hypothetical case with frozen 1990 structures and technologies for both energy supply and end-use.” These results are summed up in Figure 3.33 chapter 3 of WG3 (see below) and were described in the following way: “The difference (denoted by a grey shaded area in Figure 3.33) illustrates the impact of technological change, which leads to improved efficiency and ‘decarbonization’ in energy systems already incorporated into the baseline emission scenario.”

Using the frozen technology scenario the authors go on to argue that “the IPCC implicitly assumes that the bulk of the challenge of reducing future emissions will occur in the absence of climate policies". Thus the authors assert that the IPCC seriously underestimates the scale of the technological challenge associated with stabilising

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greenhouse gas concentrations: if this were true and correct it would indeed be a serious charge against the IPCC.

A down-to-earth verification of the facts behind the issues raised in this ‘Commentary’ however show beyond doubt that the bomb that the authors intend to drop is in fact at best a dud.

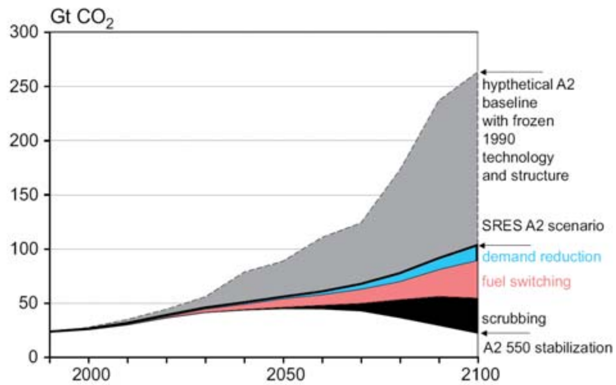

Figure 1: Contribution of different mitigation options to achieve a CO_2 concentration stabilisation at 550ppm (assuming a baseline development according to the IPCC SRES A2 baseline scenario without measures and policies directed at reducing GHG emissions). Source: Fisher et al. (2007), Fig. 3.32, p. 219 and Fig. 3.33, p. 220.

A frozen technology scenario is a thought experiment on the worst-case, not likely

Mitigation effort is the difference between the emissions likely in the 21st century in the absence of climate policies and the measures needed with climate policy to reach specific stabilisation or temperature limit goals. This task would be massively expanded if autonomous improvements in technological efficiency underpinning much, if not all of the academic literature on future scenarios, were not to be realised in practice. Hence, if the frozen technology scenario were more than a thought experiment of what could happen in the worst case and in any way a reflection of the likely future trajectory of technological developments, this would undermine completely the core finding of Working Group III in the Fourth Assessment Report (AR4). In particular, Working Group III found that ambitious climate policy can be initiated with existing technologies and at relatively low cost. The Pielke et al. ‘Commentary’ suggests but does not explicitly say that the mitigation cost estimates of the IPCC are as unrealistic as its estimation of the technical and economic challenge.

Thought experiments such as the ‘frozen technology’ scenario tell us mainly what would happen if some well established trends did *not* continue. This is useful for didactical

purposes, but its use for scenario-building relevant to climate policy is extremely limited and in particular cannot be used to frame projections of likely future emissions.
The relevance of the reference scenario reinforces another key message of IPCC AR4 – that the development path we find ourselves on is as important as climate policy. In other words, policy on technology, industry, agriculture, energy, housing and a whole range of other areas will be important, not only climate policy – conceived as environmental policy alone.

We should start out and by it examining the role of technological change in the past and in future emission scenarios. Technical progress plays above all a decisive role regarding the question how much will presumably be emitted. This progress can be separated into two components - energy and carbon intensity. Figure 2 shows the historical trend of the last three decades.

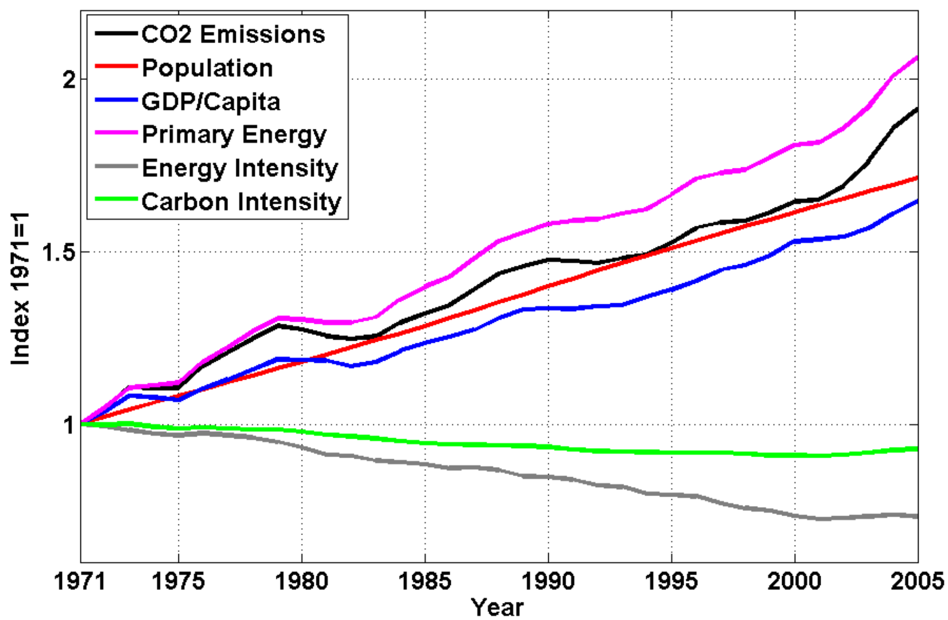

Figure 2: The historical trend of economic growth, population development, energy and carbon intensity. IEA 2007

The energy intensity describes how much energy is necessary to produce one unit of social product; the carbon intensity describes how much CO_2-emission is produced per unit primary energy. If people find a lifestyle where they waste less energy, e.g. by better building insulation, energy intensity will decrease; if coal, oil and gas are replaced by renewable energies or by nuclear energy, carbon intensity will decrease. This technical progress is described as "autonomous" technical progress, since it is very likely to occur even if no climate policy was pursued. The majority (75 %) of the energy scenarios in the scientific literature and assessed by the IPCC assume a 0.6% autonomous decrease of energy intensity per year in the next century. This is a low rate compared to the historical trend of the last thirty years in which the energy intensity has decreased by even

1.1%/annum (see Figure 2). In this respect, the scenarios assessed by the IPCC are much more conservative than the historical experience suggests.[3]

Given the mandate of the IPCC to assess the scientific literature of climate change and given that the literature on energy scenarios almost universally assumes an autonomous decrease of energy intensity in the coming century due to ongoing technological change, the IPCC assessment process cannot simply set this aside without firm or overwhelming evidence that a break in this pattern is likely to occur in the next century. The Pielke et al. commentary is thus a direct challenge to the entire energy scenario community, rather than to the IPCC itself. What the frozen-technology scenario represents is a thought experiment – what if all technological change stopped? This is not likely to be the case, if history is anything to go by.

Is there evidence of a slowdown in technological change affecting carbon and energy intensity?

Since the year 2000 there is an apparent slowdown in the reduction in carbon intensity of aggregate world energy supply. This issue arose in the context of the writing, review and intergovernmental approval and adoption of the IPCC WG3 fourth assessment report and was discussed by authors, reviewers and governments. In the summary for policymakers of WG3 it is stated: "The long-term trend of a declining carbon intensity of energy supply reversed after 2000." Thus there is a question as to whether there could be a break in the development of the worldwide energy system compared to the longer-term historical trend. Is the Pielke et al. assertion that "in recent years, those global energy intensity and carbon intensity have risen, reversing the trend of previous decades", correct?

It is certainly correct that developments in China raise concerns in this context, however as we will see below the picture is rather complex and it is too early to draw conclusions. The recent development in the Chinese energy system could indicate that autonomous technical progress may be slower in the future however little can be said on the basis of a five-year record. Similar slowdowns in autonomous technical progress have occurred in the past, only to be compensated by more rapid periods of development.

In China, neither the carbon nor the energy intensity has decreased the years 2001-2004 (see Figure 3). At the global scale, worldwide the development of energy intensity for the years 2001-2004 shows the same increasing trend as in China. This is due to the fact that China's CO_2-emissions trend seems to dominate the worldwide trend as they contribute to nearly half of the worldwide growth of CO_2-emissions. The increasing use of brown coal in power plants with low levels of efficiency, the high economic growth and the increasing energy demand led in 2004 to the highest growth rates of CO_2-emissions that have been measured during the last 30 years. It is however not very likely that the growth of emissions at these rates will continue like that for an extended period of time in China (see Figure 3). Energy efficiency e. g. already increased in 2005 and moreover, the

[3] IPCC, AR4, WG III, 219

Chinese government has formulated its target to reach a further increase of energy efficiency by 20% until 2010.

It is interesting to note that the other important emerging economy – India – does not show decreasing trend of energy efficiency. Quite the contrary, the increase in energy efficiency seems to grow over the last years. For the USA and Europe, this trend of increasing efficiency remains the same or slightly slows down, respectively, over the same period.

Whereas we have shown that there are hints that the future development of energy intensity will be in line with the observed trend, there could be a trend reversal with respect to carbon intensity. Worldwide, carbon intensity is increasing similarly as in China in the period 2001-2005 (Figure 3). The same trend can be observed for India and the USA; for Europe: the decrease of carbon intensity is slowing down. In contrast to the analysis of the energy intensity, the year 2005 does in this case not bring it back on the track.

Analysing the different components of energy carriers that influence carbon intensity, it becomes obvious that on the world level the reason for increasing carbon intensity is mainly the use of coal (see Figure 4). As in the last four years, the use of oil already decreases. This could be a first hint that due to the high oil price, the energy system switches to coal instead of oil, bringing about an increase in emissions. The trend to coal in the last years can also be identified for China and India. Whereas in Europe the fraction of renewables has increased since the late eighties, the fraction of renewable energy decreased in China and India over nearly the whole period 1971-2005, probably due to the general transformation of the energy system and the growing electrification of rural areas.

This decomposition analysis lets us conclude that the focus should be on both the development of energy intensity and carbon intensity. Moreover, the decomposition of the different drivers of the carbon intensity gives a more sophisticated picture of the transformation of the energy system that is currently going on. The development of carbon intensity is indeed worrying, but not yet sufficiently strong to warrant the discarding of the historical experience of autonomous improvements in efficiency at the level assumed in most of the scenarios reviewed by the IPCC.

On the basis of the data for the 5-year period 2000 to 2005 a trend reversal in energy efficiency cannot be attested - neither in China nor worldwide. This implies that Figure 2 of their commentary cannot be reproduced with our data[4]. There is evidence however of a trend reversal in carbon intensity and the question remains as to its significance to which we turn next.

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[4] For the decomposition we use IEA primary energy data and the IPCC conversion factors from the single primary energy carriers to CO_2-emissions.

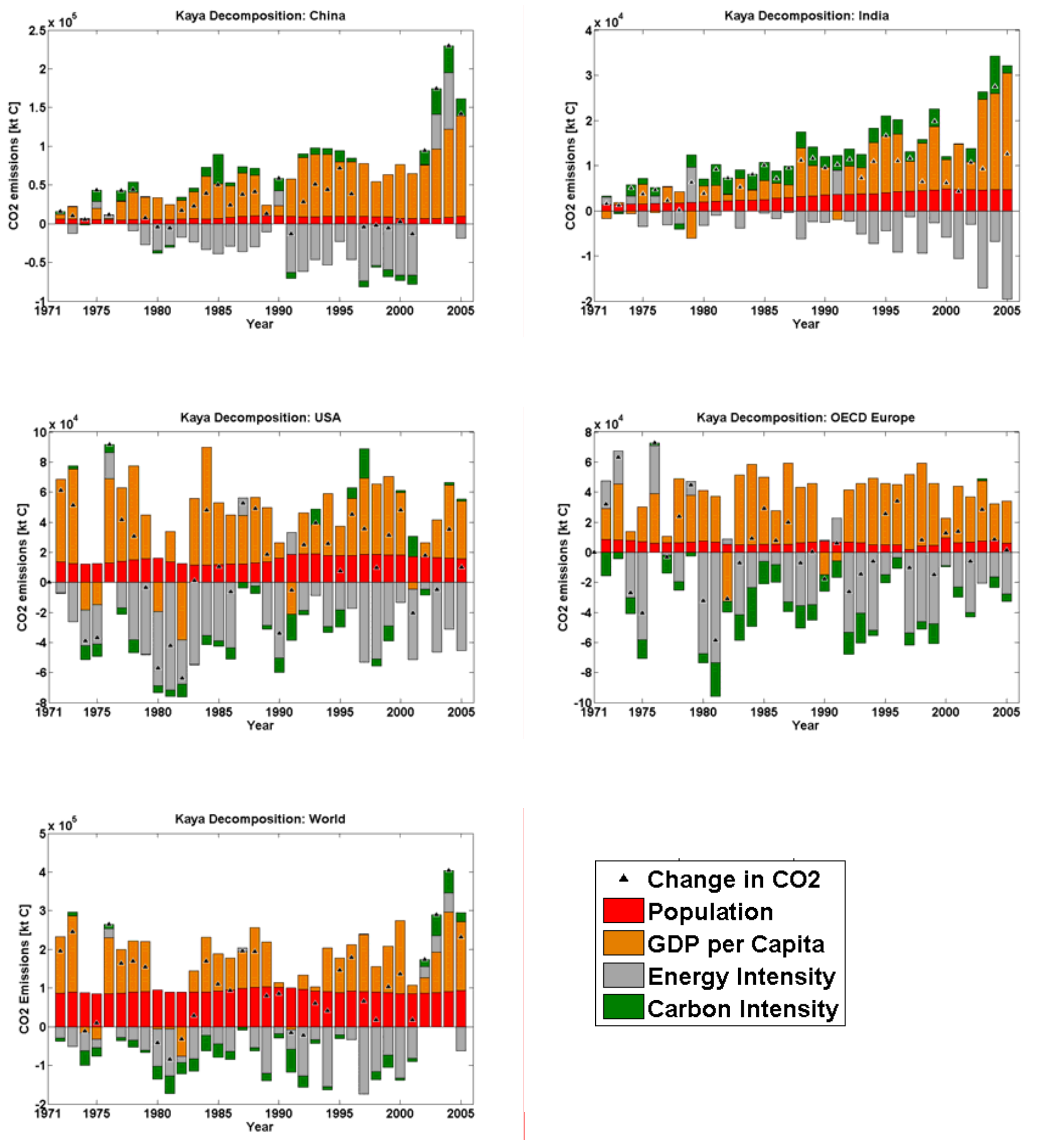

Figure 3: The development of the energy system for (a) China, (b) India, (c) USA, (d) Europe, (e) the World. The change of CO_2-emissions from each year to the one before is shown that can be attributed to the respective change of the components population, GDP per capita, energy intensity and carbon intensity.
Source PIK 2008

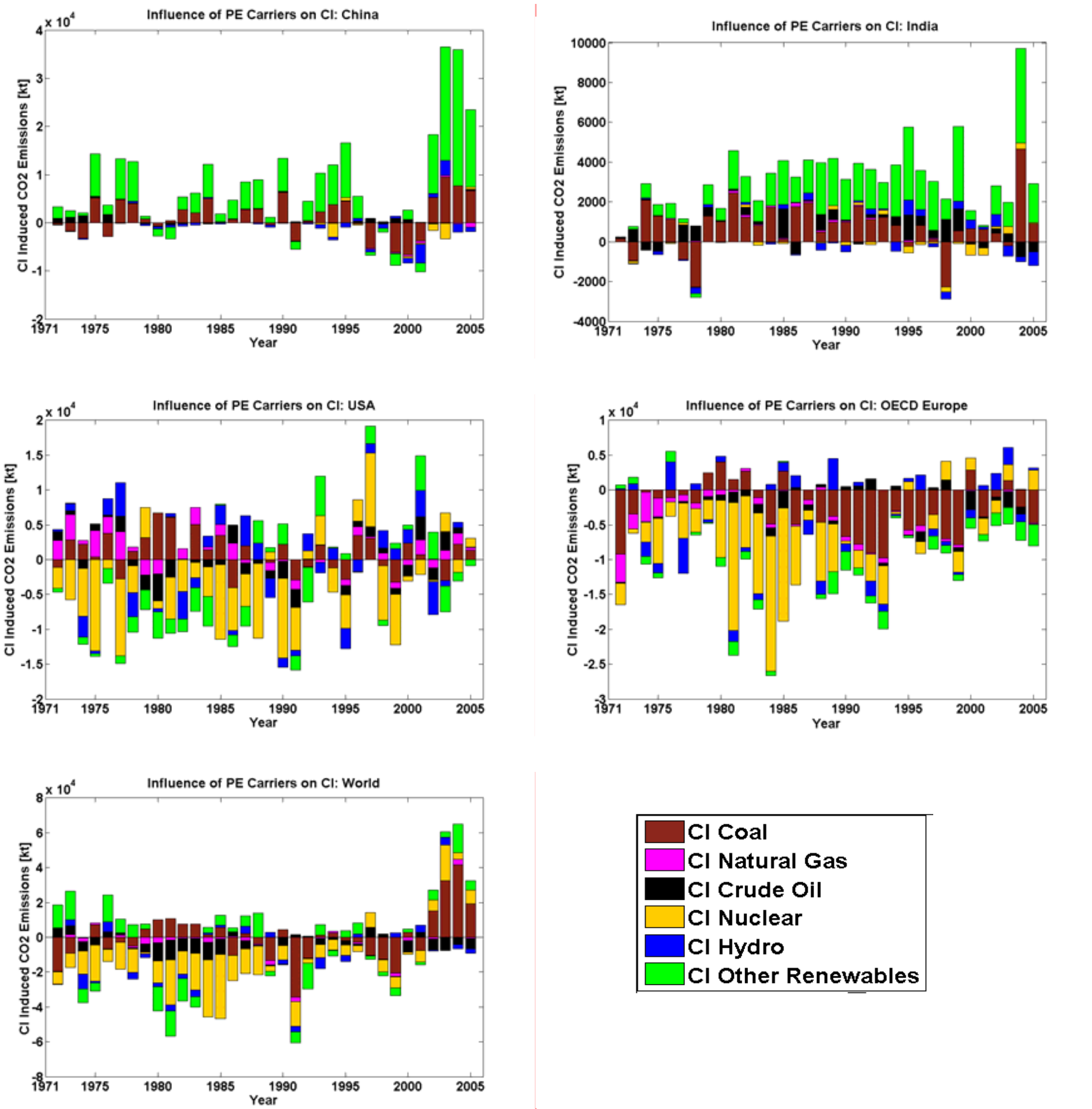

Figure 4: The development of carbon intensity for (a) China, (b) India, (c) USA, (d) Europe, (e) the World. The change of CO_2-emissions from each year to the one before is shown that can be attributed to the respective change of coil, natural gas, crude oil, nuclear, hydro and other renewables. A decreasing share of carbon-free technologies (renewables, hydro, nuclear) leads in this decomposition to an increase of CO_2-emissions induced by carbon intensity.
Source PIK 2008

What does all this mean for mitigation costs?

The reason for increased energy efficiency and declining carbon intensity may be the same – more rapidly increasing oil and gas prices compared to coal prices. An increasing oil price is one of the major reasons for China's government to put emphasis on efforts to increase energy efficiency again. For the Chinese government high growth rates of resource consumption are a burden, for the Chinese economy in as much as the prices for coal, oil and gas will increase. At the same time an increasing oil price may lead to a substitution of oil and gas by coal. At oil prices of 40 $ per barrel, conversion of coal to liquid fuels becomes an important option. Since oil prices are currently sustained well above this level, there is a real risk of a move into these technologies, which would result in a significant increase in carbon intensity. The US and the Chinese government have invested in coal to liquid in order to become more independent from oil imports. The assumption that these substitution processes will not increase the coal price as much as oil and gas prices is especially due to the fact that the stocks of coal are very much larger than the stocks of oil and gas. As the comparison between Figure 5a and 5b shows, the business-as-usual-emissions will be lower in the case of high oil and gas prices.

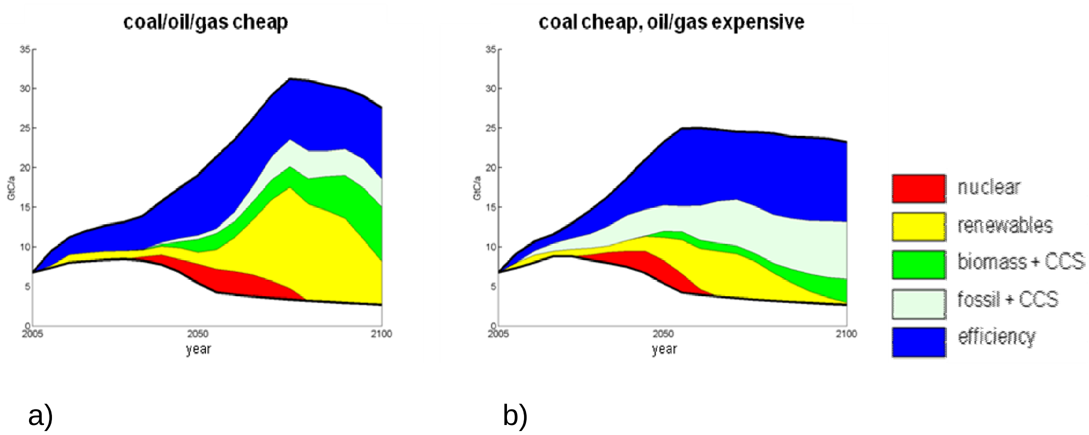

Figure 5: Mitigation strategies under different assumptions about the development of fossil resource prices (5a and 5b); Source PIK 2008

The economically optimal mitigation strategies will thus also change as a consequence of these relative price effects: The increase of energy efficiency will become more important as well as carbon capturing and sequestration which supports the opinion that the development of fossil resource prices will make the energy system more efficient with lower emissions even without climate policy since the scarcity of fossil resources is more perceivable in their prices than in the last thirty years.

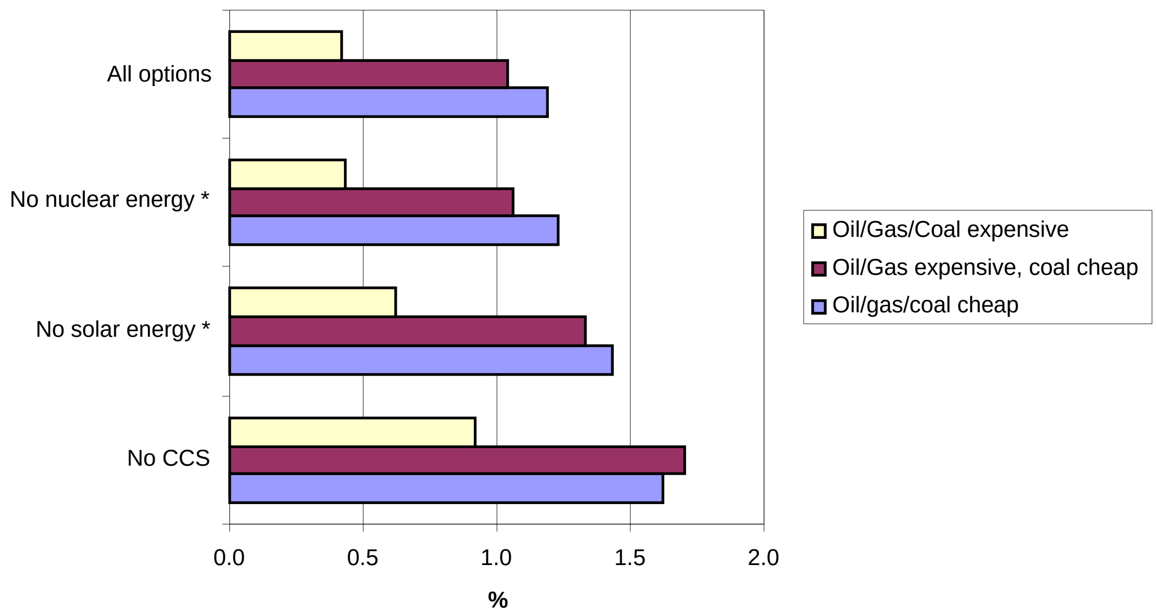

Figure 6: The economic costs - measured as percental losses in the world social product produced by climate policy. Different price paths are assumed here for coal, oil and gas. Moreover, those costs were calculated here that incur if different options are not available.

And here is the final area where Pielke et al. come unstuck. They argue that the IPCC is “diverting attention from policies that could directly stimulate technological innovation". As can be shown in Figure 5a and 5b, the question how much technical progress can be induced by climate policy is more decisive for the estimation of emissions reductions and thus their economic costs than the assumed baselines. Important research results were obtained here during the last years which Pielke et al. could have easily learnt from the IPCC report. This research work explicitly shows that a reasonable climate policy is able to induce the technical progress necessary to stabilise the atmospheric concentration of greenhouse gases at a level of 450 ppm CO_2 equivalent. Figure 5 shows that different rates of technical progress are generated for different resource prices. If coal, oil and gas are cheap, autonomous investments in the increase of energy efficiency and the lowering of carbon intensity are relatively small; in the case of climate policy, relatively much needs to be invested which is reflected in higher mitigation costs. A model comparison however could demonstrate to what extent mitigation costs depend on autonomous, endogenous technological change in different modelling concepts.

The fact that "much" technical progress needs to be induced by climate policy does nowhere near mean that this also needs to be expensive. Three economic effects primarily support this fact: First, many bottom-up-studies, as for instance the ones of McKinsey (Enkvist et al., 2007), show that substantial CO_2-savings can be realised at negative costs. This mainly concerns measurements to increase energy efficiency. Second, many mitigation technologies become cheaper by learning-by-doing. Third, and this effect has already been mentioned, climate policy does not become more expensive with increasing prices of fossil energy sources but cheaper which is also true if the price for coal increases slower than the prices for gas and oil. Since increasing fossil energy sources make a rebuilding of the energy system already inevitable which however needs to take place more rapidly due to climate policy reasons. Therefore, many cost estimates on the basis of different methods result in the fact that the mitigation costs amount to approx. 1-3% of the world national product if the atmospheric concentration should be stabilised at 450 ppm CO_2 equivalent, or lower in some cases.

As we have shown the question of induced technological progress following on from climate policies is fundamental to the transitions in the energy system required over the next century and estimations of overall mitigation costs and their timing.

Conclusions

To a naïve reader the Pielke et al. 'Commentary' raises many questions. Is the optimistic message that the IPCC announced in 2007 to the whole world unfounded? Is the challenge of combating climate change greater than assumed? Is climate policy more expensive than assessed in the AR4? Did the IPCC mislead policy makers? Is the IPCC not the "honest broker" between science and politics that it was set up to be and does it pursues its own political agenda with the authority of science?[5]

In their commentary, the authors take up a frozen technology thought experiment that was conducted by the IPCC itself and use it to argue that the IPCC is too optimistic in the estimation of the mitigation effort required. It is however unrealistic and misleading to make projections on the basis that technology will be frozen at year 2000 levels for the next 100 years or more: the assumptions of autonomous technological change embedded in the scenarios assessed by the IPCC are in fact more conservative than the historical trend suggests. Thus Pielke et al mislead the readers, and do a grave disservice to a wide

[5] This is a theme that has been pursued by the first author for some time. See for example Pielke, R. (2005). "Nature's experts: Science, politics, and the environment." Nature **434**(7030): 139-140, where he argues that the IPCC "has the temerity to claim that it is "policy neutral", yet its website trumpets its success in advocating the adoption of the Kyoto Protocol to the Framework Convention on Climate Change". The IPCC has never made any statements in this direction and has never posted on its website anything remotely resembling this.

body of academic literature and research, if they pretend that the hypothetical frozen technology scenario with a constant energy and carbon intensity is economically and technically plausible. The crucial question is how much technological change can be induced by climate policy even if coal becomes more important due to rising oil prices. The article of Pielke does not offer an answer.

Pielke et al. use a thought experiment of the IPCC and pass it off as a plausible future scenario. For estimation of the future trend, it is absurd to construct a business-as-usual-scenario that does not produce any technical progress: Business-as-usual-scenarios are only consistent if the economic growth, the development of resource prices and the price elasticity of the energy demand describe a consistent and plausible development. A world with high economic growth but without increasing energy efficiency is not conceivable. Quite the contrary, there is much to argue for the fact that especially the increase of fossil resource prices triggered by high economic growth will lead to a higher autonomous technical progress which may lead to a trend reversal compared to the development so far. Admittedly, a possible increase of carbon intensity due to a renaissance of coal is indeed a worst-scenario for any climate policy. As it is shown in Figure 6, availability of cheap coal increases mitigation costs and makes carbon capturing and sequestration more important compared to other mitigation options. A model comparison of the most important models (not only of one model as shown above), which shows the quantitative dimension of this effect on the induced technical progress and the mitigation costs, would here be worthwhile.

If the authors had intended that the IPCC needs to revise its results in principle, they should have used a model comparison to demonstrate which factors change the dimension of the autonomous technical progress (e. g. an increase of fossil resource prices) and which influence these factors have on mitigation costs. These questions have not been answered by Pielke et al.

Throughout its 20 year history the IPCC has not failed to deliver on this task despite the attacks from many sources, including some of the authors of this commentary. The fourth assessment report is no different in a sense than the third: it has highlighted the policy measures needed if the level of technological deployment and change necessary to realise substantial global emission reductions are to be achieved. The challenges highlighted by recent trends in oil prices and carbon intensity can in our judgement be met through the adoption of the kinds of policies and measures outlined in the summary for policymakers of IPCC working group III. We therefore reject the assertion of Pielke et al. that the IPCC has diverted attention from policies needed: evidence from the real world demonstrates the opposite.

From our perspective, the IPCC has been the true honest broker between the different viewpoints in the scientific community on the broad issue of the science, impacts and mitigation of human induced climate change. Its reports and assessments do not reflect the individual judgments of loan scientists or even research groups but of the combined judgment of leading scientists across the disciplines. On the core issue of the mitigation task ahead for whatever greenhouse gas stabilisation level or climate protection goal is chosen by policymakers, the IPCC has laid out the assessment of the scientific community on the policies required and their likely consequences and effects. Far from "diverting attention from policies that could directly stimulate technological innovation" the IPCC has told it how it is: climate policies that put a significant price on carbon in the short to medium term will directly stimulate the kind of technological innovation and commercialisation and deployment required to rapidly reduce future CO_2 emissions to the levels assessed, and that what is required is governmental action to remove the barriers and set up the market to achieve this. What more can one require of an honest broker than honesty and telling policymakers how it is, and not a story about how it might be if things that never happened before happen in the future?

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