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OECD Workshop on the Benefits of Climate Policy:
Improving Information for Policy Makers

The Forgotten Benefits of Climate Change Mitigation: Innovation, Technological Leapfrogging, Employment, and Sustainable Development

by

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FOREWORD

This paper was prepared for an OECD Workshop on the *Benefits of Climate Policy: Improving Information for Policy Makers*, held 12-13 December 2002. The aim of the Workshop and the underlying Project is to outline a conceptual framework to estimate the benefits of climate change policies, and to help organise information on this topic for policy makers. The Workshop covered both adaptation and mitigation policies, and related to different spatial and temporal scales for decision-making. However, particular emphasis was placed on understanding global benefits at different levels of mitigation -- in other words, on the incremental benefit of going from one level of climate change to another. Participants were also asked to identify gaps in existing information and to recommend areas for improvement, including topics requiring further policy-related research and testing. The Workshop brought representatives from governments together with researchers from a range of disciplines to address these issues. Further background on the workshop, its agenda and participants, can be found on the internet at: www.oecd.org/env/cc

The overall Project is overseen by the OECD Working Party on Global and Structural Policy (Environment Policy Committee). The Secretariat would like to thank the governments of Canada, Germany and the United States for providing extra-budgetary financial support for the work.

This paper is issued as an authored "working paper" -- one of a series emerging from the Project. The ideas expressed in the paper are those of the author alone and do not necessarily represent the views of the OECD or its Member Countries.

As a working paper, this document has received only limited peer review. Some authors will be further refining their papers, either to eventually appear in the peer-reviewed academic literature, or to become part of a forthcoming OECD publication on this Project. The objective of placing these papers on the internet at this stage is to widely disseminate the ideas contained in them, with a view toward facilitating the review process.

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EXECUTIVE SUMMARY

Traditional concepts for ancillary benefit/co-benefit frameworks reflect a macro and welfare economics perspective. They are often designed to serve certain modelling requirements, and typically focus primarily on avoided environmental damages and/or on induced net employment. This paper presents a conceptual framework that is extended to non-environmental and non-climate-change externalities. It not only includes the net ancillary and co-benefits that accrue from the dynamics of technological innovation and market diffusion, but also those from spillover effects that arise from global trade, communications, and technology transfer, which can all have important impacts on both the business economics and the macroeconomic level. We show that multi-functionality of energy-efficient technologies at the useful energy level, in contrast to mono-functionality of energy conversion technologies, leads to net ancillary benefits/co-benefits of GHG mitigation that may go far beyond fossil energy savings and emission mitigation, and that are in many cases not (or at least not sufficiently) accounted for in investment decision-making and policy-making processes. Several illustrative examples are provided to underline the points that are made.

INTRODUCTION

Additional benefits of greenhouse gas mitigation are defined in most cases from the point of macroeconomics or as social welfare improvements. The OECD workshop held in March 2000 (OECD 2000) distinguished two terms:

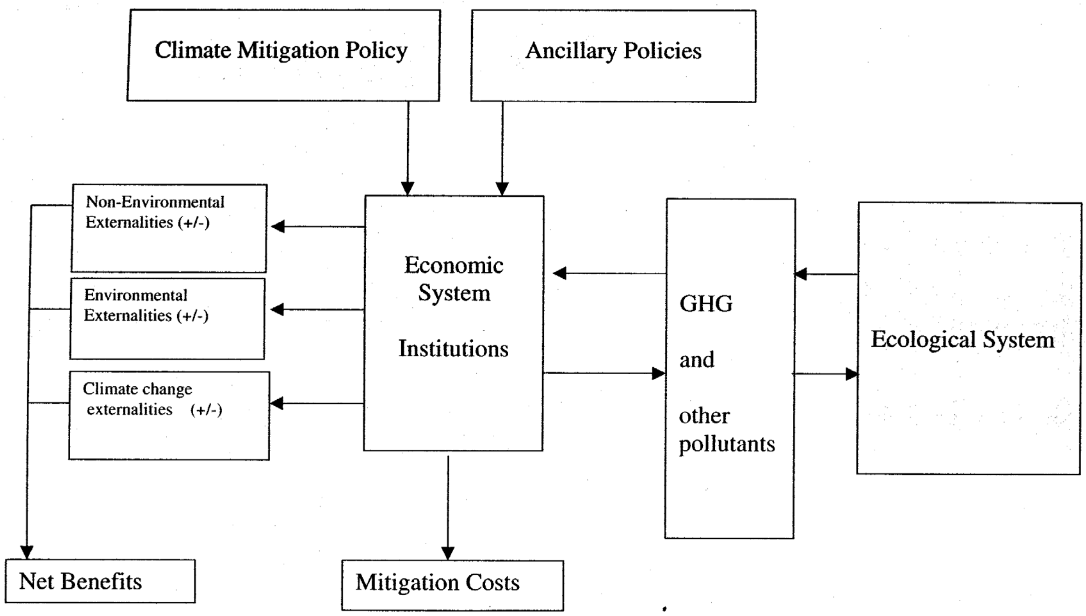
- *co-benefits*, signalling (monetised) effects that are taken into consideration as an explicit (or intentional) part of the development of GHG mitigation policies, and

- *ancillary benefits*, indicating effects that are incidental to mitigation policies (i.e. not explicitly taken into account).

The conceptual framework introduced by Krupnick et al. (2000) does not try to differentiate between co-benefits and ancillary benefits, simply because unintended benefits in one policy context and period may become an intentional and explicit benefit in another policy programme, in the next period, or in another country. But the authors still adhere to the concept that the policy-induced emission changes work through an ecological or environmental system that eventually feeds back into the economic system. Then, depending on conditions of the economic system and its institutions, such as labour markets, tax systems, existing environmental and other types of regulation and policies, this feedback may transform into environmental externalities (such as changes in conventional air or water pollution), non-environmental externalities (such as employment effects) and, of course, climate change externalities (such as leakage of carbon emissions; see Figure 1). Again this concept reflects the view of macro and welfare economics.

The cited and existing literature on ancillary benefits focuses primarily on avoided local and regional environmental pollution (including related benefits of health, corrosion and production of agriculture and forestry) and on economic growth and additional net employment due to a more efficient use of natural resources as a consequence of (effective) climate change mitigation policy action (OECD 2000; IPCC 2001, pp.523-535 and pp.565-588). This rather limited view may be acceptable in some cases, like in studies concerning energy conversion technologies. However, in many cases the ancillary and/or co-benefits from innovative energy- and material-efficient technologies emitting less pollutants and greenhouse gases are not solely limited to environmental and macroeconomic aspects: changes due to the diffusion of new technologies at the useful energy level may also improve characteristics at the micro level, such as product quality, quality of life, the value of a building, and many others. Furthermore, such technologies/technology concepts may increase the share of secondary material in total material demand by increased recycling, or improve the capital productivity and/or labour productivity of the new machinery or plant by the use of an improved control technology or by process substitution. Entrepreneurial innovations may also intensify product use by renting and pooling, enhance utilisation of the capital stock (capacity utilisation) without reducing the service level delivered and, hence, increase economic efficiency as an ancillary benefit/co-benefit (see Figure 2). In many of these cases of non-environmental net effects, the benefits are reaped by the producers and/or consumers as private benefits, but are often not mentioned in the impact evaluations of mitigation policies and/or not accounted for in economic analyses, including investment decisions.

Figure 1. Conceptual framework of ancillary benefits and costs of climate change mitigation



Source: According to Krupnick, Burtraw and Markandya (2000)

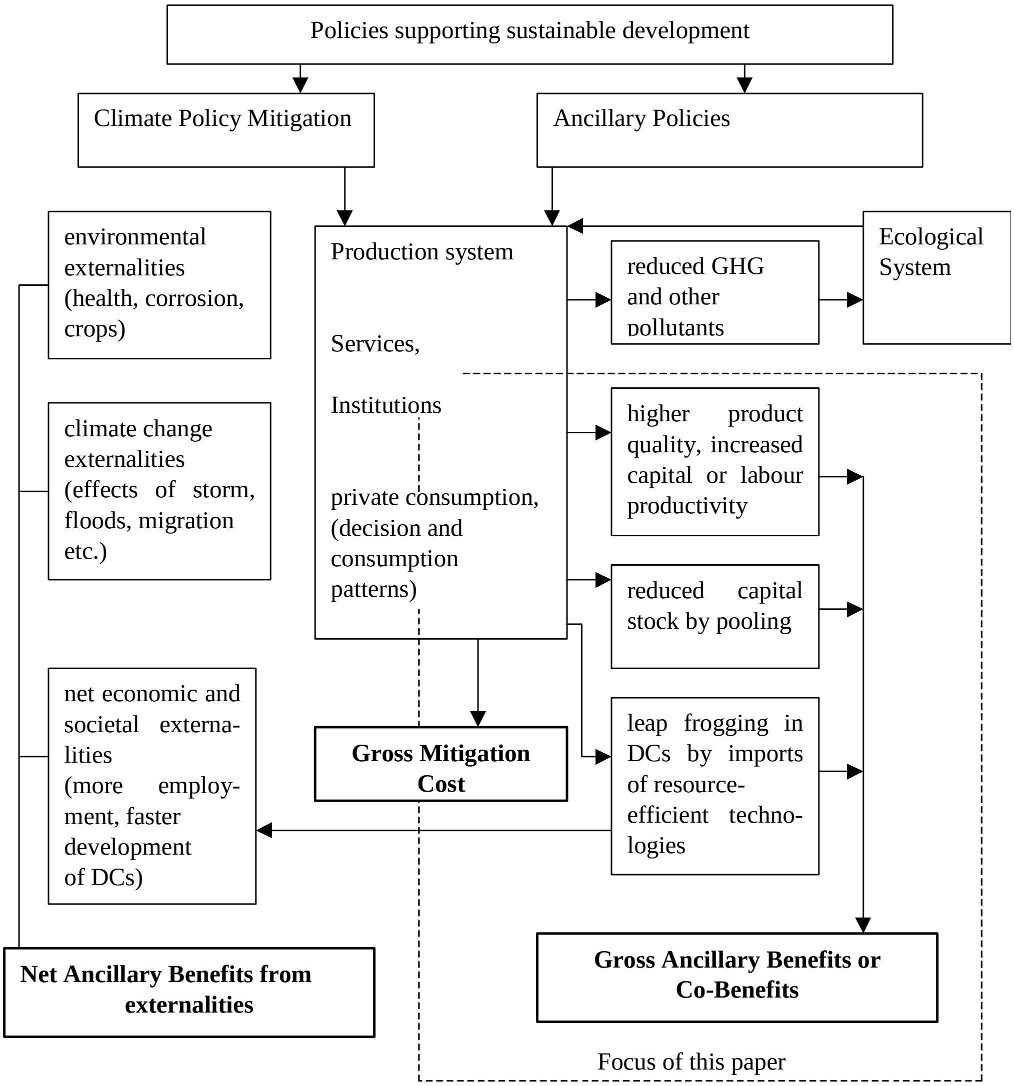
Of course the whole subject area of international technology transfer in general, and technology transfer to developing countries in particular, is very complex and involves a number of additional considerations on which we can only briefly touch upon here (useful references are IPCC 2000; Radosevic 1999; Kumar 1998; Cantwell 1995; Jeremy 1994; Lall 1993 and 1992; Kim 1991; Pack/Westphal 1986; Teece 1977; and Mansfield 1975; among others):

- In contrast to the transfer of pure knowledge, the transfer of technologies usually incurs costs: equipment in which technology is embodied has to be engineered for the scale, climatic, material, skill and other needs of the recipient country in order to be truly appropriate; besides, technology cannot be fully embodied in the equipment, in blueprints or in instructions (Lall 1993); therefore, recipient countries need to invest in skills, technical and organisational capabilities and in information gathering and management in order to be able to use the technology effectively and to actually create, exploit, and maintain spillover effects.

- Technology transfer costs can be substantial (20-60% of total project cost, according to Teece 1977) and may be continuous as a consequence of technical progress, in order to maintain the know-how and equipment economically viable. These costs tend to be larger, the larger the difference is in terms of technological capabilities of the importing and exporting country, respectively.

- Technology markets, in contrast to physical goods markets, are often fragmented and poorly defined, which may render the search for an optimal technology at the best price difficult and costly. Moreover, there is information asymmetry between the seller and the buyer.

Figure 2. Enlarged conceptual framework of ancillary benefits and costs of mitigation



Source: Own illustration

- The value or benefits of technology transfer are difficult to measure, and the local context and mode of technology transfer have a strong influence. The fact that many ways exist to sell technology may considerably increase the complexity for decision- and policy-makers of the issue to be decided upon. Besides, data on technology transfer transactions are often not available, and if they are available they may be distorted, e.g., by bargaining processes.

- Efficient assimilation, adaptation and further development of imported knowledge involve a complex and often costly and risky process of capacity building (Lall 1992). At the business economics level capacity building is determined by efforts to acquire and maintain new technical and organisational skills, to gather and manage information, and to network with (potential) suppliers, buyers and relevant institutions.

- For very little developed countries it is often difficult to master even very simple technologies, let alone such that reflect the state-of-the-art in the developed world.

- Foreign direct investment has the advantage that it may relieve the financial burden of investment and shorten the learning period by opportunities for faster leapfrogging, but on the other hand comes at the cost that the investing firm may provide a complete package only that includes elements that could just as well (or maybe even at lower cost) be produced in the importing country at the same or a comparable quality.

Our aim here is less concerned with an exhaustive discussion of all complexities inherent in technology transfer issues, but merely to raise an important issue that has so far been largely neglected, i.e. that there exist significant ancillary benefits/co-benefits that have so far been largely neglected and that could make climate change mitigation policy measures less costly than assumed so far, and that could – provided entrepreneurs are indeed able to take these properly into account in their decision-making, could have a tremendous effect on climate change mitigation.

Particularly, this paper extends the perception of ancillary benefits/co-benefits with regard to two aspects: starting from the process level or the business economics point of view as described above, it tackles the beneficial intra- and international dynamics of innovation and market diffusion of more energy- and material-efficient technologies and related ancillary benefits in the assessment of climate mitigation policies. Secondly, it considers the impact of global trade of used compared to new technologies and fast communication of new knowledge on energy-efficient technologies at the global level under the aspect of sustainable development in developing countries. Thus, this paper focuses mainly on the “forgotten” impacts of entrepreneurial action and technology transfers in terms of their environmental and non-environmental externalities, both at the business economics level and at the national and international macroeconomic level (see Figure 2).

1 NEGLECT AND NON-AWARENESS OF ANCILLARY BENEFITS/CO-BENEFITS AT THE BUSINESS ECONOMICS LEVEL

Considerations about climate change mitigation due to future improvements in energy efficiency or the use of renewable energies are often focused on energy technologies converting primary to final energy, or final to useful energy. These technologies are *essentially mono-functional*, i.e. technically they only serve the single purpose of converting energy from one form into another. Of course a variety of additional secondary characteristics (e.g. reliability, flexibility) may determine their overall attractiveness and merits. Therefore, the restriction of ancillary benefits/co-benefits to the issue of greenhouse gas and pollutant emissions mitigation is understandable. However, there are two additional areas for reducing future energy demand, and presently very little attention is devoted regarding the adequacy or non-adequacy of the economic evaluation traditionally undertaken by many actors and by the majority of climate and energy policy analysts:

- Energy losses at the level of useful energy (presently more than one third of the OECD primary energy demand) could be substantially reduced or even avoided through technologies such as low energy buildings, membrane techniques or biotechnological instead of thermal processes, and through lighter vehicles or even substitution of physical transport by electronic communication (e.g. IPCC 2001, pp.182-229; Jochem et al. 2002).

- The demand for energy-intensive materials could in principle be significantly reduced by recycling or materials substitution (Gielen 1999), by improving their design or material properties, and by intensifying the capacity utilisation of products and vehicles through pooling (e.g. car-sharing, leasing of machines; Fleig 2000). Where consumer choices are involved, of course aspects other than purely economic ones may also play a major role (e.g. social acceptance, lifestyle, habits, status, image). Also, there may be significant barriers involved.

In both areas, the *benefits of new technologies or services* do not only comprise the energy savings (and reduced emissions). Because they are *multi-functional,* usually serving a number of different objectives, their net co-benefits (or ancillary benefits) may be important and actually reduce the net cost of the investment, even at the level of business economics. Examples in the manufacturing and building sector (see below) can provide first insights into these different forms of co-benefits/ancillary benefits:

- Climate change mitigation by reducing the useful energy demand through new substitution technologies may change many production cost components of a particular good; moreover: energy efficiency may not have been the major motive for changing an existing production process, but it may occur as a co-benefit/an ancillary benefit! (see Box 1).[1]

[1] Of course the opposite can also be true in some cases (i.e. that a co-benefit would be eliminated). Chicken farmers, for example, did not like to switch from incandescent light bulbs to fluorescent lighting, because the former would keep the coops warmer (we are grateful to H. Dowlatabadi for providing this illustrative example).

- Improved control techniques, for example, may reduce production defect ratios, or may increase production output at the same capacity level, hence reducing the capital cost per unit produced, and/or the labour intensity, and (almost as a co-benefit) the energy intensity of production.

Box 1. Reduced energy demand and related environmental benefits as ancillary benefits or as co-benefits in areas of useful energy: The case of energy efficiency improvements at Toyota

In Long Beach, Toyota Auto Body of California (TABC) manufactures and paints the rear deck of Toyota pickup trucks. In 1991, TABC consumed 2.5 million kWh of electricity. By 1996, TABC had doubled production, was winning special awards for quality and yet reduced its electricity consumption to 1.7 million kWh. TABC achieved these incredible results with a comprehensive set of energy efficiency improvements. These included improvements in electrical motors, compressed air systems, and lighting.

The most striking upgrade turned out to be variable-speed motor drives for controlling the air in the paint booths. These drives not only save a great deal of electricity but also improve control over the entire production process. Microprocessors keep these drives at precise flow rates. Moreover, when the production process has to be redesigned, adjustable drives run the motor at any required new speed without significant loss in energy efficiency, reducing electricity demand by 50% on average. *The company's primary goal in this retrofit was not to save electricity but rather to improve the quality of the paint application.* Before the upgrade, TABC had a production defect ratio of 3 out of every 100 units.

After the upgrade, the ratio dropped to 0.1 per 100 and TABC's senior electrical engineer Petar Reskusic says, "In terms of customer satisfaction, it's worth even more than the energy savings."

Source : adopted from Romm (1999)

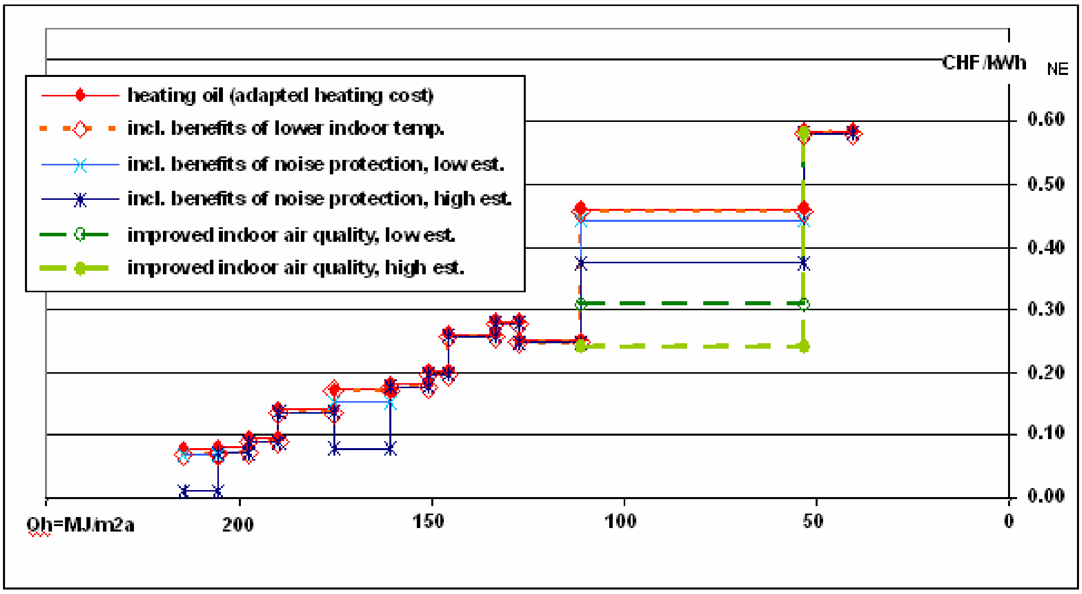
- High insulation in new buildings or in refurbished buildings increases the indoor temperature of the outer walls. A possible reduction of the difference of this wall temperature and the average indoor temperature by 5 °C allows a reduction of the indoor temperature by 1 °C (or an additional approximate 5 % of heat supply) at a constant level of comfort, which represents a co-benefit.

- Triple glazed windows and/or high-efficiency wall and roof insulation can reduce the level of outdoor noise in residential or commercial buildings substantially. Investors often neglect this effect in their decision-making, and in many cases it is even unknown, although the co-benefit may be in the same order of magnitude as the energy saved (see Figure 3).

- Highly insulated and airtight buildings need ventilation systems in order to guarantee a minimum rate of air exchange. Improved indoor air quality is a co-benefit of ventilation, particularly where smokers, humid indoor climates or high concentrations of chemicals (emitted from synthetic materials such as carpets or furniture) are involved. Again, the co-benefits from ventilation systems of highly insulated buildings may amount to the same order of magnitude as the energy recovered by the ventilation system. Without considering these co-benefits, the investment in ventilation systems (being a necessary additional investment of highly insulated buildings) would not be profitable (see Figure 3). This example also refers to the additional ancillary benefits of avoiding medical treatment costs faced by people suffering from asthma and other diseases of the respiratory system, or from certain types of allergies.

- Finally, if there is a buyer's market of renting apartments in stagnating populations, the possibility to increase rents depends on the standard of comfort and, hence, the thermal standard and related heating cost, the noise level and the indoor air quality. Non-rented apartments incur financial losses and contribute to the higher interest rates building owners will probably have to pay after 2006 when the Basel II Convention on risk-adjusted equity capital endowments of banks has entered into force. Under this convention banks will have to evaluate each of their debtors according to their risks and performance. We know from first cases in Switzerland that the difference of one percentage point of interest rate taken from the banks from low- or high-risk customers can make a difference in capital cost of up to 20 % (Jakob et al. 2002).

Figure 3. Marginal costs of various investments in insulation and ventilation systems including selected co-benefits (improved comfort, noise protection, and improved indoor air quality) in Swiss residential buildings.



If net co-benefits are included, marginal costs may be reduced by CHF 0.01 to 0.15 per kWh of useful energy saved, which can totally change the economic attractiveness of heat protection investments.

Source: Jakob et al. (2002)

These examples at the useful energy level demonstrate that an investment in energy efficiency at this point of the energy chain (and also material efficiency) often includes much more than the ancillary benefits and/or co-benefits of reduced greenhouse gas emissions and local pollution; the benefits of other aspects may even surmount the benefit of saved energy costs from the viewpoint of business economics and also the net environmental and climate change externalities from the welfare economics perspective. The major reason for the likelihood of co-benefits and ancillary benefits to occur is the often very pronounced multi-functional character of investments at both the useful energy level and the material efficiency level.

More importantly, significant net ancillary benefits/co-benefits of these investments are often not identified by the investors or not considered in the profitability calculations; this is due to one of the major obstacles to realising profitable energy and material efficiency potentials: the investor's lack of knowledge.[2] Of

[2] Note that this touches upon the almost classical "energy efficiency gap" or „energy efficiency paradoxon" debate on the lack of (or only limited) diffusion of commercially available and apparently cost-effective energy technologies (e.g. Jaffe/Stavins 1994). Due to space limitations we cannot reflect on this debate here, and the reader is referred to the pertinent literature; the same applies to issues regarding the theory of technological diffusion (for detailed accounts see, e.g., Rogers 1995 for the sociological/communications theory and Stoneman 2002 for the economic theory).

course fixing of such market failures incurs specific direct costs and ancillary costs/co-costs as well, but we argue that these may, in many cases, be substantially lower than the ancillary benefits/co-benefits that can be reaped (further theoretical and empirical research is needed to corroborate this argument). In macroeconomic models, such ancillary benefits/co-benefits are usually not explicitly considered, because the models are not constructed to reflect process substitutions and related ancillary benefits/co-benefits, as they were described in this section, in sufficient detail at the process or sectoral level. Instead, they assume incremental changes and substitution between capital, labour, energy and other natural resources.

2 ANCILLARY BENEFITS – ADDRESSING THE INNOVATION DYNAMICS OF NEW TECHNOLOGIES

As early as in 1990, the Enquête Commission “Protection of the Earth” of the German Bundestag called for a CO_2 reduction target by -80 % relative to 1990 CO_2 emission levels for industrialised countries by the middle of this century. The IPCC Third Assessment Report (IPCC 2001) notes that achieving stabilisation of atmospheric concentrations in 2100 at any level considered (i.e. ranging from 450 ppm to 1,000 ppm) will eventually call for global emissions to drop significantly below current emission levels. The challenges of climate change are so demanding that it implies the need for the existing capital stock of the industrialised countries to be completely replaced (or at least refurbished) by new, highly energy-efficient and low (to zero) emission technologies. New technologies – including new energy conversion technologies based on renewable energies or fuel cells, or new technologies at the level of useful energy, such as membranes or nanotechnology and material efficiency (foamed plastics or non-ferrous metals) and material substitution by biomass-based materials – are expensive during the market introduction phase, and generally can only be produced at higher cost than the conventional high emission technologies.[3]

New technologies have to face at least two major disadvantages when competing on a direct cost basis with conventional technologies:

- They are produced in low series and at low levels of knowledge as to how to produce them most efficiently, and
- they generate fewer environmental externalities than conventional technologies, a benefit which is typically not (or not fully) reflected in market prices.

It is well known from business economics that substantial learning and economies-of-scale effects are achievable for new technologies, and it is also well known that new technologies induce new efforts to improve the technical performance of the traditional technologies by their manufacturers (also referred to as the ‘sailship effect’). Examples of these effects regarding experience curves in the energy domain include the gas turbine, wind power and photovoltaics, and regarding technological competition the boiler and burner technology (condensing boiler, modulating burners) when heat pumps appeared on the market in the 1970s and 1980s, or the internal combustion engine as incumbent to fuel cells for non-stationary applications (e.g. Wörlen 2003; Barreto 2001; Messner 1997; Neij 1997, among others). Both of these aspects, the reduced cost of new technologies due to learning effects and economies of scale, and the incentives for further technological improvement due to technological competition, are ancillary benefits of climate change policy.

A recent and well-known example for the first aspect is wind power where substantial and unexpected progress in cost reduction and up-scaling has been achieved during the last decade (Wörlen 2003). Taking into account the externalities of coal-fired power plants, there is little doubt that wind power will be competitive with this GHG-emitting technology within the next 10 years. These ancillary benefits/co-

[3] Another reason for initially higher prices is that the in many cases substantial R&D costs need to be recouped in the early stage of market diffusion.

benefits of exploiting the cost dynamics by learning and economies of scale (and of course also any adverse effects that might occur through such competition) have to be considered if the policy targets of stabilising greenhouse gas concentrations in the atmosphere are taken seriously. Another recent example refers to substantial cost reductions of highly insulating windows and insulation of buildings during the last 30 years (Jakob/Madlener 2003).

The second aspect, the policy- and competition-induced technical progress of conventional technologies has not yet received much analytical attention and has been almost completely absent in top-down modelling so far.

3 ANCILLARY BENEFITS IN DEVELOPING COUNTRIES – LEAPFROGGING BY FAST INNOVATION IN INDUSTRIALISED COUNTRIES AND SUSTAINABILITY-ORIENTED TRADE POLICIES

Developing countries are dependent on the technology produced, applied and used in industrialised countries with regard to several aspects:

- The machinery, plants and vehicles imported from industrialised countries determine in most cases the best practice in terms of efficient resource use in developing countries.

- Abstracting from other aspects for a moment, the imports of dismantled plants and used machines, appliances and vehicles from OECD countries (currently a 150 billion $/a market) imply a slower technological development in developing countries in comparison to a situation where only new technology would be imported (Janischewski et al. 2003; OECD/UNDP 1999; Gersten 1997). Given the fact that in quite a few cases (e.g. plants of basic goods industries, vehicles) the resource efficiencies of these imported goods represent the technical know how and performance of 20 to 40 years ago, it is quite obvious that the external cost of these imports are relatively high.

- Finally, the non-adoption of best practice, for example, on how to construct large and energy-efficient buildings (adopted to specific climates), or how to develop efficient transport infrastructures in developing countries, results in unnecessarily high energy use levels and related greenhouse gas and pollutant emissions.

This aspect of the ancillary cost of re-selling plants, machinery, appliances and vehicles is totally overlooked in most of the present analytical and modelling activities. Restricting these second-hand markets to some extent, which tend to slow down energy and resource efficiency in developing countries (for example by carefully designed policies and standards) would aid leapfrogging towards sustainable development in developing countries and also increase the dynamics of learning and economies-of-scale in the industrialised countries.

As already mentioned in the introduction, technology transfer is a very complex and multi-facetted subject issue and we do not intend to indicate that there is indeed a “free lunch” out there in terms of “forgotten” benefits that come at no or very low cost. What matters is the word “net” if one speaks of benefits and costs. Developing countries need to decide very carefully on how to spend their scarce financial resources available for technology investment and related build-up of capabilities needed to operate and maintain the technology, and to possibly benefit further in terms of positive spillover effects. Typically, developing countries face severe lack of capital, rarely have the infrastructure and search capabilities that is needed to decide upon complex decisions on technological choice options and the attached needs for further action and assessments of the economic and societal impacts. The decisions are often being made by small and medium-sized companies, without sufficiently detailed information on operating conditions and operating and maintenance costs. In the case of efficient buildings, hotels and other service buildings, as well as in multi-family buildings, there may be some lack of life-cycle cost analysis and/or the investor-user dilemma that prevents the exploitation of “forgotten” benefits. In the case of cars, further aspects, such as societal prestige or the need to generate income from transportation services, may be very influential on the investment decisions (OECD/UNDP 1999).

In many cases older technologies are simpler to operate, service and maintain. For the investment goods industries the older technologies may be quite useful in terms of their lower investment cost, better match with prevailing levels of labour productivity, and lower demand for often scarcely available skilled labour. Also, if there is a lack of skill and capacity to operate equipment with embodied state-of-the-art technology, the operation and maintenance may be inefficient, or even lead to a complete failure of a project.

Overall, it seems that there is a balance somewhere, that differs from country to country and situation to situation, between reaping the additional benefits that may accrue from using state-of-the-art and hence more expensive and often more complex technologies, and between using somewhat outdated but in many other respects less costly technologies.

A few examples are given below to illustrate possible ancillary benefits/co-benefits from limiting the re-use of second-hand and inefficient machinery and plants in the basic product industries or in the construction industry regarding non-adoption building constructions to local circumstances and needs (Janischewski et al. 2003):

- A German steel works, constructed in 1960, with a capacity of 4 million tonnes of steel has been dismantled, is presently being rebuilt and is due to start operation in Jiangsu, China, in 2003.

- A similar case is that of a refinery, built in the 1960s in Karlsruhe, Germany, which started operation again in 2001 in India, where 75 % of all imported investment goods have been used in other countries.

- The USA, Japan, Korea and Germany exported 840,000 used cars to Latin America, South East Asia, China, Russia, the New East and Eastern Europe in 1998.

- Hotels and office buildings built in tropical and subtropical countries often have neither wall insulation nor double-glazed windows, and sometimes not even shade-generating components. In many cases these buildings demand more electricity per year for cooling than average buildings in moderate climate zones do for heating.

Again, we acknowledge that such benefits must not be seen in isolation, but only in the context of appropriateness. On the other hand, they should not be forgotten. It is quite obvious that a large leapfrogging potential exists, which could create large ancillary benefits/co-benefits, and which could be reaped by adjusting the foreign trade regime in a way that the most obsolete technologies must not be traded internationally any more. These changes may be achieved by labelling of mass-produced goods, mandatory information on specific energy demand and related emissions and on operating and maintenance cost, or export and import restrictions of highly polluting equipment and vehicles. In the case of buildings, extensive know how transfer from OECD countries and introduction of mandatory planning and of stricter construction standards in developing countries can help to avoid external costs, and losses of economic growth potentials.

4 ANCILLARY BENEFITS ON EMPLOYMENT

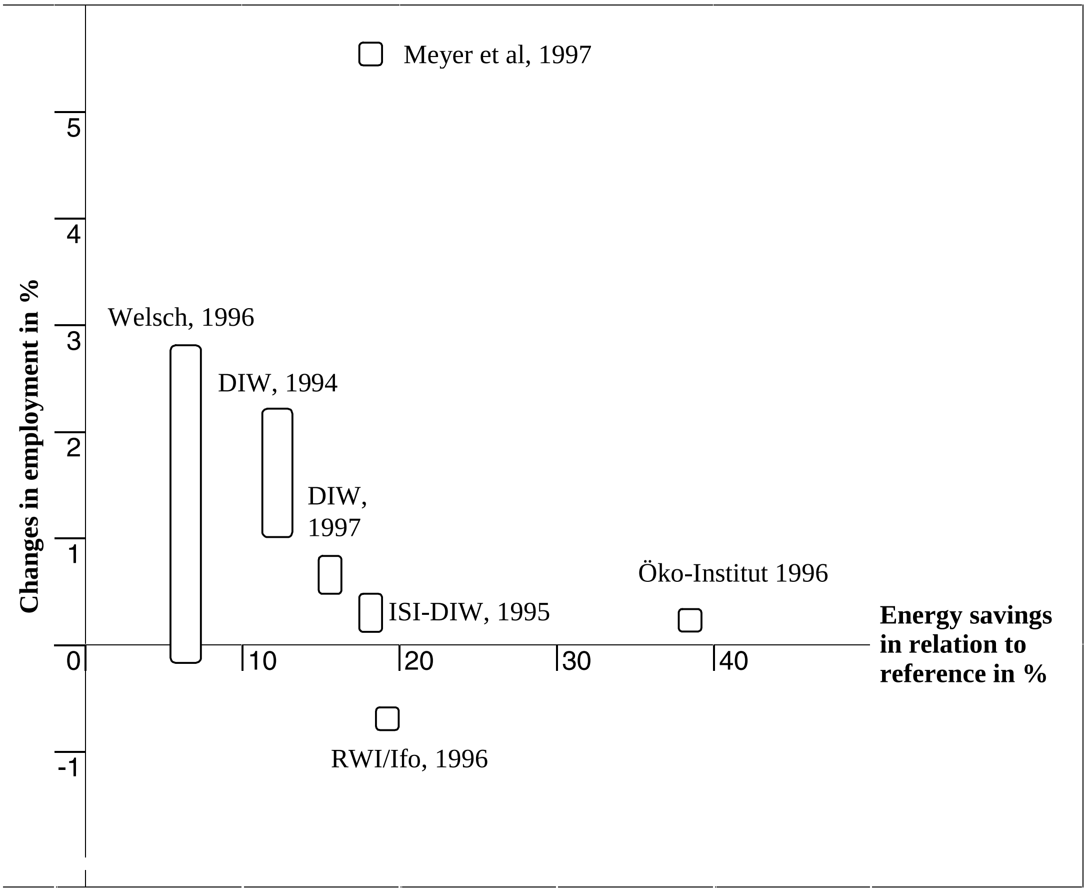
The results from discussing the effects of climate change policies on economic growth and employment (IPCC 2001, pp.504-535 and pp.544-552) show that a systemic and comprehensive view is necessary to adequately determine the net ancillary costs and benefits of climate change mitigation policies. Studies on indirect economic and employment effects which incorporate a coherent perspective of this kind, such as DIW (1994), Laitner et al. (1998), and Walz (1999), generally arrive at slightly negative to positive macroeconomic impacts of mitigation policies on growth, depending on the model used and some central assumptions regarding the capital and labour markets. Regarding net employment creation results tend to be positive (Figure 4). The following two research findings may further illustrate this point:

- Net employment effects balance the positive effects induced by energy efficiency investments against the negative effects due to decreased energy production and distribution. Jochem/Hohmeyer (1992), for example, report that the 4.1 exajoules per year of energy savings achieved in Western Germany between 1973 and 1990 alone created approximately 400,000 new jobs. In other words, the net employment effect in this country was about 100 new jobs per petajoule of primary energy saved in the 1980s.

- Today, the *net employment effect* due to increased labour productivity since the 1980s and reduced energy prices between 1986 and 1999 found in European and North American studies in the late 1990s is *in the order of 40 to 60 new jobs per petajoule of primary energy saved* (e.g. Laitner et al. 1998).

The results of the analyses cited here are plausible when one considers energy efficiency investments as increasing the marginal benefits of capital and/or energy. They also imply that energy efficiency improvements in any country could create new jobs by substituting (often imported) energy by domestically produced energy-efficient technologies and services and by re-spending the energy costs saved as additional available income in other ways.

Figure 4. Results of different analyses of the impacts of climate policy on net employment in Germany. The areas of each analysis cited represent the range of results depending on different assumptions (e.g. labour markets, price impacts, multiplier effects).



The differences among the authors depend on different models used and related different structures, related empirical data and assumptions on sectoral energy efficiency improvements and on foreign trade.

Source: Ostertag et al. (1999)

Finally, major sectoral employment creation is concentrated in the manufacturing of advanced investment and consumer goods, banking, trade, and other services – often taking place at centralised sites and in densely populated regions. From a regional viewpoint, most fuels and electricity have to be “imported” from other regions. By contrast, new energy and material efficiency-related jobs are created not only in the manufacturing industry, but also in the building sector and in the installation, planning, maintenance, consulting and other services businesses – in short in that segment of the economy, which is basically locally organised and served by small and medium-sized enterprises. Therefore, it ought to be stressed that the *regional distribution of net employment in a resource-efficient economy* will be *more equitable* than the jobs that accrue from the energy supply system. This may be a desired ancillary benefit (co-benefit), particularly for underdeveloped regions and/or regions with persistently high unemployment rates.

For many countries, *international trade* is an important determinant for economic well-being. Particularly for technology-intensive goods, high international market shares are often found to be positively correlated with the innovative capability of a national economy and the early presence in the market (‘first mover advantage’). A national policy, which intensively promotes the rational use of energy and materials, generally has the effect that a country specialises early on in supplying the necessary energy- and material-efficient products and services. Subsequently, when the international demand for these products and services expands, this country is in a better position to compete internationally, due to its early specialisation. Thus in the early 1980s – due to the energy efficiency standards and policies of several Western European governments for example – energy-efficient products such as high efficient windows systems, high-efficiency burners and energy-saving control systems achieved export rates and world market shares that were far above average (EU 1999). So far, however, such ancillary effects of resource-efficient technologies and services on international trade and competitiveness as dynamic and policy-induced effects have (if at all) been scarcely considered in macroeconomic models.

CONCLUSIONS

1) Analyses of the ancillary benefits of mitigation and mitigation policies have focused on environmental, climate change and national economics effects in the past. Health effects have been at the centre of ancillary benefit considerations. This paper broadens the view regarding

   – ancillary or co-benefits at the technology and service level, with particular emphasis on multi-functional and resource-efficient technologies and related services, and

   – the dynamics of innovation by reducing the cost of new mitigation technologies, initiating technological competition between the new and the traditional technology, and by improving international competitiveness of "first movers".

2) Net ancillary and co-benefits of mitigation are an important and until now often neglected decision element for policy analysts and policy makers. There are many cases where the net ancillary benefits/co-benefits are not monetised, quantified or even identified by the decision-makers, and/or not explicitly considered in economic models.

3) In investment decisions, the co-benefits to be considered by the investor and the ancillary benefits of a private investment for the society as a whole may have the same order of magnitude in monetary terms as the benefits from saved energy and natural resources and related reduced damage from climate change. In some cases, the effect of mitigation may even be considered itself as an ancillary benefit, given the importance of the other effects of investments in multi-functional durable goods and services (such as pooling of machines or vehicles).

4) The dynamics of policy-induced cost reduction of new technologies by learning and economies-of-scale can be considered as ancillary benefits or co-benefits of mitigation policies, but also further improvements of conventional technologies arising from policy-induced technological competition.

5) The three types of ancillary benefits/co-benefits discussed in this paper (i.e. ancillary/co-benefits from process substitution; dynamic effects of learning, economies of scale and technological competition; net employment effects due to import substitution and first-mover effects) have so far not been adequately addressed by top-down economic modellers. This is why, in many instances, modelling results may actually overestimate net mitigation costs at the macroeconomic level. It is a challenging task for modellers to improve and enlarge existing models in this direction.

6) Increased net employment as an ancillary benefit/co-benefit of mitigation is an important issue, given the high unemployment levels in many countries. The net employment effect of mitigation is more decentralised than the alternative production of energy and materials, which may be an important ancillary benefit/co-benefit for many rural and mountainous regions in the world.

7) Many of the ancillary benefits and co-benefits of mitigation turn out to be short-term effects, while the objective of climate change mitigation policies is, for obvious reasons, very long term.

These short-term co- and ancillary net benefits may support the acceptance of mitigation policies in a world in which the orientation of many decisions is on the short term.

8) Given the variety of ancillary benefits and co-benefits stemming from the diffusion of innovative multi-functional technologies, new services that promote resource efficiency, the dynamics of innovation and diffusion, the leapfrogging potential inherent in technology transfers to developing countries, both mitigation- and other resource-efficiency-related policies should be understood as an essential part of both innovation and economic policies also striving for sustainable development at the local, regional, national and international level.

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