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Nuclear Energy and Kyoto-Protocol in Perspective[1,2]

The Nuclear Advisory Board of the Austrian Minister for the Environment (FAF), previously advising the Austrian Federal Chancellor, was asked to assess nuclear energy in view of the Kyoto-Protocol and to contribute to the discussion of whether or not investments in nuclear energy projects should qualify for the Kyoto-Mechanism CDM or JI.

In recognition of the facts that there is a need for more electric power, especially in developing countries and new industrialized countries, and that nuclear energy provides electricity free of CO_2-emissions and therefore is able to contribute to reduce CO_2-emissions, it is argued here that using nuclear energy is no favorable option for CO_2-reduction because it is counter-productive to successful climate change policy. Instead, successful climate change policy, consequently also CDM and JI, should prioritize on the increase of efficiency in conversion and use of energy.

This paper is based on some hypothesis, that are presented here as well as evidence to support these contentions. However, this paper did not intend to give ultimate proof of these contentions, but an invitation to the knowledgeable reader to take up the debate and to contribute to clarification by factual support or contradiction.

Keywords: *Nuclear Power, Kyoto-Protocol, Negajoule, Energy Intensity, Energy Efficiency*

Perspektiven der Nuklearenergie in Bezug auf das Kyoto-Protokoll

Das Forum für Atomfragen (FAF), das Beratungskomitee des österreichischen Umweltministers (früher Beratung des Bundeskanzlers), wurde gebeten die Rolle der Atomenergie aus Sicht des Kyoto-Protokolls abzuschätzen und zu argumentieren inwieweit Investitionen in Nuklearenergie bei den Kyoto-Mechanismen CDM und JI anrechenbar sein sollen.

Obwohl der Bedarf an elektrischer Energie insbesondere in den Entwicklungsländern und in den Reformstaaten steigen wird und die CO_2-frei produzierende Nuklearenergie zur CO_2-Reduktion beiträgt, wird hier argumentiert, dass Investitionen in Atomenergie einer erfolgreichen Klimapolitik zuwiderlaufen. Als adäquates Instrument einer CO_2-Reduktionspolitik wird vielmehr eine Priorisierung der Effizienz von Energie-Umwandlung und -Verbrauch angesehen.

In diesem Beitrag werden dazu sowohl Hypothesen als auch ansatzweise Belege dafür präsentiert. Trotzdem kann der Beitrag keinen endgültigen Beweis dieser Behauptungen liefern und ist vielmehr eine Einladung an den kundigen Leser, die Argumentation aufzunehmen und zur Klärung durch stützende Fakten oder Gegenargumente beizutragen.

Schlüsselworte: Kernenergie, Kyoto-Protokoll, Negajoule, Energieintensität, Energieeffizienz.

Nuclear Energy versus Energy Efficiency

All recent scenarios for the next decades (IEA 1998, EC 1999, WEC/IIASA 1998, etc.) suggest that the global/regional Gross National Product (GDP) will grow faster than the energy demand and that the part of energy demand not saved by "negajoules"[3] (by decreasing the energy intensity of the GDP) will

1 **Acknowledgement:** Many thanks for valuable comments on a draft version are due to our colleagues from European Council for an Energy Efficient Economy (ECEEE) and Energieverwertungsagentur, Vienna (E.V.A).

2 This Paper is one out of a series of papers that address various aspects of this issue, all of them, including a summary, can be obtained from faf@irf.univie.ac.at. This version is slightly shortened. The paper in full length can be found on www.eva.ac.at

3 Negawatt would be the more common term; however, "negajoule" was chosen to emphasize that the greater part of "avoided energy consumption" is in the form of heat and fuel rather than electricity.

come overwhelmingly in form of fossil fuels, with nuclear playing a marginal role.

The International Institute for Applied System Analysis (IIASA) has presented several scenarios in which varying assumptions on the availability of technology and resources have been made.

A comparison of scenarios emphasizing technological progress (especially increasing efficiency) with those relying heavily on nuclear power indicates that the future development of the CO_2-emission does not primarily depend on whether or not nuclear energy is deployed, i.e. that the key factor is the energy intensity of the GDP.

This strongly suggests that there is no simple correlation between deployment of nuclear power and reduction of CO_2-emission. The availability or unavailability of nuclear power is certainly not a major determinant for the level and dynamics of CO_2-emissions, while the attention politics and the market (consumer and investor) pay to energy efficiency certainly is.

Avoiding energy consumption

Attempts to solve the energy and climate change problem primarily on the supply side have not produced convincing results in the past and no plausible solutions can be expected for the future. None of the CO_2-lean[4] energy carriers – be it nuclear or renewable – on its own or all together offer more than a slight reduction of the speed at which energy demand and CO_2-emissions grow world wide. This has been true in the past, and is what the various scenarios predict for the future as the most plausible development.

In conjunction with a forceful efficiency policy, CO_2-lean energy carriers could enhance the pace at which CO_2-emissions are reduced. However, in view of the past, it remains yet to be shown that there is, in real world, a policy mix, which can simultaneously support the growth of nuclear energy and of energy efficiency[5]. This was not the case in the past, especially not in centrally planned economies, but also not in the OECD (Organization for Economic Cooperation and Development) countries. The recent development – cheap, abundant energy as an explicit goal of liberalized energy markets – and the requirements for a successful policy for energy efficiency do not match.

The potential for reducing CO_2-emissions by politically inducing a market change in the sectors of heat, appliances and mobility is by far more important than that by building nuclear instead of fossil power plants in an otherwise unchanged economic environment.

Global considerations

The energy intensity of (worldwide) economic activities (global GDP) has been and is expected to be steadily decreasing, at a certain rate (say x) that is usually smaller than the rate (say y) at which the global GDP is growing. Therefore economic growth is usually coupled with increasing demand for energy. If x were zero, then the GDP and the energy demand would grow at the same rate. If x were equal to y, then economic growth would not entail growing energy demand, i.e. would be "fuelled" solely by the decrease of energy intensity that can be thought as a source of avoided energy demand, i.e. as a source of negajoules[6]. In

[4] Usually, nuclear and renewable forms of energy are termed "CO_2-free". Here they are referred to as "CO_2-lean" to account for the CO_2-emission resulting from construction of power plants, dams etc.

[5] This is certainly also true for other central power options such as large hydro-power-plants. Decentralized CO_2-lean energy options seem less likely to be in conflict with pro-efficiency policies.

[6] negajoules produced in year X are therefore found as the difference between the fictitious energy demand in year Y2 at energy intensity in year Y1, and the actual energy demand. These Negajoules can be compared to the increase in energy demand in period (Y1, Y2) to appreciate the relative contribution of the two different types of fuel for economic growth.

the past decades, the average value of x was close to half of that of y, i.e. about half of the "fuel" needed to sustain the growing economic output was supplied in form of additional primary energy, the other half in form of avoided energy (negajoules), as shown in Figure 1. In other words: Would the reduction rate of the energy intensity have had twice the actual value – i.e. 2 %, a value which has been observed in the European Union (EU) in the 1970's and 1980's as a result of the OPEC (Organization of the Petroleum Exporting Countries) induced price increases – then the global energy demand would have remained constant, all other things unchanged.

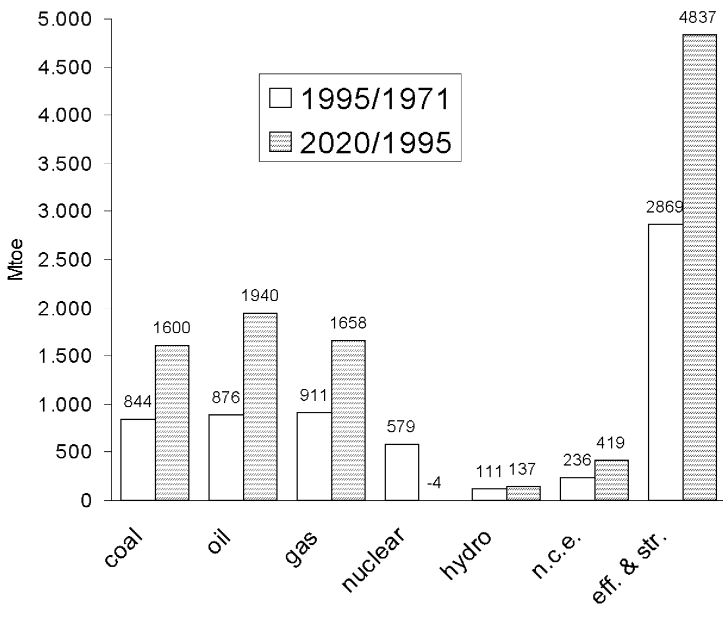
The reduction of energy intensity of GDP is a result of increased efficiency of conversion and use of energy and of structural effects. Structural effects are generally small as compared to efficiency effects, although a more detailed analysis would be appropriate at a global scale[7]. On the other hand, structural effects may become more important when it becomes recognized that the efficient supply of energy services is only the second step, the first and more fundamental one being to reduce the need for energy services, where they emerge as an unintentional by-product of poorly designed buildings (need for air conditioning), by poor urban and regional planning ("forced" auto mobility) etc.

The amount of CO_2 not emitted as a consequence of this decrease of energy intensity – or supply of negajoules – can be taken as the pertinent "reduction of CO_2-emission" resulting from decreased energy intensity of the GDP.

As a consequence of the important contribution of the reduction of energy intensity, and to the modest contribution of CO_2-lean sources to additional energy supply (from 1970 to 1995, negajoules contributed 43 %, fossil 40 %, nuclear 9 %, and hydro plus non conventional energy sources 5 %), the decrease of energy intensity was responsible for the most part of "avoided CO_2-emissions" in the previous decades. Considering the time interval 1970 to 1991 this means: Without nuclear, the level of CO_2-emission for 1990 would have been reached in 1988, without decreased energy intensity already in 1979.

Figure 1 shows, on the basis of data taken from the International Energy Agency (IEA 1998), the actual amount (in mega ton oil equivalent) by which the use of conventional energy sources has increased, within 25 years from 1970 to 1995, to meet world wide energy demand. The same figure also shows the IEA projection for the increase to be expected, in a business as usual scenario, within the 25 years following 1995. Most importantly, the figure also shows the ener-

Fig. 1: "Fuel" for Global Economic Growth Worldwide



n.c.e. stands for non conventional energies, i.e. renewable forms of energy without large hydro; eff.&str. stands for energy efficiency and structural change, i.e. for the effect of the decrease of energy intensity
Source: IEA 1998

[7] Structural effects can have negative and positive contributions, in particular when considering the global economy, e.g. negative effects if non-commercial forms of energy – and therefore previously unaccounted for in statistical energy-data – are replaced by commercial ones.

gy "not demanded" by the growing world economy (negajoules in mega ton oil equivalent) as a result of the reduction of energy intensity which has occurred between 1970 and 1995, and which is anticipated for the time interval 1995 to 2020, respectively.

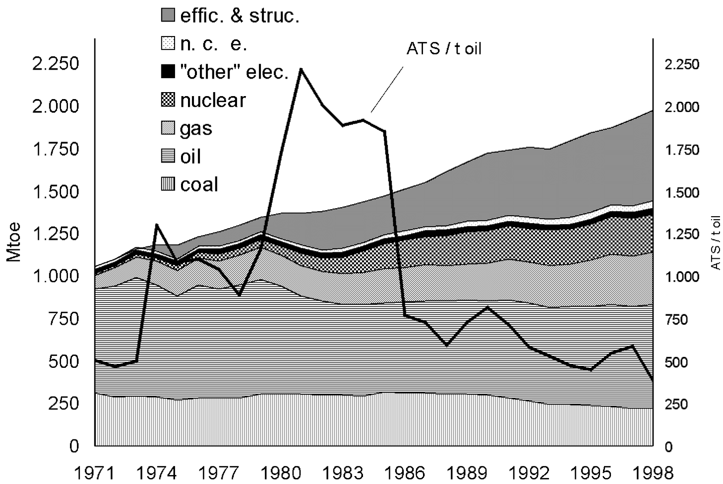
This rather unconventional presentation of additional primary energy demand (actual) and avoided energy demand (as a result of reduced energy intensity of the economy) in the same figure indicates the different order of magnitude of CO_2-emission reduction as a result of CO_2-lean energy sources and of efficiency gains.

EU: Dynamics of the energy demand

The European Union, with about 15 % of global primary energy consumption, with more than a third of its electricity produced in nuclear power plants, is of particular interest in the context of the question what role nuclear energy can play in the attempt to meet the Kyoto-Target.

From 1995 to 2020, the European Commission (EC 1999, 2000) expects that two third of the growth of the GDP will be fuelled by the anticipated decrease of the energy intensity of the European economy, and only one third by additional supply (and only 3 % of GDP growth and 9 % of energy demand growth is from non-fossil forms of energy, among which nuclear). That is, two third of the GDP growth is expected to be fuelled by "saved energy", 3 % by CO_2-lean fuel, the rest by fossil fuel.

Fig. 2: Primary Energy Demand, Energy Intensity and Price



EU: Development of the primary energy demand (coal, oil, natural gas, nuclear, "other" electric energy such as hydro, non conventional sources of energy (n.c.e.) such as biomass) and of negajoules (effic.&struc., referred to 1971 energy intensity) and of oil price (black line and right hand scale in ATS/t).
Source: ENERDATA 2000

This projection anticipates the implementation of some "lessons learned" with respect to energy efficiency and renewable energy policy: The recent past has shown that the energy intensity reduction rate of the EU's economy can depart from the 1 % average to as much as 2 % (as was the case in the 1970's and 1980's when the OPEC made the "energy price policy" on the EU's behalf), but also to a mere zero percent, or even change its sign (in times of low energy prices, e.g. as an effect of market liberalization policy, as in the 1990's).

This margin of plus/minus 1 % intensity reduction rate, which has been demonstrated to be accessible as a result of (voluntary or imposed) price policy, suggests the availability and accessibility of a CO_2-reduction potential which goes far beyond that accessible to the nuclear power sector which has not shown any revival even at times of high energy prices.

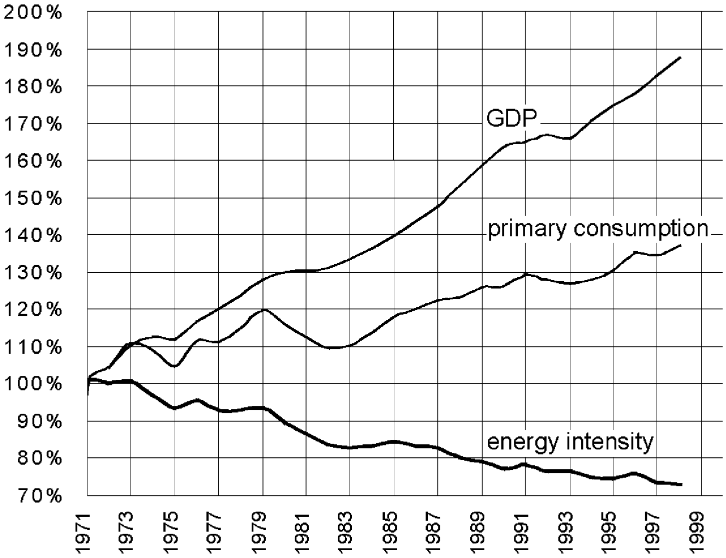
This phenomenon of economic growth with essentially constant energy demand, which had been referred to as "decoupling of the economic growth from energy demand", has been observed for many decades in the industrial sector of EU, and has been true for the entire economy as a whole during the 1970's and 1980's. However, this has been a futile phenomenon, linked to past high energy prices and, unfortunately, not to an efficiency policy with lasting impact. Presently, energy demand and GDP grow in harmony at about the same rate, a result of low energy prices and the absence of policy measures that would appropriately guide the market forces, in spite of low prices.

Figure 2 looks into the dynamics within the 1970's, 1980's and 1990's, and correlates changes in economic growth, in energy demand and in energy intensity (expressed as negajoules) with energy prices (here indicatively represented by the cost of oil imported by Austria, in ATS per ton, right hand scale). The top line indicates, how primary energy demand would have had evolved, if the energy intensity of the GDP had remained constant, i.e. reflects the evolution of the GDP. The top area gives the amount of energy saved as a result of the actual decrease of the energy intensity of the GDP (domestic=EU).

Within the last three decades, the contribution of energy efficiency and structural change to GDP growth was about 2.4 times that of nuclear energy. Had the energy intensity decreased at a slightly higher rate as it actually did (by 30 %), this would have "replaced" the contribution of nuclear energy. It would be interesting to make an ex post scenario assuming that the expenses for nuclear power would have been made available to fund an energy efficiency policy. Would this have brought this 30 % increase of efficiency gain, or even more? In view of the fact that virtually all projections of the energy demand in the next decades do not assume a growth of nuclear energy contribution in the EU, and that a further decrease of energy intensity is expected to be the "principal fuel" to the European GDP growth, such an analysis would be of particular political relevance.

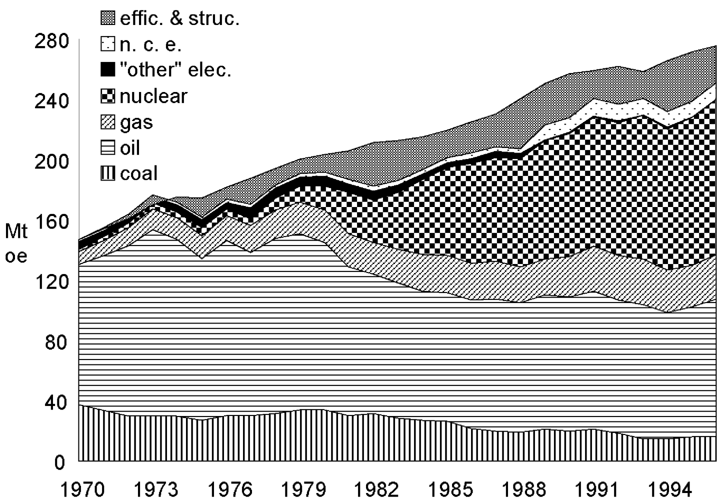
Figure 3 condenses this information to the index (1971=100 %) of three key parameters, energy intensity (lower curve), primary energy consumption and GDP (top curve). In the period 1973 to 1983, the decrease of energy intensity has been "fueling" the GDP growth, yielding the often quoted decoupling of the growth of economy and of energy, i.e. stagnant energy consumption in spite of economic growth. In the period thereafter, the decoupling was partial: about half of the economic growth was achieved at the expense of additional energy demand, the other half "earned" by decreasing the energy intensity.

Fig. 3: Development of GDP, Energy Intensity and Primary Energy Consumption in the EU 1971-1998



Index:1971=100 %, Source: ENERDATA 2000

Fig. 4: Primary Energy Demand and Energy Intensity in France

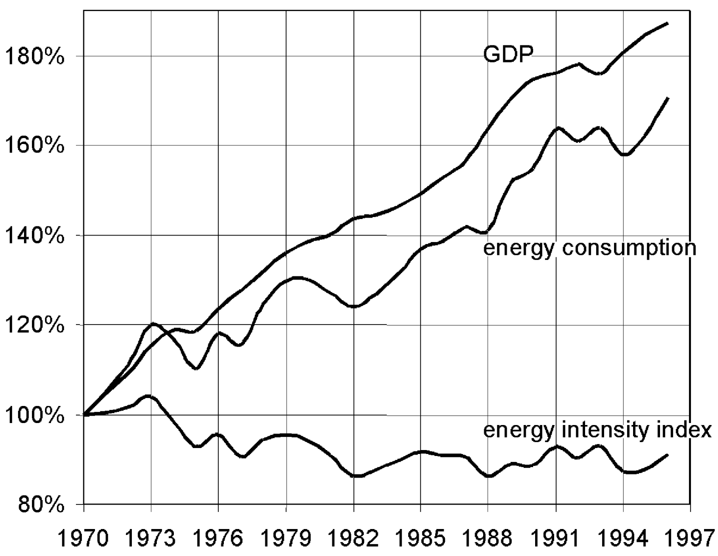


Development with time of primary energy demand (coal, oil, natural gas, nuclear, electric energy) and of the contribution of the reduction of energy intensity (eff.&struc.) to the growth of the GDP (top line) Source: ENERDATA 2000

Figure 4 and 5 give the same set of information, this time for a member country of the EU, with France as an illustrative example. The figures show the stagnation of energy intensity improvement since the late 1970's, entailing a very modest contribution of energy efficiency to GDP generation. In this respect, France clearly deviates from the European average, as is evident from a comparison with Figures 2 and 3. Nuclear energy was introduced at a rate well above the European average, while energy efficiency was de-emphasized.

This analysis can not only be performed for each EU member state, but also for each economic sector of the EU and each of its member states, as well as of any economic sector of any world region. On the basis of such analyses for all sectors and all world regions, it becomes evident how the different economic sectors in different countries or world regions react to changes in energy prices and in other conditions influencing market behavior. This type of information can be a valuable basis for the design of efficiency oriented energy and climate change policies.

Fig. 5: Development of GDP, Energy Intensity and Primary Energy Consumption in France 1970-1996



Index: 1970=100%, Source: ENERDATA 2000

Nuclear Energy in Developing Countries

The future of global energy demand will mainly result from what will happen in developing countries and in emerging economies, in particular China and India. There the energy demand is expected to double or treble within the next 30 years, the share of global energy demand will exceed that of OECD countries shortly after the turn of the century, and incremental energy demand is expected to being supplied almost exclusively in form of fossil fuel.

In view of this, nuclear energy can only play an essential role in mitigating CO_2-emissions if it addresses the markets in these countries, i.e. if the nuclear technology can be made to match with the respective social, economic and legal structures and safety cultures. The present generation of nuclear power plants does not fulfill this requirement by any means: Present nuclear power technology requires a safety culture, an infrastructure and specialized education, which are at the limit of what the industrialized world is able to provide. Nuclear power technology is therefore not adapted to countries with emerging/developing economies.

There are several mismatches between nuclear technology as developed in and for industrialized countries, and the need of developing countries (Kendall 1999).

■ **Dimensional** incompatibility: Due to the economy of scale, the "economic" size of the current reactor generation is of one GW(e) and more, designed for base load, whereas the need is for small, adaptable, load following plants.

■ **Cultural** incompatibility: The actual nuclear power technology has been designed for a safety culture that is typical for highly industrialized countries (e.g. relying on active intervention in case of abnormal functioning). A technology adapted for another safety environment may require "walk away safety", i.e. would have to rely on natural processes, to eliminate the need for emergency action.

■ **Infrastructure** incompatibility: If the prerequisite of implementing the present nuclear power technology was to modify a society – its industry, its labor force, its regulatory processes – to make it suit the needs of present nuclear power technology, this could hardly be called a sustainable approach. If these countries were to be reduced to vendors of sites for nuclear power plants to be operated by companies and crews from highly industrialized countries, this could not be called an "adapted technology", and would not be acceptable.

There are good reasons why many ambitious nuclear power programs of many ambitious developing/emerging countries have failed. One reason certainly is that they have been based on a reactor technology conceived for highly industrialized countries and a specific safety culture. By now, strong expansion of nuclear power seems to be considered mainly by countries with modest democratic tradition and a less developed safety culture, with the exception of some countries which have to cope with special energy resource situations, such as Japan.

This seems to suggest that present nuclear power technology would have to be substantially changed in order to suit the requirements for nuclear power to be operated safely and economically in these countries. No such development is in sight. Therefore there is no reason to expect that nuclear energy in developing countries and in emerging economies could or should be implemented at a rate which would make it significant for climate protection.

But this is not the only question mark. The other one is: By qualifying nuclear power for Clean Development Mechanism (CDM) and Joint Implementation (JI), do we offer the appropriate option to these potential host countries?

International Atomic Energy Agency (IAEA) Director General Dr. M. ElBaradei (1998) has been emphasizing, in many of his recent addresses to various conferences, that *"Nuclear power alone cannot ensure secure and sustainable energy supply world wide, nor can it be considered as the only means of reducing green house gases. But, together with renewable energy sources, improved fossil fuel conversion, and efficiency improvements throughout the energy system – all of which are important – nuclear power could continue to be a key component of many national energy strategies for environmental improvement and mitigation of climate change*".

This statement points out that nuclear energy may be one of the components of a climate change policy, but by calling it a key component it exaggerates this role, as well for industrialized countries (see previous sections of this paper), but even more for emerging/developing countries: How many approaches can these countries pursue simultaneously, all of the quoted ones equally well? Is it wise to invest scarce human and financial resources into the development, implementation, operation and regulation of nuclear power in these countries? Can this be as effective as if they were invested in efficiency programs? The answer clearly is: No, they cannot.

Energy intensity in countries with emerging/developing/transient economies is three to five times that of OECD countries, and may even increase when previously unaccounted non-commercial fuel is successively replaced by commercial forms. This is a clear enough hint what type of climate change policy would have to be considered adequate for these countries.

Summary and Conclusion

■ If nuclear energy is to play a non-marginal role in reducing CO_2-emissions, its rate of deployment would have to be increased to the level at which it would es-

sentially compensate the anticipated increase in fossil fuel consumption.
This would require a rate of commissioning of nuclear power plants, which is about an order of magnitude above that experienced in the “golden” decades of nuclear energy, i.e. in the 1970's and 1980's. However, there is no basis for such a rate of deployment, neither regarding production capacity nor regarding the ability of host countries to absorb such a growth. It would also mean a drastic increase of the share of electricity in the energy mix, well above historical rates.

■ In the past decades, the increase of global CO_2-emissions would have been about two times higher as it actually was, i.e. about twice as much additional fossil energy would have been consumed, if the growth of our economies had not been associated with an important reduction of their energy intensities, i.e. of the amount of energy consumed to produce one unity of GDP (world). In comparison, all CO_2-lean energy sources, among them nuclear, have had a much more modest contribution to the reduction of the rate at which CO_2-emissions have actually grown. That is, the contribution of nuclear and renewable energy has been outweighed by far by the increase of efficiency in energy conversion and use.

■ The emission of CO_2 occurs mainly and increasingly as a result of the decentralized conversion of primary energy to low temperature heat and of transportation (mobility). These sectors have both a high growth rate and a high potential for increased energy efficiency. The CO_2-emission of these two key sectors can be dramatically reduced by harvesting their efficiency potential, whereas providing CO_2-lean electricity to these sectors would have to be associated with a fundamental change of technologies. In addition, in the context of the Kyoto-Protocol, any nuclear contribution would come too late as a result of the long lead times of their planning, construction and commissioning.

■ These two observations suggest that an energy efficiency policy has a much larger potential for reducing CO_2-emission than a policy relying on CO_2-lean nuclear energy.

■ The rate at which total world energy intensity decreases (historically about 1 % per year) can be substantially influenced. Through appropriate policies, this seems to be feasible. Take the OECD region, which has the lowest energy intensity of all world regions, as an example: During the 1980's the average was 1.8 % per year, during the 1990's it was only 0.4 %, a clear reflection of energy prices and price expectations, thus a clear reflection of the extent to which climate/energy policy (energy prices, legislation in practically all sectors of the economy etc.) determines the efficiency gains.
These observations seem to suggest that market forces have been much more successful in influencing energy intensity than in providing additional CO_2-lean energy supply, and there is no reason to believe that this statement does not hold for the future. In this context it is interesting to note that the energy intensity in the countries of the Commonwealth of the Independent States (CIS, former Soviet Union) and Central and Eastern European Countries (CEEC) is five times higher than in OECD countries and three times higher in the rest of the countries in the world, suggesting that a focus on energy intensity could be particularly effective in those countries which experience the highest economic growth and the highest additional energy demand.

■ There is evidence that, in the real world, market forces and politics work in such a way that either nuclear energy supply or energy efficiency is emphasized, i.e. the social, economic and legal requirements for, and the structural consequences of entrusting CO_2-reduction to nuclear energy seem

to be in conflict with those requirements which yield a successful efficiency policy.
This seems to suggest that a climate change policy which relies on nuclear energy should realize that nuclear energy tends to be an alternative, not a complement to a successful efficiency policy, thus forgoing that key part of the energy policy which potentially contributes an order of magnitude more than any additional CO_2-lean energy source.

■ Additional energy demand is increasingly shifting from industrialized to developing countries and emerging economies, in particular China and India. Therefore, nuclear energy can only be expected to play an essential role in mitigating CO_2-emissions if it is marketed in a form, which matches with the respective social, economic and legal structures and safety cultures. The present generation of nuclear power plants does not fulfill these requirements.

■ This seems to suggest that present nuclear power technology would have to be substantially changed in order to suit the requirements for nuclear power to be operated safely and economically in these countries. No such development is in sight, which would suggest that nuclear energy in developing countries and in emerging economies could or should be implemented at a rate that would make it significant for climate protection. In addition, with respect to the time horizon of the Kyoto-Protocol, such a need for technological change excludes nuclear power from CDM and JI considerations.

It is crucial, for a successful climate change policy, not to mislead the attention of industrialized countries (as donors), of emerging/developing countries and of countries in transition (as hosts) by investing in technologies which (a) are not technologically adapted, (b) even if they were, do not have the potential to contribute significantly to the mitigation of climate change, and (c) favor/require socio-economic and structural conditions ("contextual factors") which tend to discourage the utilization of the single largest potential, i.e. that of increased energy efficiency.

Flexible mechanisms such as JI and CDM have the potential to shape the economies of the host countries into the direction of efficient CO_2-reduction. The arguments presented in this paper strongly suggest that the reduction of energy intensity, i.e. the increase of the efficiency of conversion and use of energy needed to meet the increasing demand for goods and services, has a potential, both in donor and host countries, to result in considerable reduction of the associated CO_2-emissions.

The extent to which nuclear power has contributed and will be able to contribute, even in the most optimistic scenarios, not only is much smaller than that of increased energy efficiency, more importantly its deployment seems to be in conflict with the socio-economic environment a successful efficiency policy needs, and is therefore contra productive.

Relying on nuclear energy to mitigate CO_2-emissions therefore seems to imply forgoing the much larger potential of reducing the energy intensity of our economies at a much faster pace than in the past.

For efficiency alternatives to become the choice of the market, higher energy price strategies may be a necessary, but certainly are not a sufficient condition. The reasons for the energy intensity decrease of past decades would have to be carefully analyzed: What part was technology driven, what part policy driven? Transaction costs, legal, social and technical barriers would have to be identified and overcome by appropriate strategies, often yet to be developed. Past (negative and positive) experience would have to be carefully analyzed with respect to driving and opposing factors. This is probably more difficult to organize than to launch a new nuclear initiative, but it would certainly be more appropriate for solving our climate change problem (rather than the problem of the stagnating nuclear industry).

In view of the unrivalled potential of efficiency alternatives to lower CO_2-emissions, in countries on both sides of CDM and JI, the challenge to the world is to master the difficult implementation of efficiency alternatives. The Kyoto-Protocol could become the motive and the motor for doing so – if it will be implemented with the proper rules and instruments.

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Terms and Short-terms of this Article:

CDM: Clean Development Mechanism
CEEC: Central and Eastern European Countries
CIS: Commonwealth of the Independent States (former Soviet Union)
GDP: Gross National Product
GW: Giga Watt
IAEA: International Atomic Energy Agency
IEA: International Energy Agency
IIASA: International Institute for Applied System Analysis
JI: Joint Implementation
Negajoule/Negawatt: Energy/Power which was “saved” as a result of decreasing energy intensity of GDP.
n.c.e: non conventional sources of energy.
OECD: Organization for Economic Co-operation and Development
OPEC: Organization of the Petroleum Exporting Countries
WEC: World Energy Council