Dräger Foundation

Kiel Institute for the World Economy

XVI Malente Symposium

2006






Energy, Climate, and Future Welfare –
Changing Global Dynamics

October 08 - 10, 2006
Music and Congress Centre Lübeck

XVI Malente Symposium
Energy, Climate, and Future Welfare – Changing Global Dynamics

The Malente Symposia, organized by the Dräger Foundation at two-year intervals since 1981, are the Foundation's most comprehensive and best-known international recurrent events. They are named after a small town in Germany which was the first conference venue in 1981, and provide a forum for innovative debate at the crossroads where economic and sociopolitical issues meet.

The XVI Malente Symposium, entitled 'Energy, Climate, and Future Welfare – Changing Global Dynamics', took place from October 8 – 10, 2006, and was organized by the Dräger Foundation in cooperation with the Kiel Institute for the World Economy. The aim of the conference was to examine in depth the dual challenges of the 21st century – energy insecurity and global warming.

The industrial revolution and today's income levels in the developed countries are to a major extent the result of easy access to different energy sources. Coal was the first main driver of industrial expansion, and was later supplemented by oil and gas. Nowadays, renewable energy sources and nuclear energy also meet some of the world economy's energy needs. The availability of energy is closely connected to economic growth and social welfare. Mobility in a globalized world, the production of goods and services, and the fulfillment of basic needs such as heating, lighting and cooking, all require substantial energy inputs, and the demand for energy is growing rapidly.

However, such freely available energy is not sustainable, and the next decades will see the world facing new challenges. The way in which energy needs were satisfied in the post World War II era is now endangered by several factors, thus threatening the prospects of sustained economic growth – so essential if living standards in the industrialized countries are to be maintained and those in the developing world raised.

With regard to energy, the known oil and gas reserves are shrinking, and are located in politically somewhat insecure regions. With regard to climate, there seems to be widespread agreement that we are experiencing a change in climate and that the world's increasing consumption of energy – in particular the consumption of fossil fuels – is accelerating global warming. The Symposium therefore sought to explore the kind of policy changes which could be implemented to slow down the process of global warming, while at the same time securing the energy needs of industrialized countries, rapidly growing emerging markets like China and India, and developing countries.

Climate change is a truly global phenomenon affecting people all over the world. One of the important questions of the Symposium therefore concerned global action. How can a global accord for climate protection be reached that goes significantly beyond the Kyoto Protocol? What are the costs of these strategies, how efficient are they, how sustainable, and how can politics and business be alerted to the economic and societal consequences if no action is taken, or if action is not taken early enough?

The XVI Malente Symposium brought together experts and stakeholders from all parts of the world and from all fields of society who were keen to discuss these challenges in a comprehensive way and to identify practical solutions to these problems.

For their active and valuable support in the preparation of this conference, the Dräger Foundation wishes to thank its co-operation partner, the Kiel Institute for the World Economy, and the members of the steering committee for the preparation of the XVI Malente Symposium

Professor Rudolf Dolzer
Director, Institute for International Law, University of Bonn

Professor emeritus Hartmut Grassl
Max Planck Institute for Meteorology, Hamburg

Professor Gernot Klepper
Kiel Institute for the World Economy

Rainer Laufs
Member of the Supervisory Board, LANXESS AG; former Chairman, Deutsche Shell AG

Furthermore, the Dräger Foundation wants to thank the **Kittner Group** in Lübeck for generously providing the cars for the limousine service, and **OCÉ Deutschland Business Services** for their technical support and for reproducing the photographs exhibited in the conference center. The photographs are by Zurich film-maker and photographer **Basil Gelpke**, taken during the shooting of his film 'Oil Crash Movie', and by photographer **Gerda Sökeland**, who photographs coal dumps in Dortmund.

Last but not least, the Foundation thanks the Hamburg artists **Beatrice Dettmann** and **Karin Ohlsen**, who once again exhibited their work at a Malente Symposium, this time on the subject of 'The Forest' – providing a nice contrast, we feel, to the oil fields and waste dumps depicted in the photographs.

Responsible for the preparation and organization of the Symposium:

Petra Pissulla
Director, Dräger Foundation, Lübeck

XVI

The Program

XVI Malente Symposium, Lübeck, October 8 – 10, 2006 – The Progam

Sunday, October 8, 2006
Media Docks – European Campus for Digital Media, Stair Case 4, 'Balkensaal'

Reception and Dinner

Opening Speech
Energy, Climate and Security Concerns of the Future

Professor John Deutch,
former Director, CIA;
Massachusetts Institute of Technology (MIT), Cambridge, MA, USA

After Dinner
Participants Play Jazz!
Professor Eckhard Maronn, bass
Dr. Uwe Petersen, bass
Arno Engelhardt, drums
Professor Peter Eigen, tenor sax
Gebhard Ohnesorge,
clarinet and baritone sax
Professor Dieter Feddersen, piano
Craig Morris, Vocals

Monday, October 9, 2006
Music and Congress
Centre Lübeck

Plenary Session

Chair:
Professor Dieter H. Feddersen,
Member of the Board,
Dräger Foundation, Lübeck,
Germany

Welcome

Professor Dieter Feddersen
Professor Dennis Snower,
President, The Kiel Institute for the World Economy, Kiel, Germany

Keynotes
Energy and Climate – Global Challenges of the 21st Century

Topics and Questions:
- What are the energy policy and climate challenges of the coming decades?
- Interdependencies and security issues;
- Options and economic costs; risk potentials, consequences and strategies;
- Why do we need an international energy policy?

Dr. Uwe Franke,
CEO, Deutsche BP AG, Berlin, Germany
Professor emeritus Hartmut Grassl,
Max Planck Institute for Meteorology, Hamburg; Meteorological Institute, University of Hamburg, Germany
Luc Werring,
Principal Adviser to the DG Transport and Energy, European Commission, Brussels, Belgium

Panel Discussion
Are We Running out of Gas?

Chair:
Rainer Laufs,
former Chairman of Deutsche Shell AG;
Member of the Supervisory Board,
Lanxess AG, Kronberg, Germany

Topics and Questions:
- What is the situation today – energy policy facts and framework conditions?
- Access to energy sources: the politics; future energy supply and demand;
- Efficiency of energy use;
- Technological deficits; technologies of the future; risk management and investment decisions;
- Reshaping the world of energy: options and actions; inconsistencies, conflicts, costs and deficits of current energy policies.

Speakers:
Professor Gernot Klepper,
Director, The Kiel Institute for the World Economy, Kiel, Germany
Professor Klaus S. Lackner,
Director, Gerry Lenfest Center of Sustainable Energy; Chair, Dept. of Earth and Environmental Engineering Center, Columbia University, New York, NY, USA
Vijay V. Vaitheeswaran,
Author and Global Correspondent,
The Economist, New York, NY, USA

Parallel Working Groups 1 - 4

Working Group 1
Future Energy Systems

Chair:
Dr. Fridtjof Unander,
Vice President, Enova SF, Trondheim, Norway; Former Acting Head, Energy Technology Policy Division, International Energy Agency, Paris, France

Topics and Questions:
- How do we achieve a post-fossil energy supply?
- The future role of alternative energies (security and supplies, cost efficiency, climate change);
- Can nuclear energy solve the problem?
- How to make use of energy potentials;
- The cost of energy.

Speakers:
Professor emeritus Joachim Luther, former Director, Fraunhofer Institute for Solar Energy Systems, Freiburg, Germany
Dr. Gregor Czisch
Researcher, Institute for Electrical Energy Technology/Rational Energy Conversion, University of Kassel, Kassel, Germany
Andreas Wagner, Manager, Technology External Programs Europe, GE Energy, Salzbergen, Germany
Dr. Bob van der Zwaan, Senior Scientist, Energy Research Centre of the Netherlands (ECN), Amsterdam, The Netherlands

Working Group 2
Energy Policies: Implications for Global Climate and Future Wealth

Chair:
Dr. Johannes Linn,
Executive Director, The Wolfensohn Center, The Brookings Institution, Washington, D.C., USA

Topics and Questions:
- What is the state of the global climate?
- To what extent is energy consumption responsible for global warming?
- Where are scientific debate and political negotiations currently going?
- Economic efficiency of alternative energies;
- Emissions trading – what can it contribute?
- Will climate change lead to cultural change? Effects on work attitudes and behavior.

Speakers:
Professor Anders Levermann, Junior Professor for climate modeling on long timescales, Potsdam Institute for Climate Impact Research, Potsdam, Germany
Professor Peter Höppe, Head of Geo Risks Research, Munich Re Group, Munich, Germany
Professor Claudia Kemfert, Director, Department of Energy, Transport and Environment, German Institute for Economic Research (DIW), Berlin, Germany
Dr. Alexander Golub, Senior Economist, Environmental Defense, Washington, D.C., USA

Working Group 3
Technological Challenges and Options for Future Energy Supply

Chair:
Dr. Udo Brockmeier,
Chairman of the Board, EnBW Kraftwerke AG, Stuttgart, Germany

Topics and Questions:
- How to optimize existing technologies;
- Potential of different technologies;
- Near term options and long term trends;
- How to improve technology transfers.

Speakers:
Lord Ronald Oxburgh, House of Lords, Westminster; former Chairman of Shell Transport and Trading plc, London, United Kingdom
Dr. Wolfgang Eichhammer, Deputy Head, Department of Energy Techniques and Energy Policies, Fraunhofer Institute for Systems and Innovation Research, Karlsruhe, Germany
Gary V. Litman, Vice President, Europe & Eurasia, U.S. Chamber of Commerce, Washington, D.C., USA
Dr. V. Sumantran, former Executive Director and Head of R&D, Tata Motors Ltd; Strategic Consultant, Mumbai, India
Dr. Hans Jürgen Wernicke, Member of the Executive Board and Chief Operating Officer, Süd-Chemie Group, Munich, Germany

Working Group 4
The North-South Conflict – Energy Consumption and Sustainable Development

Chair:
Dr. Robert Watson,
Chief Scientist, ESSD, The World Bank; former Chairman of the Inter-governmental Panel on Climate Change (IPCC), Washington, D.C., USA

Topics and Questions:
- Energy and climate protection policies in emerging markets;
- Costs and benefits of sustainable energy policy;
- Trade-offs in climate and related policies (adjustment vs. rejection);
- Distribution problems and energy security for developing countries.



Speakers:
Professor Gerhard Berz,
Professor for Meteorology, University of Munich; Member of the Council, Munich Re Foundation, Munich, Germany
Professor Graciela Chichilnisky,
Director, Center for Risk Management, Columbia University, New York, NY, USA
Professor Nazli Choucri,
Professor of Political Science and Director, Global System for Sustainable Development (GSSD), Massachusetts Institute of Technology (MIT), Cambridge, MA, USA
Professor Peter Eigen,
Chairman of the Advisory Council, Transparency International; Chairman, Extractive Industries Transparency Initiative Berlin, Germany

Dinner at the Schiffergesellschaft Restaurant

Dinner Speech:
Climate Change: Consequences for Oceans and People

Frank Schweikert,
Biologist and Journalist; ALDEBARAN Marine Research & Broadcast, Hamburg, Germany

Tuesday, October 10, 2006
Music and Congress Center

Plenary Session

Chair:
Professor Dennis Snower

Reports from the Working Groups and Panel Discussion on Working Group results

Professor Emeritus Joachim Luther, Working Group 1
Dr. Johannes Linn, Working Group 2
Dr. Udo Brockmeier, Working Group 3
Dr. Robert Watson, Working Group 4

Closing Speeches

How to Reach Global Accords on Energy, Climate and Development Policies

The Chinese Perspective:
Professor Bo Qiang Lin,
Director, Center of China Energy Economic Research, University of Xiamen, PR China

The Psychology of Denial or Why Do We Find it So Hard to Act Against Climate Change?

George Marshall,
Executive Director, The Climate Outreach and Information Network (COIN), Oxford, United Kingdom

Farewell
Professor Dieter Feddersen
Professor Dennis Snower

Lunch buffet and end of conference

Sunday, October 8, 2007 – Dinner Speech

Professor John M. Deutch
Massachusetts Institute of Technology (MIT), Cambridge, Mass., USA

Professor
John M. Deutch

Energy, Climate and Security Concerns of the Future

I want this evening to have a discussion with you about the connections between energy and national security. I think I should begin by saying that there is an intimate connection between the two – domestic energy policies and programs undertaken entirely in the interests of one country have international implications. Let me give you two examples:

- China's expanded use of coal-fired electricity generation has major implications for global warming.
- Iran's decision to enrich uranium, allegedly to produce fuel for nuclear power plants, is viewed by the United States and by many European countries as an unacceptable proliferation risk, because it moves Iran closer to a bomb.

The United States has not been successful, and I believe that many European and OECD countries have been equally unsuccessful, in integrating these issues of domestic energy policy and the foreign policy implications of energy issues. The fact that we have not been successful, or have not been doing a good job at integrating these domestic and international aspects of energy, means that there are consequences for the future, for future generations. Future generations in our countries will face higher costs and greater difficulties because we have failed to take actions today that we should have taken.

I would like this evening, as a basis for a discussion, to raise four security issues very briefly, and then make some suggestions about different ways of going forward in order to provide a better future by dealing with these energy insecurity problems. The four issues that I want to touch on are:

- the need to achieve an international consensus and manage the risks of global warming;
- the importance of reducing our dependence on imported oil and natural gas;
- protecting the energy infrastructure from natural disasters and terrorist attacks; and
- ways of minimizing the proliferation risks of nuclear power.

Each of these are energy issues which I think have tremendous foreign policy and security implications. I want to

begin by mentioning two realities that should draw our attention to the issues of energy and security. The first is that the only way to avoid oil and gas dependence would be to begin today a gradual transition away from a petroleum-based economy. The second reality is that the only way to avoid the adverse effects of global warming is to reduce greenhouse gas emissions or to adopt elaborate measures of geo-engineering or adaptation that will also be costly to our society. Progress on both of these issues will be quite slow – it will take decades rather than years. Why? Because programs for both require the development and deployment of new technologies and the design and adoption of new regulatory, political and economic incentive measures, and this will take a great deal of time. During the intervening period – the decades, not just the years – we need to manage the security aspects of these issues, so this is a matter of importance for us all.


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China's Energy Security Challenges

Let me begin by talking about oil and gas dependence. I choose to do so by discussing China with you, and I select China not because I want to pick on China or blame China, but rather because I think it illustrates quite poignantly the kinds of stresses and strains there are in the international system as a result of oil and gas dependence. I also should remind you and myself that energy is just one of the issues between the developed countries and China. There are other foreign policy issues that are very important and loom large: Taiwan, North Korea, human rights, trade, intellectual property rights – all of these are matters that are also on our agenda in dealing with our relationships with China, and none of them can be considered wholly independently of the others.

But the fact is that China's remarkable economic growth over the past two decades has enabled it to achieve social progress and a greatly strengthened geopolitical position in the world. For the foreseeable future, the leaders of China will continue to make economic growth their top priority. We should assume therefore that the country's economic expansion will be accompanied by a corresponding surge in energy consumption. China, which only became a net importer of oil in the early 1990s, is today the third largest importer of oil and the second-largest oil consumer in the world. China has so far been able to meet this increase in demand and prevent the economic slowdown that an energy shortage would precipitate. But the supply challenge is going to become greater for China in the years to come. We should anticipate that over the next few decades China's energy demand will grow at a rate between three and four times that of the OECD countries.

The Implications for Oil and Gas

China will need access to international markets for ever more significant quantities of oil and natural gas. To date, China receives about 11 percent of its oil supply from Iran (which amounts to approximately a quarter of its total supply from the Middle East) and five percent from Sudan.

China has so far sought to avoid doing business with international oil companies, companies like Exxon, Total and Chevron. Instead, the Chinese have entered into state-to-state agreements with other countries. In making such arrangements with producer countries, China, as a consumer country, is willing to pay higher prices and offer political concessions in order to lock up supply. For example, in 2001 China entered into two such arrangements with Indonesia and Venezuela. In 2005, China entered into nine separate state-to-state arrangements with such countries as Iran, Algeria, Ecuador, Syria and Russia. These deals would be unobjectionable if China were relying on transparent arrangements arrived at on market terms – if China chooses to overpay in the market, to take exceptional financial risk, so be it. US international oil companies would love to be able to do the same thing. The problem, however, is that China's increased use of state-to-state arrangements implies a move away from transparent world oil markets and invites other large consumer countries, for example India, to follow their example of making special deals with certain countries.

These state-to-state arrangements with major resource holders include significant non-market aspects. I could go on and give you examples for each of the countries I have mentioned, but let me just make a few remarks about the arrangements that China has in Africa, notably in Angola, but also with the Sudan, and which are especially troublesome. For example, it is reported that China has supported local warlords in the Sudan with military equipment in exchange for gaining preferential access to oil properties and protection from attacks or terrorist events. The net result of all of these non-market transactions is the following: China is building economic relationships that constrain the ability of the United States and

„China will continue to make economic growth their top priority. We should anticipate that over the next few decades China's energy demand will grow at a rate between three and four times that of the OECD Countries".

other countries to pursue their interests with major resource holders.

We should also pay special attention to the growing relationship between Russia (a major resource holder that uses energy to gain political leverage) and China (a major oil and gas importer interested in locking up supply). Both are acting aggressively to try and tie up the oil and natural gas assets in Central Asia, and direct them to places which will fulfill their political objectives. As their energy ties form, so too will their political relations, and it is patently not in the interest of the United States for these countries to become closely aligned. For instance, their joint membership in the Shanghai Cooperation Organization (SCO) – a regional security group that also includes Kazakhstan, Uzbekistan, Tajikistan, and Kyrgyzstan – has already allowed Russia and China to increase their influence in Central Asia at the expense of other consuming countries.

Of course, China is not the only Asian country which seeks oil and gas – all the other countries in Asia which are growing, like Japan, South Korea, and Taiwan, are concerned about this competition for oil and gas resources, which could lead to very distressing political realignments in the region.

China's Electricity Sector

Following on from my example of China and its oil and gas situation, let me say a word about the electricity sector. China's electricity production, and its coal use, are projected to grow at two or three times the rate of Europe or the United States. At present, coal comprises about 65 percent of China's primary energy consumption, and is going to figure prominently in China's energy mix for years to come. The reason for this is simple: China has vast coal reserves, and coal is cheap, about a dollar per million British Thermal Units, compared to imported natural gas which costs about seven dollars for a similar amount of energy. Last year, China built 75 large coal power plants, each of which emits about 15,000 metric tons of CO_2 per day. The United States built zero such coal reactors over the past three years.

Yes, China will also make greater use of nuclear power, but even under the most optimistic scenario, nuclear power will be providing less than ten percent of China's electricity by the year 2030 – the remainder coming from coal. It is true that China's government is demonstrating a much greater awareness of the environmental burdens that accompany the current and projected pattern of energy use. However, even assuming that the Chinese achieve their tremendously ambitious goals of improving energy efficiency, they are going to be using a lot more coal than the United States by the year 2030, and also emitting a great deal more CO_2 than the United States. It is very unlikely that China will choose to pay for the higher capital costs of electric power alternatives associated with carbon capture and sequestration. Why?

– First, China, like other developing economies, does not believe it

should bear the costs of carbon emission measures because the past emissions that are responsible for the high concentrations in the atmosphere today come from our old developed economies.

- Second, despite its great balances of dollar assets today, China has enormous requirements for internal investments, especially as regards public infrastructure, i.e. in the areas of water quality, healthcare, and old-age assistance. They are very unlikely to be willing to set aside the money for the investments that would be required for more costly yet lower-producing electricity generating technologies.
- Finally and most importantly, decision-making in China in the energy sector is extremely regional rather than central. Local authorities are delegated the responsibility for maintaining economic growth and managing energy supply in their areas. Even if the central government in Beijing were willing to undertake to limit carbon and other greenhouse gas emissions, it would take an enormous length of time before the local authorities would adopt such policies and practices, given the fact that economic growth is the central government's principal target imposed on them, and it would take a very long time before inspection and enforcement of these regulations would be put into place.

However, the picture that I am painting with respect to electricity generation in China is again not because I want to single them out as behaving any differently to the other large emerging economies, like India, Indonesia, Brazil and Mexico. My point is that if we do not find a way forward with these large emerging economies like China in the area of greenhouse gas emissions, it is not clear what the point is of the western policies that we are discussing. What then is the purpose of Kyoto? What is the purpose of the United States adopting a cap-and-trade system if we don't see some way clear to including the large developing economies in our efforts to reduce the emissions of greenhouse gases, and especially CO_2?

Let me briefly turn to two other matters. These have to do with the vulnerability of the international energy infrastructure to terrorist attack and also natural disaster, and with the proliferation risks of the expanding use of nuclear weapons

International Energy Infrastructure Protection

I don't know how many of you in the audience here this evening noticed that in February of this year a terrorist attack on one of the major Saudi oil processing facilities was thwarted by the internal security service of Saudi Arabia. This oil processing facility in Saudi Arabia produces 650,000 barrels of oil per day for export. On September 15, 2006, terrorists alleged to be connected with Al Qaeda simultaneously attacked two different oil facilities in Yemen, an oil storage facility and a refinery.

There are some important lessons here. As energy use and trade in energy grows, the enormous infrastructure that supports the production, transportation, processing and distribution of energy expands and becomes increasingly vulnerable to terrorist attack. Energy facilities are an enormously attractive target for terrorists, particularly because they can be attacked and enormous economic damage and huge inconvenience caused to the operation of the economy without killing many people. The other lesson to be learnt from these two recent attacks is that energy facilities can be successfully protected and defended against terrorist attack if sufficient effort is made – it is by no means a hopeless task.

More attention needs to be given by European countries and by the United States to protecting our energy infrastructure. That attention needs to be given by both governments and corporations. It is almost certain that governments around the world will adopt new regulations for the protection of energy infrastructure and the transportation of energy. I'm including here gas processing facilities, production platforms, pipelines, tankers, electricity grids, power plants – especially nuclear power plants – and of course hydrocarbon storage facilities. And as I mentioned, if we do a better job of protecting this infrastructure we will have a better chance of surviving and defending against natural disasters such as the hurricanes Katrina

and Rita which in 2005 created such devastation in the Gulf of Mexico and caused such damage to energy production facilities in the United States.

Reducing Proliferation Risks from Nuclear Power

My last comment on the connection between energy and security has to do with nuclear power. As we look around and think about what we are going to do over the long term to reduce the emissions of greenhouse gases, and especially CO_2, from power plants, many people have naturally started to wonder whether nuclear power could be expanded to take up some – though certainly not all – or even a majority of the required reductions in CO_2 that are needed. In other words, we have had a call for a reevaluation of nuclear power. There are many challenges to having nuclear power serve our economies – let me just mention the principle ones. First of all, it's too expensive today, even given the higher prices of natural gas and the high costs of environmental abatement for coal-fired power plants. We need to be sure that improved safety is possible. There has to be some progress on radioactive waste management, on which there has been little progress in the past two decades anywhere in the world. And most importantly, in my point of view, for our discussion of security here this evening is that we have to ensure that commercial nuclear power does not become a source of technology for bomb-usable material for weapons. The proliferation challenge is particularly important because most of the projected expansion of nuclear power is likely to occur in those parts of the world – obviously the ones that are growing the most rapidly – that are the most unstable and the most dangerous from the point of view of proliferation risks.

In 2003, MIT did a study of the future of nuclear power and concluded that the greatest growth and possible deployment of nuclear power would take place

in the following countries: Indonesia, Brazil, Mexico, Egypt, Turkey, South Korea, Taiwan, Thailand and Vietnam. These are not countries that are generally thought to be as stable as – to choose a random example – Germany or the United States. The question is, how do we manage this nuclear power in a way that will not allow the dangerous parts of the fuel cycle – enrichment and reprocessing – to spread around the globe? In 2004, the G8 took the first steps towards a solution to this problem at its meeting in Savannah, Georgia. The G8 endorsed a proposal under which nuclear supplier states, notably Russia and France, but also in principle the United States, would offer enrichment services and take back the spent fuel from the nuclear reactors at very attractive financial terms. Thus countries who wanted to use nuclear power, in exchange for foregoing early deployment of fuel cycle technologies of proliferation concern, would gain advantageous access to fuel cycle services of enrichment and waste management.

A perfect example of this is the contentious case of the two nuclear power stations Russia is building in Iran. Here the idea would be to offer the Iranians the possibility of having these reactors as long as the fuel was supplied on, basically, a leased basis by the Russians – they would supply enriched fuel, then take the spent fuel back from the reactor at the end of its useful life and bring it back to Russia for waste management, reprocessing or disposal as the Russians see fit. Now, I don't think this arrangement is likely to prove successful, because in my judgment the Iranians are not just looking to build commercial nuclear power plants, but are also trying to move closer to access to a bomb. The principle, nevertheless, is important. If we are going to have the advantage of using nuclear power, so important in a carbon-constrained world, we must be sure from the security point of view that it is not accompanied by a proliferation risk. The G8 initiative is very important and deserves all of our support.

Guiding Principles for Energy Security Policy

Are there some guiding principles for going forward? I conclude by mentioning to you six principles that I believe should guide our attention towards this energy security issue over the next years – again, these are not problems that will be dealt with swiftly, they are problems that are far from being widely agreed, but I draw them to your attention as important guideposts for dealing with the security problems as we move forward.

The first is that the International Energy Agency should be broadened to include the rapidly developing economies that are so important as consumers of energy. Currently the IEA is limited in its membership to OECD countries, while China, India, Indonesia and Mexico are not members. It seems foolish to me that this should be the case; we urgently need to find a mechanism to include these large importing countries that have common interests in managing the international oil and natural gas marketplace in one place, which is precisely what the IEA was created to do.

Second, in my judgment inadequate progress is being made on building an international consensus on carbon emission policies. If we do not reach some agreement with the developing economies about carbon emissions and control, it is going to be impossible to prevent the global warming phenomena from placing enormous costs on our future generations of citizens. If we do not work to mitigate

emissions today, we are going to be faced with the problems of dealing with adaptation and geo-engineering in the future.

Emerging economies will be unwilling to pay these additional costs associated with carbon emission controls, which poses the question as to what industrial economies will be willing to do to pay the difference. Of course, no progress on this subject can be expected so long as the United States has no carbon control policy itself, and let me tell you, we do not have this now. If we are going to make progress, in other words, the international community must come together with new ways of reaching agreement on carbon emission controls which will include both the developed and the developing economies.
My third point is that our countries must make a much greater level of effort on the research, development and demonstration of future energy technologies. Technology is needed for many purposes, for example to improve end-use efficiency, in the area of carbon capture and sequestration, to encourage alternative liquid fuels, or to increase the use of biomass feedstocks.

Development and deployment of these technologies will require adoption of new mechanisms to internalize the social costs of oil dependence and global warming. This means higher energy prices. It means an energy tax or some equivalent measure. Higher energy prices are of course very unpopular with both the consumer and their political representatives. But I must say that without this kind of long-term technology development effort, I really fear that we will be not prepared to make the necessary transition away from oil and gas and will not be prepared to deal with the global greenhouse gas threat.

Let me give you just one example of an R&D incentive which is lacking. We know that carbon capture and sequestration is an important potential way of

managing greenhouse gas emission reductions. Today there is not a single example of a CO_2 capture and sequestration project in the world that starts with the CO_2 produced at a coal-fired power plant, captures that CO_2, transports it by pipeline, and places it into an aquifer, a deep aquifer, which has been authorized by some independent regulatory authority for storage over a long period of time. Nor is there any example of a CO_2 sequestration project where there is sophisticated instrumentation available to allow independent people to measure, monitor and verify the location and safe storage of that CO_2 underground. It seems to me that the world urgently needs to have three or four such carbon capture and sequestration projects up and running and that these are projects that can be successfully mounted on an international basis and should not and need not be done by individual countries.

My fourth point, as I've already mentioned to you, is that this transition from a petroleum-based economy will take decades. In other words, in the near term we are all going to be dependent on oil from the Persian Gulf, notably from the following four countries: Saudi Arabia, Iran, Iraq and Kuwait. All of these are the major oil-producing countries in the Persian Gulf region. This means that we have to deal with these countries and must deal with them in a manner which takes their own societies into account and encourages them to continue and indeed expand their production.

Fifth, a condition for expanded deployment of nuclear power around the globe should be that there must be no expansion of the proliferation risk, which means making operational and effective means of managing the dangerous parts of the fuel cycle, i.e. enrichment and reprocessing, so they do not spread around the world.

Sixth, more attention needs to be given to international cooperation on energy infrastructure protection. A great deal could be done here in joint projects, joint planning, transfer of knowledge about how best to manage our energy infrastructure and exercises for protection of key energy infrastructure facilities, such as liquefied natural gas (LNG) terminals and electricity grids; joint naval operations to protect sea lanes of communication for all the tankers that travel from one country to the other; and information security for Supervisory Control and Data Acquisition (SCADA) systems that control key elements of the energy infrastructure.

Your conference is going to be dealing with global climate change and the future welfare of the world. This is a worthy and important subject – it may in fact be one of the key subjects that we have in front of us. The fact that we are not doing enough today around the world means that future generations are going to find themselves in much worse circumstances than they otherwise would. An essential aspect of this project is to make sure that we realize that it's going to take a long time, to be sure to pay attention to these security matters which are so vital to the proper functioning of our energy economy during this intervening period, and to be sure that we keep on reminding both the public and public officials that we need to move away from our dependence on oil and need to take the global climate change threats seriously. Thank you so much for your attention.

Monday, October 9, 2006 – Welcome

Professor Dieter Feddersen

Member of the Board, Dräger Foundation, Lübeck

Professor
Dieter Feddersen

Ladies and Gentlemen,

I would like to welcome you, also on behalf of Dr. Christian Dräger, my colleague on the board of the Dräger Foundation, to this year's Malente Symposium. We are delighted to be staging this XVI Malente Symposium in cooperation with the Kiel Institute for the World Economy.

For over 30 years, the Dräger Foundation has been supporting and organizing international conferences and symposia.

The Malente Symposia represents one of the Foundation's most important and best-known series of conferences. The symposia provide a forum for innovative discussions of national and international political, economic and social issues, and were named for the first conference location in the German state of Schleswig-Holstein at which our founding father, Dr. Heinrich Dräger, established this series of events. Although for reasons of transport links it makes more sense to hold the conferences, as we have been doing for twelve years now, in Lübeck, where Dräger and the Dräger Foundation are based, we still like to use the name Malente as a reminder of those successful early years.

Previous conferences have dealt with many topics, among them issues of the labor market and employment policy, of global trade and technology transfer, of globalization and the integration into the world economy of the East European transition countries, of strategies for tackling poverty in newly industrialized countries, of the reform of our health-care system, of the state of German small and medium-sized enterprises, and of the involvement of young people in the social process.

This year we will be focusing on problems which cannot be solved by one country alone; we will be talking about energy and climate policy, and about the effects on the future wellbeing of the world which changing developments in energy and climate policy may have.

Energy experts from the fields of science, politics and economics have been devoting their time for many years, if not decades, to the problems which humankind and the world economy may face if there is a future shortage of energy resources, especially oil and gas.

Climate experts have been warning us for equally long of the consequences of advancing global warming. Yet it is only now that people seem to have developed an awareness of the extent of the potential consequences, having until now consumed energy with little or no thought for the future. This is because in the past – at least in our developed industrialized countries – we have always appeared to have a plentiful and inexpensive supply at our disposal. Only now do the consequences of our unchecked consumption of fossil-based energy feedstock on the climate seem to be being taken seriously, now that more and more reports are appearing in the press about the melting of the polar ice caps, the disappearance of glaciers and the rise in sea levels. The public perception of energy consumption and climate change has likewise changed in the USA in the wake of Hurricane Katrina. Since we started preparing for this XVI Malente Symposium on the subject of energy and climate over a year ago, it is more than anything else the scale of reporting on these two "global challenges of the 21st century" that has increased enormously, reaching a wide audience – including non-experts – through the daily media.

There is no doubt that some of these reports and articles, portraying as they do catastrophic scenarios, can be written off as alarmist. Nonetheless, there appears to be widespread consensus in the scientific community that

we are indeed caught up in the middle of a process of global warming which at least to some extent is of our own making and which will have fatal consequences for life on our planet if we do nothing to stop it. We thus need to develop innovative ways to ensure a sustainable, safe, efficient – and, preferably, affordable – supply of energy capable of both maintaining the level of prosperity enjoyed in the industrialized world and improving living conditions in the poorer regions of the world, while at the same time being clean and having zero impact on our climate.

Global consumption of energy today is already twice as high as it was at the beginning of the 1970s, and is set to rise by an additional 33 percent by 2020 unless counteraction is taken; this is the conclusion drawn by the German government's status report on energy supply, published in April of this year. Of today's total global energy consumption, oil accounts for 34 percent, coal 24 percent, gas 21 percent, renewable energies 14 percent and nuclear power 7 percent. Many of the leading industrialized nations are almost completely dependent on the import of energy raw materials. Germany's import dependence has risen constantly over the years too: the country's dependence on uranium is 100 percent, on mineral oil close to 97 percent, on gas 83 percent and on hard coal 61 percent. It is only in the case of lignite – which is an extremely dirty fuel – and renewable energies, which account for only an eight percent share of the country's total energy production, that Germany is entirely self-sufficient.

Much remains to be done therefore, not only in Germany, to achieve a sustainable and secure source of energy supply. We are doubtless facing a difficult, yet hopefully not unsolvable challenge. A lot can be done if only we want to! However, this requires global strategies and international agreements which go significantly beyond the targets set down in the Kyoto Protocol. This is one of the issues we intend to discuss today and tomorrow.

We are pleased that energy and climate experts from many parts of the world have come to share their knowledge and ideas with us and to attempt to find solutions to the problems. I thank you for your attention and wish us two days of stimulating discussions and a fruitful exchange of ideas.

Welcome and Introduction

Professor Dennis Snower

President, The Kiel Institute for the World Economy, Kiel

Professor
Dennis Snower

Let me please first of all join Dieter Feddersen in welcoming you all to this XVI Malente Symposium on energy and climate. We are pleased and honored that the Kiel Institute for the World Economy is the organizing partner of the Dräger Foundation for this conference that tackles two of the most important topics of our time.

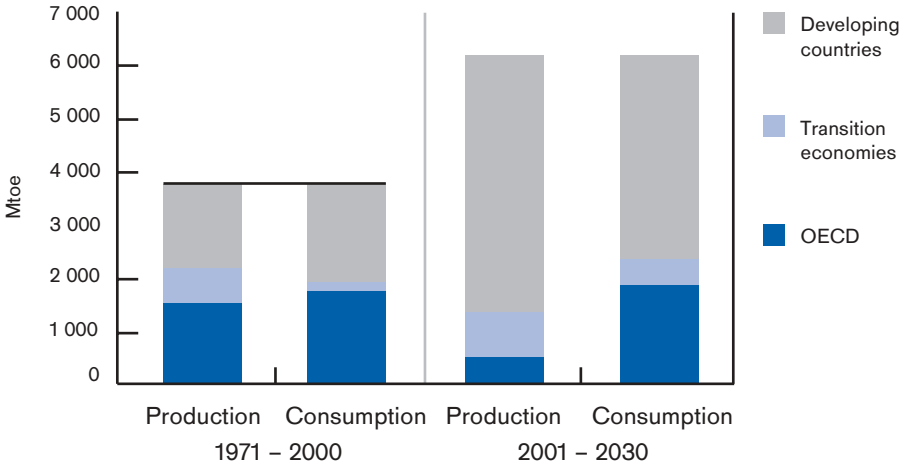
I think this symposium should be about one really important question that confronts the world nowadays, and that is the conflict between our growth strategy and our need to preserve the world's climate. The global dynamics of societies is presenting us with challenges that are all mentioned in the title of this conference.

Economic growth and our current prosperity in the industrialized world depended and still depend to a large degree on the availability of large amounts of inexpensive energy. But while in the middle of the 19th century each human being lived with an energy consumption of roughly 150 watt hours, this consumption has increased to about 2000 Wh today, and with a very unequal distribution between the industrialized and the developing world.
This energy consumption has changed the global dynamics of the carbon cycle with consequences that are currently under investigation. Climate change, as far as we know today, will affect terrestrial as well as marine systems. Temperature increases, changing precipitation patterns with an increasing threat of water scarcity in many parts of the world, and threats to biodiversity are expected. Worst of all, the latest findings indicate that previous predictions about the negative impacts have been too low. The possibility of irreversible changes such as the melting of the Greenland ice sheet or the freeing of methane stored in the permafrost imply climate changes that surely nobody wants their children and grandchildren to experience.

Today, about 25,000 people die every day from insufficient nutrition, and 6,000 – mostly children – die every day from water-related diseases. These are urgent needs that can only be met if economic growth supported by better management also benefits the people living in the poor parts of the world. The challenge is therefore clear: to promote economic growth for the world's poorest people whilst protecting the climate system from changes that will endanger future generations. Translated into energy terms, this means more energy consumption in the Third World whilst at the same time reducing emissions from fossil fuels, the major source of energy today.

Let me, finally, present to you some facts and figures about energy and climate:

Increase in World Energy Production and Consumption



Energy:

- Energy consumption is steadily rising. Business as usual would lead to a further increase by at least 50 percent.
- The additional energy will predominantly come from fossil sources (coal, gas, oil)
- The dependency on oil will increase most in Asia. China's import share of about 35 percent in 2000 will rise to over 80 percent in 2030. Europe's share from 50 percent in 2000 will also rise to over 80 percent in 2030.
- About 1 percent of world GDP needs to be invested in energy infrastructure over the next 25 years. This small number means 550 billon dollars per year.
- Security concerns: future oil supplies will predominantly come from the Middle East, gas from Russia and the Middle East.
- Only coal in ample supply is more evenly distributed across the earth, yet it is the major contributor to CO_2 emissions.
- Up to now, improvements in energy efficiency have just compensated for population increases, as is evident from the constant per capita energy consumption over the last 30 years. At the same time, energy consumption overall has increased by 80 percent. Today a dollar of GDP is produced with 30 percent less energy than in 1970.

The challenge in terms of welfare and energy is to supply safe energy in sufficient amounts to provide for the basic needs of a sizable proportion of the world's population that still lives on less than a dollar per day.


Musik- und Kongreßhalle Lübeck
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Energy, Climate, and Future Welfare – Changing Global Dynamics
Lübeck, October 8 - 10, 2006
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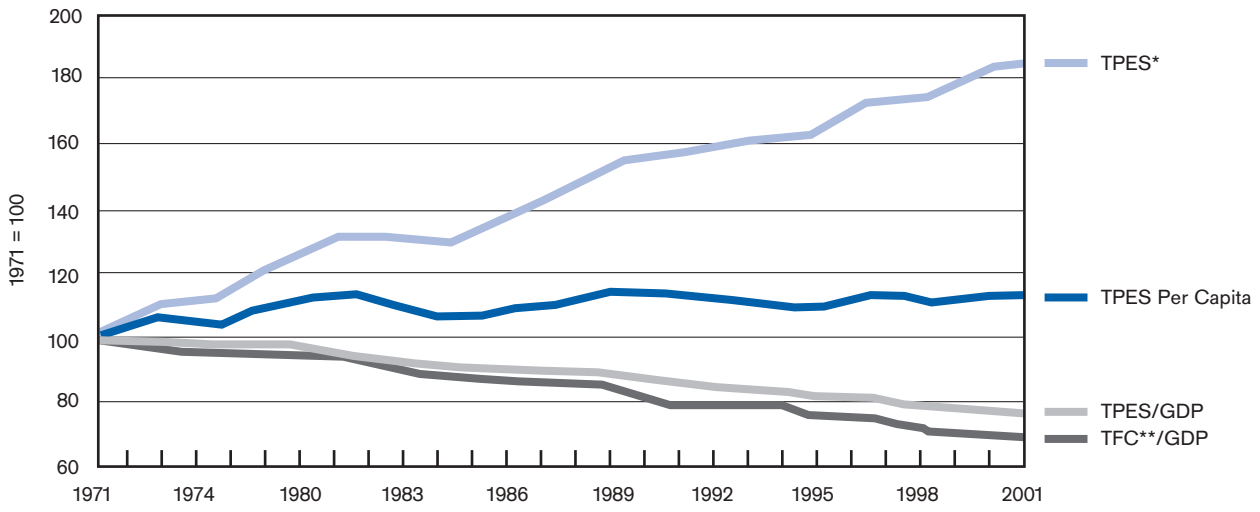
Total Primary Energy Supply (1971 = 100)



* TPES = Total Primary Energy Supply

** TFC = Total Fuel Consumption

Climate:

- The increase in energy consumption has been accompanied by increasing CO_2 emissions.
- The CO_2 has a long half life in the atmosphere, hence the CO_2 concentration in the atmosphere increases for as long as we continue to emit one or, at most, two gigatons of carbon. Today emissions are roughly seven gigatons per year!
- CO_2 concentrations have varied over the last 500 thousand to one million years between 200 and 280 ppm CO_2 equivalents. For the last 10,000 or so years, homo sapiens has enjoyed a more or less constant temperature.
- Now CO_2 concentrations are at 380 ppm and are expected to rise to 700 or, in the worst case scenario, to 1,000 ppm CO_2 -eq. No such experiment with the earth has been observed in millions of years. Its outcome is open, though the signs emerging already today are alarming.
- Recent research indicates potentially irreversible processes like the melting of the Greenland Ice Sheet, possibly resulting in several meters of sea level rise – not in our generation, however, but several hundred years into the future.
- The oceans take up about 40 percent of our CO_2 emissions and are also showing the first signs of reaction. The thermohaline circulation (i.e. the Gulf Stream) is changing, the acidity in our oceans is increasing and their temperature is also rising. Given a reaction time of several thousand years, such processes have long term consequences and can most likely only be slowed down but not stopped.

The ultimate question to answer, therefore, is how can our energy demand be satisfied while at the same time meeting our obligation of 'preventing dangerous climate change' (UNFCCC, Art.2)?
In order to meet this challenge to our energy and climate policies we have several options: we can use energy more efficiently, we can consume less energy, we can develop 'clean energy sources', we can capture CO_2, and we can sequester CO_2 from the atmosphere into safe deposits.
Let us discuss these options during the next two days with regard to sustainability, efficiency, and practicability, and let us look for the best possible solutions.

Keynotes

Energy and Climate – Global Challenges of the 21st Century

Dr. Uwe Franke
CEO, Deutsche BP AG, Berlin, Germany

Dr.
Uwe Franke

It is a particular honor for me to have the chance to talk to you about this topic today, for the title of this conference "Energy and Climate – Global Challenges of the 21st Century" neatly sums up the key problems of the 21st century. Energy and climate are two sides of the same coin: to put it simply, we must meet the growing demand for energy, while at the same time taking climate protection very seriously. We are indeed facing great challenges, so it is imperative that we put all our options on the table. The conventional energy industry, providers of alternative energy sources and conservationists must all pull together to tackle the task which lies ahead of them. There is no room here for antagonism or ill feeling; this is the only chance for us to rise up to this major challenge.

Our future energy situation is determined by a number of key factors: growth in many respects, supply, resource management, environmental and climate protection, and innovation. Many of our energy and climate scenarios nowadays are pessimistic, with everyone fearing the worst. However, this can at least have the beneficial effect that something is done and that steps are taken towards implementing the necessary structural changes. In this respect we are still right at the beginning, and can no longer afford to stand still. Structural change will open up new opportunities and new prospects, in which I of course can see some very positive elements. The core factors influencing our future energy situation can be summed up from our society's standpoint in three main questions which I will attempt to answer during the next half an hour.

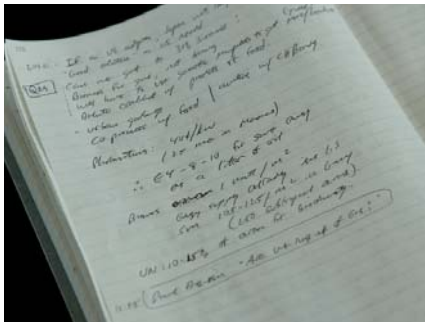
1. How will we be able to meet the growing demand for energy, and what action will this involve?
2. Which climate protection measures are available to us?
3. In which areas of activity can big business like our company, BP, play a part?

Nobody will be able to ignore the global energy trends over the next 25 to 30 years. The world's population is projected to grow to eight billion people by the year 2030, and energy consumption will increase by 50 percent during the same period – in China and India demand will grow by even twice this amount. Fossil fuel sources will continue to meet this demand, with oil and gas contributing more than 60 percent. The proportion of renewable energy sources will remain moderate – somewhat higher in Europe, and somewhat

lower in the rest of the world. The really big era of renewable energies will only begin after this point, somewhere around the middle of the century. Nonetheless, it is of course right to already start pushing forward these renewable energies today.

The central role of the fossil energy suppliers always throws up the same old question of resources. Allow me to dispense with a few misconceptions here. Oil, it is often claimed, will last roughly another 40 years, while gas reserves will last fewer than 70 years. This is correct and incorrect at the same time, because these figures refer merely to the lifetime of the current reserves which can be extracted under today's economic conditions and using today's technologies. On top of this, however, we have the suspected reserves, which represent a good two thirds of today's known reserves. Coupled with the advances in production technology and the large stocks of non-conventional energies like tar pits and heavy oil, this means that we won't have to worry about our supplies of oil and gas any time during this century. In other words, the discussion about oil peaks and a shortage of resources does more to confuse people than it does to shed light on the subject. After all, the physical presence of the reserves is not the issue – it is a question of access to these reserves and climate protection.

Less than 20 percent of what can be described in the broadest sense as oil has been extracted so far. Developing and exploiting the remaining reserves is primarily a cost issue and a matter of further developing the production technology. The effects of advances in extraction technology can be seen clearly in the example of the North Sea reserves. The extraction technologies which were available in the mid 1980s pointed to North Sea production reaching its peak as early as 1986. Improvements in technology, however, allowed this point in time to be shifted forward by about 20 years. If similar advances are made worldwide – I'm thinking here about countries like Russia – the 40 year figure for oil reserves which is frequently cited these days would increase by over 50 percent purely on the strength of this. The figures for the non-conventional oil reserves like the Canadian tar



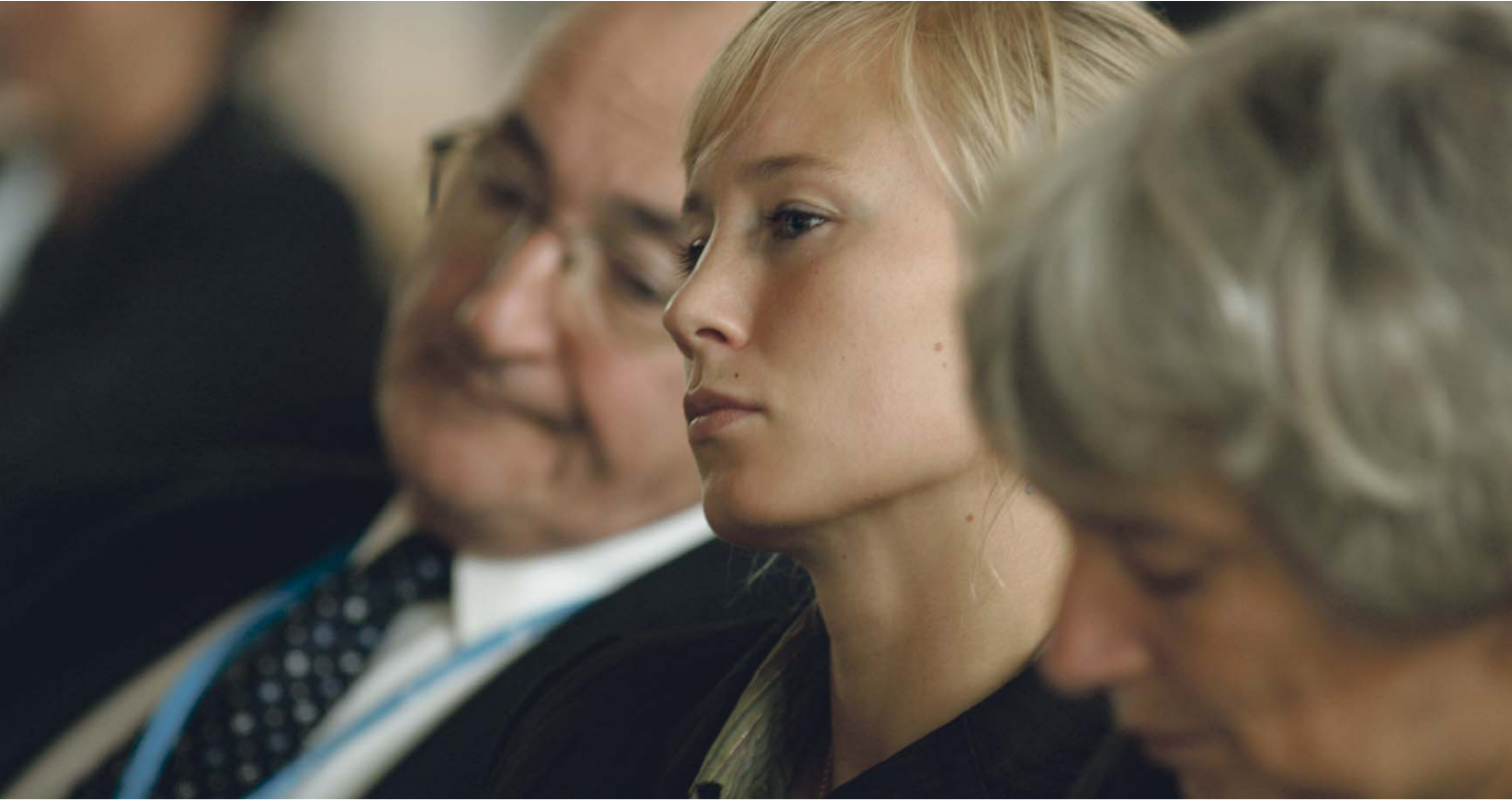
pits are even more impressive, with resources of 1,400 billion barrels anticipated. This is more than the conventional reserves which are currently being exploited, and approximately five times as much as the reserves in Saudi Arabia.

However, the costs of exploiting the tar sands are considerable, both financially and ecologically speaking: an average production cost of 35 US dollars per barrel, significant CO_2 emissions and impacts on the countryside and natural environment are extremely unappealing symptoms of the exploitation of unconventional energies. In other words, here too our real challenges lie in the area of environmental and climate protection. For the sake of completeness, what I said about the extent of the oil reserves is equally true of gas, where less than 20 percent of the resources have been exploited to date, though as with oil it is not only a question of environmental issues but also of access to the remaining stocks.

This brings us to another fact which many people in Germany are not particularly conscious of. 80 percent of the world's oil and gas reserves come from three regions and are controlled by state-owned companies. These are the former Soviet Union, i.e. Russia in particular, the Near and Middle East, and West Africa – these constitute the backbone of our future supply of oil and gas. All of these are states and regions which are highly interested in expanding their own economic capacities, and their wealth of natural resources represents a cornerstone of their development potential. In the past, it may be that the consumer states have paid too little attention to the psychological aspects which are associated with this. Today, however, we have a much better understanding of this situation. We cannot demand that private foreign companies be granted unhindered access to oil and gas reserves if this will not support the long-term economic development of these states and regions. This is why forming mutually beneficial partnerships is the way forward, i.e. securing sales markets for the resource states and kick-starting the local economy with benefits for the population, while at the same time securing sources of supply for ourselves.

If we take a look through a magnifying glass, we can see that 70 percent of the global oil reserves and 40 percent of the global gas reserves are to be found in the Persian Gulf and Caspian regions. These regions are, as it were, right on Europe's doorstep, so we should not be indifferent to any developments there. I very much welcome the fact that the German Federal Government and the

European Union acknowledged this situation some time ago and take it into account in their foreign policy. We have to get used to the fact that these regions will increasingly become the world's filling station, because the dependence of all major consumer states and regions on oil imports will reach 70 to 100 percent within the next 20 to 25 years, and the situation is much the same for gas. For Europe, this means specifically that our reserves – especially those in the North Sea – will decline, while new reserves outside Europe will be put into operation. Will perhaps the Caspian Region, for example, become something of a second North Sea? It certainly has the potential to do so. Although it is situated not in Europe but at the continent's edge, the supply of energy is bringing the states of Azerbaijan, Kazakhstan and Turkmenistan closer and closer to Europe, as pipelines create links on a political, economic and cultural level. These changes in our oil and gas supply require business and political management. New pipelines need to be built, for instance. The oil pipeline from Baku via Tbilisi to Ceyhan on the Turkish Mediterranean coast which was recently taken into service by BP is one such important project. Together with our partners, we have invested over three billion dollars in this new supply line. Next year, we will be adding the South Caucasus Pipeline for the transport of gas, which along some of its length runs parallel to the oil pipeline. In total, 20 billion dollars are being invested in the Caspian reserves of oil and gas. However, this is only a small part of the total sum which will need to be invested over the coming decades to secure our oil and gas supply. Access to oil and gas has to be guaranteed on four different levels. First, financially, i.e. through investment by business; second, politically, i.e. by creating the right political framework conditions; third, ecologically, i.e. by minimizing the impact on the environment, and fourth, economically, i.e. companies need to be able to earn money and remain competitive with clean energy.



As regards the first aspect, the financial one: the oil and gas industry is well aware of its major responsibility as a supplier. Between the years 2000 and 2030, 6,200 billion dollars need to be invested in securing the supply of oil and gas. That's a good 200 billion dollars per year, with oil and gas accounting for roughly 100 billion dollars each. Last year alone our company spent 15 billion dollars, and Shell always invests between 15 and 20 billion dollars too.

As far as the second aspect, the political framework conditions, is concerned: to make these investments possible it is crucial that we correctly define the role of politics. The strategic considerations and investment decisions, i.e. the commercial side of things, must remain the business and the risk of the companies themselves. This is an area in which politics cannot and must not intervene. The responsibility of politicians, on the other hand, is to establish the sort of framework conditions which will be conducive to these investments. Within these framework conditions, we must be able to place our trust in the functioning of the marketplace. This is why close coordination is necessary between business and politics, though without this involving any blurring of responsibilities.

Let me say a word on the subject of "international energy policy" before I come to the next aspect. We have global organizations to deal with world trade, global finance, development cooperation, food and health, yet in the energy sector there is just one producer and one consumer cartel in the form of OPEC and the IEA respectively, plus a handful of powerful individual players. Is that enough? Is that enough to cope with the challenges of the future? We don't think so. It is time to establish a world energy organization or something similar, or at least make initial steps in this direction. It is worth thinking about this and taking this idea further.
Now for the third aspect, the clean supply and utilization of oil and gas. We must minimize pollution of the environment during the production and consumption processes. This brings me to the topic of climate protection, and I would like to repeat some facts of which you are already aware. At the present time, annual global CO_2 emissions are in the order of 25 billion tons, of which 50-60 percent can be absorbed by our

planet while the rest remains in the atmosphere and fuels global warming. If we sit back and do nothing, these CO_2 emissions will double by the year 2050, to approx. 50 billion tons per year. There is broad consensus that we can prevent the worst effects of the continuing climate warming if we succeed in limiting the rise in the share of greenhouse gases in the atmosphere – currently at 380 ppm – to a maximum of 500 ppm of CO_2 equivalents. This would correspond to an average global temperature increase of two degrees. But to achieve this, according to the latest IPCC Report, we need to reach a CO_2 emissions level by the year 2050 that is equivalent to about half of today's level, and this against the backdrop of the growth in population and energy demand, particularly in the emerging economies of India and China.

With our support, Princeton University has worked out which dramatic measures alone would be necessary to stabilize CO_2 emissions, not at half of today's level – as is demanded by the IPCC – but merely at today's level, until 2050. Princeton grouped all of the 18 potential measures into theme-based "wedges". Each of these wedges on its own would represent an annual saving of 3.5 billion tons of CO_2. In other words, we would need seven wedges to achieve the targeted 25 billion saving.
Ladies and gentlemen, not one of these measures is 100 percent achievable in political, economic or resource terms. Because of this, and because of the scale of the problem, we need as many measures as possible, and the best possible measures. The good news is that the technologies to do this already exist, so we don't need to invent these as well as everything else. But be warned – the challenge is so overwhelming that we cannot afford any more "hobby horses", as the money can only be spent once.

I'd like to give you some concrete examples of these wedges. One wedge, for instance, involves cutting in half the fuel consumption of the two billion vehicles that are expected to be in use around the world by 2050. Today we have 700 million vehicles, and by 2050 this figure will grow to two billion. To save 3.5 billion tons of CO_2, you have to half the fuel consumption of all these vehicles – once this has been achieved, you will still have solved only a seventh of the problem. Another wedge involves replacing 1,400 coal-fired power plants with gas-fired power plants. Or the capture and sequestration of carbon in 800 coal-fired power plants. Another particularly nice example involves discussing the possibility of doubling the current capacity of nuclear power plants. Another wedge would be to increase today's wind power capacity by 50 times to save 3.5 billion tons of CO_2, solving a seventh of the problem – but this entails achieving 50 times today's wind power capacity, which is a pretty interesting example from the point of view of energy efficiency. If, starting today, all new buildings around the world could be completed with 25 percent less energy consumption, this would represent exactly one wedge of 3.5 billion tons of CO_2. As you can see, the task we face is huge, and I always like to use the following image to illustrate it – a tsunami is coming our way, and we are awaiting it with sandbags in our arms, and are still fighting over who has the biggest sandbag.

Let me now turn to the fourth aspect: competitiveness and the need to make profits with clean energy. The measures I have just outlined are both highly ambitious and controversial in terms of their detail. At the same time, however, this is a dream come true for entrepreneurs. Just look at all the new fields of business this creates, and the potential for jobs and profit! It goes without saying that a company like BP is also keen to profit from this new business potential, which is why we have geared our operations to the packages of measures and, last November, established a new field of business which we call "Alternative Energy". Our intention is not only to expand the use of solar power – in which field we are already one of the world's leading companies – but to play a key role in the provision of CO_2-free energy production like hydrogen power, renewable energies and natural gas. One of the reasons for this is that we are anticipating that CO_2 will have a price in ten years, all over the world. Not just at the regional level, in other words, but in those areas which view climate protection and emissions trading in a rather different way to the way we do. We need a global price for CO_2 because when CO_2 becomes a global


7 Wedges of the Stabilisation Tri
Wedges
Detail
Efficiency
Double fuel efficiency of 2 billion cars from 30 to 60 mpg
1 wedge = Double the average fuel efficiency
Fuel Switching
Replace 1400 coal electric plants with natural gas-powered facilities (Adding an amount in 2054 almost equal to today's world gas usage)
1 wedge = bringing one Alaska pipeline on line
Carbon capture and storage
Capture AND store emissions from 800 coal electric plants
1 wedge = 50 large LNG tankers docking and
Nuclear
Add double the current global nuclear capacity to replace coal-based electricity
400 nuclear plants today, 1 wedge = addi
Wind
Increase wind electricity capacity by 50 times relative to today, for a total of 2 million large windmills
1 wedge = windmills on an area ap
Solar
Use 40,000 square kms of solar panels to produce hydrogen for fuel cell cars
1 wedge = solar panels coveri
Natural sinks
Eliminate tropical deforestation AND create new plantations on non-forested land to quintuple current plantation area
1 wedge = new plantatio
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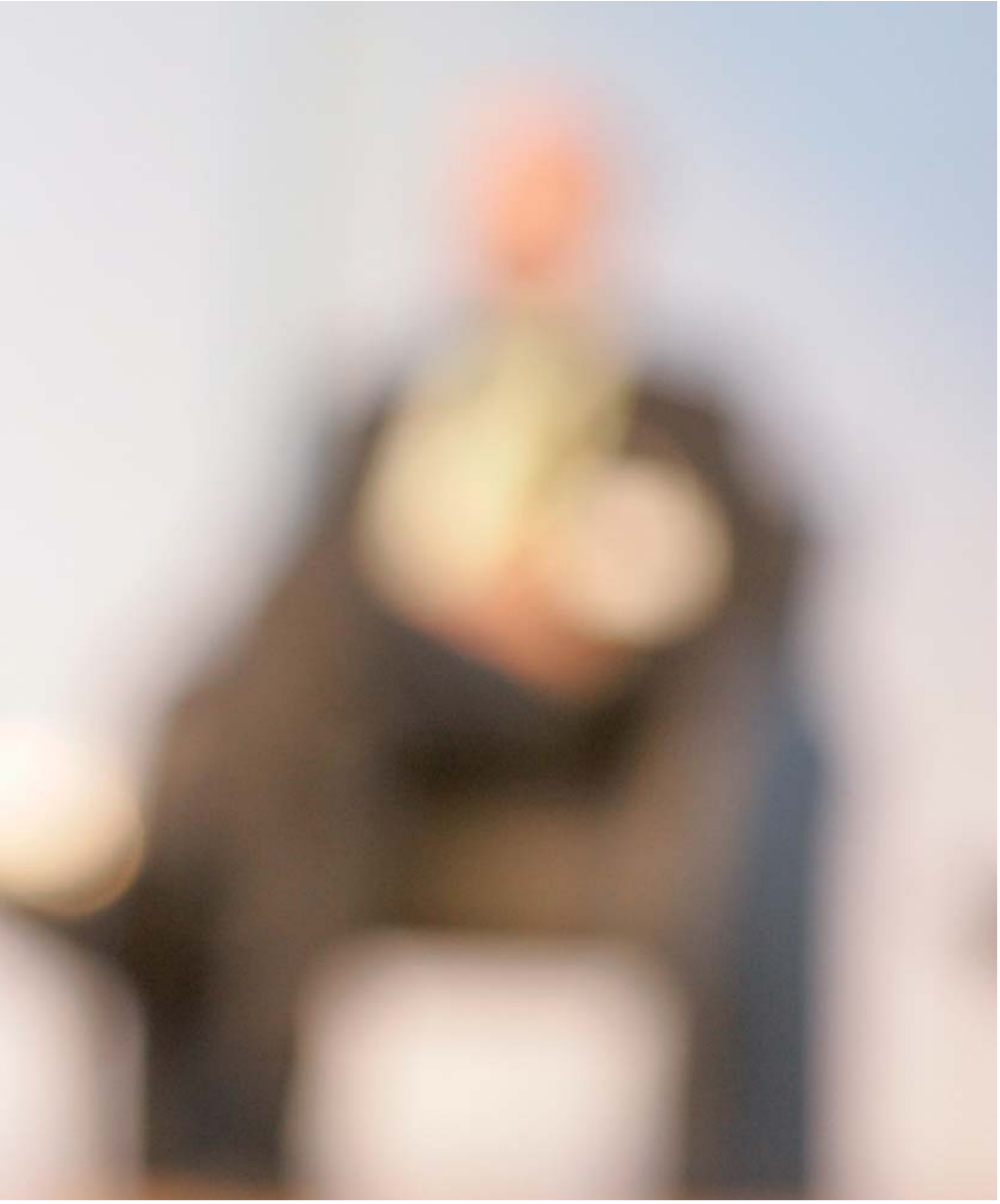
cost factor it will make sense to invest in energy production technologies which emit as little CO_2 as possible. We will then also have solved the problem of competition and can view more calmly those German companies which are going it alone.

We have already taken the first steps in this direction with EU emissions trading, but that is of course still not enough. There are major business opportunities at stake here – let me give you an example. 40 to 50 percent of the energy production capacity projected for 2020 has yet to be built. We expect a global market of 230 gigawatts of alternative power production capacity, and we estimate this market potential to be as much as 600 billion dollars worldwide. Our company plans to invest eight billion dollars in this area by 2015, yet this is only the beginning. If the business develops well, this sum will be significantly higher. In 2015, this "Alternative Energy" business unit is expected to bring an annual turnover of six billion dollars, with an expected global CO_2 saving in the region of 25 million tons of CO_2.

One particular focus in this context is the generation of carbon-free electricity from hydrogen, in conjunction with CO_2 sequestration. To this end, we are planning two large-scale projects, one in Scotland and one in the US. These involve extracting natural gas and converting it into hydrogen and CO_2. The CO_2 is then pumped back into the underground reserve, which increases not only the pump pressure but also the amount which can be extracted. The CO_2 then remains underground. The hydrogen is used as fuel in a power plant in a carbon-free combustion process. In total, this will achieve an across-the-board CO_2 saving of 90 percent. This project is just getting underway in Peterhead in Scotland. This will not be a small test-level hydrogen power station but will have a capacity of 500 megawatts. Investments will total a billion dollars, and the power plant will be able to supply 320,000 households with carbon-free electricity.

In Parson in the USA we will be applying much the same principle, but this time using feedstock, i.e. not natural gas but petroleum coke. In our traditional line of business, which is oil and fuels, we are also developing strategies to cut CO_2 emissions long-term. After all, as I have already said, we project that the number of vehicles around the world will increase three-fold by the year 2050, so sustainable mobility naturally has to be placed right at the top of the agenda. Everyone involved must play their part in this: the auto manufacturers by producing far more effi-



cient vehicle technology, the petroleum industry by making available more efficient and lower-emission fuels and, last but not least, the state in the areas of infrastructure and traffic management.

I do not intend to deal here with the technologies needed to increase the efficiency of conventional engines, hybrid vehicles or, in the longer term, the fuel cell, but would rather touch briefly on biofuels which we estimate could be used to meet as much as roughly 30 percent of our fuel needs by 2050. However, we will only be able to make this substitution, and achieve the desired long-term CO_2 saving, under one condition: we must focus our development quite specifically on the next – the second – generation of biofuels. We will not achieve our goals with the so-called first generation of biofuels like biodiesel and bioethanol. Their significance will be that they can help pave the way for the next generation of biofuels, and the faster we advance in this direction – with the support of politicians – the better. The more we insist on conserving current capacities of biodiesel and bioethanol, or even on generating additional capacities, the worse the effect will be on our 2050 CO_2 targets. Naturally, the biofuels are just as close to our hearts as the alternative energy sources, which is why we created another field of business in June of this year, "BP Biofuels Business". First, we intend to invest 500 million dollars over the course of ten years in a new Energy Bio-Sciences Institute, which will focus on researching and further developing biofuels. Second, we have signed a partnership deal with the US chemicals company Dupont to develop the next generation of biofuels. Here too we plan to invest 500 million dollars, making a total of a billion dollars altogether.

To sum up, I hope that I have been able to highlight a few areas which we need to tackle as regards the dual issue of energy and climate protection. This is a very necessary and ambitious program, but one which is also associated with many new opportunities. Essentially, it is a matter of ensuring the following: the growing demand for energy worldwide can and must continue to be met mainly by fossil fuels in the next two to three decades, primarily oil and gas. There are sufficient stocks available, though they are concentrated in the three regions of the former Soviet Union, the Near and Middle East, and West Africa, countries where state-owned oil and gas companies run the show. We need to secure our access to these reserves on a basis of partnership and mutual benefit. It is a good thing that energy policy has now become an integral part of foreign policy. The question as to the institutionalization of the energy sector, right up to the idea of a world energy organization, is one which is likely to become highly relevant in the near future. Climate protection is the other side of the coin. By 2050, despite a growing demand for energy, we need to maintain CO_2 emissions at today's levels. The energy production and transport industries are key sectors in this context. It is a matter of finding ways to generate electricity with the lowest possible CO_2 emissions, and achieving long-term mobility. Renewable energies, hydrogen, natural gas and biofuels are essential areas which present a variety of business opportunities and in which our company is highly active. A global CO_2 price is necessary for competitive and economic reasons, and as a catalyst for technology development and marketing.

Allow me to make one closing statement. The challenge is not – as is so often claimed – for us to move away from oil, away from gas, away from coal, but to move away from having CO_2 in the air, and away from putting CO_2 into the air. I would like to remind you that the greatest reservoir of bioenergy on this earth is to be found in natural oil and natural gas. It has just one small disadvantage – the renewal process takes slightly longer. Thank you for your attention.

Climate Change and Energy Supply

Professor Hartmut Grassl
Max Planck Institute for Meteorology, Hamburg; Meteorological Institute, University of Hamburg

Professor
Hartmut Grassl

Introduction

Let us talk about the two key challenges for this century: the first being to ensure the development of developing nations, something that has not been particularly stressed until now. Last year, the global economic product grew by about five percent. This is one of the highest – if not the highest – figure ever achieved. All our climate scenario calculations to date have assumed an average annual per capita growth in economic product of 2.5 percent until the end of this century. Assuming that the world population will grow by 1.2 percent annually in the same period, this 2.5 percent growth per year/capita would result in an up to 25-fold increase in global economic product by the end of the 21st century, accompanied by a correspondingly rising energy demand. But at present we are most likely going beyond this 2.5 percent average growth per year/capita, since I can't imagine that China or India will drop to a 2 or 3 percent growth rate per year/capita in the near future. And this will also mean an even higher than anticipated increase in global energy input.

The second challenge was succinctly described: our increasing energy consumption must go hand in hand with a reduced emission of greenhouse gases. It was once put to me by a journalist at a press conference in Berlin that what I was arguing for was to "square the circle", and I agreed, explaining that mathematicians had in fact managed to solve this recently, and that we would achieve it as well.

Climate Research Results

No doubt you are expecting some news from the field of climate research from me, and I am happy to oblige. Although I will be drawing on recent publications, I will not be quoting from the IPCC Fourth Assessment Report as this is still confidential, despite the fact that it has leaked, as you will have seen, onto the front pages of German newspapers. I was asked to comment on this but refused, pointing out to journalists that they were citing a confidential document. Instead, I will rely on what I know from my colleagues.

Number one: the recent warming, and by this I mean about the last 40 years, is predominantly anthropogenic. This was not so well known about ten years ago – we still had problems expressing this in such strong terms. The sun has had no significant influence since 1978, since we directly measured the output from satellites. In other words, the sun is fairly stable – between an active period with a high number of sun spots and the inactive part with nearly no sun spots in the eleven-year period the average amplitude is only one per mille. That's all, and it has been stable for the last 28 years.

Next comes something much newer – namely sea level rise. Sea level rise is now estimated - using satellite data which has been continuously available since 1992 – as being 3.2 mm per year. This is the conclusion drawn by several groups. About two-thirds of it is merely due to the expansion of sea water, while the remainder is attributable to melting land ice, mainly from glaciers in mountainous areas, and to a lesser extent from the big ice sheets.

Number three: global dimming as seen from the 1950s to the 1980s has definitely ended, and has turned into a recent

brightening. What does this mean? More solar radiation is again penetrating to the surface because air pollution across large parts of our globe has been reduced since, mainly, the collapse of the Soviet Union, and since the implementation of a number of clean air

acts in certain OECD countries. Only over India and parts of China is a regional dimming still ongoing, with less solar radiation penetrating to the surface because of high levels of air pollution.

Let us now turn to the sinks for anthropogenic carbon. It has become increasingly clear over the years that only about two of the total 8.5 billion tons of carbon emitted by fossil fuel use and deforestation each year end up in the ocean – about 3.5 billion tons of carbon each year remain in the atmosphere, increasing the CO_2 level. Where does the rest go? This is no small amount – we are talking about some three billion tons of carbon per year. At present it is going into the terrestrial biosphere, i.e. forests and soils. We do not know whether this will continue at this rate – this is a key research question.

Emerging earth system models have produced some new findings concerning the duration of global warming. When various scenarios are run in a coupled ocean, atmosphere, land, vegetation, ice sheet model over about four thousand years, we find that coastal cities and marshlands disappear eventually in all scenarios without climate protection. This will not happen in the 21st century, nor in the 22nd century, but will start to become a very serious problem in 2500. The mean global warming will continue not only for 200 years, but for millennia. And it is even speculated – and speculation is after all allowed in science, as there can be no progress without speculation – that under scenario A2 (i.e. massive population growth to 11 billion people, no significant development of developing nations but major use of coal across the planet), the global conveyor belt in the oceans, the Gulf Stream or, in scientific terms, the North Atlantic Drift, will collapse.

This is the conclusion drawn by all the groups who have examined this scenario: the collapse of the Gulf Stream will lead to a lower rise in sea level than that which would be seen in a moderate scenario, because in the moderate scenario the Greenland Ice Sheet would completely disappear. In hundreds of years from now it will start to melt at a high rate, but the reason for the collapse of the conveyor belt will not be fresh water from Greenland, but more precipitation falling or discharged by rivers into the Atlantic Ocean. This differs significantly from what climate history teaches us, where we have generally seen a major additional freshwater flux from ice sheets. If we take this seriously, the next few decades will determine whether Hamburg will still be a big city in 2800. Up to now, climate scientists have shied away from making such statements as the computing power and the modeling capability were not sufficiently advanced.

Political Reactions?

The sensitivity of the climate system seems to be comparatively high, so that even the European Commission's tolerable climate window of plus two degrees centigrade warming by the end of 2100 would not prevent parts of the Greenland Ice Sheet from melting, which is why we on the German government's Global Change Advisory Council urged that we try to aim for a very, very low stable concentration of carbon dioxide in the atmosphere. If knowledge is gained later which permits goals to be relaxed this can be done easily, but the opposite is very difficult.

What follows from the findings of climate researchers? It is interesting to note that nearly 20 years ago a warning was issued by the Meteorological and Physical Society in Germany, addressed to the public and the government, claiming that we would see global climate change caused by mankind and we should react politically now. It has taken 20 years for a small minority of scientists to prompt the Dräger Foundation to hold such a conference. Very first high-rank statements were issued in 1985 by a small group of scientists who had been asked by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) to assess the potential threat of global climate change caused by humankind. The Villach Conference – named for the town of Villach in Austria where it was held – resulted in a very clear final statement which still holds true today. They said that within a few decades all our security-related infrastructure would no longer be adapted to the frequency distributions of climate parameters (which also contain the rare weather extremes in their tails). This statement, issued 21 years ago, was a very wise one. Nonetheless, it took 20 years to achieve a global international law (the Kyoto Protocol of the Framework Convention on Climate Change of the United Nations) to serve as an umbrella and persuade major companies to acknow-

"In the 21st Century it is global climate protection that will decide on the survival of coastal cities in marsh lowlands".

ledge the signs we have been hearing about today.

An Energy Supply System to Protect Climate

We can now ask ourselves what sort of energy supply system might be conceivable that would no longer be a threat to global development. All the scenarios we have discussed up to now have no direct coupling between the socio-economic system and anthropogenic emissions. It is simply assumed that we will continue to burn fossil fuels. But there is no assumption that conferences like this can change people's minds and lead to a style of policy-making that is more focused on climate protection. There is not sufficient understanding of this socio-economic feedback to allow anyone to forecast with any degree of certainty what will happen.

That is why the Global Change Advisory Council to the German government said that any scenario which assumes that our personal behavior must change will mean that we will lose immediately, because next day Frankfurter Allgemeine Zeitung, an opinion-maker in our country, would run a headline talking about "The good people of the GCAC/WBGU", i.e. those illusionists who are trying to change the character of humankind. That is why we recommended assuming a high economic growth scenario with technology-friendliness, namely A1T. The A stands for high economic growth, 1 for multilateralism (we hope, for example, that the United States of America will come back on board), while T stands for technology to be used once it is available. Under such conditions, you could aim to remain below two degrees of warming in the 21st century, mainly by relying on renewables. For a certain period of time, however, as described in Dr. Franke's presentation, namely from about 2020 to 2050, we would need intermittent carbon sequestration under this scenario.

Before I presented this report to our government, Joachim Luther and I had to persuade the Minister for the Environment, who was Jürgen Trittin at the time, that carbon sequestration is not a sin. Because at the time there was no way that many of the environmentalist groups would accept an interim period of sequestration if economic growth were high and new technologies were not yet available. For example, we did not count on nuclear fusion. Why? Well, this has not been proven yet. Solar photovoltaics, on the other hand, is a proven technology; it functions, but is very costly and will only come to the fore at a later date, and then has to show very steep learning curves. At the same time, however, learning curves, as has been shown today already, also apply to fossil fuels. We will use them more intelligently than has been the case up to now. And where do the learning curves meet that make solar energy more economical than coal burning in a global emissions trading scheme? This was one of the key questions for the global economy model which was run by key scientists in the field rather than by us in the Council.

Let me end by saying that it will not only be possible with renewables but also cheaper. This will involve an interim period of partial sequestration, but what has not been said up until now is that this will have major consequences for the distribution of power on our planet. Who will have the basic fuel – the sun – in a society which uses mainly renewables? These will be countries like Somalia, Burkina Faso, i.e. those countries where most solar energy per square meter and time unit is offered. And most of us in the areas of climate and energy research, believing as we do in a bright future for renewables, would call this a peace dividend.

If we switch to renewables, we won't need to struggle for our fuel because it will be available for everybody. North Germans may believe that there is no sun in Northern Germany – yet if you ask how much energy is provided by the sun in Hamburg versus Somalia, the answer is that the difference is only slightly higher than a factor of two. If you then consider how well Central Europeans and Scandinavians typically handle technology, shouldn't we expect nearly the same harvest despite a lower net input in our latitudes? If you want to know more about this – for example about contraction and convergence, which I did not talk about – then go to the website www.wgbu.de and you will find all the reports, including a recent one about the threatening changes in the oceans. Then you can judge for yourself what the German government has learned from scientists and how much has been implemented or disregarded.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Why Do We Need a Common European Approach Towards Energy and Climate?

Luc Werring
Principle Advisor to the DG Transport and Energy, European Commission, Brussels

Luc Werring

Why Do We Need a Common European Approach Towards Energy and Climate?

(Excerpt from the speech)

Luc Werring made it very clear that the European Commission has to be involved in shaping future energy and climate policy in Europe. After all, the European Union of today started out as the result of a 1951 agreement on energy issues within the framework of the European Coal and Steel Community (ECSC). Nonetheless, even after the first oil crisis in 1973, in took another 20 years before an article outlining a common energy policy was included in the draft EU constitutional treaty in 2003. Following the 2005 G8 Summit in Gleneagles, there were calls for the European Union to adopt an integrated approach to energy.

Among the instruments for climate protection developed by the European Union is the European Emissions Trading System which, however, encompasses only 15 EU countries and has not yet integrated the new members. The EU-15 has a Kyoto target to cut greenhouse gas emissions by 8 percent of 1990 levels by 2012. Within this overall target, each EU-15 member state has a different emissions target which can be achieved by a variety of means. However, even these rather modest cuts are not likely to be reached, according to Werring. What is more, the EU emits only 14

"Coal will remain the most important source of energy for many countries. We need to develop policies and find mechanisms to convince all the countries concerned that without carbon sequestration our attempts to reduce CO_2 emissions in the atmosphere will fail".

percent of the world's total emissions, meaning that a global approach beyond the borders of the European Union is of paramount importance.

Given the fact that fossil fuels – primarily oil and gas, but also coal – will remain the major source of energy over the next decades, another reason besides climate protection for the call for an integrated European energy policy is the concern about energy supply security. The EU-25's dependency on energy imports will rise, which means that energy imports as a share of the total primary energy supply will increase from 47 percent in the year 2000 to almost 70 percent by 2030. For oil and gas this share will reach almost 90 percent. Even for solid fuels the EU's import dependency will increase to over 65 percent by 2030.

Coal, in contrast to oil and gas, will remain abundant in the world and relatively cheap. Coal will therefore remain the most important source of energy for many countries, in particular for countries like China with a dramatically rising energy demand. If we do not want to ignore the effects on the global climate of CO_2 emissions generated by burning coal, we need carbon sequestration – not only in Europe, but worldwide. We need to develop policies and find mechanisms to convince all the countries concerned that without carbon sequestration our attempts to reduce CO_2 emissions in the atmosphere will fail, says Werring. This means that the efforts to develop the technical foundations for carbon sequestration need to be intensified.

There are five reasons for the EU to develop a common approach to energy:
- to equip the EU to play a full role in global markets
- to improve sustainability in the EU and globally
- to improve the functioning of internal markets
- to improve stability in the EU and neighboring markets
- to reflect the strategic role of energy in achieving other political objectives.

Three overlapping and equally important common energy policy goals have to be addressed by the EU: competitiveness, environmental sustainability and security of supply. Our competitiveness will increase if we have functioning internal gas and electricity markets with a common regulatory framework and structures, if we establish a European electricity grid, and through research and innovations with regard to clean coal, alternative fuels, nuclear fuels, and energy efficiency. The environment will be protected by the promotion of renewable energy and nuclear energy, by increasing energy efficiency, by innovation and research, and by emissions trading. And, finally, security of supply will be reached through international dialogue, European stock management (oil and gas), refining capacity and storage of energy, protection against terrorist attacks, and – once again – improvements in energy efficiency.

The EU will establish a strategic review of the EU energy mix including, among other things, a blueprint for Europe to offer a long-term vision towards an efficient and integrated energy policy, a roadmap for renewable energy, a common vision to establish a coherent framework for better coordination of energy actions within Europe, and a strategic energy technology plan that gives the EU a horizon for 2030 and 2050 respectively.

The external energy policy issues on the EU's agenda are a new energy partnership with Russia, a coordinated reaction to disruptions in supply, strengthened energy relations with major producers and consumers, an international agreement on energy efficiency, common security standards to protect essential energy infrastructure, and new mechanisms to ensure solidarity and assistance in the event of damage to this infrastructure.

Panel Discussion – Are We Running out of Gas?

Professor Gernot Klepper

Director, The Kiel Institute for the World Economy, Kiel, Germany

Professor
Gernot Klepper

Gernot Klepper, Director of The Kiel Institute for the World Economy, started by answering the question "Are we running out of gas?" with a quote from the former Oil Minister of Saudi Arabia, Sheikh Yamani, who in response to the same question had replied that the Stone Age did not end because the world ran out of stones.

To give a fuller answer to this question, Klepper first of all pointed to the fact that energy specialists are by no means certain about the future availability of oil and gas. Many of them admit that they do not have any precise information about the quantities of fossil fuels remaining in the world. If price is a measure of scarcity, it can be observed that real prices for oil have remained constant over a long period. Price rises occurred only twice – the first time during the oil crisis in 1973, when prices increased not because of an actual scarcity of oil and gas but because of the Yom Kippur war, i.e. for political reasons. The second price increase occurred during the last couple of years in the wake of the U.S. invasion of Iraq – on political grounds once again, in other words. Thus the oil price so far has not reflected any genuine scarcity. Furthermore, the much-discussed reserves-to-production ratios are not very meaningful from an economist's perspective if you want to know when reserves will be depleted, says Klepper. When scarcity increases and prices rise, consumption goes down, making known resources last longer. Overall, you get a very diverse picture if you look at the predictions of energy specialists. The peak oil community, for example, claims that oil production will decline and oil resources will be depleted within the next 40-50 years. Extreme optimists, in contrast, forecast rising oil production until 2060, while the majority believes that we will have production increases until 2020 or 2030 and a slow downward trend from then on.

The key factor in these predictions is that they all – with the exception of the peak oil community – include not only the known reserves of oil and gas, but also those reserves that are not yet economically usable but may be usable at higher prices in the future – the so-called resources. What we do already know is that roughly 300 gigatons of carbon were consumed worldwide from 1860 to 1998, of which 50 percent was coal, 35 percent was oil, and the rest was gas. Relative to known reserves plus resources, this equals approximately 35 percent in the case of oil, 15 percent

in the case of gas, and only 3 percent in the case of coal. Total known fossil energy reserves, on the other hand, amount to 1,000 gigatons, with resources to almost 6,000 gigatons. If we then add unconventional energy resources like methane hydrates, we are talking about a total of something between 9,000 and 17,000 gigatons of carbon. If this number is compared with an annual consumption of about 6.5 gigatons today, we can conclude that there is plenty of fossil energy left, even considering that worldwide energy consumption will increase significantly due to rising demand from countries like China and India in particular.

However, taking into consideration CO_2 emissions from burning fossil fuels, the abundance of oil, gas and coal cannot be the decisive criterion in planning our future energy consumption.
Even if there appears to be enough energy available, we cannot continue to use it as in the past. We may not run out of gas at gas stations, but will have too much gas in the air and risk losing some of the earth's life support systems.

Looking at CO_2 emissions per unit of GDP as an indicator of how efficiently fossil fuels are turned into energy services, it can be observed that China has been making tremendous progress since the 1970s, though it started out at a very inefficient level. Compared to European standards, for example, there are still huge improvements possible. Similarly, the USA has made only little progress in terms of energy efficiency and could improve significantly. Russia is also still quite inefficient, so there is a huge amount of potential for increasing energy efficiency worldwide and preventing CO_2 emissions going beyond the 500 ppm CO_2 equivalent – which is the rather optimistic aim for 2050.

Maintaining this level of greenhouse gas concentrations in the atmosphere would in turn limit CO_2 emissions drastically. Depending on the growth of emissions over the next decade, emissions in 2050 must not exceed 50 percent of today's emissions. And if the projected emission growth in the next 5-10 years continues, the reduction will need to be even more significant.

For charts refer to *www.draeger-stiftung.de*.

Panel Discussion – Are We Running out of Gas?

Professor Klaus S. Lackner

Director, Gerry Lenfest Center of Sustainable Energy; Chair, Dept. of Earth and Environmental Engineering Center, Columbia University, New York, NY, USA

Professor
Klaus S. Lackner

Klaus Lackner, Director of the Gerry Lenfest Center of Sustainable Energy at the Columbia University in New York started by pointing out that the world will need a lot more energy in the future than it did in the past. Even though he claimed that predictions are nearly impossible in this business, some normative scenarios can be calculated.

First of all it is essential to figure out whether we will be able over the next 100 years to afford to maintain the standard of living worldwide that we take for granted in the developed world today. If we take U.S. or Canadian average energy consumption as a basis, this could mean an increase in global energy consumption by a factor of ten. On the other hand, we have to take conventional wisdom into consideration, which suggests that growth in energy consumption will in fact be lower thanks to the improved energy efficiency of our economies. Typically, we have a track record of GDP outpacing energy consumption by between one and two percentage points a year. If this track record is maintained – and the predictions are based on these figures – we are talking about a factor four rather than a factor ten increase in energy consumption. The uncertainty as to whether the difference between GDP growth and energy consumption growth amounts to one or two percentage points is, of course, a very significant factor, meaning that precise predictions are hard to make.

With regard to future carbon emissions and climate change Lackner stressed that it is not so much a problem of keeping emission flows constant, but a matter of stocks. It is a question of how much carbon we can afford to release into the environment. Unfortunately, when we talk about stopping climate change, we are ultimately saying that we will have to stop CO_2 emissions completely, he said. Once the level set for future CO_2 emissions is reached, no matter what level that may be, the ocean uptake at a constant level of CO_2 in the air will drop very rapidly, and it will not be long before we are forced to set 30 percent of current emissions worldwide as the maximum limit in order to maintain the CO_2 concentration in the air at a constant level. Once the world has reached 30 percent of today's emissions and the per capita allowance applies to everybody on earth, we will end up with three percent of the United States' per capita emissions today. This dramatic reduction of CO_2 emissions cannot be achieved by switching from coal to natural gas; it is a question of how to stop CO_2 emissions almost completely.

However, Lackner argued, the world does have options, making the point that scales matter! If you have ten billion people consuming energy at the rate we do today, you are talking about requiring an energy production amounting to tens or even hundreds of terawatts in the future – compared to 13-14 terawatts today. There are at this point only three major 'players' in the game (fossil fuels, nuclear energy and solar energy) capable of producing energy on that scale, plus myriads of smaller players who can add to this but most likely will never be more than niche players. Of course, there will be efficiency gains which will greatly help though they will not solve the problem on their own.

Since 85 percent of all the commercial energy is generated using fossil fuels, it seems impossible in the short term to do without oil, gas and coal. Nonetheless a decision has to be made as to what to do about this problem. Even if we do not know precisely how much oil and gas we will have left in the future, it is a fact that we have so much coal, tar and shale oil that we do not need to worry much about actual quan-

tities of oil and gas, Lackner said. Technically, the different forms of hydrocarbons are fungible. Coal, oil and gas can all be converted into liquid fuels. The costs of this liquefaction are competitive when a barrel of oil costs US$ 45 or more. If the world increased from three converter plants to 3,000 so as to cover the entire global energy demand, prices would come down by at least another factor of two. After all, there is plenty of fossil energy available. It may well be that the fossil era runs out long before we run out of fossil fuels, Lackner agreed, but added that today's world consumes a lot more stones than the stone age ever did. In other words, even though the world may well not consider itself a fossil energy economy in the future, far more fossil energy than is consumed today may be used tomorrow. Carbon capture therefore seems to be one of the options we should keep in mind.

The second big option is nuclear energy, but there are four problems to deal with here. First, the costs right now are too high, so nuclear power is not competitive. Carbon capture and storage is cheaper. Second, safety is an issue. There have been two very serious incidents in the world over the last 30 years, and if we had one hundred times as many nuclear reactors, we better not have one hundred times as many accidents. The third issue is waste – something that can and needs to be resolved. And finally, there is the proliferation challenge which is the most severe problem of all, and ultimately needs global political agreement and understanding. This problem is made particularly difficult by the fact that uranium supplies may not be sufficient to meet future demands, which means that over the one hundred year time scale nuclear energy producers will very likely start using breeding technologies in order to keep their reactors working; if this happens, the danger of proliferation becomes even greater.

The third big player is solar energy. However, Lackner argues, solar energy today is far too expensive, and being primary electricity is intermittent. It cannot be stored yet and has to be transformed into a form of energy that can actually be used. In order to be a real competitor, the costs of solar energy have fall below a penny per kilowatt hour. In other words, prices have to come down by a factor of 30 – considering what mass manufacturing has done in the computer sciences, however, a price cut of this scale can certainly be achieved.

Lackner concluded by saying that all three options look plausible. All three are possible, yet none of the three has really been developed to work on the necessary scale. On the other hand, he said, if anyone of the three does succeed, there will not be an energy crisis in the 21st century. If none of the three succeeds, we will have an energy crisis regardless of how successful we are with wind or biomass because these players will never be large enough to actually solve the problem.

According to Klaus Lackner the focus has to be on these three options. He personally is working on carbon capture and storage. Carbon can be injected underground. It is already possible to collect CO_2 from power plants and it will be possible in the foreseeable future to extract CO_2 from the atmosphere – he together with colleagues is working on this technology. It will be possible to make fossil fuels carbon-neutral, though this requires political will and new technologies. State of the art technology – if applied systematically – would satisfy the world's need for water and food, but it would fail dramatically in the energy sector, because it would create an environmental catastrophe. To produce sustainable, environmentally safe and economically efficient energy we need science and technology and innovative engineering to make it work.

"The oil age may end long before we run out of oil. Fossil energy may well last for further 100 to 200 years, but with today's fuel technology we will not be able to sustain a future world population of 10 billion".

Panel Discussion – Are We Running out of Gas?

Vijay Vaitheeswaran
Author and Global Correspondent, The Economist, New York, NY, USA

Vijay Vaitheeswaran

Vijay Vaitheeswaran, Author and Global Correspondent of The Economist, discussed options and actions for reshaping the world of energy, starting with a question asked 60 years ago by Mahatma Gandhi: "How many planets will it take?". Gandhi was referring at the time to a particular dilemma of that age when Britain was the dominant economic power and India the potential rising giant. How many planets will it take, he asked, if India follows the path of industrialism that Britain has taken and that has consumed half the planet's resources? And how many planets will it take if China follows the American model of development? If every Chinese in the aspiring middle classes, of which there are hundreds of millions, buys a "gas guzzler" and sets off on the same path of urbanization, motorization and industrialization as North America. How many planets' worth of resources will this take?

The world is indeed not constrained in terms of energy per se, agreed Vaitheeswaran, but it is the consequences of our energy use that are worrying. The fundamental principles of our current energy system are unsustainable, and they are unsustainable for three reasons:

First, we of course talk about the linkage between energy and the environment and the needlessly inefficient and dirty ways that we use energy today, thereby also contributing to local pollution problems. This is particularly true of many developing cities, and China has many of the world's dirtiest cities. However, it is not just the air pollution that we are familiar with, or the climate question. There are environmental problems that do not even appear to be related to energy and can be obliterated by shifting to a more sustainable energy paradigm. Water, for example: Many people talk about water being the next world crisis, and people sometimes even argue that the next world war will break out because of water. Yet 70 percent of the earth is covered in water. Although it is not what we want it to be – it is salt water – we know how to desalinate and move water. Fundamentally, this is a question of political will, and that is a different nature of problem. However, desalination is very energy-intensive, and if the energy used is dirty energy then all we are doing is shoveling problems from one side of the ledger to another. Similarly, other environmental problems that appear to have nothing to do with energy, like recycling, for example, or dealing with chemical waste, would become much more manageable if we were to gain access to cheap and clean energy. In other words, getting

energy right is the essential enabler of sustainability, Vaitheeswaran argued on the environmental front – to put it the other way around, unless we get it right we have no hope of having a sustainable future.

The second link is energy and poverty. According to the estimates of the International Energy Agency, 1.6 billion people do not have access to modern forms of energy, be they electricity or other forms of clean-burning energy. Most of these unfortunates live in sub-Saharan Africa, southern Asia, or parts of Latin America. They are usually women and girls, and they typically walk miles a day to fetch agricultural residue, cow

dung, and other really filthy, solid and inefficient forms of fuel to burn in a makeshift cooking stove in their huts. Often children are in the huts at the time when this happens – according to the WHO, the resulting smoke and indoor pollution, as well as various other factors, constitute one of the leading preventable causes of death in the world besides malnutrition. But when was the last time you heard of a Live Aid concert to stamp out the cow dung fires in India, he asked. We need to think about an energy system that meets the needs of not only the world's wealthiest, but also of its most needy, and of its most aspiring, the ones who are now making their way from one side of the ledger to the other: in Brazil, Russia, India, China, the so called BRIC countries.

The third link Vaitheeswaran talked about was energy and geopolitics, agreeing that it is undeniable that we will experience geopolitical tension, particularly if China, India and other countries approach African or Middle Eastern countries for oil with which the U.S. has existing geopolitical alliances. Rightly or wrongly, this is clearly an area of potential conflict in the future, and is going to happen.

These three examples that have nothing to do with depletion or scarcity, show why Vaitheeswaran thinks that the existing inefficient approach to using primarily fossil fuels is not sustainable. He shared Klaus Lackner's view, however, that fossil fuels can be part of a sustainable future if used in a carbon-constrained fashion, and that many technologies can be part of that solution. Nevertheless, he believes that the current paradigm is not sustainable. But to add an element of optimism and talk about solutions, there are some reasons why there is more hope in the energy world today. Today we are entering a new era of energy innovation, for three reasons. The first reason is the trend towards a liberalization of markets we have observed over the last couple of decades. Why does that matter? Competitive markets are better than the alternatives, because over time they lead to a more efficient outcome, and liberalization is the essential enabler of innovation in energy. And so far, energy is the least innovative big business on earth.

If you look at the U.S. electricity industry, it is in many ways a vast enterprise. In terms of revenues, it is bigger than the U.S. long distance and cellular telephone businesses put together. In terms of assets it is even bigger. According to the estimates of the industry's own experts, they have for decades been reinvesting less than one half a percent of revenues into research and development. Any other enterprise, be it biotechnology or IT or computing or the like, reinvests as much as five percent, and sometimes even ten percent of its turnover. In the energy industry, however, we have seen a "business as usual" mindset that has actually been anti-innovation. Liberalization, if combined with certain other trends, will change that paradigm and enable the next innovations in clean energy.

The second mega trend that gives rise to hope is the emergence of a new kind of environmentalism which first and foremost is a market-minded environmentalism. We are seeing an embracing of sensible policies rather than the old paradigm of left versus right, of environmentalism versus business. We are seeing market-based instruments, be they carbon tax or other kinds of pollution taxes, which provide incentives in the market. It all starts with carbon trading, and with the European trading system. A growing level of environmental awareness is also evident in developing countries like China, India and Brazil. People are rich enough now in many parts of the developing world, particularly in urban clusters, to be able to afford to look beyond their next bowl of rice, Vaitheeswaran said.

The third mega trend is technology. The world is on course for a clean technology revolution in energy. We are seeing the arrival of clean carbon technologies and the incipient introduction of technology policies around the world. This is not a done deal, but this third great wave of technology really has the potential to change the paradigm.

So where is this leading? he asked. With these three mega trends combined we have the chance to set the world on a much more sustainable energy footing. The future development is not inevitable; it depends on choices, choices that are made in this room, choices that policymakers in the rich world as well as in the developing world make about the direction of those three mega trend outlines. Technology sometimes emerges spontaneously, innovation often happens in the marketplace. But innovations do not necessarily always go in the most sustainable direction, unless public policy enters the game.

In closing, Vaitheeswaran answered Gandhi's question by saying: Of course we have only one planet, and we must meet the legitimate needs of the developed world, as well as the legitimate aspirations of the developing world, with the resources that are available, including the environmental strains that are implied by those resources. But we are not resource–constrained, neither in terms of primary energy nor in the resource that matters most of all, which is human ingenuity.

Monday, October 9, 2006 – Dinner Speech

Frank Schweikert
Biologist and Journalist; ALDEBARAN Marine Research & Broadcast

Frank Schweikert

Climate Change: Consequences for Oceans and People

Frank Schweikert started his speech with a presentation of his film 'Sound of the Sea':

What you can hear now, he explained, is the sound of the seas. These are recordings from a coral reef on the Seychelles, made audible using underwater microphones. The ocean is by no means a silent world, even though it may often seem quiet, uncanny and, to a large extent, unexplored, concealed as it is under the surface of the sea.

As we all know, our planet is not called Ocean, but Earth. Nevertheless, the seas are by far the largest habitat of the planet, covering about 70 percent of the earth's surface. More than 99 percent of all life on earth is water-based. Even so, deep sea exploration is far from completed. At unknown depths life forms may exist that we cannot even begin to imagine; indeed, we are only just starting to understand the effects of ocean currents, salinity, and tides on land-dwellers and global climate. Only about 0.1 percent of the entire mass of ocean waters can be regarded as well-investigated.

Introduction

Human interest in the exploitation of marine resources is rapidly increasing, yet education and knowledge about the world's largest and most important habitat lag behind. The long-term consequences of human interference are still far from clear. Considering that the seas are extremely important for human systems like food and nutrition, and to global climate in general, the question of the relationship between humanity and the oceans is more important than ever. What exactly are the changes we can expect in marine environments, and what implications will they have for humans? And how does human behavior impact upon the complex habitat of the oceans?

The sea as recreation and living space

We all know that the oceans are vital as recreational and tourist areas. However, the number of people permanently living on or near the coasts is already high and constantly increasing, due in part to climate-change-induced desertification processes inland. Currently almost half the world's population lives within 100 km of the coast. Seaports and coastal cities have always been attractive for human settlement, and the population of coastal mega cities is rapidly increasing. 8 of the 10 largest cities worldwide are located directly on the coast. UNESCO estimates state that about 6.3 billion people will be living in coastal areas by 2025, marginally less than the number of people alive today. With a growing human population in coastal areas, the pressure on marine ecosystems will increase as a result of pollution, industrial and municipal waste, and because of the sheer number of inhabitants and tourists. Infrastructure and urban management have to adapt to ever-changing environmental de-

mands. The more people that settle on the coasts and work in marine industries, the greater the strain on the immediate surroundings. Coastal erosion, declining water quality, increased flood risks, and the loss of swamps and mangrove forests and of biodiversity in the sea and on land are possible effects. For example, an average increase in water temperatures by just two degrees would have devastating consequences for coral reefs.

The sea as food source

For more than one billion people, the sea is the only source of protein and thus essential to their survival. According to an FAO (Food & Agriculture Organization of the UN) survey, the demand for fish is increasing even more rapidly than the exploding world population curve. Due to the ever-increasing demands on fisheries, there is a great need for new catch technologies, depth and fish monitoring systems, while real conservation of fish as a vital resource is almost impossible given the plethora of international industries. By the time the effects of fishing have been researched and translated into legislation, it is usually too late. Almost half of food fish stocks have been overfished or have simply disappeared.

Aquacultures are supposed to be cheap replacements, yet they bring more damage than benefits in the concerned regions. Nevertheless, the World Bank has been making exorbitant funds available to finance shrimp farms in a highly sensitive coastal region of Belize. UNESCO states that fish farms are not an appropriate substitution for natural fishery. Coast populations are just starting to understand that the ocean is not an inexhaustible resource.

Ultraviolet radiation has increased due to the thinning of the ozone layer, and has negative effects on plankton, and especially on fish larvae and eggs. The quantity and quality of sea food sources suffer from these impacts. Problems generated as a result of by-catch and other pressures from human activities such as industrial shipping and fishery affect not only fish stocks, but also a multiplicity of species ranging from minute plankton to marine mammals.

The sea as biological resource

Like the rainforests, the oceans present an abundance of biodiversity, in parti-

cular in coral reefs and deep ocean. Only a few years ago, scientists discovered coral reefs not only in tropical but also in cold waters. At the moment scientists are working on projects to develop cancer drugs based on chemical protection mechanisms from underwater species such as cold-water sponges and sea squirts.

Global regulation instruments are not applied sufficiently, and the fragile balance of economy and conservation is hard to maintain. The question of human adaptation to the changing demands of marine environment and climate change circumstances will remain explosive in future. Many models show that the effects of climate change on humans will have wide and mainly negative effects. Expected changes due to climate change or variations include an increase in sea surface temperature, an increase in mean sea level, a decrease in polar ice cover, as well as various unpredictable changes in salinity and

layering of water, waves and ocean circulation, as outlined in the IPCC report for 2007.

According to the latest IPCC report, the reduction in the quality and quantity of biological resources from the ocean is having immediate effects on human society, especially as a large number of coast-dwellers depend on marine services like fishing. Humans are record-breaking collectors of data and information, and we can afford high-profile research projects – yet we fail in the evaluation of this data and in communicating the results to people worldwide who should be translating these research results into actions. Still, there are individual projects that help support climate and marine environments.

For example, the renaissance of sailing ships: modern freighters can be towed across the seas using huge kites, saving up to 50 percent in fuel costs. If only half our commercial ships were fitted with this towing system, pollution equivalent to total US emissions could be prevented each year. Tests were carried out by SkySails technology and took place on a 55 meter research vessel a month ago in the Baltic Sea.

In future, human society must learn to bridge the gap between “knowledge about the sea” and action. Reliable cultural forms of adequate contact with the ocean must be reactivated and a new global consciousness created. This should be established quickly, so as not

to bite the hand that feeds us merely because we do not know enough yet about the seas and their immense importance for our survival on this planet. The oceans will only have a future if people learn to overcome the inconsistencies of resource exploitation and environmental conservation.

Reports from the Working Groups

(For charts and/or notes of the working group speakers please also refer to www.draeger-stiftung.de)

Tuesday, October 10, 2006 – Summaries of the Working Group Discussions

by Professor emeritus Joachim Luther

Future Energy Systems

Chair:
Dr. Fridtjof Unander,
Vice President, Enova SF, Trondheim, Norway; Former Acting Head, Energy Technology Policy Division, International Energy Agency, Paris, France

Speakers:
Professor emeritus Joachim Luther, former Director, Fraunhofer Institute for Solar Energy Systems, Freiburg, Germany
Dr. Gregor Czisch,
Researcher, Institute for Electrical Energy Technology/Rational Energy Conversion, University of Kassel, Kassel, Germany
Andreas Wagner,
Manager, Technology External Programs Europe, GE Energy, Salzbergen, Germany
Dr. Bob van der Zwaan,
Senior Scientist, Energy Research Centre of the Netherlands (ECN), Amsterdam, The Netherlands

The discussions in Working Group 1 on 'Future Energy Systems' revolved around the questions of how we can achieve a post-fossil energy supply and which role alternative energies will play, as well as dealing with energy efficiency and the cost of energy. There were four presentations: one on solar energy systems; one on future energy systems based on wind energy, solar thermal power and hydro storage; one on alternative energies and energy security; and, finally, one on the future prospects for nuclear energy.

The main problems underlying any discussion of future global energy systems concern the protection of our natural life support systems, the eradication of energy poverty in developing countries, the promotion of peace by reducing geopolitical conflicts induced by dependencies upon regionally concentrated energy reserves, and of course boundary conditions like reasonable energy costs, energy security and public acceptance.

The main findings of our group in this area were the following:

- There are no limitations to making the global energy system sustainable in terms of restricted physical potentials of energy sources (fossil, nuclear, renewable);
- Limitations arise in connection with the problems of sinks/pollution and risks;
- Sustainability potentials have to be analyzed (biomass, in particular, was discussed in this respect, also with regard to potential conflicts between growing crops for fuel or for nutrition);
- Significant and sufficient cost reductions are feasible as a result of upcoming energy technologies, especially with regard to renewables;
- The electricity grids have to be optimized, i.e. interconnectors, long-range transport of, for example, solar electricity from northern Africa, bi-directional transport from low-voltage to high-voltage lines, smart grids, and load management – something that appears to be very

important when it comes to implementing fluctuating or non-controllable energy inputs;
- On a long-term basis, storage systems for fluctuating renewables are important (using the grid as a system of virtual storage);
- Targeted industrial activities are crucial for mass production, cost reductions and energy efficiency; the new energy technologies will come to the market and into use through industry and not through R&D activities alone. In other words, we have to get industry on board;
- Another important question that remained unresolved in our discussion concerned fuel for transport – should this be fossil, bio fuels, electricity and batteries, or hydrogen?

Finally, we had a very balanced presentation and discussion about nuclear energy, leading us to conclude that it is increasingly likely that the lifetime of most existing nuclear power plants will have to be extended, in Europe and elsewhere. Let me summarize the key aspects of this discussion:
- The incorporation of externalities into energy prices would reinforce the competitiveness of nuclear energy.
- Enhancing security to protect against potential terrorist attacks on nuclear power plants and spent fuel cooling ponds increases costs.
- The reprocessing and recycling of plutonium is more expensive than the direct disposal of spent fuel.
- The economics of reprocessing remains a relevant subject of study, especially now that some countries face major decisions regarding the future management of spent nuclear fuel.

With regard to radioactive waste, nuclear proliferation, and reactor accidents we have to admit that the problems related to these three intrinsic nuclear drawbacks are real, significant, and will never be solved entirely. Nonetheless, they are dynamic: they have evolved substantially over the past decades, and more progress can be made. The waste problem can be mitigated, for example, by implementing lifetime reduction (transmutation) and regional disposal options (IMWRs). The proliferation problem can be reduced by introducing new reactor types (Gen-IV) and expanding the mandate of supranational means (IAEA). Last but not least, accident risks can be cut by incorporating passive safety features and improving and coordinating reactor operation. It was very clear that nuclear energy requires action and control on the part of the government, and will not enter the market by market forces alone.

Summary of Working Group 2

by Johannes Linn and Cornelius Adebahr

Energy Policies: Implications for Global Climate and Future Wealth

Chair:
Dr. Johannes Linn,
Executive Director, Wolfensohn Center for Development, The Brookings Institution, Washington, D.C., USA

Speakers:
Professor Anders Levermann,
Potsdam Institute for Climate Research, Potsdam, Germany
Professor Peter Höppe,
Head of the Geo Risks Research, Münchener Rückversicherungs-Gesellschaft, Munich, Germany
Professor Claudia Kemfert,
Head, Department Energy, Transportation, Environment, German Institute for Economic Research (DIW), Berlin, Germany
Dr. Alexander Golub,
Senior Economist, Environmental Defense, Washington, D.C., USA

Introduction

The working group focused on the following questions: what is the current and expected future state of the global climate; to what extent is energy consumption responsible for global warming; where are the scientific political debates headed, and what are the policies and institutions that can influence human behavior for long-term sustainable energy use and climate conditions.

The session started with presentations by four outstanding experts, who combined skills and experience in the fields of science, economics, politics and law. The wide-ranging discussions revealed remarkable agreement among the participants (with one notable exception) on the key challenges and risks currently facing the global community at the interface between energy use and climate change. Five main issues were discussed.

Issue # 1: Global warming is clearly on the upswing with serious environmental, economic and social costs.

Drs. Levermann and Höppe presented scientific evidence that there is a global warming trend and noted that the year 2005 was the warmest year in 140 years of global temperature record-keeping. They also demonstrated that there are serious risks associated with this trend:

- the melting of ice sheets in the Arctic and Greenland is causing sea levels to rise at rates more rapid than projected even in the recent past;
- the increased incidence of severe weather, reflected for example in 2002 and 2005 in unusual floods and in 2004 and 2005 in a record number of severe hurricanes, including in previously hurricane-free areas, has resulted in serious damage to human life, infrastructure and the environment;
- extreme heat waves, unlikely to fall within the normal range of probable occurrence, have recently led to many deaths.

The working group discussion concluded that the scientific community agrees on these trends; that they present serious risks not only in the distant future, but

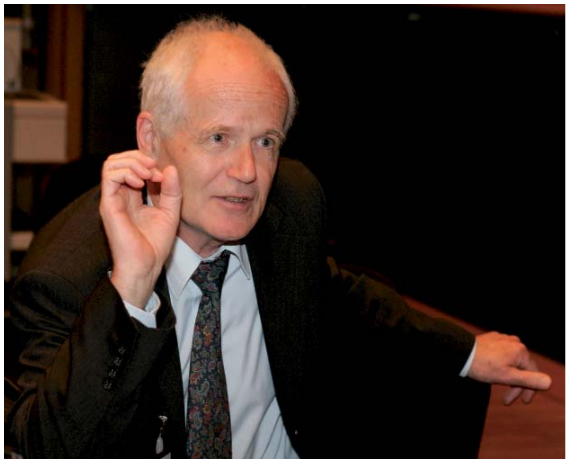
already today; that clear limits need to be set for global warming, and that the EU ceiling of a further permissible increase in global mean temperature by no more than two degrees Celsius is, if anything, too high; and that effective action needs to be taken urgently and early on to assure that the ceiling is not breached.

Issue # 2: There is a direct causal chain between energy use and CO_2 emissions and between CO_2 emissions and global warming.

Dr. Levermann informed the working group that this causal chain had already been analyzed by the Swedish scientist Arhenius in 1886. Ironically, he tried to demonstrate that this was beneficial to Scandinavia because it would raise mean temperatures in this cold region. More importantly, the group was informed that CO_2 emissions tend to rise more rapidly than energy consumption, requiring a more drastic reduction in the rate of energy consumption growth to achieve any targeted reduction in the growth of emissions. Furthermore, given the delayed effects of past emissions, global warming would continue for some time even if greenhouse gas emissions were stopped entirely today.
A voice of dissent: contrary to the general agreement in the working group on issues # 1 and # 2, a representative of the German Coal Association asserted that (a) while global warming is happening, it is not clear from the scientific evidence that there is a link between severe weather and global warming, nor even that there is an increase in severe weather; and (b) the scientific evidence does not clearly establish that global warming is predominantly due to CO_2 emissions. In response, panel members uniformly and strongly argued that while the links and causalities are complex and to some extent uncertain, a vast preponderance of the evidence certainly points towards a clear causal chain.

Issue # 3: Policy instruments for reducing conventional energy use, CO_2 emissions and, therefore, global warming exist and should be implemented.

There was agreement in the working group that policy instruments exist to achieve necessary changes in energy use and emissions, even though a different combination of instruments (energy efficiency, renewable energy, etc.) may be appropriate in different countries. Drs. Kemfert and Golub agreed that increased research and



development (R&D) are critical, since current technology is not enough to address the global warming challenge. Currently there is too little R&D, especially in Europe, and insufficient policy focus on how to address this. According to Dr. Golub's research, emissions caps and trading are the preferred instruments (better than taxes) since they encourage innovation. The experience of the EU with its emissions trading program is useful, although there have been problems with its design and implementation as regards lack of transparency, lack of auctions and over-allocation of permits. There was general agreement that action needed to be taken urgently, since any impacts could be delayed by up to 30 years.

Issue # 4: The costs of limiting the growth in energy use and controlling greenhouse gas emissions are significantly lower than the costs of global warming.

Any estimation of the costs and benefits in this area is subject to severe analytical and data constraints. However, according to estimates reported by Dr. Kempfert, the damage done by unchecked global warming will by 2100 incur costs equivalent to about eight percent of global GDP, while the costs of controlling greenhouse gas emissions will only be in the order of two to three percent of GDP, or even as little as one percent thanks to possible future technical innovations. Dr. Höppe noted that the insurance industry has registered a significant increase in natural disasters and a related rise in insurance claims, leading in turn to higher insurance premiums. Dr. Golub observed that the ex-post costs of environmental controls have generally been found to be less than the estimated ex–ante costs; that past control measures have not had a negative impact on economic growth; and that the ancillary benefits of environmental protection measures (e.g. reductions in pollution and related improvements in health) tend to be neglected or underestimated.

Issue # 5: Despite widespread and growing scientific agreement on issues # 1-4, there is not yet the political will among key players to take the urgent actions necessary to avert global warming and the related environmental, economic and social costs.

Participants noted that there are conflicting interests in the global and national societies. In particular, the costs of control tend to be concentrated in the short term and affect certain countries and interest groups within countries, while the costs of not imposing limits occur in the long term and affect other countries and groups. Moreover, politicians as a rule tend to have short time horizons and hence neglect the long-term implications of their actions or lack thereof. Information and public outreach campaigns are essential, and the engagement of the private sector (such as the insurance industry) is very helpful. Dramatic crises and disasters, such as Hurricane Katrina, while highly regrettable and to be avoided, may actually be necessary to swing public opinion and change political behavior. The United States is a key player – without progress in US policies, not much is likely to be achieved worldwide in the fore-

seeable future. Fortunately, there are some signs of an improving political climate as a result of the public outcry after Katrina and the path-breaking actions recently taken by the State of California. Another key player is China, but the working group concluded that unfortunately it was not yet clear what might be done to entice Chine to do more to limit the rapid growth in its energy use and in greenhouse gas emissions.

In sum, there was broad consensus within the working group regarding the key linkages and impacts of energy use and greenhouse gas emissions, and also regarding the feasibility of and pressing need for action to control them, but there was no clarity on how to move forward to achieve the urgent global climate agenda in the world's political arena.


Deeva

Summary of Working Group 3

by Dr. Udo Brockmeier

Technological Challenges and Options for Future Energy Supply

Chair:
Dr. Udo Brockmeier,
Chairman of the Board, EnBW Kraftwerke AG, Stuttgart, Germany

Speakers:
Lord Ronald Oxburgh,
House of Lords, Westminster; former Chairman of Shell Transport and Trading plc, London, United Kingdom
Dr. Wolfgang Eichhammer,
Deputy Head, Department of Energy Techniques and Energy Policies, Fraunhofer Institute for Systems and Innovation Research, Karlsruhe, Germany
Gary V. Litman,
Vice President, Europe & Eurasia, U.S. Chamber of Commerce, Washington, D.C., USA
Dr. V. Sumantran,
former Executive Director and Head of R&D, Tata Motors Ltd; Strategic Consultant, Mumbai, India
Dr. Hans Jürgen Wernicke,
Member of the Executive Board and Chief Operating Officer, Süd-Chemie Group, Munich, Germany

Working Group 3 focused on 'Technological Challenges and Options for Future Energy Supply'; the discussions mainly dealt with different technologies, future options, long-term trends and the question of how to improve technology transfer. We addressed our topic in the wake of the Berlin declaration of the first German conference on climate change that took place in Berlin on September 20 and 21, 2006:

"It is already accepted by the vast majority of climate scientists that human activities, through greenhouse gas emissions from burning fossil fuels and land use changes, are the main driver of the climate change that is now taking place. In this regard it can no longer be prevented. What is now important, however, is to reduce as far as we can the risk of 'dangerous climate change', i.e. an increase in temperature that causes serious threats to ecosystems and human society. We must do all we can to keep the global average temperature rise from pre-industrial times below 2°C. We recognize the challenge this represents. To maintain this 2°C limit, the concentration of CO_2 and other greenhouse gases in the atmosphere would need to be stabilized at a maximum of 450 ppm CO_2 equivalent, and probably below this value."

Let me present one highlight that supported our discussion of the challenges we are facing, taken from Ron Oxburgh's presentation. His figures show the energy demand per head and per year in 2002, distinguishing between developed, emerging, developing and poorest countries. Of course, by far the highest numbers are to be found in the developed world. Consequently, CO_2 emissions are also overwhelmingly caused by the developed industrial countries. If we take a look at the predictions for the year 2050, which are

based on very conservative assumptions, one thing becomes abundantly clear: due to the increase in the world's population to approx. nine billion by 2050, and because of the growth in worldwide per capita consumption, the per capita demand of the emerging countries (some 1.2 billion people) will reach a level of almost two thirds, while that of the developing countries (some 4.5 billion people) will reach a level of almost half of the industrial countries' demand today.

From this, it is obvious that the industrial countries have to bear the greatest responsibility with regard to CO_2 reduction. For these countries, the challenge will be to reduce carbon emissions by 70-80 percent by 2050. Of course, we reviewed the potential offered by different technologies that are available and feasible from today's perspective. Our conclusion was that there is no single measure capable of solving the problem, and that the only way to achieve this goal is to implement a conglomerate of measures based on short- and medium-term technological opportunities along the lines of the 'seven wedges approach' that was brought to the table yesterday by Dr. Franke:

- Energy efficiency gains achieved by doubling average fuel efficiency
- Ambitious implementation of renewables and new storage technologies
- Maintenance of the nuclear option
- Decarbonization of the transport sector
- Ambitious program to implement combined heat and power
- Smart grids on a micro-generation level, especially in the context of urban growth and planning
- Clean coal technologies, including carbon capture and storage

What does this mean for Germany? It could be helpful to look at the outcome of yesterday's and today's consultation within the German government. The roadmap for Germany that was defined yesterday aims to achieve a 20 percent reduction in energy consumption by the year 2020, which also means a 20 percent reduction in CO_2 emissions in Germany. German CO_2 emissions today are 860 million tons, 20 percent of this being roughly 170 tons. That, interestingly enough, is exactly the amount of CO_2 that will be additionally emitted if we phase out nuclear energy in Germany, which means that German energy policy would achieve only a zero net result in carbon reduction by 2020.
That is the truth of German energy policy.

The key to successful implementation of these measures on a global level is to find a way to make them part of the economic growth process in developed

and developing countries. Research and development, technology transfer and an energy policy that systematically allocates economic value to environmental resources will indeed become the key drivers in climate change litigation. Finally, and this was one of the most important points made during our working group discussions, we have to be aware of the fact that the developing world has different priorities; it will be a major challenge to address this issue, particularly on the part of the industrial countries, which in fact are recognized as being responsible for the present level of CO_2 concentration in the atmosphere.

Summary of Working Group 4

by Dr. Robert Watson

The North-South Conflict – Energy Consumption and Sustainable Development

Chair:
Dr. Robert Watson,
Chief Scientist, ESSD, The World Bank; former Chairman of the Intergovernmental Panel of Climate Change (IPCC), Washington, D.C., USA

Speakers:
Professor Gerhard Berz,
Professor for Meteorology, University of Munich; Member of the Council, Munich Re Foundation, Munich, Germany
Professor Graciela Chichilnisky,
Director, Center for Risk Management, Columbia University, New York, NY, USA
Professor Nazli Choucri,
Professor of Political Science and Director, Global System for Sustainable Development (GSSD), Massachusetts Institute of Technology (MIT), Cambridge, MA, USA
Professor Peter Eigen,
Chairman of the Advisory Council, Transparency International; Chairman, Extractive Industries Transparency Initiative Berlin, Germany

The presentations and discussions in Working Group 4 focused on energy security and climate protection policies in emerging markets, and also on the costs and benefits of sustainable energy policies for developing countries.

Gerhard Berz from Munich Re Foundation talked about the challenges for the insurance industry. Graciela Chichilnisky from Columbia University in the USA talked about how to move the policy framework forward. Nazli Choucri from MIT talked about issues to do with adaptation, governments and knowledge systems, and Peter Eigen from Transparency International focused primarily on the negative correlation between resource richness and democratic development – the resource curse.

In many respects, our group looked at some very similar issues to group 2. And in many sections our conclusions are, as we would hope, quite consistent. The risks associated with a changing and more variable climate – even with

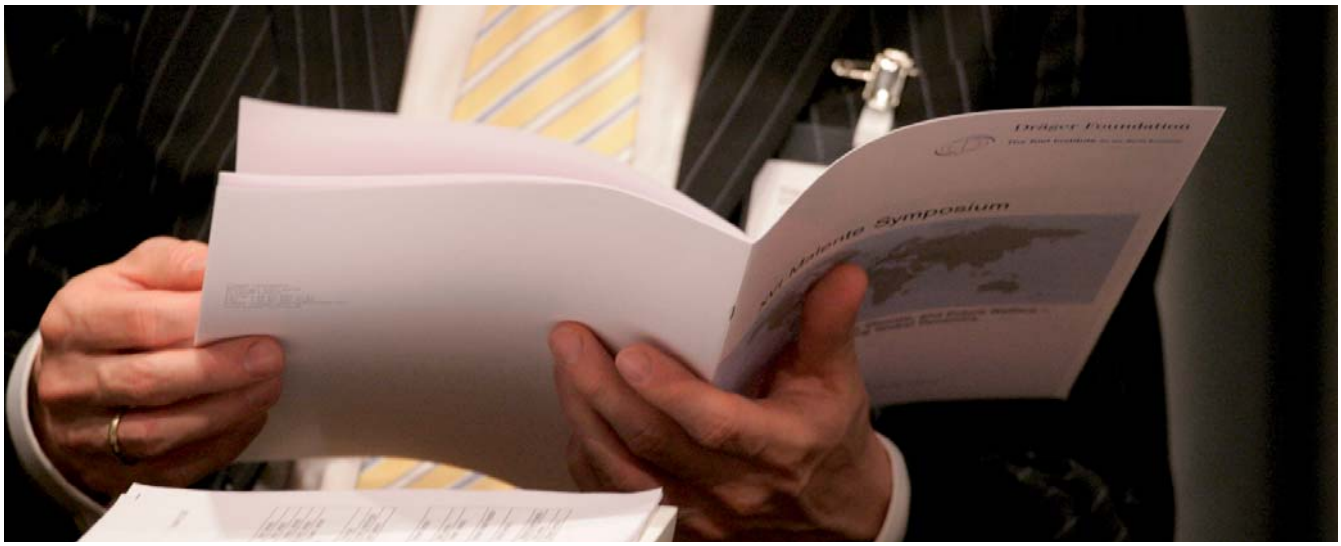
abrupt changes in climate – are increasing (e.g. storms, floods, droughts), resulting in both economic losses and loss of human life, with 1.5 million deaths recorded over the last 25 years. Climate change is an additional risk in developing countries which are already stressed, as it adversely impacts on water resources, agriculture, human health, coastal zones and ecological systems.

Developing countries and poor people are most vulnerable. It is clear that developing countries are already severely burdened by limited financial capabilities, limited technological capabilities, limited institutional capabilities, and in some cases a lack of access to knowledge. Climate change, therefore, can only be viewed as an additional stress factor. Climate change is going

to put a strain on the agricultural sector, the water sector, human health, coastal zone management and ecosystems that provide essential services for sustainable development. Climate-related risks are not insured in most developing countries, though new opportunities are potentially available for poor people in these countries. Adaptation involves integrating climate considerations into sector and national economic planning. Governance and fighting corruption are critical issues – all relevant stakeholders must be involved, from governments to the private sector and civil society.

A level playing field is needed by the private sector to fight corrupt practices in the energy sector, and civil society can play a vital role in this. In addition, accountability is needed for all stakeholders, including the NGOs. And finally, knowledge is critical – both the dissemination of current information and the generation of new knowledge, i.e. e-networking.

Energy is needed for poverty alleviation and economic growth, while reform of the energy sector is needed to attract private sector investments. Only 25 percent of people living in sub-Saharan Africa have access to modern energy today. Several million women and children die every year as a result of indoor air pollution caused by inefficient biomass in the home. The International Energy Agency has estimated that 165 billion dollars per year are needed for electricity in developing countries alone, a figure which increases by about three percent a year. Today, because of poor energy sector policies, only about 80 billion dollars per year are attracted. The challenges, therefore, are to give people access to energy and to provide



energy for development. We have to enforce energy sector reform to attract the private sector investment that is needed for electricity production and

other forms of modern energy, which also means a transition to a low carbon economy. This brings together both the developed and the developing countries that have full ownership of the new policy framework.

There is an urgent need to find a way to address human-induced climate change involving full ownership of both industrialized and developing countries. The Clean Development Mechanism of the Kyoto Protocol is a financing vehicle that can transfer billions of dollars annually to developing countries and stimulate the development of low-carbon technologies – but the Kyoto Protocol expires in 2012. Consequently, a regulatory framework offering long-term stability and equity (with differentiated responsibilities) and involving all major emitters (including the USA, China and India) is needed to address climate change, which in turn would stimulate the development of appropriate domestic policies and investments in climate-friendly technologies by the private sector. New financing instruments are needed to complement the current grant mechanisms (e.g. the GEF) and carbon financing mechanisms – new business models are essential.

While a long-term framework is being negotiated there is a need to:
- encourage bilateral and regional initiatives – the EU can send a vital signal by extending the time-frame of its carbon trading system;
- improve energy efficiency and renewable energy technologies;
- ensure continuity of the carbon market beyond 2012;
- increase investment in public and private sector energy R&D (e.g. carbon capture and storage), which has dropped precipitately in the last 10 or 15 years throughout Europe.

One issue that is attracting significant – and controversial – attention is bio-energy, which could decrease greenhouse gas concentrations if coupled with carbon capture and storage. However, there are environmental, economic and rural development issues to be taken into consideration. While some participants believe that biofuel – in particular the second generation of biofuels – is the solution, and that this can also benefit rural development as well as enhance energy security, others believe that environmental and economic issues undermine its potential. If the price of food is linked to the price of energy in the future, this will have serious adverse effects on poverty.


Szoboszlai

Tuesday, October 10, 2006 – Closing Speeches

Professor Bo Qiang Lin
Director, Center of China Energy Economy, University of Xiamen, PR China

Professor
Bo Qiang Lin

How to Reach Global Accords on Energy, Climate and Development Policies: A Perspective from China

I. Some Basic Facts about China's Energy Sector

(i) Production and Consumption: China is the world's second largest energy producer and consumer and the largest coal producer and consumer (about 32 percent of the world total); China is the second largest electricity producer and consumer, the second largest oil consumer and the third largest oil importer.

(ii) Energy Dynamics: In 2000, China consumed 1.3 billion tons of coal; in 2006 coal consumption is expected to be 2.4 billion tons. In the same period, installed electricity capacity increased from 320 GW to 580 GW. Over the last two years, China added more than 60 GW per year and this will continue for at least the next two years. In 2004 alone, oil consumption increased by almost 16 percent. Total energy consumption increased by 15.3 percent in 2003, 16 percent in 2004 and almost 10 percent in 2005.

(iii) Future Perspectives: Because of its large population, China's per capita energy use is still below the world average: in 2004 China's per capita consumption was 7 percent of the average global per capita consumption of oil, 6 percent of natural gas, and 94 percent of coal; in total it is less than half of the world average, and one tenth of that of the United States. With GDP growing at more than 10 percent in recent years, the expectation for China's future energy demand is high. In 2004, for example, China produced five million cars, with an expected capacity of 14 million by the end of 2007.

(iv) Energy Mix: In 2004, coal accounted for 67.7 percent of the country's total energy consumption, oil 27.7 percent. 75 percent of electricity capacity was coal-fired. SO2 and CO2 emissions are the largest and second largest in the world, respectively.

II. Why China Needs So Much Energy

(1) Growth patterns and industrial structure: recent major investments in heavy industry have been fueled by large-scale infrastructural development for economic growth and urbanization. Annual GDP growth has been 9.6 percent on average for almost three decades, while investment as a percentage of GDP has typically been more than 40 percent and is close to 50 percent now. Heavy industry is considered to be the most important industry in the economy. In 1985, the share of heavy industry accounted for 55 percent of total industry. By 2004 this share had increased to 68 percent. In 2003, investments in the automobile, aluminum, steel and cement industries increased by 78 percent, 88 percent, 96 percent and 113 percent respectively. In 2004, China produced 27 percent of the world's total steel output, 30 percent of coal, and 50 percent of cement. The production of electricity, steel and cement accounted for 70 percent of coal consumption.

(2) Urbanization: Why does China need so many energy-intensive industries? By 2020, China's per-capita GDP is expected to reach US$3,000, which will make China a middle-income country. One key characteristic of a middle-income country is urbanization. Judging by the urbanization process of other middle-income countries, about 300 million people from China's rural regions will move to the cities. It is estimated that the per capita energy consumption of Chinese urban residents is about three times higher than that of the rural population.

Investment in urban infrastructure and housing will be needed to facilitate the urbanization process. This requires steel and cement that can only be produced domestically, because of the large quantities needed. These industries are highly energy-intensive. In other words, for as long as China is firmly resolved to develop into a middle-income country as fast as possible, the continued growth of energy-intensive industries seems to be inevitable.

(3) Slow market reforms: reforms of energy prices, including oil, electricity and coal, have not been completed, and may not be in place in the near future. The energy industries in China are mainly state-owned monopolies, and the energy issues are often socialized and politicized, leading to slow market reforms. For example, the power market reforms started in 2002 have made very little progress so far. Most energy investments still require government approval, and the government sets power tariffs, prices of oil products, and – to a certain degree – also coal prices. With a high concentration of state-owned enterprises (SOEs) and actively controlled energy prices, the state essentially still monopolizes the energy industry.

Why are energy market reforms in China so slow compared to the reforms of other sectors? Energy, a producer good as well as a consumer good, affects both growth and social stability. If you want me to sum up what I consider to be the most valuable lesson learnt from China's close to 9.5 percent average growth over more than two decades, I would argue that it has been social and political stability that provided a relatively stable and predicable business environment. China has been able to attain high economic growth by ensuring social and political stability, and in turn has achieved social and political stability as a result of its fast economic growth. For the Chinese government, social stability is the number one priority. Everything else – including efficiency – comes secondary.

III. Energy Situation

A. Energy Supply and Demand

(1) Energy consumption in China increased by 50 percent between 2002 and 2005. If business continues to develop as in the past, China may be consuming 3.5 billion tons of coal by 2015, and oil dependency could reach 65 percent. Given its limited energy resources, it is argued that China could import energy, like many other countries that do not have sufficient energy resources of their own. Although China was able in 2005 to meet about 93 percent of its energy consumption needs from its own resources, the remaining 7 percent could still have a significant impact on the world energy market given the size of its demand.

(2) The recent surge in energy consumption has lifted China's energy demand to a higher level. Even a low growth rate of energy consumption could result in a large absolute increase. China's high dependency on imported oil has been considered a matter of national security that has led to many Chinese state-owned energy companies actively engaging in cross-border mergers and acquisitions of energy assets.

B. Prices

(1) Not reflecting energy scarcity or environmental impact, energy prices in China are kept artificially below market prices, apparently in the interests of both social stability and economic growth.

(2) The low energy prices lead to inefficient use of energy. The energy intensities of Chinese industries are usually substantially higher than in developed countries. A survey of eight highly energy-intensive industries indicates that Chinese firms consume 47 percent more energy. Low energy prices encourage Chinese firms to invest in cheaper equipment and technologies with lower energy efficiency.

(3) China's economic investment-driven growth has often led to overcapacities in many industries. Low energy prices could have been one of the main factors that contributed to this. Given the country's resource constraints, the previous and present policy of keeping energy prices low – that has led to 'excessive' energy consumption – will in future lead to higher energy prices. The recent surge in energy consumption has already been accompanied by a significant increase in energy prices in China, though the increases were not sufficient to reduce demand. The domestic coal price has increased by 29 percent – the sharpest rise in China's history. Electricity prices and prices of oil products have also increased substantially, though they still remain firmly under the government's control. In the same period, coal prices in the international market increased by 79 percent and international oil prices have been more than doubled.

IV. Environmental Condition

(1) Some rough assessments of the actual state of pollution in China are shocking. According to China's Environmental Protection Agency, environmental damage led to economic losses of 64 billion dollars or 3 percent of GDP in 2004. More than 400,000 people died because of air pollution and more than 300 million people live without clean drinking water. Some other indicators could also be used to illustrate the acute nature of the environmental problem in China: 90 percent of rivers near cities have been seriously polluted and one third of China's territory is affected by acid rain. SO_2 and CO_2 emissions are the largest and second largest respectively in the world, while coal utilization accounted for 90 percent of SO_2 and 85 percent of CO_2 emissions in 2004. 60 percent of the cities in China didn't meet the secondary air quality standard, and six of the 10 most polluted cities in the world are located in China.

(2) China is exposing future generations to an immense burden in terms of clean-up costs. It was estimated that China needs 36 billion dollars to mitigate all environmental damage caused in 2004, or close to 2 percent of GDP.

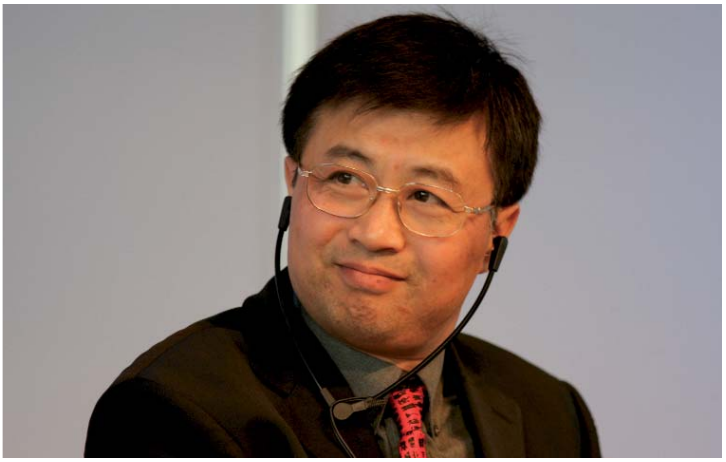
(3) Another aspect giving rise to environmental concern is the way China is rushing to meet its high energy demand. From June 2002 to June 2006, China experienced a severe power shortage. People were impressed by China's ability to address the power shortage with an unprecedented rate of increasing power capacity. In my view, however, this could prove problematic. It was obvious that China had not expected the demand surge. Because of the urgency to meet the demand, the environmental aspects of power plants may not have been properly assessed.

V. What China Needs to Do

(1) Energy Intensity Target in the 11th Five-Year Plan:

a. Energy intensity in 2010 is targeted to be 20 percent lower than that of 2005. In fact, this is one of the few targets with specific numbers in the plan which demonstrates the willingness of the Chinese Government to address energy and environmental issues. But even

"As long as China is firmly resolved to develop into a middle-income country as fast as possible, the continued growth of energy-intensive industries seems to be inevitable".



though people in China recognize that current rates of energy consumption and pollution in China are unsustainable, and improvements in energy intensity are a high priority, adjusting current patterns of economic growth may require slower GDP growth and a slower urbanization process.
b. Even if China is willing to do this, it is difficult to adjust industrial structures within five years. The government is also actively promoting energy conservation activities. However, with low energy prices and a lack of energy market facilities at this stage, scant results are produced by any of the energy conservation activities. The energy intensity target in the 11th Five-Year Plan will therefore be difficult to meet as all measures to reduce energy intensity take time to implement. In fact, instead of decreasing, China's energy intensity actually increased during the first eight months of this year.

(2) Energy Market Reforms:
a. China is now facing a very difficult choice between a more efficient energy sector and higher energy prices.
b. Without addressing energy market and pricing issues, the targets of neither energy conservation nor improved energy efficiency will be achieved.

(3) Energy Conservation and Energy Mix:
a. Given a certain industrial structure, energy intensity can be addressed through energy conservation, both on the supply and the demand side. The prospect of urbanizing 300 million people is a huge challenge, but also an important opportunity. If those people could be provided with more efficient housing and transport than current standards, this would produce large savings in energy consumption. The government can play an important role by enforcing building design and energy efficiency standards based on international best practices. Planning cities and other urban areas for more efficient public transport is a further area of opportunity.
b. Given a certain level of energy consumption, environmental pollution can be addressed by achieving a cleaner energy mix. However, China's energy sector will continue to be characterized by a high level of coal consumption, high demand for coal production and transportation, and an extensive coal infrastructure.
A significant shift away from coal in the medium term is unlikely due to the limited oil and gas reserves and potential for further development of its hydropower resources. However, China is nowhere near reaching the end of its clean energy options, including nuclear power and other renewables.

(4) Building Consensus:
a. China needs to establish an effective mechanism for energy conservation and environmental protection.
b. China needs to avoid the development strategy of 'economic growth first and environmental protection later', which is still popular at local levels.

VI. Ways in Which Other Countries Can Help

(1) Good Understanding of China's Energy Demand:
The demand for energy in China will continue to increase. With annual growth rates projected at nine percent, a large population and a low level of per capita energy consumption, an emerging high rate of motorization in the transport sector, and a rapid urbanization process to accommodate about 20 million rural emigrants a year, energy demand is expected to be strong and will continue to rise until 2020. The central government in China now is very defensive about the impact of its energy demand, particularly in the international market. The worry is that people at local levels might take this as a signal that energy is not a problem for China. Positive dialogue and cooperation can help to put this in the right perspective. On the other hand, negative propaganda and a less cooperative attitude will strengthen China's defensiveness and worsen the prospects for addressing world energy and environmental issues. Similarly, it would be a mistake to think that the Chinese government does not take energy and the environment seriously.

The difficulty is that it has to make choices without a clear understanding of possible outcomes. For example, large coal-fired power plants will pollute the environment. But what other choices does China have if it is to maintain low energy prices while fueling nine percent economic growth and preserving social stability? Would higher energy prices affect social stability? It is also not unrealistic to assume that people with a per capita income of $1,300 will value the environment less than people with a per capita income of more than $35,000 in the developed countries.

(2) Promoting Energy Efficiency and Clean Technology: If China were given enough time, it may be able to resolve these problems in its growth process. However, will it be too late? Can we imagine the impact when China burns five billion tons of coal a year? We cannot tell China not to burn coal for its economic development, but we can persuade China to burn less and in a more efficient and cleaner way. Since coal is presently the dominant energy in China and will remain so for a long time, it is important to encourage the use of clean coal technology by providing assistance and technology. Even if there are no serious technical difficulties in utilizing coal in a clean way, it requires the political will to promote and enforce it. In searching for clean energy, some financial incentives could be provided. But there are other things that could be done in this area. For example, the government could be encouraged to more strictly enforce energy efficiency and technical standards for industries, buildings standards and pollution emission standards. A considerable strengthening of the monitoring and enforcement mechanism will also be necessary.

(3) Engaging China in Energy Policy Dialogue and Providing Assistance in Addressing Reform Issues: More assistance is needed when demonstrating successful international experience to convince China that a strong and fast energy market reform does not necessarily lead to social instability. Through energy market reforms, the government can focus more on the macro aspects of energy production and consumption, such as system planning and resource allocation, and let the market play a more important role in micro energy investment decisions.

(4) Helping China to meet the energy and environmental challenge means helping the planet and ourselves, as we are ultimately all in this altogether.

Tuesday, October 10, 2006 – Closing Speeches

George Marshall
Executive Director, the Climate Outreach and Information Network (COIN), Oxford, UK

George Marshall

The Psychology of Denial or Why Do We Find It So Hard to Act Against Climate Change?

George Marshall started his presentation with two slides showing front pages from different magazines, one announcing an article on 'The Melting Mountains' that revealed how climate change is destroying 'the world's most spectacular landscapes', and the other advertising the world's 50 best ski resorts.

Is this not extraordinary?, he asked, describing this as a small-scale reflection of a far wider, more profound and sustained disconnection at all levels of society between the seriousness of the threat of climate change and the action that we take in response: Tony Blair, the UK Prime Minister, tells us that climate change is 'a challenge so far-reaching in its impact and irreversible in its destructive power, that it alters radically human existence'. His chief scientific advisor, Sir David King, says this is the most severe problem we face, far more serious than terrorism. And yet, nothing in the government's response reflects this rhetoric. Its work on climate change is incoherent, underfunded, and constantly undermined by the support that it continues to give to the polluting industries.

In repeated polls, over 90 percent of the population identify climate change as a serious problem. Yet there is no evidence of any change in people's personal behavior or in their voting preferences. People buy ever larger cars and homes, fly ever further for holidays, and vote for the parties that promise to do the most to support their expansive lifestyles.

People receive conflicting messages all the time. Even car advertisers working, for example, for the Mini or Jeep incorporate the same kind of disconnected messages into their work. What is interesting in these cases is that the advertiser is not ignoring climate change but is absorbing it into the sales pitch as if to say 'yes, I know all about that, and I DON'T CARE!'

People who we think might care are NGOs which, historically, have played a hugely important role in social change movements. Earlier this year I was writing a chapter on the role of climate change in the work of major NGOs, expecting that it would have a huge influence, since the IPCC, for example, estimates that there will be as many as 150 million environmental refugees by 2050, and Human Rights Watch has 21,400 references to refugees. And yet climate change scarcely figures in their work. I was comparing the number of times the word 'climate change' appeared on their websites with the number of mentions of the randomly-chosen word 'ice cream' – here are the results:

Numbers of mentions of 'climate change' on websites of major NGOs

	'Climate Change'	'Ice Cream'
Amnesty International	0	1
Human Rights Watch	16	25
World Vision US	4	12
Survival International	0	1
Refugees International	4	27
YWCA	0	1
CARE US	1	1

Source: website search 8/6/06.
'Asleep on their watch: where were the NGOs?' from 'Surviving Climate Change: The Struggle to Avert Global Catastrophe', Pluto Press, 2007.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I think we can draw several conclusions from this:

- Our response to climate change is out of proportion to the threat and urgency of the problem.
- This lack of response cannot be satisfactorily explained as a deficit of information. We can observe a profound psychological disconnection between what people know about climate change and what people do about climate change.
- The lack of response can also not be explained as a temporary failure in the political and economic system. Yes, there is a lack of political will and short time spans, but politicians are able to respond rapidly to other issues. Rainer Laufs said yesterday that 'politicians have split brains – we need to push them'... and I would argue that this is widespread.
- Also, the lack of response is not related to an individual's capacity to effect change. Other people argue that people's apathy is a result of the powerlessness they feel to effect change. This is no doubt true, but there are people and organizations that do have that power. And the people I know who are most actively engaged with this issue and determined to push for change actually have very little personal power.

Resolve it, deny it, or displace it Psychologists have a name for this disconnection – cognitive dissonance. Dissonance is destabilizing because it challenges our view of our core principle and sense of self. We can achieve stability in three ways: we can resolve it, deny it, or displace it.

Everything I've spoken of so far: the refusal to recognize the issue, the compulsive over-consumption; the open and active indulgence in activities we know to be destructive, the 'bring it on' posturing - all these behavior patterns would, in a psychotherapy context, be seen as symptoms of denial.

One of the reasons climate change lends itself to denial is the enormity of its moral dimension. We can intellectually accept the evidence of climate change, but we find it extremely hard to accept our responsibility for a crime of such enormity.

There are marked similarities with individual and collective responses to state-sanctioned human rights abuses when people are faced with huge challenges to their self identity as moral beings.

In such situations people attain a remarkable state of both knowing and not knowing:

Denial in the Face of Human Rights Abuses
- Morally neutral euphemisms
- Suppression
- Denial of knowledge ('I didn't know'),
- Denial of agency ('I didn't do it')
- Denial of personal power ('I couldn't do anything', 'no one else did anything')
- Bystander effect

Indeed, the most powerful evidence of our denial is the failure to even recognize that there is a moral dimension with identifiable perpetrators and victims. The language of 'climate change', 'global warming', 'human impacts', 'adaptation' is scientific euphemism that suggests that climate change originates in immutable natural forces rather than in a direct causal relationship with moral implications for the perpetrator.

Suppression – in South Africa, many white bystanders who intellectually opposed apartheid retreated into private life, cut themselves off from the news media, refused to talk politics with friends, and adopted an intense immersion in private diversions such as sport, holidays and families. In Brazil in the 1970s a special term was coined for the disavowal of the political: 'innerism'.

What appears to happen above all is that people redefine their 'social norms of attention'. In his book 'States of Denial, Knowing About Atrocities and Suffering' Stanley Cohen of the London School of Economics wrote in 2001 "Without being told what to think about (or what not to think about), and without being punished for 'knowing' the wrong things, societies arrive at unwritten agreements about what can be publicly remembered and acknowledged".
Kari Marie Norgaard of the University of California spent a year with a small community in Norway, conducting interviews to study their responses to climate change. She concluded: "Denial of global warming was socially organized... It took place in response to social circumstances and was carried out through a process of social interaction". The people in this community were strongly aware of climate change but never openly discussed it. In interviews it appeared that they had developed collective narratives to avoid dealing with the issues – little Norway, we are the clean country.

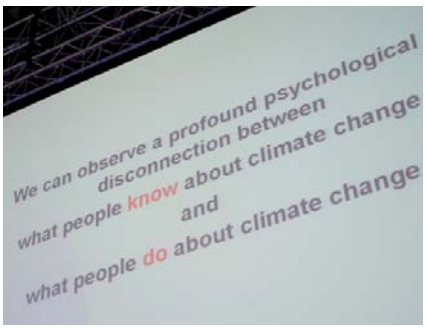
Another very interesting study by academics at the Potsdam Institute and UEA in the UK sought to study climate change in Switzerland and found denial strategies specific to climate change.

But I believe there is more to it than this because climate change is not just a moral challenge – it is a very real and direct threat. Our perception of any specific risk is affected by our world view, by gender, by trust in the source of information, by the question as to whether the risk is imposed, by catastrophic potential, and by the wider attitude to that risk.

Denial Strategies Specific to Climate Change

Metaphor of displaced commitment	*I protect the environment in other ways*
Condemn the accuser	*You have no right to challenge me*
Denial of responsibility	*I am not the main cause of this problem*
Rejection of blame	*I have done nothing wrong*
Ignorance	*I didn't know*
Powerlessness	*I can't make any difference*
Fabricated constraints	*There are too many impediments*
After the flood	*Society is corrupt*
Comfort	*It is too difficult for me to change my behavior*

Source: S. Stoll-Kleemann, Tim O'Riordan, Carlo C. Jaeger, The psychology of denial concerning climate mitigation measures: evidence from Swiss focus groups, Global Environmental Change, 11 (2001) 107-117



Our response is strongest to threats that are visible, with historical precedent, immediate, with simple causality, caused by another 'tribe', and have direct personal impacts. Climate change, on the

other hand, has none of these qualities. It is invisible, unprecedented, drawn out, with complex causality, caused by all of us, and has unpredictable and indirect personal impacts. It is, in many ways, perfectly designed to silence our alarm bells. We know that risk assessment is highly subjective – there is

extensive literature on the psychology of risk. John Adams, one of the leading UK academics in this field, argues that humans are all provided with 'risk thermostats' with a wide range of different settings which trigger a response when people encounter an unacceptable level of risk. I believe that climate change fundamentally fails to trigger our risk thermostat – intellectually we accept the risk but somehow we do not feel it.

And What Happens If We Do Not Respond?

Maybe we will wake up. If so, it will probably happen because one of our risk triggers will be set in motion – when climate change becomes immediate and violent and visible. However, this is unlikely to be an easy process.

If we do not wake up, we risk going into even greater denial. We could create climate 'enemies', but we are also very capable of displacing into an entirely unrelated issue. One denial strategy is to create scapegoats. Public fear and scapegoats can create a dangerous

mix. If we now add conflicts over water and land to this scenario, plus millions of people on the move, we will find ourselves in a very ugly situation.

How Do We Move Forward?

- We must recognize that information alone cannot produce change.
- We must openly recognize the tendency to denial; Professor Cohen argues very clearly that denial is the normal state of affairs. He argues that "far from being pushed into accepting reality, people have to be dragged out of reality".
- We must encourage emotional responses and 'whistle blowers'.
- We must develop a culture of engagement that is visible, immediate, and urgent – in other words we must bestow on our actions the qualities that engage us best.
- As individuals we must act with integrity and clarity, i.e. we must recognize our own impacts and struggle to live a low carbon life, we should not be embarrassed to challenge others, we need to recognize that there is a larger truth and historical calling that is greater than our own short-term interests, we must be prepared to take personal risks – for example in our careers, incomes or status – in order to effect the greatest change on this issue.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Gernot Klepper
Litma
Levern
Lack
Klepp
Höpp

List of Participants A – C

A

Adebahr, Cornelius
Wirtschaft am Wasserturm
Political Consultant
Berlin, Germany

Adeniran, Prof. Tunde
Embassy of Nigeria
Ambassador
Berlin, Germany

Ahlmann, Hans-Julius
ACO Severin Ahlmann & Co. KG
Managing Director
Büdelsdorf, Germany

Ahlmann, Iwer
Büdelsdorf, Germany

Ahlmann, Johanna
ACO Severin Ahlmann & Co. KG
Büdelsdorf, Germany

Ahlmann, Johannes
Karlsruhe, Germany

Altrock, Dr. Martin
energiewerk Foundation
Deputy Chairman of the Board
Munich, Germany

Arnold, Wolf
Bundesverband mittelständische Wirtschaft
Managing Director of the Federal State of Mecklenburg-Western Pomerania
Schwerin, Germany

Artale, Dr. Vincenzo
Climate Modelling Laboratory, ENEA
Head
Rome, Italy

B

Bagdasarjan, Juliane
Student
Lübeck, Germany

Bartels, Dr. Ralf
Mining and Energy Policy, Mining, Chemical and Energy Industrial Union (IG BCE)
Head of Department
Hanover, Germany

Bassey, S.B.
Embassy of Nigeria
Attaché
Berlin, Germany

Bednorz, Dr. Michael
Landesamt für Kultur und Denkmalpflege Mecklenburg-Western Pomerania
Director
Schwerin, Germany

Belov, Dr. Vladislav
Europe Institute of the Russian Academy of Science
Director, Research Center Germany
Moscow, Russian Federation

Berz, Prof. Dr. Gerhard
University of Munich;
Munich Re Foundation
Professor for Meteorology;
Member of the Council
Munich, Germany

Besserer, Dirk
Moskauer Deutsche Zeitung
Advisor to the Board
Moscow, Russian Federation

Biel, Dr. Jörn
Chamber of Commerce and Industry Kiel
Managing Director
Kiel, Germany

Bilger, Dr. Hartmut
EnBW AG
Former Member of the Board
Ettlingen, Germany

Bitzer, Prof. Dr. Klaus
University of Bayreuth;
ASPO Germany
Professor for Geology;
Member of the Board
Bayreuth, Germany

Block, Prof. Dr. Hans-Jürgen
Innovationsstiftung Schleswig-Holstein
Member of the Board
Kiel, Germany

Blumenthal, Dr. Julia von
Helmut Schmidt University
Assistant Professor
Hamburg, Germany

Böttcher, Dr. Welf
Corporate Communications, Drägerwerk AG
Head of Department
Lübeck, Germany

Bothe, David
Institute of Energy Economics
Scientific Assistant
Cologne, Germany

Boyken, Dr. Friedhelm
Political Planning, Chancellery of the State of Schleswig-Holstein
Head of Department
Kiel, Germany

Brockmeier, Dr. Udo
EnBW Kraftwerke AG
Chairman of the Board
Stuttgart, Germany

Buchta, Ullrich
Climate Protection, Ministry of the Environment of the State of Mecklenburg-Western Pomerania
Head of Division
Schwerin, Germany

Burdzy, Zbigniew
General Consulate of the Republic of Poland
Vice Consul
Hamburg, Germany

C

Chaerony, Ade Rina
Embassy of the Republic of Indonesia
Attaché
Berlin, Germany

Chichilnisky, Prof. Dr. Graciela
Center for Risk Management, Columbia University
Director
New York, NY, USA

Choucri, Prof. Nazli
Global System for Sustainable Development (GSSD), Massachusetts Institute of Technology (MIT)
Director
Cambridge, MA, USA

List of Participants C – L

Christ, Angelika
Verband der Wellpappen-Industrie e.V.
Managing Director
Darmstadt, Germany

Czisch, Dr. Gregor
Institute for Electrical Energy Technology/ Rational Energy Conversion, University of Kassel
Researcher
Kassel, Germany

D

Deeva, Olga
Student
Lübeck, Germany

Deutch, Prof. John
Department of Chemistry, Massachusetts Institute of Technology (MIT) Institute
Professor
Cambridge, MA, USA

Dörffel, Michael
Immission Control, Chemistry, Recycling Management, Ministry of Agriculture and Environment of the State of Saxony-Anhalt
Head of Department
Magdeburg, Germany

Dolzer, Prof. Dr. Rudolf
Institute for International Law, University of Bonn
Director Bonn, Germany

Domonski, Dennis
GreenStream Network GmbH
Assistent to the Board
Hamburg, Germany

Dräger, Dr. Christian
Dräger Foundation
Member of the Board
Lübeck, Germany

Dräger, Hartwig
Dräger GmbH
Managing Director
Hamburg, Germany

Dräger, Lisa
Lübeck, Germany

Dräger, Stefan
Drägerwerk AG
CEO
Lübeck, Germany

Dräger, Theo
Drägerwerk AG
Member of the Supervisory Board
Lübeck, Germany

Dreesmann, Dr. Gerwin
Strategic Planning, Conergy AG
Director of Department
Hamburg, Germany

Duan, Dr. Hongxia
International Human Dimensions Programme on Global Environmental Change (IHDP)
Senior Programme Manager
Bonn, Germany

Duscha, Vicki
The Kiel Institute for the World Economy
Researcher
Kiel, Germany

E

Egan, Peter Zachary
Columbia Wanger Asset Management
Fund Manager
Chicago, IL, USA

Eichhammer, Dr. Wolfgang
Energy Techniques and Energy Policies, Fraunhofer Institute for Systems and Innovation Research
Deputy Head of Department
Karlsruhe, Germany

Eigen, Prof. Dr. Peter
Transparency International; Extractive Industries Transparency Initiative Chairman of the Advisory Council; Chairman
Berlin, Germany

Eisenbeiß, Dr. Ralf
Regionalpartnerschaft Lübecker Bucht e.V.
Regional Manager
Lübeck, Germany

Eisenblätter, Dr. Bernd
Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH
Managing Director
Eschborn, Germany

Etzel, Paul Erich
Naturkost Oekol Agrarwirtschaft
Managing Director
Wehrheim, Germany

Euler, Dr.-Ing. Hartmut
Ministry for Agriculture, Environment and Rural Regions
Director-General
Kiel, Germany

F

Feddersen, Prof. Dr. Dieter
Dräger Foundation
Member of the Board
Lübeck, Germany

Fischer, Prof. Dr. Jürgen
Institute for Space Sciences, Free University of Berlin
Professor
Berlin, Germany

Fluthwedel, Dr. Andrea
German Institute for Standardization (DIN e.V.)
Managing Director
Berlin, Germany

Franke, Dr. Uwe
Deutsche BP AG CEO
Berlin, Germany

G

Gadó, Dr. János
KFKI Atomic Energy Research Institute
Director
Budapest, Hungary

Geißler, Thorsten
Hansestadt Lübeck
Senator
Lübeck, Germany

Golub, Dr. Alexander
Environmental Defense
Senior Economist
Washington, D.C., USA

Graßl, Prof. em. Dr. Hartmut
Max Planck Institute for Meteorology;
Meteorological Institute,
University of Hamburg
Member of the Max Planck Institute
Hamburg, Germany

H

Hakala, Rainer
Deutsche Gesellschaft für Technische
Zusammenarbeit (GTZ) GmbH
Eschborn, Germany

Halenka, Tomas
Meteorology and Environment
Protection, Charles University Prague
Deputy Chair of Department
Prague, Czech Republic

Hamelmann, Dr. Roland
Kompetenzzentrum Wasserstoff- und
Brennstoffzellentechnologie (KWB),
University of Applied Sciences Lübeck
Head of KWB
Lübeck, Germany

Hartmann, Dr. Uwe
International Solar Energy Society,
GermanSection
General Manager
Berlin, Germany

Heid, Benedikt
The Kiel Institute for the World Economy
Researcher
Kiel, Germany

Hein, Dr. Joachim
Federation of German
Industries (BDI e.V.)
Official Responsible
Berlin, Germany

Hersetiati, Wahyu
Embassy of the Republic of Indonesia
Counsellor
Berlin, Germany

Höppe, Prof. Dr. Peter
Geo Risks Research, Munich Re Group
Head of Department
Munich, Germany

Holz, Felix
Central Research and Evaluation,
Conergy AG
Head of Department
Hamburg, Germany

Huther, Dr. Heiko
Research and Development,
AGFW e.V.
Deputy Head of Department
Frankfurt/Main, Germany

J

Jahn, Dr. Karin
bremer energie institut
Researcher
Bremen, Germany

Jantzen, Prof. Dr. Jan-Peter
Klinik für Anaesthesiologie und
Intensivmedizin
Chief Medical Officer
Hanover, Germany

Jungfer, Prof. Dr. Eckhardt
Climate/Energy, Ministry for Rural
Development, Environment and
Consumer Protection of the State of
Brandenburg
Head of Department
Potsdam, Germany

K

Katte, Dr. Christoph von
Lawyer
Kamern, Germany

Kemfert, Prof. Dr. Claudia
Energy, Transport and Environment,
German Institute for Economic
Research (DIW e.V.)
Director of Department
Berlin, Germany

Kirk, Dr. Annette
Corporate Communications,
Max Planck Institute for Meteorology
Official Responsible
Hamburg, Germany

Klepper, Prof. Dr. Gernot
The Kiel Institute for the World Economy
Director
Kiel, Germany

Klossok, Karl
ThyssenKrupp AG
Executive Secretary
Düsseldorf, Germany

Knoche, Dr. Guido
The Federal Environment Agency
Scientific Assistant
Dessau, Germany

König, Dr. Hannes Jochen
University of Göttingen
Nusse, Germany

Krómer, Prof. István
VEIKI zrt.
Director General
Budapest, Hungary

Kromp-Kolb, Prof. Dr. Helga
Institute of Meteorology,
University of Natural Resources and
Applied Life Sciences
Professor
Vienna, Austria

Kusmierczak, Stephen
Columbia Wanger Asset Management
Portfolio Manager International Equities
Chicago, IL, USA

L

Lackner, Prof. Dr. Klaus
S. Earth and Environment Engineering
Center, Columbia University
Director
New York, NY, USA

Lamp, Helmut
Bundesverband Bioenergie e.V. (BBE)
Chairman of the Board
Bonn, Germany

Lapin, Prof. Dr. Milan
Meteorology and Climatology,
Comenius University
Head of Division
Bratislava, Slovakia

Laufs, Rainer
LANXESS AG
Member of the Supervisory Board
Kronberg, Germany

List of Participants L – S

Lehmann, Dirk
Dräger Medical AG & Co. KG
Skill Management
Lübeck, Germany

Lehmann, Prof. Dr. Eike
The Association of
German Engineers (VDI e.V.)
President
Hamburg, Germany

Leisner, Prof. Dr. Thomas
Institute for Meteorology and Climate
Research at the Research Centre
Karlsruhe
Head
Karlsruhe, Germany

Lender, Hans-Joachim
HS-Kulturkorrespondenz
Editorial Journalist
Lübeck, Germany

Levermann, Dr. Anders
Department for Climate System,
University of Potsdam; Potsdam
Institute for Climate Impact Research
Potsdam, Germany

Lieberum, Andreas
Ecolo – ecology and communication
Managing Director
Bremen, Germany

Lin, Dr. Bo Qiang Center for China
Energy Economic Research,
University of Xiamen
Director Xiamen, China

Linn, Dr. Johannes F.
The Wolfensohn Center,
The Brookings Institution
Executive Director
Washington, D.C., USA

Litman, Dr. Gary
Europe & Eurasia, U.S. Chamber
of Commerce
Vice-President
Washington, D.C., USA

Lomeling, Anna
Investitionsbank Schleswig-Holstein
Customer Consultant Municipalities
Kiel, Germany

Lopatowska-Rynkowska, Dr. Joanna
Commission of the Bishops'
Conferences of the EU (COMECE)
Legal Adviser
Brussels, Belgium

Luther, Prof. Dr. Joachim
Fraunhofer Institute for Solar Energy
Systems Former Director
Freiburg, Germany

M

Marshall, George
The Climate Outreach and Information
Network (COIN)
Executive Director
Oxford, United Kingdom

Messal, Dr. Constanze
MICOR GmbH
CEO
Groß Lüsenitz, Germany

Miller, Gunnar
RCM a company of Allianz Managing
Director
Frankfurt/Main, Germany

Mimler, Solveig
European Institute for Energy Research
Scientific Assistant
Karlsruhe, Germany

Miskinis, Prof. Dr. Vaclovas
Laboratory of Energy Systems
Research, Lithuanian Energy Institute
Chief
Kaunus, Lithuania

Möhrstedt, Udo
IBC SOLAR AG
Chairman of the Board
Bad Staffelstein, Germany
Monbart, Claudia M. von
The World Bank
Senior Councelor
Paris, France

Morris, Craig
Petite Planète Translations
Translator and Author
Freiburg, Germany

Müller-Hilgerloh, Heinz-E.
Kamue Kommunikations-Agentur
Medien Umwelt Energie KG
CEO
Hamburg, Germany

N

Nath, Christian
Division for Wind Energy,
Germanischer Lloyd
WindEnergie GmbH
Global Business Manager
Hamburg, Germany

Neuhoff, Dr. Karsten
Faculty of Economics,
University of Cambridge
Senior Research Associate
Cambridge, United Kingdom

North, Peter H.
ASPO Ireland
Cloyne, Ireland

Nowak, Werner
Energy Economy, E.ON Ruhrgas AG
Head of the Department
Essen, Germany

O

Obersteiner, Dr. Michael
International Institute for Applied
Systems Analysis (ITASA)
Research Scholar
Laxenburg, Austria

Orth, Dr. Hans Wilhelm
University of Applied Sciences Lübeck
Former Rector
Lübeck, Germany

Oxburgh, Lord Ronald
Shell Transport and Trading plc;
House of Lords
Former Chairman;
Member London, United Kingdom

P

Peters, Dr. Lutz
CHOREN Industries GmbH
Member of the Administrative Council
Hamburg, Germany

Pierce, Maj. Scott E.
American Consulate General Istanbul
Olmsted Scholar
Istanbul, Turkey

Pissulla, Petra
Dräger Foundation
Director
Lübeck, Germany

Prien, Tim
Student
Lübeck, Germany

Prinz, Prof. Detlef W.
Prinz Medien
Owner
Berlin, Germany

Priyanto, Wahyu H.
Embassy of the Republic of Indonesia
Counselor (Economic Affairs)
Berlin, Germany

R

Rasmussen, Dr. Cornelis
Bremer Energie-Konsens GmbH
Managing Director
Bremen, Germany

Read, Dr. Peter
Department of Applied and International Economics, Massey University
Senior Lecturer
Palmerston North, New Zealand

Rehder, Sönke
Energy Resources, Federal Institute for Geosciences and Natural Resources (BGR)
Member of Department
Hanover, Germany

Reim, Dr. Wolfgang
Dräger Medical AG & Co. KG
CEO
Lübeck, Germany

Rickels, Wilfried
The Kiel Institute for the World Economy
Researcher
Kiel, Lübeck

Riecke, Wolfgang
German Meteorological Service
Head of Regional
Consultant Office
Hamburg, Germany

Riedel, Dr. Erik
Energy and Environment Policy, RWE AG
Essen, Germany

Rogers, Prof. Dr. Katrina
Institute for Social Innovation, Fielding Graduate University
Director
Santa Barbara, CA, USA

Rohwer, Prof. Dr. Bernd
Chamber of Commerce and Industry Lübeck
Managing Director
Lübeck, Germany

Rolle, Dr. Carsten
German National Committee of the World Energy Council
Managing Director
Berlin, Germany

Rudek, Barbara
Policy & Govermental Affairs, Sharp European Headquarters
Manager
Hamburg, Germany

S

Sauer, Dr. Gustav W.
Ministry for Science, Economics, and Transport of the State of Schleswig-Holstein
Director General
Kiel, Germany

Sawicki, Daniela
Lübeck, Germany

Sawicki, Otto
Actor
Lübeck, Germany

Schläpfer, August
Division of Science & Engineering, Murdoch University
Lecturer/Coordinator for Sustainable Energy Management
Murdoch, Western Australia

Schmidt, Dr. Susanne M.
German Institute for Economic Research (DIW e.V.)
Managing Director
Berlin, Germany

Schwara, Dr. Matthias
STEAG AG
Head of President's Office
Essen, Germany

Schwarz, Heinz-Werner
BWE AG
Chairman of the Supervisory Board
Hamburg, Germany

Schweer, Rüdiger
Climate Protection, Ministry for Environment Protection, Rural Regions, and Consumer Protection
Head of Department
Wiesbaden, Germany

Schweikert, Frank
ALDEBARAN Marine Research & Broadcast
Biologist and Journalist
Hamburg, Germany

Snower, Prof. Dr. Dennis
The Kiel Institute for the World Economy
President
Kiel, Germany

Solms, Jürgen
German Council for Sustainable Development
Consultant
Berlin, Germany

Spahr, Kristoff
Private Banking,
Haspa – Hamburger Sparkasse
Head of Department
Hamburg, Germany

Spitzer, Prof. Dr. Hartwig
University of Hamburg
Coordinator of Working Group „Energy and Environment"
Hamburg, Germany

Stricker-Berghoff, Undine
Pro Economy
Coach
Lübeck, Germany

List of Participants S – Z

Stryi-Hipp, Gerhard
German Solar Industry Federation (BSW)
Managing Director
Berlin, Germany

Sumantran, Dr. V.
Science Advisory Committee of the
Prime Minister of India; Tata Motors Ltd.
Strategic Consultant;
former Executive Director
and Member of the Board
Mumbai, India

Szoboszlai, Beáta
MOL plc. (Hungarian Oil and Gas plc.)
Risk Management Expert
Budapest, Hungary

T

Tänzler, Dennis
Adelphi Research GmbH
Research Fellow
Berlin, Germany

Thiele, Torsten
Investec Bank
Project & Infrastructure Finance
London, United Kingdom

Traerup, Sara
UNEP Risoe Centre,
Risoe National Laboratory
Research Assistant
Roskilde, Denmark

U

Unander, Dr. Fridtjof
Enova SF
Vice President
Trondheim, Norway

V

Vaitheeswaran, Vijay V.
The Economist
Author and Global Correspondent
New York, NY, USA

Vajen, Prof. Dr. Klaus
Institut für Thermische Energietechnik,
University of Kassel
Professor
Kassel, Germany

W

Wagner, Andreas
Technology External Programs Europe,
GE Energy
Manager
Salzbergen, Germany

Waldmann, Lars
SCHOTT Solar GmbH
Public Relation Manager
Alzenau, Germany

Watson, Dr. Robert T.
The World Bank
Chief Scientist and Senior Advisor
Washington, D.C., USA

Weber, Dr. Gerd-Rainer
German Coal Mining Association
Environment and Policy
Essen, Germany

Welina, Reinhold
German Institute for
Standardization (DIN e.V.)
Member of the Board of Management
Berlin, Germany

Welling, Ingo
Drägerwerk AG
Lübeck, Germany

Wernicke, Dr. Hans-Jürgen
Süd-Chemie AG
Member of the Executive Board and COO
Munich, Germany

Werring, Luc
Directorate-General for Energy and
Transport, European Commission
Principal Advisor
Brussels, Belgium

Wilcke, Angelika
DLG-Verlag
Chief Editor
Frankfurt/Main, Germany

Winkler, Prof. Dr. Wolfgang
Fuel Call Lab, Hamburg University
of Applied Sciences
Director
Hamburg, Germany

Wittenburg, Dr. Christian
University of Hamburg
Scientist and Head of Energy-Team
Hamburg, Germany

Wojtkowska-Lodey,
Prof. Grazyna
Institute of Foreign Trade and European
Studies, Warsaw School of Economics
Professor
Warsaw, Poland

Wolf, Andreas
Ministry of Economics of the
State of Brandenburg
Chairman of the Second
Chamber of Allocation
Potsdam, Germany

Z

Zwaan, Dr. Bob van der
Energy research Centre of The
Netherlands (ECN)
Senior Scientist
Amsterdam, The Netherlands

Zweifel, Prof. Dr. Peter
Socioeconomic Institute,
University of Zurich
Professor of Economics
Zurich, Switzerland

Editorial

Responsible:
Dipl.-Volksw. Petra Pissulla

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Werbeagentur von Krottnaurer,
Lübeck

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Axel Kirchhof, Hamburg

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