Driven by curiosity

Initiated by the German Federal Ministry of Education and Research

Science Year 2010

The Future of Energy

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Federal Ministry of Education and Research

wissenschaft im dialog

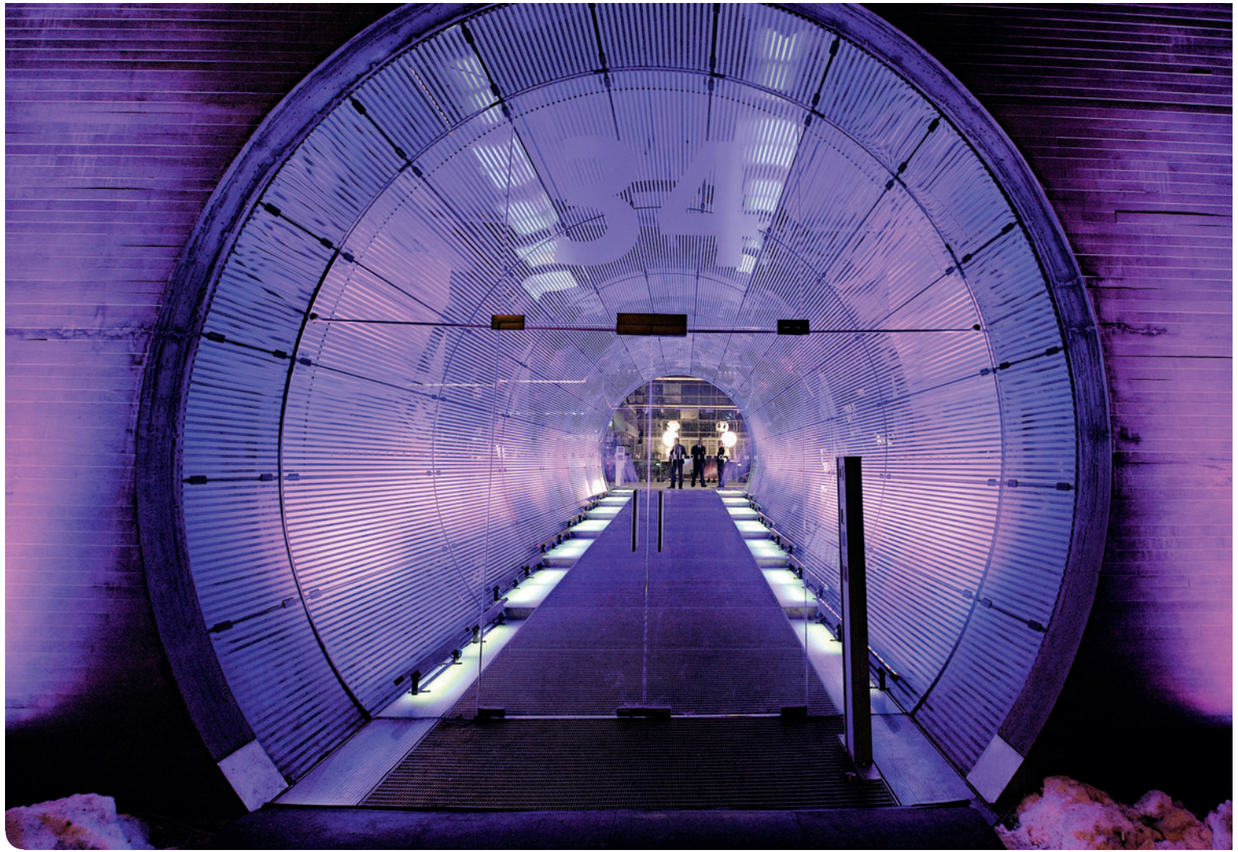
HELMHOLTZ GEMEINSCHAFT

KICK-OFF EVENT SCIENCE YEAR 2010 – THE FUTURE OF ENERGY

on 26 January 2010 at the Energieforum Berlin

Opening speech: Prof. Dr Annette Schavan,
Federal Minister of Education and Research

Keynote speech: Prof. Dr Ottmar Edenhofer,
Deputy Director of the Potsdam Institute for Climate Impact Research



INTRODUCTION

Science Year 2010 – *The Future of Energy* was launched at a kick-off event on 26 January 2010. The opening address by Prof. Dr Annette Schavan, the Federal Minister of Education and Research, and the lecture given by Prof. Dr Ottmar Edenhofer, the Deputy Director of the Potsdam Institute for Climate Impact Research, are printed in full in this brochure. They highlight the central importance of climate and energy for the future and the survival of humankind. Industrialised nations have a special responsibility to work towards restructuring their energy supply and to make a relevant contribution to reducing global warming.

Against this background, Science Year 2010 – *The Future of Energy* is designed not only to provide comprehensive information on the subject, arouse people's interest in it and create links between research and society, but especially to initiate a dialogue on the future of energy, the necessary restructuring of our energy supply and the future orientation of our research activities. In the coming decades, we will have to reorganise our energy supply dramatically, and this will not be possible without intensifying energy research. In particular, we need new solutions and technological advances in the areas of natural energy sources, increased energy efficiency and a more responsible use of natural resources. Under the slogan "Driven by curiosity", the organisers of the Science Year – the Federal Ministry of Education and Research, the *Science in Dialogue* initiative and the Helmholtz Association of National Research Centres – and other partners will hold a large number of events, discussion forums and meetings between energy experts and children and young people.

The Day of Energy on 25 September will be a highlight of the year. On this day, universities, research institutes, energy providers and companies will open their doors and give an insight into new developments and research projects. The day before, hundreds of thousands of "little researchers" will conduct energy-related experiments in nursery schools across the country. Study material and information on the subject of energy will be provided online via the *Schools Online* initiative. The floating science centre *MS Wissenschaft* and the "Discoveries" exhibition on the subject of energy on Mainau island in Lake Constance will start in May. The exhibition *Climate, Energy and Sustainability* at Senckenberg Museum in Frankfurt will conclude the Science Year in December.

WELCOME TO THE OPENING OF SCIENCE YEAR 2010!

Opening speech by Federal Minister Prof. Dr Annette Schavan

This year, as we enter the second decade of Science Years, we will focus on the future of energy.

The first ten Science Years were each dedicated to a certain topic, a subject area or, in 2004, the great scientist Albert Einstein. In the second decade, we will focus on topics that will not just dominate this decade's research agenda, but also our national and international political agenda. We will look at questions that are relevant to the development of modern societies. In his new book "Hot, Flat, and Crowded: Why We Need a Green Revolution – And How It Can Renew America", Thomas Friedman writes: "We are entering into the Energy-Climate Era".

To prove this point, he writes about two inevitable forces that influence our planet in a "fundamental way": global warming and the rapid growth of the global population. In 1953, there were 2.681 billion people living on the planet. Today, there are about 6.7 billion. In 2050, there are expected to be 9.2 billion people. The least developed regions of the world are likely to experience the highest growth rates.

Global energy consumption is set to at least double by 2050. This prognosis is based on the combination of population growth and the boost in prosperity resulting from globalisation. Many countries where people live in poverty consider this boost to be a central aim for the development of their society – and rightly so. In short: In the coming decades, an increasing number of people will consume significantly more energy as a result of improved standards of living.

The Intergovernmental Panel on Climate Change has presented its prognoses and declared that global warming needs to be limited to 2 °C to avoid worldwide flood disasters. The future of energy is closely linked to the future of humankind and its survival. For this reason, industrialised nations have a special responsibility to work towards restructuring their energy supply. Those who use the most energy are expected to make the greatest efforts and the most relevant contribution towards limiting global warming.

We cannot restructure our energy supply unless we intensify our activities in the area of energy research. Both at national and international level, research is expected to generate new solutions that enable us to fulfil our responsibilities – technological advances in the areas of natural energy sources, increased energy efficiency, and a more responsible use of natural resources.

What will the energy mix of the future look like? How long will we need nuclear energy as a bridging technology? What will modern energy storage solutions and intelligent energy transport systems be like? What will the energy sources of the future be?

The coalition agreement puts forward the aim of achieving a breakthrough towards renewable energy sources in the knowledge that fossil fuels will not last forever. Many people are convinced that green technologies can accelerate new, sustainable economic growth. What steps are needed to restructure the economy along those lines? All these questions cannot simply be be answered through political decisions. On the contrary, political decisions only have realistic chances of success if they are based on scientific knowledge and insights. In the next few months, the Federal Government will work on its energy policy concept for the future, and energy research will play an important role in it. The advances made in research will determine to what extent we can realise our political priorities for restructuring the energy supply and protecting our climate. That is why the Federal Government will significantly increase its financial investments in the coming years. In this context, the extension of the service times of our nuclear power plants is to be linked to an obligation on the part of power supply companies to invest considerably more in energy research. Our

“When I was 16, I got the girls dancing. Now I am doing the same with hydrogen isotopes.”
Driven by curiosity. Professor Günther Hasinger conducts research on fusion power at the Max Planck Institute for Plasma Physics. Research to create a better future for us all. Join in at **www.zukunft-der-energie.de.**

national strategy for strengthening energy research needs to be jointly backed by the public sector and commercial companies. Germany is well equipped to restructure its domestic energy supply and make a relevant contribution to internationally agreed climate protection targets. Energy and the climate are priorities in our High-Tech Strategy. Germany is a global leader in the areas of renewable energy and environmental technology. In the coalition agreement, we have set out to develop a new Energy Research Programme focusing on energy efficiency research, storage technologies, intelligent networks and renewable sources of energy. Next month, I will present the new framework programme “Research for sustainable development”, for which we will provide two billion euros until 2015.

The new Federal Government has been criticised for not establishing a ministry of energy. We should meet this criticism by making special efforts to coordinate all initiatives in the field of energy research, which are currently split between five different ministries. The High-Tech Strategy shows that it can be done. The dialogue between science, industry and politics is equally important. The Industry-Science Research Alliance, which is based at the Ministry of Research, will continue this important dialogue in the current legislative period. Last year, I asked the National Academy of Sciences (Leopoldina) to develop basic ideas for a Federal Government Energy Research Programme. The first concept has already been presented.

This is how I envisage our future dialogue: Scientists will define future research needs, and policy makers will – as set out in the coalition agreement – identify the aims for restructuring the energy supply and align the Energy Research Programme to the needs defined by scientists. Publicly financed research institutes and companies with strong research departments will work together to implement the National Energy Research Programme. One of the reasons why Germany is in such a good position is that we have a large number of excellent research groups, research institutes and innovative companies. We are internationally competitive thanks to our excellent research. We have a large number of international research collaborations. Energy research needs to be a priority not only at a national level, but also in the preparations for the European Union’s 8th Research Framework Programme. Science Year 2010 offers us an opportunity to initiate a broad social dialogue about the future of energy and the restructuring of our energy supply. That is vital for gaining understanding and acceptance.

In recent years, we have seen that understanding and acceptance for new technological solutions are not given as a matter of course. We need to take this lesson seriously. People need to understand the opportunities and risks associated with technological solutions. To this end, universities, research institutes, companies and energy providers across the country will open their doors on Energy Day, the 25 of September, to give people a glimpse behind the scenes.

As in past Science Years, our main aim is to reach out to young people and fill them with enthusiasm. A large number of events, workshops and competitions will be carried out under the slogan "Driven by curiosity". The Youth Congress of the German Energy Agency in August is an example of this dialogue.

The topics of this Congress are being prepared by young people. It will offer outstanding opportunities for discussions with leading scientists. The "little researchers" project brings the subject of energy into nursery schools. Together with the responsible ministries at state (Länder) level and the initiatives "Schools Online" and "Teachers Online", we want to open the fascinating world of research to our educational institutions. The Year of Energy has some strong supporters. For the first time, the Federal Ministry of Education and Research and the "Science in Dialogue" initiative have been able to persuade the Helmholtz Association to act as the supporting organisation. I would like to express my thanks for this.

I am also grateful to the members of the coordination group, which supported us in developing the priorities and selecting the subject areas of the Science Year and which is now acting as a partner.

Many other partners have also agreed to support the Science Year. With their help, we can turn "Science Year 2010 – The Future of Energy" into a success. The time is right. The Science Year can help us make sure that the important debate on the restructuring of our country's energy supply is not restricted to the ivory tower of experts. In this way, Science Year 2010 is also contributing to our country's democratic culture. When we take new paths that will affect everybody, we need to make sure that everybody understands the implications.

In this spirit, I hereby open "Science Year 2010 – The Future of Energy"!

"When I was 14, I used to put all my energy into karate. Today I put it into coal."
Driven by curiosity. Dr Regina Palkovits of the Max Planck Institute for Coal Research is working to make sources of energy even more efficient. Research to create a better future for us all. Join in at **www.zukunft-der-energie.de.**

GLOBAL CHALLENGES FOR ENERGY AND CLIMATE RESEARCH

Keynote speech by Prof. Dr Ottmar Edenhofer

Madam Minister, Ladies and Gentlemen, thank you for the invitation, I am very honoured to speak here in front of you.

In December last year, we concluded the famous Copenhagen climate summit. While this summit was clearly a failure in political terms, it still seems to me that it represented a turning point in some important respects, and this was due to science. For it was the first time that the leaders of all countries sat at the negotiating table and accepted three main basic statements which they had not accepted before. These three key messages are:

1. Climate change is mainly anthropogenic and largely results from burning fossil fuels.
2. Unmitigated climate change has dangerous consequences.
3. Technologies for mitigating climate change are at our disposal, and can be implemented at acceptable economic costs.

This marks, in my opinion, an important turning point in the history of climate diplomacy, and science was the decisive factor in this development.

You probably noticed the recent accusations against the Intergovernmental Panel on Climate Change (IPCC) that were partly justified, and to some extent unjustified. I will, therefore, comment on these three basic messages that are of utmost importance for climate policy. I will then draw some conclusions regarding the relationship between science and politics, and between science and the public.

Climate change, or more precisely the rise in global mean temperature, is anthropogenic. This statement is the result of a large-scale scientific inquiry process lasting almost 20 years and having come to a preliminary end in 2007.

The more critical issue, both scientifically and politically, is the question: why should we worry about the rise in the global mean temperature? Science has provided a first answer to this important question, but this answer is much less certain than the first message. Still, there is a preliminary answer: if we allow the global mean temperature to rise by much more than 2 °C, we will redraw the physical geography of this planet in a way never experienced in the history of mankind. Furthermore, we run the risk of triggering irreversible tipping points in the earth system such as the acidification of the oceans, melting of the Greenland Ice Shield, drying up of the Amazon, or changes in monsoon dynamics in China and India. We are not saying that this will happen with 100% certainty. We are merely saying that we are running considerable risks that these tipping points will be activated if we let the global mean temperature increase beyond 2 °C. In other words, this is a risk assessment, and the choice of the 2 °C objective reflects the precautionary principle.

If this was all there was to be said about the climate problem I could finish now, stating we should limit this risk, the rest being up to politicians. I could do so if there were no other, equally important, risk that figured so importantly in the Copenhagen negotiations. It has mainly been emphasised by Chinese and Indian negotiators: the risk of dangerous emissions reductions.

I would like to briefly describe what I am talking about. Please imagine a world map that shows how per capita income is distributed worldwide. You would see on this world map what you already know, namely that the United States is rich, Europe is rich, Latin America is poor, and Africa is very poor. If I showed you the second map that shows where cumulated CO_2 emissions originated over the last five decades and which region deposited the most in the atmosphere, then you would notice that all those countries which

have become rich, and all those countries that have overcome poverty, are those which have deposited the most CO_2 in the atmosphere.

It seems deeply entrenched in the historical memory of mankind that achieving wealth and overcoming poverty is associated with burning coal, oil and gas. And the risk of dangerous emissions reductions is, of course, particularly obvious to the emerging countries, as they wish to grow, and become wealthier. After all, in the last 30 years China has elevated 500 million people to the middle class – a tremendous achievement – and against this background the question arises whether we have the technical possibilities to disentangle economic growth and emissions growth.

This is the fundamental question that the emerging countries are facing, and we tried to provide an answer to this question in the IPCC. For this, we have developed various scenarios demonstrating that it is indeed possible to separate economic growth from emissions growth, and we came to the conclusion that this is possible if we transform our global energy system and decide on other ways of land use. This is certainly a formidable task, but the scenarios showed that the transformation of the world energy system in the coming decades needs to be quite substantial.

In the last 30 years essentially nothing has changed in the global energy system. It is mainly based on coal, oil and gas, a bit of biomass in primary energy consumption, and a bit of nuclear energy. But when we try to transform the global energy system into one being compatible with both the 2 °C objective and a high level of economic growth especially in emerging economies, it is obvious that we need a substantial transformation.

In the first place, of course, we need to increase energy efficiency. But besides energy efficiency we will need renewable energy carriers and the sustainable use of bioenergy. Renewable energy sources are key technologies to facilitate a transformation towards a CO_2-free energy system in the long term. However, we will also continue to use coal, oil and gas to some extent. And if we want to use coal and gas in the electricity sector, we will have to capture CO_2 at the power plants and store it in underground formations. Everyone knows that this carbon capture and storage (CCS) technology is not yet commercially available, and so we need demonstration projects to investigate if capturing, transport and storage actually function.

If we want to achieve the two-degree target, at the end of the century we will possibly require creating "negative emissions". This means that we need technologies to remove CO_2 from the atmosphere. This can be done either by using biomass in combination with this CCS option, or by removing significant amounts of CO_2 from the atmosphere with the help of artificial trees. This major research project is called "CO_2 extraction". Also nuclear power will still be used to a certain extent as a "bridging technology" until the other technologies, such as renewable energies, are fully available. It is, therefore, clear that we need a broad portfolio of technologies to transform the energy system. In the end we will maybe also have to think about nuclear fusion. Even if the probability that nuclear fusion will be successful is low, the potential success is so great that it is also justifiable to invest in research and development in this area. In other words, what all these scenarios show is that a combination of energy efficiency, renewable energy sources, biomass in combination with CCS and fossil energy in combination with CCS is an important option in each portfolio that seeks to transform the energy system at acceptable costs. This transformation is an enormous challenge that we are facing because of the climate problem. We would not have to rebuild the energy system so quickly, if there were no such climate crisis. It is not the shortage of fossil fuels that is forcing us towards this reconstruction, but it is the limited disposal space of the atmosphere that initiates this drastic transformation process.

The crucial question is: are the economic costs bearable? Of course, uncertainties over abatement cost are great, but the economic costs are so significant because nobody – and especially neither China nor India – would be able to set this transition process in motion unless we could guarantee that it is possible to separate economic growth from emissions growth. Which raises the question of how many percentage points of economic growth will be needed for such a restructuring of the energy system. Again, we have tried to give an answer and have come to the conclusion that between one and two per cent of the world gross product would be needed for such a transformation process. That does not mean that we reduce the rate of growth. That only means that we delay economic growth by, for example, six months until 2030, in order to put such a transformation process in motion.

The crucial question is – and thus, I return to the climate summit in Copenhagen – what exactly do we need in the economic and political context in order to succeed in this transformation process? And it is clear to me that one thing is of the greatest importance in this context.

Because of the climate problem mankind has learned that it is not the shortage of fossil fuels but the limited absorbing capacity of the

atmosphere that is forcing us towards such a reconstruction. But polluters do not have to pay anything for discharging CO_2 into the atmosphere. So the immediate and meaningful economic response is: when the goods become scarce – such as disposal space for greenhouse gases in the atmosphere – CO_2 should be priced, and, if possible, globally. The major task of economic and social energy research is to find out which appropriate conditions should exist in order to establish such a CO_2 price. I personally think that the best way to generate such a price for CO_2 would be global emissions trading. But it is a controversial issue and there are smart economists who think that a CO_2 tax might be better. The resolution of this issue will be one of the major tasks of researchers in the field of economics of climate change.

These are significant demands for the research community; the crucial question, however, is – and the recent events in the IPCC, for example, are certainly a cause for it – can you really trust science? How sure can we be that the knowledge that science is offering us will find solutions to social issues?

I would like to be honest and admit that we have made mistakes in the IPCC. The most recent error is that we had an incorrect number – a transposed number – in the report, a stupid mistake! It was an unintelligent mistake, and such a mistake should not have happened. But it turns out that behind this question – what should the IPCC do, and how valid is our knowledge – a much more fundamental issue is hiding, namely the question: what exactly should science do in the context of climate and energy? And how does science relate to society and politics? Because this is such a complicated topic that could easily lead us into philosophical chasms, I'd like to finish my speech with an allegory to explain what I mean.

Imagine there are ten people in a desert. These ten people have a limited amount of water. Two of these people have already used half of the water. These ten people now realise that water is scarce in the desert. So the two "heavy drinkers" have an idea and say: we will now split the water between the ten of us equally – this is what the proposal in Copenhagen was about. Most people, including the other eight in my allegory, would not accept this proposal because they would find it unfair. So then the question arises: how to resolve this conflict of goals? Let us assume that in this group of ten people who wander through the desert are economists, and that the others ask them: how do we solve this distribution problem? And the economist says, "I'm sorry, but economics has nothing to tell us here because there is no room for Pareto improvements. It's a purely distributional issue." Since they have nothing to say, you have to ask the philosophers what a fair allocation of water would be. The problem is that the philosophers sit at home and write wonderful essays about why it is not a good idea to go into the desert without bringing enough water. Now, in this group of ten, a woman has an idea and says, "We now have two choices: we either fight over the distribution of water or over the rules of how to distribute it. In the end it does not matter whether we die from the conflict about distribution and perish in the desert, or whether we get into a fight over the distribution rules and become so enraged that the conflict will turn out to be just as bloody". So, there is no hope, it seems. Now, this woman comes up with an idea and says, "It would be really useful if there was an oasis nearby but this oasis must first be found somehow." And it is perhaps a good idea that the two people who have already drunk a lot of water should form an exploration team and go and find the next oasis.

Who was this woman? She was from the IPCC. And this is not meant to be a joke because this allegory shows what the role of an institution such as the IPCC is. It should put specialists, engineers, economists and sometimes even philosophers to work together, in order to provide us with the knowledge relevant to actions and decisions, and to raise the question: how do we – as a whole, these ten men – come to the nearest oasis, or to the carbon-free global economy? And who could be the first one to lead this exploration team? The answer is: those who have plenty of scientific experience, and who already possess advanced scientific knowledge and know-how. The second thing is that it requires the identification of knowledge gaps. What do we need to know?

Maybe we know only the path we are on now. But maybe there is one oasis or two oases. Maybe we need to initially concentrate on the oasis that offers a little bit more water, and then go to the next one, where the world economy is actually carbon-free. And the third thing that we have to admit is that we will make mistakes during this exploration. We will have unintended side effects, we will do things that perhaps we would better not have done. But we simply have to admit that a flawless exploration team is absolutely impossible. That is the third thing that we are trying in the IPCC, as we gather the science together, which is to ask this question: "What are the actual unintentional side effects of our actions?" I believe that these are the tasks for science. The issue is not about ensuring that science is happening in a closed circle, because then, science would actually be a secret authority. But it is essential that this knowledge is presented to society in a decision-relevant way and that we offer self-consistent scenarios, so that in

the end society decides as a whole – a part of which we are – which development pathway we will take, and to which oasis we will go. And it is clear that we have to find more than one way, because there are always several routes to one or another oasis. What we learn in the process and what we had to learn in recent weeks within the IPCC, is that science is not error-free. This is in my view a good result, because making mistakes is human! But it is also human to learn from our mistakes. And science is a very intelligent way to learn from our mistakes, and therefore I am convinced that we will emerge even stronger from the climate crisis, and from the crisis of the IPCC.