

## Chapter 20

### Research and technology for sustainability – a global cause

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Annette Schavan was born in 1955. She studied Catholic theology, philosophy and education. After holding leading positions in several Christian organizations, she served as Minister of Education, Youth and Sport of the state of Baden-Württemberg from 1995 to 2005. Schavan has been a member of the German parliament and Federal Minister of Education and Research since 2005. In February 2009, she received an honorary professorship of the Catholic Theology Department of the Freie Universität Berlin. In 1998 she was elected Vice Chair of the German Christian Democratic Union party (CDU).

The Earth has been entrusted in our care, and we are all responsible for it. This responsibility challenges the way we think and act on two different levels: first, we need to think beyond the local environment in which we live; second, we need to think beyond our own lifetimes here on Earth. In other words, acting responsibly at a global level also means thinking of those who have not yet been born, who will follow us in future generations. And it means thinking of those who suffer the worst consequences of our actions, even though they may live in other parts of the world.

The UN Millennium Development Goals underline the fact that all people share the need for healthy food, clean water and safety. Climate change will threaten each of these essential conditions of life, and will challenge our ability to adapt. We therefore need to find ways in which we can fulfil our responsibilities towards all life on Earth more effectively.

What is now quite obviously an essential and urgently necessary step for combating climate change has been looming on the horizon for quite some time: we need greater resource and energy efficiency and independence from fossil fuels, but also effective and fair ways to pursue welfare and prosperity. The most recent IPCC Report sent an unequivocal message: climate change is accelerating, and is almost certainly largely man-made. Although some uncertainties remain, nobody can seriously deny that the rate and intensity of change in key environmental parameters poses an unprecedented risk to the long-term stability of social, economic and environmental systems worldwide.

The international debate about climate change has finally acknowledged the urgent need for action. With her comments at the G8 Summit in Heiligendamm, Chancellor Angela Merkel put Germany's position in a nutshell: 'Accelerated climate change is a serious threat. ... Therefore, we need determined action from the international community. ... We need to work together to promote innovation and technological developments for climate protection.' The international community must treat the subject of climate change with priority. It is a problem that affects the wealthy, developed world, as well as emerging and developing nations.

Science has played a significant role in making us realize that urgent action is needed. Thanks to improved scientific understanding of global climate change, we have finally increased the pace of our response. Around the world, we are not only seriously discussing how to deal with climate change and its consequences for politics, the economy and society; we are also about to reach a global consensus that joint emission reduction targets are absolutely necessary. What we now need are ambitious climate protection goals in Germany, in the European Union and beyond. We also need more extensive research to strengthen the scientific foundations for our decisions and actions.

This essay aims to shed light on what climate change means for technological

innovation policies in an increasingly globalized economy and society. What impact will climate change have on our efforts to achieve sustainable development? And how does this translate into scientific and technological progress?

### **Climate change as a challenge for technological innovation policy**

There is an urgent need today to find joint solutions to the emerging effects of global climate change. The need for a global solution to this global problem is one of the most important lessons that we have learned from the findings of climate change research. As an issue it has fully penetrated the international political agenda during the past decade.

The challenges we face as a result of climate change are highly complex. Extensive research is being carried out to find knowledge-based approaches that answer some of the main societal questions. Can climate change still be mitigated to such an extent that adverse outcomes are averted? How can societies adapt to the changes that are inevitable? Who will gain from climate change and who will lose, and how can we provide fair compensation? Are there ways to manage our common resources to the benefit of all, and to achieve long-term sustainability for human life on Earth?

Ever since the German government began supporting measures to reduce greenhouse gas emissions, it has also committed itself to playing a leading role in implementation of reduction strategies. In order to accelerate this process, the German Ministry of Education and Research commissioned a large number of experts from science, industry and politics to draw up a comprehensive ‘High-Tech Strategy on Climate Protection’ (BMBF, 2008). It was presented in October 2007 at a climate research summit in Berlin.

This strategy has involved pooling strengths and resources, and identifying areas where we believe renewed action, new strategies, and targeted support are needed to achieve technological advances. The core aim of the Strategy is to achieve sustainable energy supply and utilization alongside sustainable use of natural resources. We need to focus consistently on this aim to ensure that research makes a lasting contribution to attaining the climate goals that we have set.

We also have to realize that dealing with climate change requires more than technological progress. We also need to improve public understanding of the problem. A further important goal is to develop and promote fundamental changes in society, the economy, institutional structures, and lifestyle and consumption patterns of individuals. We need a change of consciousness in our society: individual citizens must accept their share of responsibility and recognize that their decisions also influence global processes and the environment.

Scientific research plays a key role in climate protection by providing a broad knowledge base for political decisions and for strategy and investment planning. To support this process we need novel forms of communication and collaboration between climate researchers and decision-makers (see Kadner, this volume). Germany's High-Tech Strategy on Climate Protection focuses on this information process. That is why a 'Climate Service Center' was established in January 2009 in Germany, allowing climate-related knowledge to be pooled, evaluated and disseminated.

Three considerations are particularly important for Germany's national and international strategies on climate change.

### ***1. Climate protection as a global driver of innovation and economic growth***

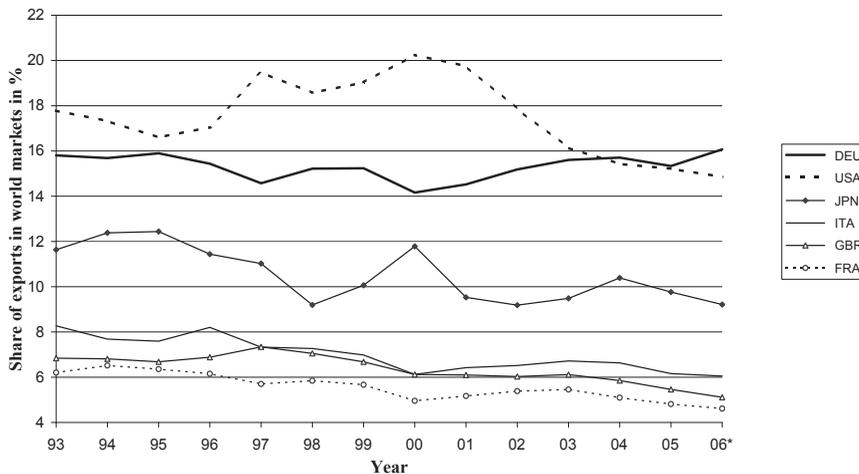
We need strategic alliances and partnerships between science, industry and politics. These innovation alliances should pursue joint strategies that enhance the existing potentials of each partner. These strategies will increase awareness in society, industry, and politics that climate protection does not merely require restrictions, but may offer new opportunities and prospects.

'Green markets' and environmental goods already account for 5% of industrial production and 1.8 million jobs in Germany. To further promote this development, we need the business community to join the public sector in significantly increasing investment in research and technology. The current financial and economic crisis underlines the necessity of redirecting our investments and establishing new fields of innovation and business.

Research and investment in alternative energy sources and in mitigation of and adaptation to climate change will be among the main priorities in Germany in the next few years. Germany has a strong international reputation for scientific research and is a world leader in sectors relevant to climate protection, resource efficiency and new energy systems. For this reason, we in Germany believe that investing in climate protection is more than just a moral obligation. We believe that it will also pay dividends. Germany is already a leading exporter of environmental technologies (Fig. 1).

Germany's experience shows that climate protection measures can contribute to economic growth, prosperity, and the creation of new jobs.

Innovation policy plays a key role in this process. With the High-Tech Strategy on Climate Protection, Germany is helping to mobilize private research efforts and capital with the aim of accelerating critical innovation processes that enhance climate protection. To this end, we have initiated the following cross-industry innovation alliances:



\*) estimated

**Fig. 1.** World market share of major suppliers of environmental technologies from 1993 to 2006. (Source: adapted from Legler *et al.*, 2007, p. 110)

**Solar cells.** This alliance aims to develop new and significantly improved solar cells based on organic materials (see Heeger, this volume). The medium-term plan is to develop mobile solar energy converters that are cheap to produce, have an efficiency rate of 10%, (i.e., transforming 10% of the incident solar energy into exploitable electrical energy), and a lifespan of more than 20 years.

**Energy storage.** A second innovation alliance focuses on the development of highly efficient energy storage solutions. This is an important technological link for efficient use of renewable energy sources. Currently, lithium-ion batteries represent the most promising energy storage technology. However, the storage capacity and reliability of these batteries need to be improved, allowing for more flexible applications in mobile devices, for stationary energy storage in the energy sector, and for use in vehicles.

**Auto industry.** Because the car industry plays such a major role in Germany's economy, it comes as no surprise that we are supporting the development of innovative technologies such as automotive electronics systems that reduce carbon dioxide emissions and fuel consumption. Computer-based communication and data exchange technologies for cars also need to be developed. These will enable drivers to communicate with other road users and traffic infrastructure systems – for example, in the form of traffic congestion warnings, minimum distance regulations, and traffic control – thereby greatly reducing traffic-based emissions.

**Carbon nanotubes.** Carbon nanotubes (CNT) represent one of the most promising innovations in the field of materials research. They have higher electric conductivity than copper, lower thermic conductivity than diamonds, and an elasticity ten

times greater than steel. If we succeed in transferring these properties to new, macroscopic materials, we would be able to improve numerous applications in energy and environmental technologies, light-weight construction, and energy storage.

**Financial investments.** For every euro that the German government invests in these alliances, the private sector has agreed to add a further five euros to help new innovative technologies become marketable. This should greatly speed up the integration of these new technologies into the market, and will in turn accelerate effective climate protection.

We have also begun speaking to partners from the financial sector about their role in climate protection. We believe that this step is long overdue. It will encourage investments in resource and energy efficiency and in renewable energy. So far, investment in this area has been limited, and substantial deficits in research and information still exist. In cooperation with major German financial services providers, we have established the 'Finance Forum: Climate Change'. Our goal is to enable financial markets to make an effective contribution to climate protection and adaptation.

**Establishment of public-private networks.** Last but not least, we are developing new instruments to support and finance the development of regional clusters in cutting-edge fields of technology such as energy efficiency and sustainable energy generation. The aim is to establish several highly integrated public-private networks that include commercial companies, research organizations and political institutions. They will work together to identify the potential commercial opportunities of new ideas and to translate research findings into marketable products and services.

## *2. Strategic partnerships with future generations*

A second important area concerns the relationship between generations: We must make sure that each new generation is aware of – and passionate about – the issues and responsibilities that relate to climate protection. In other words, we also need to form strategic partnerships with future generations. Young people tend to be open-minded about issues relating to climate protection and are usually willing to face their individual responsibility in the global context. That is why we must give young people the tools and skills they need.

The support of young researchers is therefore an integral part of the High-Tech Strategy, and, indeed, is key to the success of our overall climate strategy. We must fill the next generation with enthusiasm for science and technology and offer young people interesting career opportunities in these fields.

Among young researchers, international exchange of experience and knowledge has become routine. After all, innovation comes about not only thanks to the wisdom of the old and experienced, but also thanks to the inquisitiveness of the young.

Modern means of communication greatly facilitate the exchange of ideas. However, we must not forget that personal contact with inspiring personalities will probably remain the most important source of enthusiasm for science and research. That is why we need more networks and platforms that facilitate encounters between leading researchers and young people. At the same time, we need to create settings in which children and young people can develop a fascination for research and technology.

Research funding and education are two sides of the same coin; it is all about securing our future. We need to structure our education system in such a way that it challenges and supports young people according to their individual talents and abilities. A society that loses interest in its talented young people has no future. That is why we need to ensure that young people do not see climate change only as a threat. It should also challenge them to think and act in new, innovative and unconventional ways. High-quality education programmes with plenty of transfer opportunities will be a key factor in attracting more young people to science.

### ***3. International cooperation – the key to sustainability***

To ensure effective climate protection, adaptation and resource management, the science and research communities need to act globally. In the future, the institutional and regulatory framework will no longer be created just at a national level. International cooperation – also beyond established partnerships – is becoming ever more important. That is why we need European and international innovation alliances. Germany's High-Tech Strategy on Climate Protection aims to create targeted links between European and international partners.

The European Institute of Innovation and Technology (EIT) is just one of many beacons of European innovation policy. Looking beyond Europe, we have a strong interest in involving developing and emerging countries, and engaging them in an intensive, open dialogue about the opportunities and risks of science and technology. The time has also come for us to enter into innovation alliances with the countries whose development will play an enormous role in our future decisions about global emissions. The partners in these alliances should all stand on an equal footing, acknowledging the role of industrialized nations in the past while also recognizing the present and future need for climate protection measures in all countries.

As one of the world's largest economies, Germany has a responsibility to engage in a mutual learning process. This is the only way we can improve our understanding of what it will take to achieve sustainable development. We can pool our strengths by increasing international research cooperation and developing joint research agendas. The science and research communities are giving us access to a

large base of knowledge and experience, which is also aiding the development of effective global solutions.

### Outlook

Modern democracies are knowledge-based societies. Policy-makers derive their legitimacy not just from the democratic consent of citizens, but also by basing their political decisions on the most up-to-date knowledge available. Regardless of individual interests, the science and research communities have an obligation to deal with issues that are of fundamental relevance to common welfare and to the future of our society.

Given the complexity of many of the societal, economic and ecological challenges we face, we need solution-oriented research. We need reliable and honest advice on scientific matters as well as speedy access to new findings and technological advances, which will encourage the development and production of innovative technological applications.

The tasks and solutions confronting us today in the field of climate protection are so complex that they hardly ever fall neatly within one single discipline. They require an interdisciplinary, international and intercultural dialogue (see also Gell-Mann, this volume). That was one of the reasons why the *Leopoldina*, Germany's Academy of Natural Scientists, was renamed The National Academy of Sciences in mid-2008. It will represent German science at an international level. In addition to promoting the sciences, the Leopoldina sees its main mission in the interdisciplinary study and dissemination of scientific findings. It will offer a setting for encounters, discussions and exchanges in which the boundaries between disciplines and countries can be transcended more effectively.

To ensure that our research agendas are successful, we must increase our investments in science and research. The European Union has set itself a target for 2010: three percent of gross domestic product is to be invested in research and development (R&D). This will require both the public and the private sector to considerably increase their R&D spending. The money we invest today in research and development will form the basis for the prosperity of future generations. In light of the current financial and economic crisis this principle is more valid than ever.

Germany has a great tradition of scientific innovation, and we want to apply this experience more effectively as an instrument for achieving global sustainability. We cannot consider our efforts successful until we have reconciled the demands of preserving the Earth's resources not only with prosperity and welfare, but also with the development of a free, dynamic and informed society. We want a society that is capable of thinking in terms of integrated and interrelated systems, and is capable of achieving sustainability, both for its own benefit and that of future generations.

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