Research for global markets – International exchange of experience

- Welcoming message from the International Renewable Energy Agency (IRENA)
- The global research market for renewable energies: Competition and technology partnerships
- The energy and research policy framework conditions for renewable energies in Germany
- TREE – Transfer Renewable Energy & Efficiency – The Renewables Academy’s knowledge transfer project
- The CERINA Plan – An alternative to the Kyoto instrument

Welcoming message from the International Renewable Energy Agency (IRENA)

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Ladies and Gentlemen,

Allow me to begin by thanking the Renewable Energy Research Association for organising this conference and for their kind invitation. I am delighted to be able to discuss research developments and technologies related to renewable energies with you today.

It is true to say that 2009 marks a turning point in the development and spread of renewable energies. 52 years after the foundation of the International Atomic Energy Agency and 36 years after the foundation of the International Energy Agency, the International Renewable Energy Agency (IRENA) was founded in Bonn in January 2009. IRENA, the first international organisation that will concentrate solely on the promotion of renewable energies, is to become a voice for renewable energies that will be heard all over the world.

It is a pleasure to speak to you today as the first Interim Director-General of IRENA. Allow me to say a few words about our still very young organisation.

Locations and members

In June 2009, the members of IRENA selected the United Arab Emirates as the location of the IRENA secretariat. In addition, a Technology and Innovation Centre will be established in Bonn and a Liaison Office to interact with international organisations will be set up in Vienna.

The interim headquarters in Abu Dhabi will soon move to Masdar City – the first almost completely CO_2-free city, which will exclusively use renewable energy sources to meet its energy requirements. The fact that the sixth-biggest producer of oil in the world has committed itself to renewable energies shows that we have achieved global agreement on the need for an energy revolution – away from carbon-based energy supply that impacts negatively on the environment, and towards sustainable and clean harnessing of energy.

Just this morning, the EU Commission became the 138th member to join IRENA. The high number of members achieved within such a short time demonstrates just how important the issue of renewable energies has become to member states. They are a must for developing, emerging and industrialised countries, regardless of whether states are rich or poor in raw materials. With renewable energies, dependencies on fossil fuels can be reduced and the various targets that have been set for climate protection can be achieved. Renewable energies are a "must" if climate change is to be kept in check.

IRENA's tasks

The expansion and growth of renewable energies in recent years has been considerable. Worldwide investments in clean energy technologies amounted to the considerable sum of 120 billion US dollars in 2008.[1] As a further example, solar energy capacities were increased by a factor of six between 2004 and 2008 to reach 16 gigawatts, and those of wind power were increased by 250% to 121 gigawatts. In addition, numerous states have now created the necessary political framework conditions, such as feed-in acts, in order to support renewable energies.[2]

1 See Global Status Report 2009, page 14.
2 Global Status Report 2009, page 8.

Despite the sometimes positive trends in the worldwide use of renewable energies, there are still currently serious barriers to the spread of clean fuels in place. These include long permission procedures, import duties and technical barriers, uncertain financing for renewable energy projects, centralised infrastructure, and insufficient awareness of the possible applications of renewable energies.

IRENA will help to dismantle these barriers. In order to promote the expansion and sustainable use of renewable energies worldwide, IRENA will be offering its members practical help. This will include the provision of relevant information on the subject of renewable energies, including analyses of potential and scenarios, best-practice examples and effective financing mechanisms. The Agency will also be providing capacity building, training, workshops and policy advice. It will be facilitating the transfer of knowledge and technology, and will be providing help with the improvement of political framework conditions.

Initial activities

IRENA is currently in the process of establishing itself. We are working tirelessly to recruit qualified staff and complete the organisational and structural infrastructure at our headquarters. Despite these start-up steps, the Agency has already begun its initial activities. For example, it has set up a working group under the leadership of the DLR that will consider the potential of and scenarios for renewable energies. Among its other tasks, the working group will prepare an appraisal of the current global potential of all renewable energy sources. In addition, scenarios are to be developed that show how a changeover from the current energy supply system to an energy system based on renewable energies can be implemented.

The sudden death of the project leader Wolfram Krewitt came as a shock to us. I would like to take this opportunity to express my sincere condolences to his colleagues and, in particular, to his family and friends.

As an additional activity, IRENA is advising the Kingdom of Tonga with regard to the electrification of its outer islands using renewable energy sources.

IRENA has also conducted workshops on the topics of capacity building and knowledge management. These workshops analysed tried-and-tested methods and identified needs and knowledge gaps.

Another focus was the dialogue with a large number of stakeholders and other international organisations in the field of energy (e.g. UNIDO, IEA, UNFCCC, IPCC), NGOs and networks in the renewables sector in order to investigate the possibility of cooperations and partnerships.

IRENA will be cooperating with Ren 21, EREC/Greenpeace and the IEA to organise a side event at the UNFCCC Conference of the Parties in Copenhagen on 15 December. Under the motto "Renewable Energy – Our Chance to Mitigate Climate Change", IRENA and its partners will be presenting renewable energy scenarios and showing how renewables can contribute to achieving CO_2-reduction goals and placing energy supply on a secure basis.

Activities in the area of research

In future, IRENA will be focussing increasingly on the area of research. In the light of increasing trade volumes worldwide and strong increases in the numbers of automobiles, IRENA will be promoting research on electrical drive systems in the transport sector in particular. Overall, IRENA will be working towards a gradual reduction in the production costs of renewable energies so that they become competitive on the market as quickly as possible and are no longer dependent on subventions.

A major amount of research continues to be necessary, particularly in the area of technologies that are not yet competitive or are not yet ready for the market. These needs must be addressed quickly.

In order to further support our work, our long-term aim is that IRENA be advised by a scientific advisory board. We are working to establish contacts with the leading research institutions. All research institutes represented here are also cordially invited to work with us. Alongside its e-learning programmes, IRENA will also be offering stipends for academics who wish to work on renewable energies in order to promote young talent in this area.

IRENA will be expanding its activities in the research sector by actively influencing the direction of further research. In its role as a global voice for renewable energies, IRENA will be distributing the latest research findings, communicating them to the relevant stake-holders and basing its ongoing activities on these findings.

With the study of potentials, IRENA wishes to give every country the opportunity to calculate its own renewables technology mix that offers the most promise. In this way, every country should be put in a position to create its own "technological roadmap" on the path to more renewable energies.

It is my own personal aim to help the poorest of the poor. For this reason, IRENA will initiate the development of an affordable PV application. Already today, there are Solar Home Systems (SHS) that start at $300. Our goal is to reduce this price by 50% in the near future, to begin series production of these SHS, and to identify suitable distribution channels for them. There is already a competition for this organised by the Fraunhofer ISE in Freiburg.

I am pleased that the conference programme is dealing with the investigation and further development of renewables technologies. The plenary session – which consists of players from politics, excellent research institutes and the private sector – gathers together highly qualified experts, investors and decision-makers. I am certain that only effective cooperation between these players will result in progress in development and thus contribute to solving the world's climate and energy supply problems.

We must ensure that international research co-operation is expanded so that the opportunity to develop technologies on a global scale and adapt them regionally, as mentioned by Prof. Staiß in the invitation, can be realised. IRENA will be happy to participate in these efforts and invites all involved to work together closely.

To close, allow me to make another "personal" appeal to everyone present. I call upon everyone – and in particular on women – who shares IRENA's goals and is interested in working with IRENA to apply to the secretariat in Abu Dhabi. It is my explicit goal to employ at least 50% women at IRENA.

I thank the organisers for the opportunity to speak to you today. I wish you all a successful conference.

The global research market for renewable energies: Competition and technology partnerships

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Humankind is faced with a double global challenge from the scarcity of fossil fuels, which has already begun, and from the risks to the basis for human life due to the increase in CO_2 in the atmosphere to values that our planet has not seen for a million years.

This challenge can still be met today, but the "window of opportunity" for avoiding drastic negative effects on the world's economies –due to the steep rise in energy prices and the consequences of an unstable climate with droughts and storms of unprecedented strength – will probably only remain open for another 10-15 years. For this reason, urgent and decisive action is the order of the day.

The world was concentrating in vain on achieving agreement on the values for the targeted reduction in national CO_2 emissions at the failed COP 15 Climate Conference in Copenhagen in 2009, but an alternative positive target would appear to be easier to implement politically and thus ultimately more effective. This reorientation of global climate policy could concentrate on two goals:

- Increasing the share of renewable energies in the national and global energy mix
- Increasing energy efficiency, e.g. as expressed by the ratio of energy consumption to the value created nationally

Even though CO_2-reduction targets are difficult to achieve in countries such as the USA or emerging countries such as China or India, these types of positive goals are readily understood and even contribute to the creation of jobs in sophisticated technology sectors. The European 20-20-20 scenario already contains the goal of 20% of renewable energy in final energy consumption by 2020, which should certainly be extended to a goal of 80-100% by 2050.

No targets have yet been established for energy efficiency, but they can easily be formulated based on current energy intensity values (kWh/k€ of gross domestic product). The aim of these calculations must be to formulate a global model that also makes it possible to achieve CO_2 goals. In the IPCC's 2007 report, it is shown that the world can afford another 750 Gt of CO_2 emissions if global warming of over 2 °C is to be avoided; this is not a large amount in the light of the current annual emissions level of around 30-35 Gt.

A rapid increase in the share of renewable energies in the energy mix and improvements in energy efficiency both require active research and development in these technology-related fields. There is still much research needed, both nationally in Germany and globally.

Figure 1 shows German expenditure on energy research in the last 35 years. The maximum was €2.4 billion in 1982, spent mostly on nuclear fission research and research on coal and other fossil fuels. Current research expenditure is only around one-third of this maximum, and of this amount, only a third again, i.e. around €200 million, is directly associated with renewable energies.

Figure 2 shows that this amount has remained approximately constant over the last 30 years; in 2003, it still corresponded to 2.2% of the turnover of the sector, but the figure was only 0.9% in 2008.

Figure 1
German federal government expenditure on energy research

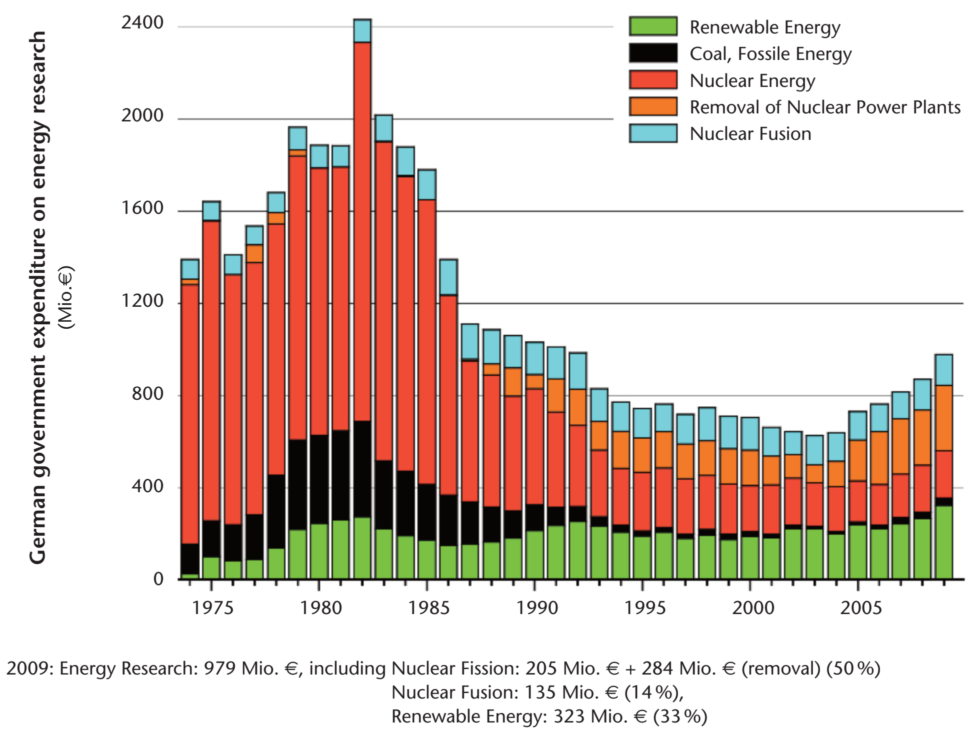
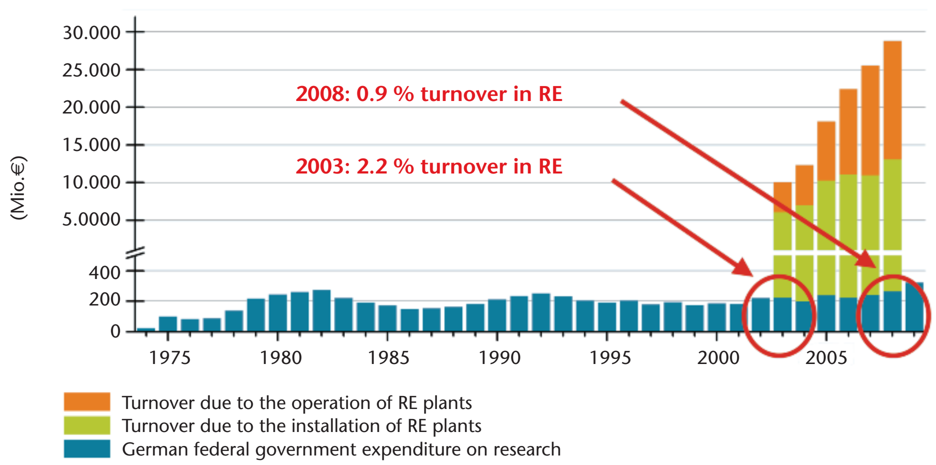


Figure 2
German federal government expenditure on research and turnover with renewable energies



An improvement to over € 300 million appears likely for 2009, also due in particular to investments in offshore wind. However, it remains to be seen if the research budget for renewable energies that was recently increased in 2009 will continue at the present level.

It can thus be observed that the global challenges outlined above have not yet resulted in long-term increases in budgets for the research necessary to develop new, more efficient and more cost-effective energy technologies.

The impressive growth in this sector, which was stimulated to a significant extent by the financially attractive feed-in tariffs for renewable energies specified in the German Renewable Energy Sources Act (EEG), even led to a significantly reducing percentage for state research expenditure as a fraction of the turnover of the sector.

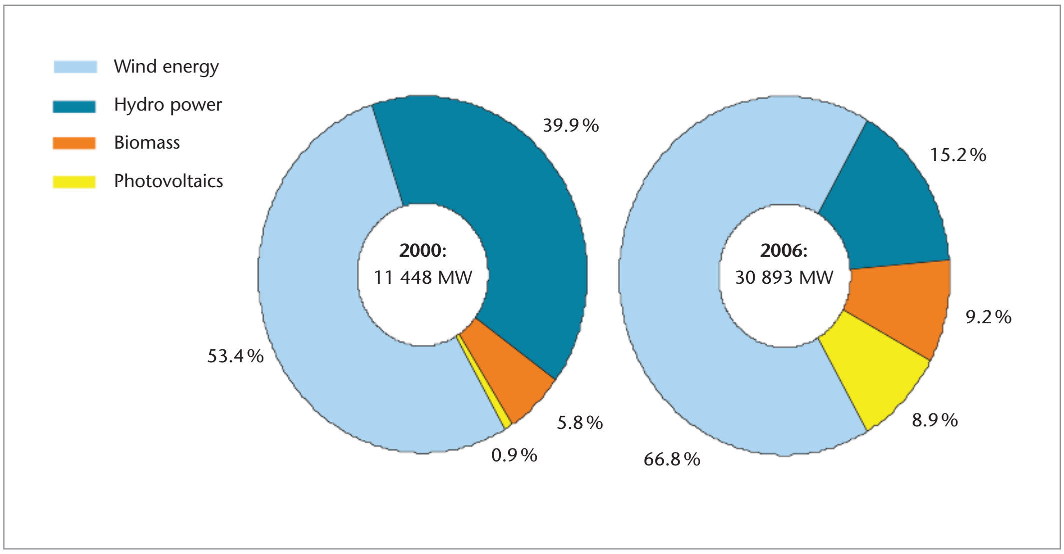


Figure 3
German federal government expenditure on research and turnover with renewable energies

Figure 3 shows that photovoltaics grew particularly quickly – from a 0.9% share of renewable energies in 2000 to as much as 8.9% in 2006 – in the context of the rapidly increasing power capacities for renewables that tripled between 2000 and 2006 in Germany to reach 30 GW. This is not surprising when you consider that photovoltaic technology is a semi-conductor technology which is experiencing a continuous increase in performance accompanied by price reductions, in a manner similar to the development of microelectronics over the last 50 years.

The learning curve for photovoltaics over the last 25 years (*Figure 4*) shows a continuous reduction in prices of approximately 20% for every doubling of the installed amount. A special development in photovoltaic technology has taken place in recent years: Global demand for PV modules was so strong in the years between 2003 and 2008 that system suppliers could essentially pick and choose the clients that they wished to supply. Despite huge rationalisation gains at manufacturing companies, the prices remained constant and the rapidly increasing profits were mainly invested in quickly expanding capacity, which was necessary and also politically desired. The economic

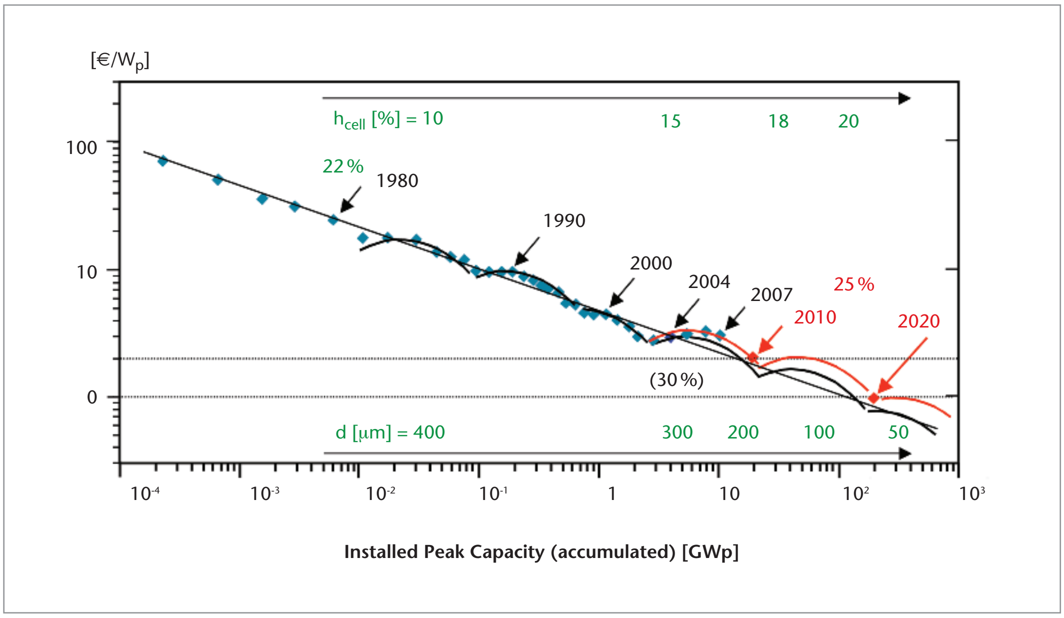


Figure 4
Price learning curve for PV modules made from crystalline silicon

crisis of the last 18 months has led to a significant cooling-off in the market, and it is interesting to note that the extrapolated learning curve of the last 30 years now applies again thanks to significant price reductions in 2009.

The continuation of this learning curve or even acceleration along it is possible, but this would require funding for application-oriented research and development to increase in line with sector turnover. In parallel, expenditure on fundamental research and development would also have to increase as unexpected breakthroughs are always possible – e.g. in the area of organic solar cells.

In principle, research on all types of renewable energies and on energy efficiency for buildings, transport and production should be supported. However, certain areas are worthy of particular attention: photovoltaics; the conversion of solar thermal energy; wind energy; energy optimisation of buildings; electromobility and the closely related development of electrical storage devices. This should be accompanied by the development of new, intelligent energy-distribution grids which will allow for bi-directional feed-in and storage of electricity.

Photovoltaics have the potential to supply a very significant fraction of electricity generation in a renewable manner and with negligible operating costs in the long term. To achieve this goal, more cost-effective production methods and continuously improving conversion efficiencies are necessary. With system prices below €3/Wp, this technology can already compete with other renewable technologies such as concentrating solar thermal technology or offshore wind.

At the moment, thin-film technology and, in particular, cadmium telluride (CdTe) technology – as supplied by First Solar and others – offer a cost advantage, with module costs of less than €1/Wp being quoted. However, this cost advantage comes at the cost of significant disadvantages in conversion efficiency: While PV modules made from crystalline silicon currently have efficiencies of between 16% and 21%, thin-film modules only achieve between 8% and 11%, i.e. half as much.

Thin-film equipment offers advantages for large-scale systems on cheaply acquired land. However, if the area available is limited, as in the case of roof-mounted systems, good efficiency becomes more important. A keen price war is currently in progress. In particular, manufacturers of solar cells made of crystalline silicon in Germany have to regard the prices of thin-film technology as the target.

The advantage still enjoyed today by German and European technology is under serious threat, and a rapid increase in R&D expenditure in this area is essential for this reason.

The third significant PV technology is concentrating PV, which uses high-efficiency solar cells with conversion efficiencies of up to 41% and degrees of concentration of up to 500; this technology is still in its initial stages, but has the potential to achieve significant market shares in sunny regions.

Solar thermal technology provides hot water without using electricity generation as an intermediate step. There is further potential for improvement here in operations management and in the manufacture of the vacuum collectors that are particularly necessary in zones with cooler climates.

Concentrating solar thermal technology is being used increasingly for electricity generation in sunny regions. This technology is particularly attractive in combination with heat storage, as melted salt solutions make it possible to use heat stored during the day to generate electricity at night too. In one of the latest developments, work is being done on combining this technology with concentrating PV.

The harnessing of onshore wind is one of the most cost-effective renewable methods of power generation. However, good locations are limited in both number and availability, meaning that significant growth is possible at these locations only by repowering existing wind turbines with larger rotors.

Offshore wind presents a completely different situation: We are still faced with major technological challenges here that demand intensive research work – e.g. on large-scale equipment extending into the 20-MW range, or in the area of corrosion resistance.

The energy optimisation of existing buildings and the development of innovative strategies for new buildings – right through to the Masdar City project for a city that is completely self-sufficient as regards energy – offer huge potential for increasing energy efficiencies, as more than one-third of our energy consumption is used in buildings. The refurbishment of old buildings presents particular challenges, as the development of suitable technologies must be accompanied by support from aids to market introduction here. These should make it possible to distribute the short-term costs over the many years of energy use.

The increase in the use of renewable energies in the transport sector has led to the birth of the field of electromobility. Taking the lead from developments in Japan and China and with the support of significant state support programmes, the German automobile industry is beginning to tackle this challenge. It remains to be seen how and when hydrogen fuel-cell technology will make a breakthrough in the transport sector.

The capacity of battery systems is already sufficient to drive plug-in hybrids with limited electric range and a combustion motor to increase range. With improved battery technology, purely electric vehicles with sufficient range will also become available. There is still need for major research here, both on the batteries themselves and on the energy management necessary for these systems.

The last item that should be mentioned here is the transition required from the conventional unidirectional electricity grid to a bi-directional grid with locally distributed intelligence. With this grid of the future, power consumers will be able to adapt to fluctuating electricity prices and will switch on significant loads when the price is the lowest – e.g. when sufficient wind power is being fed in. At the same time, consumers will also be able to feed in power from wind or solar systems or from the batteries of electric cars, which of course only need to be fully charged when the customer actually wants to use their car. The power grid of the future will also require transmission technology for long distances in the form of high-voltage direct current transmission in order to connect sunny regions in the south, windy and water-rich regions in the north, and the customers.

- Renewable energies only accounted for 13% of the total energy research budgets of IEA states in 2008.
- In international comparison, Germany has the highest share of the energy research budget, but this still amounts to only 33%, while nuclear energy research (including fusion and waste) has 64%.
- Germany is responsible for only 5% of the energy research spending of the IEA countries, Japan 28%, USA 31%.
- When related to gross domestic product, Germany spends €0.20 per €1,000 of GDP (USA €0.25, Japan €0.72).

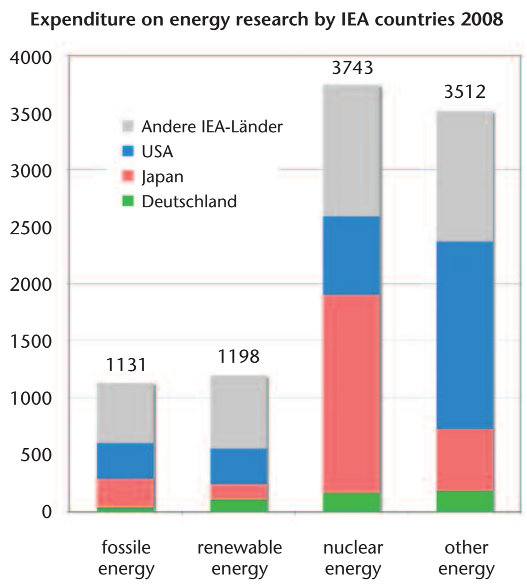


Figure 5
Energy research budgets worldwide

This brief outline of an energy system of the future shows up many areas where considerable research is necessary. In order to achieve the climate protection targets in time, it is essential that technology expertise be developed more intensively worldwide. However, this can only happen successfully if funding for this research area increases significantly.

Figure 5 shows that research on renewable energies is only responsible for 13% of the energy research budget of all countries in the International Energy Agency (IEA). When related to gross domestic product, Germany spends €0.20 per €1,000 of GDP on research and is thus behind the USA (€0.25) and far behind Japan (€0.72). In the USA, spending on PV research alone was almost doubled from $135 million in 2008 to $260 million in 2009, and this figure is set to rise to $320 million in 2010. In addition, around $800 million is to be spent on 46 Energy Frontier Centers in the next five years, with eleven of these concentrating on PV.

In Europe, close technology partnerships have already been initiated in the area of silicon PV technology by European programmes such as Crystal Clear. Unfortunately, the opportunity has been missed to establish a Knowledge and Innovation Center (KIC) for renewable energies as part of the European Institute of Technology. Nonetheless, it can be expected that further relevant programmes will be part of the 8th EU Framework Programme at the latest. Transatlantic technology partnership will also be strengthened. The Fraunhofer-Gesellschaft has already established the rapidly developing Center for Sustainable Energy Systems (CSE) at MIT in Boston, and the German Federal Research Minster Annette Schavan has signed the first transatlantic agreement on technological cooperation, particularly in the area of renew-able energies.

The challenge to humankind is a clearly global one, and for this reason technology expertise must also be bundled globally. The countries that tackle this process the most effectively – and Germany is clearly one of the leaders here – will reap the greatest economic benefits.

On the other hand, growing interest – in Asia, in particular – will result in keener competition. If Germany does not respond to this competition with the necessary level of effort in the area of research and development, it is possible that we will lose our position of technological leadership – something that has already been observed in the past with other key technologies such as microelectronics.

The energy and research policy framework conditions for renewable energies in Germany

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For 20 years now, Germany has been expanding renewable energies with the support of state incentive instruments. What is the reasoning behind the systematic retention and refinement of these instruments over this period with the aim of creating a reliable basis for the successful development of renewable energies?

Reasons for the promotion of renewable energies in Germany

Germany is dependent on energy imports to a considerable degree. Almost three-quarters of the total energy consumed must be imported from abroad. The dependence on a small number of supplier countries – e.g. Russia – is increasing. The risk of political dependencies due to the increasing importance of energy is thus also increasing. Reducing the dependency on imports is thus an important aim of German energy policy.

With a share of around 10% for renewable energies in the German energy mix (2008), Germany has indeed made good progress, as renewable energy sources are largely domestic. However, the high share of 90% for fossil fuels provides motivation to further speed up the shifting of energy production in favour of renewable energy sources.

Another reason for supporting renewable energies is the inability of the free market to integrate the high consequential costs of climate change into current energy prices. The costs of environmental damage, damage to health, the disposal of waste from nuclear and coal-fired power plants, and the costs of security measures and of conflicts for energy raw materials are not yet reflected in our energy prices to an appropriate degree. Support for renewable energies, which would avoid the majority of the consequential costs described in the first place, thus helps avoid financial burdens on future generations.

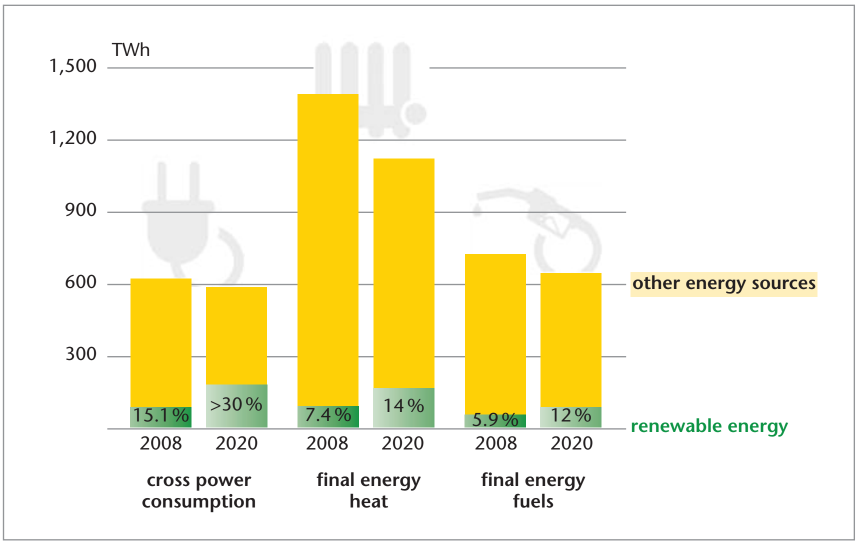


Figure 1
Targets for the expansion of renewable energies in Germany up to 2020

Source: German Federal Ministry for the Environment (2009)

The European Union has set binding targets for the expansion of renewable energies by the year 2020. Member states must achieve a total of 20% of their energy supply from renewable energy sources. Germany, with 18%, is slightly below the average. The German figure is made up of a share of at least 30% of power generation, 14% of heat provision and 12% of fuel supply.

However, the main reason for the promotion of renewable energies in Germany is the economic-technological factor. With the introduction of Germany's Electricity Feed-in Act in 1990 and its development into the Renewable Energy Sources Act (EEG) that came into force in April 2000, a strong new industry gradually establishes itself. The fact that renewable energy technologies have been able to compete on the market has led to economies of scale and increases in efficiency. State support has meant that German companies have been able to establish a technological advantage that will become increasingly important in the light of future climate protection agreements. In 2008, German companies achieved turnover of almost €29 billion from the installation and operation of equipment and another €12 billion from exports.

The innovations that have resulted are now available to the whole world in order to reduce CO_2 or help even the smallest units in developing countries to achieve self-sufficiency of energy supply.

Technologies that are close to being market-ready are supported by incentive systems such as electricity feed-in tariffs, premium models or fuel quotas; other technologies that are not yet ready for the market require fundamental research that is mainly conducted by scientific institutes and universities.

Development of research support

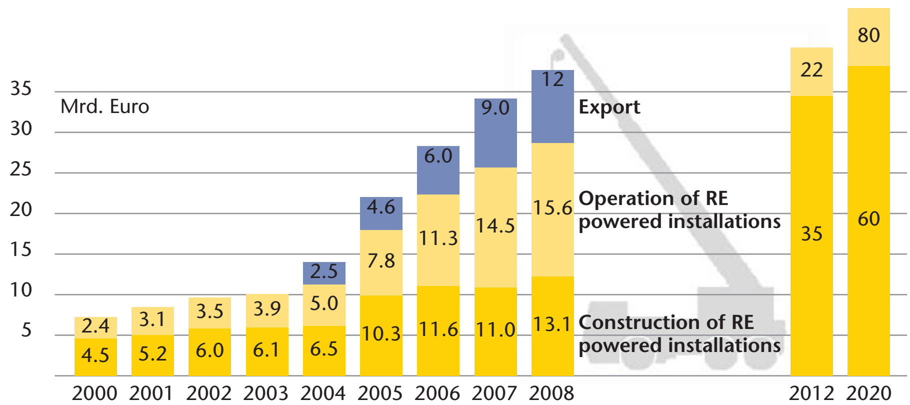
Since 1973, the German federal government has been preparing energy research programmes. The currently applicable, fifth energy research programme is entitled "Innovation and new technologies". It was initially intended to cover the period 2005 to 2008, and was then extended to 31/12/2010.

In the initial period up to 2008, the programme was given a support budget for fundamental research of €1.7 billion. Although support for renewable energies and energy efficiency grew – at a low level – up to 2008, most of Germany's research funding is still spent on nuclear technologies, including the decommissioning of plants and research on nuclear fusion.

The four federal ministries responsible for energy issues – i.e. the Ministries of Research, the Environment, Economics and Agriculture – spent a total of €161.2 million in 2008 on institutional support and support for specific renew-

Figure 2
Turnover for the renewable energies sector in Germany

Source: German Renewable Energy Agency



able energies projects. This funding was used for the following purposes:

1. Reduction of costs by increasing efficiency and achieving economies of scales by optimising production processes and improving product lifecycles
2. Development of new technologies
3. Sustainable expansion of renewable energies by investigating ecological and social effects

Technologies for system integration and wind power are becoming more important as part of the project support. Photovoltaics had a 44.1% share of the budget in the 2005-2008 support period, but this figure dropped to 26.3% for project support approved in 2008. On the other hand, the area of system integration has now grown from around 0% to 18.7%, while the wind power area has increased from 21% to 26.6% driven mainly by offshore wind power. This development shows that the processing of large amounts of energy, the storage associated with this, and the intelligent control of energy consumption are becoming increasingly important.

Conversely, less support is being provided for fundamental research as the various technologies become more competitive on the market. In this phase, market incentive instruments become technology and innovation drivers. The German Renewable Energy Sources Act (EEG), which provides for defined tariffs over a period of 20 years for electricity fed in from renewable sources, has proven one of the most successful support measures worldwide.

How the feed-in tariff works

The German Renewable Energy Sources Act (EEG) came into force on 1 April 2000, and has been the most important factor in the increase of the share of renewable energy sources in the electricity supply from around 6% initially to about 16% in 2009. The act follows the principle of cost-covering remuneration, and for this reason it must be monitored and updated continuously.

The five core elements of the EEG were defined after a ten-year learning period (1990-2000) with the Electricity Feed-in Act, which was the predecessor of the EEG, and they continue to apply today:

- **Priority for EEG electricity:** Every system for the generation of electricity from renewable sources must be connected to the electricity grid by grid operators. Every kWh of electricity may be fed into the grid and is transmitted to consumers.
- **Defined remuneration:** Every kWh of electricity from renewable energy sources receives a guaranteed tariff, which in turn makes it possible to calculate the payback period for the investment in equipment.
- **Long period of applicability:** The remuneration applies for a 20-year period, which gives investors a high degree of yield security. During this period, operators are free to opt out of EEG tariffs or opt back in again, depending on whether higher prices can be obtained on the open market.
- **Technology-specific support:** Each technology offers different advantages that cannot only be measured in terms of current economic performance. The other factors include the maturity of the technology, the technology's potential for the future, the suitability for the location, and issues relating to landscape and nature conservation. The principle is thus to support each technology (PV, wind, biomass, ...) with its own different tariffs in order to cover the respective costs of each technology.
- **Degression:** In order to speed up learning effects and avoid windfall gains, an annual reduction of the initial tariff has been specified. This innovation pressure helps all technologies to gradually approach grid parity, i.e. a price level which reflects that paid by end users.

A significant factor in the EEG's success has been and continues to be the fact that it is independent of the government's current budgetary policy. As the feed-in tariffs are fully financed by a levy system between producers, grid operators and consumers, there is no "EEG budget" that is subject to the whims of overall budgetary decisions.

This situation also helps provide the financial security desired by investors for the development of larger projects. This independence must continue as it is.

Costs and benefits of the EEG

Additional costs for society as a whole are of course also associated with the EEG, as it compensates for the difference between the lower market price for conventional energies and the costs for renewable energies. If the entire EEG levy of €4.5 billion for 2008 is considered per kWh unit of electricity, every consumer had to pay an extra 1.1 cents, which represents around 5% of the average consumer electricity price. When this figure is considered per average household in Germany, additional costs of around €3 per month arose.

On the other hand, the support for renewable energies has led to a remarkable boom for the industry. Alongside the €40 billion in turnover thanks to investments, operation and exports, the sector has also created 280,000 jobs so far.

Equipment efficiencies have increased significantly. For example, modern wind turbines now produce 50 times more electricity than turbines in 1990 did, thanks to innovative technology, larger rotor diameters and greater hub heights.

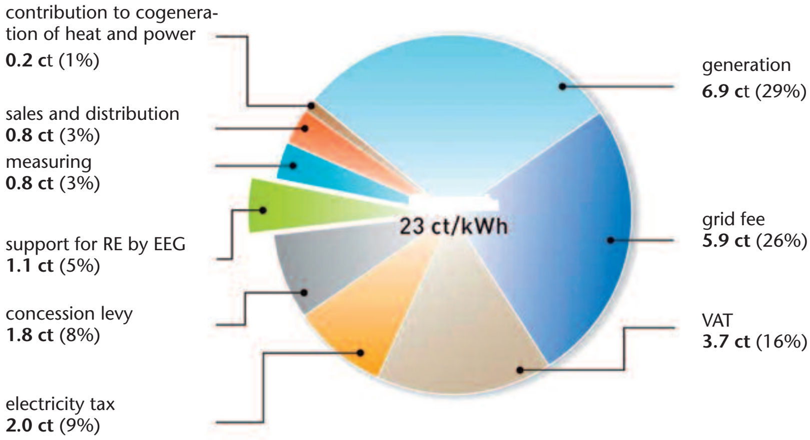
The CO_2 emissions avoided by renewable energies in 2008 amount to around 72 million tonnes for the electricity sector alone. If the CO_2 emissions avoided by the heating and fuel sectors are also included, around 110 million tonnes of CO_2 in the atmosphere have been avoided. No other climate protection instrument apart from support for renewables can boast similarly high levels of CO_2 savings. The specific costs of the savings per tonne of CO_2 differ and are higher than for other measures in certain cases; however, the potential for development and cost reductions for these technologies is great, and the demand envisaged on the world markets is immense too.

Germany's systematic support for research is indeed showing the way: Technologies that are

Figure 3
Make-up of the average consumer electricity price in Germany in 2009
Source: BDEW (2009)

Average Consumer Electricity Price 2009

Support for RE generates only a very small share of the average electricity price.



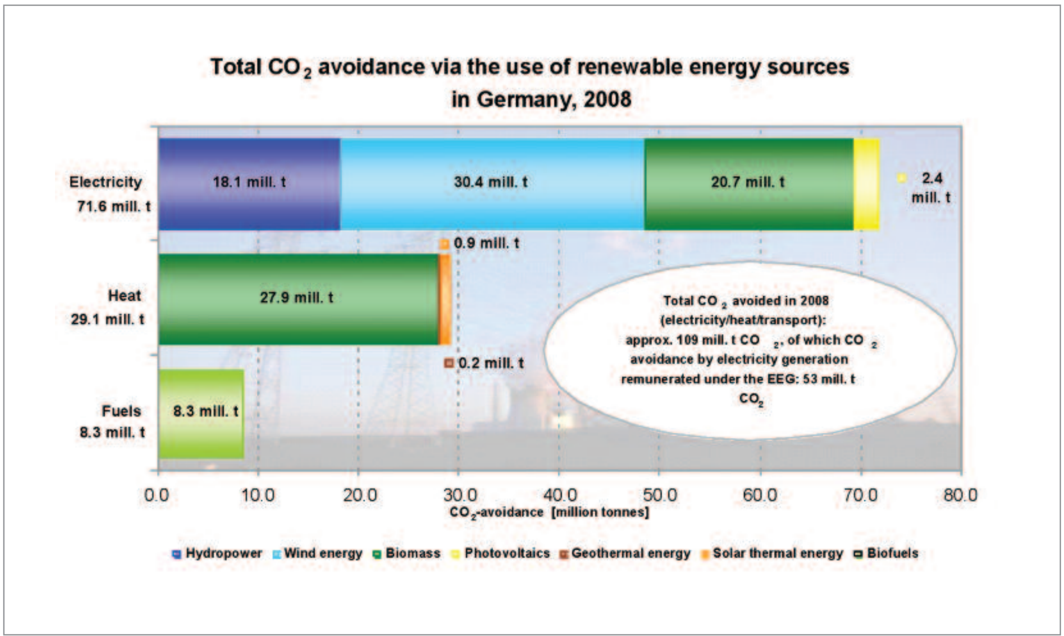


Figure 4
CO_2 avoidance thanks to renewable energies in Germany in 2008

Source: "Renewable energy sources in figures – national and international development" brochure from the German Federal Ministry for the Environment (2009)

not market-ready are developed by means of fundamental research, and technologies close to market maturity are launched with the help of incentives and are then subject to innovation cycles.

However, two weaknesses can be identified: With current funding of €161 million, fundamental research is not receiving the same level of financial support as in the USA or Japan, which are investing more heavily in their research capacity in the area of renewable energies. In addition, more effective research incentives must be developed in the areas of heat and fuels, which could potentially make major contributions to climate protection, in order to make progress here more quickly.

TREE – Transfer Renewable Energy & Efficiency – The Renewables Academy's knowledge transfer project

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More and more governments worldwide are setting ambitious targets for the expansion of renewable energies. The diversification of the energy mix by increasing the share of renewable energy sources is not only critical for the reduction of CO_2 emissions, but also offers an opportunity to harness new economic potential, particularly for numerous developing and emerging countries as these countries often have significant natural resources. Renewable energies offer secure energy supply and can stabilise electricity grids, even with a continuously growing energy demand. In subsidised energy markets, falling energy imports give the exchequer greater room for financial manoeuvre.

One difficulty with the practical implementation of expansion targets is that specialist knowledge is required for the successful and, above all, speedy development of the renewable energy sector.

Ministries have to develop laws and regulations, decision-makers from the private sector are in demand for the financing of equipment, the analysis of viability and the management of complex project processes, and engineers and technicians are needed for engineering design and for installation and maintenance. A lack of expertise at one of the bodies involved can quickly lead to a bottleneck in the value-added chain.

The TREE project (Transfer Renewable Energy & Efficiency) initiated by the Renewables Academy is implementing international knowledge transfer where all key participants are involved. Seminars on capacity building, which are available for various levels, provide decision-makers on policy and economic matters from developing countries, emerging countries and transition countries with the expertise necessary to implement renewable energy technologies in a fast and sustainable manner.

Other countries should benefit from Germany's experience in the last 20 years with the creation of suitable policy framework conditions and economic incentive mechanisms, the harnessing of financing methods, the establishment of commercial expertise and the implementation of technologies.

TREE is being supported by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) as part of the International Climate Protection Initiative, as decided by the German Bundestag. Income from the sale of CO_2 certificates for emissions trading is invested in national and international climate protection measures.

In 2008 and 2009, a total of 170 projects were initiated in developing, emerging and transition countries. TREE is one of these projects that aim to make cost-effective use of existing potential for the reduction of emissions and also to demonstrate the technological feasibility of innovative model projects for climate protection. Increasing energy efficiency, expanding renewable energies and the transfer of knowledge are all supported in a targeted manner.

RENAC offers seminar stipends for participation in TREE seminars on solar energy, wind power, bioenergy and energy efficiency technologies. The most important selection criterion is that the applicants be able to apply the knowledge they acquire in their everyday work as directly as possible and that they pass on this knowledge as widely as possible.

Participants in the courses for decision-makers familiarise themselves with requirements as regards policy framework legislation.


The RENAC training centre has a wide range of equipment from the areas of solar thermal energy, photovoltaics, wind power and energy efficiency for practical exercises.


Practical installation can also be practised in the photovoltaics courses.

However, other factors such as motivation, level of qualification and English-language skills also play a role.

In order to teach the principles of clean energy supply in the long term, the educational concept behind TREE is structured in a multi-dimensional manner. With the one-week introductory seminars in Berlin, every target group can learn about the technology aspects relevant to them: After an introduction to technology issues, decision-makers on policy and economic issues can learn more about the structuring of framework conditions, about project financing and management, and about economic viability, market entry, legal and insurance matters related to renewable energies. For engineers, the focus is on planning, installation, maintenance and quality management for equipment. Individual issues can be dealt with in more detail in later specialised seminars that build on the introductory seminars. Certain courses are also conducted in the target countries.

These seminars are then followed by an e-learning phase. In cooperation with the Beuth University of Applied Sciences in Berlin, RENAC has set up an online learning portal that participants can use to complete specialised seminars. In addition, participants can also use the online advice facilities to obtain suggestions and tips from lecturers on practical projects. Further services are also available in addition to the learning services – e.g. a series of publications for ministry staff regarding legal aspects of renewable energies or a mobile exhibition that offers a closer look at various technologies.

TREE was started in November 2008. In the first year, the 560 participants in total came from 14 countries in South America, Africa and Asia. This year, the states that have signed the IRENA (International Renewable Energy Agency) statute and those from the MENA region can also participate, i.e. a total of almost 100 countries.

The thematic focus this year is the training of project developers from industry and private sector service-providers, as the economic strength of a given country is increased when the prerequisites for investments are created and new areas of activity in energy efficiency and renewable energies are established. Since suitable policy framework conditions are the prerequisite for this, there is also a focus on courses for decision-makers on policy and representatives from specialist committees in the legislature area.

The training offered as part of TREE supports participants in expanding capacities in their own participating countries. The crucial element here is not only the transfer of knowledge, but also the initiation of international dialogue.

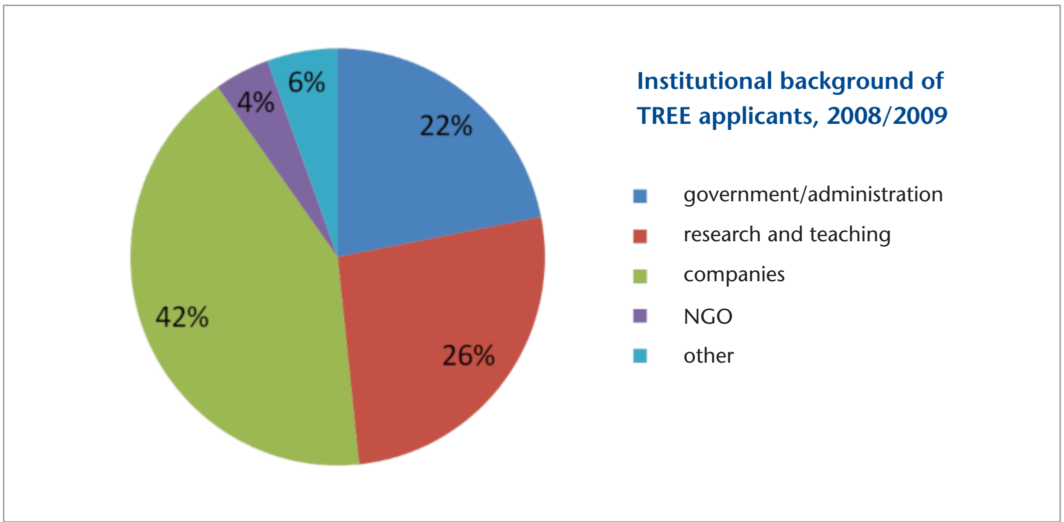
TREE 2009: Countries and number of participants

Country	Applicants	Total participants	Engineers	Decision-makers	Specialised seminars	Regional CSP seminars
Argentina	5	3	1	2	0	
Brazil	72	24	8	13	3	
Chile	62	100	13	4	10	83
China	106	13	4	6	3	
India	66	22	8	9	5	
Indonesia	59	19	3	8	8	
Jordani	56	80	8	13	1	62
Malaysia	82	26	9	8	9	
Mexico	68	21	8	7	6	
Namibia	47	54	9	13	0	42
Peru	35	88	2	10	2	81
Philipines	42	18	6	8	4	
South Africa	57	70	18	8	2	47
Thailand	77	20	10	7	3	
Total	834	558	107	116	56	315*

Total participants in seminars in Berlin and regional CSP seminars: 558

Participants in CSP seminars are not taken into account in the "Applicants" category, and some have also taken part in seminars for engineers and decision-makers.

Institutional background of TREE applicants, 2008/2009



The TREE seminars in Berlin represent an opportunity for participants from various continents to meet and exchange their experience. And they can stay in contact with the help of the TREE Community, and can discuss current problems or projects and thus ultimately contribute to the progress of the expansion of renewable energies in their own country thanks to the support of a worldwide network.

The project is being supported by the German Federal Ministry for the Environment: Additional information:

Weitere Informationen:
www.tree-project.de
www.renac.de

Tables

Seminars

Overview seminars for policy decision-makers
Brief description: Participants in these courses will receive a comprehensive overview of the most important technologies, how they work, and their possible applications. Strategies for the development of suitable framework conditions will be identified and financing instruments will be explained. Participants will be able to create important stimuli for the use of renewables and energy efficiency technologies in their own countries. **Topics** • Renewables (grid-connected) and energy efficiency: technologies, framework conditions, financing • Rural electrification: technologies, framework conditions, financing
Number of seminars: 4 **Duration: 5 days** **Location: Berlin**

Technology-specific specialised seminars for policy decision-makers
Brief description: In these seminars, the lifecycle of renewables and energy efficiency applications will be highlighted in various project phases and from the perspective of various participants such as financers, project developers, legal specialists and operators. Existing systems will be compared and analysed. Participants will be given specialist knowledge on technology, costs, financing, legal aspects, quality assurance and the necessary framework conditions. **Topics** • Grid-connected photovoltaics • Photovoltaic stand-alone systems (including examples of applications in water management) • Biogas and biofuels • Wind power (large-scale and small-scale) • Solar thermal energy (large-scale and small-scale) • Energy efficiency in industry and commerce, in the building sector and in the water sector • Hybrid systems
Number of seminars: 7 **Duration: 5 days** **Location: Berlin**

CSP seminars for engineers and decision-makers from the areas of policy and business
Brief description: The participants will acquire knowledge about the CSP technologies currently available, the state of the art in technology, and about possible applications. They will develop an understanding of the most important implementation steps and the main factors influencing the success of a CSP project. **Topics** • Prerequisites, technologies, project management, costs, financing, local value creation, grid connection and operation of solar thermal power plants
Number of seminars: 3 **Duration: 3 days** **Location: Abu Dhabi, Mexico, India**

Seminars for financers and project developers
Brief description: The seminars aim to support investments in renewables and energy efficiency projects by providing training for financers and project developers. Economic analyses of various technologies and of various application conditions are presented, and viability analyses, financing mechanisms and examples are introduced. **Topics** • Financing for renewables and energy efficiency with technical introduction, cost calculations, examples of financing
Number of seminars: 4 **Duration: 2 days** **Location: Malaysia, Abu Dhabi, South Africa, Mexico**

The CERINA Plan – An alternative to the Kyoto instrument

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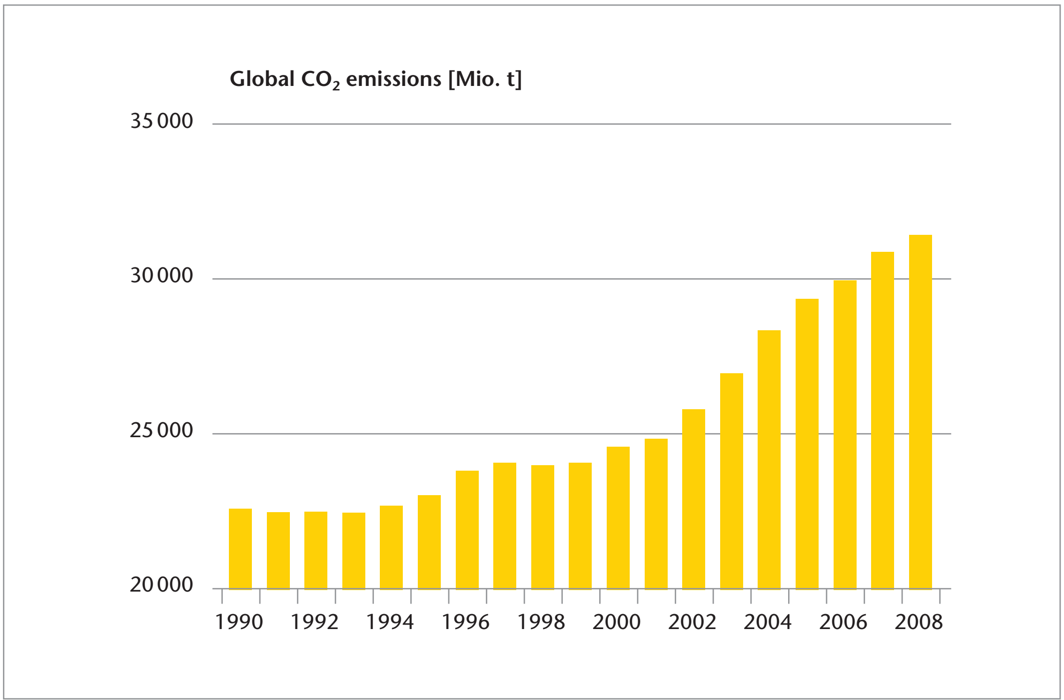
1. Introduction

International negotiations on a follow-up agreement for the Kyoto Protocol, which will expire in 2012, have stalled to a significant extent and it is currently not expected that agreement will be reached in Copenhagen. The Kyoto instrument is essentially based on the approach of limiting the CO_2 emissions of individual countries, with the amounts ideally agreed upon by the international community. An alternative instrument, the CERINA Plan (CO_2 Emissions and Renewable Investment Action Plan), will be presented here. Its model approach is based on investments rather than setting limits.

2. Worldwide CO_2 emissions – the status quo

Global carbon dioxide emissions in 2008 rose to a new record value of 31.5 billion tonnes and are thus 40% above the level of 1990 (IWR 2009). The goal of the Kyoto Protocol was to reduce emissions in Kyoto countries by 5.2% by 2012 relative to the reference year of 1990 (UNFCCC 1998). However, emissions have risen considerably worldwide because of economic development in numerous emerging countries. This outcome is evidence that the Kyoto limit mechanism does not work. One cause that can be identified is the fact that political representatives cannot or do not wish to accept economic limitations for their own countries in negotiations in connection with climate protection. Resistance in their home countries to upper limits and emissions trading with the threat of

Worldwide CO_2 emissions



companies moving abroad to new locations all lead to mistrust among politicians in the context of global competition for industrial investment.

This results in low levels of willingness to make voluntary commitments. These are the reasons why it is not expected that a new climate protection treaty will be agreed in Copenhagen. Even in the case of agreements between countries, the issues of whether and when CO_2 reductions will actually be implemented and what sanctions apply if targets are not reached are still open. The example of the Kyoto Protocol is evidence that these problems still remain.

3. The Cerina Plan – An alternative investment approach

The IWR approach is based on investments rather than setting limits. The basic principle of the CERINA Plan is to directly link CO_2 emissions of individual countries to investments in renewable energy. The higher a country's CO_2 emissions, the higher the investments they must make in renewable energy technologies. Every country emits CO_2, which means that every country is obliged to take responsibility and make a proportional contribution. The annual global increase in CO_2 is known (in millions of tonnes), which means that the necessary investments in renewable energy generation systems (electricity, heat, fuels) required to at least compensate, and thus slow down the global CO_2 increase, can be calculated retroactively.

In 2008, global investments in renewable energy systems totalled €120 billion. In order to stabilise the CO_2 emissions, the investments would have to be increased fourfold, to at least €500 billion per year, according to IWR calculations.

The most important aspect of the CERINA Plan is the distribution of the investments to the various countries, as determined by the CO_2 emission quantity in each country. The more CO_2 a country emits, the higher the investments required in the country. With total global CO_2 emissions of 31.5 billion tonnes, and investments totalling 500 billion euros required per year for renewable energies, this results in a theoretical CO_2 offset price of €16 per tonne. The specific investments in renewable energy technologies can be calculated for each country according to the country-specific CO_2 emissions. IWR calculated the investments in renewable plant technology required based on the individual CO_2 emissions for a total of 65 countries.

Sample calculations

According to the CERINA Plan, China, which currently has the world's highest CO_2 emissions at 6.8 billion tonnes (2008), would have to initiate annual investments in renewable energy technologies of 109 billion euros by means of political framework conditions to build wind, solar, hydroelectric or biomass-powered plants. India – with emissions of 1.4 billion tonnes of CO_2 – requires investments totalling 22.5 billion euros, while Germany would have to invest 13.7 billion euros, for emissions of 860 million tonnes. The CERINA Plan also takes smaller countries with lower emissions into account. For example, Hungary, with emissions of 60 million tonnes (2008), would have to organise investments of one billion euros, and New Zealand would require investments of 600 million euros.

4. Outlook

Copenhagen is unlikely to produce a binding climate protection treaty. As an alternative to the Kyoto instrument, the CERINA Plan offers an opportunity to establish a transparent, verifiable and clear system for the reduction of emissions.

The advantage of the CERINA model approach is that the direct linking mechanism gives each country two types of action to take to fulfil their obligations: They can either reduce emissions or increase investments in renewable energies. Accordingly, countries with lower emission values make lower contributions than countries with higher emissions. Each country can select the option suitable for them. In the end, the increasing proportion of renewable energies or the reduction of CO_2 emissions via savings or increased efficiency will result in a reduction of global emissions.

Further information and contact options:

www.cerina.org
www.iwr.de
www.renewable-energy-industry.com

Bibliographie

IWR (2009): Monatsreport „Regenerative Energiewirtschaft". Ausgabe 08/2009, Münster. (Online: www.iwrpressedienst.de/iwr/monats-report0809)

UNEP (2009): Global Trends in Sustainable Energy Investment. Analysis of Trends and Issues in the Financing of Renewable Energy and Energy Efficiency. Nairobi.
(Online: www.unep.org/pdf/Global_trends_report_2009.pdf)

UNFCCC (1998): Das Kyoto Protokoll zum Rahmenabkommen der Vereinten Nationen über Klimaänderungen. Bonn.
(Online: http://unfccc.int/resource/docs/convkp/kpger.pdf)