Knowledge series

Munich Re *newables*
Our contribution to a low-carbon energy supply

Münchener Rück
Munich Re Group

Installing photovoltaic modules: Faulty components of this type are an entrepreneurial risk for which the manufacturer can obtain coverage from Munich Re.

Dear Reader,

Climate change is not only a cause of concern for scientists and politicians. In the coming years, it will also pose an immense challenge for the industrial sector too, both in terms of the measures required to adapt to our changing environment and of the necessary endeavours to reduce greenhouse emissions.

Energy policy and economic policy will play a pivotal role here, for they must strike the right balance between security of supply, cost-efficiency and climate protection, despite a simultaneously spiralling worldwide demand for energy which is particularly pronounced in developing markets. Converting our energy supply sector to renewable energy sources and new technologies with low CO_2 emissions will be a key issue in the search for a solution to these conflicting interests.

As the world's leading reinsurer, we intend to contribute to the success of this conversion.

In every field – be it classical renewable energy sources such as wind and water, new means of generating electricity using solar thermal power plants or photovoltaics, geothermal energy or biomass, or even trading in pollution rights, not to mention such increasingly important technologies as those for the carbon capture and sequestration from coal-fired power plants – we are keeping an eye on all developments, can offer risk-transfer solutions and are close to the market.

With our excellent know-how, we can assess the risks and offer investors interested in new power plant technologies the necessary planning safety, thus supporting this conversion of our energy supply sector.

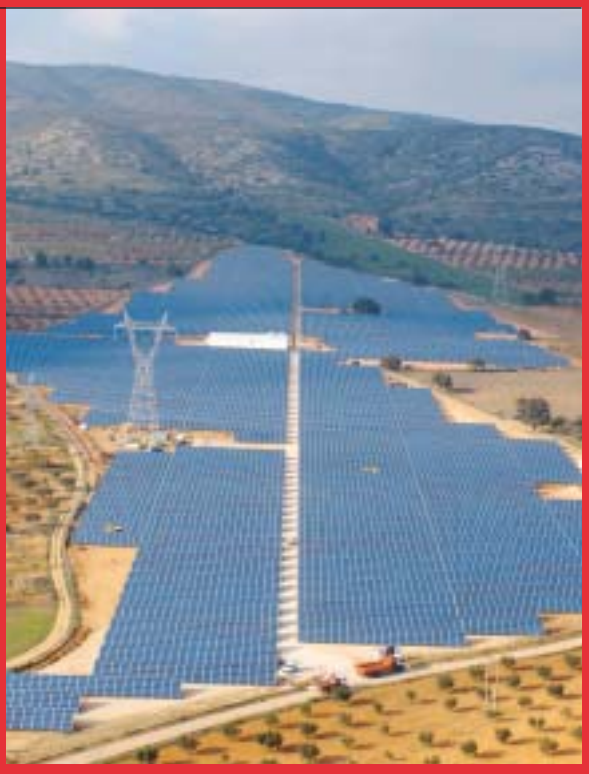
We are also ready to meet the future, for we are in constant contact with visionary thinkers and companies seeking to safeguard future energy supplies on an industrial scale with the aid of solar thermal power plants and new electricity distribution networks.

This publication presents Munich Re's contribution to a future energy supply with reduced CO_2 emissions. It is more than just a reprint of the "Renewable energies" brochure that originally appeared in 2004. It demonstrates the consistent development and improvement of insurance solutions in the rapidly changing "energy supply" growth market.

I hope you enjoy reading these interesting articles.

Dr. Torsten Jeworrek
Member of the Board
of Management
Chairman of the Reinsurance
Committee

Munich Re is keeping a close eye on developments in the energy mix of the future – including not only water, wind and sun but also new technologies such as carbon capture and sequestration.



Climate change and the finite supply of fossil fuels call for a long-term conversion of our power supply systems to renewable forms of energy.

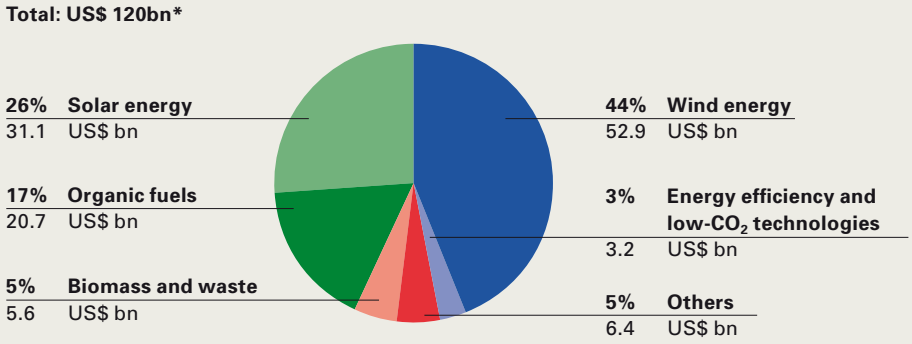
Energy mix of the future: New risks and opportunities

The long-term conversion of our energy landscape is a task with many facets: more money is being invested in renewable energy sources, new technologies are boosting the efficiency with which energy is used and alternative fuels are increasingly gaining ground in the automotive sector. Working towards the objective of a low-carbon energy supply, ambitious projects have demonstrated that they are both technically and economically feasible. Innovative solutions from Munich Re help to ensure that all parties can make use of the dynamically growing future energy market and minimise the associated risks.

The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) published in 2007 has confirmed that the follow-up costs of climate change will soar and that far-reaching consequences for mankind and the environment must be expected if we do not immediately and consistently enforce a more effective policy to protect the climate. According to the IPCC Report, future energy supplies will play a key part in the efforts to reduce greenhouse gas emissions. More efficient production, distribution and use of energy are also considered vital.

The long-term conversion of the energy landscape from today's dependence on finite, climate-damaging fossil fuels to energy sources with few or no carbon emissions is a matter of paramount importance if a sustainable, low-CO_2 supply is to be secured. In 2006, 79% of our electricity and heat was still being generated from fossil fuels. Rising

Fig. 1: Worldwide investment in renewable energy sources and energy efficiency in 2008



* Only includes new investment in energy supply, excluding re-investment, expenditure on research and development, and small-scale projects; excluding corporate takeovers and financial transactions.

Source: New Energy Finance 2009

energy demands inevitably drive up CO_2 emissions. Particularly in the dynamically expanding, newly industrialised countries, such as the BRIC countries (Brazil, Russia, India, China), economic growth has led to a dramatic surge in the demand for energy. By 2008, China's CO_2 emissions had already overtaken those of the USA.

In view of the negative consequences of climate change, the question of future energy supplies is increasingly becoming a focus of economic, social and political debate. Alternatives to conventional sources of primary energy are urgently being sought, not only in the industrialised countries with their high per-capita emissions, but also in the developing and newly industrialised countries with their large populations.

Fossil energy sources: finite and harmful

The fossil energy sources – oil, coal and gas – have two major disadvantages: their availability is limited and their combustion produces emissions which are harmful to our climate. It will become progressively more difficult for current reserves of the fossil raw materials, which supplied most of the primary energy consumed in the 19th and 20th centuries, to cover the rising demand of the coming decades.

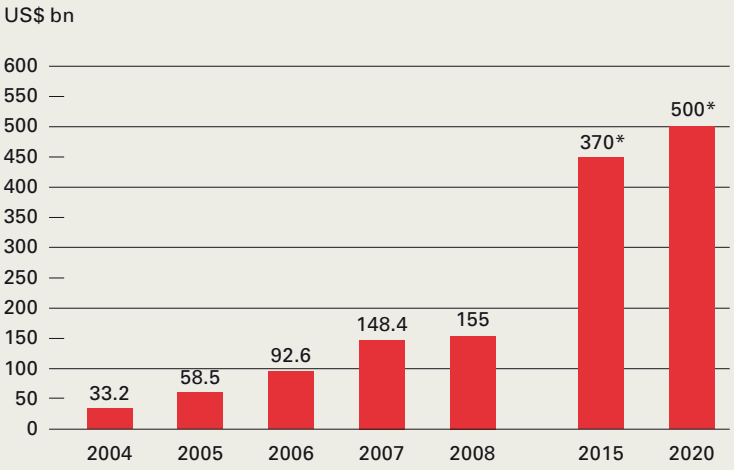
Raw material prices are therefore set to climb steeply in the long term, especially for natural gas and oil, which are in shorter supply than coal. In the coming decades, coal will presumably replace dwindling oil and gas supplies as a source of energy and will spiral in price as a result. This is why some national economies are focusing on nuclear power in their energy mix, although uranium is also a limited source of primary energy.

The shift towards a new energy supply has begun

Renewable energy sources have been constantly gaining momentum in recent years, especially in Europe. In 2007, renewable energy sources accounted for 8.5% of energy consumption in Europe (EU-25) and for no less than 18% worldwide (source: Ren21). Most of this energy is produced by hydropower plants and biomass. As the debate on climate policy progresses, the G8 countries are now planning to reduce global CO_2 emissions by 2050 to 50% of the level in 1990. Back in 2007, the European Union (EU-27) had already undertaken to reduce CO_2 emissions by 20% of the 1990 level, to boost energy efficiency by 20% and to increase the share of renewable energy sources to 20% by 2020. This goal is formulated in even more ambitious terms in the Fourth IPCC Assessment Report (2007): by 2030, renewable energy sources are to supply 30% of the world's electricity.

Although the measures implemented by individual countries to protect the climate differ considerably depending on basic political conditions, they all share the same goals: to reduce emissions with a gradual transition to renewable primary energy sources, to use new technologies for supplying energy and to make more efficient use of the energy.

Fig. 2: Development of worldwide investment in renewable energy sources and energy efficiency**



Annual investment in renewable energy sources and energy efficiency from 2004 to 2008, with projection to 2020.

* Prognosis
** Includes new investment in energy supply, re-investment, expenditure on research and development, and small-scale projects; excluding corporate takeovers and financial transactions.

Source: New Energy Finance 2009

Reinsurance assures growth for new energy sources

Many countries have introduced financial incentives for investors by directly promoting renewable energy projects and new technologies or by implementing state rulings to increase earnings from feeding-in power from renewable sources. Capital investment in renewable energy sources has soared in recent years, totalling US$ 155bn worldwide in 2008. Most of this capital is invested in wind power (44%), solar energy (26%) and organic fuels (17%) (see Figures 1 and 2).

However, the transition to future energy supplies using new technologies also gives rise to new risks. Some are inherent in the technological innovations, while others stem from liability issues similar to those already known from other technologies. And then there are new enterprise risks.

Dependence on the weather and economic-policy decisions harbour enterprise risks

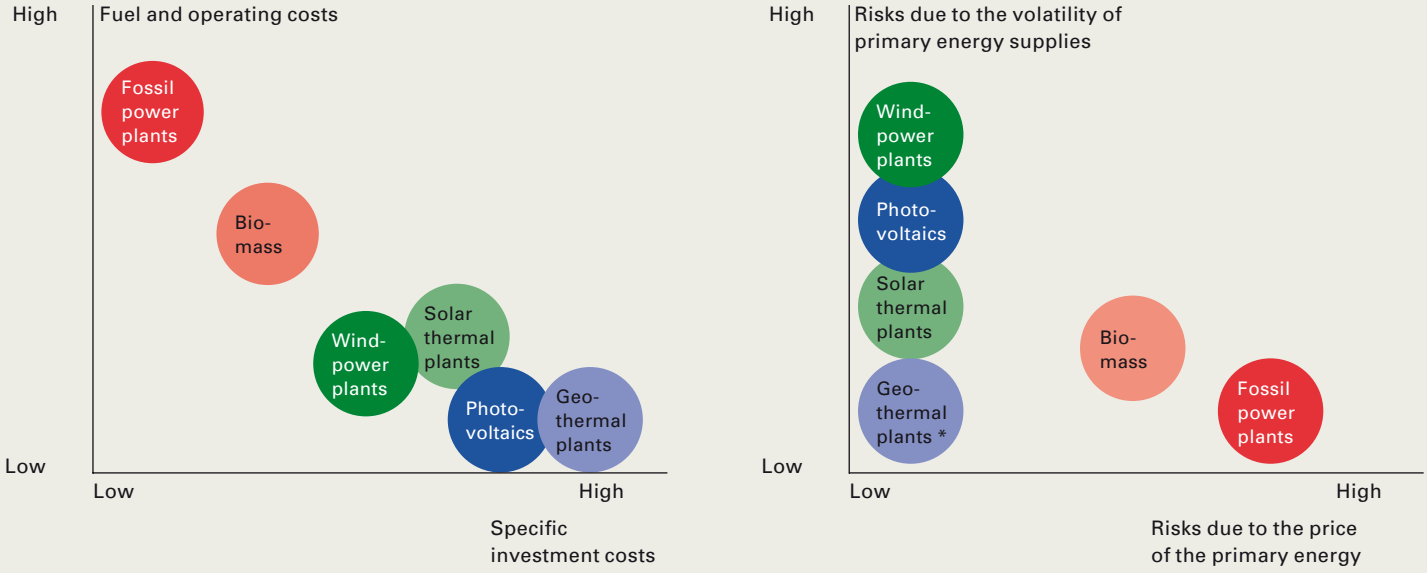
Solar irradiation and the wind supply primary energy free of charge, but the amount of energy available fluctuates considerably over time, even in eminently suitable locations, thus leading to fluctuations in the revenues which can be generated. For (potential) investors, the volatility of the returns may exceed tolerable levels.

Particularly during credit market squeezes, banks have a very great interest in ensuring the best possible flowback of funds from projects. Volatility must be minimised. To this end, Munich Re offers "wind covers" (in the event of too much or too little wind) and "lack-of-sun" covers which are tailored to the specific needs of an investor or financing institution.

Projects which generate electricity, heat and fuel from biomass (cereal, sugar cane, field crops) compete with other forms of use for such vegetable raw materials, especially the production of food and animal feedstuffs. In addition to possible ethical and moral conflicts, such competition also creates price risks.

The risks for renewable energy projects arising from the long-term development of feed-in revenues for electricity, heat and biogas, as well as possible revenues from CO_2 certificates, are predominantly political in nature, particularly in conjunction with the "clean development" and "joint implementation" mechanisms (CDM and JI) defined in the Kyoto Protocol.

Fig. 3: Costs and risks of different forms of energy production



The diagrams illustrate the different costs and risks confronting the parties concerned in the various branches of renewable energy production.

* Exploration risk not relevant for the operating phase.

Munich Re supports the development of renewable energy sources with innovative risk transfer products

As a pioneer for climate change and renewable energy sources in the insurance industry, Munich Re supports both the development of new energy technologies and the goal of reducing CO_2 emissions worldwide. Our strength lies in professional risk management and the competence to develop innovative and economical new risk transfer products, together with our clients, to the benefit of both the market players and the environment (see articles on pages 16 and 34).

In the case of projects involving renewable energies, losses in the double-digit million range are becoming increasingly common. This shows the growing demand for insurance in this branch of industry. Munich Re's clients can rely on the technical know-how, worldwide experience and individually tailored insurance solutions offered by our experts. There is great economic potential in the dynamically growing energy industry, but it also faces new risks associated with the new technologies and products. Munich Re relieves companies and investors of these risks so that they can concentrate on their business and profitable growth.

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New technologies and insurance concepts – Empowering our clients to succeed

Manufacturers, project companies, operators, energy suppliers, investors and insurers are all interested in lowering CO_2 emissions and benefiting from the fast-growing renewable energy sector.

The technical approaches to renewable energy generation have reached various stages of development. They involve very different challenges and risks for those concerned and demand much experience and innovative thinking.

The challenge

Before a plant is ready for commissioning, the various parties in the project face a variety of challenges and risks – risks that can erode reserves, reduce earnings or even scupper the entire project.

The solution

Munich Re's experts are able to appraise the various risks and offer individual solutions. The performance insurance thus protects against unexpected losses in earnings.

Sunny future

Suppliers, project-development companies, operators of and investors in solar thermal power plants are players in a fast-growing market. Munich Re offers innovative insurance solutions that allow them to exploit the market's economic potential.

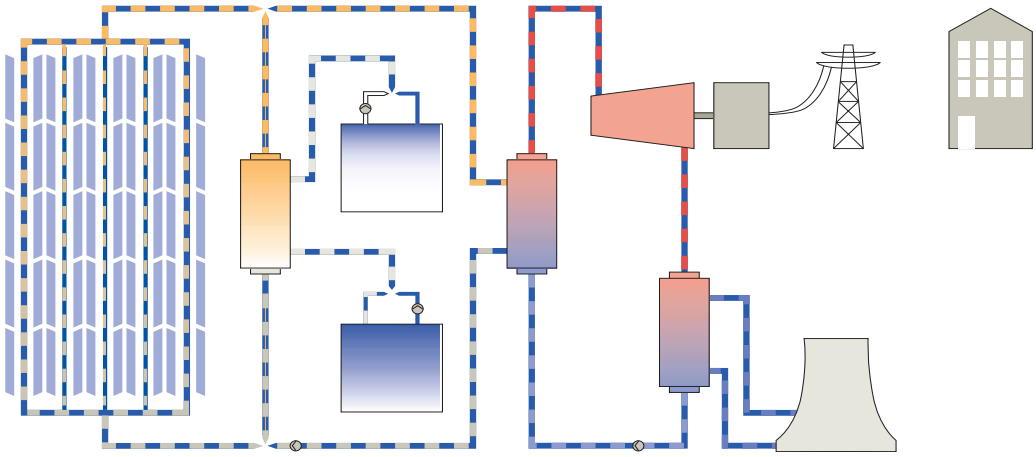
Huge parabolic mirrors dominate the scene at solar thermal power plants.

Ambitious projects, up-and-coming firms, high hopes for the future – the solar thermal sector is dynamic. Concentrating solar power (CSP) technology uses the sun's heat to produce energy. In contrast to photovoltaic systems, solar thermal power plants concentrate the sun's rays first before converting the solar energy into electricity. In standard parabolic trough solar plants, parabolic mirrors direct the sun's rays onto receiver pipes along the focal line of the collector, heating the thermal oil in the pipes to several hundred degrees Celsius. This energy is used to power conventional steam turbines to generate electricity (Fig. 4).

The key advantage of solar thermal power plants over photovoltaic systems (which cannot store the electricity generated) is that they are able to store thermal energy. This energy is collected during sunny periods, allowing for electricity generation during the night or periods with little sun. In this way, solar thermal power plants serve to cover basic electric power demand. During periods of maximum solar radiation, the sun's energy not only generates steam but is also used to liquefy special salts stored in a salt tank. Controlled cooling of these salts during periods of little sunlight releases energy which can then be used to generate steam and consequently electricity.

Fig. 4: The components of a solar thermal power plant

A parabolic trough power plant comprises the solar field, the thermal storage and the power block with turbine and generator.



Solar field **Thermal storage** **Power block**

High investment costs, numerous risks and a great deal of pressure from all sides

For technological reasons, solar thermal power plants are only economically viable above a certain size. New projects often attain previously unrealised dimensions, even though the proportion of familiar and tried-and-tested components used to generate the energy is very high, thus pushing planning and construction costs to several hundred million euros.

On the one hand, business models for solar thermal power plants are based on the local meteorological conditions and the remuneration for electricity supplied to the public grid, which is usually subsidised by the state. On the other hand, they also depend decisively on the performance and availability of the technology. To safeguard the return on their investment, investors also demand additional bank guarantees to cover the contractual obligations imposed on them by the customer, which ties up additional equity.

As a result, the mostly small or medium-sized project-development companies with limited financial resources are often compelled to borrow heavily from a hesitant capital market. The same applies to everyone involved: failure of a single link in the chain to fulfil its contractual obligations can jeopardise the financial success of the entire project. Delays in starting up can result in loss of income for both the operator and consequently also the investors.

Munich Re supports the solar thermal industry right up to commissioning – and beyond

Before a plant is ready for commissioning, the various parties in the project face a variety of challenges and risks – risks that can erode reserves, reduce earnings or even scupper the entire project. Munich Re's experts are able to appraise the various risks and offer individual solutions tailored to all the companies in the value chain:

– Suppliers and component manufacturers: The insurance needs of suppliers and component manufacturers vary widely, from CAR and EAR policies for new manufacturing plants to property covers and product liability. Finished components which are being delivered to the site require marine cover. Loss of profit due to delayed start-up of the project following transit losses can also be insured.

Andasol 1 power plant: Situated in the middle of the solar field are the salt storage and the power block with turbine and generator.

– Contractors, owners and operators: EAR insurance is needed to cover losses incurred on site during the construction of the power plant, as well as loss of profits – under a supplementary ALoP cover (advanced loss of profits) – due to delays caused by damage or losses during construction. Third-party liability insurance is required during construction and operation.

– Project-development companies: Munich Re also offers products minimising the entrepreneurial risk of project-development companies and consequently also the risk of a substantial loss of profits for the investors.

Innovative performance covers to protect investors

For investors, delay in start-up, reduced technical performance or unexpectedly low annual solar radiation can result in a loss of profits not covered by "classic" insurance.

Operation soon becomes uneconomical if a solar thermal power plant is unable to generate the planned electrical output: investors and banks see flow of payments and debt servicing at risk. Munich Re has developed an innovative insurance product for precisely this risk: its performance insurance is designed to secure the power plant's completion or performance parameters, thus guaranteeing the flow of payments and debt service. The product transfers some of the plant's engineering risk from the banks or investors to the insurer. The main advantage for the customer of such a risk transfer is that the cost of borrowed capital can also be reduced.

In order to be able to offer these special insurance solutions, Munich Re works closely with all the parties involved in a project, carefully balancing the various interests and the need for insurance.

Not oil but electricity from the desert?

In tomorrow's sustainable energy mix, solar thermal power plants could make a key contribution as a reliable source of energy. Scientific institutes specialising in this technology presume that electricity from solar thermal power plants will be able to compete with electricity from fossil fuel power plants in just a few years from now. Considerable potential for solar thermal power plants exists in the sun-rich southwestern USA, southern Europe and northern Sahara. From there, solar thermal plants could even export electricity to Europe via submarine cables or by ship in the form of liquefied hydrogen.

A strong partner – Munich Re supports clean, innovative alternatives to fossil-fuel power plants.

Parabolic-shaped mirrors direct the rays of the sun onto the collector at the focus of the parabola. The thermal oil in the collector is heated to a temperature of several hundred degrees centigrade.

The construction projects involved are immense and require huge investments, not only for the power plants themselves, but also for the related infrastructure. At the same time, such ambitious projects also need a strong insurance partner – one with a global presence, such as Munich Re, whose expertise and solutions will help promote sunny and profitable times for the industry.

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Harvesting the sun

An interview with Christian Beltle,
CEO of Solar Millennium AG,
on the perspectives of solar thermal power plants.

"We expect these power plants to be fully competitive within a few years."

Munich Re: The Andasol power plants you constructed in Andalusia are the first European plants to use parabolic trough technology on a commercial scale. How do you view the growth potential of this technology?

Christian Beltle: Commercial electricity production by solar thermal power plants has enormous growth potential. Cautious estimates indicate that a total capacity of around 20,000 MW will have been installed by 2020 – the equivalent of 400 Andasol power plants. In Spain alone, plants with an overall output of some 700 MW are currently under construction or have already been completed.

Munich Re: Large solar thermal power plants can slash CO_2 emissions. What investment costs per MW of installed capacity must be expected in the medium to long term?

Christian Beltle: The investment costs per kilowatt of installed capacity are currently in the order of €6,000 to €7,000 per power plant. However, these plants cannot be directly compared with other renewable energy sources, for the costs depend above all on whether or not the power plant has an integrated storage system or a supplementary fuel system. Power plants with a storage system, such as the Andasol plants, are more expensive than those without, but they also produce a great deal more electricity in the same period of time. The Andasol power plants achieve almost twice as many operating hours as a solar thermal power plant without a storage system.

I suggest using the kilowatt-hour as a reference parameter for the purposes of comparison. Depending on the site-specific solar radiation, we are currently talking about costs of roughly €0.25/kWh in Spain and around US$ 0.15/kWh in the south-western USA. These electricity generating costs are expected to decline by 20% to 40% during the next five to ten years, as market volumes increase and innovations are developed.

Munich Re: What basic political conditions need to be created to ensure that this technology can compete with conventional power plants?

Christian Beltle: These power plants are expected to be fully competitive within a few years, especially in comparison with fossil-fired peak and medium-load power plants. To achieve this objective, i.e. to develop the markets and simultaneously improve the technology, the political framework must be created today.

Among other things, we need to make investing in solar thermal power plants an attractive proposition, for example by using the feed-in tariff in many European countries, subsidies from the World Bank and Global Environment Facility (GEF) or so-called Investment Tax Credits (ITC) in the USA, as well as other incentives and regulations for avoiding the emission of climate-changing greenhouse gases. Concrete examples include trading in emission allowances or the quota incentive structure in the United States – Renewable Portfolio Standards (RPS) – which require utility companies to generate a certain percentage of their energy from renewable sources. However, we believe that feed-in tariffs bring more benefits than quota rulings, as they offer greater planning safety for project development.

Munich Re: What, in particular, are the technological risks associated with solar thermal power plants?

Christian Beltle: Solar thermal power plants present relatively few technological risks. In the United States, parabolic trough power plants have been generating electricity from solar energy for more than 20 years without encountering any major failures or incidents. The figures available for the nine power plants currently in operation in California are convincing and provide a sound basis on which to assess the risks for new power plants. The storage technology based on molten salt which is used in our Andasol power plants in southern Spain has already been used for decades in the electroplating industry and other sectors of the chemicals industry, so that extensive experience is also available here.

Nonetheless, there is still some scope for optimising the technology, and also Solar Millennium is concentrating on doing so. One of the most important objectives is to bring down the costs of the technology. We are therefore further developing new generations of solar collectors, as well as their key components, working with the respective manufacturers. Direct evaporation of water in the absorber tubes is another area for potential optimisation, as this will eliminate the need to circulate heat transfer fluid, permitting higher temperatures. The use of solar thermal power plants for desalination and cooling processes is also under investigation.

Hybrid operation of solar thermal power plants is yet another important topic, as it will permit reliable baseload, i.e. 24-hour, operation. In this field of research, we are working on a combination of solar energy and hydrogen-rich gas which we intend to produce from regenerative residual materials. A demonstration project called "Blue Tower" is being prepared in order to qualify the required technology. Moreover, the commercial viability of solar-chimney power plants is being examined as an alternative to parabolic trough power plants.

Munich Re: How can the insurance sector support such projects?

Christian Beltle: The insurance sector is a fundamental cornerstone of Solar Millennium's work. Real economic cooperation can only be realised through an understanding of our business activities and the correct assessment of risk linked to a long-term approach to risk transfer.

Christian Beltle,
CEO of Solar Millennium AG.

Erection projects for solar thermal power plants involve several points of common interest: firstly, the coverage of traditional risks associated with the construction and operation of the plants, and secondly the overall financial planning and financing of power plant projects. Above all, I see further interesting opportunities for business in the design of "non-traditional" insurance products, such as those covering the power plant parameters that have to be guaranteed when such projects are implemented in collaboration with construction and financing partners. Moreover, I feel that the renewable energy sector is notably underrepresented in the portfolio mix of European insurance companies and am confident that this will yield clear opportunities in the coming years.

The challenge

The key production factor for operators of wind farm projects is the wind. But the wind speed cannot be influenced, giving rise to a new type of entrepreneurial risk.

The solution

Munich Re offers covers that compensate for reduced earnings whenever wind turbines cannot produce enough power due to gales or a lack of wind.

Guaranteed earnings, even in windstill conditions

Renewable energy sources using wind, water and sun are future technologies destined to reduce our dependency on conventional energy sources in the long term. They are now also considered a profitable investment. But the returns on such projects are susceptible to a very particular kind of risk – a fact which is often overlooked – for there is no way of influencing the weather.

Wind farms help to reduce global CO_2 emissions: the environment always benefits – but investors can only reap the rewards within a specific wind-speed range.

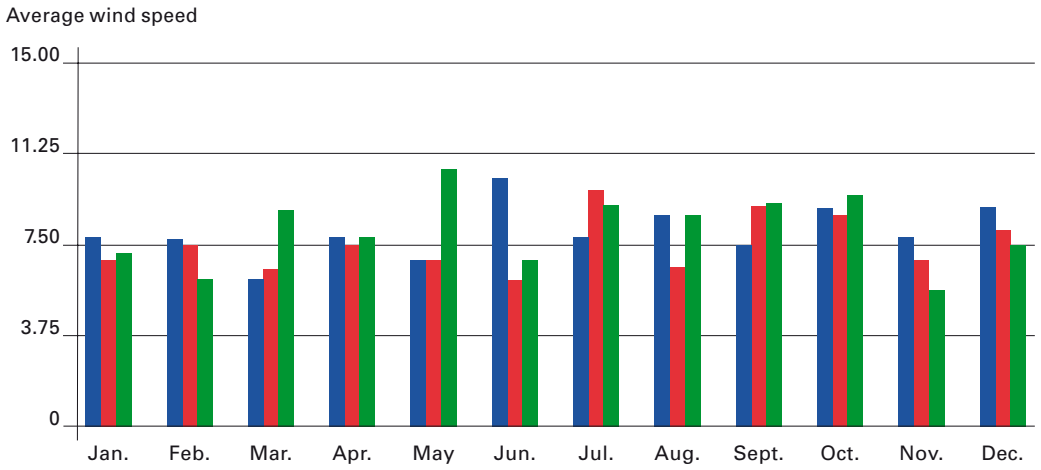
The phenomenon is particularly evident in wind farm projects: forecast earnings can quite literally be blown away. If the wind speed is too high or low, the quantity of electricity generated can fall below the expected value calculated by an expert for a prolonged period. This leads to a loss of income which, in some cases, may jeopardise the repayment of project financing funds. A cover for this risk can appreciably improve the creditworthiness of an operator. This is because innovative cover concepts from Munich Re provide planning security for operators, investors and financers.

At onshore wind farms, the rotors stop turning when the wind speed drops below around 14 km/h. At speeds above this level, the higher the wind speed, the more energy the operators can feed into the grid. However, the turbines have to be shut down at very high wind speeds – generally from around 90 km/h. Otherwise, rotors and other plant parts could be damaged. Wind conditions thus dictate the annual income. And depending on how high or low the wind blows, this can deviate – sometimes substantially – from the forecast average values.

Too much wind, too little wind –
We safeguard our clients' earnings.

Fig. 5: Fluctuating wind conditions put earnings at risk

The diagram shows exemplary fluctuations in average wind speed per month in the years 2004 to 2006.



Tailored concepts minimise the financial impact

When facing this entrepreneurial risk, the operator of a wind farm need not have to brave the financial headwinds all alone. Munich Re offers its customers a needs-based product against the whims of nature – the risk of too little or too much wind. The innovative insurance solutions cover the loss of income, for instance on an annual basis. If the average wind speed measured falls below a specified value – known as the trigger – the policy indemnifies the equivalent value of the corresponding decrease in electricity generated. The amount paid out is based on the charges which the operator could have earned – in Germany, for example, it would be based on the minimum charge set forth in the German Renewable Energies Act (EEG). However, this product is only suitable for regions in which strong winds are uncommon and the shutdown of turbines is therefore regarded as a rare occurrence.

In response to this situation, Munich Re is working closely with its customers to develop more sophisticated solutions, too – adapted to the level of detail of the available data, the individual situation and the attitude to risk-taking of each wind farm operator. By these means, needs-oriented cover can be tailored to the potential output, for example: based on the average wind conditions measured daily compared with the planned energy output. To this end, the potential electricity output is calculated for each day, applying the production function specific to the plant. This production function indicates how much electricity can ideally be generated, depending on the prevailing wind speed. If, on an annual average, the sum of the potential electricity output figures on individual days falls below the planned level, the insurance covers the difference – i.e. the value of the amount of energy not produced.

Operators and investors alike benefit from Munich Re's solutions: their annual turnovers are safeguarded against the risks of wild winds or balmy breezes.

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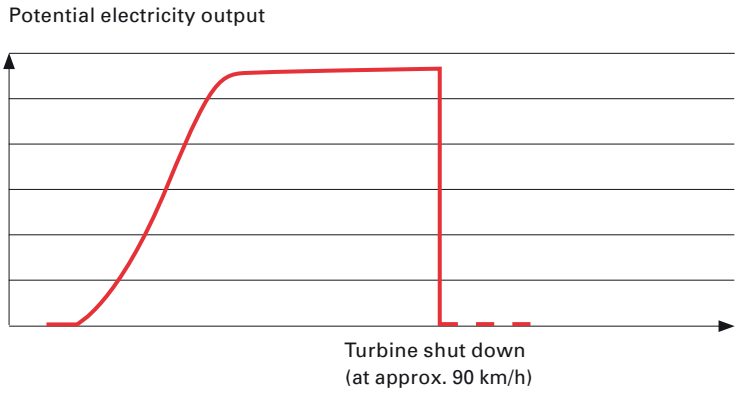
Wind power plants with innovative insurance cover always generate sufficient return.

Fig. 6: Schematic diagram of production function



The higher the wind speed, the more electricity the wind farm can produce. However, the production function also shows that once the optimum wind speed has been reached, more electricity cannot be generated even at higher speeds. The wind turbine operates at maximum capacity and the production output remains constant. At winds speeds of more than about 90 km/h, the turbines must be shut down.

Risks before commissioning

Even during the installation phase of a wind farm, there are numerous risks which can jeopardise the economic success of the project. These include the classical property and financial loss risks associated with installation, for which a large range of established insurance products are available.

At the same time, investors or purchasers frequently require insurance against risks due to non-fulfilment or poor fulfilment of performances warranted by the manufacturer, so as to ensure completion of the project as contractually agreed. In many cases, the required collateral cannot be provided by the manufacturers themselves, who commonly lack the necessary capital. It is hence frequently obtained through banking or insurance products, such as bonds, guarantees and indemnities.

The many types of security demanded by the customer even when inviting bids for a wind power project can include the following bonds, for example:

- Bid bonds to cover a manufacturer's funding capabilities during the bidding and planning phase
- Completion bonds to cover completion of the project
- Performance bonds to cover the plant's contractually warranted technical capabilities

Munich Re offers tailor-made insurance and reinsurance solutions here as an alternative to the classical banking products.

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The challenge
Safety has to be ensured during the transportation and installation of offshore wind farms in rough seas.

The solution
Close cooperation with the offshore warranty surveyors brings about more safety and minimises losses.

Offshore wind farms: A secure foot in the sea

For owners, investors, banks and insurers of offshore wind farms, the construction phase can be a trying time. With its know-how and risk-commensurate coverage concept, Munich Re contributes considerably to minimising losses.

In future, the energy generated by offshore wind farms will contribute a significant share to the energy mix.

The general public and political circles are pinning their hopes on offshore wind technology. As the energy yield of offshore wind farms is roughly 40% higher than on land, many countries are banking on having a large share of offshore wind power in their mix of renewable energy sources. In Europe alone, the number of wind farms planned for the North and Baltic Seas is substantial. The European Wind Energy Association (EWEA) expects offshore wind farms with a total installed capacity of 40 GW (the equivalent of roughly 50 coal-fired power plants) to be in operation in Europe by 2020. This poses a major challenge for all the industries involved.

It takes roughly a three-year construction phase fraught with technical and logistical difficulties before a wind farm is ready to prove that it can function long term in a challenging environment. The various components of offshore plants, such as nacelles, rotor blades, tower segments and piles that anchor it to the seabed, are all produced on land before being transported to their final location at sea by special ships and installed on site by huge cranes. Utmost care and attention are called for in this phase, for instance when loading the parts (loadout) and securing them on board the ships for transport to the installation site (seafastening).

The components of offshore wind farms are manufactured on land. They may sustain considerable damage during loading.

Calm seas and preferably no wind are ideal conditions for installing the offshore wind turbines. Reliable weather forecasts are essential, together with a great deal of experience and the resolve to postpone installation work if weather conditions unexpectedly deteriorate. Laying the main cable connecting the wind farm to the onshore grid is another challenge. Considerable care must be taken when laying new cables over existing pipelines, power cables or telephone lines to avoid damaging or impairing these.

Munich Re supports the offshore warranty surveyor with experience from other offshore wind projects it has already covered

With a view to guaranteeing safe transport and installation, operators of offshore wind farms engage independent experts or offshore warranty surveyors to take on any additional tasks needed to ensure that the work proceeds safely and without losses. Originally deployed in the offshore oil and gas industry, offshore warranty surveyors have also become standard practice in the offshore wind energy sector. For most insurers of offshore wind projects, an extended project-related use of offshore warranty surveyors is also a mandatory requirement for the insurance of such projects.

Since 2001, Munich Re has provided innovative coverage concepts to accompany offshore wind power developments. As a global player, Munich Re was consequently able to collect invaluable experience in a number of insured offshore projects – ultimately to the benefit of customers and owners. Together with the project's offshore warranty surveyor, Munich Re also contributes valuable experience from the perspective of a reinsurer, for Munich Re's experts know exactly which risks have already resulted in losses in similar projects worldwide in the past.

In close consultation with the client, Munich Re develops a catalogue of tasks specially tailored to the specific project and set out with binding force in the policy's warranty clause. The schedule of tasks for the offshore warranty surveyor outlines additional information that may be required for reviewing specifications and procedural instructions. It also stipulates concrete requirements, such as exactly when surveyors must be present at the offshore site; particularly during high-risk phases and installation activities they can help minimise risks by applying their long-standing experience.

Our knowledge enables us to minimise the risk during the construction phase.

It takes calm seas, a lot of experience and good judgement during installation.

Profiting safely with Munich Re from wind energy even in rough seas

Collaboration with Munich Re and the offshore warranty surveyor brings considerable added value for the customer. In addition to the marine warranty survey, the customer can also rely on Munich Re's consistent risk management. Even during the risk analysis, quotation and initial talks, Munich Re also provides invaluable information on aspects that may increase risk.

In the future, risks may grow or additional risks could arise as new wind farms are commissioned, possibly even with shared use of the same cable routes connecting them with the shore. Along with property damage and business interruption losses, attention will increasingly focus on third-party liability risks. With its innovative coverage concepts and experience of numerous offshore projects, Munich Re will continue to ensure that offshore facilities can be installed and operated as safely and profitably as possible, in the interests of their operators and investors.

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The challenge

Many insurers are currently exploring the impact Kyoto will have on their business, and also the risks and opportunities that the Kyoto market mechanisms will open up.

The solution

With its Kyoto Multi Risk Policy, Munich Re is offering a coverage concept providing buyers and sellers of carbon credits with comprehensive insurance protection.

Carbon credits – Sure enough!

An increasing number of climate-friendly projects are being carried out in developing and emerging countries as a result of the mechanisms established by the Kyoto Protocol. With its Kyoto Multi Risk Policy, Munich Re protects stakeholders against the many challenges and risks associated with these projects.

Companies that need to increase their emission allowance must buy credits from those who pollute less.

The project mechanisms of the Kyoto Protocol ("Kyoto") are a "win/win" answer to the problems of climate change, creating benefits for stakeholders and the environment alike: companies from developed nations invest money, know-how and resources in greenhouse-gas-reducing activities in developing countries. The projects generate "carbon credits" in respect of the greenhouse gas emissions not put into the atmosphere, which are sold to help finance the projects. The developed-nation companies can then offset these credits against part of legally binding limits on their greenhouse gas emissions, or sell them in carbon-credit markets.

Carbon credits are a completely new class of financial assets and until Kyoto's first phase, which started in early 2008, no one had to consider what to do to protect them. As of January 2008, however, these assets have a demonstrable value – they are earned as a by-product of project activities transparently audited by internationally renowned certification firms.

The expansion of emissions trading schemes is creating potential for coverage concepts like the Kyoto Multi Risk Policy.

One look at the size of this new asset class shows that there will be increasing demand for protection. As of the third quarter 2008, more than 4,000 projects were registered or in the process of registration under the Clean Development Mechanism, one of the two project mechanisms established by Kyoto. The market value of carbon credits up to 2012 from these project mechanisms is in the region of €25bn, driven largely by EU companies needing to meet their compliance limits. To date, the Kyoto Protocol has been ratified by most of the world, the notable exception being the USA, whose participation would increase demand for carbon credits exponentially.

Kyoto Protocol too difficult to grasp for insurers?
Whilst insurers are evaluating what impacts climate change will have on their business, they are mostly not considering what risks and opportunities are opened up by the Kyoto market and project mechanisms. Kyoto seems to have been placed on the "under review" pile, perhaps because of its apparent complexity and the multi-line input its underwriting requires, the latter always being a tremendous challenge.

However, with Munich Re's support, insurers can harness their existing expertise and risk management skills and take advantage of this unique opportunity.

Munich Re's Kyoto Multi Risk Policy: Innovative, cross-line approach
As a result of detailed analysis, drawing on underwriting skills from a number of disciplines, Munich Re has created a comprehensive policy designed to be issued by cedants, called the Kyoto Multi Risk Policy (KMR).

For buyers of carbon credits – companies which need the credits for compliance, carbon project aggregators, investment funds, project finance banks and commodity traders – the policy reflects the fact that buyers are unlikely to have a direct and insurable interest in the project assets, whereas for project owners/developers (sellers), project assets can additionally be covered.

A special feature of KMR is that it is a multi-line product. KMR therefore has a modular coverage structure and covers a wide range of perils from physical damage, machinery breakdown and political risks to insolvency – with the capability of being extended to other areas, such as weather-related events and technical performance risks, where appropriate. But Munich Re has been careful to structure it in such a way that it does not cover unmanageable risks.

Through KMR, Munich Re provides cedants with a way of protecting clients whose aim is to successfully invest in projects which benefit the planet by reducing the emissions of harmful, man-made greenhouse gases, including projects which generate low-carbon, sustainable energy.

Generate new business and thereby promote reductions of carbon emissions
Kyoto opens up a completely new risk segment for insurers that offers potentially high growth rates. By underwriting these new risks, insurers demonstrate to shareholders, customers and employees that the insurance market is not just self-interestedly adapting to change, but is actively working to help reduce climate-change greenhouse gas emissions.

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The Kyoto Multi Risk Policy in a nutshell

The policy sections of Munich Re's Kyoto Multi Risk cover:

– The construction phase (property)
– The operational phase (property and machinery breakdown)
– Political risks
– Insolvency risks
– Specified performance risks (manuscript section)
– Weather risks (manuscript section)

The challenge

The potential for reducing carbon emissions contrasts with the known and unknown risks facing the providers and operators of carbon capture and sequestration plants.

The solution

Munich Re provides its clients with support and advice in realising CCS power plant projects.

Carbon capture and sequestration: A future technology with many unknowns

New technologies for sequestering carbon dioxide can significantly help to reduce CO_2 emissions from fossil-fired power plants, but many questions remain to be answered before they can be used on a commercial scale.

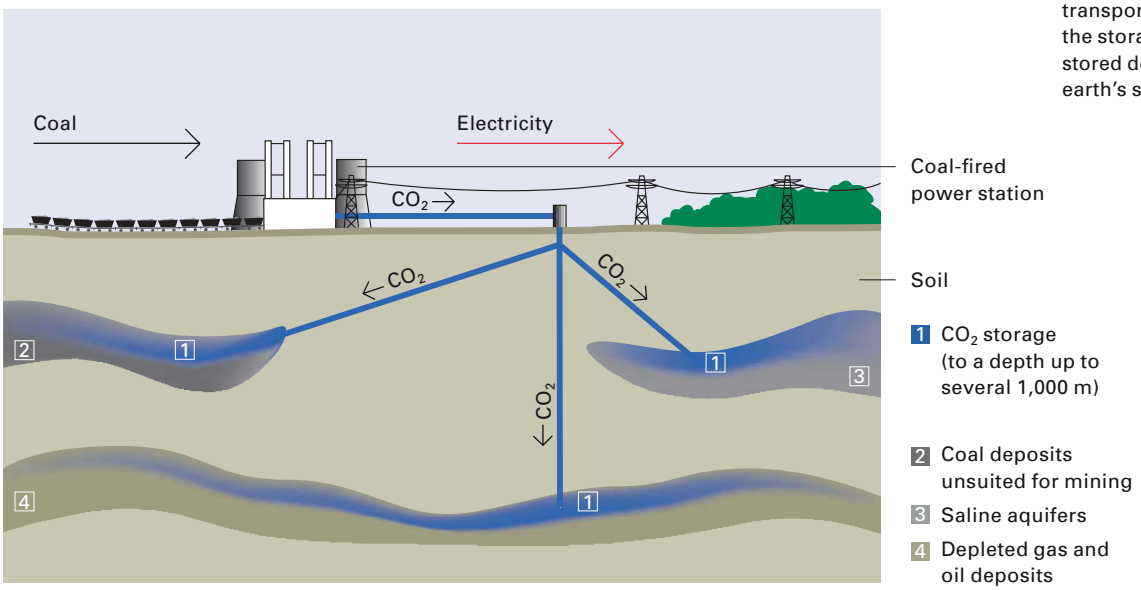
Coal-fired power plants are responsible for a third of global CO_2 emissions but generate 40% of the world's electricity.

Around one-third of global CO_2 emissions currently stem from coal-fired power plants, which generate 40% of the world's electricity. In 2007, the International Energy Agency (IEA) predicted that several hundreds of new coal-fired power plants will be built by 2030, most of them in the booming countries of East Asia, where a new coal-fired power plant goes on stream almost every week. In this region some countries generate up to 80% of their electricity from coal. In connection with this growing demand for energy, CO_2 emissions have almost doubled in the period from 2000 to 2007.

Although the importance of renewable energy sources is constantly on the rise, the IEA predicts that fossil fuels will continue to account for a major part of our energy mix for many years to come, not only in Asia, but in the western industrialised nations, too. In the United States, for example, coal-fired power plants will have produced roughly one-half of the required electricity in 2008. In Germany, coal and lignite plants similarly produce half the country's electricity, corresponding to CO_2 emissions of around 345 million tonnes per year.

Munich Re assumes risks and promotes CCS projects. In this way, we contribute to reducing CO_2 emissions.

Fig 7: Carbon capture and sequestration



CCS: CO_2 is captured in a coal-fired power plant, transported via pipelines to the storage location and stored deep below the earth's surface.

CO_2 emissions from coal-fired power plants must be reduced swiftly

Researchers have been working intensively for a number of years to develop new ways of capturing and storing the CO_2 produced when generating electricity from coal. "Carbon capture and sequestration" (CCS) is the name of a technology whose technical viability has already been demonstrated on a pilot scale in ongoing trials. It can not only be integrated into new plants, but – if possible – also retrofitted in existing power plants.

The financial infrastructure for funding research on CCS technology is in place. Funds for investment are available from operators and technology suppliers; public funds are also available in many countries worldwide. At the same time, growing public pressure to reduce CO_2 emissions from electricity generation is prompting the energy supply companies to make use of new technologies. Furthermore, reducing CO_2 emissions provides power plant operators with an opportunity to trade in CO_2 certificates and earn credits for every sequestered tonne. By the time the CCS technology is ready for commercial use the cost for sequestration and storage of CO_2 are expected to decline to around €30 per tonne. These additional costs will drive up the price of electricity, but CO_2 emissions trading offers a means of generating additional income to mitigate this price hike.

Numerous pilot projects with different technical concepts for sequestering CO_2 are either under construction or in operation worldwide. There are no fewer than 60 projects devoted to investigating geologic sequestration in deep saline formations, i.e. porous rock formations in which the gaseous CO_2 is converted over several years to solid matter. The possibilities of storage in exhausted oil and gas reservoirs, of replacing gas hydrate sediments with CO_2 under the seabed and of storage as biomass in forests and wetlands are further aspects of this research. The coming years will show which of these technologies becomes established as the standard. All approaches ultimately have the same objective, namely to reduce the CO_2 emission to the air from fossil electricity generation as efficiently, safely and economically as possible.

Identifying risks and avoiding the repercussions

Suppliers and operators are faced with a number of known risks along with several new risks, when putting the theoretical potential CO_2 reduction into practice. With decades of worldwide experience in the oil and gas industry, as well as in the construction of power and chemical plants, Munich Re has acquired valuable know-how which can also prove very useful in the implementation of CCS projects. In many of the fundamental questions connected with the separation of CO_2 in the power plant or its subsequent transport and storage, Munich Re can fall back on its significant expertise as a risk carrier in the oil and gas industry. This lays the basis for innovative, tailor-made insurance solutions which can be highly instrumental in the successful implementation of such projects. It would take considerably longer for these new technologies to become established in the market if many of the risks were not transferred to and shouldered by the insurance industry. In this way, Munich Re promotes their use while helping to reduce CO_2 emissions at the same time.

A number of issues remain to be clarified by operators, as well as policy-makers, before these technologies can be used commercially:

– Legal aspects and liability: Who owns the carbon dioxide and who is responsible for it after compression and deep injection? Is it the responsibility of the power plant operator, or of the operator of the storage reservoir? Or should it even be a matter for the state? From a legal angle, these are not only administrative issues under environmental and technological law, but also questions of liability. As things stand today, risks to life, health and property and financial risks are governed by the general rules on liability.

– Design feasibility: Commercial CO_2 sequestration plants take up considerable additional space which is often not available in existing power plants, making a retrofit very much more complicated. Due to the large but pressureless flue-gas streams, the scrubber columns needed for sequestration in post and pre-combustion capture processes can reach diameters of up to 20 metres and this imposes significant demands on the contractors building the plants. This is where Munich Re's experience in similar projects can prove useful. With its innovative Comprehensive Project Insurance (CPI) Munich Re offers extensive cover during the construction phase, while the Comprehensive Machinery Insurance (CMI) covers the subsequent operating phase.

– Technical risks: Since the use of CCS technology reduces the efficiency of a power plant, the CO_2 must be sequestered as efficiently as possible. If defects or damage impair sequestration efficiency, considerable financial losses can ensue, especially if the "clean power plants" engage in emissions trading and find themselves unable to earn the planned carbon credits. Another aspect to be considered is the large-scale use of environmentally harmful chemicals, such as those required in the post-combustion process for CO_2 sequestration. Large volumes of chemical scrubber liquid are charged with CO_2 in a closed cycle and subsequently regenerated in this process. A leak could have far-reaching consequences for the environment.

– Risks during transport: In principle when retrofitting existing coal-fired power plants, the CO_2 reservoirs are geographically remote from the power plants themselves, sometimes lying up to several hundred kilometres away. For this reason, the captured and liquefied CO_2 was to be transported through pipelines to the deep injection site. If such a pipeline were to develop a leak, the deep cold and liquid (cryogenic) CO_2 could evaporate instantly and explosively on escaping from the pipeline. Since it is denser than air, it could fill lower-lying areas and form whole lakes of carbon dioxide. Any leaks would also result in soil contamination through the formation of carbonic acid when carbon dioxide reacts with water. In addition, cryogenic CO_2 can cause severe burns when it comes into contact with skin.

– Non-proven storage technology: Carbon dioxide can be stored in the ground in a variety of ways. It is injected into deep saline formations or exhausted oil and gas reservoirs either in gaseous form or as a cryogenic liquid. The long-term stability of such reservoirs has not yet been fully proved. Hitherto unknown geochemical reactions are also possible.

At the power station site "Schwarze Pumpe", an oxyfuel combustion capture pilot plant went into operation in Germany at the beginning of September 2008. 10,000 tonnes of CO_2 are expected to be captured over the next three years and sequestered in a depleted natural gas deposit some 350 kilometres away.

"Clean coal" makes renewable energy sources more competitive

CCS technology can only make coal-fired power plants cleaner. It cannot eliminate CO_2 emissions entirely. Depending on the technology used, CO_2 separation only remains economically viable up to a rate of 90–98%. Moreover, CCS reduces the efficiency of a power plant by up to 15% in comparison with that of a conventional coal-fired power plant – and the additional cost of CO_2 separation drives up the cost of electricity generation. Depending on their price, selling CO_2 certificates could generate additional revenues to offset at least some of the additional costs of CCS technology. Furthermore, new materials and more efficient power plant technology are expected to result in a 10–15% increase in efficiency in the coming years. This could in turn compensate the loss of efficiency caused by CO_2 separation.

Due to the additional costs incurred for building CO_2 separation plants and the simultaneous loss of efficiency, electricity from correspondingly equipped power plants will be more expensive than electricity from power plants without carbon sequestration in the foreseeable future. But this will ultimately also benefit the renewable energy sources as successive improvements in efficiency and costs make them more competitive in relation to the more expensive "clean coal". In this respect, CCS technology could prove economically to be a medium-term transitional solution, making conventional coal-fired generation of electricity cleaner until demand can be covered by renewable energy sources.

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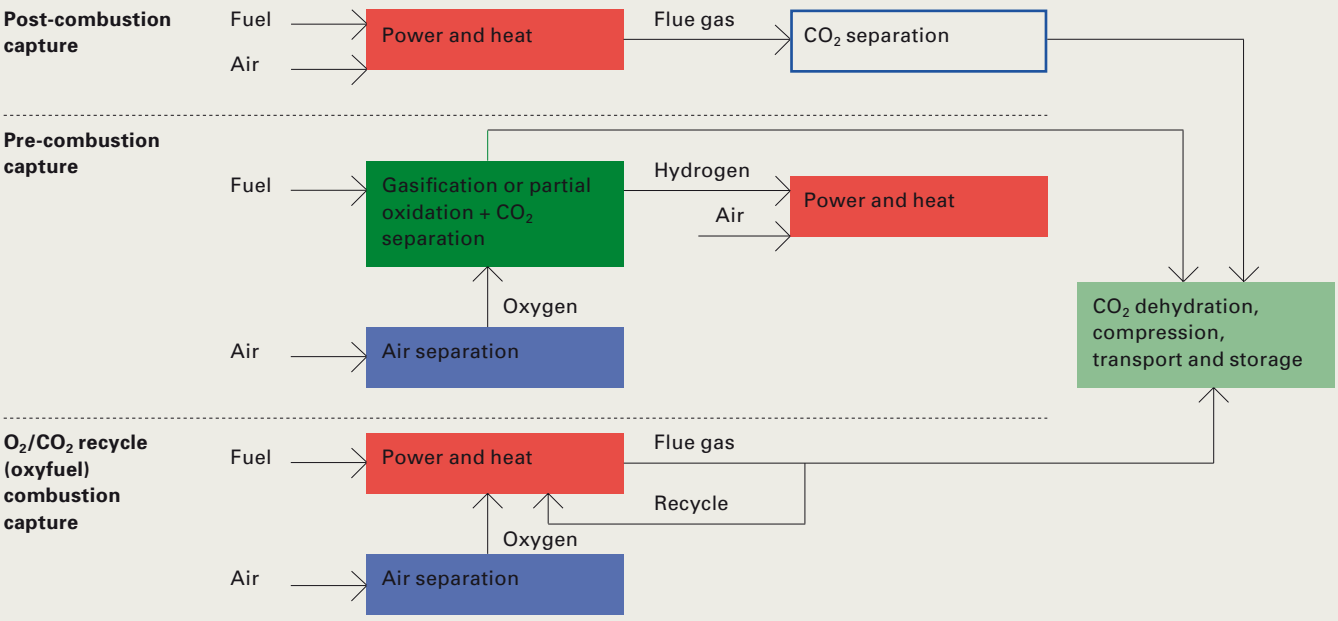
Fig. 8: Three technologies, one goal: to reduce CO_2 emissions



Three CCS technologies are currently being tested in a number of pilot projects. While post-combustion capture technology is the best option when retrofitting existing coal-fired power plants, the other two methods are more suitable for new plants or for large-scale conversions.

Post-combustion capture: Flue gas from coal-fired power plants contains up to 14% CO_2. To separate the carbon dioxide, the flue gas streams through scrubber towers in a counterflow with scrubber liquid which absorbs the CO_2. When the scrubber liquid is regenerated, it is heated to release the carbon dioxide which is then captured, cooled, dried and compressed for transport.

Pre-combustion capture: This technology is destined for use in IGCC (integrated gasification combined cycle) power plants. When the coal is gasified with pure oxygen, the result is a so-called synthesis gas containing mainly carbon monoxide, methane and hydrogen. Before combustion the synthesis gas in a gas turbine, the carbon monoxide is converted to carbon dioxide and then captured from the gas stream by absorption.

Oxyfuel-combustion capture: In the processes described above, carbon dioxide is removed from the flue gas by absorption. The oxyfuel process, on the other hand, concentrates the flue gas stream itself by reducing other components to produce a stream of almost pure CO_2. To achieve this, coal is incinerated in a boiler in an atmosphere of 95% oxygen and recirculated flue gas. In contrast to air-fired boilers, the absence of nitrogen reduces the exhaust mass flow to such an extent – as compared with conventional combustion with air – that the flue gas contains more than 80% CO_2. The carbon dioxide can then be condensed without complex further processing and compressed for transport and storage.

The challenge

Investors in and operators of geothermal projects are always dogged by the geological exploration risk: major investments are lost if their bore holes do not yield the desired results.

The solution

Munich Re's exploration risk insurance covers the costs of the bore hole in the event of unsuccessful exploration, providing security for investment and planning.

Geothermal energy: In search of hot water

Volcanoes, geysers, hot springs – in some places the immense energy hidden within its depths is particularly evident. Modern technologies make the climate-friendly and regenerative resource of geothermal energy usable. The greatest hurdle for investors up to now has been the exploration risk – but Munich Re has an innovative solution for that, too.

Drilling rig for a geothermal project.

Geothermal energy – i.e. heat from within the earth – is an inexhaustible source of energy. As a rule, the temperature increases directly, the deeper a well is drilled into the earth. The earth's core has a temperature of between 5,000 and 6,000°C. But it is not necessary to drill to such depths, for the temperature rises by roughly 35–40°C with every kilometre drilled. In some regions, such temperatures occur much closer to the surface, with the result that homeowners seeking to heat their homes with the aid of a heat pump often do not have to drill to any great depth in order to find relatively hot water – depending on geological conditions.

Deep geothermal energy presents a different picture: depending on the location, it may be necessary to drill several kilometres deep in search of the best water-bearing strata. These strata – known as aquifers – can contain water at temperatures of over 100°C. High water temperatures are needed for geothermal power plants to produce electricity cost-efficiently. The hot water tapped can also be used for district heating, to generate steam for industrial use or for combined heat and power generation. Such co-generating plants can achieve a utilisation rate of up to 90%.

Munich Re is the world's first reinsurer to provide productivity risk coverage.

Regions with volcanic rock formations offer particularly promising possibilities for using deep geothermal energy. Thermal anomalies in the earth's crust – i.e. particularly warm strata almost directly below the surface of the earth – are encountered in Iceland and New Zealand, but also elsewhere. Countries such as China, the USA, Sweden, Turkey, Italy, Hungary and the Philippines are also increasingly using geothermal energy in order to wean themselves off their dependence on fossil fuels and reduce their CO_2 emissions. The Molasse Basin south of Munich, the Upper Rhine Valley and the North German Basin are particularly suitable regions for deep geothermal energy projects in Germany. The country's largest geothermal power plant, with an installed thermal capacity of 38 MW, was built in Unterhaching near Munich in early 2007.

Investment constraints: The expense of drilling and the exploration risk

For investors in geothermal projects, the temperature encountered and the potential flow rate of the hot water are key parameters by which the economic success of a venture stands or falls. Reasonably reliable data on water temperature are only available to a very limited, local extent – if at all – especially when drilling to great depths. The thermal water production (or flow rate) to be expected is even less predictable and depends on a number of factors, such as the permeability and porosity of the rock.

No matter how carefully the exploration has been prepared, investors must always be prepared for the eventuality that they may fail to find a viable geothermal resource. Commercial exploitation of deep geothermal energy depends first and foremost on finding adequate quantities of underground water at sufficiently high temperatures. In the past, this exploration risk and the high drilling costs have repeatedly hampered investment in deep geothermal projects. Investments of more than €10m per project will be lost if the expected water temperatures and flow rates cannot be achieved.

Exploration risk insurance from Munich Re creates security for investments

From the outset, Munich Re has supported the geothermal energy industry by providing valuable expertise and innovative covers. Munich Re was the first insurer worldwide to develop an exploration risk insurance cover in 2003. The insurance essentially covers the costs of drilling in the event of unsuccessful exploration or partially successful exploration. Drilling costs are partly or completely indemnified if the flow rate and/or temperature of the extracted water is/are not sufficient to produce electricity and heat. Partially successful exploration means that although the flow rate of hot underground water circulated is not sufficient to produce electricity as planned, it can be used to generate heat.

Munich Re supports deep geothermal projects from the planning stage to completion of the drilling work. After all, the investors, the operators and Munich Re are all pursuing the selfsame goal: successful wells. To ensure that it can optimally respond to the clients' individual needs, Munich Re does not offer any standard policies in this domain; instead, the risk is appraised separately for every single bore hole. For its geological risk assessment, Munich Re employs its own experts with practical experience in the oil industry. These experts are also on hand to provide advice during the drilling phase, especially when stimulation measures (sidetracks, acid jobs and other measures to improve flow properties) have to be decided.

This client-oriented approach presents the policyholder with a flexible insurance solution. It allows free scope in terms of the conditions, such as deductible, no-claims bonus or total/partial loss. Munich Re also offers flexible solutions for the scope of cover: in addition to the drilling costs as such, the insurance can also cover expenses incurred for stimulation measures if required.

Assessment of the exploration risk: We use the practical experience of our experts, e.g. from the oil industry.

Innovative approaches meet global challenges in geothermal energy

The cooperation agreement concluded in late 2008 between Munich Re, the German Federal Ministry of the Environment and the state-owned KfW banking group also reflects the company's prominent position as a financial service provider with expertise in the geothermal sector: under this agreement, KfW provides so-called liability-exempted loans for deep geothermal projects through house banks. The special feature of these loans is that the borrower is exempted from liability for repayment of the loan if the drilling is not successful. Here too, before a loan is granted, Munich Re assesses the exploration risk and consequently the deep geothermal project's funding eligibility on the basis of its experience with exploration risk insurance. In addition, Munich Re provides liability capital of €20m (see box).

Another approach pursued by Munich Re is to strengthen the geothermal industry on a global scale. To this end, Munich Re is in close contact with the relevant organisations, such as the World Bank. Munich Re's attention is currently focused above all on Asia, Eastern Europe and Turkey, which has a geothermal potential of roughly 31,500 MW of heat and 3,300 MW of electricity (source: Lund, J.W. et al., 2005). Plants with a total capacity of 60 MW were under construction here in 2007 alone.

As a global company, Munich Re supports geothermal projects around the world. We are constantly developing new risk transfer solutions to cover the exploration risk, working with great innovative zeal. At present, Munich Re's experts are investigating possible covers to increase planning security for investors, such as through options to safeguard long-term operation.

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Internationally pioneering collaboration promotes geothermal industry

Due to the considerable investments and the high exploration risk, most geothermal projects are dependent on state aid. In a partnership that could well have a path-breaking impact worldwide, the German Federal Ministry of the Environment, KfW and Munich Re joined forces at the start of 2009 in order to promote deep geothermal drilling ventures. Their objective was to make greater use of the heat within the earth as a means of halting the process of climate change. This eight-year collaboration aims to eliminate a major investment constraint by covering the exploration risk. Up to €60m are being made available for this purpose.

The KfW group grants loans through house banks for deep geothermal drilling projects. If minimum levels of thermal water production and/or temperature have not been achieved on completion of the drilling work, the investor is exempted from repayment of the remaining loan as from the moment at which unsuccessful exploration is established. The exploration risk of the respective deep geothermal projects and consequently their funding eligibility is assessed by Munich Re's experts before the loan is granted.

In addition to the usual interest, the loans also include a "risk loading" for the exploration risk. A one-off fee is additionally charged on applying for a loan and on conclusion of the loan agreement; these fees are intended to cover the costs of KfW and Munich Re. In return, the investor receives an expert assessment and support for its deep geothermal project before and during the drilling phase. The German Federal Ministry of the Environment, KfW and, in a secondary capacity, Munich Re will each provide liability capital of €20m for this purpose.

Global challenge – Local solution

The conditions for renewable forms of energy vary worldwide. This is due to differences in geography and meteorology and to different state initiatives.

Three regions – three examples …

The challenge
A high number of complaints and low reserves can result in financial imbalances at the manufacturers of photovoltaic modules.

The solution
Munich Re covers claims arising outside the statutory warranty period and in excess of the relevant manufacturer's deductible.

Photovoltaics: Profiting securely and sustainably from the boom

Sunny times for manufacturers of solar modules: the market is booming, yet complaints from customers and low reserves could put a spoke in their wheels. Munich Re offers innovative products that fit the bill.

Replacing faulty photovoltaic modules results in costs not only for the operators but especially also for the manufacturers since the costs are usually related to warranties.

Manufacturers of solar modules are operating in a fast-growing, dynamic market. A pioneering spirit is called for, along with an innovative approach and a sizeable wad of capital. To remain competitive, manufacturers must push ahead with technical innovations, increase production capacities and above all improve the efficiency of their modules.

In several countries, the high worldwide growth in the photovoltaic sector is closely linked with legislation governing the remuneration for electricity fed into the public grid. Germany is a trailblazer in this respect: the German Renewable Energy Sources Act (EEG) came into force in 2000 and systems modelled on it have already passed muster in many other countries, too. Similar rulings on remuneration for electricity fed into the public grid are now in force in 32 countries worldwide and in 18 European countries, demonstrating the system's future capability and reproducibility.

In Germany, customers are remunerated at a specified rate per kWh of photovoltaic electricity fed into the grid over a period of 20 years. And this pays off in the long-term for investors and plant operators: even in the scheme's twentieth year, the remuneration paid remains well above the current market price of electricity on the various electricity exchanges.

The world's largest solar park is already generating 60 megawatts of electricity. With us the market can grow.

Left: The world's largest photovoltaic power plant in Beneixama has been in operation since 2007. The surface area of 500,000 m^2 corresponds to 71 football fields.

Right: Gut Erlasee, Germany's biggest solar park.

Stable earnings over a long period of time are important for operators and investors in solar farms. Although high capital investments are initially required, running costs for the solar modules are very low: solar modules produce electricity without mechanical parts, are completely noiseless and do not produce emissions. For the operators of solar farms and their investors, for the related funds and also for all other customers of the solar module manufacturers it is therefore particularly important that the modules operate faultlessly at all times. If modules fail, they not only have to be replaced, but also result in loss of earnings.

Main risk for manufacturers: defective modules and an unexpected number of complaints

Most manufacturers guarantee the minimum performance of their modules in relation to the condition on delivery for at least 20 years. In almost all cases, the manufacturers guarantee a minimum performance of 90% in the first ten years and 80% in the next ten. Precisely these performance guarantees are reflected in the amortisation calculations of solar farm operators.

Accounting legislation compels the manufacturers to set up reserves for the expected volume of complaints arising from their performance guarantees. The capital tied up in these reserves is consequently not available for investment. Experience and calculations by Munich Re's experts have shown, however, that the reserves only cover part of the liability that may accrue in the event of a loss, for serial losses usually affect several production years. Even just a single serial loss could pose a serious threat to the survival and market position of a firm in the photovoltaic sector.

Stable growth with innovative products from Munich Re

Manufacturers are consequently always faced with the need to make a strategic risk decision: should they dispense with insurance in the hope that the reserves required by accounting regulations will cover any loss which occurs, or should they purchase more comprehensive insurance cover? Should they choose the latter option, manufacturers can fall back on Munich Re's extensive expertise: Munich Re provides cover for losses occurring outside of the statutory warranty period (24 months in Germany, for example) and exceeding the manufacturer's deductible. Munich Re's solution ensures rapid liquidity when a loss occurs.

When provisions run short

The manufacturers of photovoltaic modules are obliged under accounting standards and conventions to establish reserves for the volume of complaints they expect to receive in connection with their performance guarantees. Under these performance guarantees, module manufacturers assume 20 years of liability for each and every year of production, the potential claims under the guarantees thus accumulating into huge sums. The provisions actually established, however, make up only a fraction of the liabilities and could potentially be exhausted by a single major loss or serial loss. If further losses occur in subsequent years, these provisions are no longer available, and the manufacturer is faced with a liquidity shortage that threatens its very existence.

Transferring entrepreneurial risk to Munich Re stabilises the solar module manufacturers' sales and yield planning. This is essential if more advantageous refinancing terms are to be obtained and gives equity investors a further incentive to maintain or even increase their holdings in solar firms.

Another advantage is that while even relatively small losses may deplete a manufacturer's own reserves entirely, an insurance policy can cover claims time and again.

New challenges, new technologies – and new risks

Manufacturers of solar modules want to share in the growth of an extremely dynamic market. Munich Re supports these firms as a strong, reliable partner in a future-oriented industry. The products offered by Munich Re are particularly attractive for young, thriving firms in the solar industry which lack the financial backing of a highly capitalised corporate group.

In the coming years, manufacturers will be faced with major challenges requiring their full commitment: production capacities will continue to increase and competition in the marketplace will become even fiercer; new technologies which have yet to stand the test of time, such as thin-film modules, are already swamping the market. With Munich Re, manufacturers of solar modules can look forward to sustainable growth – so that times will remain sunny in the photovoltaic industry.

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The challenge

Investors and operators of hydroelectric power plants face a variety of hydrological and geological risks during the construction of the plants.

The solution

So that hydropower plants can be operated safely and profitably in the long term, Munich Re supports plant operators at every stage, from planning, construction, installation and commissioning to the operation of complete plants.

Brazil – Let the water flow!

Hydroelectric power covers almost 80% of Brazil's electricity requirements. Several additional hydropower plants are currently either in the planning stage or under construction. Munich Re supports contractors and operators with its expertise and innovative insurance products.

Concrete dam at the Itaipu hydropower plant. With an output of around 14,000 MW, the plant is one of the largest of its kind worldwide.

Together with Norway, Canada and Austria, Brazil is one of a group of countries that rely primarily on electricity generated by hydropower plants to cover their energy needs. In 2005, Brazilian hydroelectric power plants generated roughly 85,700 MW of electricity, accounting for around 77% of the total installed capacity of all the country's power plants. That is roughly equivalent to the output from 85 nuclear power plants. Between 1970 and 2003, electricity generated from hydropower grew at a rate equal to 6.4% per year in Brazil, more than two-and-a-half times higher than the average worldwide growth in this sector.

Especially for newly industrialising countries like Brazil hydropower plays a key role. There are several reasons for this: demand for energy is rising constantly in the emerging markets, and those with few natural oil or gas deposits must concentrate on the available coal or on renewable energy sources. Countries with the hydrological and geological conditions necessary for generating hydropower, as well as with a low population density permitting the construction of hydroelectric power plants without major resettlement and without loss of farmlands or valuable natural habitats are particularly fortunate.

Hydropower risks lurk in the underground and often only come to the surface during the construction and erection phase.

Hydropower is the most important renewable energy source worldwide. Although the investment costs for hydroelectric power plants are relatively high, their low operating costs over the long term, extremely low emissions, high efficiency of almost 90% and prolonged service life of up to 100 years make hydropower a truly sustainable renewable energy source.

According to figures from EnterPrise of Energetic research (EPE), hydropower plants in Brazil produced 340.5 TWh of electricity in 2005. A study presented in November 2008 by Fundação Getúlio Vargas (FGV) and management consultants Ernst & Young forecasts that Brazil will become the world's fifth-largest electricity consumer in 2030, with a power requirement of 1,072 TWh/a.

Additional hydropower plants are being built so that the steadily growing Brazilian economy can meet its constantly rising demand for energy. At present, there are 706 hydropower plants in operation, 89 plants are under construction in 2008 and another 258 plants have already received planning permission or are at an advanced stage of planning. And that is only the beginning. There is plenty of available capacity: only 30% of the total estimated capacity of this huge country with its vast rivers have been explored so far with regard to its hydropower potential. Many areas with immense potential remain to be developed in the country's north and mid-west (Amazon and Tocantin/Araguaia basins).

Complicated approval processes a stumbling block to planning certainty

No matter how efficient they may be and regardless of their size, hydropower plants virtually always have a major impact on the environment. Natural river landscapes are affected and the habitats of people, fauna and flora altered. Environmental impact assessments are necessary to ensure that hydropower plants are built at ecologically suitable locations, and developers are required to apply to the respective environmental protection agency for a permit prior to construction. Due to public and political pressure, recently it became extremely difficult to obtain such a permit. For owners of the hydropower plants and their investors, this is often the first stumbling block in Brazil, for this process is complicated and protracted, reducing planning certainty for operators and investors.

The main risks facing prospective plant operators during the construction phase are hydrological and geological in nature. Hydrographic data for the planned location are, especially in remote areas, frequently lacking or inadequate, so that data from similar locations must be used instead and extrapolated for the planned location with the aid of mathematical models. This can result in hydrographic and geological conditions being underestimated, something which is then only revealed during the construction and installation of the plants. Particularly in the case of small hydropower plants, the number of comparatively inexperienced market players involved in the construction of such projects is growing. Although soil and hydrological analyses are considered essential prior to building a hydropower plant, they tend to be underestimated or minimised on account of their relatively high costs, thus giving rise to risks which can jeopardise entire projects.

Münchener Rück do Brasil: Local partner with global experience

The investors, owners, contractors and operators of ambitious hydropower projects need a partner in the insurance sector who not only understands the local market and speaks the same language as the parties concerned but can also build on the global expertise of a trusted and solid group network.

For 69 years, the Brazilian market was dominated by a reinsurance monopoly, and in April 2008 legislation was introduced to gradually open up the market to outside players. Munich Re has been active in Brazil for over ten years, providing support for the former state institution Instituto de Resseguros do Brasil, now IRB Brazil Re. The experience it has been able to gather during this time can now be employed even more effectively.

Since the market was deregulated in April 2008, Münchener Rück do Brasil, as a wholly-owned subsidiary of Munich Re Munich, has used its privileged position as a local reinsurer to offer its clients tailor-made reinsurance products in various classes of business, such as engineering, fire, third-party liability, marine and surety bond.

Large range of insurance solutions for the hydropower industry

So that hydropower plants can be operated safely and profitably in the long term, Münchener Rück do Brasil supports plant operators at every stage, from planning, construction, installation and commissioning to the operation of complete plants. Individual insurance solutions for smaller hydropower plants with an installed capacity of up to 30 MW have been specially developed by Münchener Rück do Brasil for the Brazilian market.

Münchener Rück do Brasil – Local expertise in hydropower

Close-up of the pressure pipelines feeding water into the turbines.

On the right: Itaipu hydropower plant by night. Situated near the Iguazu waterfalls, the facility is also a tourist attraction.

Together with its primary insurance partners, Münchener Rück do Brasil often acts as the leading reinsurer, offering the various companies involved in construction and operation of the power plants a wide range of insurance solutions. For the planning and construction phase, these are mostly traditional CAR and EAR policies covering not only natural perils, such as windstorm, torrential rain and flooding, but also faulty design and manufacture, clean-up costs, strike, civil commotion, third-party liability and risks arising in conjunction with plant maintenance. After commissioning the hydropower plants, operators need cover in particular for machinery breakdown, fire, business interruption and third-party liability risks, in addition to natural perils.

Moreover, Münchener Rück do Brasil has also developed a comprehensive risk monitoring programme for major, highly complex projects. Under this programme, technical experts from Munich Re work together with local experts in carrying out extensive local risk inspections.

With its financial guarantee products, Munich Re also plays a key role in securitising the investors' financial commitment throughout the entire project phase, in addition to providing insurance cover for pure construction risks. Demand for insurance of such financial risks as advance loss of profits, liquidated damages and debt service covers has grown considerably of late. Innovative insurance solutions such as "lack of water" or cover for entrepreneurial risks will become increasingly important in Brazil in the future.

Plan 2015: 260,000 MW electricity from hydropower

The flourishing Brazilian economy predominantly relies on hydropower to cover its electricity demands, and this situation will not change in the future. According to the "Plan 2015" launched by the Brazilian government, the total estimated hydraulic capacity of the country's hydroelectric power plants is to be increased two-and-a-half-fold to 260,000 MW by 2015. For operators and investors, this not only creates highly promising financial potential, but also an enormous demand for insurance which can be covered by Munich Re with its capacities. With many years of experience in covering risks associated with hydropower plants in Brazil and other countries worldwide, Munich Re can help to make the use of hydropower safe and sustainable, thus preventing further CO_2 emissions.

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The challenge

Energy production using biomass is currently being heavily promoted in many countries. Investors and operators are dependent on the political framework as well as strong price fluctuations on the commodity markets and have to protect themselves against risks during the construction and operating phase.

The solution

Munich Re offers solutions for risks during the construction and operating phase and supports up-and-coming branches with its expertise.

USA: Energy from biomass showing an upward trend

Apart from fiscal and environmental aspects, many biomass investments are influenced by fluctuations in the prices of two key commodities: oil and feedstocks. Commodity prices can fluctuate dramatically, creating market risks for producers, the supply chain and investors.

A critical point regarding biomass concerns its ecological impact. As in the case of many alternative energies, there are wide-ranging opinions about whether biomass will help or hurt the environment.

Since the beginning of 2007, the DOE (Department of Energy) of the United States of America has announced investments of over US$ 1bn to spur the growth of a diverse and sustainable biomass industry. Most of these investments target the development and deployment of the next generation of ethanol – ethanol and other products made from biomass products that are outside the food chain and thus do not consume agricultural resources. This could help address the tendency to use the food chain to feed our energy needs. In 2006, 14% of corn grown in the United States was converted to ethanol. The figure is projected to rise to 31% by 2016 based on actual boundary conditions.

In March 2008, the DOE set a goal in its Strategic Plan aimed at promoting energy security by means of a diverse energy supply that is reliable, clean, and affordable. As part of this, the DOE Office of Energy Efficiency and Renewable Energy's (EERE's) biomass programme was assigned the task of developing biomass technologies in partnership with other government agencies, industry and academia. This was followed up with an action plan released in October 2008 drawn up jointly by the DOE and US Department of Agriculture. The plan outlined interagency actions, federally supported research and development efforts, and future goals, and required that steps be taken in seven areas: sustainability; feedstock production; feedstock logistics; conversion science and technology; distribution infrastructure; blending; environment, health, and safety.

With its long-standing competence and experience, Munich Re supports its clients also in the area of conventional insurance protection for biomass investments.

Increasing vehicle efficiency, and developing alternative fuel vehicles are high on the agenda in the United States.

Focus on cutting down petrol consumption

Many of these efforts are intended to support the national goal of cutting petrol consumption in the United States by 20% over the next ten years by increasing vehicle efficiency, developing alternative-fuel vehicles, and investing in renewable and alternative fuel sources. The incentives provided through these and other programmes are primarily focused on two areas: R&D and federal tax incentives.

From a tax-incentive perspective, the US Congress took action as part of the October 2008 Economic Stimulus Bill. The bill provides authorisation of US$ 2bn in new Clean Renewable Energy Bonds (CREBs) for facilities producing electricity from resources that include all types of biomass, landfill gas, and trash combustion. It extended existing legislation on Product Tax Credits by an additional two years in the case of biomass (one-year extension for wind, eight-year extension for solar).

The extension of these credits helps to provide a more certain outlook for biomass and other renewable energies as new technology is commercialised to the point where it can compete directly with traditional energies. Along with these federal incentives, there is a wide array of incentives provided by different states throughout the USA.

The linkages between agriculture and the energy sector are becoming stronger

The stage is clearly set for the biomass market. However producers of ethanol and investors in biomass are dependent not only on state investments and fiscal incentives but also on oil prices and the outcome of current discussions concerning the pressure biofuel exerts on agricultural prices. The United Nations Food and Agriculture Organization noted in an October 2008 report "the historic linkages between agriculture and the energy sector are becoming stronger and are changing in character. Biofuel demand will continue to exercise upward pressure on agricultural prices for a considerable time to come."

Operators of biomass plants and investors face several economic challenges. Fluctuations in the price of oil will continue to impact demand for alternative energies, such as biomass; that demand will affect the level of government biomass subsidies and incentives; and finally the demand will also impact raw materials and construction costs for biomass and other renewable energies.

Highly flammable substances as intermediate or final products of the processes cause a considerable fire and explosion exposure.

An additional challenge with respect to biomass is an environmental one. Like many alternative energies, opinions are divided as to how biomass will help or hurt the environment. Some of the generally accepted benefits are that biomass uses renewable sources of energy and can help reduce the amount of waste that goes to landfills. However, points of contention are the net environmental impact of biomass plans and the impact of biomass on overall land-use policies.

Technical challenges of biomass facilities

Particularly in the case of biomass facilities that use raw materials from outside the food chain like the organic fraction of municipal waste or residues of food stock production, there is competitive research aimed at optimising the procedures applied to gain the best economic results in the individual environment, especially in terms of the raw materials to be used.

Consequently, there is a broad variety of biomass facility programmes deploying primarily proven technologies and procedures for the individual production stages. But new technological risks arise from the new methods of combining the individual procedures.

– Use of organic municipal waste: In the majority of cases, inhomogeneous raw materials cannot be blended to a mixture that has consistent mechanical and energetic properties. This impedes mechanical handling and the conveyance and steering mechanisms used in the corresponding processes may be prone to interference or even mechanical damage.

– Biomass facilities: Highly inflammable substances such as ethanol, seed oil or biogas are the intermediate or final product of the processes, which results in a considerable exposure to fire and explosion, especially when interference in the steering equipment leads to interruptions or malfunctions in the production processes.

– Oilseed-based biomass facilities: The high mechanical strain on the oil presses employed often constitutes a key risk during the operational phase. The use of seed-oil-based fuels in automotive and stationary combustion engines has a history of specific problems caused by mechanical and chemical impurities and the comparatively high acidity. Biogas impurities are also one of the main causes of loss when biogas is used in gas engines.

A cow produces some 10–20 kg of manure every day, enough for 1–2 cubic metres of biogas. Dung from four cows is sufficient to supply an average household with electricity for a whole year.

– Thermal power plants: With regard to plants fired with biomass such as wood or straw, the technology in general can be considered as proven. Specific attention should be paid to the increased content of flue ash and possible high levels of inorganic impurities, which can cause early wear and tear or damage to the flue gas duct.

Munich Re's expertise in insuring biomass projects

Munich Re supports clients' risk transfer needs by offering market stability to support long-term risk-transfer relationships. In the US market, Munich Re's experts work closely with clients and brokers to find opportunities for developing new insurance and reinsurance products and markets.

Compared with wind farms, photovoltaic plants and solar-thermal plants, the insurance requirements with regard to biomass investments are by and large conventional. Munich Re offers the relevant solutions for the erection phase (CAR – Construction All Risk and EAR – Erection All Risk) and also for the operational phase (All Risk and Loss of Profit) in the US market and around the world. If corn or other agricultural products are used as raw materials, Munich Re's crop insurance experience can minimise the risks investors face from corresponding shortfalls by providing innovative insurance solutions for the supply of biomass for this type of investment.

The outlook for biomass in the USA appears to be positive. The recent financial incentives provided by the Economic Stimulus Bill have removed much of the uncertainty surrounding the industry. These actions and supporting insurance solutions provided by Munich Re will help the industry confront the challenges posed by continued R&D and new commercial ventures.

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Definition of biomass and biofuels according to the U.S. Department of Energy

The U.S. Department of Energy (DOE) is the primary federal government agency responsible for overseeing the development of biomass in the USA. The DOE defines biomass as "any organic material made from plants or animals. Domestic biomass resources include agricultural and forestry residues, municipal solid wastes, industrial wastes, and terrestrial and aquatic crops grown solely for energy purposes." Biofuels are considered as "any fuel derived from biomass. Agricultural products specifically grown for conversion to biofuels include corn and soybeans. R&D is currently being conducted to improve the conversion of non-grain crops, such as switchgrass and a variety of woody crops, to biofuels."

Electricity from the desert

Munich Re's experts are accustomed to "looking beyond the garden fence" in order to develop solutions.

It takes a lot of commitment and zest for action to consistently put visions into practice. Project DESERTEC is such a vision. Making them come true requires close cooperation between everyone involved.

DESERTEC – Vision of a carbon-neutral energy supply

"The main goal must be to reduce CO_2 emissions."

Power from the desert: by 2050, solar power plants in North Africa, covering an area of 130 x 130 kilometres (16,900 square kilometres), could supply a large share of Europe's electricity needs. The power would be transported through a Euro-Mediterranean high-voltage transmission grid with low transmission losses. This is the ambitious goal behind DESERTEC (desert + technology). Dr. Torsten Jeworrek and Ernst Rauch from Munich Re, Max Schön for the Club of Rome, and Professor Hans Müller-Steinhagen from the German Aerospace Center (DLR) discuss the opportunities, challenges and risks from a reinsurance point of view.

Fig. 9: The DESERTEC vision: Solar thermal power plants covering the area represented by the red squares could supply the energy needs of the whole world, the European Union (EU-25) or the MENA region (Middle East and North Africa).

Ernst Rauch: The initiative of the Club of Rome is dedicated to sustainable development. DESERTEC is one of the projects you have promoted. Mr. Schön, what do you expect from this project, from the Club of Rome's perspective?

Max Schön: We consider DESERTEC to be by far the most important concept available at present for getting to grips with the pressing problem of climate change in the energy supply sector. The earth's deserts receive as much energy in six hours as mankind consumes in a whole year. Two factors are decisive here: what makes DESERTEC so attractive is that the concept makes a vital contribution: firstly, to protecting our climate and, secondly, to ensuring the security of energy and water supplies for Europe, North Africa and the Middle East. Another aspect must also be mentioned in this context, one which has rarely been discussed or researched to date: migration. We believe that DESERTEC will also help to promote peace. If everyone in the Mediterranean region is pursuing a single, common goal, then it would be futile for anyone to engage in armed conflict. And if the people of North Africa can achieve a certain level of prosperity, there will be no need for them to emigrate in order to survive.

Ernst Rauch: How feasible do you consider DESERTEC to be?

Max Schön: We like to show three small red squares on a map of the North African desert (see Figure 9). Solar thermal power plants installed on a corresponding area would suffice to supply Germany, Europe or the world with electricity. The spontaneous reaction is always the same: "What! That's what you're aiming at? That must be possible!" And that is the most important point: it must appear possible. The required technology exists and has passed muster, as has the technology for transmitting the electricity generated to Europe.

Hans Müller-Steinhagen: The technologies needed to produce electricity from concentrated solar radiation basically exist. Solar thermal power plants with a total capacity of 500 megawatts are already in operation and additional plants with a capacity of 1 gigawatt (1 GW = 1,000 megawatts = 1,000,000 kilowatts) are under construction and more than ten-gigawatt power plants are at an advanced planning stage.

Ernst Rauch: How economical are solar thermal power plants at present and how could the electricity acquisition costs look in the DESERTEC scenario?

Hans Müller-Steinhagen: We intend to reduce electricity acquisition costs by pursuing two parallel approaches which were developed in detail in the EcoStar study. At present, each power plant is unique. Mass production and experience will lower costs substantially. Moreover, we are also working to make parabolic trough power plants and solar tower power plants more efficient. The next step will be to develop solar-powered gas turbine plants that operate without cooling water. The German Aerospace Center (DLR) assumes that, in ten to 15 years from now, the electricity generated by solar power plants will be able to compete with the medium-load electricity from fossil power plants. Then the production costs might reach the region of eight to ten eurocents per kilowatt-hour of medium-load electricity, in terms of present-day purchasing power.

"We support solutions that are economically reasonable, but which do not create the wrong incentives in the longer term."

Dr. Torsten Jeworrek, member of the Board and Chairman of the Reinsurance Committee of Munich Re

Torsten Jeworrek: What is the basis underlying your cost-efficiency hypotheses? Will the technology have to be improved in the next ten to 15 years or will it simply be necessary to produce sufficient quantities in order to benefit from economies of scale?

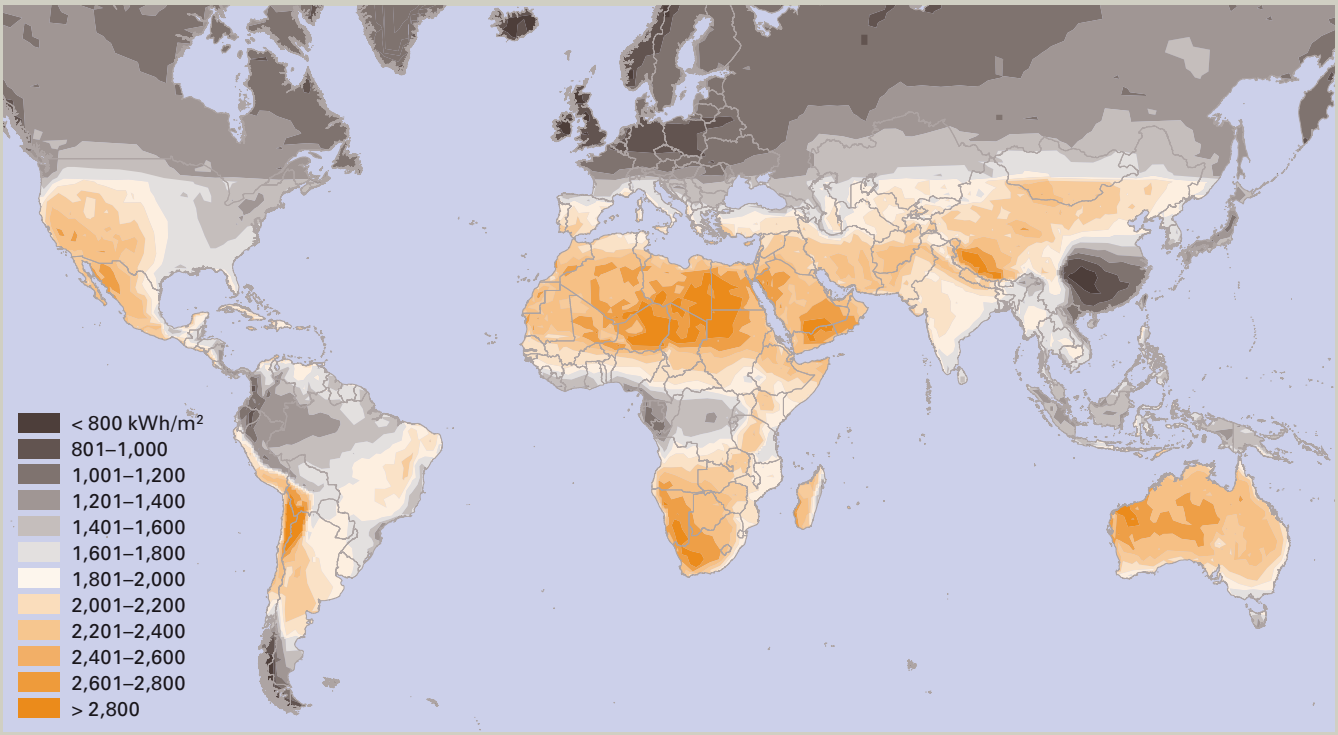
Hans Müller-Steinhagen: Both developments will be necessary. According to industry sources, sufficient production capacity will be available and experience collected when 5 gigawatts have been installed worldwide, enabling power plants to be built more cost-effectively in future. By then, we will also have new research findings permitting further increases in efficiency. However, the DESERTEC project will require considerable initial financing.

Torsten Jeworrek: Let me put forward the following hypothesis: an investor would not be unwilling to invest many billions in financial support for a subsidised product provided that cost-efficiency could be achieved as it became more widespread. That, however, would be an indispensable prerequisite for any long-term financial commitment. Why is that not possible here, particularly as the technology is already available to a great extent?

Hans Müller-Steinhagen: All concerned must be aware that a new technology is always very much more expensive in the initial phase than power plant concepts which have been established for decades. That is why the plants currently available can only be built in countries in which the investment pays off. In other words, in countries which have a programme for introducing such energy into the market, for instance under a renewable energy act. Besides which, the investment costs for solar thermal power plants are generally very high. The 50-megawatt power plants with heat storage for eight hours of full-load operation which are currently being built in Spain cost around €300–350m at present. The financing for such projects is consequently the first hurdle to clear. In addition, the project management companies and operators must expect to face numerous, currently almost incalculable risks.

Ernst Rauch: That is precisely where we see an overlap with reinsurance. As a company whose core competence lies in risk management, we are not afraid to assume complex or innovative risks. In this way, we not only generate value for our stakeholders, but also contribute towards investment security in new projects, such as the transition to new energy generation technology.

Torsten Jeworrek: As a reinsurer, we have a one-to-one interest in this, as does the general public. Our economic interest is directly linked with the tribulations and triumphs which are felt by the general public as the effects of climate change unfold. On the one hand, we must cope with the losses caused by climate change and with the higher loss potentials. At the same time, new or changing risks also provide us with an opportunity to develop new fields of business. You could call us the insurance industry think tank in this respect. Our aspiration is therefore that, if a solution for a new risk can be found at all, then it must come from Munich Re. Climate change is a strategic business concern for us. We recruit many experts to address this topic. True to our aspiration, we intend to operate economically and gear our business development for the long term.



DESERTEC: Electricity from the desert

Fig. 10: The map shows the global distribution of long-term average direct normal irradiation in kilowatt-hours per square metre per year. The direct normal irradiation varies according to geographic latitude, cloud cover and atmospheric turbidity, and serves as an indicator of the potential solar energy yield.

Source: NASA, DLR

By far the largest technically accessible source of energy on our planet is to be found in the deserts of the equatorial sunbelt. Concepts for using the desert areas and for technologies using renewable energy sources to safeguard water and power supplies, as well as the climate, have existed for decades but have only recently attracted the attention of politicians and scientists. The so-called DESERTEC concept was developed by the Trans-Mediterranean Renewable Energy Cooperation (TREC) on the basis of scientific studies by the German Aerospace Center (DLR) and attracted widespread public interest. TREC was founded by the Club of Rome, the Hamburg Climate Protection Foundation and the National Energy Research Center of Jordan (NERC).

For the DESERTEC concept, TREC has proposed a cooperation between Europe, the Middle East and North Africa (EU-MENA). Its ambitious goal is for solar thermal power plants and wind farms in the deserts of the northern Sahara to produce clean electricity for Europe in addition to covering the growing demand for electric power and desalinated seawater for the MENA region. Electric power from the desert can be transmitted to Europe via High Voltage Direct Current (HVDC) transmission lines with low transmission losses (10–15%).

All the technologies needed to realise the DESERTEC concept are available and some have been in use for decades. The abundant supply of solar energy has been confirmed by satellite data and a number of studies conducted by the German Aerospace Center on behalf of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). Solar thermal power plants covering an area of 130 x 130 km could supply Europe's energy needs. Yet the project also has its price: roughly €400bn would be needed between now and 2050 in order to build sufficient solar thermal power plants to cover 15% of Europe's electricity demand. The power plants themselves would cost €350bn, plus another sum in the region of €50bn for the transmission lines to bring the electricity from North Africa to Europe.

"DESERTEC is a promising vision, but is still very far from being implemented. Many challenges must first be mastered and risks identified."

Ernst Rauch, Head of the Corporate Climate Centre (CCC) at Munich Re

Max Schön: This combination of a long-term approach and Munich Re's aspiration to act as a think tank for future-oriented action is something more usually associated with family-run companies.

Torsten Jeworrek: That is exactly what we are in terms of our structural organisation. We employ around 3,500 men and women in Munich and roughly 7,000 worldwide. Our structures are closely aligned to the business we do. Though we do move a great deal of capital. We are much more innovative than many people might suspect. That is why we also consider it our job to find new solutions for projects for which a statistical basis has yet to emerge or for which the claims expenditure or the premium cannot be calculated by conventional methods at present. Take offshore wind platforms which are anchored to the seabed, for instance. We are looking for solutions here. Ultimately, it is also a question of providing security for investors.

Hans Müller-Steinhagen: Precisely such situations are also facing us with the DESERTEC concept: many things cannot be calculated exactly at the present juncture. What happens, for instance, when clouds of sand pass over the desert and reduce the level of direct solar irradiation? How will this affect output by the solar thermal plants?

Ernst Rauch: Indeed, will the plants be able to withstand sandstorms or will they wear down because the material is damaged? We are devoting attention to precisely these questions in order to find insurance solutions for such risks, too.

Torsten Jeworrek: Another question is what happens if the plants ultimately receive less solar irradiation than forecast in the pre-investment analysis? Less sun means less electricity. We do not directly insure the market prices as such but, in our economic appraisal, we can estimate just how large the fluctuation in solar irradiation will be and the economic impact on operators. We are already offering products to cover this scenario.

Max Schön: Do you see your role purely as that of an insurer or do you also invest in major projects in the field of renewable energy sources?

Torsten Jeworrek: We do indeed see ourselves as an investor with a diversified portfolio of renewable energy sources. Here too, we think in longer terms, with time scales of more than ten years. Well over 80% of our investments are already based on sustainable criteria, even today.

Hans Müller-Steinhagen: Solar thermal power plants need investors just like this. The investment costs are high and most banks have trouble with such large sums. Yet the investment is worthwhile. Normally, these projects are calculated over a term of 20 to 25 years. The power plants built in California have been consistently supplying electricity for the last 25 years. Three years ago, we analysed the performance of these solar thermal plants in the US and found that they had not deteriorated within the scope of measurement accuracy. There is no reason why these plants, which have been written off economically, should not remain in operation for another five or ten years and generate further revenues.

Max Schön: The DESERTEC project must be launched now. It must not be allowed to fail simply because we

"The technology needed for DESERTEC basically exists. We are confident that, in ten to 15 years from now, the electricity generated by solar power plants will be able to compete with the medium-load electricity from fossil power plants."

Prof. Hans Müller-Steinhagen, Director of the Institute for Technical Thermodynamics at the German Aerospace Center (DLR) in Stuttgart

cannot organise the financing. That is why the subject must also be discussed and decided at top political levels. The project's inclusion in the founding statutes of the Union of the Mediterranean in summer 2008 is a first step in this direction. The door to stabilising our climate has been opened, but the next steps must follow quickly.

Hans Müller-Steinhagen: Above all, it is important to expand the electricity grids so that all renewable energy sources can be integrated. We need a backbone of electricity lines so that the existing power plants can be used more effectively and to compensate fluctuations. That is both a political topic and a European topic – but it is also a field for investors in the context of private-sector solutions or so-called public-private partnership agreements.

Torsten Jeworrek: Opinions often diverge on one point, namely the price tag on climate change and its consequences. Many people hesitate and would prefer not to look at the price. We strongly advocate against an involvement in concealed or direct subsidisation mechanisms which, in our view, tend to promote a line of conduct that is detrimental to the climate. We support solutions that are reasonable and long term in nature and which do not create the wrong incentives in the longer term.

Ernst Rauch: How do you see Europe's energy mix in the future? What percentage of our energy should come from the desert?

Max Schön: Even just from the point of view of sustainability, it would make good sense to have an energy mix from different renewable sources. A geographic diversification of the energy supply would also be desirable. By 2050, we could obtain between 15 and 20% of our electricity from North Africa; the rest could increasingly be covered by domestic production from such renewable technologies as photovoltaics, wind and geothermal energy.

Hans Müller-Steinhagen: Such a mix would reduce Europe's dependence on imports from 70% today to around 45–50%. We have already developed scenarios taking security of supplies into account. Twenty electricity lines from various locations in North Africa would suffice to ensure that the risk is spread as required. Since the solar thermal power plants can cover the base load, we will also be able to make better use of the other renewable energy sources with their fluctuations. Above all, this will be made possible by storage technology allowing us to store the heat generated during the day so that we can also produce electricity during the night. With a realistic mix of higher efficiency and renewable energy sources, the share of fossil energy supplies could be reduced to 50% by 2050, according to our scenarios.

Torsten Jeworrek: To what extent does nuclear power play a part in your considerations? Extreme scenarios are often discussed, especially in Germany. The opponents of nuclear power want to shut down all nuclear power plants immediately, while its supporters advocate the construction of new plants worldwide. The question is whether reasonable, economically appropriate transitions exist. In my opinion, we should not shut down power plants which operate safely and cost-effectively without good cause.

"DESERTEC goes beyond safeguarding our climate. It also safeguards energy and drinking water supplies, limits the problem of migration and thus helps to promote peace."

Max Schön, President of the
Club of Rome Germany, Hamburg

Renewable energy sources alone would hardly be able to compensate the resultant shortage of supply. Instead, such a step would increase the share of fossil energy sources and coal-fired power plants, jeopardising our climate goals in the process. At the same time, we should not continue spending money on the construction of new nuclear power plants, money that is then no longer available for investment in more sustainable areas. We should invest – specifically and very swiftly – in clean technologies. What is your position on this?

Hans Müller-Steinhagen: The main goal must be to reduce CO_2 emissions. And they must be reduced as quickly, efficiently and sustainably as possible. The long-term storage of nuclear waste is still an unsolved problem of nuclear power. In my view, there are simply a large number of risks involved here. At the same time, dynamic developments have been set in motion due, in particular, to more efficient technologies and the possibility of sequestering CO_2 from coal-fired power plants. Thermal energy for heating could be supplied in addition to electricity by extending the network of co-generating plants and this would considerably reduce the additional energy required today for heating buildings. That would be a meaningful development which would not hamper the ongoing development of renewable energy sources.

Ernst Rauch: Energy mix is a topic that will take up a great deal of our attention in the coming years. DESERTEC is still a vision at present. It is a promising concept, but is still very far from being implemented. Many challenges must first be mastered and risks identified. As Lord Nicholas Stern of the London School of Economics – with which we have concluded a multi-year research partnership – once said, every euro that is invested in avoiding CO_2 emissions today will be repaid several times over in the medium term, in the form of savings for avoided claims costs. We are prepared to accept risks associated with these technologies and also support our clients in the development of new concepts of cover.

Gentlemen, thank you for talking with us.

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