

New Research Focus for Renewable Energies

€ 30 million research funds awarded under German Government Future Investment Programme by the Federal Environment Ministry

In May 2001 the Budget Committee of Germany's Federal Parliament allocated approx. € 30 million to the Federal Environment Ministry to finance research and development in the field of green energies. This will permit R&D projects in the following fields by the end of 2003 as part of the German government's Future Investment Programme (ZIP):

- 1 geothermal power generation
- 2 solar thermal power generation
- 3 ecological research associated with offshore wind farms
- 4 ecological research associated with stationary fuel cells
- 5 ecological research associated with the use of biomass

Some 50 project proposals were submitted with a total financial requirement of over € 65 million. Under participation of corresponding departments of the Federal Environment Ministry, the Federal Environmental Agency (UBA), the Nature Conservation Agency (BfN) and the project carriers (German Redevelopment Bank – KfW for solar thermal power generation and Projektträger Jülich for the other fields) about 20 of these projects were selected and negotiated with the applicants. The funding applied for these projects had to be reduced substantially and the defined tasks were amended accordingly. The projects and partners are summed up below.

1 Geothermal Power Generation

The energy stored within the earth is inexhaustible by human standards. Because this energy is available at any time of day and in any season, it can be used to generate base load power and thereby to substitute about a quarter of Germany's current electricity requirements while producing almost no emissions. Geothermal energy can also be used for district heating as well as power generation, and combined heat and power (CHP) stations obtain both forms of energy at once with particular efficiency.

However, the right technologies must be developed to unleash this potential. The programme will serve to promote power generation, both on its own and in CHP facilities. Three technological approaches are being explored, depending on regional conditions:

- In the **hot dry rock process (HDR)** subterranean heat exchange surfaces are created within hot, dry layers of rock. This is achieved by drilling down to levels of 4,000 metres or more, thereby triggering heavy stimulation. Water circulating in the resultant artificial fractures is heated before returning above ground, where it can be converted into power in a conventional power station or an ORC unit. The HDR process can be established in almost any region, but in Germany it is typically associated with the crystalline rock in the south of the country and the volcanic rock of the northern plain.
- **Hot water from aquifers** can also be extracted directly to provide power and heat. However, the application calls for certain location factors, which are relatively rare in Germany. Exceptions include the Upper Rhine Valley and the foothills of the Alps. The water is converted into electricity above ground and then returned to the earth via a second borehole.
- The third process is using **existing boreholes** – drilled, for example, for identifying cavities for nuclear waste storages or for searching natural gas – to evaporate liquids with low boiling points and thereby derive power from geothermal energy.

Projects for research in geothermal power generation

1	Further development of the HDR process in the crystalline rock of Southern Germany at the Bad Urach site in Baden Württemberg
Partner	Bad Urach Council
Objective	appraisal of options for geothermal power generation in Southern Germany; preparations for the construction of a power station
2	Further development of the HDR process in the volcanic rock of the North German Plain at the Gross Schönebeck site in Brandenburg
Partner	Georesearch Centre Potsdam
Objective	appraisal of options for geothermal power generation in the North German Plain; preparations for the construction of a power station
3	Geothermal power generation in Upper Rhine muschelkalk at the Offenbach site in Rhineland-Palatinate
Partner	Hot Rock EWK Offenbach/Pfalz GmbH, Karlsruhe
Objective	specimen demonstration of cost-effective geothermal power generation in the Upper Rhine trough using thermal water from aquifers
4	Geothermal power generation in the Bavarian Molassebecken using the Kalina Cycle system at the Unterhaching site
Partner	Unterhaching Council
Objective	demonstrating the scope for generating power from mildly thermal deep-lying water in the Malmkarst; retrieval of surplus hydraulic energy
5	Closed geothermal heat exchange
Partner	Technical University Berlin
Objective	demonstrating the use of existing boreholes to produce electricity
6	Networking and evaluating activities in the field of geothermal power generation
Partner	Institut für Energetik und Umwelt, Leipzig
Objective	promotion of scientific exchange, including the organisation of conferences and the compiling of information; analysis of current research with a view to future projects

2 Solar Thermal Power Generation

In solar thermal power stations, concentrated reflector systems produce high-temperature thermal energy to generate electricity. Process heat and space heating can be drawn off, and space cooling can also be provided. Storage technologies permit nighttime and base load operation. Only direct radiation can be bundled in this way, which means, that most potential locations are in dry, hot zones south of latitude 40°.

This technology could play a major role in combating global warming by means of the flexible instruments defined in the Kyoto Protocol. Not only German companies, but also German research institutes are among the global pacesetters in this relatively unexploited form of renewable energy.

There are three significant processes for solar thermal power generating:

- **Parabolic trough systems**, which focus the sun's light onto an absorber tube by means of concave parabolic reflectors. The resulting heat produces steam, which is converted to electricity in a power station block. Parabolic trough systems are currently the most economical option for generating solar power, thereby presenting the greatest opportunity for a large-scale implementation in the short term.
- **Solar tower plants**, where solar radiation is concentrated by individually positioned heliostats. The absorber is in a central position on the tower. The high temperatures obtained offer particularly favourable conditions for integrating gas turbines or highly efficient gas and steam units.
- **Solar dish systems**, consisting of individually positioned parabolic mirrors with an integrated thermal power generator. This is usually a Stirling (hot air) engine driven by continuous heat input. The system can be run around the clock by integrating storage capacity or additional fossil fuel firing. This is why solar dish systems are well suited for the use in decentralised power networks unconnected to a national or other large-scale grid.

Projects for research in solar thermal power generation

1	Parabolic trough technology
Partners	German Aerospace Center (DLR), Cologne/Stuttgart; Flabeg, Cologne; Schlaich Bergermann & Partners, Stuttgart; Schott, Mitterteich
Objectives	a) further development of a prototype European power plant concept (Euro-trough) as a major step towards serial production; assembly and testing of a mirror in California for commercial power generation b) further development of the absorber tube to market maturity c) further development of the storage technology d) development of mobile measurement equipment to optimise solar fields
2	Fresnel trough technology
Partners	Fraunhofer Institute for Solar Energy Systems, Freiburg; E.ON, Munich
Objective	model calculations; optimisation and feasibility study for a trough collector system built over flat mirrors
3	Solar tower technology
Partners	German Aerospace Center (DLR), Cologne/Stuttgart; Kraftanlagen München GmbH, Munich; G+H Isolite GmbH, Ludwigshafen
Objective	improving the efficiency and reducing the cost of the solar tower technology for a medium-term installation of a demonstration plant

4	EnviroDish
Partners	German Aerospace Center (DLR), Cologne/Almeria (Spain); Klein + Stekl, Stuttgart; Mero, Würzburg, Schlaich Bergermann & Partners, Stuttgart; Solo, Sindelfingen
Objective	preparations for small series production of the dish/Stirling technology; creation of a reference units
5	Solar dish system with thermo chemical storage
Partner	BSR Solar Technologies GmbH, Lörrach
Objective	Development of a zero-series prototype for a solar dish system with innovative low-temperature Stirling engine and storage
6	Sokrates
Partner	German Aerospace Center (DLR), Cologne/Stuttgart
Objective	technological appraisal and support for the market launch of solar thermal power plant in conjunction with a satellite-based geographical database

3 Ecological research associated with offshore wind farms

To achieve the German government's targets for the expansion of renewable energies, offshore wind farms with a total capacity of approx. 3,000 MW are to be constructed by 2010. By 2025 to 2030 about 15 per cent of the demand for power – equal to an installed capacity of 20,000 to 25,000 MW – is to be met by these maritime wind farms. In the launch phase there is a particular need for research into the impact of this expansion on the environment and natural resources.

The projects on the list include surveys of bird and bat flight paths as well as the measurement of sonic spectra and intensities. Some of the work is to be conducted on measuring platforms set up as part of the R&D ZIP programme run by the Federal Ministry of Economics and Technology (BMWi). One research output will be recommended thresholds, for example, for acoustic emissions from offshore wind farms. This requires prior investigation into the hearing of small whales and harbour seals. Other projects will address the optimisation of pilings to shield wind farms from collisions with seagoing vessels and the routing of undersea cables with due respect for the requirements of natural protection and legal provisions.

At the same time, the population and distribution of resting birds and sea mammals will be recorded over large areas. This will help to assess head counts undertaken in smaller areas by operators applying to build wind farms at specific sites.

Given the specific problems raised by applying the IPPC Directive in the Exclusive Economic Zone (EEZ), legal and technical instruments are to be developed to assist in environmental planning and the definition of precautionary measures during the licensing process for offshore wind farms.

One particular objective of this research will be supporting the identification of suitable areas for offshore power generation and, by the same token, areas within the EEZ, which merit special protection by the German government.

Projects for ecological research associated with offshore wind farms

1	Warm-blooded marine fauna in the North and Baltic Seas
Partners	Wattenmeer National Park Authority, Tönning (lead partner); Deutsches Meeresmuseum, Stralsund; West Coast Research and Technology Centre, Kiel University; Marine Fishing Institute, BFA, Hamburg; Marine Studies Institute, Kiel University; Ruhr University, Bochum
Objective	monitoring of the population, behaviour and acoustic sensitivity of marine resting birds, divers, marine ducks and mammals
2	Nature protection requirements of bird protection areas
Partner	Schreiber Umweltplanung, Bramsche
Objective	preliminary research for the designation of protected areas and suitable wind farm locations in the EEZ
3	Platform-based field studies on the impact of offshore wind farms on the marine environment (BEOFINO)
Partner	Alfred Wegener Foundation, Polar and Marine Research Institute, Bremerhaven
Objective	Monitoring bird migration paths and benthos communities in the vicinity of piles; determining the impact of electromagnetic fields on marine life; procedural proposals for IPPC implementation
4	Evaluation of foundations for offshore wind farms with a view to potential shipping collisions
Partner	Technical University Hamburg Harburg
Objective	model calculations for shipping collisions with wind farms; formulation of recommendations for different pilings
5	Acoustic pollution of the marine environment by offshore wind farm emissions
Partners	Curt Risch Institute of Dynamics, Sound and Measurement Technology, Technical University of Hanover (lead partner); German Wind Energy Institute, Wilhelmshaven; Institute of Technical and Applied Physics, Oldenburg
Objective	monitoring of sonic spectra and intensities; formulation of recommendations for acoustic emission thresholds for future offshore wind farms
6	Environmentally compatible sound grid connections for offshore wind parks
Partner	Schreiber Umweltplanung, Bramsche
Objective	formulation of criteria for routing undersea cables given the requirements of nature protection and legal provisions
7	Environmental planning tools for the licensing of offshore wind farms
Partner	Technical University Berlin
Objective	development and adjustment of precautionary and planning instruments for the use in the licensing of offshore wind farms in the light of technical and legal factors

4 Ecological research in association with fuel cell applications

Fuel cells are galvanic elements used for energy conversion. They generate power and heat due to a direct reaction between the fuel cell and ambient oxygen. Compared with conventional combustion systems, they display lower emissions and potentially greater electrical efficiency. Moreover, the efficient operation at partial load and the modular construction permit a broad range of applications, from powering laptops via vehicle propulsions to power plants in the megawatt class. With the aid of networked, decentralised combined heat and power units in buildings, they can even be used to run “virtual” power stations.

Fuel cells can be operated with different fuels. They are particularly helpful as a smooth transition from fossil fuels to renewable energies. This makes them an important stepping-stone on the road to sustainable energy supply.

Combined project for ecological research associated with fuel cell applications

1	Environmental impact, framework conditions and market potential of decentralised fuel cell systems
Partners	German Aerospace Center (DLR), Cologne/Stuttgart (lead partner); Fraunhofer Institute for Solar Energy Systems, Freiburg; Institute of Energy and Environment Research, Heidelberg; Ruhr University, Bochum; Wuppertal Climate, Environment and Energy Institute; Centre of Solar Energy and Hydrogen Research, Stuttgart
Objective	analysis of the entire fuel cell process chain (production, operation and disposal/recycling) regarding the operation experience of existing fuel cell systems; scenario-based calculations on the development potential for different fuel cell technologies in the German energy sector; appraisal of the environmental impact of fuel cell systems

5 Ecological research in association with the use of biomass

For achieving the targets, which have been set to expand renewable energies and ensure a sustainable energy supply, it will be essential to make greater use of biomass. The term covers a broad spectrum of possible materials of plant and animal origin. Biomass can be used to obtain propellant fuels, electricity, heat and also combined heat and power. As it can be stored, energy can be produced at base load. The diversity of biogenic inputs also encourages innovative conversion technologies, including the Stirling engine and fuel cells.

Under the Renewable Energies Act and the Biomass Ordinance the Federal Environment Ministry has been entrusted with monitoring the use of biomass for energy purposes and, if necessary, rectifying counter-productive trends. Therefore the energy and environmental balances, induced by the use of different types of phytomass and zoo mass combined with various conversion technologies must be evaluated. Research also includes the generating of development scenarios founded on a variety of assumptions and conditions for the use of biomass.

Combined project for ecological research associated with the use of biomass

1	Material flow analysis for a sustainable use of biomass in energy applications
Partners	Öko-Institut, Darmstadt/Freiburg/Berlin (lead partner); Fraunhofer Institute for Environmental, Security and Energy Technologies, Oberhausen; Institut für Energetik und Umwelt, Leipzig; Institute of Energy and Environment Research, Heidelberg; Institute of Future Energy Systems, Saarbrücken; Institute of Geoecology, Department of Environmental Systems Analysis, Technical University, Brunswick; Weihenstephan Scientific Centre for Food, Land Use and the Environment, Munich
Objective	material flow analysis for the requirement "biomass in energy applications"; development of a model and analysis of possible future trends based on scenarios; formulation of an ecologically compatible strategy for using the biomass potential in Germany for energy conversion