SOLAR THERMAL ENERGY
COMES TO RAJASTHAN

Technology transfer through an innovative public-private partnership

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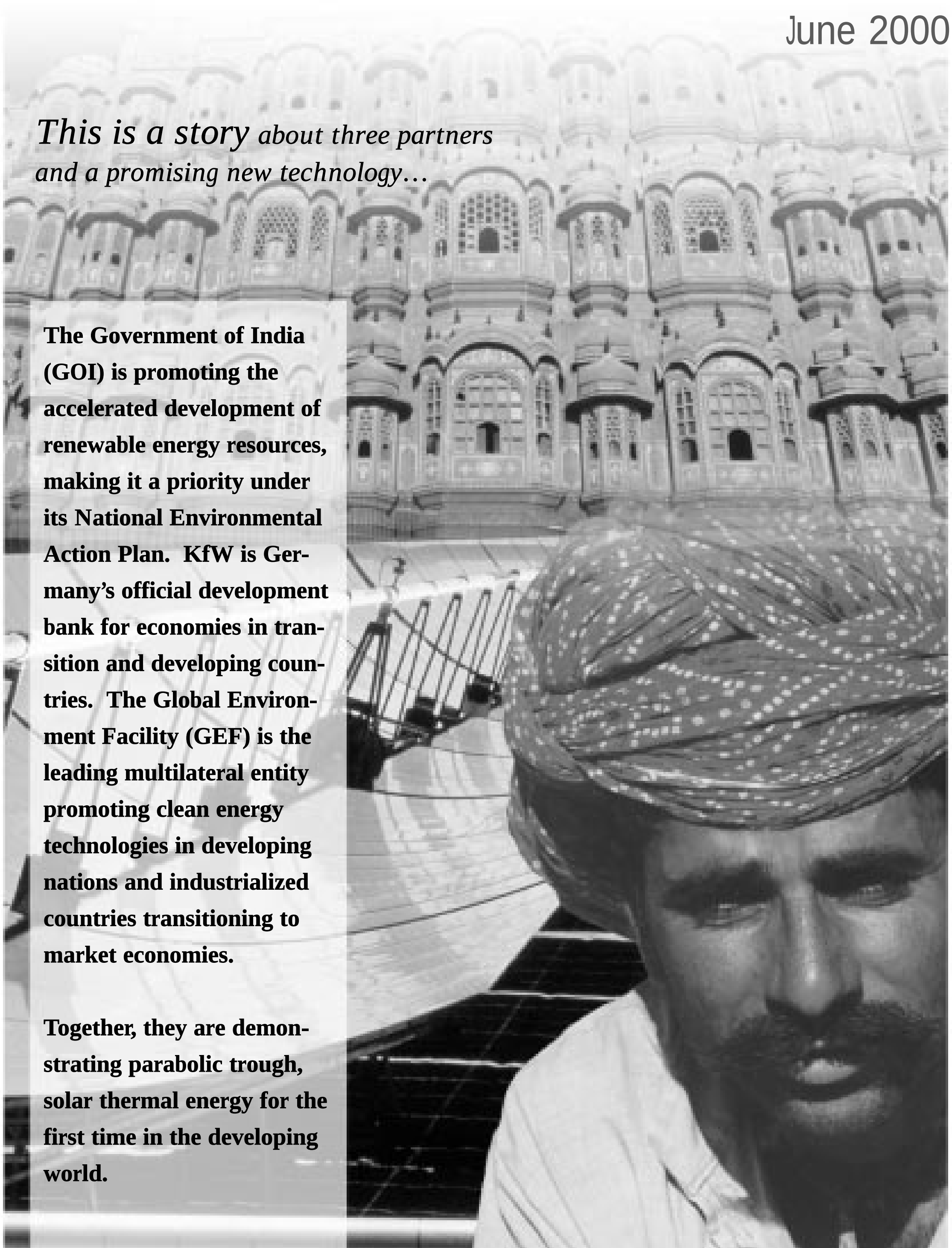

This is a story about three partners and a promising new technology…

The Government of India (GOI) is promoting the accelerated development of renewable energy resources, making it a priority under its National Environmental Action Plan. KfW is Germany's official development bank for economies in transition and developing countries. The Global Environment Facility (GEF) is the leading multilateral entity promoting clean energy technologies in developing nations and industrialized countries transitioning to market economies.

Together, they are demonstrating parabolic trough, solar thermal energy for the first time in the developing world.

History

Beginning in the 1980s, energy planners reviewed options for parabolic trough, solar thermal power stations in developing countries. However, this renewable energy technology, particularly suitable for tropical developing countries with stable and intensive degrees of solar insolation, was first introduced in industrialized country power markets. More than 300 megawatts (MW) of active solar thermal power capacity were installed in California in the early 1980s.

In 1994, the Indian government commissioned a site specific feasibility study for a 35 MW power plant to be situated in arid Mathania, Rajasthan, near Jodhpur. This study became the subject of further review by engineering consultants engaged by the state government of Rajasthan and was supplemented by technical options assessments conducted in 1996 with the assistance of the German bank KfW. As the outcomes of these assessments and solar field performance reviews were favorable, the Rajasthan government decided to pursue the first commercial-scale, solar thermal investment in a developing country and invited KfW and the GEF to support this pioneering undertaking.

The main objectives of the Mathania project are: (a) to demonstrate the operational viability of parabolic trough, solar thermal power generation in India; (b) promote commercial development of solar thermal technology and cost reduction; and (c) help reduce greenhouse gas global emissions in the short and longer term. Operational viability will be demonstrated through operation of a solar thermal plant by an independent power producer which will sell power to the utility through commercial power sales and contracts. Technology development will be supported through technical assistance and training. The project is expected to avoid emissions of 3.1 million tonnes of carbon over the solar thermal plant's operating life, relative to generation from a similar-sized coal-fired power station.

The Mathania project concept entered the GEF work program in 1996. With a GEF contribution of US$49 million and a total financing volume of US$245 million (co-financed by the government of India and KfW, and executed by KfW), it is one of the largest of some 82 GEF-sponsored energy investments. Two additional solar thermal technology commercialization projects for Morocco and Mexico have recently been added to the GEF work program. Another two for Brazil and Egypt are in the GEF project pipeline.

GEF Strategy and Rationale for GEF Support

As a financial mechanism for the U.N. Framework Convention on Climate Change, GEF is supporting country efforts to reduce the burning of fossil fuels and increase use of renewable energy technologies. A variety of short, medium, and long term approaches to hasten the achievement of these goals are supported by three GEF operational programs that:

- Remove barriers to energy efficiency and energy conservation
- Promote the adoption of renewable energy by removing barriers and reducing implementation costs
- Reduce the long-term costs of low greenhouse gas-emitting energy technologies.

The last of these programs puts the global warming challenge in a strategic, longer term perspective: taking into account that none of the current mainstream energy technologies provides a solution, GEF helps open doors for renewable energy technologies with superior potential in developing countries. These technologies are not yet economically viable, but constitute the most promising medium-term alternatives with potentially significant shares in these energy markets.

Recognizing that investing in visionary solutions entails risks similar to investing in any other emerging technology market, GEF limits its role as a "technology prospector" to options that are technically proven and have already gained some commercial interest. The diversity of GEF's approaches to promoting cleaner energy solutions provides an effective hedge for GEF's technology prospecting ventures, including its solar thermal investments.

GEF generally aims to foster strategic shifts in technology market development trends towards sustainable solutions. This is being done by offering co-finance for innovative tools and services that can help developing country clients activate market forces for rapid commercial transfer and dissemination of environmentally prudent technologies. This may include co-financing for information, advisory, and financial services with a promising track record. Proven effectiveness in the removal of constraints that hamper market development is a prerequisite for GEF support.

Experience gained in GEF operations suggests that one key to success is to find ways and means to effectively influence market development trends without distorting them. Examples abound where government sponsored clean technology programs actually had adverse effects on these markets. Some interventions generated considerable short-term demand for emerging technologies that temporarily led to premium prices. However, as soon as the subsidy "cushion" which fueled the price hike was gone, the technologies sometimes were even less competitive.

GEF seeks to build public-private partnerships based on a good understanding of market forces and on comprehensive assessments for the commercialization potential of emerging technologies such as solar thermal power. GEF aims to engage the most innovative technology providers in a competitive process that leads to the demonstration of the most promising application in specific developing country markets. Demonstrations are led by developing country clients and executed together with public and private partners.

The initial motives for GEF co-financing newly emerging technologies like solar thermal troughs are:

- Awareness raising about promising clean technology alternatives particularly suitable for developing country markets
- Demonstration of feasibility under developing country conditions and to expedite the introduction of new technologies in developing countries
- Transfer of instrumental technological skills and know-how, including training and capacity building
- Building local engineering and technology assessment capacity
- Reducing initial costs.

Once these goals have been met in the solar thermal projects currently planned in India, Brazil, Morocco, Mexico, and Egypt, the GEF may consider playing an active role in facilitating progressive market development. If the outcomes of comprehensive market analysis suggest that the GEF — together with other partners — has a strategic potential to expedite commercialization of this technology alternative in developing country markets, GEF may take the next step. This phased approach and formation of strategic public-private partnerships allows GEF to effectively manage and share risks, and to respond flexibly to unexpected barriers on the path to commercialization.

The Mathania Case

The project involves construction by the private sector of a solar thermal/fossil-fuel hybrid power plant of about 140MW incorporating a parabolic trough solar thermal field of 40 MW; and technical assistance to support commercialization of solar thermal technology.

The solar thermal/hybrid power station will comprise: a solar field with a collection area of 219,000 m2 to support a 35MWe to 40MWe solar thermal plant; and a power block based on mature fossil fuel technology. The proposed project will be sited at Mathania, near Jodhpur, Rajasthan in an arid region. In addition to high solar insolation levels (5.8 kWh/m2 daily average), the proposed site involves approximately 800,000 m2 of relatively level land with access to water resources and electric transmission facilities. The solar thermal/hybrid station will operate as a base load plant with an expected plant load factor of 80%. The final choice of the fossil-fired power block will be left to the bidders, subject to performance parameters set out in the tender specifications.

The design choice is an Integrated Solar Combined Cycle (ISCC) involving the integrated operation of the parabolic trough solar plant with a combined cycle gas turbine using fossil fuels such as fuel oil, low sulfur heavy stock (LSHS) or naphtha. Such a plant would consist of the solar field; a combined cycle power block involving two gas turbines each connected to a heat recovery steam generator (HRSG) and a steam turbine connected to both HRSG; and ancillary facilities and plant services such as fire protection, fuel oil/LSHS/naphtha supply and storage system, grid interconnection system, water supply and treatment systems, etc. A control building will house a central microprocessor control system that monitors and controls plant operations.

The project will provide technical assistance to ensure that adequate institutional and logistical support for the technology is available for future expansion of solar thermal power. Specifically, funds will be made available for: the promotion of solar thermal technologies among potential investors; an operation and maintenance efficiency improvement program; monitoring and evaluation of the project and of the overall solar thermal program in India; staff training and development of a local consultancy base; upgrading of test facilities; and improved collection and measurement of solar insolation data and other solar resource mapping activities.

The capital cost of solar thermal power generation technologies is significantly higher than fossil-based conventional power. Nevertheless, costs have been falling sharply, from $5,000 per kW for the first solar thermal plant to $2,900 for the latest Luz plant in California. Recent estimates for proposed integrated solar combined cycle plants are estimated to be $2,000 per kW. GEF support, supplemented by a financial contribution of $20 million from the government of India, will directly help “buy down" the installation and associated technology development cost of the solar power plant to render it competitive with other sources of power in Rajasthan.

Demonstrating the solar plant's operational viability under Indian conditions is expected to result in follow-up investments by the private sector, both in the manufacture of the solar field components and in larger solar stations within India. Insights into local design and operating factors such as meteorological and grid conditions, and use of available back-up fuels, are expected to lead to its replicability under Indian conditions, opening up avenues for larger deployment of solar power plants in India and other countries with limited access to cheap competing fuels. Creation of demand for large scale production of solar facilities will in turn lead to reductions in costs of equipment supply and operation. It is also expected to revive and sustain the interest of the international business and scientific community in improving systems designs and operations of solar thermal plants.

Another Partnership Example

Another example illustrating potential roles for GEF and KfW beyond initial technology demonstrations and related capacity building is a study jointly commissioned by the two partners on the commercialization of photovoltaics (PV) for certain grid-connected applications in conjunction with hydro-power.

India's Energy Sector

India's power sector has a total installed capacity of approximately 77,000 MW of which 65% is coal-based, 28% hydro, and the balance gas and nuclear-based. Power shortages are estimated at about 10% of total energy and 20% of peak capacity requirements and are likely to increase in the coming years. For the period fiscal years 93 to 97 nearly 50,000 MW of capacity additions were required, but due to financial constraints less than 20,000 MW were realized. The bulk of capacity additions involve coal thermal stations supplemented by hydroelectric plant development. Coal-based power involves environmental concerns relating to emissions of suspended particulate matter (SPM), sulfur dioxide (SO_2), nitrous oxide, carbon dioxide, methane, and other gases. On the other hand, large hydro plants can lead to soil degradation and erosion, loss of forests, wildlife habitat and species diversity, and, most importantly, the displacement of entire communities.

To promote environmentally sound energy investments as well as help mitigate the acute shortfall in power supply, the Government of India (GOI) is promoting the accelerated development of the country's renewable energy resources and has made it a priority thrust area under India's National Environmental Action Plan (NEAP). GOI estimates that a potential of 50,000 MW of power capacity can be harnessed from new and renewable energy sources but due to relatively high development costs experienced in the past these were not tapped as aggressively as conventional sources. Nevertheless, development of alternate energy has been part of GOI's strategy for expanding energy supply and meeting decentralized energy needs of the rural sector. The program, considered one of the largest among developing countries, is administered through the Ministry of Non-Conventional Energy Sources (MNES), energy development agencies in the various States, and the Indian Renewable Energy Development Agency Limited (IREDA).

Although current PV installation prices would still need to come down by more than 50% to enable full competitiveness, leading PV suppliers have confirmed independently that this would be a realistic target if GEF, together with KfW and other interested financing entities, could facilitate procurement of 500MW or more in one large package. Aggregating the market to such an extent would require a strategic alliance of key actors interested in developing it. In addition to targeted efforts to identify and match capacity demand and PV panel supply by the manufacturers, it would require consortia of public and private banks as well as other sources of venture capital.

The role of the GEF in facilitating the design and implementation of investment packages of such a scale could be the one of broker and syndicator. In addition, GEF may also consider provision of partial risk guarantees and other forms of contingent financing to address incremental investment risks in such pioneering market transactions.

Taking into account that the above approach might be as interesting for the commercialization of solar thermal troughs as it is for PV-hydro co-generation, one could imagine that a follow-up study to address solar thermal commercialization options could become the next addition to the KfW-GEF partnership.

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The Global Environment Facility is a multilateral financial mechanism that assists developing countries and countries with economies in transition to protect the global environment in four areas: biodiversity, climate change, international waters, and ozone layer depletion. GEF has funded more than 650 projects in 140 countries, committing close to $3 billion in grants and raising an additional $8 billion in co-finance. These projects are implemented by the United Nations Development Program, the United Nations Environment Program, and the World Bank on behalf of the GEF.

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