

Pakistan has an enormous potential of its energy resources however it still remains energy deficient and has to rely heavily on imports to satisfy its needs. Renewable resources that are technologically viable and have prospects to be exploited commercially in Pakistan include micro-hydel, bio-energy, wind and solar energy. Nevertheless increasing demands on limited resources has been a major environmental concern for the country. This resource crunch is exacerbated by use of unclean energy sources and continuing pollution threat.

## Chapter 8 Energy and Renewable Resources – fuelling the future

### Pressures

The general shortage of energy supply, complemented with inefficient use and wastage continues to broaden the demand supply gap. The cost of load shedding – caused mainly to meet the demand supply gap – is estimated at 1.7% reduction in GDP. This does not include the cost due to lost trade and energy theft. Following sub-sections present some of the key pressures faced by Pakistan's energy sector.



### Increased Energy Consumption

Pakistan's energy consumption has nearly tripled in the last 20 years, from 0.6 quadrillion Btu in 1980 to 1.9 quads in 2001. Still, Pakistan accounts for less than 0.5% of total world energy consumption. In terms of per capita energy consumption, Pakistan's level of 12.9 million Btu in 2001 was higher than Bangladesh's (3.7 million Btu), but virtually on par with India's (12.6 million). In comparison, China's per capita energy consumption in 2001 was 30.9 million Btu, Iran's was 80.3 million Btu, and Russia's was 195.3 million Btu, while U.S. per capita consumption was 341.8 million Btu.

As industry has expanded, factories have emitted more and more toxic effluents into the air. Also, as in other developing countries, the number of vehicles in Pakistan has swelled in recent years--from 680,000 in 1980 to 5 million in 2003. The 1992 National Conservation Strategy Report claims that the average Pakistani vehicle emits 25 times as much carbon dioxide as the average U.S. vehicle, as well as 20 times as many hydrocarbons and more than 3.5 times as many nitrous oxides in grams per kilometre.



Cars are the leading source of air pollution that adversely affects Pakistan's economy and population. Economic damages from urban air pollution are estimated at about \$370 million, with 6.4 million people hospitalized annually for air-pollution-related illnesses. A recent advertisement placed by the government in a newspaper warned, "Take care of your tune-ups before the poison in the air takes care of you."

Many Pakistani environmentalists say that poor fuel quality is also to blame for the country's serious air pollution problems. Fuel consumption rose by 188% in Pakistan from 1980 to 1998, and gasoline continues to contain high levels of lead and sulphurs. Unleaded gasoline was introduced in 2001, but many vehicles in Pakistan's major cities still use leaded gasoline. Various grades of gasoline sold contain about 350 mg/litre of lead--in comparison, leaded gasoline in other countries usually contains no more than 150 mg/litre.

## GHG Emissions

Energy generation and combustion activities are the most significant contributor to Pakistan's greenhouse gas emissions, accounting for about 70,000 Gg, or approximately 60% of total estimated emissions in the country. Emissions from fossil fuel combustion comprise the vast majority of these emissions, while releases of carbon dioxide from fossil fuel combustion account for 66,298 Gg. The production, transmission, storage and distribution of fossil fuels also emit greenhouse gases (primarily methane) and are termed fugitive emissions from natural gas systems, oil production/refining and local mining. These gases represent a much smaller portion of total energy emissions than CO but are, nonetheless, important. More than 85% of energy in Pakistan is produced through the use of fossil fuels, primarily natural gas and petroleum. The remaining 15% consists of renewable or other energy sources such as hydropower, biomass and nuclear energy.

### Emission by Energy Source

| Energy Source           | Emission Levels (%) |
|-------------------------|---------------------|
| Oil                     | 39.2                |
| Gas                     | 38.0                |
| Coal                    | 7.7                 |
| Nuclear/Renewable/Other | 15.1                |
| Total                   | 100                 |

Source: ENERCON

The energy related emissions can be significantly reduced through the implementation of programs that reduce energy consumption and thereby reduce the resulting emissions proportionately; as well as improve the efficiency of combustion and as a result, reduce emissions by a factor possibly much larger than the percentage reduction in energy use. The impact of both these effects is increased profits or lower costs. In addition to the direct reduction in emissions, energy efficiency programs also promote environmental protection by greatly enhancing awareness of the concept of conservation; by training and education of engineers and technicians regarding more efficient management practices; and by developing policies which promote rational pricing of energy.

### High Costs of Alternative Energy Sources

The potential for renewable energy has remained largely unutilised in Pakistan with the exception of mini and micro-hydel power generation. Renewable energy sector has struggled against institutional and policy failures and optimal exploration of additional sources of energy supply has not gone very far. An important factor behind this relatively limited interest is the high costs associated with renewable energy sources. For instance, the plans to harvest solar energy in Pakistan despite extensive solar mapping as the PV costs are 4 times higher than any other energy sources available. Similarly, the potential to exploit wind energy or geothermal power has remained minimal due to high costs associated to establishing proper demonstration units and research laboratories.



## State

Pakistan obtains its energy requirements from a variety of traditional and commercial sources. Oil supply from indigenous resources has been the weakest link in the energy supply system of Pakistan. Until early 1980 crude oil production was a nominal 13,000 barrels per day (BDP), which rose to 64,349 BPD in 1990-91. Since then production has been continually declining. The remaining oil reserves are estimated at 221 million barrels which, on the average production rate of 57,000 barrels per day, will be exhausted in about 10 years. Consequently, it appears that Pakistan will remain a net importer of crude oil and refined oil products unless a major discovery of crude oil is made.

The total primary energy consumption in Pakistan is currently estimated at around 60 million tons of oil equivalent (MTOE). Of this, two-thirds are met by commercial energy resources with about one-third being based on non-commercial energy resources like fire-wood, charcoal and cow-dung. The primary commercial consumption of 41.7 MTOE is largely based on the use of hydrocarbons.

#### Primary Energy Supplies by Source

| Source of Commercial Energy | Primary Energy Supplies (%) |
|-----------------------------|-----------------------------|
| Gas                         | 38.61                       |
| Oil                         | 42.8                        |
| Coal                        | 5.2                         |
| Hydro                       | 13.0                        |
| Nuclear and other           | 0.2                         |

Source: ENERCON

Oil and gas account for more than three-quarters of the commercial energy consumption in the country. Gas has emerged over the years as the leading domestic source of energy. Pakistan has appreciable coal reserves of 1.7 billion tonnes of oil equivalent (TOE). Oil is by and large an imported source of energy. The imports of oil account for 85% of oil consumption in the country and 42.8% of commercial energy consumption. The production of indigenous oil is around 15% of total imports of oil products, which is likely to remain the case. Pakistani oil sector performance, unlike that of the natural gas sector, has not been satisfactory, both by way of exploration, exploitation and development of oil fields, and by way of refining of crude oil into various products, with the result that 70% of total demand of crude oil is being met through imports. It costs about US\$ 2.5 billion every year to import about 18 million tons of oil as both crude and refined products, representing a great burden on foreign exchange resources. No significant new discovery of crude oil has been reported in the recent past. Of course efforts are underway both by national and international exploration and development companies to make new oil discoveries. Transport, power and industry are the major oil consuming sectors of the economy.

#### Sectoral Consumption

| Sectoral Consumption | %    |
|----------------------|------|
| Transport            | 47.2 |
| Power                | 33.2 |
| Industry             | 12.9 |
| Agricultural         | 1.5  |
| Domestic             | 3.0  |
| Other Govt.          | 2.3  |

Source: ENERCON

Today, the primary energy supplies are not enough to meet even the present demand. So, Pakistan, like other developing countries of the region, is facing a serious challenge of energy deficit. Renewable energy sources can play an important role in meeting this challenge.

#### Oil Resources and Exploration

Pakistan produced 61,769 barrels per day (bbl/d) of oil in 2003 (of which 60,000 bbl/d was crude oil), and consumed 360,000 bbl/d of petroleum products. Net oil imports were 308,000 bbl/d in 2003. While there is no prospect for Pakistan to reach self sufficiency in oil, the government has encouraged private (including foreign) firms to develop domestic production capacity. Pakistani domestic oil production centers on the Potwar Plateau in Punjab and lower Sindh province.

State-owned Oil and Gas Development Corporation Limited (OGDCL) is a leading firm in the industry, producing around 22,334 bbl/d according to company information. A 5% stake was sold in a public offering in November 2003 for approximately \$119 million. OGDCL is Pakistan's second-largest oil producer after UK-based BP. The government will also offer a stake of up to 15% of Pakistan Petroleum Limited (PPL), the largest exploration and production firm in Pakistan. Currently the government controls 93% of the company, which owns the Sui fields in Balochistan, as well as exploration interests in 22 blocks. The government also has a 35% stake in Pakistan Oilfields Limited (POL).



Oil sector reforms in Pakistan are generally on track, but the privatization of several firms, including Pakistan State Oil (PSO), continues to be postponed. The government's divestiture of its 51% stake in PSO to a strategic partner has been planned for several years. PSO holds a 60% domestic market share in diesel fuel and has more than 3,750 retail outlets. Deregulation of prices for petroleum products is being pursued in parallel with the privatization of PSO.

As part of the country's privatization process, Pakistan is setting up a Gas Regulatory Authority (GRA) and the Petroleum Regulatory Board (PRB), which will separate out government functions from state-owned companies to be privatized. Pakistan's government hopes to reap significant revenues from these privatizations over the next several years. The two most significant foreign oil firms in Pakistan are BP and Eni. BP operates 43 fields in Pakistan and had reported average production of 25,877 bbl/d in 2003. Other firms include BHP Billiton (Australia) OMV (Austria), Petronas (Malaysia) and Premier Oil (UK).

Pakistan's net oil imports are projected to rise substantially in coming years as demand growth outpaces increases in production. Demand for refined petroleum products also greatly exceeds domestic oil refining capacity, so nearly half of Pakistani imports are refined products. Pakistan's Pak-Arab Refinery (PARCO) became operational in late 2000, adding to the country's refining capacity, and alleviating refined product import dependence. The PARCO Mid Country Refinery at Mahmood Kot was formally commissioned in 2001 and has capacity of 100,000 bbl/d of throughput (mostly crude oil from Abu Dhabi and and Light Arabian Crude from Saudi Arabia), supplied to the plant by pipeline from Karachi.

A small, 30,000 bbl/d refinery operated by private Bosicor Pakistan Limited (BPL) near Karachi began commercial operation in November 2003. The plant is supplied with shipments of crude oil from Qatar. The Bosicor plant will allow Pakistan to become a new supplier of naphtha to Far Eastern markets. Naphtha makes up approximately 9% of the plant's output. The plant produces about 10,800 bbl/d of fuel oil, 6,980 bbl/d of diesel, and 4,350 bbl/d of kerosene, among other products. PSO has a supply contract to purchase the totality of the Bosicor refinery's products for the next 10 years.

Another major planned project is the "Iran-Pak" refinery, which would have a capacity of 130,000 bbl/d. The refinery will be located near the border with Iran in Baluchistan province and would be a 50:50 partnership between Pakistan's Petroleum Refining and Petrochemical Corporation (PERAC) and the National Iranian Oil Company (NIOC). Oil processed at the Iran-Pak refinery would come almost exclusively by sea from Iran, and would be unloaded at a terminal to be built for the refinery. The project has failed to reach financial closure, however, as NIOC's demand for a guaranteed rate of return is at odds with Pakistan's policy against such guarantees.

## Nuclear Energy

A small (125 MW<sub>e</sub>) PHWR plant was commissioned in 1971. Known as Kanupp (Karachi Nuclear Power Plant), this facility makes a minor contribution (less than 1%) to the national electricity supply. In addition, a second plant (Chasnupp 1), a 300 MW<sub>e</sub> PWR, has been constructed at Chasma; it was connected to the grid in June 2000. Plans are reported for a second unit at Chasma, to be operational in about 2009: negotiations with China on its construction were under way in May 2001.



The Karachi facility, which was built in 1965 with Canadian assistance, has demonstrated a poor operating record, which--in addition to concerns in the international community about Pakistan's possible use of nuclear material for weapons--has contributed to the lack of further development of the country's nuclear power sector. The Chashma Nuclear Power Plant was built with Chinese assistance and inaugurated in 2001. Pakistan is placing more emphasis on nuclear power to meet future energy needs and has begun talks with China over the development of a second facility at Chashma.

## Natural Gas

Pakistan has 26.8 trillion cubic feet (Tcf) of proven gas reserves, and currently produces around 0.8 Tcf of natural gas per year, all of which is consumed domestically. Natural gas producers include Pakistani state-owned companies Pakistan Petroleum Ltd. (PPL) and Oil and Gas Development Corporation (OGDCL), as well as BP, Eni, OMV, and BHP. As part of its energy sector reform program, the government is committed to privatizing a 15% stake of PPL (see above), the largest gas producer in the country, capable of producing 770 million cubic feet per day (Mmcfd). The largest currently productive fields are Sui, by far the largest at 650 Mmcfd, Adhi and Kandkhot (120 Mmcfd), Mari, and Kandanwari.



Pakistan's demand for natural gas is expected to rise substantially in the next few years, with an increase of roughly 50% by 2006, according to Pakistan's oil and gas ministry. Pakistan also plans to make gas the "fuel of choice" for future electric power generation projects, hoping to substitute domestic gas supplies for imported foreign oil. This will necessitate a sharp rise in production of natural gas, and also has generated interest in Pakistan in pipelines to facilitate imports from neighbouring countries.

Development of new natural gas fields with the help of foreign investors is proceeding, with Pakistan's government expecting recently discovered fields to add about 1 billion cubic feet per day (Bcfd) to Pakistan's natural gas production. Currently, fields in production include Sawan at about 366 Mmcfd, Bhit at about 316 Mmcfd, and Zamzama in Sindh province producing about 248 Mmcfd, but possibly able to produce 380 Mmcfd following a new gas discovery in January 2004.

Pakistan's government restated its willingness to permit a natural gas pipeline linking Iran's massive reserves to Indian markets across Pakistani territory. Pakistan would earn transit fees for Iranian gas supplied to India and also would be able to purchase some gas from the pipeline when and if its own demand was sufficient. While Iran and Pakistan have shown great interest in the project, India has been reluctant to move forward as long as political and military tensions with Pakistan over Kashmir persist. The issue was due to be discussed at bilateral talks between India and Pakistan in June 2004, although negotiations are still expected to be protracted and difficult. Iran is offering India that it will cover 60% of the construction costs of the pipeline, but India remains wary of Pakistani access to its energy

supply. Indian officials said the plan could be considered if Pakistan can provide security guarantees for the \$3 billion project. Pakistan could earn about \$600 million annually in transit fees from the pipeline.

Another natural gas import possibility is an eventual link with the Dolphin Project, a scheme to supply gas from Qatar's North Dome gas field to the United Arab Emirates and Oman, via a sub-sea pipeline from Oman. Even though Pakistan has signed a preliminary agreement to eventually purchase natural gas from Qatar, it remains to be seen how the initial stages of the pipeline project go before a route to Pakistan can be conclusively negotiated.

### **Electric Power**

Pakistan has 18 gigawatts (GW) of electric generating capacity. Thermal plants using oil, natural gas, and coal account for about 70% of this capacity, with hydroelectricity (hydro) making up 28% and nuclear plants 2.5%. Pakistan's total power generating capacity has increased rapidly in recent years, due largely to foreign investment, leading to a partial alleviation of the power shortages Pakistan often faces in peak seasons. Rotating blackouts ("load shedding") are, however, still necessary in some areas. Transmission losses are about 30%, due to poor quality infrastructure and a significant amount of power theft. Periodic droughts affect the availability of hydropower. With much of the Pakistan's rural areas yet to receive electric power, and less than half of the population connected to the national grid, significant power demand growth is expected in the long term, though in the short term, Pakistan has some excess generation capacity.

The electric power sector in Pakistan is still primarily state-owned, but a privatization program is reportedly underway. The main state-owned utilities are the Water and Power Development Authority (WAPDA), and the Karachi Electricity Supply Corporation (KESC), which serves only Karachi and surrounding areas. Together, WAPDA and KESC transmit and distribute all power in Pakistan -- over half to household consumers, about one third to industrial consumers and the rest to commercial and government consumers. Rates are determined by the National Electric Power Regulatory Authority (Nepra) and disputes over adjustments to rates are common within the industry.



For example, Nepra announced in July 2004 that electricity rates would be lowered for domestic, industrial and agricultural customers in the three distribution areas of Hyderabad, Peshawar, and Quetta. The distribution companies affected complained that due to the lower rates, they will be unable to cover their operating costs. Nepra has advised the federal government to subsidize the providers at a cost of around \$24 million. WAPDA and KESC too blame low rates on weak earnings and enormous debts to fuel suppliers. WAPDA is at the center of a public sector "circular debt" problem, in which state firms and government ministries have failed to pay power bills, and WAPDA has failed to meet obligations to them and to private sector creditors, especially state-owned PSO.

Power theft is a pressing issue in Pakistan. While it is impossible to precisely measure theft (as opposed to line loss), it is obvious that it constitutes a sizable proportion of Pakistan's overall 30% loss rate. The situation was so severe by early 1999 that the Pakistani government assigned army units to look for illegal connections to transmission lines and rigged meters. Power theft is just one part of the financial problems for WAPDA, however.

Growth in power generation in recent years has come primarily from new independent power producers (IPP's), some of which have been funded by foreign investors, and a few WAPDA

hydroelectric dam projects. The two largest private power plants in Pakistan are the Hub Power Company (HUBCO) and the Kot Addu power company (KAPCO). HUBCO is owned by a consortium of International Power (UK), Xenal (Saudi Arabia), and Mitsui Corporation, and has a 1,300-MW capacity. The Kot Addu plant, with a 1,600-MW capacity, was privatized in 1996 (from WAPDA), and International Power holds a 36% equity stake, while the government holds a soon-to-be divested 64% stake. Both of these plants, as well as a few other small private operators, sell power to the national grid currently run by WAPDA. By May 2004, International Power cut its holdings in HUBCO from 26% to 16%, after the plant saw a drop in profits. This is reportedly part of International Power's overall global strategy and not a comment on the Pakistani energy sector.

In April 2003, the Ministry of Industries and Production announced that it was planning to build coal-fired power-generation plants in export processing zones and in special industrial states to provide a less expensive source of energy. Officials hope to exploit the large, untapped coal reserves in Tharkparkar. At present, coal makes up less than a 5% share in overall energy production.

Plans are also underway to expand Pakistan's hydro capacity -- the government approved the construction of 4 new hydro plants to be built in the North West Frontier Province by 2005/2006 that would generate several hundred megawatts of additional power. If the \$5.5 billion Kalabagh project is approved -- currently it is being held up because of environmental impact and downstream economic impact concerns -- the new hydro plant could supply 2,400-3,600 MW of generation capacity. The Ghazi Barotha hydro plant came online in 2003 at a cost of \$2 billion and a generation capacity of 1,450 MW.

### **Thar Coal**

Coal currently plays a relatively minor role in Pakistan's energy mix, but the discovery of large volumes of low-ash, low-sulphur lignite in the Tharparkar (Thar) Desert in Sindh province could increase its importance. Thar reserves are being developed under the jurisdiction of the provincial Sindh Coal Authority and have enormous economic potential. The Authority's policy is to develop the reserves primarily to fuel large electric power plants to be built in tandem with the coal mines. A feasibility study recently was carried out for the construction of a coal-fired



power plant near the Thar coal mines, and the government has stated that coal should make up more than the current 1% of electric power generation in Pakistan.

### **Impact**

Pakistan's attempt to raise the living standards of its citizens has meant that economic development has largely taken precedence over environmental issues. Unchecked use of hazardous chemicals, vehicle emissions, and industrial activity has contributed to a number of environmental and health hazards, chief among them being water pollution. Much of the country suffers from a lack of potable water due to industrial waste and agricultural runoff that contaminates drinking water supplies. Poverty and high population growth have aggravated, and to a certain extent, caused, these environmental problems. In the cities, widespread use of low-quality fuel, combined with a dramatic expansion in the number of vehicles on Pakistani roads, has led to significant air pollution problems. Although Pakistan's energy consumption is still low by world standards, lead and carbon emissions are major air

pollutants in urban centers such as Karachi, Lahore, and Islamabad. In addition, stress on already stretched supply of energy in the county has led to serious civic responsibility problems. Theft or diversion of electricity in transmission, as well as a lack of energy efficiency standards, have contributed to Pakistan's high energy and carbon dioxide intensities.

## **Response**

### **Committed Government**

Pakistan has an installed electricity generation capacity of 19,222 MW, which will produce more than 80,000 GWh of electricity this year (of which 30% is in the private sector). Currently, less than 50% of the country has access to electricity and therefore, the government is committed to further develop this sector in order to promote sustained industrial growth.

The Economic Hydropower potential in Pakistan is estimated at 20,000 MW, while the country's existing Hydropower generation capacity is 6,460 MW and projects for an additional 3,500 MW are currently under development in the public and private sectors.

The estimated requirement in Pakistan for building mega dams in the next two decades is USD 20.4 billion, against which the World Bank has approved annual funding of USD 900 million. The Government of Pakistan, on its part, has also planned on spending a similar amount on an annual basis for the next 20 years. In addition, private investors have submitted Expressions of Interest to generate over 9,000 MW of power required in the next 5-6 years through Hydel, Thermal and Coal based projects. Similarly, under a phased programme the entire Thermal power Generation, which consumes a major part of the imported fuel oil, is also being switched over from oil to indigenous natural gas.

The government is currently spending USD 200 million a year to upgrade the existing generation, transmission and distribution system. However, the Water and Power Development Authority (WAPDA), requires funding of USD 5 billion to improve upon the existing transmission and distribution network of 360,000 km's in the country. Pakistan also possesses an estimated 185 billion tons of Coal reserves, which are one of the largest in the world. Feasibility studies are also underway for the development of Energy of over 1,000 MW, through the use of coal and solid waste. Exploration and utilization of alternate sources of power through use of Solar and Wind energy, has also been initiated in Pakistan. During the last two decades Pakistan has developed its potential in Photovoltaic (PV) technology, which is suitable for small power requirements and remote area applications.

### **Clean Fuels Initiative**

The government's 1995 Clean Fuel Initiative introduced the possibility of using alternative fuels for vehicles. As of 2001, 200,000 cars were fitted to use compressed natural gas (CNG) which pollutes less than gasoline. The government has also set up 150 CNG fueling stations around the country, and is looking into converting diesel vehicles to CNG as well. Pakistan has investigated converting rickshaws to CNG through a pilot project with the Canadian International Development Agency (CIDA). Preliminary results suggest that converting rickshaws to CNG would bring considerable cost-savings for rickshaw owners and environmental benefits throughout Pakistan. Unfortunately, outside funding would be required to expand the program as the capital investment to convert rickshaws to CNG is beyond the reach of most rickshaw owners.

### **Renewable Energy**

Renewable energy consumed in Pakistan in 1997 totaled 1,132 trillion Btu, a 1% increase from 1996. Hydroelectric power is an important domestic energy source, generating 28% of

all electricity in the country, and a number of new sites are being developed. Although the mountainous north gives Pakistan much hydroelectric potential, difficulty of access and the high cost of transmission to the populous south make development of this potential a distant prospect. Nevertheless, the Pakistani government has started working on feasibility studies for the construction of more dams, with feasibility reports of at least five small dams expected to be completed by the end of 2000.

Indeed, some development of renewable energy sources has been undertaken precisely *because* of the population's difficulty of access. In order to provide electricity to rural areas that would otherwise not have electricity in the foreseeable future (because they are either too remote and/or too expensive to connect to the national grid), Pakistan is turning to solar power. Pakistan has worked with WorldWater, an American company, to install solar-powered water pumps that can help address the water needs of people in rural areas without electricity. The government hopes that, by harnessing solar power for energy in rural areas, it will reduce villages' reliance on firewood. Pakistan is still shifting to modern energy sources, with firewood, dung, and bagasse (the woody residue left over from crushed sugarcane) making up one-third of all energy consumed in Pakistan as recently as 1988. Although Pakistan is an ideal physical environment for solar energy, many projects have failed because systems needed maintenance after expert personnel had left. Studies are underway on how future solar projects can be sustained at a local level by Pakistani villages.

### **National Energy Conservation Centre (ENERCON)**

To capture the substantial economic benefits provided by conserving energy, the Government of Pakistan, established the ENERCON as a permanent agency to serve as a focal point for all energy conservation activities, including policy formulation. ENERCON is dedicated to conduct and undertake energy conservation activities in Pakistan. The main program areas consist of energy conservation in industry and power sector, agriculture,, buildings, and road transport sector.

Through the implementation of its wide-ranging activities, the ENERCON has made significant contributions to the development of the energy conservation technology and has achieved a significant energy saving potential in various sectors of economy of Pakistan. The impact has been both, direct and indirect, quantitative and qualitative. ENERCON's programmes provide a comprehensive and unified approach to energy conservation. In a short period of its inception, ENERCON has:

- Created awareness regarding the cost-effectiveness and potential for energy savings;
- Proved that energy conservation is the cheapest and most readily available source of additional supply of energy in Pakistan; and
- Demonstrated that simple measures implemented on a nation-wide scale can achieve large savings quickly and at a fraction of the cost of new supplies.

### **Research and Development**

Renewable energy systems are expensive in terms of installation costs. The power from them is also available intermittently – when the renewable source (for instance, wind or solar energy) is available. On the other hand, they are free of any input fuel, and hence their ever rising costs. They also incur much less operation and maintenance costs and are supposed to have a longer lifetime. Thus, using renewable power looks uneconomical in the short term, but may turn out profitable in the long term. Therefore, the key question is what can make investment in renewable power generation acceptable? The creation of Pakistan Council of Renewable Energy Technology (PCERT) in 1990, and later the creation of Alternate Energy Development Board (AEDB) in 2003 have kept the potential and hopes of developing renewable energy alive.

In addition, the Energy Group at SDPI is conducting research to find answers to this question through a financial analysis, which looks at the costs involved in setting up renewable power businesses in Pakistan and in identifying factors that can help attract investment in the renewable technologies. The research especially focuses on finding out the cost of renewable power generation and then on determining a suitable tariff that is acceptable both to the prospective investor and electricity purchasers in the country.

### **Coal Exploitation**

The Government of Pakistan is strongly emphasizing a wide use of the vast deposits of coal found in the desert of Thar. It is planning to provide incentives to independent power producers to set up production plants at the mine sites and to sell electricity to the national grid. It is also urging cement industries all over the country to use this coal. However, the coal, low quality lignite, is known to contain significant sulfur concentrations. Extensive use of this coal is, therefore, likely to substantially increase environmental degradation, particularly when used in cement plants situated near cities and towns. Any future use of the Thar coal demands schemes for removing pollutants, particularly sulfur, and reducing ash contents. There are several ways of doing this, one among them being the conversion of coal to Di-methyl ether (DME) or any other compound of higher energy content. The project will investigate the technology and economics of pre-combustion conversion of the Thar coal and will advise the government on the best use of it.

### **Liberalization and De/regulation of Power sector in Pakistan**

Pakistan's power sector was liberalized in mid 1990s. Since then WAPDA, the state utility has seen an increase in its losses and has gone bankrupt. The nature of agreements inked with Independent Power Producers (or IPPs), drained out WAPDA. Consumers, on the other hand, have constantly suffered rising tariffs since the inception of private power in Pakistan. WAPDA's own conditions have deteriorated to an extent that the utility's annual losses hover around Rs.40 billion. Its old and outdated infrastructure only adds to its woes. The utility's line losses lie between 27-30 percent. The Government of Pakistan has taken steps to revamp WAPDA, foremost of which is the unbundling of the utility into distribution and generation companies. The Energy Group of SDPI is preparing a report, which tries to address the problems/controversies generated by liberalization and deregulation of power sector in Pakistan. The report is in its final stages and would come out soon.

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