SAARC Road Map for Energy Efficiency & Energy Conservation in Pakistan

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Tables

ABBREVIATIONS

ADB -	Asian Development Bank
ADF -	Asian Development Fund
AFD -	Agence Frangaise de Developpement
BRESL-	Barrier Removal to the Cost Effective Development and Implementation of Energy Efficiency Standards and Labeling
CDM -	Clean Development Mechanism
EA -	Executing Agency
EARF -	Environmental Assessment Review Framework
EE -	Energy Efficiency
EESR-	Energy Efficiency Sector Road Map
EIRR -	Economic Internal Rate of Return
EMP -	Environmental Management Plan
EPA -	Environmental Protection Agency
FFA -	Framework Financing Agreement
FIRR -	Financial Internal Rate of Return
FNPV -	Financial Net Present Value
GDP -	Gross Domestic Product
IA -	Implementing Agency
ICB -	International Competitive Bidding
IEE -	Initial Environmental Examination
IPD -	Irrigation and Power Department
IPP -	Independent Power Producer
LAA -	Land Acquisition Act
LIBOR -	London Interbank Offered Rate
LRMC -	Long Run Marginal Cost
MFF -	Multitranche Financing Facility
MTDF -	Medium Term Development Framework
NCB -	National Competitive Bidding
NEPRA -	National Electric Power Regulatory Authority

NGO – Non Governmental Organization
O&M - Operation and Maintenance
OCR - Ordinary Capital Resources
PFR - Periodic Financing Request
PMO - Program Management Office
PMU - Project Management Unit
PPA - Power Purchase Agreement
PPTA - Project Preparatory Technical Assistance
PV – Photovoltaic
PEP- Pakistan Environment Program
PAMP - Protected Area Management Project
PRIF- Pre Investment Feasibility
PEPC- Pakistan Environmental Protection Council
PSC - Project Steering Committee
PEP- Pakistan Environment Program
PEPC Pakistan Environmental Protection Council
QCBC - Quality and Cost Based Selection
RE - Renewable Energy
RP - Resettlement plan
UNIDO- United National Industrial Development Organization
WACC - Weighted Average Cost of Capital
WAPDA - Water and Power Development Authority

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Asif Masood

EXECUTIVE SUMMARY

The demand of energy around the world is growing in an immense pace. Government of Pakistan has resolved to revitalize national action towards achieving greater energy efficiency in the country to help meet the challenges of rapid demand growth, improving economic competitiveness, and ensuring equitable and affordable energy access across all consumer categories. Energy Conservation & Energy Efficiency (EC&EE) is a movement to resolve & to plug in all kind of inefficiencies and wastage in all aspect of Energy Conservation. All sector of economy can Conserve Energy to the extent of 25% of total energy consumption.

The Government of Pakistan is keen to implement a comprehensive energy efficiency investment program the detail of investment plan of each sector of economy and financing mechanism has designed in the report to scale up the deployment of proven energy efficiency technologies in energy supply and use of dynamic energy efficiency market. A multitranche financing facility (MFF) will provide the anchor for a much needed sustainable financing for the energy efficiency investments.

Pakistan is seriously looking for capturing all possible opportunities for Energy Conservation and Efficiency enhancement. The implementation plans of these initiatives and their outcomes reveals several impediments that have prevented even the most concerted and well conceived of these efforts to fail in achieving sustainable, long-term energy savings. Where deliberate, programmatic government and donor-supported actions have foundered; commercial and market-based drivers (i.e., rising energy prices, availability of supplies, technological improvements, etc.) have inadvertently been more successful in affecting fuel switching and end use changes that have significantly impacted energy demand patterns in the country.

The report consist of details of fast growing vehicular population in the country creating various economic and social issues such as polluting environment, excessive consumption of oil and gas which adds to financial burden on the economy due to rising oil imports. Integrated Environmentally Sustainable Transport (EST) strategies and measures offer solutions not only for the improvement of human health through the reduction of urban air pollution, but also provide unique opportunities for local and national governments to receive important complementary benefits including the reduction of GHG emissions, death and injury

from road accidents, harmful noise levels, and traffic congestion levels. Transport services affect all aspects of sustainability, social, economic, environmental, safe, clean, and energy efficient transport in order to achieve green growth through low-carbon transport.

The study includes evolution of Energy Conservation & Energy Efficiency (EC&EE) for effective implementation of policies and relies on corrective measures to promote and encourage energy consumers to save energy and make conservation economically profitable for individuals and the society. Energy Conservation Bill 2010 will fundamentally pave the way for all Energy Efficiency/Energy Conservation programs and measures. Once the Energy Conservation Bill is promulgated, it would become easier to implement the policies and strategies across Pakistan.

In the interim Pakistan has develop a comprehensive EE&EC standards, testing, and certification regime for different categories of energy consuming equipment and stock, existing international standards can easily be leveraged, where possible, to affect a positive change in the accumulation of new stock. Such measures would rely on international standards, testing, certification and labeling that is already universally adopted, particularly with respect to imported products, as well as some standards that can be implemented easily for certain domestically manufactured goods. CO2 emissions reductions will be dispersed across the participating countries and will likely lead to substantial indirect emissions reductions as well.

A detail action plan on regional cooperation has specially been incorporated in the report with a view to minimize the gap between demand and supply which is a major regional policy concern and it is the basis for developing strategies to meet the challenges of Energy Conservation & Energy Efficiency (EC&EE). The investment costs for achieving these demand side energy savings over the period from FY2010 to FY2019 are estimated at $2.3 billion. Sectoral requirements are estimated at $1.9 billion for industry and $0.4 billion for domestic. Phasing out of proposed investments for these sectors over a ten-year period. All member countries need to strengthen management infrastructure in a manner to making the planning process more participatory, transparent and forward looking, increasing the capacity to monitor and implement decisions and legislation effectively and generating funds by carrying out service functions.

Pakistan has launched Standardization and labeling regime for appliances like air conditioners, fans, motors, refrigerators, Compact Fluorescent Lamps. This will help

Pakistan to discourage millions of inefficient appliances and unnecessary overload on Power and Energy Consumption. It's a good business opportunity for private sector and foreign direct investors, to invest in manufacturing of standard electrical appliances.

An important initiative taken to involve Energy Service Companies (ESCOs) in improving the energy efficiencies of municipal and agricultural water pumping systems. It is expected that utilization of the services of Energy Service Companies (ESCOs) by public sector municipal tube-wells and private sector agricultural tube-wells, for conservation of energy, would help reduce the impact of prevailing shortage in energy supply in the country. We are looking forward to oblige consumers of gas, water and electricity utilities to resort to self audits through Energy Service Companies (ESCOs) in the private sector. GoP has planned to involve ESCOs in Building, Transport and Industrial sectors. This will have multiple effects on the overall economy, such as improvement in energy efficiency, business opportunity for entrepreneurs and regional cooperation opportunities for technically skilled people.

Due to economic conditions we were unable to carry out massive R&D activity in the country but few of the listed best practices can be shared between the member countries for guidance & experience the valuable knowledge in order to implement Energy Conservation & Energy Efficiency programs in other respective member countries.

A detail of policy recommendation along with project proposal for regional cooperation for promoting partnership, sharing of R&D experiences among SAARC members especially on biomass, bio-fuel & hybrid technologies, capacity building initiatives and achieving goal of the organization.

To conclude the report, Pakistan's current and forecast energy requirements, development needs and resource shortages require immediate attention towards improving the efficiency of energy supply and use across all economic sectors, where much room for improvement exists. However, attempts in this respect have demonstrated the need for a more vigorous, systematic, and long term multi-stakeholder approach. Special emphasis was given institutionalize role of decision-making process, leading to involvement in actual implementation & need to strengthen management infrastructure in a manner to making the planning process more participatory, transparent and forward looking by increasing the capacity to monitor and implement decisions and legislation effectively in the SAARC members countries.

1 Introduction & Background

Increased energy demand for sustainable socio- economic development & increasing scarcity of resources, volatility of market and the awareness against the adverse affects of green house gases, has strongly influenced the world to opt for adopting a strategy for improving Energy Efficiency & Energy Conservation. Energy conservation is a least cost option to meet the increasing energy demands. Being energy deficient region it is imperative to set goals for use of energy,, use energy intensity to increase the resources and reduce cost of production, increasing affordability and minimize the effects on climate change.

1.1 COUNTRY PROFILE

General

The Islamic Republic of Pakistan emerged on the map of the world as an independent sovereign state on 14th August 1947, as a result of the division of the former British India. It lies between 23-35 to 37- 05 degree north latitude and 60-50 to 77- 50 degree east longitude. It touches the Hindukush mountains in the north and extends from the Pamirs to the Arabian Sea. It is bounded by Iran in the west, Afghanistan in the north-west, India in the east and south east and Arabian Sea in the south. There is a common border with China alongside Gilgit and Baltistan in the north. The total area of the country is 796,095 sq.kms with a population of 160 million according to population census. It is divided into four provinces viz. Sindh, Punjab, North West Frontier Province and Balochistan. It consists of such physical regions as;

a) The western offshoots of Himalayas which cover its northern and north western parts of which the highest peak K-2 rises to 8611 meters above sea level;
b) The Balochistan plateau
c) The Potohar Plateau and salt range, and
d) The Indus plain, the most fertile and densely populated area of the country. It gets its sustenance from the Indus River and its tributaries.

Climatically, Pakistan enjoys a considerable measure of variety. The coastal strip in the South has a moderate climate. There is a general deficiency of rainfall. In the plains annual average ranges from 16 centimeters in the northern parts of lower Indus plain to 120 centimeters in the Himalayan region. Rains are monsoonal in origin and fall late in summers. Due to the rainfall and high diurnal range of temperature, humidity is comparatively low. Only the coastal strip has high humidity. The main natural resources are natural gas, coal, salt and iron. The country has an expanding industry. Cotton, Textiles, Sugar, Cement, and Chemicals play

an important role in its economy. It is fed by vast hydroelectric power. Urdu is the national language and is used as a medium of understanding throughout the country. Pakistan is culturally divided into four bilingual provinces. Punjabi is spoken in the Punjab, Sindhi in Sindh, Pashto in NWFP, and Balochi in Balochistan.

1.2 Economic conditions

The country's important economic data is summarized as under

Table – 1 Pakistan's Economic Data

	2008
Large scale manufacturing growth rate	15.4%
Agriculture growth rate	7.5%
Services growth rate	7.4%
Overall growth rate	8.4%
Per Capita Income	US$ 736

Source: Economic Survey Report 2008-09

1.3 Incentives for investors

Many multinational organizations have established themselves over many years in Pakistan in various sectors including automobile and engineering, banking and insurance, chemical and pharmaceutical, electronics, transport and communication and consumer product industries. In addition to subsidiaries and joint ventures, there are many licensing and technical support arrangements with local entrepreneurs.

In addition to an inexpensive labor force, real estate and an ever increasing consumer market, the Government of Pakistan offers following package of incentives for both local and foreign investors

(a) No levy of sales tax on renewable plants, machinery and equipment, as the same will be used in production of taxable electricity.

(b) Exemption is already available from income tax including turnover rate tax and withholding tax on imports, provided that no exemption of income tax on oil fired power plants.

(c) Repatriation of equity along with dividends is freely allowed, subject to the prescribed rules and regulations.

(d) Parties may raise local and foreign finance in accordance with regulations applicable to industry in general. GOP approval may be required in accordance with such regulations.

(e) Maximum indigenization shall be promoted in accordance with GOP policy.

(f) Non Muslims and non residents shall be exempted from payment of Zakat on dividends paid by the company.

2 Objectives

The objective of the study is to adopt a strategy for improving Energy Efficiency and Energy Conservation. Energy Efficiency is a least cost option to meet the increasing energy demand. Being energy deficient region it is imperative to set goals for use of energy use energy intensity to increase the resources and reduce cost of production, increasing affordability and minimize the effects on climate change. The South Asia energy dialogue held in New Delhi on 5th March 2007 also recommended setting up a task force to study & formulate Energy Efficiency standards & labeling at regional level & to explore possibilities of harmonization of standards & labels. Fifteenth SAARC summit Colombo, 2-3August 2008 declaration also recognized the need to expeditiously develop and conserve the conventional sources of energy, and to built up renewable, alternative energy resources including indigenous hydro power, solar ,wind & bio, while introducing energy reforms, energy efficiency, enhancing the trade and sharing of technology and expertise. The study is conducted to facilitate the implementation of the SAARC road map on energy conservation & energy efficiency prepared by SAARC expert group meeting held on 23-24 April 2007 in Islamabad. An envisaged in the road map, SEC can play an important role to facilitate the implementation of some activities identified in the road map. During 2009, the centre will undertake a study on "implementation of SAARC Road Map for Energy Efficiency and Energy Conservation".

- To review the initiatives taken by the SAARC countries on energy efficiency and energy conservation;
- To help Member States in formulation of policies on energy efficiency and energy conservation to implement the SAARC Road Map for Energy Efficiency and Energy Conservation; and

- To prepare an action plan on cooperation in efficient use of energy and its conservation.

3 METHODOLOGY

The approach and methodology adopted for this study was carefully designed and implemented. The details of which are provided in the following sections:

3.1 General Approach

To meet the objectives of this study, an approach based upon a straight forward and open working was followed. This study was carried out based on the expertise of Government & Private professional staff relating to the subject, educational background and overall guidance from following reference sources:

- Books, studies, reports and articles collected as part of this study;
- Information on legal and regulatory framework in Pakistan;
- Meetings and discussions with resource persons in departments like Planning Commission, Ministry of Communication Ministry of Environment, Ministry of Water & Power, Ministry of Food and Agriculture & other Federal and Provincial departments, EPAs and ENERCON
- Meetings and discussions with other knowledgeable people and/or related departments;

3.2 Specific Approach

The approach adopted during different phases of the study is given below:

Planning

At the start of the study, most of the planning activities have been carried out to review the TORs in detail to develop an outline and a detailed work plan to carry out the study. Some of the activities are given as follows:

- Planning phase
- Review of TORs
- Development of a detailed outline and work plan for the study;
- Meetings with Government Officials
- Development of Information/Data Collection tools

- Collection of Data
- Review and Analysis of the information;
- Revision and finalization of the data
- Broader Planning for Information/Data collection

4 Energy Conservation Strategy

Energy Conservation Centre (ENERCON) is attached department of Ministry of Environment. ENERCON is being mandated as focal federal agency for initiating, catalyzing and coordinating all energy conservation activities in the country. Recently, ENERCON has succeeded in obtaining important policy directives from Prime Minister of Pakistan for en-cashing the energy conservation potential in all sectors of the economy. Work for implementing the same has been in hand and a valuable conducive environment has been created for achieving the objectives as enunciated in the duly approved implementation strategy. ENERCON's current strategy is not just to Conserve Energy, but also to encourage other sectors to adopt a least cost approach to energy development and efficient use. This means ensuring the availability of energy for sustained development and, at the same time, ensuring the most efficient and environmentally sound use of energy. To implement this strategy, ENERCON uses the private sector to the greatest possible extent, as both means and an end of Energy Conservation programs, closely coordinates its activities, particularly concerning pricing and other policy reforms, with the international donor community and other public and private institutions, and targets Energy Efficiency initiatives to the industry and electric power sectors, which offer the greatest potential for a large and immediate impact. In all of its Energy Efficiency initiatives, seeks to establish the lasting local institutional and technical capabilities (through training, management and technical support) awareness that are needed to identify and implement Energy Efficiency measures and to ensure such measures are actually implemented through financing and demonstration programs and support of policy reforms.

The industrial and power sectors offer the largest and most easily captured Energy Efficiency & Energy Conservation potential. Technically proven, cost effective Energy Efficiency techniques and processes can save an estimated 10 to 30 % of industrial sector energy consumption and 10 to 25 % of power sector energy consumption (Energy Conservation Policy – 2006). Until very recently, the Energy Conservation strategy was shaped primarily

by the urgent need to save foreign exchange by cutting energy waste in facilities that use large quantities of petroleum products. As a result, the priority targets were industrial facilities. In light of rapidly increasing power demand, crippling power shortages, poor system reliability, the tremendous capital requirements for new capacity, and the shortfall in available capital, is placing an increasing emphasis on improving efficiency in the power sector, through both improving the efficiency of the existing system, using measures such as load management, power plant rehabilitation, transmission and distribution (T&D) loss reduction, and improvements in end use efficiency, promoting private investment in power generation. Efficiency improvements can increase power supply for as little as 25 % of the cost of an equivalent capacity expansion and private investment in power generation, it can help to alleviate both the growing shortages of power supply and the public capital constraints of building new generating capacity.

ENERCON recognizes that the buildings, transport, and agriculture sectors also offer significant opportunities for Energy Efficiency & Energy Conservation. The buildings sector is the fastest growing consumer of electricity in our country, with demand increasing by up to 20 % per year, and energy use tends to be very inefficient. On average, 40 % (approx) of petroleum products consumption is accounted for by the transport sector and transport energy use is growing rapidly. In agriculture, irrigation accounts for a large share of electricity use for example, tube wells account for approximately 50 % of electricity consumption in Pakistan.

4.1 National Energy Conservation Policy - 2006

Security and affordability of energy supplies are key inputs to ensure sustainable development. Energy Conservation or efficient use of energy resources has been practiced as a cost effective and environmentally sound option to plug energy deficits in several developed as well as developing societies. The first ever National Policy on Energy Conservation approved by the Cabinet & will go a long way in tapping a large energy reservoir which remains un-harnessed due to inefficient practices in various sectors of economy. The National Energy Conservation Policy, prepared by ENERCON through an extensive consultative process involving all stakeholders, is a contribution to the national effort to steer the country out of a difficult energy supply situation by promoting efficient use of energy resources. It must be pointed out here that conservation of energy resources covers a very wide spectrum, with a large number of stakeholders in the public as well as

private sector. The responsibility for implementing the policy lies collectively on these stakeholders and together we can rise to meet the energy challenge.

Policy Initiatives

- Formulate and enact a comprehensive legislation on Energy Conservation and Management.
- Development of Energy Conservation codes and standards.
- Create Public Awareness through training education, information dissemination and demonstration.
- Participatory approaches and practices to be adopted to design and implement energy management demonstration and undertaking targeted services.
- Strengthen institutional capacities and ensure resource availability to enable develop and achieve sector specific targets on conservation of energy resources and meet national aspirations in this regards.
- Declare Energy Conservation as an industry to allow fiscal and financial incentives to be available for Energy Conservation pursuits.
- Institution of National Awards for outstanding work on Energy Conservation.

Sectoral Initiatives

Industry

- Introduce and facilitate Energy Audits in Industries and promote targeted technical services.
- Encourage and promote better housekeeping and implementation of low-cost, fast payback Energy Conservation measures in industry.
- Promote Energy Efficient combustion processes, instrumentation and control and metering practices in industry.
- Develop MIS on Energy Efficiency Potentials indices; and BAT/BAP Best Available Energy Efficient Techniques
- Promote Energy Efficiency & Energy Conservation modernization and revamps

Power

- Support the deployment of cost effective and environment friendly technologies for electricity production from Coal.
- Promote Co-Generation as a means to plug power deficits
- Collaborate with WAPDA and utilities to devise and enforce efficient administrative and technical measures for promoting conservation projects/programs.
- Collaborate with power utilities in reducing T&D losses as well as energy loss reduction on the generation sides.

Transport

- Promote use of better fuel quality and quality automotive lubricants
- Promote regular tune-ups of vehicles and Energy Efficient driving practices
- Assist strengthening the institution of motor vehicle examiner at local levels.
- Facilitate local production and import of low-sulphur diesel fuel.
- Promote safe disposal of waste from automotive workshops.
- Promote cycling culture and pedustrianization.
- Promote CNG as preferred fuel; and local manufacture of CNG systems.
- Promote conservation in other modes of transportation like railways, shipping and aviation
- Promote mass transit public transport systems and institute Fleet Management practices. Set model solutions for public transport

Building

- Encourage and facilitate introduction of energy audits in commercial and community buildings.
- Encourage adoption of Energy Efficient considerations in the household.
- Evaluate Building and Insulation materials for Energy Efficient characteristics.

- Encourage use of Energy Efficient equipment, fixtures and appliances in buildings.
- Develop/update a Building Energy Code for the country and institute measures for its compliance.
- Promote use of Energy Efficient HVAC and lighting practices in buildings
- Develop appropriate database/MIS with respect to Energy Conservation in building
- Promote Energy Efficient building design and ensure compliance with Building Energy Code

Agriculture

- Promote Energy Efficient agriculture tractor and farm machinery
- Promote Energy Efficient tube wells and Water Pumping Stations
- Coordinate/Integrate water pumping activities with proper water resources.
- Promote Energy Efficient practices through education, information dissemination, outreach and demonstration

Renewable Energy

- Promote development and deployment of Biogas Units; Bring Livestock Farms and Diary Industry in the loop
- Promote development and deployment of Solar Thermal technologies like solar water heater and solar desalinaters, driers etc
- Promote development and deployment of cost- effective solar and wind energy technologies
- Promote development of Micro and Mini-Hydel Plants
- Promote use of new and alternate sources of energy wherever cost-effective and feasible

4.2 Implementation and Monitoring

- ENERCON be the focal national institution to coordinate and facilitate the implementation.
- The provincial governments shall be asked to establish policy directorates and designate relevant departments/ministries to ensure coordinated implementation of the policy
- Task Force/subject specific advisory committees to be constituted by Secretary, Environment
- Legislative Framework to have strong implementation mechanism

5 Review of National Energy Conservation Policy Framework

Goal:

The National Energy Conservation Policy has four strategic goals;

- **Sustainable Development:**

  Energy Conservation, as a least cost supply option, will help in meeting the rising levels of energy consumption without putting corresponding additional burden on the environmental resources.

- **Improve Economic Productivity and Poverty Alleviation:**

  Cost effective Energy Efficiency measures will improve Pakistan's economic performance and the value the economy derives from the use of energy resources. Energy Efficiency and conservation measures can result in profitable business opportunities and will become a means for poverty alleviation.

- **GHG Mitigation and Climate Control:**
  Energy Efficiency and conservation measures will reduce CO2 emissions and help Pakistan meet its international climate change responsibilities. Efficient use of energy in various sectors of economy will reduce adverse local environmental effects which are otherwise attributed to energy inefficiency and wasteful energy use practices.

- **Gender Mainstreaming:**

  A unit of energy conserved is a unit of energy produced, which in turn creates a room for energy supplies for rural areas. Provision of energy to rural areas serves the goals of gender equality and mainstreaming.

Objectives

The National Energy Conservation Policy has four broad objectives as stated

- Foster Energy Conservation through stimulation of resources and regularizing total energy management programs in all sectors of economy.
- Energy Conservation Market development and facilitating commercialization by creating awareness and launching nation-wide demonstration projects.
- Maximize satisfaction of demand for energy from indigenous resources.
- Create an enabling environment to reduce energy intensity of different energy consuming sectors through appropriate technological and policy measures, to promote sustainable growth.

5.1 Identification of Policy Barriers and Solutions

There are basically four categories of barriers to Energy Efficiency & Energy Conservation:

- Management
- Knowledge/information
- Financing
- Policy

Solutions to overcome barriers and the stakeholders who need to be involved in implementing solutions were also identified & summarized below,

KEY BARRIERS	SOLUTIONS	STAKEHOLDERS
MANAGEMENT Lack of awareness at company top management level of Energy Efficiency. This is the root cause of many other barriers, especially: • Management finds production more important • Management is concerned about investment costs of Energy Efficiency measures • Lack of policies, systems, energy/environment managers within companies • Lack of integration of energy into core business management and reporting	Awareness raising / marketing strategy aimed at company top management • Awareness raising seminars for top management • Training / capacity building of energy manager and external facilitators on how to convince and assist management • Information dissemination • Demonstration projects • Comparative study (benchmarking) • Clearing house • Awards & recognition • Networks • Success stories / best practice examples • Energy labeling of technologies • Media campaign • Inclusion in school curriculum	Everyone influencing comp any management: International, organizations, government ESCOs, financial institutions, NGOs, Academia Suppliers, customers, Industry associations Media Employees, environmental manager Business management schools & consultants (not just technical) Schools
KNOWLEDGE • Limited access to and availability of technical information • Limited technical knowledge at company level and facilitating organizations	Strategy that aligns demand and supply of information / technology aimed at ompany staff and external facilitators .Training/ demonstration on EE technologies, EMS, and CP audits, technology requirements & feasibility studies .Establish systems to maintain knowledge within companies .Customize information and technologies Research & development	• International / • Government agencies • Research institutions / universities, ESCOs • Industry / trade associations • Suppliers

KEY BARRIERS	SOLUTIONS	STAKEHOLDERS
FINANCING • Difficulty in obtaining external financing for Energy Efficiency projects, in particular by SMEs	Financing strategy aimed especially at financial institutions • Assist companies to make proposals bankable • Different criteria for evaluating / investing in EE projects • Special funds & CDM • Awareness raising of financial institutions • Inform companies about existing financing packages / institutions	• Financial institutions • Central Bank • Government • International orgs (e.g. related to CDM) • Company finance managers (CFO, accountants) • Financial consultants / accountants
POLICY • Weak legislation and/or enforcement • Limited financial incentives by government for Energy Efficiency • Irrational (subsidized) energy pricing policies	Policy & legislative reform strategy aimed at government • Resource pricing • Transparency of energy prices, policy, and investments, contracts • Fiscal / economic policies aimed at aligning energy, environment and economic policies and removal of energy subsidies • Pragmatic legislation (something than can actually be implemented & enforced) • Enforcement strategies • Monitoring of compliance	• Government • Policy makers • Lobbyists • International community • Service providers (e.g. QMS) • Public / community • Consultants • Industry associations

5.1.1 Lack of Money Investment

The most common barrier mentioned is lack of money to invest in. Options with a payback period of more than two or three years were rarely implemented. Some options provide huge savings and a short payback period of often less than one year, but the option requires a high investment but do not have the money at hand. One option is to take out a loan, but interest rates can be high, and banks often do not have confidence in the credit worthiness of companies to give them a loan, especially small and medium sized companies (SMEs).

5.2 Lack of Policies & Legislation Enforcement

The major problem is weak enforcement of environmental policies and legislation.

During interaction meeting a company representative confessed "It is cheaper to bribe the government official than to spend money on complying with permit conditions. It also revealed that stealing electricity from the network is common because no one is there to check. A reason for limited enforcement is that governments allocate insufficient funds for policy implementation and enforcement. Plus local authorities are often hesitant to fine & afraid. But most damaging to energy potential are government policies that are only aimed at short-term rapid economic gain & ignore the environmental impacts and therefore are a threat to long-term economic and social development. An important cause is that many government agencies have an interest in energy, but from a different angle.

6 Pakistan's National Energy Conservation Program

Pakistan's ability to sustain its current economic growth is strongly linked to its ability to supply adequate energy to various categories of consumers at a reasonable cost. With a population of 160 million and an economy growing at the rate 7% GDP growth over the last five year, keeping up with the galloping energy demand is a Herculean task. Indeed, Pakistan's energy supplies have not been able to keep up with rising demands. Over the past few years, peak electricity demand has exceeded peak supply by approximately 25%, necessitating load shedding of more than approx 3200 MW. The cost to the country from both scheduled and unscheduled outages have been estimated to be a reduction in annual GDP of 1.8%. Within the industrial sector, the reduction in value added was estimated at 8.2%. In addition, power shortages were estimated to reduce the national export of manufactured goods by 7.2% resulting in a loss of foreign exchange of $675 million.

Thus, the inabilities of Pakistan's traditional energy supplies to keep pace with demand are placing a serious constraint on the national economy. Prospects for closing the supply/demand gap in the immediate future are compounded by the following issues:

- Demand will continue to surge due to an aggressive rural electrification program launched by the government. In addition, domestic electricity demand has been rising at an average annual rate of 16.8% for the past 15 years
- The shift from non-commercial to commercial energy sources will continue with non-commercial energy supplies dropping from 31.8% at present to 26.8% of total supply over the next few years
- Oil imports will increase from 78% at present to 80% over the next five years

(2008 to 2012), in spite of an increase in oil production of 50% over the same period

6.1 Performance Indicators and Analysis

The Government is struggling to resolve the energy crisis. Adhoc measures are being taken with no immediate avail, while more shortages loom in an already overstretched energy system. Pakistan's economy continues to grow and industrialize, and standards of living improve. Coupled with rapid population growth, these factors are causing a steep increase in energy demand. Energy Efficiency is identified as the least cost short to medium term development solution to addressing energy shortfalls.

Under the Energy Efficiency Initiative, a diagnostics assessment of the Energy Efficiency sector in Pakistan, found that it has a large untapped Energy Efficiency market. The past efforts to mainstream and implement Energy Efficiency projects in Pakistan failed due to lack of sustainable financing and strategic policy planning. The diagnostics assessment identified the unavailability of sustainable financing as a key barrier to achieving Energy Efficiency benefits in the past in Pakistan. The Government is keen to implement a comprehensive Energy Efficiency investment program and is looking for a flexible public sector financing mechanism to:

- Scale up the deployment of proven Energy Efficiency technologies in energy supply and use,
- Establish a dynamic Energy Efficiency market

6.2 Rationale

Improving Energy Efficiency and energy productivity are key components of Pakistan's energy strategy. Reducing unproductive and volatile demand will result in immediate energy savings. Lower energy intensity will boost energy access and meet social development goals, and reduce carbon emissions and meet climate change targets. Energy productive Pakistan will be more competitive in the global economy. Pakistan is determined to pursue a sustained long term plan to optimize the energy mix and consumption across all sectors of the economy.

Overall energy savings potential in the country in FY-2008 is estimated at 8.4 MTOE (371,400 TJ). These savings correspond to 14.9% of the primary energy demand of 56.3 MTOE (2,489,200 TJ). Savings in electricity in FY-2020 corresponds to a generation capacity of 3,710 MW. In addition the natural gas saved could be utilized to fuel a power

generation capacity of 3,060 MW. The corresponding reduction in annual fuel imports are estimated at 51%. A ten years investment program, starting in FY-2010 and is estimated at $8.16 billion. This will result in energy savings of 52.11 MTOE (2303,434 TJ) over this period, with many savings continuing beyond FY-2019.

6.3 Strategic Context

A successful long term national Energy Efficiency program requires:

- Comprehensive policy and regulatory framework
- An integration of Energy Efficiency in all levels of national planning and public investments
- Energy price and utility rate setting reforms and incentives
- A strong equipment standards, certification, and testing regime

Energy Efficiency improvement has been identified as a key intervention area in Pakistan Country Strategy. The strategy recommends careful prioritization of new public sector investments, with an emphasis on creating a favorable business environment. Priority areas include

- Increasing Energy Efficiency (both supply and demand);
- Optimizing hydropower and support for public private partnerships in hydropower generation;
- Balanced energy generation, transmission, and distribution;
- Sector restructuring, rationalization of tariffs, and greater private sector participation.

Policy Framework

The Government of Pakistan has established a policy framework for Energy Efficiency. Achieving energy security and energy affordability are two main goals set in the Government's Vision 2030 and the Medium-Term Development Framework (MTDF). The National Energy Conservation Policy was adopted in 2006, which

defines national Energy Efficiency objectives and broad cross sector implementation parameters. Implementation has been slow, due to limited capacity and financial resources.

Sector Roadmap

To achieve the goals defined in these policies, the Government has adopted the Energy Efficiency Sector Roadmap (2010-2019). This Roadmap will be an integral component of the Government's integrated energy planning and will help resolve the current energy crisis, particularly by improving the supply of electricity and gas. The Roadmap comprises of a series of correlated regulatory and institutional measures and capital investments. It also defines the overall approach, elements, impacts, responsible parties, and timelines necessary to improve energy productivity in the country.

6.4 Sector Investment Plan

Energy Efficiency investment requirements for Pakistan over the ten year period from 2010-2019 are estimated at $8.16 billion study conducted by ADB in conjunction with Pakistan Planning Commission. These can be achieved through implementing Energy Efficiency improvement projects, assuming that no external barriers to such actions in the form of financing, information and technology access, policy and pricing disincentives, and other such constraints exist.

Details of the proposed Energy Efficiency investment plan are based on realizable potential for energy savings, attractiveness of investments, and existing barriers and constraints to Energy Efficiency improvements, the priority areas identified for the ten year investment plan are:

- Energy efficient lighting and replacement of gas and electrical appliances in the domestic and commercial sectors
- Replacement of existing inefficient thermal power generation units with new higher efficiency configurations
- Replacement of inefficient compressors in the gas transmission systems with high efficiency compressors
- Energy Efficiency upgrades in the industrial sector focusing on the cement, pulp and paper, sugar, and textile industries.

6.5 Analysis of Key Problems and Opportunities

One of the key challenges facing Pakistan is the current energy crisis which is intense, costly and multidimensional. Pakistan's primary energy supply during FY-2008 was 62.9 MTOE, consisting of natural gas (47.5%), oil (30.5%), hydel power (10.9%), coal (9.2%), LPG (0.7%), and nuclear (1.2%). Based on an expected GDP growth rate of 3.5% - 5%, the total energy demand is expected to increase to 122 MTOE in the next 15 years. Given the current constraints in developing the indigenous energy resource base and losses in the power generation and transmission systems, the country will have to face an unprecedented dependence on energy imports. Assuming a crude oil price of US$ 60 per bbl, the annual energy import bill of the country will exceed US$ 41 billion compared to current level of about US$ 7.5 billion in FY- 2008.

Production of natural gas in the country has peaked at 4,000 MMscfd compared to a demand of 4,500 MMscfd. The country faced gas shortages during the winter months; supply to the industries has been cut to meet the demand from the households. The installed power generation capacity is 19,420 MW for a population of 160 million. However only 14,000 MW of firm capacity was available in 2008 due to a low level of reliability in the generation capacity and the financial crisis faced by the power sector. The shortfall in electricity supply has resulted in rationing of power in the peak demand periods. The rationing is expected to persist in the coming years as planned capacity additions will fail short of the increase in demand for electricity.

Pakistan is responding to its energy development challenge by pursuing a wide range of options. These include import of natural gas as LNG through pipeline, import of power from Central Asia and Iran, construction of large scale hydel power projects, and development of Thar coal reserves. A number of Independent Power Projects (IPPs) projects have been contracted and are in different stages of development. The Government has also formulated a new policy to encourage investment in oil and gas exploration. Renewable energy projects are being promoted with a target of 10% of energy mix to be met from renewable sources by 2015.

Compared to the supply side options, Energy Efficiency (EE) offers Pakistan a least cost alternative for augmenting and maximizing the utility of the energy resource base of the country. Energy Efficiency and conservation is therefore emerging as a

priority in government's energy policy to address the current energy crisis in a sustainable manner. Additional benefits of EE include reduced expenditure on energy for the end users, environmental impacts and carbon emissions, raise economic productivity and accelerate social development, create significant new job opportunities, result in better resource utilization, improve returns on infrastructure investments, and help integrate Pakistan better into the global economy as it grows along a more sustainable development path.

The households in Pakistan accounted for about half of total electricity consumption in 2008. Lighting is the main driver of the peak load in this sector. Efficient lighting can reduce the demand for electricity by around 40%, and replacement of incandescent bulbs with compact fluorescent lamps (CFLs) can save about 1,600 MW of the peak demand. Retrofits of existing space and water heaters and purchase by households of energy efficient appliances could be financed by the gas utilities through loans to residential gas consumers repaid on their utility bills in affordable installments. In addition, standards and regulations promoting efficient appliances would be required, as well as a program to improve the efficiency of domestically manufactured gas appliances.

The Government has a Power Distribution Sector Roadmap and a Power Transmission Sector Roadmap to improve efficiency and cut down losses in these sectors.

6.5.1 External Assistance to the Sector

The major sources of external assistance to the energy sector are ADB, Japan, and the World Bank. These three partners together have provided more than half of the official external assistance. The assistance from ADB has been directed to KESC, WAPDA, PEPCO, NTDC, DISCOs and gas sector restructuring. The World Bank mainly provided assistance to WAPDA and PEPCO, as well as support for generation of power from coal. Japan has provided major support for investment projects in the power sector. The key policy thrust pursued by all three major development partners individually has been to evolve a strategy for the privatization of the power sector. For example, ADB supported the privatization of KESC, and both ADB and World Bank Group through their private sector arms provided debt financing to the privatized KESC. The policy matrix prepared for the reform program in the sector has

been a joint effort of the ADB, World Bank, and the Government in consultation with stakeholders and other development partners, with clear delineation of the division of labor between the two multilateral institutions. European investment Bank is a co-financing partnership with ADB & assisting Government for renewable energy investment. Recently, the Islamic Development Bank is under discussion with the Government to support augmentation of Rawat Grid Station and assistance for three small hydropower projects in Northern Pakistan. In terms of bilateral support, the Canadian International Development Agency (CIDA) has supported WAPDA to rehabilitate the Warsak Hydroelectric Power Station and development of national power plan. It has also provided assistance to strengthen the capacity of the Ministry of Petroleum and Natural Resources to develop and implement sound policies and regulatory frameworks to encourage private sector investment and to enforce effective conservation and environmental regulations. CIDA also supports public and private companies to develop and manage hydrocarbon resources. The Government of France is providing support for development of mini hydel power plants in the NWFP and Northern Areas of Pakistan. The Government of Germany is supporting a hydropower promotion program and a grid station in Ghakkar for power transmission from Ghazi-Barotha. It is also financing hydropower feasibility studies and hydropower projects development as well as technical support for policy development and pilot programs in renewable energy and Energy Efficiency with the Alternate Energy Development Board and the National Energy Conservation Center. The Government of Japan is supporting upgrade of load dispatch system at the National Power Control Center, as well as investments in transmission, and distribution system. It is also extending technical cooperation for grid system operation and maintenance system improvement. Expected assistance for rehabilitation of thermal power plants in Jamshoro and Muzaffargarh is also in the pipeline. The Government of Netherlands is extending support for a cleaner production program with the industrial sector and compliance with National Environmental Quality Standards (NEQS) and Energy Efficiency. USAID has a planned assistance pipeline for energy policy and pricing, Energy Efficiency and Conservation and capacity building of energy sector line agencies. The ADB has been the major source of external assistance to the energy sector in Pakistan, having provided about one-third of total external resources to the sector. ADB's non-lending activities have also been

important in the sector with a total of $18.6 million provided for projects. Since 1968, total lending to the energy sector in Pakistan amounts to about $4.2 billion, of which $3.6 billion is to the power sub sector and $0.6 billion to the natural gas and petroleum sub sectors. Since 2006, ADB's overall lending to the energy sector accounted for about 32% of total lending to Pakistan. About three-fourths of the assistance to the power sub sector ($2.2 billion for 15 loans) has been provided to WAPDA (and its unbundled entities), $150 million to provincial power departments and the rest to KESC.

6.5.2 Sector Portfolio Description

The energy sector portfolio currently has three MFFs ($2.1 billion) and two ongoing projects, amounting to $2.4 million. The main areas covered include tariff rationalization and integration, management information systems, power generation coordination, thermal power plant maintenance, institutional strengthening and restructuring, and privatization.

6.5.3 Key Sector Portfolio Performance

The Country Assistance Program Evaluation (CAPE) rated ADB's interventions in the energy sector as "successful", noting that the overall success rate of energy sector projects during 1985-2006 was a high 81%. The success rate for projects approved in the 1990s was, however, much lower at 50%.

6.5.4 Impact and Outcome

The proposed Investment Program will help realize Energy Efficiency benefits in critical energy consuming sectors, and create a dynamic institutional and business environment for further Energy Efficiency investments. It will improve Pakistan's energy security by balancing energy demand and supply, improving use of available resources, and optimizing the energy mix by reducing oil imports.

Outputs

Increased investments and market penetration of energy efficient technologies as a result of the proposed Investment Program would bring about:

- Reduced electricity use in the industrial, residential and public sectors amounting to 2,880 GWh per year
- Reduced energy transformation losses in the gas transmission and thermal power generation sectors totaling 601,670 tonnes of oil

equivalent (TOE), or 26,595 tera joules (TJ), per year

- Reduced gas, oil and coal use in the residential and industrial amounting to 896,870 TOE (39,643 TJ) per year
- Establishment of National Energy Efficiency standards, testing and certification regime
- Energy Efficiency mainstreamed into planning and investments, and managed effectively under strengthened policy, legal, and regulatory frameworks and institutional capacities
- Reduced air pollution and greenhouse gas emissions from environment

6.6 Technical Justification

Substantial energy savings can be achieved in the country through investments in Energy Efficiency projects. The principal energy consuming sectors and their shares of total consumption in 2008 were industry (43%), transportation (29%), domestic (20%), and others (8%). Estimates for achievable energy savings were developed on the basis of the technical potential and the extent to which this potential can be realized over a ten years period, taking into account existing barriers and constraints to .implementation. The annual energy savings potential in Pakistan is currently estimated at 6.07 million tonnes of oil equivalent (MTOE), or 268,400 TJ, which corresponds to 15.4% of the total energy consumed in FY-2008.

Based on the assessment of realizable potential for energy savings, financial and economic viability, and existing institutional barriers and constraints, the proposed Investment Program will target two priority areas:

- Demand side reduced energy waste in the domestic, industrial and public sectors
- Supply and transformation side reduced energy losses in thermal power generation and gas transmission

6.7 Energy Efficiency Sector Investment Plan

The total investment requirement for the Energy Efficiency sector from FY2010-2019 is estimated at $8.16 billion.

Table no: 2 Energy Efficiency Investment Plan

	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19
Domestic	.18	37		329	384	384.				
Commercial		1	5	15	24	22	11	3	1	
Industrial		22	134	403	650	605	314	90	22	
Agriculture		5	28	85	137	127	66	19	5	
Transportation	-	7	41	123	199	185	96	27	7	
Oil Refining		1	5	15	23	22	11	3	1	
GENCO Replacements		151	205	129	52	305	572	946	664	260
Generation at Decompression	-	0	2	6	10	10	**5**	1	0	
Gas	16	42	44	28						
Total	**34**	**266**	**464**	1,133	1,479	**1,660**	1,075	**1,089**	**700**	**260**
Cumulative	**34**	**300**	**764**	1,897	**3,376**	**5,035**	6,110	7,200	**7,900**	8,161

Source: Pakistan Energy Yearbook, 2008 and PPTA consultants

For the GENCOs and Gas Company investments, it is expected that at least 20% of the investment will come through internally generated funds or equity and 80% from financiers. The private sector (domestic, industrial, agricultural, transportation, oil refining) is expected to finance 45% and borrow commercially for 55% of the investment. The Government is actively looking for funding from the private sector and other agencies. Agence Frangaise de Development (AFD) is expected to co-finance EURO 150 million. ADB's proposed multitranche financing facility (MFF) will act as the anchor for the investment plan and act as front-runner for commercial investments.

Table: 3 Financing Plan, ($ million)

Total Program	Investment Projects		**Program Support**	
	Amount	Share	Amount	**Share**
Government of Pakistan	650	8%	17	20%
Asian Development Bank	760	9%	20	23%
Agence Francaise de Developpement (EUR 150 million)	180	2%		
	1.858	23%	50	57%
Private	2,120	26%		
Commercial Borrowing	2,592	32%		
Total	8,161	100%	87	100%

Source: ADB, PPTA Consultants

The Investment Program cost (physical and non-physical) is estimated at $1,192 million, including taxes and duties. The total cost includes physical and price contingencies, and interest and other charges during implementation.

Table: 4 Tentative Investment Program Investment Plan

Item		Amount ($ million)
A.	**Physical**	
	1. T-1: National CFL Distribution	102.00
	2. T-2: Gas Compressor Upgrade	130.00
	3. T-3: Thermal Power Plant Loss Reduction	545.00
	4. T-4: Government Buildings Lighting Retrofit	60.00
	5. T-5: Domestic Appliance Replacement	80.00
	6. T-6: Industrial EE Financing Facility	250.00
B.	**Non Physical**	
	1. Support Component	25.00
	Total (A+B)	**1,192.00**

Source: ADB, PPTA Consultants

7 Best Available Practices for Energy Efficiency & Energy Conservation in Pakistan

7A. Energy Efficiency Techniques and Practices

ENERCON, the designated focal national agency, mandated to coordinate Energy Efficient & Energy Conservation activities for all sectors of the economy, has been grappling to find ways and means to plug the huge inefficiencies and wastages of energy amounting to about 25% of total consumption in Pakistan. Series of intensive consultations and interaction with the consumers and stakeholders have thrown up mutually agreed steps and actions to be taken by different actors in the energy sector which however, need higher policy support and ownership for successful implementation. Some of the best practices are enumerated below; where as remaining practices have been discussed in sector wise in detail;

7.1 Entrusting Provincial Governments with Responsibility for Energy Conservation at Grass Root Level

To achieve Energy Conservation and maximum Energy Efficiency in the country, it is considered pertinent that in order to create a sense of ownership and foster Energy Efficiency and Energy Conservation (EE&EC) culture for effective results, an Energy Efficiency and Energy Conservation (EE&EC) cell to be established in all the departments through out the country and all Provincial governments be entrusted the responsibilities to adopt appropriate necessary measures of Energy Efficiency and Energy Conservation at grass root level.

The following measures of Energy Efficiency & Energy Conservation (EE&EC) are suggested by ENERCON & endorsed by Ministry of Environment to reduce the demand and supply gap

- Demand Side Management program being implemented through aggressive awareness campaign.
- Efforts to reduce the Transmission and Distribution (T&D) losses both in Gas & Power sectors and to brought down to minimum levels through energy losses reduction program.
- Introduction of Energy Conservation plans and audits in all major Industries & Energy sectors.
- Energy audits and efficiency considerations are introduced in all commercial, government and community buildings.
- All future building designs to be based on Energy Efficient building codes in order to save at least 30% of energy in building sector.

All Provincial governments after having been entrusted with full responsibility for Energy Conservation & Energy Efficiency may be financed to the extent of 1/3rd of the expense in this regard.

7.2 Designation / Appointment of Energy Managers

One of the prime objectives of the Government has been to achieve self sufficiency in all its energy requirements so as to cease dependence on imports of crude oil and save valuable foreign exchange. This objective can only be achieved by exploring the potential resources including the substantial untapped energy resources of Energy Conservation. Energy Conservation will help to reduce load shedding which is destructive of agricultural and industrial production. Energy Conservation will save money that would have been spent

on fuel or power, and even accelerate production and income by contributing to efficiency and competitiveness. The energy waste is common factor amongst all sectors and this energy can be saved with little care & concern. The Energy managers deputed in Government Offices & different ministries are responsible for developing plans, managing and monitoring Energy Conservation and Energy Efficient activities in the respective entities and formation. The key responsibilities include the following:

- Coordinate and direct the overall Energy Conservation program in the respective Institution & Departments.
- Responsible to monitor the efficient use of energy through implementation of measures and report progress on monthly basis to the top management.
- Collect all the necessary data like gas and electricity bills, equipment performance etc. to be used in Energy Conservation planning and to assess energy performance.
- Analyze energy use patterns/trends, develop specific energy indices and establish energy accounting systems.

7.3 Prototype Energy Efficient Water Heaters

In Pakistan there are 3-4 million users of storage gas water heaters. Domestic consumers in Pakistan consume around 14 % of the natural gas consumption. The storage gas water heaters presently installed have very low efficiencies which are around 25-40 % as compared to the international benchmark of 65%. These inefficient appliances consume excessive amount of natural gas for water heating purposes, resulting in wastage of precious natural resource. As compared to storage water heaters, Instant Water Heaters have a higher efficiency of around 70 % according to the international efficiency benchmark. Therefore there use can substantially contribute to Energy Conservation and mitigate the effects of energy crisis in the country. This underlines the importance of developing and promoting energy efficient domestic gas water appliances. Therefore, the concerned ministry to expedite the development of a prototype of energy efficient gas water heater and promote their use & may propose zero rated duty on Instant Water Heaters along with their related components for their promotion.

Replacement of Old Inefficient Geysers

The storage gas water heaters currently installed have very low efficiencies which are around 25-40 % as compared to the international benchmark of 65%. Considering the fact

that, these inefficient appliances consume excessive amount of natural gas for water heating purposes, resulting in wastage of precious natural resource. To achieve Energy Conservation through replacement of old inefficient gas water heaters Ministry of Environment, ENERCON along with SNGPL has approved PC-I for replacement of gas geysers with solar geysers with amount of 39.4 million in FY 2010-11. Ministry of Environment, ENERCON along with SNGPL has approved PC-I for replacement of gas geysers with solar geysers with amount of 39.4 million in FY 2010-11.

Promotion of High Efficiency Electric Arc Furnaces

Currently our steel industry consumes about 700 KWh of energy to melt 1 ton of steel whereas the international benchmark is in the range of 250 – 300 KWh per ton. The steel industry melts approximately more than 400 tons of steel annually and is one of the major consumers of energy in the industrial sector. The industry is being encouraged to use high efficiency Electric Arc Furnaces with at least 50 ton capacity through financial incentives.

Capacity Building of Textile Units

Energy Efficiency & Energy Conservation with a view to minimize the gap between demand and supply is a major National policy concern and the basis for developing commensurate strategies to meet the challenges. Efficient use of the energy resources is an immediately available and tried out methodology to achieve the following objectives:

- Identify suitable energy saving measures by conducting high quality energy audits
- Generate success stories to demonstrate the energy and cost savings
- Generate information on best practices within the Pakistan textile industry
- Incite other companies seek for optimization at their premises.

The objectives can be achieved through the capacity building of its engineers/technicians through intensive training courses for industrial staff; managers at shop floor level to capacitate them to identify energy saving potentials at their own plant, for capacity building of its engineers/technicians the following activities have been planned & implemented with the expertise of GTZ.

- Broad seminar activities, Round table conferences on Energy Efficiency & Energy Conservation in public & private sector in coordination with ENERCON, AEDB & NPO.

- Conduct 2 to 3 weeks training courses at least twice a year to produce energy auditor and managers in order to stimulate the market for energy consultancy services along with Consultant & Enterprises.

7.3.1 Development of Efficiency Standards

The electricity consumed by the domestic sector constitutes approximately 45% of the total consumption. Generally the domestic appliances being used are not Energy Efficient. Similarly pumps and motors being used in the Industrial / Agriculture sector are also not Energy Efficient and therefore a lot of energy is being wasted by using substandard equipment. Pakistan Standard Quality Control Authority (PSQCA), a regulatory framework of standards is being enforced with an emphasis on Energy Efficiency for these products. The enhancement of the efficiency of these products will greatly contribute to Energy Conservation. Further this framework will act as a non tariff barrier to the import of substandard goods which are currently being imported into the country unrestricted.

7.4 Favorable Import Tariff Regime and Standardization of Pumps and Motors

The Pumps and Motors are world largest consumer of electrical energy accounting for 70% of all industrial electricity used, and during use much of the energy consumed is being wasted un-necessarily in the form of excess heat, vibration & noise. These losses when compound creates further problems, which are time consuming & expensive to rectify. The user can improve overall efficiency providing a safer and more reliable operation with substantial reductions in both energy consumption and maintenance cost.

Engineering Development Board (EDB) has already been working for developing and formulating Pakistan Standard on mechanize items including pumps, motors and Energy Efficient appliances. Prime Minister's Crash program / Agenda through effective implementation & to finalized Pakistan Standards on all commercial & domestic appliances by the Pakistan Standards Quality Control Authority (PSQCA). It was inferred that the only solution to solve the Energy Conservation lies with the pragmatic approach in implementing and enforcing effectively the Pakistan Standard in respect of all commercial & domestic appliances. Pakistan Standards Quality Control Authority (PSQCA) have already compile Pakistan Standards in respect of all commercial & domestic appliances included pumps & motors which are in line with those applicable in the global market and are available for voluntary / Compulsory Certification Mark. Pakistan Standards Quality Control Authority (PSQCA) & Engineering Development Board (EDB) has ensured, standardization with

participation of all the stake holders including ENERCON and Ministry of Petroleum and Natural Resources on Energy Efficient appliances including pumps & motors.

7.5 100 Mega Watt Saving Through Reduction in Line Losses

PEPCO can save at least 100 mega watt & millions of rupees monthly by managing minimum of 1% in distribution & reduction in line losses. Distribution & line losses of 10 to 15 % annually can cost a utility millions of rupees. PEPCO has developed a comprehensive plan in order to reduce the line loss problems systematically reconciling the cooperative's wholesale power purchase with its sales down to the substation and feeder line loss management. Improving distribution system, Energy Efficiency and metering accuracy is an important step to reduce the line losses in their distribution net work.

7.5.1 Measures to Reduce Line Losses:

Following are the Prime Ministers directives & important measures to reduce the line losses:

- The most important aspect is to develop a program to control over the distribution line loss management. PEPCO should immediately implement programs of Loss Analysis and Reporting System (LARS).
- The system quantifies and confirms where line losses occur, as well as helping to identify specific tasks to recover lost revenue.

7.5.2 Load balancing

Electric power transmission is the bulk transfer of electrical power delivery to consumers. A power transmission network typically connects power plants to multiple substations near a populated area. Usually transmission lines use three phase alternating current (AC). The transmission system provides for base load and peak load capability, with safety and fault tolerance margins. The transmission system usually does not have a large buffering capability to match the loads with the generation. Thus generation has to be kept matched to the load, to prevent overloading failures of the generation equipment. Multiple sources and loads can be connected to the transmission system and they must be controlled to provide orderly transfer of power.

7B. Energy Conservation Techniques and Practices

The Necessary Steps for Protecting Earth Environment globally as well as Coping with the Immediate Energy Short Fall in Pakistan. The world in general and Pakistan in particular is facing the energy crisis which is compounded by the earth environment protection demand where any extra watt consumed is directly contributing to the global warming as that watt is generated mostly by burning fossil fuel adding carbon to the atmosphere. The symptoms of these crises are mainly because of in-efficient use of energy.

Summary of In-Efficient Energy Usage in Pakistan

a. Most of the motors, fans, pumps and generators are over engineered.
b. The lighting systems in houses and streets are old heavy load types.
c. The sign boards are just draining the resources.
d. The use of UPS is doubling the load in turn increasing load shedding.
e. Rivers are flowing down without utilization of the flow potential.
f. Flue gases from industry are not used for regeneration.
g. Vast potential form small solar and wind packages are untapped.
h. The car breaking energy is wasted on congested roads every day.
i. HVAC, Lighting and irrigation works in un-optimized way.
j. Industries and buildings are operated in manual mode wasting energy.
k. Buildings are not built with proper insulation for energy saving.
l. Natural lighting and fresh are is not utilized in buildings.
m. Rain water flows without being utilized.

Elimination of Energy Drain through In Efficient Equipment

The motors , pumps , fans, heaters, air conditioners, refrigerators , water coolers and generators are not engineered precisely for the required output but are most of the times over engineered to make sure the functionality and reliability. In this process the equipment is un-necessarily oversized and is taking more current thus becoming a bourdon on the electricity system. There is need for adopting the existing standards available to have mandatory certification of the equipment and having incentives for compliance. Free support shall be provided to local manufactures to audit there designs and help them improve according to the energy efficiency requirements. The support shall be localized and propagated through the

districts and Chambers level and shall be ensured that the compliance is recognized and non compliance is discouraged. Rewards system shall be worked out to implement the system with ease and in an effective way.

Automation and Optimization of Processes in Every Aspect of life

Automation and Control is the key to energy conservation, optimizations and proper utilization in all aspect of life and all stages of energy handling. Automation of power plants, transmissions and distribution systems, power factor correction, metering, industrial processes, even load shedding will help to solve much of the problems in the energy sector and consumers side. Automating the common area lights working on the presence of people at home will save energy. Automatic irrigation of plants at home will save energy if they are irrigated by time, humidity, time of the year all around the year. Automatic Drip irrigation will save 70% water and thus energy.

Automatic street lights based on time and light will save energy. Automatic outside temperature compensation in HVAC controls will save energy and health. Automatic maintain management system will save energy and production loss before jammed equipment fills the bill and stopping the plant.

Automatic flue gas analysis will prevent loss of energy and will prevent direct damage to environment. Automated homes will save energy by controlling light, fresh air and air-conditioning and other equipment as and when needed. Automatic Gas control will help saving gas and lives.

Codes for Energy Efficient Buildings and Implementation

There is urgent need for introducing the building energy codes developed by ENERCON with all aspects staring from orientation with respect to utilization of natural light, fresh air, insulation, rain water storage and utilization, safety, lighting, wiring, solar and wind systems, LED based lighting, UPS and car energy utilization.

The code and its benefits shall be propagated and implemented at the local levels on mandatory basis and as free as possible. Free support and verification and compliance shall be done by government body. Check shall be established by third parties for implementation compliance on all levels.

Usage of Car kits for storing wasting breaking energy for home use

On our roads the cars are doing a lot of breaking due to congestion and road conditions. The government shall provide a controlled design for breaking energy storage kit for cars and busses. This kit shall be implemented by the people with necessary capability and compliance to the design. The car kit shall be a simple deployment of heavy charger before engagement of actual breaks to charge the extra batteries. These batteries can be used as spare in the same car as well as with a standard plug connection, it can be connected to the house system in the car park utilizing the power for lights or even recharging the UPS. Some standardization will be needed & finalizing the typical designs for different cars and energy utilization.

Using floating turbines for Small Power Production on Rivers

Small zero head, slow speed, floating base turbine design shall be made available to all wood working and iron workshops. This turbine shall be used of small power generation practically every 50 meters at the entire length of the rivers and canals. The design shall be provided free with free support for verification and safety with respect to electricity handling. Workshops and road shows can be arranged to create awareness and showing the demos.

Utilizing the flue gas heat in brick owns for electricity generation

Every industry dealing with heat and combustion have the potential of re-generation through flue gases where the exhaust or chimney heat can be utilized to produce energy for the local use. The designs shall be made public with verification safety aspects and to be implemented by certified personal with certain capability.

Vision and Recommendation for Practical Implementation

ENERCON prepared the frame work for workable measures leading to energy conservation and energy utilization and propagate this as necessity not an option. The engineering institutions and organizations shall be put on board to have their expert opinion and support where needed. The energy policy shall be finalized in consensus with all stakeholders including, WAPDA, Oil and Gas, Automobile manufacturers, Private power and Alternative Energy Development Board (AEDB), Chambers of Commerce in all provinces and the provincial Governments.

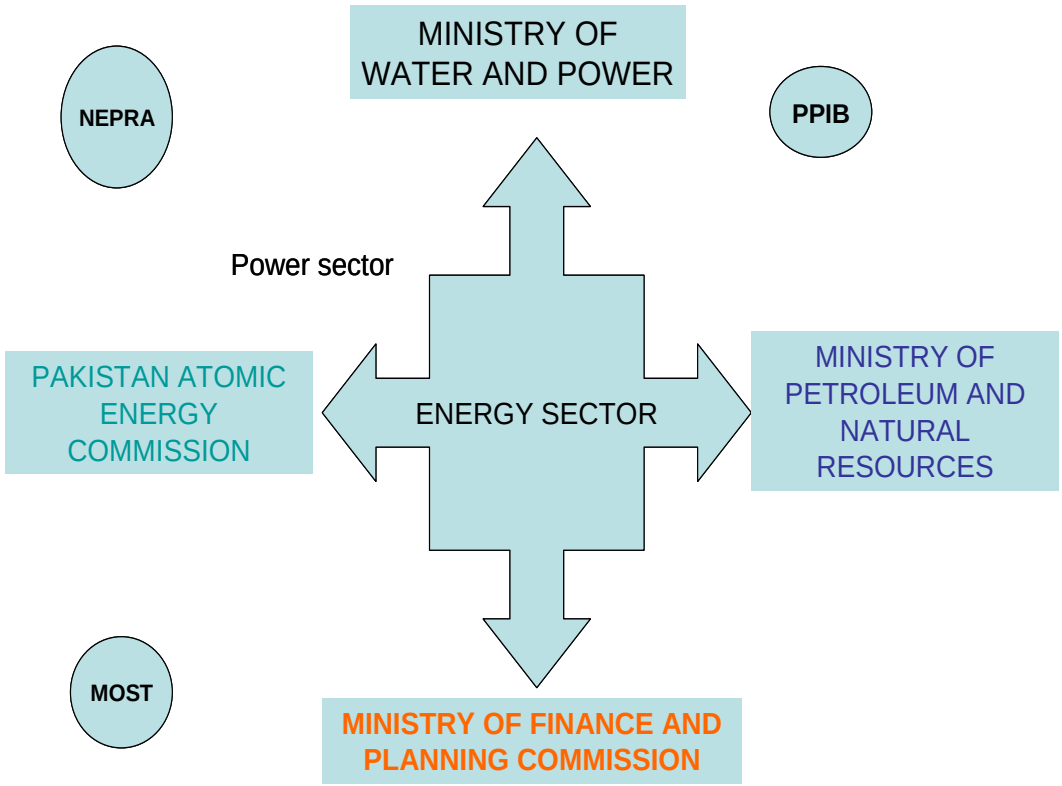
PAKISTAN POWER SECTOR

8 Pakistan Power Sector

To cater to the increased electricity demand of the Pakistan market the government has abolished the monopoly in power sector thereby allowing private companies to set up power projects. Accordingly, the Power Policy announced in 2002 committed attractive incentives for power project investors, particularly producers from renewable resources like wind, solar, biomass etc. To explore and develop these renewable sources of energy institutional arrangements made by the Government of Pakistan (GOP) primarily include creation of Alternative Energy Development Board (AEDB), an autonomous body created through an Act of Parliament.

Legal and regulatory framework in Pakistan

The Ministry of Water and Power (MoW&P) is responsible for formulating Pakistan Power Policy. Due to the shortage of electricity in the 1980s and early 1990s, a strategy plan



geared to restructuring the Pakistani electricity sector was adopted in1992.

8.1 Private-sector power law of 1994

Full implementation of the strategy plan has suffered multiple delays already- for example, it has not yet been possible to establish a whole sale market- but that goal is still being pursued. A new energy law adopted in 1994(Policy framework and packages of

incentives for private sector power generation projects in Pakistan) aims primarily to attract private capital to the Pakistani power sector and to standardize the conditions of investment for independent power producers. It covers the following measures in particular:

- Standardization of contracts with regard to implementation agreements, contracts of supply for primary sources of energy, and power consumption contracts
- Remuneration for all electricity amounting to 10-12 US cents/kWh (Approx), coupling to the exchange rate between the Pakistani rupee and the US dollar, Including allowance for the US inflation rate and potential fluctuation in raw material prices
- Surrender of decision-making powers to the project's implementing institutions with regard to size, technology, energy source of the power plant
- Power grid connection and supply guarantee for the required primary energy sources
- Exemption of independent power producers from numerous forms of taxation (capital gains tax, income tax and turnover tax) and duties, and
- Guaranteed acceptance of supplied power and delivery of required primary energy sources.

8.2 Creation of Private Power and Infrastructure Board (PPIB)

Also, with a view to improving investment incentives in the Pakistani power sector, a new state owned consulting institution was established in 1994, the Private Power and Infrastructure Board (PPIB). This instrumentality is primarily dedicated to serving as a one window facility to investors in Pakistan's private power sector. Acting in the name of Pakistani Government, PPIB provides advice and guidance for the implementation of power plants projects. Its main task is to negotiate the implementation agreement and provide support in negotiating fuel supply agreements and power purchase agreements. PPIB also provides guarantees to private investors for the performance of government entities (WAPDA, KESC, etc.), monitors litigation and inter-national arbitration for and on behalf the Government of Pakistan, and, finally, assists regulatory authority in determining and approving tariffs for new private power projects.

8.3 Power Law of 2002

A new power law was enacted in the year 2002. Basically, it closely resembles its predecessor dating from 1994, but it has a broader range of application. Entitled "Policy for

Power Generation Projects year 2002" the new power law applies both to private investment projects and to public private partnership and public sector power plants projects. The law also makes it possible for investors not only to participate in public tendering, but also to propose power plant project on their own.

Now, the respective provincial governments are responsible for the approval of plants with ratings below 50MW. A two-component system of pricing has been defined for power providers, part of the remuneration depends on the output of the respective plant (Capacity Purchase Price, (CPP) and the rest is a function of the sources of energy employed for producing the electricity (Energy Purchase Price, (EPP). The later is supposed to account for at least 34% to 40% of the total remuneration.

The new provisions of Power Law of 2002 give preference to projects involving the use of domestic energy resources, which are mainly water, coal and natural gas. This manifests itself primarily in the exemption of all such power plants projects from income taxes, turnover taxes and capital gains taxes on imports (with oil-fired power plants constituting an exemption). Moreover, import duties on plant components have been reduced to a mere 5% of the standard rate.

Policy for Development of Renewable Energy Sources

Pakistan's first promotion measures for renewable energy sources were implemented in the early 1980s, for example, the sixth Pakistani Energy Plan (1983-1988) devoted approximately 14 million to the areas of re-grow able energy crops, biogas and a feasibility study for the commercial exploitation of solar energy.

8.4 First activity between 1975 and 1992

The Pakistan Council of Appropriate Technology (PCAT), established in 1975, and the National Institute of Silicon Technology (NIST), established in 1981, were jointly responsible for implementing the measures. While PCAT focused its attention primarily on the areas of mini-hydropower, biogas plants, solar cookers and small wind energy conversion system for driving water pumps, NIST was more involved in the research, development and commercialization of solar energy with focus on photovoltaic. For lack of concrete promotion instruments, the output of all solar and wind energy system plus mini-hydropower plants together amounted to less then 5MW at end of the 1980s.

The 1990s also saw some isolated instances of promotion measures for renewable energy sources in Pakistan, but they were all very limited in their financial scope. In this connection,

mention could be made of the 1992 National Pakistan Conservation Strategy (PNCS) which was subsequently integrated into the 9th Pakistani Energy Plan (1993-1998). Altogether, PNCS spent some Rs.63 million on introducing biogas, wind power and hydropower facilities.

Pakistan Council for Renewable Energy Technology (PCRET)

The latest alternative energy promotion activities in Pakistan again encompass institutional measures and define target objectives. In May 2001, the two separate research institutions NIST and PCAT merged to become the Pakistan Council for Renewable Energy Technology (PCRET), the main goal being to better coordinate the research activities and avoid overlaps.

Alternative Energy Development Board (AEDB)

Pakistan is blessed with abundantly available and inexhaustible Renewable Energy (RE) resources, which if tapped effectively can play a considerable role in ensuring Energy Security and Energy Independence of the country. Sporadic efforts and initiatives have been undertaken by the Government in the past leading to lackluster results due to non-commitment, improper and disjointed planning and lack of focused, integrated efforts on part of the stakeholders involved.

The increase in demand for energy to meet the needs of energy intensive modern lifestyles and growing concern about environmental hazards associated with the use of conventional energy sources has laid emphasis on the possibilities of tapping the renewable energy sources in Pakistan. These energy sources (hydro- power, Bio-fuels, wind and solar etc.) have many environmental and economic benefits over the conventional energy sources (coal, gas and petroleum), the prices of which are already on rise.

The Alternative Energy Development Board (AEDB) was founded in May, 2003 for the purpose of supplying wind-and solar generated electricity in remote regions of Pakistan. AEDB is also responsible for the developing the country's medium and long-term promotion policy for renewable energy resources. In addition, its functions include the coordination of the joint ventures with the aim of having foreign technologies in the field of alternative energies fabricated in Pakistan.

Realizing the need to integrate the efforts for promotion and development of Renewable Energy (RE), the Government of Pakistan established the Alternative Energy

Development Board (AEDB) as an autonomous and the apex national organization in April 2005 with the mandate to undertake development of medium and long term national plans and policies, promotional and dissemination activities in the field of Renewable Energy Technologies; and to facilitate power generation through alternative or renewable energy resources by acting as a one window facility for establishing, promoting and facilitating alternative or renewable energy projects based on wind, solar, micro-hydel, fuel cells, tidal, ocean, bio gas, bio mass etc.

Planning of setting up of 2x50 MW Wind Power Generation Plant at Gharo in Sindh Province by the joint efforts of Alternate Energy Development Board (AEDB) and private investors is a major initiative in this regard. Besides supplementing the National Grid with cheaper and environmentally friendly energy, this project is also expected to generate additional revenue through sale of Carbon Credits under the Clean Development Mechanism.

AEDB has been assigned the following targets by the Government of Pakistan:

- Development of wind and solar energy to ensure that at least 5% of total power generation capacity is met through these resources by 2030 (i.e. 9700 MW).
- Alternative Energy Development Board to ensure the installation of 700 MW of wind energy at Keti Bandar and Gharo, Sindh through the private sector.
- Solar products like solar lights, solar fans, solar cooker, solar geyser, etc. must be developed through private sector on top priority.
- Laws and taxes designed to encourage self energy generation by domestic sector like use of solar heating, solar geyser etc.
- Provision of electricity to remote, off-grid villages through Renewable Energy Sources, e.g. solar, wind, biomass etc. 7,874 such villages in Balochistan and Sindh have been identified initially.
- Replacement of 5% of total annual diesel consumption with Bio-diesel by the year 2015, and 10% by the year 2025.

Current installed capacity of RE in the country (excluding large hydro projects above 50 MW capacity) is roughly around 25 MW only.

Potential for various RE technologies in the country vary from significant to phenomenal, which is as follows:

- Wind: 346,000 MW

- Solar: 2.9 Million MW
- Small Hydel: 2,000 MW
- Bagasse Cogeneration: 1,800 MW
- Waste to Power: 500 MW

In addition, potential for other RE technologies such as Geothermal, Wave Energy, Tidal Energy, Biomass etc. also exists but is yet to be determined. In this regard the following activities have been completed:

- National Renewable Energy Laboratories (USA) under the USAID assistance program in 2007 has carried out the wind resource study of Pakistan and developed a map showing the wind speed potential available at 50m altitude. National Renewable Energy Laboratories (NREL) study has also indicated the wind corridor in the south of Pakistan. The National Renewable Energy Laboratories (NREL) wind resource map of Pakistan has given a great boost to the wind power development activities in the wind corridor regions. Now this potential area has become the focal point for the development of wind energy in the near future.
- Wind mapping of Gharo-Kaiti Bandar wind corridor has been conducted. Solar Map of Pakistan has also been completed by NERL/USAID.
- A Feasibility Study conducted by SNV of Netherlands indicates the potential of 5 Million Biogas units for domestic use; one of the largest in the region.
- Estimated potential for electricity generation through Biomass / Waste to Power (including Bagasse cogeneration) also exceeds 2000 MW.

8.5 Salient Features of the Government Power Policy (particularly from renewable sources)

As stated in Government of Pakistan's (GOP) Policy for Power Generation (2002) the basis of the selection of the successful bidder in each case will be minimum levelized tariff, either through International Competitive Bidding (ICB) for solicited proposals or through negotiations/ICB for proposals on raw sites, i.e. locations where no feasibility studies have been initiated. An appropriate support mechanism by the regulator would be determined by the regulator (NEPRA) in consultation with the Government, if required. It is expected that environmental, social and security benefits, associated with renewable sources would be taken into account while determining cost of service of different technologies.

8.6 Energy Conservation Pricing in Pakistan - Policy Issues

Pricing is a very effective tool for influencing the magnitude and pattern of energy consumption i.e for energy demand management. However, unlike the "harsh" measures such as mandatory regulations, physical controls, rationing etc which can influence energy consumption within a short span of time, pricing has a more mundane approach, its impacts are slow to come about but generally last for a much longer period. In this way, pricing, like other "soft" demand management measures (e.g. financial incentives, public education) is more effective in the medium to long run. The scope of an energy pricing policy is not restricted to energy demand management alone it encompasses a broad range of issues covering the management of both energy demand and supply. The objectives of a rational and equitable energy pricing policy are;

- Promotion of economically efficient allocation of resources both within the energy sector and between rest of the economy
- Enabling the utilities to generate sufficient surplus funds to facilitate the financing of their future investment requirements
- Reflecting the costs of energy supplies to different categories of customers in the corresponding consumer prices
- Inducing more efficient utilization of available energy
- Encouraging inter fuel substitutions in desired directions leading to conservation of certain fuels (e.g. imported oil)
- Provision of a certain minimum energy to all citizens at prices affordable by the poorest consumers
- Promotion of specific socio-political aims such as rural electrification, regional development, technological diversification, environment protection etc.

These objectives are not necessarily consistent with one another e.g. the equity related objectives and call for subsidizing energy supplies to certain sections of the population and as such run against the spirit of the objectives. With the exception of indigenous coal, the consumer prices of all fossil fuels and electricity in Pakistan are regulated by the government and are essentially held uniform all over the country. The energy prices in Pakistan have undergone considerable changes over the past 15 years. These changes have partly been induced by the changes in world oil prices and partly prompted by specific government objectives at different times e.g. to promote the use of natural gas in place of oil, to generate

necessary revenues for energy investments, to provide price subsidies to certain categories of consumers and to affect a certain level of price induced issues which constrain the balanced growth and healthy performance of the energy sector.

The present restructuring of the electric utility industry, which is underway, consists of eventually creating a whole sale power market in which vertical integration will be eliminated. All distribution companies will have to buy from the market. The transmission system will serve public interest by treating all users equally and charge a price for transmission service that allows for effective competition between generation sources.

The power market in its restructuring has been opened to competition. Such an arrangement may hinder investment in renewable in the absence of strong policies to promote renewable resources.

Two main types of regulatory policies have been used to open the grid to renewable sources.

8.6.1 Targets for Renewable Energy Resources - 2020

At the legislative level still there are no concrete measures in place for the promotion of renewable energy resources in Pakistan, but the 2002 Power Law does at least formulate the target of creating some 500MW of new power generating capacities based on renewable energy sources by the year 2015 and an additional 1,000 MW by 2020. The establishment of AEDB also defines the goal of gradually expanding the share of renewable energy sources used for generating electricity (excluding major hydropower) to 10% by 2015.

Table: 5 Global Renewable Energy Status

Selected Indicators	2005	2006	2007
Investment in new renewable capacity (annual)	$40 billion	$55 billion	$71 billion
Renewable power capacity (existing, excl. large hydro)	182	207	240 GW
Renewable power capacity (existing, incl. large hydro)	930	970	1,010 GW
Wind power capacity (existing)	59	74	95 GW
Grid-connected solar PV capacity (existing)	3.5	5.1	7.8 GW
Solar PV production (annual)	1.8	2.5	3.8 GW
Solar hot water capacity (existing)	88	105	128 GWth
Ethanol production (annual)	33	39	46 billion liters
Biodiesel production (annual)	3.9	6	8 billion liters

Source: Renewable 2007 Global Status Report

Global Market Trends

- Renewable power capacity of about 240 GW in 2007 (ex. large hydro) represents almost 6% of total global power capacity (4,300 GW) and the share is increasing.
- Over 70 countries now have wind power, and many developing countries have joined the trend recently, including Brazil, Egypt, Iran, Mexico, Morocco, and South Africa, all with added capacity in 2006.
- Off-shore wind power grew significantly in 2006-2007, with several projects in the 100-300 MW range underway in Europe and the United States.
- Solar PV market growth is centered in Germany, Japan, Spain, Italy, South Korea, California, and New Jersey, but with the market now broadening to more countries and states (such as France).
- Rooftop solar collectors provide hot water to over 50 million households worldwide, most in China. China now represents 75% of global annual additions of solar hot water.
- Geothermal heat pumps are a rapidly growing market, with over 2 million heat pumps used in over 30 countries, mostly in Europe and the U.S.

- Biomass-fueled heating still provides five times as much heat worldwide as solar and geothermal combined, and continues to grow in northern Europe.
- The U.S. has become the dominant ethanol producer (corn-based), although Brazil has started an ambitious program to increase production by 50% by 2009 (sugar-based).
- Ethanol provided > 40 % of all (non-diesel) motor vehicle fuel in Brazil in 2005.
- Bio-diesel production has increased at 20-100% annual rates in recent years, particularly in Germany, France, Italy, Poland, and the United States.
- Almost half of world bio-diesel production continued to be in Germany.
- The first group of commercial-scale solar thermal power plants since the 1980s started operation in 2006-2007, including in Nevada (USA) and Spain. Many more plants are now planned.

8.7 Policy Highlights (A brief description of successive policies relevant to the industry)

The RE sector had been largely ignored prior to the establishment of AEDB. Upon its inception, one of the tasks undertaken by AEDB was the formulation of country's first ever Renewable Energy Policy. As a result, the Policy for Development of Renewable Energy for Power Generation was approved by the Federal Government and issued in December 2006. Salient features of the Renewable Energy Policy 2006 are as follows:

- It invites investment from the private sector for following categories of proposals:
    - Independent power projects or IPPs (for sale of power to the grid only).
    - Captive cum grid spillover power projects. (i.e., for self-use and sale to utility)
    - Captive power projects (i.e., for self or dedicated use)
    - Isolated grid power projects (i.e., small, stand-alone)
    - Except for Category (a) above, these projects will not require any LOI, LOS, or IA from the Government.
- Electricity purchase by NTDC / CPPA from qualifying renewable energy-based generation projects has been made mandatory.
- It permits an investor to generate electricity based on renewable resources at one location and receive an equivalent amount for own use elsewhere on the grid at the investor's own cost of generation plus transmission charges (wheeling).

- It allows net metering and billing so that a producer can sell surplus electricity at one time and receive electricity from the grid at another time and settle accounts on net basis. This will directly benefit the economics of small scale, dispersed generation and optimize capacity utilization of installed systems.
- It de-licenses and deregulates small scale power production through renewable resources (up to 5 MW for hydro and 1 MW for net metered sales) to reduce the transaction costs for such investments. This will be particularly beneficial for micro, mini and small hydro as well as solar-based electricity production.
- It lays down simplified and transparent principles of tariff determination.
- It insulates the investor from resource variability risk, which is allocated to the power purchaser.
- It facilitates projects to obtain carbon credits for avoided greenhouse gas emissions, helping improve financial returns and reducing per unit costs for the purchaser.
- Demand/ Supply Scenario (Current vs Projected, graphs and tables can be included)

Demand/ Supply Scenario

Current installed capacity of the country stands at 19,522 MW. There exists a shortfall of 6,000 MW today. The energy demand over the next five years is expected to grow at a rate of 7.4 % per annum. In order to meet additional power generation requirement of 143,310 MW during 2005-2030, an investment of $ 150 billion would be required.

Renewable Energy, however, can effectively complement the conventional energy resources for meeting the demand / supply gap. Given the right kind of support, over 10,000 MW can be added to the national installed capacity through Renewable Energy resources by the year 2030.

Projects in Pipeline at this Time

Several projects in different RE technologies, which include wind power projects, micro / mini hydel, bio mass / bio gas, waste-to-energy and solar, are currently in the pipeline.

Table : 6 Renewable Energy Projects In Pipeline						
S #	**Name of Project**	**Technology**	**Capacity (MW)**	**Expected Commissioning Year**	**Estimated Cost (Million $)**	**Implementation by**
1	Zorlu Enerji Pakistan Ltd.	Wind	50	2009	121	Private sector
2	Green Power Pvt. Ltd.	Wind	50	2010	135	Private sector
3	Arabian Sea Pvt. Ltd.	Wind	50	2011	161.3	Private sector
4	Dawood Power Ltd.	Wind	50	2011	133	Private sector
5	Beacon Energy Ltd.	Wind	50	2011	135	Private sector
6	Clean Energy Development	Bio Mass	25	2010	-	Private sector

Hydropower

Pakistan's total hydropower potential has been estimated at up to 40,000MW, some 24,000 MW of which could be harnessed, and approximately 5,000MW of which is actually exploited. By reason of anticipated growth in demand and of the fact that only about 20% of the available hydropower potential is being utilized, the "Vision 2025" development plan provide first and foremost for the vigorous, multi stage development of hydroelectric power.

Run-of-river Ghazi-Barotha Power Plant

Ghazi-Barotha power plant, a run-of-river plant that is presently being commissioned in successive stages, constitutes an initial large scale project in this sector. Located on the upper reaches of the Indus and built for a total output of 1,450MW. The plant's full and final commissioning was scheduled for the mid-2004. The project is being implemented under the auspices of the state-owned WAPDA. At present, the total cost is situated at roughly US$ 2.1 billion. The project is being financed by the World Bank, the Asian Development Bank, the Japan Bank for International Cooperation (JBIC), the European Investment Bank, the Islamic Development Bank and resources from German Financial Cooperation. WAPDA is contributing approximately US$ 1 billion, or nearly half of the overall cost. Fully utilized, the power plant is supposed to lower CO2 emissions by approximately 5.5 million tons annually.

Micro Hydropower Potential

In northern Pakistan alone there is an estimated potential of 300 MW for micro hydropower plants with installed capacities below 100 KW each. As of 2003, only about 4 MW of that potential had been tapped by a total of 250 projects co financed by PCRET and/or its predecessor institutions. Now, with the assistance of Asian Development Bank and within the scope of a rural development project, 100 micro hydropower plants with rating ranging from 5 to 50 kW are being installed in and around Malakand in NWFP.

Biomass

In Pakistan, where, according to the last census, approximately two out of three people live in rural areas, the rural residents in particular rely almost exclusively on biomass in the form of fuel wood or charcoal for cooking and heating. Indeed, the majority of Pakistan's urban population (58%) also takes recourse to those traditional resources of energy. According to official data, the country's total wooded area expanded from 34,600 km^2, but each year local residents remove some 1.2 million m^2 of wood from the country's forests for use as fuel. In Balochistan, this practice has reduced the total area of standing forest by 70%.

The Government of Pakistan started a biogas propagation programme in 1974, and by 1987, 4,137 biogas plants had been installed in the course of the programme's several phases. However, since the last phase no longer offered any official financial assistance, no more such systems were installed.

Then in May 2003, PCRET announced a new biomass/biogas programme designed to promote the installation of 1,200 additional installations within the following four years. It is hoped that by the end of the project, the annual production of the biogas for house hold purposes will amount to 1.2 million m^3. M/s Clean Energy Development Ltd of New Zealand is actively working on the development of a 25 MW biomass project at Landhi, Karachi. The pilot phase of the project (250 kW) has been initiated and the full scale plant of 25 MW will be completed by 2010.

Bio-Diesel

Oil imports of Pakistan continue to rise, presenting a serious cause of concern for the Government due to rising and unstable crude oil prices. Pakistan consumes 8 Million tons of Diesel annually out of which 4 Million tons is imported. Diesel is consumed by the industrial, transportation and agriculture sectors, which make up for 75% of the country's

annual energy use at 26.280 MTOE. 10% of country's annual Diesel consumption replaced with bio-diesel will result in estimated savings in excess of US $ 1 Billion per annum.

The Energy Cabinet Committee (ECC) of the Federal Cabinet approved the Policy Recommendations for Use of bio-diesel as an Alternative Fuel in February 2008, which has set the indicative target of Gradual introduction of bio-diesel fuel blends with petroleum diesel so as to achieve a minimum share of 5% by volume of the total Diesel consumption in the country by the year 2015 and 10% by 2025.

Pace of development of bio-diesel sector in Pakistan is such that events may overtake policy leading to Government losing control over the production of bio-diesel which can either destabilize this sector or stint its growth before the sector gets the opportunity to mature and become viable. Integrated and focused efforts are required on government's part as multiple stakeholders are involved from the public sector including AEDB, Ministry of Food, Agriculture & Livestock, Ministry of Petroleum & Natural Resources, PSO, OGRA as well as the provincial governments. These stakeholders need to realize the gravity of the situation and address all the critical issues associated with the sustainability of the National Bio-diesel Program spearheaded by AEDB. Immediate decisions are required in order to effectively address these issues and formulate a National Bio-fuels Policy in the soonest possible time span.

Solar Energy

Pakistan has a very good overall solar- energy potential. The average daily insulation rate amounts to approximately 5.3 kWh/m2. Especially the south-western province of Balochistan offers excellent conditions for harnessing solar energy. There, the sun shines between 8 and 8.5 hours daily, or approximately 3,000 hours per annum.

Despite these favourable prerequisites, the use of solar energy for generating electricity or for heating is still in its beginnings. Photovoltaic systems are used primarily for producing electricity in rural areas. As far back as the early 1980s, the Government of Pakistan had 18 PV systems with a composite output of 440 kW installed in various parts of country. Due to the lack of technical know-how about their operation and maintenance, no further systems were installed. For the same reason, 7 other PV systems with a total output of

234 kW, which were installed in the Pakistani part of the Hindu Kush in the late 1980s, are no longer in operation.

Two solar-powered sea water desalination facilities with a daily through output of 22,710 are in use in the province of Balochistan.

In July 2003, with the establishment of AEDB, the measures planned for the field of renewable energy sources for the fiscal year 2003/2004 were publicized. Most of the activities concern solar energy. According to that data, 5,000 Solar Home Systems (SHSs) are to be provided in each of the country's four province by mid-2004.

8.8 Solar Water Pumping and Desalination

In order to provide clean, potable drinking water in the remote areas of the Tharparkar Sindh, AEDB has initiated Solar Water and Desalination project. The project includes installation of Solar PV Brackish Water Pumps and Solar Thermal Desalination units. The selected villages in Tharpakar, Sindh have been provided with a Solar PV Brackish Water Pump and Solar Thermal Desalination unit at each house.

Table : 7 Details Of Solar Water Pumps Installed In Sindh (2006-07)

Sr. #	Name of Village	No. of Solar Water Pump Installed
1.	Pinpario	01
2.	Bhandafanda	02
3.	Chachi	01
4.	Roheraro	02
5.	Bharomal	01

Source: AEDB

8.9 Challenges facing the sector (policy issues, technical challenges)

POLICY ISSUES

- The efforts of the government have not met with success mainly due to a lack of integrated planning and implementation mechanism. Unfocussed efforts with duplication of activities by various agencies which is uncoordinated combined with limited resources and constraints leads to confusion and attainment of targets is not possible. There is a proliferation of Government agencies often duplicating functions. These agencies under various Ministries are not empowered sufficiently to develop RE resources, and are working with limited resources and constraints. Lack of coordination and cohesion among the agencies responsible for developing

the RE sector is preventing from achieving a critical mass concentration of these technologies. Scant, peripheral and parallel activities by various agencies also cause confusion among the Donor Agencies. The provincial governments do not have a proper 'buy-in' and do not support the process.

- Another key issue responsible for hindering the growth of RE sector in the country is the general lack of capacity in the public sector, which coupled with the already burdensome approval process for RE IPPs, is slowing down tangible progress for setting up RE projects in the country. It is important to understand that building capacity is as important as adding Mega Watts to the grid. The challenge faced today is to make the different Government of Pakistan players coalesce around the development and implementation of a national RE strategy in a complimentary way.
- One of the most critical factors responsible for preventing the realization of RE projects, especially Wind Power Projects is that of tariff. More often than not, wind IPPs has found the tariff determined by NEPRA to be unworkable and unacceptable. The leading wind IPPs of the country, i.e., Zorlu Enerji, Green Power Pvt. Ltd. and Dawood Power Pvt. Ltd., all have gone through the cumbersome process of filing multiple tariff petitions with NEPRA due to the fact that the offered tariff was always considerably less than the one petitioned for. Green Power has so far gone through this process three times and still hasn't been awarded a tariff of its liking. This leads to inevitable delays in the project as the IPPs are unable to firm up their turbine supply and EPC agreements and the window of opportunity is lost; not to mention the direct and indirect additions to the project cost as filing of each tariff petition costs in excess of Rs. 2.5 Million and the turbine prices in the international market have been experiencing a continuous upward trend for the past three years. The biggest reason that not a single wind power project has come on-ground to date is that of tariff disputes with NEPRA; thus compounding the current prevailing energy crisis.

8.10 Technical Challenges

- Renewable Energy projects are going to be a first in the history of country's power sector. Due to their unique nature and intermittent resource variability, they

also pose technical challenges. The Government entities in the power sector are only experienced in dealing with thermal and large hydro projects, and are therefore not technically equipped to handle RE projects. One of the main reasons for delays in developing a standard Energy Purchase Agreement for wind projects was lack of experience and capacity for understanding and handling the technical aspects of wind energy generation and dispatch issues.

- The currently enforced Grid Codes do not cater for Renewable Energy projects. Modification of these Grid Codes to successfully incorporate wind energy projects is proving to be a major technical issue and challenge. The issue needs to be addressed at the earliest possible to inject wind energy to the national grid without any further delays.
- The NPCC which is the agency responsible for managing and controlling the national grid also lacks the experience to manage dispatch of wind energy to the grid.

8.11 Immediate Problems Immediate Solutions

- Focused and integrated approach by the Government to develop the RE Sector is required without any further delays. This can be achieved by strengthening the AEDB as an institution, both in terms of its legal mandate and financial resources. Another practical and extremely useful approach can be to establish a separate ministry for Alternative Renewable Energy, along the similar lines as adopted by India and various other countries around the world which have served them really well. In this way, integrated efforts can be undertaken by the Government by displaying the necessary resolve and political will for development and promotion of RE.
- Renewable Energy around the world has flourished mainly due to the reason that it got unflinching support of the Governments in the form of binding targets, legislations and attractive incentives for private sector investment. Among them, the concept adopted universally with great success is that of feed-in Tariffs and this mechanism should be adopted in Pakistan without any further delay. Feed-in Tariff not only takes into account the private cost of the project, but also accounts for the externalities arising due to social costs had it been a business-as-usual scenario using conventional energy resources. The approach adopted in Pakistan so far for such RE projects is on “cost-plus” basis. The cost-plus computation

requires a case-by-case determination of the applicable tariff for every single producer. This approach is typically favored by NEPRA in order to help reduce the risk faced by the developers who want to undertake such projects, since it guarantees a return-on-equity (ROE) of at least 15 %.

While this method reduces some of the risks to the developer, it also eliminates any additional incentive to develop these types of projects. For instance, the ROE assured is the same regardless the type of power generation project under consideration (i.e., renewable or conventional). This can lead to quite curious situations, such as that the upfront tariff allowed by NEPRA for conventional generation using reciprocating engines burning diesel oil is 25% higher than the upfront tariff for generation using wind, regardless of the benefits that the latter brings to the environment or in terms of fuel independence.

Additionally, available international evidence shows that feed-in tariffs are the best incentive mechanism for developing RE capacity, as can be observed in the cases of Europe and some BRIC (Brazil, Russia, India and China) countries.

- The few initial wind power projects may be exempted from the Grid Codes currently in vogue in the country so as to ensure their immediate dispatch of energy. In addition, the Grid Codes should be revised to cater for off-take of wind energy based on the best international practices instead of re-inventing the wheel all over again.
- The Gharo – Keti Bandar Wind Corridor may be declared a perennial wind corridor by the Government, dedicated to the development of wind energy projects. This will help in making these projects bankable as it would be easier for financial institutions to finance these projects without any fear of land lease for the project being revoked by the Government of Sindh at any stage during the project life.

Mid term and Long Term Problems and Mid Term and Long Term Solutions

The issues addressed above are also generally applicable for the mid term as well as the long term. However the biggest challenge will be for the Government to continue its resolve to support the initiatives undertaken already and during the short term to make this sector a viable and sustainable option for Pakistan. This may include the following:

- Capacity and capability building of the public sector institutions involved with the development of RE sector, i.e., AEDB, NTDC, NEPRA, CPPA, NPCC etc.
- Development of an enabling environment for Renewable Energy technologies by introducing and implementing plans and policies that offer enough incentives to sustain the sector in the medium term and enable the RE technologies to become competitive with the conventional technologies on a level-playing field in the long term.
- Introduction and implementation of the feed-in tariff mechanism at least for the medium term.
- Introduction of binding targets and legislations for use of RE technologies, both for utilities and consumers.
- Incentives to manufacturers for indigenization of RE technologies, as it will help in not only considerably reduce the projects' cost in future but will also have a very positive impact on the overall economy of the country.
- Strengthening of the Alternative Energy Fund (AEF), which has been recently established with an objective to develop the RE sector and to promote PPPs as well as to assist the private sector for developing RE projects that have certain risk perceptions associated with them due to not having any past precedence in the country.

On grid RE projects in the country are mainly being established on the IPP model. However pilot projects are planned to be undertaken by the public sector to provide a certain level of comfort to the private sector for investing in such projects of mega scale. In addition, RE projects are also being undertaken by the Government to improve the livelihood of the impoverished inhabitants of remote, off-grid areas with a view of social development and meeting the Millennium Development Goals.

To meet the projected targets in the next 15 years, an investment of USD 500 Billion will be required for wind energy projects alone. USD 250 Million may be required for Rural Electrification Program.

This capital requirement may be met from various sources, including Government funding, e.g. PSDP, international donor agencies (who are already supporting such initiatives in Pakistan, e.g. ADB, UNDP/GEF, USAID, EC, World Bank etc.), and the private sector which may be the biggest driver for investment in the RE sector. However

it is estimated that a support of USD 1-2 Billion dollars during the mid term will enable the sector to become self-sustainable in the long term.

Opportunities for improving efficiency (production, transmission)

Renewable Energy technologies, by default, are the most energy efficient options available. Implementation of RE technologies will result in considerably improving the efficiency of the country's power sector. In addition, one of the biggest advantages of utilizing RE technologies is the reduction of T&D losses in the grid. This is achieved either by having the electricity generating source right next to the point of consumption or relieving the grid of the amount of power that is otherwise generated by an RE application. Hence using RE options provides excellent opportunities for considerably improving both the production and transmission efficiencies of the overall grid system.

Opportunities for technological enhancement

Promotion of RE technologies in the country can also open the floodgates to technological advancement of Pakistan in this area. Indigenization and transfer of such technologies can bring about a revolution in the engineering and industrial sector of the country. Another advantage that can be gained out of this technological advancement is the strategic location of the country. Pakistan has the potential of becoming a hub for exporting the RE technologies and equipment to the countries in the region.

8.12 Geothermal Energy

Although there are numerous hot springs with temperatures ranging from 30 degree centigrade to 170 degree centigrade to be found in various parts of Pakistan for example in the vicinity of Karachi and in Pakistani part of Himalayas, there has been no attempt to make use of geo thermal energy in Pakistan yet.

8.13 Financial Regime

The following financial incentives available in policy for Power Generation 2002 are applicable;

- Permission for power generation companies to issue corporate registered bonds.
- Permission to issue shares at discounted prices to enable venture capitalists to be provided higher rates of return proportionate to the risk.

- Permission for foreign banks to underwrite the issue of shares and bonds by the private power companies to the extent allowed under the laws of Pakistan.
- Non-residents are allowed to purchase security issued by Pakistani companies without the State Bank of Pakistan's permission and subject to prescribed rules.
- Abolition of 5% limit on investment of equity in associated undertakings.
- Independent rating agencies are operating in Pakistan to facilitate investors in making informed decisions about the risks and profitability of the project company's bonds/TFCs.

8.14 Pakistan Power Market

8.14.1 Generation capacities

Between 2001/02and 2008/09, Pakistan's total installed power generating capacity increased from 17,776MW to 19,420MW. Thermal power plants contributed 69% of that total, while hydroelectric power plant accounted for 28%, and Pakistan's two nuclear power plants produced 3% of the total.

Table : 8 Total Installed Generation Capacity (MW)

S.No	Power Company	Installed Capacity 2007-08	Share (%)	Installed Capacity 2008-09	Share (%)	Change
1	WAPDA	11,654	59.6	11,454	58.0	-1.7
	Hydel	6,474	55.6*	6,555	57.2*	1.3
	Thermal	5,180	44.4*	4,899	42.8*	-5.4
2	IPPs	5,760	29.4	5,954	30.1	3.4
3	Nuclear	462	2.4	462	2.3	0.0
4	KESC	1,690	8.6	1,884.0	9.5	11.5
	Total	19,566	100	19,754	100.0	1.0

*** Share in WAPDA system** **Source: Hydrocarbon Development Institute of Paki**

Electric Generation By WAPDA

Table : 9 Electricity Generation (GWh)

Year	Hydro	Share (%)	Thermal	Share (%)	Total
1998-99	22,448	41.8	31,235	58.2	53,683
1999-00	19,288	34.3	36,585	65.5	55,873
2000-01	17,259	29.5	41,196	70.5	58,455
2001-02	19,056	31.3	41,804	68.7	60,860
2002-03	22,350	34.9	41,690	65.1	64,040
2003-04	27,477	39.8	41,617	60.2	69,094
2004-05	25,671	34.9	47,849	65	73,520
2005-06	30,855	37.5	51,370	62.5	82,225
2006-07	31,942	36.4	55,895	63.6	87,837
2007-08	28,667	33.23	57,602	66.77	86,269
July-March					
2007-08	21,606	33.5	42,963	66.5	64,569
2008-09	20,665	33.7	40,653	66.3	61,318

Total generation includes purchase from IPPs and imports **Source: PEPCO**

Growth in Consumers

With the expansion of the electricity network, the number of consumers has increased by 7,675 thousands since 1998-99. During July-march 2008-09, the growth of consumers stood at 4.2 % as it reached 18.5 million consumers during July- March 2008-09 as compared to 17.7 million in same period last year. The share of domestic consumers remained 84.9 % followed by the commercial and industrial sectors having a 12.3 % and a 1.4 % share respectively.

8.15 Power transmission losses

The transmission and distribution losses exhibited decreasing trend during July-March 2008-09 with transmission and distribution losses declining at 19.4 % as compared to 20.3 % in the corresponding period of last year. NTDC and DISCOs have started a range of technical and administrative measures to e.g use of copper wires etc enhance operational and managerial efficiency to reduce power losses. These measures have showed positive signs resulting in the reduction of power losses and leading to an increase in revenue. Along with these, other measures which involve continuous processes like renovation, rehabilitation, capacitor installation and strengthening the distribution system network are being carried out to control the wastage of power.

8.15.1 Power consumption

With the sole exception of fiscal year 1998/99, power consumption has grown steadily between 1990/91 and 2007/08, total consumption increased by more than 61%, from

31 TWh to 51 TWh. Again with a single exception fiscal year 1990/91 the domestic sector consumers grew with the largest proportion of consumption, followed by industry and agriculture.

Table: 10 Total Power Consumption

	Households		Industry		Agriculture		Public Institutions		Trade & Commerce		Street lighting		Total
	TWh	%	TWh	%	TWh	%	TWh	%	TWh	%	TWh	%	
1990/91	10.4	33.1	11.2	35.7	5.6	17.8	2.2	6.7	2.1	6.7	0	-	31.4
1997/98	18.8	42.1	12.3	27.6	6.9	15.5	3.9	8.7	2.3	5.2	0.4	0.9	44.6
1998/99	19.4	44.9	12	27.8	5.6	13	3.6	8.3	2.4	5.5	0.2	0.5	43.2
1999/00	21.4	47.2	13.2	29.1	4.5	9.9	3.6	7.9	2.5	5.5	0.2	0.4	45.3
2000/01	22.8	47	14.3	29.5	4.9	10.1	3.5	7.2	2.8	5.8	0.2	0.4	48.5
2001/02	23.2	45.9	15.1	29.8	5.6	11.1	3.5	6.9	3	5.9	0.2	0.4	50.6
2007/2008	26.4	47.3	15.8	29.9	5.7	11.7	3.9	8.7	2.7	5.6	0.3	0.4	51.7

Source: Pakistan Energy Book 2008

8.16 Expansion of generating capacities

By reason of the projected increase in the demand for electricity by some 10,000 MW by the year 2010, the government of Pakistan has launched a large scale expansion program. Nevertheless, power shortages were anticipated, beginning in 2006 to keep that from happening, or at least to minimize future supply deficits, Pakistan has adopted a systematic development to plan called 'Vision 2025' that targets a long term capacity increase of around 35,000 MW by the year 2025. Around two thirds of the additional powers (22,563 MW) are stated to come from hydroelectric power plants. New gas fired power plants are supposed to contribute 13 % (4,680 MW), the same %age as that to be generated by coal fired power plants (4,350 MW). New nuclear power plants with a total installed capacity of 1,800 MW (5%) are planned. Finally, renewable resources of energy are supposed to account for more than 4% (1,500 MW) of the overall newly installed capacity.

8.17 Major Market Players

The main public sector actors in Pakistan's electricity sector are WAPDA (Water and Power Development Authority), KESC (Karachi Electric Supply Corporation) and the operators of the two nuclear power plants KANUPP (Chashma Nuclear Power Plant). Beyond these, a number of independent power producers (IPPs) have become established in the power generating sector since 1994.

8.18 Vertical unbundling of WAPDA

The vertical disintegration of WAPDA began in the year 2000 as part of the country's new electricity market restructuring and liberalization program. WAPDA was broken down into twelve separate units, three generating companies, eight distribution companies, and the National Transmission and Distribution Company (NTDC). However, the envisaged privatization of these independent generating and distributing companies is proving difficult, because they often operate at losses due to unpaid bills and sub marginal electricity tariffs. For the time being, hydropower will continue to be excluded from the privatization process and will therefore remain in WAPDA's possession.

WAPDA, as Pakistan's largest power producer by far, held more than 55% of the country's owner generating capacities, these capacities were split almost evenly between hydroelectric and thermal power plants. The two nuclear power plants contributed 3% and the independent power producers already owned 33% of the electricity generating capacities.

8.19 Independent Power Producers

The two largest privately owned power producers are the HUB Company (HUBCO) and the Kot Addu Power Company (KAPCO). HUBCO belongs to a consortium formed by National Power (Great Britain), Xenal (Saudi Arabia) and Mitsui Corporation (Japan) and possess just under 1,300MW of generating capacity. KAPCO with more than 1,600MW of power generating capacity was privatized in 1996 and now also belongs to the British enterprise National Power. Between 1994 and 1997, IPP projects amounting to an overall capacity of 3,158 MW and a total investment volume of some US$ 4 billion were awarded competitive-bidding contracts. By the end of March 2003, 2,728 MW of the total had already been installed. The power-producing volume was so large that the Pakistani electricity market began to exhibit intermittent over-capacities.

8.20 Regulatory Risks

National Electric Power Regulatory Authority (NEPRA) act does not explicitly impose any obligation on the regulator towards the promotion of renewable energy. It is not known to the investor as to what kind of support mechanism fixed price for every unit of electricity produced or fixing the quota of renewable in the energy mix would be provided for the promotion of renewable energy. Whatever, the regulatory tool or mechanism used by the regulator, it is imperative that the investor should be able to cover costs and also earn a reasonable rate of return on investment.

8.21 Financial Barriers

As with any new technology, the front end cost of renewable energy technology is higher in comparison to conventional energy technology that has already reached maturity. The viability of the project is therefore affected, particularly if the project is small. The financing of the projects become difficult, if one goes by the experience of the IPPs (independent power projects), where the lenders have preference for big projects. The financial institutions are generally not geared to finance renewable energy projects, as there is not records of experience of renewable energy to rely upon, unlike IPP development, where a large crop of professionals are familiar with loan syndication for power projects.

National Electric Power Regulatory Authority (NEPRA)

NEPRA is the authority responsible for granting licenses, determining tariffs, prescribing performance standards and addressing the complaints of electric power consumers. During July-March 2008-09, ten applications for the grant of Generation License for conventional power plants including thermal and hydro with a cumulative capacity of 3300 MW were processed and one license was issued. An additional two generation licenses were granted to Wind Energy Projects.

NEPRA received generation license application from 21 existing captive power plants (CPPs), 12 CPPs were granted generation licenses after processing while the remaining cases are at different stages of processing currently. Regarding addition of capacity for reducing the demand supply gap, NEPRA processed the cases of six Rental Power thermal Power Plants and finalized the cases of four such plants. Further, the case for addition of a new 220 MW thermal power plant at Korangi was finalized for KESC and the application of another 150 MW is expected to be finalized shortly. Five applications for the grant of Distribution License from Small Power Producers (SPPs) and Housing Colonies were

processed out of which 2 SPPs were granted distribution licenses and the other cases were at different stages of processing. Three companies were granted approval of tariffs under the Government of Pakistan's policy on Fast Track power Generation Projects.

Karachi Electric Supply Company Limited (KESC)

During July-March 2008-09, the company's own generation stood at 5837 Million units (kWh), 5.3 % less than the previous year generation of 6164 Million Units (kWh) owing to "Planned Maintenance Outages" undertaken in the winter of 2008-09. The installed capacity of various generating stations increased to 1884 MW by the end of July-March 2008-09 compare to 1690 MW in the corresponding period last year. KESC has increased the required supply of power by various sources including the purchase of 577 Million KWh from "Independent Power Producers" and 4398 Million KWh from WAPDA **KANUPP & PASMIC.**

The total units available to the company's system posted a decline of 0.8 % by reaching 10,349 million KWh during July-March, 2008-09 compared to10,437 million kWh in the corresponding period of last year. Transmission and Distribution losses have increased from 3216 million kWh during July-March 2007-08 to 3543 million kWh in the current fiscal year. The set back in power purchase was due to the unavailability of DHA COGEN 80MW Power Station. KESC has made considerable progress in its comprehensive rehabilitation program for the restoration of its generating capacity.

Social Considerations of Investment

The considerations upon which Energy Conservation projects are generally evaluated are quite different from the point of view of the entrepreneur compared to that of the Society. The major differences are discussed below:

Valuation of Costs

The entrepreneur will generally value the costs of a conservation project in terms of the prices it must pay compared to the public sector perspective which will focus on the opportunity or real resource cost.

Taxes

The public sector analysis should ignore taxes either as a cost or benefit since taxes do not generally represent a payment for consumption of a productive resource. In a private

sector analysis, however, taxes have a real effect on the cash flow of a project and therefore must be considered.

Valuation of Benefits and Costs Over Time

For independent entrepreneur, the appropriate discount rate for calculating present value of the project will usually be the marginal cost of capital. The discount rate used by the public sector should reflect the cost to the economy of deferring current consumption to create savings and achieve increased future production and consumption and also cost of borrowing capital in case capital is not generated domestically.

PAKISTAN INDUSTRIAL SECTOR

9 Pakistan Industrial Sector

Introduction

When petroleum prices increased more than ten fold in recent past, many countries sought to reduce the cost of their energy use. In most developing countries, these efforts focused principally on increasing the energy supply, with relatively little attention paid to managing energy demand. Even today, many of these countries continue to look for ways to increase their supplies of energy, although the opportunities for using energy more efficiently are substantial and economically attractive.

Technically proven, cost effective Energy Conservation measures can save developing countries an estimated 10-30 % of industrial sector energy consumption. In addition, Energy Conservation/demand measures, particularly in industry, can produce immediate results, while efforts to increase domestic energy supplies normally take several years to yield significant results.

These advantages are known in numerous developing countries, where decision makers have recently initiated program to promote Energy Conservation. However, the international donor community and many developing countries themselves have been disappointed by the fact that only a fraction of the tremendous Energy Conservation potential has been realized through these projects, especially those involving significant investments. It is believed that in large part, these projects have been hindered by numerous technical, economic, financial, institutional, and policy barriers.

Energy Conservation can be an equally important strategy for developing countries. By using energy more efficiently, these countries can reduce unit costs of production, save foreign exchange by reducing energy imports, eliminate or delay capital requirements for energy production, and stimulate the development of Energy Conservation related businesses.

9.1 Energy Costs as Part of Production Costs

One of the primary reasons that industrial facilities do not invest in Energy Conservation measures is a lack of awareness by decision makers of their own energy costs. They do not monitor these costs and do not compute the %age of total production

costs that energy costs account for. Lacking these basic indicators, they do not realize the savings that could be achieved by implementing Energy Conservation measures.

The industrial sector typically accounts for 20-35 % of all energy consumed in a developing country, and the largest industrial facilities in developing countries often account for 75 % or more of the energy used by industry. Large scale industrial facilities thus offer great potential for substantial and immediate savings. While such facilities are traditionally found in the government sector, the trend toward privatization in many countries means that cost conscious managers are increasingly likely to make conservation investments. Among large private industrial facilities, those that are export oriented will be most responsive to energy cost reduction opportunities in their efforts to compete in world markets. Meanwhile, up to 250 major industrial products require significant amounts of energy, a few accounts for most of the energy used in the industry sector. Major energy intensive industrial products in developing countries are:

- Steel
- Cement
- Fertilizers
- Sugar
- Pulp and paper
- Glass
- Aluminum
- Bricks

In these industries, energy represents 10 to 50 % of the production cost and still, despite this heavy cost the Energy Conservation potential can reach 50 % of current energy consumption (e.g., textile finishing, bricks). However, the realization of that potential is hampered by social, institutional, and financial factors. Because of these factors, expected savings are likely to range from 10 % to 15 % over 5 year period and from 25 % to 30 %, at best, over a 10 year period.

9.2 Government Role in Industrial Energy Conservation

Over the last 15 years, most industrialized countries have implemented successful Energy Conservation programs. Government policies, incentives, and other actions to promote Energy Conservation have been an important factor in the success of all of

these programs, although the specific role played by the government guidance, monitoring, regulation, enforcement, and implementation has varied across countries. Energy Conservation experience in developing countries is more recent and many programs are still in the design or initial implementation stage. However, it is already clear that certain government roles are essential for the success of Energy Conservation program in developing countries. These roles are;

9.3 Providing Top-Level Support for Energy Conservation

Perhaps the most important government role in Energy Conservation is a high level and visible commitment to Energy Conservation. There should be no doubt in anyone's mind that Energy Conservation is a top government priority. This top level support for Energy Conservation is the cornerstone of any successful Energy Conservation programs. Experience in other countries has shown that only when Energy Conservation receives personal attention at a very high level of government, in most cases from the head of state.

9.4 Creating a Policy Climate for Energy Conservation

The establishment of a policy and investment climate that promotes Energy Conservation is a second critical role that only the government can play. Industrial enterprises will not invest in Energy Conservation unless they receive the correct pricing and other policy signals. The creation of a highly competitive economic and business environment, which in itself encourages enterprises to undertake cost cutting and productivity enhancing measures such as Energy Conservation, is the first step in this effort.

The most important policy signals to industrial energy users are energy and industrial prices that reflect real economic costs. This means removing subsidies on electricity and petroleum products and eliminating cost plus pricing to industrial enterprises. The rational pricing is a necessary condition for Energy Conservation; it is not in itself sufficient. Substantial impediments to investment remain, such as the lack of information, trained manpower, availability of technologies, and adequate and attractive financing. Thus, even when price signals are economically "correct", it will often be necessary for the government to implement additional measures and incentives to overcome other distortions and non-market barriers.

Non-price incentives include:

- Offering tax incentives
- Reducing or eliminating tariffs and import restrictions on energy efficient equipment
- Developing efficiency standards and labeling for energy consuming equipment
- Enacting mandatory Energy Efficiency requirements and regulations
- Ensuring that adequate and attractive financing is available.

Tax incentives, which reduce the taxes that would otherwise have to be paid by an energy user that has installed an Energy Efficiency improvement, include investment tax credits, accelerated depreciation of conservation investments, and tax holidays. A few developing countries, including the Philippines and India, are experimenting with tax related incentives. India, Thailand, and the Philippines have reduced or eliminated tariffs and duties for conservation related imports.

Energy Efficiency standards have been established in many countries for boilers, furnaces, kilns, dryers, and electric power factors.} Standards and labeling requirements are most cost effective for large energy consuming equipment. In most cases, it is worthwhile for governments to review existing standards and consider ways to provide purchasers with better information on and more reliable standards for efficiency, fuel consumption, and operating costs for boilers, electric motors, and other equipment.

Mandatory requirements, such as requiring large energy consuming enterprises to appoint energy managers and develop and implement energy management plans, have also been effective tools in several countries (e.g., Japan, Korea, the Philippines). The Japanese government, for example, has the right to inspect an industrial site, and it requires an Energy Conservation plan to be submitted for any new industrial, residential, or commercial project. The appointment of energy managers is required by law. In some countries, energy managers are required in factories whose energy consumption is above a fixed threshold (e.g., the Philippines). Portugal has a mandatory energy manager program for firms that consume more than 1,000 tonnes of oil equivalent per year. Portuguese firms are required to implement an energy management service, have their energy use patterns examined every five years, and develop five year plans for rational energy use, which must be approved by the government. However, the political feasibility of mandatory measures is country specific and is likely to be most effective in countries where the government has traditionally played a dominant role or where public-sector companies are the major energy users.

Energy Conservation measures range from simple housekeeping measures, which require little or no cost and can be implemented immediately, to more expensive, capital intensive projects, which require significant financial investments and can take several months to implement. The inability or unwillingness of industrial managers to finance these more expensive Energy Conservation projects is one of the most serious obstacles to greater investment in Energy Conservation.

To a large degree, the difficulty in financing Energy Conservation projects results from several factors related to the nature of conservation investments themselves and the business environment in which investment decisions are made. These factors include:

- Lack of visibility of conservation projects and their benefits
- Lack of a clear cash flow stream
- Lack of asset security
- Preference for investment in measures that are directly related to plant expansion and production, rather than cost reduction and productivity
- Uncertain project performance
- Technical sophistication and lack of experience with conservation technologies.

Experience in industrialized countries indicates that financial assistance is usually required to encourage energy consuming enterprises to invest in Energy Conservation technologies, at least during the early stages of an Energy Conservation program. For example, in France, Germany, Japan, the United Kingdom, and the United States, grants of up to 50-100 % of Energy Conservation investments have been common. Interviews and recent experience in Pakistan, Philippines, Thailand, Egypt, Morocco, and other developing countries confirm that many energy consuming enterprises require financial assistance to take the risk of implementing a technology for the first time in their country.

Thus, it is clear that a government's Energy Conservation role will often need to include specific provisions for financing. This assistance can include measures that reduce the capital cost of a project, such as direct grants, cost sharing, low-interest loans, and measures that reduce risk, such as performance and loan guarantees. This financing role does not always imply the creation of new subsidies, although financial incentives are often essential at the beginning of an Energy Conservation program. Rather, in some cases it may mean ensuring that financial institutions have adequate funds and the

appropriate infrastructure to support cost effective Energy Conservation investments. This government role also confirms the government's commitment to Energy Conservation and demonstrates to energy users that Energy Conservation is a top national priority.

Several developing countries offer financial assistance for Energy Conservation. The Dominican Republic has offered grants and low interest loans and established a special credit fund for Energy Conservation projects. Korea, Panama, the Philippines, Sri Lanka, and Thailand have offered grants for Energy Conservation.

9.5 Coordinating and "Orchestrating" the Energy Conservation Program

In addition to showing a top level commitment to Energy Conservation, creating an appropriate policy climate, and ensuring the availability of financing, the final essential role for the government is that of catalyst and coordinator of Energy Conservation programs. The analogy of an orchestra conductor is particularly appropriate. The government can effectively serve as both a facilitator and a participant in conservation efforts, not attempting to play all the parts, but rather to engage the services of qualified specialists in each of the many areas needed for a harmonious and successful program (analogous to the various instrumental players in a symphony). While the musicians could, perhaps, play without a conductor just as some energy users may act alone to save energy without effective leadership, the results are unlikely to attain the highest standards of quality or to include the full repertoire of possibilities. On the other hand, beginning with composition of the musical score the National Energy Conservation mandate and plan, the government can achieve broad acclaim and serve both public and private interests by putting the full power of its commitment and policy role behind a comprehensive program to achieve Energy Efficiency. While undeniably important, the government role in Energy Conservation should not be all encompassing. Governments need to initiate, coordinate, promote, and generally facilitate Energy Conservation through appropriate public policy, but actual implementation and day-to-day management of Energy Conservation programs is best left to others. In each country, the appropriate government role in Energy Conservation will depend on the country's particular needs, priorities, resources, and capabilities, and the roles chosen will reflect the structure of the economy, the political and social philosophy of the government, and the specific barriers to investment in Energy Conservation. For example, in a country

such as Egypt, where the largest industrial energy users are government owned and there is a history of government regulation of industry and the economy in general, the government will need to play much more of a leader-ship role in the implementation of an Energy Conservation program.

9.6 The Role of the Private Sector

The private sector has two main roles to play in promoting Energy Conservation:

- It must be the government's partner in designing and evaluating Energy Conservation policies.
- It must be the key implementers of government policies and Energy Conservation projects.

There is ample evidence that the government has little or no role to play in implementing its policies. It is the private sector that represents the main engine of Energy Conservation. Without its involvement, there can be no lasting results. The private sector thus bears heavy responsibility for the success or failure of any National Energy Conservation Program.

Based on a review of international experience, the private sector should undertake three key activities:

- Set up an organization in private enterprises to properly manage energy consumption
- Implement those activities or projects that are cost effective
- Participate in nation wide activities through active involvement in such professional associations as the Chamber of Commerce.

9.6.1 Setting Up an Organization within the Enterprise

The Energy Conservation process in an enterprise passes through seven distinct phases:

(1) Development of Energy Conservation awareness and information;

(2) Development of energy management skills;

(3) Identification of savings opportunities;

(4) Implementation of house-keeping measures;

(5) Implementation of well-proven and commercially available technologies;

(6) Implementation of new and advanced technologies;

(7) Monitoring

Facilities seeking to improve their Energy Efficiency should thus:

- Appoint an energy manager
- Develop a management information system
- Monitor energy consumption costs
- Develop energy-production indices
- Establish a systematic approach
- Evaluate energy savings possibilities

A vital prerequisite to the success of these actions is the full commitment of top management. Without it, necessary support and resources are unlikely to be available in a timely manner. Top management's commitment must be communicated to operating personnel and staff workers. The workers on the production floor should understand exactly what is required and what is expected from them. Personnel at all levels should be involved in setting Energy Efficiency goals and targets and in improving operating standards and performance quality.

In many companies, the efficiency of production and maintenance is the direct responsibility of the managers in charge of those departments. The monitoring of energy use, however, is often not a clearly defined task. The production manager will try to use energy in his plants as efficiently as possible (provided it is an important part of the cost-price of the product he is manufacturing), as will the manager in charge of utilities, and the maintenance chief will also contribute to Energy Efficiency. Nonetheless, a production site may not use its energy resources in the most efficient way. One reason is that energy raw materials like natural gas, oil, electricity, and steam are not comparable to normal raw materials. Energy is used not only in production, but also in utilities, offices, and garages, for heating, cooling, and lighting. Such plant-wide use necessitates an energy demand management system, and if energy accounts for an appreciable part of production site costs, an energy manager should be appointed. His

task is to examine the manner and extent of all energy use, including the appropriateness of the process used.

The appointment of an energy manager with sufficient company responsibility is an important institutional step in realizing an Energy Efficiency program. Normally, an energy manager would be responsible for the coordination and direction of the company's Energy Conservation program.

His duties will depend on the size and type of organization. For small companies, it pays to combine the task of Energy Conservation with an existing function such as that of manager for utilities or production, or that of electrical engineer.

The job description of an energy manager would include all or some of the following activities:

- Generate interest in Energy Conservation, introducing new ideas and activities
- Be the focal point for energy use in each department, keep records of energy purchases, stocks, and consumption, expressing figures in consistent and uniform units
- Review and report regularly on energy use
- Set challenging but realistic targets for improvement and provide technical advice on energy
- Identify the major energy waste areas, quantify losses, and develop practical recommendations for reducing waste, Initiate, monitor, and review activities
- Provide advice to purchasing, planning, production, and maintenance on all aspects of Energy Conservation
- Produce a manual of good energy practice for the plant and utilities operating departments
- Ensure that health and safety are not adversely affected
- Maintain contacts with research organizations and equipment manufacturers to ensure they stay up to date on significant developments
- Cooperate with working groups within his own industry, advise senior company management, and cooperate with government departments or committees in energy related matters.

There is no question that the presence of an energy manager is critical to achieving lasting saving in large enterprises. The case of smaller plants, however, is not so clear. Small and medium sized enterprises represent a special case. They contribute close to half the total value added of the sector to which they belong, but consume only 10-20 % of the energy used by the sector. Because these enterprises often have only a low level engineer to take care of all the technical aspects of the facility, including new projects, operation and maintenance, and troubleshooting, it is unreasonable to expect that they would appoint an energy manager. Moreover, in companies where the energy bill is less than 50,000 a year, it would be almost impossible to justify the appointment of a full time energy manager. Nonetheless, energy should be considered as any other production cost by top management, and should receive proper attention. The first step is to find out how much money is spent on energy and what a reasonable reduction in energy costs would mean in terms of production costs. Most small and medium sized enterprises fail to identify energy consumption as a separate "line item." Energy is viewed as just another cost or overhead that has to be paid at the end of the month. In addition, owners are often unwilling to give their employees any information about costs or other financial matters. Without proper accounting of energy and distribution of cost information to managers in an enterprise, effective energy management is impossible.

The industrial sector of Pakistan accounted for 19% of the GDP in FY2008, making it the second largest sector of the economy. Potential for Energy Efficiency and investments was studied for the principal energy consuming sub sectors namely textiles, fertilizer, cement, sugar, iron and steel, paper and pulp, and brick kilns. The remaining industries are categorized as `other industry. A discussion of Energy Efficiency potential, issues and barriers, and investment requirements for each of the industry sub sectors is given in the following sections. This section provides an overview of the energy demand in the industrial sector and summarizes the energy savings potential and investment requirements for the sector.

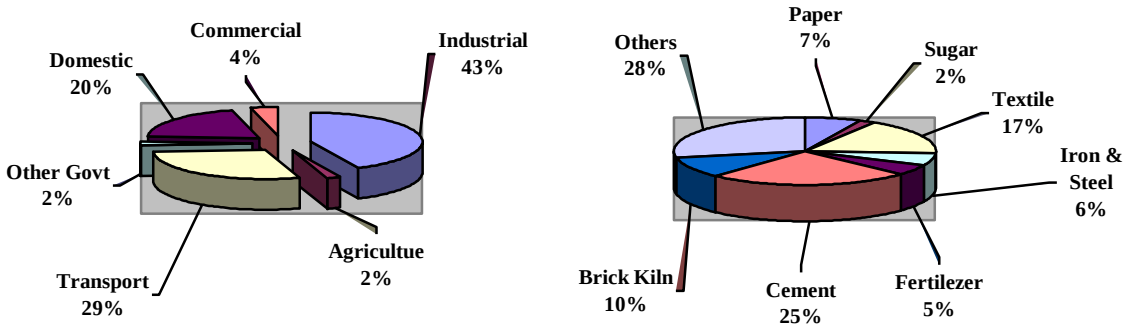


Figure shows the energy consumption by sector in Pakistan, amounting to 39.4 million TOE, 43% of which is accounted for by the industrial sector.

9.7 Energy Efficiency Investment Plan

This investment plan for Energy Efficiency was prepared for improving Energy Efficiency and associated investments was carried out for the energy sector in Pakistan. The plan covers a period of ten years investment period starting in FY-2010 and ending in FY-2019, and covers all sectors of the economy. Analysis was conducted for the following sectors:

Energy Demand:

- Domestic
- Commercial
- Industry
- Transportation
- Agriculture Energy Transformations

and Transmission

- Power Generation and
- Gas Transmission
- Oil Refining and Pipelines.

9.8 Domestic and Commercial

Electricity: Lighting, fans, air-conditioning, water pumping, other appliances Natural Gas and LPG: Cooking, space heating, water heating, other appliances

Industry

Electricity, natural gas, oil, and coal use in fertilizer, cement, sugar, pulp and paper, iron and steel, brick making, and other industries

Transportation

Petroleum products, natural gas, and electricity use in vehicles, railways, and mass transit systems. Fuel use in tractors was considered as a part of transportation as figures are not reported separately for the transportation and agriculture sectors

Agriculture

High speed diesel (HSD), light diesel oil (LDO), and electricity use in tractors and water pumping systems (tube wells)

Table: 11Energy Prices by Sector in Pakistan

	Financial	Economic	Unit
Electricity			
Domestic Sector	6.76	6.08	Rs/kWh
Commercial Sector	10.30	6.08	Rs/kWh
Industrial Sector	7.15	6.08	Rs/kWh
Agriculture	5.10	6.08	Rs/KWh
Natural Gas			
Domestic Sector (Mid-slab)	181.97	-	Rs/MMBtu
Commercial	456.26	-	Rs/MMBtu
Industrial	393.74		Rs/MMBtu
Power Plants	405.49		Rs/MMBtu
CNG	50.00	-	Rs/kg
Petroleum Products			
Gasoline	57.66	34.35	Rs/liter
HSD	57.14	30.24	Rs/liter
LDO	48.00	34.49	Rs/liter
FO	31,347.00	27,023.28	Rs/tonne
Coal			
Indigenous	5,674.83	4,892.10	Rs/tonne
Imported	87.00	75.00	$/tonne
LNG			
Price of Imported LNG for Essential Sectors[3] @ $50/bbl	931.03	802.61	Rs/MMBtu

Source Energy Book 2007-08

9.8.1 Energy Consumption

Data for energy consumption by fuel type in each industrial sub sector is reported in the Pakistan Energy Year book 2008, for the following industries only:

- Cement
- Fertilizer
- Brick
- Pakistan Steel.

Fuel-Wise Energy Consumption in Industrial Sector and Sub sectors

Energy Consumption: 16.8 MTOE

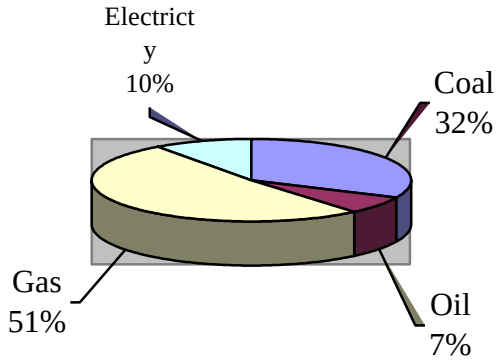


Table =12 =Energy Consumption by Type (Year 2007-08)

Iron and Steel	9.3%	3.7%		6.4%
Pulp and Paper	12.9%	4.6%	-	3.0%
Textile	27.7%	5.1%		27.6%
Sugar	2.6%	6.2%		0.8%
Fertilizer (Fuel)	9.1%			
Cement	3.5%	13.8%	68.9%	
Brick Kiln			31.1%	
Other	35.0%	66.5% ?		62.2%
Total	**100%**	**100%**	**100%**	100%

Table: 13 Fuel-Wise Energy Consumption in Industrial Sub sectors(Year 2007-08)

Sub sectors	**Gas (TOE)**	**Oil (TOE)**	**Coal (TOE)**	**Electricity (TOE)**	(GWh)
Iron and Steel	804,276	40,387		107,849	1,324
Pulp and Paper	1,112,443	50,037		50,108	615
Textile	2,392,180	55,270		466,267	5,725
Sugar	220,754	67,304		13,151	161
Fertilizer	782,979				
Cement	298,025	149,449	3,721,727		
Brick Kiln			1,682,540		
Other Industry	3,018,320	720,438		1,050,795	12,902
Total	**8,628,978**	**1,082,885**	**5,404,267**	1,688,171	**20,729**

9.9 Energy Efficiency Potential and Investments

Natural Gas and Oil:

The potential for energy saving for natural gas and oil in the industrial sector is estimated at 4.8% over a ten year period for the forecasted energy consumption till

FY2019, for which an investment of $ 291 million will be required. Opportunities for improving Energy Efficiency are mainly in the textile, pulp and paper, iron and steel, and other industries.

Coal:

The potential for saving coal in the industrial sector is estimated at 8.2% over a ten year period for the forecasted energy consumption till FY2019, for which an investment of $ 309 million will be required. Opportunities for improving Energy Efficiency are mainly in the brick kiln and the cement industry, which are the principal coal consuming industries in the country.

Electricity:

The potential for saving electricity in the industrial sector is estimated at 11.2% over a ten year period for the forecasted energy consumption till FY2019, for which an investment of $ 1,641 million will be required. Opportunities for improving Energy Efficiency are mainly in the textile, iron and steel, sugar, and other industries. Energy Efficiency improvements in the sugar industry result from the saving of bagasse fibre, which can be used as fuel for the generation and export of power.

Investments in Energy Efficiency and the corresponding energy savings can be achieved in the country are summarized below in Tables. The Tables provide a breakdown of energy savings that can be realized in each of the sectors by type of energy, and investments that would be required to achieve the savings. Overall energy savings potential in the country in FY-2008 is estimated at 11.16 MTOE (493,304 TJ), inclusive of savings in demand as well as transformations. These savings correspond to 17.7% of the primary energy demand of 62.92 MTOE (2,780,941 TJ). Considering a ten year investment program ending in FY-2019 for improving Energy Efficiency in the economy, achievable energy savings in FY-2019 are estimated at 9.5 MTOE (418,800 TJ), requiring an investment of $8.16 billion.

Energy savings potential in the energy consuming sectors in FY-2008 is estimated at 6.1 MTOE (268,400 TJ), which corresponds to 15.4% of the total energy consumed in the country. Energy savings in domestic, transportation, and industry sectors account for 25.8%, 13.9%, and 11.1% respectively, of the energy consumed, followed by 23.9% in

commercial and 19.6% in agriculture. Energy savings that can be realized in FY-2019 are estimated at 7.1 MTOE (315,800 TJ), accounting for economic growth in the energy consuming sectors and the extent to which the savings can be realized on the energy consuming equipment added in the sectors.

Table: 14 Summary of Savings by Sector and Investment Requirements

Sectors	Energy Consumed, FY2008		Savings as % of Consumption, FY2008	Energy Savings, FY2019		Investment Required
	000' (TOE)	TJ		000' (TOE)	TJ	($ Million)
Domestic	8,046	355,659	25.8%	2,074	91,696	1,152
Commercial	1,456	64,337	23.9%	347	15,348	82
Industrial Sector	16,804	742,776	11.1%	2,445	108,081	2,240
Agriculture	804	35,531	19.6%	331	14,623	472
Transportation	11,567	511,297	13.9%	1,906	84,224	685
Other Government	736	32,520	2.7%	42	1,851	-
Subtotal, Demand	**39,413**	**1,742,119**	**15.4%**	7,145	**315,822**	**4,631**
Transformation-Oil Refining				61	2,676	81
Transformation-Power Generation				2,121	93,763	3,284
Transmission-Gas Compression				132	5,853	130
Transmission-Gas Decompression				16	691	35
Subtotal,	**16,903**	**747,131**	**13.8%**	**2,330**	**102,984**	**3,530**
Total	**56,316**	**2,489,250**	**14.9%**	**9,475**	**418,806**	8,161

Source:ADB

Table: 15 Summary of Savings by Type of Energy

Sectors	Savings as % of Total Consumption,	Energy Savings, FY2019		Savings as % of Total Savings _	Corresponding Power Generation
		000' (TOE)	TJ		MW*
Electricity	23.3%	1,589	70,253	22.2%	3,713
Natural Gas	14.2%	2,732	120,773	38.2%	3,064
Petroleum Products and LPG	14.3%	1,916	(84,687	26.8%	
Coal	12.8%	907	40,109	12.7%	
Total	**15.4%**	7,145	**315,822**	**100%**	6,777

- MW calculated by assuming a plant load factor of 60% and power generation efficiency on gas at 48% (Source Energy Book – 2008)

Table: 16 Sectoral Distribution of Energy Savings

Sub-Sectors	Gas	Oil	Coal	Electricity,
Domestic	54%	0%	0%	37%
Commercial	10%	0%	0%	5%
Industry	34%	0%	100%	38%
Agriculture	0%	3%	0%	17%
Transportation	2%	97%	0%	0%
Other Govt.	0%	0%	0%	3%
Total	**100%**	**100%**	**100%**	**100%**

Investment requirements for of energy savings for a ten year period from FY 2010 to FY 2019 are estimated at $ 8.16 billion. Sectoral requirements are estimated at $ 1.15 billion for domestic, $ 2.24 billion for industry, $ 0.69 billion for transportation, and $ 0.47 billion for the agriculture sector. Phasing of investments for the sectors over a ten year period is shown in Table below. Bulk of the investment will be required in the first 5 years to replace the existing low Energy Efficiency equipment, followed by some additional investments to maintain Energy Efficiency in the sectors where the induction of inefficient equipment is expected to continue in the foreseeable future.

Table: 17 Phasing of Investments by Sector

	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19
Domestic	18	37		329	384	384				
Commercial		1	5	15	24	22	11	3	1	
Industrial		22	134	403	650	605	314	90	22	
Agriculture		5	28	85	137	127	66	19	5	
Transportation		7	41	123	199	185	96	27	7	
Oil Refining		1	5	15	23	22	11	3	1	
GENCO		151	205	129	52	305	572	946	664	260
Generation at Decompression		0	2	6	10	10	5	1	0	
Gas	16	42	44	28						
Total	34	**266**	**464**	1,133	1,479	1,660	1,075	1,089	700	260
Cumulative	**34**	300	**764**	1,897	**3,376**	**5,035**	6,110	7,200	7,900	8,161

There are a number of barriers and constraints in improving Energy Efficiency in the industrial sector, particularly in industries such as iron and steel, sugar, and paper that primarily serve the local markets. Following are the major constraints in the realization of Energy Efficiency potential in the industrial sector, indicated by the owners and managers of various industries.

- Local capability in design, application and support is limited and even where the management is aware of conservation possibilities; it is hesitant to adopt these approaches. Training materials and application manuals developed in other countries often do not address problems and issues specific to the industrial environment in Pakistan. Furthermore, foreign technical support, when available, is expensive.
- The industrial sector in Pakistan is not entirely competitive, and the price of energy tends to have a lower significance in operational decisions. The government also exercises control over input and product prices in some of the sub sectors such as fertilizer and sugar, which can also lower the incentive for improving Energy Efficiency.
- Due to the regulation of energy prices in the country, natural gas and to some

extent electricity, which constitute a major share in the industrial energy mix, are generally priced at a level below the prevailing energy prices in the international market. This lowers the incentive for Energy Efficiency investments the industry.

Table: 18 Energy Consumption, Savings, and Investment Requirements for Natural Gas and Oil

Sub sectors	Oil and Gas Consumed, FY2008 000' (TOE)			Oil and Gas Consumption Forecast, FY2019 000' (TOE)			Energy Efficiency Potential			Realizable Savings FY2019		Investmen Required	Simple Payback Period	
	Gas	Oil	Total	Gas	Oil	Total	Technical	Realizable	Effective	(MMscf)'	000' (TOE)	($ Million)	(Fin.)	(Eco.)
Iron and Steel	215	-	215	435	-	435	20%	50%	10%	947	21	8	1.8	1.1
Pulp and Paper	1,144	52	1,197	2,317	106	2,423	10%	70%	7%	7,480	170	70	2.0	1.2
Textile	2,461	58	2,519	4,983	117	5,100	22%	50%	11%	12,052	273	67	1.5	0.9
Other Industry	3,105	753	3,858	6,287	1,52	7,812	16%	35%	6%	20,780	471	146	1.5	0.9
Pakistan Steel	395	-	395	395	-	395	0%	0%	0%	-	-	-	-	-
Fertilizer	783	-	783	1,585	-	1,585	0%	0%	0%	-	-	-	-	-
Sugar	227	70	297	460	142	602	0%	0%	0%	-	-	-	-	-
Cement	298	149	447	603	303	906	0%	0%	0%	-	-	-	-	-
Total	**8,628**		9,712	17,065	**2,193**	**19,258**				**41,259**	**936**	**291**		

Table: 19 Energy Consumption, Savings, and Investment Requirements for Electricity

Sub sectors	Electricity Consumed, FY2008		Electricity Consumption **Forecast,** FY2019		**Energy Efficiency Potential**			Realizable **Savings FY2019**		Investm Required	Simple Payback Period	
	(GWh)	(TOE)	(GWh)	**(TOE)**	Technical	**Realizable**	Effective	(GWh)	**(TOE)**	($ Million)	(Fin.)	[(Eco.)
Iron and Steel	2,704	220,218	5,475	445,89	12%	50%	6%	166	13,479	17		1.1
Textile	5,318	433,113	10,768	876,96	7%	50%	4%	186	15,159	42		2.51
Other Industry	11,98	976,078	24,267	'	10%	35%	3%	817	66,548	183	2.5	2.9
Sugar	150	12,216	304	24,735	0%	0%	0%	-	-	-	-	-
Generation on	-	-	-	-	100%	i 100%	100%	3,547	506,994	1,399	4.4	5.2
Pulp and Paper	572	46,545	1,157	94,244	0%	0%	0%	-	-	-	-	-
Total	**572**	**46,545**	1,157	**94,244**				**3,547**	**506,994**	**1,399**		

Table: 20 Energy Consumption, Savings, and Investment Requirements for Coal

Sub sectors	Coal Consumed, **FY2008**		Coal Consumption **Forecast, FY2019**	**Energy Efficiency Potential**			**Realizable FY2019**		Investment Required	Simple Payback Period	
	(Tonnes)	**(TOE)**	**(Tonnes) (TO**	Technical	**Realizable !Effective**		(Tonnes)	**(TOE)**	($ Million)	(Fin.)	(Eco.)
Brick Kiln	3,760,707	1,682,540	7,614,632 3,406.78	49%	26%	13%	962,489	430,530	189	2.8	3.2
Cement	5,720,972	3,721,727	11,583,751 7,620.19	14%	87%	12%		724,935 1476.887	120	1.9	2.2
Total	**9,481,679**	**15,404,714**	**19,198,383 11,026,983**					**1,687,424 1907,417**	**309**		

9.10 Cement Industry

There are 29 cement production units in Pakistan with an installed capacity of about 37 million tonnes per annum. Taking into account the scheduled addition of new production facilities and planned up gradation of the existing production lines, the installed capacity will increase to approximately 49 million tonnes by the end of fiscal year-2011. Total cement production in FY-2008 was 25,900' thousand tonnes, resulting in an average plant factor of 70%. Cement production in the country includes:

- Ordinary Portland Cement (OPC)
- Sulphate Resisting Cement (SRC)
- Blast Furnace Slag Cement (BFSC)
- White Cement

The cement industry in Pakistan mainly uses the following three types of cement production processes:

- Wet process
- Dry-process with single-stage preheating
- Dry-process with multi-stage preheating

Of these, the dry process with multi-stage preheating is the most energy efficient, with the least energy requirements per tonne of cement produced. Process wise plant distribution is presented below;

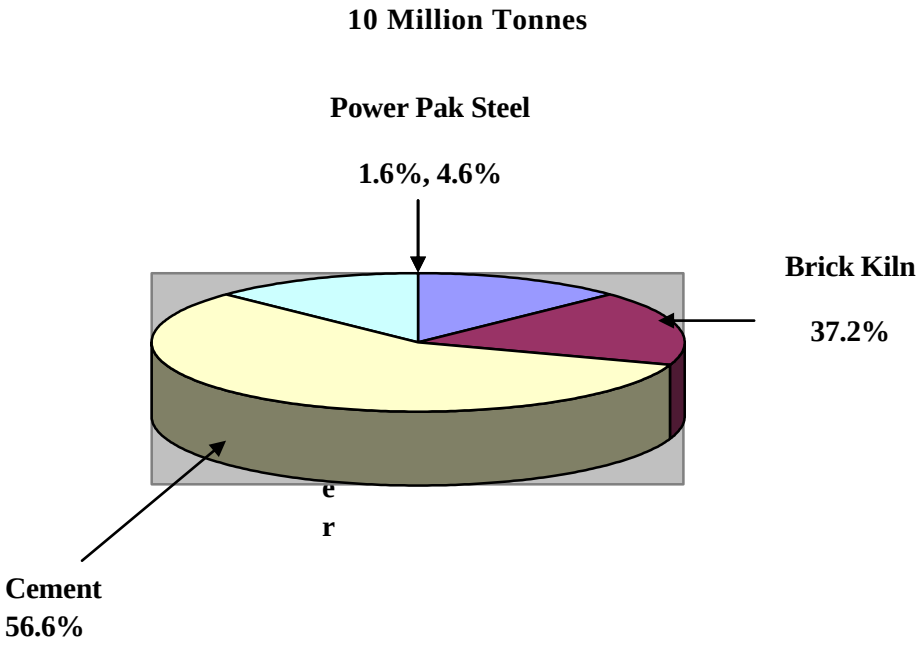
Plant Capacities and Production Processes in the Cement Industry

Production Proces	**No. of Plants Installed**	**Capacity Million Tonnes/Yr)**
Wet	5	5.84
Dry with single-stage preheating	10	7.43
Dry with multi-stage preheating	14	23.81
Total	**29**	**37.09**

9.10.1Energy Consumption

Coal is the principal source of energy used in the cement industry. About 86% of the total energy requirements of the cement industry are met through coal, where it is used mainly for heating purposes. The cement industry also has the largest share, 56.6%, in the total coal demand of the county. Coal consumption by the industrial sub sectors in Pakistan is presented in below**.** Natural gas accounts for the remaining fuel consumption in the cement industry. The policy for the allocation of gas adopted by the government places the cement industry on low priority. As a result, the industry has gradually shifted to imported coal blended with some local coal of lower quality to meet its energy requirements.

Coal Consumption by Industrial Sub sectors (2007-08)



The simple payback period of the cement industry is calculated as 2.21 years at an economic price of Rs 6, 000/tonne of imported coal, which shrinks to 1.91 years at a financial price of Rs 6,960/tonne. Coal consumption in the cement industry is expected to increase up to twice as much as the current level of consumption at a moderate GDP growth rate of 5.5%. However, any capacity additions in the cement

industry are assumed to be state of the art technologies, therefore no energy saving potential has been foreseen for upcoming additions in the industry.

9.11Energy Saving Potential in the Cement Industry

Based on international energy consumption benchmarks per tonne of coal, wet process and single stage dry process are more energy intensive consuming 40% and 20% more energy respectively, as compared to multi stage dry process. The additional coal consumed in these two processes can be saved by replacing the wet process units with multi-stage dry process units, and upgrading the single-stage plants to multi-stage plants.

Assuming a 70% plant utilization factor, estimates for cement production, coal consumption, and potential savings for the FY2008 are presented below;

Table: 21 Process-Wise Cement Productions, Coal Consumption, and Savings Potential

(Million Tonnes/Yr)

Production Process	Total Production	Coal Consumption	Savings Potential		Annual Coal Savings
			Technical	Realizable	
Wet	4.08	1.26	40%	40%	0.50
Dry - single-stage preheating	5.18	1.37	20%	16%	0.22
Dry - multi-stage preheating	16.61	3.08			
Total	**25.87**	**5.72**	**14%**	**13%**	**0.72**

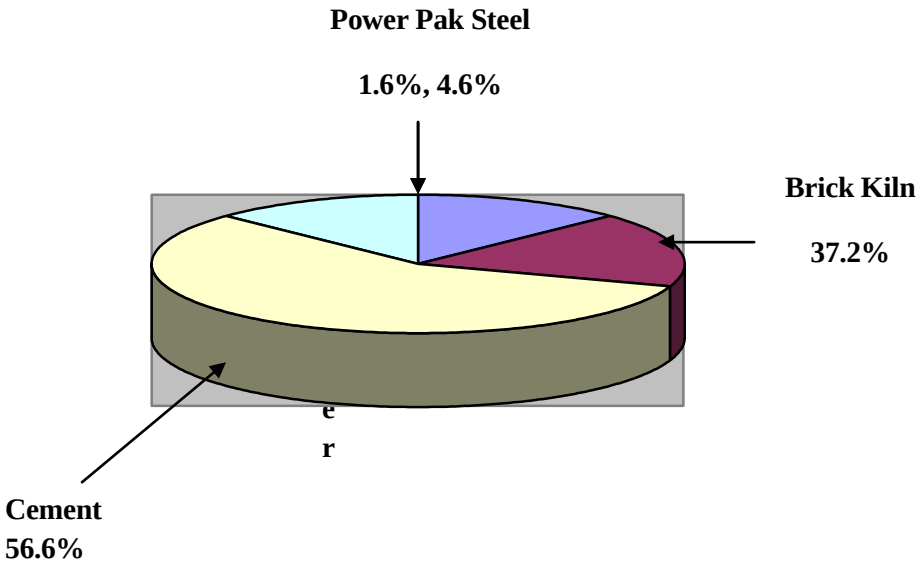
Issues, Barriers, and Investment Requirements

The cement industry is almost entirely privately owned and operates in a competitive environment. There are no subsidies on the coal used by the industry, and manufacturers procure the fuel at market prices from local as well as international sources. In the near term, individual production units may be constrained to convert to more efficient configurations due to loss of production associated with down time required for upgrading the machinery and equipment. The older inefficient units are also generally fully depreciated and enjoy a lower capital cost per unit of capacity and output. In the long term, however, the units operating at lower levels of efficiency will not be able to survive in a competitive environment. Conversion of the investment requirements have therefore been estimated assuming 100% and 80% replacement of wet and single-stage dry process units respectively, with the most efficient available process over a period of ten years.

Brick Kilns:

There are about 10,000 brick kilns operating in the country, mostly in Punjab and NWFP, with an average monthly brick production capacity of 650,000 bricks per kiln. Brick making in Pakistan is an energy intensive activity, with coal being the only fuel used in the process. The brick kiln industry accounts for 37.2% of the total coal consumption of the country. Sector wise coal consumption is presented below;

Energy Consumption in Brick Kilns Industry



Bull trench (BT) and clamp are the only technologies being used for brick making in the country. Of the total installed capacity, 95% of the brick kilns are bull trench type, while the rest are clamp type. Vertical Shaft Brick Kiln (VSBK) technology offers a much higher level of efficiency and is being used extensively in China and India. This technology has recently been introduced in the Pakistan as a successful pilot project. However, VSBK does not have a share in the market yet, and needs to be promoted on commercial basis.

9.12 Coal Consumption

Total coal consumption in the brick kiln industry for FY-2008 was 3,760,708 tonnes, which for the purpose of this study is distributed between BT and clamps according to their proportion in total operating capacity and fuel efficiency. Clamp technology is less fuel efficient and requires 20% more energy as compared to the BT technology, therefore

constituting a dominant share in the coal consumed by the brick industry. Technology wise coal consumption is given below;

Technology Wise Coal Consumption in the Brick Industry

Fuel Consumption	(kg/brick)
Bull Trench	0.19
Clamps	0.23
Vertical Shaft Brick Kiln	0.10

9.13Energy Saving Potential

Coal saving potential from the conversion of bull trench and clamp technology to VSBK is 48% and 57% respectively. Based on current production, the estimated coal savings up till FY-2019 are 962,489 tonnes, which correspond to savings of $ 59 million at an economic price of indigenous coal of Rs 4, 892/tonne. At a financial price of Rs 5, 675/tonne, expected savings translate to $ 68 million. Details of coal consumption and annual saving potential are presented below;

Considering the present industry structure, operating patterns and profits margins, it is assumed that the industry will follow the prevailing expansion pattern, sticking to existing energy inefficient technologies. This would increase the coal consumption of the brick kiln industry up to twice the current level of consumption, at a moderate GDP growth rate of 5.5% while keeping the energy saving potential intact up to FY-2019.

9.14 Barriers, Constraints, and Investment Potential

Brick manufacturing in Pakistan is a low technology, labor intensive operation. Kilns are generally either located close to the market centers in major urban areas, or in rural locations where labor costs are lower. The practice of bonded and child labor is also common in this industry, and is a subject of concern highlighted by various human rights groups and organizations. The management expertise of kiln owners and their capacity to utilize better technologies therefore tends to be low. The industry is not familiar with the VSBK technology, and brick kiln owners may therefore be reluctant to shift from their existing brick kilns to the VSBKs. Expertise for the construction of VSBKs is also very

limited. At current prices coal accounts for about 25% of the cost of production of bricks. Savings of the order of 10% in the production costs therefore do not provide significant incentive to brick manufacturers for shifting to energy efficient technologies.

Brick kiln replacement can be stimulated by conducting trainings and workshops to create awareness of the different types of technologies available, their operation and efficiency levels. Sulphur and particulate emissions from brick kilns are a major environmental concern, particularly where the kilns are located in close proximity of urban areas. Introduction of VSBK technology will result in reduced sulphur and particulate emissions as well. Enforcement of environmental regulations will therefore expedite the shift from the low efficiency and high emission technologies presently in use.

Table:22Energy Consumption, Savings, and Investment Requirements for the Brick Industry

Energy Type	Energy **Consumed,** FY2008		Energy **Consumption Forecast, FY2019**		Energy Efficiency Potential			Realizable Savings FY2019		Investment Required	Simple Payback Period	
	(Tonnes)	**(TOE)**	(Tonnes) 1	(TOE)	Technical)	**Realizable**	Effective	(Tonnes)	**(TOE)**	($ Million)	(Fin.)	(Eco.)
Bull Trench Brick Kilns	3,535,065	1,581,588	7,233,900	3,236,446	48%	25%	12%	858,930	384,207	174	2.9	3.3
(BTBK)	225,642	100,952	380,732	170,339	57%	40%	23%	103,559	46,323	15	2.0	2.3
Total	3,760,707	**1,682,540**	**7,614,632**	**i 3,406,786**	**49%**	**26%**	13%	**962,489**	**430,530**	**189**	**2.8**	3.2

$ Million

	FY10	**FY11**	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	**FY18**	**FY19**
Annual	2	11	34	55	51	26	8	2		
Cumulative	2	13	47	102	153	180	187	189	189	

Iron & Steel Industry

The Iron and Steel industry in Pakistan consists of about 650 steel mills with a total installed capacity of 4.6 million tonnes. The demand for iron and steel products in Pakistan has been in the range of 5 million tonnes recently, resulting in a gap between demand and installed capacity that is met by imports. Of the installed capacity, 1.1 million tonnes is with Pakistan Steel Mills in the public sector, while the remaining 3.5 million tonnes is in the private sector.

Energy Efficiency Potential

Pakistan Steel Mills was established near Karachi in 1973 with assistance from Russia, and mainly produces pig iron and flat steel products including, billets, slabs, hot rolled coils, cold rolled coils, galvanized sheets and formed sections, and corrugated sheets. The mill includes blast furnaces and has a very limited realizable energy saving potential due to the outdated technology being used. Steel mills in the private sector mainly consist of induction furnaces that utilize scrap metal and steel re-rolling mills.

The most efficient production technology available in the iron and steel industry is the DRI technology, which is being introduced in the country by Tawarqi Steel Mills presently under construction near Karachi. The steel industry in Pakistan utilizes energy in the form of electricity, gas, and fuel oil, of which there is an energy saving potential in gas and electricity. The consumption of electricity and gas by the steel industry is shown below;

The induction furnaces installed in the private sector use electricity as an energy source. These furnaces have an average specific electricity consumption of 650 kWh/tonne. Based on an analysis of a typical production unit provided by industry experts, there is a potential to reduce this consumption by 8% to 600 kWh/tonne, with $ 8.8 million investment for the entire industry. Consumption of gas is mainly in the re-rolling process that has an improvement potential of 20% requiring an investment of $ 8.1 million for the industry. Electricity is used in the re-rolling process to drive the motors, blowers, overhead cranes, and other equipment, and has a savings potential of 36% that can be achieved with a total investment of $ 8.1 million.

Issues, Barriers, and Investment Requirements

Excluding Pakistan Steel in the public sector for reasons outlined above, the potential for improving Energy Efficiency is mainly in the private sector steel industry. The private sector steel industry in Pakistan predominantly consists of small and medium scale production units where the penetration of energy efficient technologies is relatively low. Furthermore, their business mainly depends on the procurement of raw materials, marketing of products, and relatively high labor costs, particularly in the re-rolling industry where the level of automation is low. Energy does not account for more than 20% of the production costs. However, in view of attractive returns on Energy Efficiency investments, it is estimated that 50% of savings can be realized. The table shows electricity consumption and savings potential in both sub sectors, followed by gas consumption and savings potential.

Table: 23 Electricity and Gas Consumption by the Iron and Steel Industry

Iron and Steel Industry	Electricity (GWh)	Gas
Pakistan Steel	???	16,901
Private Sector	2,704	9,472

Table: 24 Process-Wise Electricity Consumption and Savings Potential in the Private Sector

Iron and Steel Processes	Energy Consumption	Energy Efficiency Potential	
	Electricity (GWh)	Technical	Realizable
Melting	2,275	8%	4%
Re-rolling	429	36%	18%

Process-wise Gas Consumption and Savings Potential in the Private Sector

Considering the current expansion plans, it is assumed that future expansion in the iron and steel sector will be on efficient technologies and therefore there will be no realizable saving potential in the future. Tables below present the details of energy savings and investment schedules for electricity and gas respectively, in the private sector iron and steel industry.

Iron and Steel Processes	Energy Consumption Gas (MMscf)	Energy Efficiency Potential	
		Technical	Realizable
Melting		0%	0%
Re-rolling	9,472	20%	10%

Table: 25 Electricity Consumption, Savings, and Investment Requirements for Private Sector Steel Industry

Energy Type	Energy Consumed,		Energy Consumption Forecast, FY2019		Energy Efficiency Potential			**Savings** FY2019		Investment Required	Simple Payback	
	(GWh)	**(TOE)**	(GWh)	(TOE)	Technical	**Realizable**	Effective	(GWh)	(TOE)	($ Million)	**(Fin.)**	(Eco.)
Melting	2,275	185,280	4,606	375,152	8%	50%	4%	88	7,126	8.8	1.1	1.3
Re-rolling	429	34,938	869	70,743	36%	~ 50%	18%	78	6,352	8.1	1.2	1.4
Total	2,704	220,218	**5,475**	**445,895**	12%	} **50%**	**6%**	**166**	**13,479**	17	1.1	1.3

($ Million)

	FY10	FY11	FY12	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	**FY18**	FY19
Annual		0	1	3	5	5	2	1	0	
Cumulative		0	1	4	9	14	16	17	17	17

Table: 26 Natural Gas Consumption, Savings, and Investment Requirements for the Private Sector Steel Industry

Energy Type	Energy Consumed, FY2008		Energy Consumption Forecast, FY2019		**Energy Efficiency Potential**			**Savings** FY2019		Investment Required	Simple Payback Period	
	(MMScf)	(TOE)	(MMScf)	(TOE)	Technical	**Realizable**	Effective	(MMScf)	(TOE)	($ Million)	(Fin.)	(Eco.)
Natural Gas	9,472	214,790	19,179	434,905	20%	50%	10%	947	21,479	8	1.8	1.1

($ Million)

	FY10	FY11	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	**FY18**	FY19
Annual		0	0	1	2	2	1	0	0	
Cumulative		0	1	2	4	7	8	8	8	8

9.15 Fertilizer

There are six fertilizer companies in Pakistan. The annual production of fertilizers including urea and phosphate, both by the public and private sectors, was 6.24 million tonnes in 2007-08. Since the soil in Pakistan is generally deficient in nitrogen, urea is the most used fertilizer. Out of the total fertilizer production, the share of urea was 4.92 million tonnes and DAP was 0.36 million tonnes. Domestic production was about 83.6 % of the total fertilizer demand during 2007-08, and the gap between the demand and domestic production was met through imports. The government subsidizes the gas supplied to the fertilizer sector in view of the significance of fertilizer prices to the agriculture sector. The supply of gas to the fertilizer industry is accorded high priority, and the industry enjoys uninterrupted gas supply through the winter peak demand period when supply is curtailed to other sectors.

Natural Gas is used in the fertilizer sector as feedstock, and as a fuel for the process and for power generation. Energy Efficiency upgrades in the fertilizer industry generally involve significant process upgrades and expansion of production capacity and it is technically difficult to separate savings in energy investment from benefits associated with capacity enhancement.

9.16Textile Industry

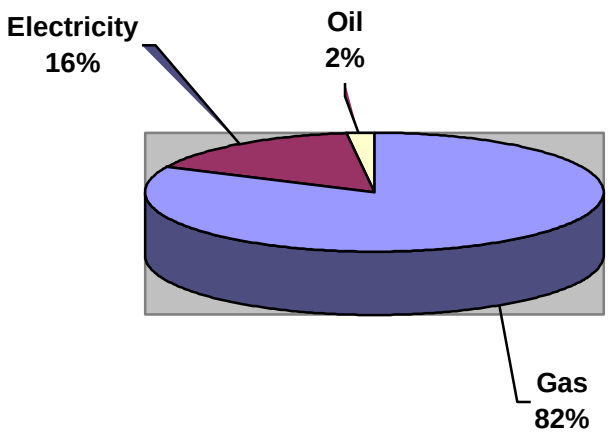
Pakistan is the world's fourth largest cotton producer and the third largest cotton consumer. Cotton based textiles contribute over 60% to the country's total merchandise exported. The main products of the textile industry include cotton yarn, cotton cloth, cotton products, garments, hosiery, blended and synthetic cloth. At present, 521mills operate in the country, majority of which are located in the provinces of Sindh and Punjab. The installed equipment includes:

- Installed spindles 12 million
- Shuttle less looms 24,000
- Air jet looms 6,000
- Auto-power looms 300,000
- Knitting machines 18,000
- Fabric processing capacity 4.6 billion sq. meters
- Stitching machines 450,000

Energy Consumption

The textile industry has a share of 17% in the total industrial energy consumption, utilizing electricity and natural gas as its main energy sources of the total energy consumption of the sector, 82% is natural gas and 16% is electricity supplied from the public utilities. The remaining 2% is oil, which is utilized as a backup energy source to gas. 70% of the total electricity requirement of the textile sector is fulfilled by natural gas based in-house generation, and the remaining is supplied from the public utilities WAPDA and KESC. The end use of energy varies with the mill's process type.

Energy Consumption in the Textile Industry



Energy Consumption, 2.9 MTOE

9.17Energy Saving Potential in the Textile Industry

Areas with Energy Efficiency Improvement Potential in the Textile Industry

Thermal Energy Savings

I. Boiler Replacement
II. Improving Efficiency of Boilers and Water Treatment Ill. Improved Design of Steam Distribution System
IV. Insulation of Bare Steam Line

V. Steam Traps and Condensate Recovery VI. Improving Efficiency of Heaters VII. Waste Heat Recovery from Stenter and Oil Heater Exhaust VIII.Waste Heat Recovery from Wash Water	
Total Thermal Savings	**22%**

Electrical Energy Savings

I. Improvement of Electrical Distribution System ii. Use of Natural Light III.Use of High Efficiency Reflectors in Lighting Systems IV. Replacement of Standard Motors with High Efficiency Motors V. Rewinding of Electrical Motors Using Standard Specification Wire VI. Use of Electronic Motor Controllers (Soft Start)	
Total Electricity **Savings**	7%

The thermal saving potential of 22% is applied on the total natural gas and oil consumption of the textile industry and the thermal savings are shown as natural gas savings only, since oil is being utilized as backup energy source to natural gas. The total savings potential for the textile sector is estimated at 281,868 TOE, 94% of which is natural gas and the rest is electricity.

Issues, Barriers, and Investment Requirements

Most of the textile industry in the country is privately owned, and operates in a competitive local and international market environment. There are no subsidies on the energy used by the industry, and the industry procures fuel at market prices from local sources. As a result, manufacturers focus on optimizing energy use. Almost a third of the mills were set up over the last 7 years, therefore, a proportion of the installed equipment of the total industry is recent and efficient. The energy savings are achievable at a realizable potential factor of 50%. Based on estimates available from surveys conducted in the industry, investment requirements are estimated assuming a 1.5-year payback of the total investment required upgrading gas based equipment, and

a 2.5 year payback of the total investment required to upgrade electricity based equipment. Based on these paybacks, the average investment requirement per mill is estimated at $ 0.4 million. It is assumed that future expansions and additions in the textile industry will be on efficient technology, therefore there will be no realizable savings potential in the future. The total investment required for upgrading equipment utilizing natural gas as fuel is about $ 67 million. The total investment required for up gradation is about $42 million.

Energy Conservation Awareness Program

A training course for the plant engineers is being conducted each year for the plant engineers/managers to train them in the techniques of applying Energy Conservation measures.

9.17.1Problems

Although the review indicates that considerable efforts are being made in the Sector Units to control the energy consumption and improve the overall energy utilization efficiency, however, a lot has to be done to materialize the Energy Conservation program already developed. Matters which are the bottleneck in speedy implementation are as follows:

- Plant Management Commitment

  Management commitment is the key to the successes of any improvement program at the plant level. Unfortunately, due to more emphasis on production related matters the plant management has not been able to give proper attention to efficient energy utilization.

- Performance Monitoring:

  Due to non-availability of proper trained staff and facilities, proper attention cannot be given to the up keep of the instruments and control system which help the plant operators to monitor the operating parameters and maintain them within the permissible limits. As a result, with the passage of time, the instruments and control systems are either bypassed or rendered inoperative.

- Awareness in Operating Staff

  The plant operating staff is generally unaware of the importance of the Energy Conservation. They would like to operate the plant with ease rather than

giving due attention to the operating parameters which have a significant impact on energy consumption. Plant operating staffs in most of the plants are not properly trained for applying Energy Conservation measures.

- Equipment Limitations

  In some of the plants, the equipment has already outlived its useful life and it is becoming more and more difficult to keep it in proper working condition. Such equipment is generally inefficient and is responsible for poor plant performance. In some of newer plants, due to constraints such as available financial resources and source of technology, the installed equipment is not efficient as compared to the available state of the art. With the prevailing energy cost a higher initial investment in energy efficient system are paid back in reasonably short time.

9.17.2Actions Required:

In order to achieve the desired results envisaged in the initial plan for Energy Conservation in the industrial plants, following actions are suggested:

- Plants, for which the Energy Conservation program has already been developed, as a result of the energy audit studies, should expedite the implementation of the plan so that the actual energy savings become visible. Energy Conservation program should be considered as a development activity and should be considered as important as the other program/projects leading to increased profitability. Finances required for the implementation of the recommendation should, there-fore, be arranged on priority basis.
- Plants for which the Energy Conservation plans still remain to be developed should arrange for a comprehensive energy audit and implementation of the recommendations.
- It should be made compulsory for all up-coming plants to be based on energy efficient technology. As indicated earlier, a little extra investment at the initial stage will be paid back by energy cost savings in a short period. It would be more appropriate to evaluate all upcoming projects at the design stage to ensure optimum energy utilization.
- Facilities for the maintenance of instruments at the plant level are generally insufficient and spare parts supplies and back-up services from the vendors

are inadequate. As a result most of the plants prefer to bypass the installed instrument system and are reluctant to install the new system. The proper working instrument system is a basic requirement for monitoring the plant performance and keeping it at a desired level. For a meaningful Energy Conservation program, it is, therefore, essential that proper instrument workshop should be established for each plant and trained staff should be arranged. In order to reduce the cost of establishing such facilities common, facility for a group of 4 to 5 plants may be considered. Steps should be taken at government level to facilitate the vendors for keeping sufficient inventory of spares for the instruments so that they may be able to provide proper back-up to their clients.

- Intensive training program for each level of plant staff should be conducted to induce the awareness for Energy Conservation. Some incentive programs should be initiated to attract the operating staff in active participation in the Energy Conservation plan.

Natural Gas Consumption, Savings, and Investment Requirements for the Textile Sector

Energy Type	Energy Consumed, FY2008		Energy Consumption[T] Forecast, FY2019		**Energy Efficiency Potential**			Realizable Savings FY2019		**Investment** Required	Simple Payback	
	(MMscf)	(TOE)	(MMscf)	(TOE)	Technica	Realizable	Effective	(MMscf)	(TOE)	($ Million)	(Fin.)	(Eco.)
Natural Gas	108,530	2,518,768	219,750	5,099,970	22%	50%	11%	273,286	6,196,970	67	1.5	0.9

($ Million)

	FY10	**FY11**	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	**FY18**	FY19
1	4	12	20	18	9	3	1			
1	5	17	36	55	64	67	67	67		

Table: 27 Electricity Consumption, Savings, and Investment Requirements for the Textile Industry

Energy Type	Energy Consumed, FY2008		Energy Consumption **Forecast, FY2019**		**Energy Efficiency Potential**			Realizable Savings FY2019		**Investment Required**	Simple **Payback** Period	
	(GWh)	**(TOE)**	**(GWh)**	**(TOE)**	**Technical**	**Realizable**	**Effective**	**(GWh)**	**(TOE)**	($ Million)	**(Fin.)**	**(Eco.)**
Electricity	5,318	433,113	10,768	876,963	7%	i 50%	I 4%	186	I 15,159	42	2.5	I 2.9

($ Million)

	FY10	**FY11**	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	FY18	FY19
Annual	_	0	2	7	12	11	6	2	0	
Cumulative	-	0	3	10	22	34	40	41	42	42

9.18Sugar Industry

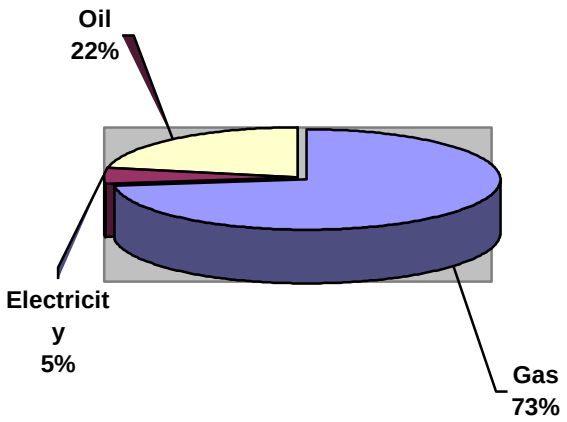
Pakistan ranks fifth in the world in terms of area under sugar cane cultivation, eleventh by production, and sixtieth in yield. The sugar industry of Pakistan is the second largest agro based industry in the country, comprising of 79 sugar mills with an annual crushing capacity of over 6.0 million tonnes. As sugarcane cannot be transported over long distances, the sugar industry is located in Punjab and Sindh near areas where sugarcane is cultivated. Sugarcane farming and sugar manufacturing contribute significantly to the national exchequer in the form of various taxes and levies.

Sugar production is a seasonal activity, due to which sugar mills operate on an average for 4 months a year. Bagassse production is 29% by weight of the total sugar cane crushed, of which 70% is utilized as fuel in boilers. The rest is sold to other industries such as pulp paper and board.

Energy Consumption

The sugar industry has a share of 2% in the total commercial energy consumption of the industrial sector, utilizing natural gas as its main energy source. The total energy consumption of the industry, 73% is natural gas and 5% is electricity supplied from the public utilities. The remaining 22% is oil.

Total Commercial Energy Consumption in the Sugar Industry Total Energy Consumption, 0.3 MTOE



9.18.1Energy Saving Potential in the Sugar Industry

The saving potential for commercial energy utilized in the sugar industry is negligible. However, there is a significant potential for upgrading the mills to save the bagasse being produced, and utilizing it for the generation of power for export to the national grid. As explained above, approximately 70% of the bagasse produced is consumed by the industry itself. Bagasse consumption of sugar mills can be reduced by 42% by introducing efficient replacements. Therefore, the power generation potential is estimated on only 42% of the total bagasse consumed by the sugar industry. Table below gives the details of the potential to export power in the sugar industry.

Power Generation Potential from Bagasse

Total Cane Crushed (FY2008)	tonnes	52,776,922
Total Bagasse Production	tonnes	15,079,121
Bagasse Consumed by the Sugar Industry	tonnes	10,555,384
Bagasse Available for Power Generation	tonnes	4,433,261
Heat Content of Bagasse	MJ/kg	9.6
Efficiency		30%
Power Generation	MWh	3,546,756
Plant Load Factor		60%
Equivalent Installed Capacity	MW	675

The total electricity generation potential from bagasse is estimated at 3,547 GWh.

Issues, Barriers, and Investment Requirements

Policy incentives need to be provided to the sugar industry to encourage mill owners to save bagasse and utilize it for additional generation and export of power. This can include competitive electricity tariffs and the acceptance of interruptible seasonal supply by the power purchasers.

The installed capacity of 675 MW was priced at 2,073 $/kW, corresponding to the capital cost of a steam cycle power plant operating on coal. Table below gives the investment requirements, investment schedule and the estimated payback period of the power generated from bagasse.

Table: 28 Investment Requirements and Schedule for Export of Power by the Sugar Industry

Electricity Generated Period (GWh)	Investment Required (TOE)	Payback ($ Million)	Payback (Years)
3,547	506,994	1,399	4.5

($ Million)

	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19
Annual	14	84	252	406	378	196	56	14		
Cumulative	14	98	350	755	1,133	1,329	1,385	1,399	1,399	

9.19Paper Industry

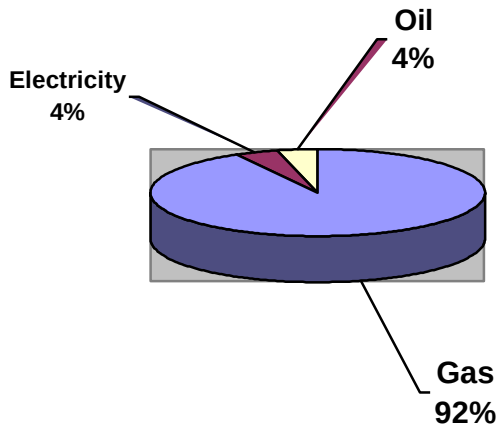
The production of paper products in Pakistan is based mainly on local grass and wheat straw, which constitute about 46% of the basic raw materials, followed by waste paper at 29%. About 10% of the input consists of imported pulp, which is used for production of specialty grade products. Other raw materials used are bagasse, rice straw and cotton linter. The industry consists of over 44 processing units[23] of various products and capacities ranging from 20 to 120 tonnes per day. The paper industry in Pakistan is mainly located in the provinces of NWFP and Punjab.

Energy Consumption

The paper industry has a share of 7% in the total industrial energy consumption in Pakistan, consisting mainly of electricity and natural gas in terms of value of the energy. The total energy consumption of the sector, 92% is natural gas, 4% is electricity, and 4% is oil.

Energy Consumption by the Paper Industry Total Energy Consumption, 1.2

MTOE



This energy is consumed in the following processes:

- Pulping
- Bleaching
- Rolling.

Pulping involves thermo mechanical conversion of wood chips into pulp and is therefore the most energy intensive of these processes. However, the specific energy consumption per tonne of paper produced varies with the quality of paper being manufactured. Therefore, the end-use of energy by process varies with the product quality. With the exception of a few large paper producers, the industry does not utilize energy efficient technologies such as cogeneration, and energy recovery from waste streams.

Energy Saving Potential in the Paper Industry

The areas with potential for Energy Efficiency improvements in the paper industries are;

Thermal Energy Savings	
1. Efficient Use of Natural Light	
2. Insulate Bare Steam and Condensate Lines	
3. Recover Flash Steam from Paper Machines and Use in Pre-Dryers	
4. Improving Efficiency of Boilers and Water Treatment	
5. Recover Blow Steam from One Digester to Pressurize Another	
6. Cogeneration	
Total Savings in Thermal Energy	10%

For the purpose of this report, savings in thermal energy are shown as savings in natural gas, as oil is being utilized as a backup fuel when natural gas is not available. The total energy saving potential for natural gas in the paper industry is estimated at 169,621 TOE in year FY2019.

Issues, Barriers, and Investment Requirements

Almost a third of the mills operate in line with International standards and benchmarks. The savings are therefore estimated at a realizable potential factor of 70%, which accounts for the proportion of industry that is not operating at an efficient level.

Investment requirements are estimated assuming a simple payback period of two years for the investments required to bring upgrades in the paper industry, as indicated by industry experts. The average investment requirement per mill on this basis is estimated at $ 0.75 million. Considering the small scale of the paper industry, it is assumed that future expansion patterns will follow the existing inefficient technologies, therefore keeping the realizable savings intact till FY2019. Table 26 indicates investment requirements, investment schedule, and the estimated payback periods.

Table: 29 Energy Consumption, Realizable Savings, and Investment Requirements and Schedule for the Paper Industry

Energy Type	Energy Consumed, FY2008		Energy Consumption Forecast, FY2019		Energy Efficiency Potential			Realizable Savings FY2019		Investment Required	Simple Payback Period	
	(MMScf)	(TOE)	(MMScf)	(TOE)	Technical	Realizable	Effective	(MMScf)	(TOE)	($ Million)	(Fin.)	(Eco.)
Natural Gas	50,470	1,196,746	102,191	2,423,157	10%	70%	7%	7,480	169,621	70	2.0	1.2

($ Million)

Annual	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18
Cumulative		1	4	13	20	19	10	3	1
	1	5	17	38	57	66	69	70	70

9.20 Other Industry

The category 'Other Industry' includes the following industry sub sectors:

- Chemicals
- Leather
- Food and Beverages
- Other general small and medium sized industries

Energy Consumption

Other Industry has a share of around 29% in the total industrial energy consumption, utilizing natural gas and electricity as its main energy sources. Natural gas and electricity account for 63% and 22% of energy consumption in Other Industry. The remaining 15% is accounted for by oil, which is utilized as a backup fuel for natural gas.

Energy Saving Potential in Other Industry

The technical potential for saving thermal energy is estimated at 17%, corresponding to average energy savings potential for gas consuming industries such as textile, iron and steel, and paper, for which an industry-wise analysis was conducted. Adopting a similar approach for electricity, the potential for savings in electricity is estimated at 10%. The total energy savings on electricity are estimated at 66,548 TOE. The total savings potential for the other industry is 537,739 TOE.

Issues, Barriers, and Investment Requirements

The savings are achievable at a realizable potential factor of 35%, which accounts for all the constraints in achieving a higher technical energy saving potential. Investment requirements are estimated assuming a 1.5-year payback of the total investment required to upgrade gas based equipment and a 2.5-year payback of the total investment required to upgrade electricity-based equipment. Investment requirements, investment schedule, and the estimated payback period are indicated below for natural gas and electricity respectively. The total investment required for upgrading natural gas based

Total Energy Consumption, 4.8 MTOE

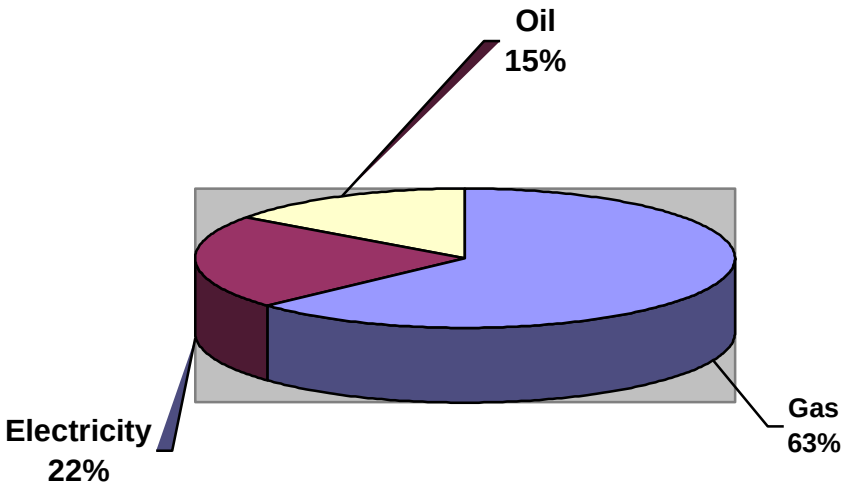


Table: 30 Natural Gas Consumption, Savings, and Investment Requirements for Other Industry

Energy Type	Energy Consumed, **FY2008**	Energy Consumption **Forecast, FY2019**	**Energy Efficiency Potential**	Realizable Savings FY2019	Investment Required	Simple Payback Period
	(MMScf) (TOE)	(MMScf) (TOE)	Technical l **Realizable** I	(MMScf) **(TOE)**	($ Million)	(Fin.) I (Eco.)
Natural Gas	136,937 j 3,858,161	277,269 i 7,811,956	17% 35% 6%	20,780 ; 471,191	146	1.5 0.9

($ Million)

	FY10	FY11	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	**FY18**	FY19

Table: 31 Electricity Consumption, Savings, and Investment Requirements for Other Industry

Energy Type	Energy Consumed, **FY2008**	Energy Consumption **Forecast, FY2019**	**Energy Efficiency Potential**			**Realizable FY2019**	Investment Required	Simple Payback Period	
	(GWh) 1 (TOE)	(GWh) (TOE)	Technical	**Realizable**	Effective	(GWh) (TOE	($ Million)	(Fin.)	(E[co.)
	FY10	FY11	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	**FY18**	**FY19**
Electricity	j 11,985 976,078	24,267 I 1,976,351		10% j	35%	3%	817 66,548	183	2.5	2.9
										($ Million)
Annual	-	2	11	33	53	49	26	7	2	
Cumulative	_	2	13	46	99	148	173	181	183	183

PAKISTAN TRANSPORT SECTOR

10 **Pakistan Transport Sector**

Introduction

Pakistan's economy has experienced steady growth since 2000; the 8.4% GDP growth in 2006 was second only to China. This growth has been accompanied by rising urbanization, higher incomes and affluence, and an increase in the private ownership of motor vehicles. In the absence of any urban transport policies and sustained investments in public transport, most urban citizens rely either on their private motor vehicles or the informal transport sector for urban transport. The resulting urban congestion is straining the capacity of the Government of Pakistan to resolve the urban transport issues and fund sustainable solutions. As a consequence, urban areas of Pakistan are experiencing deteriorating qualities of life. Moreover, the economic losses resulting from urban transport congestion are significantly impacting sustainable growth of the country.

Other significant factors contributing to urban congestion includes the lack of an efficient and well-planned transport infrastructure, weak traffic management, lack of a focal agency to oversee public transport, an absence of a comprehensive urban transport policy, and a lack of investments into public transportation.

The consequences of inefficient urban transport have a direct bearing on sustainable development in Pakistan in terms of:

- Economic growth that is constrained by urban congestion;
- Foreign exchange reserves that decrease with the increased consumption of imported fuels;
- The livability of urban areas that is deteriorating;
- Poverty alleviation where lower income households who rely on public transport are disproportionately impacted by increased urban congestion.

Background

Over the last two decades, rapid population growth and expansion has led to a sharp increase in demand for urban transport facilities and services in many medium/large cities of Pakistan. However, following factors have hindered the adequate provision of services to match the ever-increasing demand:

- Densification and spatial expansion have occurred with little or no development planning.

- Failure of the instruments of governance has resulted in a significant wastage of resources or substandard quality of infrastructure.

- Huge capital costs and time required to develop high capacity transit systems have prevented the timely implementation of such systems in rapidly growing urban areas.

Until now, almost total reliance has been on road-based systems, which have serious capacity constraints, negative environmental consequences and other limitations. Consequently, all major cities of Pakistan (Karachi, Lahore, Faisalabad, Islamabad-Rawalpindi, Peshawar, Quetta etc) are facing serious problems, including serious congestion, air pollution from transport sources, high rates of traffic accidents and inadequate access to transport facilities by poor and vulnerable groups, such as people with disabilities. The deteriorating urban environment threatens the "livability" and productivity of many cities.

There are a number of initiatives underway in developing urban transport in major cities of Pakistan including:

- **Karachi:** The Planning and Development Division of the GoP funded a detailed study in February 2006 in collaboration with the Provincial Government of Sindh and the City District Government of Karachi on the Environment-Friendly Public Transport System for Karachi. The study provides a baseline scenario for public transit in Karachi and a number of interventions including policy and institutional development in support of public transport, bus system development, route development, Bus Rapid Transit (BRT) as a mass transit system, financial and operational models, improvements to bus fleet and infrastructure, financing and funding options and implementation strategies. There is also a pending ADB loan for Mega City Development targeted for Karachi City. The funds are to be used for the creation of an enabling environment that will increase the opportunities for private sector partnerships with the City government towards urban transport (Bus Rapid Transit) amongst other initiatives.

- **Lahore:** The Lahore Development Authority are funding and implementing a number of ongoing studies related to traffic management (through the installation of a

computerized traffic lighting system) and mass rapid transit (that includes rail and bus modes of transport). In addition, the Punjab Provincial Government is supporting a program to replace 2-stroke auto-rickshaws with 4-stroke CNG auto-rickshaws through interest free loans.

- **Islamabad/Rawalpindi:** A proposal for concept clearance for foreign assistance has been submitted by the Capital Development Authority (CDA) in February 2006 for a study on rapid mass transit for Islamabad and Rawalpindi. No donor assistance has yet been materialized for this proposal.

The Government of Pakistan's investment into public transport has historically been low. Demand for public transport to a large extent along several urban transit corridors in Pakistan is serviced by the informal sector. This includes smaller transporters that are energy inefficient and highly polluting reflecting to some extent, the lower incomes of the users and the areas that they serve. In general, these vehicles are energy inefficient and emit high levels of pollutants. With concerns over deteriorating urban air quality, there are increasing demands for demonstrating environmentally friendly vehicles that are economically viable and more energy efficient.

10.1Public Transportation/Public Transit/Mass Transit

Public transportation, public transit or mass transit comprises all transport systems in which the passengers do not travel in their own vehicles/transport.

Public transportation comes in many forms. For example

- Roads: Taxi, Vans, Rikshaw, Electric Buses and Transit Buses etc
- Rails: Light Rail, Mono Rail, Tram, Train, Metro (Underground/Subway),
- Cable Car on Rails and Rapid Transit etc.
- Water: Ferry, Hovercraft etc
- Air: Airliner, Helicopters

10.2Current Challenges in Urban Transportation

Growing Motorization

While the level of motorization in Pakistani cities is still much lower than levels in European cities, a trend of rapid motorization is evident in almost all of them. There has been a considerable increase in the motor vehicle populations of all major cities and it is expected

that Pakistani cities will continue to experience high rates of vehicle population growth, particularly for private vehicles, for many years to come.

Financial burden on the Government

The growth in motor vehicles has led to increased demand for new and improved road infrastructure and services, which require massive investments of financial and other resources. The Government has not financed transport infrastructure projects by charging the users directly. Consequently, transport infrastructure development has remained mainly the responsibility of the public sector, putting an enormous financial burden on national and urban local governments.

Public transport

Public transportation has a very important role in urban transportation. In most cities of the country, the majority of the common people, the poor and other disadvantaged groups are very heavily dependent on public transportation. Compared with private cars, public transportation is more sustainable on economic, financial, social and environmental grounds. However, the failings of public transportation have become one of the major challenges faced by many cities. Dissatisfaction with the level and quality of public transportation services leads those people who can afford it to turn to private modes of transport. Another common problem in many cities is that women, people with disabilities and other disadvantaged groups have poor access to public transport services and that it is found difficult to meet their basic mobility needs.

Congestion

Congestion is a common mark of motorization in most cities of the country. The central parts of large cities are particularly congested, with weekday peak-hour traffic speeds average 10-20 km per hour or less. Delays due to congestion account for a significant proportion of the total trip time. The estimated social and economic cost of congestion could be enormous in addition to the cost of damage to the environment and human health. The root cause of traffic congestion in several of Pakistan's urban corridors is the increasing reliance of private motor vehicles in Pakistan. The congestion problems are now becoming acute as commute times for many urbanites are increasing, and urban environmental quality is deteriorating. The objective is to promote sustainable transport that will lead to decreased commute time, improving urban environmental indicators and the eventual outcome of a lower trajectory growth of GHG emissions.

Air pollution

Vehicular emissions have become a major source of air pollution in many cities. Overall CO_2 emissions in Pakistan are estimated to have risen from 76 million tons in 1990 to 200 million tons in 2007. CO_2 emissions will grow to 482 million tons in 2020, an average increase of 6.5% annually. The transport sector is a significant contributor to GHG emissions with an estimated 15 million tones in 1990; if we assume a proportionate increase in GHG emissions with the 100% increase in motor vehicles, the sector is responsible for the emission of 30 million ton CO2eq. By 2020, GHG emissions from the transport sector could be as high as 72 million tons CO2eq if there are no GHG mitigation interventions in the sector.

The poor air quality conditions prevail despite relatively low levels of motorization and vehicle use per person, by global standards. The existence of a large number of vehicles with poor emission control standards and the low quality of available fuel are the two primary reasons for this situation. In some cities, the prevalence of three-wheelers with two-stroke engines has further aggravated the situation.

10.3Trends in Urban Transport Development

10.3.1 Initiatives for Rail-Based Systems

A notable trend in urban transport development is the growing interest in rail-based public transport systems. Governments in many countries have begun studying or implementing projects to develop rail-based transit systems in response to the shortcomings of road-based transport systems to meet growing demand in very large cities. Bangkok (Thailand), Busan, Incheon and Seoul (Republic of Korea), Kolkata (India), Kuala Lumpur (Malaysia), Manila, Beijing, Guangzhou, Shanghai, Shenzen, Daegu and Tianjin (China) have implemented new projects or are undertaking major extensions for their existing systems, while cities such as Bangalore, Dhaka, Hyderabad, Mumbai, and about 10 cities in China are understood to be actively considering rail-based systems.

The improvement of Bus Transport Services

Another notable trend is the increased attention being given to raising the quality of bus transport services, through the improvement of existing services and the introduction of new services. Premium (air-conditioned) bus services are now available in a large number of cities in the region. Cities with relatively higher incomes such as Bangkok, Kuala Lumpur, Shanghai, and Shenzhen have introduced higher-quality buses on their roads. Advanced technology, low-floor kneeling buses have been introduced in Hong Kong, China; Singapore;

and many Japanese cities to facilitate the embarking and disembarking of passengers, particularly for elderly passengers or passengers with disabilities.

10.3.2 Integration of Public Transport Services

Another major direction of development is the integration of public transport services. Cities with more advanced forms of transportation such as Singapore and Hong Kong, China have successfully integrated their various public transport services provided by multiple operators, such as the underground and bus systems. Seoul and Metro Manila, meanwhile, have been less successful in modal integration. Bangkok has prepared a plan to integrate the city's bus services with the rail transit systems, such as the underground system currently under construction.

10.3.3 Private Sector Participation

The increased participation of the private sector in providing urban transport infrastructure and services is an encouraging feature of transport development in many cities. Major toll roads and rail transit systems have been developed in Bangkok, Delhi, Johannesburg, Kuala Lumpur and Manila with private sector participation. Even the London Underground is now operating as a Public Private Partnership. The private sector is also assuming a greater role in providing transport services. The deregulation of bus fares has encouraged private operators in Dhaka to introduce a large number of buses. As a result of a new franchising scheme in Pakistan, the private corporate sector has introduced large fleets of buses in Lahore and Rawalpindi/Islamabad.

10.3.4 The applications of Intelligent Transport Systems Technology

The application of Intelligent Transport Systems (ITS) technology is an important mark of transport development in cities with relatively advanced systems of transportation. The major application areas of ITS technology include electronic road pricing, traffic management, integrated ticketing systems for different public transport modes, and traveler information. Typical applications like en-route traffic information systems using Variable Message Sign (VMS), traffic surveillance and incidence management are quite common, especially for the management of expressways.

10.3.5 Road Safety

Road safety is an important aspect that needs to be integrated in transport policies, particularly the need to improve safety for vulnerable (elderly, children and disabled) road users. The rate of occurrence of road accidents in Pakistan in the year 2006 was much higher

than in other developing countries. On average approximately 7,000 lives are lost every year in the country because of road accidents. In 2006, 92% of road crashes were in result of violation of traffic laws by drivers, 5% were due to dilapidated roads and 3% were due to poorly maintained vehicles operating on the roads.

10.3.6 Objectives of Sustainable Urban Transport

Main goals of a sustainable urban transport are as under:

- Maximizing the overall competitiveness and productivity of the national economy, so as to achieve a sustainable high level of GDP growth.
- Reducing transport's emissions of CO2 and other GHG gases.
- Contributing to better health and longer life-expectancy through reducing the risk of death, injury or illness arising from transport, and promoting travel modes that are beneficial to health.
- Improving quality of life for transport users and non transport users, including through a healthy natural environment.
- Promoting greater equality of transport opportunity for all citizens, with the desired outcome of achieving a fairer society.

10.4 Environmental and Social Impact of Transport

The majority of the world's scientists now agree that at least 90%, human emissions of GHG's, rather than natural variations are warming the planet's surface. The Inter-governmental Panel on Climate Change (IPCC) predicts an increase of 1.8 to 4.0 ºC by the end of the century. A major GHG is carbon dioxide (CO2) which results from the burning of fossil fuels such as coal, oil, and gas. The increasing contribution of the transport sector to GHG's emissions and consequent climate change is a major issue for the global community. Transport is not only the largest source of emissions, & is also growing very fast. Vehicle fleets are doubling after every 6 to 8 years. It is also consuming 28% of Pakistan all-sector total energy consumption. These facts reinforce the urgency of producing cost effective GHG's reduction solutions for transport. Though Pakistan's overall contribution in world's total GHG's emissions is negligible nevertheless it is perceived as a great threat to economic progress and sustainability.

Annual Average Levels of Different Category Pollutants for 1999, 2004, and 2006

Year	TSP Ug/m3	PM_{10} Ug/m3	Nox (PPB)	SO_2 (PPB)	O_3 (PPB)	CO (PPM)	Methane (PPM)
1999	210	164	16	11.7	11.2	4.4	0.5
2004	349	182	20.9	17.0	17.0	2.5	0.7
2006	374.5	194	28.8	24.0	18.8	3.6	6.5
%Increase/ Decrease	78.4	18.3	80	105	68	22	1300

Source: SUPARCO. Baseline Ambient Air Quality Studies; World Bank

The Improvement in Air Quality

The present levels of air pollution have prompted many cities to undertake measures to improve air quality. These measures include the introduction of lead-free petrol and low-sulphur diesel; the introduction of vehicle emission control standards and a mandatory regular vehicle inspection system; the promotion of cleaner fuels like liquefied petroleum gas (LPG) and compressed natural gas (CNG) for commercial vehicles; the banning and phasing out of certain types of vehicles; restrictions on diesel vehicles; and transport demand management.

10.5 Low Carbon Economy (LCE) in Transport Sector

Ambient air quality in major cities of Pakistan is constantly deteriorating due to urbanization and industrialization as well as growing commercial and transportation activities. The UN – desirable carbon emissions from motorized vehicles in Pakistan is approximately 5 million plus and increasing at the rate of 6% annually. The air pollution problem in major cities gets aggravated due to continued use of aged vehicles with worn out engines, poor maintenance, over loading and adulteration of fuel. The increasing concentration of Green Houses Gases (GHG's) is warming the earth atmosphere. The phenomenon is called climate change or global warming. This is among the most pervasive threats to the life. It has dynamic impacts,

functioning & structure of eco – system which reduces the productivity and has negative impacts on the species and their habits it also adversely affects on water availability, food security, human health & well being. The climate change threatens economic development and has considerable negative effects on various socio - economic sector of society.

Low Carbon Emissions

Most of the automobiles exhaust carbon dioxide (CO2) and water vapors (H2O). CO2 is the most important anthropogenic green house gas and increases in carbon dioxide concentration are due to primarily from fossil fuels.

10.6 Mitigation Options

Mitigation of GHG's emissions in transport sector can be achieved through a combination of following measures.

- There is need to introduce attractive transportation options that include fuel efficient automobiles/devices to control carbon emissions and increase the fuel economy.
- Efficient and affordable public transport, mini cars and 4 stroke engines in two wheelers. In addition to this, policies should address externalities caused by vehicles and force drivers to face full social cost of their use through permits and fees to enter cities, parking fees, road tolls and in general, raise public awareness.
- The government should also attempt to make available to user an alternative to fossil fuels by creating Cycling culture, linking Rails and Bus services and rewarding car sharing programs.

There are number of options available to mitigate the Green House Gases (GHG's) to reduce the carbon emissions for Clean Development Mechanism (CDM) like introducing Battery Operated Vehicles (BOV's), Mass Rapid Transport System (MRT's), CNG Buses, CNG Cars and efficient devices for fuel efficiency to control carbon emissions.

10.7 Strengthening the Institution of Motor Vehicle Examination (MVE's)

The comprehensive plan for inspection and certification of vehicles will be introduced by ENERCON to strengthening the institution of Motor Vehicle Examiner's (MVE's). As a part of this phase ENERCON will establish a model inspection and certification centers using project fund or with donor support. The center will standardize inspection procedures and

provide training and support to MVE's in private sector and concerned police staff. The formation of advisory board at district level has been recommended to ensure proper check & balance on the working of MVE's and private inspection facilities.

Inspection System Objectives of Motor Vehicle

The motor vehicle inspection system is normally to strengthen and streamlined the following objectives:

- Enhance awareness of motor vehicle safety.
- To reduce the carbon emissions from environment.
- Reduce road traffic accidents.
- Conduct carbon emissions inspection based on National Environmental Quality Standards (NEQS).

Transport pollution causing health hazards and smoke emitting is identified as source of Hydro carbons, Carbon dioxide (CO2), Carbon mono-oxide Sulpher and Nitrogen oxide. Thus, imperative to have effective and comprehensive motor vehicle inspection system. In order to improve low carbon economy & environment conditions and enhance public health and safety. Some of the findings are as follows:

- Existing vehicles inspection system can be improve by involving private sector.
- Private investment can be achieved by only practical demonstration.
- Motor vehicles ordinance 1965 and motor vehicles Rule 1969 has not been implemented in true spirit in the country.
- No specific arrangements exist for coordinating motor vehicle inspection or certification.

10.8 Fuel Efficiency in Road Transport Sector (FERTS) Project

ENERCON has set up computerized tune up centers through out country, where through tuning engines & by good house keeping of vehicles, 10% fuel can be saved and noxious exhaust emissions can be reduced by 60% thus reducing air pollution and Green house Gases (GHG's). By introducing Fuel Efficiency in Road Transport Sector (FERTS) project only about 14% of total vehicles population is covered from this project and there is need to establish more tune up centers to improve quality of repair & maintenance of vehicles.

Model Inspection Center

In later, 90's Hydrocarbon Development Institute of Pakistan (HDIP) has established a model CNG station. This station has facilitated and expedited the process of setting up CNG stations by private sectors. The experience can be replicated to facilitate private sector investment in modern vehicle inspection in Pakistan to improve inspection practices, it also improve quality of maintenance and repair along with cleaner and healthier environment. The objectives are:

- To demonstrate economic feasibility of setting up similar stations by private sector in the country.
- To facilitate investment in modern maintenance and repair shops.
- To establish government / Private sector partnership at district level.
- To provide technical support to prospective investors on the sources and functions of inspection equipment.
- To demonstrate benefits of an improved inspection system.

10.9 Energy Consumption and Saving Potential in the Transport Sector

The transportation sector in Pakistan consumed 11.6 MTOE of petroleum products and natural gas in FY-2008 with high speed diesel (HSD) accounting for 68%, natural gas for 15%, motor spirit (gasoline) for 13%, and aviation fuel for 4% of the energy consumed.

In 2008, Pakistan became the largest user of compressed natural gas (CNG) in road transportation, with 1.7 million vehicles, or a quarter of the total number converted to this technology. There are currently more than 1,700 CNG fueling stations in the country, 65% of which are dedicated CNG stations, while 35% are co-located with liquid fuel dispensing facilities. An additional 200 CNG stations are under construction and almost 4,000 new license applications are pending.

Heavy traffic vehicles (HTV) are the main consumers of HSD, with a small amount being consumed by passenger cars and 4 wheel-drive passenger vehicles.

Of the total HSD consumed in the country, road transportation represents 91%; accounting for a significant part of the country's oil import bill. Initiatives to save fuel consumption in the transportation sector have been taken in the past, one of them being the 'Fuel Efficiency in Road Transport Sector' (FERTS) program, which was funded by

the Global Environment Facility (GEF). The program focused on a vehicle tune up effort on a large-scale.

Energy Efficiency potential for HSD use in road transport is estimated based on savings achieved under the FERTS program. According to the FERTS program, a 20% reduction in HSD consumption is achievable after tuning. This factor was reduced to 10% for present analysis to account for the addition of efficient vehicles over time. A 12% reduction in gasoline and natural gas consumption was applied to estimate the total Energy Efficiency potential through vehicle tune-ups in the transportation sector. The proportion of the energy savings realized is assumed at 30% to 50% to account for the number of vehicles that do not participate. Furthermore, the effects of tuning in terms of reduction in fuel consumption start to wear off after some time.

The cost of a vehicle tuning station for light traffic vehicles (LTV) is taken as $ 0.0927 million, with a capacity to tune 900 vehicles annually. The capacity of a tuning station for heavy traffic vehicles (HTV) is assumed as half of the LTV tuning station. The cost of setting up such a station is approximately $ 0.13 million. Based on these estimates, the total energy saving potential and associated costs to achieve the potential are estimated.

Table: 32 Energy Consumption, Savings, and Investment Requirements and Schedule for Vehicle Tune-Ups

Energy Type	Energy **Consumed, FY2008**		**Energy Consumption Forecast, FY2019**		**Energy Efficiency Potential**			**Savings FY2019**		Investment **Required**	Simple Payback	
		(TOE)	(GWh)	**(TOE)**	Technical	**Realizable**	Effective			($ Million)	(Fin.)	**(Eco.)**
CNG (MMscf)	72,018	1,685,232	137,425	3,116,203	12%[1]	50%	--	2,161	48,992	75	2.9	2.8
HSD	-- 7,369,705	---- 7,747,768	-- --- 14,062,853	14,784,542	— 10%	30%	3%	336,194	353,447	72	0.3	0.5
Gasoline (Tonnes)	1,432,635	1,530,586	2,733,751	2,920,764	12%	30%	4%	25,787	27,552	9	0.3	0.6
Total	**18,874,358**	**10,963,5861**	**16,934,028**	**20,821,509**						157		

($ Million)

	FY10	**FY11**	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	**FY18**	**FY19**
Annual	1.6	9.4	28.2	45.4	42.3	21.9	6.3	1.6		
Cumulative	1.6	11.0	39.2	84.6	126.9	148.9	155.1	156.7	156.7	

10.10 Railways

Pakistan Railways operates passenger and freight trains on a network extending to 7,791 kms throughout the country, and is presently carrying 84 million passengers and 6.42 million tonnes of freight annually. The Energy Efficiency potential in railways can be exploited through the following measures:

- Maintenance measures in the existing rolling stock
- Track electrification to switch from diesel electric to electric traction combined with modal shift in freight.

Maintenance Measures

The batteries on a number of engines in service are old and cannot be used to start up the engine. The drivers have no choice but to leave the engines running in an idle mode when not in use, which increases the fuel consumption. Replacement of filters and periodic maintenance is also not adequate. Replacement of batteries and improving engine maintenance through timely replacement of accessories can result in up to 7.5% reduction in the overall HSD consumption of the existing fleet. The cost of upgrading one locomotive is approximately $ 0.75 million, which could be applied to 520 of the existing 550 diesel electric locomotives in operation. Training of staff and technicians will be required to improve the maintenance practices.

Energy savings achievable through simple maintenance measures are not included in the investment program as these do not qualify as capital measures, and can easily be implemented by Pakistan Railways through operational measures.

10.10.1 Track Electrification and Freight Modal Shift

Presently, the electrified section between Lahore and Khanewal is not in use as only one line of the double track is electrified, making a two way operation impossible. Studies show that electrification of the rail track can lead to fuel conservation, as electric locomotives are more efficient than diesel-electric locomotives. Based on international experience, net fuel (HSD) savings from track electrification are estimated at 18%. The cost for track electrification is approximately $ 0.25 million per km track electrified. The length of the main freight corridor from Karachi to Islamabad enroute Faisalabad is approximately 1,716 km. The total cost of track electrification comes to $ 423 million.

Presently, Pakistan Railways is transporting only 4% of the total freight transported across the country. Transporting one tonne of freight by railways consumes 80% less fuel than road. Investment in track electrification will therefore be economic only if it is combined with proper utilization of the track capacity to gain full benefit from the additional investment. It is assumed that following track electrification, the share of railways in freight can be increased at a rate of 1% per year from the present level of 4% to 14% over a ten year period. The modal shift will result in avoided fuel consumption in transportation of the freight by road. Table summarizes the results of energy saving potential, investment requirements, investment schedule, and the estimated payback period for electrification of railway track in the high traffic corridor.

Table: 33 Energy Consumption, Savings, and Investment Requirements and Schedule for Railway Track Electrification and Freight Model Shift

	Energy Efficiency Potential			Realizable Savings Investment Required		Simple Payback Period	
	Technical	Realizable	Effective	(Tonnes)	(TOE)	($ **Million)**	**(Fin.)**	**(Eco.)**
HSD	18%	100%	18%	782.090	822,226	423	0.6	1.2

($ Million)

	FY10	**FY11**	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	**FY18**	**FY19**
Annual		4.2	25.4	76.2	122.7	114.3	59.2	16.9	4.2	
Cumulative	-	4.2	29.6	105.8	228.5	342.8	402.0	419.0	423.2	423.2

10.11 Mass Transit

Mass transit allows economies of scale in comparison to road based private transport as well as public transport. A Shift to mass transit systems will result in fuel savings, saving in commuting time, and lower emissions leading to better air quality in the urban areas. The government is already considering mass transit programs for Lahore, Karachi and Islamabad. Detailed costs and specifications of the Lahore mass transit program are available, and were used as a basis to develop cost estimates for mass transit systems in Karachi and Islamabad by applying adjustment factors for the size and population of the cities. The cost and program specifications for the three cities are given in below;

Table: 34 Program Specifications and Costs for Mass Transit Programs

Cities	**Cost** ($ Million)	Pricrity Line Length (km)	**Passengers per Day (No.)**	Annual Passengers (No.)
Lahore	2,704	27.5	275,000	100,375,000
Islamabad	867	8.8	28,293	10,326,916
Karachi	1,169	37.1	499,316	182,250,480

The energy saving potential is estimated by calculating the fuel avoided in the road transport through a shift to mass transit. It is assumed that 80% of passengers travel on buses, and the remaining 20% using private transport will switch to mass transit facilities. It was also assumed that the average distance traveled by a passenger is half of the total length of the trunk mass transit line. The number of passengers per vehicle was assumed at 1.5 and 20 for cars and buses respectively. The total passenger kms were calculated on this basis and the corresponding fuel consumption (CNG for cars and HSD for buses) was determined using the average mileage of a car and bus on CNG and HSD respectively i.e. 22.5 km/lit for cars and 7.2 km/lit for buses. The avoided fuel was assumed as 80% of the total fuel consumed by cars and buses.

Table below summarizes the results of energy saving potential, the investment requirements, investment schedule, and the estimated payback period for introducing mass transit in three major cities. A high simple payback period calculated for savings in energy alone indicates that it will not be possible to justify the switch to mass transit systems based on energy use alone, and other factors such as the value of time saved and environmental benefits will have to be considered to justify the investment. Furthermore, due to the high payback period the Energy Efficiency potential in mass transit is not viable, and is therefore not included in the total investment requirements for the country.

Table: 35 Energy Consumption, Savings, and Investment Requirements and Schedule for Mass Transit Programs

	Energy Efficiency			Realizable Savings		Investment	Simple Payback	
	Technical	Realizable	Effective		(TOE)	($ Million)	(Fin.)	(Eco.)
HSD	100%	100%	100%	18,088	19,016	4,740	226	334
CNG				(Tonnes)				
				481	10,906			

($ **Million)**

	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19
Annual	-	47	284	853	1,375	1,280	664	190	47	-
Cumulative	-	47	332	1,185	2,560	3,840	4,503	4,693	4,740	4,740

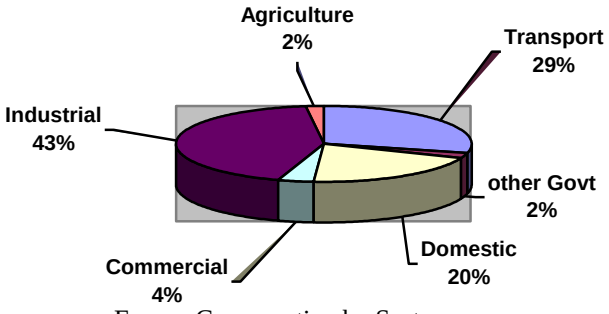
PAKISTAN BUILDING SECTOR

11 The Building Sector

The Residential Sector

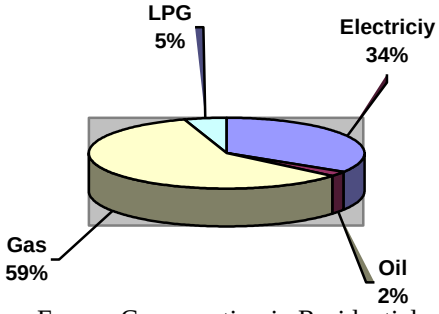
The residential sector in Pakistan consists of over 24 million households that account for 20% of the total commercial energy consumption of the country. Natural gas dominates the fuel mix of the residential sector with a 59% share in the total commercial energy consumption. About 20% of the households have access to natural gas. Electricity is available to about 70% of the households, and accounts for 34% of the total energy consumption in the residential sector. Oil, mainly kerosene, and LPG account for the remaining 7% of the energy consumption.

Energy Consumption in the Residential Sector



Energy Consumption by Sector

FY-2008 39.4 MTOE



Energy Consumption in Residential

Sector 8.05 MTOE

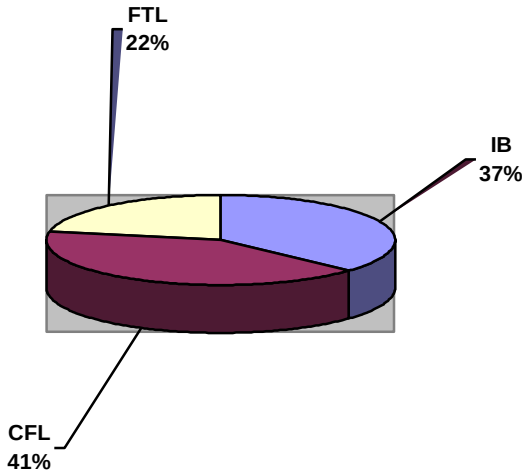
Table below illustrates the fuel consumed by end use in the residential sector. Electricity is predominantly used for lighting, space cooling and to operate other household appliances. Natural gas is used for space and water heating, and cooking.

Fuel Utilization by End Use in the Residential Sector

End-Use	Natural Gas	Electricity	Oil	Coal
Lighting		✓		
Cooking	✓			
Space Heating	✓	✓		
Water Heating	✓			
General Use Appliances	✓	✓		

Electricity Consumption

In FY-2008, electricity consumption in the residential sector was 33,704 GWh. These estimates were arrived at using an end use approach.



11.2Energy Saving Potential in Lighting Appliances

There are approximately 17 million residential electrified customers in Pakistan. Figure above gives a distribution company (DISCO) wise breakup of the total residential customer base, with further division by consumption categories.

There are approximately 117.4 million light points in the country, as reported by the Pakistan SEED Baseline Domestic Lighting Survey - 36% of which are incandescent bulb (IB) light points, 42% are CFL light points, and 22% are FTL light points as illustrated in further survey results show that an IB and CFL light points are used for an average of 2.9 hours daily, and FTL light points are used for an average of 3.3 hours daily.

Table: 36 Total Residential Customer Base

Categories (kWh/month)	LESCO	GEPCO	FESCO	IESCO	MEPCO	PESCO	TESCO	HESCO	QESCO	PEPCO Total	KESC	TOTAL
Up to 50	667,788	719,772	891,631	582,955	1,528,326	760,814	38,016	446,521	122,120	5,757,943	370,365	6,128,308
51-100	546,008	551,466	681,884	372,223	896,475	562,278	8,268	256,710	137,537	4,012,849	340,738	4,353,587
101-300	1,051,772	652,697	699,315	596,537	793,153	690,013	56,592	414,893	85,221	5,040,193	659,135	5,699,328
301-1000	131,367	45,491	52,737	66,720	48,644	76,182	99,655	52,115	11,039	583,950	125,827	709,777
Above 1000	14,586	2,979	4,866	8,976	4,403	10,636	50,521	8,221	1,921	107,109	6,254	113,363
Temporary Residential	, 6,061	372	93	991	702	217	1	32	6	8,475	-	8,475
Al (TOD)	24	11	50	253	32	1		6		377		377
Total	2,417,606	1,972,73E	2,330,576	1,628,655	3,271,735	2,100,141	253,053	1,178,493	357,644	15,510.896	1,502,319	17.013,215

11.3 Replacing Incandescent Bulbs (IB) with CFLs

Significant savings in electricity consumption can be achieved by replacing IBs in the domestic sector with energy efficient CFLs that provide the same lumen output at lower wattage levels, and have a longer lifetime. Upgrading Fluorescent Tube Lights

Survey results show that presently 40W fluorescent tube lights (FTLs) with electromagnetic ballasts are commonly being used in Pakistan. Electricity savings can be achieved by replacing them with 32W FTLs with more efficient electronic ballasts that have ballast losses of 1W as compared to average losses of 11W in electromagnetic ballasts.

Table no 37 below summarizes the results of energy saving potential, the investment requirements, investment schedule, and the estimated payback period for replacing IBs and Upgrading FTLs in the residential sector. The investment requirements are based on the international bulk procurement rates for CFLs and an assumed procurement rate of $ 0.5 for a 32W FTL, with an additional 5% of the procurement cost taken as the program handling cost. Given the attractiveness of this investment, it is assumed that 80% of the technical potential can be realized. Furthermore, it is assumed that all future electrical lighting appliances introduced in the residential sector will be efficient, and therefore the future realizable saving potential will be nil.

Table: 37 Energy Consumption, Savings, and Investment Requirements and Schedule for Replacing and Upgrading Lighting Appliances

Energy Type	Energy Consumed, **FY2008**		Energy Consumption **Forecast, FY2019**		Energy Efficiency Potential			Realizable Savings **FY2019**		Investment Required	Simple Payback Period	
	(GWh)	(TOE)	(GWh)	(TOE)	Technical	Realizable	Effective	(GWh)	(TOE)	($ Million)	(Fin.)	(Eco.)
Lighting	5,641	459,433	13,156	11,071,410	54%	80%	44%	2,455	199,938	55	0.3	0.3

($ Million)

	FYI 0	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19
Annual		0.5	3.3	9.8	15.8	14.7	7.6	2.2	0.5	
Cumulative		0.5	3.8	13.6	29.4	44.1	51.8	54.0	54.5	54.5

11.4 Electrical Appliances

The total electricity consumption in the residential sector, 47% can be attributed to appliances used for space cooling. These include ceiling or pedestal fans that operate for seven months of the year, and room coolers and air conditioners that are utilized for four months during the peak summer period. Other appliances such as refrigerators, water pumps, televisions and computers utilize the remaining 36%. Saving potential in refrigeration, water pump and air conditioning is assessed. Of the total residential sector electricity consumption, air conditioning consumes around 17%, refrigeration 13% and water pumping 4%. Table below provides a brief summary of the main assumptions based on which the final saving potential and the associated costs are estimated.

Basis for Saving Potential and Investment Estimates for Replacing Inefficient Electrical Appliances

Residential Electricity Customers	**17.0 Million**
Refrigeration	
Electrified Customers with Refrigerators	38%
Improvement Potential	67%
Replacement Cost	250 $/ Refrigerator
Proportion of Appliances Inefficient	24%
Water Pumping	
Electrified Customers with Pumping	38%
Improvement Potential	50%
Replacement Cost	100 $/Pump
Proportion of Appliances Inefficient	9
0% **Air Conditioning**	
Electrified Customers with Air conditioners	15%
Improvement Potential	40%
Replacement Cost	250 $/Air Conditioner
Proportion of Appliances Inefficient	29%

The table below summarizes results of energy saving potential, the investment requirements, investment schedule, and the estimated payback period for replacing

inefficient refrigerators, water motors and air conditioners in the residential sector. It is assumed that all future electrical appliances introduced in the residential sector will be efficient,

Table: 38 Energy Consumption, Savings, and Investment Requirements and Schedule for Replacing Electrical Appliances

Energy Type	Energy Consumed, FY2008		Energy Consumption Forecast, FY2019		Energy Efficiency Potential			Realizable Savings FY2019		Investment Required	Simple Payback Period	
	(GWh)	(TOE)	(GWh)	(TOE)	Technical	Realizable	Effective	(GWh)	(TOE)	($ Million)	(Fin.) i	(Eco.)
Refrigeratio	4,524	368,424	10,550	859,176	67%	80%	54%	2,425	197,475	304	1.5	1.6
Water pump	1,258	102,422	2,933	238,852	50%	80%	40%	503	40,969	465	10.9	12.2
Air Conditioning	5,845	476,024	13,631	1,110,102	40%	80%	32%	1,870	152,328	149	0.9	1.0
Fans	10,105	822,950	23,565	1,919,143	0%	0%	0%	-	-	-	-	-
Others	6,332	515,657	14,765	1,202,526	0%	0%1	0%	-	-	-	_	-
Total	**28,064**	**2,285,E77**	**65,444**	**5,329,799**	**i**	j	_	4,798	**390,772**	**918**		

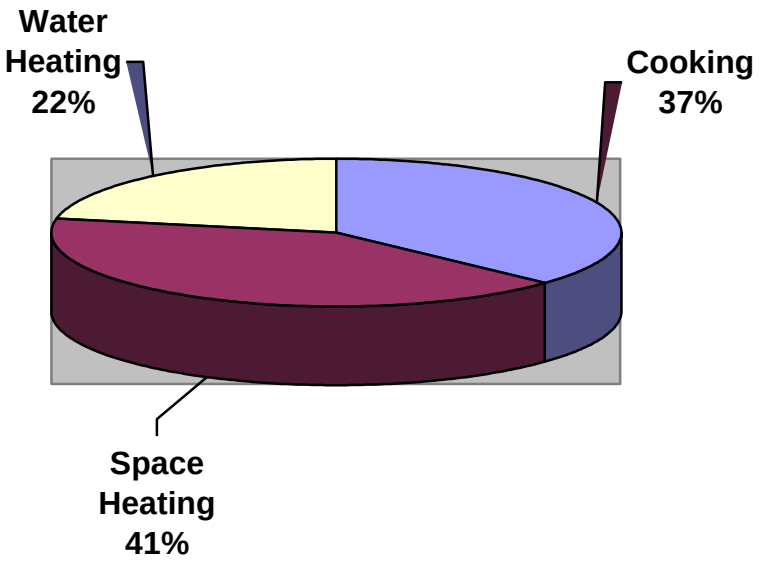
($ Million)

	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19
Annual		9.2	55.1	165.2	266.2	247.9	128.5	36.7	9.2	
Cumulati		9.2	64.3	229.5	495.7	743.6	872.1	908.9	918.0	918.0

11.5Natural Gas Consumption

Figure gives estimates for the proportion of heating and cooking in total residential natural gas consumption.

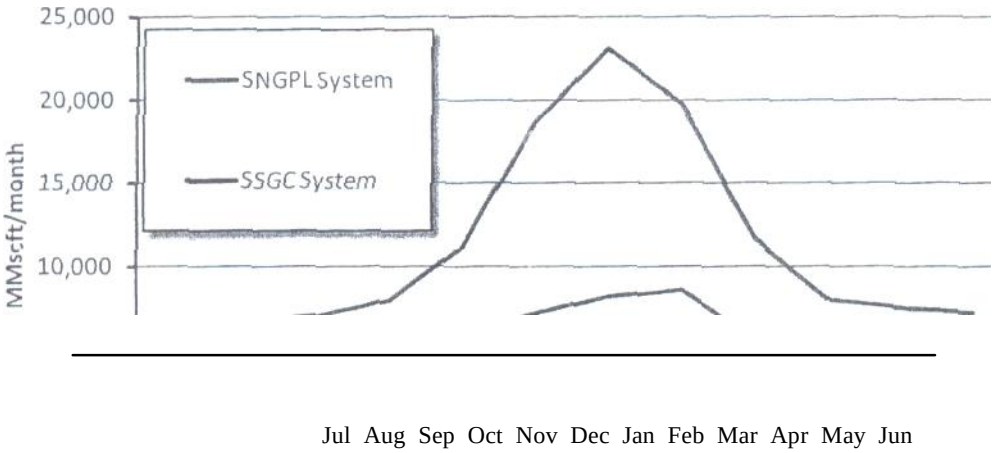
Natural Gas Consumption by End-Use in the Residential Sector



Total Natural Gas Consumption, 4.8 MTOE

Estimates for the end use of gas are developed through analysis of monthly demand profiles for the gas utilities figure below gives the actual picture of monthly gas demand profile in residential sector. Gas demand for cooking is uniform through the year, whereas space and water heating both contribute to the peak load during the winter season. The minimum monthly demand in the summer season is considered as demand for cooking, and the difference from peak demand (demand during the winter season) is attributed to space and water heating. To estimate the proportion of water heating in the total natural gas demand, the difference in the minimum monthly demand and le demand during the months of March, April, October and November is taken as gas demand for water heating. During these months, there is no space heating and the additional demand in comparison to the minimum monthly demand is entirely due to water heating.

Utility-wise Monthly Gas Demand Profile for Residential Sector



The Energy Efficiency potential in gas demand for water heating is 30%, which can be achieved by retrofits in the water heating appliances. The gas utilities, SSGC and SNGPL have devised these retrofits for the existing water heating appliances. The cost of these retrofits is approximately $12.5 per water heater. Potential for improvement of Energy Efficiency in space heating is estimated at 36%, which can be achieved by replacing the space heaters with more efficient ones. The cost of a new space heater is approximately $ 25 per heater. Similarly, potential for improvement of Energy Efficiency in cooking is estimated at 40%, which can be achieved by replacing the existing inefficient stoves. The cost of a new stove is approximately $10. Table below summarizes the results of the energy saving potential, the investment requirements, investment schedule, and the estimated payback period for replacing and upgrading water heaters, space heaters and cooking stoves in the residential sector. It is assumed that all future gas heating and cooking appliances introduced in the residential sector will be efficient.

Table: 39 Energy Consumption, Savings, and Investment Requirements and Schedule for Replacing Gas Appliances

Energy Type	Energy FY2008		Energy Forecast, FY2019		Energy Efficiency			Realizable Savings FY2019		Investmen Required	Simple Payback	
	(MMscf)	(TOE)	(MMscf)	(TOE)	Technical	Realizable	Effective	(MMscf)	(TOE)	($ Million)	(Fin.)	(Eco.)
Water	42,241	988,441	98,507	2,013,679	30%	80%	24⁰/0	10,138	237,226	28	1.3	0.3
Space	33,430	782,274	77,961	986,886	36%	80%	9'	9,628	225,295	99	4.8	1.1
Cooking	128,363	3,003,705	299,347	7,788,899	43%	80%	34⁰/0	43,644	1,021,260	52	0.5	0.1
Total	**204,035**	**4,774,412**	**1475,815**	**10,789,464**	**39%**	**80%**	31%	**63,409**	**1,483,780**	179	1.3	**0.3**

($ Million)

	FYI 0	FY11	FY12	FY 13	FY14	FY15	FY16	FY17	FY18	FY19
Annual		1.8	10.7	32.2	51.9	48.3	25.1	7.2	1.8	
Cumulative		1.8	12.5	44.8	96.7	145.0	170.1	177.2	179.0	179.0

11.6Roof Insulation

Energy savings can be achieved by installing roof insulation in existing residential buildings. This can result in energy savings by reducing the electricity demand for air conditioning by 20%. The energy saving potential is estimated for the proportion of the population that uses air conditioning, which is 9% of the 17 million residential electricity customers in the country. To calculate the energy savings by roof insulation, it is assumed that all customers are using efficient air conditioning units. Taking into account these assumptions, energy savings due to roof insulation in residential buildings are estimated at 634,831 MWh per annum. Based on current market prices, the cost of roof insulation is estimated at $1,500 per household. Therefore, energy savings through roof insulation in residential buildings can be achieved at a total cost of $2.2 billion. Table below summarizes the results of energy saving potential, the investment requirements, the investment schedule, and the estimated payback period for roof insulation in the residential sector. Due to the high payback period, the Energy Efficiency potential of installing roof insulation is not viable.

Table: 40 Savings, and Investment Requirements and Schedule for Installing Roof insulation

	Energy Efficiency			Realizable		Investment	Simple Payback	
	Technical		Realizable	(GWh)	(TOE)	($	(Fin.)	(Eco.)
Roof Insulation	20%	100%	20%	1,047	149,634	3,826	43	48

($ Million)

	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19
Annual	18	37		329	384	384		-		
Cumulative	18	55	55	384	768	1,152	1,152	1,152	1,152	1,152

11.7COMMERCIAL SECTOR

The commercial sector in Pakistan consists of government and private offices, shops, markets, hotels etc, which account for 4% of the total commercial energy consumption of the country. Natural gas dominates the fuel mix of the commercial sector with a 55% share in the total energy consumption. Electricity accounts for 31% of the total energy consumption in the commercial sector, and LPG makes up the remaining 14% of the fuel mix.

11.7.1 Electricity Consumption

In FY-2008, electricity consumption in the commercial sector was 5,572 GWh. Breakup of the final electricity consumed by end-use, the details are as follows;

- General Appliances - 26%
- Lighting - 38%
- Space Cooling - 36%

Energy Saving Potential in Lighting Appliances

There are approximately 2.8 million commercial electrified customers in Pakistan. To calculate the total number of commercial light points in the country, an average of 5 light points per commercial unit is assumed, giving a total of 13.8 million commercial light points in the country. 25% of the total light points are taken as IB light points, 55% as CFL light points, and the remaining 20% are assumed to be fluorescent tube lights (FTLs).

11.7.2 Replacing Incandescent Bulbs with Compact Fluorescent Lamps

Of the total IB light points in the country, 90% are assumed to be 100W, IBs and the remaining 10% as 200W, IBs. Significant savings in the electricity consumption by the commercial sector can be achieved by replacing the 100W and 200W, IBs in commercial units with energy efficient CFLs that provide the same lumen output at lower wattage levels, and have a longer life time. For a 100W, IB with a minimum 1350-lumen output and at an enhanced 60 Im/W efficacy standard, CFLs in the range of 23-25W can be used as a replacement. For a 200W, IB, a 46W CFL is taken as the efficient replacement.

11.8 Upgrading Fluorescent Tube Lights

Presently, 40 W fluorescent tube lights with electromagnetic ballasts are commonly being used in Pakistan (80% of total FTL light points). Electricity savings can be achieved by replacing them with 32W, FTLs with more efficient electronic ballasts that have losses of 1W as compared to average ballast losses of 11W in electromagnetic ballasts.

Table shows the summary the results of energy saving potential, the investment requirements, investment schedule, and the estimated payback period for replacing IBs and upgrading FTLs in the commercial sector. The investment requirements are based on international bulk procurement rates for CFLs and an assumed procurement rate of $ 0.5 for a 32W FTL, with an additional 5% of the procurement cost taken as the program handling cost. Given the attractiveness of this investment, it is assumed that 80% of the technical potential can be realized. Furthermore, it is assumed that all future lighting appliances introduced in the commercial sector will be efficient.

Table: 41 Energy Consumption, Savings, and Investment Requirements and Schedule for Replacing and Upgrading Lighting Appliances

Energy Type	Energy Consumed, FY2008		Energy Consumption Forecast, FY2019		Energy Efficiency Potential			Realizable Savings FY2019		Investment Required	Simple Payback Period	
	(GWh)	(TOE)	(GWh)	(TOE)	Technical	Realizable	Effective	(GWh)	(TOE)	($ Million)	(Fin.)	(Eco,)
Lighting	1,537	125,17	5,373	437,596	25%	80%	20%	312	25,430	6	0.2	0.3

($ Million)

FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19
	0.1	0.4	1.1	1.8	1.7	0.9	0.3	0.1	
	0.1	0.4	1.6	3.4	5.1	6.0	6.2	6.3	6.3

11.9Electrical Appliances

The total electricity consumption in the commercial sector, 47% can be attributed to appliances used for space cooling. These include ceiling or pedestal fans that operate for seven months around the year, and room coolers and air conditioners that are utilized for approximately four to five months during the peak summer period. Other appliances such as refrigerators, water pumps and general use appliances utilize the remaining 25% of energy. Energy saving potential in refrigeration and air conditioning is assessed. Similar assumptions to be taken in the domestic sector are applied to estimate the end-use share of refrigeration and air conditioning in the commercial sector. The total commercial sector electricity consumption, air conditioning consumes approximately 17% and refrigeration 13%. The summary shows, the results of energy saving potential, the investment requirements, investment schedule, and the estimated payback period for replacing inefficient refrigerators and air conditioners in the commercial sector. It is assumed that all future electrical appliances introduced in the commercial sector will be efficient.

Table: 42 Energy Consumption, Savings, and Investment Requirements and Schedule **for Replacing Electrical Appliances**

Energy Type	Energy Consumed,		Energy Consumption		Energy Efficiency Potential			Savings for FY- 2019		Investment Required	Simple Payback Period	
	(GWh)	**(TOE)**	(GWh)	**(TOE)**	**Technical**	**Realizable**	Effective	(GWh)	**(TOE)**	($ Million)	**(Fin.)**	**(Eco.)**
Refrigeration	748	60,908	2,615	212,935	67%	80%	54%	401	32,647	40	0.8	1.3
Air	966	78,697	3,378	275,124	40%	80%	32%	309	25,183	20	0.5	0.8
Fans	1,671	136,051	5,840	475,633	0%	0%	0%	-	-	-	-	-
Others	650	52,965	2,274	185,164	0%	0%	0%	-	-	-	-	-
Total	**4,0351**	**328,621**	14,107	**1,148,856**				710	**57,830**	**60**		

($ Million)

11.10 Natural Gas Consumption

Natural gas consumption in the commercial sector amounted to 0.8 MTOE in FY-2008. Estimates for end use of gas were developed through the analysis of monthly demand profiles of the gas utilities. Gas demand for cooking is uniform throughout the year, whereas space and water heating contribute to the peak load during the winter season. The minimum monthly demand in the summer season is considered as demand for cooking, and the difference from peak demand during the winter season is attributed to space and water heating. To estimate the proportion of water heating in the total natural gas demand, the difference in the minimum monthly demand and demand during the months of March, April, October and November is taken as gas demand for water heating. During these months, there is no space heating and the additional demand in comparison to the minimum monthly demand is entirely due to water heating. The Energy Efficiency potential in gas demand for water heating is 30%, which can be achieved by retrofits in the water heating appliances. The gas utilities, SSGC and SNGPL have devised these retrofits for the existing water heating appliances. The cost of these retrofits is approximately $ 12.5 per water heater.

Potential for improvement of Energy Efficiency in space heating is estimated at 36%, which can be achieved by replacing existing space heaters with more efficient ones. The cost of a new space heater is approximately $ 25 per heater. Similarly, potential for improvement of Energy Efficiency in cooking is estimated at 40%, which can be achieved by replacing the existing inefficient stoves. The cost of a new stove is approximately $ 10.

11.11 Roof Insulation

Energy savings can also be achieved by installing roof insulation in the existing commercial buildings in the country. This can result in energy savings by reducing the electricity demand for air conditioning by 20%. The energy saving potential is estimated for the proportion of the population that uses air conditioning, which is 60% of the 2.7 million commercial electricity customers of in the country. To calculate the energy savings from roof insulation, it is assumed that all customers are using efficient air conditioning units. Taking in to account these assumptions, energy savings due to roof insulation in commercial buildings are estimated at 193 GWh per annum. Based on current market prices, the cost of roof insulation is estimated at $1,500 per building. Therefore, energy savings through roof insulation in commercial buildings can be achieved at a total cost of $ 949 million. The results of energy,

saving potential, requirements, schedule, and estimated payback period for installing roof insulation in the commercial sector. Due to the high payback period, the Energy Efficiency potential of installing roof insulation is not viable.

Table: 43 Savings, and Investment Requirements and Schedule for Installing Roof Insulation

	Energy Efficiency Potential			Realizable Savings	Investment Required		Simple Payback
	Technical	**Realizable**	**(GWh)**	**(TOE)**	($ Million)	**(Fin.)**	**(Eco.)**
Roof Insulation	20%	100% 7 2 0 %	193	27,626	949	38	65

($ Million)

PAKISTAN AGRICULTURE SECTOR

12 The Agriculture Sector

In spite of structural shift towards industrialization, agriculture sector is still the largest sector of the economy with deep impact on socio-economic set up. It is the source of the livelihood of almost 44.7% of the total employed labor force in the country. With the present contribution to GDP at 21.8 %, agriculture sector is the mainstay of the rural economy around which socio-economic privileges and deprivations revolve. Thus given for its stretched distinct forward an backward linkages particularly with the industrial sector, a large impact on balance of payments and highest share in employment, agriculture sector has assumed an added significance in backdrop of global food crunch and food security. No strategy of economic reforms can be realized without sustained and broad based agricultural development which is critical for raising living standards, alleviating poverty assuring food security, generating buoyant market for expansion of industry and services, and making substantial contribution to the national economic growth. Agriculture has grown at an average rate of 4.1 % per annum since 2002-03 with variations, from 6.5 %to 1.1%. The fluctuation in agriculture has largely stemmed from a fluctuation in major crops which in turn is the result of the behavior of Mother Nature, pest attacks on crops. The trends in agriculture growth since 2002-03 are shown in table

Table: 44 Agriculture Growth (%)

Year	Agriculture	Major Crops	Minor Crops
2002-03	4.1	6.8	1.9
2003-04	2.4	1.7	3.9
2004-05	6.5	17.7	1.5
2005-06	6.3	-3.9	0.4
2006-07	4.1	7.7	- 1.0
2007-08	1.1	-6.4	10.9
2008-09	4.7	7.7	3.6

Source: Federal Bureau of Statistics

The performance of agriculture sector has been stronger than expected during 2008-09 as against the target of 3.5 %and last year's performance of 1.1 %, overall agriculture this year is estimated to grow by 4.7 % on account of bumper wheat, rice and maize crops estimated as 23, 42, 6.9 and 4.0 million tons respectively.

Pakistan's agricultural output is closely linked with the supply of irrigation water. As shown in table below against the normal surface water availability at canal heads of 103.5 million-acre feet (MAF), the overall (both for Kharif and Rabi) water availability has been less in the range of 2.5 % (2005-06) to 20.6 % (2004-05). Relatively speaking, Rabi season faced more shortage of water than Kharif during these years.

Table: 45 Actual Surface Water Availability **(Million Acre Feet)**

Period	Kharif	Rabi	Total	%age incr/decr. Over the Avg.
Average system usage	67.1	36.4	103.5	-
2002-03	62.8	25.0	87.8	- 15.2
2003-04	65.9	31.5	97.4	- 5.9
2004-05	59.1	23.1	82.2	- 20.6
2005-06	70.8	30.1	100.9	- 2.5
2006-07	63.1	31.2	94.3	- 8.9
2007-08	70.8	27.9	98.7	- 4.6
2008-09	66.9	24.9	91.8	-11.3

Source: IRSA

12.2Crop Situation

There are two principal crop seasons in Pakistan, namely the "Kharif", the sowing season of which begins in April -June and harvesting during October – December and the "Rabi" which begins in October - December and ends in April – May, Rice, sugarcane, cotton, maize, mong, mash, bajra and jowar are "Kharif" crops while wheat, gram, lentil (masoor), tobacco, rapeseed, barley and mustard are "Rabi" crops. Major crops, such as, wheat, rice, cotton and sugarcane account for 89.1 % of the value added in the major crops. The value added in major crops accounts for 33.4 % of the value added in overall agriculture. Thus, the four major crops (wheat, rice, cotton, and sugarcane), on average, contribute 29.8 % to the value added in overall agriculture and 6.5 % to GDP. The minor crops account for 12.0 % of the value added in overall agriculture. Livestock contributes 51.8 % to agricultural value added much more than the combined contribution of major and minor crops (45.4%).

Table: 46 Production of Major Crops (000 Tons)

Year	Cotton (000 bales)	Sugarcane	Rice	Maize	Wheat
2003-04	10048	53419	4848	1897	19500
	(-1.6)	(2.6)	(8.3)	(9.2)	(1.6)
2004-05	14265	47244	5025	2797	21612
	(42.0)	(-11.6)	(3.6)	(47.4)	(10.8)
2005-06	13019	44666	5547	3110	21277
	(-8.7)	(-5.5)	(10.4)	(11.2)	(-1.6)
2006-07	12856	54742	5438	3088	23295
	(-1.2)	(22.6)	(-2.0)	(-0.7)	(9.5)
2007-08	11655	63920	5563	3605	20959
	(-9.3)	(16.8)	(2.3)	(16.7)	(-10.0)
2008-09	11819	50045	6952	4036	23421
	(1.4)	(-21.7)	(24.9)	(11.9)	(11.7)

Source: Ministry of Food and Agriculture

12.3Major Crops

12.3.1 Cotton

Cotton is the important non-food cash crop and a significant source of foreign exchange earnings. Cotton accounts for 7.3 % of the value added in agriculture and about 1.6 % to GDP. The crop was sown on the area of 2820 thousand hectares, 7.7 % less than last year (3054 thousand hectares). The production is estimated at 11.8 million bales for 2008-09, higher by 1.1 % over the last year's production of 11.7 million bales. However, the cotton production was 14.5 % less than the target of 14.11 million bales mainly due to the shortage of irrigation water, less use of DAP to cotton crop, attack of Cotton Leaf Curl Virus (CLCV), mealy bug and white fly on the crop and last picking of cotton was affected due to higher prices of wheat announced by the Government.

12.3.2 Bt. Cotton

Cotton Leaf Curl virus (CLCV) has been the major problem in achieving the higher cotton production. In order to improve per hectare yield of cotton crop, Ministry of Food & Agriculture (MINFA) has been working on a two pronged strategy i.e., developing the technology through indigenous capabilities as well as inviting the Multi-National Companies to bring in the latest cotton production and protection technologies for enhancing cotton production in the country. In this respect, letter of intent (LOI) and memorandum of

understanding has been signed with Monsanto Company for introduction of latest technology (Bollgard - II) in the country to maximize cotton production. National Bio-safety Committee (NBC) of Ministry of Environment has also authorized bio-safety clearance to eight cotton varieties with Bollard - I trait. Area, production and yield of cotton for the last five years are given in Table below;

Table: 47 Area, Production and Yield of Cotton

Year	Area		Production		Yield	
	(000 Hectare)	% Change	(000 Bales)	% Change	(Kgs/Hec)	% Change
2004-05	3193	6.8	14265	42.0	760	32.9
2005-06	3103	-3.0	13019	-8.7	714	-10.3
2006-07	3075	-0.9	12856	-1.2	711	-0.4
2007-08	3054	- 0.6	11655	- 9.4	649	-8.7
2008-09	2820	-7.7	11819	1.1	713	9.9

Source: Ministry of Food and Agriculture

12.3.3 Sugarcane

Sugarcane is an important cash crop of Pakistan. It is mainly grown for sugar and sugar related production. It is an important source of income and employment for the farming community of the country. It also forms essential item for industries like sugar, chipboard, and paper. Its share in value added of agriculture and GDP are 3.4 % and 0.7 %, respectively. For 2008-09, sugarcane has been sown in the area of 1029 thousand hectares, 17.1 % lower than last year. Sugarcane production for the year 2008-09 is estimated at 50.0 million tons, against 63.9 million tons last year. This indicates significant decline of 21.7 % over the production of last year. The main reasons of lower production are shortage of irrigation water, shifting of area to rice crop less use of DAP and non-payments of dues to farmers by the sugar mills on time for the last year's crop. The area, production and yield per hectare for the last five years are given in Table below;

Table: 48 Area, Production and Yield of Sugarcane

Year	Area		Production		Yield	
	(000 Hectare)	% Change	(000 Tons)	% Change	(Kgs/Hec.)	% Change
2004-05	966	-11.8	47244	-11.6	48906	-3.8
2005-06	907	-6.1	44666	-5.5	49246	0.7
2006-07	1029	13.5	54742	22.6	53199	8.0
2007-08	1241	20.6	63920	16.8	51507	-3.2
2008-09	1029	-17.1	50045	-21.7	48634	-5.6

Source: Ministry of Food and Agriculture

12.3.4 Rice

Rice is an important food cash crop. Rice is also one of the main export items of the country. It accounts for 5.9 % of value added in agriculture and 1.3 % in GDP. Pakistan grows enough high quality rice to meet both domestic demand and for exports. Area sown for rice is estimated at 2963 thousand hectares, 17.8 % higher than last year. The size of the crop is estimated at 6952 thousand tons 24.9 % higher than last year. Higher production of rice crop is primarily based on over achievements of area targets in Punjab and Sindh. In Punjab, area surpassed the target by 12.1 % and as a result production overshot the target by 14.7 %. Sindh production surpassed the target by 22.2 % solely on accounts of area, which surpassed the target by 23.2 %. In Punjab sugarcane area was shifted to rice crop, as the growers were discouraged from the non-payment of their dues timely by the sugar mills. The area, production and yield of rice for the last five years are given below;

Table: 49 Area, Production and Yield of Rice

Year	Area		Production		Yield	
	(000 Hectare	% Change	(000 Tons)	% Change	(Kgs/Hec.)	% Change
2004-05	2519	2.3	5025	3.6	1995	1.2
2005-06	2621	4.0	5547	10.4	2116	6.1
2006-07	2581	-1.5	5438	-2.0	2107	-0.4
2007-08	2515	-2.5	5563	2.3	2211	4.9
2008-09	2963	17.8	6952	24.9	2346	6.1

Source: Ministry of Food and Agriculture

12.3.5 Wheat

Wheat is the main staple food item of the country's population and largest grain crop of the country. It contributes 13.1 % to the value added in agriculture and 2.8 % to GDP. Area and production target of wheat for the year 2008-09 has been set at 8610 thousand hectares and 25 million tons, respectively. Wheat was cultivated on an area of 9062 thousand hectares, showing an increase of 5.9 % ove last year's area of 8550 thousand hectares. The size of wheat crop is provisionally estimated at 23.4 million tons, 11.7 % more than last year crop. The main reasons for higher production are attractive wheat support price of Rs. 950 per 40 kg before the sowing of crop, significant increases in area under crop timely rains during December, January and March and other supportive measures like setting a higher wheat procurement target by the public sector and extending fertilizer subsidy to the tune of Rs.32 billion. Government capped the DAP fertilizer price at Rs.3050 per bag by providing a

subsidy of Rs.2200 per bag. The Area, Production and Yield per hectare of wheat for the last five years are given below;

Table: 50 Area, Production and Yield of Wheat

Year	Area		Production		Yield	
	(000 hectares)	% Change	(000 tons)	% Change	(Kgs /Hec.)	% Changes
2004-05	8358	1.7	21612	10.8	2568	8.1
2005-06	8448	1.1	21277	-1.6	2519	-1.9
2006-07	8578	1.0	23295	9.5	2716	7.8
2007-08	8550	-0.3	20959	-10.0	2451	-9.8
2008-09	9062	5.9	23421	11.7	2585	5.5

Source: Ministry of Food and Agriculture

12.3.6 Other Major Crops

The production of gram, maize and tobacco has increased by 60 %, 11.9 % and 4.6 % respectively. Gram is the largest Rabi pulses crop in Pakistan. For the years 2008-09, gram production target was fixed at 652 thousand tons. Due to timely ample rains, the gram production surpassed the target and stood at 760 thousand tons. This indicates an impressive growth of 60 % over the last year production of 475 thousand tons. The production of rape seed and mustard, barley, bajra and jawar decreased by 16.7, 4.6 , 3.0 and 2.9 % respectively.

Table: 51 Area and Production of Other Major Kharif and Rabi Crops

Crops	2007-08		2008-09 (P)		% Change In production
	Area (000 hectares)	Production (000 tons)	Area (000 hectares)	Production (000 tons)	
KHARIF					
Maize	1052	3605	1118	4036	11.9
Bajra	531	305	470	296	-3.0
Jawar	281	170	263	165	-2.9
RABI					
Gram	1107	475	1094	760	60.0
Barley	91	87	86	83	-4.6
Rapeseed & Mustard	224	176	209	147	-16.7
Tobacco	51	108	52	113	4.6

Source: Ministry of Food and Agriculture; Federal Bureau of Statistics

12.4Energy Consumption

Agriculture is the largest sector of the economy in Pakistan with a contribution economic of about 21 % to the GDP. The average economic growth rate of the sector for the period 2004 to 2008, however, was relatively low at 4.7%, compared to an overall growth rate of 6.98%. This is reflective of inefficient farm and cultivation practices that contribute to low levels of productivity. The agriculture sector in Pakistan comprises of major crops, minor crops, livestock, fishing, and forestry. Most of the energy consumed in agriculture is for the operation of pumps for irrigation and tractors for cultivation, as well as for the transport of agricultural supplies and products. Energy use in the sector is gradually increasing with mechanization and adoption of technologies and practices to improve productivity.

Energy used in the agriculture sector includes electricity, Light Diesel Oil (LD0) and High Speed Diesel (HSD). Electricity is used only for the operation of tube wells (turbine pumps), whereas LDO and HSD are used to operate both tube wells and tractors. Agriculture accounts for 11.5% of the demand for electricity and 94.5% of the demand for LDO in the country. Published statistics report HSD consumption in the agriculture sector as a part of the transport sector, therefore, separate figures for HSD consumption in agriculture are not available. Energy Efficiency improvements related to the use of tractors are therefore accounted for in the transport sector. However, to estimate the total energy consumption in tube well operations, HSD consumption is worked out assuming an average load factor of 12%, which resulted in approximately 13.90% of the overall consumption in the transport sector. The fuel wise consumption in tube well operations is presented below;

Table: 52 Fuel-wise Consumption in Tube Well Operations, 2008

Fuel	Electricity	LDO	HSD(TOE)
Country Consumption	5,977,697	120,012	7,907,464
Consumption in Pumping and Tube Wells	689,948	113,418	1,099,361
Consumption Share in Pumping and Tube Wells	11.54%	94.51%	13.90%

To estimate the energy use for the base year of 2008, data for the number of tube wells Installed for the year 2004 is adjusted based on the average growth rate of the agriculture sector over the last four years. The data is also adjusted to account for non-operating tube wells. Tube wells operating in Pakistan can be divided into three categories, electric,

diesel engine operated, and others. The total number of tube wells with respective horse power ranges for each category is presented below;

Table: 53 Total Number of Tube Wells in 2008

Horse power	8	12	18	22	24	30
Electric Motor Operated	14,666	27,283	19,561	380	279	8,812
Diesel Engine Operated	413	15,230	75,424	1,710	1,869	12,218
Others	96	32	173	10		1,073
Total	15,175	**42,546**	**95,158**	**2,100**	**2,148**	**22,103**

Source: Pakistan Agriculture Machinery Census

Both diesel and electric pump sets are used for irrigation pumping. The efficiency of these engines depends on the loading, speed, quality of its design, and fabrication. Centrifugal lift pumps are mostly used in the Indus plains to raise groundwater for irrigation. The efficiency of the pump depends upon its operating speed for a given pump, there is an optimum speed which yields maximum efficiency. Small and low speed pumps operate best at about 1500 rpm. For low speed diesel engines that are generally coupled to run at about 500 rpm, a transmission system is required the simplest and cheapest method of which is by running a transmission belt between two pulleys of different sizes. Belt transmission systems often cause losses due to flapping and slippage of the pulley wheels. When belts are correctly fitted, the efficiency of the transmission system should be 85 to 90 %. With the direct coupling system, the efficiency can be as high as 95 % for high speed engines and motors operating at higher speeds and can be coupled directly to the pumps. Operated in an appropriate manner, the efficiency of the pumping system can exceed to 80%, which can drop to 50% at incorrect and partial loads. Engine manufacturers in Pakistan typically claim a diesel fuel consumption of 0.33 liters per kWh (0.25 liters/ horse power-hour) of shaft power, which is equivalent to about 30% efficiency. These estimates are based on laboratory tests, and in field conditions. The best efficiency expected of a poorly maintained and loaded engine is approximately 25% with a poorly maintained engine, this could drop to as low as 10 to 15 %.

As with diesel engines, the efficiency of electric motors used to drive pump sets also

depends on loading. Operating at the rated load, the motor's efficiency should be between 80% and 90%. This efficiency drops with the capacity of motors used. For high quality motors, at 75% of rated capacity, efficiency drops by about 10% from full load efficiency. For motors with poor quality windings and incorrect insulation, the efficiency of the electric motor could be as low as 54%. These poor quality motors are prevalent in Pakistan, especially among motors that have been locally rewind and repaired. In addition, many of the locally manufactured motors exhibit very poor power factor throughout their operating range.

Direct energy use in irrigation can be influenced in two basic ways, increasing the efficiency of pump systems used and reducing the quantity of water required for irrigation. The irrigation pumping sub-sector has been analyzed on the basis of new and existing diesel and electric pump sets. Energy savings are computed on the basis of increasing the efficiencies of existing and new electric pumps from current estimated efficiency of 21.6 % to a new of 35.7 %, and from the current 5.4 % to 10.1 %. It should be noted that these efficiency improvements represent a conservative estimate of the average achievable improvements.

The economic price for electricity is assumed at Rs 6.08/kWh, whereas the economic prices of LDO and HSD are taken at Rs 39,263/Tonne and Rs 35,724/Tonne respectively, with a combined payback period of 0.90 years. The financial price for electricity is assumed at Rs 5.10/kWh, whereas the financial prices of LDO and HSD are taken at Rs 54,643/Tonne and Rs 67,505/Tonne respectively, with a combined payback period of 0.66 years. The electric motors and diesel pumps market is dominated by locally manufactured inefficient equipment at low prices. Generally, since farmers are price conscious, it is expected that the current market share of the local manufacturers is unlikely to change.

12.5 Energy Savings Potential, Barriers and Constraints to Energy Efficiency, and Investment Potential

According to agriculture experts and manufacturers of high efficiency pumps, motors, and engines, approximately 38% of the electricity consumed by electric pumps can be saved by replacing the existing electric motors and pumps with more efficient ones available in the market. Similarly, LDO and HSD consumption can be reduced by up to 50% by replacing the existing low efficiency pump sets used in the tube wells. The

farmers in Pakistan, however, have limited access to capital, and are therefore severely constrained in making cash investments required for the purchase of high efficiency tube wells. These barriers can be removed by improving access to credit, and promoting awareness on the benefits of high efficiency pumping technologies. In view of the significant potential for saving energy and recognizing the constraints faced by the farmers, investment requirements for the replacement of older inefficient tube wells with new more efficient configurations are estimated assuming 50% replacement of the existing equipment over a period of ten years. Investment requirements, investment schedule, and estimated payback periods for Electric motors and Diesel engines are given below;

Table: 54 Energy Consumption, Realizable Savings, and Investment Requirements and Schedule for Electrical Motor Replacement

Energy Type	Energy Consumption Consumed, FY2008		Energy Forecast, FY2019		Energy Efficiency Potential			Realizable Savings FY2019		Investment Required	Simple Payback Period	
	(GWh)	(TOE)	(GWh)	(TOE)	Technical	Realizable	Effective	(GWh)	(TOE)	($ Million)	(Fin.)	(Eco.)
Electricity	8,472	689,948	17,791	1,448,946	38%	50%	19%	3,336	1271,677	93	0.4	0.4

($ Million)

	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19
Annual	-	0.9	5.6	16.8	27.1	25.2	13.1	3.7	0.9	
Cumulative		0.9	6.5	23.3	50.4	75.6	88.7	92.4	93.3	93.3

Table: 55 Energy Consumption, Savings, and Investment Requirements and Schedule for Diesel Engine Replacement

Energy Type	Energy **Consumed,** FY2008		**Energy Consumption**		**Energy Efficiency Potential**			**Realizable Savings**		**Investment Required**	Simple Payback	
	(Tonnes)	**(TOE)**	**(Tonnes)**	**(TOE)**	Technical	**Realizable**	Effective	(Tonnes)	**(TOE)**	($ Million)		(Fin.) (Eco.
LDO	108,867	113,889	228,621	238,178	50%	50%	25%	57,155	59,547	379	0.8	1.4
HSD	-	-	-	-	50%	50%	25%	549,001	577,175			

Note: HSD consumption for tractors and tube wells in agriculture sector is not reported separately and is included in transport sector.

	FY10	**FY11**	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	**FY18**	**FY19**
Annual		3.8	22.7	68.2	109.9	102.4	53.1	15.2	3.8	
Cumulative	-	3.8	26.5	94.8	204.7	307.1	360.2	375.3	379.1	379.1

12.6Agriculture and Energy

A year or two ago, there were high expectations surrounding liquid bio-fuels as a resource that could potentially mitigate global climate change, contribute to energy security and support agricultural producers around the world. Many governments cited these goals as justifications for implementing policies promoting the production and use of liquid bio-fuels based on agricultural commodities. Since then, there has been a marked change in perceptions of bio-fuels. Recent analysis has raised serious questions regarding the full environmental impacts of producing bio-fuels from an already stressed agricultural resource base. The costs of policies aimed at promoting liquid bio-fuels and their possible un-intended consequences are beginning to attract scrutiny. Food prices have risen rapidly, sparking protests in many countries and giving rise to major concerns over the food security of the world's most vulnerable people.

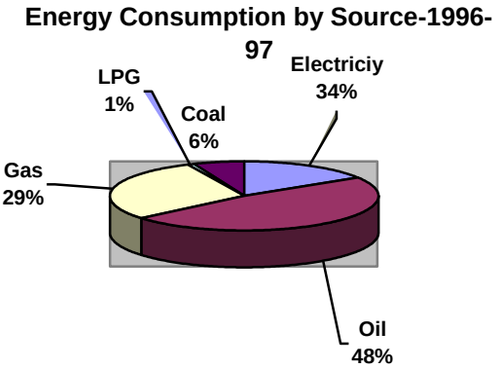
However, bio-fuels are only one of many factors that have driven the recent rise in commodity prices. Also, bio-fuels have other implications beyond their effect on commodity prices. It examines the policies being implemented in support of bio-fuels and the policies that would be needed to address their implications for the environment, food security and the poor. Agriculture and energy have always been tied by close links, but the nature and strength of the relationship have changed over time. Agriculture has always been a source of energy, and energy is a major input in modern agricultural production. Until the nineteenth century, animals provided almost all the "horse power" used for transport and farm equipment, and in many parts of the world they still do. Agriculture produces the "fuel" to feed these animals; two centuries ago, around 20 % of the agricultural area in the United States of America was used to feed draught animals. The linkages between agriculture and energy output markets weakened in the twentieth century as fossil fuels gained prominence in the transport sector. At the same time, linkages on the input side strengthened as agriculture became increasingly reliant on chemical fertilizers derived from fossil fuels and machinery powered by diesel. Food storage, processing and distribution, too, are often energy intensive activities. Higher energy costs, therefore, have a direct and strong impact on agricultural production costs and food prices. The recent emergence of liquid bio-fuels based on agricultural crops as transport fuels has reasserted the linkages between energy and agricultural output markets. Liquid bio-fuels have the potential to exert a significant effect on agricultural markets, but they are, and are likely to remain, a relatively small part of the

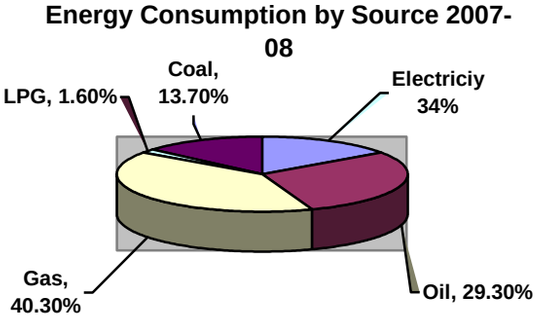
overall energy market. The world's total primary energy demand amounts to about 11400 million tonnes of oil equivalent (Mtoe) per year (IEA, 2007); biomass, including agricultural and forest products and organic wastes and residues, accounts for 10 % of this total. Fossil fuels are by far the dominant source of primary energy in the world, with oil, coal and gas together supplying more than 80 % of the total. Renewable energy sources represent around 13 % of total primary energy supply, with biomass dominating the renewable sector. In some developing countries, as much as 90 % of the total energy consumption is supplied by biomass. Solid bio-fuels such as fuel wood, charcoal and animal dung constitute by far the largest segment of the bio-energy sector, representing a full 99 % of all bio-fuels. In recent years, liquid bio-fuels have grown rapidly in terms of volume and of share of global demand for transport energy.

13 Pakistan Energy Conservation Directory

13.1Energy Consumption

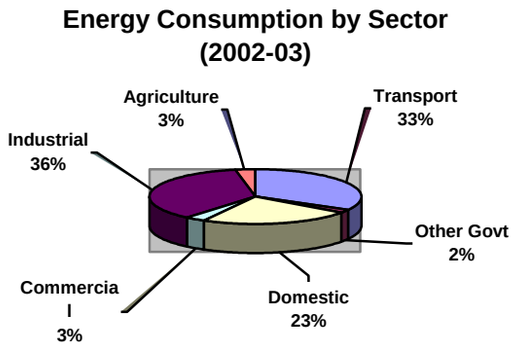
The energy consumption mix of Pakistan has changed over the past decade or so. The shares of gas and coal increased to 40.3 % and 13.7 % respectively since 1996-97, coal consumption has witnessed a 7.7 %age point increase in its share during the period. On the other hand, the share of oil consumption has decreased to 29.3 % while the share of electricity consumption has remained almost equal to its 1996-97 position. This overall change in the energy consumption mix is due to the availability of indigenous energies such as gas and coal as well as the partly due to volatile prices of oil.

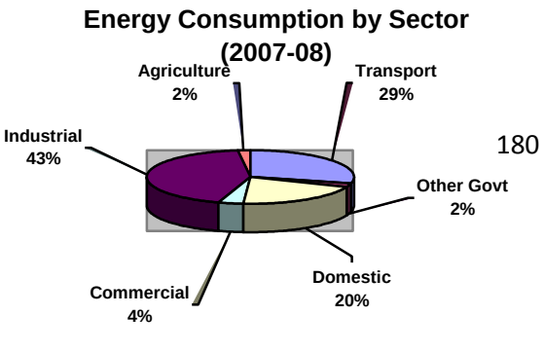




Source: Hydrocarbon Development Institute of Pakistan

Sector wise energy consumption during the year 2007-08 witnessed variation from its position of 2002-03. As Industrial and commercial sector witnessed an increase in its Share in overall energy. A review of the past pattern of energy consumption from 1998-99 to 2007-08 reveals





that there is a

persistent shift in energy consumption from petroleum products to other energy sources such as Coal, Electricity and Gas. The consumption of petroleum products increased at an average rate of 1.4 % annually, whereas the consumption of Coal, Gas and Electricity grew at an annual average rate of 13.5 %, 8.2 % and 6.1 % respectively. Notwithstanding the positive annual growth during last decade, energy consumption witnessed a negative growth in all sources (except electricity which showed almost flat growth of 0.7 %) during July-March 2008-09. A major reason for negative growth in energy consumption is the relatively lower level of economic activity during this period, and partly due to circular debt problem in the energy sector.

Table: 56 Annual Energy Consumption

Fiscal Year	Petroleum Products		Gas		Electricity		Coal	
	Tones (000)	Change (%)	(mmcft)	Change (%)	(Gwh)	Change (%)	M.T* (000)	Change (%)
1998-99	16,647		635,891		43,296		3,461.40	
1999-00	17,768	6.7	712,101	12.0	45,586	5.3	3,167.90	-8.5
2000-01	17,648	-0.7	768,068	7.9	48,584	6.6	4,044.70	27.7
2001-02	16,960	-3.9	824,604	7.4	50,622	4.2	4,408.60	9.0
2002-03	16,452	-3.0	872,264	5.8	52,656	4.0	4,889.90	10.9
2003-04	13,421	-18.4	1,051,418	20.5	57,491	9.2	6,064.50	24.0
2004-05	14,671	9.3	1,161,043	10.4	61,327	6.7	7,893.80	30.2
2005-06	14,627	-0.3	1,223,385	5.4	67,603	10.2	7,714.00	-2.3
2006-07	16,847	15.2	1,221,994	-0.1	72,712	7.6	7,894.10	2.3
2007-08	18,080	7.3	1,275,212	4.4	73,400	0.9	10,110.60	28.1
Avg. 10 years		**1.4**		**8.2**		**6.1**		**13.5**
July-March								
2007-08	13,342		955,625		55,208		6,559	
2008-09 (e)	12,892	-3.4	931,700	-2.5	55,614	0.7	4,822	-26.5

e: estimated for coal
***Million Ton**

Source: Hydrocarbon Development Institute of Pakistan

13.2Petroleum Products

During three quarters of current fiscal year i.e. July-March 2008-09, the consumption of petroleum products by most of the sectors (other than the power sector and government sector) exhibited a negative growth over the same period last year. The consumption of petroleum products in the power sector increased marginally. The fact that the consumption of petroleum products remained negative reflects the state of the economy along with higher consumer prices of POL Products.

Table: 57 Consumption of Petroleum Products (000 tones) **(%age Change)**

Year	House holds	Change (%)	Industry	Change (%)	Agriculture	Change (%)	Transport	Change (%)	Power	Change (%)	Other Govt.	Change (%)	Total
1998-99	493		2,140		249		7,864		5,526		376		16,648
1999-00	477	-3.2	2,116	-1.1	293	17.7	8,308	5.6	6,228	12.7	346	-8.0	17,768
2000-01	451	-5.5	1,924	-9.1	255	-13.0	8,158	-1.8	6,488	4.2	372	7.5	17,648
2001-02	335	-25.7	1,612	-16.2	226	-11.4	8,019	-1.7	6,305	-2.8	464	24.7	16,960
2002-03	283	-15.5	1,604	-0.5	197	-12.8	8,082	0.8	6,020	-4.5	266	-42.7	16,452
2003-04	231	-18.4	1,493	-6.9	184	-6.6	8,464	4.7	2,740	-54.5	309	16.2	13,421
2004-05	193	-16.5	1,542	3.3	142	-22.8	9,025	6.6	3,452	26.0	317	2.6	14,671
2005-06	129	-33.2	1,682	9.1	82	-42.3	8,157	-9.6	4,219	22.2	359	13.2	14,627
2006-07	106	-17.8	1,596	-5.1	97	18.3	7,982	-2.1	6,741	59.8	325	-9.5	16,847
2007-08	121	14.1	1,071	-32.9	109	12.7	9,384	17.6	7,084	5.1	311	-4.5	18,080
July-March.													
2007-08	82		861		87		6816		5255		243		13342
2008-09	75	-8	718	-17	50	-42	6307	-7	5497	5	245	1	12892

Source: Hydrocarbon Development Institute of Pakistan

13.3Natural Gas

Consumption pattern of gas by different users since 1998-99 is presented below. The sectoral consumption of gas indicates that the household, commercial, fertilizer, industrial and transport sectors have experienced growth in consumption of gas during 2007-08. Likewise, consumption of gas in the transport sector increased by 27.1 % mainly due to a shift from imported fuel oil to relatively cheaper source of gas during July-March 2008-09 followed by the commercial, industrial and fertilizer sectors with the growth rate of 3.2 %, 2.8 % and 0.7 % respectively. The gas consumption in industry increases owing to its cost effectiveness. Fertilizer sectors gas consumption showed a negligible improvement of 0.7 % during first nine months of the current fiscal year. However, the major gas consuming sectors witnessing negative growth are cement and power having declined by 35.3 % and 13.1 % respectively over the same period last year due to reduced construction activities coupled with problems like inter corporate circular debt which laid power plants to remain under utilized;

Table: 58 Consumption of Gas (Billion cft) **%age**

Year	House hold	Change (%)	Comm-ercial	Change (%)	Cement	Change (%)	Ferti-lizer	Change (%)	Power	Change (%)	Indus-trial	Change (%)	Transport (CNG)[P] mmcft	Change (%)
1998-99	131		21		8		167		184		121		2,182	
1999-00	139	6.1	22	4.8	9	12.5	177	6.0	227	23.4	135	11.6	2,426	11.2
2000-01	141	1.4	21	-4.5	7	-22.2	175	-1.1	281	23.8	139	3.0	4,423	82.3
2001-02	144	2.1	22	4.8	7	0.0	178	1.7	315	12.1	151	8.6	7,369	66.6
2002-03	154	6.9	23	4.5	3	-57.1	181	1.7	336	6.7	165	9.3	11,320	53.6
2003-04	155	0.6	24	4.3	8	166.7	185	2.2	470	39.9	193	17.0	15,858	40.1
2004-05	172	11.0	27	12.5	13	62.5	190	2.7	507	7.9	226	17.1	24,443	54.1
2005-06	171	-0.6	29	7.4	15	15.4	198	4.2	492	-3.0	279	23.5	38,885	59.1
2006-07	186	8.8	31	6.9	15	0.0	194	-2.0	434	-11.8	307	10.0	56,446	45.2
2007-08	204	9.7	34	9.4	13	-15.1	200	3.1	430	-1.0	323	5.1	72,018	27.6
July-March														
2007-08	173		25.6		9		149		320		227		51,700	
2008-09	172	-0.5	26.4	3.2	6	-35.3	150	0.7	278	-13.1	234	2.8	65,725	27.1

P: Provisional **Source: Hydrocarbon Development Institute of Pakistan**

13.4Electricity

After at an average rate of 6.1 % per annum since 1999-00 to 2007-08, the electricity consumption by different sectors increased merely by 0.7 % during July-March 2008-09 against the comparable period last year. This trend of the decelerating growth of electricity consumption started in 2006-07. With the exception of Other Government Sector, all remaining sectors witnessed a negative growth during July-March 2008-09 over the same last year. Reduction in consumption of electricity by different sectors is due to a shortage of electricity, its higher cost due to gradual phasing out of a subsidy on electricity.

Table: 59 Consumption of Electricity by Sectors **%age**

Year	Trac-tion	House hold		Commercial		Industrial		Agriculture		Street Light		Other Govt.		Total
		GWH House hold	Change (%)	GWH (000)	Change (%)	GWH (000)	Change (%)	GWH (000)	Change (%)	Gwh	Change (%)	GWH (000)	Change (%)	
1998-99	15	19.4		2.4		12		5.6		224		3.6		43,296
1999-00	15	21.4	10.3	2.5	4.2	13.2	10.0	4.5	-19.6	239	6.7	3.6	0.0	45,586
2000-01	13	22.8	6.5	2.8	12.0	14.3	8.3	4.9	8.9	213	-10.9	3.5	-2.8	48,584
2001-02	11	23.2	1.8	3	7.1	15.1	5.6	5.6	14.3	212	-0.5	3.5	0.0	50,622
2002-03	10	23.7	2.2	3.2	6.7	16.2	7.3	6	7.1	244	15.1	3.4	-2.9	52,656
2003-04	9	25.8	8.9	3.7	15.6	17.4	7.4	6.7	11.7	262	7.4	3.7	8.8	57,491
2004-05	12	27.6	7.0	4.1	10.8	18.6	6.9	7	4.5	305	16.4	3.8	2.7	61,327
2005-06	13	30.7	11.2	4.7	14.6	19.8	6.5	7.9	12.9	353	15.7	4	5.3	67,603
2006-07	12	33.3	8.5	5.4	14.9	21.1	6.6	8.2	3.8	387	9.6	4.4	10.0	72,712
2007-08	8	33.7	1.2	5.6	3.7	20.7	-1.9	8.5	3.7	415	7.2	4.5	2.3	73,400
July-March														
2007-08	7	25.2		4.1		15.7		6.5		321		3.4		55,208
2008-09	4	23.6	-6.3	3.8	-7.3	14.6	-7.0	6.5	0.0	307	-4.4	6.8	100.0	55,614

Source: Hydrocarbon Development Institute of Pakistan

ENERCON, has been designated as focal national agency, mandated to coordinate Energy Conservation activities for all sectors of the economy, & has been grappling to find ways and means to plug the huge inefficiencies and wastages of energy amounting to about 25% of total consumption. Series of intensive consultations and interaction with the consumers and stakeholders has thrown up mutually agreed steps and actions to be taken by different actors in the energy sector, some of the best practices are as follows;

13.4.1 Enactment of Pakistan Energy Conservation Act

After series of consultations the Draft Energy Conservation Bill has been finalized and after appropriate procedural touching up it would be submitted for consideration of the Cabinet. After clearance from Cabinet, the same would be placed before the Parliament for debate, discussion & followed by promulgation.

Designation/Appointment of Energy Managers

All public sector concerns directed to designate/appoint Energy Managers for efficiency considerations in all industrial entities, commercial, government and community buildings and public sector transport / fleets e.g. PIA, NLC, etc.

Replacement of Old/ Inefficient Geysers

All old and inefficient geysers in government residences in major cities be started replacing by SNGPL & SSGC; and similarly the gas utilities may launch an incentive replacement scheme (through subsidized billing) for general consumers.

Ban on Import of More Than 5 years Old Boilers

A complete ban be imposed on import of more than 5 years old boilers.

Incorporation of Energy Efficiency Parameters in the Inspectorate of Boilers Manual

Ministry of Industries may include "Energy Efficiency" parameters in the "Inspectorate of Boilers" Manual.

Promotion of High Efficiency Electric Arc Furnaces

Ministry of Industry may undertake / launch incentives promotion of high efficiency Electric Arc Furnaces with minimum 50 ton capacity

Capacity Building of Textile Units

100 textile units, through capacity building of its engineers/technicians may be prepared for efficiency considerations.

Development of Efficiency Standards

Ministry of Industry has developed efficiency standards for pumps, motors and fans for over 5000 manufactures.

Reduction in Inefficiencies of Water Pumping Stations

Municipal authorities (KW&SB, WASA etc.) have taken steps for reducing their pumping systems inefficiencies by 50%. MINFAL, Provincial Departments has undertaken mandatory energy audit of tube wells and water pumping stations through consultancy services developed by ENERCON. An advanced model for energy service companies cannot address all challenges on the way to grow an EE market. It needs to be accompanied by massive efforts for capacity building in the regulatory and administrative bodies, by the development of standardization, monitoring and enforcement of regulations, by education and promotion of EE throughout all sectors of the economy. But it can address issues which occurred at EE

projects in the past, and which remain relevant in today's EE markets, such as fraud by clients, who want to avoid payment to the ESCO under a performance contract, addressing the bank's risk perception by risk sharing, and attracting international service and equipment providers to bridge the initial shortcomings of emerging EE markets in terms of quantity and quality of domestically available services and technologies. It is a part of the solution, and not the only effort required to foster EE market development in Pakistan

Favorable Import Tariff Regime and Standardization of Pumps and Motors

Engineering Development Board (EDB) and Pakistan Standards Quality Control Authority (PSQCA) ensured favorable import tariff regime and standardization of pumps and motors. Pakistan Procurement Regulatory Authority (PPRA) has been directed to amend regulations to prevent procurement of energy inefficient equipment including pumps and motors.

100 Mega Watt Saving Through Reduction in Line Losses

PEPCO is making an effort to reduce line losses by 1% for achieving 100 Mega Watt savings. Savings Through Reduction in Line Losses of Gas Transmission & Distribution System Line losses in gas transmission and distribution system be reduced by 0.5 % for nearly a billion rupees saving.

Replacement of Inefficient Domestic Burners in 10 Major Cities

Ministry of Petroleum & Natural Resources has been directed to finalize launch of the project for replacement of inefficient domestic burners in 10 major cities (benefiting over 3 million middle and lower middle class consumers).

Certification of Motor Vehicle Fitness Through Private Sector to Strengthen Motor Vehicle Examiner

All road plying vehicles be brought under the ambit of Motor Vehicle Examiner (MVE) through legislation and the certification function & may be transferred to private sector after phased installation of emission control/tune up equipment at selected retail outlets of oil companies.

Efficiency Standards for Domestic Appliances

Ministry of Science & Technology (Pakistan Standard Quality Control Authority) be directed to finalize efficiency standards for domestic appliances comparable with South Asian region. Federal Board of Revenue (FBR) to allow import of only energy efficient and duly labeled appliances as per approved standards.

Time of Use (TOU) Meters

Ministry of Industries has the instruction to encourage use of "Time of Use (TOU)" Meters for maximum utilization of off-peak hours. PEPCO is taking initiative to initiate multiple 4 part tariff system for maximum utilization of off-peak hours. Federal Board of Revenue (FBR) may abolish import duty and sales tax on "Time of Use" (TOU) Meters to incentives their use.

One Time Exemption on Import Duty of 10 Million Energy Savers

Government is planning to grant one time exemption on import duty for 10 million Energy Savers, and 5 years tax holiday for domestic industry on energy savers local manufacture. PEPCO to ensure registration of this activity under Kyoto Protocol for earning Carbon Emission Reductions (CERs)

Building Energy Code

ENERCON has completed the consultation process with stakeholders & finalized Building Energy Code and steps are being taken to incorporate in the Building Code of Pakistan for mandatory compliance & appropriate tariff facilitation is being provided by Federal Board of Revenue (FBR) for import of needed inputs e.g. insulation, HVAC and other materials/ appliances.

14 Energy Conservation R & D Activities

14.1Energy Conservation Assessment and Planning

Pakistan has already given the assessment of Energy Conservation potential, setting of National Energy Conservation targets and strategies, planning and budgeting of sectoral programs, development of legislative and regulatory initiatives, identification of training and educational needs.

Energy Conservation Policy Analysis:

Economic and policy analysis of energy demand and conservation potential at the national level, with a particular emphasis on the role of energy pricing policies, and recommendations for policy changes to improve the efficiency of energy use.

Energy Conservation Program and Project Design and Evaluation:

Detail design of Energy Conservation initiatives and the evaluation of existing conservation activities.

Research and Development:

Research and development to support technical assistance activities involving the implementation of Energy Conservation technologies or the adaptation of existing technologies.

On-Site Management and Technical Assistance:

Direct management and technical assistance to the staffs of energy-consuming facilities (e.g., factories, electric power generating plants, oil refineries, commercial buildings, transportation fleets) and public and private organizations those are responsible for designing, implementing and monitoring Energy Conservation projects and programs. This includes energy audits, identification and recommendation of short, medium, and long term energy saving improvements ranging from no cost measures to those requiring major investments, feasibility studies, installation, operation, and monitoring of Energy Conservation measures, and design and implementation of fiscal, personnel, and procurement management systems.

Training and Curriculum Development:

Classroom and on-the-job training for managerial and technical personnel on topics including energy management techniques, energy auditing, proper operation and maintenance practices, feasibility analyses of investments, financial evaluation of Energy Conservation projects, and the development of programs to promote Energy Efficiency. Development of new courses and degree in Energy Management and teacher training.

Support Services for Financing and Implementation of Conservation Projects:

Advisory services to public and private sector enterprises with a secure financing for Energy Conservation investments. This includes pre-investment analyses, pre-feasibility and feasibility studies, assistance with the preparation, packaging, and presentation of financing proposals and requests for proposals, and assistance to governments in establishing programs of credit, tax incentives, or other policies and programs to encourage investments.

Information Development and Dissemination:

Preparation and dissemination of materials to improve education and the flow of information on Energy Efficiency, including written reports, articles, brochures and other promotional materials, computer software, audio-visual materials, newsletters, conferences, and workshops.

Importance of High Level Commitment to Energy Conservation

One of the most important lessons, one that seems obvious, but is often over looked, is that there is no better policy than a high level government commitment to Energy Conservation. A government endorsement of Energy Conservation, at the highest levels, to-

gether with a political mandate to promote Energy Conservation, is the starting point for effective Energy Conservation policies.

14.2 Importance or Energy Pricing Policies and the Proper Policy and Investment Climate

The creation of the proper policy and investment climate is especially critical to the success of Energy Conservation programs. Energy Conservation projects will not succeed if energy users are not receiving the correct pricing and other policy signals. One of the most important government policies or incentives is the creation of a highly competitive economic and business environment, which encourages energy consuming enterprises to undertake cost cutting and productivity enhancing measures such as Energy Conservation.

14.3 Importance of Applying a "Total Energy Management" (TEM) Approach

The largest energy savings are achieved when Energy Conservation is viewed as a "Total Energy Management" (TEM) process that takes into account and orchestrates all the activities that need to be carried out to achieve energy savings, beginning with top management commitment and following through to retrofit construction. The Total Energy Management (TEM) approach requires the full integration of most Energy Conservation activities and the careful timing of program implementation. The Total Energy Management (TEM) approach is being used in the planning, design, and implementation or Energy Conservation programs in Pakistan.

14.4 Development of Energy Conservation "Infrastructure" Takes Time

Energy Conservation is not a discrete activity, but rather a complex process that proceeds through at least five phases;

- Development of Energy Conservation awareness
- Development of energy management skills
- Implementation of housekeeping and other no-cost/ low-cost measures
- Implementation of well proven and commercially available technologies
- Implementation of new and advanced technologies

experience has shown that it takes a long time usually several years to reach the fourth and fifth phases. Time is required to develop the institutional infrastructure for Energy Conservation and the necessary awareness and skills, to convince energy users of the technical and economic viability of more capital intensive Energy Conservation measures.

14.4.1 Importance of the Private Sector

Energy Conservation is an excellent vehicle for private sector development and it is important to look at the private sector as both a means and an end for Energy Conservation programs. Past experience has shown that well established and well respected private sector

organizations can play a key role in the design and implementation of Energy Conservation programs. Efforts should continue to focus on using the private sector to design, finance, and implement Energy Conservation projects and more technical assistance and training should be directed toward private sector "intermediaries" (e.g., engineering firms, equipment distributors, commercial banks).

14.4.2 Role of Technologies

Most of the energy savings achieved to date in developing countries have been through no cost and low cost housekeeping measures. However, international experience has shown that additional substantial energy savings (between 10 and 40 percent) can only be achieved by investing in specialized technologies. Although many of these technologies are already well proven in industrialized countries, most developing countries have not entered these later phases in the Energy Conservation process. Experience in both industrialized and developing countries indicates that incentives are usually required to encourage energy consuming enterprises to investment in these technologies, at least in the early stages of an Energy Conservation technology promotion program.

Experience in developing countries has shown that many energy consuming enterprises are eager to use new, more efficient technologies, but that they need financial and technical assistance in order to take the risk of implementing a technology for the first time in their own country. These factors imply a need for technology demonstration programs to prove the technical and economic viability of Energy Conservation technologies in the individual country environment. Technical and financing assistance, training, and the dissemination of information are also necessary to promote widespread and broad based investments in Energy Conservation technologies.

14.5 Electric Utility Based Demand Management

Electric utility sponsored programs in the areas of power plant rehabilitation, load management, and end use Energy Conservation have been very successful and still offer a very large potential for additional savings. The reason for this success and potential include the fact that the national electric utility is often;

- A unique reservoir of talents in a country
- A highly respected and credible organization
- A favored program counterpart because of its track record of working with organizations and its ability to handle large programs and large budgets. It has been estimated that up to 10 percent of both maximum demand (kW) and energy (kWh) could be saved with no or little experience in these fields, at a benefit/cost ratio of 4 to

6 times higher than new power generation projects.

14.6Energy Conservation and the Environment

For many years, the international scientific and environmental communities have issued warnings concerning the health and environmental implications of air pollution. Most recently, there has been growing concern about the high concentrations of carbon dioxide (CO_2) and other trace gases in the atmosphere, the resulting "greenhouse" effect, and its implications for global climate changes. The combustion of fossil fuels is the major source of increased concentrations of CO_2 in the atmosphere, and emissions of nitrogen oxides (NOx) and sulfur dioxide (SO_2) which cause acid deposition as well as other particulates, which have determental impacts on public health and can cause serious crop damage.

Most developing countries have relied on fossil fuels to meet the energy needs of industrialization and development, and their future development plans are also based on the use of fossil fuels. Coal, which has the most serious environmental impact, plays a particularly important role in the development plans of a number of countries, including China, India, and Pakistan.

Energy Conservation and efficiency offers an important opportunity to decrease emissions of CO_2, NOx, SO_2, and particulates from electric power plants, industrial facilities, and motor vehicles, and hence delay and mitigate environmental degradation and global climate changes, by reducing the energy needs of economic growth and conserving depletable energy resources, Energy Conservation promotes the most environmentally sustainable and economically sound growth and development.

14.6.1 Buildings

The buildings sector is the most rapidly growing energy consuming sector in Pakistan and is creating the most severe problems for electricity supply; Electricity use in buildings is now growing at 13.7% annually. A major portion of this growth is air-conditioning, which although in use in less than one percent of households, accounts for a significant portion of system peak.

Unlike the industrial sector where large savings can be relatively quickly obtained through retrofit or operation and maintenance changes, the problems in the buildings sector are more systemic. Design of large buildings has become increasingly "Westernized", necessitating the use of air-conditioning. Building materials needed to conserve energy, such as lightweight concrete, insulation materials, weather stripping or reflective, water-proofing coatings, are either not produced in the country or produced in only limited amounts. Also, the awareness level of those pertaining to Energy Efficiency designing and

constructing more buildings is inadequate, so that the upgrading of skills may take much longer than in the industrial sector.

14.6.2 Agriculture

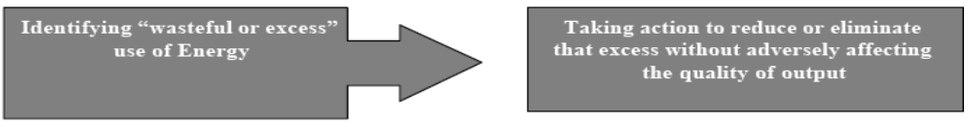
Although agriculture consumes 11% of commercial energy, the sector accounts for approximately half of all employment and exports. The two main uses of commercial energy in the sector are tractors and tube wells R&D efforts has been concentrated all efforts in these areas.

Tube well Audit and Retrofit: A program to audit tube wells and retrofit has been initiated. The results will form the basis of a national program to improve the efficiency of tube wells.

Tractor Efficiency Improvement: A detailed plan has been developed to improve the efficiency of tractors, both in their mechanical efficiency and their efficiency of operation.

14.7Best Practices in Spinning Sector

The Energy Efficiency (EE) by definition means using less energy to achieve same or better output compared to pre-implementation of the Energy Efficiency project. It means not rationing rather identifying wasteful energy and takes steps to reduce or eliminate that waste without adversely effecting the production and the quality of output, as depicted below:



It refers to any process, technique or equipment that helps to achieve reduction in energy consumption to perform a designated operation to achieve same or better level of output while maintaining or improving process time, quality, performance and safety with minimal environmental impact.

Advantages of Energy Efficiency

The following are some of the advantages of implementing EE projects:

- Reduction in energy consumption, thereby adding directly to the profits
- Lowering the vulnerability to energy prices for unit/corporate that has EE projects
- Reducing the need for investment in newer power plants and import of energy
- Reducing the dependence on conventional resources like oil and natural gas
- Reducing emissions of air pollutants

15 Energy Efficiency Projects

A preliminary Energy Efficiency assessment conducted in 2007 under ADB's Energy Efficiency Initiative determined that Pakistan has a large potential for Energy Efficiency improvements. They have identified several Energy Efficiency improvement opportunities in gas distribution and power generation and in the industrial, transportation, commercial, government, and residential sectors that can be tapped into. Some of these opportunities can be exploited immediately without extensive analysis, policy design, or framework development. International experience shows that among all these potential programs one of the most efficient is to promote Compact Fluorescent Lamps (CFLs) in the domestic sector, it can be quickly implemented; results in savings through its impact on peak demand in the evening and generates economic benefits for energy users as well as the society at large.

CFLs already have a substantial shade of the residential lighting market and are out selling incandescent lamps. But a program to accelerate their market penetration can have a quick and lasting impact on the power demand curve. The government is interested in just such an aggressive CFL program that has a quick payback and can have an immediate impact on alleviating the ongoing power supply shortages.

15.1 Renewable Energy & Energy Efficiency (REEE) Program- NPO & GTZ

The Renewable Energy & Energy Efficiency (REEE) Program was initiated in July 2006 jointly by Small and Medium Enterprise Development Authority (SMEDA), National Productivity Organization (NPO) and Deutsche Gesellschaft für Technische Zusammenarbeit-German Technical Cooperation (GTZ). The objective of REEE Program is to strengthen the industrial sector of Pakistan and to help better cope with rising energy prices and resource constraints. Textile is the first sector that has been selected under this Program. In the first phase, six textile units from Spinning and Processing sub-sectors (two each from Karachi, Lahore and Faisalabad) were selected as pilot projects to demonstrate energy efficiency gains as a result of Detailed Energy Audits (DEAs) and targeted interventions. The outcomes of Energy Audits show great potential for energy efficiency. By implementing suggested measures, an average 10% of the energy saving potential in spinning units and 25-30% saving potential in processing units has been identified. Since the results of energy audits are very encouraging, we are confident that expanding the same with the co-operation of stakeholders and trade associations will greatly help in bridging the gap between demand and supply of energy and ensuring competitiveness of the textile industry. We are currently in the process of devising a strategy for replicating these DEAs and also expanding the scope of this work to other sub-sectors of textile industry.

Looming resource constraints, rising energy prices and consumer demands for environment friendly textile products are some of the challenges faced by the Pakistani

industry. The Program Renewable Energy & Energy Efficiency (REEE) specifically addresses the productivity energy efficiency deficits of the industry. The textile industry being an energy intensive sector is vulnerable to a higher rate of energy losses across various production processes resulting in higher energy bills, and productivity losses all of which have significant financial impact. Employing energy efficient, environmentally sound technologies and adopting cleaner production techniques will help ensure that Pakistani Textile Industry remains competitive in the post WTO scenario.

To assist the textile sector in this regard, SMEDA and National Productivity Organization (NPO) have collaborated with the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH to help identify and address the energy losses experienced by the textile sector within the framework of the Renewable Energy & Energy Efficiency (REEE) Program.

A joint team comprising of German Experts and SMEDA/NPO along with local consultants is conducting detailed Energy Audits. The main objective of the investigations is to determine concrete, technically and economically feasible measures suitable to reduce cost of energy at the investigated plants. The energy savings potential are quantified for specific measures which will be evaluated technically and economically. The analysis starts with a comprehensive and systematic stocktaking of the energy situation at the sites at production process level, taking into account existing and available information. Consequently, the critical points are identified and analyzed.

As a first step, to demonstrate energy efficiency and related productivity gains in the textile industry, six demonstration projects within the different sub-sectors (Spinning, Weaving and Processing) have been selected. It has been observed that REEE program will help the Textile Industry in the following key areas:

- Raise awareness with respect to industrial energy efficiency
- Conduct/ facilitate industrial energy audits
- Energy and cost savings by identifying suitable energy saving measures
- Reduction in Electricity & Gas Bills
- Recycling or utilization of useable waste resources
- Optimal capacity utilization of Energy Resources
- Institute industrial training, ‘train-the-trainer’ programs.
- Build capacities of local consultants with specific reference to energy efficiency

In order to share the benefits of the expertise and knowledge of the Energy Experts team, the relevant industrial units are invited to be the part of this program as model unit(s). Upon

request, the relevant team of experts would spend a defined time period at the factory and will guide about the energy saving measures that can take place based on the specific needs of unit.

15.2National Compact Fluorescent Lamp (CFL) Project

Project will replace 30 million incandescent bulbs in the domestic sector with efficient, high-quality CFLs. The project will accelerate CFL market penetration and will result in around 1,131 MW reduction the evening peak electricity demand and yearly savings in electricity consumption of 2310.5 GWh by 2011, thus alleviating the current power supply deficits.

Projects to be financed under subsequent tranches will include;

- Loss reduction in gas transmission and distribution networks
- Replacement of inefficient thermal power generation units
- Public buildings Energy Efficiency retrofits
- Financing of industrial Energy Efficiency investments
- Domestic gas appliance upgrades and replacements

15.3Project Preparation, Implementation, and Monitoring Capabilities

The Investment Program combines both physical and non-physical investments, with the objective of establishing a self sustaining national Energy Efficiency market. The implementation of the Investment Program requires significant dedicated management capacity within the Government for effective policy formulation, planning and program implementation, and coordination amongst various stakeholders. However, the current institutional capacity is weak, and the investment program support component focuses on addressing existing shortcomings at different levels.

15.4Planning and Policy Level

The Planning Commission, as the apex government economic and energy planning agency with an overarching, cross ministerial advisory and coordination mandate, will be the Executing Agency (EA) for the overall Investment Program, while the Program Management Office (PMO), to be established under the Member, Energy, Planning Commission, will be responsible for the supervision and monitoring of the Investment Program.

The PMO will be sufficiently staffed and resourced under the Investment Program Support Component, with a capacity to undertake overall program management and coordination with the Government, ADB, and other development partners. It will oversee the implementation of each tranche, including monitoring compliance with performance milestones, environmental requirements, and social safeguards. It will also recruit consultants to support relevant agencies to prepare future investment

projects. External expertise will be provided under the program to support PMO in the implementation of the Energy Efficiency Sector Roadmap and for adopting best practices in project and policy development, as well as human resource development and training.

15.4.1 Project Implementation Level

The individual investment projects will be managed by the relevant implementing agencies. Project will be implemented by PEPCO and the power distribution companies (DISCOs). The Project Management Unit in PEPCO will be responsible for day-to-day project implementation tasks. PEPCO is an agency responsible for managing the unbundling of the power sector. It functions as the government's holding and managing agent for the four GENCOs, nine DISCOs, and the NTDC. PEPCO has appropriate capacity in managing investment projects being the executing agency for the ongoing Power Distribution Enhancement Program financed under an ADB MFF. However, the entities under PEPCO are currently facing severe financial constraints due to mismatch in the cost of electricity supply and consumer tariffs, arrears with government agencies, volatile fuel prices, and low revenue collection by some DISCOs.

In conjunction with other ongoing assistance, the Investment Program will help PEPCO and DISCOs in improving their financial and operational performance by reducing subsidized electricity consumption in the domestic sector, increasing sales to commercial and industrial sectors, and improving service quality. Project implementation consultants will be deployed to provide adequate support to project management, monitoring and evaluation, reporting, procurement, disbursement, operation and maintenance, financial management and compliance with policies and procedures.

15.5 Gas Transmission and Distribution Upgrades

In the natural gas transmission system, gas compressors are used to increase the upstream pipeline pressure of the gas by compressing it into smaller volumes. The increased pressure allows the transport of the gas through the transmission and distribution pipeline network. Currently, Sui Northern Gas Pipelines Limited (SNGPL) operates 11 compressor stations that use natural gas as fuel. SNGPL proposes to replace the existing outdated compressors with new, more efficient, and larger machines to enhance compression capacity and improve system reliability. Installation of more efficient compressors will reduce the consumption of gas and consequently the emission of air pollutants. The new compressors will replace existing compressors and will be installed within the premises of the existing facilities.

15.6Thermal Power Plant Loss Reduction

There are four public sector power generation companies (GENCOs) in Pakistan that operate 13 units based mainly on steam-cycle and combined-cycle technologies. Due to various reasons, mainly associated with the financial constraints faced by these companies, these plants are being operated at de-rated capacities nearly 25% below their nameplate ratings. The average forced outage rate for the GENCOs, at 12%, has been high compared with 6% for IPPs in the country. Nearly all GENCO plants are operating at much lower efficiency than the industry benchmark levels for plants of similar ages and configurations. Due to the aging of several plants, all of the de-rated capacity and efficiency cannot be economically restored. It is proposed that the existing units at three plants Guddu Steam, Faisalabad Steam, and Multan Steam be replaced by modern combined-cycle plants. The plant at Guddu is gas-fired and can use the same gas already allocated to the existing power plant to fuel the replacement plant. At the other two plants, the less efficient steam-cycle plant will be replaced by high efficiency combined-cycle plants. This will increase the power generation capacities of the plants by improving the efficiencies from the existing 22% to 31% to about 43% to 48%. The installation of these more efficient plants will also result in overall environmental benefits. These include reduced air pollution, reduced global warming and climate change impact, and less water consumption. The new units will be installed at the existing plant sites. Lower emissions will also benefit the communities living around the plants by reducing potential health risks to them. Good environmental practice demands that the operation of the entire facility comply with applicable environmental standards. Thus, the modification the plants will also address the environmental and social issues associated with the existing plants, and will bring the plants at par with modern power plants in terms of their environmental performance. This will be an added benefit to the local community and the environment.

15.6.1 Public Buildings Retrofits

This program aims at improving the Energy Efficiency through system upgrades of three targeted groups of government buildings offices, hospitals and educational institutions. The component includes creation of a new national Energy Efficiency Center (EEC) under the management of the Planning Commission. It includes a detailed study of selected buildings, energy audits, purchase of energy audit tools, data loggers and energy analysis software tools for undertaking building energy use analysis. It also includes the financing for implementation of

EE retrofits for the buildings selected for efficiency upgrades.

15.7 Industrial Energy Efficiency Financing

An industrial sector EE fund will be established to provide loans, contingency loans, or leases for the purchase of energy efficient equipment by industrial plants, especially electrical motors, boilers and furnaces, and other large- to medium scale investments, although small cogeneration units, HVAC, lighting retrofits, process controls, and other measures could be financed as well Retrofits and expansions would he supported through working capital and bridge funding arrangements with Pakistani commercial banks supplemented by equity financing from owners. Other than benefits associated with Energy Conservation, these measures often result in the installation of modern technologies that also have localized benefits, particularly in terms of occupational health and safety for the workers and the local community.

15.8 Domestic Gas Appliance Upgrades

The Energy Efficiency potential in gas used for domestic water heating in Pakistan is estimated to be 30%, which can be achieved by retrofitting existing water heating appliances. The gas utilities, SSGC and SNGPL, have devised some of these retrofits in collaboration with local technical partners. These retrofits include;

- Timing device to switch off the heater during parts of the day when hot water is not required
- De-scaling to improve heating efficiency
- Flue gas control to minimize heat loss from the exhaust

The potential for improvement in Energy Efficiency in space heating appliances is similarly estimated at 36%, which can be achieved by replacing them with more efficient ones.

16 Energy Covservation And Efficiency - Action Plan

Energy Conservation and Efficiency with a view to minimize the gap between demand and supply is a major national policy concern and it is the basis for developing strategies to meet the challenges. Adoption of Energy Conservation measures is the need of the hour as we have to share the national resources justly and also keep up the pace of economic progress. Due to prevailing energy crisis all industrialists, agriculturalists, businessman, workers and the common peoples, all have to sacrifice in bit of their needs and accordingly determine for themselves how to reduce the consumption of electricity, gas and fuel. For efficient use of available energy resources:

- Identify suitable energy saving measures by conducting energy audits
- Demonstrate energy and cost savings achievable
- Create greater awareness on efficient utilization of available resources through application of energy conservation techniques

16.1 Identification Of Energy Saving Potentials In Industrial Units

The following areas should be taken into consideration while assessing technical measures for energy saving:

Electrical Power

- Analysis of system efficiency of power plants, assessment of dimensions, design and operation mode
- Identification of main energy consumers
- Review of design and operation of equipment in order to get the maximum out put
- Identification of measures to optimize operating time of equipment and avoid idle time of machine

Thermal Systems

- Determination of system efficiency of boilers
- Assessment of distribution grids for steam and hot water (Insulation, Steam Trap, Condensate recirculation)
- Review of dimensions, design and operation of equipment in order to get the maximum out put
- Minimizing process steps

Energy Awareness

Energy Management program cannot run successfully unless workers are directly involved. To develop energy awareness, training should be imparted to all concerned; the focal points can be the importance of operational efficiency of the plant in order to achieve optimum performance of equipment.

16.2 Energy Savings Potentials in Transport Sector

In order to achieve the objectives in transport sector, all provincial governments and other major public and private transport sectors to carry out energy audit on quarterly basis. Government should also promote CNG public transport as preferred fuel. Following are the main objectives of transport energy audit:

- Encourage and facilitate energy conservation in transport sector
- To enhance productivity in transport sector

- To induct fuel efficient transport fleet
- Promote mass and transit public transport system and institute fleet management practices
- Promote use of other mode of transport like Railway, Buses etc

16.3 Energy Efficiency Improvements in Building

The Building Energy Codes draft has developed by ENERCON for optimum use of energy to operate the air conditioning, heating, ventilation and lighting system of building. The code shall regulate the design and construction of building for effective use of energy. The code is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve the effective use of energy. The Building Energy Codes have highlighted the importance of using energy efficiently to ensure sustainable growth of energy resources to power national development efforts. The focus is in the industrial, commercial and residential sectors and to:

- Help to align with efficient energy supply chain norms of major international markets
- Enable corporate and public institutions to discharge their responsibility towards resource conservation and environmental objectives
- Analyze the potential for increased values in energy efficient buildings from reduce utility bills, operating cost and increased occupant satisfaction using the income
- The benefit to the utility companies through significant reduction in peak demand

16.4 Energy Conservation Management Programs

ENERCON is engaged to develop the Energy Conservation Management in collaboration with Ministry Of Industries to embark upon efficiency enhancement programs. The salient features of programs are:

- Energy improvements in use of good quality material, wiring, chokes, fans and fluorescent lamps
- Use of energy saver lamps
- Proper adjustment of thermostat
- To make efficient use of energy in motors and pumps and other electric devices. (e.g Gas Geyser, Fans and Space Heaters etc)
- Use of LED lights
- Promote culture of Energy Conservation through electronic and print media to generate public awareness of economic and judicious use of electricity in houses and standardization of electric cables, wires and switches used in domestic sector

16.5 Training Methodology

Energy management program cannot be run successfully until workers & management realize the importance of energy conservation. The training can be conducted on following parameters:

- Provision of energy conservation measures checklist for each equipment to operator
- Provision of machine process parameters
- Energy awareness campaign
- Holding of presentations, lectures, lectures from guest speakers & In house brain storming sessions
- Safety procedures

17 Suggestions for Strategy & Mechanism for Initiating Sustainable Projects in the Region

Despite recent efforts to increase capacity and supply, Pakistan is presently suffering from serious energy shortfall. This shortfall is more pronounced in the electricity sector during peak hours resulting in significant power cuts affecting economic activity and delivery of social services. Frequent power cuts in the recent past resulting in reduced production levels in various industries have rendered many workers, mostly belonging to the poor segments of society, as unemployed. In addition, the phased adjustment to petroleum prices and electricity tariffs starting in 2008 following the increase in international oil prices has burdened poor consumers with growing expense in meeting their energy needs.

Achieving energy security and energy affordability are two main goals set in the Vision 2030 and the Medium-Term Development Framework of Pakistan. A recently updated Poverty Reduction Strategy (PRSP-ll) for 2009-11 aims at achieving poverty reduction through sustainable economic growth and employment generation. In achieving these objectives the strategy regards it essential to provide adequate energy to industry to drive economic growth and create employment opportunities; to the domestic sector for cooking and heating; and to prevent the continuing environmental degradation and deforestation by massive use of wood for domestic fuel. Based on these government priorities, improving Energy Efficiency is among key target of regional participation in these sectors under its Country Partnership Strategy for Pakistan.

The energy savings resulting from improved efficiency under the proposed program are expected to provide a more reliable energy supply to various sectors of the economy. The resulting sustained economic activity in particular in the industrial sector will indirectly benefit the industrial labor as their jobs will not be threatened by power cuts any more. Poor

and vulnerable consumers including social utilities like hospitals and schools often hardest hit by insufficient power supply and load shedding will also benefit as well from efficient and more reliable delivery of services.

17.1 Barrier Removal Cost-Effective Development and Implementation of Energy Efficiency Standards and Labeling Project (BRESL)

Energy-efficiency standards and labeling (ES&L) are among the most cost-effective types of policies and programs to mitigate global climate change. The reason for this is that these programs have the potential to effect complete market transformations for different classes of energy-saving products, at a cost far below the cost of providing new energy supply. ES&L programs contribute to the realization of the Millennium Development Goals (MDG), particularly MDGs 1, 7 and 8, whereby the program can contribute to the eradication of extreme poverty, improve environmental sustainability of a country's and/or a region's development path, and help improve trade ties and develop global partnership for development.

Asia accounts for 28% of world energy use, with China, Japan, India and South Korea using 73% of the total energy used in the region. The average rate of growth in energy use in Asia over the past decade has been 3.7%, over double the 1.6% world average. Throughout this region, growth in the demand for electric power is requiring the extension and upgrading of electricity transmission and distribution networks. Energy use related to buildings (including use of appliances and equipment and lighting) accounts for a significant percentage of the region's total energy consumption. With the rapid economic growth in many countries in the region, the demand for major appliances and equipment - ranging from refrigerators and clothes washers in homes, to photocopiers and lighting equipment in office buildings is expected to continue to grow. Such technologies primarily rely on fossil fuel based power generation, which is one of the major sources of greenhouse gas (GHG) emissions. It is estimated that, over the next decade, GHG emissions in the region will increase commensurate with economic growth, and these will have to be reduced if the global climate is to be stabilized.

Clearly, without focused efforts to better utilize energy efficient technology and reduce energy consumption by household and office appliances and equipment, energy demand in the residential and commercial sectors throughout Asia will continue to outstrip supply. The proposed project is entitled Barrier Removal to the Cost-Effective Development and Implementation of Energy Efficiency Standards and Labeling (BRESL). The goal of the project is the reduction in the annual growth rate of green house gas (GHG) emissions from thermal power generation in selected Asian countries. The objective of the project is the removal of barriers to the development and effective implementation of energy efficiency

standards and labeling (ES&L) programs, thereby facilitating the transformation of the regional product markets of targeted energy consuming appliances, equipment and lighting products. It will also facilitate harmonization of test procedures, standards and labels among developing countries throughout Asia, when appropriate. The project is applied for funding from the Global Environment Facility (GEF) and will be implemented by the United Nations Development Program (UNDP).

BRESL will be implemented on a regional basis in order to transform the regional product markets of the targeted appliances, equipment and lighting products, and address the common barriers to, and concerns about, ES&L by the participating countries. The harmonization of government policies and program that will help these markets deliver more energy efficient products can be most efficiently addressed regionally. The project will focus largely on capacity building and assisting government, manufacturing, distributing, retail, consumer and environmental stakeholders throughout the Asian region to implement the most cost-effective energy efficiency measure available. The technical assistance activities that make up this GEF project will be carried out by key agencies in the participating countries. In each country, priority activities, selected among a menu of interventions that will be offered by the project to help foster each country's preferred process for developing or expanding its ES&L program.

17.2Emissions Reduction Estimates

The BRESL Project is an OP-5 project intended to remove barriers to the cost-effective development and implementation of energy efficiency standards & labeling programs. The anticipated energy savings from the use of energy efficient products (appliances/equipment) that will be facilitated and influenced by the interventions that will be carried out in the project’s 7 participating countries (including Republic of Korea) will bring about CO2 emission reductions from the reduced utilization of fossil fuels used in thermal power generation units that produce the electricity utilized in these energy using products. BRESL is comprehensive OP-5 project covering 6 large end-use products. The implementation of ES&L initiatives catalyzed by the BRESL project will lead to about 24.8 million tons of CO_2 by end of project, and a cumulative CO_2 reduction of 37.3 million tons. The long-term CO2 emissions reductions will be much greater and cumulative reductions are expected to reach about 1,195 million and 3,867 million tons of CO_2 in 2021 and 2031, respectively.

These CO2 emissions reductions will be dispersed across the participating countries and will likely lead to substantial indirect emissions reductions as well. The product that will yield the largest CO2 emissions reductions is air conditioner.

18 Regional Project Proposal for Vehicle Fuel Efficiency and Emissions Standards Program

Motor vehicle fuel performance and exhaust emission standards exist in most developed countries and several developing nations. Since automobile manufacture and imports are highly centralized operations, such regulations can be easily promulgated and enforcement monitored, provided the government takes the lead in instituting them. The standard practice is to define fuel efficiency and emissions standards for different categories (e.g., engine sizes) of vehicles, institute a testing and certification program, and impose a punitive tax on those vehicles that fail to meet the applicable standards.

Pakistan is experiencing a dramatic increase in road transportation use road traffic has been increasing at an average annual rate of 14.1% in the 20 years since 1989, while more recently the local automobile and motorcycle manufacturing capacity has grown spectacularly. While instituting a comprehensive vehicle fuel and emissions standards, testing and certification regime will require significant time and effort, a start towards this goal can be initiated immediately. For instance, if certain international standards can be adopted locally, multinational automobile companies can be forced to implement them in their local manufacturing facilities rather than implementing lower quality engine technology in the country, as is often the case at present. Similarly, imported vehicles can be required to conform to such standards or face addition custom and excise duties.

A brief study can be conducted to review current international vehicle standards and regulations, and appropriate elements adopted, in other regional countries. For instance, India started adopting Euro 1 to 4 emission standards in 2000 for automobiles, light diesel vehicles, and inter-state buses, and Euro 2 and 3 standards for two-wheelers in 2005 and 2008, respectively. These standards are also gradually being extended to all diesel trucks and buses. Similarly, China applied Euro 1 standards in 2000, upgrading to Euro 2 in 2005 and Euro 3 in 2007. The United States first introduced Corporate Average Fuel Economy (CAFE) regulations in 1975, which uses sales-weighted average. The project can be implemented in other member countries with regional cooperation and exchange of reliable data information for effective energy efficiency planning. SAARC energy centre will provide base for regional cooperation projects for government & prospective investors.

18.1 Government Commitment

As in many other countries undertaking initial steps towards introducing energy efficiency on a national scale, government commitment to the cause in Pakistan has been sporadic, predicated largely by short-term economic necessity (fuel or power shortages, oil price escalation, etc.) rather than as a long term planning goal. However, given that one of the

pioneering national EE&EC programs amongst developing countries was undertaken by Pakistan beginning in the 1980s, the lack of meaningful progress subsequently in this respect should be of particular concern, highlighted not only by many other less advanced economies that have over taken Pakistan in terms of national EE indicators, but also the sharp reduction in the GoP's own current institutional EE&EC capacity and spending compared to the peaks achieved under donor-assisted programs in the past.

Meaningful political support to a national EE&EC initiative can only be assured if energy efficiency is accepted by the country's economic planners not just as a useful energy management option to be resorted to whatever extent possible when supply shortfalls loom or fuel prices surge, but as an economic goal in itself by targeting specific, time-bound reduction in national energy intensity in order to obtain maximum socio-economic benefits for its citizens as well as for making its industry competitive in the global marketplace.

This would require several conceptual changes in the planning process that would include:

- Embedding EE&EC in the national energy policy and security strategy as a targeted 'supply' option by identifying realizable energy use improvements in key consumption sectors of the economy.
- Evaluating available options, and the actions and means required, for achieving such EE&EC improvements according to a phased, sequential action plan which includes performance benchmarking, institutional monitoring, and verifiable program milestones.
- Devising an effective EE&EC institutional, policy, legal, and regulatory framework that can facilitate the implementation of such a coherent, long-term national EE&EC action plan in both the public and private sectors, including proper provisioning of financial, manpower, and technical resources for the purpose.
- Coordinating government and donor actions, policies, and planning to help, sustain and build upon successive EE&EC gains over the long term to help redirect national economic growth on a more energy efficient footing.

18.2 Planning and Coordination

Thoughtful planning of a revised national EE&EC initiative is required if previous mistakes are to be avoided. Well designed and sufficiently detailed planning would take into account past experience and local conditions, especially implementation and capacity constraints amongst potential stakeholders, as well as current conditions and emerging market opportunities, in four key aspects:

- Market and economic evaluation of significant, cost-effective EE&EC opportunities in key sectors, prioritization and sequencing of action areas, and definition of realistic national EE targets
- A review of the strategic approach to EE&EC implementation, with well defined stakeholder and institutional roles (including leadership responsibilities), focus areas, tasks, outputs, organizational setup, coordination and networking arrangements, and reporting requirements
- An evaluation of the technical, material, financial, manpower, and other resources required, and their respective sources, for meeting the investment and recurring costs of a sustained, long term EE&EC strategy, and necessary allocation and procurement of commitments from the respective stakeholder entities, led by the committee members.
- Establishment of effective institutional and national EE&EC performance data collection and monitoring mechanisms in the form of measurable milestones, information sharing, institutional and program evaluation, end-user and market feedback, etc., that allow for corrective actions and mid-course refinement to be undertaken promptly.

US AID has also been implementing the South Asian Regional Initiative (SARI) project in several South Asian nations (excluding Pakistan) since 2000, which has a major component focusing on the energy sector. Under the current phase of the SARI Energy Cooperation and Development (SARI/Energy) program, begun in 2007, Pakistan has also been included as a recipient of technical assistance. The program focuses on regional approaches to meet South Asia's energy security needs, including energy trade, energy efficiency, rural energy supply, regulatory issues and energy statistics. Under its previous phases, SARI/Energy in particular focused on developing regional appliance standards and labeling programs, as well as the

promotion of ESCOs in the private sector. Improvements of energy efficiency contribute to a reduction in energy demand without compromising the productivity and comforts in a given socio-economic system. By reducing the Energy Intensity (El) of an economy (the ratio of units of energy used to produce one unit of economic output), a overall reduction of energy usage is achieved, which in turn relieves stress from the development of energy production capacities, and the financial burdens that it imposes for both private and public funds, and enhances its competitiveness in the international market environment. Enhancing Energy Efficiency (EE) is also a cost-efficient way to contribute to the international efforts to combat Climate Change, without compromising economic development. For member countries, EE improvements create new revenue sources by their ability to generate carbon reduction certificated under the CDM mechanisms of the Kyoto Protocol. Pakistan can also be included in the ESCOs program due to emerging markets, including but by no means limited to Pakistan, EE projects with strong financial return remain un-implemented. The essential issue hindering the realization of the potential energy savings is the underdeveloped state of energy efficiency investment delivery mechanisms, adapted to work well in international, national and local economic environments. Sharing of R&D experiences among SAARC members especially on Capacity building initiatives should be taken up in the field of establishment of ESCOs & CDM projects development.

19 Conclusions & Recommendations

Strengthening SAARC Management Strategy and Mechanism Infrastructure

The Policy formulation and adopting a right strategy require supporting data. By far the main difficulty in developing countries is related to statistical data that is often scarce and unreliable. Innovative solutions are invariably premised on a partnership within the regions and between public, private and non-profit organizations NGOs. There is need to institutionalize the role of these actors in the decision-making process, leading to involvement in actual implementation. We need to strengthen management infrastructure in a manner to making the planning process more participatory, transparent and forward looking, increasing the capacity to monitor and implement decisions and legislation effectively and generating funds by carrying out service functions and from fines and dues. The Government of Pakistan has devised several specific command and control instruments to encourage

greater national compliance with existing policies and legislation, some of which have been implemented and others that have been proposed but are yet to be launched. An effective management infrastructure is required to overcome these deficiencies. Industrial pollution charges, water use and discharge permits, pricing of fuels, waters, and rationalization of tariff in favor of environment friendly inputs and products can bring about a visible change. There is dire need to take concrete measures to tap potentials of cooperation in all sectors of economy specifically in the field of energy.

Recommendations

A Regional Program for Strengthening Environmental Management Infrastructure may be devised and implemented by pooling common resources of SAARC countries. The program may focus on enhancing capability and capacity to:

a. Reforms in the Energy Sector in the Region

- Exchange of reliable data information for effective energy planning
- Establishment of regulatory jurisprudence in SAARC Member States
- Regulatory law to be analyzed to assess regulatory independence
- Each government to ensure enforcement of regulations
- Carry out studies on efficacy of common energy regulator & safeguarding consumer interest & also identify procedural & bureaucratic bottlenecks in investments
- Experiences on privatization in energy sectors need to be shared
- There is need to build regulatory capacity in the region. R&D efforts in academic institutions can be organized for capacity building, also explore mutual cooperation in hydrocarbon trading

b. Provision of Various Non-Conventional Sources of Energy

- SAARC energy centre will provide base for regional cooperation projects for government & prospective investors
- Sharing of R&D experiences among SAARC members especially on biomass, bio-fuel & hybrid technologies
- Capacity building initiatives should be taken up in the field of CDM projects development

- SAARC Members must promote renewable & co-generation energy policy

c. Approach & Principle To Facilitate Development Of Grid Connectivity & Gas Pipelines In The Region

i) Electricity

- Establishment of task force to ensure common template on technical & commercial aspects
- Sharing of information on transmission parameters

ii) Natural Gas

- Due to shortage of gas, there is needed to approach to gas grid as for power grid. All efforts to lay gas pipeline though Bangladesh, to transport natural gas in south East Asian region and explore the option of gas supply from Middle East, central & East Asia
- Detail System & procedures should be evolved for operation, safety, and security monitoring
- SAARC members may consider joining Energy charter treaty for risk mitigation

d. Universal Access to Commercial Energy

- Provisional of affordable life time power & fuel supply initially the cost will be provided by the government directly or through private participation
- Power supply to rural areas are not cost effective thus decentralization distributed generation (DDG) must be encouraged
- Sharing the good experience especially in the area of financial models, management practices and in basic technologies
- Collaborative R & D will brings down costs of renewable sources (solar & bio mass). Members need to develop pilot projects to understand problems & issues

e. Development Of Hydro Potential in The Region

- Identify large hydropower projects, to develop jointly and costs & benefits to be shared by each member state. Prospects of financial support from international financial agencies need to be explored
- Special emphasis should be laid on joint R & D efforts and comprehensive exercise in resource mapping using latest technology

- Study group may be constituted to examine the impact of climate changes, hydrological flow, glacier formation & environment on hydro potential in the region

f. Energy Efficiency Measures & Harmonization Of Standards

- Task force should be set up to formulate the energy efficiency, assessment of current level of trade develop strategies & explore possibilities of harmonization
- Develop strategies for removal of barriers to promote energy efficient products
- Training & Capacity building initiatives at regional levels & regular monitoring & evaluation energy efficiency program
- Sharing of experiences on test facilities & programs among SAARC Member states establish minimum energy standards in addition to harmonization of test procedures & capability of testing facility

g. Need for Strengthening Environment Management Infrastructure

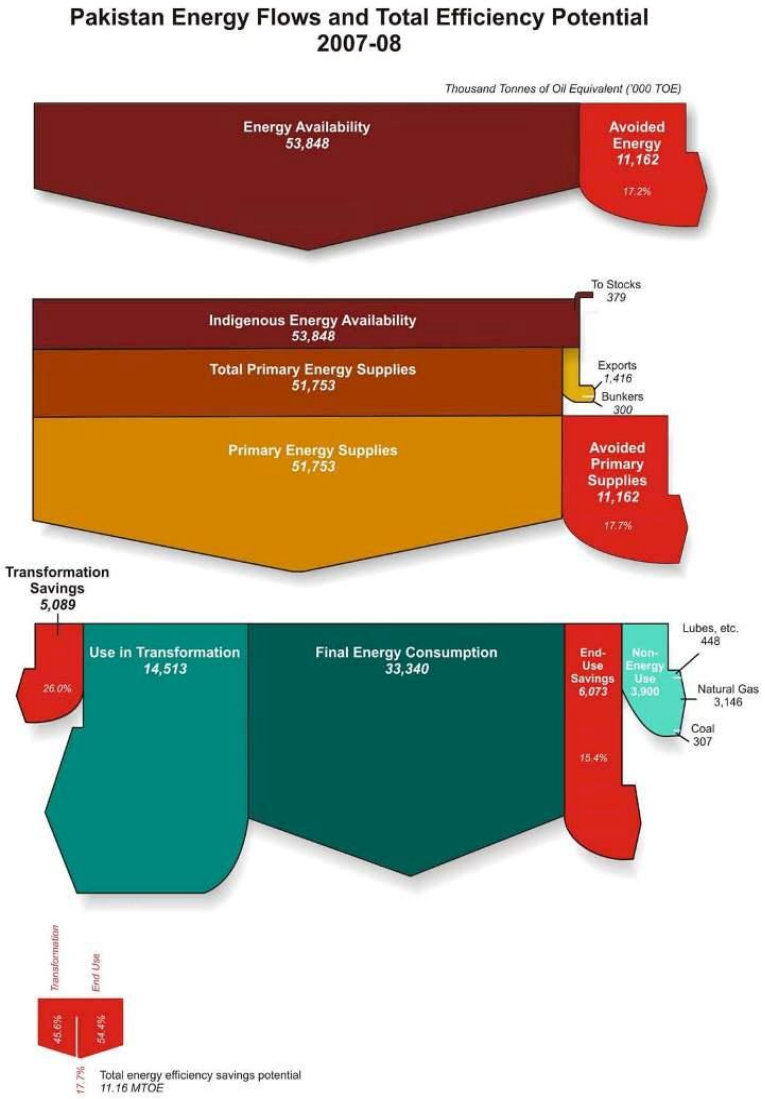
- Take policy measures in preventing and mitigating the rate of environmental degradation by affecting a real shift to a sustainable development track by better integrating an understanding of environmental implications, costs and benefits and the means for addressing these explicitly in all aspects of development
- Effectively develop and utilize existing and new sources of environmental data, stakeholder views and monitored trends into national environmental planning and devising protection measures

Recommendations on 10 years Investment Plan in Energy Efficiency Sector

19.1 Pakistan's Energy Efficiency Sector

The overall energy savings potential in Pakistan in FY2008 is estimated at 11.16 MTOE (493,304 TJ), inclusive of savings in end use as well as transformations. These savings correspond to 17.7% of the primary energy demand of 62.92 MTOE (2,780,941 TJ). The term 'energy' here is used to denote 'modern' or 'commercial' supplies only, and does not include 'traditional' sources, such as simple combustion of biomass. In addition, energy efficiency savings relate to improvements in technology, processes, infrastructure, and do not include the impacts of enhanced management, conservation, or behavioral change. Similarly, the benefits of alternative fuels and renewable resources (with the exception of bagasse use in the sugar industry) are not considered. These estimates correspond to technical potential

assessment for the entire economy, unlike the investment plan, which is scoped around specific projects.



The investment plan focuses on the six sub-projects being proposed under the investment program, estimating the overall energy saving potential of these projects. The investment program will set the basis for energy efficiency in the economy and will lead to the implementation of the investment plan. Considering a ten-year investment plan ending in FY2019, the achievable energy savings in FY2019 are estimated at 4.5 MTOE (199,129 TJ), requiring an investment of $3.8 billion. These estimates were developed based on the technical EE potential, and the extent to which this potential can be realized over a ten year period taking into account the financial attractiveness of the investments and existing implementation barriers and constraints. The assessment was based mainly on secondary data

and interviews with sectoral and industry experts, with the exception of a countrywide household survey on use of domestic lighting devices.

19.2 Demand Side EE Potential and Investments

The demand side savings potential in FY 2008 is estimated at 3.04 MTOE (134,411 TJ), which corresponds to 7.7% of the total energy consumed in the country in that year. Realizable energy savings potential in FY2008 in the industrial sector corresponds to 8.1% of the sector's final energy consumption and for the domestic sector is 20.9% of FY2008's domestic energy consumption. Energy savings on the demand side that can be realized by FY2019 are estimated at 3.13 MTOE (138,206 TJ), taking into account projected economic growth and the extent to which the savings can be realized in the two sectors.

The investment costs for achieving these demand side energy savings over the period from FY2010 to FY2019 are estimated at $2.3 billion. Sectoral requirements are estimated at $1.9 billion for industry and $0.4 billion for domestic. Phasing of proposed investments for these sectors over a ten-year period. The bulk of the investment will be required in the first five years to replace the existing inefficient equipment, followed by some additional investments to maintain efficiency in sectors where, due to market imperatives, the induction of lower efficiency equipment is expected to continue into the near future.

19.3 Supply and Transformations

Savings that can be realized in the transformation, transmission, and distribution of energy include efficiency improvements in power generation, estimated at 1.2 MTOE (55,070 TJ) in FY2019. These savings constitute 27.7% of total realizable demand and supply side savings in FY2019 for the selected sectors, requiring an investment of $1.4 billion. The corresponding figures for installation of high efficiency compressors in gas networks are 2.9% and $0.13 billion bringing the total supply side EE requirements up to $1.5 billion by FY2019.

19.4 Distribution of Savings by Type of Energy

Realizable energy saving in final electricity consumption is estimated at 12% of the electricity consumed in the country in FY2008. Savings in electricity in FY2019 are projected at 0.7 MTOE (31,964 TJ) corresponding to a generation capacity of 1,690 MW, assuming a system wide load factor of 60%. The residential sector accounts for about 27.8% of the savings potential for electricity that can be realized through replacement of incandescent bulb

- Includes Textile, Sugar, Pulp Paper and Board, and the Cement subsectors
- Thermal plants selected based on lower efficiency and lower payback criteria.
- Compact fluorescent lamps. Industry accounts for the remaining 72% of the savings potential.
- Industrial electricity savings can be realized through use of efficient motors, process controls and mainly through bagasse generation.

Realizable energy savings in natural gas use are estimated at 12% of the total gas consumed in the country in FY2008, and are projected at 2.1 MTOE (91,016 TJ) in FY2019, accounting for 46% of the total energy efficiency potential of 4.5 MTOE in FY2019. These savings could be utilized to fuel a power generation capacity of 2,300 MW.4 The bulk of the savings potential in natural gas use is in the domestic sectors (72% of total), and is associated with the replacement of existing appliances, such as cook stoves, water and space heaters, with high efficiency ones. Energy efficiency upgrades in industry account for 28% of the natural gas savings potential, which can be realized through modifications in production and manufacturing equipment, heat recovery, process improvements mainly in the cement, pulp and paper, and sugar industries, as well as loss reduction and efficiency improvements in the gas utilities networks. Realizable savings for coal account for 9% of all coal consumed by industry, and can be achieved through implementing heat recovery in the cement industry.

The energy efficiency potential in oil use resides primarily in the power sector, where through thermal plant upgrades, savings of around 1.2 MTOE (55,070 TJ) can be realized. Taking into account the realizable potential for energy savings, attractiveness of investments, and existing barriers and constraints to energy efficiency improvements, the priority areas for a ten-year investment program are identified as:

- Energy efficient lighting and replacement of gas appliances in the domestic sector
- Replacement and rehabilitation of existing inefficient thermal power generation units with new high efficiency configurations
- Replacement of inefficient compressors in the gas transmission systems
- Efficiency upgrades in the industrial sector, focusing on the cement, pulp, paper, sugar, and textile industries

Analyses of the technical, economic, policy, and institutional aspects of these opportunities is recommended on an on-going basis to select program areas that will result in the optimum utilization of available investment funds.

Conclusions

Pakistan's large and complex energy sector is undergoing important structural changes and expansion, as the national economy liberalizes and moves towards middle income status requiring a quantum jump in energy consumption. However, the policy, institutional, regulatory, and market support infrastructure for EE&EC remains weak, and in many respects, non-existent. Efficiency improvements in the recent past have largely taken place due to market drivers, such as energy prices and technological development, and not due to deliberate interventions. Such a program of coherent logically sequenced, and sustained facilitative programs and provision of a supportive environment is, however, necessary for achieving the economy's true EE&EC potential within a reasonable timeframe.

In addition to overall EE&EC roadmap and institutional capacity development, there exist many opportunities for immediate, medium, and long-term policy and technical interventions, incentives, pricing reforms, and investments, especially in industry, agriculture, transport, buildings, power and demand-side management (DSM) activities. The revival of an overarching national EE&EC action plan, development of requisite institutional and support infrastructure, and creation of effective implementation linkages between stakeholders in major energy consuming sectors also needs to be undertaken in parallel through effective government, donor, and market-based initiatives and support mechanisms.

REFERENCES

- Hydrocarbon Development Institute of Pakistan, "Pakistan Energy Book 2008.
- Pakistan National Operational strategy for Clean Development Mechanism (CDM) Ministry Of Environment.
- Climate Change & Pakistan Industries.(www.cdmpakistan.gov.pk)
- Kyoto Protocol (www.unfccc.int)
- Economic Survey, Ministry of Finance, Govt of Pakistan
- National Energy Conservation Policy-2006
- National Conservation Strategy (NCS)
- Environmental Challenges & Responses
- National Environmental Quality Standards, EIA/IEE review procedures/system
- Government of Pakistan, National Energy Conservation Centre-2006, Standardization of Electrical Equipment
- Initial Environmental Examination (IEE) & Environmental Impact Assessment (EIA)
- Government of Pakistan- Investigation Report of Air & Water Quality
- Government of Pakistan- Planning & Development Division & IUCN, Report of the external Review
- Government of Pakistan- The Gazette of Pakistan -2007, Pak EPA
- Government of Pakistan- Planning Commission, 2005, Mid Term Development Framework 2005-2010
- The world Conservation Union – Strategy for Sustainable Development
- Government of Pakistan- Ministry of Environment, Local Government & Rural Development, 2007, Pakistan Country Assessment Report
- Grid load Data for 2004 to 2008, Islamabad Electrical Supply company Ltd, (IESCO), Islamabad
- AEDB Ordinance, 2006.
- Ministry of Law, Justice, Human Rights and Parliamentary Affairs, Government of Pakistan, Islamabad, 2006
- Brochure. Pakistan Council for Renewable Energy Technologies (PCRET)
- Capability and Peak Load Sharing Comparison 02-05-06/02-05-07, Office of the Chief Engineering Advisor, Power Whig, Water and Power Development Authority,

Lahore, 2007.

- Compendium on Energy Conservation Legislation in Countries of the Asia and Pacific Region. Environment and Sustainable Development Division, United Nations Economic and Social Commission for Asia and the Pacific (ESCAP)
- Compressed Natural Gas (CNG) as a Transport Fuel. Brief for ADB EE Assessment in Pakistan. Hydrocarbon Development Institute of Pakistan (HDIP), Ministry of Petroleum and Natural Resources, Government of Pakistan, Islamabad, 2008
- Determination of Tariff in Respect of Petition Filed on My 06, 2007, by Islamabad Electric Supply Company Ltd. (IESCO) (Case No. NEPRA/TRF-35/TESCO-2007) National Electric Power Regulatory Authority (NEPRA), Islamabad, 2007.
- Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on Energy End-use Efficiency and Energy Services and Repealing Council Directive 93/76/EEC, Official Journal of the European Union, April 2006.
- Energy Efficiency Guide for Industry in Asia. United Nations Environment Program (UNEP), 2006
- Hathaway, RM, B Muchhala, and M Kugelman, Fueling the Future: Meeting Pakistan's Energy Needs in the 21st Century, Woodrow Wilson International Center for Scholars, Washington, DC, March 2007.
- Industrial Efficiency and Environmental Management Project. Final Report Asian Development Bank, Manila, and Hagler Bailly Pakistan, Islamabad,
- National Electric Power Regulatory Authority (NEPRA) Act, 1997. Government of Pakistan, Islamabad
- National Environmental Quality Standards (NEQS),Ministry of Environment, Local Government and Rural Development, Government of Pakistan, Islamabad, 2000
- National Transport Policy Support, Asian Development Bank, Manila, MoC /NTRC, Wilbur Smith Associates/ECIL, Islamabad, April 2007.
- Natural Gas Regulatory Authority Ordinance. Ministry of Law, Justice, Human Rights and Parliamentary Affairs, Government of Pakistan, Islamabad, 2007.
- Oil and Gas Regulatory Authority (OGRA) Ordinance. Ministry of Law, Justice,

Human Rights and Parliamentary Affairs, Government of Pakistan, Islamabad Pakistan

- Economic Survey 2007-08. Ministry of Finance, Government of Pakistan, Islamabad