Air Pollution:
Key Environmental Issues in Pakistan

Mahmood A. Khwaja and Shaheen Rafi Khan

Working Paper Series # 99
2005

A publication of the Sustainable Development Policy Institute (SDPI).

Sustainable Development Policy Institute is an independent, non-profit think-tank founded for doing research on sustainable development.

WP-099-002-065-2005-021

Mailing Address: PO Box 2342, Islamabad, Pakistan.
Telephone ++ (92-51) 2278134, 2278136, 2277146, 2270674-76
Fax ++(92-51) 2278135, URL: www.sdpi.org

Table of Contents

The Sustainable Development Policy Institute is an independent, non-profit, non-government policy research institute, meant to provide expert advice to the government (at all levels), public interest and political organizations, and the mass media. It is administered by an independent Board of Governors.

Under the Working Paper Series, the SDPI publishes research papers written either by the regular staff of the Institute or affiliated researchers. These papers present preliminary research findings either directly related to sustainable development or connected with governance, policy–making and other social science issues which affect sustainable and just development. These tentative findings are meant to stimulate discussion and critical comment.

Acronyms and Abbreviations

ADB	Asian Development Bank
ALGAS	Asia Least-cost Greenhouse Gas Abatement Strategy
ARI	Acute Respiratory Infection
BCS	Balochistan Conservation Strategy
BPbL	Blood Lead Level
CFC	Chloro-flouro-carbon
CIDA	Canadian International Development Agency
CNG	Compressed Natural Gas
CPC	Cleaner Production Center
EIA	Environmental Impact Assessment
ENT	Ear, nose & throat
EPD	Environment Protection Department, Punjab
EPA	Environment Protection Agency
FERT	Fuel Efficiency in Road Transport Sector Project
GEF	Global Environment Facility
GHG	Green House Gas
GOP	Government of Pakistan
GTZ	German Agency for technical cooperation
HCFC	Hydro-chloro-flouro-carbon
HDIP	Hydrocarbon Development Institute of Pakistan
HSFO	High Sulfur Furnace Oil
IEE	Initial Environmental Examination
IMR	Infant Mortality Rate
IUCN	The World Conservation Union
JICA	Japan International Cooperation Agency
LPG	Liquefied petroleum gas
LSFO	Low sulfur furnace oil
MELGRD	Ministry of Environment, Local Government & Rural Development
MVET	Mobile Vehicle Emission Testing
MW	Mega Watt
NCS	National Conservation Strategy
NEAP	National Environmental Action Plan
NEQS	National Environmental Quality Standards.
NGOs	Non-governmental Organizations
NEPRA	National Electrical Power Regulatory Authority
NOx	Oxides of Nitrogen
NORAD	Norwegian Agency for Development Cooperation
NWFP	North West Frontier Province
ODSs	Ozone Depleting Substances
O & M	Operation and Maintenance
Pak-EPA	Pakistan (Federal) Environmental Protection Agency
PCSIR	Pakistan Council for Scientific and Industrial Research
PECC	Population and Environment Communication Center
PED	Population and Environment Digest
PEPA 97	Pakistan Environmental Protection Act, 1997
PEPC	Pakistan Environmental Protection Council

PEPCO	Pakistan Electric Power Company
PM	Particulate Matter
PM_{10}	Particulates matter having size equal to or less than ten microns
POP	Persistent Organic Pollutant
ppb	Parts per billion
ppm	Parts per million
SDPI	Sustainable Development Policy Institute
SM&R	Self-Monitoring and Reporting
SMART	Self-Monitoring and Reporting Tool
SPC	Specific Program Component
SPCS	Sarhad Provincial Conservation Strategy
SUPARCO	Pakistan Space and Upper Atmosphere Research Commission
T&D	Transmission and Distribution
TOE	Tons of Oil Equivalent
TSP	Total Suspended Particulate Matter
TTSID	Technology Transfer for Sustainable Industrial Development.
ug/dl	Microgram per deciliter
ug/m^3	Microgram per cubic meter
UIEP	Pak-German Urban Industrial Environment Protection
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
VETS	Vehicle Emission Testing Station
WAPDA	Water and Power Development Authority
WHO	World Health Organization

Air Pollution:
Key Environmental Issues in Pakistan

Mahmood A. Khwaja and Shaheen Rafi Khan

Abstract

Air pollution is rapidly growing environmental problem in Pakistan. Highly inefficient energy use, accelerated growth in vehicle population and vehicle kilometers traveled, increasing industrial activity without adequate air emission treatment or control, open burning of solid waste including plastic, and use of ozone depleting substances (ODSs) are some of the major causes of deterioration of ambient air quality.

Some key environmental issues about air quality in Pakistan have been assessed and discussed, using the Pressure, State, Impact and Response (P-S-I-R) framework.

Rapidly growing energy demand, fuel substitution such as high emitting coal and oil, and high-energy intensity are the key factors contributing to air pollution. Some factors contributing to high-energy intensity are transmission and distribution losses in power generation, fuel prices subsidies on diesel and ageing vehicles, which are primarily diesel powered.

The state of air quality has been assessed by examining the emission levels of air pollutants and ambient air quality. The average increase in sulfur dioxide across major emitting sectors (industry, transport and power) has been 23-fold over the past 20 years. Similarly, nitrogen oxides increased to 25-fold in the power sector and carbon dioxide increased an average of fourfold. Pakistan's per capita greenhouse gas (GHG) emissions are far below the global average.

Ambient air quality data show that carbon monoxide levels in Karachi and Lahore considerably exceed WHO's recommended levels. Particulate matter content cross safety levels in the major industrial cities in the Punjab province. The reported lead levels in ambient air sites in Peshawar, Rawalpindi, Lahore and Karachi are also quite high compared to WHO's permissible levels.

The health impacts of air, water pollution and productivity losses from deforestation and soil erosion have been assessed at 1.71 billion dollars, or 3.3 percent of GNP, in the early 90s. The losses attributed to air pollution, in terms of health care costs, amount to 500 million dollars a year.

To combat air pollution, the government has formulated acts and policies, including the National Environment Action Plan (NEAP). Pakistan Environmental Protection Act, 1997 (PEPA-97) covers air, water, soil and noise pollution, including hazardous waste disposal and vehicular pollution. Its section 15, sub-sections 1 to 3, pertain to regulation of motor vehicles.

NEAP reflects a renewed commitment to environment and focuses on taking immediate measures in four priority areas of concerns – air, water, solid waste, and ECO system management – to achieve a visible improvement in the quality of environment, including air.

Introduction

Generically, air pollution is caused by fuel combustion in various sectors: domestic use, power generation, transport, and industry. The problem is aggravated by meteorological conditions and a combination of population density and urbanization.

Air pollution results in several problems, such as health hazards, especially for women and children, adverse effects on agriculture, livestock, building material and structures, cultural and archaeological monuments.

While air pollution is generally considered to be an urban phenomenon, it is becoming a rural problem with the penetration of transport and expansion of industry and the growth of brick kilns. Air pollution monitoring and control efforts are both inadequate and tend to be urban-centered.

The state of air pollution has been described, discussed and assessed employing the Pressure, State, Impact and Response (P-S-I-R) framework. This framework links pressures on air quality as a result of human activities with changes in the state (quality) of air. In this connection different pressures and their impacts on air quality are discussed.

The response of the government to mitigate the pressure or to improve the air quality by instituting environmental and economical programs and policies has also been examined.
Having described and discussed the key factors contributing to air pollution in the first section, the ambient air quality of a few metropolitan cities and the resulting health impacts, especially on children, are described and discussed in sections 2 and 3.

To combat air pollution, the government has formulated acts and policies, including the National Environmental Action Plan (NEAP). An account of the activities and programs implemented to mitigate air pollution is given in section 4.

Besides identifying the areas and measures for control of air pollution, the paper also emphasizes the need and importance of energy conservation, efficient energy use and development of alternate energy sources, in a power-deficient country like Pakistan.

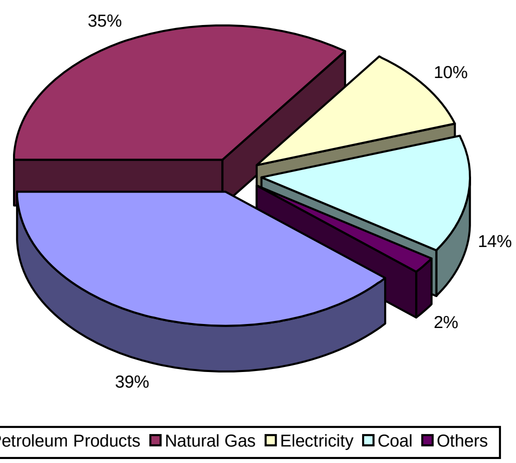
1. Pressure

Rapidly growing energy demand, high-energy intensity (a measure of energy inefficiency), and an expected change in fuel composition based on recoverable reserves are the key factors contributing to air pollution in Pakistan.

1.1. Energy Demand Projections

The energy system in Pakistan is traditionally demand based. The level, structure, and evolution of this demand is derived from the level of economic activity and the intensity of energy use at the sector level (Hagler Bailly, 1997a). The distribution of energy sources is presented in Fig.1:

Figure 1: Percentage shares of commercial energy delivered in 1992-93



Source: Ashfaque Mahmood, National Conservation Strategy, Energy, National Conservation Strategy Secretariat, Islamabad, 1998

Energy sector studies predict that if energy demands continue to grow at the currently estimated rate of about 7% per annum, Pakistan will need annual energy investments of about 6%-8% of GDP during the decade, as opposed to the historical average of about 4% of GDP. Load forecasting studies undertaken by the Water and Power Development Authority (WAPDA) indicate that over a span of 24 years, power demand will increase to between 4.8 to 5.8 times its present level (Hagler Bailly, 1997b).

Table 1 shows the projected energy demand by sector. Fuel consumption is expected to increase sixfold by 2050. The domestic sector is the major energy-consuming sector (55%), followed by industry (22%), transport (18%), and agriculture (2%).

Table 1: Projected sector fuel consumption (TOE)

	1996	2000	2005	2010	2020	2035	2050
Power Sector	8,925	11,400	16,500	24,300	47,400	53,000	58,000
Industry	7,729	9,400	12,500	15,500	23,500	35,000	50,000
Agriculture Sector	1,800	3,700	4,700	6,200	10,700	12,000	15,000
Domestic Sector	3,365	3,300	4,500	6,000	11,700	20,000	30,000
Transport Sector	7,494	7,600	10,500	13,500	22,500	30,000	40,000
Commercial Sector	888	950	1,200	1,500	2,150	5,000	7,500
Total	30,201	36,350	49,900	67,000	117,950	155,000	200,500

Source: Khan and Iqbal, 2001

1.1.1 Households

The household sector is the largest single energy-consuming sector in Pakistan. Biomass fuel, fuel-wood, crop residue and dung account for 95% of energy consumed by households in rural areas, with the share dropping to 56% in urban areas. However, this figure conceals its disproportionately high concentration in the low-income settlements. Biomass combustion is a major source of indoor air pollution and primarily affects the health of women and children. In this context, the expected switch to conventional fuels as a result of depleting biomass stocks will be an encouraging development.

1.1.2 Transport

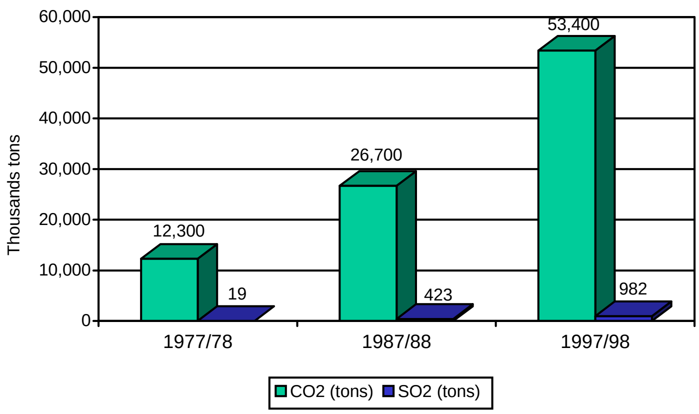
Increasing prosperity and population growth in developing countries have resulted in accelerated growth in vehicle numbers and kilometers traveled. Pakistan is no exception. The total road length measured at 94,000 kilometers in 1981 has increased to 232,000 kilometers in 1998, an overall increase of 147%. The number of vehicles has increased almost precipitously, from 0.8 million to about four million within 20 years, an overall increase of more than 400%.

Road transport consumes 47.2% of the total petroleum products produced and imported. Lead compounds are added to petrol to increase the efficiency of car engines and to reduce engine knock. The high lead content in petrol is released into the environment. On average, it measures about 0.35 gram/liter, which is relatively very high as compared to the United States and many European standards (0.00–0.15 gram/liter). Two other factors contributing to high emissions are the predominant use of diesel (in about 72% of the vehicles driven) and fuel use inefficiency, as explained under section 1.3 (Khan and Iqbal 2001).

1.1.3 Industry

Industrial activity without adequate air emission treatment or control is one of the major causes of the ambient air quality's deterioration. It has not been possible to assess the magnitude of industrial air pollution, as there is little information available. However, figure 2 illustrates the problem reasonably well.

Figure 2: Estimated air pollutants from industry



Industrial discharges have increased significantly over the past 20 years. Emission of carbon dioxide and sulfur dioxide has increased by a factor of four and five hundred, respectively.

1.2 Fuel Substitution

Inter-fuel substitution trends indicate a move towards high emitting fuels. This is likely to continue, based on diminishing reserves of the less polluting energy sources, such as natural gas and hydroelectricity. The status and prognosis with regard to fossil fuel reserves is shown in table 1.2.

Table 2: Fossil fuel reserves as on June 30, 1996 (Million gigajoules)

Fuel	Original Recoverable Reserves	Cumulative Production	Balance Recoverable Reserves	Production Per Year	Depletion Time (Year)
Crude Oil	3309	2005	1309	125	10.5
Natural Gas	25116	9383	15736	622	26
Coal	10527			80	

Source: Energy Wing, GOP, 1998

The nation’s original gas reserves had already fallen from 25.12 billion gigajoules in 1996 to 15.74 billion gigajoules in 2000. At a yearly production rate of 62 billion gigajoules, the reserves are likely to be exhausted by 2026 (Beg, 2000), while oil reserves are forecast to last for the next ten years. These were not very significant to start with and Pakistan has been meeting the bulk of its oil requirements through imports, which it is likely to continue doing. In fact, imports notwithstanding, electricity production is moving rapidly towards thermal energy and in this category towards oil as a fuel source.

Another potential energy supply source is coal. The country has recoverable reserves of about 184 billion tons as of June 1996; 95% of which consist of the recently discovered coal in the Thar region. The coal is of a low-grade quality with very high sulfur content and, therefore, its emission potential is high. A rising trend is likely to be seen in coal use, both for thermal power generation and household consumption. The future tendency will be to tap the extant large coal reserves, as cleaner fuel sources diminish.

1.3 Energy Inefficiency

Pakistan is an energy deficient country but uses the commercial energy at its disposal in a highly inefficient manner. Some of the factors contributing to high-energy intensity are (a) transmission and distribution losses in power generation (an average 25% over the past 20 years), (b) tariff concessions on imported, second-hand machinery, (c) fuel price subsidies on diesel, (d) an ageing vehicle fleet (50% over 10 years old), which is primarily diesel powered (75%), (e) relative inefficiency of vehicle production, and (f) rapid penetration of new appliances (air conditioners, refrigerators, heaters) in private homes (Energy Wing, GOP, 1998). Energy inefficiency in developing countries is a source of growing concern.

1.4 Ozone Depleting Substances (ODSs)

In Pakistan, the ODSs are used mainly in deep freezers, refrigerators, car air-conditioners, foam, fire extinguishers and solvents. The country does not produce any ODS and imports all of its requirements. Total consumption of ODS in 1995 was 0.0319 lakh tons. This translates into an annual per capita consumption of roughly 0.018 kg. Twelve ODS were identified in use in 1999. The most common among them in descending order were CFC-12, HCFC-22, CFC-11 and carbon tetrachloride (MELGRD, 2001).

1.5 Others

For a developing country like Pakistan, urbanization has been one of the significant factors contributing to environmental degradation and air pollution in particular. The number of cities with a population of over one million increased from three in 1981 to seven in 1998. Air pollution in urban centers, particularly in the larger cities, has assumed alarming proportions. Open burning of solid wastes, including plastic bags, is a common practice in the urban and rural areas, and is compounded by biodegradation of such wastes.

Methane produced by the decomposition of municipal and industrial waste is estimated to contribute 338,000 tonnes/year of methane (Hagler Bailly, 1997c). Another significant source of air pollution, especially around suburbs of major cities, is brick manufacturing. Large quantities of coal, leather and rubber wastes are used as fuel in brick kilns, which emit quantities of ash and other pollutants in the air. Emission levels worked out on the basis of energy consumption and emission factors indicate that emissions of carbon monoxide and sulfur dioxide from brick manufacturing exceed those from most industries (TTSID, 1995).

2. State

Industry is the largest emitter of air pollutants, followed by the transport sector. However, the share of the power sector in total emissions has increased in recent years because of its growing dependence on petroleum products, specifically furnace oil. The domestic sector's contribution to total emissions has remained constant over time in absolute terms, but declined relative to other sectors i.e. industry, transport and power (Hagler Bailly, 1997).

2.1 Emission of Air Pollutants by Sector

Table 3 shows sharp increase in air emissions over two decades between 1977-78 and 1997-98 across the major commodity producing sectors.[1] Thus, for example, the average increase in sulfur dioxide across all the sectors was 23-fold over these two decades. Similarly, nitrogen oxides increased 25-fold in the power sector and carbon dioxide increased an average of fourfold.

Table 3: Estimated air pollutants from various economic sectors (Thousand tons)

	1977-78			1987-88			1997-98		
Sector	CO_2	SO_2	NOx	CO_2	SO_2	NOx	CO_2	SO_2	NOx
Industry	12308	19	N.A	26680	423	N.A	53429	982	N.A
Transport	7068	52	N.A	10254	57	N.A	18987	105	N.A
Power	3640	4	3	11216	95	na	53062	996	76
Domestic	16601	5	N.A	24054	16	N.A	39098	40	N.A
Agriculture	845	5	N.A	4490	28	N.A	6368	40	N.A
Commercial	1726	11	N.A	2587	13	N.A	4261	25	N.A

Source: Government of Pakistan / IUCN (1992, P. 82)
Notes: N.A.= Not applicable
CO_2 = Carbon dioxide
SO_2 = Sulfur dioxide
NOx = Nitrogen oxide

1 Note the numbers for 1997/98 are projections based on actual increases between 1977/78 and 1987/88.

Figure 3(a): NO_X Emissions

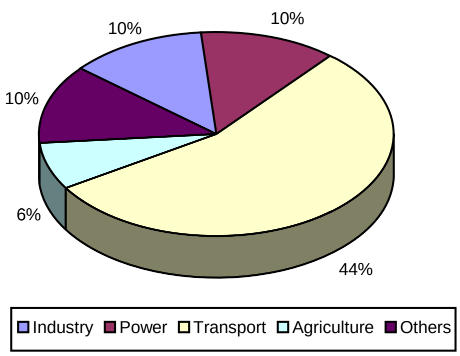


Figure 3(b): CO_2 Emissions

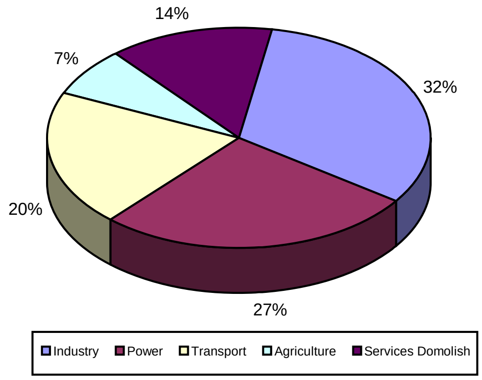
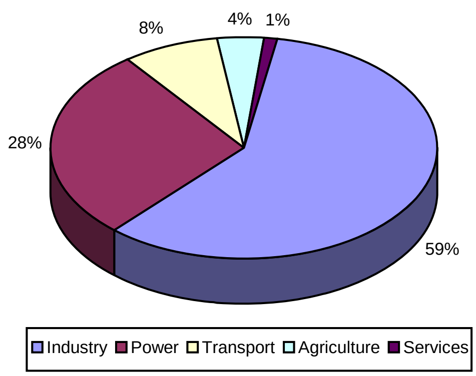


Figure 3(a) : SO_X Emissions



The sectoral distribution of these emissions is shown in Figs. 3 a, b and c (GOP/IUCN, 1992). During 1995–96, SO_2, NO_x and CO_2 emissions were about 1.1 million tons, 540,000 tons and 92 million tons, respectively (GOP Energy Wing, 1998).

Table 4: Industrial emission levels **(000 tons)**

Sector	**CO_2**	**SO_2**	**CO**	**NOx**
Iron & Steel	3,939.96	15.02	0.73	0.61
Cement	4,156.34	55.04	50.82	5.27
Glass, Ceramics	153.03	0.87	0.80	0.14
Refining, petrochemicals	696.51	8.77	8.17	0.88
Chemicals	1115.28	0.37	1.07	0.87
Textile	1,343.27	2.45	2.94	1.10
Pulp and paper	631.42	1.94	2.15	0.57
Sugar refining	5,887.02	0.81	173.64	0.16
Leather and footwear	49.65	0.14	0.15	0.04
Food, beverages and tobacco	1,154.55	2.08	2.45	0.93

Source: TTSID, Oct. 1995

Table 4 desegregates emissions in sugar, cement, iron and steel, refining and petrochemicals industries. Sugar and cement industries are the highest emitters of carbon dioxide and carbon monoxide, and sulfur dioxide, and oxides of nitrogen, respectively.

2.2 Greenhouse Gas Emissions

Pakistan's per capita emissions are far below the global average. They are more a source of national rather than global concern because of their localized impacts. However, efforts to record greenhouse gas (GHG) emissions reflect Pakistan's commitments to the United Nations Framework Convention on Climate Change (UNFCCC), to which it is a signatory. The two main GHG emissions are methane and carbon dioxide. The primary source of methane emissions is agriculture, consisting of enteric fermentation in livestock and anaerobic decomposition in rice paddies. Together they constitute approximately 80% of the total methane emissions.

2.3 Ambient Air Quality

Table 5 presents the average concentration of major ambient air pollution in suburban Karachi and table 6 describes estimates of ambient air quality in major cities in the province of Punjab for 1996. Relative to WHO safety levels, the amount of sulfur dioxide (SO_2), carbon monoxide (CO) and Ozone (O_3) in the atmosphere are well below danger levels. On the other hand, National Conservation Strategy data (NCS 1992) shows carbon monoxide levels in Karachi and Lahore exceeding considerably WHO's recommended levels. Data regarding particulate matter in the atmosphere is more uniform. The estimates (both total suspended particulate matter (TSP) and PM_{10}) are well above safety levels across all the major industrial cities in Punjab.[2] Table 5 shows that the same is true for suburban Karachi during different times of the day.[3]

Given the fuel mix and efficiency standards in Pakistan, which are far below those in industrial countries, it is difficult to accept findings which indicate that, conversely, ambient air quality is much better. More reliable data is needed to arrive at clear conclusions. The emission trends, per se, suggest caution in developing a false sense of security with respect to ambient air quality. In metropolitan cities of Pakistan, an accurate assessment of ambient air quality is difficult because of the dearth of reliable information and data on environmental parameters and the differences in the data collection methodologies adopted by various research organizations. Also, due to the absence of monitoring facilities, pollutant concentrations have never been checked on a continuous basis.

Table 5: Average concentration of major ambient air pollution in suburban Karachi at different times of the day

Time	Ozone (ppb)	$S0_2$ (ppb)	CO (ppm)	PM_{10} (ug/m^3)
00:15	7.52	1.04	0.59	137.66
10:30	10.75	1.48	0.45	173.62
14:15	20.09	1.35	0.41	251.80
Average	9.89	1.29	0.51	174.13

Continued…

2 Note that GOP/IUCN (1992) mentions that CO of 8-30 ppm and 6-40 have been recorded in Karachi, but no source is cited.

3 Ibid. Study by the PEPA/EPD/JICA, July 2000 was cited to show that particulate matter in Lahore, Rawalpindi and Islamabad was 6.4 times higher than WHO standards.

Time	Ozone (ppb)	$S0_2$ (ppb)	CO (ppm)	PM_{10} (ug/m^3)
Maximum	20.36	4.69	0.77	251.84
Minimum	4.62	0.73	0.14	115.31
WHO guidelines values	47-56	35-52	9.0	90-150

Source: Based on Government of Pakistan (1997, pp.178-181).
Notes:
SO_2 = Sulfur dioxide
TSP = Total suspended particulate matter
O_3 = Ozone
CO = Carbon monoxide
PM_{10} = Particulate matter having size up to 10 microne (respirable dust)
ppb = Parts per billion
ppm = Parts per million
ug/m^3 = Parts per million microgram per cubic meter

Table 6: Ambient air quality of major cities in the Punjab (1996)

City	SO_2 (ppb)	NO_x (ppb)	CO (ppm)	TSP (ug/m^3)
Islamabad	28.5	148.5	1.55	520
Rawalpindi	30.7	74.7	1.83	709
Lahore	44.6	156.6	2.82	895
WHO Guideline Values	35-52		9.0	150-230

Source: JICA, March 2000
Notes:
SO_2 = Sulfur dioxide
TSP = Total suspended particulate matter
CO = Carbon monoxide
NO_X = Nitrous oxide
ppb = Parts per billion
ppm = Parts per million
ug/m^3 = Microgram per cubic meter

In 1993, the Environmental Protection Agency (EPA), NWFP, carried out air quality monitoring over a 48-hour period at a few sites in Peshawar, Kohat and Mingora (Swat). The range of average concentrations (ug/m^3) for SO_2, NO_2 and dust were found to be 1–5, 38-156 and 1290– 640 (Khan et al, 1998). A comparison of these results with the generally accepted air quality standards showed the dust level to be ten times higher than the limit value (WHO/US standards). The Pakistan Council for Scientific and Industrial Research (PCSIR) monitored CO concentration in the air for a twelve-hour period at 16 sampling points along the main roads in Peshawar. The range of average CO concentration was found to be 11–17 ppm, as compared to the WHO tolerance limit of 9 ppm. At certain sampling points, CO levels were observed in the range of 40–100 ppm during peak hours.

The content of lead in petrol is proportional to the release of lead into the environment. In Pakistan, before July 2001, the lead content in petrol was reported to be 0.35 gram/liter, which was very high compared to the maximum lead content of 0.00 – 0.15 gram per liter in the US and many European countries. Regular, Super Premier and HOBC were reported to have lead content of 0.42, 0.63 and 0.84 gm/liter, respectively (Lovei, 2000 and Hagler Bailly, 2001).

At present, all refineries in the country claim to be producing lead-free petrol. However, there are other sources of lead exposure, which include old lead pipelines, lead-based soldering in water supply systems, old houses/buildings with lead-based paints, lead-based ceramics and lead containing fabric dyes.

Various studies have been reported on lead levels in ambient air sites and dust fall in Peshawar, Rawalpindi, Lahore and Karachi (Khan, 1991; Shigeta, 2000). The reported lead levels (micrograms/cubic meter) were:

Karachi (1980–81)	0.13 – 11.24
Peshawar (1994–95)	0.21 – 7.79
Lahore (1993–94)	0.15 – 8.36
Lahore (1999–2000)	0.89 – 7.85
Rawalpindi (1999–00)	0.71 – 10.00

These levels can be considered high when compared to the WHO permissible level in ambient air which, based on an annual average, gives a range of 0.5 to 1.0 ug/m (Shigeta, 2000).

3 Impacts

Air pollution is source of several problems: adverse health impacts on citizens, especially senior citizens and children, effects on vegetation, building material, structure, livestock, agriculture and visibility. Epidemiological data collected in developed countries suggest that air pollution affects both death and illness rates and generates high social costs, associated with premature death and deteriorating quality of life. While not many studies have been carried out in Pakistan on health impact assessments, the few that exist are quite detailed in their quantitative and explanatory content.

3.1 Health Impacts

The health impacts of air and water pollution as well as productivity losses from deforestation and soil erosion were assessed at 1.71 billion dollars, or 3.3 percent of GNP, in the early 1990s (ADB, 2001). The losses attributed to air pollution, in terms of health care costs, are around 500 million dollars a year.

3.1.1 Acute Respiratory Infection (ARI)

ARI and other lung diseases are related directly to polluted air. In the province of Punjab, the incidence of ARI is increasing rapidly. A survey of 18 common disorders in the province indicates that ARI is the third most common disease among children after diarrhea and dysentery. The number of reported ARI among children almost doubled between 1998-00 (Table 7).

Table 7: Reported cases of ARI in the Punjab province

Year	Children (Under five years)	All age groups
1998	837,693	2,826,000
1999	1,024,004	3,304,000
2000	1,536,514	4,989,000

Source: PED, PECC/SDPI, 2001

Other respiratory diseases, such as asthma, are also linked to air pollution. A health survey was carried out in Peshawar in 2000 to study the health impacts of air pollution. 479 residents (male and females between 30–40 years) were selected around brick kilns (158 sites), heavy traffic (63 sites) and control sites (158). According to the report findings, 33% and 31% of residents around brick kiln and heavy traffic sites, respectively, suffered from asthma, compared to 13% residents of the controlled sites (GTZ-NWFP, EPA, 2000).

The health impacts of air pollution are also evident from media reports of public complaints lodged with the provincial EPAs. A survey report published in 2000 revealed that dwellers of Babri Banda Town (Kohat, NWFP) living around an old cement plant (installed in 1983) were experiencing lung and chest ailments and respiratory problems, caused both by the emission of poisonous gases and dust from the plant and blasting in the nearby mountains (GTZ-NWFP, EPA, 2000).

Another survey, carried out in 2000, reported numerous health problems faced by the people of Nawabshah, Sindh, due to smoke and emissions from several industries operating in the town. Doctors at the Medical College Hospital, Nawabshah, reported an increase in the number of patients with symptoms of asthma, bronchitis, ulcer and skin diseases (Manser, 1990; Ahmad, 1992; Agha, 1995).

3.1.2 Blood Lead Levels (BPbLs)

Lead pollution is one of the most serious health hazards and, as demonstrated by several studies worldwide, poses a special risk to children. Experimental and epidemiological evidence indicates that lead is a neurotoxin and impairs brain development in children. Children in developing countries with dietary deficiencies are particularly susceptible. According to the 1998 population census, 43.19% of Pakistan's population comprises children below the age of 15.

Blood lead levels (BPbLs) were studied in 900 healthy schoolchildren (boys & girls) in some cities in Pakistan. The results are tabulated below:

Table 8: Blood lead levels in the study population of Peshawar, Islamabad and Chak Shahzad

Sites/Cities	Number of Males	BPbL Male ug/dL	Number of Females	BPbL Female ug/dL
Peshawar	3074	21.2 + 8.15	126	16.8 + 4.81
Islamabad	101	23.05 + 2.8	129	22.5 + 3.90
Chak Shahzad	88	3.22 + 0.19	82	1.49 + 0.10

Source: Ahmad, 1992; Agha, 1995

The children were below 15 years of age and belonged to lower income families. The overall mean BPbLs (micrograms per deciliter) in the three cities were found to be 22.8 +/- 3.30, 19.00 +/- 6.48, and 2.30 +/- 0.19 (rural site). The BPbLs of children in Peshawar and Islamabad were higher than that observed for children in Chak Shahzad, a rural site with comparatively less traffic activity. The BPbLs in Peshawar and Islamabad are considerably higher than the acceptable levels of 10 micrograms per deciliter.

A joint study of the Agha Khan University and Medical College and the Karachi University estimated the mean BPbLs for males, females, soldiers and schoolchildren residing in the metropolitan area at 34.4, 31.8, 29.9 and 38.2 ug/dl respectively. These are considerably higher than the acceptable BPbLs (Manser, 1990). Over 90% of the children studied had BPbLs higher than 25ug/dl, which can cause irreversible mental impairment. Another study, also carried out on a segment of Karachi's population in the Denso Hall area, where traffic activity is high, showed high lead concentrations in urine. Excessive lead concentration of this kind can pose serious kidney problems.

Two studies on metal concentrations in the air and their possible health impacts on a segment of population in Quetta were carried out by the University of Balochistan. Metals levels were estimated from depositions on tree leaves, along 13 major roads of Quetta City. The results compiled from questionnaire responses and chemical analyses showed a strong association between high lead (and some other metals) levels and heart and respiratory diseases, anemia, blood pressure, ear, nose and throat (ENT), gastrointestinal and skin diseases (Zaidi et al, 1997).

3.2. Visibility, Vegetation, Building Material

Fog reduces visibility, causes economic loss and creates health problems. For the past few years, winter fog in Lahore during December and January has become a recurring phenomenon. It has been known to last for as long as three weeks, especially in calm wind conditions. Excessive emissions and the presence of particulate matter in the air are the main contributing factors, and are attributed to increased fuel combustion (such as furnace oil, diesel oil, wood and coal) and the increased use of petrol for transportation in and around the city. Visibility problems for pilots due to emissions from brick kilns around Quetta airport area have been reported. Orders issued to close them down are under judicial review (BPCS, 2000). Traffic problems have also been reported on the main road in the Bucheki area (about 80 kilometers from Lahore), caused by reduced visibility, due to dust and husk emissions from the 35 rice mills in the area (Dawn, July 27, 2000).

Investigations carried out in Lahore and Karachi on vegetation around air polluting industries and on roadsides have shown negative impacts of atmospheric pollution on the plants in the surrounding areas. Pollution stress due to emissions from automobiles indicated a general decrease in chlorophyll and protein content in most of the plant species examined (Iqbal and Qadir, 1990).

Over the years the space surrounding Badami Bagh, outside the historical Lahore Fort (rebuilt in the 16th century with its origins as far back as AD 1025), has become a massive parking lot. The fort is constantly ringed on all sides by smoke emitting vehicles. Over the years prolonged emissions from vehicles has caused extensive damage to the walls and facades of the various buildings within the fort (Quraishi, 2000).

4. Responses

4.1 Institutional Responses

Pakistan has responded to its environmental problems by passing laws, establishing environmental protection institutions and by developing human resources and technical capacities through local resources and foreign assistance. Pakistan’s constitution confers concurrent legislative on the federation and the provinces to legislate with respect to environmental pollution and ecology. Pakistan has had laws that contain provisions for environmental protection. These laws, which were partly inherited from the British India, dealt with air and water quality, canal irrigation, land tenure and use, forest conservation, wildlife protection, energy development, pesticides use, noise and public health. However, these laws were ineffective and punishment for violation was mild and easy to circumvent. The laws also did not adequately cover the subject areas and several were outdated. Many aspects of the environmental degradation remained uncontrolled and under-regulated.

Air pollution is one of those complex environmental problems where control through point source reduction is considered most desirable, and the only way to prevent adverse health and other damaging impacts. Once emitted into the atmosphere, unlike other matrix/media, the recycling or re-use of the emitted products from the atmosphere is almost impossible. There is no dearth of acts, regulations, policies and strategies to combat air pollution. The legislative agenda, in particular, is comprehensive.

4.1.1 Legislation

- The Pakistan Penal Code, 1860 (update of the pre-partition British code)
- The Factories Act, 1934
- The West Pakistan Prohibition of Smoking in Cinema Houses Ordinance, 1960

- The Motor Vehicles Ordinance, 1965
- The Motor Vehicles Rules, 1969
- Punjab Local Government Act, 1996

Pakistan Environment Protection Act, 1997 (PEPA 97): The Pakistan Environment Protection Act, promulgated in December 1997, is an improvement over the 1983 Environmental Protection Ordinance, and reflects extensive and prolonged consultations with the stakeholders. The PEPA, a comprehensive law, provides for protection, conservation, rehabilitation and improvement of environment, for prevention and control of pollution and promotion of sustainable development. The act covers air, water, soil and noise pollution, including hazardous waste disposal and vehicular pollution. Section 11, sub-section (1) prohibits strictly emission of any air pollutant in an amount, concentration or level which is in excess of the National Environmental Quality Standards (NEQS). Section 15, sub-sections 1 to 3 pertain to the regulation of motor vehicles (see Box 1).

PEPA 97 Section 15, Regulation of Motor Vehicles

Sub-Section (1)
Subject to the provisions of this Act and the rules and regulations made thereunder, no person shall operate a motor vehicle from which air pollutants or noise are being emitted in an amount, concentration or level which is in excess of the National Environmental Quality Standards, or where applicable the standards established under clause (g) of sub-section (1) of section 6.

Sub-Section (2)
For ensuring compliance with the standards mentioned in sub-section (1), the Federal Agency may direct that any motor vehicle or class of vehicles shall install such pollution control devices or other equipment or use such fuels or undergo such maintenance or testing as may be prescribed.

Sub-Section (3)
Where a direction has been issued by the Federal Agency under sub-section (2) in respect of any motor vehicles or class of motor vehicles, no person shall operate any such vehicle till such direction has been complied with.

Section 16 empowers environmental protection agencies (EPAs), both federal and provincial, to issue environmental protection orders (EPOs) to violators directing them to take any measures that the agencies may consider necessary for the mitigation and prevention of pollution.

Under PEPA 97, the following rules and regulations have been finalized in consultation with stakeholders, and notified:

- National Environmental Quality Standards (Self Monitoring and Reporting by Industries) Rules, 2001.
- Provincial Sustainable Development (Procedure) Rules, 2001.
- Provincial Sustainable Development Fund (Utilization) Rules, 2001.
- Pollution Charge for Industry (Calculation and Collection) Rules, 2001.
- Composition of Offences and Payment of Administrative Penalty Rules, 2000.
- Environmental Samples Rules, 2001.
- Hazardous Substances Rules, 2000.
- Pakistan Environmental Protection Agency (Review of IEE/EIA Regulations, 1998).
- National Environmental Quality Standards (Environmental Laboratories Certification Regulations), 2000.
- Sector specific EIA guidelines have also been developed by Pak-EPA for major thermal power stations, oil and gas exploration and production, major chemical and manufacturing plants and industrial estates.

4.1.2 Strategies

The National Conservation Strategy (NCS, 1992): Preventing and abating pollution, increasing energy efficiency, and management of urban wastes are among the 14 core program areas of the NCS. With regard to air pollution control, specifically, the NCS emphasizes energy conservation in industry and transport, site industries appropriately to minimize pollution impacts, and introduce clean fuels, upgrade refineries, set up vehicles tune-up stations and compressed natural gas (CNG) stations.

Provincial Conservation Strategies: The Sarhad Provincial Conservation Strategy (SPCS, 1996) and the Balochistan Provincial Conservation Strategy (BPCS, 2000) refine further the NCS core areas according to the needs and requirements of the provinces. Brick kiln conversion, energy conservation, networks of meteorological stations, atmospheric environmental services and monitoring are some of the proposed initiatives.

The National Environmental Action Plan (NEAP): In the meeting of Pakistan Environmental Protection Council (PEPC, 2001) in February 2001, the council approved a National Environmental Action Plan (NEAP) developed by the Ministry of Environment, Local Government and Rural Development. The plan reflects a renewed commitment to the environment and focuses on taking immediate measures in four priority areas of concern –air, water, solid waste, and ECO system management – to achieve a visible improvement in the quality of air, water and land. The program for the control of vehicular pollution, industrial emission and indoor air pollution would be developed by the federal EPA, in which a special *Program Unit* for clean air has already been established.

4.1.3. International Conventions and Treaties

Pakistan has signed the following international treaties pertaining to air emissions:

- United Nations Framework Convention on Climate Change, 1992
- Vienna Convention for the Protection of the Ozone Layer, 1985
- Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal, 1987 and amendments
- Stockholm Convention on Persistent Organic Pollutants (POPs), 2001

4.1.4. Program and Project Initiatives

Project initiatives aimed at encouraging energy use-efficiency or curbing emissions provide important demonstration effects. These projects have been launched in the hope of a quick take-up. However, as seen above, their scope is constrained by an institutional and policy climate that seems to be lagging in interest and political will. Pilot projects should, ideally, inform polices but, as yet, there is not sufficient evidence that this is happening.

Fuel Efficiency in Road Transport Sector project (FERTS): Initiated in 1999, executed by MELGRD and ENERCON, and funded by GEF/UNDP, the FERTS project aims to reduce emissions at source by improving fuel efficiency of road transport vehicles. Ten demonstration tune-up centers in major cities of the country have been established. Also, 36 training workshops for 800 mechanics and 20 workshops for 443 workshop owners have been organized. Special studies have also been carried out in collaboration with the provincial EPAs, NGOs and other stakeholders (MELGRD, Oct. 2001).

Introduction of Alternative Fuels, CNG: As part of the clean air program and based on the recommendations of the Clean Fuels Committee, more than 100,000 vehicles converted to compressed natural gas (CNG) and CNG stations were set up in the country (Pakistan energy year book, 1999). The Canadian International Development Agency (CIDA) has supported experiment, motivational and incentive programs to convert auto-rickshaws to CNG in the cities of Quetta, Karachi and Lahore (Hagler Bailly, 2001).

Establishment of Cleaner Production Centers (CPCs): Cleaner production centers in the petroleum and leather sectors sector are functioning with the assistance of UNIDO and NORAD (Hagler Bailly, 2001). The CPCs are promoting adoption of ISO 14,000 international environmental standards and will also support environment friendly in-house practices, cleaner fuels, process improvement/substitution and the use of improved technologies.

Urban-Industrial Environment Protection (UIEP) program in NWFP: The UIEP program consisted of studies and pilot projects, which were executed by the NWFP-EPA with the technical assistance of GTZ (Malik, 2001). The focus of the program is on achieving emission reductions in vehicles, brick kilns and industries. A vehicle emission testing station (VETS) equipped with emission testing analyzers and with a capacity to test up to 10,000 vehicles a year for opacity and carbon monoxide was established on the Grand Trunk Road near Peshawar City. In addition, four mobile vehicle emission testing (MVET) teams were also set up to carry out on the spot testing of vehicular emission on city roads (GTZ-NWFP-EPA, 2000).

Pollution Monitoring and Inventories p*rojects:* Over the past few years, the Environmental and Space Sciences Division of SUPARCO has conducted studies on atmospheric pollution. Data on some of the major air pollutants and aerosols is being collected through regular and round the clock measurements. The ADB-funded Asia Least-Cost Greenhouse Gas Abatement Strategy (ALGAS), completed in 1998 and the first comprehensive national project on climate change, compiled an emissions inventory for Pakistan, identified emission options and developed a long-term emissions reduction program (Hagler Bailly, 1997c).

Measures for Control of Industrial Emissions: A number of innovative plant level and institutional measures have been initiated:
- Revised and more realistic National Environmental Quality Standards (NEQS) have been issued by the Pak-EPA. The standards specify limits for industrial gaseous emissions and effluents, and for emissions of sulfur dioxide and nitrogen oxides from power plants operating on coal and oil.
- Under PEPA 97 Section 6(1)(i), a Self-Monitoring and Reporting (SMR) system has been introduced after exhaustive consultations with the representatives of industry. Based on the notified Self-Monitoring and Reporting Rules, 2001, a Self-Monitoring and Reporting Tool (SMART) has been developed by Pak-EPA, with technical assistance from the Sustainable Development Policy Institute (SDPI). A pilot–phase program for SMART demonstration and testing has already been completed with 50 industrial units (Khwaja, Mahmood, A, SDPI, 2001).
- Under PEPA-97, section 16, EPAs have issued 235 environmental protection orders (EPOs) and several show cause notices to polluters.
- Two Environmental Protection Tribunals, one each in Lahore and Karachi, have been established to hear and decide environmental cases submitted by the public as well as appeals against the orders of EPAs.

These innovative measures need to be supported by implementation mechanisms to ensure effectiveness and transparency.

4.2 Policy Failure

4.2.1 Energy Policies

In contradiction to the prevailing acts, regulations and environmental conservation strategies, policies have tended to lag behind. In fact, energy policies – either by default or through intent – have encouraged wasteful consumption and favored high emitting fuels. The salient features of the policy are summarized below (Table 9):

Table 9: Energy sector price distortions

	Electricity	Natural Gas	Petroleum Products
Relative Prices			Gasoline price almost twice the price of diesel and kerosene Grading of gasoline encourages adulteration (premium with normal) Price of high speed furnace oil (HSFO), used extensively in industry and power sectors, 15% lower than less emitting LSFO
Production Costs	Commercial users, bulk supply and fertilizer producers cross-subsidize residential and agricultural users (flat rate) of electricity. The weighted average price of electricity below the long run marginal price.	Commercial and industrial users cross-subsidize residential users and fertilizer producers. The weighted average price of natural gas below the long run marginal cost.	
Incentives			Lack of tariff incentives to import fuel efficient cars Low tariffs on heavy duty diesel vehicles
Administrative			Use of leaded petrol which precludes use of catalytic converters

Source: Energy Wing, GOP, 1998

It can be clearly seen that distortions including below cost pricing, relative price differentials, absence of incentives and administrative slack are responsible for high emission levels. The low gas and electricity prices to residential, agricultural and selective industrial consumers only encourage over consumption and keep consumers from conserving energy. While Pakistan has taken initial steps towards rationalizing energy pricing, the persistence of distortions and the associated emission scenarios suggest that it still has far to go before such emissions can be stabilized.

Institutional measures such as privatization should be accompanied by enforced standards for environmental protection. In reality, the government's private power policy appears to be focusing on increasing supply of conventional energy by attracting private capital for thermal power generation.[4] A number of regulatory agencies (NEPRA, PPIB, PEPCO) have been set up to oversee energy pricing, investment and privatization of WAPDA's thermal generation, transmission and distribution functions. Other institutional initiatives are on the anvil in the oil and gas sectors. However, the

4 An attractive bulk power tariff of US Cents 6.5/kWh (for first 10 years of project life) has been offered to IPPs (Independent Power Producers) for sale of electricity to WAPDA/KESC with indexation mechanism for fuel price, US & Pakistan inflation, exchange rate, O&M cost etc. Besides, fiscal incentives, standardized security package (including Implementation Agreement, Power Purchase Agreement & Fuel Supply Agreement) is a vital part of the package (Energy Wing, GOP, 1998). In order to implement the private power policies, the Private Power and Infrastructure Board (PPIB) was set up to provide one-stop operation for the approval of power project.

frailty of these institutions is reflected in the present private power imbroglio in the delays in corporatizing WAPDA and in the mixed signals emanating from NEPRA regarding electricity tariffs.

4.2.2. Macroeconomic Policies

Traditionally industrial protection, through trade restrictions (tariffs, quotas), industrial licensing and other administrative controls on investment, provided the protectionist slack for using inefficient, high emission generating technologies. This was contributed in part by low energy prices and a disregard of environmental concerns. The trade and industrial reform program, which includes elimination of quotas, tariff reductions and relaxation of industrial licensing requirements, has removed many of the constraints to industrial energy use efficiency. Concurrently, privatization also creates an impetus for energy efficiency through increased competition and use of improved technology. Exchange rate liberalization has contributed to raising imported energy prices, and the attempt to achieve budgetary balance has been accompanied by reduction of subsides, including those on energy. However, if sector policy distortions continue to persist they can undermine the impacts of economy wide reforms. In addition, the institutional dimension relating both to energy use and emissions is no less critical than the need for complementary price measures.

4.2.3. Emission Policies

The track record of environment specific policies aimed at addressing market failure is not too good either. The norm has been to rely on command and control policies, which are weakly enforced because of deficient implementation capabilities. Current efforts are being made to replace these with voluntary, market-based pollution charges. The consultative process (between the government, NGOs and industry) followed in determining that these charges bode well for implementation, and also reflect the failure of the government's traditional enforcement approach. In addition, the emissions problem is also an outcome of bad zoning – where proximity to urban residential areas, combined with urban pollution from mobile sources, leads to high emission concentrations.

Other measures/regulations aimed at addressing vehicles emissions such as the Motor Vehicle Ordinance, 1965, and the Motor Vehicles Act, 1969, are not complied with, even in the most rudimentary way due to lack of resources. It provides little comfort to know that the average vehicle in Pakistan, which is over 15 years old, emits 20 times more hydrocarbons, 25 times more carbon monoxide and 3.6 times more nitrous oxides than the average vehicle in the US (NCS, 1992).

5 Conclusions and Recommendations

5.1 Tapping the Renewable Energy Potential: The Wave of the Future

Fuel consumption trends for Pakistan indicate a configuration dominated increasingly by dirty fuels (oil, coal), as gas and hydel resources begin to deplete. The importance of developing renewable energy cannot be emphasized enough to address pollution concerns and to meet growing energy shortages. Renewable technologies such as mini-hydel dams, wind turbines and solar panels are particularly relevant in the Pakistani context. It is imperative that such options are explored immediately, given their high development costs and the long lead times required to gain institutional acceptance.

The potential for renewable energy with the exception of mini and micro hydel power generation has largely remained unutilized. Tables 10 and 11 illustrate the present take-up of various options, the associated financial costs, and their mitigation potential.

Table 10: Utilization of renewable resources

Type	Number	Capacity
Biogas Plants	4165(150 f3/day/plant)	624750 CFT/day
Solar Plants	20(I.C=0.45-57kWP)	438 kWP
Wind Mills	2(I.C=12kWP)	24 kWP

Note: I.C = Installed Capacity; Source: Energy Wing, GOP, 1998

Table 11: Renewable options: Mitigation potential and cost effectiveness

	Estimated Investment Cost of Option (US$/typical size)	Estimated GHG Emission Reduction, Tonnes of CO2 equiv./yr	Cost Effectiveness, US$/t of CO2	Benefit/Cost Ratio
Mini-micro Hydro, 2MW	2,000,000	11,665	-5.05	1.46
Photovoltaic, 1 MW	1,535,000	3,403	69.82	0.46
Wind Power Generation, 15 MW	19,330,000	43,753	68.47	0.46
Solar Water Heater	394	1.71	-12.39	1.82
Waste to Energy Generation, 5 MW	8,150,000	20,480.00	-1.88	2.40

Source: Energy Wing, GOP, 1998

In terms of benefit-cost, the solar water heater and waste to energy generation are better renewable energy options to be considered for the country.

The estimated renewable energy potential by source is given below.

5.1.1 Hydel

Estimates of small hydro potential – still to be exploited – range between 1,000 to 1500 MW.[5] In Chitral district alone, the potential is estimated to be about 600 MW.

5.1.2 Solar

Data gathered from five large and 32 small observatories indicate excellent solar potential. Pakistan receives about 1.5 quadrillion KWh of solar energy a year. Interestingly, Pakistan's total electricity production in 1996 amounted to only about 0.003 percent of this. Clearly, solar technologies can contribute substantially to alleviating future energy needs (Rahim, 1996). Pakistan can generate over 27,000 GWh of electricity – 10% of the electricity needs in 2018 and using less than 0.35 percent of its land area. It also means an annual reduction in CO_2 of over 41 million tones.

Solar project

The pilot solar power system set up by an American firm, World Water Corporation, has yielded encouraging results. The system, set up in the suburbs of Quetta, is a trendsetter in providing sustainable methods for pumping drinking and irrigation water, lighting and communications in arid and semi-arid areas of Balochistan and in similar terrain in several parts of Pakistan.

Source: Business Recorder, February 23, 2000

5 Mini hydro project ranges between 100 kw to < 5,000 kw while micro hydro is < 100 kw

5.1.3 Wind

Wind power is well suited for various coastal locations in the Balochistan province, for rural areas in Sindh and in the Northern Areas characterized by scattered, isolated hamlets with populations of less than 50 households. Dispersed energy systems like wind power plants in such areas are a viable option. It is conservatively estimated that the annual wind energy potential for Pakistan is in the range of 2000 to 3000 MW (Ali Khan, 1998). Recently, a demonstration project of 15 MW has been set up in Pasni, Balochistan, to promote wind energy.

5.1.4 Waste

Methane produced from decomposition of municipal and industrial waste is estimated to contribute 338,000 tonnes/year of methane. A demonstration project for generation of about five MW for Lahore City from municipal solid waste is under process.

5.2 Improving Energy Efficiency

Renewable energy is still in its infancy in Pakistan. While it will take considerable political will and financial resources to harness and utilize this resource, measures to improve energy efficiency are relatively more viable. However, because of the limited additionality that this recourse offers, it is imperative that both options be seen as complementing rather than competing with each other.

5.2.1 Electricity

Thermal power plants presently account for 75% of fuel oil consumption in the country. Most are equipped for dual fuel firing, and switching from fuel oil to gas can be accomplished in a short time with minimum expense. Another potential source of energy saving is reducing losses in electricity transmission and distribution (T&D). Such losses presently average 26%, against the internationally acceptable levels of 15%.

5.2.2 Industry

The industry sector offers considerable scope for energy efficiency gains. Boilers in textile, fertilizer and food processing and other industries account for 35% of the total energy consumed. About 50% of the total boilers are imported second hand and, according to a recent study, almost 75% of boilers in the country operate at less than 70% efficiency. A report indicates that energy efficiency in the industry sector can be improved by about 20% for thermal energy and 15% for electricity (Hagler Bailly, 1997b).

5.2.3 Transport

The transport sector is the third largest energy-consuming sector after the power and industry sectors. Improved engine maintenance such as engine diagnostics and tuning can result in savings of up to 60% in fuel use. A number of vehicle maintenance practices such as wheel alignment and balancing, brake adjustment, and timely replacement of tires can contribute to about 12% in fuel savings. Other options assessed for this sector include improved engine and vehicle maintenance, and use of improved engine design (Hagler Bailly, 1997b).

5.2.4 Household savings

The growth rate of electricity consumption in the residential sector alone is estimated at an annual average of over 10%. Electric appliances being marketed in Pakistan typically consume 25% more energy than high efficiency appliances currently being marketed in other countries. Studies conducted in selected residential and commercial buildings indicate that electricity demand for lighting can be reduced by up to 17% using available technologies. Moreover, buildings are often inadequately insulated which also places additional strain on appliances. Improvements in design can contribute to about 45% reduction in air-conditioning loads while maintaining comfort levels.

5.3 Energy Conservation and Substitution Measures

5.3.1 Short-term measures

- Periodic testing of vehicles for emissions.
- Full scale implementation of the self-monitoring and reporting/SMART program for industry.
- Improvement in fuel quality.
- If located within municipal limits, mandatory closure of (i) coal fired brick kilns; (ii) steel melting units without pollution control equipment; and (iii) stone crushing units.
- Expansion of the natural gas distribution system to areas not yet covered.

Formatted: Bullets and Numbering

5.3.1 Medium term measures

- Mandatory low emission engine technologies.
- Phasing out of two-stroke engines.
- Reduction in diesel use through (i) reduction of price differential between diesel and petrol; (ii) further promotion of CNG, including in public transportation; (iii) increase in taxes on diesel vehicles used for personalized transport.
- Mandatory installation of catalytic converters.
- Improved traffic management.

Formatted: Bullets and Numbering

5.3.2 Long-term measures

- Shifts from personal cars to railways, public transport and mass transit system.
- Introduction of low emission technologies, such as hybrid cars and fuel cell powered vehicles.
- Upgrading of road transport infrastructure and networks.
- Institution of bicycles lanes and routes.
- Improved urban planning to minimize travel distances.
- Implementation of pollution charge system for industry.
- Zoning of industrial activities.
- Enforcement of EIA regulations.
- Shift to cleaner fuels and technologies in industry.
- Promotion of efficient wood cooking stoves.
- Reduction in disparity of price between natural gas and PLG.
- Promotion of bio-gas plants and renewables.

Formatted: Bullets and Numbering

Bibliography

Agha. S., Agha. F., Khatoon. Naz., Sultana, K., (1995). *Journal of Pakistan Medical Association, pp 8, vol 45*.

Ahmed, Sofia. (1992). *Pakistan Journal of Medical Research,* 31(2).

Asian Development Bank. (2001). *Asian Environment Outlook 2001*. Manila

Beg, M. (2000, July 17). *Energy Production in Pakistan. Dawn, Karachi*.

Business Recorder. (2001, February 22). Karachi.

Dawn. (2000, July 27). *Bucheki Environmental Disaster Imminent*

Government of Balochistan/IUCN-Pakistan. (2000). *Balochistan Provincial Conservation Strategy*.

Government of NWFP, Planning, Environment and Development Department. (1994). *Environmental Profile of North West Frontier Province Pakistan*. Peshawar.

Government of Pakistan, Federal Bureau of Statistics. (1997). *Compendium of Environmental Statistics*. Islamabad.

Government of Pakistan, IUCN, (1992). *National Conservation Strategy*. Pakistan.

GTZ-NWFP, EPA. (2000, April). *Air Pollution in Peshawar and Its Health Impacts*.

Hagler Bailly. (1997a, February). *National Baseline Scenarios: Projection of Greenhouse Gas Emissions upto the Year 2020*. Islamabad.

Hagler Bailly. (1997b, July). *Environmental Issues in the Energy Sector in Pakistan*. Islamabad.

Hagler Bailly. (1997c, November). *Asia Least-Cost Greenhouse Gas Abatement Strategy*. Pakistan National Reports.

Hagler Bailly. (2001, November). *Strategy Paper for Pakistan Clean Air Program*. HBP Ref. D1V01CAP. Canada.

Iqbal, M.Z., Qadir, M.A., (1990). *Determination of Br, Rb, Cs, Sc and Na in various plants leaves located in an Urban Park by Neutron Activation Analyses.* Journal of Radioanalytical and Nuclear Chemistry Letters. pp 145 (3), 189.

Japan International Cooperation Agency. (2000, March). *Investigation of Air and*

Journal of Pakistan Medical Association 40 (1990); 45 (1995)

Khan, Farid Ullah, Saeed, Akhtar and Akif, M. (1998). *Rate of Dust fall and Particulate Analysis in Peshawar-Pakistan*. Science Technology and Development. 17(3)

Khan, Shaheen Rafi and Iqbal, Fareeha. (2001, September). *A Climate of Trust Report: Domestic Actions in Developing Countries to Advance Development Priorities While Slowing Climate Changes*. Sustainable Development Policy Institute. Islamabad.

Khan. Ali A. (1998). *Role of Renewable Development in Pakistan & the E-7 Utilities*. Environment and Sustainable Development Division, Ontario Hydro, Canada

Khwaja, Mahmood A. (2001). *Present Status of Self-Monitoring and Reporting Program/SMART for Industry*. Sustainable Development Policy Institute (SDPI). Islamabad.

Lovei, Magda. (2000). *Phasing Out Lead from Gasoline: World-wide Experience and Policy Implications*, The World Bank, Washington 1996 HB-Strategy paper.

Malik, Murtaza. (2001). *Improving the Urban Environment-Experience in Peshawar*. The Nucleus. pp. 38, 2, 177

Manser, W.W.T., Lalani, R , Haider , S. and Khan, M.A., (1990). Journal of Pakistan Medical Association 40

Pakistan Environmental Protection Act, 1997

PEPC. (2001, February 3). *Minutes of 9th Meeting of Pakistan Environmental Protection Council*. SDPI, Islamabad.

Population and Environment Digest, Volume (1), Population and Environment Communication Center (PECC). (2001, August). SDPI, Islamabad.

Quraishi, Omar R. (2000, July). *Pollution Threatens the Fort*. Dawn.

Rahim, Shahid. (1996, April 5). *Tapping sun's energy for power sector's future need*s. The News, Rawalpindi.

Sarhad Provincial Conservation Strategy, Government of NWFP/IUCN. (1996). Pakistan

Shigeta,Y. (2000, July). *Environmental Investigation in Pakistan*. Pak-EPA/JICA, Islamabad.

Technology Transfer for Sustainable Industrial Development. (1995, Oct). *Phase II Technical Proposal, Volume 1*. SDPI, Islamabad.

The Ministry of Environment, Local Government and Rural Development. (2001). *Ozone Brief*.

The Ministry of Environment, Local Government and Rural Development. (2001, Oct). *Environmental Challenges and Responses*

The Ministry of Planning and Development, Energy Wing., Applied System Analysis Group, & Pakistan Atomic Energy Commission. (1998, June). *Country Study on Energy and Environment*. Islamabad.

The Pakistan National Conservation Strategy, 1992

Water Quality. Hagler Bailly, Pakistan.

Zaidi, M., Aban, A., Kamal, L. and Siddiqui, S.A. (1997). *Statistical Study of the Diseases Related to Lead in Air in Quetta city*. University of Balochistan, Quetta.