REVIEW ARTICLES

ENERGY POLICIES FOR THIRD-WORLD COUNTRIES

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1. INTRODUCTION

It is universally recognized that energy is one of the most important inputs to economic growth and development; the consumption of energy is considered as one of the critical indicators of the level of development of any country. Developed countries use more energy per unit of economic output and far more energy per capita than developing countries. Energy-use per unit of output does decline somewhat over time in the more advanced stages of industrialization, reflecting the adoption of increasingly more efficient technologies for energy production and utilization as well as changes in the composition of economic activity. At present, over a billion people in the industrialized countries use some 60 percent of the world's commercial energy supply, while 5 billion people living in the developing countries consume the remaining 40% – a large number of them are really poor. It is estimated that about two billion people around the world have no access to modern energy-services and as a result, struggle to meet their basic daily needs. Economic growth is the key to changing this situation, and for economic growth energy is vital.

The energy demand is expected to increase significantly, due to fast industrial growth in the developing countries, as well as for meeting the energy-needs of the people deprived of basic necessities of life. The projection for World Energy-consumption broken up by natural resources is indicated in Figure 1. This will of course be supplemented by the development and commercialization of non-conventional sources of energy.

2. PRESENT ENERGY STATUS IN THE THIRD-WORLD COUNTRIES

General

- Per-capita consumption of energy is extremely low. The per-capita consumption is 14M Btu in Pakistan, 34M Btu for China and 92M Btu for

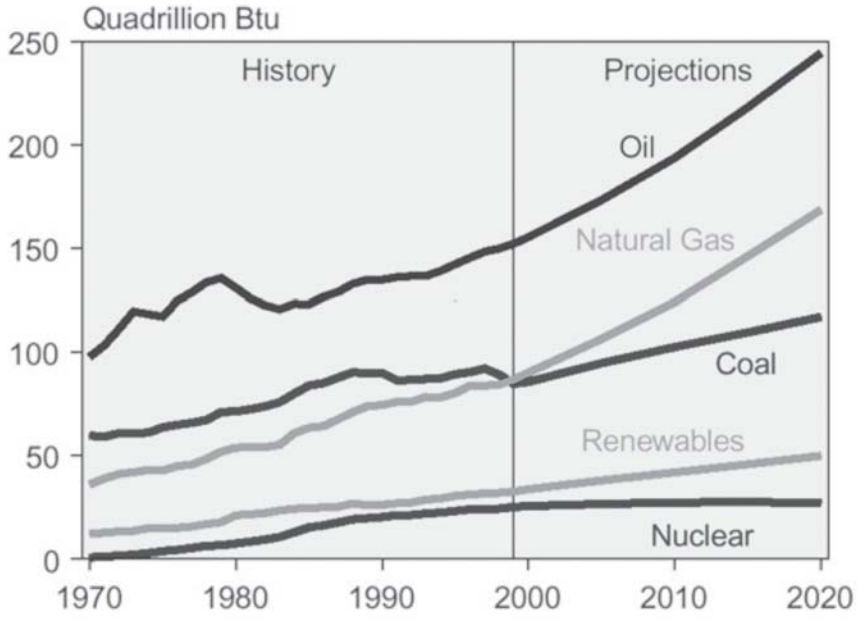

Figure - 1: World-Energy Consumption by Natural Resources Types 1970-2020

Source: History: Energy Information Administration (EIA), Office of Energy Markets and End Use, International Statistics Database and International Energy Annual 1999, DOE/EIA-0219(99) (Washington, DC, January 2001). Projections: EIA, World Energy Projection System (2001)

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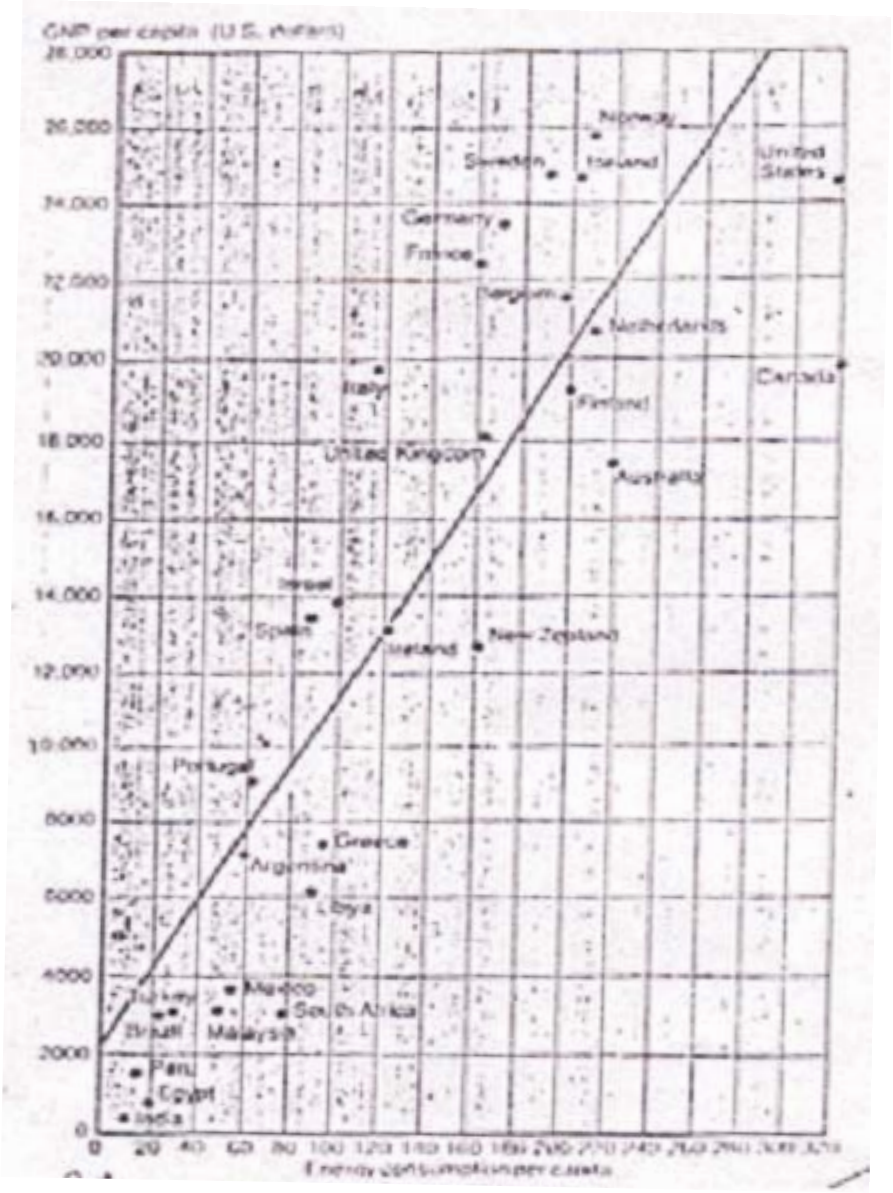

Figure - 2

Energy and GNP. Energy consumption rises with increasing gross national product. Because the internal-combustion engine accounts for a large share of national energy consumption, this graph is a statement both of economic development and of the role of mass transportation, automotive efficiency, and mechanization of agriculture and manufacturing in different national economies. On the graph, energy units are in gigajoules. Data from World Bank.

Malaysia. For Pakistan it is estimated that the energy consumption is half of the average of all developing countries, one ninth of the world average and 1/48 of the US average. The electric power generation is much lower than the requirements.

- Millions of villagers consume/utilize biofuels for domestic energy, causing deforestation, soil-erosion and environmental degradation.
- Commercial energy needs and the fuels used are steadily changing as per demand, stage of development and process of industrialization. In Pakistan, for example the total commercial

Table - 1: Economic Indicators and Agriculture's Share of Labour

Country Group	Per Capita GNP[a]	Per Capita Energy Consumption[b]	Percent of Labour Force in Agriculture
Least Developed Countries	270	4.3	74
All Developing Countries	1250	855	61
Industrial Countries	20,900	5259	8

needs are today met by Gas (49.7%), Oil (29.9%), Hydro (12.7%), Coal (6.5%), and Nuclear (0.8%), whereas in 1947 the major energy sources were 55.1% coal, 37.8% oil and 3.1% Hydro, indicating a major shift from coal towards gas and hydro power.

- Major portion of the energy, in terms of electricity, fuel and wood, is utilized for domestic purposes: upto 48% and, in some cases, it may go to 70% depending on the stage of economic development.
- The transmission and distribution power-losses often range between 20 and 30 per cent. Appropriate technical and administrative measures should be taken to improve efficiency of operational management. Power losses and theft are rampant in the big cities in some countries.
- There is little effort made for energy conservation and energy efficiency in industries, agriculture and transportation and for developing integrated energy-systems for decentralized sectors.

Nuclear and Hydro-Power etc.

- Few third-world countries have nuclear power plants to supplement the energy-need. The industrialized countries are hesitant to construct, install and operate the nuclear power plants in the third-world countries, fully knowing that these plants are least polluting, are capable of providing sustainable supply of fuel and are economically viable. The population in third world countries is likely to keep growing for several decades, so the energy-demands will increase faster and hence nuclear power generation is a possible option.
- Hydro power provides about 5% of the world's power. Micro-hydel and mini-hydel energy generation is simple and easy to operate, but not adopted properly in the mountain-regions for want of local skills, distribution-system and billing.
- Known technologies are available for solar pump, drying, heating, wind-energy and photo-voltaic electric generation system, etc, but not utilized /popularized due to high cost of installation, maintenance, repair and instrumentation.

To Sum-up:

Dozens of the Third World Countries continue to import oil to meet the local demands at whatever costs. Pakistan imports oil to meet 90 percent of its oil-requirements and spends 60-70 per cent of total foreign-exchange earnings on it. Heavy reliance on fossil fuels, albeit limited supply and at high cost, is the major source of atmospheric concentration of toxic emissions and rising temperature of earth. Dependable and affordable supply of energy is of critical importance in order to improve/accelerate the economy and to alleviate poverty. The known energy-potential of many third-world countries is much larger than the present need of exploitation. If carefully planned and efficiently implemented and managed, this potential is sufficient to provide immediate relief to the national economy.

Because of the close association of energy and economic development, a basic disparity between societies is clear. Countries that can afford high levels of energy-consumption, through production or purchase, continue to expand their economies and to increase their levels of living. Those without access to energy, or those unable to afford it, see the gap between their economic prospects and those of the developed states growing ever greater.

Per-capita energy-consumption

This is a common measure of technology-advancement of nations, because it broadly correlates with per-capita income, degree of industrialization, and use of advanced technology (see Figure 2). In fact, the industrialized countries use about 10 times more energy on a per-capita basis than developing economies do. The consumption, rather than the production of energy, is the concern. Many of the highly developed countries consume large amounts of energy, but produce relatively little of it. Japan, for example, must import from abroad the energy-supplies that

its domestic resource-base lacks. In contrast, many less developed countries have very high per-capita or total energy production figures but, primarily, export the resource (petroleum). Libya, Nigeria, and Brunei are a case in point.

The advanced countries developed their economic strength through the use of cheap energy and its application to industrial processes. But energy is cheap only if immense capital-investment is made to produce it at a low cost per unit. The less advanced nations, unable to make those necessary investments or lacking domestic energy resources, use expensive animate energy or such decreasingly available fuels as firewood. The data presented in Table 1 clearly indicates that industrial countries are consuming ten times more energy per capita than the Third World countries, where over 65% of the population is engaged in agriculture, the main occupation of the populace, whereas only 8% of the labour force in the industrial countries is employed in agriculture.

3. VARIOUS SOURCES OF ENERGY AND PROJECTIONS

Conventional	Non-Conventional
• Gas • Oil • Coal • Hydro-energy	• Geothermal Energy • Nuclear Energy • Mini & Micro-hydel • Solar Energy - Biomass Energy - Wind Energy - Wave and Tidal Energy - Photo-voltaic electric generation system

There are few countries in the Third World that are bestowed with conventional as well as non-conventional sources of energy. For example, Pakistan is utilizing oil, gas, coal, hydropower and nuclear power for generating electricity and utilizing it for commercial, industrial and domestic purposes. Also it has established institutions and some demonstration units to harness non-conventional sources of energy (solar, biomass, micro-hydel, wind, tidal, wave and photovoltaic solar technology). The power demand is projected to grow at an annual average rate of 7.9 per cent during the five years (2005-10) and will increase from about 15,5000 MW in 2005 to 21,500 MW in 2010 (Table 2). The major demand is concentrated in industrial and domestic sectors. Various mega-projects and regulatory bodies have been approved and some are functioning in hydro-power, oil, coal, nuclear technology and renewable energy technologies to meet the power demand.

3.1 Conventional Sources of Energy

Except for the brief and localized importance of water-power at the outset of the industrial revolution, modern economic advancement has been heavily dependent on the mineral fuels: coal, petroleum, and natural gas. Also known as fossil fuels, these non-renewable energy-sources represent the capture of the sun's energy by plants and animals in earlier geological times and its storage in the form of hydrocarbon compounds in sedimentary rocks within the earth's crust. About 75% of the world's energy-supplies presently come from these fossil fuels, barely 2 percent from hydro-power resources, 13% from biomass while about 10% of energy requirement is met from nuclear power.

Coal was the earliest in importance and is still the most plentiful of mineral fuels. Although coal is a non-renewable resource, world supplies are so great (of the order of 10,000 billion (1013) tons) that its resource-life expectancy is measured in centuries, not in the much shorter spans usually cited for oil and natural gas. Worldwide, the most extensive deposits are concentrated in the industrialized middle latitudes of the Northern Hemisphere (Table 3). Two countries, the United States and China, accounted in roughly equal shares for more than 50% of total world coal-output at the start of the 21st century; Russia and Germany both with large domestic reserves, together produced less than 9%. Utilization of coal for power-

Table - 2: Estimated, Sector-Wise Power Demand in Pakistan (2005-10)

Year	Domestic	Commercial	Agriculture	Industrial	Other	Total
2005-06	7,199	1,216	1,763	5,891	1,035	15,500
2006-07	7,585	1,251	1,820	6,481	1,086	16,600
2007-08	8,127	1,312	1,893	7,252	1,159	17,900
2008-09	8,783	1,354	1,979	8,181	1,243	19,600
2009-10	9,531	1,408	2,079	9,267	1,341	21,500

Source: Planning Commission of Pakistan

Table - 3: Proved Reserves of Petroleum, Natural Gas and Coal, January 1, 2001

	Share of Total Petroleum (%)	Share of Total Natural Gas (%)	Share of Total Coal (%)
North America[a]	6.1	4.9	26.1
Europe	1.9	3.5	12.4
Former Soviet Union	6.4	37.8	23.4
Of which: Russian Fed.	4.6	32.1	15.9
Others	1.8	5.7	7.5
Central and South America	9.0	4.6	2.2
Africa	7.1	7.4	6.2
Middle East[b]	65.3	35.0	--
Australia/New Zealand	0.3	0.8	9.2
Japan	--	--	0.1
China	2.3	0.9	11.6
Other Asia Pacific	1.6	5.1	8.8
Total World	100.0	100.0	100.0
Of which OPEC[c]	77.8	44.2	NA

[a]: includes Canada, Mexico, U.S.A
[b]: Middle East includes Arabian Peninsula, Iran, Iraq, Israel, Jordan, Lebanon, Syria
[c]: OPEC: Organization of Petroleum Exporting Countries. Member nations are, by world region:
South America: Venezuela
Middle East: Iran, Iraq, Kuwait, Qatar, Saudi Arabia, United Arab Emirates (Abu Dhabi, Dubai, Ras-al-Khaimah, and Sharjah)
North Africa: Nigeria
Asia Pacific: Indonesia
Source: BP Amoco, BP Amoco Statistical Review of World Energy

generation is as high as 75% in China, 54% in India and 29% in Pakistan.

Petroleum, first extracted commercially in the 1860s in both the United States and Azerbaijan, became a major power source and a primary component of the extractive industries only early in the 20th century. The rapidity of its adoption as both a favoured energy resource and a raw material important in a number of industries from plastics to fertilizers, along with the limited size and the speed of depletion of known and probable reserves, suggest that petroleum cannot continually retain its present position of importance in the energy-budget of countries. Assuming total extraction from known reserves and a constant end-of-century rate of extraction, proven reserves at these estimates would last only about 40 years. More optimistic assessments assure us that petroleum reserves that could be extracted at acceptably competitive prices would last for about 150 years at present consumption rates.

On a world basis, petroleum accounted for 47% of commercial energy in 1973, but had dropped to 40% by 2001 as a reflection of its increasing cost and of conservation measures to offset those increases. The worldwide demand for oil would rise at the rate of approx. two per cent annually between now and 2020, which means that consumption of oil will rise from 77 million barrels per day (mbd), in 2000, to 94 mbd in 2010. The price has already crossed 65 dollars. Oil shall be costly and rare due to the high demand in industrial countries and the high pace of industrialization in China and India. For instance, America being five per cent of the world's population consumes 25 per cent of world's oil, and imports 60 per cent of its requirements, with little concern for depleting oil-resources. Petroleum is among the most unevenly distributed of the major resources. Seventy-five percent of proved reserves are concentrated in just 7 countries; and 83% in only 10: Iran and the Arab states of the Middle East alone control nearly two-thirds of the world total (Table - 3). Therefore, there is great pressure on Middle Eastern countries to share oil resources. Scarcity of oil in the near future is inevitable. Wars will be fought not over ideology but over diminishing supplies of the world's most precious natural resources, particularly oil.

Natural gas has been called the nearly perfect energy-resource. It is a highly efficient, versatile fuel that requires little processing and is environmentally benign. Ultimately recoverable reserves, those that may be found and recovered at very much higher prices, might last another 200 years. As for coal and

petroleum, reserves of natural gas are very unevenly distributed. (Table-3), 37.8% in former Soviet Union, 35.0% in Middle East, 7% in Africa and 5% in North America. For the world as a whole, gas consumption rose more than 60% between 1974 and 2000, to 25% of global energy consumption. The source of energy through natural gas is increasing rapidly due to escalating cost of petroleum in some developing countries.

3.2 Nuclear Energy

Nuclear energy for power generation is considered an important alternative for the alarming rise in oil prices and dependency on foreign sources and routes. Nuclear power plants are operating in 30 countries around the world. Till 1985, 382 reactors were operating and now there are 438 nuclear plants running safely in the world. And around sixteen percent of the world's electricity is now being generated through nuclear reactors. India had 6 reactors in 1985 and now 3 more, Pakistan had one in 1985, now one more is in operation and another one under construction. Nuclear technology can contribute significantly towards sustainable development in terms of food security, clean water, health care, pollution-free environment, and reliable energy supply.

In some of the European countries, the proportion of the total electricity generated through nuclear power plant is as high as 65% (France – 65.4%, Belgium – 60.4%, Sweden – 43.4%, Switzerland – 40%). The developing countries should also endeavour to build nuclear plants having advantages, such as:

i. sustainable supply and security
ii. compatibility with environment
iii. long-term economically viable
iv. it may spin off new technologies and business ventures.

Greater demand for nuclear power generation is envisaged in Asia particularly in China, Pakistan and India, with an eye to accelerating transition of the base-load from oil and gas, to nuclear in view of the depletion of oil and the subsequent peaking of gas usage around 2030. Pakistan plans to increase domestic nuclear power generation from the present 430 MW to 8800MW in the next 25 years. This may appear too ambitious a target to realize, but there is no alternative. With $ 65/barrel, oil import costs 5 billions dollars, a burden difficult to bear.

The long-term availability of different fuels is listed below:

Uranium (once through)	150 years
Breeder reactor	1000 years
Thorium Cycle	Several thousand yrs.
Oil	40 years
Gas	60 years
Coal	200 years

It is obvious that, barring coal, no other fuel has any long-term sustainable supply. In comparing the pollutionability, the coal is most polluting, followed by oil and gas, while the nuclear energy is the least polluting, as given in Table - 4 below:

While it is correct that no new nuclear power plants were built in the United States or Britain for over 20 years, the "fear factor" linked to the accidents at Three Mile Island and Chernobyl which reduced the market demand. But this should not be discouragement in adopting nuclear power technology, as no other large-scale technology, worldwide, has a comparable overall safety record. Also to waive off the worst effects of climate change, massive expansion in nuclear power generation is required which produces hardly any carbon dioxide. Intensification and self-sufficiency in using nuclear energy for power-generation is the only immediate solution to curb the energy-deficit situation. The new breed of safer and better performing reactors marks the new era of cleaner, safer and, perhaps, cheaper energy resource. Nuclear power for meeting the energy-needs is poles apart from

Table - 4: GHG Emissions from Electricity-Production for Chains

Energy Source	Emissions (GCeq/kWh)
Nuclear	2.5-5.7
Wind Power	2.5-13.1
Large Hydro	4-6
Solar PV	27-76
Natural Gas	120-188
Oil	219-246
Coal	264-357

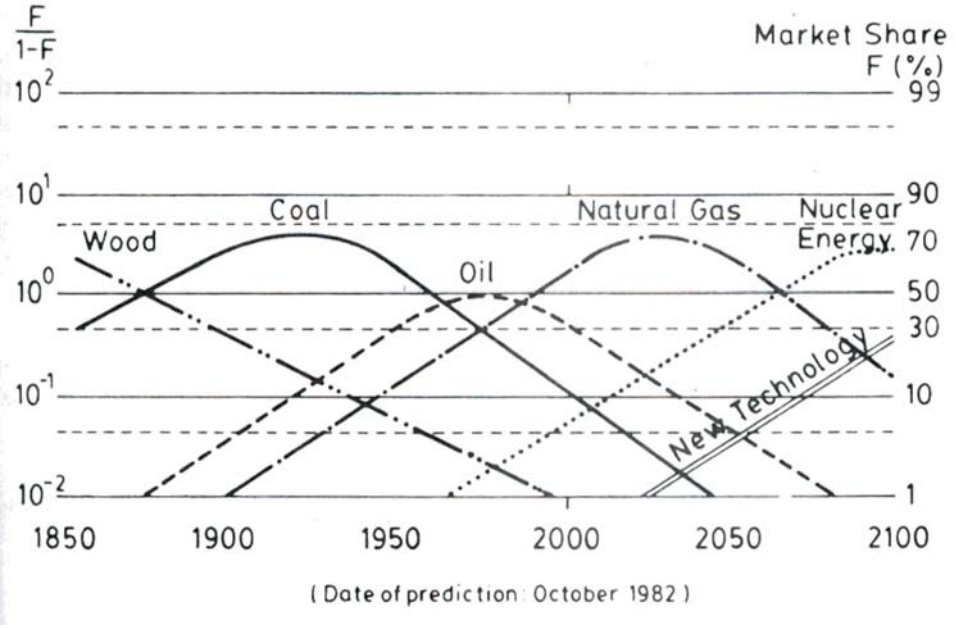

Figure - 3: Showing the schematic representation by C. Marchetti of the rise and fall of the market shares of various energy-forms over the period from 1850 to 2100 A.D.

nuclear proliferation for weapon-use.

Thus we can see that the proportion of Nuclear Energy usage in Third-World countries also likely to increase steadily, as it has done in the developed world. In fact, the estimates for the future are that, once the use of gas has peaked (somewhere around 2030), the contribution from Nuclear Energy would begin to increase rapidly, as indicated by the inclined dotted line in the conceptual diagram from Marchetti (Figure-3). This is further supported by the fact that Nuclear power contributes directly towards sharing the base-line load in the city or area concerned.

3.3 Renewable Energy

The fossil fuels (coal, oil and gas), beside limited reserves, have harmful effects on the environment and release toxic gases containing Sulphur, NOx, CO and heavy metals, which are great health-risk. The Kyoto Protocol (1997) directs that the Developed countries shall by 2008-2012 reduce the total emission of six key greenhouse-gases by at least 5% from the 1990 level. This is possible only if use of renewable technologies is increased substantially. In year 2000, the developing countries' electric power capacity (1,500,000 MW) was 45% of world electric power (3,400,000 MW). World's fossil fuels account for about two-third of generating capacity, with the remaining third being composed of large hydro (20%), nuclear (10%) and other renewable energy (3%) units. Electric Energy consumption in the developing world is increasing with economic growth and they will need to double their current generation capacity by 2020.

3.3.1: Solar Energy

Amongst all renewable energy resources solar energy is in great abundance, freely available, widely distributed and can easily be converted into other processes of energy. Over 1000 million people live in underdeveloped economic conditions around the world between latitudes 35°N~35°S. In general greatest amount of solar energy is found in two broad bands around the earth between latitudes 15° and 35° north and south of the equator. Three approaches to the utilization of this solar energy are (a) use of low-grade heat; (b) direct conversion to electric energy; and (c) photosynthesis and biological conversion processes. Solar energy covers a wide range of applications, some of which are mentioned below. These are old technologies, improved upon over the ages while some have been recently introduced:

i. Solar room heating system

Table - 5: Renewable Energy Sources

Technology	All Countries	Developing Countries
Small hydropower[a]	43,000	25,000
Biomass power[b]	32,000	17,000
Wind Power	18,000	1,700
Geothermal power	8,500	3,900
Solar thermal power	350	0
Solar photovoltaic power (grid)	250	0
Total renewable Power capacity	102,000	48,000
Large hydropower	680,000	260,000
Total world electric power capacity	3,400,000	1,500,000

Source: Renewable energy in developing countries-lessons for the market" Renewable Energy World, July-August 2003, p.55

Notes:

(a) Small hydro is usually defined as 10MW or less, although the definition varies by country, sometimes up to 30 MW

(b) Biomass figures omit electricity from municipal solid-waste and landfill gas; commonly, biomass and waste are reported together.

ii. Solar water heaters
iii. Solar cookers
iv. Solar fruit and vegetables dryer
v. Solar desalination
vi. Solar thermal power system
vii. Photovoltaic(PV) power generation

Photovoltaic solar cells devices enable conversion of sun's energy into electric power. Tremendous research in new materials, as well as processing technologies for the production of solar electricity has resulted in reduction in the price by two orders of magnitude during the last 30 years. Besides providing electricity, even in remote areas, PV applications are in satellite equipment, telecommunication, navigation, information technology etc. Photo-voltaic systems have virtually no operational and maintenance costs. They can provide energy security without any embargoes like oil or nuclear embargo.

There is burgeoning demand for photovoltaic panels, both domestically in the United States and overseas. American solar manufacturers estimated that the solar market has grown 40 percent roughly in the last five years, albeit less in comparison to Japan and Germany. Germany consumes 39 percent of all the solar panels in the world, with Japan next at 30 percent and the United States a distant third at 9 percent. Japan had the greatest solar capacity by the end of 2004, at 1,100 MW followed by Germany with 790 MW and the United States with 730 MW. However, there is little response to use solar photo-voltaic technology in the third-world countries and the highest impediment is its cost. The average cost per kilo-watt hour is 20-40 US cents whereas that of oil, gas, thermal electric power is 3-10 cents per kilo-watt hour. In some countries steps have been taken to provide electricity through PV cells. In Kenya 20,000 small-scale PV systems have been installed since 1986 and play a prominent role in decentralized, sustainable electrification. Although efforts /initiatives were made since 1981 in Pakistan to manufacture PV Cells/Panels, but with little success and confined to laboratory. PCRET has installed a number of PV systems in the areas of rural electrification, illumination, water pumps etc. The third-world countries, which have abundant solar energy, should develop joint ventures with firms in Japan, Germany and USA for installation and popularization of PV systems for rural electrification.

3.3.2 Biomass Energy

The FAO estimates that wood accounts for atleast 60 percent of the fuel used in the third world countries and exceeds 90 percent in the poorest countries such as Ethiopia and Nepal. Demand for fuel wood continues to grow inline with growing populations. Declining supplies are having serious human and natural consequences. Over 1.5 Billion people meet their needs only by serious depletion of wood resources upon which they totally depend, mainly living in Asia and drier regions of Africa. In parts of Tanzania and highlands of Nepal, it takes 200-300 workdays to fill the yearly firewood needs of a single household. This is the energy crisis of the poor. The use of wood for cooking, heating and other purposes, besides causing deforestation and environmental degradation, is also the cause of suffering to children and women due to smoke

generated in process of cooking (blindness, respiratory diseases and cancer) These countries, being mainly agriculture based, breed sufficient livestock for different purposes; and the animal waste is utilized for generation of energy. Currently all such animal waste is burned in dry form as a domestic source of energy, although it could be used for producing biogas on a community basis:

- Biomass energy is obtained by converting animal and agricultural waste and Industrial processing to useful fuels, which is renewable, environment-friendly and a sustainable source. Current biomass energy takes separate forms which includes distillation to produce alcohol, and fermentation to produce gases through various types of biogas digesters, which can be directly used for cooling, heating and running of power generators. Biogas technology is an option, which could offset, albeit partially, the fossil-fuel and fuel wood consumption. There are different biogas plant models and the selection depends on the geographical, economic and continued availability of waste. The various biogas uses and its requirements for different applications are as given in Table-6. The exhaust slurry of biogas plant is an enriched organic fertilizer, widely used in vegetable fields in China. Social customs, habits, prejudices, correct knowledge about the selection of model, etc. pose problems for popularization of the biogas technology.

3.3.3. Geothermal Energy

Geothermal energy is one of the oldest forms of renewable energy with the longest industrial history. The four main sources of geothermal energy are: underground hot fluids (hydro thermal), hot dry rocks, geo-pressurized system, and (volcanic) magma; so far only hydro thermal sources are exploited. The potential geothermal energy is estimated equal to 5.0 x 1012 Gj/year which is 12.5 times the current annual energy consumption. Presently only 0.01% of this value is being used. 39 countries have been identified that could be powered 100% geothermally, mostly in Africa, Central and South America and the Pacific, representating 620 million people. Geothermal energy with a total capacity of 15000 Megawatt is being utilized in the following manner:

1. 42% for geothermal heat pumps
2. 31% for space heating
3. 11% for bathing
4. 9% for greenhouses
5. 3% for industrial
6. 1% for agriculture

Geothermal energy is a clean renewable energy,

Table - 6: Biogas Requirements for Typical Applications

Purposes	Specifications	Gas Required, (M^3)	Country
Cooking	Per person	0.5 / day	China
	Per person	0.34-0.43/day	India
	Per person	0.425/day	Nepal
Gas Stove	5 cm dia.	0.33/h	
Gas Stove	10 cm dia	0.47/h	
Boiling Water	15cm dia	0.64/h	
Boiling Water	Per gallon	0.28/h	
Lighting	200-candle power	0.1/h	China
	40-watt bulb	0.13/h	India
	1-mantle	0.07-0.08/h	
	2-mantle	0.14/h	
	3-mantle	0.17	
Gasoline engine	Per hp	0.45/h	India (Engine efficiency 25%)
	Per hp	0.41/h	Pakistan (Engine efficiency 28%)
	Per hp	0.43/h	Philippines
Diesel engine	Per hp	0.45/h	Pakistan (Consumption ratio 20)
Generating Electricity	Per kWh	0.616/h	
Refrigerator	Per m^3	1.2/h	U.K
Incubator	Per m^3	0.5-0.7/H	Nepal
Table fan	30 cm dia	0.17/h	
Space heater	30 cm dia	0.16/h	

sustainable and independent of both time and weather and operates 24 hours a day. Hence geothermal power-generating capacity needs to be increased to provide electricity.

3.3.4 Wind Energy

This is the fastest growing renewable source of energy, with annual growth rate of 40%. This is supposed to replace 10% of EUs annual electricity production by conventional source by the year 2010. The total installed capacity around the world in 2001 was 24,900 MW. These are about 55000 wind-mills stalled and 70,000 people are employed in the industry, globally with the investment of US$ 5 billion. The commercial viability depends on the availability of required mean wind-velocity that is 4 m/s for commercial exploitation. The wind turbine technology is fully matured and commercially viable. Cost of power generation with wind energy is quite comparable with other sources. Many modern high-speed horizontal-axis and vertical-axis machines with much higher efficiencies have been designed and are available in the market. The wind-produced electricity, can often be fed into the local or sub-network directly without any storage of energy being needed, with resulting saving of cost.

3.3.5 Tidal & Wave Energy

Today, wave energy is only used on a small-scale to power buoys, the average power-output of these systems ranges from 70 to 120 MW. Tidal power can be harnessed at specific sites, where the tidal amplitude is several meters and where the coastal topography is such as to allow the impoundment of a substantial amount of water with a manageable volume of civil works. Potential sites for Tidal Power stations have been surveyed in 25 countries, including Mauritius, China, Brazil, Chile, India, Burma and Madagascar.

3.3.6 Mini/Micro Hydro-Power

In general, hydro-power is considered as a conventional source of energy. However small hydropower sources (less than 1MW) are now included in the list of renewable sources of energy. The technology is well-developed and is effectively being used as rural energy in many countries of the world, particularly in the terrain, where natural and manageable water falls are abundantly available. For instance, in Pakistan, several sites have been identified in the northern mountainous regions and the PCRET has installed 236 units with potential generation of 2.8 MW electricity in collaboration with the local population. Perennial waterfall is channelized and allowed to fall on the turbine from the forebay, through a penstock. In Austria there are 1690 small hydro-power plants with a total of 600 MW capacity. In Pakistan so far 290 Mini-hydel plants with local generation capacity of 4MW have been installed, electrifying about 300 villages comprising 25000 homes.

4. LUKEWARM ATTITUDE TOWARDS RENEWABLE ENERGY

The industrialized countries are not so keen to invest in R&D for the development of renewable technologies as long as the conventional sources of energy are available at affordable cost. The Third World countries are shy even to adopt the known technologies in the renewable energy sector. Akhtar in his paper published in JSTD. Tech in 2001, gave a number of reasons for this attitude:

i) lack of education and knowledge
ii) fear of high cost
iii) lack of motivation and incentives
iv) inadequate demonstration of effective use
v) unavailability of suitable appliances
vi) non-existence of proper infrastructure
vii) trained manpower
viii) market development and feed back services

The initiatives taken by Germany for the promotion of renewable energy and enhancing energy efficiency is worth consideration. German Chancellor and International Financial Institutions have pledged in the International Conference for Renewable Energies in June 2004, to establish a special facility with an investment of Euro 500 million for the promotion of renewable energy and enhancing energy efficiency in the developing countries. This facility includes low-interest leased loans to public and private sector institutions in the developing countries for the establishment of renewable energy projects and enhancing energy efficiency. These measures are an effort to control the rising atmospheric concentration of toxic emissions because of heavy reliance on fossil oils, particularly petroleum products. Several delegates emphasized for action oriented commitment towards the promotion of “cleaner energy” (renewable energy) to achieve goals set under the Kyoto Protocol viz-a-viz reducing toxic emissions’ level by 2008-12. The leaders pledged future investments and measures to bring sources of renewable energies – sun and wind-under use to

actively demonstrate their will to combat rising temperature of earth and counter climate change. The Third World countries should come forward and avail this assistance.

5. CONCLUSION: SOME PRIORITY AREAS IN ENERGY SECTOR

A series of conferences, seminars and workshops have been organized in recent years, both by developed, as well as developing countries in cooperation with the United Nations and International Agencies/Institutions, to solve the energy problems and assist in acquiring and adopting known technologies. Some of the priority areas in the energy sector identified are:

1. Energy conservation and energy efficiency in industries, agriculture, transportation and domestic use, and developing integrated energy systems for the decentralized sectors;
2. Acquisition of basic nuclear technology for a self-reliant programme of nuclear power generation. In addition, increased production of nuclear energy to replace gas as it phases out after 2030.
3. Research and development in renewable energy sources, including direct solar, biomass, geothermal, ocean and wind energy;
4. Production of methanol and methane gas through fermentation of vegetables and animal residues;
5. Technologies for coal beneficiation and converting coal into gaseous and liquid fuel;
6. Developing enhanced-recovery techniques for different oil-fields, including the application of nuclear energy towards the improvement of recovery from the power sources
7. Formulate national action programmes to promote and support reforestation and national forest regeneration.
8. Promote wide dissemination and commercialization of renewable energy technology-transfer mechanisms.
9. Build capacity for energy planning and programme management in energy efficiency, as well as for the development, introduction and promotion of new and renewable sources of energy
10. Cooperate in identifying and developing economically viable, and environmentally sound sources to promote the availability of increased energy supplies to support sustainable development and to provide light in the homes of millions of rural population.

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