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DIRECTORATE GENERAL OF ENERGY RESOURCES

"PAKISTAN APPROACH TO NEW AND RENEWABLE ENERGY"

Energy Resources potential has become a key factor in managing economies progressively both for developed countries and developing countries including, Advanced developed countries, Less Developed countries and the third window countries. The rationalization of prices of petroleum crude by the oil producing developing countries transfered the then existing undue profit incentive with developed economies, made as marginal gain due to very low prices paid for petroleum crude, to the credit of raw material producer economies. This shifted the net surplus with the oil producing developing countries more favourably, than it was before the crude prices were economically evaluated and established as such in 1973. This situation gave a reason to developed economies, which concentrate capital goods manufacture and technology, to raise the consumer prices of their goods and services and also improve the man management position to keep the prices competitive to the extent possible. This tilt in balance of increasing deficit with such countries where per capita energy consumption is very high and those which are non-producer of oil to a net deficit in their current account, have focussed their attention to energy conservation, a mandatory cut in oil imports by some countries and all countries seeking development and deployment of new and renewable sources of energy. The new and renewable sources of energy are to become a supplement to the commercial energy in the future.

Among developing countries, Pakistan is not presently as fortunate as the 28 developing countries which are net exporter of crude oil like China, Indonesia, Nigeria, etc. but is better off than the 64 countries which have to rely upto 75 percent of their commercial energy in terms of imports of petroleum crude and

products. Pakistan is self-sufficient upto 68 percent of its energy requirements with about 40 percent contributed by natural gas, with total natural gas reserves of over 10 trillion cubic feet, plus 5 percent of total energy in form of indigenous production of petroleum crude with having potential to become self-sufficient in the future. Coal with proven reserves of over 450 million tons shares 6 percent of the indigenous sources and the balance by hydel. Pakistan has to import about 32 percent of total energy requirements as petroleum crude (20 percent) and deficit products (12 percent) namely high speed diesel, kerosene oil, 100 octane gasoline, light diesel oil, lube oils and some aviation spirit. Pakistan energy needs in terms of secondary source are met upto 28 percent by electricity which has 45 percent hidel generation and balance being thermal. The present capacity is 3500 MW with the generation about 30,000 million killowatt hours. Till the end of the current plan period i.e. 1983 the hydel generation capacity would increase by 84.8 percent with an addition of 250 MW generation capacity using coal as the primary energy source in the next plan period.

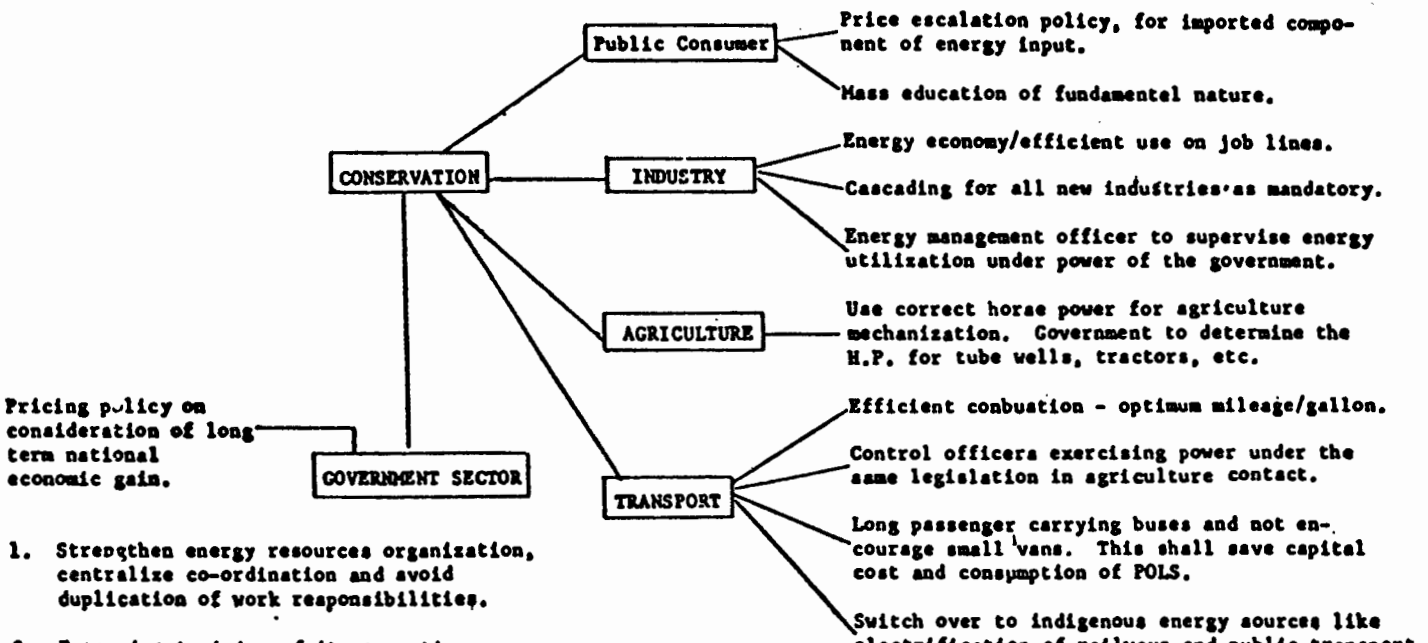
High Speed Diesel is consumed upto 65 percent in public road transport with 8 percent by railways, 15 percent in agriculture and the balance in other uses. The second largest consumption is of kerosene where 95 percent of its use is in domestic sector, it being the principal source of fuel, light, operating oil heaters in winter and kerosene operated refrigerators in areas where electricity is not available. 100 octane gasoline is consumed in transport sector and so are lubricants, light diesel oil consumption varies with rain fall and is principally used in agriculture sector.

Pakistan has connected more than 13,000 villages with the national grid out of 45,000 villages and many thousand settlements. The villages are generally connected with more than thousand houses and a population of more than 6,000 while the settlements would contain 50 to over 100 houses in it with an average of two or more cattle heads per family. The supply of energy to the rural areas in the above perspective has always been a priority with the Government of Pakistan. The environments without energy availability contribute to provide a reason for the rural population to migrate to cities more in search of better environments and conveniences than incomes, thus energy has a strong bearing on rural like and its environments.

For the meagre 32 percent of its energy need as oil imports, Pakistan has paid 1.2 million dollars for the fiscal year 1979-80 - the current bill touching 1.5 billion dollars or more. This constraint has to be reduced and alongwith energy conservation measures modeled in figure I, the development and deployment of new and renewable sources of energy does play a critical role in future needs of the country more in context of domestic sector than industrial needs.

Pakistan has substantial resources in terms of feed stock for renewable energy systems. It has over 2500 hours of sun shine each year. The bio-gas production based on animal waste has a total potential of 150 billion cubic feet per year which can yield biogas for cooking and in addition produce 350 MWs of electricity, in localized fashion, in respective villages, and provide 6 million tons of improved and enriched dry manure from harmful micro organism which otherwise cause plant diseases or become a source of insect breeding. Winds are inconsistent having velocity range of 5 knot to 16 knot across the country.

ENERGY CONSERVATION



1. Strengthen energy resources organization, centralize co-ordination and avoid duplication of work responsibilities.
2. Extensive training of its expertise.
3. Extensive utilization of technical assistance.
4. Avoid creation of too many energy departments since it creates co-ordination and communication problems.

The mean monthly average wind speed for coastal area is in the range of 8 to 14 knots with an average of 4 knots in other areas. In these areas the wind storm is a frequent performance of changing weather in the country.

In perspective of the aforestated facts, new and renewable sources of energy, more so in terms of future energy needs and to a substantial extent for the present energy needs, plays a vital role in terms of compact energy systems to the rural population which constitutes more than 70 percent of country's people. The role of renewable energy in context of rural requirement would be:

a) Fuel for domestic consumption and energy for electricity for the purpose of light and pumping of water, drinking and irrigation both.

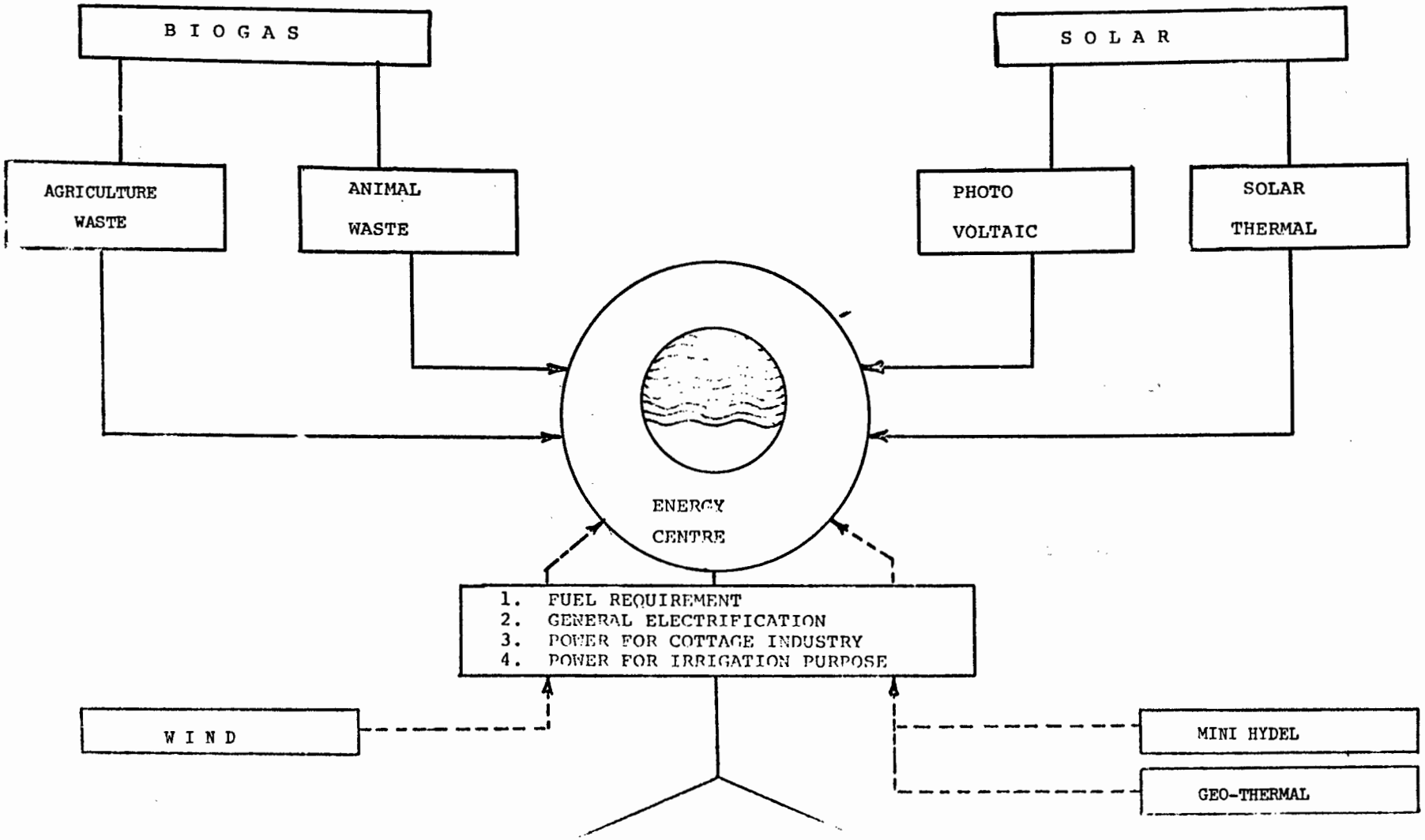
b) Production of enriched manure which could increase the present low yield per acre by 25 to 35 percent, particularly in rainfed areas via anaerobic fermentation of animal waste and agricultural by products etc.

c) Improve the environments and social consitions of villages to cause discouragment to migrate to urban areas.

d) Also provide energy for cottage industry and appropriate the cottage industrial system.

To achieve the above objectives Pakistan has developed the concept of Energy Centres which mean a village or a settlement which is energy deficit and has raw material for bio-gas production and wind to be utilized for conversion to useable from of energy as a fuel for cooking, heat, electric generation and water pumping. The Energy Centre model given in figure II spells out the priority out of the 5 major renewable sources of energy. In addition Pakistan has undertaken to cultivate quick maturing fire-wood trees to supplement the fuel requirements of the villages.

ENERGY CENTRE



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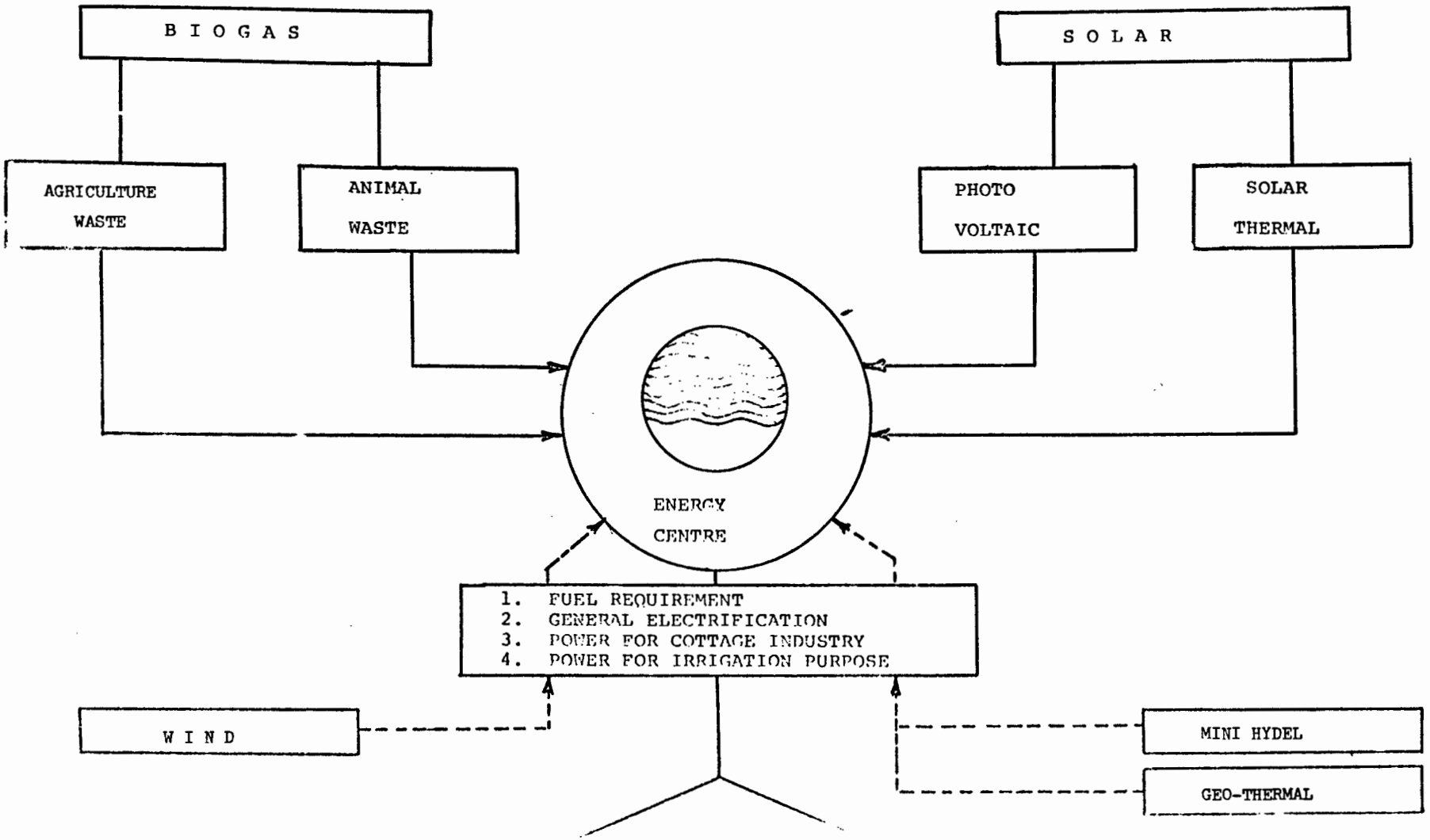

The deployment of new and renewable sources of energy achieves a greater significance, when it is seen that biogas production potential alone can substitute the deficit imports of kerosene in the country. In addition Bio-electrification successfully achieved in Pakistan in June 1980 could further spplement the electricity requirement in the rural sector.

In the urban sector renewable energy can play a vital role, again in domestic sector, like deployment of solar water heaters, solar water cookers to reduce consumption of natural gas and save the house-wives bill. In addition sewage treatment and anaerobic treatment of industrial wastes could produce large quantity of biogas which could supplement the fuel generators to electric supply or meet the needs for fueling in the semi-urban areas - also it would improve the environmental conditions of cities, and make the atmosphere free from pollutions. Pakistan gives first priority to biogas production both from agriculture by product and animal waste. This concept is extended to production of biogas in city from industrial waste and urban refuse. Pakistan experience in biogas has been in principal of research development and deployment. After setting up more than 100 biogas units starting with a family biogas unit having capacity of 40 cu.ft per day it has standardized the family biogas unit at 150 cu.ft per day. In process of developing the family biogas unit to meet the requirement of one family upto 8 family members it has designed its own community biogas system which uses thermophilic anaerobic process conditions using solar thermal heat for obtaining higher process temperature. The first community biogas plant having a capacity of 2,000 cu.ft per day was commissioned in March 1980 and Bio-electrification was achieved in June of the same year. This system succesfully deployed in a village having 52 houses and a population of 400, with more than 300 cattle heads,

has been termed as Compact Biogas System (CBS). The biogas project underway is to instal Compact Biogas System in 160 villages in 3 years by which time it is expected that the farmers would see and feel the benefit of the system and make its own investment. The government, having seen the success has made liberal allocation for development and deployment of Biogas Compact System.

Solar energy is the next vital source. Pakistan has just finalized, on turn-key basis, establishment of its first solar village having a capacity of 5 KWp which shall provide light to 50 houses in a village with water pumping and storage facility for human and cattle consumption and for selected irrigation for vegetable cultivation. It would also provide energy to 3 communal TV systems in the village which shall keep the villages abreast with the progress the nation is making and also will enable them to educate themselves by seeing the educational programmes televised by the Government. This system is complimented by a 5 KW Bio-electrification system at the village.

Pakistan has a second Project under which a 20 KWp solar thermal system and 35 KWp photovoltaic systems will be set up in different ecological environments and thus would provide compact energy supply including water pumping for irrigation of project command areas. The third Project would see installation of 60 KWp of photovoltaic system at 4 villages which shall deploy biogas production and wind as a supplement sources for generation of electricity. Both the above projects would start coming off the ground in 1981.

The wind potential is also being tapped though it has the problems of inconsistent wind velocities. The development of wind energy is being done with greater emphasis on using wind for pumping of water than for production of electricity.

Geothermal potential is being explored and some indications of such sources have been recorded in Pakistan. The likelihood of a geo-thermal source having a potential to be used for electric generation are presently considered remote.

The tidle and ocean wave energy appears to have very high cost benefit ratio. Therefore, it is being pursued with last priority.

While the above project would come on the ground the possibilities of manufacturing photovoltaic cell through importing silica wafars could mature some time in 1981. Pakistan feels it essential that while it is developing and establishing the benefits of new and renewable sources of energy it should ensure self-reliance in technological systems and the equipment which converts the energy into usable form.

Research alone for a developing country like Pakistan has no application unless it is practised as applied research with demonstration for the development and deployment with evaluating the systems proven elsewhere. As these systems are being established in the villages the on job training, the acceptance of a system, socio-economic gains and such factors will be continuously evaluated to come up with a decision as to when and in which forum and which source of new and renewable sources of energy can become reliable and independent source to be developed to supplement the national requirement, initially, in domestic sector. Pakistan does not see the renewable energy sources playing a crucial role in term of industrial consumption and needs.

In view of the above Pakistan have adopted the following strategy for development and deployment of renewable sources of energy.

B I O G A S

a) Field research and development to continuously improve upon temperature, solid contents and such factors which could optimise production of one cubic feet of gas per weight input from animal source in solids and for agriculture by-product material like wheat straw, rice husk etc.

b) Develop plant designs and demonstrate its benefits to achieve continuous cost reduction in terms of construction costs like materials of construction, excavation etc.

c) Design systems which are simple and need minimum maintenance for ready acceptance of responsibilities of continuous operation of such units by the rural population, themselves.

S O L A R

Photovoltaic system with low volt (24 volts) would appear to resolve energy supply situation in villages where animal waste is either not available or there is a waste collection problem for reasons of cattles grazing out.

a) It would initially be limited to villages with a housing intensity of less than 1000 houses.

b) It would be more oriented towards provision for light, irrigation water pumping, and energy for cottage wheat grinding mills, oil expellers and looms for handicraft cottage industry.

c) With local manufacturing facilities for photovoltaic cell and modules, once commissioned the domestic package of a 250 watts or 500 watt photovoltaic system designed to meet a family needs will be developed.

It shall, after local manufacture, will give a growing market for its annual use to reach beyond 100 KWp per year in semi-urban areas and large villages.

W I N D

Wind generators having a capacity of 20 KW each would be imported and tested in northern and coastal areas. It can make a substantial contribution but presently it is more expensive that solar photovoltaic system.

Wind in terms of using for continuous water pumping and storage for controlled irrigation has a great potential both in terms of costs per unit of energy and per litre of water output.

TEN YEARS PROGRAMME

The 10 years plan is given in table A on next page and peak production cost in table B.

Pakistan is fortunate that it has no coordination problems at the national level since such work is coordinated by one agency e.g. Directorate General of Energy Resources in the Ministry of Petroleum and Natural Resources. This agency also has additional responsibilities of energy conservation and energy policy and planning and is the secretariat of inter-ministerial National Energy Policy Committee chaired by the Federal Finance Minister and Federal Secretaries as its members. This gives a situation where the role of renewable energy becomes acceptable to Government in a shorter time as compared with a national situation where there is duplication or over-lapping of such work being shared by more than one institutions in the country.

Pakistan feels that sub-regional and regional level are very crucial level of co-operation and coordination if the countries have to gain an expertise to develop new and renewable sources of energy most efficiently and economically. The field of sub-regional activities in energy is considered very vital and would include the following:

a) Technical Assistance on regional and sub-regional level.

b) Exchange of experts to work on-going projects in other countries and exchange of technical and such information which could be of use to countries with in a region.

c) Financial assistance from world financing agencies including EEC etc. to finance the foreign exchange costs of equipment and services grant basis.

d) Provision of facilities like costs within the region or sub-region for the renewable energy engineers of different member countries to obtain on the job training in developed countries which have established such system as proven.

e) The transfer of technology i.e. renewable energy system proven elsewhere should be made by developed economies to developing countries at a very low cost.

f) For purpose of energy, the regional activities needs to be made more active between countries having similar renewable resources and energy balances at national level.

The development and deployment of renewable sources of energy can beeome a substitute, with application in domestic sector, improve the energy supply and coupled with energy conservation can improve the

energy supply situation both at the national level and for any integrated study at sub-regional level, regional level and inter-regional level. Such developments of new sources to supplement the energy needs of Pakistan can not be considered as a substitute for our need for nuclear generation or thermal generation of electricity or as substitute for liquid fossil fuel for transport and agriculture sectors.

At the international level of cooperation there is a dire need -

a) To identify one United Nations Agency which should conduct workshops, seminars, experts group meetings and such activities in the field of energy including renewable sources of energy. Presently almost all agencies of United Nationas are holding such activities with emphasis on New and Renewable sources of energy. The result is that it is impossible for most of the countries, for their concerned experts, to participate in all such forums and even to collect the reports of such forums to fully appreciate the efforts being made by these agencies as a whole.

b) An information Bank approach on collection of work being done at regional sub-regional level both in technical development and socio-economic gains and perspective needs to be adopted for continuous publication. This could be done on quarterlybasis by the same UN agency which is proposed to be identified as stated above.

c) Creation of an interim fund of an order of at least 25 million dollars would appear necessary to finance the sub-regional, regional and inter-regional activities of a single UN Agency in the field of new and renewable sources of energy.

T A B L E I

Pakistan 1980-1990 renewable D+D programme

	Biogas MCFT/D by source			Solar (KWp)		Wind	
	Animal waste	Agriculture by product	Bio-electrification (KW)	Photo - voltaic	Thermal	Electric generat.	Mechanical energy HP
1980	26	--	5	5	--	--	--
1981	130	10	100	40	20	10	10
1982	250	20	200	65	20	20	20
1983	400	30	300	100	30	40	30
1984	700	40	400	120	50	50	40
1985	1000	55	600	170	90	60	80
1986	1500	70	900	220	130	80	120
1987	2000	85	1200	240	160	100	160
1988	2700	100	1500	280	190	120	200
1989	3400	120	2000	320	220	130	240
1990	4500	150	2500	350	250	150	300

Note: 1 - Each year is to be taken as fiscal year like 1980 will mean July 1979 to June 1980 and 1981 shall mean July 1980 - June 1981 and so.

2 - Other than government resource allocation like now the foreign exchange component needed for purchase of a system on turn key basis and payment for service and equipment component is expected to be met by grant from world agencies and friendly countries on bi-lateral basis.

T A B L E II

Cost Estimates of Compact Biogas System

1 - Cost per cubic feet of Biogas (assumed us costs payable for animal waste)

Family Biogas Unit (FBU)	=	0.91 paisa (with cost written of in one year)
Community Biogas Plant (CBP)	=	0.07 paisa (cost paid back in one year, excluding distribution cost)

2 - Cost factor in terms of Kerosene oil replacement

Family Biogas Unit	=	1.94
Community Biogas Plant	=	0.025

(This has been taken at kerosene price at $485 per metric ton)

3 - Bio-electrification cost for 10 hours use/day = 1.82 paisa per KWh

Conversion, 10 US cents = 1 Pak Rupee = 100 paisas