ENERGY CONSERVATION STRATEGIES, WITH SPECIAL REFERENCE TO PAKISTAN

*Abdul Qayyum Kazi**

ABSTRACT

As a result of limited fossil-fuel resources, slow adoption and propagation of renewable energy technologies, spiraling prices of petroleum products and worsening environmental conditions, due to climate change, every country is faced with the need to define new directions with respect to energy consumption, conservation, and energy-options. These aspects are discussed in some detail in this article, which proposes that a multi-pronged strategy, encompassing (i) a change in overall life style, (ii) energy-efficient construction, distribution and utilization, (iii) effective environment-management and energy-discipline, be adopted to control and conserve energy in the increasing energy-demand scenario.

1. ENERGY CONSERVATION

Energy conservation contributes to the security of energy-supply, economic growth and the resolution of problems of fuel-poverty. Controlling transmission-losses is just one aspect of energy conservation. More critical is conservation of energy in the industrial, commercial, transportation and domestic sectors and at the consumer-end.

According to a World Bank Report, the world's lighting market is constituted of 28 per cent household electricity users, while the services and commercial sectors consume 48 per cent, industry 16 per cent and street lighting eight per cent. The report predicts that global lighting saving potential is 40-60 per cent for residences, 25-40 per cent for commercial sectors, 15-25 per cent for industry and 25-30 per cent for street lights, thus indicating the considerable potential for energy-saving in countries where demand for energy far exceeds the energy resources.

It is of interest to mention here that, even in the United States, upto 60 per cent of the energy-content in the supply is wasted through inefficient conversion to electricity at the power-plants and during delivery to the consumers. So, one can imagine the state of energy losses in the Third World countries. For example, power theft and system losses in Pakistan are as high as 25 to 27 per cent in case of 16 power distribution companies, and could be upto 47 per cent in the case of Karachi Electric Supply Company (KESC).

The Third World countries are presently faced with the need to (i) increase their energy production and energy conservation while, at the same time reducing the cost of energy production, (ii) make it affordable for the end-users, and considerably reduce the energy-related pollution. In order to accelerate energy-production to meet the burgeoning demands of various economic and social sectors, the majority of developing countries have been compelled to live with increasing cost of energy-production. Above all, power-losses and theft are rampant, even in the big cities. The transmission and distribution related power-losses often range between 20 to 35 per cent.

A multi-pronged strategy, encompassing a change in consumers' overall life-style, effective environmental management, energy-efficient construction, distribution and utilization, and strict energy-discipline needs to be adopted in order to control and check the increasing energy usage.

2. EFFICIENCY IN OPERATIONS

Reducing the amount of energy and materials used, per unit in the production of goods and services, can contribute both to the alleviation of environmental stress and to greater economic and industrial productivity and competitiveness. The government needs to encourage the environmentally sound use of new and renewable sources of energy as well as dissemination of appropriate technologies suited to the particular circumstances.

Many Third World countries, including Pakistan, import oil (at the cost of a major portion of the export portfolio) to run their transportation vehicles and factories. In Pakistan, 60 per cent of transportation depends on petroleum products, as large numbers of cars, buses, trucks, and other means of transportation on the road need oil to function, which has to be imported at any cost and so we succumb to unannounced oil crises. It is not possible to shift to alternative sources in the immediate future, but conservation measures to improve operational techniques, adhering to vehicle-maintenance standards and improving modes of transport can help to reduce the costs (railroad transport should be preferred to road transport).

ENERCON was established by the Government of Pakistan in 1986, evaluating, planning and implementing energy-conservation programmes at

* Joint Scientific Adviser (Retd.), Ministry of Science and Technology, Government of Pakistan, Islamabad

the national level, and for training and educating the required human resources in the field, but it has yet to play its role effectively, particularly in the area of creating awareness for saving oil and, thereby, saving the import bill. Following are some options for energy conservation:

2.1 Energy-Saver Lamps

China, India, Sri Lanka, and South Africa have launched programmes to replace incandescent lamps with compact fluorescent lamps (energy savers) having guaranteed life of 8,000 hrs. This has not only reduced energy-bills, but power-consumption has also dropped significantly. Pakistan Electric Power Company (PEPCO) submitted a project proposal to provide 10 million 'energy-savers' free of cost to its consumers in a bid to conserve electricity, but the proposal was declined by the Planning Commission of Pakistan, due to high cost. Individual consumers in Pakistan as well as in the above mentioned countries have installed 'energy-savers' on their own. However, replacement with energy-savers has a price tag.

Recently, the Government of Bangladesh decided to distribute about 28 million compact fluorescent light (CFL) bulbs under a World Bank project costing US $ 43 million. In the project's first phase, 5.5 million bulbs are to be handed out to nine million consumers in 27 districts, including Dhaka. The project would save up to 500 mega watts/day. Only about one-third of the residents of Bangladesh have access to electricity. City residents are subjected to a power cut every other hour, while those living in rural areas are deprived of electricity for a much longer duration. The solution is replacing the regular bulb with energy saver bulbs reducing the demand which will ease the chronic electricity shortage.

2.2 Promotion of Clean Fuel Technology

The Hydrocarbon Development Institute of Pakistan (HDIP) introduced Compressed Natural Gas (CNG) in 1989 as an alternative environment-friendly fuel in the transport sector. Within years, the number of refueling stations and CNG-based vehicles increased astronomically. By 2009, over two million vehicles had shifted to CNG use and some 3,116 CNG stations were operating in the country. Research, development and demonstration efforts led to the successful commercialization of CNG in Pakistan, as an environment-friendly, economical and safe road-transport fuel. Introducing CNG for city buses for intra-city urban transport and for auto-rickshaws that are on the roads in towns have helped in reducing pollution and improving air-quality.

With these developments, Pakistan has become the leading country in Asia and the world's third largest user of CNG. Instead of importing costly motor gasoline that causes air-pollution, locally accessible CNG-units have been fitted in the vehicles, as natural gas is locally available at an affordable price, and infrastructure for transmission and distribution of CNG is already in place. Just for illustration, Table-1 (IANGV, 2001) shows the ranking of Pakistan in world's population of CNG-based vehicles. There is so much demand for CNG that the government has to introduce rationing in certain parts of the week/year.

Table - 1: World's Population of CNG-based Vehicles

Country	Natural Gas Vehicles	Refueling Stations	Data Received Month - Year
Argentina	1,807,186	1,851	December 2009
Italy	628,624	730	December 2009
Pakistan	2,300,000	3,116	December 2009
Brazil	1,632,101	1,704	December 2009
USA	110,000	1,300	December 2007

Source: *IANGV, 2001*

Table - 2: Percentage Consumption of Various Forms of Biomass in Pakistan as Source of Energy

Biomass	Percentage (%)
Fuelwood	54
Bagasse	16
Shrubs	06
Cotton Stubs	06
Animal Dung	16
Others	02

The experience gained by Pakistan can be used by other developing countries.

2.3 Increasing Fuelwood Requirements

Notwithstanding the growing demand of energy and scarcity of energy-sources, it is estimated that 80 to 90 per cent of all rural households still meet their fuel requirements (for heating and cooking) from fuelwood and other biomass resources. The percentage of various forms of biomass used as a source of energy in Pakistan is given in Table-2.

Increasing population exerts more pressure on forest resources; depletion of forest resources due to mismanagement is threatening the socio-economic fabric of the mountain people. Many countries have less than 25 per cent forest-cover, which is the world's average. As there is no other immediate energy-source available, it is essential that extensive community reforestation programmes be undertaken. The local people need to be involved in protecting and nurturing the forests. There is a need to develop fuelwood plantation, as a part of the reforestation effort, through a community-based approach. Planting fast-growing species calls for trainings on plantation and tending the young trees. The Government should formulate national action-programmes, to promote and support reforestation and national forest-regeneration, as well as to promote energy-efficient cooking stoves, with a view to achieving sustained provision of the biomass energy to meet the needs of the low-income groups in urban and rural areas.

2.4 Addressing Problems of Energy Consumption in Irrigation System

Many developing countries have established irrigation systems to enhance agriculture and livestock production and for generation of electricity. Pakistan possesses the world's largest continuous irrigation system, spread across an area of about 35 million acres, and encompasses the Indus River and its tributaries. The system includes three large reservoirs (Tarbela, Mangla and Chashma), 23 barrages/ headworks/siphons, 12 inter-river links and 45 canal-commands extending for about 60,800 km. Irrigated agriculture is the backbone of the national economy. However, mismanagement of the irrigation system has rendered the land infertile due to water logging and salinity. Thousands of acres have become useless due to this twin menace. One solution is to dig tubewells to irrigate the land.

According to the Water and Power Development Authority (WAPDA) of Pakistan, there are about 1.1 million sanctioned tubewells, out of which about 0.2 million work on electricity and the remaining 75 per cent run on diesel. Tubewells working on the national grid consume about 2,700 MW of electricity, whereas the remaining take a toll on the country's import bill since they consume large amounts of diesel-fuel. The consumption of electricity for operating these tubewells is almost equal to the total power deficit. Further, there is a huge wastage of power and water during the working of the tubewells. The experts assert that there is a dire need for introducing solar-based tubewells, coupled with water-conservation techniques, like drip and sprinkle irrigation systems. Unavailability of finances and lack of awareness about the availability of renewable energy technologies are also creating hurdles in installing the required machinery. Also, there is little realization of the important training component with regard to functioning and maintenance of the solar-based tubewells.

2.5 Replacing Inefficient Industrial Equipment

Due to an alarming rise in energy costs and load-shedding for several hours a day and 2-3 days a week, all industries in Pakistan are looking for ways to save energy and reduce cost. In this regard, the textile industry particularly has taken the lead. The larger groups have achieved efficiencies that have reduced their energy bills by 40 to 45 per cent, against those who still adhere to inefficient ways. Some industries have gone for the low-cost option, under which inefficient motors and fans are replaced with efficient equipment. M/S Nishat Mills is installing high-tech heat-exchangers to capture heat escaping from its six stenters and recycle it, which could reduce the cost by 25 to 30 per cent. The larger textile groups have exploited every avenue that could save them energy and thus millions of rupees monthly. Other industrial units should follow a similar approach for utilizing energy efficiently.

3. REDUCTION IN ENERGY LOSSES

Energy conservation can be simply defined as "the more efficient and optimum utilization of energy". Efficient utilization of available energy resources is the prime objective of all countries, irrespective of their development phase and industrial advancement. This is because: (i) the need for energy-services continues to increase; and (ii) the available energy resources are not sufficient to meet the present and future requirements. The conventional energy resources are limited and the burdens of high cost of importing fuels,

plus energy security and distribution, are alarming. The oil crises since 1973 have compelled different countries to adopt energy-saving measures, including fiscal measures, regulations and quality standards and educating the masses.

Energy conservation can play a central role in global and national energy-strategies. Some of the energy-conservation measures for reducing losses are enlisted below:

a) Technical Measures

- Improvement in transportation system (e.g. oil-saving auto-technologies);
- Planned replacement of old, insufficient equipment;
- Efficiency improvements (e.g. switching away from overwhelming dependence on oil);
- Energy-efficient construction of commercial and residential units;
- Use of energy-efficient technologies in agriculture;
- Cogeneration of heat and electricity in industry;
- Introduction of energy-efficient processes wherever possible.

b) Education and Regulatory Actions

- Changes in social patterns and norms giving conservation a high priority;
- Educating the general public to save energy;
- Research and development;
- Development of energy-pricing policies;
- Fiscal measures (e.g. tax relief, loans and grants);
- Government standards affecting safety, environment and fuel-economy;
- Intelligent legislation.

Energy-conservation in industry is assumed to be more price-sensitive than other sectors, as it requires nearly 20 to 30 years for turn-over of major equipment used. In residential units, energy can be conserved through replacement of incandescent lamps by energy-saving tube-lights or fluorescent lamps, or simply by cutting down the use of lights, fans, T.V. and refrigerators. The developing countries are becoming wealthier and more industrialized; some are now designated as newly industrialized countries, like China, India and Korea. These countries will now be able to afford more efficient technologies already in use by more developed nations. The caution for other countries is to stringently follow the energy-conservation measures.

4. ENERGY EFFICIENCY AND ENERGY-RELATED POLLUTION

At present, the developing countries are faced with the need to increase the energy production in an efficient manner so as to accelerate development and improve the quality of life of their populations, while at the same time reducing both production-costs of energy and energy-related pollution. In this exercise to increase the efficiency and energy-use while also reducing the effect of pollution, priority must clearly be given to promote the use of new and renewable energies. For this purpose, we need to:

- Formulate a national action-programme to promote integrated development of energy-saving and renewable technologies, particularly the ones based on the use of hydro, solar, wind and biomass;
- Promote wide dissemination and commercialization of renewable technologies, through suitable measures, inter alia, fiscal and technological transfer mechanisms;
- Review current energy-supply mixes to determine how the contribution of environmentally sound energy-systems as a whole, particularly new and renewable energy systems, could be increased in an economically, efficient manner, while taking into account the respective country's unique social, cultural, physical, economic and political characteristics;
- Promote the development of institutional, scientific planning and management capacities, to develop, produce and use increasingly efficient and less polluting forms of energy;
- Carry out information and training programmes directed at administrators, manufacturers and users, in order to promote energy-saving techniques and energy-efficient appliances;
- Address the inefficiencies in power generation, transmission and distribution; this may cost less as compared to the cost of constructing and generating new power units.

5. CONNECTING RENEWABLE ENERGY TO THE NATIONAL GRID

Promoting the renewable energy technologies based on hydro, solar, wind and biomass provides an option for a more sustainable energy in future. Large investments and long lead-times are required to produce alternative fuels on a scale large enough to fill the shortage of oil and gas. The continuous increase in energy-demand calls for a vigorous development of renewable energy resources. It is also required that

the energy thus produced is utilized efficiently and distributed properly. The electricity business consists of four key functions, namely: Generation, Transmission, Distribution and Supply. At each stage, connecting renewable energy to the national grid needs different parameters and set of equipment, and a proper environment.

Transmission efficiency can be improved over long distance by using a high-voltage direct-current transmission system and installation of smart meters to foster energy-saving. The grid of the future will thus be able to integrate more energy produced by solar, wind and other renewable energy sources. Since these sources will be widely distributed throughout the country, energy will have to be bundled and distributed more intelligently and the grid would need to accommodate varying energy-generation sources coupled with varying loads. The energy produced from different renewable energy sources may not be utilized immediately and at the place where it is produced, so it has to be (i) stored and (ii) connected with the national grid. "Smart-grid" provides an opportunity to make wise decisions about energy use, and ultimately save energy and money. Further, interconnecting the national grids regionally could provide benefits in terms of supply, security, economy, efficiency and environmental impact.

6. ENERGY-CONSERVATION LITERACY

With limited fossil-fuel resources, slow propagation and adoption of renewable energy technologies and worsening environmental conditions due to climate change, every country now needs to define new directions with respect to energy consumption, conservation, resources and independence. An informed energy-literate public is more likely to be engaged in the decision-making process and will be better equipped to make thoughtful, responsible energy-related decisions, choices and actions.

A number of surveys conducted in the developed countries to access energy-related knowledge, particularly in areas of energy conservation, have indicated that many people have not even heard or read about nuclear energy, renewable energy or hydrogen cars. Even if the technological knowledge is available, the ability and willingness to use that knowledge for practical purpose is absent. Specifically, an energy literate person is one who:

- has a basic understanding of how energy is used in everyday life;
- has an understanding of the impact that energy production and consumption have on all spheres of our environment and society;
- is sensitive to the needs of energy conservation and to the development of alternative energy resources;
- is cognizant of the impact of energy-related decisions and actions on the global communities; and
- strives to make choices and decisions that reflect these attitudes with respect to energy resource development and energy consumption.

An energy literate person would have the desirable characteristics of: (a) a sound knowledge and understanding of energy issues; (b) ability to share a common attitude and; (c) has common energy-related intentions and behaviours.

In the Third World countries, where literacy ranges from as high as 90% to as low as 30%, the energy literacy is minimal. Either at institutional or individual level, energy wastage is high, with little or no consideration for energy saving. Government, educational institutions, non-governmental organizations and the electronic media should play their role in spreading energy literacy/education among policy-makers, planners, administrators, field workers, the student community and the general masses, to highlight:

- Basic scientific energy facts;
- Issues related to energy resources;
- Importance of energy-use for individual and societal functioning;
- Impact of energy-resources development and use on people, society and the environment (for instance coal for energy);
- Energy conservation strategies;
- Impact of import of oil and gas on economy and environment ;
- Global, regional and sub-regional situation and changing attitude towards utilization of energy; and
- Need to advocate change, in order to reduce costs of energy-use in homes, shops, factories and transportation.

Seminars, workshops, panel discussions, field demonstrations, popular articles and, above all, direct mass-contacts should be regular features to reduce the energy consumption, loss and theft, and for utilization of energy for more beneficial uses in industry, agriculture, transport and service sectors,

and reducing the environmental hazards.

7. ENERGY MIX

Global oil supplies are increasingly becoming scarce and costly, the GHG emission concerns establish the need to develop cost-effective solar and wind resources for domestic use and to invest in these resources, in collaboration with other advanced countries. However, most of the renewable technologies are still not at par with conventional energy.

Sharing of resources among the countries of a region is gaining importance, for instance supply of excess gas and electricity to Pakistan by Iran, or supply of electricity from Nepal to India are examples of sharing of energy resources. Necessary infrastructure and protocols have to be developed for resource-sharing and trade. Iran and Pakistan signed an accord on June 13, 2010, whereby the former would supply natural gas to Pakistan from 2014; costing $ 7.5 billion. The construction of pipelines is essential, not just to meet the growing energy needs, but also help to create job opportunities, to keep the factories functioning and for social uplift in the rural areas.

Countries have to depend on their own resources for generating energy, but very few countries can meet their entire demand while others resort to import of oil, gas and coal. Eighty four per cent of energy needs of Asia is met using oil and coal. In China, oil accounts for only 24% of the country's energy consumption and coal for 70%. Primary energy-mix is balanced by 56% coal in India and more than 50% in the USA, whereas coal contributes to meeting only about 9% of the energy needs in Pakistan. Pakistan's total energy-consumption (2008-9) of about 37.7 million tons of oil equivalent (MTOE) is met by a mix of gas, oil, coal and LPG sources, with different levels of shares. A major portion of the oil has to be imported to meet the energy need.

The upward trend of the world energy costs would make the economies depending on utilization of gas and hydro resources among the countries of the region a feasible venture. The Association of South East Asian Nations (ASEAN) prepared Vision 2020, in 1997, for long-term energy development and consumption programme among the 10 countries of the region. The concept is to interconnect the natural gas-market centres to the supply point in the region, with the objective of enhancing greater security of energy/natural gas for the ASEAN. Proper joint agreements have to be drafted for the long-term energy development in improving the regular supplies and lowering energy costs.

In Pakistan, short supply of oil/gas to power plants has been aggravated and is causing a 3,000 to 4,000 MW supply demand gap compared to 1,000 MW, in 2006. On the other hand, there are 1,750-2,000 billion tons of coal available in the Thar zone of Sindh, which can be mined and utilized optimally through gasification and clean coal technologies. These technologies are available in Japan and China and need to be applied through bilateral/multilateral agreements. The "black gold" (coal) has to be used to light up millions of houses and run hundreds of factories presently lying idle. The energy mix with increasing percentage of coal can narrow down the demand-supply energy gap.

8. ROLE OF PRIVATE SECTOR IN ADOPTING ENERGY-CONSERVATION MEASURES

The Prime Minister of Pakistan announced a 10-point energy-conservation plan in May 2010 aimed at saving at least 500 MW of electricity on a daily basis. This is to provide some respite to the population from the constant power outages. It was the result of unannounced long spells of load-shedding, compelling the public to come out on the streets and damage the properties of the public sector power companies. The short-fall in energy-supply has greatly damaged the manufacturing sector, agriculture, trade and business activities and growing domestic needs leading to unrest and slowing down economic growth. The salient features of the energy-conservation strategies are as follows:

i. A five-day working week, i.e. two weekly holidays in the public sector;
ii. Closure of all commercial markets by 8pm (special exemption provided to bakeries and pharmacies);
iii. Power to neon signs and billboards to be cut off;
iv. Air-conditioners not to be used before 11am in government offices, and officials below grade 20 not to be permitted to use air-conditioners;
v. There would be a reduction of 300 MW in power supply to Karachi from Pakistan Electric Power Company (PEPCO);
vi. Industrial units to be closed down on alternate days;
vii. Agricultural tubewells not to be provided electricity during peak hours;
viii. Sufficient funds to be provided by the government to retire the 'circular debt';
ix. A 50 per cent reduction in power usage in the

houses of the President, Prime Minister, Provincial Chief Ministers and other public offices;

x. Scheduled load-shedding to be reduced by 33 per cent.

The industry barons, business community and the public sector organizations have serious reservations about the implementation of the above mentioned conservation strategy. Moreover, there is no mechanism available to implement the energy conservation strategies. Prolonged unannounced load-shedding has compelled the general public, shop-keepers and corporate organizations to buy generators and install uninterrupted power supply (UPS) units. This is resulting in additional daily expenditure and foreign exchange drainage in buying these units and oil.

Also, there is little realization on part of the Government and the policy-makers that apart from the loss of billions of dollars in manufacturing and trade due to long hours of load shedding, these prolonged load-shedding hours are also affecting the academic performance and output of the student community and R&D workers, creating social conflicts.

9. RECOMMENDATIONS AND CONCLUSIONS

The energy-conservation strategies stated above are worth considering by the Government, non-government organizations and civil society, to save energy, utilize the natural resources economically and tap the renewable energy sources optimally. Following are the key observations made in this paper:

a) Pakistan should build capacity for energy planning and programme management for energy efficiency and conservation, as well as for the development, introduction and promotion of new and renewable sources of energy.

b) Cleaner coal burning technologies available in China and Japan may be acquired to help in reducing energy cost by improving efficiency and reduction in particulate emissions.

c) Biomass in all its forms will continue to be a major source for cooking, heating be used and be used in small-scale service industries in villages, towns and slums of cities. Any improvement in efficiency in its use will assist in conserving energy and abating environmental degradation.

d) Renewable energy is an abundant resource that can be harnessed in various forms, including solar-thermal, wind energy and biomass. The costs of most commercial forms of renewable energy have declined considerably over the past three decades. Local research, development and demonstration will be necessary to help adapt and popularize these technologies.

e) Cooperation should be sought in identifying and developing economically viable and environmentally sound energy-sources, to promote and conserve the availability of increasing energy-supplies to support industry, agriculture and sustainable development and to provide electricity to millions of houses in rural areas.

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