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LOCAL TECHNOLOGIES INVENTION, INNOVATION, PROMOTION AND APPLICATION

Case Study
by

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CONTENTS

ABSTRACT

Of the thousand million poor in the world, 80 per cent of them live in rural areas. They have right to better life. They cannot also wait indefinitely for better days to come. The imperative need is to see that better days come to these rural poor, sooner than expected.

As late E.F.Schumacher put it *"poor countries slip and are pushed into adoption of production methods and consumption standards which destroy the possibilities of self-reliance and self-help. The results are unintentional neocolonialism and helplessness for the poor."*

If the benefits of science and technology are to reach the vast majority of the people who live in countryside, some serious thinking is called for to develop science to serve the needs of these people. Science must be relevant and percolate to reach these people and involve the people in the process of development. This calls for organisation and management of science and developing science to suit the development of these people.

Technology must be presented in an acceptable, understandable and assimilable manner to people at their levels to meet their needs and satisfy their values. To do that, technology should be coupled with social technology. If we look at science as questioning the critical creative attitude, raising the resourcefulness in man; technology as the enterprising and innovative attitude and problem solving capability; coupling science and technology what do we have?

S&T becomes an admirable tool for a man-centred endogenous development, where resourcefulness becomes his best resource problem solving capacity, helps gainful employment and self-reliant attitude and to live with a sense of values of human dignity.

Science and Technology applied in this fashion will increase man's rational attitudes, his innate capacity to absorb and utilise fresh ideas and change his way of life and life styles.

The *Society of Science for the People* in general and the *author* in particular adopted the above ideals while initiating innovative projects. In short the approach had been *Modernise the Traditional--Traditionalise the Modern.*

In this case study, typical inventions by the author in different fields are presented.

In the field of Renewable Energy Sources, the author invented a simple *Solar Water Heater* utilising locally available materials, which can be built in rural areas with local skills. Also presented is the design of a *Solar Water Pre-Heater for Cooking* which will conserve considerable energy in the cooking process.

In *wind energy,* the author presents a new approach *to convert low-wind sites to usable ones and to extract more energy at existing sites by an innovative concept of building escarpments of 30 degrees inclination around a wind-mill/wind-turbine.*

A *Savonius Wind Rotor* with 30 degrees concentrator above and below the rotor for battery charging in rural areas is also presented. The case study includes innovative low-cost devices like *Pedal Operated Washing Machine, Air-cum-Water Cooler, Extending TV to the next room through Periscope.*

In the energy conservation field, the author describes his designs like *Attachment of a low-angled (10 degrees) Cone to the Delivery Pipe of Electric and Diesel Pumpsets, Clay Covers on Concrete Roof tops to reduce heat during Summer* and a *Micro-Hydro Pumpset Built for low flows.*

The case study also brings out the constraints faced in the designing of various technologies, their dissemination, production in the artisan as well as in small and medium-scale industry and remedial measures to promote innovative technologies (unique) designed by the author.

1. INTRODUCTION

Solve the small problem before it becomes big.
The most involved fact in the world could
Have been faced when it was simple,
The biggest problem in the world
Could have been solved when it was small.

-- **Lao Tzu,**
The way of life, 604 B.C

Technology provides products and services to meet the potential human needs. It provides techniques and tools for improving the production of the known items and methodology and means of producing new ones; both of these can materially enalrge the returns from human effort, at the individual or collective level, and bring about a change in life styles.

The ultimate objective of the accelerated use of science and technology by the masses is the betterment of their socio-economic condition, or their development--the improvement in the quality of life.

1.1. NEED FOR NEW TECHNOLOGY

The proposed New Technology is based on a new concept of science and is intended for the well-being of men and his habitat. It encourages direct innovation with human needs and environmental imperatives in view. It is unique to people and their culture, it is their technology and will meet their needs and their requirements.

1.2. CONTENT AND SCOPE OF NEW TECHNOLOGIES -- INNOVATIVE ALTERNATIVE TECHNOLOGIES

In the choice of technologies, several terms have sprung and have been indiscriminately used like,

(a) Intermediate technology,

(b) Appropriate technology, and

(c) Alternative technologies.

1.2.1. Intermediate or Low Technology

Intermediate technology has meant many things to many people as a type of technology which lies in between the primitive technology and sophisticated technology. The concept of intermediate technology comes very near the one propogated by Mahatma Gandhi. Development of intermediate technologies, by and large, remained a programme to be worked at technician's level.

1.2.2. Appropriate Technology

Appropriate Technology is *a priori* a normative concept which implies that its delimitation can take place only after the norms are decided. These norms change with every shift in time and place. At the advent of Industrial revolution, Technological Innovations aimed at diversifying product design and cheapening the production cost for meeting the needs of rapidly expanding consumer market, formed the basis for Appropriate Technology. Appropriateness of technology was considered in terms of profit, with or without a concern for social goals.

1.2.3. Alternative Technologies

Alternative Technology is defined as development of technologies or production systems, which are not only appropriate to a social situation at a particular point of time, but also is free from the deletrious effects such as alienation or environmental imbalances. In considers the possible social and environmental changes and this has built-in flexibility to adjust to changing needs.

Such a technology should suit local resources, skills, culture and needs of the people with less-capital, energy, pollution and centralisation. Such a technology may involve extensive recycling; full utilisation of wastes, emphasis on household and industrial appliances with long life and recyclability; more use of solar and other non-convential energies, etc. It may require little or no modification of existing skills; improving traditional skills and tools; simple, easily manageable, low-cost, locally made technologies, where possible using local resources and skills, weaving in modern technology where required.

Such a technology is a new technology -- a basket woven with low and high, traditional and modern, simple and sophisticated technologies to meet the needs of people.

In line with the above approach, some *Innovative Aternative Technologies* were designed and developed by the author.

2. RENEWABLE ENERGY TECHNOLOGIES

2.1. ENERGY SOURCES AND TECHNOLOGY OPTIONS

The conventional energy-supply systems that have evolved in conjunction with large-scale, highly concentrated production and distribution units have often proved to be inadequate for the needs of the rural populations of developing countries. Even the small trickle-down benefits that have reached the rural sector have not been equitably distributed, either geographically or between various income groups. Rural electricity supplies for agriculture, irrigation and transport which normally involve substantial grid subsidies, have mainly benefited plantations and other large scale agricultural interests. The pattern of energy development in developing countries over the past 50 years, for example, has been described as urban islands of energy affluence amid vast oceans of rural energy deprivation.

Only about 12 per cent of the total electricity produced is distributed for rural use. The distribution of even this small fraction of the total electricity generated has been highly inequitable.

Thus, conventional energy systems based on centralised sources have failed to yield adequate electrical power in relation to the micro-economic needs in developing countries and usually have not met the specialised demands of agriculture or of rural and small-scale industries.

The problem of rural supply therefore calls for a new approach and a new planning strategy; deliberately oriented to the specialised needs of integrated rural development. In other words, integrated rural development must be sustained by an integrated rural energy system that encompass all facets of rural energy problems and result in optimum matching of supply with demand.

Wood and dung constitute the main source of energy used in the rural areas in developing countries. The possibilities of finding substitutes for them are limited. The replacement of such non-commercial fuels at present often implies a transition to petroleum products which are themselves becoming increasingly costly in foreign exchange and unavailable. On the other hand, large-scale dependence on wood and dung has resulted in depletion of forests, soil run-off and erosion, desertification and a steady decline in crop yields.

When properly used, small and perhaps intermittent, amounts of energy can be of critical value to the rural economy. The inability of developing countries to produce relatively small increments of energy is a major bottle-neck to development programmes, particularly in the rural sector where needs are much simpler. Although the provision of such amounts of energy is not, by itself, sufficient for the improvement in economic and social well-being, it is a necessary condition. Its efficacy is bound up intimately with other economic, social and political factors. Energy supply is so important that the provision for it presents a singularly opportune point of entry for rural development programmes.

The cumulative impact of the effective use of even small amounts of energy in a rural area can be considerable. Agricultural productivity, rural industries, health, communications, and educational opportunities could all benefit from the availability of even low-power devices, thus leading, perhaps, to a slowing of the rural exodus.

With this background, some innovative renewable energy technology devices were developed by the author.

2.1.1. Harnessing Solar Energy

The total amount of solar power intercepted by the earth is about 170 million million kilowatts, which is equivalent to 170 million million continuously-burning 1 kW electric fires--or, to use a more personal metaphor, the amount of power that the 3,500 million people of the earth would consume if they each left more than 48,000 1 kW fires burning continuously. Added up over a year of 8,760 hours, a power of 170 million million kilowatts amounts to no less than one-and-a-half million million kilowatt-hours of energy, because energy is equal to power multiplied by time.

Compared to this enormous annual influx, the amount of energy we humans actually consume in such forms as oil, coal, gas and electricity is extremely small. Because most developing countries lie between latitude 10 degrees North and latitude 40 degrees South, solar energy is generally available. As a source, it is well suited for production of low-grade heat at a temperature below 100 degrees Celsius. The maximum rate at which solar energy arrives on a flat surface (insolation) is approximately 1 kW/sqm; in a country such as India, this means an annual energy receipt of around 2,000 kWh/sqm. As such solar energy offers unlimited opportunities to supplement the energy needs of humanity.

2.1.2. Low-Cost Solar Water Heater – JAGADEESHWAR

The most common conception of the use to which solar energy can be put usually centres on the heating of water in solar collectors. It is true that solar water heaters are the most common form of solar technology now in use around the world. Such heaters are installed in over two million homes in Japan, 600,000 homes in Israel and well in over 30,000 homes in the USA. In addition, solar water heaters are in regular use throughout Australia, particularly in the tropical North where conventional energy sources are more expensive. Both Greece and Cyprus are making major efforts to switch from electric to solar water heating in order to reduce their dependence on oil, from which the bulk of their electricity is generated.

On the otherhand, several developing countries in Asia, Africa and Latin America, although recognising the benefits of solar water heating systems, are unable to sustain a market since the majority of these countries cannot afford solar based systems. It is also an unfortunate fact of life that in most developing countries the raw materials for solar water heater systems or system components to be assembled in these countries often attract heavy import duties, thereby making solar water heaters even more expensive than in the wealthier nations. The problem is further compounded by the fact that the earning power of the vast majority of people in the developing countries is but a mere fraction of that in the developed nations. This leads, in effect, to a double-block on the wide spread dissemination of renewable energy technologies such as solar water heating and photovoltaics in developing countries--countries whose need to reduce dependence on conventional imported sources of energy is often far greater than in the developed world.

In India, for example, the average cost of a family size solar water heating system is about Rs.9000 (approximately US $ 360). Even though some subsidy is provided by the government, few homes can afford this outlay and solar water heating systems remain a rarity.

In a bid to overcome the above obstacles, a low-cost method of heating water using locally available resources and harnessing traditional appropriate technology, which is often only waiting at the community level, has been developed by the author.

Since time immemorial, mud utensils have been widely used in the rural areas of India for cooking. Also, tea is traditionally served in small clay pots in all the railway stations throughout Northern India. In both the cases, people handle the mud pots with ease even though the contents inside are hot. This proves the efficacy of mud as an insulator.

Rice straw (hay) is widely used to ripen fruits such as mango and banana. Also, in the rural areas of India it is customary to keep the cooked rice warm and dry during functions by spreading it on a cloth placed over a bed of rice straw. Thus the heat retention properties of rice straw are demonstrated.

In the present design, four tins or drums, each of 15 litre capacity are connected together through a 3 centimeter diameter metal pipe both at the top and bottom for transfer of water. The end tin is fitted with taps in the middle and bottom. All the tins are coated outside with black paint and inside with metallic lustre or white paint. The tins are covered with two layers of transparent polythene sheet which helps to reduce convection and radiation losses besides acting as a shield against wind. Also the polythene covering helps to protect the paint on the tins. The tins are provided openings in the top to pour water. All the tins are placed on a base consisting of rice straw enclosed in a thick polythene cover to minimise heat losses.

An earthen or mud jar of 70 litre capacity is coated inside with a thin layer of cement to block the pores. The jar is also fitted with a tap near the bottom from which hot water is drawn. The exterior of the mud jar is covered with a 10 centimetre thick layer of rice straw and with a transparent polythene sheet to ensure the whole system is a air-tight. On top of the clay lid is placed a bamboo basket covered with thick rice straw and this is again covered with transparent polythene sheet to minimise losses at the opening. A similar arrangement is provided to cover the tap at the bottom of the jar when not in use. A rubber tube is used to transfer the hot water from the tins to the mud jar.

The tins are filled with water at around 8 a.m. and after exposure to the Sun, the hot water is transferred to the mud jar around 4 p.m. After this operation, the rubber tube is removed from the jar to prevent any heat losses.

Once insulated in the jar, the hot water can be used during the night or the following morning for taking a bath, cleaning utensils or washing clothes.

Experiments have shown that during summer a water temperature of 60 degrees Celsius and winter 50 degrees Celsius are obtainable in South India. During a period of 15 hours storage, an average temperature drop of 5 degrees Celsius was recorded.

All the components in the above system were available locally and the technology involved is quite simple. In India, the cost of this solar water heater is just Rs.300 (US $ 12).

Where water requirements are higher, the number of tins can be increased proportionately to the size/storage capacity of the mud jar.

This simple solar water heater can also contribute to a reduction in the use of traditional fuels such as wood and charcoal for heating water, with resultant reduction in smoke pollution, as well as saving electricity in the urban areas.

The author circulated a note on this solar water heater to several individuals, organisations involved in the promotion of renewable energy sources. The response is quite encouraging. Already similar units were setup in Nellore. The author received information recently that organisations like Energy Environment Group, Delhi; IERT, Allahabad; Central Leather Research Institute, Madras; National Energy Council, Lusaka, Zambia; Energy Planning Unit, Ministry of Works and Energy, Republic of Kiribati; Jua Limited, Musoma, Tanzania; Center for Rural Technology, Visakhapatnam, India; Khadi and Village Industries Commission, Bombay; National Heaters Industries Co. L.L.C., Rusayi, Sultanate of Oman; Centre for Rural Technology, Kathmandu, Nepal etc. are considering to implement this low-cost technology. Many National and International journals and newsletters have highlighted this simple but useful technology. Also several experts in the field hailed the device as unique.

2.1.3. Solar Water Pre-Heater for Cooking < JAGADEESHWAR II >

In the cooking process whether by firewood, kerosene, gas or electricity considerable energy is required to raise the temperature of water initially especially in the case of rice, dal, maize etc. If we can use pre-heated water of temperature around 60 degrees Celsius, considerable energy can be saved. With this objective, a simple solar water pre-heater for cooking, "JAGADEESHWAR II" has been designed and tested.

2.1.3.1. Design Details

Vertical and cylindrical solar collectors, can be used to obtain hot water. They are easy to construct, low to moderate in cost, good looking and can be effective--as effective as the wall-mounted batch collectors. Another advantage is, they perform well when the Sun is low in the sky and as such good for winter too!

In this design, a stainless steel drum of capacity 50 litres with opening at the top and taps fitted in the middle and bottom is coated with black paint (stainless steel drums are widely used for drinking water storage in India). The middle tap facilitates drawing water of higher temperature, since due to natural convection hot water rises to the top and the bottom tap is meant to draw hot water in the collector completely. The black painted steel drum is covered with two layers of transparent polythene sheet. A curved reflector made of bamboo and plastered with mud and animal dung to give smoothness and covered with tin foil is placed behind the collector. The rear portion of the bamboo reflector is covered with polythene sheet to protect the bamboo from rain. The reflector stands with the help of a supporting stick and can be oriented according to the direction of the Sun. The collector is mounted on an insulated base (rice straw enclosed in a polythene bag) to reduce heat losses.

The storage system is similar to the one described in the earlier section.

2.1.3.2. Operation

The collector is filled with potable water around 8 a.m. and covered with lid. The polythene covers are closed with the help of the clip provided. Hot water drawn from the outlet either at noon or at 4 p.m. is transferred and stored in the mud jar. This hot water can be used for cooking or making hot beverages either in the afternoon, night or next morning. To quicken the boiling process, pre-soaking of maize, dal, rice, beans etc. will help to reduce the cooking time which means less fuel consumption. Water is a better conductor than air. The wet cotton conducts (absorbs) the ink faster than dry cotton wool. Similarly, soaked wet beans/rice conduct (or absorb) heat faster than dry ones. Also once food reaches boiling point, it can cook by simmering at lower heat.

2.1.3.3. Performance and Cost

Hot water upto 70 degrees Celsius is obtainable (in south India) depending on the Sunshine. The whole system costs Rs.750 (US $ 30) and can be fabricated with local skills and material. Where water requirements are higher, the size of the collector can be increased and so is the storage of the mud jar.

2.1.3.4. Advantages

- The pre-heated water will save fuel especially in the rural areas (like firewood, kerosene) in developing countries.
- It will lessen cooking time.
- This solar water pre-heater alongwith improved cooking stoves can be promoted by global agencies in rural areas in developing countries to conserve fuel, and
- The pre-heated water can be used in the laboratories in rural schools and in hospitals.

The details of the solar water pre-heater for cooking were circulated widely, a few months back. The response is overwhelming. Many organisations are planning to implement the project. This simple device is an example of an innovative approach to conserve dwindling fuel resources in rural areas.

2.2. WIND ENERGY

2.2.1. New Method to Harness more wind energy

Though wind technology is centuries old, yet its application in developing countries is quite slow. The main constraint for wider use of windmills for water pumping and wind turbines for power generation is low to medium winds prevailing in many parts of the world. Let us consider the case of India. The pattern of wind regime prevailing in India based on Indian Meteorological Department (IMD) wind data reveals that in over half of the area in the country, the annual mean windspeeds are in the range of 5-9 km/hr, most parts of which are not suitable to harness wind energy (the cut-in-speed of most commercial windmills available in India is above 9 km/hr). If by some means we could increase windspeed by atleast 30 per cent, we can cover more areas with windmills and also increase energy output at the existing windmill sites.

2.2.2. How to achieve this?

It is a known fact that windspeeds above hills are higher than those at equivalent heights above flat ground. Moreover, power is cube of velocity. With these two established facts in mind, a new method to convert poor windy sites to usable ones has been found by the author.

The author conducted tests in wind tunnel on models simulating dams or escarpments ranging from 10 to 90 degrees and of different shapes (straight, curved, round etc.). It has been found that a 30 degree slope increases windspeed by 1.5 times which means an increase in power by a factor of 3.38.

Tests on models confirmed the validity of laboratory results.

2.2.3. Usefulness of these Results

These results can be directly applied to harness wind energy more effectively.

A 30 degree sloping structure made of bamboo screens with eucalyptus or casurina poles support, has to be arranged around windmill/wind turbine upto a height of 10 metres from the ground level in a conical shape which would enable wind from any direction to be intercepted and enhanced by the escarpment. The upper portion of the bamboo screens is plastered with mud and animal dung to give smoothness and covered with polythene sheet to give smoothness. The polythene covering also helps to protect the bamboo screen from rain.

In choosing bamboo for the sloping structure, the following advantages were taken into consideration. Bamboo is abundantly available in many developing countries. Bamboo as well as bamboo mat sails are already in use as blades for windmills in countries like Thailand. It has been found by researchers that bamboo reinforced slab can be designed like steel reinforced concrete taking permissible tensile strength and bond strength as 24,000 kN/sqm and 350kN/sqm respectively. Many studies reveal the versatality of this low-cost construction material. The cost of a typical (5x4m.) bamboo screen with clay coating and polythene covering is around Rs.300 (US $ 12) in South India.

At the instance of the author, some tests were conducted on 30 degrees slope before a windmill in Tucson, Arizona, USA and the results were encouraging.

2.3. SAVONIUS WIND ROTOR WITH CONCENTRATOR

There is a dire necessity to provide energy in unelectrified areas. In windy areas, wind battery chargers will be quite useful. The simplest and easiest type of windmill to build is a vertical-axis machine, "Savonius Rotor."

But one constraint is that savonius rotor rotates relatively slowly compared to aerodynamic horizontal-axis machines (this does not necessarily mean that the power is any lower, however). A one metre height and half metre diametre oil drum sawn in half, forms the two cup-sections of the savonius system.

A 30 degrees conical concentrator (about half metre in height) is placed above and below the rotor and the whole system is mounted on a one metre height oil drum filled to half with sand for stability. A low RPM D.C. generator is attached to the axis of the savonius rotor. The rotor has also a gear mechanism.

Comparitive tests between savonius rotors with and without 30 degrees concentrator reveal substantial increase in the output in the one with concentrator. This system can be mounted on the roof and will be a boon in unelectrified rural areas.

This novel design is yet to be commercialised.

3. ENERGY CONSERVATION

3.1. CLAY COVERS ON CONCRETE ROOF TOP TO PROVIDE COOLING

Often people living in concrete roofed buildings feel discomfort during summer because of heat inside the building. To offset this, traditional housing practices such as mud covering offer promise to provide cooling.

Mud as building material, has the following advantages.

- It is cheap and in most parts of the world, it is readily available, and
- It provides excellent heat insulation, so inside a mud building is cooler in summer and hotter in winter than a building made with steel and concrete.

Clay (mud) pots with lid are widely used to cool drinking water during summer. Utilising these clay covers a new cooling system for houses has been designed by the author.

Clay covers one or two feet in diametre and one to two inches in thickness are placed on the concrete roof of the building side by side plastering the gaps with mud. The upper convex portion is white washed (the usual practice in India). For each set of four covers, one cover is placed in the middle to fill the gap. By this arrangement the house temperature can be brought down by 5 to 6 degrees Celsius.

When the Sun rays fall on the white surface, they are partially reflected back and since the incident surface has curvature, the Sun rays reach the surface at an angle with reduced intensity of heat. The heat is further reduced when it is conducted through the thick layer of clay and the air gap.

The clay covers can be manufactured locally and are quite inexpensive. Besides the manufacture of clay covers, provides employment opportunities to rural potters.

A local photo studio owner adopted this technology on his studio concrete roof with positive results. Also some organisations in India and outside are considering to implement this traditional wisdom to cool the houses.

3.2. A MICRO-HYDRO PUMPSET FOR LOW FLOWS

A new method has been developed to extract power from irrigation flows by the author.

The micro-hydro system has a 2 feet diametre wheel with iron buckets (which acts like a pelton wheel). The shaft of the water wheel is mounted on a stand with two ball bearings. At the opposite end of the shaft, a 10 inch diametre aluminium pulley is connected to a D.C. generator with a V-belt over a dummy pulley to reduce the load on the generator shaft.

Water from the delivery pipe falls on the turbine, which rotates the generator through the pulley. Power produced by the system can be stored in batteries or used directly when the water is pumped.

With proper matching from the delivery pump of a 10 HP motor, 0.2 kilowatts power can be generated. In wet fields in India (where a farmer grows three crops a year), the pumpset will be in operation most of the time in a year.

At many irrigation sites a windmill pumps water into a storage tank. Water flowing from the tank could be utilised to generate electricity by this system before it reaches the irrigation canal.

The system costs Rs.3000 (US $ 120) and can be fabricated in local workshops. The author fabricated a prototype and tested it with satisfactory results.

3.3. PEDAL OPERATED WASHING MACHINE

A newly designed pedal operated washing machine by the author is much cheaper than the electrically operated machine. The machine can be fitted to the pedalling mechanism of the conventional pedal operated sewing machine, after seperating the sewing machine from the table.

It consists of a box 15 x 15 x 24 inch size made from thick GI sheet, a wheel of diametre 2 feet, a washing machine wheel of diametre half feet made of aluminium, and an inside box wheel of half feet diametre made of fibre glass. The whole setup is mounted on the pedalling table in place of the sewing machine. There is an opening to take out the used water. The box is coated outside with black paint so that it absorbs heat which would be useful to warm the water for cleaning the clothes.

This machine can wash 2 kg of synthetic fabrics in 10 minutes and of cotton fabrics in 20 minutes. After washing, the box can be removed to make the pedalling stand available for the sewing machine.

The box and the wheels of the washing machine cost around Rs.300 (US $ 12) and can be built with local skills.

The author received several enquiries from India and abroad (developing countries) expressing their desire to adopt the system. It is hoped some small scale industry will start commercial production of this low-cost washing machine.

3.4. AIR-CUM-WATER COOLER

Many people carrying canvas water bags while travelling in trains, cars etc. hang them outside the window to cool the water. This principle has been utilised in designing a simple air-cum-water cooler by the author. Two canvas bags of about 45 cm length and 20 cm width are hanged one on each side of a table fan at an inclination of 20 degrees. The air from the fan converges and produces cooling effect. Thus, the water oozing from the canvas bags keeps the air cool as well as makes the water ready for drinking. The cooled water taken out for drinking should be replaced by fresh water. The number of bags could be increased (say 10 or 15 as required) and placed in a semi-circular fashion about the fan. Such a system will be useful to get cool water in small restaurants and in rural schools. The two canvas bags cost just Rs.50 (US $ 2), in India.

The local CATRAN centre has adopted this novel design.

3.5 EXTENDING TV TO THE NEXT ROOM

A cheap method of extending TV in a neighbouring room or in a room upstairs has been developed by the author incorporating the principle of Periscope.

As is known, the periscope has two plane mirrors slanted with each other at an angle of 45 degrees to reflect and re-reflect the rays coming from the object.

A periscope is made with its inlet and outlet having the dimensions of the TV screen and placed in front of the TV at the same height at the other end of the room where TV is placed. The other end of the periscope projects into the neighbouring room or a room upstairs. The casing of the periscope can be made of hard card-board or plywood. The end which projects into the next room is made smaller so that the field of view is broader. A seperate speaker is arranged from the TV to the next room.

This arrangement costs only Rs.200 (US $ 8) and can be easily fabricated by a high school student. Such a TV extension would be useful in schools, railway and bus stations, community centres etc. A special arrangement of convex lenses can also be employed in between the two plane mirrors of periscope to enlarge the field of vision.

This system was adopted in a local school. The author also received enquiries from some developing countries seeking information on this simple system.

3.6. DEVICE TO SAVE ENERGY IN PUMPSETS

A simple low angled divergent cone when fitted to the delivery pipe of electric motors will save considerable energy. Such a system has been devised by the author.

There are about 7 million electric pumpsets operating for agricultural purposes in India besides millions of diesel pumpsets. In the delivery pattern of water from the pipe, in many cases, the discharge velocity of water is considerable and this kinetic energy is wasted. If this loss is reduced, considerable electricity could be saved.

During an intensive survey carried out by the author, it was found that many of the motor pumpsets have a mis-match between suction and delivery. This is because the capacity of the motor and the head are decided on the advice of semi-skilled mechanics in rural areas. Moreover, there is a wrong notion that more the velocity of water at delivery end, the more water is present at the site.

The device designed by the author would be very useful in tapping the residual kinetic energy. The principle is to fit a diverging section to the discharge end. The angle of the divergent truncated cone should be about 10 degrees to avoid seperation in the divergent section. As the loss of kinetic energy is proportional to the square of the velocity, this arrangement would lead to reducing the losses and the divergent cone will give more water. In essence the cone reduces exit losses.

In the experiments conducted by the author the electricity saving using a one foot long cone was around 10 per cent. This cone can be metallic or wooden and costs just Rs.50 (US $ 2) and can be fabricated locally.

The author brought this novel device to the attention of different state electricity boards in India.

4. OTHER TECHNOLOGIES

4.1. LOW COST FIRE-PROOF APRON

A novel and inexpensive method for protection against kitchen fire has been designed by the author.

Fibre glass cloth generally used in electric motors has anti-flame properties, but this cloth produces itching on the skin. The author coated the fibre glass cloth with silicon emulsion to save the skin from itching effect.

Apron made of above cloth can be used by housewives while cooking for portection from the flames. It can be stiched by the housewife herself by procuring the fibre glass cloth from market and costs only Rs.50 (US $2). It is also useful for persons working in bakeries, brick kilns etc. The fibre glass apron is durable and washable and can also be used to make hand gloves.

The author received many enquires from small entrepreneurs and intends to transfer the technology soon.

5. ISSUES CONCERNING TRANSFER OF TECHNOLOGIES

The major problems preventing greater application of alternative technologies are not technical; the real barriers are lack of information; markets, distribution networks, and installation, servicing and maintenance skills. All of these factors interact.

If progress is to be made, it is essential that integrated programmes be initiated in which all aspects of the implementation problem are covered. Also, although energy is an essential component of development, it is desirable that an energy programme should be seen in the overall community development plan. To succeed, the programme should benefit both the individual and the community.

New ideas do not disseminate readily in rural areas, however. One approach is to set up examples of new devices in the proper village environment, for example: a solar water heater or a wind battery charger. This enable the product to be tested under realistic conditions.

While identifying problems and designing suitable devices to solve them, the author adopted the *demand pull* approach.

5.4. ACCEPTANCE OF TECHNOLOGY

An invention must be appropriate for the kind of use for which it is meant. As such, Governments in developing countries with limited resources should evaluate new technologies carefully so that only appropriate ideas are encouraged. For example: Developing countries in Asia, Africa and Latin America with abundant sunshine may not require sophisticated designs of solar water heaters. Designs incorporating local traditional wisdom will find ready acceptance besides being less expensive.

5.5. SPECIFIC PROBLEMS FACED BY THE AUTHOR IN POPULARISING THE INNOVATIVE PROJECTS

The *Society of Science for the People* of which the *author* is the *Founder President* is a voluntary organisation devoted to the dissemination of low-cost technologies, popularisation of science, and acting as a think-tank in generating new ideas to alleviate the sufferings of rural poor. The members managing the society, work on a voluntary basis and the society carries out its activities purely by contributions of the members without any external funding. As such the society has neither the manpower nor funds to implement specific projects in rural areas to ascertain their acceptance. On the other hand, the author depends on local workshops to fabricate various components of the devices invented. The pre-requisite to prove the viability of a technology is demonstration in a selected rural area so that the rural people are convinced about the utility of the technology being introduced. Often small organisations involved in developmental activities face difficulties in securing funds from Governments as it involves continuous effort and the whole process is time consuming. To generate funds to employ some whole time staff, is a must to carry out pilot projects in rural areas. Though the author could create awareness in the public and bring his ideas and projects to the attention of local, state and central Government authorities besides global organisations through his various writings in journals, magazines and individual communications; what is needed is institutional support to carry out pilot projects in rural areas.

5.6. ROLE OF GLOBAL ORGANISATIONS

To bring the innovative projects designed by individuals and organisations to fruition, global organisations like UNIDO, World Bank, UNDP etc., can play a crucial role. These organisations can identify limited number of innovative technologies and can fund a project to implement them in a selected region in a developing country involving the inventor in the project. This way the inventor will have the freedom to experiment his creative ideas and to adopt the technologies to the local needs and conditions. Moreover, it will be easier for global organisations like UNIDO, to transfer the knowledge and experience gained through such a project, to other areas because of their global network.

6. CONCLUSIONS AND PROGNOSIS

Despite heavy odds the *Society of Science for the People* in general and the *author* in particular were able to identify and design *innovative low-cost technologies* which are unique (ie.,) weaving in modern technology into traditional tapestry. The author has not taken out any patents on his inventions so that the technology is freely available to everyone. The first step is invention, the conception of a notion, a vision, a potential possibility to be married to a potential need. The second step, innovation involves a high degree of spirit of adventure, risk and entrepreneurship to make it work, finally the technology so developed should be transferred to the industry. The technology transfer is the process of matching solutions in the form of existing science and technology to the problems in commerce and business. With all humility, the author feels satisfaction, having succeeded in the two steps but looks forward for assistance to achieve the final step.

There are countries in the developing world that can boast of centres of scientific excellence that have nothing to envy their counterparts in industrialised countries. What is often lacking is an adequate network linking these among themselves, and each of them to users who could benefit from the research carried out there. Sometimes institutes end up being attracted to undertake fashionable research rather than being responsive to the real needs of the people and the environment. If quantitative growth of the economy in the developing countries is badly needed, it is equally important to improve the quality of life.

We have before us a great challenge and a great opportunity. It is for us to ensure that technology makes a determinant contribution to bettering, in a qualitative sense, the lot of mankind.

REFERENCES

Energy for Rural Development, National Academy of Sciences, Washington D.C., 1976.

Guide to Small Power Services, ITDG Publications, London, 1978.

P.D. Dunn, Appropriate Technology, Macmillan, London, 1978.

Appropriate Industrial Technology for Energy for Rural Requirements, Monographs on Appropriate Industrial Technology, UNIDO, No. 5, 1979.

Godfley Boyle, Living on the Sun, Marion Boyars Publishers Ltd., London, 1975.

Y. Nayudamma, Endogenous Development of Science and Technology -- Weaving in Modern Technology into Traditional Tapestry, Paper presented at UNESCO meeting on "Philosophical Investigations of the Conditions for Endogenous Development of Science and Technology", Kathmandu, Dec. 10-14, 1979.

Solar Water Heaters, Share International, Vol. 9, No. 7, 1990, 10.

Low-Cost Water Heaters, IRED-Forum, No.40, July-Sept., 1991, 29.

Everybody's Solar Water Heater, Boiling Point, No.24, April 1991, 4-5.

Power to the People, Our Planet, Vol.2, No.4, 1990, 12.

Low-Cost Solar Water Heater, SCNCER Newsletter, Vol.4, No.3, Sept. 1990, 14.

Mud Jar Solar Water Heater -- An Ingenious yet Low-Cost Design, RERIC News, June 1990, 3.

Tecnologie appropriate, Cultura e Natura, Vol. VII, Numero.2, March-April, 1991, 18.

Solar Water Pre-Heater for Cooking <JAGADEESHWAR II>, Changing Villages, Vol.10, No.4, Oct-Nov. 1991, 151-153.

A. Jagadeesh, India -- Prospects and Pitfalls, Wind Power Monthly, Vol.4, No.10, 1988, 6.

IMD Climatological tables of Observatories in India (1931-60), India Met. Dept. 1966.

Anna Mani and S. Rangarajan, Solar Radiation over India, Allied Publishers Pvt. Ltd., New Delhi, 1982.

K.R. Datye, S.S. Nagaraju and C.M. Pandit, "Engineering applications of Bamboo", Proceedings of the International Conference on Materials of Construction for Developing Countries, Bangkok, 1978, 3-20.

Aliz and R.P. Pama, "Mechanical Properties of Bamboo reinforced Slabs", ibid, 49-66.

S.R. Mehra, H.L. Upal and L.R. Chadda, Some Preliminary Investigations in the use of Bamboo for reinforcing Concrete, Indian Concrete Journal, 25, 1951, 20-21.

U.C. Kalita, A.C. Khazanchi and G. Thyagarajan, "Bamboo-crete wall panels and Roofing Elements for Low-Cost Housing", Proceedings of the International Conference on Materials of Construction for Developing Countries, Bangkok, 1978, 1, 21-36.

R.J. Mentzinger and R.P. Plonridge, Investigation of Treated and Untreated Bamboo as Reinforcing in Concrete, Villanova University, Villanova, Pennsylvania, 1966.

N.P. Kurien and A.K.A. Kalan, "Bamboo Reinforced Soil Cement for Rural use", Indian Concrete Journal, Vol.51, 12, 1977, 382-389.

B.B. Broms, "Problems and Solutions to Construction in Soft Clay", Proceedings of the 6th Asian Regional Conference on Soil Mechanics and Foundation Engineering, Singapore, 2, 1979, 3-38.

M.A. Aziz, Consolidation of Soft Compressible Clayed Soils using Split Bamboo filled Coconut Coirs, Journal of the Institute of Engineers, Pakistan, 25, 1964, 32-39.

M.A. Aziz and S.D. Ramaswamy, Appropriate Technology in Civil Engineering, Proceedings of the Conference organised by Institution of Civil Engineering, Pakistan, 1980, 110-111.

J. Darmstadter et al, Energy in the World Economy, John Hopkins University Press, Baltimore, 1971.

World Energy Outlook, New York Exxon Inc, 1977.

Energy Needs, Uses and Resources in Developing countries, Brookhaven National Laboratory, Upton, New York, 1978.

J. Howe, Inc., energy for Developing Countries, Report to the International Relations Programme of the Rockfeller Foundation, New York, Oct. 1977.

R. Revelle, Energy Use in Rural India, Science, 4 June, 1975.

Denis Hayes, Energy for Development, Third World Options, Worldwatch Paper 15, Wordwatch Institute, Washington D.C., Dec. 1977.

E. Friedmann, Financing energy in developing countries, Energy Policy, March, 1976.

V. Byrappa, Appropriate Technologies for rural energy supplies -- the Indian experience, Rural Electrification Corporation, New Delhi, May 1978.

Jose Goldemberg and Robert H. Williams, Energy strategies for developed and less developing countries, Princeton University, Overseas Development Council, Center for Environmental Studies, February 1978.

James W. Howe and William Knowland, Energy and Development: an International approach, Communique on Development Issues, No.31, Dec. 1976.

Rural Electrification, The World Bank, Washington D.C., 1975.

H. Usmani, 'Rural Electrification: an Alternative for the Third World, Natural Resources Forum, No.2, 1978.