The energy crises brought-on by the petroleum price-hike of 1973 led to extensive research on alternative sources of energy. The results of this research have however, been restricted to the development of devices which a person desiring energy autonomy could purchase to get energy from free ambient sources. In the U.S.A. as well as in the third world, energy research has rarely led to the development of techniques which could be applied by an individual or a community to get free power from a free source. While an American householder may cut-down his energy needs by installing solar space heating, no such technique is likely to help an Indian or a Philipino who has barely a roof over his head. His direct energy needs are so small that even the limited oil resources of the world would last forever if everyone lived his way. The community energy needs are however, something that depend upon government administration and planning, and these are increasing with the changing policies. The mere act of removing an “illegal” squatter settlement from the heart of a city to an outlying area means an increase in the energy needs of those displaced because they can no longer walk or cycle to work and are forced to use the public transport that runs on precious petroleum fuel. While Americans may be able to afford the extra energy cost of replacing in-city shops by supermarkets which can be reached only by private automobile, in the fragile economy of a developing country it is vital that town planning itself should reduce energy needs.

This paper is based upon a city planning scheme (Ref. 1) presented in 1975 for the International Design Competition for the Urban Environment of Developing Countries - focused on manila, Philippines. The objective behind the proposal was to demonstrate that there are intricate linkages between the various city services such as energy, water and food supply and waste disposal.
LIFE IN THE SLUMS

Like any other large city in the developing world, Manila’ has hundreds of thousands of people living in illegal slums, in houses built mostly from crap, without any filtered water supply, hygienic toilets or garbage disposal facility. To supplement their meagre incomes (unemployment rate is high) they keep pigs and chickens which must share living space with human beings. Within the house, energy is used only in the form of kerosene for cooking and electricity for lighting. Since water is not supplied to individual houses, it is used in small quantities only for cooking and washing. Kitchen waste and human faeces are thrown in open areas where pigs feed on them. Many people walk to work even when it is several miles away. Only a few use the erratic bus service.

Manila is not a unique city as far as the living conditions in slums are concerned. In the “jhuggies” of New Delhi, the “bastis” of Calcutta and the “jhopar pati” of Bombay, things are equally bad, the solution offered here would apply equally well to any of these cities and to the countless other small towns in the tropics.

TOWN PLANNING AND URBAN INFRASTRUCTURE

While developing new housing areas, it is generally assumed by planners that (a) energy and clean water supply will be available, (b) means will be found for disposal of sewage and garbage, and (c) if the present supply is inadequate, enough financial resources will be available to develop new sources. The situation in the urban areas of the developing countries is such that none of these assumptions can be considered realistic or practical. Energy supply which affects the availability of all other services is extremely limited. In Calcutta all industries had to be shut down completely for one week this year so that power could be made available for domestic use. Even in New Delhi, a city which receives power on priority basis by virtue of being the capital, load-shedding (brown-outs) is a common feature. Many newly built housing units have remained unoccupied for as long as a year because electricity and water were not available.

RESOURCES CONSERVATION

While looking for alternative methods of servicing cities, the first step should be to economise on existing sources. It must be obvious that-

1. as much as 40% of the domestic consumption of water in a fully serviced house is flushed down the toilets. This waste could be eliminated by re-using bath and laundry water for the toilets.
2. If city sewage could be purified and the water recycled, perhaps up to 80% of the domestic consumption could be eliminated.

3. Transport of goods (including food) to the city, and transport of people within the city consumes large amounts of energy. There is scope for cutting down on both of them by a different organisation of the urban activities.

4. While food grains can be stored, moved, and distributed with relatively little energy expenditure, fresh produce like milk, vegetables, and meat require much greater amounts of energy for preservation and distribution. Traditionally, the production of these perishable foods has been organised within the city and the recent trend to move this away ought to be reversed.

5. Energy is being wasted in transporting and handling garbage. If its potential as a rich source of manure and energy is recognised, garbage would become a resource rather than a nuisance.

6. Large amounts of energy are being used to concentrate and partially treat sewage before it flows into a water course. This is unnecessary wasteful and polluting. As is the case with garbage, sewage can supply both energy and fertiliser.

7. In the tropical countries, there is enough sunshine available to meet all the domestic energy requirements. The problem is to find an economical method for converting and storing it in a usable form.

CAUSES OF FAILURE

Before designing a new system of urban services, the reasons for the failure of present systems need to be examined. Traditionally, town planning legislation, like all other legislation, has been designed to correct past ills, never to set the trend for future development. If water is in short supply then houses should get water supply only for a few hours each day, no attempt being made to reduce demand by proper utilisation. If transport is inadequate, more buses are added—without any strategy for cutting down on the need for transport. Most town planning schemes start as a street layout upon which are overlaid plans for other services one at a time. This perhaps is the single most important factor for failure to achieve the overall goals of town planning. Specialists—each responsible for and conversant with only one aspect such as transport or water supply—work to put together a piecemeal solution. There may be no alternative available for this fragmented thinking unless the technology used for city services is itself simplified and demystified.
A NEW APPROACH

In the developing countries, for most people supply of energy is not as big a problem as food and water. Optimisation of energy sources will however, lead to solution of other infrastructural problems as well. The potential for recycling wastes and for using, ambient sources of energy in an urban area can be seen in fig. 1. The net output of such a system would be manure, clean water, food (fish, eggs and vegetables) and energy (Methane gas and electricity) in place of dirty water which is the only product of the conventional system.

![Proposed re-cycling system](image)

The most important part of the system is a water-hyacinth pond covered with a transparent material like glass or plastic, into which would flow sewage after treatment in a simple bio-gas digestor. Water hyacinth (Ref. 2) is a water weed which infests canals, rivers and ponds in nearly all tropical areas of the world. It would take up the pollutants in the sewage, absorbing solar energy in the process. This energy would be released in the form of methane gas when the hyacinth is harvested and fed back into the bio-gas digestor. Water from the hyacinth pond would flow into an artificially aerated aquaculture pond stocked with fish and ducks (Ref. 3), where the water would be cleaned further and used subsequently for organic hydroponic vegetable cultivation (Ref. 4). After treatment in a slow sand
filter (part of the hydroponic beds) the resultant water would be of adequate purity for all purposes other than cooking and drinking.

The technical basis of the system has been experimented and established in parts by various people including NASA/NSTL (Ref. 5). The problem however is of applying it to an existing city where land availability is limited. If the system were to be installed in a remote location many of its benefits would vanish because of the cost of installing extra pipelines for gas and treated water. Fortunately the situation in the urban areas of the developing countries is such that it would be easy to apply the system where it is needed most i.e. the illegal squatter settlements mentioned earlier.

**DECENTRALISATION AND URBAN FORM**

The manner in which the large cities of the developing countries are crowing makes it impossible for centralised services, systems to keep up with them. The capital cost of such systems (Ref. 6) becomes disproportionately high when they are to accommodate geometric increases in population and the areas serviced. To avoid these extra costs the present strategy (fig. 2) is to develop new areas for the poorest outside the city with the minimum of services. In New Delhi for instance, during 1975, large areas were “developed” for re-locating slum dwellers, with only one water connection for 20-25 families and communal toilets with manual removal of faeces. The house plots are so small (25 sq. yds. each) that there is no possibility of providing the basic amenities even at a later date. In direct contrast to this, fully serviced high-rise development is being encouraged near the city centre to meet the demand for additional business space. Presumably, it is easier to provide services to large consumers in a small area than to small consumers in spread
out areas. Even in times of scarcity, the economics of centralised servicing systems encourage consumption rather than conservation.

To change this absurd situation reasonable limits need to be put on consumption and the responsibility for conservation should shift from the government to the users. Local resources need to be utilised fully. A de-centralised services system such as the water-hyacinth based cycle would meet these requirements easily,

**LAND REQUIREMENT**

Is there enough land available in cities for such a system to be applied? The answer to this would depend upon each individual situation. Most cities have large unutilised areas along the periphery where new urban development is taking place at present. In this type of an area in Manila it was possible to plan for the prescribed population density. The system (fig. 3) was optimised for water conservation and food production rather than for generating enough energy for all domestic consumption. The “recycling farms” were located close to the living areas (one for every 2,000 houses) and space was provided for “food farms” (one for every 500 houses) where pigs and chickens could be kept and vegetables grown.

fig. 2. Recycling proposal for Manila
In other places it may be necessary to optimise the system for energy generation. Given the rate of energy consumption for poor families at a population density of 600 persons/hectare, the land requirement for energy, voter and food production and waste treatment, would be roughly equivalent to the housing area itself. At lower population densities, the land requirement would be proportionately less as energy consumption would also be less. The comparative costs of conventional vs. the decentralised system depend upon many local factors and social needs. In most cases the real costs of the conventional system cannot be worked out because of the large proportion of hidden costs. It is however certain that a great deal of autonomy would be possible even for the poorest in the society if services were to be decentralised.

REFERENCES