Rural energy modelling:

Summary of the Project: This project will involve the development of a generic rural energy demand-supply model and demonstration of its applicability to village-level energy requirements and resources. The purpose of the model is to address, in particular, the inadequate supply of and access to energy services, by including all the available sources of energy services and deriving the most economical ways of meeting the demand for them. The model will consider on the one hand, estimates of the energy services required, including those not yet obtained, and, on the other, the various options for meeting these services, particularly from locally available resources. The annualised costs per unit of delivered energy through each alternative will be estimated, enabling comparatively low cost options to be indicated. Since it is intended to be a generic model, it will be applicable to any region, but during the project period, data from Indian villages will be used for demonstration.

Project description

In rural areas of South Asia, particularly the Indian sub-continent, there is a glaring lack of efficient, clean and economic energy sources, even for basic services such as lighting and cooking. Numerous villages have not yet been electrified, many homes do not have electric lighting even in electrified villages, and most are dependent on collected biomass used in inefficient stoves with the attendant ill-effects on health; for other sectors, too, energy supply is insufficient and unreliable. Although governments subsidise some programmes, these are limited. There is thus the need for addressing the economic, social, efficiency and environmental problems of energy service provision in these rural areas.

During the project, we intend developing a *g*eneric *r*ural-energy *a*ssessment *m*odel (gram) capable of addressing these problems, using the integrated resource planning approach to rural energy planning. The model will provide for the estimation of the energy requirements of a village/cluster of villages, based on the energy-services needed, such as cooking, lighting, water pumping, grain milling, and so on, including services not yet adequately provided. To meet the demand-supply gap for energy-services, both supply options -- based on local and transportable resources - and demand-side measures, will be considered. For example, in the case of electricity, these options could range from transmission and distribution from distant generating plants based on any of a variety of sources, to generation in the region from locally available resources, to measures like irrigation pumpset efficiency improvement. Each option will be assessed both for its energy-service potential and for the costs involved in energy-service delivery, on the basis of local data. The model will estimate the annualised capital and variable costs, including environmental costs where relevant, of each alternative. These annual costs per unit of energy delivered or conserved through each alternative will then be compared, so that a least-cost schedule can be drawn up.

The model thus developed would deal with the problems we intend addressing - in economic terms (by deriving the least costs among alternatives), in social terms (by aiming at energy services for all), in efficiency terms (by considering the output of energy services rather than the input of energy), and in environmental terms (by including the environmental costs of

alternatives, leading to judicious use of exhaustible resources). Sustainable provision of energy services necessitates choices – between sources of fuel, between technologies of transformation of these fuels, and so on. This model is intended to help in making appropriate choices. And, if the least-cost schedule derived through the model were implemented, the resource allocation would be optimised, i.e. total costs of energy service provision would be minimised, subject to meeting the estimated requirements.

In order to demonstrate and evaluate the model so developed, information from a few villages will be used. This will necessitate data collection in a systematic manner, through a survey instrument that will also be prepared during the project. The generic model developed is intended to be applicable in any region, but during the project period, data from Indian villages will be used for demonstration.

Problem statement and how it will be addressed:

A. The problem the proposed project will address:

The problem being addressed is that of planning for the provision of energy services for the needs of people in rural areas.

- Firstly, ***rural energy needs are not being met adequately***, with domestic access to electricity and to modernised cooking fuels still poor, and the supply of energy services for health and education facilities, for irrigation pump sets and other agricultural activities, and for local industries, insufficient and unreliable.
- Secondly, ***the costs of supply are often higher than they could have been,*** if ***appropriate planning procedures***[1] were followed.
  Apart from these main problems, we would also be *indirectly addressing the following*:
  - ***System costs*** (such as the losses incurred in transmitting and distributing electricity) are not usually included in energy delivery costs, so that supply from centralised stations is preferred. Correspondingly, ***local resources are often neglected*** in the assessment of energy potential, if any.
  - ***Environmental degradation/hazards*** are not included in cost considerations, thereby favouring less clean alternatives. Likewise, ***renewable sources of energy*** are not weighted adequately, thereby ignoring long-term (sustainable) use.
  - ***Efficiency improvement of devices is ignored as an energy option*** because energy (per unit) charges are often omitted in rural areas and there are no public standards for energy efficiency and device labelling.

B. How the proposed project will address the above problem:

In this project we intend ***applying the integrated resource planning (IRP) approach to the micro-level (village-based) problems listed***, by ***developing a rural energy planning method***. This would address the above problems by considering:

- ***the requirement of energy-services*** for sector-wise end-uses,

[1] For example, the Indian government is currently advertising "Providing Urban amenities in Rural Areas" but the costs of these amenities and how they will be defrayed are not discussed.

- ***all the resources*** through which these energy services could be met,
- ***the selection of the most economical options*** through ***rational cost comparisons*** (including environmental costs, and excluding subsidies, to the extent possible),
- ***optimising resource use***.

C. Implementation and expected results:

1. The Project's objectives – The main objective of the project will be to ***develop a method*** to ***tackle the problems of providing for the energy needs of people in rural areas***. Specifically, a ***planning model will be developed*** through which the estimated ***energy needs*** could be met***,*** through a ***least-cost combination*** of ***the available options***. When used, the model would:

1. ***improve the assessment*** of the ***required rural energy services***, ***including those basic needs not yet provided for***;
2. ***improve the assessment*** of the ***resources*** – local and transportable – and ***other technological options*** like device efficiency improvement, that could contribute to bridging the demand-supply gap for those energy-services,
3. ***estimate the costs per unit of energy-service delivered*** through each of the resource/technological options, based on the source of energy, efficiency of transformation, rate of utilisation, and so on,
4. ***compare these costs rationally***,
5. ***optimise resource allocation, i.e. bring about efficiency in resource use, in terms of both economic costs and energy use***.

2. The concrete results the project plans to achieve –

1. **Review** of rural energy planning;
2. **development of a user-friendly rural energy optimisation method or GRAM**[2] (**g**eneric **r**ural-energy **a**ssessment **m**odel) – that can be employed as **an interactive planning tool**, using the data provided for any selected region; in particular, the model intended will afford planners the freedom to adjust the computation according to their plans, adapting existing methods/models according to their requirements;
3. **demonstration** of the method with **field data from Indian villages**
4. **estimation of the annualised life-cycle costs of energy services from alternative sources in any given region,**
5. **a least-cost schedule of options** to indicate the **optimal utilisation of resources for a given region**.

[2] *Gram* (or *grama*) is the word for village in Sanskrit and therefore in most languages of the South-Asian region.