

Renewable Energy: Overstated importance or realistic alternative to contribute to poverty alleviation

Albrecht Kaupp, Manager, Indo-German Energy Programme

Introduction and basic observations

The World Bank has experienced data validation problems for utility power loss data-as have the many involved in India's first power sector reform in Orissa, where appraised power losses nearly doubled within one year of closer examination and validation of the official data. Similarly, official data for the renewable energy sector does not accurately reflect what was actually installed in the field, what is still operating, and which systems still operating function well and contribute to economic growth verses only increasing the financial losses of the State. Within the renewable energy sector, data quality and validation is fairly good for hydro but relatively poor for PV solar and biomass gasifiers. Data for wind power and biomass are somewhere in the middle of the field. Official statistics is published under www.mnes.nic.in for India.

Observation 1:

"Failures seem to spread faster and are duplicated more often than successes. The reason seems to be that the marketing of failures is better than for successes. Those who are successful are too satisfied with their success and feel no need for further marketing or to ask for additional external resources or advice to further improve their success. We therefore seldom discover them. On the other hand, commercial failures must be well marketed to find another funding source and audience to duplicate the previous failure".

Renewable energy and electrical power is a concurrent subject in India. The same applies for data collection. Planning commissions and Central Ministries are receivers of State data that may or may not be very well researched and validated. Despite a first class analysis and best efforts to obtain good data, GiGo effects are possible.

Observation 2:

"All renewable energy technologies are given the benefit of the doubt to be clean, environmentally friendly, socially fair and pro-poor. It is us who promote and force such technologies into scenarios and environments where they may become as polluting, socially unfair, unaffordable and non-sustainable as it is claimed of conventional fossil fuel sources, which they are supposed to replace."

This paper discusses various Renewable Energy technologies in a qualitative matter based on 18 years field experience in Asia. It should be viewed as an eyewitness account. Observations span a period from 1984 to the present and cover the Philippines, the South Pacific and India. Post-evaluations typically show that what had been published or promised during appraisal and implementation of a project is not always found in the field a few years after the project has been terminated, handed over or left on its own. Sustainability is therefore the critical issue.

Observation 3:

Sustainable rural electrification seems to work best if a village is matched with an entrepreneur who is interested in establishing or expanding a business in the village requiring electrical power at a level not considered "homeopathic proportions" from the very beginning. If the decision of which technology to use is left to him and support given to establish the nucleus of an electrical power generation system and business, others will connect sooner or later. They may or may not pay full costs of delivery. Accept the fact that electrification for all in a village will rarely take place.

Renewable Energy System Reviews

This paper provides a qualitative review of the pros and cons of the following renewable energy electrical power generation systems:

- A Biomass thermal power plants (3 – 7 MW)
- B Biomass gasifier engine systems (5 kW – 1 MW)
- C Run-of-the-river hydro power plants (1 MW – 15 MW)
- D Solar PV home systems (20 W_p – 72 W_p)
- E Solar PV village-scale power plants (5 kW to 25 kW)
- F Biodiesel and non edible vegetable oils.

The assessment is structured by (i) critical issues, (ii) positive effects, and (iii) desirable future trends. Most but not all of the information presented is based on the author’s own field surveys and formal/informal interviews with implementers and stakeholders.

A. Biomass Thermal Power Plants (Steam boiler + Turbine)

1. Capacities of 3 MW – 7 MW seem to be the best size for stand alone power stations because the command and control area for the fuel supply is manageable at most crop densities. Also plant size is large enough for energy efficient operation. High tension delivery prices into a grid are at most 0.08 US\$/kWh.
2. Critical issues: (i) Dependent on seasonably available “waste” biomass and related operational difficulties in keeping a high year-round PLF; (ii) may run on coal as well; (iii) may result in illegal wood cutting by small farmers selling to operators; (iv) the “waste” may suddenly become expensive; e.g., rice hulls going from 5\$ to 25\$ per ton in 5 years; (v) plant pollutes more than coal fired power plants; (vi) systems seldom focus on “real”

agricultural waste biomass because of difficulties with beneficiation of fuel and high ash/ low melting point firing.

3. Positive effects: (i) Can provide adequate power supply for a village; (ii) additional income generation for farmers supplying agricultural residues likely.
4. Desirable future trend: (i) More plants which do not compete for biomass resources which have already a market. (ii) gate prices for biomass at about 15-16 US\$/tonne at 16 MJ/kg; (iii) plant owner also manages power distribution downstream at village level to reduce pilferage and technical losses; (iv) operation should not increase the financial losses of public power utility.

The socio-economic impacts of biomass power plant in Mandya district of Karnataka are illustrated below:

Project Size, (nominal power plant capacity), MW	4.5 MW	
Land area of procurement, km ²	300	
Cultivated area within the procurement area	150	
Number of land holdings within this area	10,000	
Rural population in this area	50,000	
Agricultural labour in this area, people	8,000	
Price for biomass, moisture free basis, per ton	Rs. 1150	24 US\$
Annual value recirculated to rural economy	Rs. 44,000,000	920,000 US\$
Permanent jobs created in biomass supply business	500	

A realistic still existing potential for power generation from “real” agricultural wastes (cane trash, grain straw, stalks, coconut fronds) in nine states is 12,000 MW or 45,000 in GWh per year in India.

B. Run-off-the River Hydro

1. Scenarios refers to plant sizes of one to three units of 1 – 3 MW turbines and 3 – 5 km run off to gain 50 – 100 m height above a turbine before diverting back into river for 100 – 200 m in order to repeat the same.
2. Critical issues: (i) Some development takes place in areas where villages have already electricity; (ii) so called sacrifice flow of 0.1 m³ /second is totally insufficient in rivers at flows of 3 to 80 m³/ sec depending on season; (iii) recommended village level discussion and approval based on Indian Constitution not followed; (iv) EIA done by planners, builders or operators; (v) villagers feel they sacrifice their water and environment for the “plains” needing electricity; (vi) States earn royalties on power generation by private developers and therefore may not agree with villagers concern; (vi) pristine rivers dry up over 35 km just for meager 45 MW power; (vii) most rivers are snow fed except for July/ August monsoon and have “turn down” ratios of 1:50 or larger.
3. Positive effects: (i) Resistance and dissatisfaction at village level could be mitigated if water levels between November and March are kept as before. During monsoon and snow melting water flow is anyway 200% to 500% larger than need for power generation. (ii) no relocation and rehabilitation problems because very few villagers are affected. (iii) some projects actually electrify the

village and are therefore more beneficial to the villagers.

There is this misconception that run-off-the-river projects are better options than large dams because in the latter case relocation and rehabilitation of large numbers of people is a critical factor.

However in run-off-the-river projects large numbers of people are sometimes negatively affected because of the issue of minimal flow (sacrifice) affecting small scale farming and business (i.e. mills) depending on this natural flowing “aquifer”.

4. Desirable future trend: (i) Village council should approve project; (ii) insurance cover and committee in place to discuss and decide about rightful claims for first three years after commencement of operation; (iii) EIA should be done by agency not connected to project; (iv) operator complies with minimum water levels and village has authority to interfere if water levels are not sufficient; (v) village is receiving also royalties.

Table: Scheme for Hydro Power Projects in India.

Set up to date: 522 projects of total 1705 MW have been commissioned.

Mode of operation: 66 in decentralized mode for electrification of 104 remote villages. About 51 more to electrify additional 156 villagers are in planning stage.

State wise distribution: Uttaranchal has 75 projects (73 MW), Karnataka has 49 projects (277 MW), Andhra Pradesh has 57 projects (179 MW), Arunachal Pradesh has also 57 projects and (34 MW) and Madhya Pradesh has 208 MW.

Hydro power 50,000 MW initiative. DPR's of 33,000 MW are under preparation. All India potential 84,044 MW of which 18% are developed and 6% are under development.

Ref: MNES Minister of State written reply to Parliament March 2005 and National Electricity Policy

C. Biomass (= wood) gasification in dual fueled or spark ignition engines

1. Capacity range is from 5 kW to 250 kW. Units are mostly promoted for village electrification or smaller industrial units having waste wood.
2. Critical issues: (i) A sunset technology with no future that should not be any longer promoted for power generation; (ii) dual fueled fired units led only to inferior gasifier technology and unnecessary diesel operation since they operate with pilot injection of diesel; (ii) "black liquor" causes environmental problems from producer gas washing; (iii) contrary to steam boiler technology the gasifier technology has been abandoned after the 1950's. Almost all of one Million units in operation were shut down; (iv) twenty five years of promotion and research between 1975 and 2000 have not resulted in any revival and commercialization of the technology worldwide.
3. Positive effects: None
4. Desirable future trend: (i) No more subsidies and pilot testing; (ii) those who believe and promote the technology in a village setting should put it in a village, operate it and sell the power under commercial conditions.

D. Wind Power

1. The industry and technology has very much matured over the last twenty years in India and is commercialized.
2. Critical issues: (i) India is not blessed with high wind density all year around. Average plant load factors are therefore lower than in Germany due to unfavourable wind

conditions. Since no reliable statistic is available PLF is estimated at 0.20. (ii) some constraints such wind mills cannot be built on ridges due to forestry regulations and increasing real estate costs because farmers see an opportunity to hold on to land until the price is right. (iii) questionable past but now abandoned subsidy policy leading to "ghost wind mills (iv) in some areas farmers are very superstitious and believe wind mills keep away rain clouds.

3. Positive effects: (i) Well organized and innovative industry; (ii) adequate policy and tariff support for wind farms in some states i.e. Maharashtra; (iii) wind power provider may sell directly to selected customers and can be highly competitive although power is not firm; (iv) source of financing directly from consumers operating diesel generators at high costs.
4. Desirable future trends: (i) Power generate should be allowed to sell directly to consumer under the new electricity Act; (ii) wind power supplier should engage in demand side management, (iii) high penalties for non delivery of wind power as a challenge to supplier to compensate with "negative kWh" through energy conservation measures. (iv) point to point contracts which do not increase financial losses of public utilities.

E. Photovoltaic Solar Home Systems (SHS)

1. Sizes are usually 20 Watt (p) to 72 Watt (p) systems.
2. Critical issues: (i) Such small supplies of electricity in the order of magnitude of 200 Wh per day and household are insufficient to trigger

economic development; (ii) introduction in fact may hamper village development because of classification as being electrified; (iii) is often a rather expensive short lived transition technology for 5 to 7 years; (iv) donor agencies decision to accelerate market penetration for SHS have created parallel markets where the same firm sells systems under commercial terms to the “rich” and provides highly subsidized systems to the poor.

3. Positive effects: (i) SHS are a good choice in a scenario, where it is likely that economic development and with it demand for electrical appliances and tools does not go up for the next 10 years; (ii) reliability of critical system components has improved significantly; (iii) seems to work if proper after sales service is established and some authority has control over system financing and collecting dues; (iv) has resulted in electrification by diesel gensets due to accelerated demand for power which is considered a positive trend.
4. Desired future trends: (i) More careful selection of villages under criteria such as: really remote, development unlikely, quality of life improvement is the objective.

F. Photovoltaic PV Village Plant

1. Systems of 5 kW – 100 kW (panels + industrial type DC Battery + DC-AC inverters) to provide “public” power at AC 220 volt.
2. Critical issues: (i) From a power provider point of view a troublesome system and business with a high potential of creating social conflicts and dissatisfaction in the long run because electricity comes “out of the socket” as with conventional supplies. But supply is restricted

from 200 Wh to 500 Wh a day and household.

3. Positive effects: (i) Maintenance and repair is centralized.
4. Desirable future trends: (i) The same as with SHS. Systems cannot survive if economic development associated with higher power demand beyond 1 KWh per day and customer sets in.

G. Biodiesel and non-edible vegetable oils

1. Systems are based on conventional diesel engine generator sets of 15 kW to 500 kW operating on oil with minimum of beneficiation.
2. Critical issues: (i) Although systems have been tested for 30 years it is still unclear and no consensus exists how much the oil must be processed and how much the engine needs to be modified to make a good match. The issue simple becomes a matter of perception how much wear and tear, spark plug exchanges, gumming up, piston sleeve erosion and other ills are accepted in a country or at a village level; (ii) the oil from most collected oil fruits has already a market; (iii) in extreme cases such as low fruit density and adverse climate conditions collecting 4-5 kg fruits to yield 1 liter of oil for 3 kWh electricity may be as well expensive. Arguments such as: “it has been done in spare time using human muscle power” is no basis to judge the merit of such systems.

Positive effects:

- (i) Commercial operations to supply oil for biodiesel refineries undoubtedly generate lots of employment.
- (ii) The first biodiesel refinery, 30,000 tons per year is presently built in

Andra Pradesh and will change the nonedible oil fruits growing and collection landscape

Desirable future trends:

- (i) Village electrification with non-edible oils is an option but more care should be taken to decide to what extent the oil must be more beneficiated to match a diesel engine or a diesel engine design is adjusted to match the oil.
- (ii) The policy framework for promotion of bio-diesel will most likely get a push as soon as the first bio-diesel refinery is in operation mid 2006.

Example I:

All PV-operated battery changing stations failed and were commercially unsuccessful even at subsidized rates because battery owners were too intelligent and thrifty. The best financial solution for them was to drain a car battery and accept the fact that in doing this a car battery could be recharged at most 50-60 times. This was 8 to 12 months worth of electricity supply before a new battery had to be bought. Moreover one cannot or only with extreme difficulties charge a totally drained car battery with a PV system due to internal resistance of the battery at below 10.5 Volt. It took 2-3 days to charge. Conventional charging has not that problem and delivered the result in 3-8 hours.

Example II:

Village head on small island got into a contract with car battery retailer on main island, who had a vital interest to expand car battery markets for household electrification with or without solar panels. The village head arranged for servicing the system. Whenever enough money was collected from existing users, a new system was bought and given to the next household. Users had the choice of system with PV-panel or 3-6 day pick up service to recharge battery by conventional means.

Example III:

A village was provided with 100% subsidized solar systems for basic health centre and community hall. Appraisal after three years stated that both solar systems were gone, most likely in exchange for a diesel genset. A small movie house was built and connected to the diesel genset operated by the village

head. Except for some real poor families all houses were connected and paid a monthly lump sum. The health centre never functioned because there was no nurse. Example should be classified as success story because the major objective: "Sustainable and profitable village electrification" has been achieved by letting market forces and common sense take its course.

Example IV:

There are most likely more villages "electrified" with car batteries than villages with SHS. The reason is that it does not make sense to use expensive PV-panels to recharge a battery if village is close to a source of conventional power where conventional battery charging can take place.

Example V:

The idea to provide PV-panels and lights for community buildings, street lighting and services did rarely work, because there was no community responsibility and budget to maintain the system. On the other hand PV-systems that provided power to essential services such as radio communication between villages survived and were found in good shape. A critical issue for survival of systems was the criteria of essential services.

Example VI:

Large scale programme to introduce dual fueled gasifier-engine system for irrigation pumps totally failed because the subsidy for the system was so high that it covered the cost of the diesel generator. Consequently the gasifiers were thrown away and engines operated entirely on diesel oil since few wanted to put up with the cumbersome and unreliable operation of a gasifier engine system.

