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Access to modern energy services

6.1 Introduction

"The agriculture and micro-enterprises sectors that together employ more than 30% of the population [in India] can become more productive and efficient through the provision of clean and sustainable energy options. Hence, in order to address the needs of sustainable development, it is necessary to examine the constraints related to rural energy and to find appropriate solutions that have a bearing across all sectors of rural development" (Srivastava and Rehman, 2006, p. 643). Moreover, for communities to flourish, the entire range of human activities – food production, education, health services, transport and communication, among others – need to be ensured, and energy services[1] are the common requirements for all of these activities. Therefore, limited access to energy services is a serious constraint to development in the developing world where per capita use of energy is less than one-sixth of the industrialised world (UNCSD, 2001). However, use of fossil fuel for energy, as the basis for development is clearly not sustainable since the resources will eventually run out and there is the immediate danger of global warming as a result of waste products of fossil fuel combustion. The long-term aim in energy planning as far as sustainability is concerned must be for promoting development and prosperity (a) through gains in energy efficiency rather than increased consumption where energy access and use has reached a certain level, and (b) by a transition towards use of renewable sources or by providing energy supply from renewable sources[2] to energy deficit regions bypassing the pitfalls of conventional process of development since renewable energy sources are considered to be more environment friendly. Prior to mainstreaming of the concept of sustainable

[1] Energy by itself is not useful, the services provided by energy in combination with appliances are. Examples of energy services are cooking, lighting, processing, communication, transport (Kooijman, *pers. comm.* Nov., 2006).

[2] Renewable sources are those from where energy is collected from the current ambient energy flows or are substances derived from them. These include electricity generated from geothermal, hydro, solar, tidal, wind and wave power, and bio-fuels such as fuel wood, bagasse, charcoal, animal and vegetable wastes, and other industrial and municipal wastes, provided these fuels are available on a sustainable basis.

development, the extent of commercial energy[3] use was taken as a measure of development.

According to the World Energy Investment Outlook (OECD/IEA, 2003), the strategy for promoting sustainable development in rural areas of developing countries must include: (a) clean liquid or gaseous fuels for cooking, and electricity for lighting and other basic needs; (b) liquid fuels to mechanise agriculture; and (c) electricity, sufficiently low in cost to attract industrial activity to rural areas. In fact, the justification for rural electrification is based on two general aims in the context of rural development: (a) raising the standard of living of rural people, and (b) boosting the rural economy. According to Clancy and Hulscher (1994), particular significance is attached to electricity because it is readily identified with modernity. This view persists despite such observations as, "It is rather naïve to think that electricity can lead in expanding economy and production. Other factors such as the availability of resources, skilled labour, entrepreneurship, transport and markets for the products are equally important, if not more so. It can be argued that if other factors are favourable, electricity will follow in some or other way" (Clancy and Hulscher, 1994; p. 353). Because relationships between energy and development are drawn such as, "The relationship between energy and development is illustrated by the fact that the population living below the poverty line in developing countries reduces as we move from a low level of electrification to higher levels" (Srivastava and Rehman, 2006; p. 643), energy provision in rural areas has become synonymous with the extension of the centralised grid to villages or erection of DDG (Decentralised Distributed Generation)/off-grid systems, and if electricity reaches a village its energy needs are taken to have been met. This approach has a flaw; electricity provision does not address the cooking and heating needs for which rural communities continue to depend on inefficient biomass-based sources of energy. Besides, not everyone within the village may be connected. Therefore, in order to link energy provision with sustainable development, the provision of lighting for households needs to be coupled with the provision for meeting thermal and mechanical energy needs.

Decoupling of increased throughput of energy and materials from development represents a major challenge of sustainable development[4]. The ratio of energy supply from renewable to non-renewable resources is accepted as a measure of a country or region's sustainability (UNCSD, 2001). Though there are no international targets or recommended standards for this indicator, it is considered that the higher the ratio the greater is the movement towards achieving sustainable development goals. This chapter examines whether such a notion is relevant for a region like the Sundarbans, and also examines the constraints related to rural energy.

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[3] Energy from coal, oil and gas, and electricity is considered as commercial energy whereas energy from fuel wood and agricultural farm waste is considered non-commercial.

[4] Chapter 4 of Agenda 21 calls for an improvement of efficiency in the use of energy sources and for a transition towards environment-friendly use of renewable resources. Renewable resources can supply energy uninterrupted under sustainable management practices through a mix of technology options and their use in general, generates relatively less pressure on the environment.

6.2 Energy use in the Sundarbans

Estimation of annual energy use per capita for any geographical area, especially a rural area is a major task by itself, more so, for a region like the Sundarbans where population density is high (671/km^2) and the population spread across 48 islands. Not unlike other parts of rural India, non-commercial energy accounts for between 60 and 90 percent of energy consumed, of which 90 percent is used for domestic activities (Ghosh *et al.*, 2004). Given the fact that the Sundarbans does not host any industrial enterprise worth the name, the bulk of commercial energy use is in transport, agriculture, fishery, and domestic sectors.

In transport and fishery sectors diesel is the predominant commercial fuel although many 'engine-vans' run on kerosene. Any attempt to quantify fuel consumption in the transport sector would throw up figures far below actual consumption since boats below a certain specification do not require any registration, and 'engine-vans', the numbers of which are increasing day by day, do not have any registering mechanism at all. Sale of diesel from fuel stations in the region could have served as a proxy for consumption estimation had the region not had a porous border with Bangladesh where petroleum products are relatively cheaper. Though smuggling of diesel is a known fact the quantum is anybody's guess. Another proxy could have been the figures maintained by the various transport unions but many forms of transport being informal or illegal, obtaining detailed information without the 'correct' party connection is difficult in West Bengal, more so since the CPI(M), the dominant political party in the leftist coalition which controls most of the unions, is relatively weaker as compared to some of the smaller leftist parties in the Sundarbans. There is distrust among coalition members (political parties) at the local level, thus local contacts are not of much help since they are identified with the locally dominant party and not the CPI(M).

Agriculture in the Sundarbans is mostly rain fed; use of energy is restricted to tilling and post-harvest processing in case of *kharif* (monsoon) crop. While tilling is mostly carried out using diesel powered machines, post-harvest processing involves manual threshing and boiling of paddy using agricultural waste, mainly straw and husk. In case of *rabi* (winter) crop, commercial energy use is higher in the absence of rain and the requirements of water management for irrigation using diesel powered pumps[5], unavailability of adequate water in the season results in a single crop across most of the region.

In the fishery sector use of commercial energy in the form of diesel is predominant, but traditional fishers use row boats or boats with small diesel engines while fishing in rivers and creeks. Estimation of the number of fishing boats in the region is beyond the scope of this study as the smaller boats require no registration or licence except when fishing within the Protected Area.

The domestic sector uses a range of fuels, non-commercial as well as commercial, including LPG, the last being the rarest. Cooking and lighting are the main purposes

[5] The next chapter details the practice of *rabi* cropping.

for energy use. A range of biomass-based fuels like firewood, husk and straw, cowdung cakes, and a combination of cowdung and firewood or husk and straw are used for cooking. Kerosene and LPG are bought in cash but some of the households interviewed (36 in number) also buy firewood. Use of kerosene for cooking in households is rare but its main use is in lighting through energy inefficient wick lamps. Amongst the 243 households interviewed, 226 spend Rs. 135/- ($ 3.00) per month on an average on kerosene for lighting, ten spend a higher amount of up to Rs. 400/- (about $ 9.00) and the remaining seven have electricity connections (two of these households also have commercial electricity connection at the Markets). Domestic lighting remains poor due to the use of wick lamps and storm lanterns.

As of now very few families (5 out of 243 respondent families) use LPG for cooking since at Rs. 300/- ($ 6.50) per cylinder plus cost of transportation, it is far too expensive for most residents of Sundarbans villages; on an all India basis, only 5.4 percent rural households use LPG (NSSO, 2001). However, demand for LPG in the Sundarbans is on the rise (see Photograph 6.1) because it works out cheaper than kerosene in the long run for eateries and tea stalls which are switching over to LPG (domestic cylinders) from kerosene and firewood[6].

Industrial activity in the absence of road connectivity and formal energy supply mechanism at competitive price is next to impossible in the Sundarbans. Small industrial enterprises like ice factories, lathe workshops and grinding mills depend on local demand and their products cannot possibly compete, for example, at Kolkata markets. The agriculture sector is also plagued with low production due to inadequate surface water during winter and the expenses involved in drawing groundwater, and in the fishery sector, no processing takes place locally.

6.3 Rural electrification in the Sundarbans

Lighting in the Sundarbans has improved dramatically where West Bengal Renewable Development Agency (WBREDA) has set up stand-alone (off-grid) power stations. The power stations operate for between 6 and 12 hours a day, and use a combination of fossil fuel with a renewable source like wind power or biomass or are entirely solar photovoltaic. WBREDA was initially established as an agency of the Department of Science and Technology, Government of West Bengal, with the objective of promoting renewable energy technologies, particularly among industries. It is essentially an engineering organisation manned almost entirely by male engineers. Subsequently, WBREDA came under the Department of Power and Non-conventional Energy Sources, Government of West Bengal, and took over from

[6] LPG in India is a subsidised fuel for the domestic sector available in steel cylinders (commercial establishments are supposed to buy commercial cylinders which are not subsidised). Transportation of these cylinders back and forth between refilling stations and consumers is the major cost component in the per unit retail price of LPG which is fixed at Rs. 300/- ($ 6.50) (for domestic cylinders) by the Indian Government. To cater to the demand in the Sundarbans and bring down the turn-around time of cylinders as well as to keep transportation cost low, one of the oil companies has devised an innovative mobile refilling unit. A large LPG container mounted on a tractor-trailer is brought close to the road head on the mainland to refill cylinders. Refilling equipment is also mounted on another truck. This does away with the necessity of transporting individual cylinders to main refilling stations. Moreover, the mobile unit can cater to different areas in this deltaic region.

the State Electricity Board the task of rural electrification in remote and inaccessible regions. It is participating in the Government of India initiative (*Rajiv Gandhi Grameen Vidyutikaran Yojana* – Scheme for Rural Electricity Infrastructure and Household Electrification) launched in 2005 for providing electricity to all rural households by 2012 through rural electrification. The Sundarbans villages are among the over 18,000 villages identified in India which are remote and inaccessible to the grid due to difficult terrain and prohibitive cost and therefore will have

Photo 6.1: Empty LPG cylinders being transported from Gosaba to be refilled

Decentralised Distributed Generation (DDG) or off-grid systems. WBREDA, however, has been establishing off-grid systems in remote areas since 1994, a year after its inception. In the Sundarbans it has established 13 Solar Photovoltaic power stations (with a capacity of 652.5 kW), all of which are still in operation, the first one being in 1996 at Sagar Island. The two Wood Biomass Gasifier power stations (of 500 kW each) at Gosaba and Chotomollakhali (both in Gosaba Development Block) are also WBREDA's work. The Agency with funding from the Ministry of Renewable Energy (Govt. of India) is about to construct a 3.6 MW tidal power station at Gosaba (close to Sajnekhali Wildlife Sanctuary) although the maximum potential for generating electricity from tidal action is in Gujarat. The well-to-do in an around Gosaba are looking forward to the project in anticipation that they will have access to round the clock electricity as well as win some of the work contracts to be awarded locally. However, fisher folk and conservation organisations are concerned since one of the creeks will be blocked to serve as reservoir denying passage to fisher folk. Conservation organisations are concerned because the consequences of blocking a tidal creek are largely unknown or poorly understood in terms of impacts the tidal power station will have on the ecosystem.

Table 6.1: Details of power stations on field study islands

Type of project	Location	Type of fuel	Capacity	Commissioned	Cost/unit (US$)	Consumers[#]	Tariff (US$)	Investment (US$)
Solar Photovoltaic	Bagdanga	Solar	55 kW	April 2001	0.5	450	1.5/2.8 flat rate[1]	800,000 (approx.)
Biomass Gasifier	Chotomollakhali	Wood-Diesel	500 kW	June 2001	0.07	1000	0.09 /0.1/0.11[2]	350,000

[#] These are figures reported as of March 2006, the figures were lower during field work, Bagdanga had 250 and Chotomollakhali had 225 consumers

[1] Consumers are not charged per unit consumption, instead a flat rate is applied per month depending on the number of connection points, for three points it is US$ 1.5 and for five points it is US$ 2.8

[2] The rates are for domestic, commercial and industrial consumers respectively

Prior to the launch of the Rajiv Gandhi Scheme for Rural Electricity Infrastructure and Household Electrification, which funds 90 percent of the project cost, rural electrification projects were implemented with financial assistance from the Ministry of Non-conventional Energy Sources, Government of India, to the extent of 50 percent of project cost. The remainder was met through assistance from the Government of West Bengal, MP LAD (Member of Parliament Local Area Development) fund, and a soft loan under the World Bank line of credit. Setting up of these off-grid power stations were supposedly demand driven wherein a Gram Panchayat would put forth its demand for electrification to the Panchayat Samiti. The Panchayat Samiti would prioritise the various demands and make recommendations to WBREDA, which in turn would short list the recommendations on the basis of merits of the sites considering the number of potential willing consumers, the location of the proposed sites and the route of a distribution line. A detailed project report would be prepared for the most suitable site and funding sought from the Government of India. However, in reality, WBREDA would send in feelers to a Panchayat Samiti regarding a particular location and the paper work would then be initiated at the Gram Panchayat level. The two projects listed below came along these lines.

The following two sub-sections describe the power projects on the field research islands and their impact. The cases demonstrate the flaw in the notion that electricity and energy are synonymous and clarifies that electricity 'supply' does not imply 'access' and brings out the missing linkage between electricity supply and sustainable development.

6.3.1 Electrification of Mousuni Island (Bagdanga)

A solar photovoltaic power project was commissioned in April 2001 with the Bagdanga Market as the load centre. The power station operates daily for 5.5 hours in the evening, the average supply has remained at about 100kWh per day (18.18 kW x 5.5 hours); less than half the capacity. Solar Photovoltaic power stations are designed with minimum two days of autonomy to cope with unavailability of full sunny days. At Mousuni, full sunny days average about 280 per year. To overcome the problem of cloudy days during monsoon months the power station has been fitted with a 20 kW wood biomass gasifier power unit in June 2006 as an auxiliary power source. The current level of revenue generated by the power station is good enough to cover the running expenses. For the first five years, maintenance including replacement if necessary is taken care of by the erecting contractor. The batteries (wet cells) have a life of 5-7 years and when it is time to replace them an additional investment will have to be made as will be the case for replacing sophisticated equipment like charger, charge controller, inverter and the solar panels which unless physically damaged can last for 20 years.

A local distribution network (mini-grid) delivers electricity to the Bagdanga Market and the neighbouring households, as well as the higher secondary school. The network covers about half of the Bagdanga *mouza* (which has an area of 6 km^2 with 691 households and about 200 shops) but more than half of the 450 consumers (domestic and commercial) are in and around the market. The power station caters to about 36 percent of the population of Bagdanga, not all households within the network area are electricity consumers since it is beyond affordability. The mini-grid

passes in front of the upgraded Primary Healthcare Centre (PHC) which for some reason is not a consumer. It is altogether a different matter that the six-bedded PHC is lying defunct since upgradation (at a cost of about US$ 175,000) in 2001, due to unwillingness of trained personnel to be posted at Bagdanga. However, a diesel generator is kept running for four hours in the evening every day at the PHC for lighting up the place and occasional energising of water pumps. Running the generator is the responsibility of a contractor who is reimbursed for the diesel consumed, fixed at six litres a day[7] by the Health Department, Government of West Bengal.

Next to the market and within the mini-grid network there is a saw mill which continues to operate on diesel. The power station cannot cater for heavy loads which is a technical limitation of the Solar Photovoltaic system.

Electricity from the solar power station is mainly used for lighting. Three other uses have been noticed at the market in three different shops viz., charging of wet cells, ironing of clothes, and using a small grinding wheel at a jeweller's. The last two activities are not permitted but all those who wish, have found ways to steal electricity and use it as they desire. In 2003, the idea of selling prepaid cards to consumers was floated by WBREDA so that theft of electricity could be minimised, but it has not been implemented yet. Due to the flat rate system of payment irrespective of extent of consumption, none of the shop owners switch off lamps when they down shutters for the day; householders also behave along similar lines.

The most visible change at Bagdanga since electrification is the increased number of people (males) in the market area in the evenings. People play cards at the market for longer hours and provide more business to tea stalls; this has resulted in an increase in the number of tea stalls. Other traders also claim increased business but are unable to quantify though tailors work till almost the power station is witched off. Expansion of the market is quite visible – new shops are coming up, shop spaces are reportedly being sold/rented at higher prices – but whether electrification is driving this expansion is not clear because the new shops do not deal in electrical or electronic appliances. Shops with workshops such as jewellers and tailors continue to work till late at night even after transactions have ceased for the day. The number of television sets in the village is also reported to have increased considerably. There is round the clock electricity at the Mousuni Gram Panchayat Office and at the power station where there is a public access tap for drinking water with continuous supply, though it is not of much use except for the immediate neighbouring houses.

The higher secondary school at Bagdanga has hostel facilities for boys and girls and the school teachers claim the students are studying for longer hours but the overall performance at public examinations do not show any marked difference. A former headmaster of the school though originally from East Midnapore District has remained on the island after serving for over 30 years. He does not see a connection

[7] This contractor hails from Bagdanga. Prior to electrification he used to sell electricity to the traders at the market. At the PHC, he has installed a smaller generator and decoupled the original one. The smaller generator consumes less diesel in the four hour period than the original, thus increasing his earning.

between availability of electric lighting and performance of the students and cites examples of his pupils who have gone on to become scientists, doctors and engineers even when there was no electric lighting. A private tutorial with facilities for resident students however is able to quantify the difference between pre and post electrification though not in terms of improvement in education but in terms of cost; it is now cheaper to run the tutorial because of the savings on the cost of kerosene which was earlier used for lighting. The tutorial now spends two hundred fifty Rupees ($ 5.50) on lighting per month, one hundred and fifty Rupees (about $ 3.50) less than earlier.

Despite electrification and the benefits that come with it, there are instances where individuals and households have chosen not to become consumers; Paresh Mondol is one such individual. His house is adjoining the market and can easily be connected to the mini-grid but he has instead opted for a stand-alone photovoltaic system comprising of a 74-75 watt solar panel, one 12 volt 75 ampere-hour battery, two compact fluorescent lamps, two plug points and a charge controller. Paresh Mondol has paid Rs. 3824/- ($ 85.00) for the system that comes with a ten-year repair/replacement warranty. The system actually costs Rs. 21,544/- (about $ 480.00) and the Government pays the difference as subsidy. Paresh's family watches TV, uses a ceiling fan and lights; they can energise either the TV or the fan at a time. According to Paresh the system pays for itself in a little over two years and for the remaining eight years or thereafter, it is for free. His calculation is based on the Rs. 125/- ($ 2.80) (for five connection points) he would have to pay every month for the mini-grid connectivity apart from an initial deposit of Rs. 1000/- (about $ 22.00), and that too for a supply of a fixed number of hours in the evenings. With the stand-alone system he and his family are free to watch TV as and when they wish to and in case of cloudy weather he can have his battery charged for a fee of Rs. 5/- (about ten cents) at a neighbouring shop. Paresh has a grocery shop at the market where he uses electricity from the mini-grid for lighting for which he pays Rs. 75/- ($ 1.50) (for three connection points) every month.

6.3.2 Electrification of Mollakhali Island (Chotomollakhali)

The wood biomass gasifier power station operates for six hours daily in the evening; it has been in operation since June 2001. Biomass gasification is basically conversion of solid biomass into a combustible gas mixture also known as 'Producer gas', which is essentially low Btu (energy content) gas. The process produces carbon monoxide as well as hydrogen both of which are combustible. This gas is cleaned and directly fed into an already running internal combustion engine that runs the turbine for generation of electricity. Producer gas being low Btu gas, the diesel engine requires a continuous supply of diesel to maintain combustion. Typically, for producing each unit of electricity, the power station consumes about 0.13 litre of diesel and a kilogram of dried wood chips. Needless to say a sustainable supply of dried wood chips is a prerequisite for harnessing the advantages of the technology or else the power station will relapse into a conventional diesel power-generating unit. The generating unit has a distribution network covering about half of the Chotomollakhali *mouza* catering to about one-third of the *mouza* population; each of the consumers has a meter to record consumption, as there is no restriction to the

extent of consumption and type of use as defined within the categories of domestic, commercial and industrial[8].

The power station has a lifespan of 15 years, which is not factored in the tariff structure. As of now the revenue that the power station generates is inadequate to meet running expenses due to steep upward revision of diesel price in a period of 3-4 years. Due to this, WBREDA wanted an upward revision of tariff in 2005 but the consumers resisted on the ground that if power generation is biomass-based then diesel price rise is irrelevant. Prior to commissioning of the project and also during energy plantation, WBREDA had repeatedly claimed that electricity would be generated largely from wood. In fact, villagers refer to the power station as the 'wood electricity project'. WBREDA now finds itself in a difficult situation due to the inflated claims regarding fuel replacement to the extent of 80 percent (WBREDA, 2003; Mondal, 2005) which one of their own suppliers (gasifier manufacturer) disputes on the ground that the engines being non-dual fuel, the replacement can at most be to the extent of 60 percent. Also, due to non-payment of dues by consumers there is a gap of about 40 percent between potential revenue (US$ 1023) and collected revenue (US$ 614) on a monthly basis (Mukhopadhyay, 2004).

A gap in revenue is not the only woe that plagues the power station. Irregular supply of biomass widens the gap all the more; the power station requires about 400 kilograms of dried wood biomass everyday. Although WBREDA claims to raise seven hectares of energy plantation every year up to a total of 40 hectares, the first plantation effort was made when construction was well underway. By the time land was identified and saplings planted, the power station was nearing completion but the first year plantation (of year 2000) would be ready to harvest only five years down the line (in 2005), the second year plantation in the sixth year and so on (Ghosh and Das, 2003). In the meanwhile, the power station procures wood biomass from the market. The first plantation effort of 2000 was carried out along roadsides and canal banks making the plantations public property rather than common property. In fact, varied responses from sections of the community to undertake collective action to maintain the plantations sowed the seeds of this research[9]. I may add that because the plantations were not common property, there was reluctance to undertake collective action since most members of the community did not see any benefits accruing to them directly.

The power station was commissioned with the Chotomollakhali Market (with over 350 shops) as the main load centre. The Market is one of the largest on the Sundarbans islands but has gone into decline due to infrastructure development elsewhere. Since 2003, the larger traders have started diverting into other markets

[8] To keep the meter reading as low as possible and avoid pilferage, the Agriculture Growth Centre at Chotomollakhali (a commercial consumer) has instructed the power station to not provide electricity to the Centre from Friday through Sunday since the office remains unmanned during that period.

[9] I was responsible as a part of the ENDEV (an NGO) team for raising plantations for sustainable supply of wood biomass at Mollakhali.

and downsizing their investment at Chotomollakhali. The Chotomollakhali-Dhamakhali boat service during the day has been discontinued around the same time; the night service is still in operation and is mainly used by fish traders. One of the probable reasons for this erosion of prominence of the Chotomollakhali Market is due to the construction of an all-weather metalled (asphalt) road on the opposite island to the north, the road leads up to Dhamakhali, a road head on the mainland (see Section 5.2.1, Chapter 5). Although WBREDA claims to have revitalised the village economy and that electrification has led to the setting up of an ice factory and other industrial activities on the island (WBREDA, 2003), the only ice factory at Chotomollakhali predates the power station. The other potential consumer, a grinding mill, has not opted for an industrial connection since the hours of availability of electricity is at odds with its hours of operation, moreover, the mill owner is looking for opportunities to move out of Mollakhali as he feels that with improved road connectivity in the region, the Market will become insignificant over time. This power station is capable of driving small industrial machinery but the nearest saw mill continues to run on diesel since the mini-grid has not reached the area where the saw mill is located. Unlike the Mousuni power station which has technical limitations, this power station is underutilised due to management issues like hours of operation and distribution network.

Prior to electrification, traders had to depend on privately owned diesel generators as in Mousuni. Not only was the quality of power poor in terms of low and fluctuating voltage, it was about four times more expensive. The upgraded PHC that earlier depended on a captive source now draws electricity from the mini-grid for the time the power station is in operation. Beyond supply hours, the PHC usually uses kerosene storm lanterns. The school hostels earlier depended on kerosene lamps, now use compact fluorescent lamps, which in terms of quality of light are a big positive difference. As is the case in Mousuni, people are in the market area for longer hours as compared to pre-electrification days, but there are also similarities in instances of individuals/households and commercial establishments choosing not to become electricity consumers despite being within the catchment of the mini-grid. The three following narratives provide the reasons.

Ratan Ghosh has a busy eatery at the Market, which he runs with the help of his two older sons. His only daughter is a bachelor's graduate and lives in the northern suburbs of Kolkata with her husband's family. Ratan's youngest son lives with that family to be able to pursue a bachelor's degree in Chemistry at a college in Kolkata. Ratan had to take out the second son from school as he could not afford it at that time due to his daughter's wedding which required a hefty dowry. Ratan is keen that his youngest son pursues education as far as possible and sends him all the money he can save. At this stage, a domestic electricity connection is wasteful expenditure according to Ratan which will not only entail a recurring expenditure but also connection fees and costs of installation of electrical fittings and appliances.

Ashok Gupta runs a relatively large business at Chotomollakhali. He has three grinding machines, eight diesel engines, five alternators, three passenger boats, and a number of wet cells, all of which he rents out, except the grinding machines. He also rents out shop space at the market. His only son lives in Kolkata to pursue higher education. He could be one of the larger electricity consumers of the power station

(domestic, commercial, as well as industrial), but he has opted for only a commercial connection at his shop at the market. He runs his grinders on diesel because electricity is available only in the evening hours and most of the grinding takes place during the day. The commercial connection at his shop is used to charge wet cells that he rents out. In his house he uses electricity from a battery-inverter unit. One of his employees who stays with him, carries a recharged battery to connect to the inverter. Ashok and his wife watch TV, use ceiling fans and fluorescent tubes as and when they wish. The inverter unit meets their electricity demand adequately. Ashok feels that his house is already electrified at practically no additional cost and sees no reason to become a domestic subscriber of the power station.

During field research (2002-03) on the island, the only ice factory was recorded as a non-consumer of the power station; it had a captive diesel engine. At that time diesel was about twenty Rupees ($ 0.40) cheaper than what it is in March 2007 and therefore had no incentive to switch over to electricity. Moreover, the factory would have to make investments in machinery so that it could operate either mechanically or electrically. The changes were made in February 2005 because operating mechanically was proving to be more expensive due to increased price of diesel. The factory now saves money by operating electrically in the evening hours but continues to depend on the captive source during non-availability of electricity during the day.

6.4 Analysis

This chapter is less related to collective action per se, but foremost to sustainable development and attempts to assess the prospects of attaining sustainable development goals in the context of access to modern energy in the form of electricity. According to Srivastava and Rehman (2006), to achieve sustainable development the constraints related to access to modern energy services need to be overcome, and agriculture being the mainstay of the Sundarbans economy, energy requirements of this sector need to be addressed on a priority basis, but the two electrification projects in question do not in any way contribute to the sector, not even in terms of energising water pumps for irrigation during *rabi* (winter) season and maintaining storage facilities for agricultural produce by replacing fossil fuel. For that to happen, projects such as the one at Mousuni and Mollakhali islands need to overcome technical and management limitations. A solar photovoltaic power station by itself may not be capable of driving machinery but in combination with other types, such as a biomass gasifier, may cater for such demands. The power station at Mousuni has been augmented with a biomass gasifer, but as an auxiliary source rather than a complementary one. Even if the power stations did replace fossil fuel for energising pump sets and storage facilities, the benefits would invariably accrue to the better off since it would entail additional investment as in the case of the ice factory at Mollakhali (Subsection 6.3.2), thereby bypassing the issue of social sustainability. However, the electricity distribution network lays greater emphasis on domestic consumers rather than industrial consumers based on the common misconception that supplying energy (particularly electricity) would encourage production. In almost all cases, in practice, energy follows rather than leading the economy as noted in the following paragraph based on my observations at Mollakhali and Mousuni. Due to this misplaced emphasis on supplying electricity

to domestic consumers the opportunity for optimum capacity utilisation and boosting the local economy is missed, so is the opportunity for minimising the revenue gap. Administering many smaller consumers is more expensive as opposed to a few larger ones, and administering the smaller ones along with the larger ones may not be proportionately as expensive in terms of cost per kW supplied. Though it may not be possible to currently meet all the energy requirements from renewable sources, regions such as the Sundarbans do provide the opportunity to bypass the pitfalls of conventional development, as well as operationalise the strategy for sustainable development as articulated by the World Energy Investment Outlook if the technical and management issues are addressed and other fuels are brought within the ambit of energy planning. As of now (March 2007), even the justification for rural electrification based on the general aim of: (a) raising the standard of living of rural people, and (b) boosting the rural economy are unmet. From the cases presented it is apparent that the standard of living improves only in terms of improved lighting arrangement and that too for those who can afford and are within the distribution network; not more than 33 percent of the population in each of the *mouzas* can afford electricity and are within the distribution network. The majority of the population remains outside the ambit of the projects. Also, realities are constructed differently by different sets of individuals and organisations since not all households or small industrial units choose to become consumers even if they can afford to although there are certain psychological benefits of electrification difficult to quantify, such as a sense of modernisation and social progress. Also, for an organisation like WBREDA, the immediate reality is that of generation and distribution of electricity at remote locations using renewable resources. Financial sustainability is a real concern for those organisations that run on commercial principles.

A boost to the local economy or economic progress due to electrification is not apparent on either of the Markets. Householders are charged at a lower rate than commercial or industrial consumers; in a way encouraging households rather than movers of local economy to become electricity consumers. Therefore, a boost to local economy does not appear to be the purpose of the projects. The Bagdanga Market is expanding while the Mollakhali Market is losing significance due to other interventions elsewhere such as better road and rail connectivity; while the main road on Namkhana Island (adjoining Mousuni and the gateway for Mousuni to anywhere on the mainland) has been improved and the railway track extended on the western side, there is a metalled (asphalt) road almost connecting Mollakhali to the bus route to Kolkata. Therefore, electrification as an agent of the changes on the islands is difficult to prove. Moreover, it is usually one of a number of changes taking place in rural areas at a given point in time, which in synergy contribute to rural development. Also, there is the issue of sequence. Supply of electricity in the absence of resources, skilled labour, entrepreneurship, transport and markets cannot bring about an expansion of the economy and production. Rather, as Clancy and Hulscher (1994) have argued, electricity will follow where the situation is conducive as evident from the fact that both the Markets had access to electricity prior to the off-grid power stations albeit of poorer quality and more expensive for at least 30 years preceding formal electrification. As of now (March 2007) electricity on the islands is incapable of attracting any industrial activity, even the Biomass Gasifier power station at Gosaba which operates for 12 hours a day, by the end of 2006, has

had just one industrial consumer, that too was the telephone exchange and not a manufacturing unit though it must be said that the telephone exchange has vastly improved telecommunication as compared to the experience of the 1990s.

Under the given circumstances in the Sundarbans the ratio of energy supply from renewable to non-renewable sources as a measure of sustainable development does not appear relevant since the basic modern energy demand remains unmet, and for such regions even if all the energy supply at current levels were met by renewable sources, there would be no perceptible movement towards sustainable development goals since none of the ills undermining human well-being as identified by Holdren *et al.* (1995) are addressed. The *perverse conditions* characterised by poverty and wastage of human potential persist, the *driving forces* in the form of misdistribution of investments and mismanagement remain unaltered and the *underlying human frailties* of short sightedness and ignorance continue to guide development initiatives. All of these are evident from the fact that the investment in the Solar Photovoltaic Power Station is almost five times larger than the investment in the Primary Health Centre at Bagdanga, and it can be argued that if the same amount were to be available for healthcare delivery, trained personnel could be induced to take up postings at remote places though currently the West Bengal Government does not have provisions to raise salary of its staff selectively to induce them to take up postings at less desirable locations. This is in line with the observation made by Clancy and Hulscher that "investment in electricity generation represents a diversion away from other investments, for example for each US$ spent on education or health, US$ 8 are invested in the power sector" (Clancy and Hulscher, 1994; p. 351).

Even the very basic interpretation of sustainable development of Lele (1991) wherein traditional development objectives are to be met in conjunction within ecological constraints, remain unmet as evident from the Mollakhali sub-case given that the power station relies on supply of wood biomass from the market. This is even after an accepted plan to have regular supply from captive energy plantation; 30,000 plants were grown over a period of five years. A harvest cycle of five years was planned but the first batch is yet to be harvested. While on the one hand, there is concern for conservation of mangroves, on the other, there is increased demand for biomass and in the absence of a sustainable harvest from a captive plantation there is every possibility that part of the biomass is harvested from the Protected Area, given its proximity and the propensity of the landless to venture into the Protected Area. Thus, two contradictory forces are in operation within the state domain. Also, in terms of inter-generational equity and universality of claims as articulated by Howarth (1997) as well as Anand and Sen (2000), the electrification initiatives appear all the more dubious in the context of sustainable development since for a vast majority of those interviewed (236/243) across both field study islands, electricity does not figure among the top five priorities simply because for most of the households it is beyond affordability. For those who can afford, stand-alone photovoltaic systems provide a viable alternative[10]. Moreover, there is no provision

[10] The two field study islands do not exhibit any difference on account of access to electricity, its use and impact.

for replacement of capital equipment (through amortisation costs) which in case of the gasifier power station will become necessary in 15 years and in case of solar photovoltaic power station, even earlier in about 7 years for batteries, since inception.

"Rural energy provision [in India] has been basically driven by target-oriented and subsidy-driven national programmes that have either been technology centric (national programme on biogas development, national programme on improved cook stoves) or end-use centric (programme for provision of a single light point in each home) without having any interlinkages" (Srivastava and Rehman, 2006; p. 644). The basic purpose of subsidy on fuels and electricity to stimulate economic growth and production has been lost and instead has become an end in itself, mechanical and thermal energy needs continue to be met as in pre-electrification days. The power stations in Mousuni and Mollakhali put up at costs of US$ 800,000/- and US$ 350,000/- respectively are manifestations of targets achieved. If lighting were to be the sole purpose, then according to TERI's experience Solar photovoltaic (SPV) lanterns costing about US$ 28/- each could have been a sustainable and workable solution to rural household lighting. Moreover, the savings from solar lighting (instead of kerosene lighting) could be used for replacement of battery (TERI, 2005). This approach could have provided more than one solar lantern to each of the residents of Mousuni Island for the cost of the power station which serves only 30 percent of the population of just the Bagdanga *mouza*. This emphasis on rural electrification, according to Clancy and Hulscher is because "the main parties interested in electrification programmes … are the consumer, the utility company, the government, the power sector industry, and one or more consultancy companies" (Clancy and Hulscher, 1994; p. 366). It is natural that all these parties push for electrification and any opinion to the contrary is politically incorrect.

6.5 Postscript

Now with the launch of the new scheme (*Rajiv Gandhi Grameen Vidyutikaran Yojana*, 2005), it is likely that every habitation/village in the Sundarbans will receive connectivity through at least one distribution transformer connected to the local DDG system. The Rural Electrification Corporation (GoI) will provide 90 percent of the capital cost, the State Government may provide the rest or it may come from Local Area Development Fund of provincial/national legislators. The basic difference in approach from earlier initiatives is that the new power stations will provide electricity round the clock even in remote locations without discrimination and at par with urban locations which has the potential to boost and expand local economy. But for all households to benefit, mechanisms such as differential tariff based on income need to be found so that the poorest households can also subscribe, which the scheme leaves up to the State Government. Given the political polarisation in West Bengal it is quite possible that implementation will not be uniform, political affiliation will decide the level of poverty and access to electricity as is currently the case in identification of individuals below poverty line, and in the process jeopardise the prospects of attaining sustainable development in the context of rural electrification. Also, there is the possibility that the compulsion to provide round the clock electricity and increased demand may push renewable resources beyond what is locally feasible. A combination of technologies and resources may prove to be the solution where WBREDA's varied experiences with

different technologies and resources may just make the difference between sustainable and unsustainable development but that process will need to factor in the livelihood options and preferences of the people of the Sundarbans. The next part of the thesis consisting of three chapters looks at these options and preferences in the context of sustainable development, beginning with agriculture.