Impact Analysis of Household Electrification through Grid Electricity Connections at Ganga Sagar Island, West Bengal, India

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Abstract

"Ganga Sagar Island" otherwise called "Sagar Island" is the westernmost island of the Ganges-Brahmaputra delta that lies at the mouth of the Hooghly River in India. There was no grid-based electricity connection in the island up to the year 2012. The West Bengal State Electricity Distribution Company Limited (WBSEDCL, 2018), with the support of Integrated Coastal Zone Management Project-West Bengal, took up the grid-based power supply to the island in 2010. Subsequently, 100% household electrification programme was started from the year 2012. On the basis of sample-based cross section data obtained from 402 households in Ganga Sagar Island, present paper attempts at analysing various impacts of grid-based electrification programme. Quasi experimental research design entailing before and after method of impact assessment is applied. The study finds that because of electrification, there is good deal of social as well as household level benefits linked with better production and consumption. The study views that because of electricity connection, socio-economic development of the region is gradually getting momentum.

Keywords: ICZMP-West Bengal, Grid based Electrification, off-grid electricity connection, Household Electrification

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1. Introduction

"Ganga Sagar Island" otherwise called "Sagar Island" is the westernmost island of the Ganges-Brahmaputra delta that lies at the mouth of the Hooghly River in the Indian side of Sundarbans area and it is located 100 km from Kolkata. Sagar Island falls under the jurisdiction of South 24 Pargana and is totally cut off from the mainland by Muriganga River.[i] The total geographical area of the island is 286.03 sq. km (Chawli, 2001). The region is rich in mangrove swamps, waterways and small rivers, Sagar Island is also home to the endangered Royal Bengal Tiger. This unique island is one of the largest islands of the Great Sunderbans biodiversity hotspot. There are more than 1.5 lakhs (≡ 1,500,000) population spread over 16 villages. The island remained deprived of grid electricity connections, a necessity and prerequisite for any kind of development. The difficult topography of the region has primarily been the reason for not making grid power available to the people. Considering large scale merits of grid-based household electricity facility, the West Bengal State Electricity Distribution Company Limited (WBSEDCL), with the support of Integrated Coastal Zone Management Project (ICZMP)-West Bengal, took up the grid-based power supply to the island in 2010. Subsequently, 100% household electrification programme was started in the year 2012 under ICZMP-WB. The entire process of electricity transmission to the island was completed in 2015. The overall objective of grid based-power connection was to enhance quality of life of the people of the island and accelerate the development process.

A total of 42 villages of the island were electrified through 1219.90 Km transmission line of which 384.66 Km (31.53%) are high-tension (HT) line and remaining 835.238 Km (68.47 %) are low-tension (LT) lines.[ii] A total of 30,466 of poles were erected for providing 31,050 service connections in the island villages covered under Grid based electrification programme. All connections are of two phases in the studied households and all the households have separate meters to measure the connection specific consumption. The Status of grid-based household electrification in Ganga Sagar Island in a snapshot form is presented in Table 1.

Table 1. Number of consumers connected to diesel generator power at Sagar Island

Before grid based electrification	After grid based electrification
Number of Mouzas getting Diesel Generator based Power-12 nos. Number of Domestic Households-220 nos. Number of Commercial Consumers-394 nos. Number of Industrial Consumers-1 no. Average demand per month (kWh or, unit)-47,000 units	No of DG sets installed- 6 Nos Capacity of DG sets- 5 x 160 KVA + 1 x 320 KVA =1120 KVA Length of HT 11 KV O/H Line- 44 Km Length of LT O/H Line- 1 Phase - 9 Km, 2 Phase - 2 Km, 3 Phase - 15 Km No of 1110.4 KV distribution sub-station- 100 KVA – 9 Nos, 63 KVA - 1 Nos, 25 KVA – 10 Nos Consumers- 100 percent of households in all villages in all 42 villages of the island Total no. of service connections- 31050

Source: The West Bengal State Electricity Distribution Company Limited (WBSEDCL)

Bhattcharyya *et al.* (2014) provides a description of household energy situation of the island before the advent of grid electricity. Earlier, limited number of households were supplied electricity through diesel generators managed by the West Bengal State Electricity Board (WBSEB). But due to huge losses WBSEB did not expand its services. In some villages, private operators, in line with WBSEB, run diesel generators and supplied electricity for a few hours charging very high price. Due to non-successful delivery of electricity through diesel generators, solar energy-based electricity facility was created in the island with active collaboration of the ministry of non-conventional energy sources, Indian Renewable Energy Development Agency and the West Bengal state Government. West Bengal Renewable Energy Development Agency (WBREDA) commissioned a 25 kilowatts peak (kwp) capacity solar photovoltaic (PV) plant in Kamlapur Village, Sagar Island in February 1996. Since then, fifteen more such micro grids or mini-grids had been installed in the Sundarbans region for village electrification.

WBREDA was managing the operation, distribution and management of solar powered electricity connections to households for the first time in India by commissioning mini grids. Studies note that in many parts of the world, Sagar island included, solar energy became a supplementary energy

to diesel generated energy. These mini grids were running as regular off grid power supply centres for five to six hours in the evening and required longer time period for recharging the battery after use. These SPV units were considered as power plants owing to the design in terms of a control room with battery bank, control panels, solar array modules and overhead distribution lines. In addition to off grid power distribution, the island was also having domestic lighting systems. Lilienthal (2013) defines microgrids as "local power networks that use distributed energy resources and manage local energy supply and demand". Microgrids tend to transmit power over low-voltage distribution networks from interconnected local generation sources such as micro-hydro, photovoltaics or biomass gasifiers to a relatively small number of customers. Schnitzer (2014) remarks that in all instances, microgrids are capable of generating power locally and supplying electricity to a relatively small number of users who are connected to each other through a shared distribution system. The electricity is usually distributed at a low voltage and the microgrid can function completely independently of the central electricity grid.

Another step to contain the issue of Sagar Island's energy starvation during pre-grid situation was the implementation of Wind-Diesel Project consisting of 10 wind generators of 50 kilowatts capacity each, along with two 180 kVA diesel generators and a controlling system. Haldar (2015) notes that even if the project is implemented in full capacity, it could hardly meet the minimum energy requirements of barely 50 households. Due to such efforts, only a small fraction of households was able to get electricity connections.

Based on cross-country data, UNDP (2005: 6–8) established the positive relationship between per capita energy consumption and the HDI of many countries and there is empirical evidence to show that access to modern energy is closely linked with human development. A number of micro studies including Kanagawa *et al*. (2008) also pointed out that, due to grid-based electrification, there was improvement in literacy rate from 63.3% to 74.4% in selected rural areas of Assam. Due to electrification in rural Bhutan, electrified households were found to have a 24% higher annual cash income (Bhandari 2006). Incidence of Poverty was less prevalent in electrified villages. Grid-based electrification in Sagar Island and its access

to all households living in the island is no doubt historic. It is believed that due to electrification, some of the basic household amenities are fulfilled. Till date, there are only a few impact assessment studies on "100 percent electrification programme in Sagar island". In a study by Sur (2017), it is revealed that the grid electrification programme in Sagar Island has well contributed to the development of health services and strengthening of health infrastructure in the island. Previously people were migrating to the mainland even for treatment of minor ailment, and, as a result of electrification programme, people are getting better health care services at the island.

Number of studies point out that there are multiple household benefits as a result of rural electrification in India (Van de Walle *et al.,* 2015; Burlig *et al.,* 2016); Khandker *et al*., 2014). Their estimates, based on household consumption data in rural India during the period 1981–98, showed that there was significant positive long-run effects of rural electrification. These studies also empirically validated the positive effects of India's national rural electrification program on labour force participation, living standards, and other village-wide outcomes using census data for 2001 and 2011. According to Goldemberg *et al.* (2000), electrification provides a solid basis for development of local communities. He further noted that once a community had access to electricity, it could also have access to safe potable water, better health conditions, food security, as well as lighting and information. Dinkelman (2011) observed that "access to electricity, not only releases people from hard work, but also increases productive working hours and provides opportunities for self-employment, in particular for women in rural areas". The objective of this study was, therefore, to assess the impact of grid-based electrification programme on household socio-economic development by explicitly considering the following objectives.

2. Study Approach and Methods

The impact assessment comprised of a cross sectional study design where the average behaviour of the outcome variable calculated based on representative number of sample observations at a time "t_1" i.e., the current outcome values as a result of grid-based household electrification were

compared to their respective past values when grid-based household electrification were not there, i.e., at a time "t_0". This type of impact assessment framework is popularly referred to as "Before and After Method of Impact Assessment". Ratio scale was employed to analyse the outcome behaviour of categorised variables and ordinal scale to reveal household preference ranking of different outcomes of grid based electric connections.

The sample size consisted of a cross section of 402 households spread over 13 villages under seven Gram Panchayats ('village councils') chosen on the basis of Simple Random Sampling (SRS). SRS was chosen because no household was a beneficiary of Grid based electricity connection and all (100%) became beneficiaries as a result of grid-based electricity connection. Households, villages and Gram Panchayats were randomly selected from the available list with the Ganga Sagar administrative block of all of the concerned electrified villages.[iii] The details of the Gram panchayats, villages and number of respondents selected from the study villages are shown in table 2. The required information from the respondents were obtained by canvassing a pre-designed and pre-tested semi structured questionnaire. The study was undertaken in September and October 2018. There was mixed method of data collection from respondents comprising of quantitative as well as qualitative data.

Table 2. Sampled households

S. N.	Gram Panchayats	Villages	Sample size (No. of respondents)	Sample proportion
1	Dhablat	Purusattampur	61	15.2
2	DS-II	Bankimnagar	43	10.7
3	Gangasagar	Gangasagar	30	7.5
4		Narayani Abad	29	7.2
5	MG1	Patharpratima	38	9.5
6	MG-II	Chakfuldubi	32	8.0
7		Mandirtala	7	1.7
8	Ramkarchar	Harinbari	16	4.0
9		Khasramkar	15	3.7
10		Narahari pur	35	8.7
11	Rudranagar	Kirtan Khali	37	9.2
12		Radhakrishnapur	30	7.5
13		Rudranagar	29	7.2
	Total		**402**	**100.0**

3. Results and Discussion

3.1 Status of Household Electrification

Analysing the household socio economic characteristics on the basis of sample data as mentioned in table 3 points out that majority of households living in Sagar Island are general category households followed by Other Backward Castes (OBC) and Scheduled Caste (SC) households. The proportional share of general category, OBC and SC categories of households account 84.6%, 8.7% and 6.7%, respectively (Table 3).

Table 3. Socio-economic profile of sampled households

S. No.	Household Socio -Economic Characteristics	No of Households	(% of households)
1	Social Category		
	General category	340	84.6
	OBC	35	8.7
	SC	27	6.7
	Total	***402***	***100.0***
2	Years of residence in respective villages		
	Hereditary	397	98.8
	<5 years	2	0.5
	5-10 Years	2	0.5
	>10 Years	1	0.2
	Total	***402***	**100.0**
3	Year of House Electrification from the Grid		
	2012	13	3.2
	2013	5	1.2
	2014	98	24.4
	2015	225	56.0
	2016	40	10.0
	2017	19	4.7
	2018	2	0.5
	Total	***402***	***100.0***
4	Average amount paid to get electricity connection from the grid		
	Rs. 660.00	122	30.35
	Rs.771.00	239	59.5
	Nil	41	10.15
	Total	***402***	***100.0***
5	Separate meter	402	100.0
6	Type of Electricity connection		
	Commercial	74	18.4
	Domestic	328	81.6
	Total	***402***	***100.0***

About 99% of the households have been staying here since generations. The "100% Electrification Programme" was launched in the year 2012 and, by the year 2015, almost 85% of the households became beneficiaries of the electrification programme. By the year 2017, all households of Sagar Island had been the beneficiary's electrification programme. About 30% of households spent an average amount of Rs.660.00 for getting household electricity connection and about 60% of households incurred an average amount of Rs.771.00 for getting household electricity connections. Only 10% of households got free electricity connection. All of household electricity connections are metered. Some of the households operating business activities from their residences, have taken commercial electricity connections. About 18.4% of the overall connections are commercial connections and the remaining 81.6% are domestic connections.

3.2 Patterns of Electricity Consumption

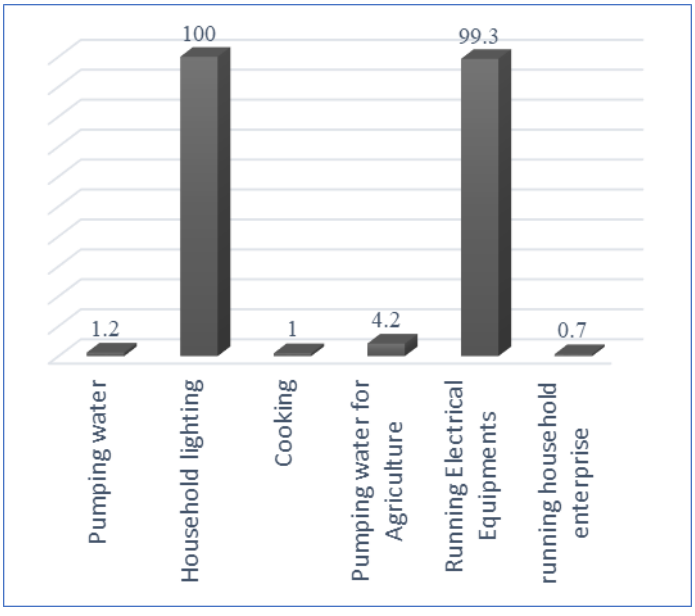
Pattern of household electricity consumption is assessed separately for domestic and commercial type of electricity connection. The average electricity connection load (watt) for commercial connections is marginally higher compared to the same for domestic connection. Overall load per electricity connection is about 428 watts. The average load for commercial and domestic connections is about 446 and 424 watts, respectively. As per WBSEDCL, generally connections ranging between 400 to 450 watts are given to households. The average billing amount per connection per month is found at Rs.249.00, which is Rs.233 for commercial connections and Rs.252.00 for domestic consumptions. Majority of beneficiaries clear the monthly bills without any outstanding payments. However, about 5.4% of commercial users and 17.4% of domestic users have outstanding bills. The higher monthly bill for domestic connections, when compared to commercial connections, is attributed to the use of more electricity appliances by the households. Based on beneficiaries' opinions, there is 19 to 20 hours of electricity supply every day. However, voltage fluctuations during daytime as well as evening hours are reported by almost 100% of the beneficiaries.

Table 4. Average monthly household consumption of electricity (No of metered units of consumption)

S. N.	Household Electricity Consumption	Type of electricity connections		
		Commercial	Domestic	Total
1	Average of Electricity Connection Load (w)	446	424	428
2	Average units of consumption per month	49	49	49
3	Average of Billing Amount per Month (Rs.)	233	252	249
4	% of beneficiaries having outstanding bill amount	5.4	17.4	15.2
5	Average of Average Hours of power supply per day	19.1	20.3	20.1
6	% of people saying voltage fluctuations in evening hours	100.0	99.7	99.8
7	% of people saying voltage fluctuations in day time	100.0	100.0	100.0

3.3 Use of Electricity in Household Activities

Household use of electricity based on different types of uses is analysed in the chart given in Figure 1. All households use electricity for household lighting. Similarly, sizable proportions (99.3%) of households use electricity for running electrical equipment. About 4.2% of the households use electricity for cooking purposes.



3.4 Changing pattern in the use of household appliances

Advent of electricity in Sagar Island has changed the course of day-to-day activities of the villagers in Sagar Island. Previously, before the grid-based electricity connection, only 36.8% of households were enjoying television, now it is almost doubled and around 71.1% of households use television for the day-to-day entertainment programmes (see Table 5).

Table 5. Household activities during pre- and post-electrification

S. No.	Components	% of Households	
		Pre-Electrification	Post-Electrification
1	Entertainment by running Televisions use	36.8	71.1
2	Use of refrigerator and Grinder	0.0	6.2
3	Toilet use in night time	53.0	71.4
4	Use of Generator for Social / Cultural Activities in the Evening/Night	97.3	3.0
5	Pumping water for irrigation	2.5	8.5
6	Pumping water for household use	2.2	4.2
7	Use of cooking gas	19.2	34.6

3.5 Incidence of Power-Run Household Equipment

Household electrification has a positive impact on the availability of the different household equipment that improves the quality of living and reduce drudgery. There has been a growth in number of power run household assets in the post-electrification phase, in comparison to the pre-electrification. Percentage of households having mobile phone for improved quality of communication has increased from 55.7% to 96.5%. Availability of television set increased by about 52 percentage points. Similarly, more numbers of households are now having such power run equipment such as electricity run fan, chargeable lights etc. Comparison of household equipment in pre- and post-electrification is presented in the table 6. There is 400% increase in the use of televisions. Similarly, increased use of micro-ovens, mobile phones, chargeable torch light etc. have increased by 285.7%, 73.2% and 66.2%, respectively. There is declining incidence in the use of land phones, coolers and radios. The analysis suggests that people have substituted their radios for televisions and land phones for mobile phones during post grid situation.

Table-6. Power-Run household equipment in pre- and post-electrification

Type of equipment	Pre-grid situation		Post-grid situation		% variation during post grid situation compared to pre-grid situation
	No. of households using	% of households	No. of households using	% of households	
Television	52	12.9	260	64.7	400.0
Refrigerator	0	0.0	23	5.7	
Washing Machine	0	0.0	3	0.7	
Micro-oven	7	1.7	27	6.7	285.7
Grinder	0	0.0	6	1.5	
Microwave	0	0.0	2	0.5	
Mobile phone	224	55.7	388	96.5	73.2
Land phone	21	5.2	1	0.2	-95.2
Water filter (Power Run)	0	0.0	2	0.5	
Torch Light (Chargeable)	145	36.1	241	60.0	66.2
Air Conditioner (AC)	1	0.2	1	0.2	0.0
Cooler	2	0.5	1	0.2	-50.0
Radio	116	28.9	31	7.7	-73.3
Fan	5	1.2	312	77.6	6140.0

3.6 Electrification and Household Economics

Electrification has influenced household economics by impacting household income and household expenditure patterns. An indicative change in the pattern of household economics is presented in Table 7. Due to electricity facility, students have been able to increase their reading time in evening. There is about 32.1% in the length of reading hours at evening ties. Use of kerosene is reduced by about 69.7%. Average cost of fuel used for lighting is reduced by 56.3%. Quantity of kerosene used for cooking per household is also reduced by 33.3%. Reduced kerosene use of the households for lighting and cooking is an encouraging sign of better air quality in the households. However, there is increased cost of fuel experienced by the households during post electrification phase. Average hours of economic activity during evening hours has increased by 5.8% and, as a result of this, average income from evening hours of work has increased by 12.4%.

Table 7. Impact of Household Electrification on Household Economics

Impact Areas	Pre-Electrification	Post-Electrification	% Variation during Post-electrification period over Pre-electrification period
Average Hours of Reading by Children in Evening	2.8	3.7	32.1
Average quantity of kerosene Used for Lighting / Month (Litre)	3.3	1.0	-69.7
Average Cost of Fuel Used for Lighting / Month	64.0	28.0	-56.3
Average quantity of kerosene Used for Cooking / Month	6.0	4.0	-33.3
Average Cost of Fuel Used for Cooking / Month	91.72	126.0	37.4
Average Hours of Economic Activity in Evening	4.0	4.23	5.8
Average Income from Evening Works (Rs.)	589	660	12.1

3.7 Pattern of Change in household Energy Demand

Electrification of Sagar Island is believed to be a turning point in the lives of people living there for decades. Electrification has brought the quality of life at pa r with the mainstream society. Before advent of electricity, households were using kerosene, diesel and solar panels for multiple energy demands. It is found that after electrification, kerosene lamps for the purpose of children's education have become completely redundant. It is also interesting to note that previously acquired solar panels by majority of households since pre-electrification days, have mostly been found as standby arrangements in the event of non-supply of electricity and voltage fluctuations. Electricity has completely replaced DG energy for the purpose of mobile recharging. Electricity has not replaced the existing fuel options for cooking. Age old acquaintance of farmers with kerosene pumps and diesel pumps has not influenced farmers to take up electric pump-sets as complete replacements of kerosene and diesel pumps. As farmer's residence and cultivated land parcels are most often independent from each other, kerosene and diesel pumps remain as most feasible options of the farmers

for irrigation purposes. Otherwise, the farmer had to take multiple electricity connections for agriculture and residence which are most often not feasible. For socio cultural activities regularly taking place in the island, in addition to generators, use of electricity is used as a supplementary source. For entertainment through radio/TV, electricity has completely replaced solar energy.

Table 8. Household Energy Management of HH activities in pre & post Electrification scenario

Household activities	Management Pre-Electrification	Post-Electrification	Remarks
Education of Children	Wind mill provided energy, Kerosene lamp, Solar panel	Electricity, Solar lamp	• Use of kerosene lamps for the purpose of children's education is found redundant. • Previously acquired solar panels by the households are mostly standby arrangement in the event of non-supply of electricity and voltage fluctuations. • Use of Electricity is the dominant mode of lighting for children's education.
Mobile Recharge	DG energy supplied to selected shops, Solar panel	Electricity	• Electricity has completely replaced DG energy for the purpose of mobile recharge.
Household Lighting	Wind mill provided energy, Lamp(kerosene") Solar Lamp	Solar Lighting, Electricity	• Electricity is mainly used for household lighting. • In the event of power cuts and voltage fluctuations, solar lighting is used by the households as solar lighting facilities are owned by majority of the households since pre-Electrification period.
Cooking	LPG and Wood	LPG and Wood	• Electricity has not replaced the existing fuel options for cooking. • LPG and fuel wood are exclusively used for cooking.

Household activities	Management Pre-Electrification	Post-Electrification	Remarks
Pumping Water for Household use	Tube-well (Non-electricity driven)	Tube-well (Non-electricity driven), Electric motors	• In addition to the existing non-electric driven tube-wells additional use of electricity driven pump-sets are reported
Pumping water for Irrigation	Kerosene Pump Diesel pump	Electricity, Kerosene Pump, Diesel Pump	• Age old acquaintance of farmers with kerosene pumps and diesel pumps has not influenced farmers to take up electric pump-sets as complete replacements of kerosene and diesel pumps. • As farmer's residence and cultivated land parcels are most often independent to each other, kerosene and diesel pumps continue to take place as most feasible options of the farmers for irrigation purposes. • Otherwise, the farmer has to take number of electricity connections for agriculture and residence which is most often not feasible.
Social and cultural Activities	Generator	Electricity, Generator	• In addition to generators, use of electricity is found to be as supplementary use.
Entertainment (TV/ Radio)	Solar Energy	Electricity	• For the purpose of entertainment through radio/TV, electricity has completely replaced solar energy

3.8. Impact Ranking in Pre and Post Electrification Scenario

Apart from the impacts of electrification on economic condition of the people, there are multiple key impact areas in terms of mobility to other places, social communication and mobile based contact with others, health accessibility etc. The impact of grid electricity on key impact areas for the households were assessed by adopting an ordinal scale and household preference was recorded on an ordinal 1-5 likert scale entailing 5 as highest ranking and 1 as lowest ranking. Ranking of households based on different aspects reveals that there has been improvement in reduction of snake/insect biting, increased accessibility to health care services at night, and improvement in household assets that run with electricity etc. Detail ranking of the households in 1-5 ordinal scales for pre-electrification and post-electrification is presented in Table 9.

Table 9: Ranking by Households on Key Impact Areas; Pre and Post Electrification

Aspects	**Pre-Electrification (% of households)**					**Post-Electrification (% of households)**				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Mobility to Other Places in Evening/Night	32.0	61.8	6.3			0.3	0.3	6.8	53.0	39.8
No. of HH Assets Running with Electricity	35.3	54.9	9.8				0.3	0.8	27.5	71.5
Social Communication / Mobile Contact	17.3	50.0	30.5	2.3			0.3	1.0	37.0	61.8
Health Service Accessibility at Night	25.8	53.3	20.5	0.3	0.3		0.8	9.5	40.9	48.9
Incidence of Snake / Insect Biting (reduction)	24.0	58.0	17.8	0.3		0.8	3.0	13.0	34.0	49.3

Note: 1 for Lowest and 5 for Highest Ranking

3.9 Household Satisfaction on the Impact of Grid Electricity on Commercial Activities

The satisfaction level of the households having home based commercial activities because of electrification is presented on a 1-5 ordinal scale

resembling 5 means best satisfied and 1 means least satisfied. As it can be observed from the following table-10, owing to better business scope during post electrification period, on all aspects of business activities, there is satisfaction improvement of households who are running home-based business activities.

Table 10. Satisfaction ranking of households running business activities from their respective homes during post electrification compared to pre-electrification

Parameters	**Pre-Electrification (% of households)**					**Post-Electrification (% of households)**			
	1	**2**	**3**	**4**	**5**	**2**	**3**	**4**	**5**
Customer foot fall in the business unit		2.1	93.8	4.2			10.2	26.5	63.3
Production / selling of items (Quantity)	2.1	14.6	37.5	45.8				49.0	51.0
Hours of operation of the unit per day		8.3	62.5	27.1	2.1		12.2	53.1	34.7
Hours of operation of unit in evening hour		12.5	56.3	31.3		2.0	8.2	40.8	49.0
Average Production per Day (if it is a production unit)		10.6	61.7	27.7		2.0	6.1	42.9	49.0
Total Value of Sell of items per Week	2.1	18.8	47.9	29.2	2.1		14.3	53.1	32.7
Average Profit per Week from sells (Net Profit)		16.7	58.3	25.0			12.2	40.8	46.9
Net Worth of the Business		22.9	45.8	31.3			4.1	49.0	46.9
Expansion of Business Unit		12.5	64.6	22.9			8.2	57.1	34.7
No. of Persons Engaged in the Business Unit		18.8	43.8	27.1	10.4				

3.10. Social Benefits of Electrification

Freudenburg, (1986) defines "Social impacts (or effects or consequences) that are likely to be experienced by an equally broad range of social groups as a result of some course of action. Emerson et al. (2000) states that social benefits implicitly consider social values which are created when resources, inputs, processes, or policies are combined to generate improvements in the lives of individuals or society as a whole. Following these definitions there are multiple social benefits as a result of grid-based electricity supply at

Sagar Island. Schools are connected with 24 hours of electricity supply which promotes e-learning in the schools. Special computer classes have been set-up by the government for school children from class V to class IX; and, to make classes interesting, ordinary class rooms are converted into digital classrooms by installing projector to provide an audio-visual effect to the learners.

School children are also able to study in adverse weather conditions because of installation of lights and fans in the classroom; to maintain hygiene of the school children, the schools have installed water purifier for drinking water as well as running water connection to school toilets only after getting the electricity connection. The only block level hospital at Rudranagar, which is the last hope for the people of Sagar Island, has opened a blood bank and a digitally equipped operation theatre to manage small operations in the hospital for fulfilling the requirement of Sagar block. Earlier they were using diesel generator only during night hours. Especially at marketplaces, after electricity connection, the running hour of shops has increased by 1.2 hour which has added more income to the sellers.

Various Small scale and Medium Enterprises (SMEs) such as Saw mill, Flour mill, Rice mill, Ice factory etc., which were earlier running their enterprises through generators, are now connected to electricity and able to reduce their fuel expenses which is now economical for them. At the household level, due to electricity connection, the people have found TV as an entertainment source which is also helping them to get updated about the outside world; Use of mobile phones has also increased by 130% which is helping them for appropriate communication during regular time as well as emergency; The electric-operated vehicles (Charged battery operated vehicles) which came up in a large-scale during post electrification period, enabled people for short duration low cost travel and on the other side it also helped in the livelihood generation of the vehicle owner.

11. Conclusions/Recommendations

Electricity connection has been a blessing for the inhabitants of the area. Because of electricity connection, socio-economic development is gradually getting momentum in the region. However, certain steps may also be further

helpful for the people of the locality to avail quality services along with quality power. As it is expressed by the households, the department is less responsive to the complaints of the customer like extra arrear of the bill, regularizing / maintaining the de-functioning of the meter, meter replacement, addressing issues of load shedding etc. The department may think of instituting a grievance redressing system on priority basis through web or through mobile application. Apart from this, bare foot volunteers may be developed, taking local youths/persons, through skill development measures who can fix such issues locally and can earn a livelihood out of their services; The people are sometime paying extra bill amount for defunct meter because the department is taking the bill amount as an average of last few months which sometimes stands at higher side compared to their actual uses. The units of power consumption normally vary month wise and regularizing bill collection and payment seems suitable. In case of need, rather than taking average consumption, previous and current reading may be used for actual unit consumption estimation and billing. Further, the pending bill amount should also be recovered at regular interval.

Very often people shift their residential place from one location to another due to change in livelihood opportunities. Such families are facing the problem in shifting their meter connection because the department is less supporting. Such cases may be dealt with by the support of barefoot volunteers who can help such families in shifting their meter or giving them connection in new place. However, in case of giving connection in new place, the matter should be referred to the department. People have demand for having streetlights on the pillar which is expected to help them to travel easily during night/evening hours. Based on the load factor estimation, the department may think of creating such provisions, giving priority to the market areas, relatively densely population or frequently visited places.

During field observation as well as discussions with the villagers, it was found that, in most of the interior villages, the gap between the electric pillars is wide. Consequently, electric wires are not properly stretched and, in some cases, come in contact with the ground thus imposing life risks to inhabitants. The department may ensure, on priority basis, that there should be no hanging power supplying wire.

More load shedding and voltage fluctuations during night in certain areas, such as Dhablat, Daspara Sumati Nagar-II, Muri Ganga-II and Rudranagar are reported. The department may take up such issues with regular maintenance and tracking of erratic consumer behavior (more consumption than stipulated connection load, using domestic line for commercial purposes, using electricity for cooking or similar high consumption activities etc.).

Disclaimer: The paper owes to the study "Impact Assessment of Pilot Investments under Integrated Coastal Zone Project, West Bengal" undertaken by CTRAN Consulting Ltd. All the errors of omission and commission remain the sole responsibility of the author.

Notes:

[1]The details of the location of Ganga Sagar Island are obtained from the State Government records of West Bengal.

2 Tension is a French word for Voltage. A low-tension line is a low voltage line and a high-tension line is a high voltage line. In India LT supply is of 400 Volts for three-phase connection and 230 Volts for single-phase connection. High tension or HT supply is applicable for bulk power purchasers who need 11 Kilo-Volts or above.

3 In India a state is divided into districts, districts are divided into blocks, blocks are divided in Gram Panchayats and each Gram Panchyat consists of a number of villages (habitations)

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