

LIGHTING THE FUTURE

ENERGY POVERTY, CLIMATE VULNERABILITY AND THE CASE FOR DECENTRALIZED SOLAR ENERGY ON GHORAMARA ISLAND

PREPARED BY

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PREPARED FOR

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(FUNDING PARTNER)



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(IMPLIMENTING ORGANISATION)



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It is our hope that the findings of this baseline survey will inform the design and implementation of effective interventions that address the energy and infrastructure needs of the people of Ghoramara Island, while strengthening their resilience to the environmental and socio-economic challenges they continue to face.

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EXECUTIVE SUMMARY

Ghoramara Island, located in the southern part of the Sundarbans delta in West Bengal, is among the most climate-vulnerable and geographically isolated regions in India. Over the past several decades, the island has experienced severe land erosion, loss of agricultural land, recurrent climatic hazards and shrinking livelihood opportunities, resulting in heightened socio-economic vulnerability among its residents.

Remaining off-grid due to its remote location and the cost and technical difficulty of extending conventional electricity infrastructure, Ghoramara faces acute and persistent energy poverty.

In this context, SEED, with support from SBI Foundation under the VIBHA initiative, commissioned this **baseline study, conducted independently by the Institute of Development Studies Kolkata (IDSK)**, to assess the extent of energy poverty and energy gaps on the island and their implications for education, livelihoods, safety and quality of life. The findings of this baseline are intended to directly inform the design of a decentralized, renewable solar energy plan suited to the island's specific vulnerabilities and to establish the benchmark against which the impact of SBIF CONSERW's investment in this intervention will be measured.

The survey covered 100 households across the hamlets of Raypara, Bagpara, Mandirtala, Hatkhola, Khasimara and Chunpuri, and collected information on demographic characteristics, housing conditions, livelihoods, land ownership, energy use, health, education, Self-Help Group (SHG) participation and community-level infrastructure challenges. Most respondents belong to economically vulnerable households characterized by low levels of education, dependence on wage labour and limited livelihood diversification. More than half of households (58%) earn between Rs. 5,000 and Rs. 10,000 per month, with limited capacity for savings given comparable expenditure levels.





100 Households surveyed	94% Rely on kerosene for lighting	98% Lost land to erosion	95% Want solar energy access
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Housing and infrastructure conditions remain modest- 65% of households live in kachcha houses and almost all rely on kerosene for lighting and firewood for cooking. Access to sanitation has improved, though a significant proportion of households still depend on shared or inadequate facilities and all surveyed households depend entirely on tube wells for drinking water.

The survey highlights the profound and compounding impact of environmental change on livelihoods. Only 22% of households currently possess cultivable land, while an overwhelming 98% reported losing agricultural land to erosion, most of them (87%) losing 20 kathas or more. This is not a historical footnote but an ongoing process- the island has shrunk from 30 sq. km to 5.5 sq. km and continues to lose an average of 5 metres of land per year. As a result, wage labour and deep sea fishing have emerged as the dominant sources of livelihood, while agriculture plays a steadily diminishing role in household income.

Energy deprivation emerged as the central concern of the study. Overwhelming dependence on kerosene for lighting (94%) and firewood for cooking (92%) reflects the near total absence of clean, reliable energy access. Kerosene must be purchased from the market at an **average monthly cost of Rs. 400 to 600 per household**, an expense that places a disproportionate financial burden on already vulnerable families while exposing them to poor-quality lighting, indoor air pollution and fire hazards. This cost also forces households to curtail evening activities- **FGD participants reported routinely finishing cooking before 6:30 p.m. to limit kerosene use, placing a particular burden on women, who must complete most domestic work before sunset. FGDs further revealed that access to an affordable renewable energy source could reduce kerosene-related expenditure and dependence by 50 to 60 percent.**

The findings also underline the developmental, not merely infrastructural, nature of this energy gap. Among households where **children study in the evening, the average time spent is 2.5 hours, often under dim kerosene light**, with direct consequences for learning outcomes. Limited lighting also restricts home-based livelihood activities such as embroidery, weaving, tailoring, net mending and poultry care, activities that 38%, 30% and 28% of households respectively use evening hours for, constraining households' ability to generate supplementary income.



A particularly significant finding is the near total absence of street lighting across many hamlets in the island. **87% of respondents reported facing difficulties as a result, most commonly safety and security concerns (67%), difficulty fetching water after dark (55%), constraints on poultry care (27%) and restricted access to evening coaching classes (18%).** Women and adolescent girls are disproportionately affected, with FGD participants describing specific fears around mobility after dark, including snake bites near riverbank vegetation and road accidents in unlit areas.

Encouragingly, the assessment found exceptionally strong community readiness to adopt and sustain renewable energy. Some households have prior, hands-on experience with rooftop solar systems distributed by WBREDA and other government agencies, though coverage has been partial and many units were damaged in cyclones and floods. This prior exposure has left residents, particularly women, with practical knowledge of battery maintenance. **Nearly all respondents (95%) expressed a desire for non-fuel-based energy services, 98% are willing to contribute financially toward maintenance, 86% are willing to participate directly in street light upkeep and 68% want training on solar operation and maintenance.**



Community institutions, particularly Self-Help Groups, provide a strong existing foundation for this transition. 65% of respondents are active SHG members with an average of nine years' tenure and all active members report regular monthly participation, suggesting a ready-made institutional channel for maintenance funds, training delivery and local accountability.

Taken together, the baseline confirms that energy poverty in Ghoramara is not simply an infrastructure gap but a significant development challenge with direct implications for education, livelihoods, safety, health, and climate resilience. It also confirms that the conditions for a successful, community-owned decentralized solar intervention are unusually favourable: high aspiration, demonstrated willingness to pay, existing technical familiarity, and strong institutional scaffolding through SHGs. This baseline establishes the quantitative starting point, set out in Chapter 7, against which SBIF CONSERW's investment in the VIBHA solar intervention can be tracked and demonstrated over the life of the programme.

By aligning these energy-specific findings with broader interventions in education, livelihoods, safety and community institutions, VIBHA can ensure a more holistic and sustainable improvement in household well-being and resilience. Addressing these interconnected recommendations is essential for breaking the cycle of socio-economic deprivation and energy poverty and for strengthening the resilience of children, women and families in these ecologically and economically vulnerable coastal communities.

CHAPTER 1- INTRODUCTION

1.0 THE GLOBAL AND NATIONAL CONTEXT

Access to reliable, affordable and sustainable energy remains one of the most pressing development challenges of the twenty-first century. Globally, despite significant progress over the past two decades, hundreds of millions of people continue to live without access to electricity and a far larger number rely on inefficient, polluting and costly traditional fuels such as kerosene, candles and biomass for daily lighting and cooking. This persistent gap, commonly termed energy poverty is not merely a technical or infrastructural shortfall but a multidimensional development challenge that intersects with education, health, gender equity, livelihood security and climate resilience.

Energy poverty disproportionately affects rural, remote and geographically isolated communities, where the cost of extending conventional grid infrastructure is prohibitively high relative to the population served. Island and riverine communities, coastal settlements and areas affected by recurrent natural disasters face a compounded form of vulnerability- they are simultaneously among the least likely to be connected to reliable energy infrastructure and among the most exposed to climate change impacts, including extreme weather events, sea-level rise and erosion. For such communities, the absence of clean energy access does not merely limit convenience; it actively reduces resilience, since reliable lighting, communication and emergency response capacity are themselves energy-dependent.



The United Nations' Sustainable Development Goal 7 calls for ensuring access to affordable, reliable, sustainable, and modern energy for all by 2030. Universal energy access is understood not as an end in itself but as a foundational enabler of other development goals, including SDG 1 (no poverty), SDG 4 (quality education), SDG 5 (gender equality), and SDG 13 (climate action). Evidence from energy-poor regions worldwide consistently shows that unreliable or absent lighting disproportionately burdens women and girls, who bear the primary responsibility for household tasks compressed into daylight hours, and that it constrains children's study time, limits home-based livelihood activities, and increases exposure to fire and respiratory health hazards associated with kerosene and biomass use. Decentralized renewable energy, particularly solar power, has increasingly emerged as the most viable and cost-effective solution for such last-mile, off-grid contexts.

At the national level, India has made energy access a central pillar of its development agenda. Flagship initiatives such as the Saubhagya scheme for household electrification and the Pradhan Mantri Surya Ghar Yojana for rooftop solar adoption reflect a strong policy commitment to expanding clean energy access, including in remote and underserved regions. India's Nationally Determined Contributions under the Paris Agreement further commit the country to scaling up the share of renewable energy in its overall energy mix and to building climate-resilient infrastructure in vulnerable geographies. Within this broader policy architecture, decentralized renewable energy systems, particularly solar home systems and solar street lighting, are increasingly recognized as appropriate, cost-effective solutions for off-grid island and coastal communities that fall outside the practical reach of conventional grid extension.

It is within this global and national context that the energy situation in Ghoramara Island must be understood. Ghoramara represents an acute, concentrated instance of the broader energy poverty challenge- a geographically isolated, climate-vulnerable, off-grid island community where the absence of reliable electricity compounds existing socio-economic vulnerabilities arising from climate induced poverty. It is against this backdrop that SEED, with support from SBI Foundation under the VIBHA initiative, commissioned this baseline study, conducted independently by the Institute of Development Studies Kolkata (IDSK)- to assess the extent and implications of energy poverty on Ghoramara Island and to generate the evidence base for a decentralized solar energy intervention aligned with both global sustainable energy commitments and national renewable energy priorities.

1.1 CHALLENGES OF ENERGY POVERTY IN THE SUNDARBANS

Energy poverty in the Sundarbans, a fragile deltaic region shared by India and Bangladesh, poses severe challenges due to its remote geography and frequent climatic disruptions. According to a 2021 report by the World Bank, around 70% of households in the Indian Sundarbans lack access to reliable electricity, relying instead on kerosene lamps and diesel generators. The region's dispersed islands make grid extension difficult, leaving solar energy as the primary alternative. However, only 25% of households use solar home systems (SHS), as per a 2020 study by the Council on Energy, Environment and Water (CEEW), highlighting gaps in renewable energy adoption. Frequent cyclones, such as Amphan (2020) and Yaas (2021), further damage infrastructure, worsening energy insecurity.

Barriers to Renewable Energy Adoption

Despite government initiatives like Solar PV Electrification Programs, challenges persist. A 2022 report by the Energy and Resources Institute (TERI) found that high upfront costs and lack of financing options deter 40% of households from adopting solar solutions. Additionally, maintenance issues and counterfeit solar products reduce system longevity. The Asian Development Bank (ADB) notes that only 15% of solar mini-grids in the Sundarbans remain functional after five years due to poor upkeep. Furthermore, policy gaps and bureaucratic delays hinder large-scale renewable projects, leaving communities dependent on unreliable energy sources.

Long-Term Consequences and the Way Forward

Energy poverty exacerbates climate vulnerability in the Sundarbans, where rising sea levels and salinity intrusion threaten agriculture. A 2023 study in Nature Sustainability warns that without sustainable energy solutions, migration rates could increase by 20% in the next decade. To address this, experts recommend expanding decentralized solar microgrids, subsidizing storage solutions and strengthening community-based energy cooperatives. The West Bengal Renewable Energy Development Agency (WBREDA) has installed 50 solar mini-grids, but scaling up requires private sector participation and better policy enforcement. Addressing energy poverty is critical not only for development but also for climate resilience in this ecologically sensitive region.

Among the inhabited islands, Ghoramara represents one of the most severely climate-affected geographies in the Indian Sundarbans. Once covering over 26 sq. km, Ghoramara has lost a substantial portion of its landmass, forcing many families to migrate while those remaining continue to face chronic insecurity. Limited physical connectivity, fragile public infrastructure, and restricted access to essential services have further compounded the island's developmental challenges, making it one of the most vulnerable climate hotspots in the region.

The absence of electricity is one of the most significant manifestations of deprivation on Ghoramara Island. Being an off-grid island, households have historically remained beyond the reach of conventional electricity infrastructure, relying instead on kerosene lamps, candles, battery-operated torches and other expensive, unsafe, and inadequate sources of lighting. Energy poverty directly affects children's education, household safety, healthcare delivery, communication, livelihood opportunities, and the ability of communities to respond to climate-induced emergencies. Women and children bear a disproportionate burden, as the lack of clean and reliable energy restricts productive activities after sunset, increases safety concerns, and limits access to information and essential services. Against this backdrop, establishing a comprehensive baseline on household energy access, energy needs, coping mechanisms, expenditure patterns and community aspirations is essential for designing evidence-based decentralized renewable energy interventions that enhance energy access, strengthen climate resilience and improve the overall quality of life on the island.





CHAPTER 2- BACKGROUND

2.1 GHORAMARA ISLAND: AN ISOLATED, OFF-GRID FRONTIER

Of the 54 inhabited islands in the Indian Sundarbans, Ghoramara is one of the most climate-sensitive and rapidly disappearing. Since the 1920s, the island has lost over 70 percent of its land mass to coastal erosion, while its neighbouring Lohachara Island was lost entirely to the Hooghly river in 1991.

The island experiences severe and compounding environmental degradation through continuous coastal erosion, saline water intrusion, tidal flooding, embankment breaches and repeated cyclonic disturbances, with cascading effects on agriculture, fisheries, water availability and food security. Repeated environmental hazards have driven widespread anxiety, social exclusion and outmigration among island residents, mirroring the broader pattern of climate-induced displacement across the Sundarbans.

Situated 6.21 km from the mainland and accessible only by ferry from Kakdwip, with limited daily services, Ghoramara remains entirely off-grid. This is not an oversight but a structural reality- the cost and technical complexity of extending conventional electricity infrastructure across the Ganges River to a shrinking, eroding island make conventional grid connection financially and logistically unfeasible. This is precisely the category of context, geographically isolated, disaster-prone and economically marginal, for which decentralized renewable energy is recognized internationally as the appropriate and durable solution, rather than a stopgap.

Ghoramara Island- Key Demographic and Infrastructure Indicators

Category	Details
Location / Coordinates	South 24 Parganas, West Bengal — 21.914°N, 88.129°E
Administrative jurisdiction	Sagar Block, Kakdwip Subdivision; Ghoramara Gram Panchayat
Area	5.5 sq. km (current), down from 30 sq. km (historical)
Total households	1,076 (Brick-walled: 824; Kachcha: 252)
Total population	4,766 (Male: 2,446; Female: 2,320)
Displaced families	356 of 1,125 households
Scheduled Caste / Minority population	871 / 1,280 persons
Literacy rate	84%
BPL population	384 persons
Active MGNREGA job cards	946 persons
Available agricultural land	527 acres
Self-Help Groups (SHGs)	71
Functional tube wells	63
Health facilities	1 Health Subcentre, 1 Suswasthya Kendra (telemedicine), 2 cyclone shelters
Schools	4 free primary schools, 1 Sishu Siksha Kendra, 1 secondary school — no high school on the island

Source: Ghoramara Gram Panchayat, Gram Panchayat at a Glance; Census 2011

2.2 CLIMATE CHANGE AND ENVIRONMENTAL VULNERABILITY- THE DEFINING RISK FACTOR

Environmental and climate risk is not a peripheral consideration in this study; it is the central condition that shapes every other finding in this report. Ghoramara falls under Very High Damage Risk Zone-B ($V_b = 50$ m/s) as per the Wind and Cyclone Vulnerability Map of India, and faces a maximum storm surge risk of 12 to 13 metres according to the Flood Hazard Map of India. The island has suffered repeated, escalating devastation from major cyclones, each event compounding the last in terms of land loss, asset destruction and livelihood disruption.

Major Tropical Cyclones Impacting Ghoramara Island

Cyclone	Date	Landfall Location	Wind Speed (km/h)	High Tide at Sagar (m)
Aila	25 May 2009	Near Sagar Island	110–120 (gusts 130)	4.2
Bulbul	9 Nov 2019	Dhanchi Island	110–120 (gusts 135)	4.77
Amphan	20 May 2020	Lothian Island	155–165 (gusts 185)	4.67
Yaas	26 May 2021	Dhamra (Balasore)	130–140 (gusts 155)	7.5
Remal	26 May 2024	Sagar Island region	Severe cyclonic storm	—

Source: Report of the Expert Committee, July 2021, Environment Department, Govt. of West Bengal; field records

The island's coastline has been retreating at an average rate of 5 metres per year between 1960 and 2012, with some stretches losing as much as 150 metres of land. With rising global temperatures, sea and estuarine water levels around Ghoramara have risen by more than 3 millimetres per year in recent decades, accelerating both the loss of agricultural and residential land and the destruction of protective coastal mangroves. A 2022 remote sensing and GIS-based study found that the island's total insular area declined from 608 hectares in 1990 to 375 hectares in 2020, with approximately 39 percent of land area degraded due to shoreline change over that period. Built-up area, agricultural land, water bodies, and vegetation each registered measurable net losses over the three decades studied.

Change in Land Use / Land Cover, Ghoramara Island, 1972–2010 (hectares)

Class	1972	1979	1989	2000	2010
Land vegetation	157.68	99.35	102.96	108.5	116.37
Wetland	151.56	145.86	155.52	98.75	87.21
Uncultivated land	272.52	170.05	201.33	208.76	129.33
Fisheries	4.68	3.72	1.89	1.22	1.71

Source: Jana et al. (2012); extrapolated with Halder et al. (2023)

This data shows a sharp post-1989 decline in wetlands, indicating ecological stress and salinity intrusion, while overall uncultivated land falls significantly by 2010, reflecting outright land loss rather than land-use conversion. Following Cyclones Amphan and Yaas, salinity intrusion has rendered many ponds and low-lying areas unsuitable for both agriculture and fisheries, a pattern this baseline survey independently confirms at the household level: 98 percent of surveyed households reported losing land to erosion.

This pattern of accelerating, climate-driven land loss has direct and measurable socio-economic consequences for residents, which this baseline study quantifies in Chapter 5. As the island's habitable area shrinks and flood risk rises, households are repeatedly forced to relocate internally or to nearby Sagar Island or Kakdwip, disrupting agricultural livelihoods, community networks and access to basic services. It is this combination, severe and worsening climate exposure layered onto pre-existing economic marginalisation that makes Ghoramara a priority geography for climate-resilient, decentralized energy infrastructure and that frames the recommendations in Chapter 9 of this report.

CHAPTER 3- OBJECTIVES AND RESEARCH QUESTIONS

3.1 SPECIFIC OBJECTIVES

The baseline study was designed around the following specific objectives:

- To assess the current status of energy access among households on Ghoramara Island, including primary sources of lighting and cooking fuel and associated household expenditure.
- To understand the socio-economic profile of beneficiary households, including demographic characteristics, livelihood patterns, land ownership status, housing conditions and access to basic infrastructure .
- To identify the implications of energy poverty on education, particularly children's study time and learning outcomes and on home-based livelihood activities such as tailoring, handicrafts, net mending and poultry care.
- To assess the impact of inadequate or absent street lighting on community mobility, personal safety and access to essential services, with particular attention to the experiences of women and adolescent girls.
- To evaluate community awareness, prior exposure to and willingness to adopt and maintain renewable solar energy solutions, including households' financial and operational capacity to contribute to system upkeep.
- To assess the strength and role of existing community institutions, particularly Self-Help Groups, in supporting community ownership and long-term sustainability of proposed energy interventions.
- To establish pre-intervention benchmark values for key project indicators, namely kerosene use, children's study hours, household income, energy-related expenses, and night-time safety concerns, against which the outcomes of the proposed solar energy intervention will be measured.
- To generate actionable, evidence-based recommendations for the design of a decentralized solar energy plan, including household solar systems, community solar street lighting and associated maintenance and capacity-building mechanisms.

3.2. RESEARCH QUESTIONS

Building on the objectives outlined, the baseline study sought to answer the following research questions:

A. Energy Access and Use

1. What are the primary sources of lighting and cooking fuel currently used by households on Ghoramara Island?
2. How much do households spend on kerosene and other energy sources on a monthly basis?
3. What proportion of household income is consumed by energy-related expenditure?

B. Socio-Economic Profile

1. What are the demographic, livelihood and housing characteristics of households?
2. What is the extent of land ownership among households?
3. What are the primary sources of household income?

C. Implications of Energy Poverty

1. How does limited access to lighting affect children's study time and educational outcomes?
2. To what extent does inadequate energy access restrict home-based livelihood activities such as tailoring, handicrafts, net mending and poultry care?
3. What are the health, safety and fire-related risks associated with continued dependence on kerosene and biomass fuels?

D. Street Lighting and Community Safety

1. What difficulties do residents face in moving safely and accessing essential services after sunset due to the absence of street lighting?
2. How does the lack of street lighting differentially affect the mobility and safety of women and adolescent girls compared to other community members?

E. Community Readiness for Renewable Energy

1. What is the level of community awareness of, and prior exposure to, solar energy systems?
2. To what extent are households willing to adopt solar energy solutions and contribute financially or operationally to their maintenance?
3. What role can Self-Help Groups and other community institutions play in supporting ownership, training, and long-term maintenance of solar infrastructure?

F. Establishing the Benchmark

What are the current baseline values for kerosene use, children's study hours, household income, energy-related expenditure, and night-time safety concerns, against which future programme outcomes can be measured?

G. Recommendations for Intervention Design

Based on the findings, what form should the proposed decentralized solar energy plan take, including the design of household solar systems, community street lighting, and associated maintenance and capacity-building mechanisms?

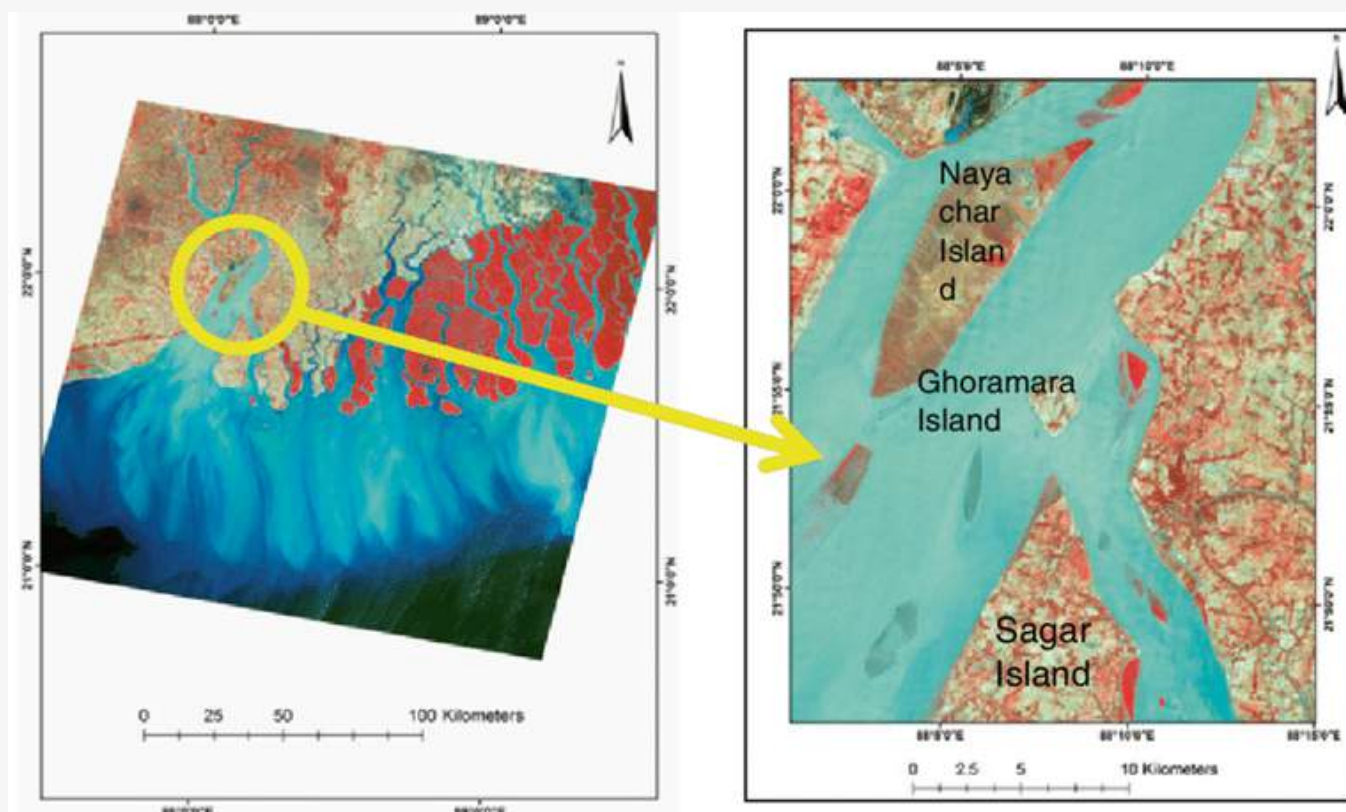


CHAPTER 4- METHODOLOGY

The baseline study adopted a mixed-methods approach, combining quantitative household-level data collection with qualitative community consultations, in order to capture both the measurable extent of energy poverty and its lived, qualitative implications for residents of Ghoramara Island.

4.1 STUDY AREA AND SAMPLING

The study was conducted across the hamlets of Raypara, Bagpara, Mandirtala, Hatkhola, Khasimara and Chunpuri, representing the major inhabited settlements of Ghoramara Gram Panchayat. Because the intended solar intervention prioritizes landless and climate-affected households, poor households with elderly members and households affected by forced migration, a comprehensive houselisting was first carried out across these hamlets to construct a stratified sampling frame. From this houselisting, a sample of 100 households was selected through stratified random sampling to ensure proportional representation across these vulnerability categories and to minimize selection bias. Quantitative and qualitative data were collected from the same sampled households to develop a coherent, triangulated understanding of the study objectives.



4.2 DATA COLLECTION TOOLS AND METHODS

The study adopted a mixed-method approach combining quantitative survey data with qualitative Focus Group Discussions (FGDs) for validation and deeper contextual understanding. A structured household questionnaire was administered to the women of each of the 100 selected households, covering demographic characteristics, housing conditions, livelihoods, land ownership, energy use and expenditure, health, education, and SHG participation.

To supplement the quantitative findings, four separate FGDs were conducted: two with female participants (under 30 years; 30–50 years) and two with male participants of the same age bands, each comprising 10 to 12 individuals of similar socio-economic background. FGDs examined gender-specific perceptions of evening activities, household chores, support for children's study, wage-earning activities after sunset, cooking-fuel expenditure, anticipated reduction in kerosene dependence if solar appliances were provided, demand for street lighting, willingness for community-based maintenance, and the potential for SHG-style user groups to manage solar assets. A structured checklist was prepared in advance to ensure consistent coverage of all study themes across FGDs.

Quantitative data were collected digitally using KoboToolbox and analyzed using Stata, generating descriptive, univariate, and bivariate statistics to identify outcome variables and their association with socio-demographic, economic, and cultural attributes. Qualitative data from FGDs were recorded, transcribed verbatim, and analyzed thematically to triangulate and contextualize the quantitative findings, particularly around lived experience, gendered impacts, and willingness to participate in maintenance and ownership. Both quantitative and qualitative data were collected during March 2026.





4.3 STUDY PERIOD AND IMPLEMENTATION

The baseline assessment was conducted during March to April 2026 by the Institute of Development Studies Kolkata (IDSK), commissioned by SEED as an independent research partner to ensure objectivity and methodological rigour in the assessment, free from any programme-implementation bias.

4.4 ESTABLISHING THE MONITORING AND EVALUATION BENCHMARK

Beyond characterizing current conditions, this baseline study serves a second, equally critical function for SBIF CONSERW- establishing the benchmark values against which the outcomes of the proposed VIBHA solar energy intervention will be measured over the course of the project. Specifically, the baseline establishes pre-intervention values for the following key indicators, which form the basis of the project's monitoring and evaluation framework:

- Percentage reduction in kerosene use
- Percentage increase in children's study hours
- Percentage increase in household income due to productive evening hours (due to solar lights)
- Percentage reduction in energy-related expenses
- Percentage drop in night-time safety concerns

These indicators have been selected to directly track the anticipated educational, economic, and social outcomes of improved energy access identified through this study and are intended to be revisited at defined intervals following project implementation to assess programme impact in a manner directly traceable back to this baseline. The full set of benchmark values is presented in Chapter 7.

4.5 SCOPE AND LIMITATIONS

Scope:

- The study was conducted across a representative sample of 100 households in Ghoramara Island to establish the baseline status of energy access, socio-economic conditions, and household characteristics prior to project implementation.
- The baseline assessed multiple dimensions, including household demographics, income and livelihoods, housing conditions, existing energy sources and expenditure, lighting practices, access to public infrastructure, perceptions of energy needs, and community priorities.
- The study also documented the challenges associated with energy poverty and its implications for education, health, livelihoods, safety, mobility, and overall quality of life.
- Findings from the baseline will serve as the primary evidence base for designing, implementing, and monitoring the SBIF CONSERW: VIBHA decentralized solar energy project.
- The baseline provides benchmark indicators against which project outcomes and long-term impacts will be measured during midline and endline evaluations.

Limitations:

- The study is based on a representative sample rather than a complete census; therefore, the findings should be interpreted as representative estimates rather than exact values for the entire island population.
- Information collected on household income, expenditure, health conditions, and energy consumption relied largely on respondents' self-reporting and may be subject to recall bias or reporting inaccuracies.
- Certain indicators, particularly the incidence of respiratory illnesses and other health-related variables, are influenced by seasonal variations. As the survey used a three-month recall period, these findings should be interpreted with appropriate caution.
- The survey captures conditions prevailing at the time of data collection and may not fully reflect future changes arising from climatic events, migration, policy interventions, or infrastructure development.
- Given Ghoramara's remote geography and difficult accessibility, minor operational constraints during fieldwork may have influenced the timing and logistics of data collection, although these did not materially affect the overall quality or reliability of the study.
- Despite these limitations, the baseline provides a robust and reliable reference for measuring the effectiveness, outcomes, and impact of the proposed decentralized solar energy intervention over the project period.

CHAPTER 5: FINDINGS

This chapter presents a comprehensive analysis of the surveyed population in terms of social, demographic, and economic characteristics, basic infrastructure and landholding status, current energy use, and the implications of energy poverty for education, livelihoods, and safety. It also presents the population's response to renewable energy, including prior exposure, willingness to pay, and readiness for community-based maintenance, the evidence base on which Chapters 7 through 9 build.

5.1 SOCIO-DEMOGRAPHIC PROFILE

Most respondents (62%) belong to the 18–40 years age group, reflecting a predominantly young, economically active population; 28% fall within 41–60 years and only 10% are above 60.

Women comprise 82% of respondents, reflecting their central role in household-level energy decisions and daily activities, the population this intervention is designed to serve most directly.

The study area is predominantly Muslim-populated (64%), with a substantial Hindu minority (36%); 93% of respondents belong to the General category and 7% to Scheduled Castes.

Educational attainment is notably low: 91% of respondents have completed five years of schooling or less, reflecting limited access to education and a likely constraint on awareness and livelihood diversification. Most respondents (89%) are married; 10% are widowed, a vulnerable group warranting particular attention in beneficiary targeting.



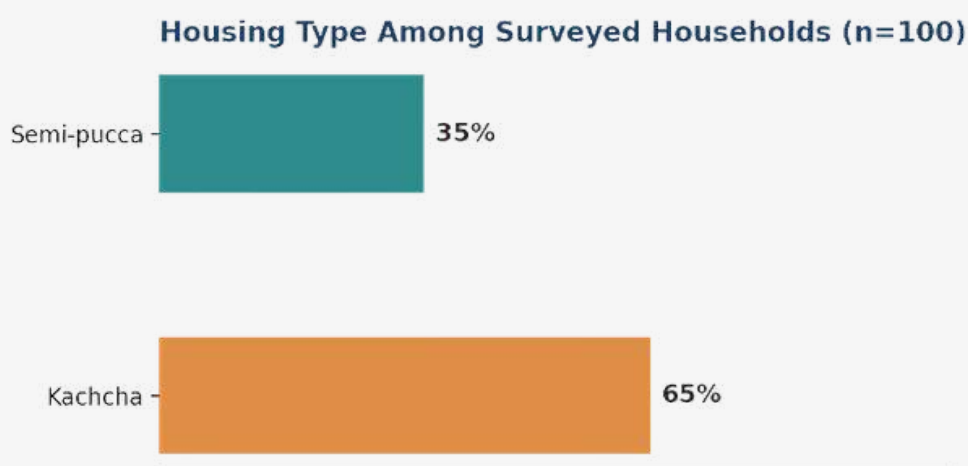
Table 5.1: Socio-Demographic Profile of Study Population (n=100)

Indicator	Category	%
Age	18–40 years	62%
Age	41–60 years	28%
Age	Above 60 years	10%
Sex	Female	82%
Sex	Male	18%
Religion	Islam	64%
Religion	Hinduism	36%
Social category	General	93%
Social category	Scheduled Caste	7%
Education	5 years schooling or less	91%
Education	More than 5 years	9%
Marital status	Married	89%
Marital status	Widow / Widower	10%
Marital status	Unmarried	1%

Source: Computed from IDSK baseline household survey, March–April 2026 (n=100)

5.2 HOUSING, INFRASTRUCTURE AND SOCIO-ECONOMIC STATUS

Two-thirds of households (65%) live in kachcha houses, with the remainder in semi-pucca structures, reflecting widespread housing vulnerability ahead of the cyclone season. Housing vulnerability is unevenly distributed: 8 of 10 widow/widower-headed households live in kachcha housing (against 2 in semi-pucca), and kachcha housing is markedly more prevalent among Muslim households (45 of 64) than Hindu households (20 of 36), pointing to specific sub-groups warranting prioritized targeting. Most households (64%) have two rooms, and 25% live in single-room dwellings, indicating considerable household congestion.



Sanitation and kitchen infrastructure remain inadequate for a meaningful share of households: 40% lack a separate kitchen, and 36% either lack a household latrine (24%) or depend on shared community facilities (12%). All surveyed households (100%) depend entirely on tube wells for drinking water, underlining complete dependence on groundwater with no alternative source.

Table 5.2: Household Infrastructure and Socio-Economic Status (n=100)

Indicator	Category	%
Dwelling rooms	1 room	25%
Dwelling rooms	2 rooms	64%
Dwelling rooms	3 rooms or more	11%
Source of lighting	Kerosene	94%
Source of lighting	Solar	6%
Separate kitchen	Present	60%
Separate kitchen	Absent	40%
Latrine	Within house	64%
Latrine	Not within house	24%
Latrine	Shared with community	12%
Drinking water	Tube well	100%

Source: Computed from IDSK baseline household survey, March–April 2026 (n=100)

5.2 HOUSING, INFRASTRUCTURE AND SOCIO-ECONOMIC STATUS

Wage labour dominates as the primary occupation (82% of households), with cultivation (5%), self-employment (6%), and government welfare dependence (7%) accounting for the remainder, a pattern of extreme livelihood concentration that leaves households exposed to seasonal and weather-related income shocks. As a secondary occupation, an overwhelming 85% of households rely on government welfare schemes, underscoring the limited cushioning households have outside formal safety nets.

FGDs revealed that male members increasingly turn to deep sea fishing as cultivable land is lost to erosion in riverbank areas, supplemented by agricultural wage labour and masonry work outside the island. During the three-month period when fishing is prohibited, displaced agricultural workers shift to pond-digging and betel-garden labour, or remain idle for lack of alternatives, a seasonal vulnerability window that a reliable energy source could help households absorb through home-based income generation instead.

“Since our land in the river bank lost due to erosion, we compelled to engage in fishing for income.”

— Male FGD participant

Table 5.3: Occupational Status of Study Population (n=100)

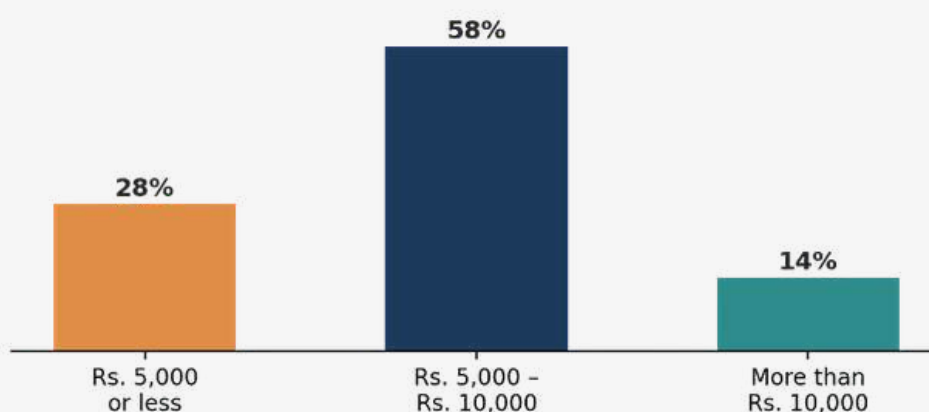
Occupation	Primary (%)	Secondary (%)
Labourer	82%	8%
Cultivator	5%	1%
Self-employed	6%	6%
Government welfare schemes	7%	85%

Source: Computed from IDSK baseline household survey, March–April 2026 (n=100)

5.4 HOUSEHOLD INCOME

More than half of households (58%) earn between Rs. 5,000 and Rs. 10,000 per month, while 28% earn Rs. 5,000 or less; only 14% earn more than Rs. 10,000 monthly. Expenditure patterns closely mirror income, 51% of households spend Rs. 5,000 to Rs. 10,000 monthly, and 35% spend Rs. 5,000 or less, leaving most households with minimal capacity to save or absorb shocks such as cyclone damage or medical emergencies.

Monthly Household Income Distribution (n=100)



Within this constrained income envelope, **kerosene expenditure of Rs. 400 to 600 per month represents a meaningful and recurring share of household cash outflow**, a cost this baseline establishes as a direct, measurable target for reduction once solar energy access is in place (see Chapter 7).

5.5 LAND HOLDING AND THE COMPOUNDING IMPACT OF EROSION

Land data in this survey should be read alongside the environmental findings of Chapter 2: this is not abstract land scarcity but the direct, ongoing consequence of riverbank erosion documented at the household level. Only 22% of households currently possess cultivable land; 78% own none. Among the minority that do hold land, 64% own 20 kathas or more, indicating considerable inequality even within this small landed group. Of land-owning households, 91% continue to cultivate annually, demonstrating resilience and continued agricultural commitment despite worsening conditions; 86% lease out land, mostly because labour constraints, declining productivity from salinity, or migration make independent cultivation unviable.

Strikingly, 98% of respondents reported losing land to erosion, of whom 87% lost 20 kathas or more. A full 40% of households previously possessed cultivable land that they no longer have today, meaning nearly two in five surveyed households have been rendered landless or land-reduced within living memory, directly as a result of the climate-driven erosion process described in Chapter 2.

Impact of Riverbank Erosion on Cultivable Land



Of those,
lost
20+ kathas



87%



Households
that
lost land
to erosion



98%

"Everything has gone into the river. Many people have become landless. Houses along the riverbank are collapsing. There is not even enough land to rebuild houses."

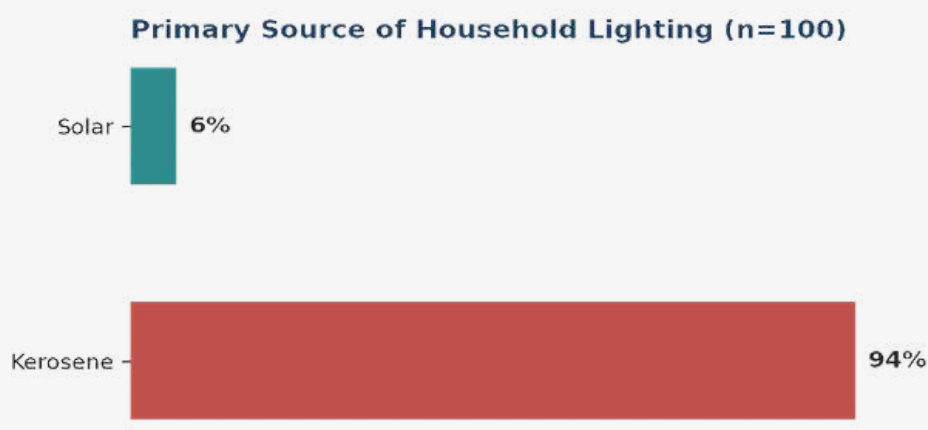
Table 5.4: Land Holding and Erosion Impact (n=100)

Indicator	Category	%
Currently owns cultivable land	Yes	22%
Currently owns cultivable land	No	78%
Previously owned cultivable land	Yes	40%
Previously owned cultivable land	No	60%
Lost land due to erosion	Yes	98%
Lost land due to erosion	No	2%
Of those who lost land, amount lost	20 kathas or more	87%
Of those who lost land, amount lost	Less than 20 kathas	13%

Source: Computed from IDSK baseline household survey, March–April 2026 (n=100)

5.6 ENERGY USE- LIGHTING AND COOKING

Kerosene remains the overwhelming primary source of household lighting (94%), with solar accounting for only 6%, almost entirely among households that retain partial-functioning legacy government-distributed systems. FGD participants consistently described kerosene as having become unaffordable, since subsidized ration-shop prices have converged with open-market prices, eliminating the historical price advantage of the public distribution system.

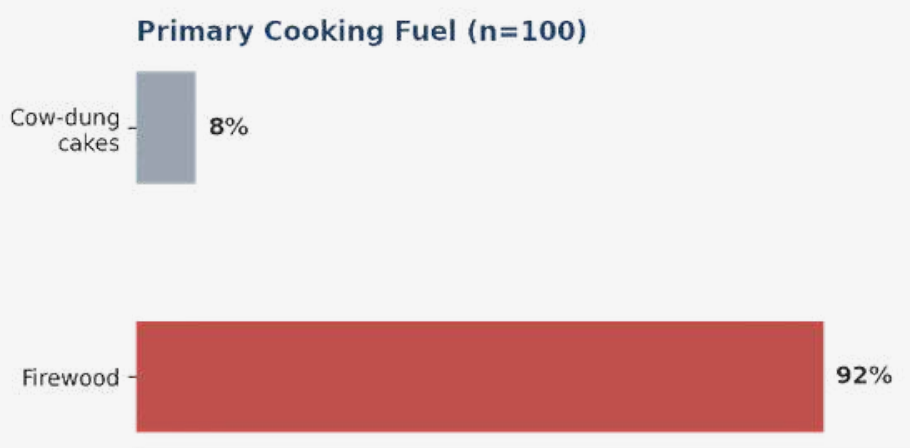


“What we received through ration was not sufficient, so we had to buy more. In a month it would be around five to seven litres. Roughly ₹500 to ₹700.”

— Male FGD participant

To manage this cost, households actively curtail evening activity, most reported finishing cooking by around 6:30 p.m. while daylight remains, a self-rationing behaviour that directly limits the time available for study, livelihood work, and rest. **When asked how much kerosene dependence would fall if solar lighting were available, respondents across age and sex consistently estimated a 50 to 60 percent reduction, the figure that anchors the kerosene-reduction benchmark in Chapter 7.**

Cooking fuel use shows a similarly stark dependence on biomass: 92% of households use firewood and 8% use cow-dung cakes, with no household reporting LPG as a primary fuel. FGDs revealed that the Ujjwala subsidy is effectively inaccessible on the island because the nearest LPG dealer is across the river, adding transport costs that push the effective cylinder price to Rs. 1,000–1,200 against a subsidized price of Rs. 900, while many households report the subsidy itself never reaching their bank accounts.



"The LPG dealer is located across the river. Transportation costs are added because cylinders must be brought here by boat."

— Female FGD participant

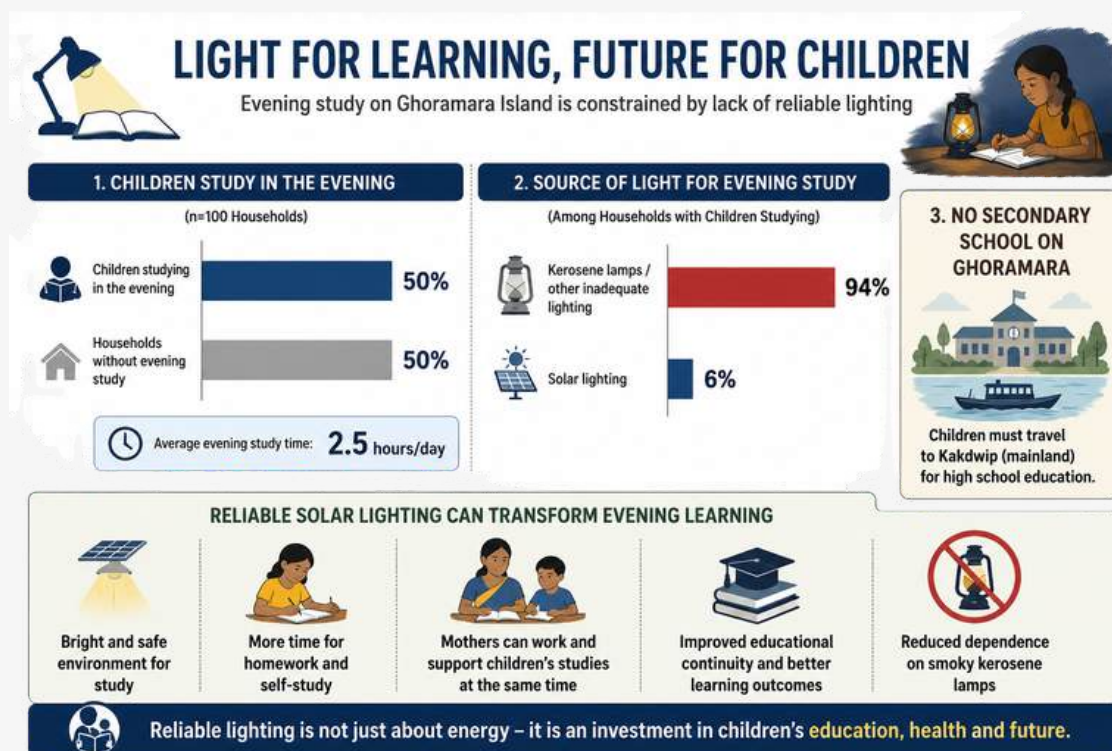
Cooking itself is highly time-intensive: 92% of households spend two to four hours daily preparing meals, mostly during daylight (74% spend two or more hours cooking in the day, against only 22% doing so in the evening), a pattern that itself reflects energy-driven time rationing rather than household preference. While reported respiratory illness in the prior three months was low (3%), all respondents (100%) believe renewable energy adoption would reduce respiratory health risk, reflecting strong, if anecdotal, awareness of the smoke and air-quality burden of current fuel use, a perception consistent with the public-health literature on solid-fuel cooking.

"Most households complete cooking during daylight because there is no dependable source of electricity after sunset. Cooking with traditional fuels is time-consuming and smoky. Access to clean energy would improve health, reduce drudgery, and allow families to manage their time more efficiently."

— Female FGD participant

5.7 EDUCATION AND EVENING ACTIVITIES

Among households where children study in the evening (50% of the sample), the average study time is 2.5 hours per day, almost entirely under kerosene light given that solar lighting penetration remains below 6% across the sample regardless of household size or number of children. Notably, the island has no secondary school: children must travel to Kakdwip on the mainland for high school education, making reliable lighting for evening self-study and tutor-assigned homework even more consequential for educational continuity.



Evening hours on Ghoramara are not characterised by leisure but by productive household and livelihood activities. However, due to the complete absence of grid electricity and reliable lighting, these activities are largely undertaken during daylight hours, before dusk, rather than in the evening.

Household members, particularly women, consciously reorganise their daily schedules to complete cooking, embroidery, weaving, mending fishing nets, poultry care and other income-generating tasks before sunset; as kerosene lamps provide inadequate illumination, emit smoke and are costly to use for prolonged periods.

This reflects a clear case of **energy-induced time poverty**, where the lack of modern energy services restricts how households allocate their time.

The burden of this adjustment falls disproportionately on women. In addition to their domestic responsibilities, women are expected to complete cooking before dark while simultaneously carrying out productive activities that contribute to household income, leaving little opportunity for rest, skill development, or supporting their children's education. **The absence of adequate lighting therefore results in a "double work burden", compressing multiple household and economic activities into limited daylight hours.**

During Focus Group Discussions respondents expressed a strong preference for using evening hours more productively if adequate lighting were available.

Table 5.5: Household and Livelihood Activities Prioritised Before Dusk Owing to Energy Poverty (Multiple Responses, n=100)

Activity	%
Embroidery	38%
Weaving	30%
Teaching children	28%
Poultry care	9%
Mending Fishing Nets	9%
Handicrafts	6%
Other	2%

"Our entire day is spent completing household chores and preparing meals before sunset. We also have to finish embroidery and other income-generating work during daylight because working under kerosene lamps is difficult. If solar lighting were available, we could continue earning after dark while sitting beside our children and helping them study."

— Female FGD Participant

5.8 STREET LIGHTING: SCALE OF THE GAP

Ghoramara's six villages are spread across roughly 5 sq km of low-lying, erosion-prone land, criss-crossed by narrow village paths, embankment tracks, and routes to water points and river ghats. **Applying standard rural lighting spacing norms ie roughly one point every 30–35 metres along primary and secondary village paths, the island is estimated to need around 290 streetlights for reasonably complete coverage of its inhabited and functional areas. Against this benchmark, the 120 lights installed so far cover barely 40% of the island's estimated requirement, leaving around 170 streetlights still needed** and more importantly, the existing lights are concentrated at a handful of institutional sites rather than distributed along the secondary paths, water points and ghats where residents spend most of their after-dark movement.

Current Streetlight Coverage

To date, SEED has installed a total of 120 streetlights across Ghoramara Island – 110 through support from Signify and 10 through Rotary International. These installations are concentrated at institutional and public-use points: market areas, the multipurpose community centre, schools, Anganwadi centres, and Community Health Centres (CHCs). This placement reflects a sound first-phase strategy – lighting the points of highest daily footfall and the facilities most critical to safety and service delivery. However, it also means that lighting on the island currently exists almost entirely at these fixed institutional nodes, rather than along the connective village infrastructure that residents rely on to actually reach them.

The Scale of the Remaining Gap

Ghoramara's six villages are spread across roughly 5 sq km of low-lying, erosion-prone land, criss-crossed by narrow village paths, embankment tracks, and routes to water points and river ghats. Applying standard rural lighting spacing norms – roughly one point every 30–35 metres along primary and secondary village paths – the island is estimated to need around 290 streetlights for reasonably complete coverage of its inhabited and functional areas. Against this benchmark, the 120 lights installed so far cover barely 40% of the island's estimated requirement, leaving around 170 streetlights still needed – and, more importantly, **the existing lights are concentrated at a handful of institutional sites rather than distributed along the paths, water points, and ghats where residents spend most of their after-dark movement.**

Where the Darkness Persists

Village interior paths- The narrow lanes connecting homes to coaching centres and each other remain largely unlit once away from the market or community centre. Children walking to evening coaching classes and the 18% of households who cited this as a direct problem, must still navigate these stretches in the dark.

Water collection points- Handpumps and tubewells which are used most heavily by women in the early morning and evening sit outside the current lighting footprint entirely, a gap directly linked to the **55% of households who reported difficulty fetching water after dark**.

River ghats- The boat landing points that serve as the island's primary connection to the mainland have only minimal, ad hoc lighting – a torch or a single bulb where one exists at all – despite being critical during evening arrivals, medical emergencies etc.

Embankment and riverside paths- These routes, already flagged by residents for dense vegetation and the risk of snakes after dark, remain among the least lit areas on the island, compounding the **safety concerns raised by 67% of surveyed households**.

Cyclone Shelter Access in Times of Disaster

Ghoramara's exposure to cyclones and tidal surges makes rapid, safe movement to shelter a matter of life and death – yet the absence of street lighting turns this into one of the island's most serious unaddressed risks. Cyclone warnings frequently arrive or intensify after dark, and in the confusion of an evacuation, households must navigate the same unlit paths, embankments and waterlogged tracks that residents already avoid on ordinary nights. For the elderly, pregnant women, young children and persons with disabilities, this is not a minor inconvenience but a direct barrier to reaching safety in time.

Families described having to use torches, mobile phone flashlights, or simply feel their way along familiar routes – a workable solution for daily life, but a dangerous bottleneck when an entire village needs to evacuate quickly and simultaneously. The risk is compounded on the approach to cyclone shelters themselves, where crowding, uneven ground and fallen debris during a storm are far more hazardous to navigate without any fixed lighting to guide movement or help shelter staff manage the influx of arrivals.

Social Life After Dark

Beyond emergencies, the absence of lighting shapes the rhythm of everyday life on the island in a more quiet but equally significant way: social and economic activity effectively comes to a stop once the sun sets. Small shops and tea stalls close early rather than stay open into the evening, informal gatherings that might otherwise happen on verandas or courtyards move indoors or don't happen at all, and women in particular described curtailing all movement after dark – not out of habit, but out of a well-founded sense that the dark paths are simply not safe to walk. Children lose the option of evening play or informal peer interaction outside the home. For a community already contending with erosion, migration and economic precarity, this contraction of public life after dusk narrows an already limited space for the everyday social exchange – sharing information, coordinating support, maintaining community ties – that helps island residents cope collectively with the pressures they face.

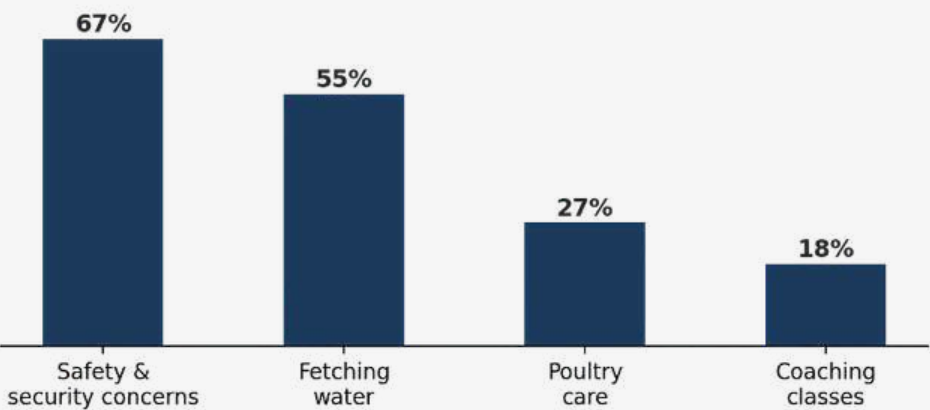
Why This Gap Matters?

The consequences of this uneven coverage are not evenly distributed either. They fall hardest on women and children navigating water points and coaching routes, on elderly residents with reduced mobility in the dark, and – most critically – on the entire community during a cyclone evacuation, when unlit paths and ghats become genuine bottlenecks to reaching shelter safely. Extending lighting beyond the current institutional anchors to the village's pathways, water points, and ghats is therefore not simply an infrastructure upgrade – it is a direct extension of safety, mobility, and disaster preparedness to the routes people actually use every day.

The Absence of Street Lighting: Safety, Mobility and Daily Life

The absence of street lighting across Ghoramara emerged as one of the most consequential findings of this study. 87% of respondents reported facing problems as a direct result, with safety and security concerns the most commonly cited issue (67%), followed by difficulty fetching water after dark (55%), constraints on poultry care (27%), and restricted access to evening coaching classes (18%).

Challenges Reported Due to Absence of Street Lighting
(87% of households affected; multiple responses)



“There is a lot of dense vegetation and jungle growth along the riverbank. We rarely go out at night. Snakes come out at night during the hot season.”

— Female FGD participant

“Children may be hit by bicycle in complete darkness. The roads are dark, and children may collide with someone cycling. There is no proper lighting in our area. That is a major problem.”

— Young married woman, FGD

These risks fall disproportionately on women, children, and the elderly, and on medium and larger households in particular: among households with two or more children, 68 of 81 reported street-lighting-related problems, against 15 of 19 among smaller households, indicating that the burden of inadequate lighting scales directly with the number of children whose safety and mobility are at stake.

“My daughter is twelve, and she used to go for evening tuition just after sunset. But the path is completely dark, there is no one else on it most days, and I kept thinking – what if something happens to her and no one even hears? I stopped sending her. Now she studies whatever she can at home, but it is not the same as having a teacher. I worry it will affect her studies, but her safety comes first.”

— Mother, FGD participant

“During Cyclone Remal, the warning came in the evening and it was already getting dark. We had to walk to the shelter holding the children's hands, feeling our way along the path with our feet because there was no light anywhere on the route. If someone had fallen or gotten separated in that rush, we would not have known until it was too late.”

— Female FGD participant

5.9 ENVIRONMENTAL EFFECTS OF KEROSENE LAMPS AND PROJECTED CO2 SAVINGS FROM SOLAR HOME SYSTEMS

Kerosene lighting is one of the most damaging yet under-recognised environmental burdens carried by off-grid communities like Ghoramara. Burning kerosene indoors releases black carbon, fine particulate matter (PM2.5), and carbon monoxide alongside carbon dioxide, contributing simultaneously to indoor air pollution, respiratory illness, and climate impact. Black carbon in particular is a short-lived but highly potent climate pollutant, with a warming effect many times greater than CO2 per unit mass, making kerosene lamps disproportionately damaging relative to the small amount of light they provide.

Baseline Kerosene Consumption and Emissions

The IDSK baseline household survey (n=100) found that **surveyed households consume an average of 6 to 10 litres of kerosene per month for lighting**. Using a standard emission factor of approximately 2.52 kg CO2 per litre of kerosene burned, this translates into a meaningful, quantifiable carbon footprint purely from household lighting, before accounting for the associated black carbon and health costs.

Projected Impact of Solar Home Systems

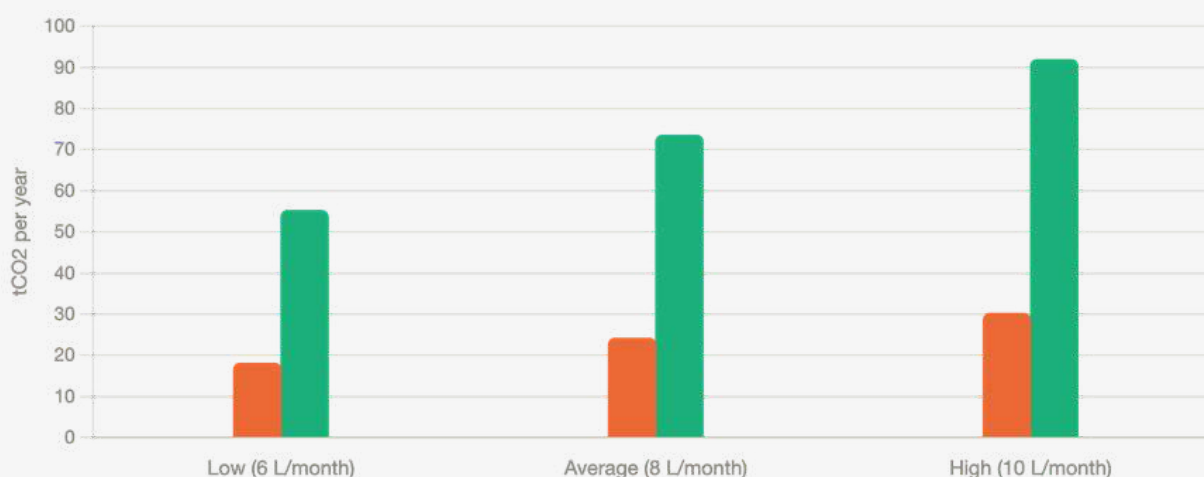
As solar home systems are deployed under the VIBHA programme (against a programme target of 380 systems), the same kerosene consumption baseline can be used to estimate the CO2 that will be averted. Applying the M&E target of an 80% reduction in kerosene use post-intervention (rather than assuming full elimination, since some households may retain kerosene for backup use), the table below sets out the estimated range of emissions avoided.

Metric	Low estimate (6 L/month)	Average estimate (8 L/month)	High estimate (10 L/month)
Kerosene consumption per household (annual)	72 L	96 L	120 L
CO2 emissions per household (annual)	181.4 kg	241.9 kg	302.4 kg
Baseline CO2 emissions – 100 surveyed households (annual)	18.1 tCO2	24.2 tCO2	30.2 tCO2
Projected CO2 averted (annual) at full deployment of 380 solar home systems	55.2 tCO2	73.5 tCO2	91.9 tCO2

Taken together, the data suggests that once all 380 solar home systems under the programme are deployed and in regular use, **the intervention could avert somewhere in the range of 55 to 92 tonnes of CO₂ annually, with roughly 74 tCO₂/year as a reasonable central estimate** – alongside the associated but harder-to-quantify reductions in black carbon, indoor air pollution, and fire risk that come with retiring kerosene lamps from daily use.

Note: These figures are illustrative estimates derived from the baseline survey's reported consumption range and a standard kerosene combustion emission factor (2.52 kg CO₂/L). They have not been independently verified against a certified carbon accounting methodology and should be labelled as an estimate; not a measured or audited figure in any formal report.

Kerosene CO₂ emissions vs projected savings from solar home systems



The infographic above shows all three consumption scenarios side by side – baseline kerosene emissions from the 100 surveyed households against the projected CO₂ averted once all 380 solar home systems are deployed at the programme's 80% kerosene-reduction target.

At present, the **380 households targeted under the VIBHA programme collectively emit an estimated 91.9 tonnes of CO₂ annually from kerosene-based lighting alone** (ranging from approximately 68.9 to 114.9 tCO₂/year across the low-to-high consumption band identified in the baseline survey). Once all 380 solar home systems are installed and in regular use, and assuming the program's targeted 80% reduction in kerosene dependence is achieved, **this is projected to fall to an estimated 73.5 tonnes of CO₂ averted annually** (ranging from approximately 55.2 to 91.9 tCO₂/year). In other words, the solar intervention is expected to eliminate roughly four-fifths of the emissions currently generated by kerosene lighting across these households each year, translating a basic lighting upgrade into a measurable and recurring climate benefit for the community.

5.10 COMMUNITY READINESS, WILLINGNESS TO PAY AND THE ROLE OF SELF-HELP GROUPS

This baseline finds an exceptionally high level of community readiness for a decentralized solar intervention, evidence that directly de-risks SBIF CONSERW's investment in this programme. 95% of respondents aspire to non-fuel-based energy provision, 98% are willing to financially contribute toward future maintenance, 86% are willing to actively participate in street-light maintenance, and 68% want formal training on solar operation and maintenance.

COMMUNITY READINESS FOR DECENTRALIZED SOLAR ENERGY



This readiness is not merely aspirational. Many households have direct prior experience with rooftop solar systems distributed by SEED “Lighting Lives” solar project supported by the Signify. Subsequent panchayat-distributed units, while welcome, also failed to achieve full coverage. Women in particular reported retained, practical knowledge of battery maintenance, cleaning terminals, judging charge state and identifying when a fault requires technician referral to Kakdwip, that represents a genuine, ready-to-use asset for this intervention rather than a training programme starting from zero.

“We women actually have more responsibility for it. Men do not always pay attention to these things because they are often away from home for work.”

— Middle-aged woman, FGD

Solar appliance use priorities are clear and consistent with the energy-poverty findings above: 80% of respondents would prioritize solar for evening cooking, 61% for home lighting, 49% for children's education, and smaller shares for phone charging (15%), weaving (11%), and poultry care (10%). When asked how they would respond to a solar malfunction, 72% said they would seek local technical help and 30% said they would attempt repair themselves, indicating a clear preference for, and dependence on, a local technician network rather than reliance on external service providers.

Table 5.7: Community Readiness Indicators (n=100)

Indicator	%
Aspiration for non-fuel-based energy	95%
Willing to contribute to future maintenance costs	98%
Willing to participate in street-light maintenance	86%
Interested in solar O&M training	68%
Would seek local technical help if appliance malfunctions	72%
Currently possess any technical skills	8%
Have received any formal skill training to date	1%

Source: Computed from IDSK baseline household survey, March–April 2026 (n=100)

Self-Help Groups represent the institutional backbone on which this readiness can be operationalized. 65% of respondents are active SHG members, with an average membership tenure of nine years and 100% reporting regular monthly meeting attendance. 87% of SHG members have received financial assistance, predominantly loans for house repair, and households consistently identified the SHG group-savings and interest-bearing loan model (Rs. 1 per Rs. 100 per month) as their preferred mechanism for financing future solar battery replacement, since few households have independent savings capacity.

For street light financing specifically, 60% of respondents preferred a combined model of individual household contribution plus a pooled community fund, reinforcing the case for an SHG-anchored, group-based maintenance and financing structure rather than a purely household-by-household or purely centralized model.

CHAPTER 6- THE ENVIRONMENTAL CASE FOR DECENTRALIZED SOLAR ENERGY

This baseline treats environmental and climate risk not as background context but as the central justification for the intervention design proposed in Chapter 9. Three environmental realities, established in Chapter 2 and confirmed at the household level in Chapter 5, together make the case that decentralized, individually-owned solar systems, rather than grid extension or centralized micro-grids, are the only durable energy solution for Ghoramara.

6.1 GRID EXTENSION IS NOT A VIABLE ALTERNATIVE

Ghoramara's isolation by the Ganges river system, combined with its continuing physical shrinkage, makes conventional grid extension both prohibitively expensive and a poor long-term investment: any grid infrastructure built today would itself be exposed to the same erosion and storm-surge risk eroding the island's land mass. Historical experience confirms this. The West Bengal Renewable Energy Development Authority (WBREDA) installed 17 solar power plants in the Sundarbans between 1996 and 2006, and grid-connected power did not reach the region until as late as 2018. Even after grid connection arrived elsewhere in the delta, supply has remained unreliable during disasters, with outages lasting days to weeks during Cyclones Bulbul, Amphan, and Yaas. Centralized micro-grid installations on Ghoramara itself have a documented record of failure, including a state-supported micro-solar project that served only 400–500 of the island's 1,100-plus households before failing within three months.



6.2 INDIVIDUALLY-OWNED ROOFTOP SOLAR HAS THE STRONGEST TRACK RECORD

By contrast, individually-owned rooftop solar systems have consistently outperformed centralized alternatives across the wider Sundarbans region. WBREDA alone installed over 200,000 rooftop solar home lighting systems across the delta, with beneficiaries contributing only 15 to 18 percent of unit cost. Many of these units, including some on Ghoramara itself, remain in household use today, years after the centralized micro-grid model failed. This baseline's own findings corroborate this pattern directly: households with prior solar exposure report functioning, multi-year-old systems being actively maintained by women household members, with battery life extended from a nominal five years to seven, eight, or even nine years through careful upkeep, a level of asset stewardship that a centralized system, owned and maintained by no one in particular, structurally cannot replicate.

6.3 CLIMATE-RESILIENT BY DESIGN

Decentralized, individually-owned solar systems are inherently more climate-resilient than either grid or micro-grid alternatives: a single damaged or flooded unit affects one household rather than the entire island, repair and replacement can proceed household by household without requiring large-scale reconstruction, and systems can be elevated, secured, or protected at the household level in line with locally understood flood risk. This is consistent with the wider evidence base on community and rooftop solar in disaster-prone settings, which finds that distributed solar infrastructure measurably increases household and community resilience to natural disasters precisely because of this fault-tolerant, decentralized structure.

6.4 DIRECT ENVIRONMENTAL AND EMISSIONS BENEFITS

Beyond resilience, the proposed transition carries direct environmental co-benefits material to SBIF CONSERW's broader sustainability mandate. The baseline establishes that 94% of households currently depend on kerosene for lighting and 92% on firewood for cooking; FGD evidence indicates that solar adoption could reduce kerosene dependence by 50 to 60 percent, directly reducing associated greenhouse gas and black carbon emissions, indoor air pollution, and the embodied transport emissions of shipping kerosene and firewood to an island accessible only by ferry. Reduced kerosene combustion also reduces fire risk in kachcha housing, 65% of the surveyed stock, where open flames present a heightened structural hazard.

Taken together, the environmental case is threefold: grid and micro-grid alternatives are neither economically nor physically viable on a shrinking, storm-exposed island; individually-owned rooftop solar has a demonstrated multi-decade track record of resilience and local stewardship in this exact geography; and the transition itself delivers measurable emissions and safety co-benefits. This is the environmental logic underpinning the recommendations in Chapter 9.



CHAPTER 7- BASELINE BENCHMARK FOR MONITORING AND EVALUATION

As set out in Chapter 4, this baseline establishes the pre-intervention values for five key indicators that will anchor the monitoring and evaluation framework for SBIF CONSERW's investment in the VIBHA solar energy programme on Ghoramara Island. These values represent the starting point of the programme and should be tracked at defined intervals (recommended: 12 and 24 months post-installation) using the same household survey instrument to ensure direct comparability.

7.1 FROM BASELINE TO ENDLINE: MEASURING WHAT CHANGES

With these baseline values now established, the programme's task shifts from measurement to monitoring. Each of the five indicators carries a defined target against which progress will be assessed: an 80% reduction in kerosene dependence, a 35% increase in children's evening study hours, a 30% rise in household income, a 40% reduction in energy-related expenses, and a 50% drop in night-time safety concerns. Reassessing these same indicators through identical survey instruments at the 12- and 24-month marks will allow the programme to attribute change directly to the solar interventions rather than to broader, harder-to-isolate shifts in the community's circumstances. Where progress falls short of target at the interim mark, this comparison will also serve a diagnostic purpose, helping the programme team identify whether the gap lies in adoption, usage patterns, or external factors, and adjust implementation accordingly well before the endline assessment.



TABLE 7.1: PRE-INTERVENTION BASELINE VALUES

Indicator	Baseline Value	Basis
Kerosene dependence for lighting	94% of households	Household survey
Anticipated reduction in kerosene use/expenditure if solar provided	50–60% (community estimate)	FGD consensus
Average monthly kerosene expenditure per household	Rs. 400–600	Household survey / FGD
Children's average evening study time (where study occurs)	2.5 hours/day (under kerosene lamp)	Household survey
Households where children study in the evening	50%	Household survey
Average monthly household income	58% earn Rs. 5,000–Rs. 10,000	Household survey
Households reporting problems due to absent street lighting	87%	Household survey
Households citing safety/security as their primary night-time concern	67%	Household survey
Households engaged in home-based income-generating activity (after sunset)	8%	Household survey

Source: Computed from IDSK baseline household survey, March–April 2026 (n=100)

7.2 OUTCOME METRICS FOR TRACKING PROGRAMME SUCCESS

Against this baseline, the programme's success can be tracked through five headline outcome metrics:

- Percentage reduction in kerosene use — target informed by the community's own estimate of a 50–60% potential reduction
- Percentage increase in children's evening study hours — measured against the current baseline average of 2.5 hours
- Percentage increase in household income — particularly through expanded home-based, evening-hours livelihood activity, measured against the current participation rate of 8%
- Percentage reduction in energy-related household expenditure — measured against the current average monthly kerosene spend of Rs. 400–600
- Percentage drop in night-time safety concerns — measured against the current 67% of households reporting safety as a primary concern

Re-administering this survey instrument at 12 and 24 months will allow SBIF CONSERW to demonstrate measurable, attributable impact against each of these five indicators.





CHAPTER 8- CONCLUSION

The baseline assessment establishes that energy poverty is one of the most significant barriers to sustainable development on Ghoramara Island. The island's geographic isolation, continued riverbank erosion, repeated cyclones and complete absence of grid electricity have created a situation where energy deprivation compounds existing socio-economic vulnerabilities. Rather than being an isolated infrastructure issue, the lack of reliable electricity affects almost every aspect of household well-being, including education, livelihoods, health, safety, gender equality and climate resilience.

The survey reveals overwhelming dependence on traditional energy sources, with 94% of households relying on kerosene for lighting and 92% using firewood for cooking. Regular expenditure on kerosene places an additional financial burden on low-income households while providing poor-quality lighting that limits productive evening hours, exposes families to smoke and fire hazards, and restricts children's educational opportunities. The inadequate public street lighting further affects mobility, especially for women, children and elderly persons, increasing concerns related to safety, access to water points, health services and emergency response after sunset.

The findings also demonstrate that energy poverty reinforces existing livelihood challenges. Continuous land erosion has severely reduced cultivable land, forcing households to depend primarily on wage labour and fishing while limiting opportunities for agriculture-based income. Women bear a disproportionate burden as household responsibilities, income-generating activities and childcare are compressed into daylight hours due to the lack of adequate lighting.

Focus Group Discussions indicate that reliable solar lighting would enable women to continue productive work after dusk while simultaneously supervising children's education, thereby reducing their daily workload and expanding household income opportunities.

Despite these challenges, the study highlights exceptionally strong community readiness for decentralized renewable energy. Most households expressed willingness to adopt solar energy systems, contribute towards maintenance costs, participate in community management mechanisms and receive technical training. Existing Self-Help Groups provide an effective institutional platform for community ownership, maintenance and long-term sustainability of solar assets. These findings indicate favourable conditions for implementing a community-driven decentralized solar energy model.

Overall, the baseline confirms that decentralized solar energy offers far more than improved access to electricity. It presents an opportunity to enhance educational outcomes, strengthen livelihoods, improve women's safety and mobility, reduce household expenditure on polluting fuels, lower carbon emissions and build long-term resilience in one of India's most climate-vulnerable island communities. The benchmark indicators established through this study provide a robust foundation for monitoring and evaluating the long-term impact of the VIBHA Solar Initiative throughout the project period.



CHAPTER 9- RECOMMENDATIONS

9.1 Prioritize Individually-Owned Rooftop Solar Home Systems

Given that 94% of households currently depend on kerosene for lighting and that home-based, evening-hours livelihood activities such as embroidery (38%), weaving (30%) and net mending (9%) are consistently constrained by inadequate lighting, individually-owned rooftop solar home systems should form the primary component of the intervention. Unlike shared or centralized infrastructure, household-owned systems place reliable lighting directly under the control of the family that depends on it most, particularly the women who manage the bulk of the evening's compressed household and livelihood workload. Prior, if partial, experience with government-distributed rooftop units on the island means this is a familiar rather than unfamiliar technology to most households, easing adoption.

9.2 Install Solar Street Lighting on a Prioritized, Surveyed Basis

With an estimated requirement of approximately 290 streetlights for reasonably complete coverage of the island's inhabited and functional areas, and only 120 installed to date, concentrated at institutional points such as markets, the community centre, schools, Anganwadi centres and CHCs, the remaining rollout should be planned on a surveyed, prioritized basis rather than an ad hoc one. Priority should go to village interior paths used by children travelling to evening coaching classes (a problem cited by 18% of households), water collection points used by women (55%), river ghats serving as the island's primary connection to the mainland, and embankment and



riverside paths already flagged for safety concerns, including snake, by residents. Cyclone shelter access routes warrant particular attention, given the demonstrated risk of unlit evacuation paths during past events such as Cyclone Remal.

9.3 Establish SHG-Anchored Beneficiary Groups for Maintenance

With 65% of respondents already active, long-tenured SHG members and 86% expressing willingness to directly participate in streetlight upkeep, the programme should formalize SHG-anchored beneficiary groups as the primary maintenance structure for both household systems and community street lighting. This approach builds on existing institutional trust and monthly meeting discipline rather than introducing a parallel management structure, and reflects the community's own stated preference, with 60% favouring a combined model of individual contribution plus a pooled community fund for streetlight financing specifically.

9.4 Create a Flexible, SHG-Style Maintenance Fund

Given that 98% of respondents are willing to contribute financially toward maintenance but few households hold independent savings, a maintenance fund modelled on the familiar SHG group-savings and interest-bearing loan structure (Rs. 1 per Rs. 100 per month) should be established for battery replacement and system repair. This model was consistently identified by households themselves as their preferred financing mechanism and requires no new financial literacy or trust-building, since it mirrors a system SHG members already operate successfully.

9.5 Deliver Structured Operation and Maintenance Training

With 68% of respondents expressing interest in formal solar operation and maintenance training, and existing technical familiarity limited to informal, partial knowledge (only 8% currently possess any technical skills, and just 1% has received formal training to date), structured O&M training should be delivered as a core, non-optional component of the rollout, rather than an afterthought.

Training should build on the practical, hands-on knowledge that women in particular already hold from prior solar exposure, battery upkeep, terminal cleaning and basic fault recognition, formalizing and extending it rather than starting instruction from zero.

9.6 Build a Local Technical Cadre Through Youth Training, and Establish Two Solar Repair Units

To reduce the island's dependence on technicians based across the river in Kakdwip, referenced by the 72% of respondents who said they would seek local technical help in the event of a malfunction, the programme should train a dedicated cadre of local youth as solar technicians, and establish two solar repair units on the island to house this capacity. These repair units would serve as the first point of call for system faults, battery servicing and minor repairs across both household solar systems and community street lighting, reducing repair turnaround time, cutting the cost and delay of mainland referral and creating a small but meaningful source of skilled, island-based employment for trained youth.

9.7 Strengthen Disaster Resilience

Ensure that all solar infrastructure is installed using climate-resilient designs capable of withstanding cyclones, flooding, high winds and saline environmental conditions. Develop community protocols for protecting and restoring systems following disasters.

9.8 Monitor Outcomes Through Evidence-Based Evaluation

Use the baseline indicators established in this study to regularly monitor changes in:

- Reduction in kerosene consumption.
- Reduction in household energy expenditure.
- Increase in children's evening study hours.
- Increase in household income through productive evening activities.
- Improvement in women's safety and community mobility after dark.
- Reduction in indoor air pollution and associated health risks.
- Improvement in overall quality of life and community resilience.

9.9 Scale the Ghoramara Model

Document lessons learned from the VIBHA Solar Initiative and develop it as a replicable model for other climate-vulnerable, off-grid islands and remote coastal communities across the Sundarbans and similar geographies where conventional grid extension remains technically and economically unviable.

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