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Women at the Heart of Energy Transition in Odisha

Baseline Evidence for Building
Pathways to Clean Energy
and Climate Resilience

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Glossary

1. Affordability Constraints

Limitations arising from low or irregular income that prevent households from adopting or sustaining modern energy use. Explains discontinuous usage patterns such as surrendering and reconnecting electricity.

2. Awareness–Aspiration–Adoption Gap

The disconnect between high awareness of clean energy options, strong desire to adopt them, and low actual usage. One of the study’s key analytical findings, guiding targeted programme design.

3. Baseline Study

A systematic assessment conducted at the start of a programme or intervention to establish reference conditions against which future change can be measured. Included because the study positions itself as an evidence base for future programming, targeting, and impact measurement.

4. Capacity Building

Processes aimed at strengthening skills, knowledge, confidence, and organisational abilities of individuals or groups. Central to the study’s emphasis on empowerment beyond asset provision.

5. Clean Energy

Energy sources and technologies that reduce health, environmental, and climate impacts compared to traditional fuels, including LPG, electricity, solar, and other renewable options. Used as the core outcome of the study, reflecting women’s awareness, aspiration, adoption, and leadership in energy choices.

6. Climate Stress

The cumulative pressure experienced by communities due to repeated exposure to climate shocks such as cyclones, floods, and extreme weather events. Used to explain how environmental pressures compound existing social and economic vulnerabilities.

7. Climate Vulnerability

The extent to which communities are exposed and sensitive to climate hazards such as cyclones, floods, extreme weather, and their ability to cope and adapt. Provides contextual justification for focusing on Odisha and underscores the urgency of resilient energy solutions.

8. Collective Structures

Formal or informal community-based organisations and networks that enable shared learning, mutual support, and collective action. Introduced to explain why some districts show stronger readiness and leadership outcomes than others.

9. Context-Sensitive design

Programme design that reflects local socio-economic, cultural, and infrastructural realities rather than applying uniform solutions. Supports the argument for district-specific strategies.

10. Convergence Mixed-Method Design

A research approach in which quantitative and qualitative data are collected in parallel and integrated during analysis. Explains how numerical trends and narratives were jointly used to interpret findings.

11. Digital Inclusion

Access to digital devices, connectivity, and skills required to use digital services, information platforms, and financial tools. Explains district-level disparities in access to schemes, energy information, and leadership opportunities.

12. District-Specific Tailoring

The adaptation of programme design and interventions to reflect local socio-economic, infrastructural, and cultural contexts. Justified by significant variation across Anugul, Kendrapara, and Koraput.

13. Drudgery

Physically demanding, repetitive, and time-consuming labour, particularly related to fuel collection and cooking. Used to articulate non-monetary benefits of cleaner energy choices from a gender perspective.

14. Economic Mobility

The ability of households or individuals to improve income levels, livelihood security, and long-term financial stability. Connects energy access to broader development outcomes rather than treating it as a standalone issue.

15. Education Gradient

The positive relationship between higher levels of education and increased agency, clean energy adoption, and leadership readiness. One of the strongest enabling factors identified, informing differentiated training strategies.

16. Enablers

Factors that actively support or accelerate adoption, leadership, and participation, such as education, networks, or infrastructure. Balances the analysis by highlighting what works, not only what constrains.

17. Energy Transition

The shift from traditional, polluting energy sources such as firewood to cleaner, modern, and sustainable energy systems. Frames the study's overall objective and situates household energy use within broader climate and development goals.

18. Equity-focused programming

Interventions designed to prioritise the most disadvantaged groups and address unequal starting conditions. Anchors the study's recommendations and justifies differentiated approaches.

19. Farmer Producer Organisations (FPOs)/Cooperatives

Economic collectives that aggregate producers to improve access to markets, services, and institutional support. Strengthen women's economic agency and leadership readiness in both energy and agriculture.

20. Financial Inclusion

Access to formal financial services such as bank accounts, credit, and government transfers. While widespread, financial inclusion alone is insufficient without income stability and digital access.

21. Gender-responsive Approach

Programmatic and policy approaches that recognise gendered roles, power relations, and constraints, and actively address them through targeted outreach, capacity-building, and leadership pathways. Explains why gender must be explicitly integrated into energy transition strategies.

22. Grid Connectivity

The degree to which households are connected to and reliably served by the electricity grid, including on-grid, semi-off-grid, and off-grid contexts. A key determinant of clean energy adoption, digital access, and leadership readiness.

23. Impediments

Conditions or factors that slow down or block progress, including social norms, income insecurity, or weak service delivery. Used to structure findings in a way that directly informs programme design.

24. Inclusive Energy Transition

An energy transition that intentionally addresses social, economic, and institutional inequities by centering marginalised groups, particularly women. Highlights that technological availability alone is insufficient without equity-focused design

25. Information Flow

The channels through which awareness of schemes, technologies, and opportunities reaches communities. Helps explain district-level differences in awareness despite similar policy environments.

26. Infrastructure Gaps

Deficiencies in physical and service infrastructure, including electricity supply reliability, transport access, and communication networks. Explains why availability of services does not always translate into effective access or sustained use.

27. Last-mile Connectivity

The availability, reliability, and affordability of energy infrastructure at the household level, particularly in rural and remote areas. Explains why formal connections do not always translate into effective energy access.

28. Leadership Pathways

Structured or informal routes through which women gain confidence, experience, and legitimacy to take on leadership roles. Used to explain how participation can evolve into agency and community-level influence.

29. Lived Experiences

First-hand accounts of daily realities, constraints, and motivations as expressed by participants during qualitative engagement. Justifies the inclusion of qualitative methods and grounds findings in real-world contexts.

30. Mixed-Method Approach

A research design combining quantitative surveys with qualitative focus group discussions and key informant interviews. Strengthens explanatory depth by linking statistical trends with lived experiences.

31. Primary Energy Managers

Household members (typically women) responsible for daily energy-related tasks such as cooking fuel management and appliance use. Highlights the contrast between responsibility and decision-making authority.

32. Readiness

A composite condition reflecting willingness, confidence, perceived capability, and enabling environment to adopt or lead initiatives. Used as a softer, more policy-relevant concept than "capacity" alone.

33. Scalability

The potential for an intervention or model to be expanded across regions without losing effectiveness. Appears in the conclusion to connect pilot insights to state-wide or national relevance.

34. Self-Help Groups (SHGs)

Women-led community collectives focused on savings, credit, and livelihoods. Identified as critical platforms for collective action, confidence-building, and clean energy adoption.

35. Social Disadvantage

A condition arising from intersecting factors such as gender, poverty, social group, geography, and limited education that restricts access to opportunities and resources. Provides a non-technical framing for layered exclusion without relying solely on social group or income categories.

36. Social Group and Ethnic Disadvantage

Social and institutional exclusion experienced by Socially Deprived Population Cohort households, affecting access to information, infrastructure, and opportunities. Central to the study's equity lens, particularly in explaining regional disparities.

37. Stratification

The process of categorising survey respondents by key characteristics such as district, education, social group, economic activity, and grid access. Ensures analytical depth and comparability across diverse sub-groups.

38. Structural Barriers

Systemic constraints including social group-based exclusion, unreliable infrastructure, limited finance, and weak institutional support—that restrict women's energy choices and leadership. Used to explain persistent gaps between awareness, aspiration, and adoption.

39. Supply Reliability

The consistency and predictability of energy availability over time. Introduced to distinguish between nominal access and functional access.

40. Transformative Change

Change that alters underlying power relations, norms, and systems rather than producing incremental improvements alone. Used to distinguish long-term impact from short-term adoption gains.

41. Women's Agency

Women's capacity to make informed choices, influence decisions, and act independently or collectively in households and communities. Serves as a unifying concept of linking education, group membership, and leadership outcomes.

42. Women-led Energy Transition

A model of energy transition in which women act not only as users and beneficiaries but also as leaders, decision-makers, and agents of change at household and community levels. Represents the study's normative vision and long-term transformational goals.

Executive Summary



Women's energy choices in rural Odisha are shaped by climate stress, social disadvantage, and infrastructure gaps. Despite high awareness of clean energy options, adoption remains limited due to entrenched social inequities, unreliable grid access, and weak collective structures in some districts.

This study is especially relevant in Odisha, India's most climate-vulnerable state, which is regularly affected by cyclones, floods, and other extreme events. At the same time, the state is well-positioned for change, with a government supportive of energy transition and climate adaptation initiatives.

Against this backdrop, education and group membership emerge as powerful levers of change. Both consistently increase women's readiness to adopt clean energy, lead projects, and access government schemes. This baseline study provides evidence for designing district-specific, equity-focused models for women-led energy transitions.

Purpose and Approach

An inclusive energy transition requires more than technology. It demands a holistic approach that places women at the centre. In rural communities, women are primary household and farm energy managers, yet they remain underrepresented in decision-making and leadership roles.

A truly inclusive transition must integrate gender-sensitive outreach, capacity building, and leadership pathways that empower women not only as beneficiaries but as active agents of change. Addressing structural barriers — such as limited access to information, finance, and institutional support — while investing in women's leadership can ensure that clean energy adoption is equitable, sustainable, and transformative.

The study aimed to identify:

-  **Challenges women face in energy access and use.**
-  **Their dimension(s) and experiences of climate change that impacted the women in these three districts.**
-  **Their level of access to schemes that are an essential pre-condition for stronger participation in energy transition activities.**
-  **Pathways and actions that can accelerate the energy transition.**

Methodology

The study applied a convergent mixed-methods design to establish an empirical foundation for a gender-responsive energy transition in Odisha.

A quantitative survey was conducted with 611 women across three districts- Anugul, Kendrapara, and Koraput. The sample was stratified by social group (General and socially deprived population cohorts), education level, formal group membership based on economic activities, and grid-connectivity status.

15 Qualitative Focus Group Discussions (FGDs) and 15 Key Informant Interviews (KIIs) were conducted that captured their lived experiences, motivations, and socio-economic contexts.

This mixed-methods approach moved beyond describing trends to uncovering underlying drivers, generating deeper insights into structural barriers and enablers. It also ensured representation across socio-economic strata, energy practices, and network participation, producing actionable insights for programme design, targeting, partnerships, and impact measurement.

Key Findings

1. High Interest in Clean Energy Adoption:

Nearly 90% of women expressed willingness to transition from traditional fuels, citing improved health and reduced drudgery. However, 87.2% (533 women) still rely primarily on firewood for cooking. Among them:

68.7%
use firewood
twice daily

18.4%
once daily

12.9%
three or more
times daily

FGDs confirmed that women are ready to shift to renewable energy if access, affordability, capacity building, and supportive networks are ensured.

2. Awareness of Government Energy Schemes:

The data indicate that overall the awareness of government energy schemes is high though with notable district-level variations. In Anugul and Kendrapara, nearly 9 out of 10 women reported being aware of such schemes (89% and 90%, respectively), suggesting strong outreach efforts and steady information flow within these districts.

In contrast, Koraput reflects a noticeable awareness gap. Only 61% of respondents reported familiarity with government energy programmes, while nearly four in ten women lacked knowledge of available schemes. This variation highlights uneven access to information across districts.

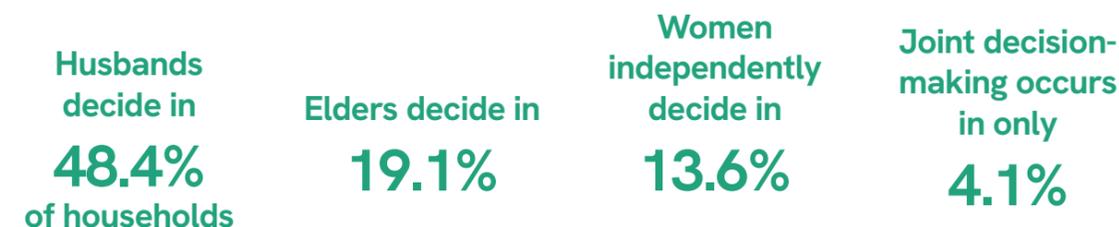
3. Awareness-Aspiration-Adoption Gap:

While 83% of women are aware of at least one clean fuel option and nearly 90% aspire to transition, only 39.4% use LPG as their primary cooking source.

This gap highlights that awareness and motivation alone are insufficient. Structural barriers-affordability, supply reliability, and cultural norms continue to limit adoption.

4. Decision-Making Power in Household Energy Use:

Women manage daily energy use but rarely control strategic decisions related to investments necessary for the clean energy transition.



Two-thirds of energy investment decisions remain outside women's control. Their influence is limited to tactical day-to-day use, while men and elders dominate strategic choices like fuel shifts or appliance purchases.

Electric connections do not guarantee reliable supply. Many households discontinue usage when bills accumulate, reconnecting only during peak demand seasons. Weak infrastructure and affordability issues exacerbate energy inequities, increasing women's dependence on traditional fuels.

5. Challenge of Last Mile Connectivity:

In many rural and remote areas, households remain underserved due to weak grid infrastructure, unreliable supply, and high electricity costs. Focus group discussions revealed that having an electrical connection does not guarantee consistent access to power.

Participants reported that when government connections were provided free of charge, households used electricity regularly. However, as bills accumulated, many discontinued their connections, often reconnecting only during the summer months when demand increased.

These gaps not only restrict access to clean and modern energy but also deepen existing inequities. Women, who are primarily responsible for managing household energy, remain disproportionately exposed to the burdens of traditional fuels and the impacts of climate shocks.

6. Income Disparities:

The income distribution of respondents across the three districts highlights significant disparities that shape both energy access and household vulnerability. A large proportion of respondent households fall into the lowest income brackets. Over 60% of households earn below INR 10,000 per month:

205 households: INR 5,000

166 households: INR 5,001–10,000

Koraput shows the starkest concentration of poverty, with 124 households in the lowest band, compared to 46 in Anugul and 35 in Kendrapara. Only 64 households across districts earn above INR 20,000. Limited financial capacity constrains clean energy adoption and bill payment.

This skewed distribution highlights the financial constraints many households face, limiting their ability to adopt clean energy technologies, pay electricity bills consistently, or invest in more sustainable energy alternatives.

7. Financial and Digital Inclusion:

The findings reflect strong progress in financial inclusion across all three districts, alongside clear gaps in digital access. Bank account ownership is nearly universal.

99%
of women in Anugul report
having a bank account.

98%
in Kendrapara
report access.

90%
in Koraput
report access.

These figures indicate the wide reach of financial inclusion initiatives. However, digital inclusion shows sharper disparities.

**Smartphone ownership
stands at 56% in Kendrapara.**

48% of women in Anugul own smartphones.

Only 39% in Koraput report smartphone ownership. And, more than half of respondents in Koraput (53%) do not own any phone.

This uneven access to digital devices limits women’s ability to use financial services, access government schemes, obtain clean energy information, and participate in digital platforms-particularly in Koraput, where access gaps are most severe.

8. Willingness to Lead Energy Projects:

Women across districts demonstrate substantial interest in leading energy initiatives, though district-level differences are evident.

Kendrapara
**81% willing
to lead.**

Anugul
75% willing.

Koraput
**56% willing;
41% unwilling.**

Meanwhile, women’s uncertainty to lead energy initiatives is minimal

**1% in
Kendrapara**

**2% in
Anugul**

**3% in
Koraput**

These findings suggest that most women hold clear positions regarding leadership in energy projects.

9. Willingness to Lead Farming Projects:

A similar trend is observed in women leading farming-related initiatives, with variation across districts.

Kendrapara
**82% willing
to lead.**

Anugul
73% willing.

Koraput
**58% willing;
40% unwilling.**

Uncertainty to lead in farming-related initiatives remains low across districts:

**0% in
Kendrapara**

**1% in
Anugul**

**2% in
Koraput**

Overall, leadership readiness is strongest in Kendrapara and Anugul, while Koraput reflects comparatively lower enthusiasm and higher resistance.

10. Climate Event Impacts on Households:

Climate events are nearly universal experiences across the surveyed districts, with widespread and multi-dimensional impacts on households.

Energy and Agriculture Disruptions:



These figures underscore the systemic effects of climate shocks on both energy access and agricultural livelihoods.

Disruptions to Basic Needs:



Impacts on Household Wellbeing:



Longer-Term Vulnerabilities:



Together, these findings highlight the layered and sustained nature of climate-related vulnerabilities, affecting immediate survival needs as well as long-term economic stability.

11. Knowledge About Reasons for Increase in Climate Events:

Climate knowledge is unevenly distributed and shaped by social and educational factors. Women from socially deprived population cohorts are approximately 1.65 times more likely to possess climate-related knowledge compared to women from General social groups.

Education emerges as the strongest determinant: graduates are three times more likely than illiterate respondents to understand the causes behind increasing climate events. Formal group membership increases the likelihood of climate knowledge by 63%.

These patterns suggest that climate literacy is influenced by social location, strengthened through education, and reinforced through collective participation.

12. Belief in Climate Event Reduction:

The belief that climate events can be reduced is closely associated with education and awareness. Graduates are three times more likely than illiterate respondents to believe that climate events can be mitigated.

Women who understand the causes of climate change are twice as likely to believe in potential solutions. Formal group membership increases the likelihood of such a belief by 63%. Differences across social groups exist but are comparatively less pronounced.

Overall, confidence in climate solutions appears to be knowledge-driven and reinforced through education and collective engagement.

13. Migration for Work:

The findings suggest that migration functions both as a distress response to vulnerability and as an aspirational pathway for economic mobility. Migration patterns are shaped by social identity, education, income, geography, and climate stress.

Households from socially deprived population cohorts are nearly twice as likely to migrate compared to those from general social groups. Households in Koraput show almost double the likelihood of migration compared to households in the other districts.

Education acts as a key enabler: graduates are three times more likely to migrate. Higher-income households are more than twice as likely to migrate, suggesting mobility requires resources.

Climate stress is a critical driver: households experiencing frequent climate shocks are twice as likely to migrate. Together, these patterns indicate that migration is not solely a distress phenomenon — it is also shaped by capacity, opportunity, and exposure to climate risk. Women's willingness to adopt and lead clean energy initiatives is shaped by a combination of enabling drivers and structural constraints.

Key Drivers

1. Grid Connectivity

- On-grid households are **1.5 times more likely** to adopt clean energy solutions and digital tools.
- Semi-off-grid households demonstrate moderate but comparatively lower gains.

2. Education Gradient

- Higher education consistently strengthens women’s agency and adoption behaviour.
- Graduate-level respondents are nearly **three times more likely** to adopt clean energy or assume leadership roles compared to women with illiterate or primary-level education.

3. Formal Group Membership

- Participation in Self-Help Groups (SHGs), cooperatives, or Farmer Producer Organizations (FPOs) significantly enhances inclusion, adoption rates, and leadership readiness.
- Collective platforms reinforce access to information, confidence, and peer support.

4. Social and Ethnic Disadvantage

- Households from socially deprived population cohorts face persistent structural barriers.
- These disadvantages are most pronounced in Koraput.
- While the nature and depth of exclusion vary across communities, this study categorizes them broadly; further research is required to unpack intra-group differences in greater detail.



District-level differences:

Koraput

- Lower baseline willingness for clean energy adoption.
- Stronger social group disadvantages.
- Significant infrastructure gaps.

Kendrapara

- Higher baseline readiness for adoption and leadership.
- Grid connectivity and education act as amplifiers of engagement.

Anugul

- Strong presence of SHGs and collective platforms.
- Education pathways and collective mobilisation serve as primary drivers of adoption and leadership.

Overall, district-specific contexts significantly shape both opportunity structures and constraints, underscoring the need for tailored programme strategies.



Implications for Future Programming

1. Apply a Strong Equity lens:

- It is necessary to prioritise households from socially deprived population cohorts, particularly in Koraput.
- Designing interventions should ideally combine digital inclusion, culturally sensitive capacity-building, and confidence-building measures.

2. Education Leverage:

- Training modules could be tailored to different literacy levels.
- Educated women could be engaged as peer trainers and local resource persons to support community-based learning.

3. Strengthen Collective Action:

- Digital literacy, digital finance, and clean energy awareness may be embedded within SHGs, cooperatives, and producer groups.
- Collective platforms can be used to improve outreach, trust-building, and sustained engagement.

Infrastructure Integration:

- Digital and financial inclusion initiatives could be aligned with energy access interventions.
- It is important to prioritise off-grid and weak-grid areas where infrastructure gaps limit adoption.

Need for Regional Tailoring:

District-specific strategies are required to ensure effectiveness and scalability.

Koraput

- Equity-focused outreach should be prioritized.
- Infrastructure deficits and access barriers can be addressed through targeted support.
- Awareness-building efforts should ideally be combined with foundational service delivery.

Kendrapara

- Scale-up efforts could be supported through education-driven engagement models.
- Relatively stronger grid connectivity could be leveraged to accelerate adoption.

Anugul

- Women's collectives could be positioned as primary implementation platforms.
- Education-linked pathways for leadership and adoption could be strengthened.

Strategic Recommendations

1. It is necessary to place socially deprived population cohorts at the centre of programme design through tailored and targeted interventions.

2. Education should be leveraged to design differentiated training and peer-to-peer learning models.

3. Group-based institutions can be strengthened as platforms for digital inclusion, financial access, and clean energy adoption.

4. Energy, digital, and financial programmes should be integrated to address infrastructure constraints in a holistic manner.

5. District-specific strategies may be developed to reflect local strengths and structural challenges, ensuring that interventions remain context-sensitive and scalable.

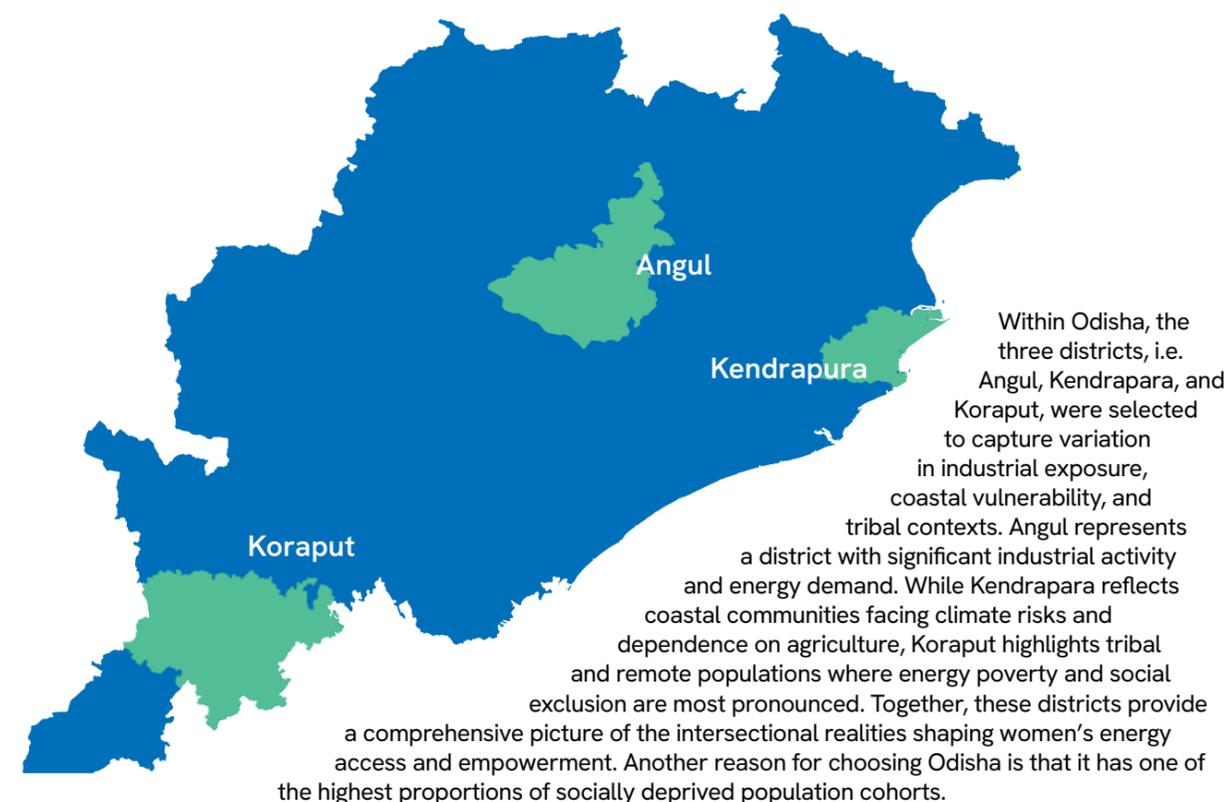
1.

Introduction

Background and Rationale

In rural Odisha, energy decisions are shaped by far more than supply constraints. It is deeply intertwined with gender norms, social group dynamics, grid reliability, migration patterns, climate shocks, and the role of local institutions. Existing energy schemes by the government and solar energy programmes have reached women unevenly, underscoring the need for robust district-level evidence. Through this research study we want to put women's voices at the centre of this inquiry, highlighting how social structures influence energy choices and adoption, and what are the pathways for clean energy transition.

Odisha was chosen as the study site because of its diverse socio-economic and cultural landscape, strong presence of women's collectives, and its critical role in India's energy transition. The state combines both high potential for renewable energy adoption and persistent challenges of last-mile connectivity, making it an ideal context to examine equity in access.



¹² These communities often face structural disadvantages in education, income, and infrastructure access, which directly shape their ability to adopt and benefit from clean energy solutions. Studying energy transition in Odisha therefore provides insights into how social identity intersects with poverty, geography, and institutional presence to influence awareness, adoption, and leadership. Within the state, for the purpose of data analysis, Angul was selected as a baseline district with strong industrial activity and predictable energy demand. Kendrapara represents coastal, agriculturally dependent communities with relatively higher awareness and responsiveness, and Koraput, a tribal district, highlights the challenges of remoteness, weaker institutional networks, and persistent inequities. Together, these districts capture the spectrum of socio-economic and cultural realities in Odisha, making them ideal for understanding how households from socially deprived population cohorts experience barriers and opportunities in the clean energy transition.

Research Questions we wanted to answer

The research was designed to answer a set of interrelated questions that explore women's roles, perceptions, and constraints in the energy transition. It examined the economic activities of women and girls, household decision-making dynamics around energy use, and the level of awareness and adoption of clean energy alternatives. The study also investigated how social identity factors such as social groups, and district context shape women's attitudes toward alternative energy sources, alongside the barriers that prevent adoption. Further, it assessed awareness of government energy schemes, interest in participating in energy transition committees, and aspirations or perceived risks of leadership in clean energy initiatives. Finally, the research sought to understand the influence of local norms and cultural factors on adoption behaviours, differences across social groups, and stakeholder recommendations for strengthening outreach and equitable adoption.

¹² Scheduled Tribe (ST) populations in India (nearly 23%) and a substantial Scheduled Caste (SC) population (around 17%), together accounting for about 40% of the state's residents. ² Scheduled Castes (SCs) and Scheduled Tribes (STs) are groups officially recognised in the Indian Constitution as historically disadvantaged communities. They were "scheduled" to ensure targeted protections, affirmative action, and social justice. In clean energy studies, their categorization is crucial because equitable energy access must account for these communities' unique vulnerabilities and ensure inclusive policy design. Source: <https://ncst.gov.in>

2.

Objectives of the Study

This study was undertaken to address a critical gap of that of lack of empirical data on women's energy access, decision-making, and participation in clean energy transitions in Odisha. While policy discussions often highlight the importance of gender equity in energy, little ground-level evidence existed to capture women's lived realities, constraints, and aspirations.

Given the urgency of ensuring that energy transition efforts are both equitable and sustainable, primary research was essential to generate reliable insights. By collecting first-hand data through surveys, focus group discussions, and interviews, the study provides a robust evidence base to inform programme design, policy advocacy, and targeted interventions.



The Year 1 survey was designed with five interlinked aims, each contributing to a deeper understanding of how women's energy futures in Odisha are shaped by social, economic, and environmental factors.

1. Establish a quantitative and qualitative baseline for clean energy adoption at the district level, led by women

- o Collect robust data on nuances and dynamics of women's energy use, climate stress, and household decision-making across the three districts of Anugul, Kendrapara, and Koraput.

- o Use both survey statistics and qualitative narratives to capture not only what women are experiencing but also how they perceive and respond to these challenges.

- o This baseline serves as the foundation for measuring change in subsequent years.

2. Examine linkages between climate, social disadvantage, and livelihoods

- o Explore how climate shocks, social group disadvantage, and livelihood strategies intersect to shape energy choices and migration patterns.

- o Identify the ways in which vulnerability to extreme climate events influences household energy decisions, particularly for women who manage daily fuel and cooking needs.

3. Identify barriers and enablers for clean energy adoption and women's leadership

- o Assess the structural and social factors that either hinder or enable women's uptake of clean energy technologies.

- o Document the conditions under which women are most likely to step into leadership roles in energy and farming projects, including education, group membership, and infrastructure access.

4. Map district-level differences to inform tailored interventions

- o Compare patterns across Koraput, Kendrapara, and Anugul, highlighting how local contexts such as social group composition, grid reliability, and formal group strength, create distinct opportunities and constraints.

- o Provide evidence to guide district-specific strategies in Years 2 and 3, ensuring that the interventions are responsive to local realities rather than one-size-fits-all.

5. Develop an equity-focused narrative on women and energy transition in Odisha

- o Centre women's voices in the story of energy transition, ensuring that the Women from socially deprived population cohorts households, low-literacy groups, and marginalised communities are not left behind.

- o Articulate how women's experiences and perspectives can guide a just and inclusive energy transition, linking clean energy adoption to climate resilience and livelihood security.

Together, these objectives ensure that the study moves beyond descriptive statistics to build a holistic, equity-driven evidence base. By combining quantitative rigor with qualitative depth. The Year 1 survey lays the groundwork for district-tailored pilots, leadership development, and policy advocacy in the years ahead.

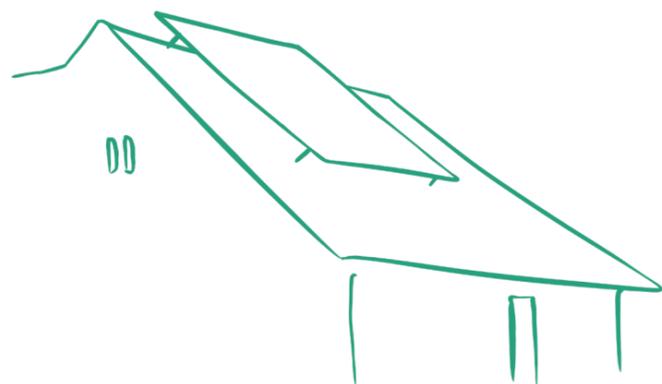
3. Scope

- **Target group:**

Women aged 18–45 years in rural and semi-rural settings across three districts were chosen.

- **Areas of focus:**

1. Energy use for cooking, lighting, and productive activities.
2. Experiences of climate shocks and migration.
3. Access to digital and financial services.
4. Participation in community groups and schemes.
5. Willingness for leadership roles.



Limitations

- The survey sample includes 611 women only, which does not represent all villages or social groups.
- Reliance on self-reported data introduces potential recall gaps and social desirability bias.
- Findings are limited to three districts and should not be interpreted as statewide averages.
- Certain quantitative analyses are based on models that assume stable relationships across groups, requiring cautious interpretation.

4.

Methodology

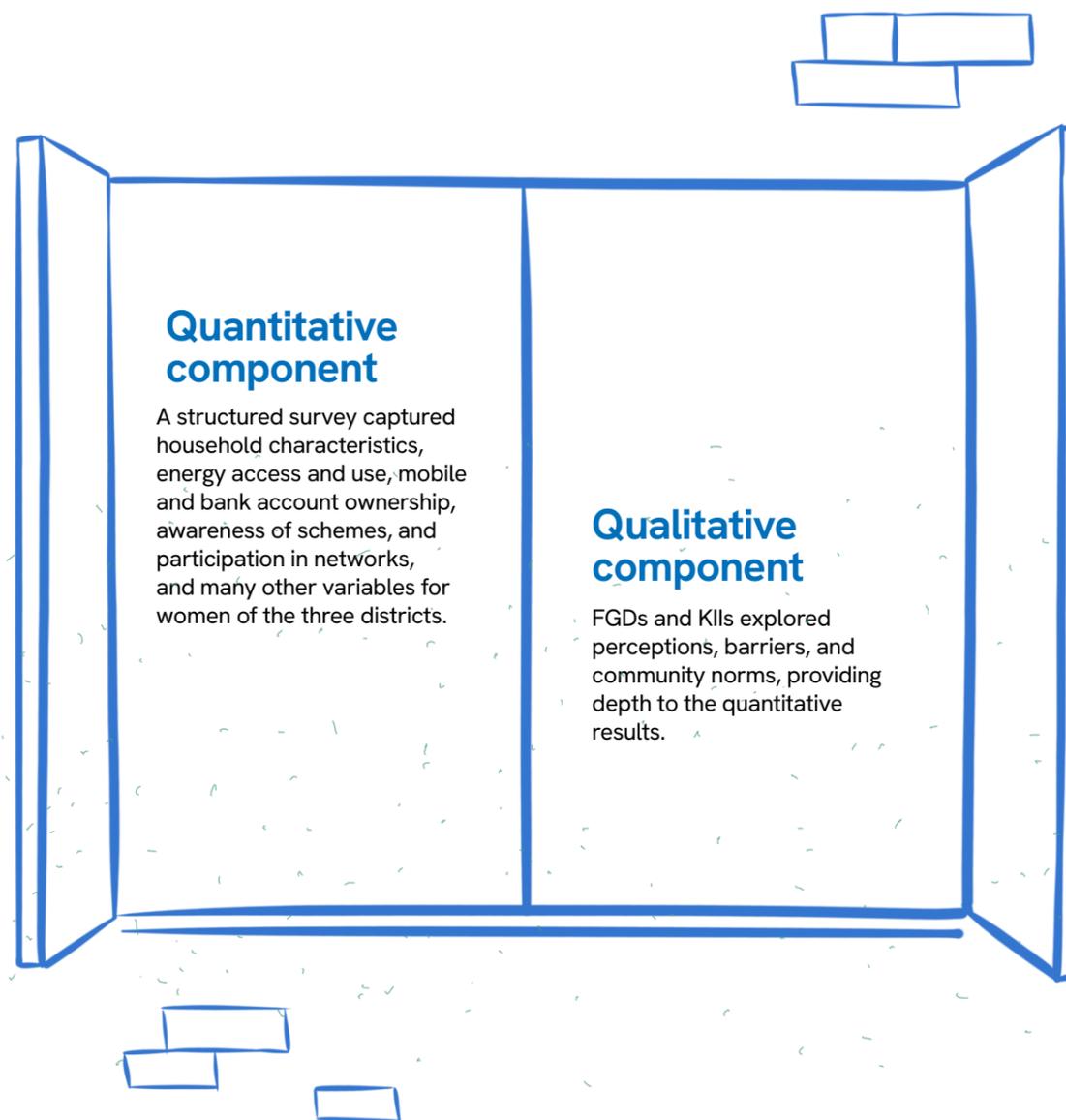
This section outlines the methodological design of the research study conducted to establish the empirical foundation for the research. The study was designed to explore the determinants of energy access, digital and financial inclusion, climate change awareness, women’s decision-making power for use of energy and fuel in their household, and women’s empowerment across three districts of Angul, Koraput, and Kendrapara in Odisha. These data thus generated were used to generate actionable insights for programme design, targeting, partnership building, and impact measurement.



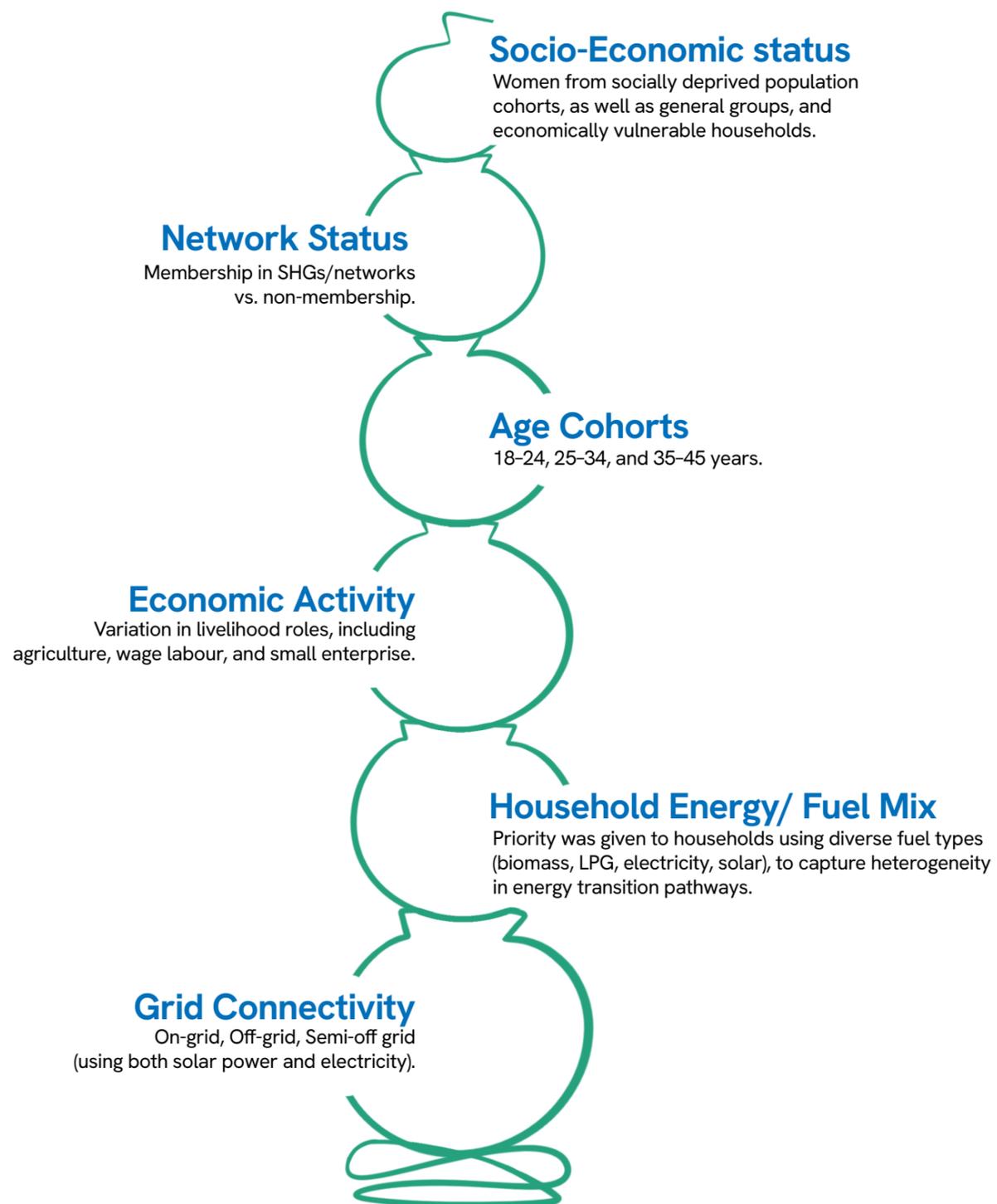
Survey Design and Sampling

The study seeks to catalyse a just and gender-responsive energy transition through ground-up action, leveraging Odisha’s active women’s networks, Self-Help Groups (SHGs), Farmer Producer Organizations (FPOs), Community-Based Organizations (CBOs), and NGOs (henceforth mentioned as ‘Collectives’ and ‘Networks’ in the report), alongside the state’s strong civil society ecosystem. To support this vision, the research study was conceived as exploratory, with the dual purpose of (a) establishing a baseline of women’s energy access and usage, digital and financial inclusion, energy consumption behaviour, awareness of Climate change, participation in networks, and (b) identifying structural and social factors that shape energy adoption behaviours.

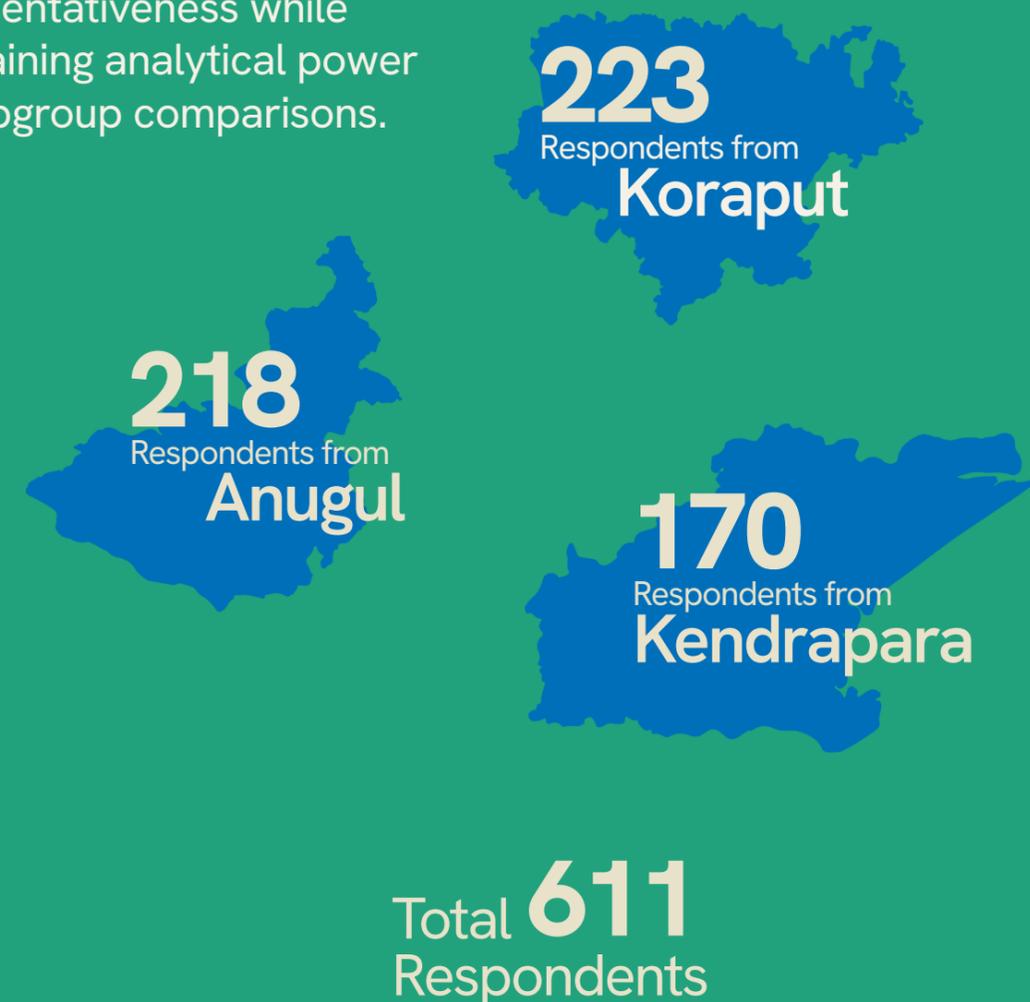
The study employed a convergent parallel mixed-methods design, combining quantitative surveys with qualitative focus group discussions (FGDs) and key informant interviews (KIs). This design allowed for triangulation of findings, ensuring that statistical patterns were enriched and validated by lived experiences and community narratives.



The sampling strategy was stratified purposive sampling, chosen to ensure diversity across key socio-economic and demographic dimensions. The strata included:



A total sample of 611 women respondents was proportionally allocated across districts and strata. This ensured representativeness while maintaining analytical power for subgroup comparisons.



District/Block	Athmalik	Banarpal	Boiparaguda	Kishorenagar	kundara	Mahakalapada	Marsaghai	Nandapur	Rajnagar	Grand Total
Anugul	97	86		35						218
Kendrapara						64	44		62	170
Koraput			75		36			112		223
Grand Total	97	86	75	35	36	64	44	112	62	611

Data Collection Process

Data collection combined structured surveys, FGDs, and KIs, each tailored to capture complementary dimensions of the research questions. Local enumerators were used to collect the data so that there was no language barrier. This also helped in overcoming the barrier of rural women not opening up to answer questions asked by strangers.

Survey Instrument

Design: Structured questionnaire with both closed and open-ended questions were used.

Topics Covered

- o Economic activity (including collective women's enterprises and intra-household roles of women and girls).
- o Household energy access and fuel mix.
- o Awareness of government schemes and programmes.
- o Adoption behaviour and barriers to adoption.
- o Household dynamics and decision-making roles.
- o Network access and participation in SHGs/networks.

Key Informant Interviews (KIs)

Number: Fifteen KIs were done with local officials, NGO staff, and community leaders.

Topics Covered

- o Outreach strategies and implementation practices.
- o Gaps in programme delivery and barriers to uptake.
- o Policy recommendations for strengthening gender-responsive energy transition.

The KIs added institutional perspectives, highlighting systemic challenges and opportunities for programme alignment.

Focus Group Discussions (FGDs)

Number: Fifteen FGDs were conducted across the three districts.

Stratification: Groups were stratified by social group and energy access status to ensure diverse perspectives.

Topics Covered

- o Awareness of energy schemes and digital tools.
- o Lived experiences of access to energy, usage, and challenges faced.
- o Perceptions of gender roles in energy decision-making.
- o Community norms and barriers to adoption.
- o Energy and future aspirations.

The FGDs provided rich qualitative insights into how women perceive energy access, the role of networks, and the constraints they face in adopting new technologies.



Analytical Framework

The analytical framework integrated quantitative and qualitative approaches to provide a holistic understanding of women's access to energy, usage, decision-making power for fuels at household level, challenges and barriers faced for usage of green energy, effect of being networked (or not), and their willingness to adapt clean energy.

Quantitative Analysis

Descriptive statistics

Frequencies and cross-tabulations were used to profile respondents by social group, education, group membership, grid connectivity, and district.

Regression analysis

Logistic regression models assessed predictors of energy access, adoption and use, women's agency and decision-making power for energy use, women's willingness for green energy adoption, women's willingness to embrace leadership in energy, and agricultural projects, and systems that enable women for sustainable energy adaption and opportunities (networks, Government scheme access, digital inclusion, and financial inclusion), women's knowledge of Climate, women's knowledge about reduction of climate events, and migration of household members for work

Qualitative Analysis

Thematic coding

FGDs and KIs were coded using both inductive (emerging themes) and deductive (pre-defined categories) approaches.

Stratified comparison

Themes were compared across social groups and energy access categories to identify intersectional differences.

Triangulation

Qualitative findings were cross-checked against survey results to validate and enrich interpretations.

Ethical Considerations

Informed consent

Informed consent was obtained from all participants prior to data collection.

Confidentiality

Anonymity is maintained, and no identifying information was disclosed during analysis or is being disclosed during reporting.

Cultural sensitivity

Language and protocols were adapted to local contexts, ensuring respect for community norms and respondent comfort.

Analytical Approach (Penalized Logistic Regression, Interaction Terms)

To address small sample sizes in certain subgroups (e.g., Graduate+ women in Koraput, semi-off grid households), we employed penalized logistic regression. Specifically, Ridge regression 3 (L2 penalty) was used to stabilize estimates and reduce variance inflation.

We ran a number of regressions with different dependent variables. For cross-comparative analysis across the three districts, we grouped some categories together to ensure that the analysis was statistically reliable and easy to interpret. This allowed us to focus on the most meaningful differences such as education levels, social groups, and grid connectivity, without losing sight of important patterns. The main set of predictors included:

Social Groups

Socially deprived population cohorts and General.

Education

Illiterate/Primary (baseline), Secondary, Higher Secondary+, Graduate+.

Group Membership

Yes vs. No

Group Membership

Off-grid (baseline), Semi-off grid, On-grid.

District

Anugul (baseline), Koraput, Kendrapara.

In the regression models, age did not emerge as a statistically significant predictor when compared with social group, education, formal group membership, and grid connectivity. Consequently, age was excluded from the final set of predictors to improve model parsimony and focus on variables with stronger explanatory power.

To capture regional heterogeneity, we included interaction terms between district and each predictor (district x social groups, district x education, district x formal group membership, district x grid). This allowed us to estimate not only the overall effect of each factor but also how its influence varied across districts.

This modelling approach provided a nuanced understanding of how structural and social factors interact with regional contexts.

³ The Ridge penalty (L2 regularization) is a technique used in regression models to prevent overfitting. It works by adding a penalty term proportional to the square of the magnitude of the coefficients. This shrinks large coefficients toward zero, making the model more stable, especially when predictors are highly correlated. <https://www.geeksforgeeks.org/machine-learning/what-is-ridge-regression/>

Model Fit and Regularization

Given the complexity of the model and the relatively small sample sizes in some strata, regularization was necessary to achieving stable and interpretable results.

Ridge penalty (L2)

Was used to shrink coefficients toward zero, reducing overfitting and ensuring convergence.

Model fit

Likelihood ratio X^2 (vs. null): For the different regression models the Likelihood ratios ranged from 43 to 62 and were statistically significant with $p < 0.001$, indicating significant improvement over the null model.

McFadden's pseudo- R^2 : For the different regression models the McFadden pseudo- R^2 ranged from 0.08 to 0.2.

Interpretation strategy

Since the study is exploratory, we focused on direction and relative magnitude of effects rather than precise point estimates.

The combination of penalization and interaction terms ensured that the model was both robust and interpretable, providing actionable insights for programme design without overstating precision.

The statistical models used in this study showed moderate explanatory power, with McFadden's pseudo- R^2 ranging from 0.08 to 0.2. These levels are expected in exploratory social research. Human behaviour around energy use, financial access, and adoption of clean fuels is shaped by many complex, unmeasured factors. While the models cannot capture every driver, they reliably highlight key influences such as education, social group, formal group membership, and grid connectivity. These findings provide a solid baseline for programme design, with future data collection expected to strengthen explanatory depth. The mixed-methods approach, combining quantitative analysis with qualitative insights, reinforces the validity of the evidence despite the inherent limitations of exploratory analysis.

5.

Descriptive Statistics

This section presents the baseline profile of 611 women from Anugul, Koraput, and Kendrapara. It highlights district-level variations in social group, education, group membership, and grid connectivity, as well as key outcomes related to energy use, climate exposure, and adoption of clean fuels.



Sample Overview by Districts

The survey engaged 611 women, proportionally represented across Anugul, Koraput, and Kendrapara. The sample reflects a predominantly young to middle-aged profile, with the majority between 25 and 45 years of age, and a large proportion currently married.

This table shows three clear patterns:

1. **Koraput** has the highest share of socially deprived population cohorts households and lower average household income.
2. **Kendrapara** has relatively higher education levels and income.
3. **Anugul** sits in the middle, with strong group membership and land ownership, and high grid connectivity.

Social Group and Social Identity

Women from socially deprived population cohorts form a large share of respondents in the three districts, with Koraput showing the highest concentration of such households compared to Anugul and Kendrapara

- **Koraput** is dominated by Women from socially deprived population cohorts.
- **Anugul and Kendrapara** have a higher share of General households, but there is still a sizable presence of women from socially deprived population cohorts.

Education and Literacy

Education levels differ across districts. At the aggregate level:

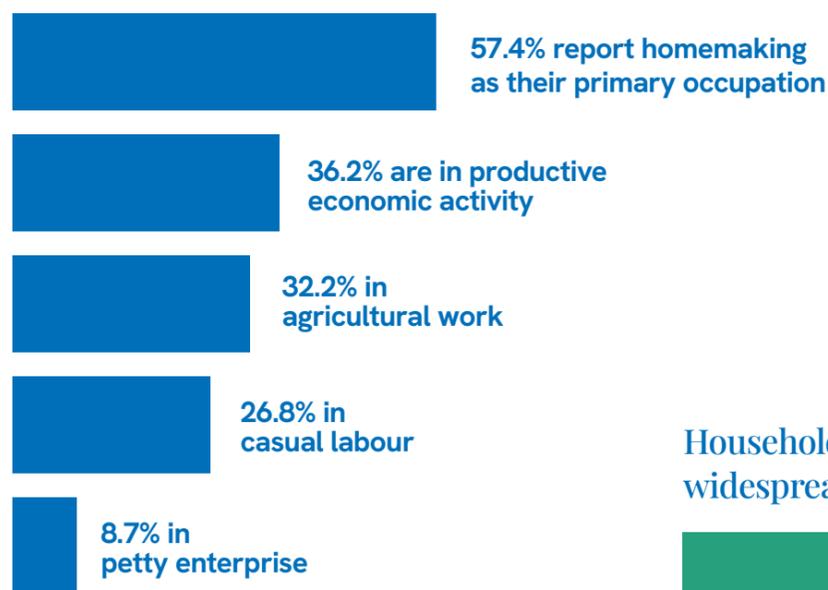
- 16.5% of women report no formal schooling.
- Over half have completed secondary education or higher.

District-level patterns

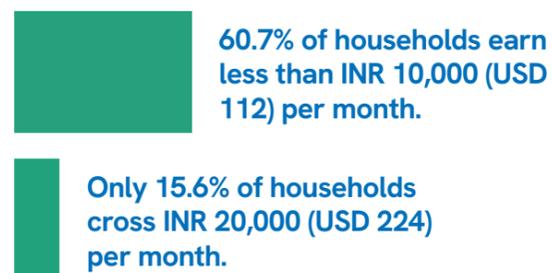
- **Kendrapara** has the highest share of women with secondary and higher education.
- **Koraput** has a larger illiterate or primary-only group.
- **Anugul** lies in between, with a strong base of women who reached primary and secondary schooling.

Livelihoods, Income, and Household Profile

In the three districts most women identify as homemakers, but many also contribute to livelihoods through farming, casual work, or petty trade:



Household income levels show widespread poverty:



Household composition shows bigger household sizes instead of small families:



Social Capital and Formal Group Membership

Formal collective membership (mostly SHGs) is a key differentiator across districts:

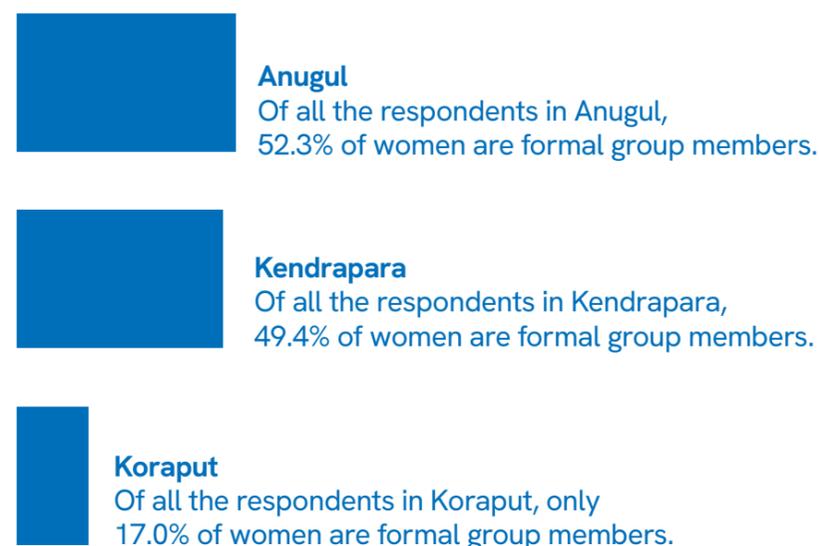


Overall, 38.6% of women (236 respondents) report membership in a formal collective or network.



The other 61.4% (375 women) have no group affiliation.

District-level Penetration:



Grid Connectivity, and Energy Access

Electricity access in the three districts is high in nominal terms, but reliability is uneven, especially in Koraput. The FGDs revealed that having access to electricity does not mean that the respondents completely rely on electricity or have access to it year-round. It appears that when the electricity connection is given for free by the Government, there is a high uptake.

As soon as the electricity becomes chargeable, people either stop using it, or the connection is taken away due to non-payment of electricity bills. The people only restore the connection once the summer arrives as electricity gives them and their children respite from the heat. Hence, it has to be noted that access to electricity does not necessarily mean usage of electricity all year-round, by the respondents.



In the district comparison table, electricity connectivity is above **80%** in all three districts, with Koraput lower than Anugul and Kendrapara.

Across the year, **67.4%** of respondents report daily or frequent power outages. Koraput faces the sharpest seasonal unreliability, especially in the monsoon months.

Energy reliability interacts with water and time:

Overall, **32.2%** of women say that water availability or pumping depends on electricity. When power fails, they turn to hand-pumps or distant sources, which increases time and effort.

Only **52.4%** rate home lighting as “adequate”,

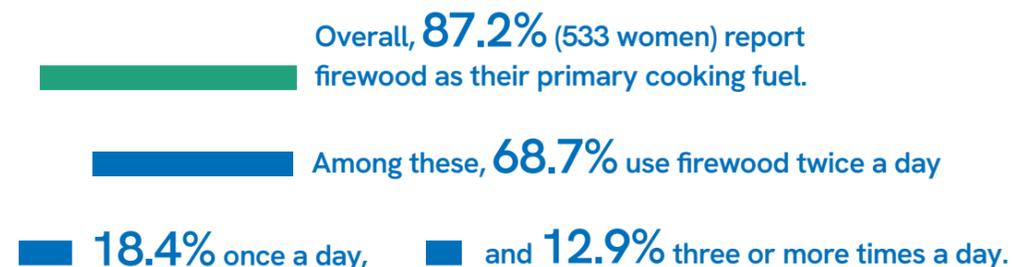
while **12.1%** call it “poor”

6.7% report no lighting at all.

Village-level lighting is rated “adequate” by only **42.1%** of the respondents.

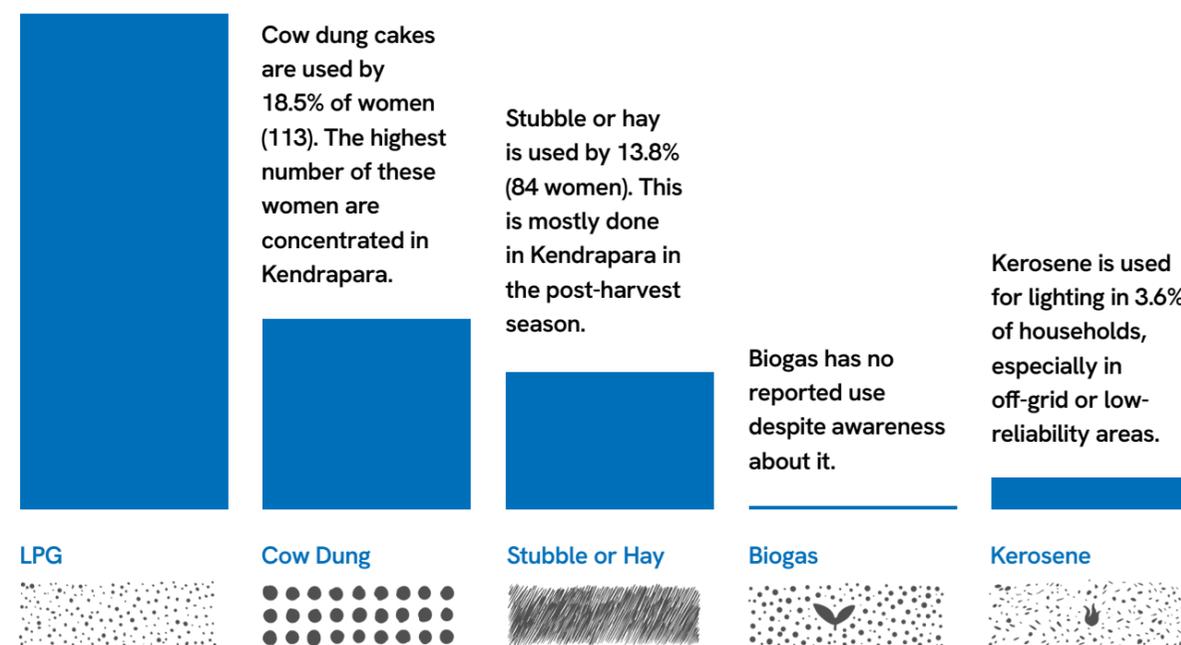
Primary Fuel Use and Multi-fuel Patterns

Fuel usage patterns indicate that cooking energy continues to be dominated by firewood, supplemented by a complex mix of other fuels. In the three surveyed districts, extensive forest cover makes foraged firewood easily accessible and is also inexpensive, leading households to prefer it despite the well-documented health risks associated with smoke exposure:



LPG is used by 47.5% of women (290 respondents). However, LPG use is occasional, as 38.6% of LPG users use it only once a day, often for quick cooking or when fuelwood is wet or scarce.

Supplementary fuels



Multi-fuel Use is the Norm

Overall, 76.8% of households use two or more fuels, shifting between them based on season, cash flow, and availability of the fuel.

Energy Decision-Making and Women's Agency

While women are the primary “managers” of household energy, spending up to 5–8 hours daily on fuel collection and cooking, the “right to decide” what form of energy or fuel to use, remains largely with men:



Overall, in 48.4% of households, husbands decide the energy choice.



Overall, in 19.1% households, the elders decide.



Women decide in only 13.6% of households. More so this is the case in households where the men in the family have migrated for work.



Joint spousal decisions account for just 4.1% of the household surveyed.

Taken together, 67.5% of energy decisions lie outside women's autonomous control. This paradox exists due to a combination of entrenched patriarchal norms, economic control, and a lack of awareness regarding the “invisible” costs of traditional fuels.

Qualitative data show that women have more say in daily, tactical decisions (for example, when to use LPG or firewood on particular days), while men and elders control strategic decisions like buying appliances or changing fuels.

Clean Fuel Awareness and Adoption Gap

The survey findings reveal a striking ‘awareness-adoption gap’ in the transition to clean cooking fuels. While knowledge of alternatives such as LPG, smokeless chulhas, solar cookers, and biogas is widespread, actual uptake remains limited.



High awareness

Overall 83% of women reported familiarity with at least one clean fuel option, indicating that information about government schemes and market-based solutions has reached rural households.

Strong aspiration

Nearly 90% of respondents expressed a desire to shift to cleaner fuels, citing motivations such as reduced health risks, convenience, and time savings. This demonstrates that women recognise the benefits of clean energy and are willing to adopt it in principle.

Low adoption

Despite this awareness and aspiration, only 39.4% of women reported using a clean fuel as their primary cooking source. The remaining majority continue to rely on firewood or other traditional fuels. This results in an adoption gap of approximately 50 percentage points between expressed intent and actual practice.

This gap underscores the structural and contextual barriers that prevent women from translating awareness into sustained adoption.

Income and social group shape this gap:

Higher-income households show more clean fuel adoption, while poorer households remain dependent on freely collected firewood.

Socially deprived population cohort households often sit in the high awareness but low adoption segment due to cost, access, and control over decisions.

Climate Events Exposure and Lived Experience

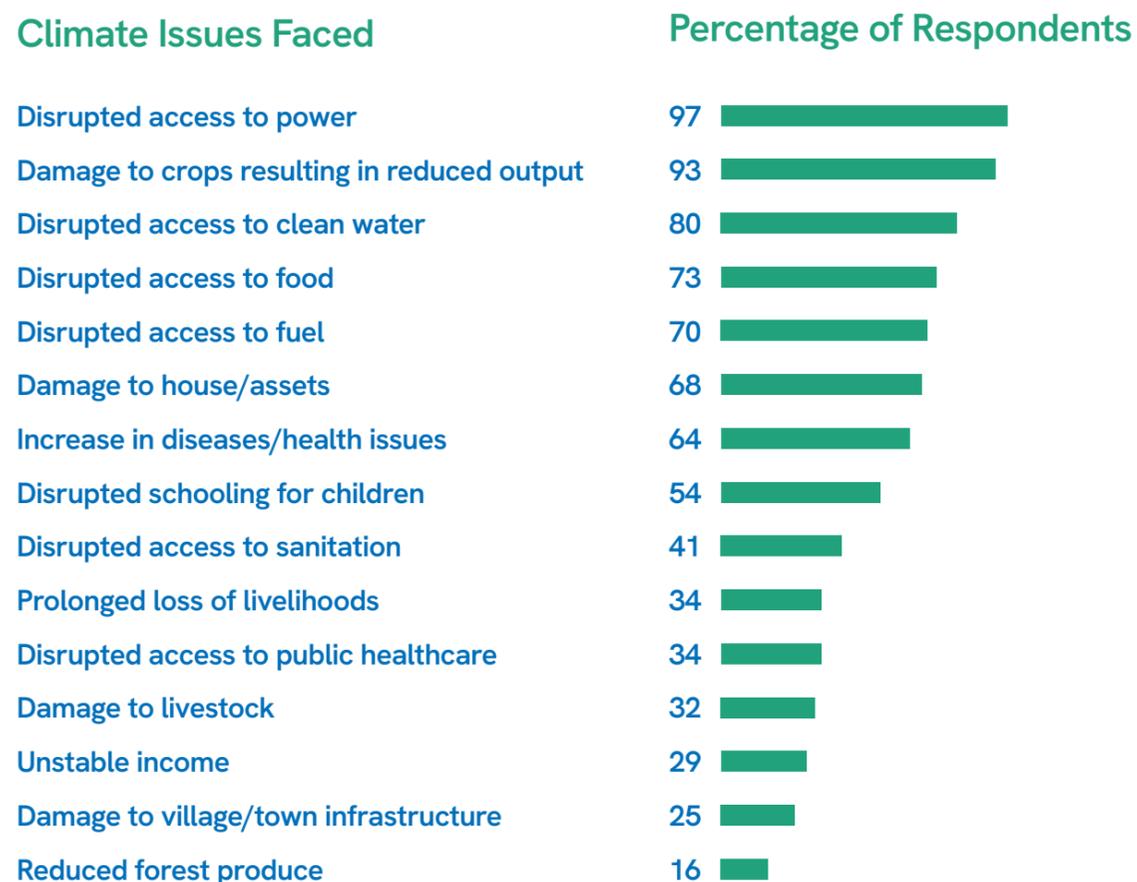
Survey findings indicate that climate events are a regular and significant part of daily life for most respondents across the three districts.

Frequency of Exposure:

Overall, 39.4% of women report experiencing climate events very frequently. Another 31.6% report experiencing them sometimes.

Taken together, 71.0% of respondents face regular exposure to climate shocks, while only 17.2% report “never” and 11.8% “rarely.” This underscores the pervasive nature of climate stress in rural Odisha.

Types of Issues Faced Due to Climate Events



Survey results show that climate events are near-universal experiences among households. Almost all respondents that have faced climate events reported disrupted access to power (96.7%) and damage to crops (93.4%), underscoring the systemic impact on energy and agriculture. Basic needs are heavily affected too. 79.8% reported disruption to clean water access, 72.7% reported disruption to food, and 69.7% reported disruption to fuel access during climate events. Household wellbeing is also compromised, with 68% reporting damage to assets and 63.7% reporting increased health issues. Over half of families (53.8%) noted schooling disruptions for children, pointing to intergenerational consequences.

Longer-term vulnerabilities are evident as 33-34% reported prolonged livelihood loss or disrupted healthcare, while 32.2% faced livestock damage and 29.2% faced unstable income. Community-level impacts are visible too, with 25.4% citing damage to infrastructure and 15.6% reporting reduced forest produce.

Together, these figures highlight that climate events are not isolated shocks but multi-dimensional crises, affecting energy, agriculture, health, education, and livelihoods simultaneously. Programmes must therefore adopt integrated resilience strategies that address both immediate needs (power, food, water) and structural vulnerabilities (healthcare, education, livelihoods).

Perceptions of Change over Time:

A majority (59.7%) believe that climate events have increased in recent years. About 33.7% perceive no change, while 6.5% remain unsure.

District-level differences are notable: Women in Anugul and Kendrapara report a stronger perception of increase, whereas in Koraput, high baseline volatility may make extreme events feel “normal,” dampening perceptions of change.

Understanding of causes:

Despite widespread exposure, only 34.8% of respondents can clearly relate human-driven causes such as pollution, deforestation, and fuel burning, with climate events. Nearly half (47.9%) express uncertainty or unfamiliarity with causal explanations, suggesting a gap between lived experience and scientific or policy narratives.

These findings highlight a critical disconnect between experience and understanding. Women are acutely aware of climate stress in their daily lives, yet many lack clarity on its underlying driver.

Clean Energy Adoption and Barriers for Women

6. Regression Results

The following thematic takeaways provide a synthesis of survey findings, organized around the core research questions of the study. Each takeaway is designed to move beyond descriptive statistics, highlighting not only the patterns observed but also the underlying mechanisms that shape women's energy use, climate event exposure, and livelihood strategies.

Importantly, the analysis draws attention to district-level variations, showing how social structures, resource access, and institutional contexts differ across Anugul, Kendrapara, and Koraput.

Together, these insights serve as a bridge between raw data and actionable evidence, offering a framework to guide intervention design and laying the groundwork for the regression results that follow.

Education and formal group membership are the strongest predictors of willingness to change from traditional to clean fuel. Age has modest positive effect. Social group differences, especially disadvantage for women from socially deprived population cohorts, highlight structural barriers.

Education increases comprehension of health and environmental benefits of clean fuel, access to information, and financial capability. Formal group membership (SHGs, networks etc.) enables collective purchasing, reduced per-unit costs, peer learning, and social trust. Social group-based discrimination and social norms restrict socially deprived population households' information access and community trust, even when education is higher.

Socially deprived population households are also more likely to be situated near forested areas, and access to foraged firewood is easy compared to buying other fuels. The magnitude of predictors of willingness to switch to clean fuels is as follows:

Education Gradient

Education increases willingness to switch to clean fuels. The willingness rises sharply with higher education levels (Illiterate/Primary < Secondary < Graduate+)

Formal Group Membership Effect

Women's association with any kind of group or network increases their willingness by approximately 62%.

Age Effect

The age effect is modest. Older women sometimes more resistant due to entrenched practices.

Social Group Disadvantage

Women from socially deprived population households show very less or negative willingness to switch to clean fuels.

District-specific Findings

The regression analysis reveals important social and district-level dynamics shaping women's willingness to adopt clean cooking fuels.

Social Group:

Structural disadvantage is evident across all districts. Women from socially deprived population households are consistently less likely to express willingness to change fuel compared to those from General households. The odds ratio (OR) for Women from socially deprived population households is approximately 0.62, meaning they are about 38% less likely to be willing to switch. This disadvantage is most pronounced in Koraput, where the interaction effect shows an OR of around 0.66, underscoring how social group identity continues to constrain energy choices even when other enabling factors are present.

Education:

A strong gradient effect is observed across all districts. Women from graduate-level or higher households are approximately 2.8 times more likely to be willing to switch compared to those with only illiterate or primary education. This highlights the critical role of education in shaping awareness, aspirations, and confidence to adopt clean fuels.

District Differences:

The regression analysis reveals important social and district-level dynamics shaping women's willingness to adopt clean cooking fuels.

Koraput

Women here show lower overall willingness to switch, with an OR of about 0.69 compared to Anugul. While education does improve willingness, its effect is weaker, and social group disadvantage remains deeply entrenched.

Kendrapara

Women demonstrate a slightly higher baseline willingness (OR approximately 1.25 compared to Anugul). Education effects are particularly strong here, with graduate-level households across all social groups showing the clearest advantage.

Anugul

Serving as the baseline district, Anugul shows the strongest education gradient, where higher education levels most directly translate into greater willingness to adopt clean fuels.

These findings highlight that while education significantly increases willingness, social group-based disadvantage continues to suppress adoption potential, particularly in Koraput. District-level variations further show that interventions must be tailored to local contexts i.e. strengthening education pathways and awareness in Anugul, addressing social group barriers in Koraput, and leveraging education gains in Kendrapara.

Women's Household Income and Effects on Awareness of Government Energy Scheme

The regression analysis how household income affects their awareness about Government Energy Schemes.

1. Income as a Driver of Awareness

- Middle-income households (INR 10,001–20,000) are about 1.8 times more likely to be aware of government energy schemes compared to the poorest group.
- High-income households (INR 20,001+) show even stronger effects, being 2.5 times more likely to be aware.
- Implication: Outreach strategies must prioritise low-income households (\leq INR 10,000), who remain least aware and most at risk of exclusion. Tailored communication such as vernacular messaging, visual aids, and community meetings, will be essential to bridge this gap.

2. District-Specific Differences

Koraput

Awareness levels are lower overall, and income gains are weaker (interaction terms <1). Even higher-income households lag behind, suggesting structural barriers such as geography, weaker institutional presence, and limited networks.

- Programme implication: Invest in intensive awareness campaigns using trusted local intermediaries (SHGs, cooperatives, village leaders).

Kendrapara

Awareness is slightly higher, especially among higher-income households (interaction terms >1).

- Programme implication: Leverage higher-income households as peer educators and early adopters, diffusing information through community networks.

Anugul :

Serves as the baseline district, where income effects are strongest and predictable.

- Programme implication: Standard outreach works here, but scaling digital channels could accelerate uptake further.

Awareness of government energy schemes rises with income, but district context significantly modifies the effect. Koraput households remain disadvantaged even at higher incomes, while Kendrapara shows stronger responsiveness. This points to the need for district-specific outreach strategies: intensive campaigns in Koraput, leveraging higher-income households in Kendrapara as peer educators, and scaling digital outreach in Anugul.

Regression analysis done on household income and willingness to change fuel, willingness to lead energy projects, and farming projects did not show statistical significance. This means that household income and district context do not meaningfully predict women's willingness to change fuel, and lead energy or farming projects. While income often shapes awareness of schemes or access to resources, it does not translate into behaviour change with fuel, or leadership readiness in these domains. Similarly, district-level differences that influence infrastructure or outreach do not appear to drive women's willingness to step into leadership roles.

Women's Decision-Making Power and Household Agency

The regression analysis highlights how social group, education, and group membership shape women's likelihood of being household decision-makers in energy and household fuel choices.

Social Group

Distinct patterns emerge across social groups. Women from socially deprived population households are significantly more likely to be decision-makers, with an odds ratio (OR) of 1.52, indicating a 52% higher likelihood compared to the baseline. In contrast, Tribal households show a marked disadvantage, with an OR of 0.54, meaning women are about half as likely to hold decision-making authority.

General households show a positive but borderline effect (OR approximately 1.32), suggesting some advantage but not as strong or consistent as socially deprived households. These findings underscore how social group dynamics can both empower and constrain women's agency in household energy decisions.

Education

A clear gradient effect is observed when it comes to education. As education levels rise, so does the likelihood of women being decision-makers at home. Graduate-level respondents are approximately 2.8 times more likely to hold decision-making authority compared to women who are illiterate or have only primary education.

This demonstrates the transformative role of education in strengthening women's confidence, bargaining power, and influence within households.

Formal Group Membership

Participation in community groups or being associated with a network, has a highly significant effect. Women who are members of Self-Help Groups, networks, or other collective platforms are nearly twice as likely (OR approximately 1.80) to be decision-makers compared to non-members. This highlights the importance of collective action and peer networks in enhancing women's leadership and decision-making capacity.

District Differences:

The regression analysis provides important insights into the notable variations across districts.

Social Group

Across all districts, women from socially deprived population households are significantly less likely to be decision-makers, with an odds ratio (OR) of approximately 0.64 compared to General households. This disadvantage is most pronounced in Koraput, where the interaction effect further reduces the odds (OR approximately 0.68) meaning only 32% of women are likely to be decision-makers, highlighting how entrenched social group-based barriers limit women's agency in household energy decisions.

Education

A strong and consistent gradient effect is observed when it comes to education. Women with graduate-level education or higher are 2.8 times more likely to be decision-makers compared to those with only illiterate or primary education. This effect is visible across all districts, though its strength varies, underscoring education as a critical enabler of agency.

Formal Group Membership

Participation in community groups significantly enhances decision-making power. Membership increases the odds by approximately 68% (OR approximately 1.68), reinforcing the role of collective agency and peer networks in empowering women to influence household choices.

District-Level Differences

The regression analysis provides important insights into the notable variations across districts.

Koraput

Women here face lower baseline odds of decision-making (OR approximately 0.68 vs Anugul). Social group disadvantage is amplified, constraining agency even among educated women. However, education and formal group membership still provide measurable improvements, suggesting that targeted interventions could help mitigate structural barriers.

Kendrapara

Women show a slightly higher baseline of decision-making power (OR approximately 1.23 vs Anugul). Education and group membership effects reinforce willingness, with graduate-level women and active formal group members showing the clearest advantage. This district demonstrates how structural enablers can translate into stronger household agency.

Anugul

Serving as the baseline district, Anugul exhibits the strongest education gradient and formal group membership effects. Here, higher education and collective participation most directly translate into increased decision-making power, suggesting that investments in these areas yield the highest returns.

Decision-making power over household fuel choice is shaped most strongly by education and formal group membership, while social group disadvantage persists, particularly in Koraput. Regional differences emphasise the need for district-specific strategies e.g. strengthening education and formal group platforms in Anugul, addressing social group barriers in Koraput, and leveraging higher baseline willingness in Kendrapara to accelerate clean energy transitions.

Women's Willingness to Learn About Solar Power and Clean Energy

The regression analysis highlights how social group, education, and formal group membership shape women's willingness to learn about solar energy, with statistically significant differences across social groups.

Social Group

Distinct patterns emerge when it comes to the influence of social group on willingness to learn about clean fuel. Women from socially deprived population households are significantly more likely to be ready to learn, with an odds ratio (OR) of 1.45, meaning they are 45% more likely than the baseline to express willingness.

General households show a positive but borderline effect (OR approximately 1.34), suggesting some advantage but not strongly significant. These findings underscore persistent social group-linked disparities, with socially deprived households facing the greatest disadvantage.

Education

A strong and consistent gradient effect of education is observed. Women with graduate-level education or higher are approximately 2.9 times more likely to be willing to learn about solar power or clean energy compared to illiterate or primary-educated respondents. This demonstrates the transformative role of education in shaping awareness, confidence, and openness to new technologies.

Formal Group Membership

Collective participation has a highly significant effect on women's willingness. Women who are members of Self-Help Groups, networks, or other community organisations are nearly twice as likely (OR approximately 1.88) to express willingness to learn about solar power or clean energy compared to non-members. This highlights the importance of peer networks and collective agency in fostering openness to clean energy solutions.

Willingness to learn about solar power is strongly shaped by education and formal group membership, both of which substantially increase the likelihood of engagement. However, social group-based differences persist, with women from socially deprived population households facing a significant disadvantage. These findings point to the need for intersectional strategies i.e. expanding education opportunities, strengthening formal group platforms, and addressing social group-linked barriers to ensure equitable participation in solar or clean energy transitions.

District-Level Differences

The regression analysis highlights notable district-level variations.

Koraput

Women here show lower baseline readiness (OR approximately 0.67 vs Anugul). Social group disadvantage is amplified, constraining willingness even among educated women. However, education and formal group membership still provide measurable improvements, suggesting that targeted interventions could help mitigate structural barriers.

Kendrapara

Women demonstrate a slightly higher baseline readiness (OR approximately 1.26 vs Anugul). Education and formal group membership effects reinforce willingness, with graduate-level women and active group members showing the clearest advantage.

Anugul

Serving as the baseline district, Anugul exhibits the strongest education gradient and formal group membership effects, where higher education and collective participation most directly translate into increased readiness to learn about solar.

Willingness to learn about solar and clean power is strongly shaped by education and formal group membership, both of which substantially increase the likelihood of engagement. However, social group disadvantage persists, particularly in Koraput, where women from socially deprived population households face the greatest barriers.

These findings emphasise the need for district-specific strategies i.e. strengthening education and formal group platforms in Anugul, addressing social group-linked barriers in Koraput, and leveraging higher baseline readiness in Kendrapara to accelerate solar and clean energy learning and adoption.

Women's Willingness to Lead Energy Projects

The regression analysis highlights how social identity, education, collective participation, and energy access shape women's willingness to take leadership roles in energy projects.

Social Group

Women from socially deprived population households are significantly less likely to express willingness to lead, with an odds ratio (OR) of approximately 0.71 compared to General households. This indicates a 29% lower likelihood, reflecting persistent structural disadvantage that continues to constrain leadership aspirations despite other enabling factors.

Education

A strong education gradient effect is observed across all districts. Women with graduate-level education or higher are 2.8 times more likely to express willingness to lead compared to those with only illiterate or primary education. This underscores the transformative role of education in building confidence, awareness, and agency to step into leadership positions.

Formal Group Membership

Participation in community groups significantly enhances leadership readiness. Women who are members of Self-Help Groups, cooperatives, or other collective organisations are approximately 67% more likely (OR approximately 1.67) to express willingness to lead. This finding reinforces the importance of collective organisation and peer networks in fostering leadership pathways.

Knowledge of Women-Led Energy Projects

Awareness of existing women-led initiatives nearly doubles the odds of willingness to lead (OR approximately 1.88). This highlights the importance of role models, visibility, and exposure in shaping aspirations, showing that women are more likely to step forward when they see examples of leadership among their peers.

Grid Connection

Energy access itself emerges as a strong enabler of leadership readiness. Women from on-grid households are approximately twice as likely (OR approximately 2.0) to express willingness to lead compared to those in off-grid households. Semi-off-grid households also show a significant advantage, being 1.5 times more likely than off-grid households. This suggests that reliable energy access not only improves household wellbeing but also strengthens women's confidence to take on leadership roles in energy projects.

Willingness to lead an energy project is most strongly shaped by education, formal group membership, and awareness of women-led initiatives, while social group disadvantage persists, particularly for women from socially deprived population households. Importantly, grid connectivity significantly boosts leadership readiness. Women with reliable energy access, whether fully on-grid or semi-off-grid, are far more likely to step forward as leaders. These findings emphasise the need for intersectional strategies that combine educational opportunities, collective platforms, and visibility of women leaders with expanded energy infrastructure to ensure equitable leadership in the clean energy transition.

District-Level Differences

The regression analysis provides important insights into the notable variations across districts.

Koraput

Women here show lower baseline odds of leadership willingness (OR approximately 0.68 vs Anugul). While education and grid access improve readiness, social group disadvantage remains persistent and heavily constrains agency. This district requires equity-focused interventions that directly address social group-linked barriers alongside enabling factors.

Kendrapara

Women demonstrate a slightly higher baseline willingness (OR approximately 1.23 vs Anugul). Education and grid connectivity amplify readiness more strongly here, with graduate-level women and on-grid households showing the clearest advantage. This district illustrates how structural improvements can translate into higher leadership potential.

Anugul

Serving as the baseline district, Anugul exhibits the strongest effects of education and formal group membership. Here, higher education and collective participation most directly translate into increased willingness to lead, suggesting that investments in these areas yield the highest returns.

Leadership willingness is most strongly shaped by education, formal group membership, and knowledge of women-led projects, while grid connectivity and district context significantly modify these effects

Women's Willingness to Lead Farming Projects

The regression analysis highlights how education, social group, formal group membership, knowledge of women-led projects, and grid connectivity shape women's willingness to take leadership roles in farming initiatives.

Social Group

Women from socially deprived population households are less likely to express willingness to lead (OR approximately 0.73) compared to General households. This disadvantage is most pronounced in Koraput, where social group-linked barriers are deeply entrenched and continue to suppress leadership aspirations despite other enabling factors.

Education

A strong and consistent education gradient effect is observed across all districts. Women with graduate-level education or higher are approximately 2.6 times more likely to express willingness to lead compared to those with only illiterate or primary education. While the effect is slightly smaller in Koraput, it remains positive, underscoring education as a critical enabler of leadership readiness.

Formal Group Membership

Participation in community groups raises the odds of leadership willingness by approximately 62% (OR approximately 1.62). The effect is positive across all districts, reinforcing the importance of collective organisation and peer networks in building confidence and agency.

Knowledge of Women-Led Farming Projects

Awareness of existing women-led initiatives increases the odds of willingness by about 77% (OR approximately 1.77). This highlights the importance of role models and exposure, showing that visibility of women leaders in agriculture has a transformative effect on aspirations of rest of the women.

Grid Connection

Energy access strongly influences leadership readiness. Women from on-grid households are approximately 1.55 times more likely to express willingness to lead compared to off-grid households, while those in semi-off-grid households are 1.31 times more likely. District and grid interactions show amplified gains in Kendrapara, where reliable energy access strengthens education effects, and more modest gains in Koraput, where infrastructure gaps remain significant.

District-Level Insights

The regression analysis provides important insights into the notable variations across districts.

Koraput

- Women here show lower baseline willingness (OR approximately 0.67 vs Anugul) and stronger social group disadvantage.
- Programmes must prioritise equity-focused interventions, including targeted outreach to socially deprived population households, culturally sensitive training, and confidence-building measures.
- Infrastructure gaps, with a higher share of off-grid households, mean that leadership training must be combined with energy access interventions (e.g., solar or biogas pilots) to create tangible pathways for women to lead.

Kendrapara

- Women demonstrate a slightly higher baseline willingness (OR approximately 1.26 vs Anugul).
- Grid connectivity amplifies education effects, positioning the district well for scaling programmes quickly.
- Leveraging existing grid access and educated respondents for pilot projects can showcase success and accelerate adoption.
- Peer-led models should be emphasized to normalize women's leadership in farming.

Anugul

- Serving as the baseline district, Anugul exhibits the strongest effects of education and group membership.
- Programmes should emphasise collective mobilisation through Self-Help Groups (SHGs), cooperatives, and farmer collectives, alongside continued education opportunities such as adult literacy and vocational training.
- Infrastructure catch-up is less urgent compared to Koraput, allowing focus on strengthening social and educational enablers.

Women's Awareness of Government Run Energy Schemes

The regression analysis highlights how education, social group, formal group membership, and grid connectivity shape women's likelihood of being aware of government-run energy schemes, with notable district-level variations.

Social Group

Women from socially deprived population households are less likely to be aware of schemes (OR approximately 0.72) compared to General households. This disadvantage is most pronounced in Koraput, where entrenched social inequities limit access to information and reduce awareness despite other enabling factors.

Education

A strong education gradient effect is evident. Women with graduate-level education or higher are approximately 2.6 times more likely to be aware of energy schemes compared to those with only illiterate or primary education. This underscores the role of education in enabling access to information and building awareness of institutional support.

Formal Group Membership

Participation in collective structures such as Self-Help Groups (SHGs), networks, or farmer collectives increases the odds of awareness by about 62% (OR approximately 1.62). This finding highlights the importance of peer networks and collective platforms in disseminating information about government programmes.

Grid Connection

Energy access itself is a strong enabler of awareness. Women from on-grid households are approximately 1.55 times more likely to be aware of schemes compared to off-grid households, while those in semioff-grid households are 1.31 times more likely. This suggests that reliable infrastructure not only improves energy access but also strengthens women's exposure to government programmes.

District Differences

The regression analysis provides important insights into the notable variations across districts.

Koraput

Women here show a lower baseline awareness (OR approximately 0.67 vs Anugul), with social group-linked disadvantage amplified. Education and grid access improve awareness but cannot fully offset structural inequities.

Kendrapara

Women demonstrate a slightly higher baseline awareness (OR approximately 1.26 vs Anugul). Education and grid connectivity amplify effects more strongly here, positioning the district well for rapid scaling of awareness campaigns.

Anugul

Serving as the baseline district, Anugul shows the strongest effects of education and formal group membership, where 30 collective structures and education pathways most directly translate into higher awareness.

Women's awareness of government-run energy schemes is most strongly shaped by education, formal group membership, and grid connectivity, while social group-linked disadvantage persists, particularly in Koraput. District-level differences highlight the need for tailored strategies. Koraput requires equity-focused outreach and infrastructure support, while Kendrapara is well-positioned for rapid scaling through grid and education, and Anugul benefits most from embedding awareness in collective structures and education pathways.

Household Access to Government Schemes

The regression analysis highlights how education, formal group membership, grid connectivity, and social group identity shape household access to government schemes, with notable district-level variations.

Social Group

Women from socially deprived population households show lower odds of scheme access (OR approximately 0.72) compared to General households. This disadvantage is most pronounced in Koraput, where entrenched inequities limit access despite other enabling factors.

Education

A strong education gradient effect is evident. Households with graduate-level respondents are significantly more likely to access government schemes compared to those with illiterate or primary education. Education equips people with the knowledge and confidence to navigate bureaucratic processes and claim entitlements.

Formal Group Membership

Participation in collective structures such as Self-Help Groups (SHGs), networks, or farmer collectives increases the odds of scheme access by over 60% (OR approximately 1.62). Groups act as conduits for information, peer support, and collective bargaining, making them critical vehicles for expanding access.

Grid Connection

Energy access itself is a strong indicator of broader scheme access. Women from on-grid households are approximately 1.55 times more likely to access government schemes compared to off-grid households, while those in semi-off-grid households are 1.31 times more likely. This suggests that electricity access which is often delivered through government programmes, correlates with awareness and uptake of other schemes.

District Differences

Koraput

- Households here show lower baseline access to government schemes.
- Social group disadvantage is amplified, Women from socially deprived population households facing significant barriers.
- Infrastructure gaps, including higher off-grid populations, mean that equity-focused outreach and infrastructure integration are critical. Programmes must combine awareness campaigns with energy access interventions to ensure inclusion.

Kendrapara

- Households demonstrate a slightly higher baseline access compared to Anugul.
- Grid connectivity and education amplify effects more strongly here, positioning the district well for rapid scaling of scheme awareness and uptake.
- Leveraging educated respondents as peer trainers and showcasing pilot successes can accelerate adoption.

Anugul

- Serving as the baseline district, Anugul exhibits the strongest effects of education and group membership.
- Programmes should emphasise collective mobilisation through SHGs and networks, alongside continued education pathways such as adult literacy and vocational training.
- Infrastructure catch-up is less urgent compared to Koraput, allowing focus on strengthening social and educational enablers.

Household access to government schemes is most strongly shaped by education, group membership, and grid connectivity, while social group disadvantage persists, particularly in Koraput. District-level tailoring is essential. Koraput requires equity and infrastructure-focused interventions, while Kendrapara is well-positioned for rapid scaling through grid and education, and Anugul benefits most from collective mobilisation and education pathways.

Digital Inclusion of Women

The analysis highlights how education, formal group membership, grid connectivity, and social group identity shape women's likelihood of owning and using mobile phones, with important district-level variations.

Social Group

Women from socially deprived population households show lower odds of smartphone ownership (OR approximately 0.72) compared to General households, with the gap most pronounced in Koraput. This highlights the need for equity-focused targeting, including subsidized mobile phones, culturally sensitive training, and confidence-building measures. Programmes should monitor mobile phone uptake disaggregated by social group to ensure inclusivity.

Education

A strong education gradient effect is evident across all districts. Women with graduate-level education or higher are nearly three times more likely to own mobile phones compared to those with only illiterate or primary education. This effect is further amplified in Koraput and Kendrapara, where higher education interacts with local conditions to produce stronger gains. Programmes should tailor digital literacy and financial inclusion initiatives to loweducation households using visual and oral formats, while leveraging highereducated women as peer trainers for mobile phone use in accessing schemes, banking, and energy apps. District programmes should also invest in adult education and vocational training as complementary pathways to digital inclusion.

Formal Group Membership

Participation in collective structures such as Self-Help Groups (SHGs), networks, or farmer collectives increases the odds of mobile phone ownership by about 62% (OR approximately 1.62). These effects are slightly larger outside Anugul, underscoring the importance of collective action in contexts where social capital is weaker. Embedding digital literacy and mobile banking training within group structures can accelerate adoption. In Koraput, where collective action is weaker, strengthening groups is essential to build social capital and expand mobile phone use. Groups can also serve as distribution channels for apps, scheme information, and energy services.

Grid Connection

Energy access strongly correlates with mobile phone ownership. Women from on-grid households are approximately 1.5 times more likely to own mobile phones compared to off-grid households, while those in semi-off-grid households are 1.3 times more likely. This suggests that electricity access (often delivered through government programmes), creates enabling conditions for digital inclusion. Programmes should pair mobile phone adoption campaigns with energy access interventions in off-grid areas. In Kendrapara, grid connectivity can be leveraged to scale digital programmes quickly, while in Koraput, integrating mini-grid or solar solutions can help reduce structural barriers to mobile phone use.

District-Level Differences

Koraput

- Has lower baseline mobile phone ownership and stronger social group disadvantage.
- Programmes must prioritise equity-focused outreach to Women from socially deprived population households, culturally sensitive digital literacy, and confidence-building.
- Infrastructure gaps mean combining mobile phone adoption with mini-grid or solar energy interventions is critical.
- Strengthening group structures will help build social capital and accelerate adoption.

Kendrapara

- Has slightly higher baseline mobile phone ownership, with grid connectivity amplifying education effects.
- Well-positioned for rapid scaling of digital programmes, leveraging grid access and educated respondents.
- Peer-led models should be emphasized to accelerate adoption of mobile banking, energy apps, and scheme access.

Anugul

- Serves as the baseline district, where education and formal group membership are the strongest drivers of mobile phone ownership.
- Programmes should emphasise collective mobilisation through SHGs and networks, alongside education pathways such as adult literacy and vocational training.
- There is less need for infrastructure updating compared to Koraput, allowing focus on strengthening social and educational enablers.

Financial Inclusion of Women

The analysis highlights how education, formal group membership, grid connectivity, and social group identity shape women's likelihood of having bank accounts, with important district-level differences.

Social Group

Women from socially deprived population households continue to face disadvantage (OR approximately 0.72) compared to General households. This disadvantage is most pronounced in Koraput, where entrenched inequities limit access to financial services. In Kendrapara, the disadvantage is slightly less, suggesting that education and grid connectivity help reduce, but do not eliminate, social group-linked barriers.

Education

A strong education gradient effect is observed. Women with graduate-level education or higher are about 1.5 times more likely to have bank accounts compared to those with only illiterate or primary education. This effect is particularly visible in Koraput and Kendrapara, where higher education amplifies financial inclusion odds, showing that education equips women with the confidence and skills to engage with formal financial systems.

Formal Group Membership

Collective structures consistently boost financial inclusion across all districts. Women who are members of Self-Help Groups (SHGs), networks, or farmer collectives show significantly higher odds of having bank accounts. This demonstrates the role of peer networks and collective action in spreading awareness, building trust, and facilitating access to financial services. It is also likely that the group or networks have helped them access bank accounts.

Grid Connection

Energy access correlates with financial inclusion. Women from on-grid households in Koraput and Kendrapara are approximately 1.2- 1.3 times more likely to have bank accounts compared to off-grid households. This suggests that electricity access (often delivered through government programmes), creates enabling conditions for broader institutional inclusion, including financial services.

District-Level Insights

Koraput

- Women here show lower baseline financial inclusion and stronger social group disadvantage.
- Programmes must prioritise equity-focused outreach socially deprived population households, combining financial literacy with culturally sensitive training.
- Infrastructure gaps mean pairing financial inclusion campaigns with energy access interventions (mini-grids, solar, biogas) is critical to ensure inclusion.

Kendrapara

- Women demonstrate a slightly higher baseline financial inclusion compared to Anugul.
- Education and grid connectivity amplify effects more strongly here, positioning the district well for rapid scaling of financial inclusion programmes.
- Leveraging educated respondents as peer trainers and showcasing pilot successes can accelerate adoption.

Anugul

- Serving as the baseline district, Anugul shows the strongest effects of collective mobilisation and education pathways.
- Programmes should emphasise embedding financial literacy and bank account facilitation within SHGs and cooperatives, alongside adult literacy and vocational training.
- Infrastructure improvement here is less urgent compared to Koraput, allowing focus on strengthening social and educational enablers.

Climate Change Knowledge Drivers

The analysis reveals important social and structural factors influencing whether respondents understand why climate events have increased. At the baseline, General group, illiterate, non-group members show relatively less likelihood of possessing such knowledge (OR = 0.43).

Social Group

Differences are evident, with Women from socially deprived population demonstrating significantly higher likelihood of possessing climate knowledge compared to General households (OR approximately 1.65 suggesting that social group-based disparities shape awareness unevenly).

Education

Education emerges as the strongest predictor. Respondents with Graduate and above education are three times more likely to know why climate events have increased compared to illiterate respondents. This underscores the critical role of formal education in building climate literacy and equipping households to interpret environmental changes.

Formal Group Membership

Social participation also matters. Membership in a formal group raises the likelihood of climate knowledge by approximately 63%, highlighting the importance of collective platforms in spreading awareness and information.

Climate knowledge is not evenly distributed. It is shaped by social group, strengthened by education, and amplified through formal group membership. Programmes aiming to build climate awareness must therefore prioritise educational access and leverage community groups to ensure that knowledge reaches marginalised households.

Belief That Climate Events Can Be Reduced

The analysis reveals important social and structural factors influencing whether respondents understand why climate events have increased. At the baseline, General group, illiterate, non-group members show relatively less likelihood of possessing such knowledge (OR = 0.43).

Social Group

Differences are visible, with women from socially deprived population respondents showing higher likelihood of belief compared to General households (OR approximately 1.67).

Education

Education emerges as the most powerful driver. A clear gradient is observed. As education levels rise, so does belief in the possibility of reducing climate events. Graduates are three times more likely to hold this belief compared to illiterate respondents, underscoring the transformative role of education in shaping climate optimism and agency.

Formal Group Membership

Social participation also matters. Membership in a formal group significantly increases belief (OR approximately 1.63), pointing to the importance of collective platforms in reinforcing confidence and shared responsibility.

Knowledge of Climate Event Causes

Knowledge of climate causes is a critical factor. Respondents who understand why climate events are increasing are twice as likely to believe they can be reduced (OR approximately 2.06). This demonstrates that awareness and knowledge directly translate into empowerment and belief in solutions.

Belief in reducing climate events is most strongly shaped by education and knowledge, and further reinforced by formal group membership. While social groupbased differences exist, they are less pronounced compared to these structural and informational factors. Programmes aiming to build climate resilience must therefore prioritise education, strengthen collective platforms, and expand climate literacy to ensure that households not only understand the causes of climate change but also believe in their capacity to address it.

Migration of Family Members for Work

The regression analysis highlights the complex interplay of social, economic, and environmental factors shaping household migration decisions. The baseline likelihood of migration are low for General households, illiterate, low-income households in Anugul (OR = 0.16). However, several factors substantially increase the likelihood of migration.

Social Group

This emerges as a significant determinant. Socially deprived population households are nearly twice as likely to report migration compared to General households (OR approximately 1.80). District-level differences are also pronounced, with Koraput households showing almost double the likelihood of migration compared to Anugul (OR approximately 1.91), underscoring the importance of localized context in shaping mobility patterns.

Education

Education plays a notable role, with graduates being three times more likely to migrate than illiterate respondents. This suggests that migration is not only a survival strategy but also an aspirational pathway for better opportunities among educated households.

Formal Group Membership

Income levels further reinforce this trend. Households earning above INR 20,000 per month are more than twice as likely to migrate compared to those earning below INR 10,000, indicating that migration is often facilitated by the resources of relatively better-off families.

Climate Stress

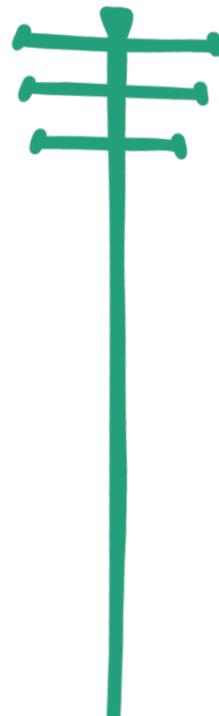
Climate stress is a critical driver. Households experiencing climate issues “very frequently” are twice as likely to migrate compared to those reporting no climate issues, highlighting the direct link between environmental vulnerability and mobility.

Migration is driven both by distress and aspiration. Climate stress and district-level vulnerabilities push households out, while higher education and income enable mobility. Social group-based disparities further shape who migrates, pointing to the need for targeted, equity-focused interventions.



7.

Programme Implications



a. Equity Lens – Focus on SC and ST Households

Programmes must place women from socially deprived population cohorts at the centre of design and delivery, ensuring they are not treated as peripheral beneficiaries but as core participants. In practice, this requires:

- o **Priority selection** of women from socially deprived population cohorts into training programmes, leadership cohorts, and pilot initiatives, ensuring they are represented in decision-making roles.
- o **Facilitator training** on social group dynamics and unconscious bias, equipping trainers to recognise and address inequities in group settings.
- o **Establishing clear rules for inclusive group processes**, with transparent mechanisms for benefit-sharing, so that socially deprived population households are not excluded from resources or opportunities. This equity lens is particularly critical in Koraput, where social group disadvantage is most pronounced, but should also be applied to such clusters across all the three districts.

b. Education-Level-Based Differentiated Training Materials

Education strongly shapes women's ability to engage with energy and livelihood programmes. To maximize inclusion:

- o For **low-literacy women**, training should use simple visual tools, vernacular stories, role plays, and hands-on demonstrations to build confidence and understanding.
- o For **higher-educated women**, training can include technical content such as solar power systems, return on investment calculations, business planning, and digital tools for financial management.
- o **Educated women can serve as peer trainers**, cascading knowledge within their villages or SHG clusters, thereby bridging the education gap and strengthening community learning.

c. Collective Action and Power of Networks

Self-Help Groups (SHGs), farmer producer organisations (FPOs), and cooperatives are powerful vehicles for scaling inclusion. Programmes should:

- o Embed digital literacy, mobile banking, climate awareness, and fuel transition modules into regular SHG and group meetings, making them routine parts of collective learning.
- o Support small group-based projects such as shared solar pumps, community grain milling units, or group LPG connections, which reduce costs and build collective ownership.
- o Link SHGs and FPOs with banks, microfinance institutions, and government schemes, enabling groups to access credit for energy assets and strengthen financial inclusion.

d. Infrastructure Integration of Grid and Decentralised Energy

Energy access is a critical enabler of women's leadership and inclusion. Programmes should align infrastructure interventions with training and leadership development:

- o In grid-enabled areas like Kendrapara, leverage grid-linked pilots for productive uses such as cold storage, food processing units, or electric irrigation pumps.
- o In semi-off-grid or off-grid pockets of Koraput and Anugul, pair leadership development with first access to decentralised solutions such as solar pumps, mini-grids, or biogas systems, ensuring women are early adopters of clean energy technologies.

District-Specific Strategies

Each of the three districts have their own strengths and disadvantages. The strengths should be leveraged and the disadvantages addressed while designing the programme. The district-specific strategies are as follows:

Koraput:

- o Core programme should include group strengthening, basic literacy, climatesmart farming practices, and solar or biogas pilots.
- o Place a strong equity focus on women from socially deprived population cohorts, with targeted mentoring, confidence-building, and culturally sensitive facilitation.

Kendrapara:

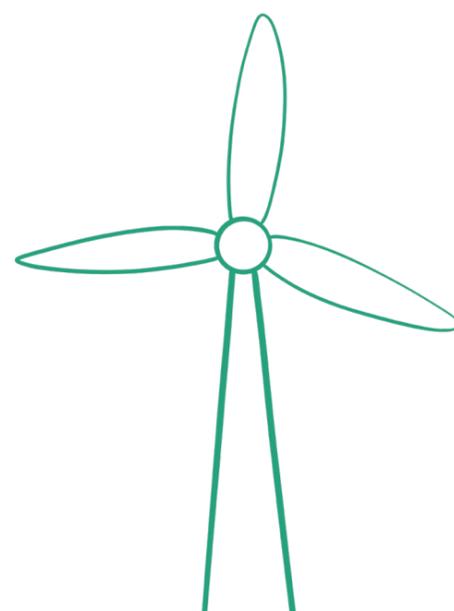
- o Core programme should emphasise rapid pilots linking energy to fisheries, cold chains, and irrigated farming systems.
- o Use educated, grid-connected women as peer leaders and early adopters, showcasing success stories to accelerate adoption.

Anugul:

- o Core programme should focus on SHG-led energy cooperatives and education expansion.
- o Use energy initiatives to frame a longer-term transition from coal-linked livelihoods to green alternatives, positioning women as leaders in this shift.

These programme implications highlight the need for intersectional, districttailored strategies that combine equity, education, collective action, and infrastructure integration. By centering women from socially deprived population cohorts, differentiating training by education level, embedding learning in group structures, and aligning energy access with leadership development, programmes can ensure that women across Koraput, Kendrapara, and Anugul are not just participants but drivers of inclusive energy and livelihood transitions.

8. Recommendations



Action Matrix for the Three Districts

The following action matrix translates the regression findings and thematic insights into district-specific priorities. By mapping key enabling factors such as social group-based equity, education, formal group membership, and energy infrastructure, against the realities of Koraput, Kendrapara, and Anugul, the matrix provides a practical guide for tailoring interventions. It highlights where equity must be centred, where education and collective action can be leveraged, and how infrastructure investments should be aligned with social inclusion. This structured approach ensures that programme design is both evidence-based and context-sensitive, addressing the unique barriers and opportunities in each district.

Factors and District Priorities

Factor	Koraput	Kendrapara	Anugul
Socially deprived population cohorts	Very high priority - core equity focus	High priority - in such pockets	High priority - in such pockets
Education	High priority - focus on adult literacy	High priority - focus on advanced skills	High priority - focus on adult literacy
Group Membership	High priority - new group formation and deep support	High priority - use SHGs/FPOs for scaling	High priority - use SHGs for scaling
Grid/ Energy Infra	Very high priority - decentralised energy solutions	Very high priority - pilots for productive uses	Very high priority - focus on mining-affected pockets

The above matrix underscores the differentiated pathways required for advancing women’s leadership and inclusion in energy and farming transitions. In Koraput, equity and infrastructure integration are paramount, demanding targeted outreach to socially deprived population households and decentralised energy pilots. In Kendrapara, stronger grid connectivity and higher education levels create conditions for rapid scaling, making it ideal for demonstration projects and peer-led models.

In Anugul, collective mobilisation through SHGs and adult literacy programmes remain the strongest levers, with energy interventions framed around a longer-term shift from coal-linked livelihoods. Together, these district-specific strategies ensure that interventions are not generic but responsive to local realities, maximizing both impact and sustainability.

Suggested Actions for Funders and Field Teams

For Funders

Funders play a critical role in shaping the enabling environment for women's leadership in energy, farming, and climate-smart livelihoods. The following interventions are recommended:

1. Support multi-year district programmes

Funders should invest in long-term, integrated programmes that combine:

A. Group strengthening

Build resilient Self-Help Groups (SHGs), farmer producer organisations (FPOs), and cooperatives as platforms for women's collective agency.

B. Clean energy assets

Provide access to solar pumps, biogas units, minigrids, and other decentralised energy solutions.

C. Climate-smart agriculture

Promote practices such as water-efficient irrigation, resilient crop varieties, and sustainable soil management.

D. Leadership and business skills

Train women in financial literacy, enterprise development, and project management to ensure sustainability.

2. Create flexible funding mechanisms

A. Establish adaptive funds that allow rapid scale-up of successful pilots in Kendrapara and Anugul, where enabling conditions (education, grid connectivity, group structures) are stronger.

B. Maintain a slower, deeper approach in Koraput, focusing on equity, literacy, and infrastructure gaps. This dual strategy will ensure both quick wins and long-term inclusion.

3. Back district-level women leadership cohorts

A. Support cross-sectoral leadership cohorts of women that cut across energy, climate, and farming.

B. These cohorts can act as peer mentors, role models, and advocates, amplifying women's voices in district planning and policy dialogues.

C. Funders should also invest in documentation and dissemination of cohort experiences to influence broader policy and donor agendas.

For Field Teams

Field teams are the frontline actors who translate programme design into community-level change. The following interventions are recommended:

1. Start with SHGs and FPOs as entry points

Funders should invest in long-term, integrated programmes that combine:

A. Use existing collective structures as the foundation for interventions.

B. Build women-led energy and farming pilots inside these groups, ensuring ownership and collective accountability.

2. Use local women as peer trainers and role models

A. Identify women who already manage projects or demonstrate leadership capacity.

B. Train them as peer educators and role models, enabling knowledge transfer within hamlets and SHG clusters.

C. This peer-led approach will build trust and accelerates adoption.

3. Build joint sessions with husbands, elders, and local leaders

A. Conduct community dialogues that include men, elders, and local leaders to shift norms around women's decision-making.

B. Use participatory methods to highlight the benefits of women's leadership for households and communities.

C. This will help reduce resistance and will foster supportive environments for women leaders

4. Document and share stories of women leaders from socially deprived population cohort.

A. Capture case studies and success stories of women from socially deprived population cohorts, who have taken leadership roles or adopted new technologies.

B. Share these stories across villages to normalize women's leadership and inspire others.

C. Use vernacular media formats (posters, radio, videos, storytelling sessions) to ensure accessibility.

Monitoring and Evaluation Framework

Effective monitoring and evaluation (M&E) are essential to track progress, ensure accountability, and adapt programmes for greater impact. The following indicators provide a comprehensive framework to measure outcomes across access and inclusion, knowledge and attitudes, practice and adoption, and leadership and agency.

Access and Inclusion

The following indicators will measure whether women, especially those from marginalised groups, are being reached and included in programme activities

Share of women from socially deprived population in groups, training, and leadership roles:

Percentage of women from socially deprived population participating in Self-Help Groups (SHGs), farmer producer organisations (FPOs), training programmes, and leadership cohorts. This will ensure that equity-focused targeting is being achieved.

Number of women with access to clean cooking and basic electricity:

Absolute count of women reporting access to LPG, improved cookstoves, solar home systems, or reliable grid electricity. This will track infrastructure-linked inclusion.

Knowledge and Attitudes

The following indicators will measure assess shifts in awareness and perceptions, which are precursors to behavioural change.

Share of women who can explain climate causes in simple terms:

Percentage of women who can articulate basic drivers of climate change (e.g., deforestation, fossil fuel use) in vernacular language.

Share who believe climate events can reduce if action is taken:

Percentage of women expressing belief that collective or individual action can mitigate climate impacts. This will measure empowerment in attitudes.

Practice and Adoption

The following indicators will track tangible changes in household and community practices.

Number of households that adopt cleaner fuel or solar systems:

Count of households shifting from traditional biomass to LPG, improved cookstoves, or adopting solar lighting, pumping systems.

Number of women-led energy or farming projects started and sustained:

Count of projects initiated and still operational after 12 months, such as women-led solar irrigation, biogas units, or collective farming initiatives. Sustainability of the projects will be the key dimension here.

Leadership and Agency

These indicators will measure women's decision-making power and formal leadership roles.

Share of women who report joint or sole decision-making on fuel and major expenses

Percentage of women reporting participation in household decisions related to energy, farming inputs, or financial expenditures.

Number of women who hold formal roles in SHGs, FPOs, cooperatives, or project committee

Count of women serving as chiefs, presidents, secretaries, treasurers, or committee members in collective organisations. This will track institutional leadership.

This M&E framework ensures that programmes are not only tracking outputs (e.g., number of trainings, assets distributed) but also outcomes and impacts such as equity in participation, shifts in knowledge and attitudes, adoption of sustainable practices, and women's leadership agency. By disaggregating data by district, social group, and education level, funders and field teams will be able to identify gaps, adapt strategies, and ensure that interventions are both inclusive and transformative.

9. Conclusion

Summary of Evidence

The Year 1 baseline demonstrates that women's energy futures in Odisha are shaped by the dynamics of climate stress, social disadvantage, and infrastructure gaps. These constraints intersect to limit women's agency, particularly for the socially deprived population households and those in off-grid areas. At the same time, the evidence points to education and group membership as powerful levers of change, consistently increasing women's willingness to adopt clean energy, lead projects, and access government schemes.



The District Context is Critical:

- o **Koraput** requires a dual focus on equity and infrastructure, as social group-based disadvantage and energy access gaps are most pronounced.
- o **Kendrapara** is positioned for rapid scaling, with grid connectivity and higher education levels enabling faster uptake of pilots.
- o **Anugul** sits in the middle, where strong SHGs and education pathways provide the clearest route to inclusion and leadership.

This baseline confirms that intersectional strategies, that of combining equity, education, collective action, and infrastructure, are essential for advancing women-led energy transitions.

Call to Action for Funders and Partners

The next two years present a critical window of opportunity to design and test district-level models of women-led, equity-focused energy transition. Funders, government partners, and NGOs should come together to use this evidence to:

- o Target the most disadvantaged groups, ensuring socially deprived population households and off-grid communities are prioritized rather than overlooked.
- o Back group-based models where women lead planning, asset use, and benefit sharing, embedding energy and farming pilots within SHGs, FPOs, and cooperatives.
- o Tie energy work to climate-smart farming and stable livelihoods, ensuring that clean energy adoption is linked to tangible improvements in income, resilience, and food security.

By aligning resources and strategies with these priorities, funders and partners can catalyze systemic change that is both inclusive and sustainable.

Next Steps

The pathway forward requires sequenced action across districts, with pilots, leadership development, and monitoring systems forming the backbone of implementation.

Implementation in Year 2:

- o Should launch district-specific pilots aligned with local strategies (equity + infrastructure in Koraput, rapid scaling in Kendrapara, collective mobilisation in Anugul).
- o Should build leadership cohorts of women, with explicit priority for socially deprived population cohorts participants, ensuring representation and equity.
- o Should establish a simple monitoring system tied to agreed indicators (access, knowledge, practice, leadership) to track progress and adapt in real time.

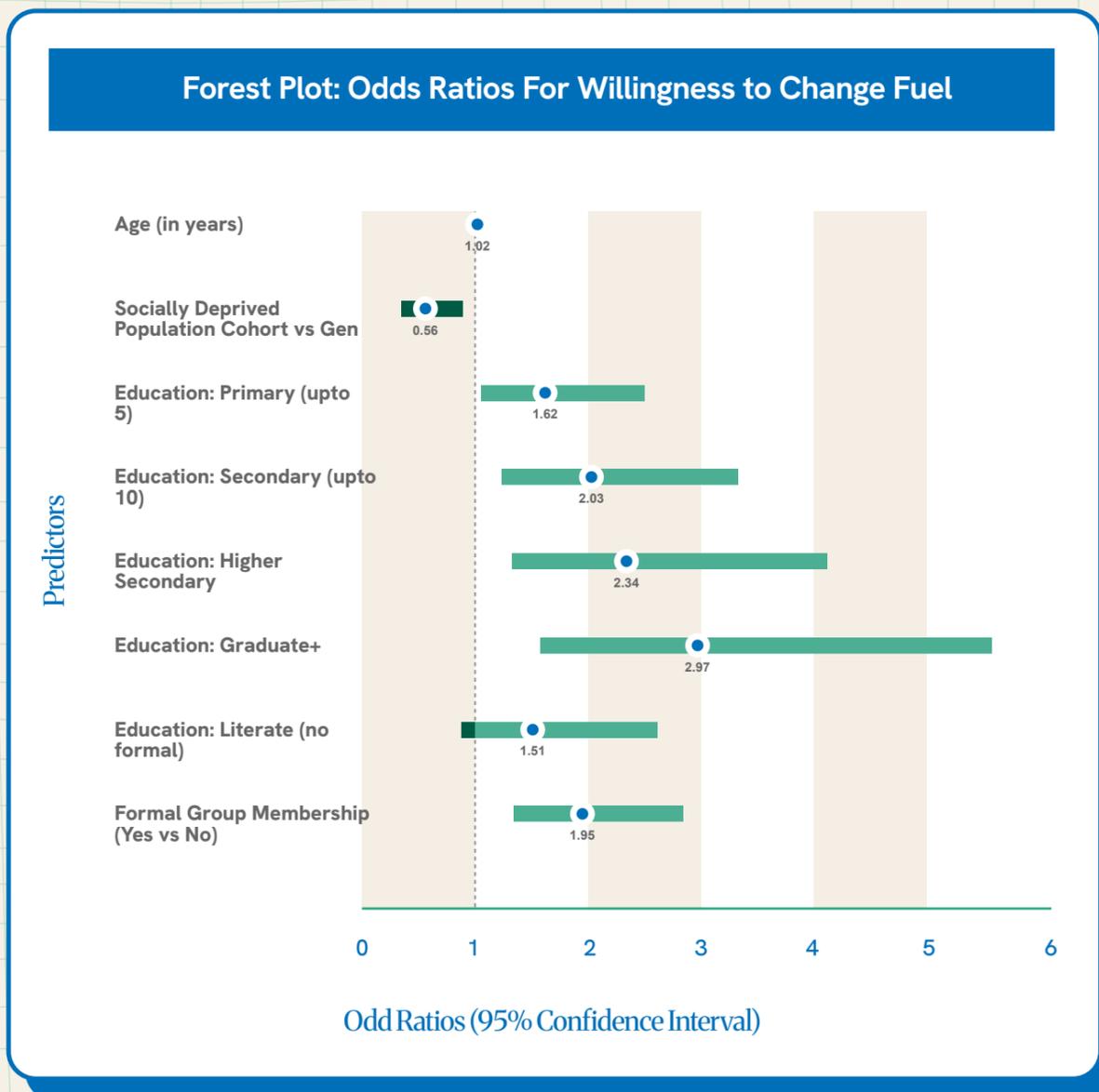
Implementation in Year 3:

- o Should scale models that succeed, adapt those that show promise, and discontinue those that fail to deliver impact.
- o Should document lessons systematically and share them with state energy and climate platforms, ensuring evidence informs wider policy.
- o Should use results to advocate for a stronger gender and equity focus in state and national energy schemes, embedding women's leadership into the broader energy transition agenda.

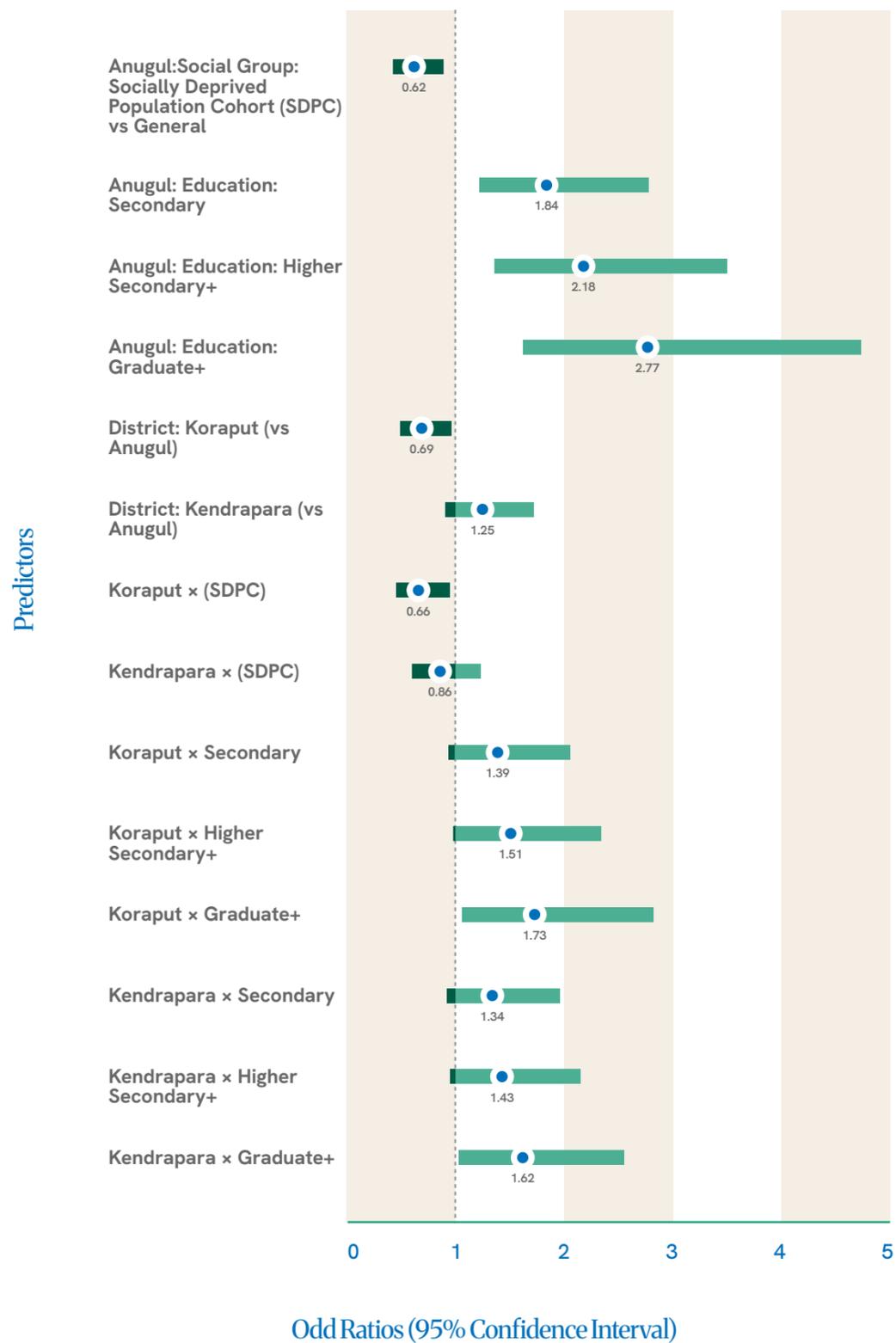
The evidence from Year 1 makes clear that women's leadership is not a peripheral issue but a central driver of equitable energy transitions in Odisha. By combining equity-focused outreach, differentiated education strategies, collective action, and infrastructure integration, funders and field teams can ensure that women, especially from disadvantaged groups, are not just beneficiaries but leaders shaping the future of energy, farming, and climate resilience.

10. Annexure

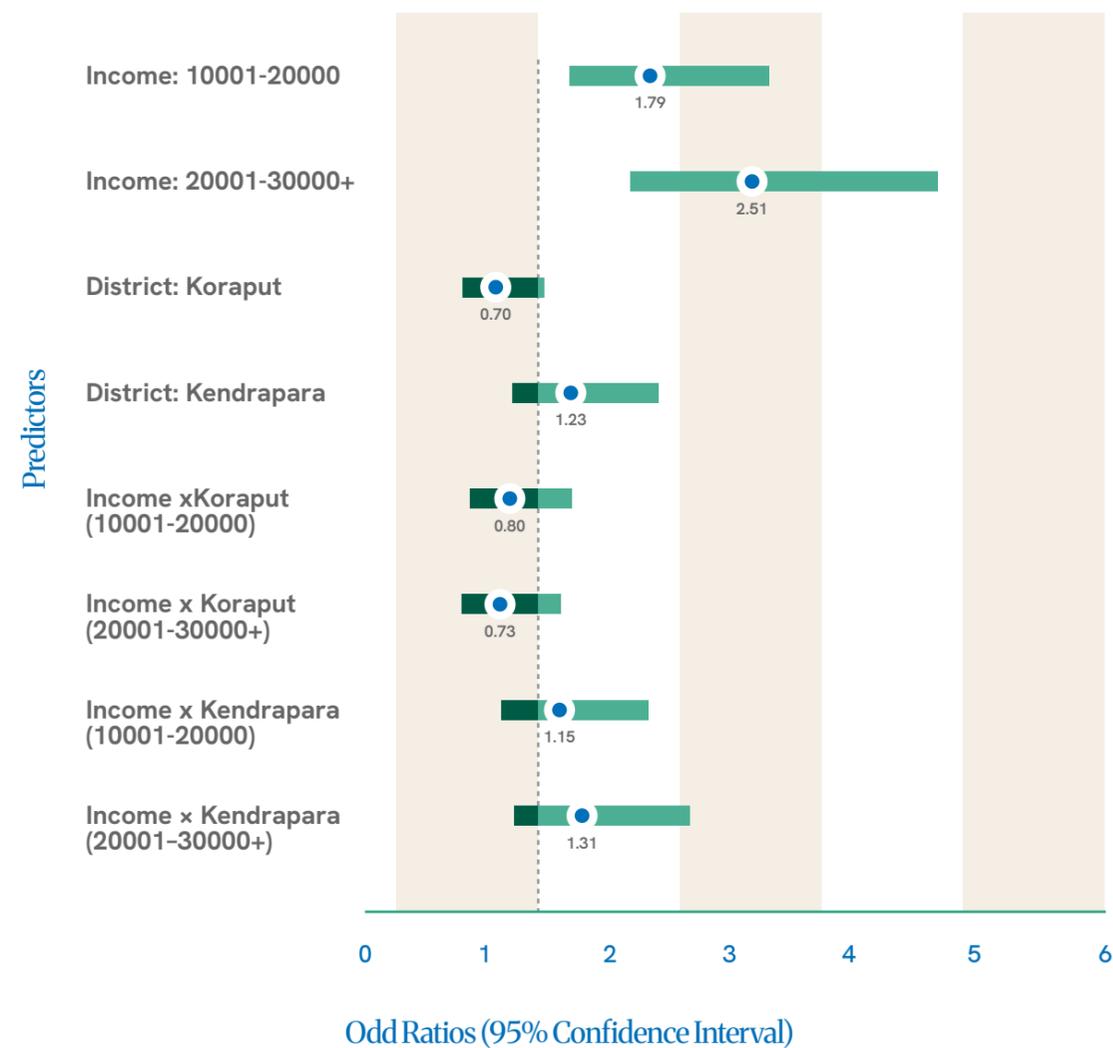
Regression Graphs



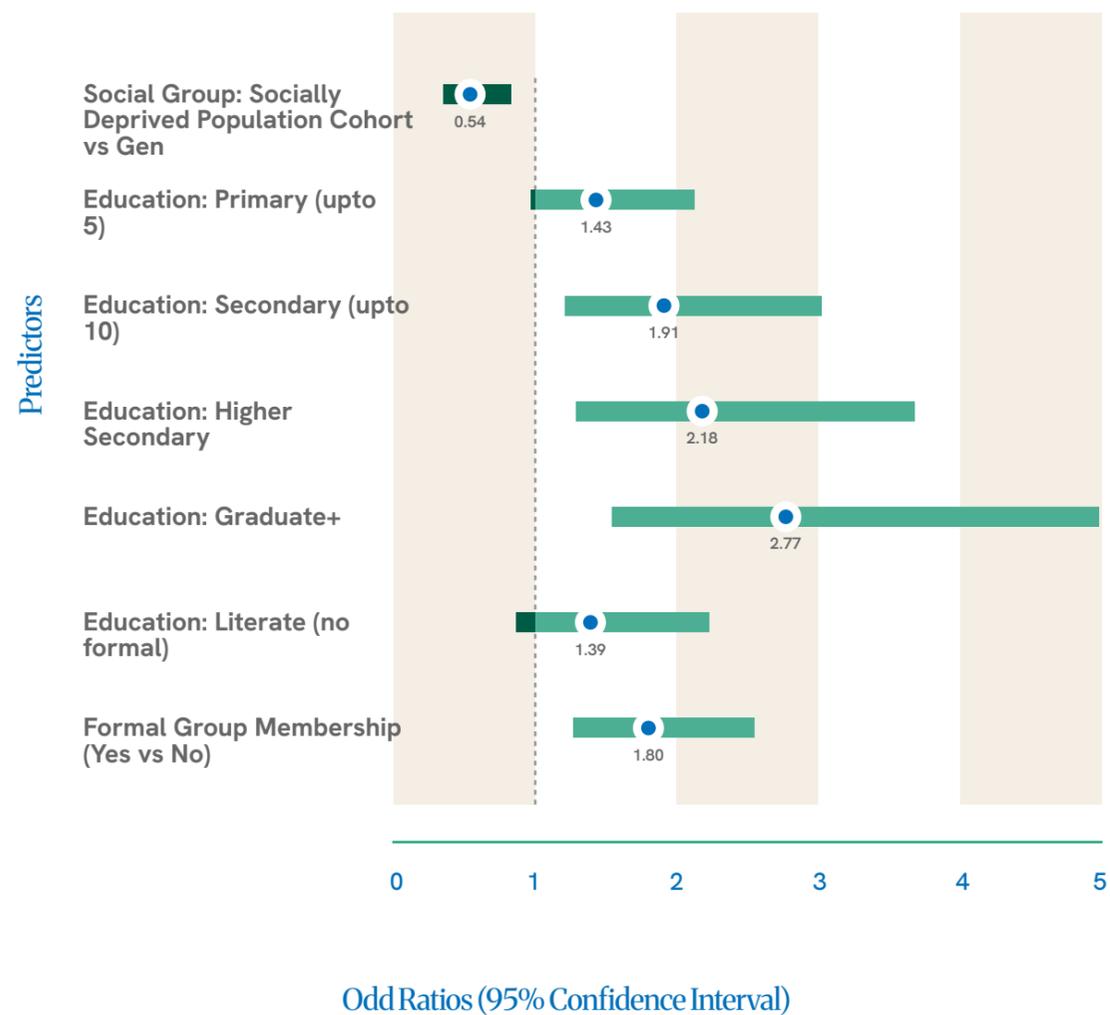
Forest Plot: District Wise Comparison of Odds Ratios For Willingness to Change Fuel



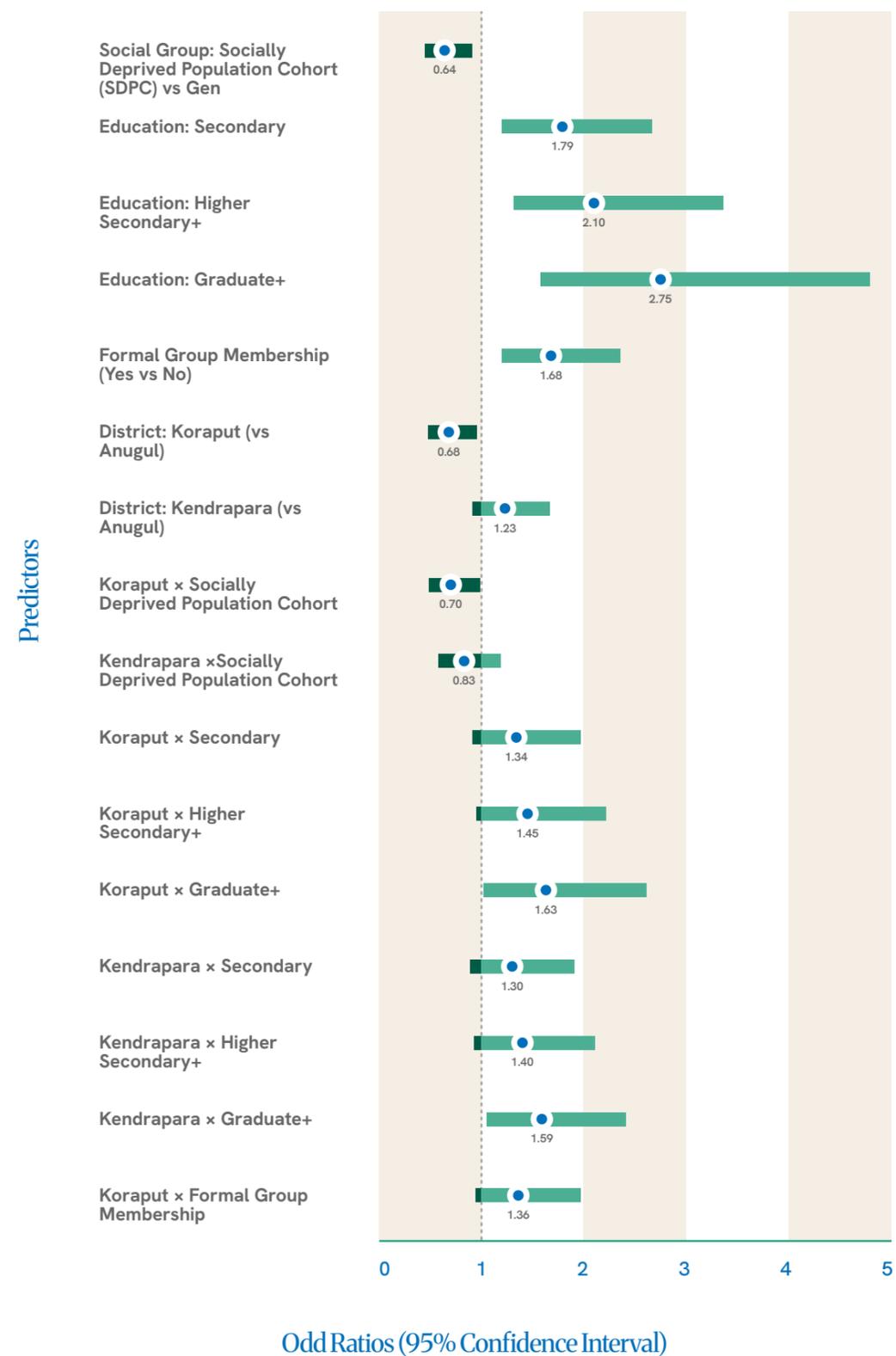
Likelihood of Respondents Being Aware of Govt. Energy Schemes



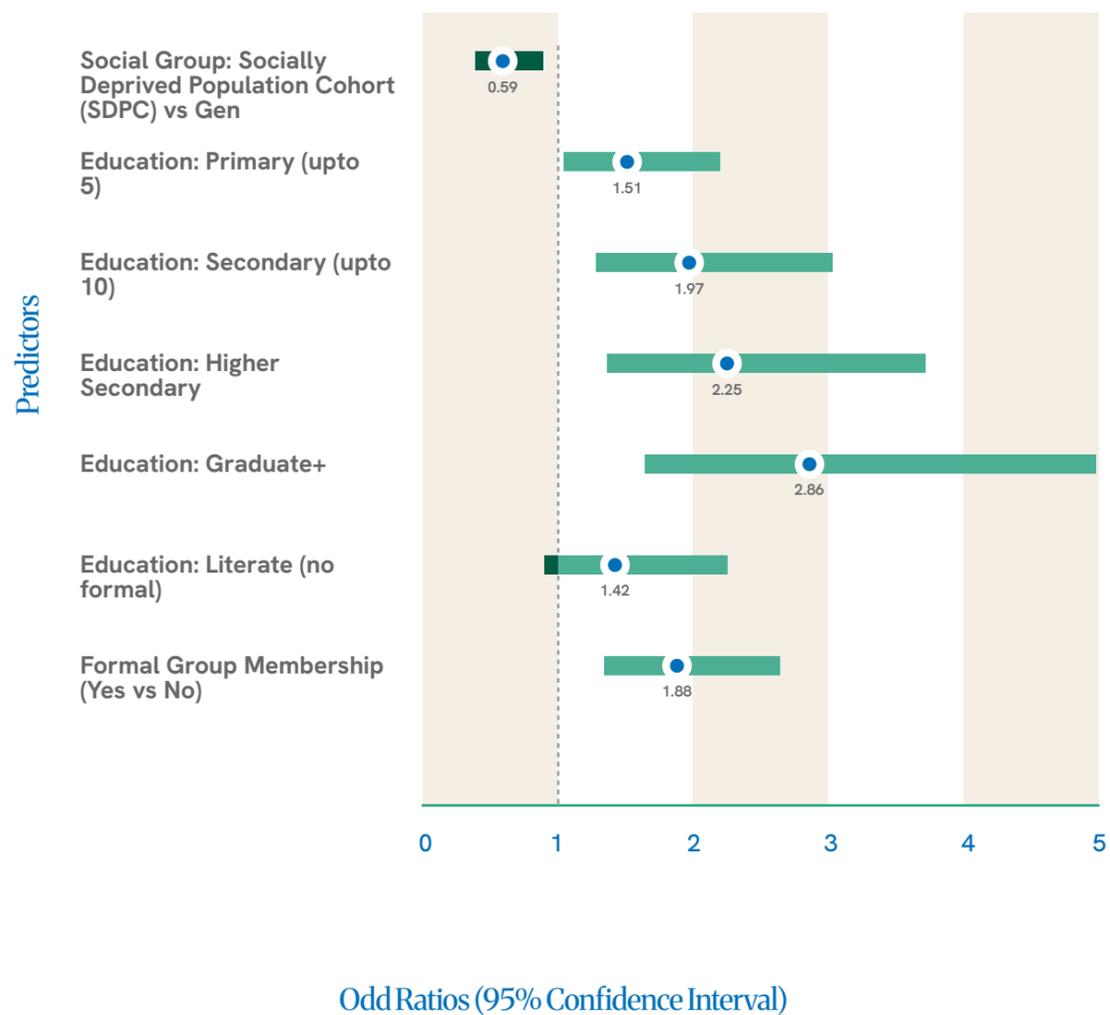
Likelihood of Respondents Being the Decion Maker of What Fuel to Use at Home



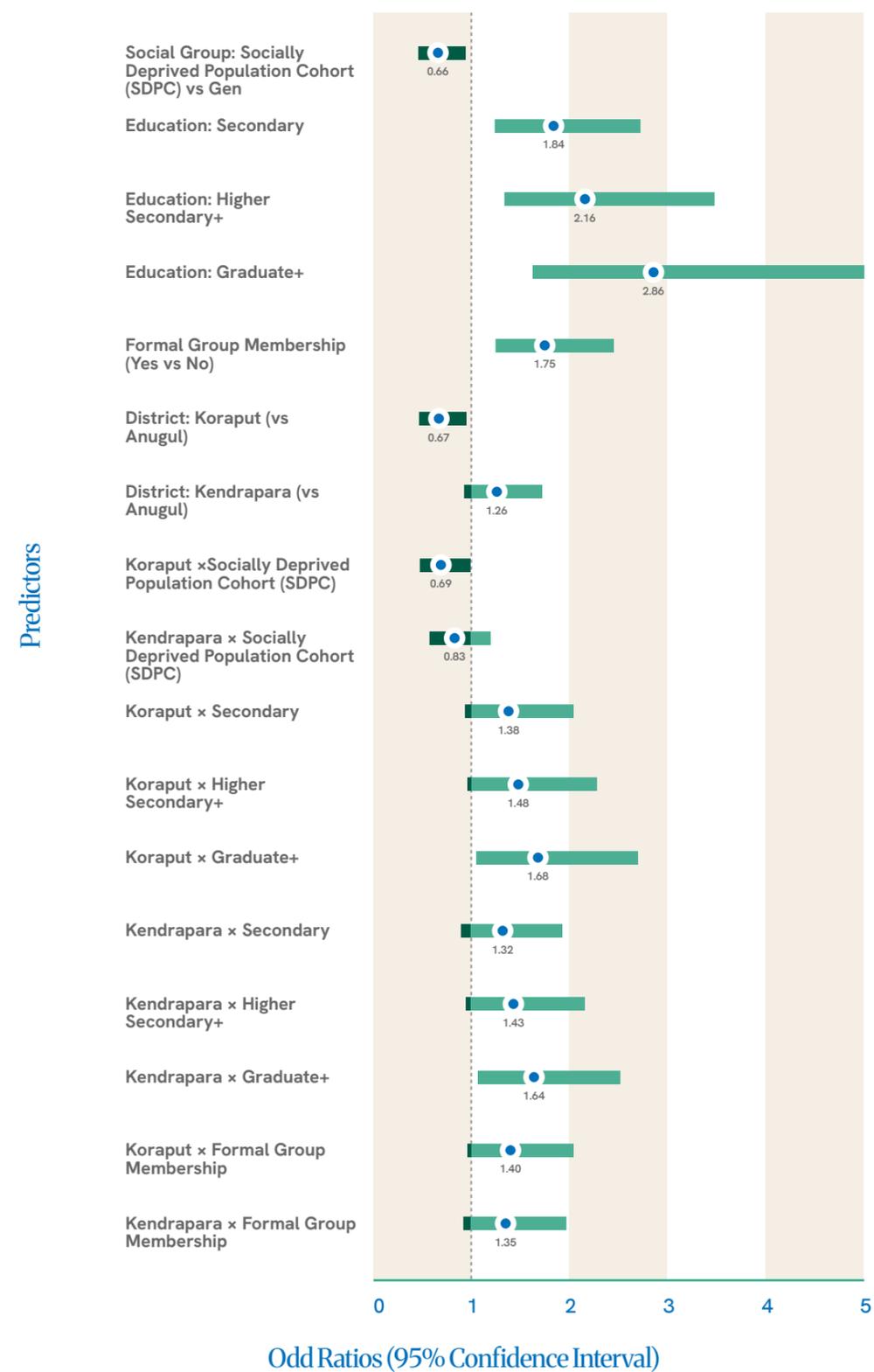
Forest Plot: District Wise Comparison of Likelihood of Decision-Making Power for Fuel at Home



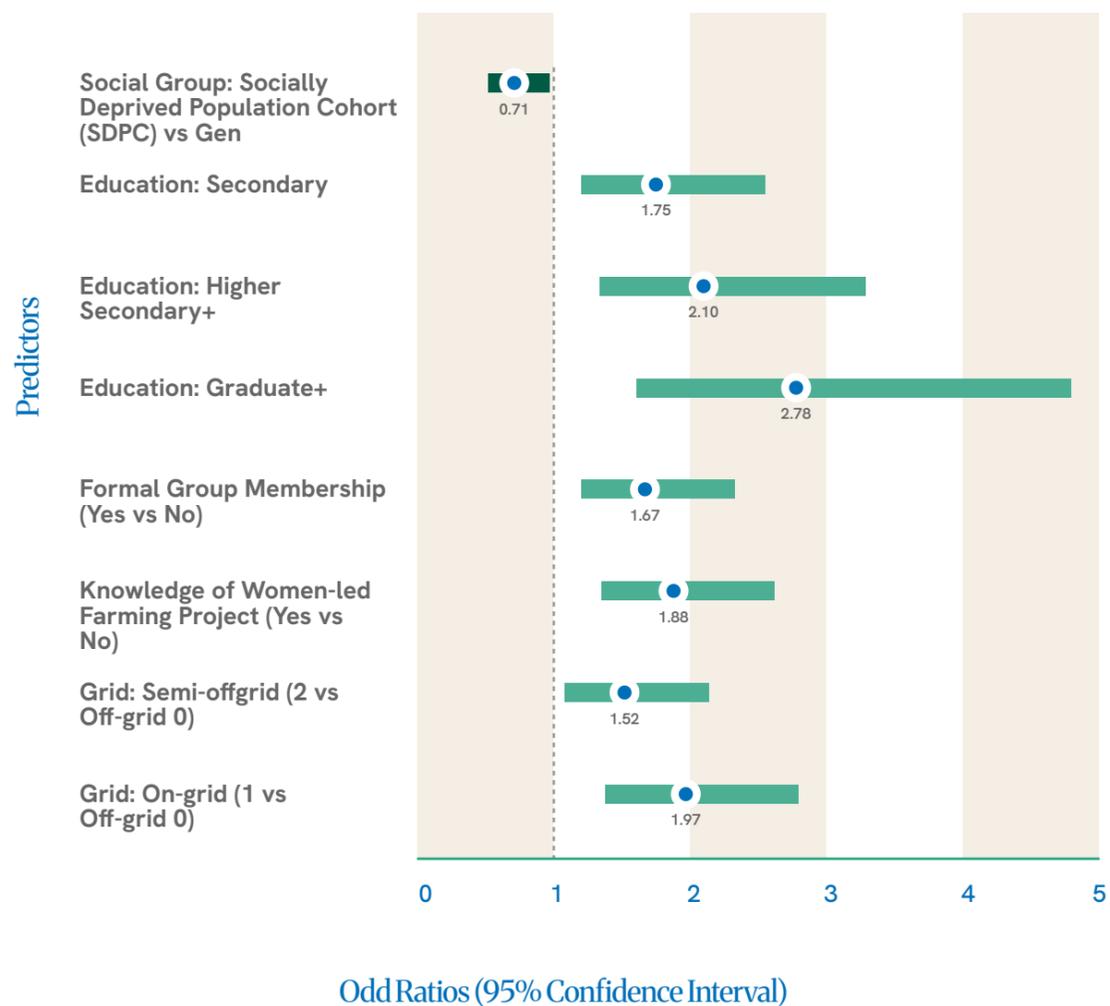
Forest Plot : Willingness to Learn About Solar Power and Clean Fuel



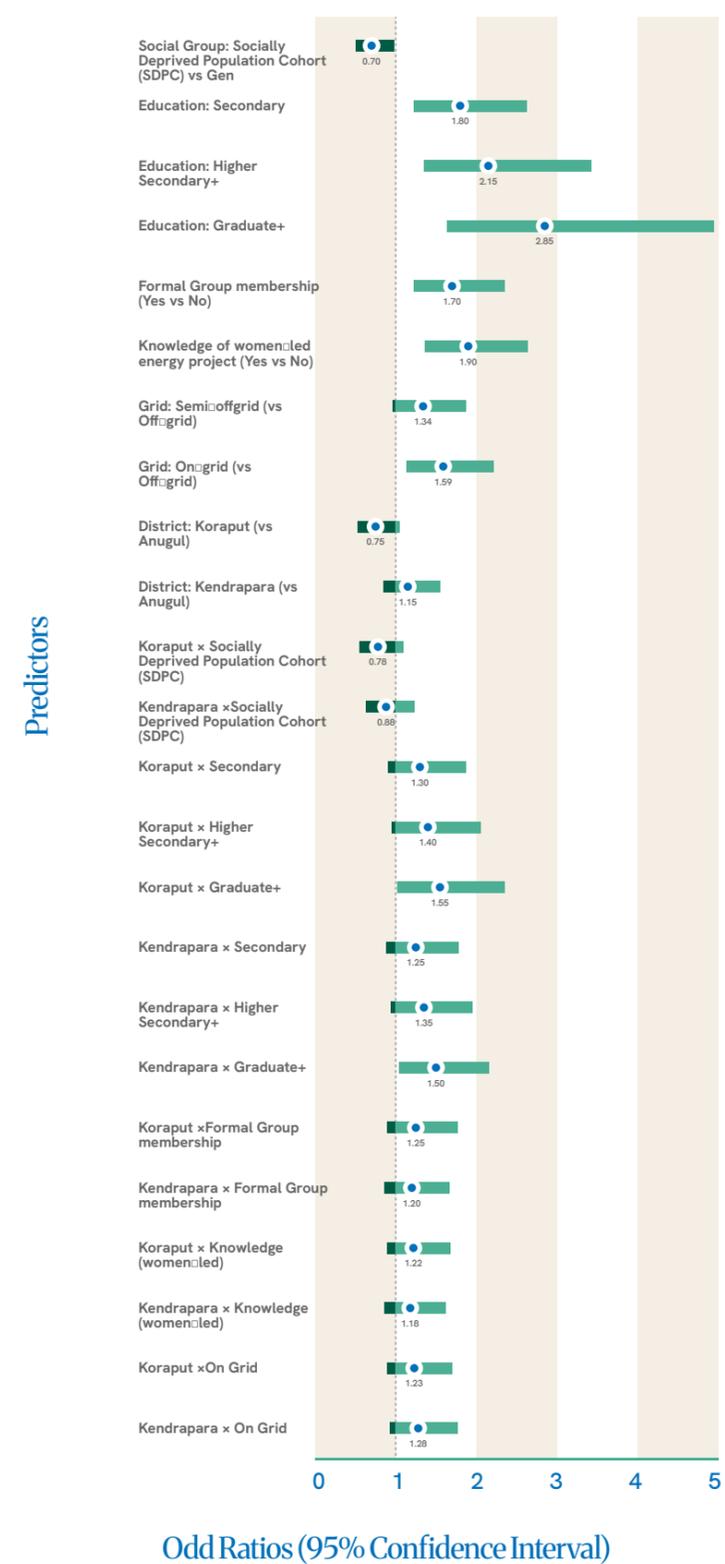
Forest Plot: District Wise Comparison of Willingness to Learn About Solar Power and Clean Energy



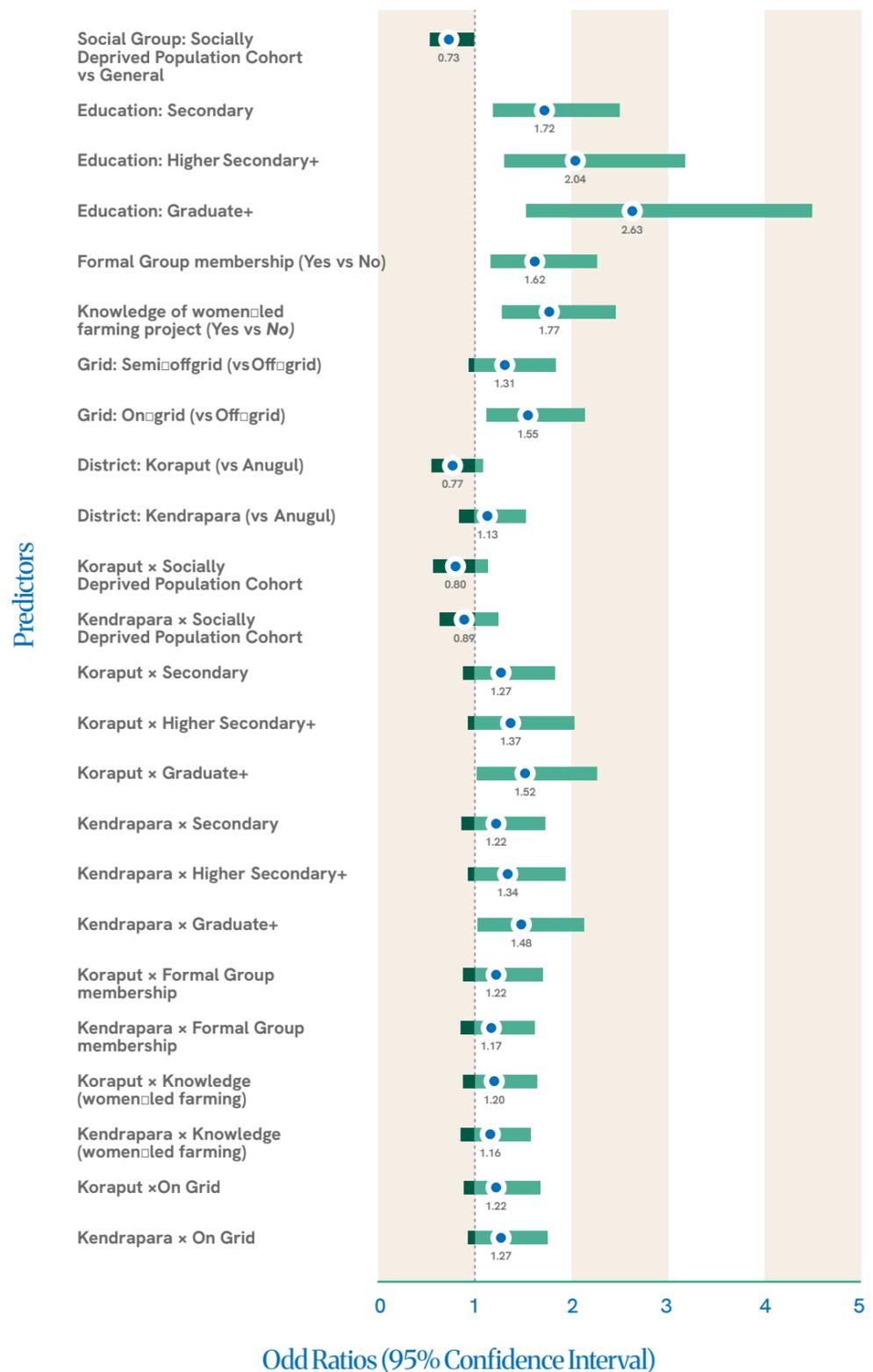
Forest Plot : Willingness to Lead Energy Project



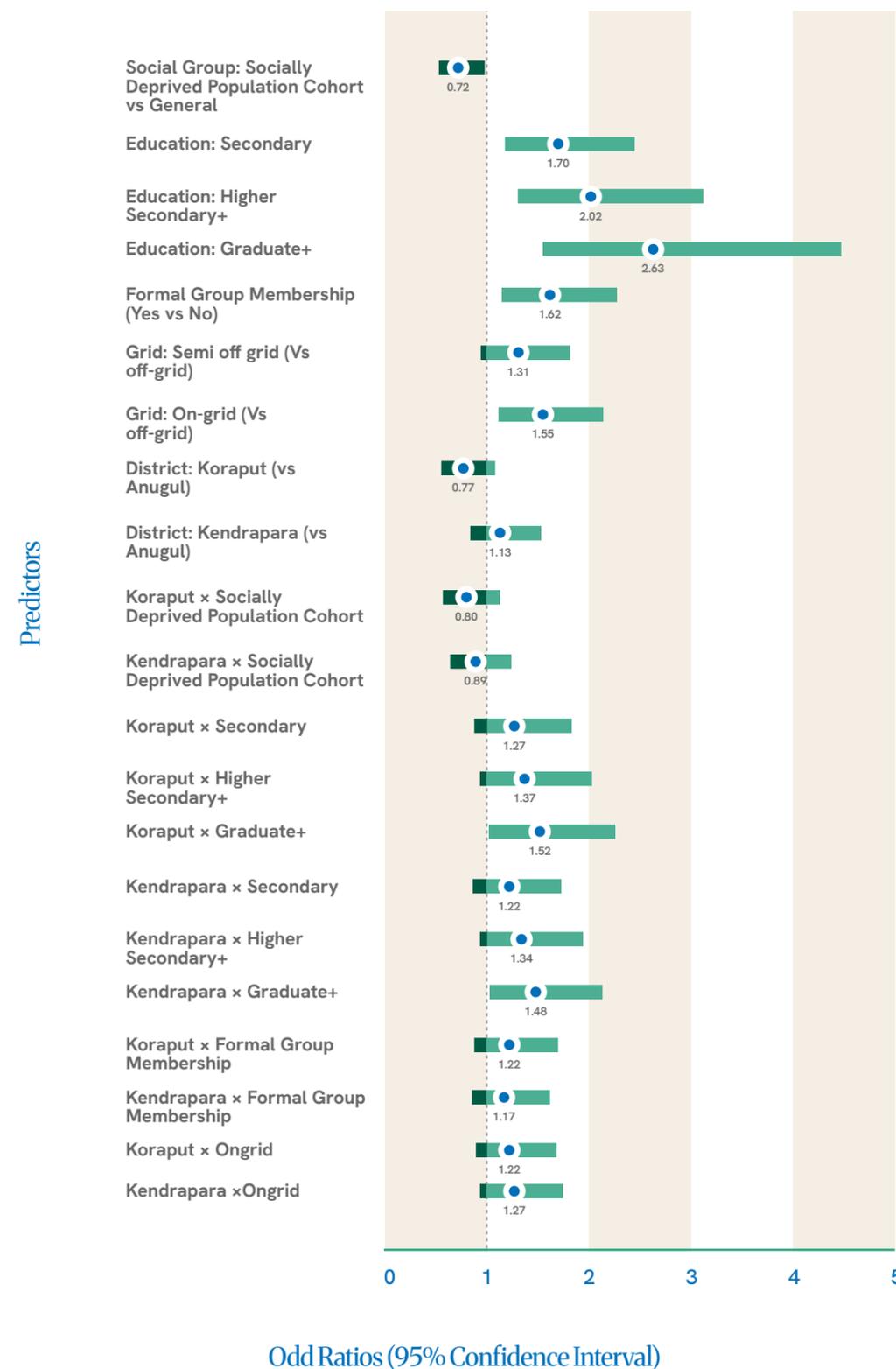
Forest Plot: District Wise Comparison of Willingness to Lead Energy Project



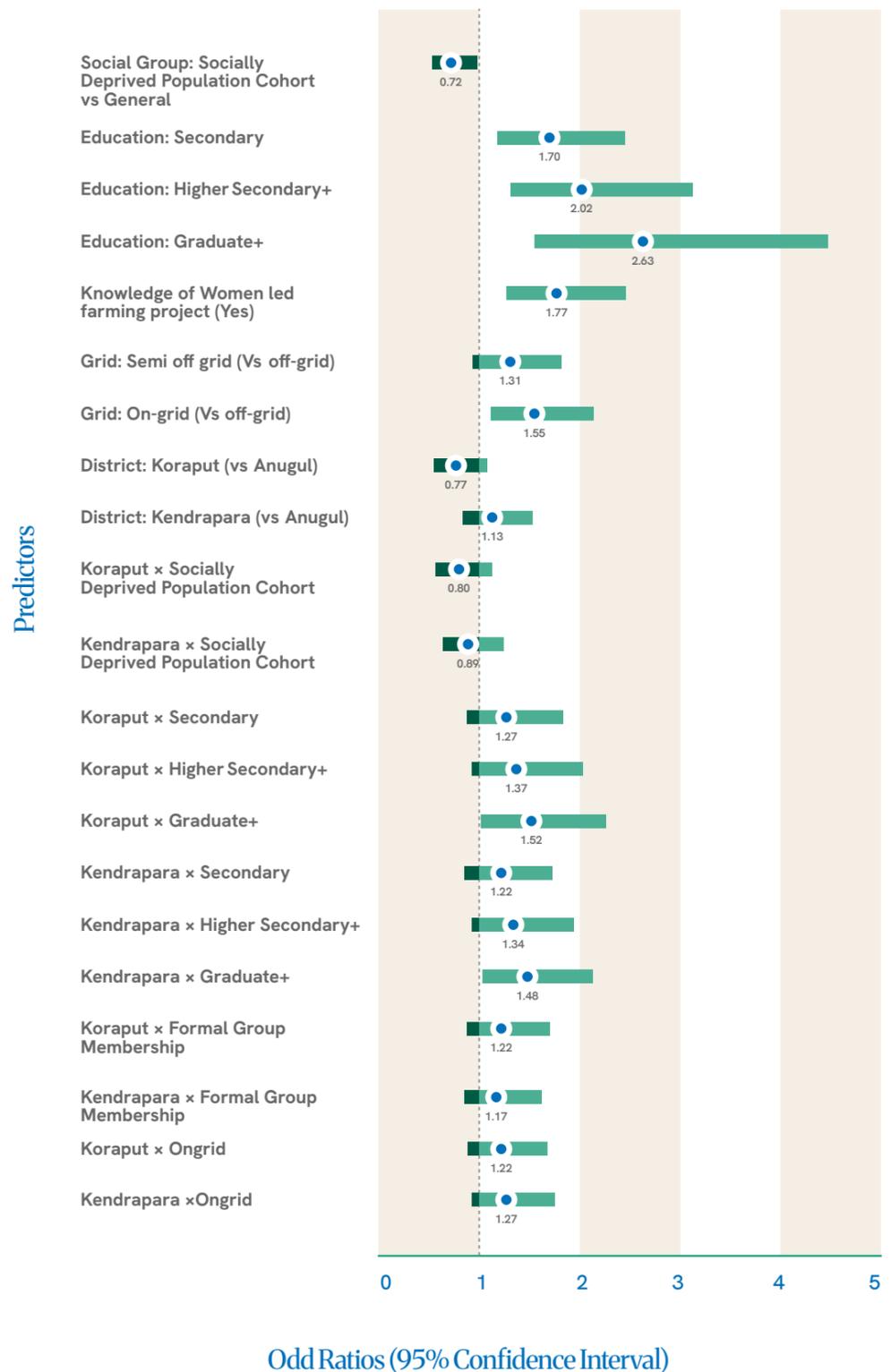
Forest Plot: District Wise Comparison of Willingness to Lead Farming Project



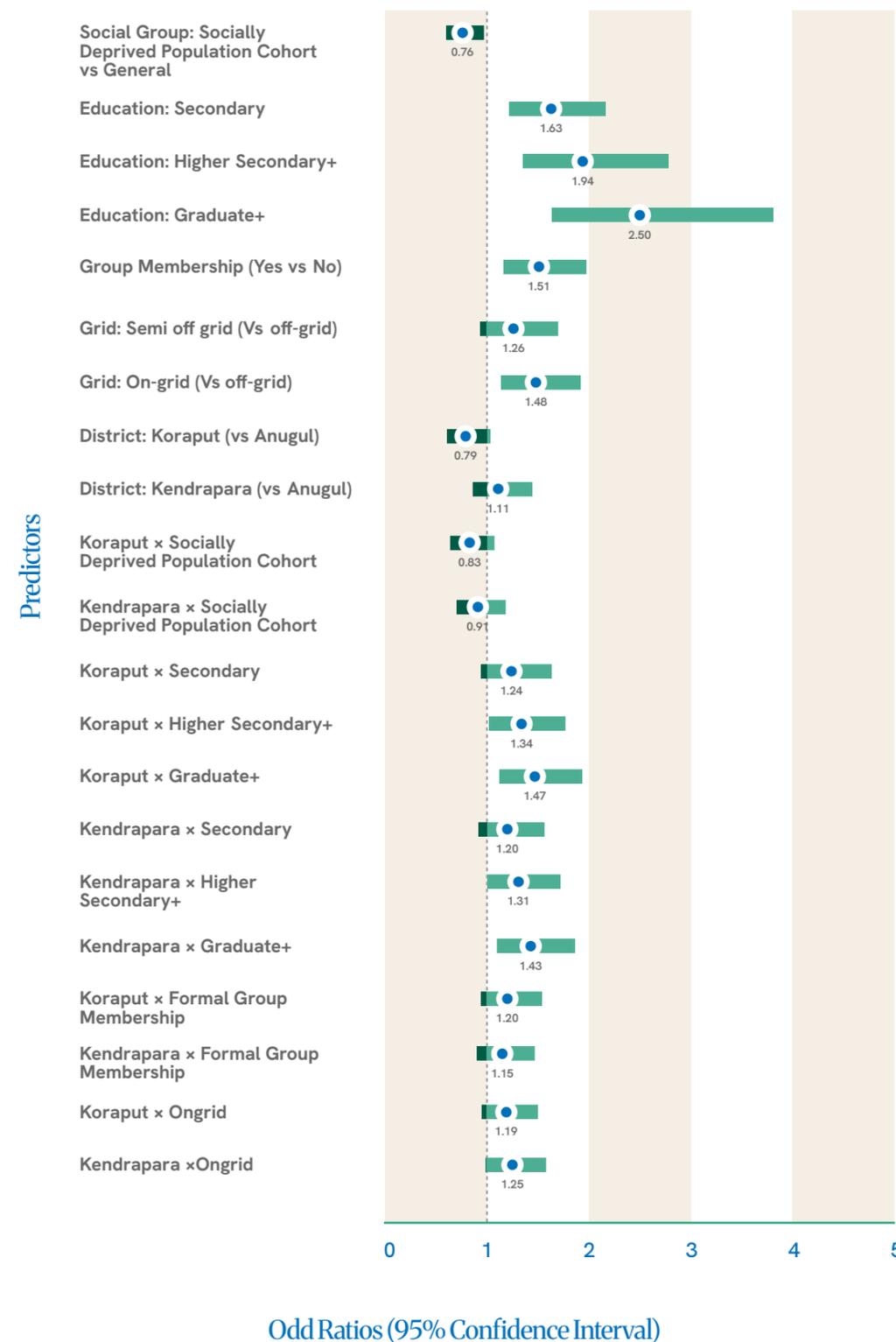
Forest Plot: District Wise Comparison of Likelihood of Awareness of Govt. Energy Schemes



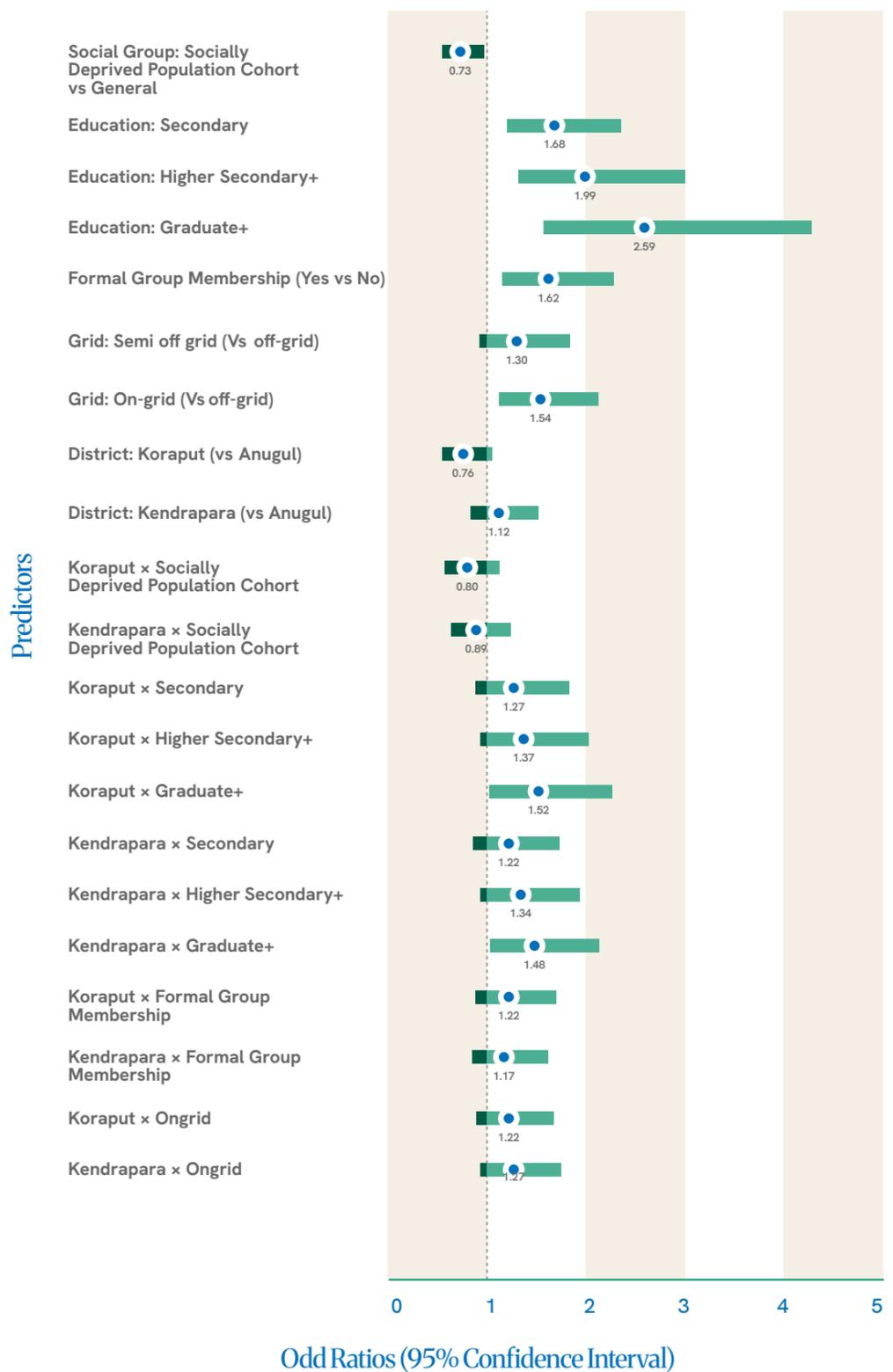
Forest Plot: District Wise Comparison of Likelihood of Families Having Access to Govt. Schemes



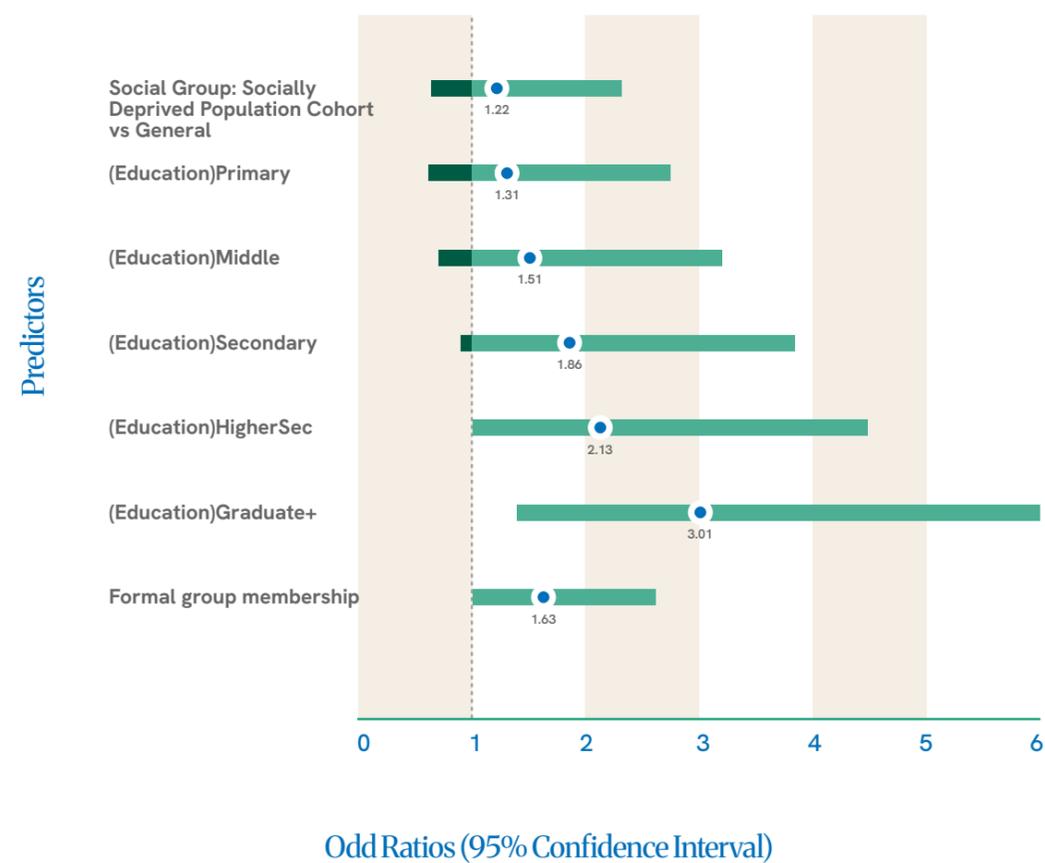
Forest Plot: District Wise Comparison of Likelihood of Women Having A Mobile Phone



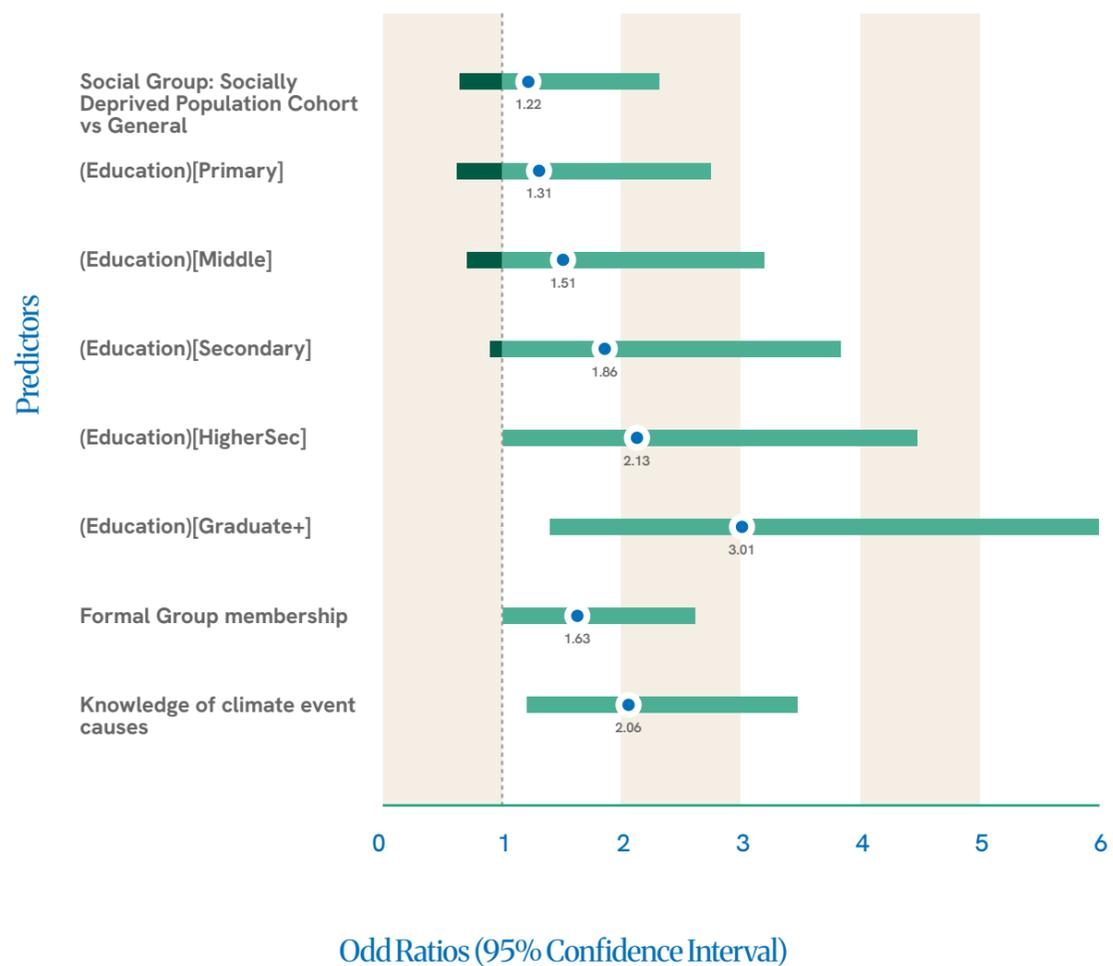
Forest Plot: District Wise Comparison of Likelihood of Women Having A Bank Account



Forest Plot: Odds Ratios For Knowledge of Why Climate Events have Increased



Forest Plot: Odds Ratios For Belief that Climate Events Can Be Reduced



Forest Plot: Odds Ratios Of Migration For Work



11. Acknowledgements

This baseline study on women and energy transition in Odisha is built on the time, trust, and honesty of the women who shared their everyday realities across Anugul, Kendrapara, and Koraput.

Through household surveys with 611 women, along with focus group discussions and key informant interviews, participants spoke about energy choices, climate stress, work burdens, aspirations, and the barriers they face. We are grateful to every woman who welcomed the field teams, answered sensitive questions, and shared experiences that added depth and meaning beyond the numbers.

We also thank the field enumerators and facilitators whose local knowledge and language skills enabled respectful, open conversations. Their presence helped reduce language barriers and build comfort with respondents. We acknowledge the strong focus on ethical practice throughout the study, including informed consent and confidentiality, to protect participant dignity during data collection and reporting.

These are the people who made it real.

Kavita Tatwadi brought the kind of quiet expertise that makes the impossible look routine. As the study's expert researcher, she designed the research framework, made the complex regression analyses possible, supported the translation of instruments into languages that could carry nuance and not just meaning, and joined the OwC team on the ground — walking the same roads, sitting in the same circles, listening with the same care. If the data speaks clearly in this report, it is in no small part because she made sure it could.

This study was supported by DAI Research and Advisory, whose commitment to grounding evidence in real lives shaped the work from its earliest stages. Ruthu G J, Senior Research Associate, and Shreya Padiyar, Research Manager, brought steady rigour to the quality assurance, and synthesis, ensuring that the numbers told a story worth telling, and that the story stayed honest.

On the ground, the work moved because people carried it. Viswa Yuva Kendra (VYK) in Angul, led by Manoj K. Mohapatra, opened doors that data alone cannot. In Koraput, the Society for Promoting Rural Education and Development (SPREAD), under Bidyut Mohanty and Rupraj Nahak, mobilised a field team — Sukramu Gadenga, Jyoti Ranjan Behera, Padmanav Khilla, Dalo Gobinda Khilla, Padmini Guntha, Dilip Kumar Gouda, and Damadar Gadaba — who navigated terrain, language, and trust with equal persistence. In Kendrapara, Nature's Club, founded by Madhusmit Pati, along with field members Dharitri Lenka and Shantilata Barik, brought a familiarity with the landscape that no training manual could replicate. Socratus Foundation, through Devjit Mitra and Jasmine Giri, added strategic depth to the coordination across districts. Ashok Satpathy brought deep contextual knowledge of Anugul its industrial rhythms, its community dynamics, its unique and layered version of the energy story and his inputs sharpened the study's relevance where it mattered most.

None of these teams simply collected data. They sat with women during lunch breaks and between chores, translated not just words but hesitations, and treated every conversation as though it mattered — because it did. Some walked considerable distances in the heat to reach the last household on the list. Others came back a second day when a respondent had to step away mid-survey to tend to a child or a cooking fire. That patience is as much a part of this study's quality as any statistical test.

We also acknowledge the wider ecosystem of women's collectives — SHGs, FPOs, CBOs, and allied civil society partners across all three districts, whose quiet, everyday infrastructure of trust made community entry possible in the first place.

Key informant interviews

Several key informants gave generously of their time and perspective, helping us understand the structures and silences that shape women’s energy access and livelihoods in these districts.

Among government representatives, Bishnu Charan Das (Assistant Director, Department of Horticulture, Kendrapara), Dibakar Purohit (Gram Panchayat Extension Officer, Nandapur, Koraput), and Bichitra Kumar Rout (Block Livelihood Coordinator, Nandapur, Koraput) shared candid insights into local service delivery realities — the kind of ground-level detail that policy documents rarely capture.

From the NGO community, Rashmi Adlekha of Harsha Trust, Bidyut Mohanty of SPREAD, Madhusmit Pati of Nature’s Club, and Pooja Bharti of Nature Menders offered perspectives shaped by years of working alongside the very communities this study sought to understand.

Among other stakeholders and allies, we thank Smita Pattnaik of Nari Surakshya Samiti (NSS) in Angul; Pravin Kumar Sahu, Head of Farmer Group, Angul; Neelkamal Sethi, Former Panch, Chhendipada, Angul; Sarpanches Khirod Samal (Naib, Kendrapara), Dilip Nayak (Kolipur, Kendrapara), and Jagabandhu Chitti (Raisingh, Nandapur, Koraput); Nimali Behera, Climate Champion; Malati Nayak, President, Gupteswari Mahila Maha Sangha, Koraput; and Rupraj Nahak, Livelihood Coordinator, SPREAD. In line with the study’s confidentiality commitments, we also acknowledge collectively several other KII participants — local officials, NGO staff, and community leaders across Anugul, Kendrapara, and Koraput — who offered candid inputs that strengthened the analysis.

The design and visual identity of this report was shaped by LastBench Studio — Raaj, Sriram, and Anna — who took what could have been dense tables and long narratives and turned them into something people would want to stay with.

They understood early on that a study about women’s lives should not read like it was written despite them, and brought a quiet intentionality to every layout choice, every visual, every page that holds space between the data and the story it carries. If this report feels like it respects its subject, the design has something to do with it. We’re grateful to Shourav Sheikh for the cover photograph.



And finally

Because every study begins and ends with the people it is about, we return to the 611 women who carved out time between wage work, caregiving, and the unrelenting rhythm of domestic life to sit with us, speak with us, and trust us with their stories. Their voices are not just the core of this report. They are the reason for it. Everything that follows the learning, the programme design, the action across these three districts begins with what they chose to share.