

EMPOWERING RURAL DEVELOPMENT: A ROADMAP FOR RENEWABLE ENERGY INTEGRATION

Summary Report

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Acknowledgments

This project timeline is from March 2024 to January 2025. During the course of our work so far, we have received valuable assistance from the following individuals and institutions representing policy makers, public and private sector and civil society organisations (CSOs) in Maharashtra:

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We also extend our sincere appreciation to all FPO directors, members, and farmers in the region for their invaluable contributions.

Team

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Abbreviations

AIF	Agriculture Infrastructure Fund
ATMA	Agricultural Technology Management Agency
CBO	Community Based Organisation
CGTMSE	Credit Guarantee Fund Trust for Micro and Small Enterprises
CSR	Corporate Social Responsibility
DISCOMS	Distribution Companies
DPR	Detailed Project Report
EE	Energy Efficiency
FPO	Farmer Producer Organization
GHG	Greenhouse Gas
GRVC	Greening of Rural Value Chain
IA	Implementing Agency
KVK	Krishi Vigyan Kendra
MAGNET	Maharashtra Agribusiness Network
MAVIM	Mahila Arthik Vikas Mahamandal
MEDA	Maharashtra Energy Development Agency
MSP	Minimum Support Price
MSRLM	Maharashtra State Rural Livelihood Mission
NABARD	National Bank for Agriculture and Rural Development
NLIC	National Level Implementation Committee
NLMC	National Level Monitoring Committee
NGO	Non-Governmental Organization
OEM	Original Equipment Manufacturer
PACS	Primary Agricultural Cooperative Societies
PDD	Project Design Document
PMFME	Pradhan Mantri Formalisation of Micro Food Processing Enterprises
PMU	Project Management Unit
PPP	Public-Private Partnership
PPPAVCD	Public-Private Partnership for Integrated Agriculture Value Chain Development
RE	Renewable Energy
RRB	Regional Rural Bank
SCB	State Cooperative Bank
SHG	Self-Help Group
SLMC	State Level Monitoring Committee
SMART	State of Maharashtra Agribusiness and Rural Transformation
STPF	Social-Technical-Policy-Financing

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Executive Summary

The Greening Rural Value Chains (GRVC) project by MP Ensystems aims to promote rural development through the integration of renewable energy (RE) technologies. The project involves mapping agricultural value chains, developing comprehensive Programme Design Documents (PDDs), and creating a roadmap for investments in selected districts of Maharashtra: Nagpur, Gadchiroli, Jalgaon and Nandurbar.

Our strategy focused on identifying Farmer Producer Organisations (FPOs) interested in RE interventions, particularly those registered under the SMART and MAGNET projects. We have approached around 20 FPOs and visited 14 of them to understand the value chains and RE potential. Thus, the field visits to the districts aimed to collect lists of registered FPOs, understand value chains, and identify practical RE technology interventions. Insights from these visits include the major agriculture and horticulture crops grown in the districts and also the major issues related to the sector, the interventions and potential benefits. In addition to FPOs, other important stakeholders consulted include district-level agricultural bodies and organizations such as the District Agriculture Department, Agricultural Technology Management Agency (ATMA), Krishi Vigyan Kendra (KVK), Mahila Arthik Vikas Mahamandal (MAVIM), National Bank for Agriculture and Rural Development (NABARD), and Maharashtra State Rural Livelihood Mission (MSRLM).

The following table showcases the key agricultural and horticultural crops grown across the selected districts:

District	Total area under cultivation (Ha)	Agro-climatic zone	Major crops	Major horticulture crops
Nagpur	624,000	Central plateau and hill region	Jowar, rice, wheat, cotton, cereals	Orange, chilly
Gadchiroli	263,281	Eastern plateau and hill region	Paddy, jowar, tur, wheat	Mohua, custard apple
Jalgaon	867,960	Western plateau and hill region	Cotton, sorghum, maize, black gram	Banana
Nandurbar	297,299	Western plateau and hill region	Cotton, sorghum, maize, pearl millet	Mango, strawberry

The following table identifies critical issues related to post harvest processing in each district and outlines renewable energy (RE) interventions aimed at addressing them, alongside their potential benefits:

District	Key issues	RE interventions	Potential benefits
Nagpur	High electricity costs, perishability	Solar rooftops, solar cold storage, solar dryers	Reduced operational costs, stabilized prices
Gadchiroli	Lack of cold storage, financial hurdles	Solar rooftops	Improved storage, financial viability
Jalgaon	High initial costs for solar PV systems	Solar rooftop, solar dryers, solar cold storage	Lower energy costs, enhanced efficiency

Nandurbar	Unreliable electricity supply, knowledge gaps	Solar rooftop, solar dryers	Continuous energy supply, market expansion
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The project team mapped the agricultural value chains in the selected districts, identifying key crops and potential RE interventions. The scope of intervention in horticulture is low in the region due to various challenges, and hence the team has focused on rice and dal mills which consume significant electricity and can benefit from solar PV systems to reduce operational costs and emissions.

The team created a roadmap using a programmatic approach for 'Solarization of Rice and Dal Mills in Maharashtra' which involves creating a comprehensive framework to implement solar PV systems in existing rice and dal mills. Hence team is exploring options such as initiative to be launched by Maharashtra Energy Development Agency (MEDA). The vision is to promote green rural value chains, create employment opportunities, and enhance livelihoods through upskilling and reskilling the workforce such as:

- **Increased Employment:** The introduction of RE solutions in processing units is expected to increase employment opportunities. For instance, solarization of mills will lead to better reliability of operations, potentially increasing the workforce from 6 to 10 per mill.
- **Economic Benefits:** Enhanced processing capabilities with solar energy will reduce operational costs and increase the profitability of processed goods.

By converting 10% of rice and dal mills to RE systems, the project expects to generate significant economic and environmental benefits. The program is expected to operate as follows: technology interventions, training and skill development, financial packages and information dissemination. The following table gives the RE deployment potential and the expected GHG emission savings from this project:

District	Total RE deployment potential (in kW)		Total GHG emission savings (ton of CO2 saved per year)	
	Min	Max	Min	Max
Nagpur	2592	6479	3587	8968
Gadchiroli	638	1596	884	2209
Jalgaon	1315	3288	1820	4550
Nandurbar	1853	4634	2565	6413
Total	6399	15997	8856	22141

The programmatic approach will focus on the collaboration of various stakeholders, including: Maharashtra Energy Development Agency (MEDA), MP Ensystems Advisory Pvt Ltd, Distribution Companies (DISCOMS), Government Bodies, FPOs, OEMs and Technology Providers, Financial Institutions, NGOs, and local Communities.

To facilitate the integration of RE technologies, the project requires substantial funding. The expected investment for the solarization of rice and dal mills in the four districts ranges from **INR 32 crores to INR 80 crores**, depending on the scale and size of the mills. The financing for the project can come from various sources, including central and state government budgets, equity from farmers and FPO members, CSR funds, and the RESCO model (Renewable Energy Service Company). The RESCO model involves the service company funding, building, and maintaining the solar power plant, with the end-consumer paying for the power generated under a long-term agreement.

By addressing these steps, the GRVC project aims to create sustainable and economically viable rural value chains that contribute to broader environmental and social goals.

1. Introduction

1.1. Overview of project

The project aims to improve rural livelihood with clean, affordable, and reliable energy. This will be achieved by integrating renewable energy solutions and creating sustainable job opportunities in post-harvesting processing activities. This report outlines the strategy for bringing clean, affordable, and reliable energy to rural areas in Maharashtra, focusing on creating jobs, reducing greenhouse gas emissions, and improving livelihoods. The project involves mapping agricultural value chains, developing comprehensive Programme Design Documents (PDDs), and creating a roadmap for investments in selected districts of Maharashtra: Nagpur, Gadchiroli, Jalgaon and Nandurbar.

The Social-Technical-Policy-Financing (STPF) approach was applied to the previous nine projects, which MP Ensystems took in 2023 in Singrauli and Chhindwara districts of Madhya Pradesh and Jalgaon and Nandurbar districts in Maharashtra, allowing for a comprehensive understanding of key actors and levers for change. The PDDs, where interventions of the solar dryer, solar-based cold storage, electric hauler and solar PV systems are possible, are prepared for submission under various government schemes, marking a significant milestone in the project's advancement.

This report is organised as follows: Chapter 1 describes the methodology of selecting FPOs, district visits and maps agricultural value chains of the major crops in the selected districts. Chapter 2 describes the data capture frameworks in developing PDDs, followed by chapter 3 which has the roadmap for RE integration, including a programmatic approach for solarisation of rice and dal mills. Finally, chapter 4 discusses challenges, opportunities and the way forward.

1.2. Approach to choose FPOs

The methodology used to identify and shortlist Farmer Producer Organisations (FPOs) in selected districts of Maharashtra involves both primary and secondary data research. To compile a comprehensive list of FPOs, we reached out to various district-level agricultural bodies and organisations, including:

Table 1: District-level agricultural bodies and organisations and role

Agriculture bodies	Role
District Agriculture Department	Scheme implementation, helping farmers for adaptation to new technology, and registration of FPOs in the region.
Agricultural Technology Management Agency (ATMA)	Works as the implementation unit for the SMART project.
Krishi Vigyan Kendra (KVK)	The KVK assists and demonstrates the farmer's and group's new technology and helps in capacity-building.
Mahila Arthik Vikas Mahamandal (MAVIM)	MAVIM implements various programmes to empower women's through SHGs.
National Bank for Agriculture and Rural Development (NABARD)	NABARD helps formation and loan-linked grant support for FPOs
Maharashtra State Rural Livelihood Mission (MSRLM)	MSRLM supports to establishment of largely women FPOs to generate employment opportunities in rural areas.

Non-governmental organisations (NGOs)	NGOs in collaboration with government bodies help FPOs with registration and business development in the initial phase.
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These entities provided lists of registered FPOs along with details of their activities¹.

Our strategy focused on identifying FPOs that show interest in RE interventions. To pinpoint active and eligible FPOs, we leveraged programs such as the State of Maharashtra Agribusiness and Rural Transformation (SMART), and Maharashtra Agribusiness Network (MAGNET) project under which FPOs are registered and propose new processing units or expansions of existing ones.

Most of the FPOs in the targeted districts are primarily engaged in trading various produce, with only a few involved in processing activities. The detailed analysis of these FPOs, including their engagement in processing and trading activities, is discussed further in chapters.

By concentrating on these active FPOs, we aimed to facilitate their integration into renewable energy projects, thereby promoting decarbonisation and enhancing the livelihoods of farmers in these regions.

1.3. District visits: Nagpur, Gadchiroli, Jalgaon, Nandurbar

To identify FPOs for assessing the potential for carbon deployment, we selected four districts in Maharashtra. The tribal population is significant in those districts, and agriculture is the dominant employer. Each of these districts presents unique challenges and opportunities within their agricultural value chains. Our field visits aimed to collect lists of registered FPOs from both government and non-governmental organisations and to gain a deeper understanding of the value chains for different crops. These visits involved direct interactions with farmers and FPOs to comprehend the specific challenges they face and to explore possible renewable energy (RE) technology interventions within these value chains. By engaging with local stakeholders, we aimed to identify practical solutions that not only support decarbonisation efforts but also enhance the livelihoods of the farming communities in these regions.

Nagpur

Nagpur is major agriculture region in the state of Maharashtra, which is well known for jowar, rice, wheat, cotton, tur, gram, soybean, chillies, oranges etc.

Table 2: Agriculture characteristics of Nagpur district

Total area under cultivation	624,000 Ha
Major crops	Jowar, Rice, Wheat, Cotton, Gram
Agro-climatic zone	Central Plateau and Hills
Major horticulture crops	Orange, Chilly

Source: MP Ensystems Research, 2024

The cultivation of cereals, pulses and oil seed crops are mainly grown in the region. Nagpur is also known as 'Orange City' as the climate is ideal for growing oranges with the ideal ratio of hot summers and mild winters. The cultivation of cereals like paddy and wheat provides security to farmers, because

¹ Identifying active FPOs proved challenging, as many registered FPOs were not operational.

of the availability of minimum support price (MSP). The oil seeds like soybean are cultivated over 2 lakh hectars in Nagpur district and horticulture cultivation like oranges and chilly are grown over 50 thousand hectares². Gram is a major rabi crop.

The areas where rice, wheat, pulses, oil seeds, orange, and chilly are cultivated have the potential for the greening of the value chain. Hence to understand the places where the proposed intervention can be implemented, the team has visited several governmental offices and NGOs working in the district. The team contacted stakeholders in the district through multiple visits and attended the 'Beejotsav' event in Nagpur to understand the farmer's issues and challenges faced in a processing unit.

Insights from field visits:

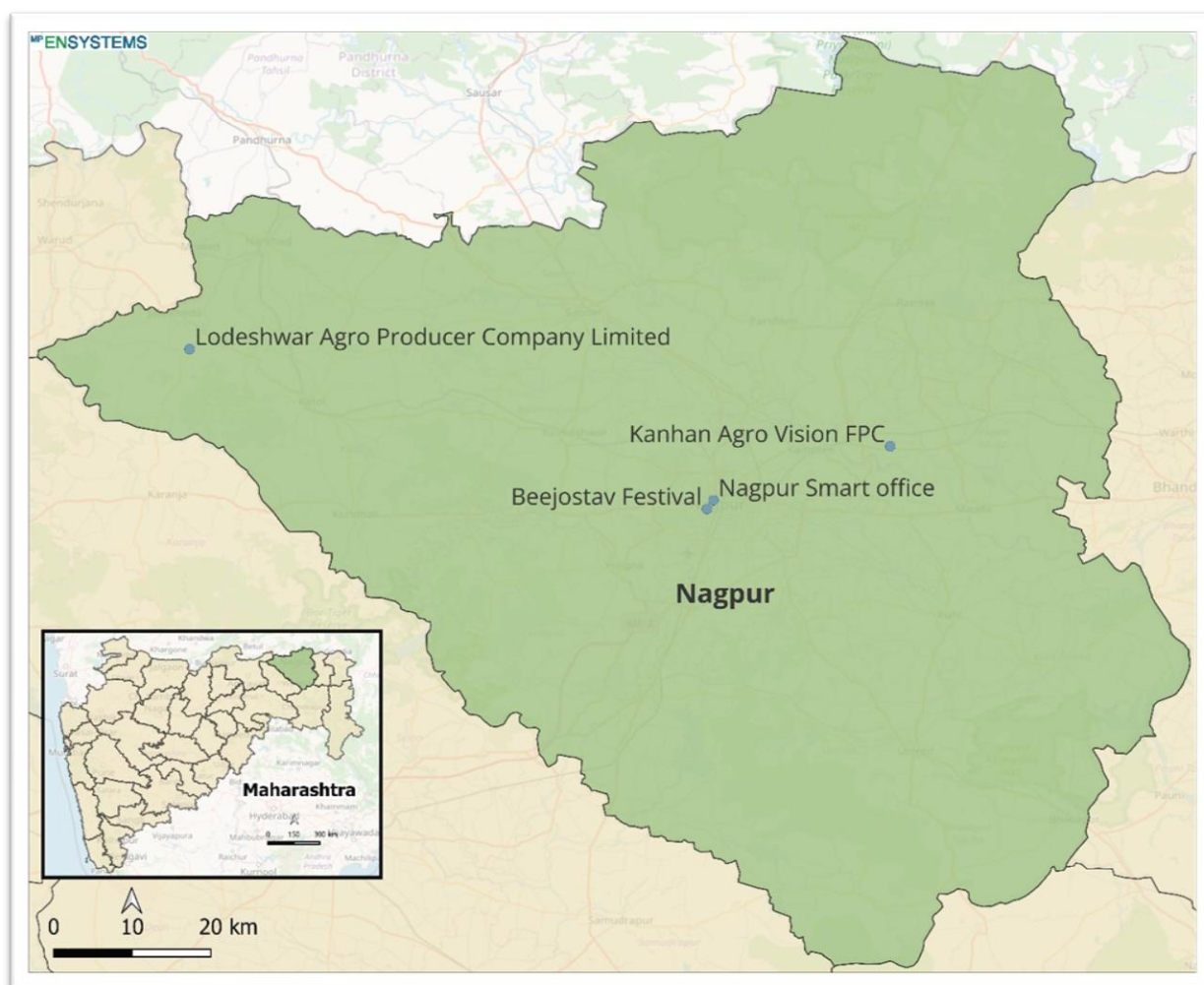


Figure 1 Map of Nagpur district highlighting the stakeholders visited

² Maharashtra state data bank, Nagpur agriculture and allied activity report 2011-12



Figure 2 Nagpur field visit photos

Table 3: Summarise Insights from Nagpur district stakeholders

District Agriculture Department	Over 50% workforce is engaged in agriculture; few active FPOs mostly trading commodities; limited processing activities due to lack of finance and technical know-how.
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ATMA office	- FPOs are interested in setting up RE-powered processing units to reduce operational costs; 11 proposals submitted under the SMART scheme for processing units for oranges, dal mills, and rice mills; aware of benefits of RE equipment but face challenges with subsidies - Previous proposals with rooftop solar components were not approved, discouraging further submissions; lack of approval is a major hurdle for financial support for RE integration.
Farmers	Kalamba to Rohana area has large-scale cauliflower cultivation; significant waste and price fluctuations due to perishability; opportunity for cold storage and solar dryers to reduce waste and stabilize prices.
FPOs and SHGs	- Kanhan Agro-Vision FPO operates a 4 TPH rice mill with high electricity costs (INR 44,000/month); interested in solar PV systems to mitigate costs but faces high initial investment barriers. - SHGs involved in making flour from millet; face electricity disruptions; interested in solarizing processing units (solar atta chakkis) for sustainable electricity supply to enhance participation in the value chain.

Gadchiroli

Gadchiroli is listed as one of the aspirational districts in India³. Approximately 39% of its population belongs to scheduled tribes (STs). The district's economy is predominantly reliant on agriculture, with 38.6% of the workforce engaged as cultivators and 42.4% as agricultural labourers. Gadchiroli also has the highest percentage of forest area and mineral deposits in Maharashtra.

Table 4: Agriculture characteristics of Gadchiroli district

Total area under cultivation	263,281 Ha
Major crops	Paddy, Jowar, Tur, Wheat
Agro-climatic zone	Eastern Plateau and Hills region
Major horticulture crops	Mohua, custard apple

Source: MP Ensystems Research, 2024

Paddy (rice) is the major crop in the district. Nearly 70% of people are engaged in rice cultivation. Mohua, also known as mahua flower or illipe flower, is a significant tree species found in the Gadchiroli district. Tribal communities have traditionally collected Mahua flowers for various purposes. The flowers can be dried and consumed as a food source during lean seasons. The mahua flowers do have a potential for value added products like mahua oil, laddoos, or could be the component of baked goods, snacks but most of mahua flowers are used for making alcohol.

Insights from field visit:

³ Based on parameters which are practical and measurable social progress outcomes, including Health and Nutrition, Education, Agriculture and Water Resources, Financial Inclusion, Skill Development, and Basic Infrastructure the list has been made by NITI Aayog. The Aspirational Districts Programme (ADP) aims to quickly and effectively transform 112 most under-developed districts across the country. https://my.msme.gov.in/MyMsme/List_of_AspirationalDistricts.aspx



Figure 3 Map of Gadchiroli district highlighting the stakeholders visited and photos from a field visit

Table 5: Summarise Insights from Gadchiroli district stakeholders

ATMA office	- Rice is the major crop; 14 proposals were submitted under the SMART scheme for processing units, primarily for rice mills. - Most FPOs engage in trading commodities; and have not ventured into processing activities due to lack of financial resources and market know-how.
NGO	- There is an opportunity to process custard apples, but the lack of cold storage facilities hinders expansion. Although the FPOs are interested in cold storage units, the major concern is the lack of affordable finance, as most farmers are from low-income groups and cannot invest in processing facilities - Mahua production is substantial in the region; however, it is predominantly used for alcohol production.
MSRLM	The FPOs are facing significant financial and market hurdles. They require assistance in marketing to overcome these challenges. Without the establishment of market linkages, the FPOs will be reluctant to invest in processing units.
Farmers	- Mahua, Tendupatta, and Chironji provide significant economic well-being to the farmers. - Chironji seeds (charoli) are edible nuts with a unique flavor and high nutritional value, fetching premium prices in the market. These nuts are washed, dried, and sent for further processing, indicating potential for further development in Chironji processing.
FPOs and SHGs	FPOs and SHGs in the region produce 'ladoos' and 'chikkis' from Mohua but lack market awareness. There is potential to produce oil from Mohua flowers, but due to an underdeveloped market, FPOs are hesitant to invest in processing units.

Rice is a major crop in the region and FPOs submitted proposals under SMART for rice mills, so there is an opportunity for RE intervention like solar PV panels for energy. In the mahua flowers processing unit solar dryer intervention will help FPOs or SHGs to increase the life of produce.

Jalgaon

The district is well-known for its high-quality banana production. The bananas grown here are renowned for their taste and are sent not only to various districts within the state and India but also exported to several foreign countries. In Maharashtra, Jalgaon district alone accounts for three-quarters of the total area under banana cultivation. The district's economy is heavily reliant on agriculture, with 70.9% of the workforce engaged as cultivators and agricultural laborers⁴.

Table 6: Agriculture characteristics of Jalgaon district

Total area under cultivation	867,960 Ha
Major crops	Cotton, Sorghum, Maize, Black gram

⁴ District Administration, Jalgaon. "District Profile."

<https://cdn.s3waas.gov.in/s3013d407166ec4fa56eb1e1f8cbe183b9/uploads/2018/03/2018032273.pdf>.

Agro-climatic zone	Western plateau and hill, Assured rainfall zone
Major horticulture crops	Banana

Source: MP Ensystems Research, 2024

The team conducted multiple stakeholder engagements during the field visit which include consultation with government officials as well as NGOs working in the region. The insight of field visit is as follows,

Insights from field visit:

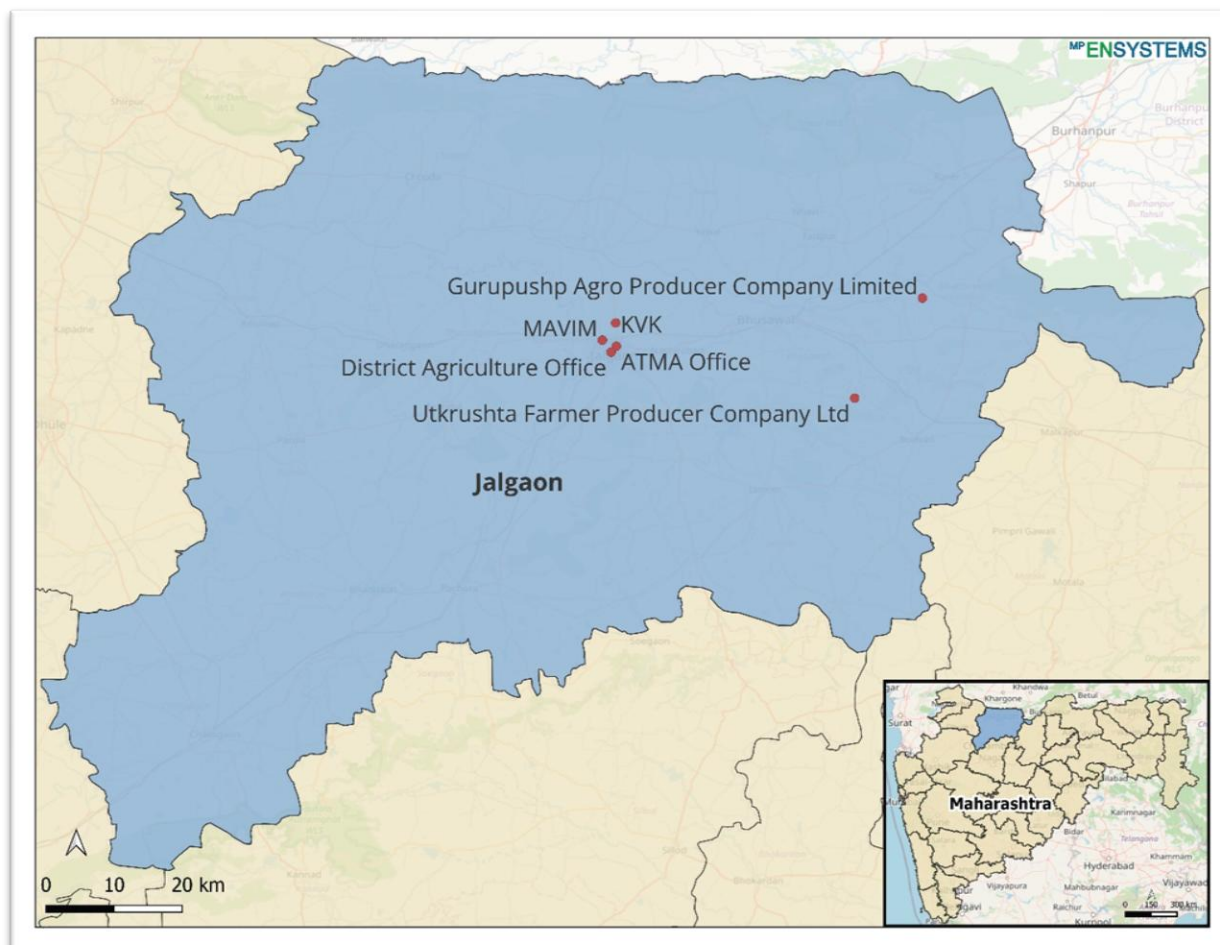




Figure 4: Map of Jalgaon district highlighting the stakeholders visited and photos from a field visit

Table 7: Summarise insights from Jalgaon district stakeholders

ATMA office	- Twenty-one FPOs in the region have submitted proposals for processing units under the SMART scheme. - Out of these, thirteen are for cleaning and grading units, while the remaining are for animal feed processing units, turmeric and oil processing units, and warehouses. - There is potential to convert these units to solar energy, which could significantly reduce operational costs and promote sustainability
KVK	- Solar dryers are a feasible intervention for turmeric processing to enhance efficiency and product quality, leveraging ample sunlight in the region. - The horticulture processing units are low in the district.
District Agriculture Department	- Cotton and bananas are cultivated in the region. - Banana is primarily exported. - Significant lemon cultivation in the district but no processing unit; lack of awareness of processing techniques and market availability.
FPOs	- There is an opportunity to establish processing units for banana powder and banana chips. - Interest shown by FPOs but lack market knowledge and potential buyers; need for market linkage and training to capitalize on this opportunity.

FPOs are interested in installing rooftop solar PV systems to power processing units. However, the high initial cost of installation is a significant barrier. Financial support or subsidies could encourage the adoption of solar PV, reducing long-term energy costs.

Nandurbar

Nandurbar district has low-ranking socio-economic indicators and is on the list of aspirational districts. 70% population of the district is Schedule Tribe (STs) and 82% of the workforce is engaged as cultivators and agriculture laborers.

Table 8: Agriculture characteristics of Jalgaon district

Total area under cultivation	297,299 Ha
Major crops	Cotton, Sorghum, Maize, Pearl millet
Agro-climatic zone	Western plateau and hill, High rainfall zone
Major horticulture crops	Mango, Strawberry

Source: MP Ensystems Research, 2024

Insights from field visit:

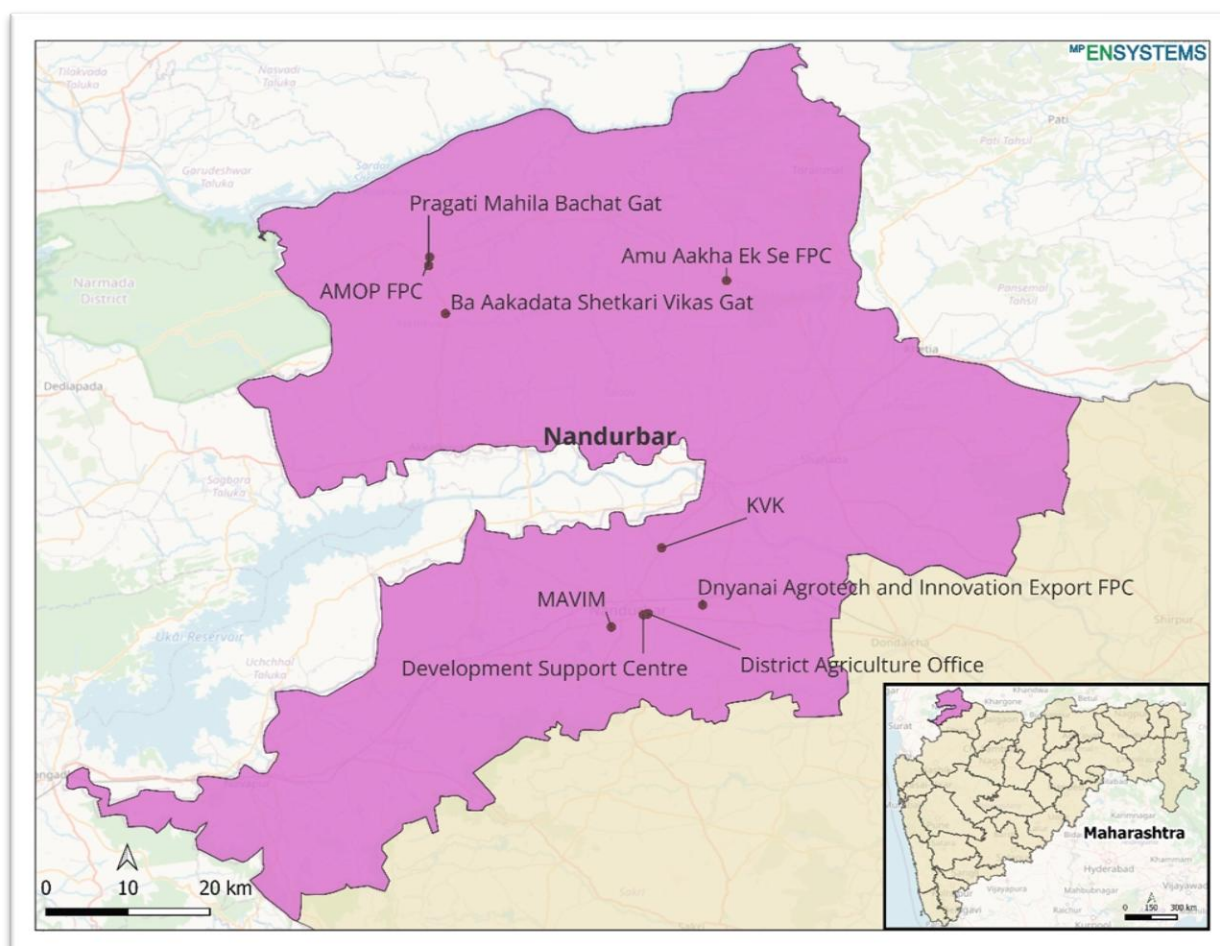




Figure 5: Map of Nandurbar district highlighting the stakeholders visited and photos from a field visit

Table 9: Summarise insights from Nandurbar district stakeholders

ATMA office	• Fifteen FPOs in the region have submitted proposals for processing units under the SMART scheme. • Out of these, seven are for cleaning and grading units, while the remaining are for animal feed processing units, chilly and turmeric processing units, cotton and ginning, cold storage, and warehouses.
District Agriculture Department	• The Molgi and Dhadgaon regions are famous for amchur, which has received a Geographical Indication (GI) tag.

NGO	• With support from NABARD FPOs are registered in the district. • These FPOs mainly engaged in the trading of produce. • Unreliable electric supply is a major concern; solar power could provide a reliable and sustainable energy source for agricultural and processing activities.
FPOs and SHGs	• Amchur can be stored in cold storage for up to a year to preserve quality and extend marketability; developing cold storage facilities and improving market linkages for amchur powder could significantly benefit farmers. • SHGs focused on cleaning and grading bhagar; not producing secondary products like cookies, chakli, and ready premixes due to lack of knowledge and market awareness; economic potential in millet processing requires better market linkages.

The amchur production in the region is significant and there is potential to install solar dryer, and solar-based cold storages.

Summary

The FPOs in this region are focused on the agriculture value chain. The scope for the horticulture value chain addition is low as the initial cost and market challenges hinder the FPOs from investing in the horticulture value chain. The FPOs which are interested in value addition in this region are mainly in rice and pulses. This trend can be seen further in the SMART-approved project.

District	Value chain crops	Possible interventions
Nagpur	Rice and pulses, oranges, chillies	Solar rooftop, solar cold storage
Gadchiroli	Rice	Solar rooftop
Jalgaon	Pulses and millets, banana	Solar rooftop, solar cold storage
Nandurbar	Mango, millet and pulses	Solar dryer and solar rooftop

During our visits to FPOs and SHGs, we identified several challenges faced by those currently engaged in processing activities as well as those involved only in trading or aspiring to establish secondary processing units. The main issues are:

- Limited financial resources: Most FPO shareholders in the region are marginalized tribal communities with low incomes. This financial limitation hinders their ability to invest in processing units, as they lack the necessary funds. A significant constraint for both processing and non-processing FPOs/SHGs is the lack of access to adequate financing. This hinders their ability to invest in equipment and infrastructure for secondary processing activities.
- Market knowledge gap: Many FPOs and SHGs, particularly those without existing processing units, demonstrate a limited understanding of market dynamics for processed goods.
- Underdeveloped markets for produce like mahua flower oil and banana powder hinder the FPOs to invest in the value chain.
- Most FPOs suffer from hand-holding support from project design with RE till its implementation as a profitable venture

Addressing these challenges requires targeted financial support, capacity-building initiatives to improve market awareness, and investment in essential infrastructure such as cold storage facilities. The team has mapped the agriculture value chain in these districts.

Mapping agriculture value chains

After meeting with different stakeholders and conducting primary and secondary research, our team compiled a list of FPOs registered under the SMART, NABARD, MAGNET, and State Agriculture Market Board schemes in the four districts. Below is the graph illustrating the proportion of FPOs registered under each scheme in these districts:

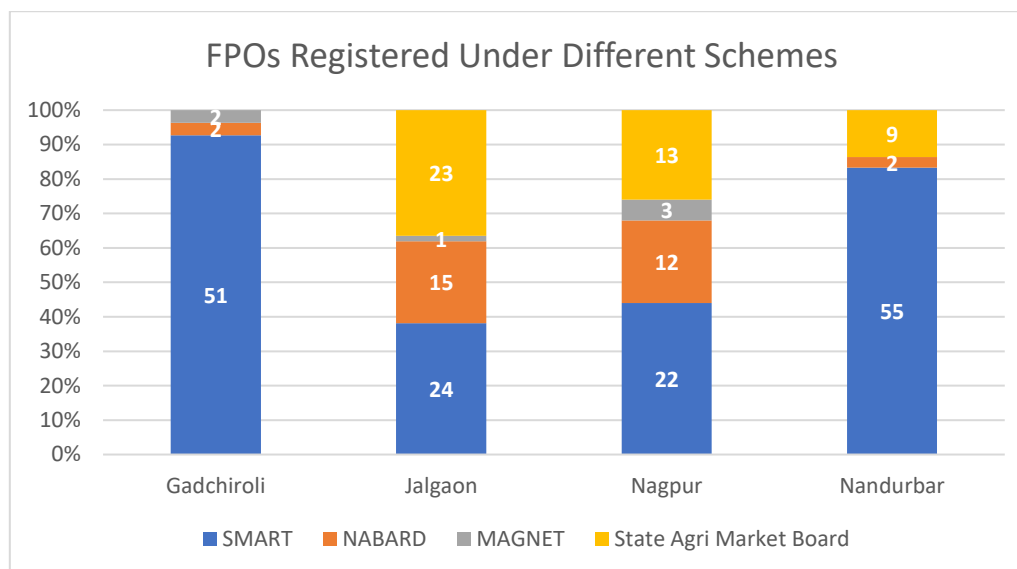


Figure 6: FPOs registered under schemes in four districts

Overall, the SMART scheme is the dominant program across all four districts, as it provides a 60% subsidy to FPOs for setting up processing units. In contrast, under the NABARD and State Agriculture Market Board schemes, FPOs are registered but primarily engaged in trading activities. Under the MAGNET scheme, a few FPOs have received approvals to build warehouses.

When our team visited the 14 FPOs, we observed that most of the approved processing units are for rice mill related cleaning and grading units, and dal mills. In Gadchiroli and Nandurbar, horticulture production is low. However, in Nagpur and Jalgaon, the production of oranges and bananas is relatively good. Despite this, most of the produce is either exported or traded directly because there is a high demand for fresh produce in the market. As a result, FPOs are not interested in processing these horticultural crops since processing requires a significant capital investment and finding a market to sell the processed products is challenging.

After registration, FPO needs to go through several approval levels to approve the processing unit. Under the SMART scheme, FPOs are first approved as Community Based Organizations (CBOs). After this initial approval, the scheme approves processing units for these CBOs. Currently, most FPOs are still at the CBO level and are waiting for approval for their processing units. The FPOs that have been approved for processing units are only in the initial phases of construction. Only a few FPOs have fully established processing units in the districts. Our team visited two rice mills in the Nagpur and Gadchiroli districts to understand their value chain.

Rice value chain:

The team visited two rice mills in the Nagpur and Gadchiroli districts and conducted in-depth interviews with the rice mill directors. The aim was to understand the value chain of rice in the region. Rice is a major crop here, and most farmers are engaged in its cultivation. The following flowchart

illustrates the rice processing and distribution system, starting from paddy collection to the end consumer:



Figure 7 Kanhan agri-vision farmer producer company ltd rice mill

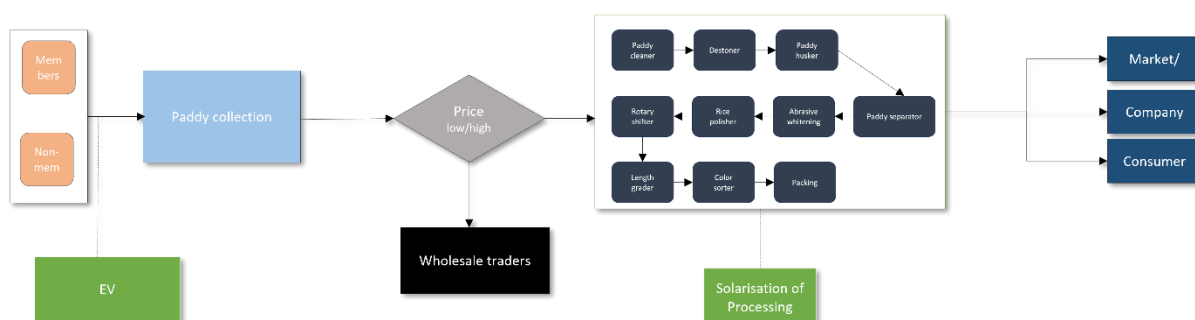


Figure 8: Rice value chain flowchart

Paddy collection: FPO collects the paddy from both members and non-members based on the market price. During high market prices, FPO acts as a trader and sells paddy directly to wholesalers. FPO focuses on processing the paddy for value addition during low market prices.

Paddy processing: The FPO has a processing unit equipped to perform several operations, transforming paddy into polished rice

- Paddy clean: Initial cleaning to remove debris from paddy.
- Destoner: Removal of stones and other heavy materials from paddy.
- Paddy Husker: Husking of paddy to remove the outer husk.

- Paddy Separator: Separation of husked rice from unhusked paddy. Unhusked paddy is cycled back to the husker.
- Rice Polishing: Polishing of husked rice using an abrasive process.
- Rotary: Further cleaning and preparation of the rice.
- Length sorter: Sorting of rice based on length.
- Color Sorter: Sorting rice based on color.
- Packing: The final sorted rice is then packed.

Distribution: The packaged rice is distributed through various channels based on prior commitments of FPO to the wholesale trader, companies, and consumers.

The two RE interventions that are possible in the rice mill are:

1. Solarisation of a unit through solar PV system: Use of grid-based solar energy to reduce the operation cost of a unit which ultimately reduce the GHG emission.
2. Electric hauler: Use of electric vehicles in some part of the collection or distribution process to enhance sustainability.

The project design documents (PDDs) of the FPOs are made considering the annual electricity demand, daily operational hours and number of operational days. While the FPOs have expressed interest in solarization, they have not currently shown interest in adopting electric haulers. The PDDs with these considerations are attached in annexure A of this report.

2. Project Design Document (PDD) structure

2.1. Data capture framework

The team at MP Ensystems has been continuously engaging with several state and district-level organizations, including FPOs, NGOs, technology providers, policymakers, and financing institutions. Our overall aim is to create partnerships, develop scale-up models based on packages of practices, and recommend programmatic interventions to governments with support from other private and civil society organizations.

The project involves a systematic approach to gathering, managing, and analyzing data from various sources to support project planning, implementation, and monitoring. This framework is crucial for ensuring that all relevant information is accurately recorded and easily accessible to stakeholders.

Components of the data capture framework:

1. Stakeholder engagement:

Continuous engagement with state and district-level organizations involves regular meetings and field visits to gather both qualitative and quantitative data from stakeholders. This approach ensures comprehensive data collection, fostering collaboration and informed decision-making for developing effective interventions and scale-up models tailored to local needs. The working register FPOs data we got from these engagements helped us reach out maximum FPOs in the district.

2. Surveys and Questionnaire:

The team prepared a semi-structured questionnaire to gain a comprehensive understanding of the current activities of FPOs, the challenges they face, and potential interventions. This survey tool facilitated the collection of both qualitative and quantitative data. During field visits, the team conducted semi-structured interviews with FPOs directors and members. This method allowed for in-depth exploration of their responses, providing valuable insights into their operations and needs. The face-to-face interaction not only enhanced the depth of the information gathered but also helped build trust and rapport with the stakeholders, ensuring more candid and detailed feedback for effective intervention planning.

The data captured through field surveys has been uploaded to the project dashboard, making it easily accessible to stakeholders. Platform enables the visualization of project activities which is further explain in the chapter.

2.2. Excel based templatization leading to PDD creation

To streamline the creation of Programme Design Documents (PDDs) and facilitate financial calculations, a standardized Excel based tool template has been developed. Field data is input into the Excel sheet, where intermediary calculations for various interventions are performed. This process generates data on economic indicators, RE production and emission savings, which are displayed in the template, which is further explain in the below figure 7. The results are then uploaded to a dashboard for easy visualization and analysis. This tool enhances project planning and reporting

efficiency, ensuring accurate, consistent, and comprehensive documentation of interventions and their impacts.

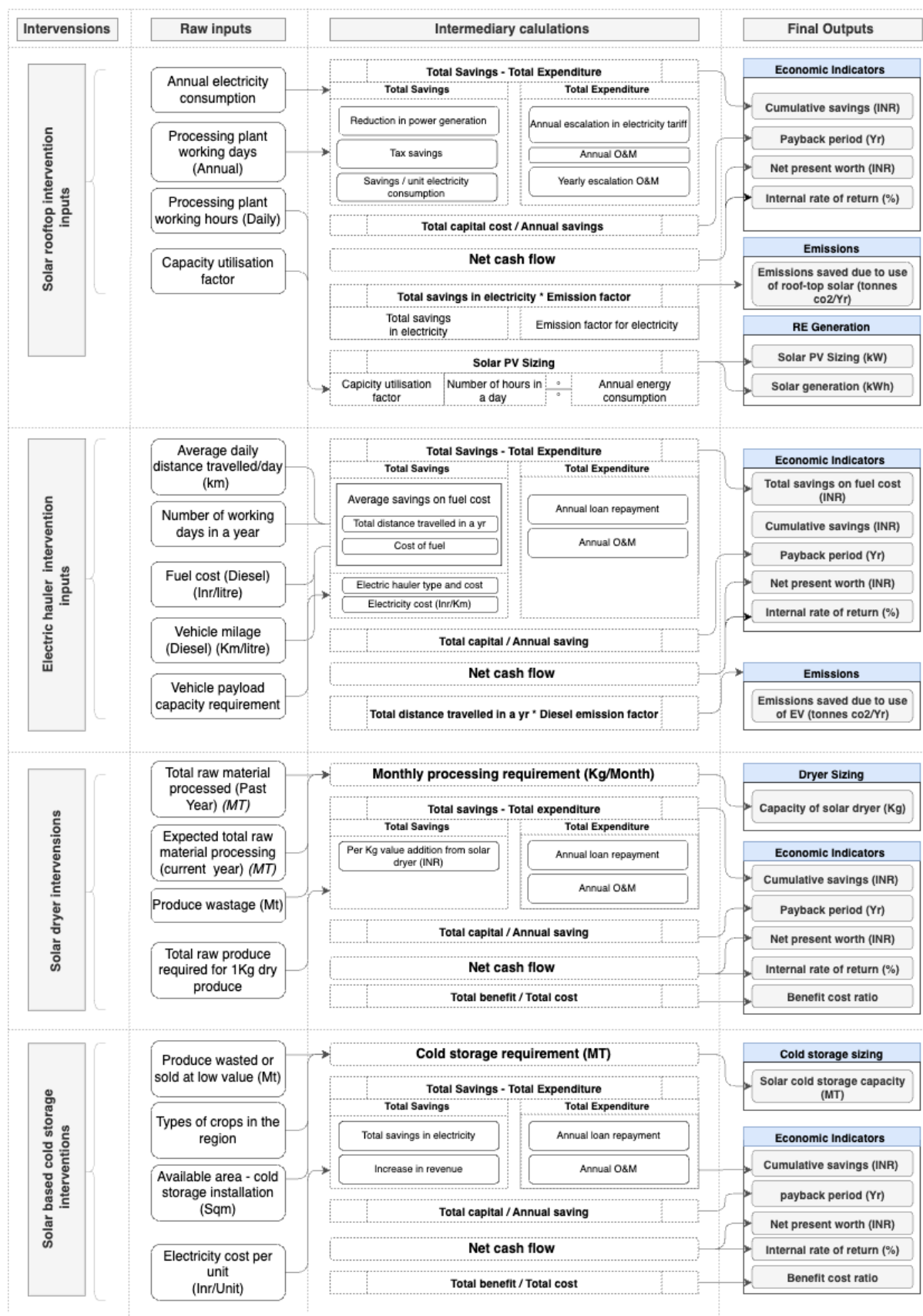


Figure 9: Overview of excel template

The primary data collected from FPO through questionnaire is used to determine which RE interventions are possible. Though more than one RE intervention may be possible, the interventions are determined depending on FPO interest and financial capacity.

The flowchart provides a comprehensive framework for evaluating the economic and environmental impacts of implementing various sustainable interventions in processes. It encompasses four primary interventions: solar rooftop installations, electric haulers, solar dryers, and solar-based cold storage systems. Each intervention is assessed through a systematic process involving several stages, from raw inputs to final outputs. The excel file screenshot is added in annexure B.

Solar rooftop intervention

For solar rooftop installations, the raw inputs include annual electricity consumption, the number of processing plant working days and hours, and the capacity utilization factor which is taken on average basis. These inputs are used to calculate total savings and expenditures. Savings are derived from reductions in tax savings and savings per unit of electricity consumed. Expenditures account for annual increases in electricity tariffs, operational and maintenance (O&M) costs and annual repayment which we assumed an interest rate of 12% per annum for 5 years. The net cash flow is determined by dividing the total capital cost by annual savings. Solar PV sizing is calculated based on the capacity utilization factor, daily operational hours, and annual energy consumption. The final outputs include economic indicators such as cumulative savings, payback periods, net present worth, and internal rate of return which is useful for determine the feasibility of interventions, as well as emissions reductions from using rooftop solar and sizing of solar rooftop.

Electric hauler intervention

The electric hauler intervention evaluates the transition from diesel to electric vehicles. Inputs include average daily distance travelled, number of working days per year, fuel cost (diesel), vehicle mileage, and payload capacity requirements. The total savings are calculated based on fuel cost savings, while expenditures include annual loan repayments and O&M costs. The net cash flow is determined by comparing total capital and annual savings. Emissions reductions are calculated based on the total distance travelled and diesel emission factors. Final outputs include economic indicators and emissions saved due to the use of electric vehicles.

Solar dryer interventions

Solar dryer interventions focus on processing agricultural produce. Inputs include the total raw material processed in the past year, expected processing volume for the current year, produce wastage, and the raw produce required for 1 kg of dried product. Monthly processing requirements are calculated, followed by total savings from value addition per kg of dried product and expenditures for loan repayment and O&M. Net cash flow is determined by the ratio of total benefits to total costs. Final outputs include the capacity of the solar dryer, economic indicators, and benefit-cost ratios.

Solar-based cold storage interventions

For solar-based cold storage, inputs involve the amount of produce wasted or sold at low value, types of crops, available area for cold storage installation, and electricity costs. The cold storage requirement is calculated, followed by total savings from electricity savings and increased revenue. Expenditures include loan repayments and O&M costs. Final outputs cover the sizing of the solar cold storage, economic indicators, and benefit-cost ratios benefit-cost ratios.

By following this structured approach one can assess the feasibility, cost-effectiveness and environmental impact of each intervention, ensuring informed and sustainable choice.

3. Roadmap for renewable energy integration for improving livelihoods in rural sector

During the last phase of the project, the team engaged with 9 FPOs across the targeted districts of Nandurbar and Jalgaon in Maharashtra and Chhindwara and Singrauli in Madhya Pradesh. Mapping of their current activities, determine their aspirations for upskilling and upscoping, developing a package of technical interventions for each FPO and identification of financing schemes to implement them, were the tasks undertaken by the team during their visits and interactions.

Currently 2 FPOs (1 each from the project states), out of the total 9 from the past phase will be submitting their Detailed Project Reports (DPRs) under the PMFME scheme. The result of the assistance⁵ are presented in the table below:

Table 10: Current status of FPO and interventions by MP Ensystems

Name of FPO	Status of the FPO (2023)	Status of the FPO (2024)	MP Ensystems interventions
Madhya Pradesh			
Amarwara FPO	• 450 shareholders engaged in trading of maize and other agricultural commodities, started extraction of niger oil • They want to process millets and set up warehouse/cold storage facilities	• The FPO is in the process of DPR creation under the PMFME scheme for procurement of smaller capacity of cleaning and grading unit for millets. • PMFME district resource person has been assisting the FPO to revise into suitable submission formats	• Technical appraisal of activities and scale of processing for the FPO and assessment of the power requirements of processing unit using solar energy • Coordination with banks to ensure timely sanction under PMFME scheme and connecting the FPO members with District Resource Person • Creating DPRs for proposed future activities • Connecting the FPO with technology providers
Sausar FPO	• FPO has 650 shareholders currently engaged in trading of maize, seeds • Have plans to establish a processing unit for peas, using renewable energy	• The FPO has backed out due to financial losses and is currently not in the position to raise equity	• Reaching out to CSR organizations to raise funds

⁵ Out of the 9 FPOs, the table contains the next steps for four FPOs. The remainder could not be included as one proposed to work on banana fibre, which does not come under the PMFME scheme, and others have either already installed processing facilities or have postponed their plans.

Yudhishtir FPO	• FPO has 450 shareholders, engaged in trading of millets • They plan to establish a cleaning, grading unit and a warehouse • At present, the value chain does not have a green component	• The supporting organization PRADAN has backed out after providing support for last 3 years. • The FPO has backed out due to unavailability of CEO to run operations and lack of processing knowledge	• Reaching out to MP Vigyan Sabha, to create linkages and see if any further support can be provided
Maharashtra			
Ba Aakadata Shetkari Vikas Gat	• The FPO has 125 shareholders • They have recently installed a cold storage unit which they are using for storage of strawberries • They want to process of strawberries to produce value added products	• The FPO is in the process of DPR creation under the PMFME scheme for procurement of strawberry processing unit • PMFME district resource person has been assisting the FPO to revise into suitable submission formats	• Technical appraisal of activities and scale of processing for the FPO and assessment of the power requirements processing unit based on solar energy • Coordination with concerned bank to ensure timely sanction under PMFME scheme and SMART project • Connecting the FPO members with District Resource Person for PMFME and guidance of SMART project • Conversion of DPRs and government scheme guidelines into Marathi for ease of usability by the FPOs • Arranging site visit to an existing strawberry processing unit, for the FPO to gain confidence

Source: MP Ensystems Research, 2024

While the team has been continuously engaging with the FPOs from the past phase and the current ongoing phase, challenges arise in terms of robust marketing strategy for the produce, availing subsidies under government schemes, availing finance, raising equity and eventually project implementation.

To resolve the challenges mentioned above, a convergence approach would indeed play a great role. The convergence approach can be brought through government schemes, creating a pool of several CSR funds. The team has been studying several such schemes and government programs and meeting the top officials with proposals to amend the existing programs with an approach towards convergence.

One of such schemes has been the Public-Private Partnership for Integrated Agriculture Value Chain Development (PPPAVCD) scheme have been approved by the Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India.

PPPAVCD Scheme Overview

The scheme is designed to facilitate large-scale integrated projects in agriculture and allied sectors, driven by entities such as private sector players, Farmer Producer Organizations (FPOs), Agri Start-ups, cooperatives, etc. The primary aim of the scheme is to enable these entities to deploy newer technologies at scale, thereby helping farmers increase their income. By aggregating farmers, the scheme ensures their entitlements are facilitated seamlessly, promoting the accelerated adoption of new technologies and practices.

Key Objectives

- Move away from a production-centric approach to a demand-driven approach.
- Enable the deployment of newer technologies and improve market access.
- Augment ongoing government efforts in agricultural development.
- Utilize the capabilities of the private sector and non-government entities as Implementing Agencies (IAs).
- Address production and price risks in agriculture and allied sectors.
- Boost production and improve nutritional security, especially in pulses, oilseeds, millets, and horticulture crops.
- Generate employment opportunities for both skilled and unskilled individuals, particularly unemployed youth.
- Enhance value addition, reduce wastage, and bring efficiency to the value chain.
- Increase farmers profitability through better market linkages and reduced input costs.

Implementation Strategy

To unlock efficiencies, the scheme emphasizes the need for large-scale projects orchestrated by Implementing Agencies, involving coordination with input companies, buyers, financial institutions, and research institutes. These projects aim to improve productivity, reduce losses, and enhance market linkages, ultimately increasing farmers' incomes and boosting agricultural GDP growth.

Key Features of PPPAVCD

PPPAVCD Cell	National Programme Management Unit (PMU)	Implementing Agencies (IAs)
•Dedicated cell within the Ministry of Agriculture and Farmers Welfare to coordinate with various divisions, state governments, and private entities	•Provides technical assistance, manages IT platforms, assists IAs in project preparation, and facilitates investment summits •Ensures implementation and monitoring of proposals and engages in knowledge management	•Includes a range of entities like FPOs, cooperatives, companies, and public sector entities •Responsible for proposing and executing integrated agricultural development projects

Project Scope and Scale:

- Projects must target at least 500 farmers (250 in NER and hill states), with proposals involving up to 10,000 farmers. Larger proposals are assisted under a cluster program.
- Projects can span up to 5 years, with flexibility in design.

The scheme represents a comprehensive approach to transforming India's agriculture sector by fostering public-private partnerships, leveraging technology, and focusing on value chain development to benefit farmers and the broader agricultural economy.

Our site visits and discussions in the targeted four districts have made us clearly evaluate the solarization opportunities that can benefit the farmers, FPOs and processors. Hence the team at MP Ensystems are exploring options such as initiative to be launched by Maharashtra Energy Development Agency (MEDA). Integration of the solarisation and energy conservations or energy efficiency (EE) measures present the robust strategy for enhancing the sustainability and operational efficiency of FPOS can be launched by MEDA based on Bureau of Energy Efficiency (BEE) SME Program.

BEE SME Program

The BEE SME Program is aimed at improving the Energy Efficiency of Small and Medium Enterprises by technological interventions in the various clusters of India. The Energy Intensity in SME is intended to be enhanced by helping these industries to improve energy efficiency and performance through technology interventions and also develop consistent steps for successful implementation of energy efficiency measures and projects in the cluster units and also financial planning for the SME owners.

To implement this the detailed energy use and technology studies in various units have to be explored. There is potential for up gradation improving the quality and enhancing the production. The measures like individual drive system for paddy cleaner, separator, whitener and grader which could be save energy consumption during partial load. Installation of energy efficient motors (IE3 or IE4) which have higher efficiency than old and rewound motors. These measures with other options need to be explored that will help in energy conservation and reduction in GHGs with solarisation of processing unit.

Delving deeper into the opportunities observed, the team has created a roadmap towards 'Solarization of Rice and Dal mills' which has been presented below:

Programmatic approach for ‘Solarization of Rice and Dal Mills in Maharashtra’

Introduction

As the part of mission, the Greening of Rural Value Chains (GRVC) project, undertaken by MP Ensystems, focuses on assessing the potential for low-carbon development. The aim is to map the value chains in selected districts and develop comprehensive Programme Design Documents (PDDs) that highlight socio-economic-climate benefits, making them ready for off-take.

Our focus is on the following: aspirational districts, districts vulnerable to climate change and districts highly dependent on horticulture/ agriculture. In 2018, the Government of India identified the most underdeveloped districts in the country on the criteria of health, education, agriculture, water resources, financial inclusion, skill development and infrastructure. 112 districts⁶ were selected and included in the Aspirational Districts Programme (ADP). The team is currently focusing on the aspirational districts of Gadchiroli, Jalgaon and Nandurbar and additionally Nagpur in Maharashtra.

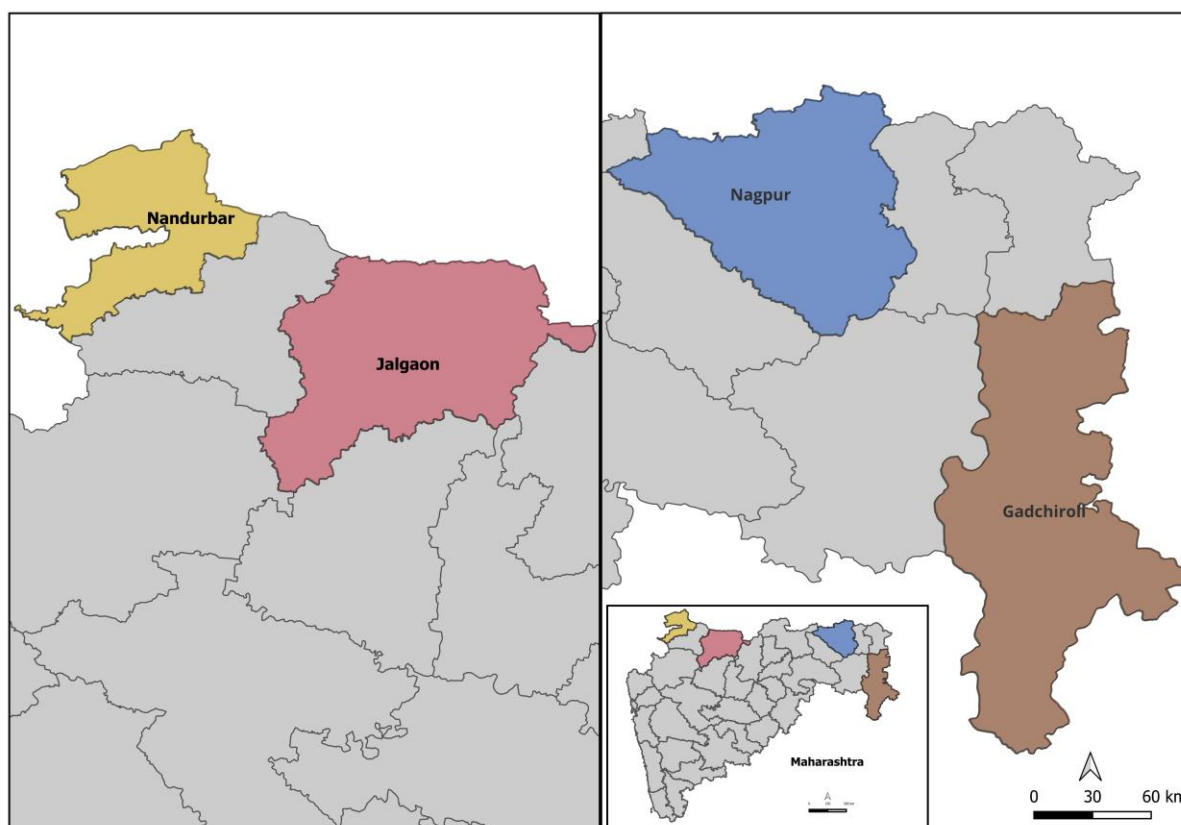


Figure 10: Map showing the districts of Nandurbar, Jalgaon, Nagpur and Gadchiroli

Some factors that influenced the selection of districts are:

⁶ List of districts https://my.msme.gov.in/MyMsme/List_of_AspirationalDistricts.aspx

- Nandurbar has been listed as highly vulnerable to climate change (Socio-economic vulnerability to climate change index, 2021)
- District GDP per capita in Gadchiroli and Nandurbar ranges from USD 1,262 to USD 1,298, which is 5% lower than India's average per capita income (Source: Maharashtra District Domestic Product, 2021-22)
- While agriculture accounted for between 6-21% of the district GDP in the selected districts, the share of the workforce engaged in agriculture (including cultivators and agricultural labourers) ranged from over 50% in Nagpur, to over 70% in Jalgaon, Nandurbar and Gadchiroli.
- Nagpur, referred to as India's orange city has 65% cultivable land, with immense potential to support agriculture, horticulture, floriculture and sericulture-based value chains that would result in substantive employment substitution from conventional economic activities.

Background

Socio-economic on the selected districts' incomes, agricultural profile and energy use, along with information gathered from site visits, interviews with policy makers, farmer producer organisations (FPOs), civil society organisations (CSOs) and other participants in rural value chains provides a basis for understanding the districts' current infrastructure, farming practices, technologies, social structures and awareness levels. This evaluation forms the basis for estimating the interventions and costs of transitioning to a low-carbon high growth regime.

The socio-economic profile of the selected districts is presented below:

Table 11: Socio-economic profile of selected districts

	Gadchiroli	Nagpur	Nandurbar	Jalgaon
Agriculture and allied (in Rs crore)	1,948	5638	3537	8566
Agriculture (%)	19	6	21	16
Mining (in Rs crore)	16	929	34	257
Mining (%)		1	0	1
Manufacturing (in Rs crore)	1418	18737	2928	7945
Manufacturing (%)	14	20	17	15
Other (in Rs crore)	6827	70103	10512	35903
Other (%)	67	73	62	68
Gross District Development Product (GDDP) (in Rs crore)	9235	100359	14058	49307
Population (in thousands)	1145	5318	1772	4631
GDP per capita (Rs)	89162	179404	95999	113736

The tribal population is significant in those districts, and agriculture is the dominant employer. Each of these districts presents unique challenges and opportunities within their agricultural value chains.

Table 12: The percentage of urban, rural, SC and ST population in selected districts

District	Urban (%)	Rural (%)	Scheduled Caste population (%)	Scheduled Tribe population (%)
Gadchiroli	11	89	11.25	38.71
Nagpur	68.3	31.7	18.65	9.4
Nandurbar	30.2	69.8	2.91	69.28
Jalgaon	31.74	68.26	9.2	14.29

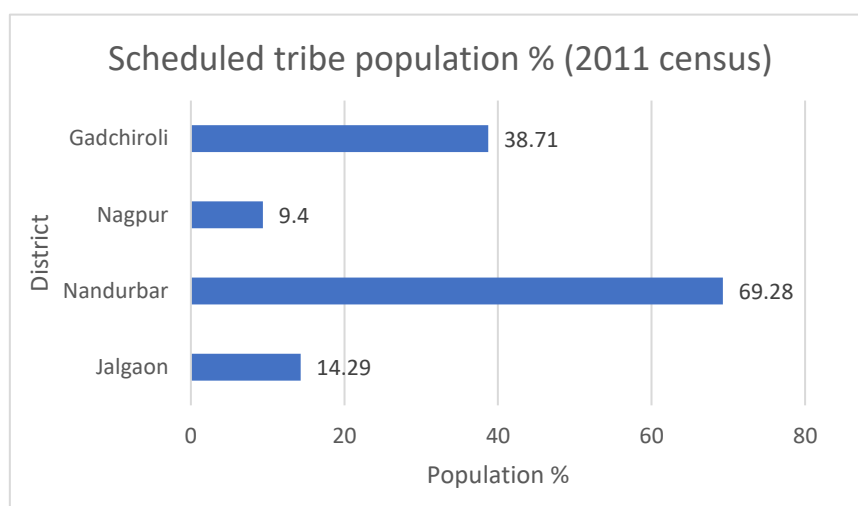


Figure 11: ST population percentage in selected districts

The table below provides information on energy consumption (in million units or MU) in the four selected districts for the year 2022.

Table 13: Energy consumption in the selected districts

District	Annual electricity Consumption (MU)	Population (Million)	Per capita electricity consumption (kWh/year)
Gadchiroli	121	1.2	-
Nagpur	3847	7.6	1106
Nandurbar	803	4.5	351
Jalgaon	4082	6.9	694

*Gadchiroli per capita electricity consumption data is not available

In order to identify FPOs that show interest in RE interventions, we have identified government programs such as the State of Maharashtra Agribusiness and Rural Transformation (SMART), and Maharashtra Agribusiness Network (MAGNET) project and also compiled comprehensive list of FPOs, by reaching out to various district-level agricultural bodies and organizations, under which FPOs are registered. Most of the FPOs in the targeted districts are primarily engaged in trading various produce, with only a few involved in processing activities. The table below highlights the major agriculture and horticulture crops grown in the four districts, pointing out the huge presence of mills for processing the cereals and pulses. The horticulture crops are mainly exported with leaving very few processing opportunities at place.

Table 14: Major agriculture and horticulture crops grown in the four districts

District	Total area under cultivation (Ha)	Agro-climatic zone	Major crops	Major horticulture crops
Gadchiroli	263,281	Eastern plateau & hill region	Paddy, Jowar, Tur, Wheat	Mohua, Custard Apple
Nagpur	624,000	Central plateau & hill region	Jowar, Rice, Wheat, Cotton, Cereals, PULSES	Orange, Chilly
Nandurbar	297,299	Western plateau & hill region	Cotton, Sorghum, Maize, Pearl millet	Mango, Strawberry
Jalgaon	867,960	Western plateau and hill region	Cotton, Sorghum, Maize, Black gram	Banana

The chart below highlights the approximate number of rice and dal mills currently present in the four districts. The rice and dal mills consume huge amounts of electricity to run their processing operations, which can be noted from the following chart. These operations often are affected due to power cuts, overloading of transformers which leads to reduced operational hours affecting the production quantity and unutilized workforce.

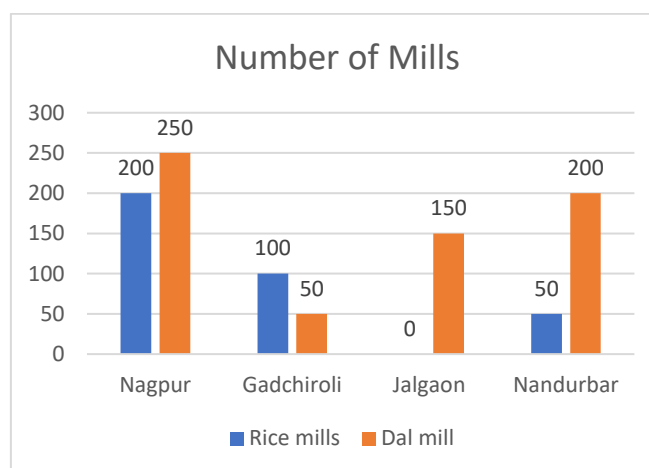


Figure 12: Number of rice and dal mills in the four districts

**No rice mills are found in Jalgaon*

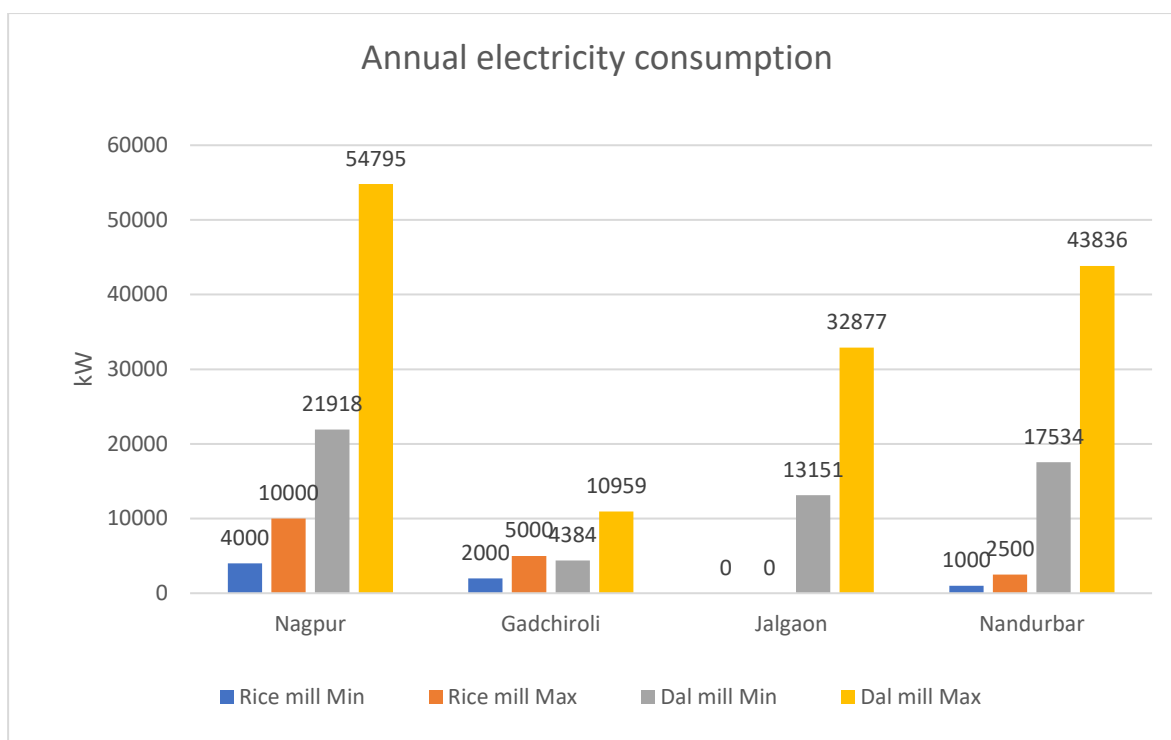


Figure 13: Annual electricity consumption in the four districts

Assumptions: Medium-sized rice mill has motors ranging from 25 hp to 60 hp, Rice and dal mill operational for 8 hours for 200 days in a year, Average Electricity consumption for micro dal mill unit: 128000 kWh/yr, Average Electricity consumption medium dal mill unit: 320000 kWh/yr⁷

Proposed intervention

In order to promote better RE solutions and greening of value-chains, we propose a programmatic intervention to promote **Solarization of rice and dal Mills**.

Vision

- Promote green rural value chains that have net zero emissions, are climate resilient and climate adaptive
- Create green rural employment opportunities in agriculture, manufacturing and services
- Enhance livelihood and employability through upskilling and reskilling of the workforce in partnership with educational institutions in the state

Targets for Phase I

1. Enhanced livelihood opportunities in the selected four districts through greening rural value chains
2. Solarizing the rooftops of existing mills of the selected districts
3. Entrepreneurship and skill development programs to be conducted

Proposed Interventions and Budget

⁷ <https://www.sunshellpower.com/solution/rice-mill/>, <http://sidhiee.beeindia.gov.in/pdf/ricemill/4.pdf>

The table below shows the proposed interventions. In this table, government expenditure has been assumed to be 10% of technology cost, which can be implemented through bulk purchase, rebate, subsidy, interest rate subvention or any other mechanism, along with training and management costs for the first year. The source of funds is the Maharashtra state general budget.

Table 15: Proposed interventions and expected government expenditure

Interventions	Govt Expenditure, INR Crore
Rooftop Solar PV for mills	20-30*
Training	30
Dissemination	10
Program Management	20
Total	80-90

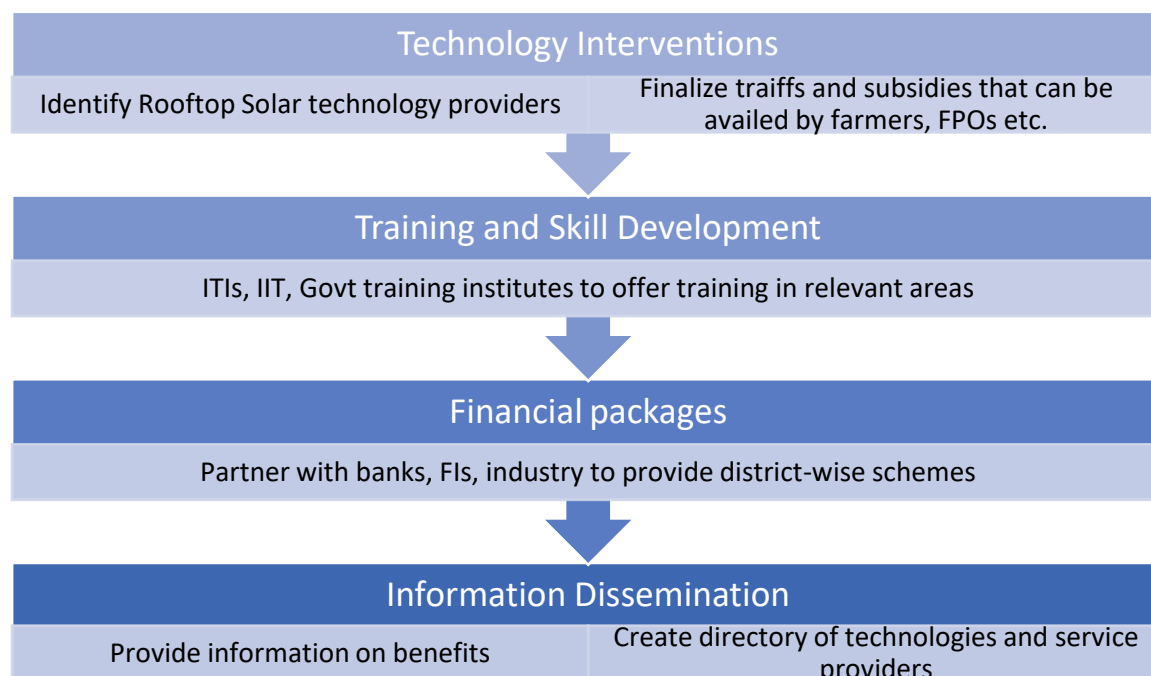
Source: MP Ensystems Research 2024

*The PM-Surya Ghar: Muft Bijli Yojana is for residential households subsidising the rooftop solar PV with INR 18000 per kW for group housing society or residential welfare associations. The implementing agency to decide the subsidy based on the recently launched PM-Surya Ghar: Muft Bijli Yojana.

During the evaluation in year 2, the management team can estimate direct and indirect benefits of the program in terms of raising income, generating employment and reducing GHG emissions. Future benefits and targets can be set accordingly.

Program management

The program is expected to operate as follows:



The policy would provide financial incentives to farmers and supply chain partners for Rooftop solar implementation. The agency managing the implementation would also conduct training programs in partnership with educational institutions and industry and undertake awareness campaigns, as well as disseminating information on technologies and service providers. Annual evaluation of the programs

benefits vs its costs will provide guidance on modifying targets, benefits and technologies for the next year.

Stakeholder's roles & responsibilities

Table 16: Stakeholder roles and responsibilities

Stakeholders	Roles	Responsibilities
Maharashtra Energy Development Agency (MEDA)	Regulatory and enforcement agency	- Regulatory body providing technical guidance, regulatory support, and financial assistance. - Oversees compliance with energy policies, administers subsidies, and fosters innovation. - Ensures alignment of renewable energy projects with state and national goals. - Contributes to sustainable rural development and decarbonization efforts.
MP Ensystems Advisory Pvt Ltd	Project Management Unit (PMU)	- Develop plans, schedules, and budgets; oversee daily activities and team coordination. - Facilitate communication, organize meetings, and act as the main contact point. - Track progress, conduct field visits, and prepare reports for internal review. - Manage budgets, conduct audits, report to funders, and address external risks.
Distribution Companies (DISCOMS)	Energy management agency	- Manage the distribution and supply of electricity to rural areas. - Facilitate grid integration of renewable energy sources. - Ensure stable and reliable energy supply. - Enable efficient transmission of power generated from renewable technologies.
Government Bodies	Facilitators	- Local government authorities, municipal corporations, and district administrations provide permissions and infrastructure support. - Facilitate community engagement. - Policy makers and regulators create and enforce renewable energy adoption policies. - Offer incentives and subsidies to stakeholders.
Farmer Producer Organisations (FPOs)	Beneficiary and implementor	- Primary beneficiaries and implementers of renewable energy technologies. - Engage in post-harvest processing activities, leveraging renewable energy to improve efficiency and reduce costs. - Enhance the value chain, increase income, and contribute to sustainable agricultural practices. - Improve livelihoods of rural farmers.
Original Equipment Manufacturers (OEMs)	Supply and maintenance	- Provide high-quality, reliable solar panels, wind turbines, and other renewable energy systems. - Offer technical support and maintenance services. - Ensure the longevity and efficiency of installed equipment.

Technology Providers	Technological solution providers	• Develop and implement innovative renewable energy solutions tailored to rural needs. • Offer technical expertise and conduct feasibility studies. • Design customized renewable energy systems to enhance efficiency in agricultural and processing activities.
Financial Institutions	Funding and supporting agency	• Include banks and microfinance organizations providing critical funding and financial support. • Offer loans, grants, and subsidies for renewable energy projects. • Facilitate the acquisition and installation of renewable energy systems. • Help overcome financial barriers to renewable energy adoption, ensuring economic viability and scalability.
Non-Governmental Organizations (NGOs)	Facilitation and training	• Facilitate community engagement, capacity building, and implementation support. • Work closely with local communities to raise awareness about renewable energy benefits. • Provide training and support the adoption of new technologies. • Act as intermediaries between the project team and rural stakeholders, ensuring community needs are addressed. • Enhance the project's social impact, promoting inclusive and sustainable development.
Local Communities	Beneficiary and participants	• Direct beneficiaries of the renewable energy integration project. • Involvement is crucial for successful implementation and sustainability. • Participate in planning and execution to ensure solutions are tailored to local needs and conditions.

Sources of finance

The source of financing can be from the following sources:

- Central government / Maharashtra state general budget
- Share of equity from farmers and FPO members
- Funds to be secured from CSR organizations

RESCO model for solar power: a viable option

- The Renewable Energy Service Company (RESCO) model is an innovative approach to implementing solar power solutions, particularly beneficial for entities such as Farmer Producer Organizations (FPOs). This model involves RESCO funding, building, and maintaining a rooftop or onsite solar power plant. The end-consumer, in this case, the FPO, pays for the power generated under a long-term power purchase agreement (PPA) at an agreed tariff for a fixed period.
- Under the RESCO model, the solar photovoltaic (PV) system is owned by the RESCO. The FPO, while availing the service, does not possess ownership of the system. The RESCO developer assumes responsibility for the annual operation and maintenance (O&M) of the solar system,

ensuring its optimal performance. Additionally, any surplus power generated is sold to the Distribution Company (DISCOM), potentially generating additional revenue.

Benefits of the RESCO Model:

- **Lower Upfront Costs:** One of the most significant advantages of the RESCO model is the elimination of the need for a substantial upfront investment. This makes it an attractive option for FPOs that may not have the financial resources to cover the initial expenses associated with solar installations.
- **Outsourced Maintenance and Performance Risks:** With a RESCO agreement, the responsibility for maintaining and optimizing the solar system's performance lies with the service provider. This reduces the operational and maintenance burden on the FPO, allowing them to focus on their core activities.
- **Flexibility and Scalability:** The RESCO model offers flexibility in terms of system size and scalability. This enables FPOs to adjust their energy requirements over time as their needs change, providing a tailored and adaptable energy solution.

In contrast to traditional models, where savings begin after the payback period, the RESCO model allows for immediate savings. There is no need for an initial investment, which can address the financial challenges faced by FPOs.

Considering these benefits, the RESCO model emerges as a highly advantageous option for FPOs. It provides a sustainable and financially viable solution for adopting solar power, ensuring immediate savings and alleviating the burden of high initial costs and ongoing maintenance.

Expected impact

The expected impact that the program would bring is highlighted below:

- Availability of continuous supply of clean energy
- Employment generation
- Livelihood creation
- Reduction in GHG emissions

District-level RE deployment opportunities

Assuming that 10% of rice and dal mills are interested in installing rooftop solar PV system, the RE potential in these 4 districts is calculated below:

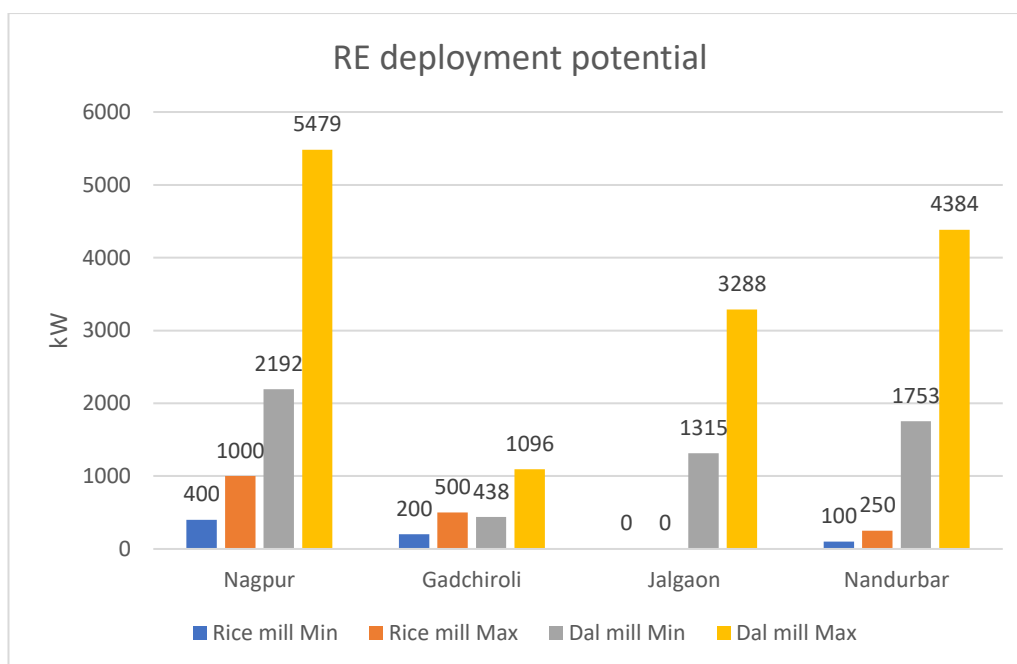


Figure 14: RE deployment potential in the four districts

Based on the above graph, the investment requirement for the 10% of rice and dal mills to get solarized in total will lead to minimum of RS. 32 crores and maximum of RS. 80 crores based on the size of the mills and the assumed requirement of connected load.

Table 17: Investment required

Investment required (in INR Crores)				
	Rice mill		Dal mill	
	Min	Max	Min	Max
Nagpur	2	5	11	27.4
Gadchiroli	1	2.5	2.2	5.5
Jalgaon	0	0	6.5	16.4
Nandurbar	0.5	1.25	8.8	22

*The rice mill energy consumption per annum is less compare to the dal mill. Refer figure 13 for energy consumption pattern.

Mapping the potential impact created at district level for 10% conversion

The current workforce getting employed at mills is approximately to 6 per mill. Whereas, considering the 10% conversion of mills to solarization the number of employment generation will go up to 10 per mill. Based on the observation and discussions with rice and dal mill owners the approximate increase in employment is assumed.

Table 18: Employment generation

Employment generation		
	Rice mill	Dal mill
Nagpur	200	250
Gadchiroli	100	50
Jalgaon	0	150
Nandurbar	50	200

Total	350	650
--------------	-----	-----

The total amount of GHG emissions abated by converting just 10% of rice and dal mills to RE deployment have been calculated below.

Table 19: GHG emission savings

GHG emission savings (tonnes of CO2 saved per year)						
	Rice mill		Dal mill		Total	
	Min	Max	Min	Max	Min	Max
Nagpur	554	1384	3034	7584	3587	8968
Gadchiroli	277	692	607	1517	884	2209
Jalgaon	0	0	1820	4550	1820	4550
Nandurbar	138	346	2427	6067	2565	6413
	Total				8856	22141

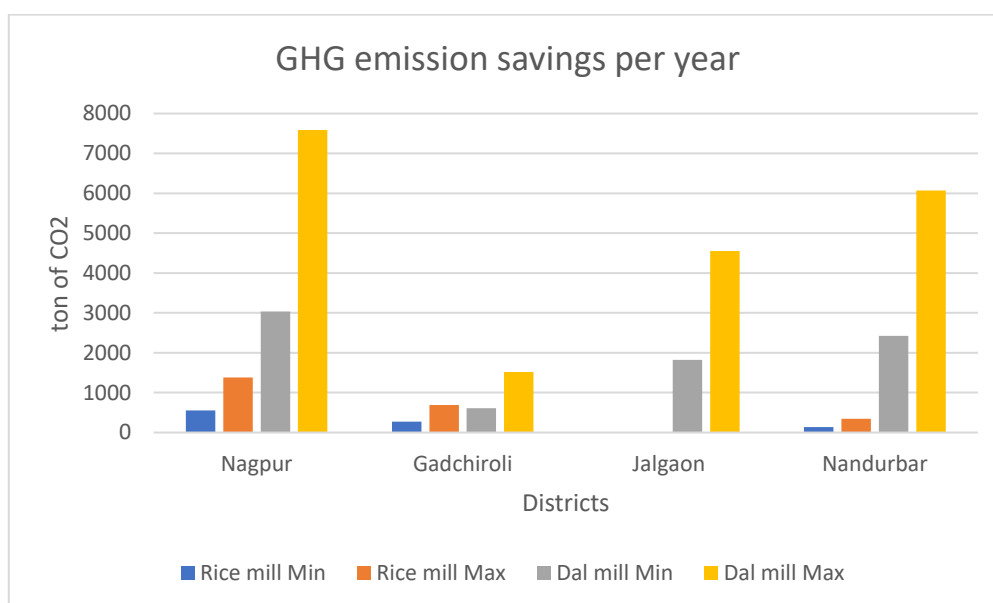
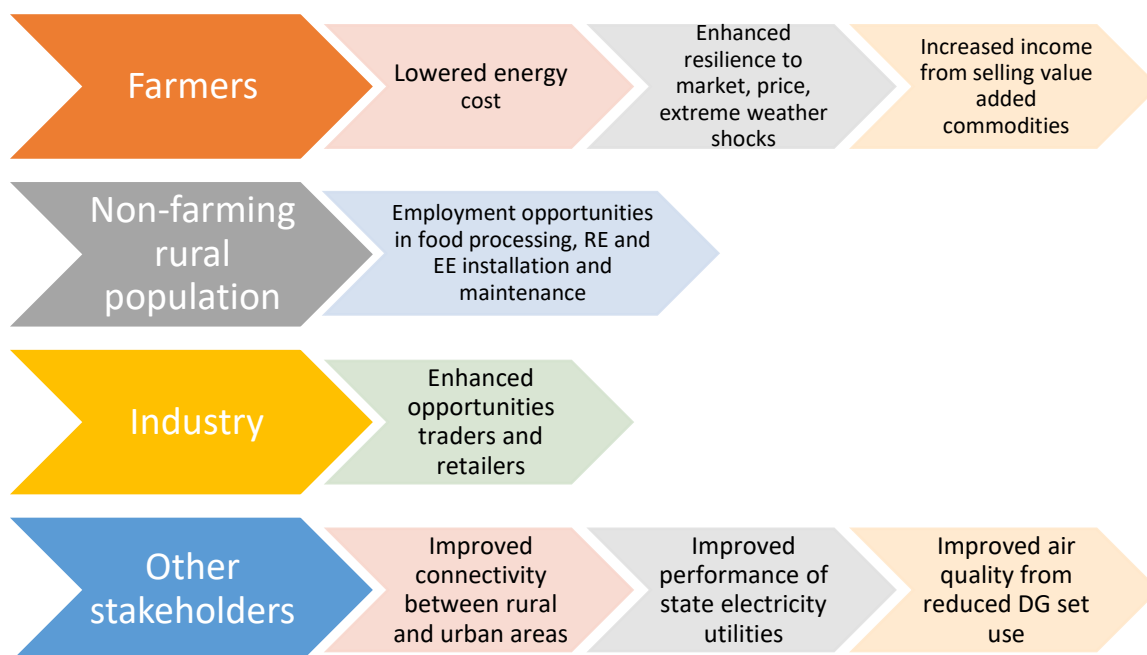


Figure 15: GHG emission savings per year

Beneficiaries

The expected beneficiaries are below:



Next steps for the roadmap

The Project Management Unit (PMU) will have to conduct district and state wide stakeholder consultations to bring awareness for the program. They will also have to identify and secure other means of funding and develop one-stop application process that will ease the process of availing the program for farmers, FPOs and other similar beneficiaries.

4. Way forward

4.1. Outreach and dissemination

MP Ensystems has initiated GRVC webinar series aiming to create awareness about the important issues faced by farmers, FPOs, women SHGs towards adoption of newer technologies, availability of finance, issues related to climate change, the food-energy-water nexus in the agriculture sector etc. to name a few. The targeted audience will include students from agriculture colleges, rural management courses, technology providers, finance institutions, FPOs, women SHGs, agri-tech startups and other knowledge partners working in the same sector. The detailed summary of the first webinar is added in the Annexure D.

Key takeaways:

- Democratize technology: Ensure that technology solutions are affordable and accessible to small farmers by promoting collective investments and scaling down models to suit rural settings.
- Enhance market linkages: Focus on improving post-harvest processing and creating efficient market linkages to increase the profitability of agricultural products.
- Promote collaborative efforts: Encourage collaboration among stakeholders to synchronize efforts in integrating green technologies into rural value chains.
- Policy support: Advocate for supportive policies and financing mechanisms that lower the cost of adopting renewable energy technologies and make them viable for small farmers.
- Raise awareness: Conduct awareness campaigns and showcase successful case studies to demonstrate the economic benefits of green technologies in rural value chains.



Addressing these points should lead to sustainable and economically viable rural value chains that contribute to broader environmental and social goals.

4.2. Potential challenges, opportunities and next steps

The team at MP Ensystems has documented following potential challenges towards achieving the aspirational target of 100 projects: The four districts have a significant tribal population where agriculture is the dominant employer. In Gadchiroli and Nandurbar, the primary crops are paddy and millet, with some farmers also cultivating mohua, mango, and strawberries. In Nagpur and Jalgaon, farmers grow paddy, pulses, cotton, oranges, and bananas, with FPOs primarily engaged in processing rice and dal. High capital costs and market challenges deter FPOs from horticulture processing. The FPOs which are engaged in processing unit are mainly in rice and dal.

Next steps:

- To continue efforts to meet more FPOs and conduct focused groups discussions to understand challenges towards solarization
- To identify RE based interventions to suit their requirements
- To conduct meetings with key stakeholders like MEDA, MAHAPREIT etc., to present the programmatic approach and assist them in launching the solarization program
- To conduct meetings with key government officials to present convergence opportunities
- To conduct value-addition webinars related to the subject leading to awareness building
- To get a few projects designed and implemented by adopting the approach recommended in this study.

Annexure A (PDDs)

1. Project Design Document: Greening of Rural value chains for Rice processing plant

Project Background

Kanhan Agro Vision Farmers Producer Company Limited is a farmer-producer organisation (FPO) comprising 312 members. The FPO was established in 2018 and has a rice processing unit of capacity of 4 TPH at Kanhan Pimpri, Nagpur. The paddy is sourced from the farmers in the region. The paddy is collected from both members and non-members of farmers. The raw paddy undergoes processing and creates final polished rice of different gradings. The polished rice is subsequently sold to the contracted companies and traders. The FPO does the job work for farmers.

However, the processing unit faces challenges of high operation cost and major component is electricity cost. This issue results in low profitability of plant.

Project Description

This project aims at the solarisation of rice processing unit by installing solar PV and energy efficiency measures at FPO situated at Nagpur. Electricity is primary energy input to the plant which has connected load of 167 kW. The daily operation of the processing unit is 5 hours. The electricity bill we collected from FPO and cumulative annual consumption of electricity is around 23500 units. The specification of solar PV system is proposed as follows,

15 kW solar photovoltaic panel system: Cumulative total savings on energy consumption amount to 23700 units annually, which accounts for 19 tonnes of CO₂ emissions mitigated annually, assuming an average capacity utilization factor (CUF) of 4.5. The initial investment is compensated for by savings in electricity bills for the operation of the plant at an average variable electricity cost of INR 10/kWh. To make the plant energy efficient the 5% cost is considered per kW.

Summary of Investments

Total project cost is expected to be close to INR 7.5 lakhs that includes design, engineering, procurement, installation. Per kW cost of solar PV is considered 50,000 Rs/kW with EE measures INR 5000 per kw for a 15 kW system is considered.

Table 1: Capital Costs for the project

S . N o	Technology	Un it	Capacit y	Qty (Nos .)	Cost (Rs/unit)	Value (Rs.)	Cost sharing			Sharing (%)	Relevan t scheme s
							FPO equity **	Govt subsidy	Loan		

1	Project Cost*				750,000	750,000	150,000	0	600,000	20::0::80	
	Solar photovoltaic panel system with battery	kW	15	1	750,000	750,000	150,000	0	600,000		
	Energy efficient measures			1	75,000	75,000	15,000		60,000		
	Total					825,000	165,000	0	660,000		

*Project cost includes all costs (plant and machinery, solar photovoltaic panel costs, et al), excluding land cost

**Based on discussions held on the ground and their financial conditions, equity share ranges from 5% to 30%, hence has been assumed at 20%

Barriers addressed in the project implementation:

The FPO has been aspiring to work for improving the income levels of farmers in the region through procurement of their produce locally at remunerative prices and distribution of the profits as dividend at a later stage. It aims to achieve these targets through a low-carbon pathway, which would further improve its sustainability in the long run and doesn't add to the widespread land and air pollution through its operations. The key barrier addressed through the proposed project implementation is listed below.

Table 2: Barriers addressed through the project

Barrier	How the proposed project will address barriers through net-zero carbon solutions
Frequent power outages, reliance on diesel generator sets as backup, high operation expenses	Installation of a rooftop solar panels which eliminates carbon emissions while ensuring continued power availability at minimal costs

Source: MP Ensystems Research

Financial Analysis

A simple cash-flow analysis is below, with the conservative assumption that the equipment has a lifespan of 20 years.

Project Cost

Project cost includes solar panel equipment cost and installation cost, other components of project cost are taken as zero as the plant is already installed and operational.

Table 3: Total Project Cost

Project Cost					
S. No.	Particulars	Unit	Qty.	Rate (Rs.)	Amount (Rs. Lakh)
1	Solar photovoltaic	kW	15	750,000	7.5
2	Energy efficiency measures			75,000	0.75
	Total				8.25

Source: MP Ensystems Research

Means of Finance

Regarding the implementation of solar rooftop installations for industrial consumers, no subsidies are accessible for this initiative. Consequently, the funding for the project will be undertaken by the FPO. The financial arrangement for this venture entails a 20% equity investment from the FPO and the remaining 80% through a loan arrangement. Additional specifics concerning the financing breakdown can be referenced in Table 5.

Table 5: Means of Financing

Means of Finance		
Total Financing required	INR lakhs	8.25
Equity	%	20%
Grant	%	0%
Debt	%	80%
Interest Rate (Per Annum)	%	12.00%
Moratorium	Years	1
Annual Instalment	Years	5
Equity Component	INR lakhs	1,65,000
Grant Component	INR lakhs	0
Debt Component	INR lakhs	6,60,000

Source: MP Ensystems Research

The financial indicators analysed by discounting cash flow at 10% are given in **Annexure I** and the summary is presented in **Table 6**.

Table: 6 Estimated Financial Indicators

Financial Indicators	Estimated	Requirement
Net Present Worth	18.36	Should be positive
IRR	83%	> 10%
BCR	4.2	Should be >1.0

Source: MP Ensystems Research

The repayment period has been drawn by considering net surplus available for repayment. The bank loan with interest is repayable within 5 years with a moratorium of one year.

The following specific attributes of ESG can further be achieved through the implementation of this project:

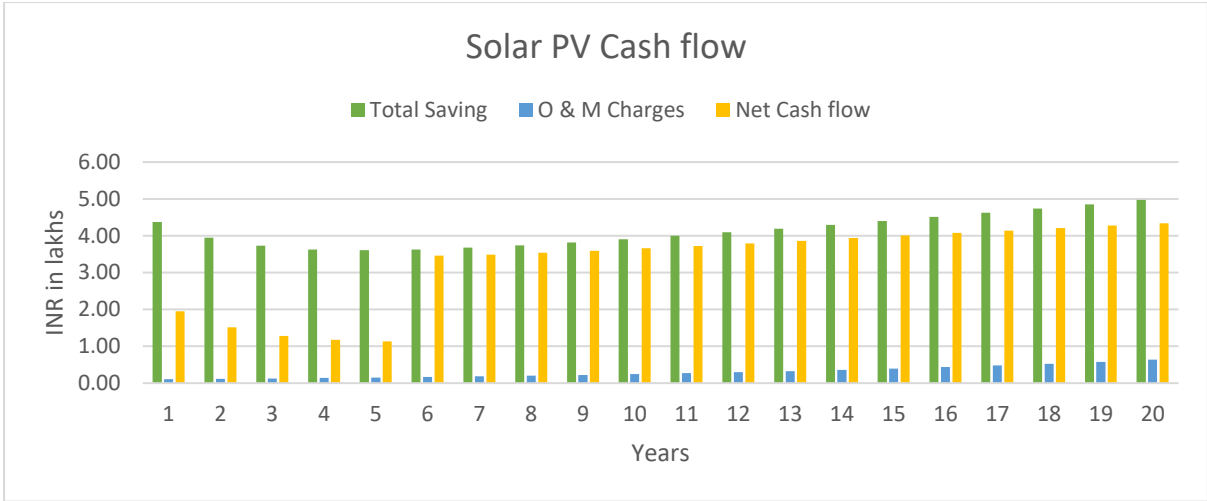
- There are a number of environmental opportunities including mitigation of carbon emissions, reduction of resource depletion. There are direct climate benefits to the project. The installation of roof-top solar results in the mitigation of 19 tonnes of CO₂ emissions every year.

Calculation of financial indicators

Detailed calculation and cash flow											
Year s	Electricity cost saving			Tax Saving			Total savin g	O&M charge s	Annual loan repaym ent	Net cash flow	Cummulati ve saving
	Electricity generatio n per annum	Electricit y tariff	Savings on Electricit y	Gross asset value	Accelerate d depreciatio n	Tax saving due to AD					
	(KWh)	(INR/KW h)	(INR Lakhs)	(INR Lakhs)	(INR Lakhs)	(INR lakhs)					
	A	B	C=A*B	D	E=D*40%	F=E*30 %					
							G=C+F	H	I	J=G-H-I	K
0	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.65	-1.65
1	24637.50	10.00	2.46	8.25	3.30	0.99	3.45	0.08	-1.83	1.54	-0.11
2	24514.31	10.30	2.52	4.95	1.98	0.59	3.12	0.09	-1.83	1.20	1.09
3	24391.74	10.61	2.59	2.97	1.19	0.36	2.94	0.10	-1.83	1.01	2.10
4	24269.78	10.93	2.65	1.78	0.71	0.21	2.87	0.11	-1.83	0.93	3.03
5	24148.43	11.26	2.72	1.07	0.43	0.13	2.85	0.12	-1.83	0.89	3.92
6	24027.69	11.59	2.79	0.64	0.26	0.08	2.86	0.13	0.00	2.73	6.65
7	23907.55	11.94	2.85	0.38	0.15	0.05	2.90	0.15	0.00	2.75	9.41
8	23788.01	12.30	2.93	0.23	0.09	0.03	2.95	0.16	0.00	2.79	12.20
9	23669.07	12.67	3.00	0.14	0.06	0.02	3.01	0.18	0.00	2.84	15.04
10	23550.73	13.05	3.07	0.08	0.03	0.01	3.08	0.19	0.00	2.89	17.92
11	23432.98	13.44	3.15	0.05	0.02	0.01	3.16	0.21	0.00	2.94	20.87
12	23315.81	13.84	3.23	0.03	0.01	0.00	3.23	0.24	0.00	3.00	23.86
13	23199.23	14.26	3.31	0.02	0.01	0.00	3.31	0.26	0.00	3.05	26.91
14	23083.24	14.69	3.39	0.01	0.00	0.00	3.39	0.28	0.00	3.11	30.02
15	22967.82	15.13	3.47	0.01	0.00	0.00	3.47	0.31	0.00	3.16	33.18
16	22852.98	15.58	3.56	0.00	0.00	0.00	3.56	0.34	0.00	3.22	36.40
17	22738.72	16.05	3.65	0.00	0.00	0.00	3.65	0.38	0.00	3.27	39.67
18	22625.02	16.53	3.74	0.00	0.00	0.00	3.74	0.42	0.00	3.32	42.99
19	22511.90	17.02	3.83	0.00	0.00	0.00	3.83	0.46	0.00	3.37	46.36
20	22399.34	17.54	3.93	0.00	0.00	0.00	3.93	0.50	0.00	3.42	49.79
Total			62.84		8.25	2.47	65.32	4.73	-9.15	49.79	419.62

Cummulative savings (INR lakhs)	419.62
Net present worth (INR lakhs)	₹ 18.36

Internal Rate of Return (IRR)	83%
BCM	4.2



2. Project Design Document: Greening of Rural value chains for Rice processing plant

Project Background

Tarang Producer Company Limited is a farmer-producer organisation (FPO) comprising 450 members. The FPO was established in 2017 and has a rice processing unit of capacity of 4 TPH at Charmorshi, Gadchiroli. The paddy is sourced from the farmers in the region. The paddy is collected from both members and non-members of farmers. The raw paddy undergoes processing and creates final polished rice of different gradings. The polished rice is subsequently sold to the contracted companies and traders. The FPO does the job work for farmers and traders.

However, the processing unit faces challenges of high operation cost and major component is electricity cost which is nearly 50% per cent of profit. This issue results in low profitability of a plant.

Project Description

This project aims at the solarisation of rice processing unit by installing solar PV and energy efficiency measures at FPO situated at Gadchiroli. Electricity is primary energy input to the plant which has connected load of 65 kW. The daily operation of the processing unit is 5 hours. The electricity bill we collected from FPO and cumulative annual consumption of electricity is around 31181 units. The specification of solar PV system is proposed as follows,

19 kW solar photovoltaic panel system: Cumulative total savings on energy consumption amount to 31181 units annually, which accounts for 24.6 tonnes of CO₂ emissions mitigated annually, assuming an average capacity utilization factor (CUF) of 4.5. The initial investment is compensated for by savings in electricity bills for the operation of the plant at an average variable electricity cost of INR 10/kWh. To make the plant energy efficient the 5% cost is considered per kW.

Summary of Investments

Total project cost is expected to be close to INR 10.45 lakhs that includes design, engineering, procurement, installation. Per kW cost of solar PV is considered 50,000 Rs/kW with EE measures cost INR 5000 per kW for a 19-kW system is considered.

Table 1: Capital Costs for the project

S. No	Technology	Unit	Capacity	Qty (Nos.)	Cost (Rs/unit)	Value (Rs.)	Cost sharing			Sharing (%)	Relevant schemes
							FPO equity **	Govt subsidy	Loan		

1	Project Cost*				950,000	950,000	1,90,000	0	760,000	20::0::80	
	Solar photovoltaic panel system with battery	kW	19	1	950,000	950,000	1,90,000	0	760,000		
	Energy efficient measures			1	95,000	95,000	19,000		76,000		
	Total					10,45,000	2,09,000	0	8,36,000		

*Project cost includes all costs (plant and machinery, solar photovoltaic panel costs, et al), excluding land cost

**Based on discussions held on the ground and their financial conditions, equity share ranges from 5% to 25%, hence has been assumed at 20%

Barriers addressed in the project implementation:

The FPO has been aspiring to work for improving the income levels of farmers in the region through procurement of their produce locally at remunerative prices and distribution of the profits as dividend at a later stage. It aims to achieve these targets through a low-carbon pathway, which would further improve its sustainability in the long run and doesn't add to the widespread land and air pollution through its operations. The key barrier addressed through the proposed project implementation is listed below.

Table 2: Barriers addressed through the project

Barrier	How the proposed project will address barriers through net-zero carbon solutions
Frequent power outages, reliance on diesel generator sets as backup, high operation expenses	Installation of a rooftop solar panels which eliminates carbon emissions while ensuring continued power availability at minimal costs

Source: MP Ensystems Research

Financial Analysis

A simple cash-flow analysis is below, with the conservative assumption that the equipment has a lifespan of 20 years.

Project Cost

Project cost includes solar panel equipment cost and installation cost, other components of project cost are taken as zero as the plant is already installed and operational.

Table 3: Total Project Cost

Project Cost					
S. No.	Particulars	Unit	Qty.	Rate (Rs.)	Amount (Rs. Lakh)
1	Solar photovoltaic	kW	19	950,000	9.5
2	Energy efficiency measures			95,000	0.95
	Total				10.45

Means of Finance

Regarding the implementation of solar rooftop installations for industrial consumers, no subsidies are accessible for this initiative. Consequently, the funding for the project will be undertaken by the FPO. The financial arrangement for this venture entails a 20% equity investment from the FPO and the remaining 80% through a loan arrangement. Additional specifics concerning the financing breakdown can be referenced in Table 5.

Table 5: Means of Financing

Means of Finance		
Total Financing required	INR lakhs	10.45
Equity	%	20%
Grant	%	0%
Debt	%	80%
Interest Rate (Per Annum)	%	12.00%
Moratorium	Years	1
Annual Instalment	Years	5
Equity Component	INR lakhs	2,09,000
Grant Component	INR lakhs	0
Debt Component	INR lakhs	8,36,000

Source: MP Ensystems Research

The financial indicators analysed by discounting cash flow at 10% are given in **Annexure I** and the summary is presented in **Table 6**.

Table: 6 Estimated Financial Indicators

Financial Indicators	Estimated	Requirement
Net Present Worth	23.26	Should be positive
IRR	83%	> 10%
BCR	4.2	Should be >1.0

Source: MP Ensystems Research

The repayment period has been drawn by considering net surplus available for repayment. The bank loan with interest is repayable within 5 years with a moratorium of one year.

The following specific attributes of ESG can further be achieved through the implementation of this project:

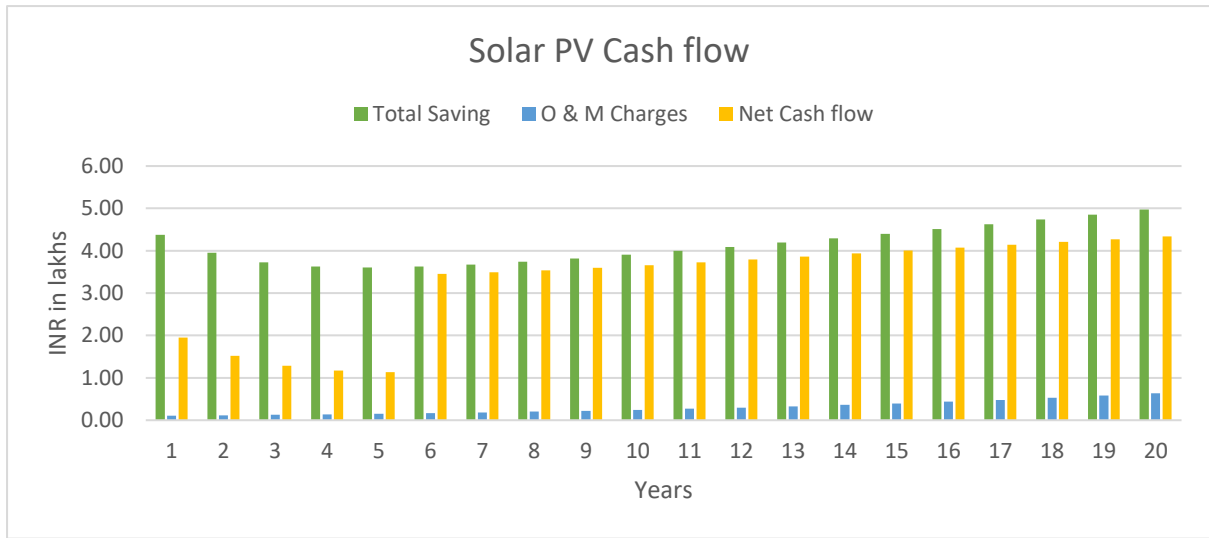
- There are a number of environmental opportunities including mitigation of carbon emissions, reduction of resource depletion. There are direct climate benefits to the project. The installation of roof-top solar results in the mitigation of 25 tonnes of CO₂ emissions every year.

Calculation of financial indicators

Detailed calculation and cash flow											
Year s	Electricity cost saving			Tax Saving			Total savin g	O&M charge s	Annual loan repaym ent	Net cash flow	Cummulati ve saving
	Electricit y generatio n per annum	Electricit y tariff	Savings on Electricit y	Gross asset value	Accelerate d depreciati on	Tax saving due to AD					
	(KWh)	(INR/KW h)	(INR Lakhs)	(INR Lakhs)	(INR Lakhs)	(INR lakhs)					
	A	B	C=A*B	D	E=D*40%	F=E*30 %					
0	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-2.09	-2.09
1	31207.50	10.00	3.12	10.45	4.18	1.25	4.37	0.10	-2.32	1.95	-0.14
2	31051.46	10.30	3.20	6.27	2.51	0.75	3.95	0.11	-2.32	1.52	1.38
3	30896.21	10.61	3.28	3.76	1.50	0.45	3.73	0.13	-2.32	1.28	2.66
4	30741.72	10.93	3.36	2.26	0.90	0.27	3.63	0.14	-2.32	1.17	3.83
5	30588.02	11.26	3.44	1.35	0.54	0.16	3.61	0.15	-2.32	1.13	4.97
6	30435.08	11.59	3.53	0.81	0.33	0.10	3.63	0.17	0.00	3.46	8.42
7	30282.90	11.94	3.62	0.49	0.20	0.06	3.67	0.19	0.00	3.49	11.91
8	30131.49	12.30	3.71	0.29	0.12	0.04	3.74	0.20	0.00	3.54	15.45
9	29980.83	12.67	3.80	0.18	0.07	0.02	3.82	0.22	0.00	3.59	19.05
10	29830.92	13.05	3.89	0.11	0.04	0.01	3.90	0.25	0.00	3.66	22.70
11	29681.77	13.44	3.99	0.06	0.03	0.01	4.00	0.27	0.00	3.73	26.43
12	29533.36	13.84	4.09	0.04	0.02	0.00	4.09	0.30	0.00	3.79	30.22
13	29385.69	14.26	4.19	0.02	0.01	0.00	4.19	0.33	0.00	3.86	34.09
14	29238.77	14.69	4.29	0.01	0.01	0.00	4.30	0.36	0.00	3.93	38.02
15	29092.57	15.13	4.40	0.01	0.00	0.00	4.40	0.40	0.00	4.00	42.03
16	28947.11	15.58	4.51	0.00	0.00	0.00	4.51	0.44	0.00	4.07	46.10
17	28802.37	16.05	4.62	0.00	0.00	0.00	4.62	0.48	0.00	4.14	50.24
18	28658.36	16.53	4.74	0.00	0.00	0.00	4.74	0.53	0.00	4.21	54.45
19	28515.07	17.02	4.85	0.00	0.00	0.00	4.85	0.58	0.00	4.27	58.73
20	28372.49	17.54	4.98	0.00	0.00	0.00	4.98	0.64	0.00	4.34	63.06
Total			79.60		10.45	3.13	82.73	5.99	-11.60	63.06	531.52

Cummulative savings (INR lakhs)	531.52
Net present worth (INR lakhs)	₹ 23.26

Internal Rate of Return (IRR)	83%
BCR	4.2



Annexure B (Excel template)

FileHomeInsertDrawPage LayoutFormulasDataReviewViewHelp																Comments		Share
Paste			Font			Alignment			Number			Styles		Cells		Editing		Add-ins
Clipboard																		
E5																		
C F G H I J K L M N O P Q R S T U																		
Intervention																		
Name of FPC		Current activity	Capacity (TPH)	Electric Hauler	Daily distance travel by vehicle (km)	Number of working days	Solar PV	Annual electricity consumption (kWh)	Machinery rating (hp)	Daily working hours	Number of days	Connected load (KW)	Available rooftop area (sq ft)	Solar dryer	Capacity requirement (kg)	Solar based cold storage	Current	
Kanhan Agro-Vision Farmer Producer Company Ltd.		Processing unit Rice mill	4	Yes	0	250	Yes	23716	20	5	200	167	5000					
Lodheshwar Agro Producer Company Limited		proposed process Cleaning and grading	2	No			Yes			5	200		4800					
Chatgaon Narishakti Farmer Producer Company Ltd.		Processing unit Rice mill	1	No			Yes			5	200							
Vanvaibhav Farmers Producer Company Ltd.		proposed process Rice mill	1	No			Yes			5	200							
Sangate Farmer Producer Company Limited		Trading	No															
Iconan Farmers Producer Company		Trading	No															
Pratidnya Women Farmer Producer Company		proposed process Rice mill	1	No			Yes			5	200							
Tarang Producer Company Limited		Processing unit Rice mill	4				Yes	31181		5	180	60						
Utkrushi Farmer Producer Company		proposed process Cleaning and grading	2	No			Yes			5	180							
Gurupushp Agro Producer Company Limited		Trading Banana trading												Yes		200	Yes	
Dnyanai agrotech and innovation export FPC		proposed process Chilly and Turmeric proc	0.5	No														
Amu Aakha Ek Se Farmers Producer Company Limited		Trading Aamchur trading	No				No							Yes		500	Yes	
AMOP Farmers Producer company		Trading Aamchur trading	No				No											
Vanashree Farmers Producer Company		Processing unit Cleaning and grading	1.5	Yes	100	200				12	200		50000	Yes		Yes		

Figure 16 Master sheet

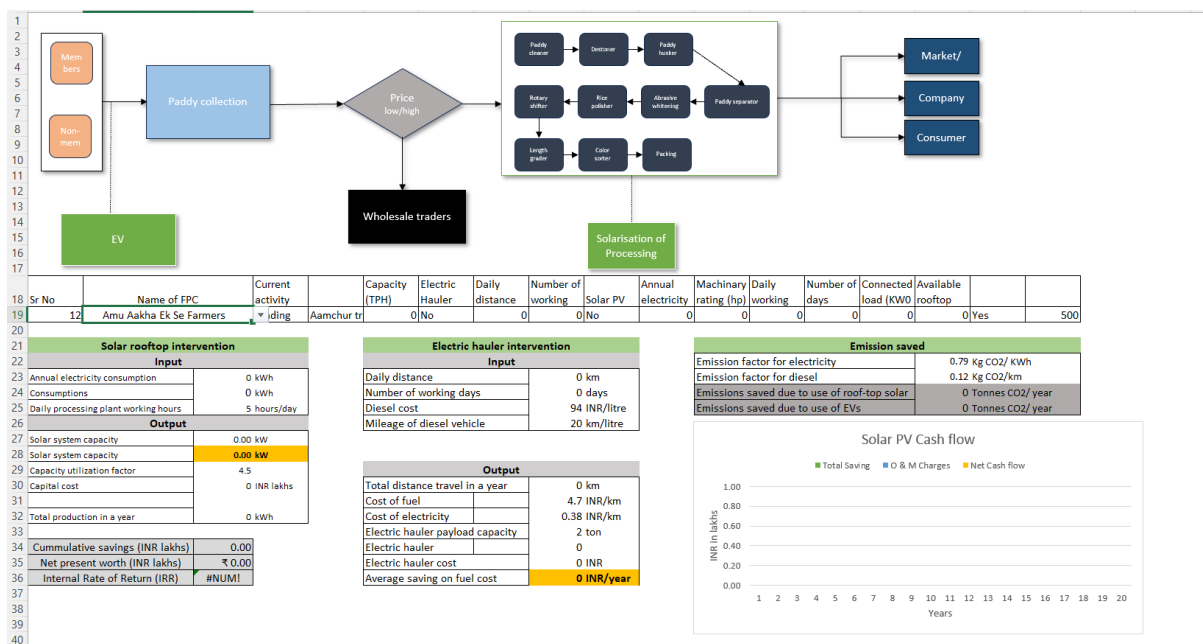


Figure 17 Dashboard

	A	B	C	D	E	F	G	H	I	J	K	L	
1	IRR/Payback period sheet for Solar PV system												
2	Project details						Financial details						
3	Installation capacity of plant			0 KWp			Capital cost of plant			0 Lakhs			
4	Average power generation per KWp			4.5 kWh/KWp/day			Proportion of loan			80% of total project cost			
5	Average power generated per year			0 kWh/year			Equity			0 Lakhs			
6	Reduction in power generation			0.50% YOY			Loan amount			0 Lakhs			
7	Expected minimum life of solar PV			25 years			Interest rate on loan			12% Per annum			
8	Saving per unit electricity consumption			10 INR/KWh			Repayment period			5 years			
9	Annual escalation in electricity tariff			3% YOY			Annual loan repayment amount			₹ 0.00 Annual EMI for 5 years (Lakhs)			
10	Annual operation and maintenance			1% of project cost			Accelerated depreciation			40% as per Sec 32 of IT act			
11	Yearly escalation in O&M			10% YOY			Tax rate			30%			
12	Detailed calculation and cash flow												
13	Years	Electricity cost saving			Tax Saving			O&M charges	Annual loan repayment	Net cash flow	Cummulative saving		
14		Electricity generation per annum	Electricity tariff	Savings on Electricity	Gross asset value	Accelerated depreciation	Tax saving due to AD					Total saving	
15		(KWh)	(INR/KWh)	(INR Lakhs)	(INR Lakhs)	(INR Lakhs)	(INR Lakhs)					(INR Lakhs)	
16		A	B	C=A*B	D	E=D*40%	F=E*30%					G=C+F	
17	0	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
18	1	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
19	2	0.00	10.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
20	3	0.00	10.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
21	4	0.00	10.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
22	5	0.00	11.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
23	6	0.00	11.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
24	7	0.00	11.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
25	8	0.00	12.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
26	9	0.00	12.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
27	10	0.00	13.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
28	11	0.00	13.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
29	12	0.00	13.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
30	13	0.00	14.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
31	14	0.00	14.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
32	15	0.00	15.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
33	16	0.00	15.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
34	17	0.00	16.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
35	18	0.00	16.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
36	19	0.00	17.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
37	20	0.00	17.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
38	Total			0.00			Chart Area			0.00			
39													
40	Payback period (Yrs)		#DIV/0!		Cummulative savings (INR lakhs)			0.00		Internal Rate of Return (IRR)		#NUM!	
41	Discounting factor		10%		Net present worth (INR lakhs)			₹ 0.00		BCR		#DIV/0!	

Figure 18 Solar PV calculation sheet

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TCO calculator							
Distance travelled per day		0 km		Proportion of loan		65%	of total cost of EV
Electric vehicle model		Mahindra Treo Zor DV		Equity		35%	of total cost of EV
Cost of selected EV		400000 INR		Loan amount		260000	INR
Battery capacity		7.37 kWh		Interest rate on loan		12%	Per annum
Vehicle range		80 km		Repayment years		5	Years
EV home charging tariff		10 INR/kWh		Annual repayment amount		₹ -72,126.53	
Cost of fuel		4.7 INR/km		Cost of Electricity		0.38 INR/km	https://evyatra.beeindia.gov.in/tco-calculator/
Diesel vehicle cost		300000 INR					
Mileage of diesel vehicle		20 INR					
Detail calculations and cashflow							
Years	Average savings on fuel cost	Annual loan repayment	Net cash flow	Cumulative saving			
	(INR lakhs)	(INR lakhs)	(INR lakhs)	(INR lakhs)			
	A	B	C=A-B				
0	0	0	-1.4	-1.4			
1	0.00	-0.72	-0.72	-2.12			
2	0.00	-0.72	-0.72	-2.84			
3	0.00	-0.72	-0.72	-3.56			
4	0.00	-0.72	-0.72	-4.29			
5	0.00	-0.72	-0.72	-5.01			
6	0.00	0.00	0.00	-5.01			
7	0.00	0.00	0.00	-5.01			
8	0.00	0.00	0.00	-5.01			
9	0.00	0.00	0.00	-5.01			
10	0.00	0.00	0.00	-5.01			
Total	0.00	-3.61	-3.61	-42.85			
Chart Area							

Figure 19 EV financial calculation sheet

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Solar dryer financials														
2	Input Information							Output Information							
3	Total raw material processed last year						kg/annum	Capacity of solar dryer				kg			
4	raw material processed in the current year (projected)						kg/annum	Number of units required							
5	Expected Increase in raw material						YOY	Cost of unit				INR			
6	Monthly processing requirement (Kg / month)							Total investment				INR			
7	Per kg value addition						INR/kg	Proportion of loan				65%	of total cost of EV		
8	Area available for unit (sq.m)						sq m	Equity				35%	of total cost of EV		
9	Annual operation and maintenance						1% of project cost	Loan ammount				#VALUE!	INR		
10	Yearly escalation in O&M						10% YOY	Interest rate on loan				12%	Per annum		
11								Repayment years				5	Years		
12								Annual repayment amount				#VALUE!			
13															
14															
15	Financials														
16	Years	Value addition	O&M	Annual loan repayment	Net cash flow	Cummulative saving	Net cash flow	Cummulative saving							
17		(INR)	(INR lakhs)	(INR lakhs)	(INR lakhs)	(INR lakhs)	(INR lakhs)	(INR lakhs)							
18															
19	0														
20	1														
21	2														
22	3														
23	4														
24	5														
25	6														
26	7														
27	8														
28	9														
29	10														
30															

Figure 20 Solar dryer financial calculation sheet

1	Solar cold storage financials																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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Figure 21 Solar based cold storage financial calculation sheet

Annexure C (Application for registration)

(On letter head of the company)

Form No.1

Application for Registration

To

Director General,
Maharashtra Energy Development Agency
2nd Floor, MHADA Commercial Complex,
Opp. Tridal Nagar,
Yerwada
Pune - 411006

Subject: Application for registration under the programmatic approach to 'Solarisation of Rice and Dal Mills' in Maharashtra.

Sir/Madam,

We, *(name of the company)* _____ intend to seek assistance on use of innovative renewable energy technologies under the programmatic approach to 'Solarisation of rice and dal mills' in Maharashtra.

Our application is submitted herewith along with essential documents, attached with this form to support the information given below. We request you to kindly sanction our proposal.

Date:

Yours faithfully,

Place:

(Signature of authorized signatory)

Enclosure:

1. Brochures from technology providers
2. Quotations/invoice from technology providers
3. Copy of PAN card of the company
4. Self-attested copy of Aadhar card of the authorized signatory
5. Self-attested copy of PAN card of the authorized signatory

Application form for Farmer Producer Organisations (FPOs)

I. General details

Sr no.	Particulars	Details
1	Name of the applicant FPO	
2	Address	
		District:
		State:
3	Contact person details (name and number)	
4	Contact person designation	
5	Registration details	Registration number:
		Registration date:
		Registration place:
6	Email ID	
7	PAN number of the FPO	
8	GST number of the FPO	
9	Total number of members of the organization	
10	Machinery details	Total number of machineries:
		Working months in a year:
		Working hours in a day:
		Total load in KW:
11	Key activities (Agriculture/ Horticulture/ Dairy/ Fisheries/ Poultry/ Other)	
12	Annual turnover (last three years)	Year 1 (20__-20__): Rs. _____ Year 2 (20__-20__): Rs. _____ Year 3 (20__-20__): Rs. _____
13	Net profit (last three years)	Year 1 (20__-20__): Rs. _____ Year 2 (20__-20__): Rs. _____ Year 3 (20__-20__): Rs. _____
14	Type of renewable technology applying for (Solar PV system, solar cold storage, solar dryer, etc.)	
15	Purpose of technology use (Irrigation, storage, processing. etc.)	
16	Proposed installation site	Address: Area (in sq. m):
17	Total estimated cost (technology and cost)	1. 2. 3. 4.
18	Are you seeking financial assistance through loan? (Yes/No)	
19	(If yes) Name of the Bank	

(On letter head of the company)

Undertaking

I am _____(Name of the authorized signatory) of
_____(Name of the company) having its registration
number _____and registered office at _____do hereby
solemnly affirm and declare/ undertake that all the information above is true and correct to the best
of my knowledge and belief and nothing material has been concealed there from.

Date:

Place:

Signature and seal of the applicant company

Annexure D (GRVC webinar series)

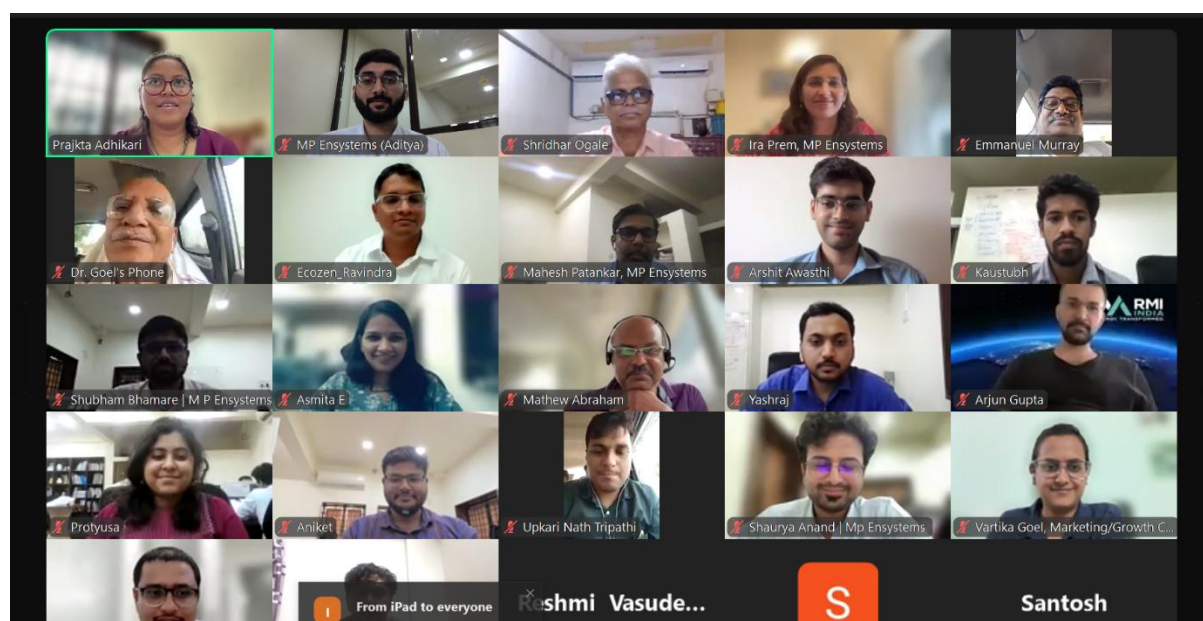
GRVC webinar series:

Recently a webinar titled "Opportunities in Western India to hasten deployment of renewable energy technologies at the farmgate, supporting rural development," was organized by MP Ensystems Advisory Pvt Ltd, focusing on the transformative potential of renewable energy in rural value chains. Approximately 55 registrations from diverse organizations and sectors.

The discussion highlighted the need for new technologies to address post-harvest processing gaps, improve farmer incomes, and reduce carbon emissions. The webinar emphasized the importance of collaborative efforts and innovative financing mechanisms to support the adoption of green technologies in rural areas.

Important points discussed:

1. **Post-Harvest Processing Gaps:** Despite increased agricultural yields, there are significant gaps in post-harvest processing and market linkages. Technology solution providers can play a crucial role in bridging this gap.
2. **Collective Investment:** With 80% of farmers holding small or marginal land, creating clusters of producers can facilitate investment in processing infrastructure, enhancing capacity and efficiency.
3. **Technology Challenges:** The availability, accessibility, and reliability of electricity and other technologies in rural settings are major challenges. The appropriateness and cost-effectiveness of these technologies must be considered, along with the capacity of local governance bodies to collaborate with innovators.
4. **Green Value Chains:** Integrating renewable energy technologies such as solar PV, solar dryers, and biomass-based systems can increase farmer incomes and make value chains more sustainable. Demonstrating successful case studies is key to overcoming skepticism about the cost and reliability of these technologies.
5. **Policy and Financing:** Developing alternative financing mechanisms, such as pay-and-use models and dovetailing costs with government subsidies, is essential to overcome financial barriers. Collaborative



efforts among technology providers, financial institutions, farmer organizations, and government support are necessary for creating sustainable rural value chains.