RE-EMPOWERED

Renewable Energy EMPOWERing
European & InDian Communities

Deliverable 6.2: Training activities report

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Horizon 2020 Grant Agreement № 101018420.

This project has received funding from the Department of Science and Technology (DST), India under Grant Agreement № DST /TMD/INDIA/EU/ILES/2020/50(c)

December 2024

Title		Document Version
Training activities report		2.0
Project number	**Project acronym**	**Project Title**
EU: 101018420 India: DST/TMD/INDIA/EU/ILES/ 2020/50(c)	RE-EMPOWERED	Renewable Energy EMPOWERing European and InDian communities
Contractual Delivery Date	**Actual Delivery Date**	**Type*/Dissemination Level***
30/06/2023	22/12/2024	R/ PU

Responsible Organisation	Contributing WP
IIT Delhi	WP6

*Type	*Dissemination Level
R Document, report	**PU** Public
DEM Demonstrator, pilot, prototype	**CO** Confidential, only for members of the consortium (including the Commission Services)
DEC Websites, patent fillings, videos, etc.	**EU-RES** Classified Information: RESTREINT UE (Commission Decision 2005/444/EC)
OTHER ETHICS Ethics requirement	**EU-CON** Classified Information: CONFIDENTIEL UE (Commission Decision 2005/444/EC)
ORDP Open Research Data Pilot	**EU-SEC** Classified Information: SECRET UE (Commission Decision 2005/444/EC)
DATA data sets, microdata, etc	

DOCUMENT INFORMATION

Current version: V2.0

Authors: Mahendra Kumar Gupta (IIT Delhi), Sujoy Jana (IIT KGP), Bikram Kumar Samanta (IIT KGP), Kostas Latoufis (ICCS-NTUA), Murugan Thangadurai (CSIR-CMERI), Santu Giri (CSIR-CMERI), Anirudh Kumar (CSIR-CMERI), Ravi Ranjan (IIT BBS), Srinivas Bhaskar Karanki (IIT BBS), Maria Valliou (ICCS-NTUA), Giorgos Gaitanakis (PROTASIS), Christian Nygaard Sørensen (BV), George Milionis (ICCS-NTUA), Athanasios Vassilakis (ICCS-NTUA), Sai Pavan Polisetty (Imperial), Thomas Joseph (Imperial), Aysegül Kahraman (DTU), Kostas Karanasios (DAFNI), Alkistis Kontou (ICCS-NTUA), Vasilis Mouzas (ICCS-NTUA), Panos Kotsampopoulos (ICCS-NTUA)

REVISION HISTORY

Revision	Date	Description	Author (partner)
V1.0	10/11/2024	Draft version prepared	IIT Delhi, all
V1.1	11/12/2024	Final draft for Review	IIT Delhi
V1.2	20/12/2024	Revision according to reviewer's feedback	IIT Delhi
V2.0	22/12/2024	Submitted version	IIT Delhi

REVIEWERS

Description	Name	Partner	Date
1	Jesús Rubio Conde	DELOITTE	14/12/2024
2	Ritesh Keshri	VNIT	15/12/2024
3	Georgia Saridaki	ICCS-NTUA	18/12/2024

COPYRIGHT STATEMENT

EXECUTIVE SUMMARY

This report outlines the training activities and workshops conducted as part of the RE-EMPOWERED project across the four demo sites: Ghoramara, Keonjhar, Bornholm, and Kythnos. These training programs were aimed at equipping demo operators, community leaders, and end-users with the necessary skills to operate, maintain, and maximize the benefits of the renewable energy systems installed in these areas. Two main tracks of training programs have been developed: an awareness program for the local community on the energy systems and a training program for the demo operators on the RE-EMPOWERED developed tools and commercial equipment.

The training for the demo operators focused on the operation and maintenance of different renewable energy systems, such as solar PV, wind energy, biogas, and biomass, along with the innovative ecoTools. These tools are integrated with the installed systems to optimize operations and energy use. Training activities were tailored to the specific needs and the particularities of each demo site to ensure effective adoption and operation of the technologies.

Key outcomes of the training included the ability of demo operators to perform routine maintenance, address technical issues, and engage community members in efficient energy use practices. The programs also emphasized raising awareness among end-users about renewable energy, promoting energy conservation, and fostering responsible use of the advanced microgrid systems.

Keywords:

Renewable energy systems, Training programs, Training activities, Education, Workshop, Energy conservation, System maintenance, Demo sites, Ghoramara, Keonjhar, Bornholm, Kythnos, Sustainable energy, Local energy system, Local community

TABLE OF CONTENTS

List of Figures

List of Tables

Acronyms

Acronym	Description
AC	Alternate Current
API	Application Programming Interface
APK	Android Application Package
BLDC	Brushless Direct Current
BESS	Battery Energy Storage System
CAD	Computer Aided Design
CNC	Computer Numerical Control
D	Deliverable
DC	Direct Current
DER	Distributed Energy Resources
DHN	District heating network
DR	Demand Response
DST	Department of Science and Technology
DWETERI	Design and Development of Locally Manufactured Wind Turbines for Empowering Rural India
EC	Energy Community
EMS	Energy Management System
EV	Electric Vehicle
FAQ	Frequently asked questions
h	Hour
HTTP	Hypertext Transfer Protocol
HVAC	Heating, Ventilation, and Air Conditioning
IEEE EPS	IEEE Electronics Packaging Society
IEEE PES	IEEE Power & Energy Society
IoT	Internet of Things
IMC	Internal Monitoring Committee
kg	Kilogram
kVA	Kilovolt ampere
kW	Kilowatt
kWh	Kilowatt-hour
kWp	Kilowatt peak
LED	Light-emitting diode
LMSWT	Locally manufactured small wind turbine
m	Meter
MW	Megawatt
MPPT	Maximum Power Point Tracking
MQTT	Message Queuing Telemetry Transport
Nº	Number

Acronym	Description
NSAC	National Scientific Advisory Committee
O&M	Operation and Maintenance
PDF	Portable Document Format
PPC	Public Power Corporation
PPE	Personnel Protective Equipment
PU	Public
PV	Photovoltaics
Q&A	Questions and Answers
R	Report
REC	Renewable Energy Community
RES	Renewable Energy Sources
RURERG	Rural Electrification Research Group
s	Second
SCADA	Supervisory control and data acquisition
SMB	String Monitoring Box
SMU	String Monitoring Unit
THI	Technische Hochschule Ingolstadt
V	Version
VPN	Virtual Private Network
WP	Work Package

1. Introduction

1.1 Purpose and scope of the document

D6.2 Training Activities Report summarizes the different training and education programs organized as part of the RE-EMPOWERED project. This project installed and demonstrated renewable energy systems and advanced solutions in the four demo sites: Ghoramara Island, Keonjhar microgrid, Bornholm Island and Kythnos Island (which also includes Gairouromantra microgrid). Each site is equipped with renewable energy solutions such as solar photovoltaics (PV), wind energy, biogas and biomass plants, and the innovative tools, namely the ecoToolset.

The purpose of these training programs was to ensure that demo operators, community leaders, and end-users gained the necessary knowledge and skills to effectively operate and maintain the renewable energy systems. Furthermore, the training sought to raise awareness within the local communities about the benefits of renewable energy and demand side management, and foster energy conservation practices. Two main tracks of training programs have been developed: an awareness program for the local community on the energy systems and a training program for the demo operators on the RE-EMPOWERED developed tools and commercial equipment which initiated a wide range of activities in the demo sites.

This report provides a detailed overview of the training activities conducted at each training site, including assessments of training needs, training methodologies, content, and participant feedback. It also highlights the outcomes of the training programs and the positive impact they have had on the sustainable management of local energy systems.

Ultimately, the document serves as a record of the efforts made to empower local communities and operators with the knowledge and tools necessary for the long-term success of the installed renewable energy and demand side management systems.

Comprehensive manuals and guides (installation processes, safety protocols, and maintenance practices) that trainees can refer to during and after the training are documented in Deliverable “6.3 Guidance documents”.

1.2 Structure of the document

Chapter 2 provides a detailed report of the training programs at: Ghoramara Island, Keonjhar microgrid, Bornholm Island, and Kythnos Island (including Gaidouromantra microgrid). First an assessment of training needs tailored to stakeholders, such as demo operators and community leaders, is performed. Each site is addressed in subsections covering a brief description of the installed energy systems, the awareness programs to educate the local energy community and the training programs focused on the operation, maintenance, and troubleshooting of systems and tools.

Chapter 3 introduces additional educational/training activities and highlights the general training provided for the ecoTools through online workshops, ensuring stakeholder’s understanding of the architecture and integration of the ecoTools.

The Conclusions include a summary of the outcomes of the training activities and their impact on fostering sustainable energy use and community empowerment.

Finally, the report includes 2 Annexes providing detailed guidelines for training and awareness programs. These include training guidelines for each commercial equipment and tool exclusively for the Indian demo sites, as these locations required the installation of complete energy systems, due to lack or limited previous electricity infrastructure. Both commercial energy equipment and RE-EMPOWERED-developed tools were installed at the Indian sites, needing for extensive training materials for their operation and maintenance. In contrast, the European demo sites already had energy systems in place, and the focus was mostly on the optimization of these systems using the RE-EMPOWERED-developed tools. Consequently, the training activities at the European demo sites cover mainly the developed tools and are included within Chapter 2.

2. Training sites and training activities

2.1 Assessment of training needs in the demo sites

The assessment of training needs for the demo sites (Ghoramara, Keonjhar, Bornholm, and Kythnos) focused on identifying stakeholder roles and tailoring training to their responsibilities. Demo operators, pivotal in system maintenance and troubleshooting, received detailed training on inverters, battery banks, and solar panels etc. Key topics included diagnostics, repair techniques, routine maintenance, and spare parts management, along with specific tasks such as corrosion inspection and data interpretation. End-users were guided on safety, and energy conservation. For Bornholm, emphasis was placed on training households and public facilities to importance of optimize district heating systems and use the ecoCommunity app. The Kythnos assessment highlighted creating user manuals and guides (for installed hardware and RE-EMPOWERED developed ecoTools), installation processes, safety protocols, and maintenance practices.

Table 2-1 Training assessment demo site-wise

Demo Site	Key Stakeholders	Training Topics	Additional Notes
Ghoramara	Demo Operators	System maintenance, troubleshooting, diagnostics, repair, and spare parts management	None
	End-Users	Safety precautions, energy conservation, minor troubleshooting	Awareness on solar/wind limitations and safe operations
	Community Leaders	Project management, community engagement, sustainability planning	Promoting local energy system awareness
Keonjhar	Demo Operators	System maintenance, troubleshooting, diagnostics, repair, and spare parts management	None
	End-Users	Safety precautions, energy conservation, minor troubleshooting	Awareness on solar/wind limitations and safe operations
	Community Leaders	Project management, community engagement, sustainability planning	Promoting local energy system awareness
Bornholm	Households/Public Facilities	ecoCommunity app usage, App navigation,	Importance of district heating optimization

Kythnos/Gaidouromantra	Demo Operators	operation, safety, maintenance, ecoTools usage	supported by comprehensive manuals
	End-Users	Safety, ecoTools usage	None

2.2 Training material development for the demo sites

The comprehensive manuals and guides (installation processes, safety protocols, and maintenance practices) that trainees can refer to during and after the training are documented in Deliverable 6.3 “Guidance documents”. The Guidance Documents for the RE-EMPOWERED project outlines detailed guidelines to manage, operate, and maintain renewable energy systems deployed across diverse demonstration sites in Europe and India. This document provides structured insights into the technical and operational aspects of renewable systems installed at various locations, including Ghoramara Island and Keonjhar in India, Bornholm in Denmark, and Kythnos Island in Greece. The document also included the developed RE-EMPOWERED ecoTools, which are innovative technologies designed to optimize energy management, promote demand-side participation, and enhance community engagement.

2.3 Ghoramara Island

2.3.1 General description about installed energy systems

Ghoramara Island is located approximately 92 km south of Kolkata, in the Sundarban Delta Complex of the Bay of Bengal in India.

The island is comprised of five different villages. The nearest mainland is Kakdwip which is approximately 5 km away and takes around 1 hour through diesel operated boats. Around 3,000 residents live in Ghoramara Island, in over 1,100 houses.

The island is isolated from connection to the utility grid. A total 160 kW microgrid system is installed in Ghoramara Island. Out of the total 160 kW, 150 kW are installed in the form of solar PV modules, with an additional 10-kW wind turbine.

Along with the renewable generation, a battery system is used. Additionally, to the above-mentioned units and apart from ecoTools (which are listed below), two electric three-wheelers, a solar powered high-mast system, with 4 LED lamps of 40 W each, an electric boat, smart meters, a charging station with local solar PV and BESS, a remote monitoring unit and load limiter, are installed.

RE-EMPOWERED tools at Ghoramara Island are listed below:

- ecoMicrogrid.
- ecoConverter.
- ecoVehicle.
- ecoDR.
- ecoMonitor.
- ecoPlatform.

- ecoResilience.
- ecoCommunity.

2.3.2 Awareness program for the local energy community on the energy systems

This program aims to educate the community and the concerned stakeholders about the local energy systems, and best practices for utilization.

Target audience: General public of the local community, local administration, and operator.

Program objectives:

The objectives are to raise awareness about local energy systems and their benefits, educating users on the limitations of solar and wind power generation (due to irradiance and wind velocity variation) and the importance of responsible consumption. Another key objective is to identify individuals interested in further learning about local energy systems, encouraging their engagement with the community energy infrastructure. The program also aims to educate participants about the proper operation of the microgrid infrastructure, providing clear guidelines on “do’s” and “don’ts” for property protection.

Methodology:

The methodology involves identifying local facilitators who are familiar with the community and its language to ensure effective communication. Trainings of energy systems were conducted using local language and analogies that were relevant to the community context, making the concepts more relatable. The sessions were highly interactive, using minimal text and relying heavily on visuals to enhance understanding. Active participation was encouraged through questions, discussions, and role-playing to engage the audience and reinforce key learning points. In Annex A, detailed content and guidelines are included.

2.3.3 Training program for the demo operators on the RE-EMPOWERED developed tools and commercial equipment

This program is designed to train recruited technical personnel (demo operators) on the local energy systems, hardware, and software necessary for the proper operation and maintenance (O&M) of both the demo sites.

Target audience: Local demo operator.

Program objectives:

- Training of locally recruited technical personnel (demo operators) on local energy systems (hardware and software) to ensure the proper operation and maintenance (O&M) of the demo site.

Methodology:

The methodology for training to recruited technical personnel involves a comprehensive approach to ensure a deep understanding of the energy systems, RE-EMPOWERED tools, and commercial equipment. This is achieved by providing training sessions conducted by demo leaders, tool developers, and suppliers who are highly acquainted with the specific technologies being implemented. These sessions are structured to offer a blend of theoretical instruction, and practical knowledge, ensuring that local operator gains practical technical skills.

Theoretical sessions cover key topics such as system design, operation, and safety protocols, providing a solid foundation for understanding the principles behind the equipment. Practical trainings follow, allowing technical personnel to look into the actual operation of tools and equipment under real-world conditions. Interactive sessions, including FAQs, and the promotion of an open dialogue between trainers and operators, ensures that all questions are addressed.

In addition to these activities, during the training, troubleshooting guides and user manuals will be given to the participants (ongoing resources). The inclusion of training videos provides visual reinforcement of key concepts, while safety drills are conducted to prepare technical personnel for emergency situations.

Post-training support will be a critical aspect of the methodology, ensuring that technical personnel continues to have access to guidance and assistance as they apply their training in the field. This will include bilateral communications, regular follow-up sessions, and access to technical support from the suppliers and developers.

This comprehensive methodology ensures that technical personnel are not only well-trained but also supported in their roles, enhancing their capacity to maintain and troubleshoot the energy systems effectively. Please see Annex B for detailed content and guidelines.

These training activities will be implemented according to the guidelines provided and the availability of the tool developer/supplier.

A. Training in commercially installed equipment by the equipment supplier:

The training program for demo operators focused on familiarizing them with the basic commercial equipment. Key training sessions included detailed instruction on the Solar PV system, inverter, battery storage, and solar charge controllers, along with an overview of the electrical connection diagram and proper operation and maintenance (O&M) guidelines (see Figure 1).

Figure 1. Training on inverter and battery system by vendor to the demo operator.

Training on RE-EMPOWERED developed ecoTools by tool developer

B. ecoMicrogrid: Giorgos Gaitanakis (PROTASIS) explained to field assistants and IIT KGP the use of ecoMicrogrid in the Ghoramara, during a physical visit. The use of the ecoMicrogrid tool and its navigation of user interface of the SCADA in case of an accident (power shutdown, or a user accidentally logs out of the program) were explained, among other topics.

Figure 2. Training on ecoMicrogrid by PROTASIS during physical visit at Ghoramara

C. ecoDR: Dr. Santu Giri from CSIR-CMERI elaborated on the functionalities of digital smart meters, emphasizing sensor operations, energy measurement, data transmission protocols, and timestamped energy management, along with controlling non-critical loads in an eco-microgrid environment (see Figure 3).

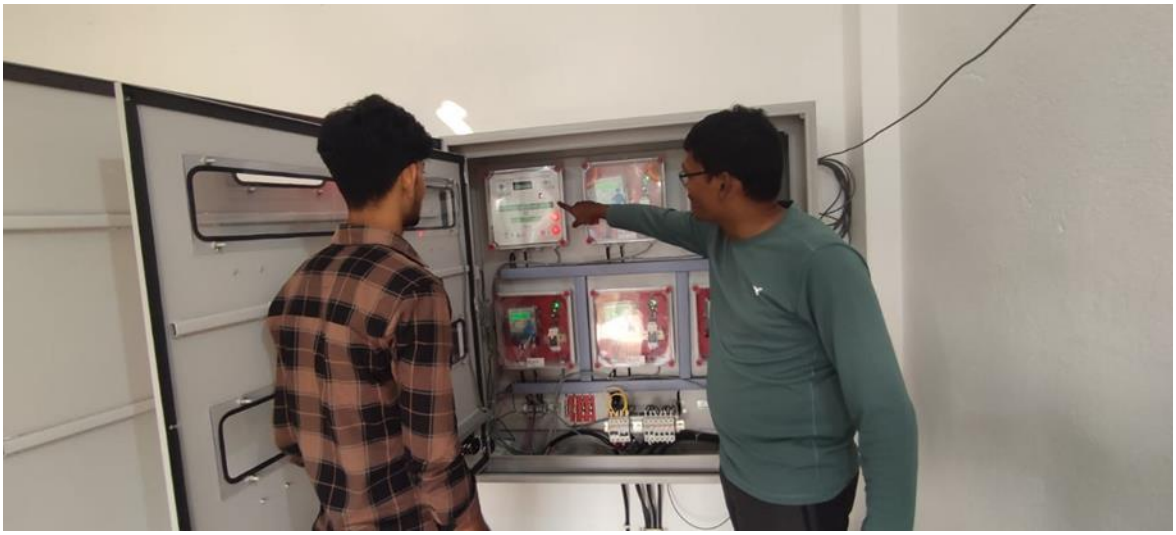


Figure 3. Training on eco-DR by CSIR-CMERI to demo operator.

D. ecoMonitor and ecoVehicle**:** Additional training covered the ecoMonitor tool for analyzing air quality data, integrated with ecoPlatform for comprehensive insights (Figure 3). The session also delved into the ecoVehicle tool, with demonstrations on troubleshooting, safety precautions, and energy monitoring during charging (Figure 4). Each training session provided critical knowledge for efficient operation and maintenance of these systems.

Figure 4. Training program of ecoMonitor by CMERI to demo operator.

Figure 5. Training of ecoVehicle and charging station to operator by CMERI and vendor.

E. ecoCommunity: The training on ecoCommunity for Ghoramara was delivered on-site by Maria Valliou (ICCS-NTUA) to Sujoy Jana (IIT KGP), and Subhojit Das (IIT KGP), using digital tools and the help manual. The relevant modules of ecoCommunity app and the different levels of access (user, manager, administrator) were explained. They will then train the ecoCommunity administrator and the users after getting installed the app on their smartphones.

Figure 6. Training workshop on ecoCommunity by ICCS-NTUA, during physical visit at Ghoramara

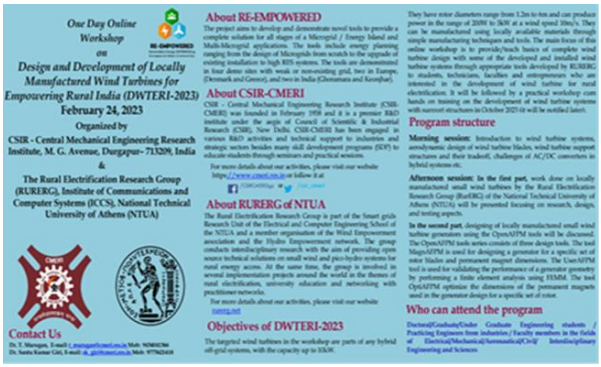
F. EcoResilience:

Training on ecoResilience included a set of activities which are described below:

i. Online workshop on design of small wind turbines for empowering rural India:

A one-day online workshop on “Design and Development of Locally Manufactured Wind Turbines for Empowering Rural India (DWTERI-2023)” was organized by CSIR-CMERI (India) and the Rural Electrification Research Group (RURERG) of ICCS-NTUA on February 24th, 2023, in the framework of RE-EMPOWERED. About 59 participants, mostly Phd and undergraduate engineering students, industrial engineers, university faculty members in the fields of electrical,

mechanical, and aeronautical engineering registered and attended the workshop. The speakers covered various aspects of small wind turbine systems, starting from its fundamental aspects, modelling, design, development, and so on (Figure 7).



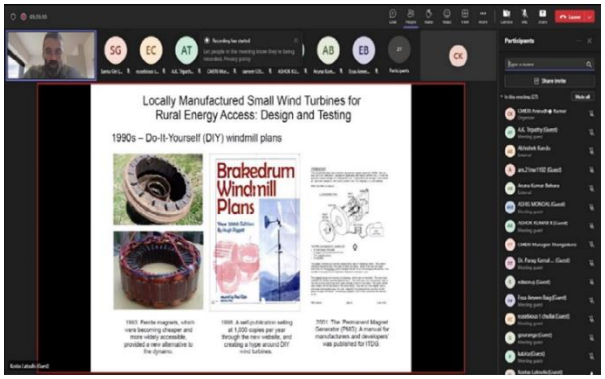


Figure 7. Joint online workshop on locally manufactured wind turbines

ii. Physical workshop on small turbine manufacturing at CSIR-CMERI Durgapur:

CSIR-CMERI, Durgapur, in collaboration with the Rural Electrification Research Group (RURERG) of ICCS-NTUA, organized a Theory and Hands-on Training Workshop as part of the RE-EMPOWERED project from September 17th to 21st, 2024. During the weeklong workshop, electrical and mechanical engineering students and CSIR-CMERI staff collaborated in teams to construct a small wind turbine from scratch, utilizing basic tools, materials, and fabrication methods. The blades were crafted from wood, the mounting frame from steel, and the tail from plywood. Copper wire was used for the coils, while ferrite magnets encased in resin formed the stator and rotor of the generator (Figure 8).

RE-EMPOWERED project partners from IIT Delhi and IIT Kharagpur also participated in the workshop. The locally manufactured small wind turbine will be installed in Ghoramara Island in the coming weeks.

The main technical data of the manufactured small wind turbine are listed below:

- Rotor Diameter 4.3 m.
- Rated Power 3 kW.
- Rated Wind Speed 10 m/s
- Hub Height 18 m.
- Mean Wind Speed 4.3 m/s.
- Annual Energy Production 4,450 kWh/year.

Figure 8. Locally manufactured generator and small wind turbines at CMERI during visit of ICCS-NTUA

iii. Installation activity of 2.5 kW wind turbine at Ghoramara island:

The existing monopole tower structure is brought down by CSIR-CMERI staff and Ghoramara locals to remove the damaged wind turbine systems (Figure 9). The monopole structure is easily brought down using a winch and few persons as it is usually installed with gin-pole arrangement. The probable/possible locations for the guy wires from the monopole base of the locally manufactured 3 kW wind turbine system's monopole foundation is finalized in consultation with ICCS-NTUA. The preparation of the foundations was delayed due to many constraints in the

demo site including administrative approvals, tendering etc. Modification of the monopole and foundation are being performed. The locally made wind turbine will be installed in early 2025.

Figure 9. Removing the old and damaged wind turbine systems

2.3.4 Outcomes

Training activities that took place at Ghoramara demo site have been very helpful and stimulated the interest of local residents, demo operators and administrators. The commercial equipment has been thoroughly presented by the supplier. RE-EMPOWERED tools functionalities have been explored with the support of the tool leaders through real time demonstrations in the pilot sites. The strong collaboration between European and Indian partners are essential for the exchange of knowledge and best practices regarding future challenges related to the tools operation and maintenance.

2.4 Keonjhar Microgrid

2.4.1 General description about installed energy systems

Kanheigola, Nola and Ranipada are small Villages/hamlets in Harichadanpur-Tehsil reserve forest in Keonjhar District of Odisha State, India. It is located 54 km towards South from District headquarters Keonjhar and 180 km from state capital Bhubaneswar.

These villages are not connected to the main utility grid. A total of 77 kWp (Kanheigola- 30 kWp, Nola -25 kWp and Ranipada- 22 kWp) of solar PV installations are supplying electricity to approximately 1,000 villagers, living in 306 households. These solar PV installations are completely isolated and were commissioned by the Odisha Renewable Energy.

A new 30 kWp solar PV plant, a 10 kWp biomass plant, and a 10 kWp biogas plant have been commissioned during the RE-EMPOWERED project, along with the construction of a control room housing a solar MPPT controller, inverter, and a 180 kWh BESS, while two EV loaders with charging infrastructure have also been deployed to the site. The newly installed system is integrated with the existing 22 kWp energy system (Figure 10).

The following ecoTools have been installed in the Keonjhar Demo Site.

- ecoMicrogrid.
- ecoVehicle.
- ecoDR.
- ecoPlanning.
- ecoCommunity.
- ecoPlatform.

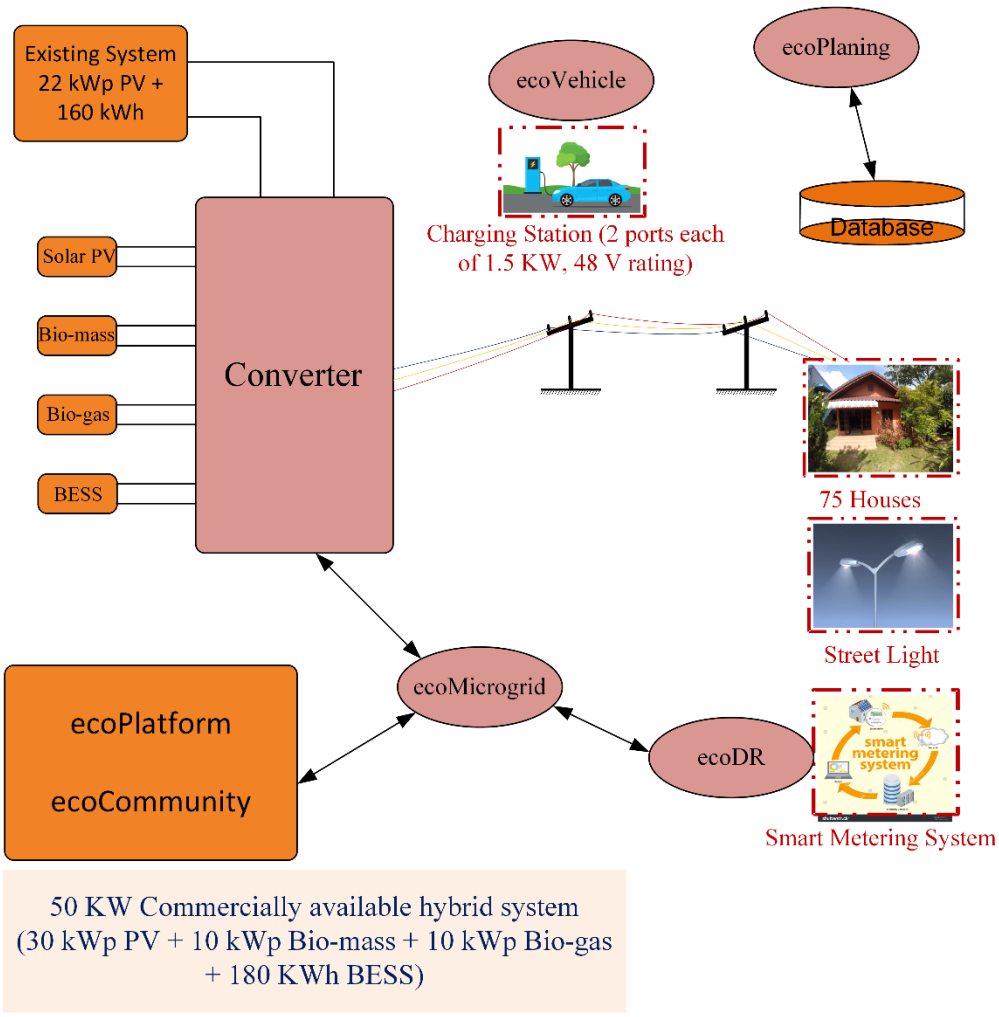


Figure 10. Keonjhar demo site.

2.4.2 Awareness program for the local energy community on the energy systems

This program aims to educate the community and the concerned stakeholders about the local energy systems, and best practices for utilization.

Target audience: Local community, local administration, and operator.

Program objectives:

The objectives are to raise awareness about local energy systems and their benefits, educating users on the limitations of power generation and the importance of responsible consumption. Another key objective is to identify individuals interested in further learning about local energy systems, encouraging their engagement with the community's energy infrastructure. The program also aims to promote proper care and respect for the microgrid infrastructure, providing clear guidelines on the “do’s” and “don’ts” for property protection.

Methodology:

The methodology involves identifying local facilitators who are familiar with the community and its language to ensure effective communication. Trainings of energy systems were conducted using local language and analogies that were relevant to the community context, making the concepts more relatable. The sessions were highly interactive, using minimal text and relying heavily on visuals to enhance understanding. Active participation was encouraged through questions, discussions, and role-playing to engage the audience and reinforce key learning points.

A. Orientation of all installed energy systems to the community:

Mr.Prusty (local operator) provided an overview of solar power technology, covering its operation, how it generates electricity, and the limitations associated with it. He explained the role of battery storage systems, detailing the process of storing energy during the day for later use, as well as important do's and don'ts for users (Figure 11). The operator emphasized the importance of responsible energy consumption, advising users to switch off electrical appliances when they are not in use to conserve power, especially since solar energy is primarily generated during daylight hours. Additionally, the significance of protecting solar equipment from vandalism or accidental damage was highlighted, along with the need to report any suspicious activity. Contact information for reporting such incidents should be clearly displayed in the area.

Figure 11. Demo operator and villagers during awareness program for solar panel and BESS

The operator also discussed biogas and biomass technology, explaining how biomass feedstocks, such as rice husk, are converted into gaseous fuel using a gasifier. This fuel is then used in a gas engine to generate electricity (Figure 12). Furthermore, the operator provided insight into the importance of e-rickshaws and their charging stations, underscoring the role of renewable energy in powering transportation (Figure 12).

Figure 12. Operator and villagers with biomass, biogas, engine and charging facilities

Conventional smart meters have been installed in homes and commercial locations, and the local community has been trained on how to monitor and measure their energy consumption. These smart meters are integrated with remote monitoring systems, allowing energy use data to be tracked both locally and remotely.

It was explained that if energy consumption surpasses a predefined threshold, the smart meter activates a relay to cut off the connected load using the installed load limiter. This system was also explained to villagers, emphasizing its importance in preventing the overconsumption of stored electricity.

Figure 13. Operator and villagers with remote monitoring system.

This comprehensive training aimed to explain participants about the efficient use of renewable energy, the significance of protecting energy systems, and ways to promote sustainable practices in their daily lives. Please see Annex A for detailed content and guidelines.

2.4.3 Training program for the demo operator on the RE-EMPOWERED developed tools and commercial equipment

This program is designed to train recruited technical personnel (demo operators) on the local energy systems, hardware, and software necessary for the proper operation and maintenance (O&M) of both the demo sites.

Target audience: Local demo operator.

Program objectives:

- Training of locally recruited technical personnel (demo operators) on local energy systems, hardware, and software to ensure the proper operation and maintenance (O&M) of the demo site.
- To ensure the smooth operation of the microgrid plant.

Methodology:

The methodology for training to recruited technical personnel involves a comprehensive approach to ensure a deep understanding of the energy systems, tools, and equipment. This is achieved by providing training sessions conducted by demo leaders, tool developers, and suppliers who are highly acquainted with the specific technologies being implemented. These sessions are structured to offer a blend of theoretical instruction, and practical trainings, ensuring that local operator gain technical skills required for effectively operating and maintaining the systems.

Theoretical sessions cover key topics such as system design, operation, and safety protocols, providing a solid foundation for understanding the principles behind the equipment. Please see Annex B for more detailed content and guidelines.

A. Training on commercially installed equipment by the equipment supplier:

The supplier conducted a comprehensive training of the solar PV system, hybrid inverter, battery storage system and other components to the recruited demo operator. The operator was introduced to the setup and functioning of these components, including controllers and distribution boxes. The electrical connection diagram was explained, showcasing the cable routing and associated accessories (Figure 14).

Figure 14. Training on the solar system, inverter, battery system, and other components.

Additionally, the biomass and biogas plants were shown, illustrating the operation of the gasifier, engine, and generator (Figure 15).

Figure 15. Training on the biomass and biogas plants with the gasifier, engine, and generator

Instructions were provided for the remote monitoring system, with an emphasis on data transfer processes, and the monitoring of power generation and energy consumption with European partners to operator (Figure 16.

Figure 16. Training on the remote monitoring system for power generation and energy consumption data

The technical personnel responsible for maintenance received training on the energy systems, including a training of all energy vectors under load conditions. Operators were trained to maintain the system performance, maintenance activities. Additionally, common issues and troubleshooting techniques were explained, and routine maintenance procedures were outlined to ensure smooth operation.

Safety protocols and emergency procedures were a major focus of the training. The supplier highlighted the installation of safety labeling, including danger boards and restricted area signs. The control room was equipped with fire extinguishers, and the battery room was fitted with exhaust fans for safety purposes. A dedicated module on safety procedures was provided, covering electrical safety protocols and the handling of large or heavy components.

In conclusion, the training activities ensured that the demo operators were well-prepared to manage and maintain the energy systems effectively. This comprehensive training, which covered system operations, safety protocols, and documentation procedures, will contribute to the long-term sustainable operation of the microgrid plant.

The training activities in RE-EMPOWERED developed ecoTools by tool developer in Keonjhar involve:

B. ecoMicrogrid: Giorgos Gaitanakis (PROTASIS) explained to Uttam Kumar Prusty (field assistant of the demo site and administrator of ecoCommunity), Ravi Ranjan, from IIT-BBS as well as some other persons relevant to the site how to use the ecoMicrogrid tool and how to access the main screen of the SCADA in case of an accident (power shutdown, or a user accidentally logs out of the program) (see Figure 17).

Figure 17. Giorgos Gaitanakis (PROTASIS) explaining ecoMicrogrid to operator, during physical visit at Keonjhar

C. ecoCommunity: Maria Valliou from ICCS-NTUA explained to Ravi Ranjan (IIT-BBS), using the relevant deliverable, the help manual of Imperial and some screenshots, how the relevant modules of ecoCommunity work and the different levels of access (user, manager, administrator). He will then train the ecoCommunity administrator and the users (see Figure 18).

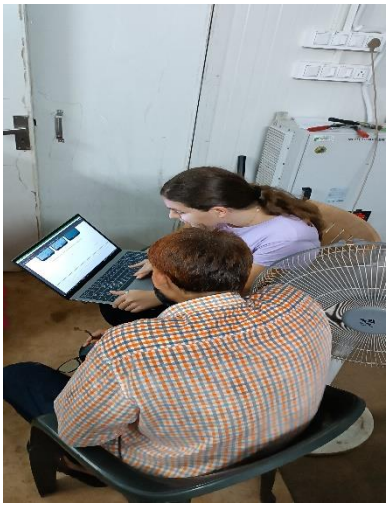


Figure 18. Maria Valliou (ICCS-NTUA) explaining ecoCommunity to IIT BBS, during physical visit at Keonjhar

D. ecoDR:

CSIR-CMERI has provided a detailed training to the operator on how to monitor and measure energy consumption using these devices (Figure 19). The data collected from smart meters offer numerous benefits, such as enabling remote monitoring and control of energy use. When energy consumption exceeds a predefined threshold, the smart meter triggers a relay to disconnect the associated load.

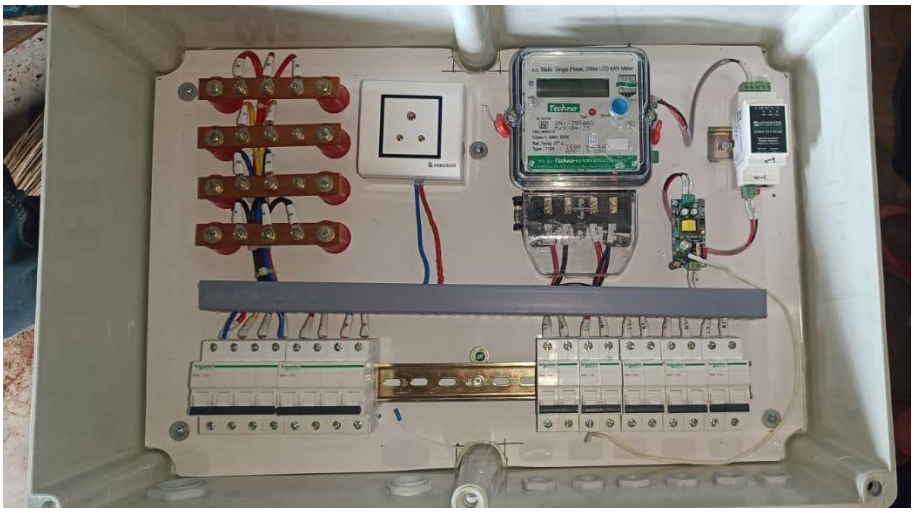


Figure 19. The customized smart meter by CMERI.

E. ecoPlanning

During the 2-week visit of Srinivas Karanki (IIT BBS) at the Electric Energy Systems Laboratory of ICCS-NTUA, a live demonstration and hands-on training session was performed by ecoPlanning tool leader, George Milionis on the 1st of July 2024. The session included the real-time creation of demand and peak models, along with the development of the electrical system model. ecoPlanning offline capabilities, independence from real-time measurements, and VPN access facilitated the execution of different scenarios during the demonstration, which were followed by a detailed discussion of the results.

F. ecoVehicle

The CSIR-CMERI team provided training to e-rickshaw drivers (see Figure 20). The electric three-wheeler's powertrain has been upgraded with a 2 kW BLDC motor, a compatible controller, and a rear axle capable of carrying up to 500 kg, making it suitable for the hilly regions at the Keonjhar Demo Site. The vehicle will be used for transporting passengers (up to six people) and goods at reduced speeds in these areas. To support ecoVehicle charging, VNIT procured a charging station (see Figure 21), offering a convenient and efficient solution for charging multiple vehicles at a single location.

Figure 20. CMERI team providing training to e-rickshaw drivers.

Figure 21. ecoVehicle charging station.

2.4.4 Outcomes

The program effectively raised awareness about local energy systems, training users on power generation limitations and promoting responsible electricity use. It emphasized the efficient operation of microgrid infrastructure, provided guidelines for protection, and encouraged energy conservation through efficient use of the devices. The program also stressed the importance of maintaining solar panels and preventing damage, fostering a sense of ownership and responsibility within the community for the long-term success of the microgrid.

Training activities equipped demo operators with essential skills for operating and maintaining local energy systems. Operators gained knowledge of system installation, solar PV, battery integration, and daily operations, with hands-on sessions in troubleshooting, diagnostics, and safety protocols. They learnt to monitor system performance, detect faults using data loggers, and maintain thorough records of system performance and maintenance activities. The training covered all relevant components, including solar PV systems, electric vehicles, and charging stations. Post-training support ensured that operators were well-prepared to manage the systems, contributing to the sustainable operation of the microgrid.

2.5 Bornholm Demo Site

2.5.1 General description about installed energy systems

The tools to be deployed at Bornholm island are listed below:

- ecoDR
- ecoMonitor
- ecoEMS
- ecoPlatform
- ecoCommunity

The overall objective of installing the ecoTools in Bornholm is to demonstrate energy flexibility through sector coupling of the electricity grid and district heating system.

Equipment to be installed:

- IoT gateways and district heating consumers for control of district heating units.
- Small electric heater for ecoDR (control of electric consumption).

The IoT gateway is a device that allows for two-way data exchange between the district heating consumer and producer. The device also connects to the district heating unit which is located in every household and will enable the functionality to control the unit. The software, built into the Neogrid device, optimizes the district heating consumption based upon predictive algorithms.

2.5.2 Awareness program for the local energy community on the energy systems

This program aims to educate the community and the concerned stakeholders about the local energy systems, and best practices for utilization.

Target audience: Project participants (district heating customers), training site operator.

Program objectives:

- Educate the community on the benefits and proper use of developed and integrated ecoTools.
- Understand and address community concerns regarding renewable energy.
- Encourage project participation from project participants through ecoCommunity.
- Guidance for optimal regulation and control of district heating systems to minimize energy consumption and proper use of the provided energy.

Methodology:

- Focused training on newly installed software and equipment.
- Meeting with all participants and a direct introduction to installed hardware, ecoCommunity and project purpose.
- Conduct group meetings with interactive sessions where project participants can ask questions and engage in discussions.

- As part of the learning module, a field trip to the heat plant is included, for a complete understanding of the energy system.
- Demonstration of the ecoCommunity mobile app that provides information and interactive tutorials on renewable energy.
- Provision of training on installed renewable energy equipment in houses and Neogrid IoT devices.
- Conduct live training and Q&A sessions on monitoring energy consumption, understanding data from smart meters and using ecoTools.
- Offer troubleshooting support and contact information for system assistance.

Implemented training program for residents of Bornholm on following solutions:

A. IoT Devices:

Trainer: Demo operator.

Troubleshooting: Contact information for assistance, if the system is not properly working has been given to the participants.

Content:

a) How to extract data related to their consumption.
b) Understanding temperature and flow volume data.
c) Overview of ecoCommunity tool fuctionalities.
d) Normal operation of system.
e) Clarification of when ecoEMS operates and when its hibernating and the difference between the two operation modes.
f) Safety precautions and whom to contact for device maintenance and issues.

B. ecoCommunity tool:

Installation of ecoCommunity and introduction to the training activities was carried out in December 2024. The ecoCommunity app on consumer and demonstration site administrator was installed based on the provided guidelines. Furthermore, the application was presented during the consortium demo site visit in 2024.

More information on the ecoCommunity training can be found in Section 2.5.3. The implementation schedule of the training activities is shown below.

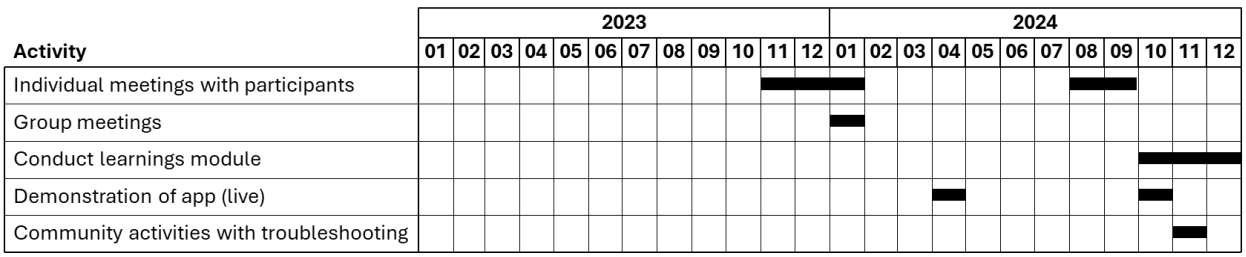


Figure 22. Implementation schedule of the training programme for the Bornholm Demo Site

2.5.3 Training program for the demo operators on the RE-EMPOWERED developed tools and commercial equipment

This program is designed to train technical personnel (demo operators) on the local energy systems, hardware, and software necessary for the proper operation and maintenance (O&M) of the demo site.

Implementation Schedule:

Introduction to the system, and operation of the IoT system (outside of training) have been carried out. Another visit to project participants (citizens, church and pool administrators) took place on week 38 (September '24).

Figure 23. Location of community event, Gudhjem Swimming Pool that is part of the demo-site

Program Outline for the demo operators:

A. ecoEMS Tool Training:

During the consortium demo site visit held on December 9th- 10th, 2024, a series of activities were conducted, including a live demonstration and hands-on training session on the ecoEMS. This session involved the real-time monitoring through the ecoEMS framework, discussion about the KPIs and cross validation of data validity (see Figure 24).

Trainer: ecoEMS Tool Developer (ICCS-NTUA).

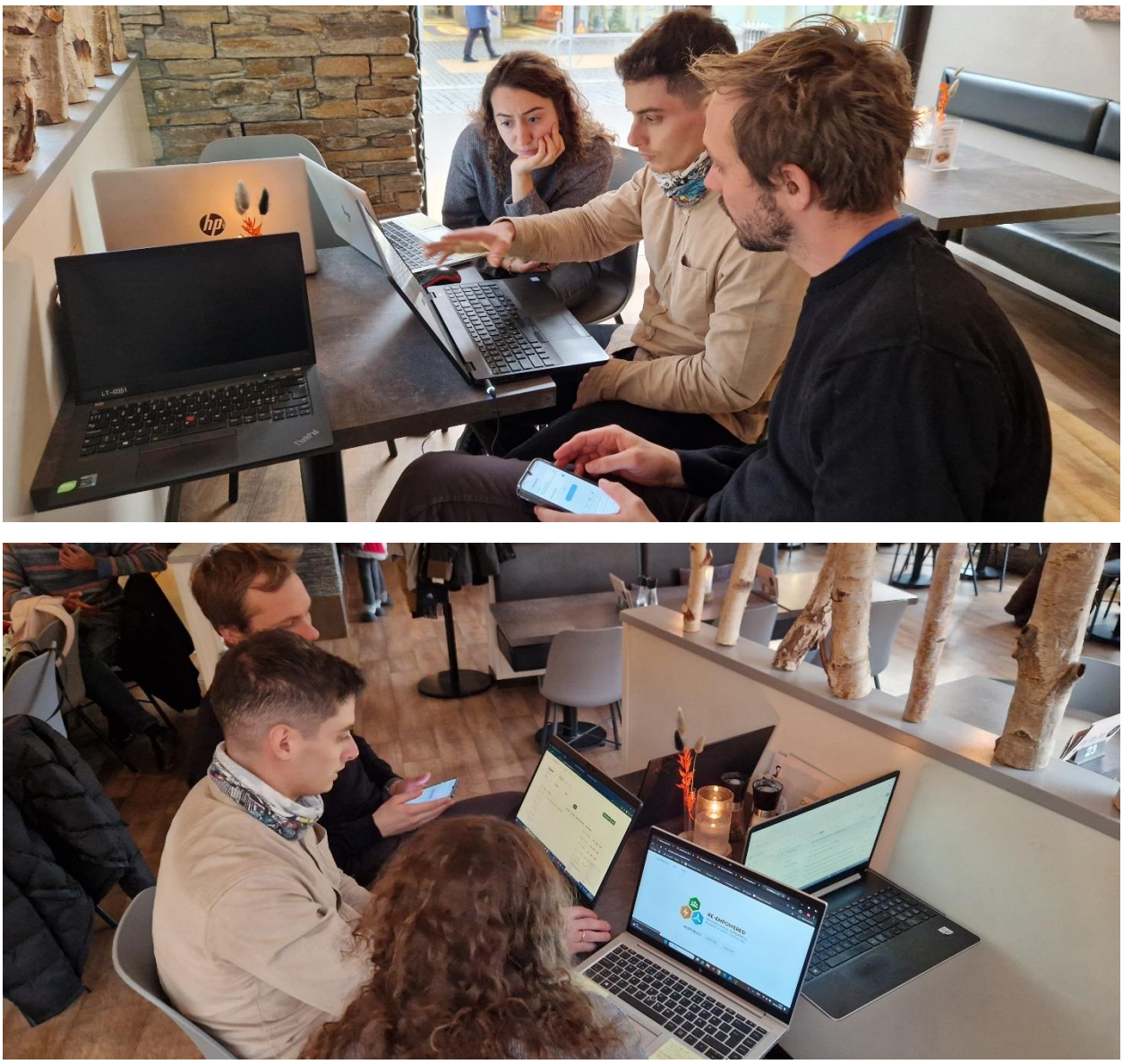


Figure 24.Training on the ecoEMS tool at Bornholm

Materials:

- Live demonstrations and hands-on training

Content:

Data analysis and reporting features.

- Practical training and hands-on practice.
- Data transfer processes and troubleshooting.
- Cost minimization strategies through ecoEMS.

B. ecoPlatform Tool Training:

On December 20, 2023, Aysegül Kahraman from the Technical University of Denmark (DTU) conducted an online session for 20 project partners, focusing on the functionalities and use of the ecoPlatform tailored to the Bornholm demo site. The session provided a comprehensive introduction to the tool, accessible at https://reempowered-ecoplatform.dk/ and covered the following key topics:

I. Account Creation and Provider Setup:
Participants were guided through creating an account on the platform and setting up providers. This included assigning datasets and data streams, along with detailed instructions for adding MQTT information.

II. API Credentials and Platform Access:

The significance of API credentials for accessing the platform was emphasized. Attendees were informed about the procedure for obtaining credentials from platform administrators (Aysegül Kahraman and Guangya Yang).

III. HTTP vs. MQTT Connections:

The differences between HTTP and MQTT connections were explained in detail, helping participants choose the appropriate protocol for their use cases.

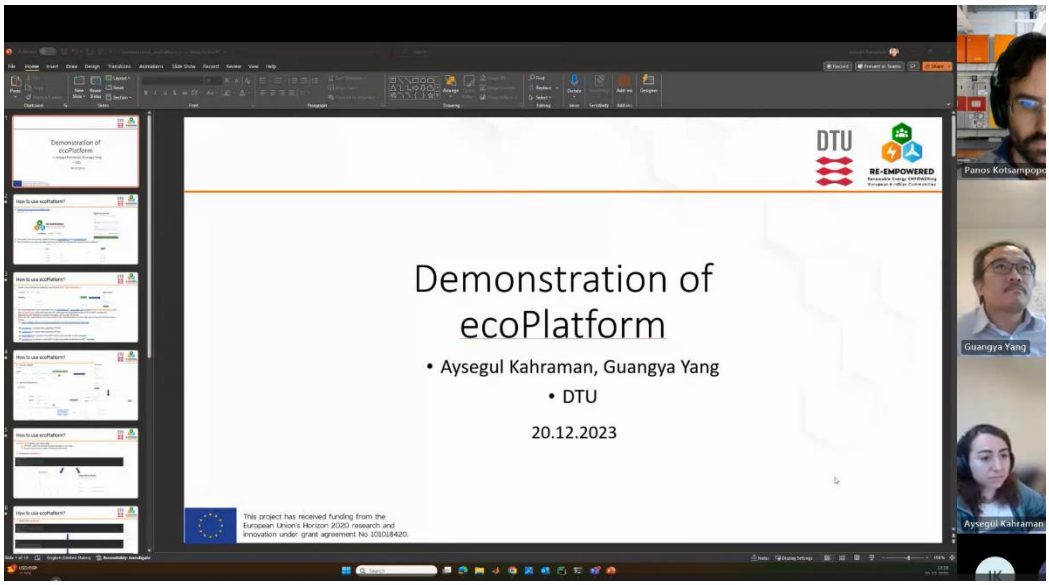


Figure 25. Online training to concerned partners for ecoPlatform

IV. Hands-On Demonstrations:

- A step-by-step walkthrough was provided for adding datasets and data streams, with accompanying screenshots from the platform.

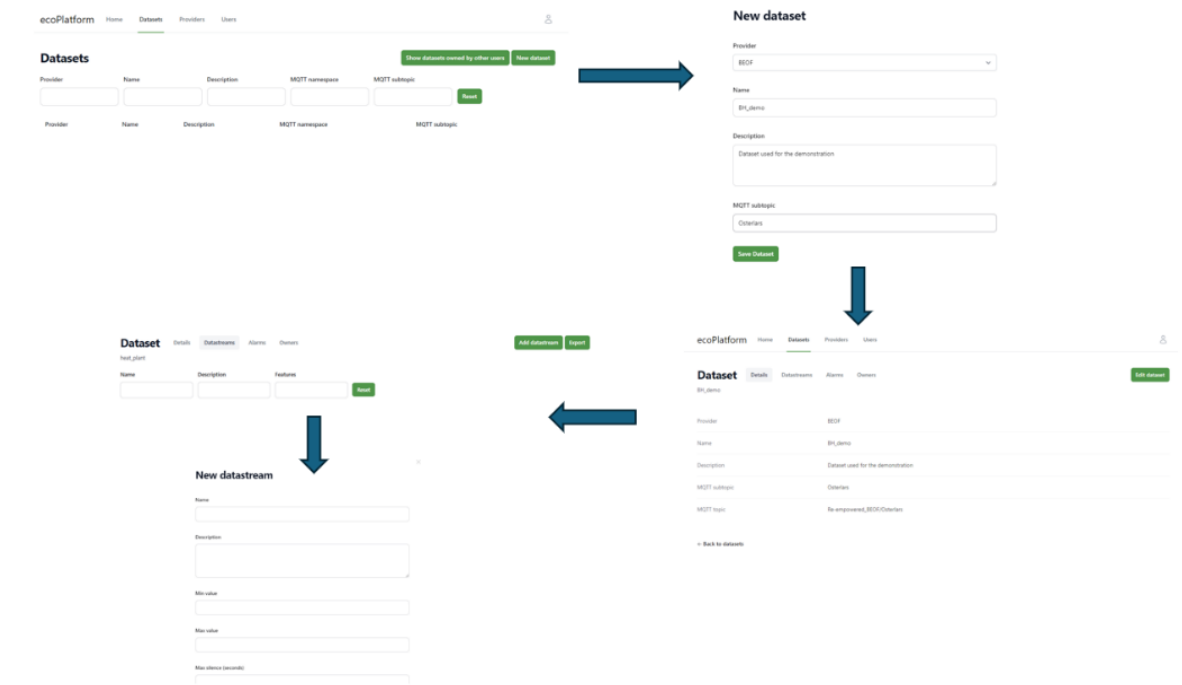


Figure 26. Step-by-Step screenshots for adding datasets and data streams on ecoPlatform.

- A simple Python script was demonstrated for exporting and importing data using the HTTP API.

- Examples of subscribing and publishing data using MQTT were also shown.

V. Supporting Documentation and Resources:

To ensure further ease of use, documentation and example codes were shared. These resources are available on GitLab:

- Documentation: https://gitlab.com/re-empowered/ecoplatform
- API Examples: https://gitlab.com/re-empowered/ecoplatform/-/tree/main/docs/api_examples.

C. ecoDR Tool Training:

Dr. Santu Giri and Dr. Anirudh Kumar from CSIR-CMERI delivered an online session on the functionalities of digital smart meters (ecoDR), covering essential aspects through user manuals, training slides, and live demonstrations. The session began with an introduction to digital smart meters, detailing their role in energy management. It highlighted the integration of sensors for accurate energy consumption measurement and the use of data transmission protocols for time-stamped energy data management. Dr. Anirudh Kumar explained the control of critical and non-critical loads, emphasizing seamless communication between ecoDR and ecoPlatform systems. Additionally, he provided a comprehensive installation manual and guidelines for connecting ecoDR with other equipment, ensuring proper setup and optimal functionality.

D. ecoMonitor Tool Training:

Dr. Santu Giri from CSIR-CMERI delivered an online session on the functionalities of ecoMonitor, covering essential aspects through installation guidelines, and live demonstrations. The training sessions focused on the ecoMonitor tool for analyzing air quality data, seamlessly integrated with the ecoPlatform for comprehensive insights. Each session provided critical knowledge for the efficient operation and maintenance of these systems, covering topics such as monitoring equipment, and data sheets.

E. ecoCommunity tool training to demo operator and consumers:

The features and functionalities of the ecoCommunity tool were demonstrated to demo site leaders by the tool developer. The tool APK (Android Application Package) along with the instructions for installation of the demo user's login credentials were shared with the demo site users so that they can interact with the tool using their mobile phones.

A PDF (Portable Document Format) user manual for the administrator and consumer user is uploaded in the help module of the tool so that the user can always refer to and have a better understanding of the functions and features during the hands-on interaction with the tool.

Trainer: ecoCommunity Tool Developer (ICL)

Materials: Interactive sessions, FAQs, training videos.

Content:

- Overview of ecoCommunity features and benefits.
- Detailed walkthrough of functionalities.
- Help section.

By implementing these training programs, both demo operators and consumers will be well-equipped to utilize and maintain the advanced systems and tools installed at the Bornholm demo site.

2.5.4 Outcomes

The training activities have been very successful. Demo participants were very interested and keen on asking all sorts of questions. Demo participants have carefully been informed about the project and available tools, resulting in good understanding and positive spirit.

2.6 Kythnos Island and Gaidouromantra microgrid

2.6.1 General description about installed energy systems

Regarding the demo site of Kythnos island, it consists of two separate sites, Kythnos power system which is a non-interconnected island (Figure 27) and Gaidouromantra off-grid microgrid. For both Kythnos sites the commercial equipment installation concerns mostly communication and data handling equipment, as well as the installation of instruments for measuring environmental conditions.

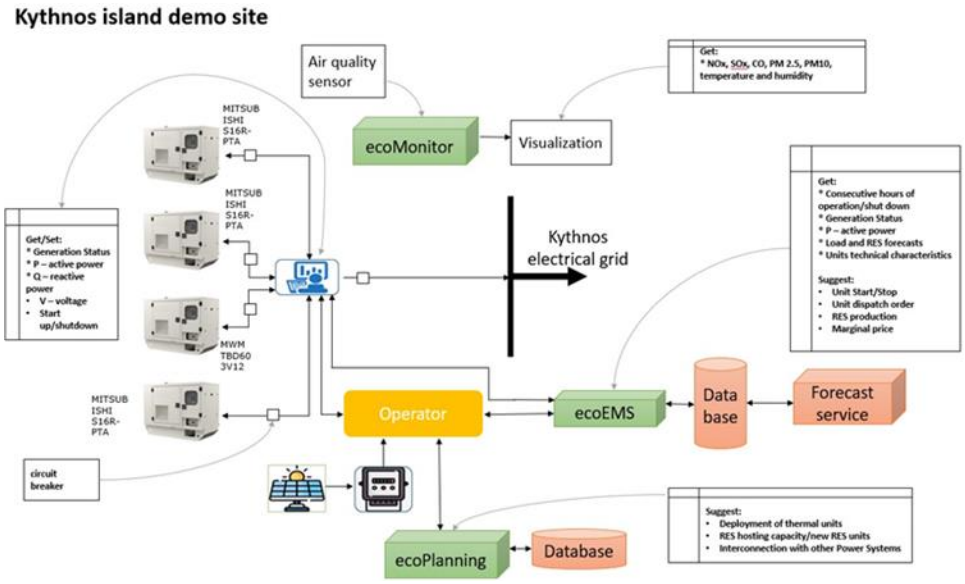


Figure 27 Kythnos power system with ecoTools overview

Gaidouromantra is a small territory in the southeast of Kythnos Island and operates the first microgrid in Europe, installed in 2001 in order to electrify 14 vacation houses. The microgrid operates autonomously and provides electric power to the 14 vacation houses, from several distributed energy resources (DER), consisting of solar PV (rooftop and ground mounted), a wind generator, a battery energy storage system (BESS) and a diesel generator as a back-up source (Figure 28).

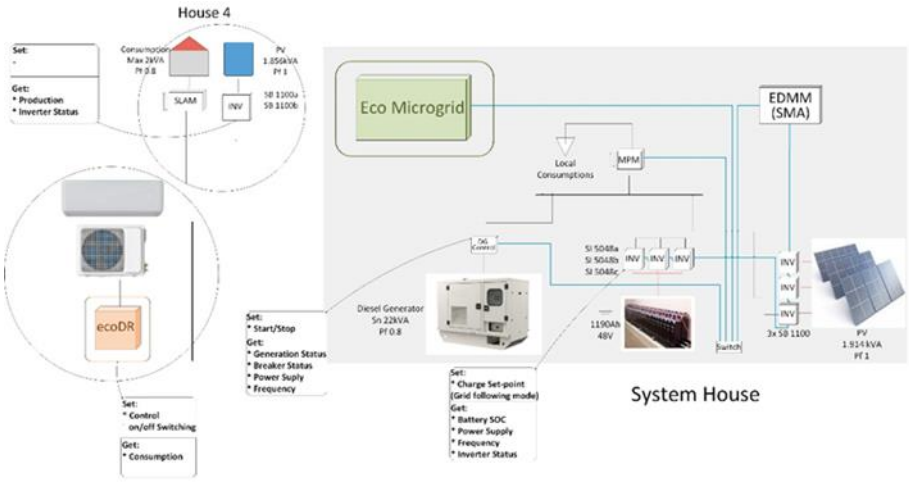


Figure 28. Gaidouromantra microgrid main components.

The commercial equipment that has been installed at both parts of Kythnos demo site is listed below.

- Ethernet gateway.
- Data logger.
- Energy meters.
- Environmental Sensors.
- Modular I/O adapter.
- Software.

As this includes mainly communication, data handling equipment and environmental sensors, dedicated training on these assets was not required and was incorporated in the overall training activities at the demo (see below sections).

2.6.2 Awareness program for the local energy community on the energy systems

A. General awareness:

The systems were introduced to the Gaidouromantra community and the municipality of Kythnos to highlight the benefits and proper use of developed and integrated ecoTools with existing renewable energy systems, which is important for raising awareness and encouraging adoption. Understanding and addressing community concerns regarding renewable energy is key to building trust and ensuring that these initiatives align with local needs.

During July and August 2023, several preparatory meetings were held on Kythnos Island, facilitating discussions with local stakeholders, including municipal officials, local technicians, and Gaidouromantra residents. These discussions primarily focused on identifying residents needs and gathering feedback on the microgrid upgrade installations. The meetings took place either in small groups, such as with local authorities, or through one-on-one informal discussions with residents and technicians who might be involved in the system future maintenance.

Educating consumers about the importance of using electricity during periods of excess Renewable Energy Sources (RES) production was emphasized as vital to optimizing energy usage. The ecoCommunity mobile app was explained to the community, along with valuable information and interactive tutorials on its use for demand side management. Additionally, residents received training on installed renewable energy equipment in their homes, such as digital smart meters, helping them maximize the benefits of these technologies. Live training and Q&A sessions on monitoring energy consumption, interpreting data from smart meters, and utilizing ecoTools further empowered the community to actively participate in energy management.

B. Small wind turbine manufacturing workshop at ICCS-NTUA:

ICCS-NTUA developed and manufactured a small wind turbine locally at NTUA in October 2022, with the participation of 30 students from the electrical and mechanical engineering schools of the university. They designed the wind turbine using online and public tools developed by ICCS-NTUA which use Finite Element Analysis, 3D CAD (Computer Aided design) visualization and 2D CAD plans for CNC (Computer Numerical Control). During the workshop, electrical and mechanical engineering students formed groups to build a small wind turbine from scratch.

They also fabricated a 12 m high tilt up guyed tower at the NTUA for the installation of the locally manufactured small Wind Turbine at the demo site of Gaidouromantra on Kythnos island. The manufacturing and installation of the 3-kW horizontal axis three blades wind turbine is shown in Figure 29.

Figure 29. Manufacturing of the wind turbine at ICCS-NTUA and installation at Gaidouromantra/Kythnos.

C. Wind turbine installation and workshop at Gaidouromantra/Greece:

The link with the local community of Kythnos Island was established by the participation of DAFNI. The locally manufactured small wind turbine and tower were installed at the demo site of Gaidouromantra in Kythnos island (Figure 30), along with project partner DAFNI (December 17th-22nd, 2022). During the workshop ICCS-NTUA and DAFNI staff, along with students from the mechanical engineering school of the NTUA, marked the footprint of the tower on the site, placed the tower anchors and concrete blocks, installed the tower and guy wires, raised the small wind turbine, and connected it to the local microgrid of Gaidouromantra.

Figure 30. Small wind turbine manufactured at NTUA (left) and installed in Gaidouromantra/Kythnos (right)

Next, a local workshop took place on September 30th, 2023 (Figure 31) for the maintenance of the wind turbine installed, with the participation of residents, students of the NTUA, local technicians of the municipality and DAFNI.

Figure 31. Workshop at Gaidouromantra for the maintenance of the installed wind turbine.

2.6.3 Training program for the demo operators on the RE-EMPOWERED developed tools and commercial equipment

This program is designed to train technical personnel on the efficient use of the ecoTools, as well as the newly installed equipment

I. Program Outline for the Kythnos power system:

A. ecoEMS Tool Training:

Trainer: ecoEMS Tool Developer: ICCS-NTUA.

During the consortium site visit on June 26th- 27th, 2024, a visit was organized to the thermal power station of the island, owned by PPC. The operation of the local thermal power station was presented and several discussions took place regarding the integration of ecoEMS with the system. Afterwards, the ecoEMS was presented to DAFNI and other project partners by ICCS-NTUA.

Figure 32. Live demonstration of ecoEMS tool during the visit at Kythnos

B. ecoPlanning Tool Training:

Trainer: ecoPlanning Tool Developer: ICCS-NTUA

During the consortium site visit held on June 26th- 27th, 2024, a series of activities was conducted, including a live demonstration and hands-on training session. This session involved the real-time development of demand and peak models, as well as the modeling of the electrical system. The offline functionality and independence of ecoPlanning from real-time measurements and the access through VPN enabled the execution of a scenario during the demonstration, followed by an in-depth discussion of the results (see Figure 33).

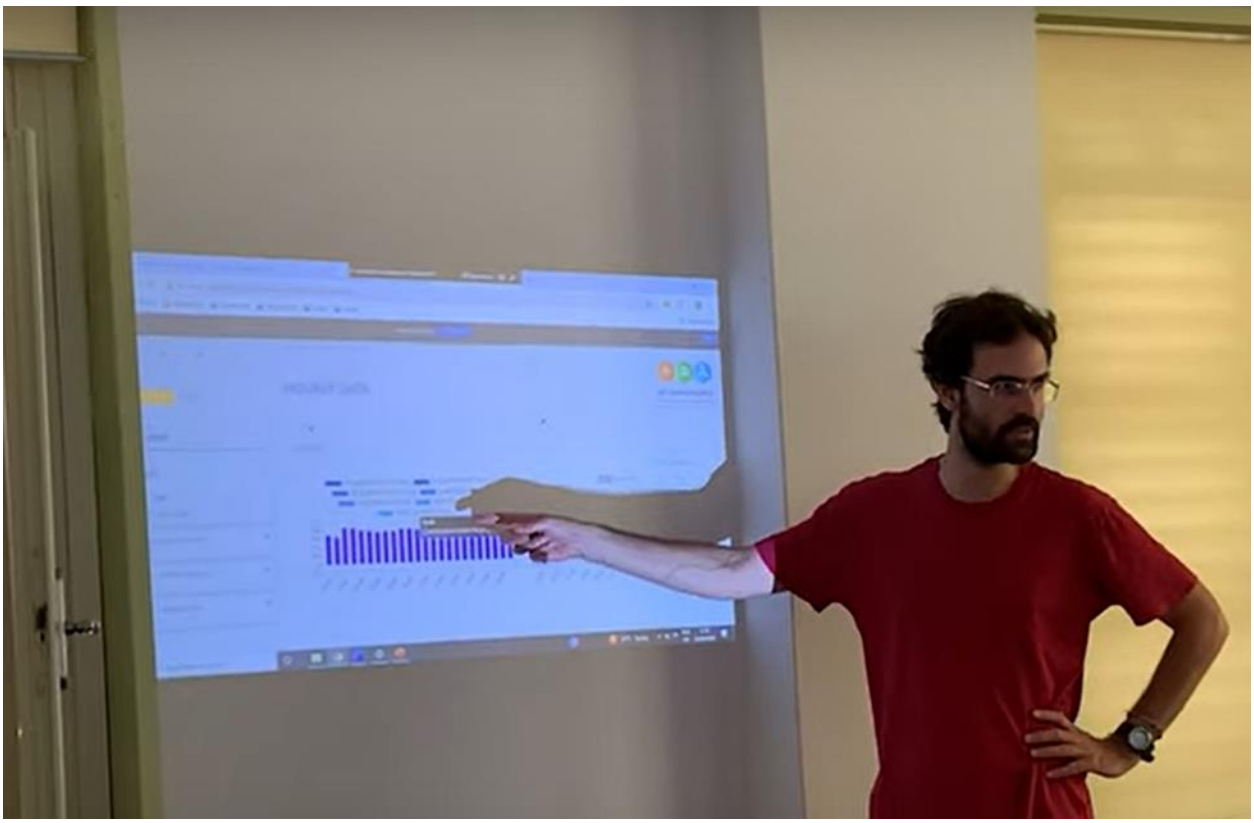


Figure 33: Live demonstration of ecoPlanning tool during the visit at Kythnos

C. ecoMonitor Tool Training:

Dr. Santu Giri from CSIR-CMERI delivered an online training session to DAFNI and ICCS-NTUA on the functionalities of ecoMonitor, covering essential aspects through installation guidelines, and live demonstrations. The training sessions focused on the ecoMonitor tool for analyzing air quality data, seamlessly integrated with the ecoPlatform for comprehensive insights. Each session provided critical knowledge for the efficient operation and maintenance of these systems, covering topics such as monitoring equipment, and data sheets.

II. Program Outline for the Gaidouromandra demo operator:

The tool leaders trained technicians and personnel of the demo site operator of Gaidouromantra, DAFNI, on the newly installed hardware on Gaidouromantra microgrid, as well as the use of the respected ecoTools.

More specifically, two separate training sessions were organized.

The 1st training session took place on March 20th, 2024, and it focused on the operation of Gaidouromantra microgrid with the integration of ecoMicrogrid, ecoPlatform and ecoDR. The Demo Site operators were trained on how the data are being collected and processed, as well on how to monitor the system.

The 2nd training session took place on April 15th, 2024, and it focused on ecoCommunity. The demo-site operators were trained on the uses of ecoCommunity and the important aspects that should be communicated to the residents of Gaidouromantra.

Additional training activities are presented below.

A. ecoMicrogrid Tool Training:

Trainer: ecoMicrogrid Tool Developers (ICCS NTUA) / Dimitris Lagos (ICCS NTUA) and Athanasios Vassilakis (ICCS NTUA)

Materials:

- Presentations.
- Live demonstrations and hands-on training.

Content:

- Data transfer processes and troubleshooting.
- Cost minimization strategies through ecoMicrogrid.
- Control and monitoring capabilities of ecoMicrogrid SCADA.
- MultiVector optimization.

On June 26th- 27th, 2024, during the consortium visit to Kythnos, attendees visited the Gaidouromantra microgrid. This visit included a hands-on training workshop organized by the ecoMicrogrid developers, aimed at demonstrating the functionalities and operation of the tool in real-time. The workshop was divided into two parallel sessions.

- Session One: It focused on the assets of the microgrid, this session provided an overview of the distribution system, controllable assets (such as diesel generators and HVAC), batteries, inverters, and photovoltaic systems. Additionally, it covered the communication infrastructure and the selected protocols utilized for data transmission.
- Session Two: This session dove into the actual functionalities of the ecoMicrogrid Tool. It presented the monitoring and control capabilities of the system, alongside an explanation of the multi-vector optimization processes available within the tool.

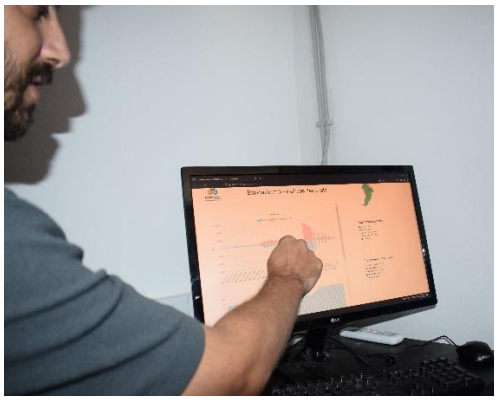


Figure 34. Hands on training workshop on ecoMicrogrid to visitors.

This training provided an in-depth understanding of the ecoMicrogrid tool and its integration within a microgrid environment, ensuring participants gained both theoretical knowledge and practical experience.

B. ecoPlatform Tool Training:

Trainer: Vasilis Mouzas - ecoPlatform Tool Developer (DTU).

Materials: Platform access, user guides, live training.

Content: The training for demo operators on ecoPlatform was carried out in two sessions, focusing on both theoretical understanding and practical application.

- **Introduction and Navigation**

a. Demonstration about the ecoPlatform interface and data visualization dashboards.
b. Training for operators to monitor and manage real-time data from the microgrid, including energy generation, consumption, and storage metrics.
c. Process of integrating datasets and using API functions for dependent tools.

- **Data Management and Troubleshooting**

a. Data archiving, retrieval, and API-based communication for dependent tool access.
b. Practical exercises, including troubleshooting common connectivity and integration issues.

These training sessions equipped the operators with the necessary skills to use ecoPlatform for efficient data management and operational decision-making.

C. ecoDR Tool Training:

Dr. Santu Giri and Dr. Anirudh Kumar from CSIR-CMERI delivered an online training session to ICCS-NTUA and DAFNI on the functionalities of digital smart meters (ecoDR), covering essential aspects through user manuals, training slides, and live demonstrations. The session began with an introduction to digital smart meters, detailing their role in energy management. It highlighted the integration of sensors for accurate energy consumption measurement and the use of data transmission protocols for time-stamped energy data management.

Dr. Anirudh explained the control of critical and non-critical loads, emphasizing seamless communication between ecoDR and ecoEMS systems. Additionally, he provided a comprehensive installation manual and guidelines for connecting ecoDR with other equipment, ensuring proper setup and optimal functionality.

D. ecoCommunity Tool Training to demo operator and consumers both:

Trainer: ecoCommunity Tool Developer (Imperial).

During the consortium visit on June 26th-27th, 2024 in Kythnos, there was a visit to Gaidouromantra microgrid. During this visit, DAFNI and ecoCommunity tool developer (Imperial) explained and trained local citizens of Gaidouromantra on the use of ecoCommunity. The main features of the tool were presented and a live training of the ecoCommunity took place (see Figure 35 and 36).

Figure 35. Training on ecoCommunity app to partners and local community

Figure 36. Training on ecoCommunity app to partners and local community.

By implementing these training programs, both demo operators and consumers are well-equipped to utilize and maintain the advanced systems and tools installed at the Kythnos demo site.

2.6.4 Outcomes

The training sessions that took place in 2024 to the demo-site operator and the general public proved to be very successful and raised significant awareness. The demo-site operators clearly understood the use and the features of the respective ecoTools and were able to successfully transfer the relevant knowledge (e.g. ecoCommunity) to the end-users (the residents of Gaidouromantra).

3. Additional educational/training activities

3.1 General demonstration of the ecoTools during an online workshop

The workshop was conducted to showcase and illustrate selected ecoTools developed within the RE-EMPOWERED project. The primary objective of this internal training was to ensure that all relevant stakeholders, including demo site leaders, tool developers, and associated partners, have a thorough understanding of the ecoTools architecture. Within this module, attendees received an overarching view of all eco tools, gained insights into their integration mechanisms, and understood how these tools communicate with each other. To ensure clarity and accessibility for participants from diverse backgrounds, the content was presented in a simplified manner, minimizing technical terminology.

Table 3-1 General trainings on ecoTools through online workshops.

Module 1: General training of the ecoTool			
EcoTool	**Lead partner**	**Date**	**Mode**
ecoMicrogrid	ICCS-NTUA	6/12/2023	online
ecoPlatform	DTU	20/12/2023	online
ecoPlanning	ICCS-NTUA	9/1/2024	online
ecoEMS	ICCS-NTUA	10/1/2024	online
ecoCommunity	Imperial	17/01/2024	online
ecoDR	CMERI	24/01/2024	online

Figure 37 displays the general training for the ecoMicrogrid tool, featuring both the presenter and a group screenshot of participants. The tool developer explained the optimization and control methods for forecasting and assets management. Additionally, he illustrated the process of gathering and storing data from various energy sources and vendors. Similar workshops have been organized for all the tools shown in the above table.

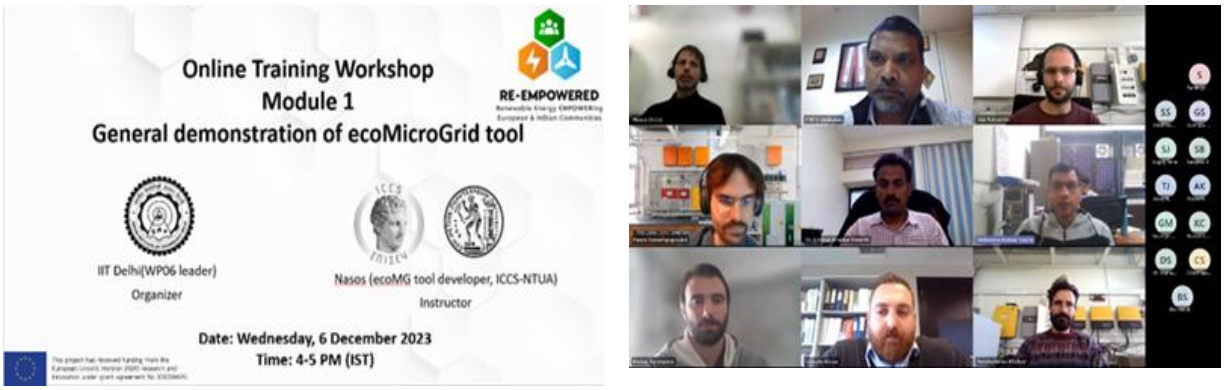


Figure 37. Online workshop on the general training of ecoMicrogrid tool.

3.2 Educational microgrid visit to Keonjhar:

On September 22nd, 2024, an educational microgrid visit to Keonjhar was organized as part of the IEEE Power & Energy Society (PES) and IEEE Electronics Packaging Society (EPS) student activities. A team from Trident Academy of Technology, comprising faculty members and students, undertook a technical visit to a remote village in Keonjhar to study the operation of a 50 kWp hybrid solar micro-grid system. It offered participants valuable exposure to cutting-edge micro-grid technologies, fostering a deeper understanding of sustainable energy solutions and their implementation in remote areas (see Figure 38).

Figure 38. Dr.Srinivas Karanki (IIT BBS) explaining the equipment to students.

3.3 Case study of Indian demo sites at Technische Hochschule Ingolstadt University

The RE-EMPOWERED Indian Demo Sites Ghoramara island and Keonjhar Microgrid were used as case studies for the student projects of the Off-Grid Energy Systems course of the Technische Hochschule Ingolstadt (THI) University in Germany (not a RE-EMPOWERED partner). Two groups of students (one for each Demo Site) worked for a few months in the beginning of 2022 to suggest an energy plan for the demo-sites (Figure 39). The analysis considered the local available resources (sun and wind), load estimation and equipment prices, among other, and came up with concrete suggestions for the sizing of the 2 off-grid systems. IIT KGP supported this activity by providing students with information on the demo-sites. DTU and ICCS-NTUA participated in the intermediate evaluation and final examination and provided feedback to the students.

Figure 39. Part of the students of Technische Hochschule Ingolstadt (THI) University who used the Indian demo sites as case studies for their student projects.

4. Conclusions

In conclusion, the comprehensive training activities conducted as part of the RE-EMPOWERED project have successfully equipped demo operators, community leaders, and end-users with the essential knowledge and skills to operate, maintain, and benefit from the renewable energy systems installed across the training sites. The training programs focused on various renewable energy technologies, including solar PV, wind energy, and battery energy storage systems, as well as innovative ecoTools designed to optimize the operation of the system. Two main tracks of training programs have been developed: an awareness program for the local energy community on the energy systems and a training program for the demo operators on the RE-EMPOWERED developed tools and commercial equipment.

Each training module was tailored to the specific needs of the target groups, ensuring that technical personnel gained a deep understanding of system components, maintenance practices, and safety protocols, while community leaders were empowered with the tools needed to foster community engagement and sustainability. End-users were trained on responsible energy consumption, basic maintenance, and safety precautions, promoting an overall culture of energy conservation.

The feedback from both the local communities and the demo-operators has been very positive. Concerning citizens, despite the initial difficulties expressed, they were able to understand the basics for the efficient use of the system. The demo-site operators posed many questions, especially on the use of the ecoTools, which were answered by the tool developers. Overall, all stakeholders appreciated the project activities and provided positive and constructive feedback.

The program methodology, which included a blend of theoretical sessions, practical trainings, hands-on activities, and ongoing post-training support, has proven effective in fostering the long-term sustainability of the installed renewable energy systems.

This project demonstrates the significant impact of targeted training in fostering local ownership, enhancing operational efficiency, and promoting the sustainable use of renewable energy resources in diverse communities.

Annex

A: Guidelines for an awareness program for the communities at the Indian demo sites

This program aims to educate the community about the local energy systems, and best practices for utilization at the Indian demo sites (Ghoramara and Keonjhar). Note that most of the members of these local communities in India do not have previous knowledge on the topic of renewable energy and the relevant physics laws.

Target audience: Local community, local administration, and operator.

Program objectives:

- To increase awareness about local energy systems and their benefits.
- To educate users about the limitations of power generation and responsible consumption.
- Identification of individuals interested in further learning about local energy systems.
- To promote proper care and respect for the microgrid infrastructure.
- To provide clear do's and don'ts for property protection.

Methodology:

- Identification of local facilitators familiar with the community and language.
- Training in the operation of energy systems with local language and analogies relevant to the technical context.
- Interactive sessions with minimal text and ample use of visuals.
- Active participation through questions, discussions, and role-playing.

Program Outline:

1. Introduction to microgrid and its various energy sources:

The following various energy sources are explained to energy community very briefly and in simple manner with the help of photos.

a. Ground and roof roof-mounted solar modules:

- They convert the sunlight into DC electricity, with a quality which is not suitable for direct use.
- Additional components are required to convert, condition, and monitor the electricity produced so that it may be utilized by common appliances used in homes and offices or maybe feed into the grid.
- This combination of solar panels, inverters, junction boxes, wires, transformers, and other components that finally deliver useful electricity is called a solar photovoltaic (PV) System or a solar PV power plant.
- The size of a solar power plant can be very small (1 kW or less), which can be easily mounted on the home rooftop, or as large as thousands of MW (covering a huge amount of land).

b. Dedicated battery banks (a battery backup system) that get charged during the day and the stored electricity can be used during the night.
c. Wind Turbine (2 units 5 kW each) (at Ghoramara Island microgrid).
d. Biomass (10 kW) (at Keonjhar microgrid).
e. Biogas (10 kW) (at Keonjhar microgrid).
f. MPPT inverters: The DC electricity produced by the solar panels is converted to AC by solar inverters. Solar inverters are different from common inverters as they have Maximum Power Point Tracking (MPPT) technology to increase the efficiency of the solar panels.
g. Solar charge controllers.
h. Distribution boxes.
i. Mounting Structures.
j. Protection & Controls.
k. e-rickshaw (Three wheelers).
l. Remote Monitoring Systems.
m. Solar high-mast light.
n. e-boat (at Ghoramara Island microgrid).
o. Smart meter.
p. Charging station with local solar PV and BESS.
q. Load limiter.

Utilization plan: The solar power plant is used to provide electricity to houses and commercial consumers.

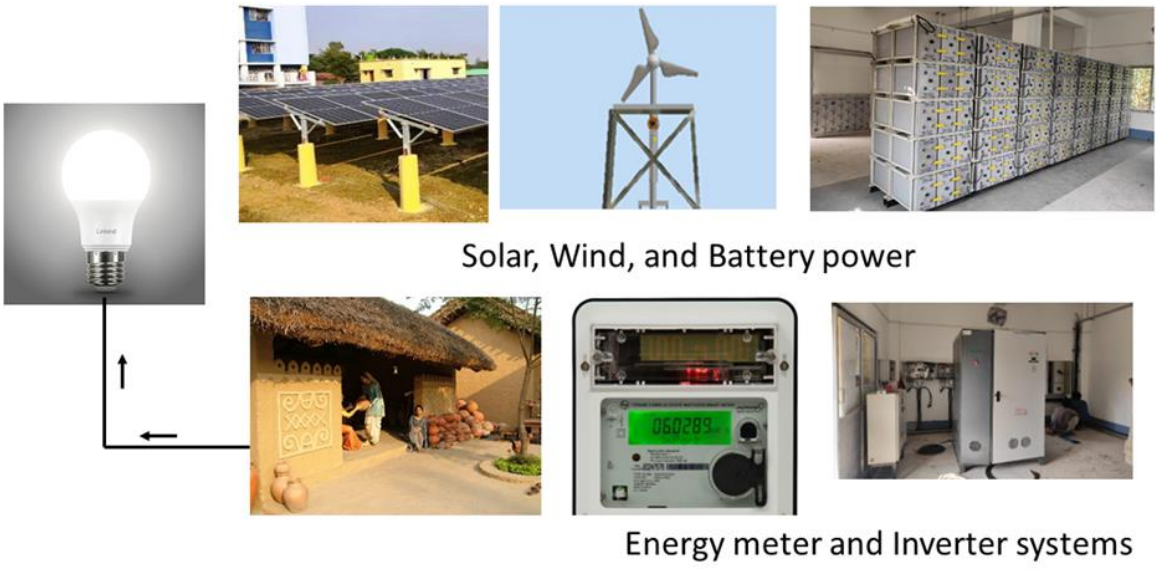


Figure 40. Different energy systems at Ghoramara Island microgrid.

Figure 41. Different energy systems at Keonjhar microgrid Demo Site.

Solar power

- When sunlight falls in these solar panels, it gets converted to electricity.
- This electricity produced from the sunlight is called solar power.
- The complete system generating solar energy is called the Solar system.
- Each panel has capacity equal or greater than 500 Wp.

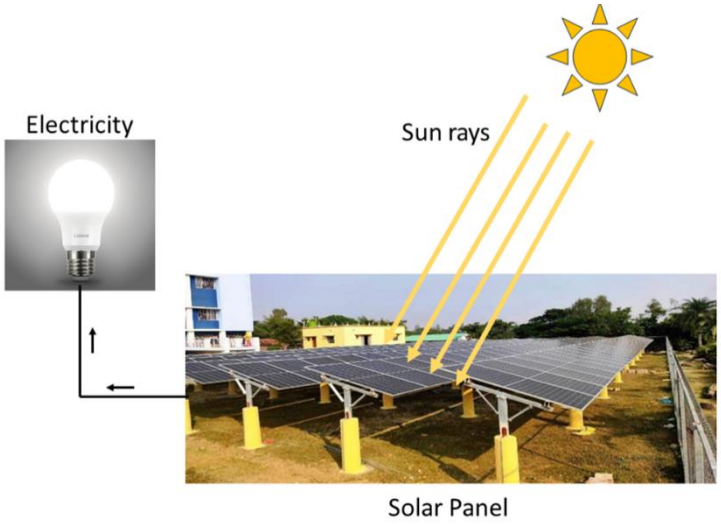


Figure 42. Training about solar power.

Wind power

- The high-speed wind rotates the turbine blade.
- The blade rotates the generator to produce electricity.
- Two horizontal axis small wind turbines of rated output power of 5 kW.
- What happens when the low wind is at the site?
- Along with all its accessories such as generator, charge controller, dump load, etc.
- Through a DC-DC converter to charge the high voltage batteries of the solar PV microgrid.
- Installed on a 20-meter cyclone resilient hybrid tower structure (Truss + monopole combination).
- Additionally, a 2.5 kW locally manufactured small wind turbine (LMSWT) designed and developed by ICCS-NTUA researchers, which has been produced by CSIR-CMERI.

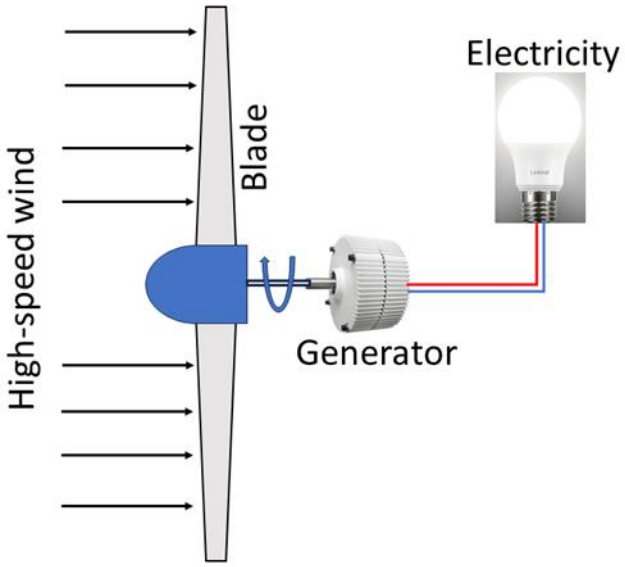


Figure 43.Training about wind power systems

.

Biomass power plant

- **Gasifier:** Biomass feedstocks (Rice husk/wood chips) to a gaseous fuel.
- **Gas engine to generator:** For the generation of electricity.
- **Plant capacity:**10 kWp.
- **Uses:** Commercial loads.

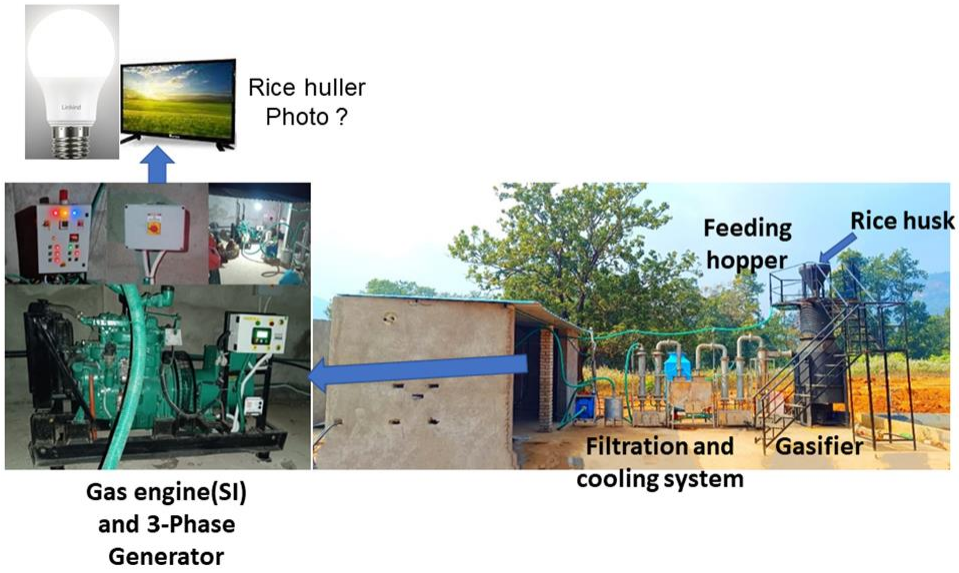


Figure 44 .Biomass with engine at Keonjhar Demo Site.

Biogas power plant

- Mixing tank: Feedstocks (Cattle dung etc.).
- Digester and gas holder tank: Biogas production and storage.
- Power generation system: For the generation of electricity.
- Effluent: Manure to fertilize the land.
- Plant capacity:10 kWp.
- Usages: Commercial loads.

Figure 45: Biogas with digester.

Solar Powered High-mast System at Ghoramara

- White- LED High Mast Light consisting of white LED luminary of 4*40 Watt (LED + Driver) along with solar PV modules and battery.
- Working during the evening and nightime in the main marketplace.

Figure 46. Solar Powered High-mast System at Ghoramara Island.

Electric three-wheelers (e-rickshaws)

- Provide training to the e-rickshaw driver by CMERI before handing it over to the driver.
- Two electric three wheelers will be deployed.
- The electric three-wheeler powertrain is upgraded to a 2 kW BLDC motor with a matching controller and suitable rear axle to carry max 500 kg payloads to suit hilly regions at Keonjhar demo site.
- The vehicle can be utilized for transportation of passengers (max 6 persons) and goods in the hilly regions at reduced speed.
- Further, the electric three wheelers are modified and customized in such a way that it can be easily converted to carry only goods when passengers are fewer passengers and vice versa.

Figure 47. e-Rickshaw with Dr. Murgan, CMERI

Solar Dimmable Lights at Keonjhar

- Solar powered dimmable streetlights are standalone outdoor lighting systems that utilize solar energy to power LED (light-emitting diode) streetlights.
- These streetlights are equipped with solar panels that capture sunlight during the day and convert it into electricity, which is stored in batteries.
- During the night, the stored energy is used to power the LED lights, providing illumination for village roads in Keonjhar demo sites.
- The solar streetlights are equipped with sensors that automatically turn on the lights at dusk and turn them off at dawn without human intervention, thereby conserving energy.
- The dimmable feature means that the brightness of the lights can be adjusted based on specific requirements.
- The streetlights are equipped with motion sensor, which offers full brightness for the first four hours and thereafter increase the brightness to full capacity when motion is detected and dim down to a lower level when no motion is detected, further saving energy.

Conventional smart meter

- Installed at houses/commercial places.
- Information about how to monitor and measure energy consumption can be extracted.
- Benefits of data obtained from smart meters.
- Facilitates remote monitoring and remote control of energy consumption.
- Once the energy consumption exceeds the predefined threshold limit, the smart meter actuates the relay to cut-off the load associated with it.

Figure 48: Smart meter training.

Load controller (Load Limit Switch)

- Installed at houses/commercial places.

Purpose: To restrict output load beyond a set limit by means of switching off the output AC supply.

- This device is necessary to avoid overconsumption of stored electricity.
- This device is to be connected between the incoming AC supply to the houses and the user's load.
- The demo operator will paste a list of Do's and Don'ts on the wall adjacent to this equipment, specifying which equipment should be used with the available power.
- What to do, when power cut-off?
- Safety precautions and whom to contact for device maintenance and issues.
- Additional points, if to be covered.

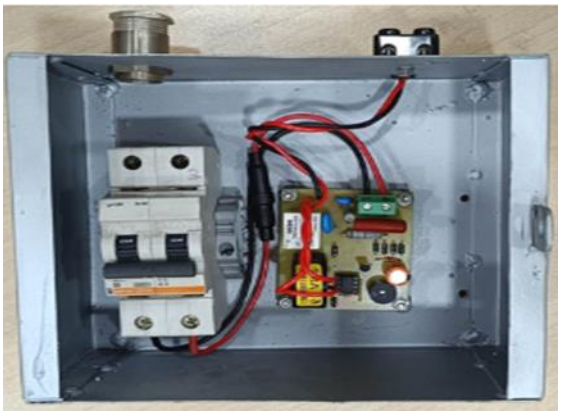


Figure 49: Load controller training and its purpose.

ecoVehicle/Charging facility

- Basic Training to user and in-detail to operator by VNIT.
- Apart from ecoVehicle chargers developed, commercial charging station also procured.
- A 2-port charger refers to a charging station designed to accommodate two electric vehicles simultaneously.
- These chargers are providing a convenient and efficient solution for multiple users or vehicles at a given location.

Figure 50. Charging e-Vehicle.

Remote Monitoring System

- IoT-Based Systems at Indian Sites for Remote Monitoring and Assessment, aim to monitor and assess the health of installed energy sources both locally and remotely.
- The Solar String Monitoring Box (SMB) with a data logger is integrated with the solar strings to facilitate fault detection.
- Monitoring of total power generation and status can be conducted directly from the inverter.
- The smart meters are connected to the ecoMicrogrid via radio frequencies devices at Keonjhar and with wired Ethernet connection at Ghoramara for monitoring energy consumption.
- Power generation and energy consumption monitoring in the control room are shown in Figure 51.

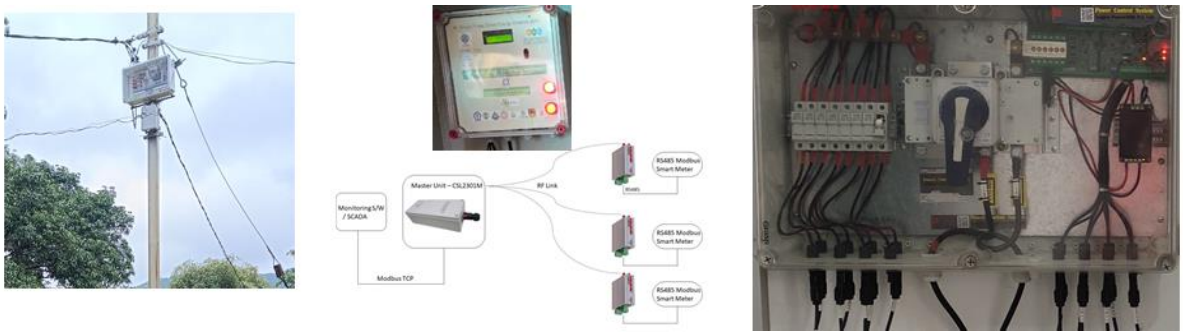


Figure 51. (a) Smart meters with RF devices. (b) Solar monitoring box.

Limitations of Solar power generation

Solar power generation when clear sky in the daytime:

- Solar power generation throughout the day and charging battery system.
- Provide electricity during the daytime.
- Batteries provide electricity at night.

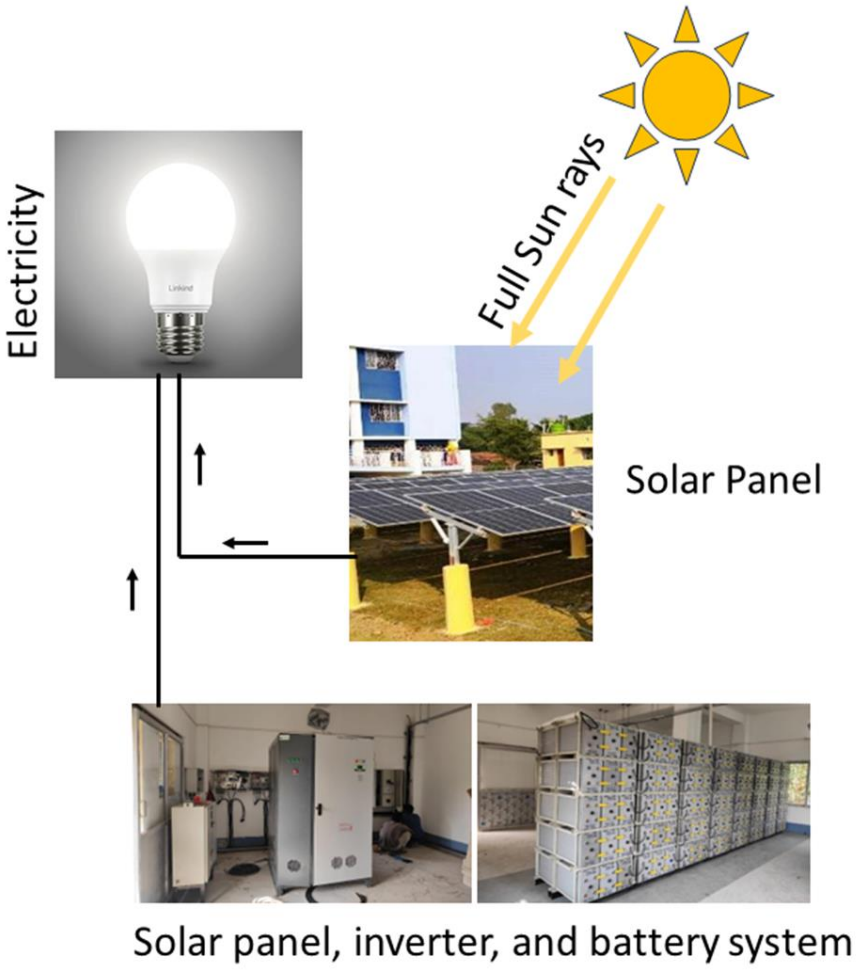


Figure 52. Solar power production with irradiance.

What happens when there is not sun (cloudy and rainy days)?

- Only charged Batteries provide electricity.
- Explain that the microgrid relies on sunlight to generate power.
- Explain that stored batteries energy can be used at night or during cloudy periods.

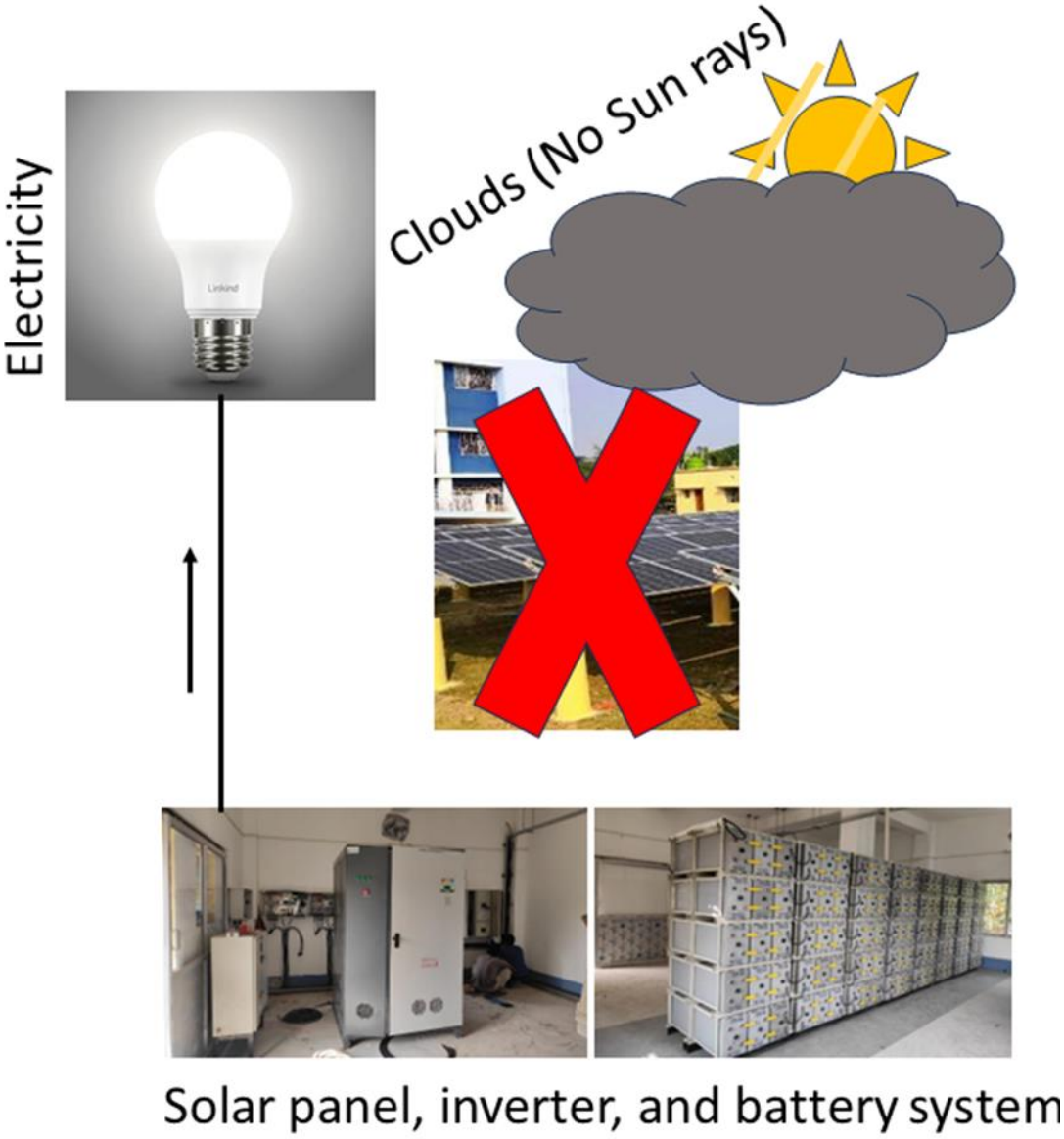


Figure 53. Solar power generation at cloudy season.

2. Responsible Consumption:

- Explain that the microgrid is designed to provide basic electricity needs, but it may not be enough for high-power appliances.
- Ask local people what appliances they have, and how they are used.
- Explain the importance of energy conservation and using appliances efficiently.
- Encourage responsible use of electricity during low electricity generation (already explain when low power generation).
- Encourage users to switch to energy-efficient appliances to reduce power consumption (LED light bulbs and a solar operated fan only).
- Explain that electricity is a valuable resource and should be used efficiently.
- Encourage users to conserve electricity by switching off appliances when not in use.
- Switch off lights and electronics when not in use (Source:https://www.gettyimages.in).

Figure 54. Turn-off appliance, when no use.

3. Identifying Interested Individuals

Activity**:** Ask questions to capture participants' interest in learning more about the microgrid.

Observation: Identify individuals who actively ask questions or show keen interest during the program.

- These individuals can spread awareness and knowledge within the community.
- These interested persons can help by:
  - Attending detailed training sessions along with the demo operator and sharing their knowledge with other local communities.
  - Answering questions and addressing concerns from the community.
  - Helping to maintain the microgrid and ensure its sustainability.

4. Care and Respect for Microgrid Infrastructure:

Figure 55. Training of how to clean the panels.

- Cleaning guidelines and training of how to clean the panels safely by the supplier to the demo operator.
- Explain that keeping the panels clean ensures optimal power generation.
- What is the suitable time for cleaning the panel in the morning or evening?
- Use a soft brush or a squeegee with a gentle detergent to clean the panels. Hard or abrasive materials could scratch the glass on the panels, reducing their efficiency.
- Check panels regularly: Monitor the panels regularly to check for dirt, dust, bird droppings, leaves, or other debris that could reduce efficiency.
- Don’t use high-pressure water.
- Don’t neglect professional cleaning: Appropriate tools and expertise to clean the panels safely and effectively.
- Warn against touching solar panels directly to avoid damage and potential injury.
- Explain the importance of preventing vandalism and accidental damage.
- Encourage participants to report any suspicious activity (paste contact number nearby).

- Emphasize the importance of working together to ensure the long-term success of the microgrid.

Figure 56. Consequences of damaging properties.

5. Do’s, Don'ts, and safety measures for Safe Microgrid Usage

- Explain the location and proper use of fire extinguishers in case of emergencies.
- Show a contact number. Report any damage or malfunction to the appropriate authorities.
- Provide a contact number for reporting any issues or concerns related to the solar microgrid.
- Don’t throw waste or objects near solar panels or batteries.

6. Conclusion:

- Recap the key points of the training program.
- Encourage participants to ask questions. Collect feedback to improve future training programs.
- Provide resources for further learning about solar energy and microgrids.
- Thank the participants for their time and participation.

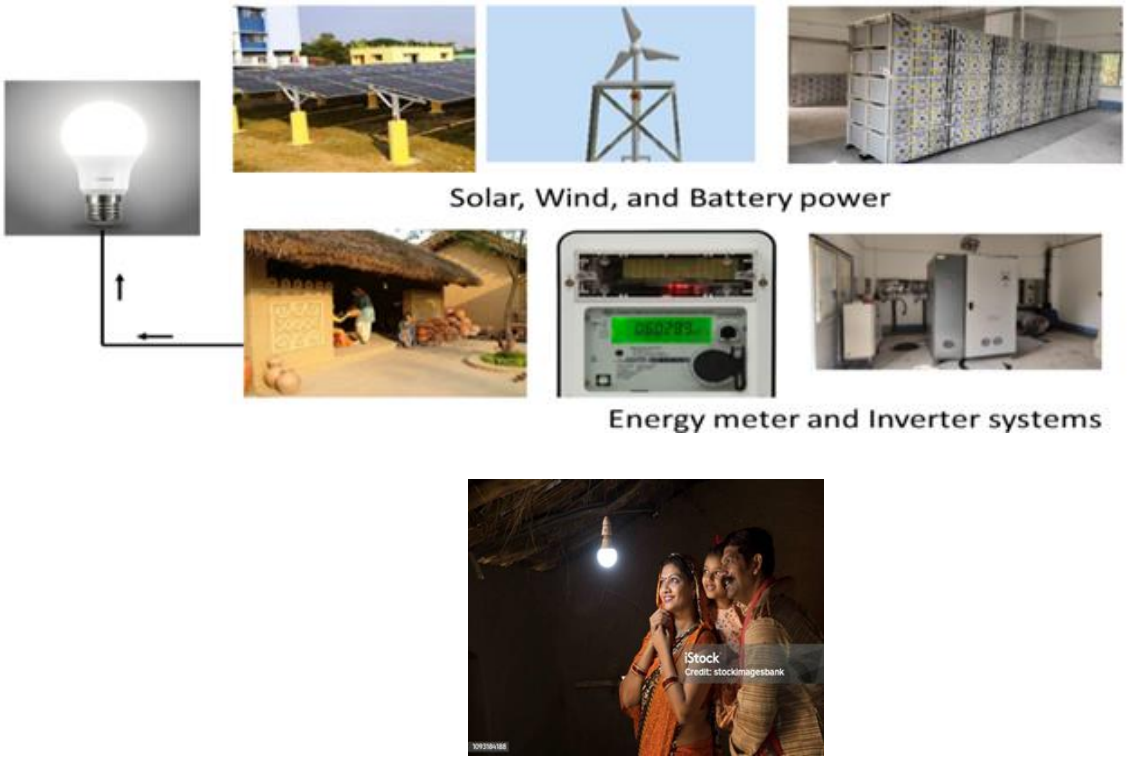


Figure 57. Continuous power supply with responsible use.

Figure 58. Encourage users not to enter the restricted area surrounding the microgrid.

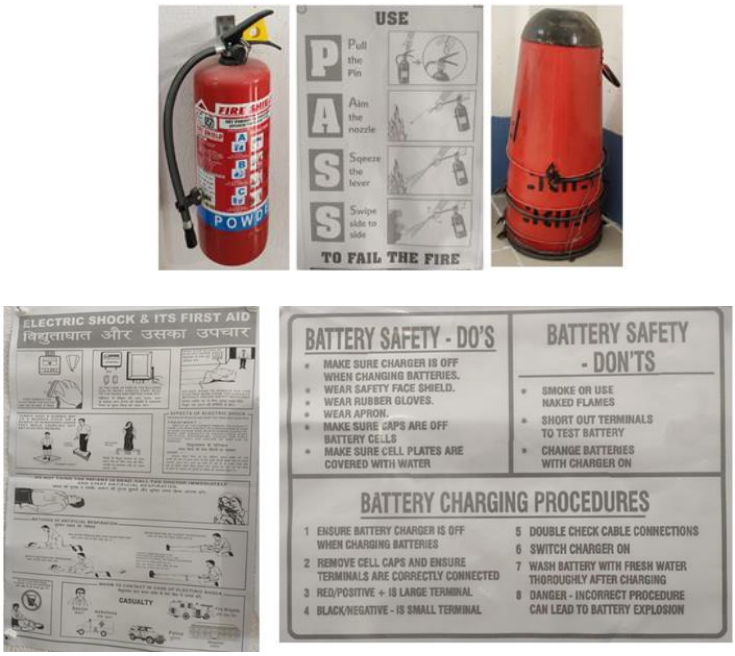


Figure 59. Safety instructions.

Additional Resources:

- Distribution of printed materials with pictures and translations in local languages with key information and illustrations.
- To provide contact information for further inquiries or assistance.
- To encourage participants to share their knowledge with others in the community.

B: Guidelines for training program to demo operators on the commercial equipment and ecoTools

This program is designed to train recruited technical personnel (demo operators) on the local energy systems, hardware, and software necessary for the proper operation and maintenance (O&M) of the demo site.

Target audience: Local demo operator.

Implementation Schedule:

Please implement this as per given below guidelines.

Program objectives:

- Training of locally recruited technical personnel (demo operators) on local energy systems, hardware, and software to ensure the proper operation and maintenance (O&M) of the demo site.
- To ensure the smooth operation of the microgrid plant.

Methodology:

- Provide training sessions conducted by demo leader/tool developers/supplier.
- Use a mix of theoretical sessions, practical trainings, and hands-on sessions.
- Include troubleshooting guides, user manuals, and live trainings.
- Integrate interactive sessions, FAQs, training videos, and safety drills.
- Ensure ongoing post-training support and the provision of necessary Personnel Protective Equipment (PPE).

Program Outline:

1. Solar PV system, Inverter, battery storage system, Solar charge controllers, Distribution boxes, Protection & Controls, etc.

- In-detail to the operator by supplier.
- An electrical connection diagram showing the cable routing.
- Proper Operation and Maintenance (O&M) Manuals and Documentation of all the equipment in a proper enclosed rack in the control room.
- Along with all its accessories.

2. Wind turbine system installed at Ghoramara:

- In-detail to the operator by CMERI/Supplier.
- Along with all its accessories such as generator, charge controller, dump load etc.
- Additionally, about a 2.5 kW locally manufactured small wind turbine (LMSWT) designed and developed by ICCS-NTUA researchers, which will be fabricated by CSIR-CMERI.

3. Biomass plant:

- Gasifier.
- Gas engine to Generator, etc.

4. BioGas power plant:

- Digester and gas holder tank.
- Power generation system.
- Effluent, etc.

5. Electric three-wheelers (e-rickshaws):

- Training to the e-rickshaw driver by CMERI/Supplier before handing it over to the driver.
- Contact information for assistance if the system is not working properly.
- Troubleshooting common issues and contact information for support.
- Safety precautions and whom to contact for device maintenance and issues.
- Demo operator will paste Do's and Don't on this e-rickshaw (Very important).
- Business plan.
- Operation and maintenance.
- Operation and timings of electric three-wheeler, keeping in mind the timing of the ferry boat.

6. E-Boat at Ghoramara:

- Provide training to the e-Boat operator by CMERI/supplier before handing it over to the operator.
- Troubleshooting common issues and contact information for support.
- Safety precautions and whom to contact for device maintenance and issues.
- Demo operator will paste Do's and Don't on this boat (Very important).
- To directly operate in the route Ghoramara -Sagar +Island.
- Once the battery energy gets depleted, it will be charged from the shore battery charging station.
- The solar powered electric boat is planned to be operated during calm weather conditions (i.e., November to March of a calendar year) mainly to promote ecofriendly river transportation and other emergency purposes.

7. Solar Powered High-mast System at Ghoramara:

- In-detail to the operator by supplier.
- Operation and maintenance.

8. Solar P Dimmable Lights at Keonjhar:

- In-detail to the operator by supplier.
- Operation and maintenance.

9. Load controller (Load Limit Switch):

- In-detail to the operator by supplier.
- Operation and maintenance.

10. Charging station with local PV and BESS:

- In-detail to the operator by VNIT/supplier.
- Troubleshooting common issues and contact information for support.
- Basic training to e-rickshaw operator, e-boat operator and the demo operator by supplier.
- Safety precautions and issues.
- Paste Do's and Don't.
- Contact information for assistance if the system is not working properly.
- How to monitor and measure energy usages.

11. ecoMicrogrid:

Trainer: ecoMicrogrid Tool Developer.

Contact Information: Contact details of the ecoMicrogrid tool developer.

Materials: Troubleshooting guides, etc.

Content:

- Data transfer processes and troubleshooting.
- Cost minimization strategies through ecoMicrogrid.
- Additional topics or areas to be covered:

12. Smart meter/ecoDR Tool Training:

Trainer: ecoDR Tool Developer.

Contact Information: Contact details of the ecoDR Tool developer.

Materials: User manuals, training slides, live training.

Content:

- Introduction to digital smart meters.
- Sensor, measurement of energy consumption.
- Data transmission protocols and time-stamped energy data management.
- Control of non-critical loads and communication between ecoMicrogrid.

13. ecoCommunity Tool Training to demo operator and consumers both:

Please provide training that focuses primarily on the application of the ecoTool to ensure it is easily understood by potential users/customers.

Trainer: ecoCommunity Tool Developer.

Contact Information: Contact details of the eco-community tool developer.

Materials: Interactive sessions, FAQs, training videos.

Content:

- Overview of ecoCommunity features and benefits.
- Detailed walkthrough of functionalities.
- Help section.
- Additional topics or areas to be covered:

14. Remote Monitoring System:

Trainer: In-detail to the operator by IIT Delhi/Supplier.

Contact Information: Contact details of the supplier.

Materials: Troubleshooting guides, etc.

Content:

- Interpreting data for fault detection (maintenance, problem diagnosis).
- Integration with equipment for Data transfer processes and troubleshooting.
- The solar string monitoring box (SMB) with a data logger are integrated with the solar strings to facilitate fault detection.
- Monitoring of total power generation and status can be conducted directly from the inverter.

- Solar monitoring box would help to monitor the solar PV string current, which would basically help to understand the faults/generation degradation at string level.
- Additional topics or areas to be covered:

15. ecoMonitor Tool Training:

Trainer: ecoMonitor Tool Developer.

Contact Information: Contact details of the ecoMonitor tool developer.

Materials: Monitoring equipment, data sheets.

Content:

Interpreting air quality data.

Integration with ecoPlatform for comprehensive analysis.

Additional topics or areas to be covered:

16. ecoConverter Tool:

Trainer: ecoConverter Tool Developer.

Contact Information: Contact details of the ecoConverter tool developer.

Materials: Troubleshooting guides, etc.

Content:

Additional topics or areas to be covered:

17. ecoResilience Tool:

Trainer: ecoResilience Tool Developer.

Contact Information: Contact details of the tool developer.

Materials: Troubleshooting guides, etc.

Content:

Additional topics or areas to be covered.

18. ecoPlanning Tool Training:

Trainer: ecoPlanning Tool Developer.

Contact Information: Contact details of the ecoPlanning tool developer.

Materials: User guides, live training.

Content:

- Data analysis and reporting features.
- Practical training and hands-on practice.
- Additional topics or areas to be covered:

19. ecoPlatform Tool Training:

Trainer: ecoPlatform Tool Developer.

Contact Information: Contact details of the ecoPlatform tool developer.

Materials: Platform access, user guides, live training.

Content:

- Navigating the ecoPlatform interface.
- Data analysis and reporting features.
- Practical training and hands-on practice.
- Additional topics or areas to be covered:

20. System installation, Integration and Operation:

Remark: The complete operations from the supplier on the below points should be documented by demo leader/demo operator in Deliverable 6.3: Guidance documents.

- The solar unit generation logbook, load data, system availability data, trip records, visitor's book, etc.
- Detailed system installation procedures.
- A map showing the location of each installation to the scale as much as possible.
- Integrating solar, wind, and battery systems, etc.
- Electrical wiring.
- Day-to-day operation of the systems.
- Monitoring system performance.
- Visual inspection of all components.
- Current & voltage measurements.

- I-V curve traces.
- Test communication network connections.
- **Hands-on session:** Complete system integration exercises, monitoring tools and software.

21. Troubleshooting and Maintenance:

- All the energy vectors should be explained with full load capacity to the recruited technical person for the demo site maintenance work.
- Inventory management for spare parts (record of all the equipment/software of the entire Micro Grid system with contact details of supplier).
- Regular logbook should be maintained at the power plant regarding maintenance activities.
- Common issues and troubleshooting techniques.
- Onsite diagnostics.
- Routine maintenance schedules and procedures.
- Identifying and replacing faulty components.
- Software updates and system calibration.
- Equipment/site maintenance.
- Emergency response.
- Equipment repair and warranty service.
- Removal and reinstallation.

22. Hands-on session: Identifying and resolving issues on mock setups.

23. Documentation and Record-Keeping:

- Operators should be trained to maintain logbooks for system performance, maintenance activities, and visitor records, ensuring thorough documentation for future reference.
- Overall, the training activities ensured that demo operators were well-prepared to manage and maintain the energy systems efficiently, contributing to the sustainable operation of the microgrid plant.

24. Safety Protocols and Emergency Procedures:

- Labelling such as Danger boards etc. needs to be placed.
- Fencing area Restricted area board should be placed.
- The control room should be equipped with a fire extinguisher and battery room with exhaust fan.

- Include a dedicated module on safety procedures and emergency protocols (Electrical safety protocols, Handling and installation of large and heavy components (in Deliverable 6.3: Guidance documents).
- Provide necessary Personal Protective Equipment (PPE) to demo operator and ensure they understand its use.
- Emergency procedures and response plans.
- Safety drills and practical exercises.

25. Support

- Offer post-training support to address any issues that arise during system operations.

  This detailed training program ensures that all aspects of the training are covered comprehensively, from basic to detailed system information, while providing ample hands-on practice.