Clean Energy Interventions for Livelihood Generation

Work Package 1 – NFA Project

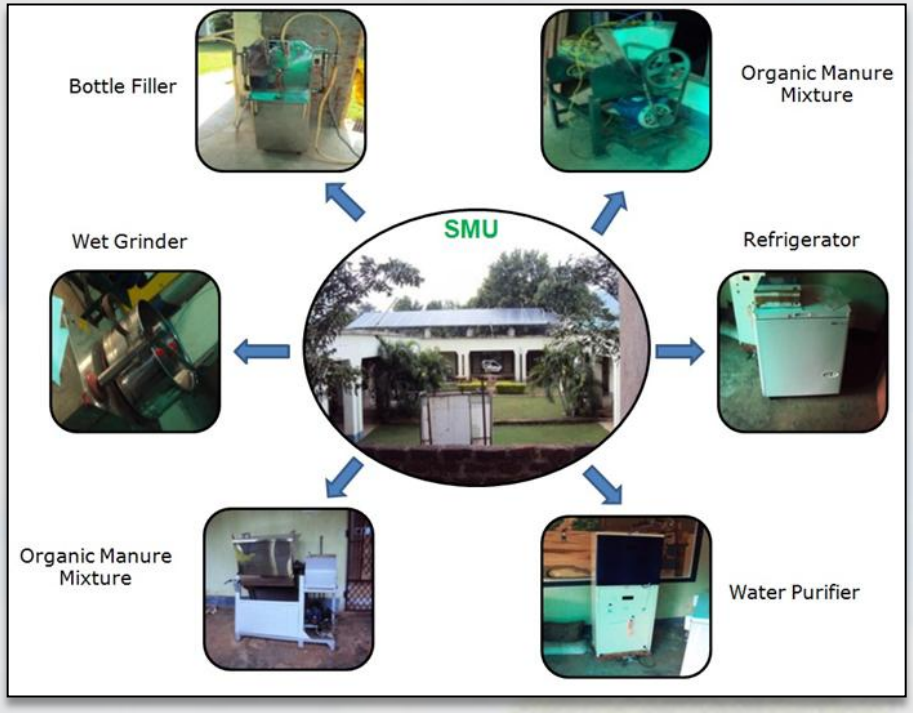
Overall Objectives

- To understand how energy can become a focal point for development activities in an area and to integrate an energy intervention with existing initiatives.
- To use our findings/challenges as inputs for off-grid JNNSM projects.

Specific Objectives

- To use clean energy as a facilitator for livelihood generation in rural areas.
- Implement systems in four (4) Indian States and to ensure their technological, financial and institutional sustainability even after the project is officially completed on TERI's end.
- In order to achieve the above, create customised technology packages, and frameworks for demand assessment, livelihoods assessment, socio-economic indicators and baselines, capacity building and innovative business models and institutions.
- To assess/compare performance of the above, across technological configurations, climatic zones, institutional and business models.
- Test technologies for smart renewable energy applications in the lab.

Solar Multi Utility (SMU)



Solar Multi Utility (SMU) is a centrally located clean energy system used to power a variety of applications such as grinders/mixers, water purifiers, ICTs, fruit pulpers and so on.

Self Help Groups, Farmer's Associations and Individuals from the surrounding villages access this SMU and utilize services for a fee.

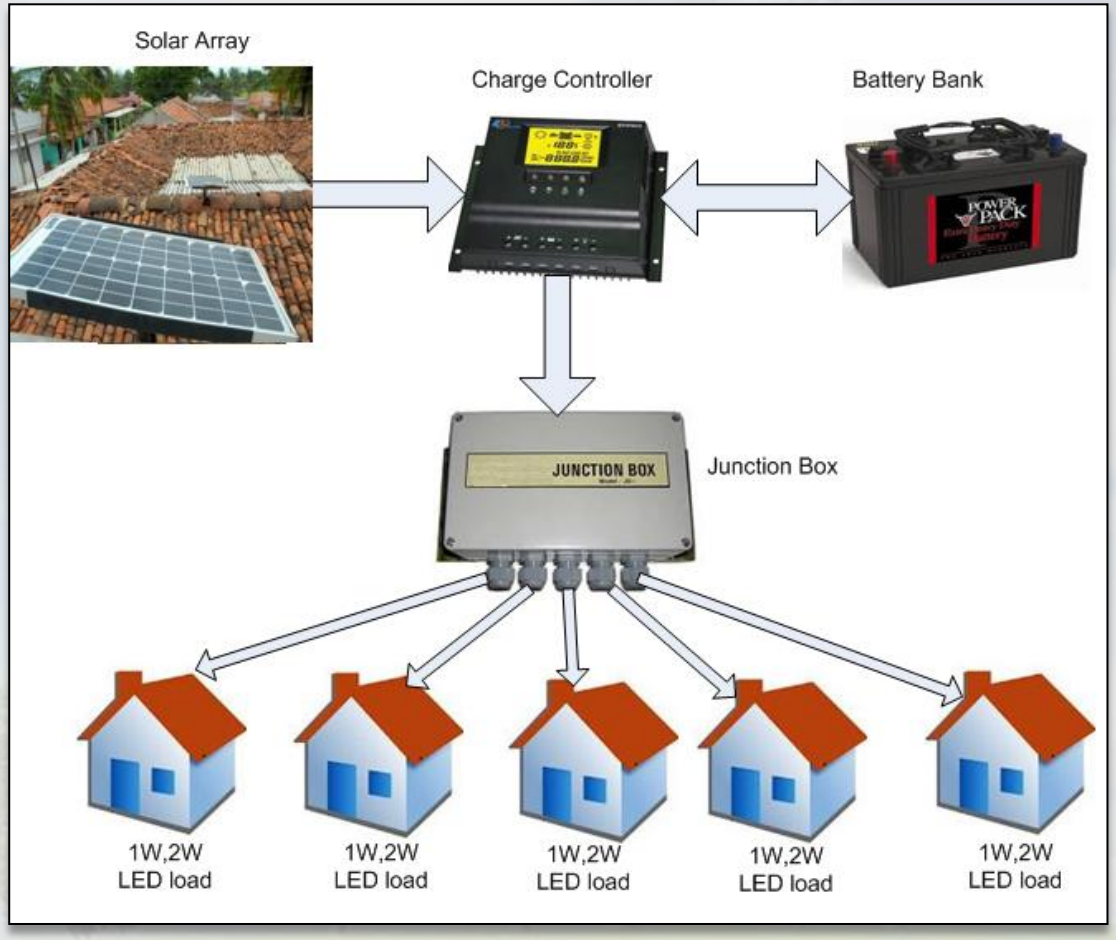
SMUs have been installed in Assam, Odisha and Madhya Pradesh (on-going)

Solar Micro Grid is operated by an entrepreneur.

The solar panels, batteries and charge controllers are housed at the premises and DC grid lines extend lighting services to between 40-100 users depending on the location.

The users pay a daily/monthly fee for the lighting services

34 such sites have been installed in UP

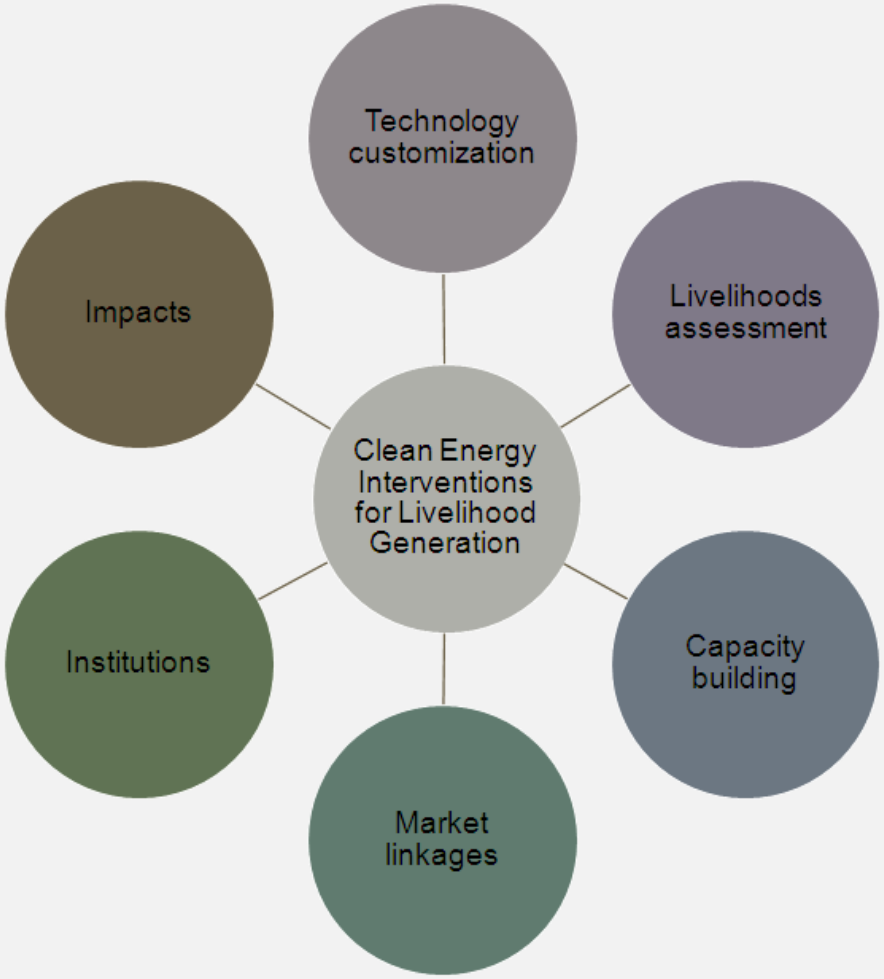


What's new . ..

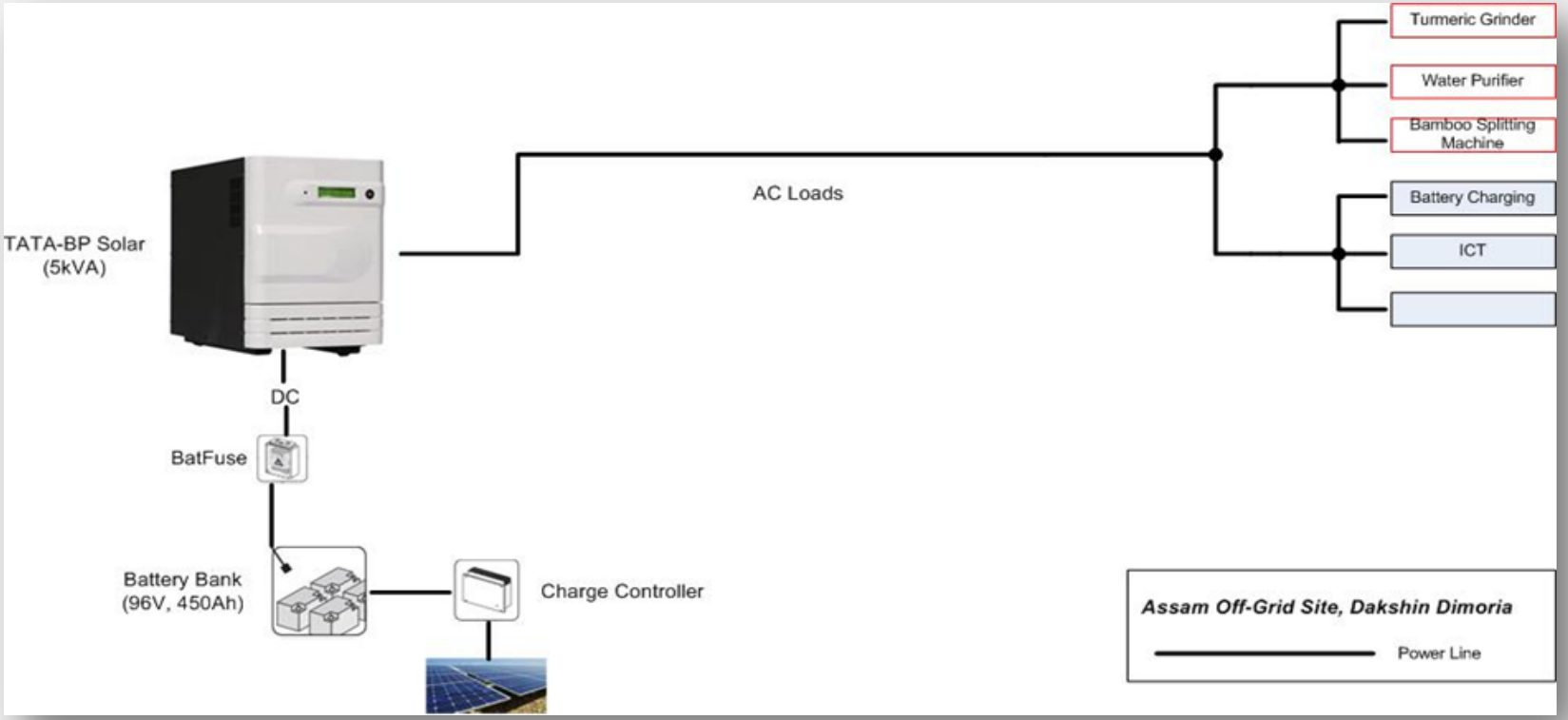
- Design customization for distributed solar electricity projects for improved reliability, efficiency and flexibility
- Ensuring adequate forward and backward linkages to ensure long term operation and sustainability of the project.
- To validate a variety of business models which go beyond subsidies to include contributions from the community and private players.
- To create knowledge on technology, business models, financing and implementation for the implementation of similar projects at a national scale.
- A focus on interdisciplinary thinking for the implementation of energy projects in rural areas.

What this involves

Breadth of interdisciplinary coupled with expertise in specific areas



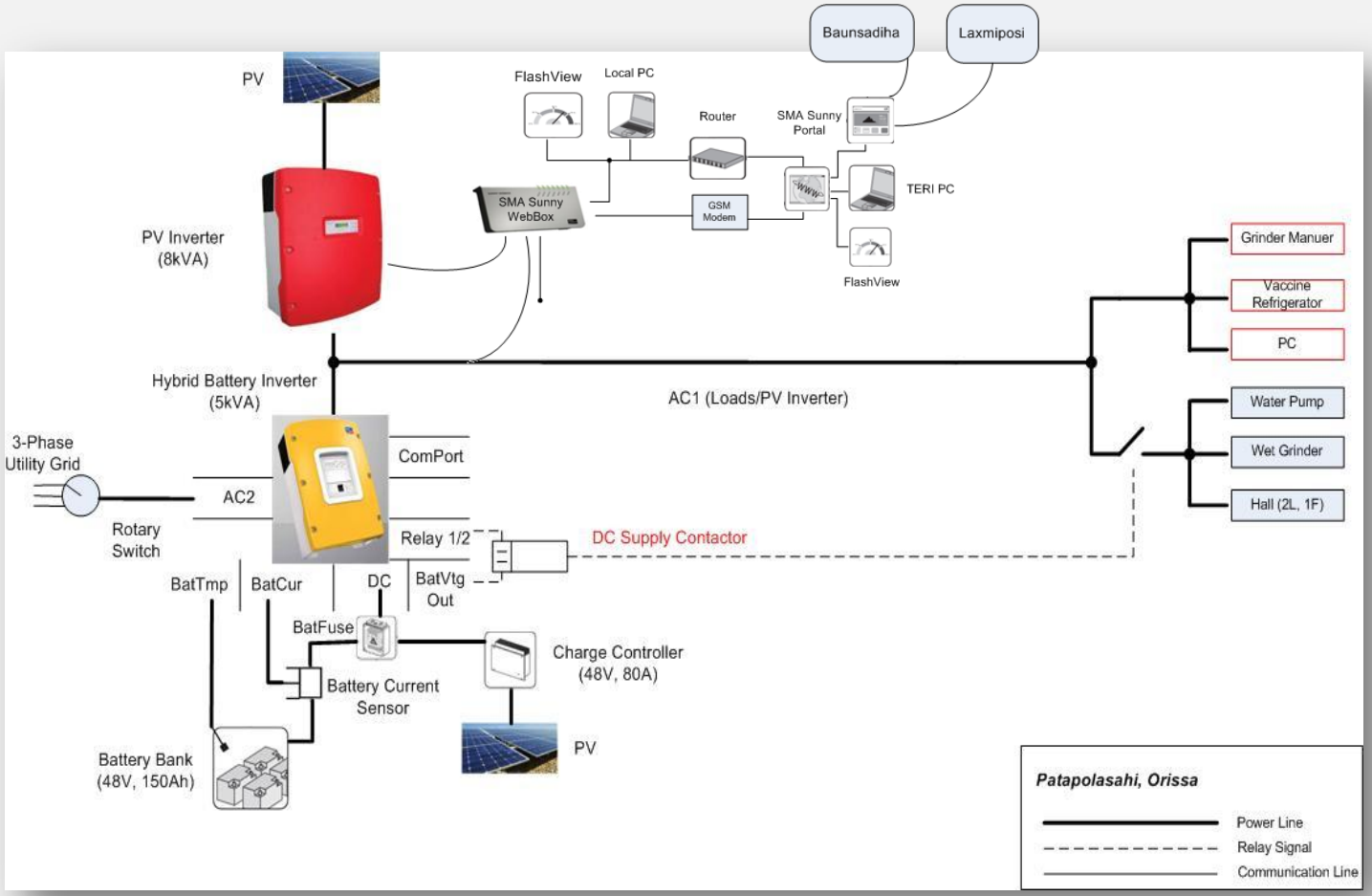
Innovation in Technology



This figure depicts the standard design of solar PV systems.

- The batteries, which are the weakest link, are always in the system loop which negatively impacts the reliability and efficiency of the system
- There is little scope for system expansion or grid connectivity.

Efficient, Reliable and Flexible Solar PV system



The improved design separates day/night, critical/non-critical loads and offers flexibility in connecting other energy resources and in the future, the grid.

Smart Controller Laboratory (SCLab)

TREE Building, TERI Gram Gwal Pahari, Gurgaon-Faridabad Road, Haryana, India

Vision:

- Become one of the pioneer laboratories in India for conducting research and development activities on smart micro and mini grids

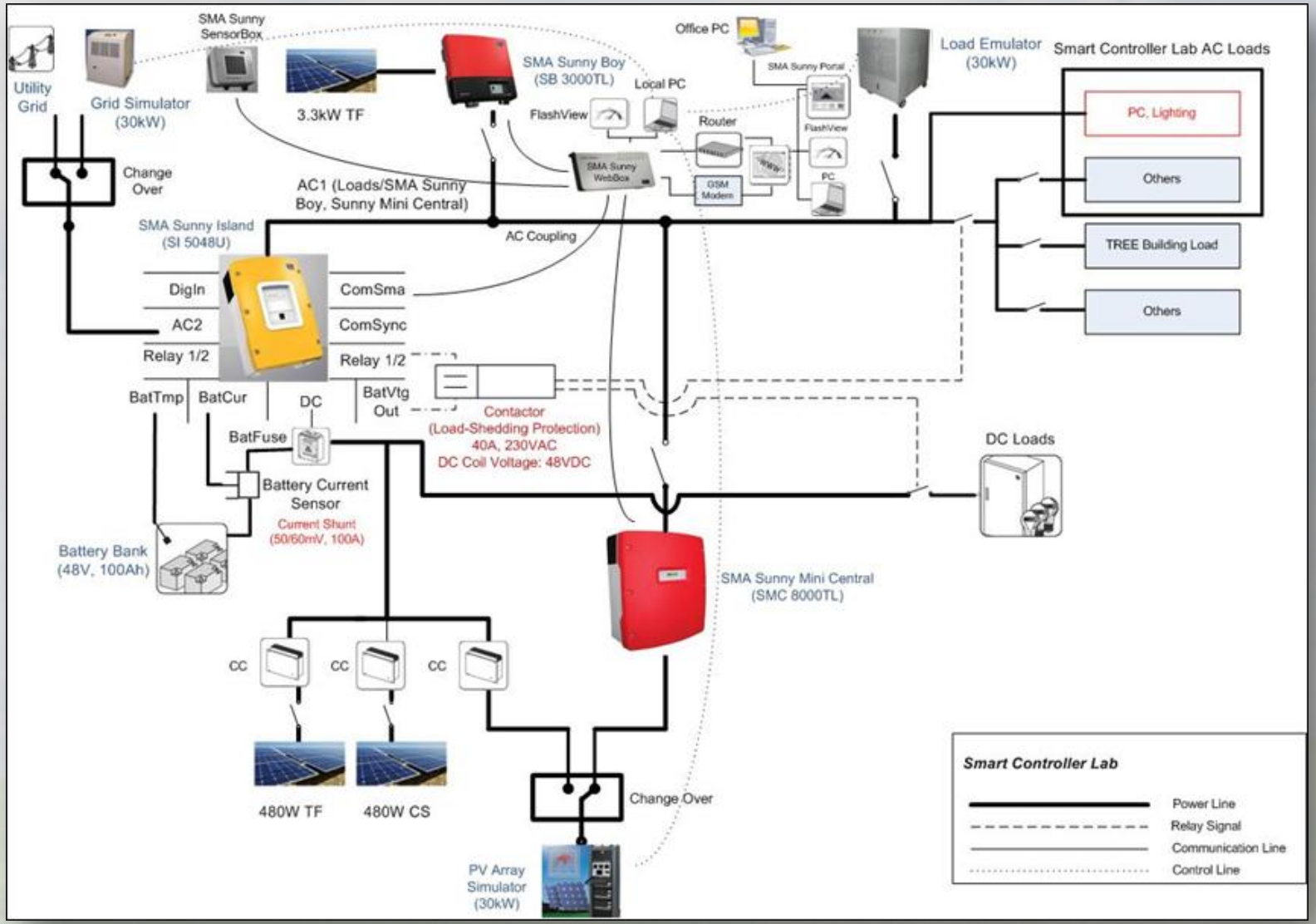
Thematic Areas of Research

- Design & Development of different Smart and Distributed Power Solutions
- Research and Development (R&D) of various Intelligent Load and Resource Management using Smart Controllers

Infrastructural facilities available in Smart Controller Laboratory

Solar Array Simulator		• Make: ElgarTM by Ametek • Model: 570236601 • Input: 380/400AC, 3-Phase Delta connection, 70Amps • Output: 0-600VDC, 0-25A • Power: 30kW • Software: TerraSAS, Version 1.6.0.2
Load Emulator		• Make: Quinling Energy resources • Model:ACLT-3803H • Power :30kW • 10kW Resistive load • 10kVAr Capacitive load • 10kVAr Inductive load • Software: ACLT-3803H Device Manager
Grid Emulator		• Make: California Instrument by Ametek • Model:MX30-3P-400-LF-SNK • Input:400VAC, 50-60Hz, 36kVA • Output:150/300VAC, 16-500Hz • Power:30kVA • Software: MXGUI, Version 1.18
Embedded System and Controller		• NI CompactRIO-9074 • NI LabVIEW Developer Suite • NI LabVIEW Real-Time Module • NI LabVIEW FPGA Module • NI 9227, NI 9225, NI 9481, NI 9403 • NI 9211, NI 9205, NI 9870
Hybrid and PV Inverter with Battery Bank		• 8kVA PV Inverter • 5kVA Hybrid Inverter • Battery Bank of 48V and 12V

Schematics for Smart Controller Laboratory



How the lab infrastructure be used for Distributed Power technology development

- Testing and Long-term Performance Assessment of different Photovoltaic (PV) technologies both in standard lab (indoor) conditions and field (outdoor) environments;
- Testing and Long-term Performance Assessment of different Battery technologies;
- Testing and Performance Assessment of different Inverters;
- Testing and Assessment of Renewable energy based Hybrid systems (including Smart Micro/Mini-Grids) under different operating conditions

Training and Capacity Building

- Both Technical and Management Training: Through short-term courses like Management Development Programs (MDP) on Smart Grid, GIS and Virtual Lab cum Hands-on facilities for the researchers;
- Workshops/Conferences on Smart Controllers, Smart Grid, Smart Mini Grid (SMG) and GIS;
- Technology training for academic community as well as field professionals;
- Specialized training courses on installation, operation and maintenance for the Off-Grid Solar PV Plants.

Lab at operation

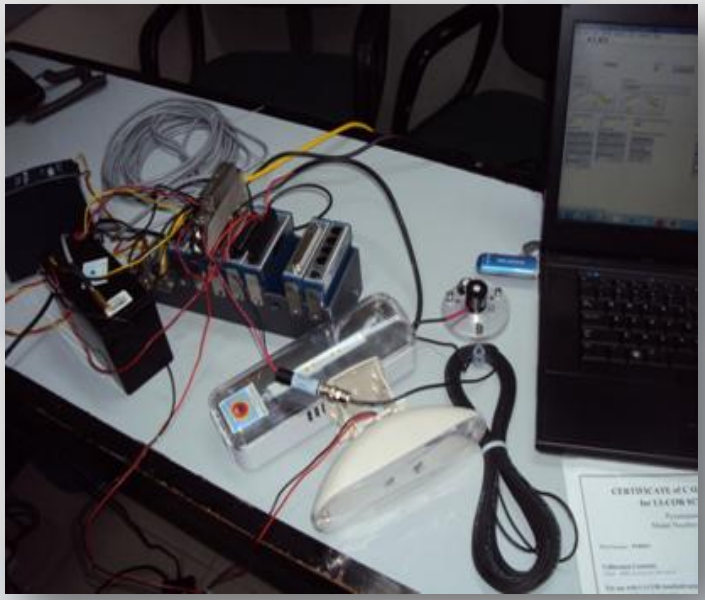
PV Solar Array Simulator (SAS)

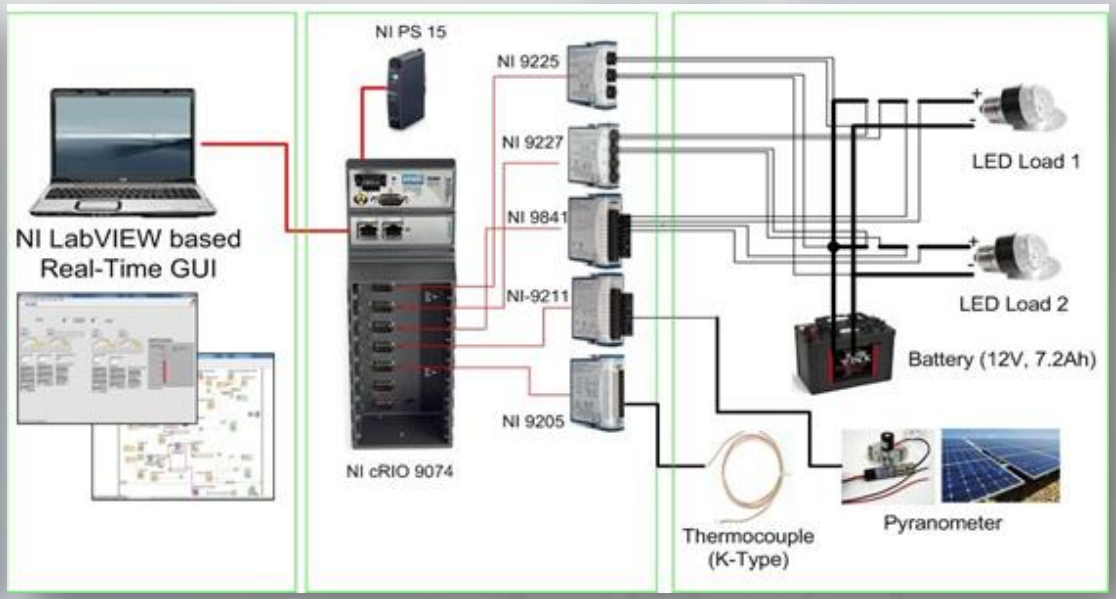
Grid Simulator

Load Emulator

Inverters

Embedded Smart Controller System





Purpose

- Customize various Smart Solutions and Packages for different applications
- Develop Intelligent Load Management and Control techniques
- Design and Development of integrated Resource Management for various Distributed Energy Resources (DERs)
- Use in different training programmes as Hands-on demonstrations and Training Tool-kit

Sustainability – going beyond technology

Technical/ Social

- Energy efficient system & intelligent load management reduces peak demand
- Optimum battery size reduces the replacement cost
- Remote monitoring of PV performance - useful long term data on performance
- Need based design with standard procedures for operation

Financial

- Variable grant: equity ratio based on system size.
- Dedicated bank account for revenue collection/battery fund
- Customised pricing strategies to suit particular livelihood activities

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Institutional

- Creating linkages with other developmental programmes
- Local capacities developed to operate and manage the system
- Creating linkages with state marketing companies to sell products

Livelihoods and business models

State	Assam	Odisha	Uttar Pradesh	Madhya Pradesh
Number of sites	1	3	34 (4 clusters)	2
Type of System	SMU	SMU	Solar Micro-Grid	SMU
Local institutions	NGO, SHGs, Co-operatives, Federation	NGO, SHGs	entrepreneurs	DPIP, NGO, SHGs
Models	• 100% grant • Community /SHGs pay varying service charges	• 20% contribution from the NGO and community • Community/ SHG pay varying service charges. • Electricity sold at INR 7 to third parties	• 45% contribution by the entrepreneur. • Links with banks established to take loans. • Customers pay 5/- per day or 150/- per month.	• 2 lakh contribution from the community • Community/ SHG pay varying service charges. • Electricity sold at INR 6 to third parties

Saal Leaf Plate making

Grinding - -*atta* and spices

Vaccine Refrigeration

Lighting for businesses and workshops

Training and Capacity Building

Type of Training	Target Group	Skills imparted
Technology	Operators/Entrepreneurs	How to operate, maintain and rectify small faults in the system. Dos and Don'ts and measures to be taken in case of major faults
Management of energy businesses	Operators/SMU managers/Entrepreneurs	Recordkeeping, monitoring, revenue collection, tariff estimation, customer relations, entrepreneurship
Livelihoods/Use of new technologies	Users/Self Help Groups/Farmer's Associations	Use of appliances to aid in increased production, production processes, marketing, branding.

- Technical Manuals and posters have been developed for both SMUs and SMGs. These manuals will be used in all trainings and can be used for trainings on these technologies in the future
- Training on technology is imparted by TERI professionals and training on business management and livelihoods is imparted by TERI professionals in collaboration with local experts.

Training and Capacity Building

Snapshots of Local operator training on Operation and Maintenance of the system

Impact on the field

Production of herbal products using machinery powered by TERI's Solar Multi Utility

Healing Heritage in the Green Haat event organized by the Ministry of Environment and Forests at Dilli Haat, between 16th January and 31st January 2013.

A poster explaining the SMU and how it has contributed to higher productivity is on display at the stall.

Some important lessons so far

Technology and customization

- Advances in technology to improve reliability even at a slightly higher costs are important in rural and remote locations where service networks are weak
- Systems should be designed such that they are grid compatible to ensure no loss in the solar plant operator's business on the arrival of the grid or better electricity supply
- Solar PV is just one of the many possible options – therefore designs must incorporate flexibility to include other sources in the future as well
- Efforts need to be made to develop guidelines on design of distributed generation systems, including guidelines on tariffs and grid interconnectivity.
- On the design side, replication, rather than scale up is important – that is, customizing technologies to suit user needs, experience with technology and future demands is essential to project success

Some important lessons so far (Contd.)

Project Management

- Working in interdisciplinary ways – how do people with different skill sets, different knowledge domains and differing views of the development process work together?
- How should organisations effectively decentralize roles and responsibilities? Clarity of roles and division of responsibilities is essential from the outset.
- Reducing overall project costs – how does having a local Project Monitoring Unit (PMU) or partner NGO help with this?
- It is essential to build capacities of partners before starting projects

Some important lessons so far (Contd.)

Community Involvement and Ownership

- If we really want the community to own the project, what is important?
- Who should operate such a project? The Panchayat, Local NGO, local businessmen, Government representatives?
- If TERI were to act only as a consultant, how can we build the capacity of PRIs to lead such projects in the future?
- What sort of training is most important and what should be the frequency of such training?
- How do people pay for these services? Is selling electricity a better option to charging for specific services?

Way forward . . .

For the project

- Research publications on different aspects of the project
- Handbook for practitioners on implementation of decentralised clean energy projects for livelihood generation
- Capacity building over the next 1 year

Beyond the Project

- Use our findings as inputs to JNNSM off-grid projects
- Using this as a base for integrating other renewables and smart technologies into the mix in the future
- Capacity building to enable local governance bodies to lead such projects in the future
- Similar interventions for SMEs and urban areas

Voices from the field

"A team member of SAMBANDH informed us about utilization of clean energy for the purpose of processing. We thought the idea was great but were confused if the staff speaking to us was from SAMBANDH or Electrical department, because even if we have electricity its hardly for a few hours in a week and the voltage is so low that no work can be done with the light" – Sinmati (58), member of Maa Mangala Self Help Group

"Today we have seen the utility of the appliances and also the income supplementation that it would provide, now we can produce more of the chatua to benefit many needy mothers and malnourished children. This unit would not only benefit us but other 7 adjoining villages, we take complete responsibility of the resources and we will adequately reward the operator and also save up for the maintenance of the SMU." -
Secretary, Maa Mangala Self Help Group

"The energy here not only helped increase production but accelerated our hopes towards brighter, cleaner, prosperous tomorrow" – Sukha (46), resident of Kuchidanuagan, who accesses the facility at Patapolsahi.