IEEE Smart Village: Power a Village, Empower Community

IEEE
Advancing Technology for Humanity

Dr. Rajan Kapur
President, IEEE Smart Village

IEEE smart village

MISSION

Our primary mission is to grow LOCAL ENTERPRISES in UNDERSERVED COMMUNITIES around the world

We do not seek financial returns, we encourage the Enterprises To use profits to scale-up, raise other funds, and become self-sustaining

Our goal is to Improve Livelihoods through the (1) Productive use of Renewal energy/technology, (2) Education and (3) Enterprise

We are an All-volunteer team, With part-time support staff

Who are we?

IEEE
Advancing Technology for Humanity

IEEE smart village®

- Institute of Electrical and Electronics Engineers (IEEE)
  - World's largest technical professional organization
  - Dedicated to advancing technology for benefit of humanity
  - Over 400,000 members in 160 countries

- IEEE Smart Village (ISV)
  - A humanitarian initiative of IEEE
  - Focuses on Technology, Education and Enterprise
  - Working in over 18 countries since 2009
  - Impacted over 1.5 million people across the globe

We are a volunteer-run humanitarian organization.

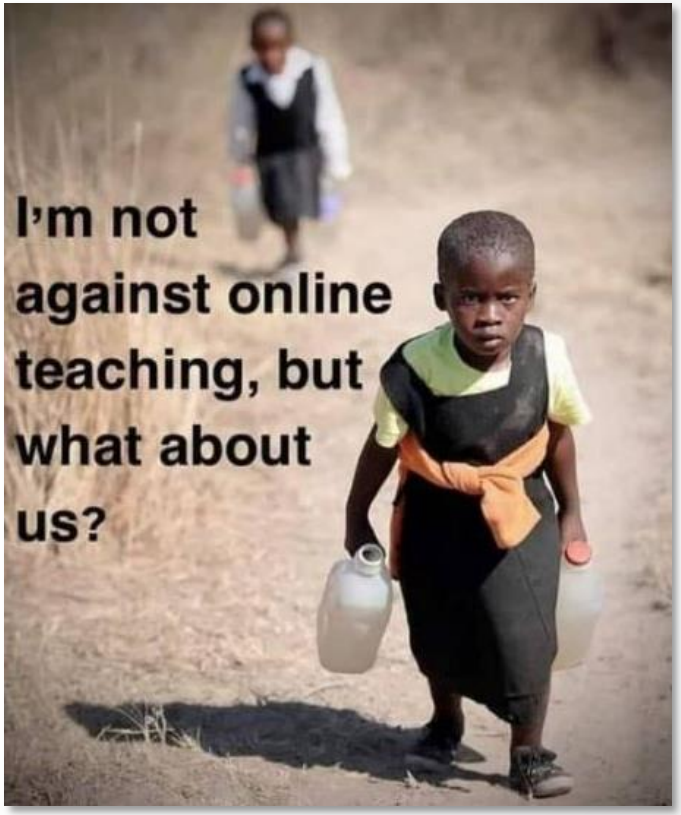
IEEE Smart Village: Motivation

The other one billion

All over the world, millions of people lack access to electricity – they depend on fuels such as wood, kerosene and diesel for lighting, cooking and their livelihoods.

Enter I**EEE Smart Village:**
One **Local Enterprise** at a time

We work to bring
Technology, Education and
Entrepreneurial solutions
To improve livelihoods through
Productive Use of Energy



*from our colleague Chief Edgar Bayani, Malawi, mid-2020
Photograph unattributed

ISV Development Approach

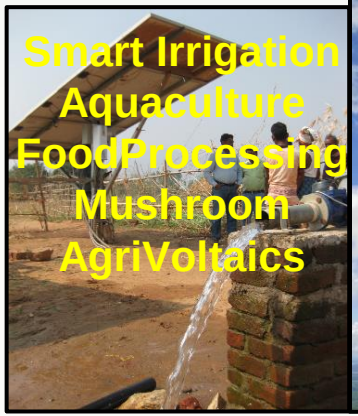
IEEE Smart Village Growth: Lighting to Productive Use

Empowerment Through Enterprise

2011-2020:
Mission: Solar Lighting

Since 2020:
Mission: Productive Use of Technology

Solar Lighting



Smart Irrigation
Aquaculture
FoodProcessing
Mushroom
AgriVoltaics

Telehealth
TeleEducation
TeleCommerce

Beekeeping &
Honey
Processing

Gem Cutting
Jewelry Making

IEEE Smart Village Growth: Regional Working Groups

REGIONAL WORKING GROUPS (RWGs): FRONTLINE CONTACT FOR APPLICANTS

Providing…

- Local presence, local sensitivities, local responsibility,
- Application mentoring, deployment guidance, advisory resources, deliverable auditing

FIVE RWGs

AFRICA
CHINA
LATIN AMERICA
NORTH AMERICA
SOUTH ASIA

Women's Center, Honduras. Courtesy Dr. Morgan Kiani

IEEE Smart Village Growth
Climate and Sustainability

IEEE smart village
Power a Village, Empower Community

Electrification of Rural Economies

Early Highlights

- I. Orajaka (GVE) hosted John Kerry at a Mini-grid in Nigeria; participated in a POTUS hosted business summit, Dec-22 in DC
- P. Loomba (GHE) 40-minute National Geographic documentary on Lighting up villages in the mountains of India

Current Highlights

Shaybis Nigeria Ltd., Nigeria *(IES)*
First of its kind Rice Mill in West Africa uses a 60kW Solar array to fully power rice processing machines

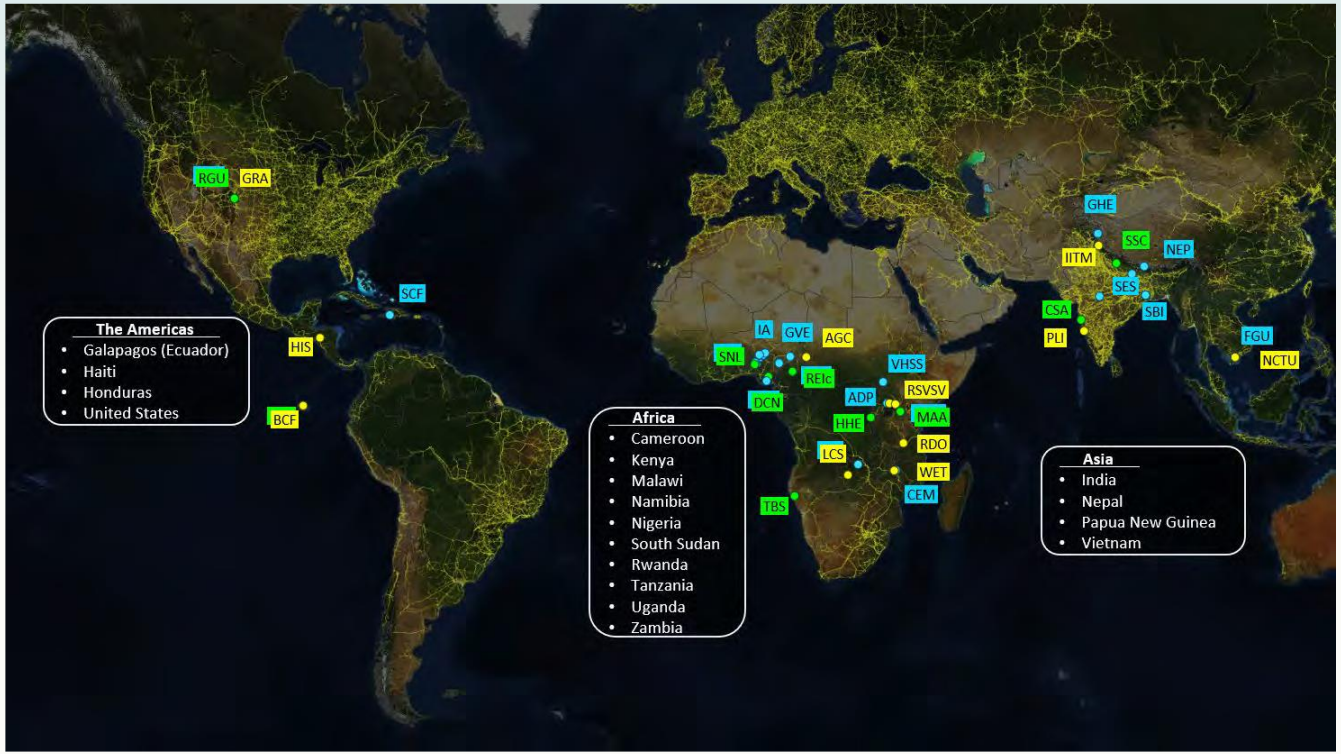
Kuumba Zed, Zambia *(IAS)*
Woman-led enterprise for Solar powered gemstone-cutting in Zambia generates local income. Today raw gemstones are sent overseas.

SunMoksha, India *(PES)*
Solar powered Smart Irrigation in India uses IoT: optimize inputs and maximize yields, on off-grid islands.

New Initiatives

- Internships for IEEE YPs and Students, for membership retention
- Vocational Awareness for Children: Prepare them for an electrified future, not just tests

IEEE Smart Village: Locations



- 87 Projects funded in 18 Countries since 2009
- Currently 16 Active Projects in 9 Countries - Cameroon, Ecuador (Galapagos),
- Honduras, India, Kenya, Nigeria, Rwanda, USA, Vietnam

IEEE Spectrum article about Lingshed Monastery
https://vimeo.com/403961329
d.sackey@ieee.org; m.m.wilson@ieee.org

IEEE Smart Village: Opportunities/Interactions

- IEEE Smart Village

Working Groups - IEEE Smart Village

- Homepage - 2023 IEEE PES/IAS PowerAfrica Conference (ieee-powerafrica.org)
- Smart Village @ PowerAfrica - 2023 IEEE PES/IAS PowerAfrica Conference (ieee-powerafrica.org)

Opportunities for Collaborations and Partnerships

Power Africa | U.S. Agency for International Development (usaid.gov)

Power Africa in Kenya | Power Africa | U.S. Agency for International Development (usaid.gov)

How do we start looking at opportunities?

U.S. INDIA COLLABORATIVE FOR SMART DISTRIBUTION SYSTEM WITH STORAGE

Evolving future energy distribution grids

www.uiassist.org

UI-ASSIST: US-India collAborative for smart diStribution System wIth Storage

N. Schulz, US Lead PI

Washington State University,
Pullman, WA, USA

WSU: A Top Power Program in U.S.

- Educating leaders in industry
- Partnering with government & industry
- Significant & sustained impact







- *Power Professorship program since 1973*
- *Over $4.2M in Research Expenditures in for FY2016*


IEEE PES Power & Energy Society®

IEEE

The Schulz Family

Andrew
PhD ME, Post-doc in Germany

Kirk
President

Noel
Engineering Faculty

Tim (son) & Tricia Schulz
MS CS
Cybersecurity Start-up & National Lab

IEEE PES Power & Energy Society®

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About Me

- Dad, PhD Electrical Engineering & Faculty Member
- Mom, Elementary Teacher
- BS and MS, Electrical Engineering
- PhD, EE with CS minor
- Faculty Experience at
  - Virginia Tech
  - University of North Dakota
  - Michigan Tech
  - Mississippi State
  - Kansas State
  - Washington State
- Research & Teaching Interests
  - Electric power engineering, smart grid, renewable energy, micro-grids

Professional Society Networking Timeline

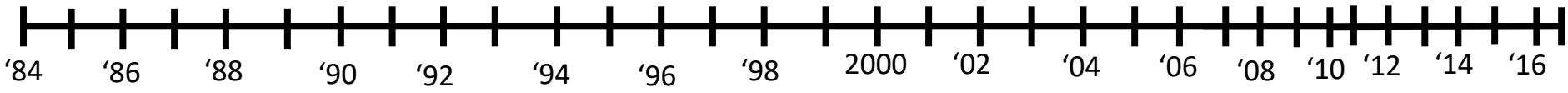
Society of Women Engineers
ASPIRE • ADVANCE • ACHIEVE

IEEE
Advancing Technology for Humanity

New Engineering Educators Division
•Paper Reviewer, Session Chair, Program Chair (1991-1999)
•Chair, 1999-2000
Women in Engineering Division Chair, 2006-2008
Division Representative on Board of Directors, 2008-2010

IEEE PES Power & Energy Society®

Subcommittee Member 1996
Subcommittee Chair 1998-2001
Society Wide Awards & Recognition Chair 2000-2003
Secretary 2004-2007
Treasurer 2008-2009
President Elect 2010-2011
President 2012-2013
Fellow 2016



IEEE PES Power & Energy Society®

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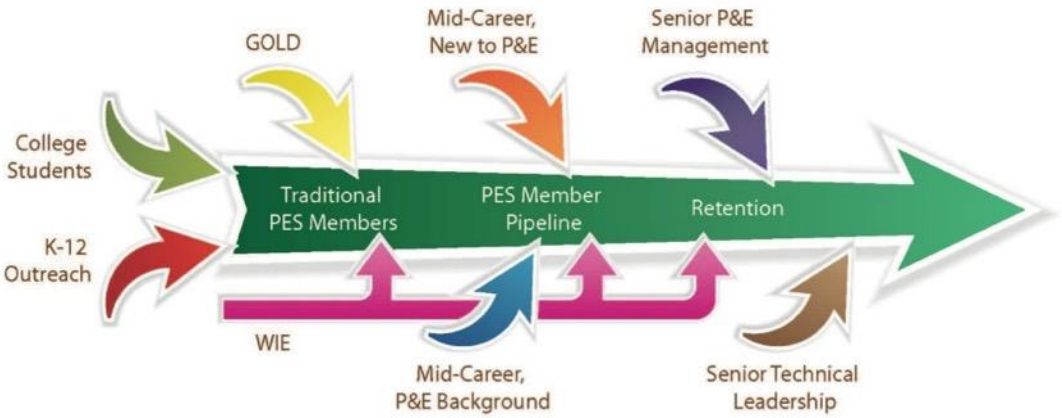
IEEE Power & Energy Society
President Experiences -2012-2013

- Over 35,000 members worldwide
- Traveled over 240k air miles over 2 years including 6 continents, interacting with students and engineering professionals from all around the world
- Two initiatives – pipeline support and women in power

PES Pipeline Efforts



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Women in Power

ISGT Asia 2013 – Bangalore

Africon 2015 – Addis Ababa

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Rural Electrification, Power Education and Africa

IEEE smart village™
Empowering Off-Grid Communities

Empowering off-grid communities through education and the creation of sustainable, affordable, locally owned entrepreneurial energy businesses.

Rural Electrification

Power Workforce

Women in STEM

IEEE PES Power & Energy Society®

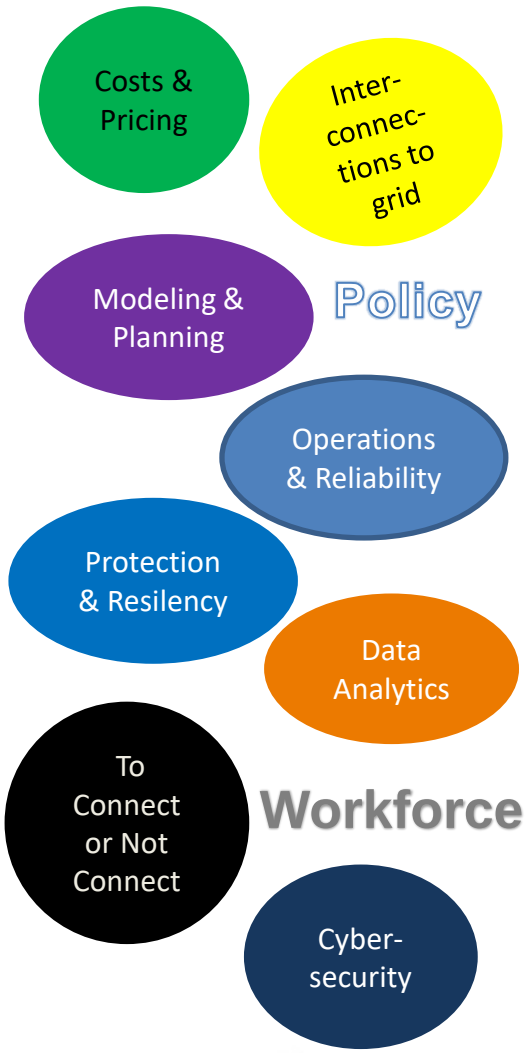
IEEE

SMART DISTRIBUTION SYSTEMS

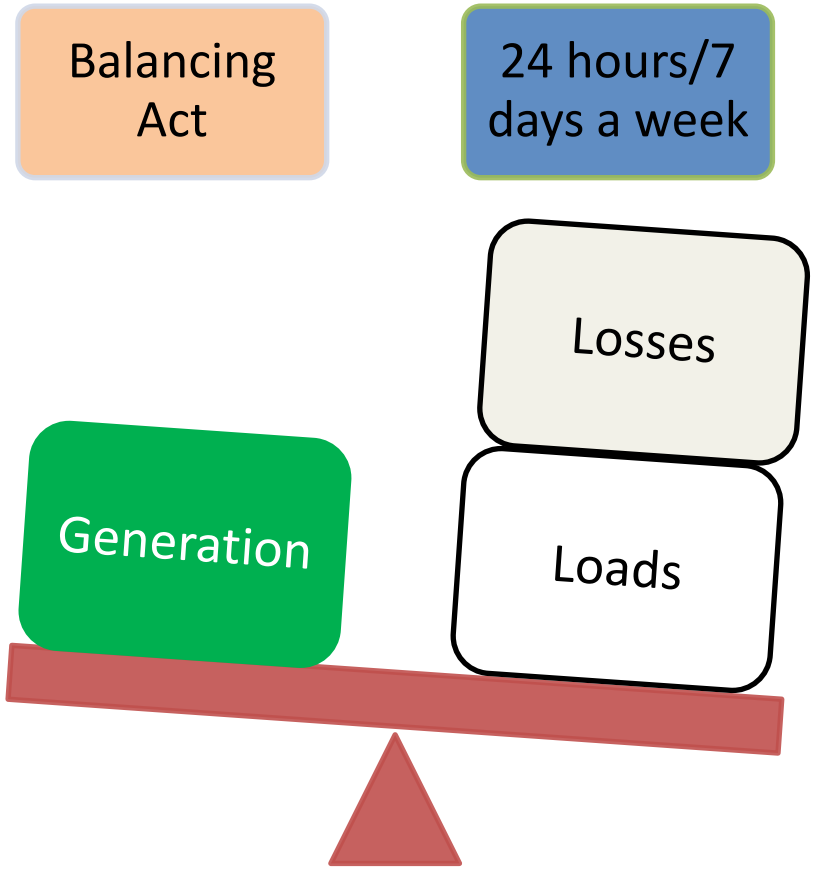
Next Generation Distribution Systems

Traditional Distribution Systems	Next Generation Distribution Systems
Centralized G-T-D power system where power source elsewhere	Distributed Energy Sources (Solar, Wind, Other)
One-direction flow, minimal local control	Power Electronic Devices, Storage and Electric Vehicles
Information at substation and a few other spots	Advanced Metering, Monitoring and Control
Always connected to transmission system	Interconnected versus Microgrids

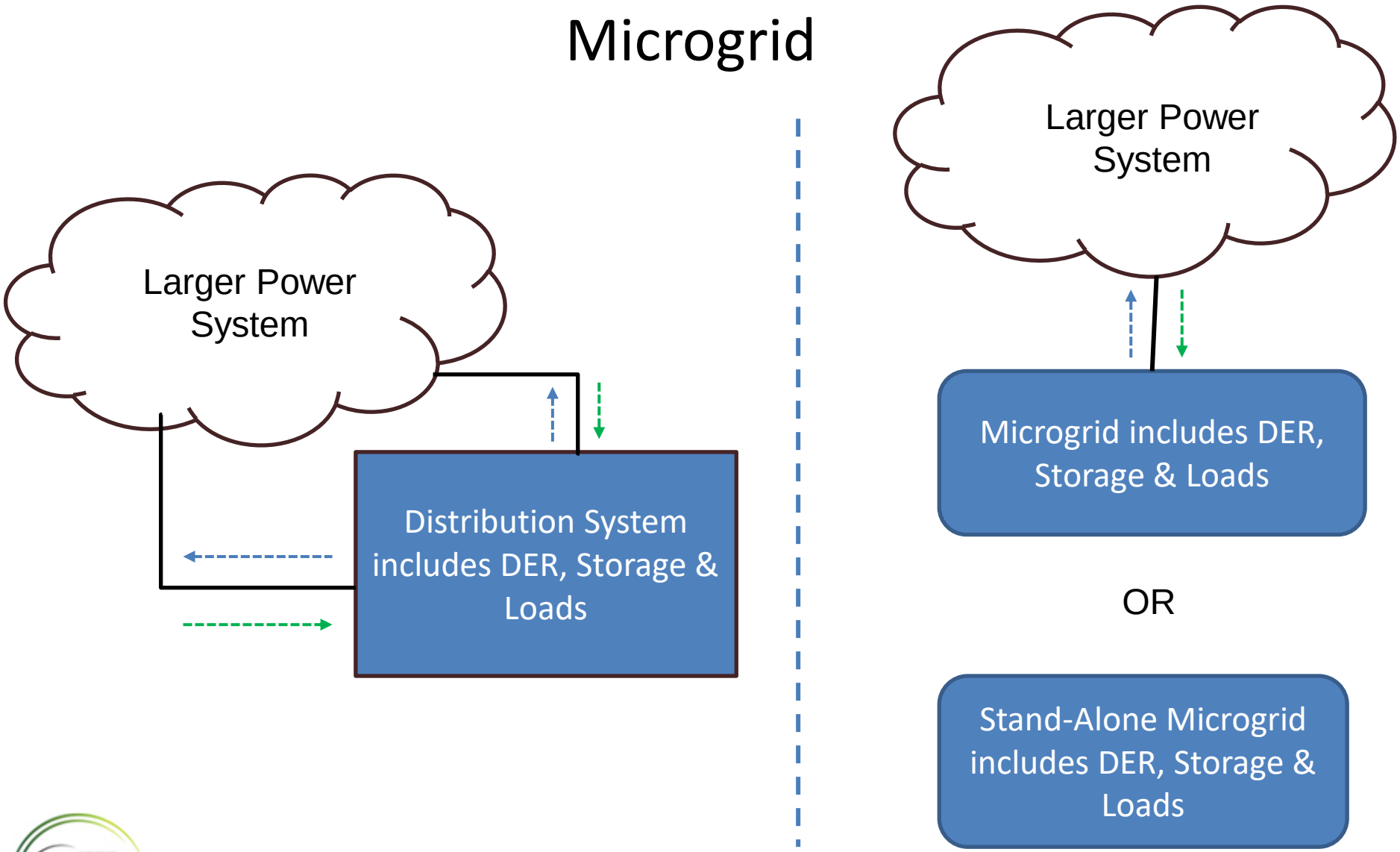
Opportunities & Challenges



Operating a Power System



Interconnected Distribution System Versus Microgrid



Collaborations on Advanced Distribution Systems

ASSIST

U.S. DEPARTMENT OF ENERGY

IUSSTF

Department of Science & Technology, Government of India

सत्यमेव जयते

WASHINGTON STATE UNIVERSITY

TEXAS A&M

West Virginia University.

Massachusetts Institute of Technology

INDIAN INSTITUTE OF TECHNOLOGY MADRAS

teri

HNEI Hawai'i Natural Energy Institute University of Hawai'i at Mānoa

BERKELEY LAB

एनटीपीसी NTPC

BSES BSES Rajdhani Power Limited

Pacific Northwest NATIONAL LABORATORY

NRECA

पावरग्रिड

Uttar Pradesh Power Corporation Limited

NREL Transforming ENERGY

AVISTA

SNOHOMISH COUNTY PUD PUBLIC UTILITY DISTRICT NO. 1

SYNERGY SYSTEMS & SOLUTIONS

Customized Energy Solutions

etap Powering Success

VCS

Panasonic

GE Global Research

BURNS McDONNELL

Digital Solutions Power Transmission & Distribution

U.S. INDIA COLLABORATIVE FOR SMART DISTRIBUTION SYSTEM WITH STORAGE

UI ASSIST

This project is jointly supported by the Department of Science and Technology (DST), Ministry of Science and technology, Government of India, through Indo-US Science and Technology Forum (IUSSTF) New Delhi, under grant no. IUSSTF/JCERDC-Smart Grids and Energy Storage/2017 and the Department of Energy under Award Number DE-IA0000025 for UI-ASSIST.

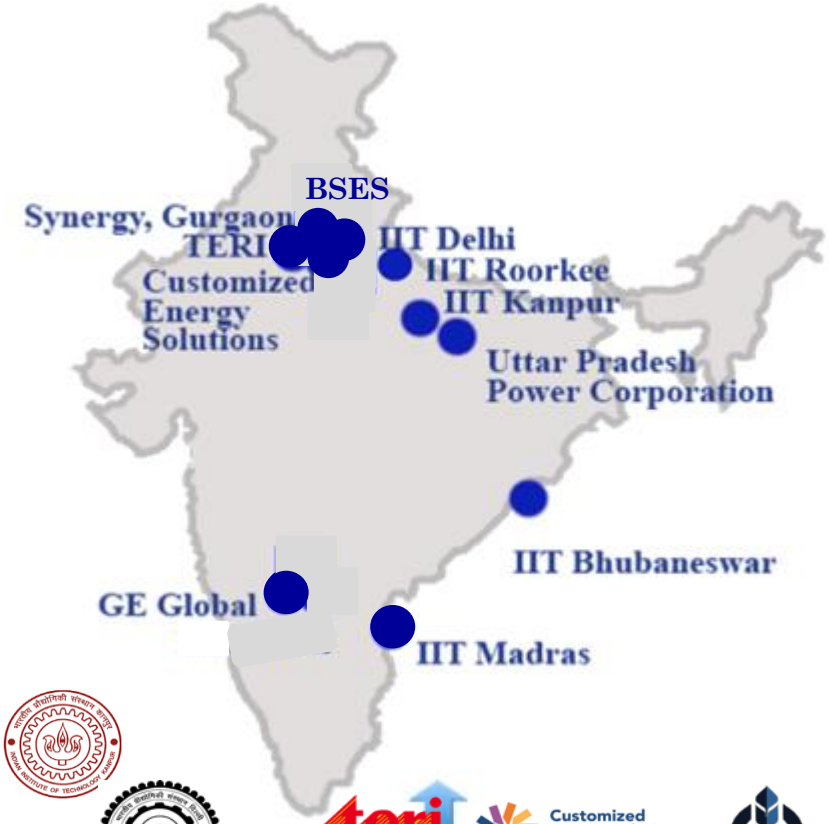
PROJECT TEAM

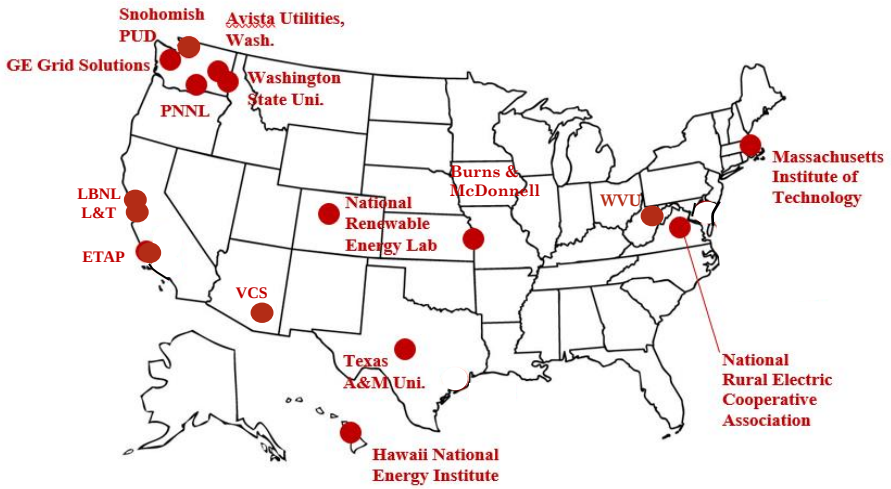
India Leads
S. Mishra
A. Sharma

US Leads
N. Schulz
A. Srivastava

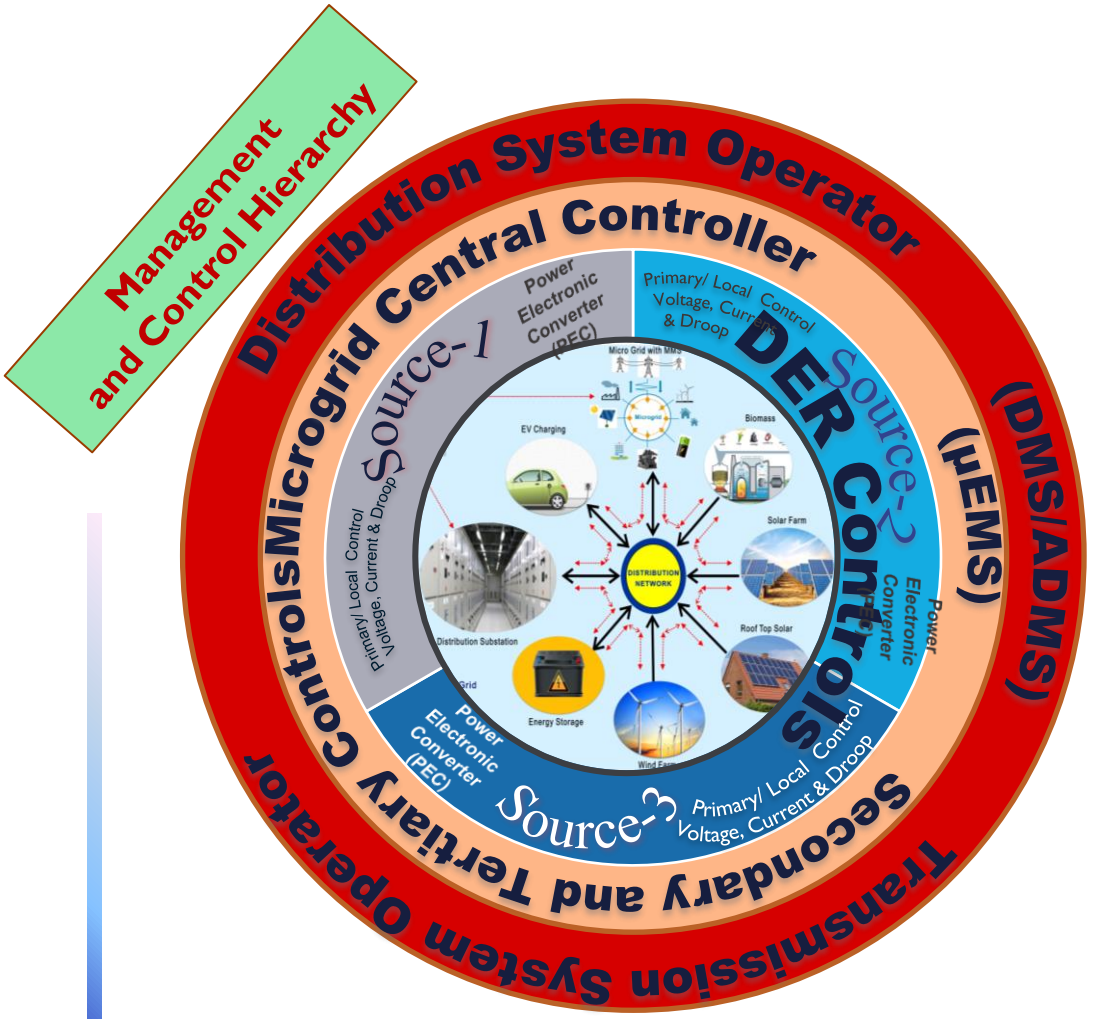
Red Indicates Team in USA

Blue Indicates Team in India



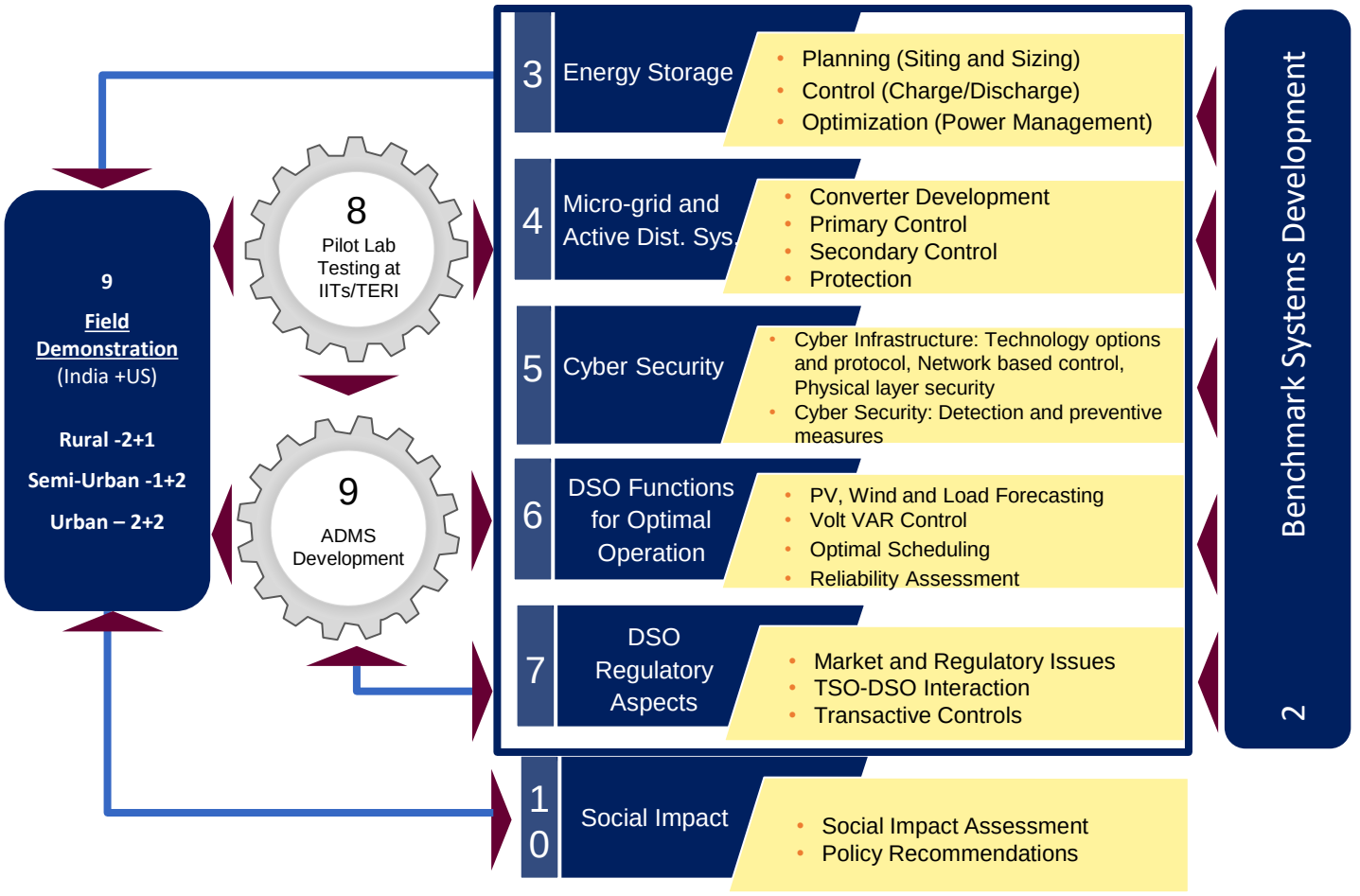


Project Objectives



- *To evolve future distribution grids that will allow the continued increase of Distributed Energy Resources (DER) penetration towards a sustainable electricity system including:*
  - Optimal utilization and management of DERs for enhanced value in secure manner;
  - Interfacing DER, microgrid control system, and Distribution Management System with high penetration of energy storage; and
  - Developing and demonstrating the DSO functions.

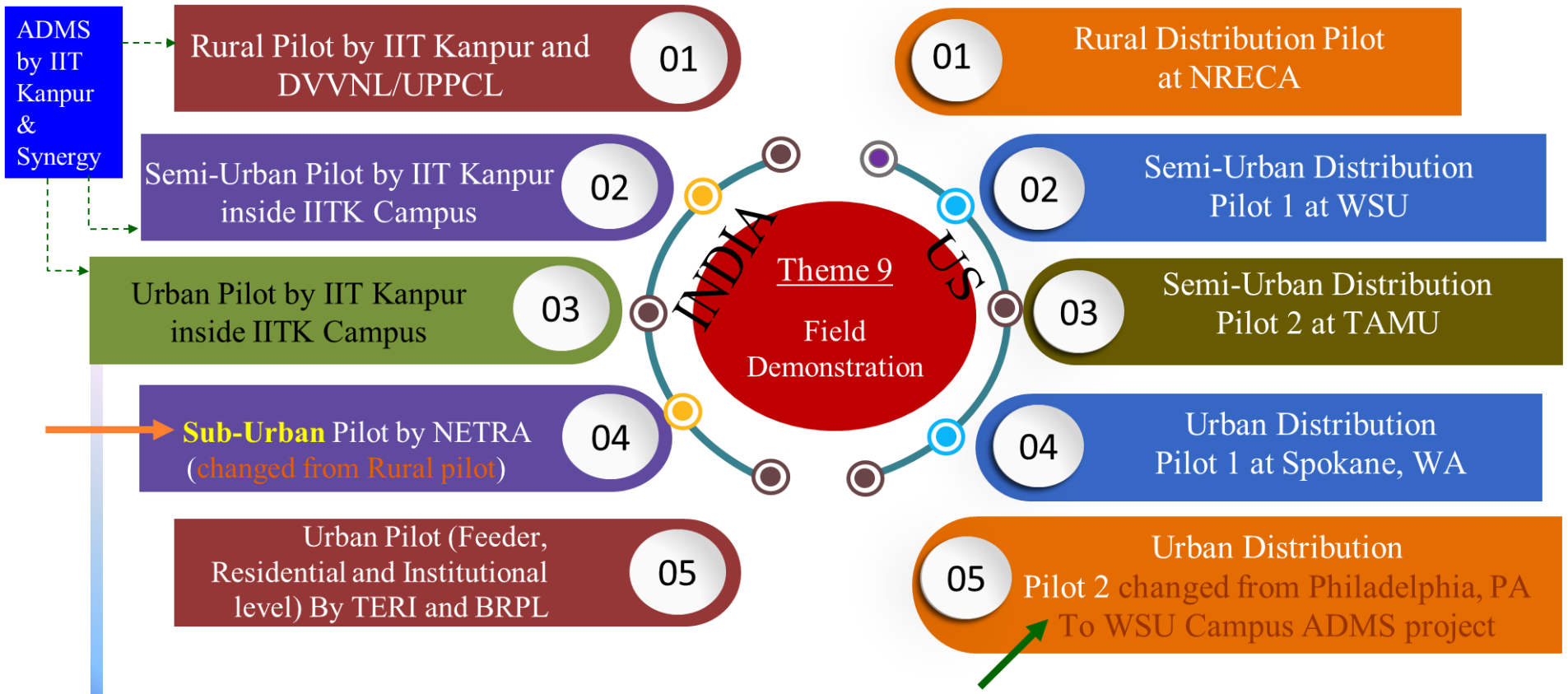
UI-ASSIST: Thematic Areas and Activities



Scientific & Technical Highlights

ASSIST

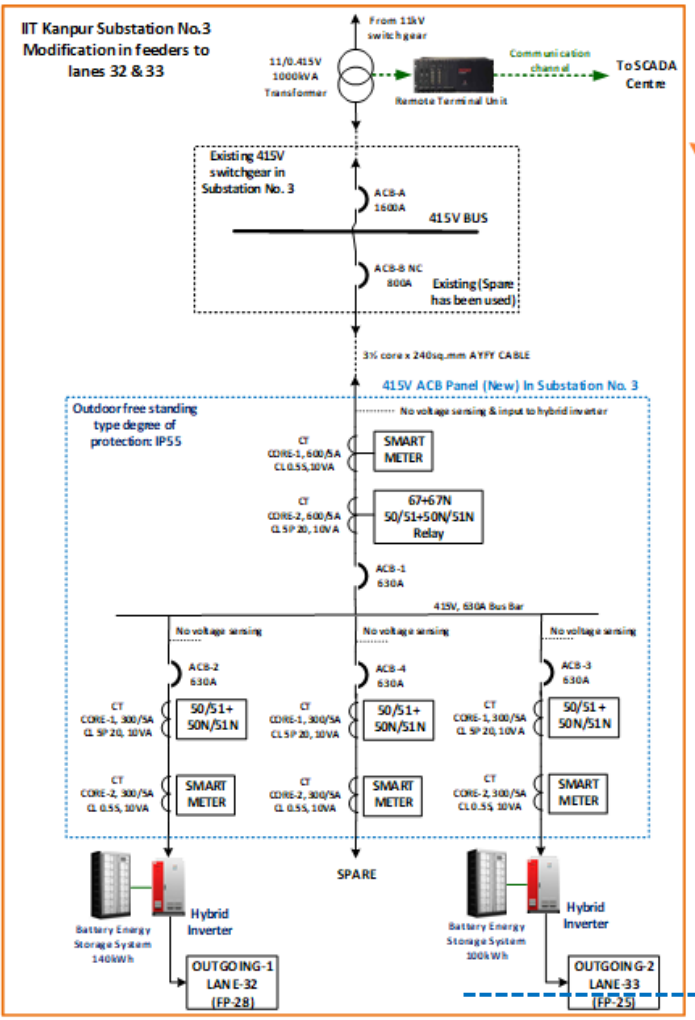
THEME 9: FIELD PILOTS

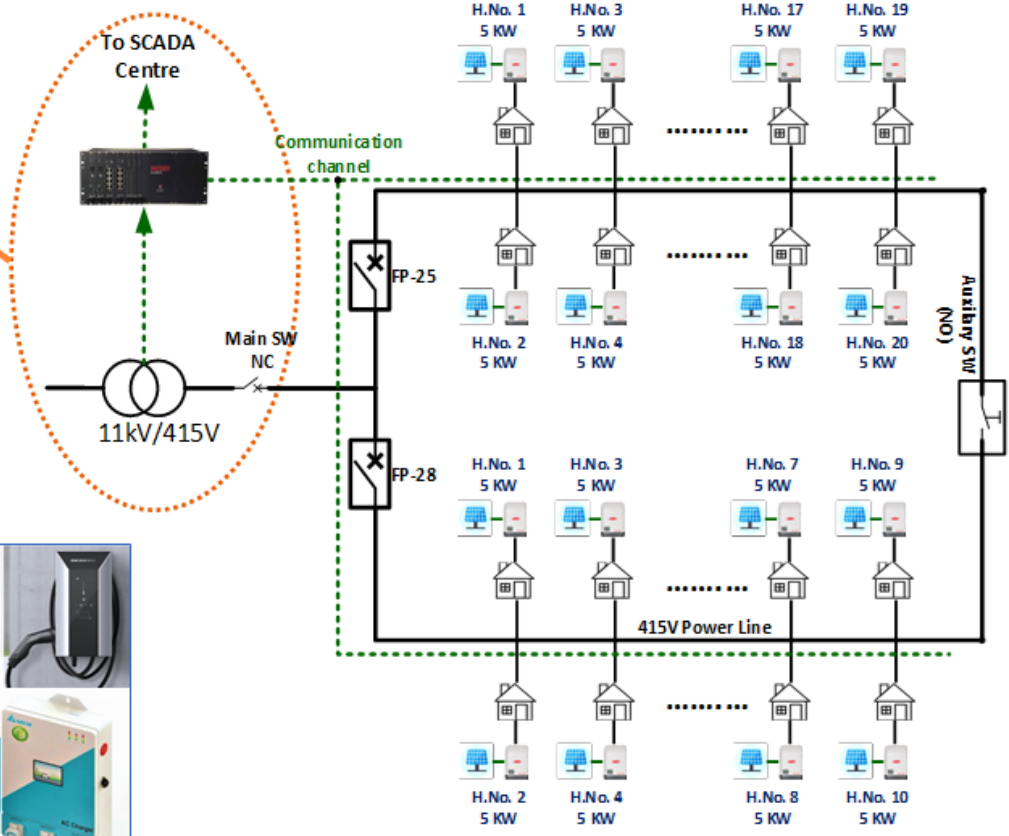


FIELD DEMONSTRATION PILOTS BY IITK, DVVNL/UPPCL

Pilots	Exact Location	Solar PV / Biomass	Battery Storage (Li-ion LFP) / EV charging	Agency Implementing and Status
Rural - Harnoo Village (45 km from IITK)-DVVNL partner	Chabbaniwada Hamlet	70kWp SPV	50 kW, 100 kWh	Siemens Ltd., Gurugram, India
	Bargadiya Purwa Hamlet	30 kWp SPV 30 kW Biomass	50 kW, 100 kWh	
Semi-urban (single storey housing within IITK campus)	Lane-32 & 33 Housing roof top, BESS at substn.	30x 5kWp rooftop SPV in both lanes	70 kW, 140 kWh in lane 33, 50 kW, 100 kWh in Lane-32	
	EV charging (2)-Type-2 Community Centre & Taxi stand	1- 25 kWp SPV at each location	1-AC 3Φ slow, 1-DC Fast, 3-1Φ E-Rickshaw chargers, 1-1Φ EV charger with E2H at each station	
Urban (Two multi-storey Buildings and one academic Building within IITK campus	Faculty Residential tower blocks C & D	25 kWp roof top SPV in each tower	25 kW, 50 kWh in each tower	
	Centre for Env. Science and Eng. Building	-	545 TRHR Thermal storage +230 TRHR existing made operational.	Kehems Eng. , Indore, India Commissioned in Nov 2020, Integrated with SCADA/ADMS.
DSO-ADMS Development	Smart Grid Control (existing SCADA)	Being implemented by Synergy Systems Faridabad, India (industry partner), Functional Design spec. finalized, Application functions being tested and integrated.		

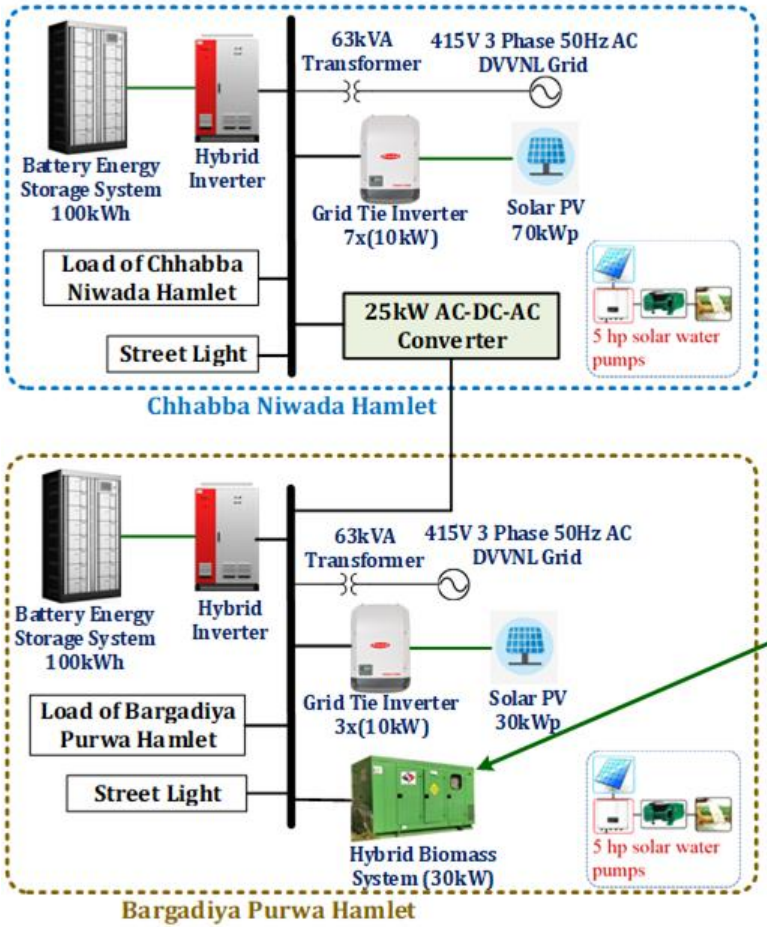
Semi-Urban Field Pilot inside IIT Kanpur



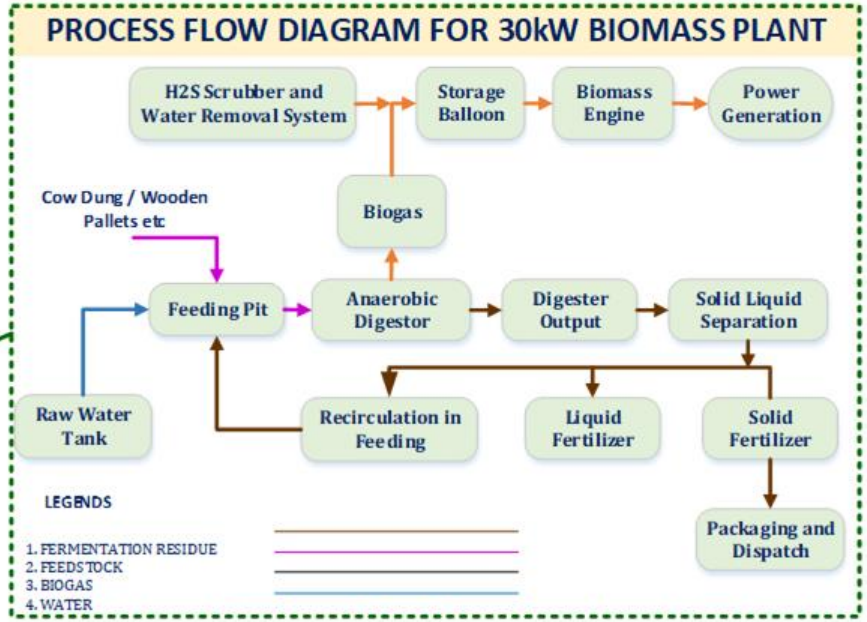


2 EV Charging Station with 25kWp SPV

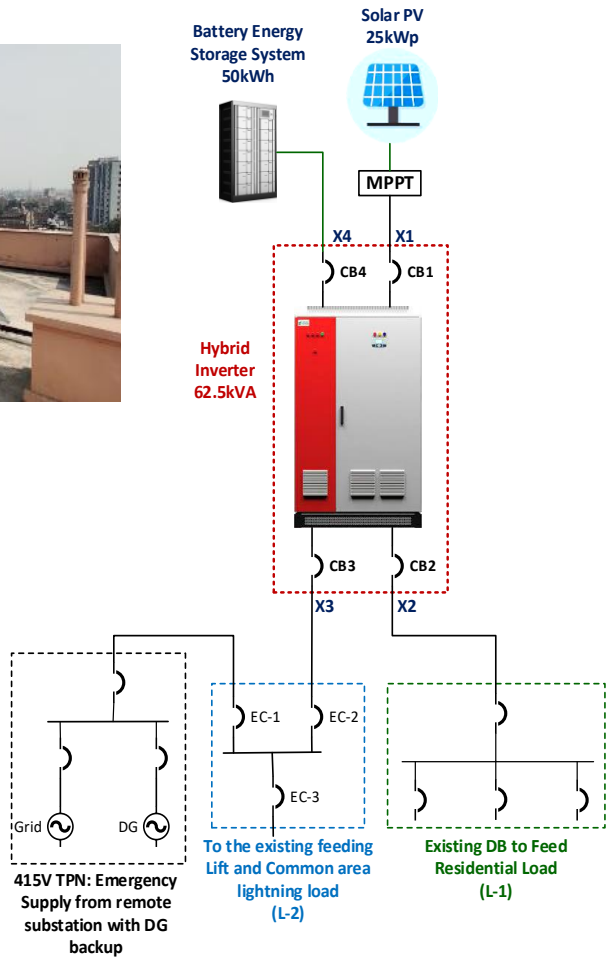
RURAL PILOT-SCHEMATIC AND RECENT ACTIVITIES



- New Community Management Model: Through a local society, already approved.
- Single Point metering by utility in each hamlet.



Urban Field Pilots inside IIT Kanpur



Roof Top SPV and Storage-Faculty Housing Towers C&D

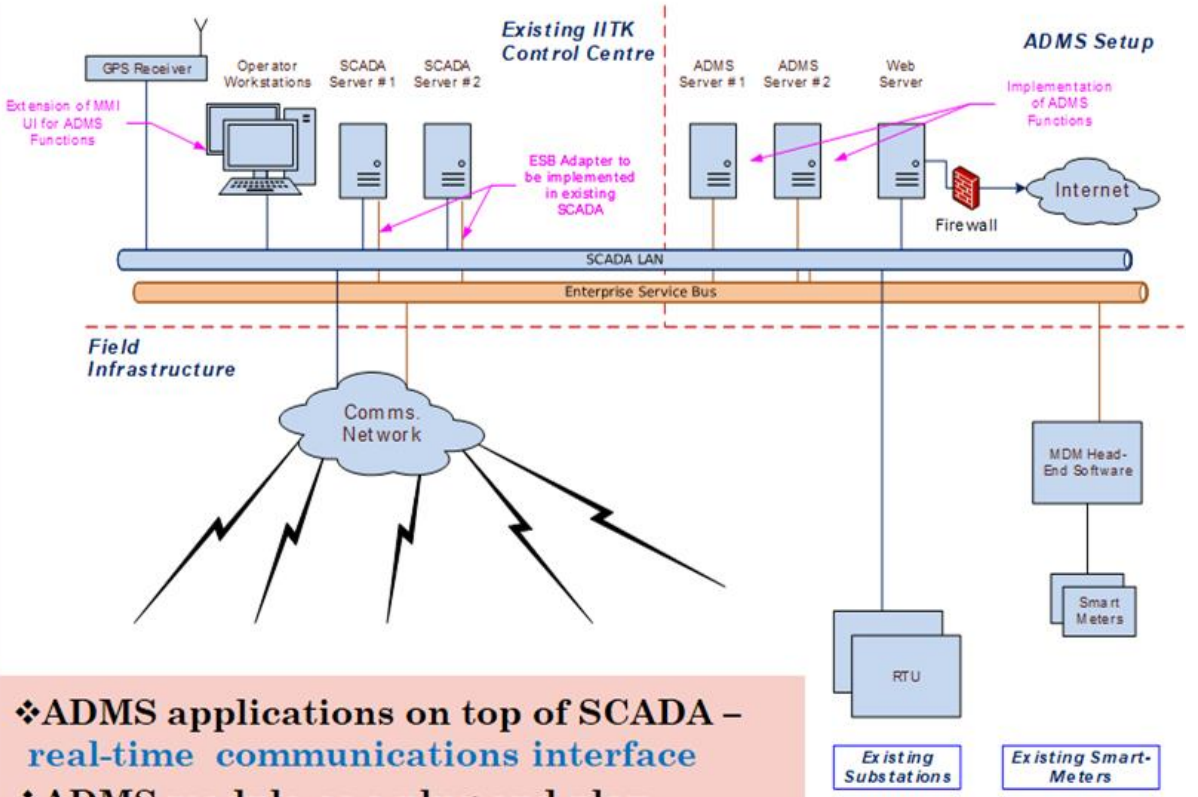
Thermal Energy Storage System

- During night hours, building AC load shall be met from Institute central AC plant, and during peak load time (11:00 to 17:00 hrs) by the TES system.
- Peak load management by TES system through SCADA system as part of ADMS.

ADMS Architecture and Functionalities

1) **ADMS functions in first phase**
   a. Topology Analyser
   b. State Estimator
   c. Distribution Power Flow
   d. Fault Location, Isolation Service Restoration
   e. Volt/VAR Optimisation
   f. Switch Order Management
   g. Loss minimisation via feeder reconfiguration
   h. Load balancing via feeder reconfiguration
2) **Interface to the following systems:**
- Geographical Information System
- Outage Management System
- Meter Data Management System, Billing System
- Weather forecast

3) **Playback / Training Simulator**



❖**ADMS applications on top of SCADA – real-time communications interface**

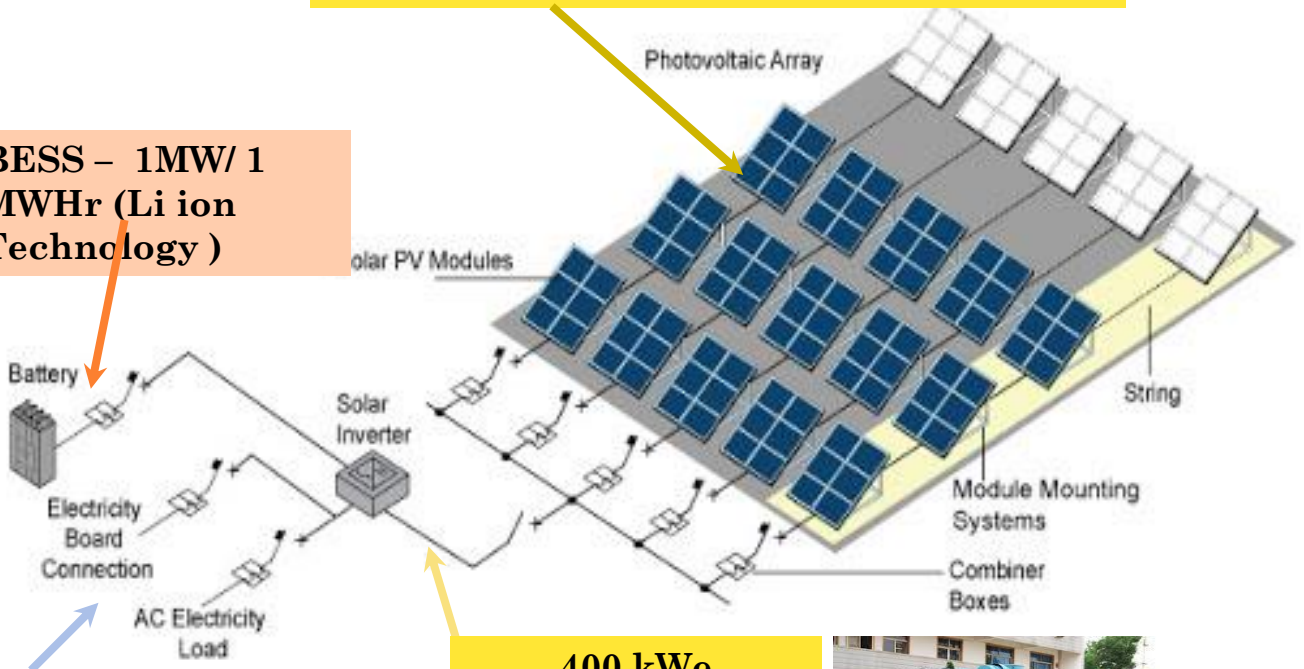
❖**ADMS module as a plug and play – distributed architecture**

❖**Separate ADMS database around CIM**

Urban Pilot by NETRA (likely to be completed by Oct. 2022)

Ground Mounted Solar PV – 4 MWp

BESS – 1MW/ 1 MWHr (Li ion Technology)



Utility Supply 6MVA at 33 kV

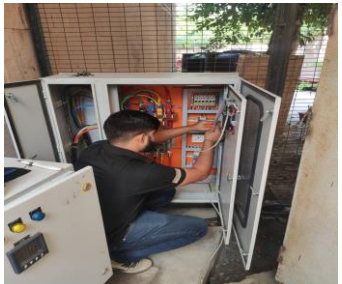
400 kWe MSW Power Gen (In Campus)

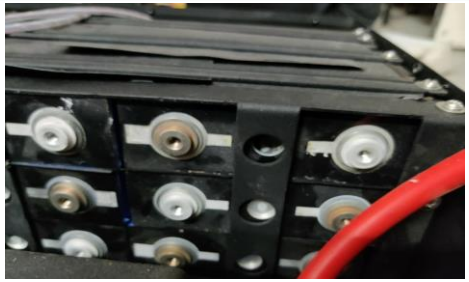
- **Solar Photo Voltaic Plant** : 4 MW Ground Mounted Solar Photo Voltaic plant
- **Battery Energy Storage System:** 1 MW / 1 MWHr Li ion technology based BESS
- **Load and Source Prioritization :** Smart controller to maximize the renewable generation with minimum grid support and prioritize in campus loads

TERI'S URBAN PILOTS IN BRPL SYSTEM NEW DELHI

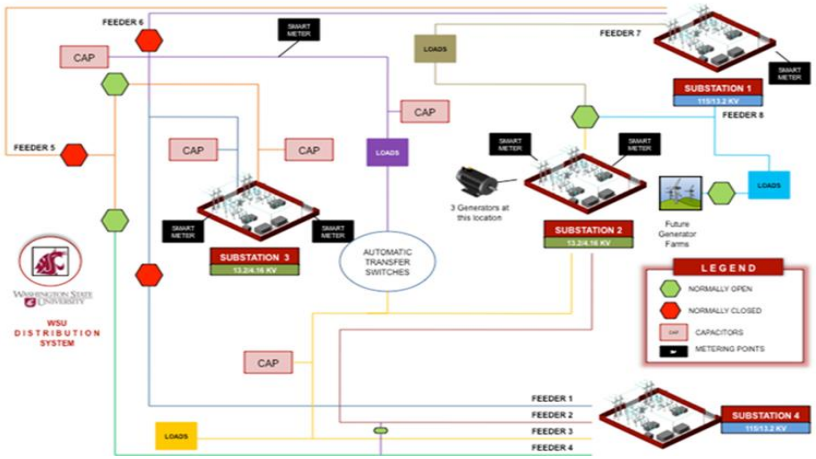
(Likely to be completed by 2021)

Pilot Locations	BESS Design Capacity	Selected Battery Type	Application (s)	Inter-connection Point for BESS Integration
Category A – DT Level (New Friends Colony, Taimur Nagar)	288 kWh (4*72kWh stack)	LFP	**Primary:** overload management of DTR **Secondary:** energy time shift	At Low Tension terminal of 990 kVA DT
Category B – Gated Community (Ispatika Society, Dwarka, Sector-4)	216 kWh (3*72 kWh stack)	LFP	**Primary:** back-up power **Secondary:** energy arbitrage	At DG Output terminal wherein Grid reference signal is received
Category C – Institutional Campus (TERI School of Advanced Studies, Vasant Kunj)	72 kWh (1 stack of 72 kWh)	LFP	**Primary:** energy time shift **Secondary:** dispatchable solar PV generation	At Low Tension terminal of 1600 kVA DT



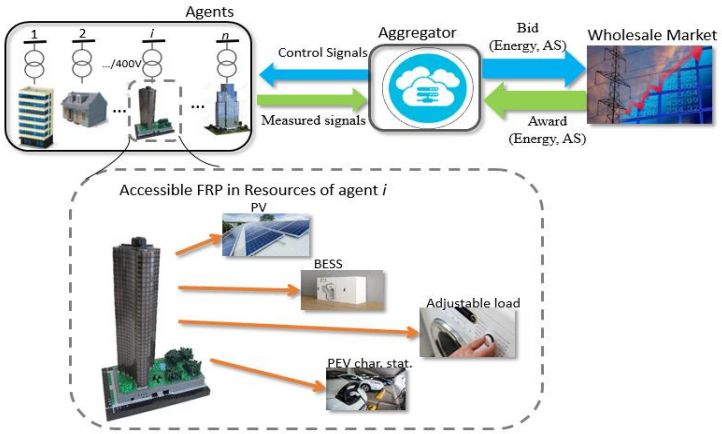


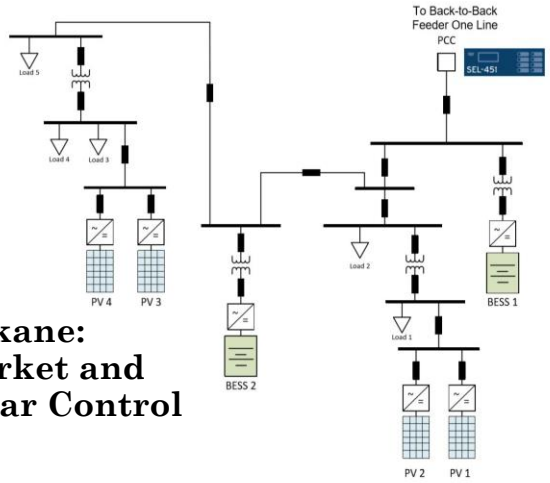
US Pilot Demonstration Projects 2022-2023



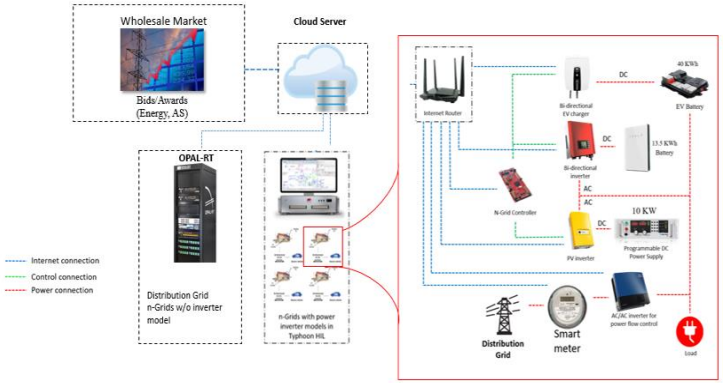
WSU: Microgrid and Battery integration

TAMU: Nanogrid Controller and Transactive Energy





AVISTA-Spokane: Distribution Market and Distributed Volt/Var Control



Cyber-physical Synthetic Electric Distribution Network (CP-SyNet)-WSU, HNEI, ETAP,NREL,TAMU

For Extending Industry Feeders AND Validating New Technologies

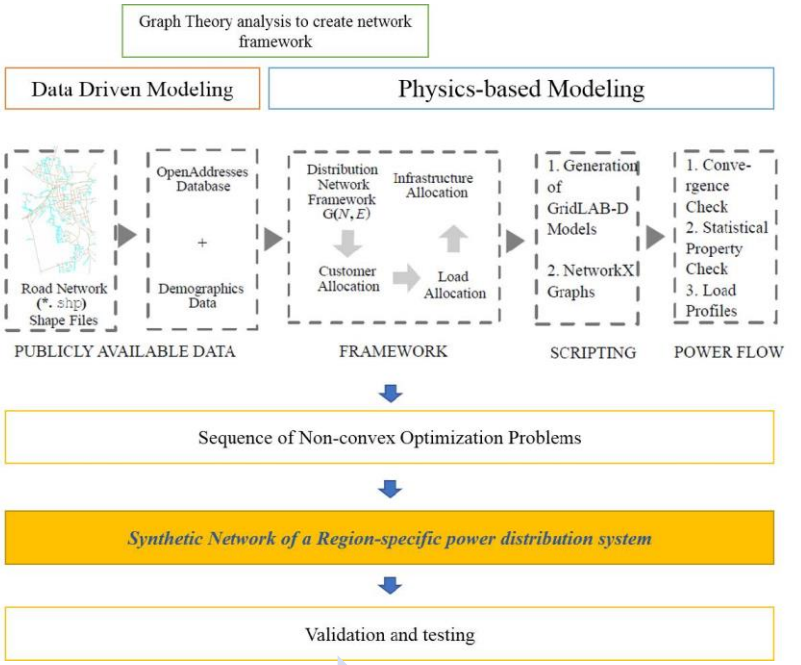
For Researchers

Customized Cyber-Physical Synthetic Electric Distribution System (CP-SyNet)

Network Size	Network Type	Configuration
10-20	Rural	Radial
20-40	Semi-Urban	Mesh/Ring
100-200	Urban	
200-400	Standard	

Type of Distribution	Inclusion of DER	Cyber layer
Primary	Standard system	with communication network
Secondary	With PV and BESS	Standard system
Both		

For Industry Feeders



Offline | Real-time | Field pilot models | Synthetic models | Cyber-physical models | **Feeder models**

ADMS-MEMS Interactions-TAMU, WSU,GE,VCS

- Constructed, validated and simulated a microgrid model to investigate the protection mechanisms.
- Developed an optimization algorithm for power scheduling at each nanogrid with the objective of loss minimization.
- Worked in collaboration with IITR on a novel effective control and management scheme of DC microgrids.
- The energy management system of a MG (MEMS) ensures stable and reliable operation of a MG.

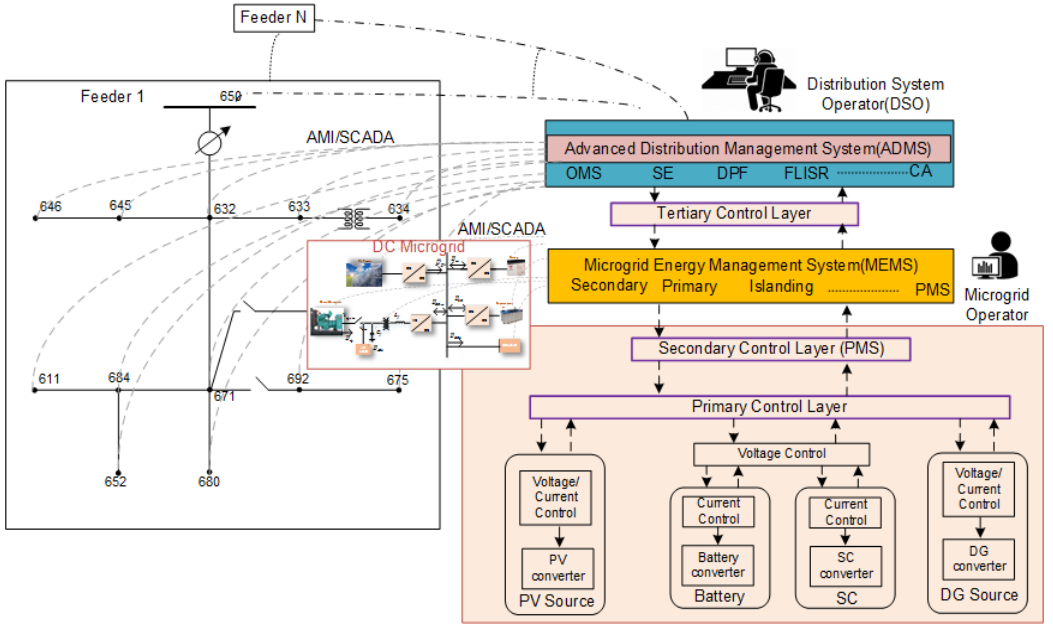


Fig. ADMS-MEMS Interaction strategy for DC Microgrids

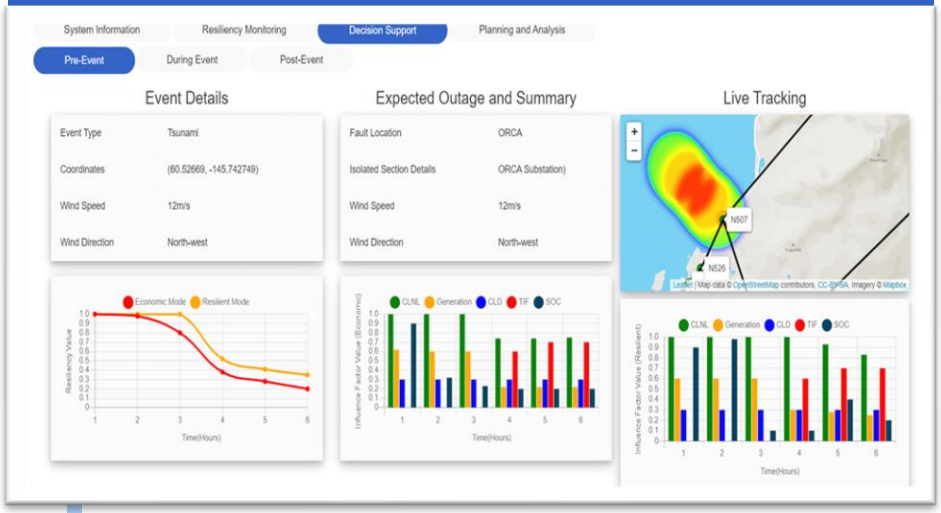
MEMS strategies | Reconfigur-ation | Control of Networked Microgrids | Loss optimization | Protection coordination schemes | **ADMS**

Resilience Management Tools-WSU, NREL

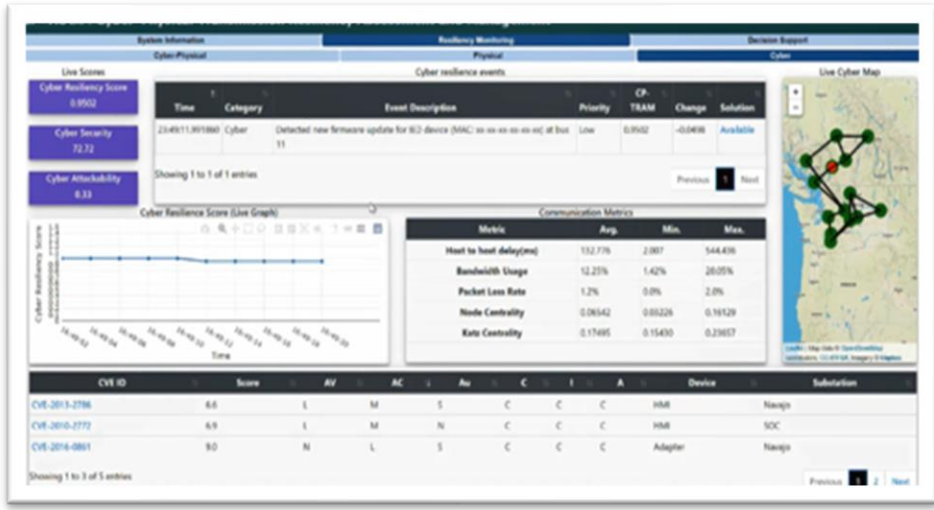
Resilience – ability of the electric grid to supply power to its critical loads at all substations, in the face of grid stress events.

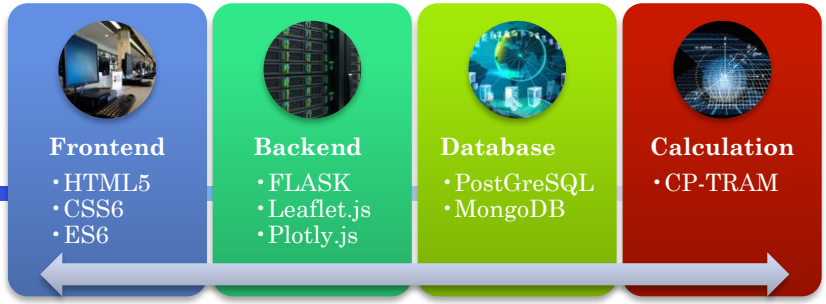
- R-PIA– Resilience Planning and Investment Analysis tool
- CP-SAM: Cyber Physical security analysis metric-based tool

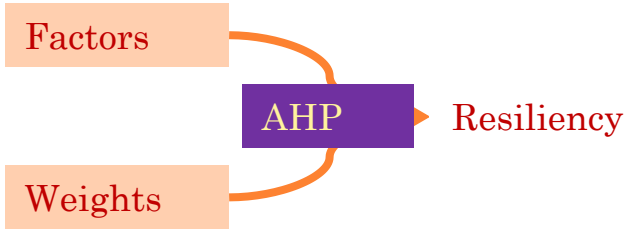
R-PIA– Resilience Planning and Investment Analysis



CP-SAM: Cyber Physical security analysis metric based tool







Data Driven Techniques-ETAP, HNEI, WSU, MIT

- **Key Activities :**
- Load profiling & forecasting techniques
  - Point and quantile (probabilistic) load forecasting
- Behind-the-meter Load and DER Disaggregation using machine learning techniques.
- PV forecasting based on ground-based sky-camera
  - Day ahead, hourly and minute interval datasets
  - Visualization tools on solar radiance predictions
  - Affordable High-Resolution Irradiance Prediction System (AHRIPS)
- Machine-learning-based algorithm for power system event analysis
- Model predictive control (MPC) based distribution network service restoration scheme
- AI driven distribution feeder restoration schemes.

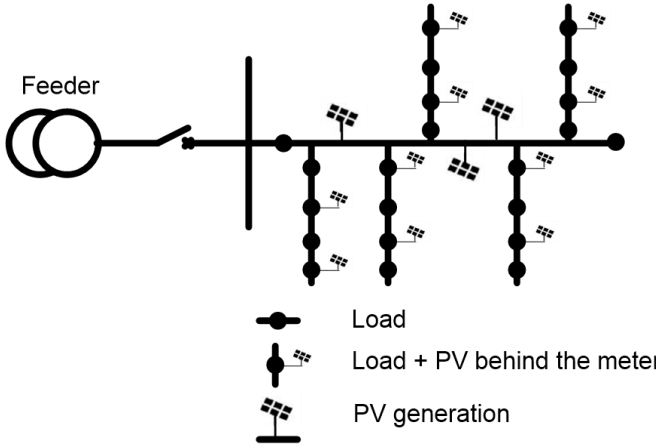
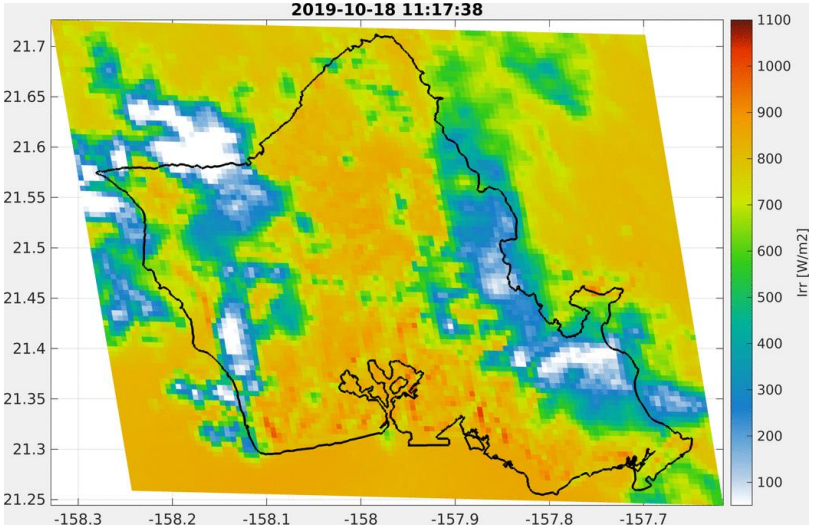


Fig. Behind-the-meter (BTM) Load and PV Disaggregation

Recent pictures of HNEI's ground-based sky imager for minutes-ahead PV forecasting.



Irradiance nowcast over Oahu for midday hours of October 18, 2019

Reliability Assessment with DERs-TAMU

- TAMU performed reliability analyses for a single residential system located in these five different climate zones, at the five locations in top figure.
- TAMU analyzed the variation of reliability indices against variation of the rated capacity ratio (RCR), and variation in the capacity limit of the energy storage installed.
- Analysis shows that reliability of the residential system is dependent on the location of the system. Hot-Dry/Mixed-Dry and Hot-Humid zones have an improvement in reliability.
- As RCR of the DG system increases SAIFI and SAIDI decrease.
- There is an initial increase in SAIFI for RCR less then 0.75, this can be attributed to customers experiencing multiple interruptions during a given outage time from the grid due to lack of sufficient power from DG output.
- Indices improve with increase in RCR from 0.75 to 1.5, increasing the RCR higher does not yield significant improvement in the indices.

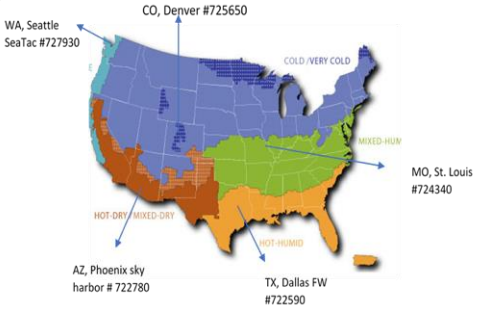
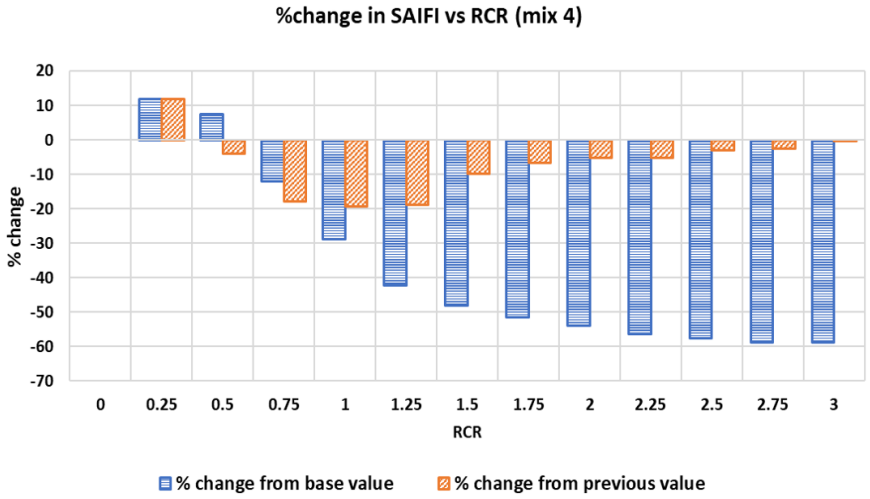
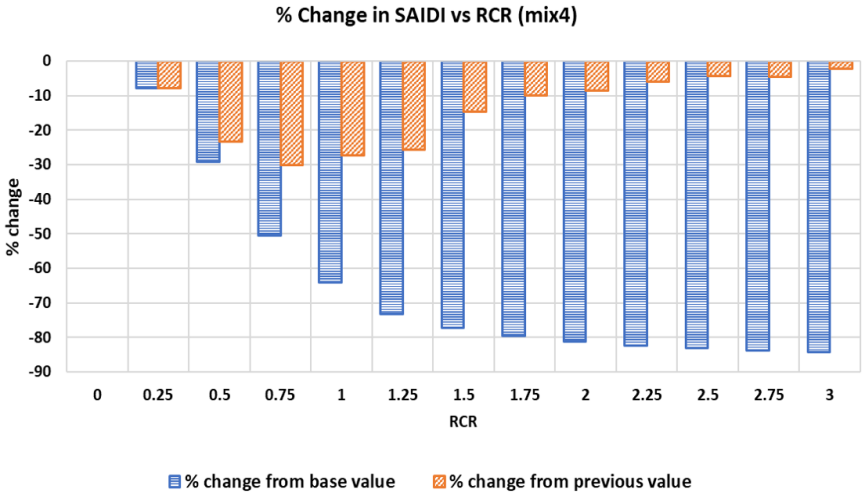


Fig. Climate zones defined by Building America



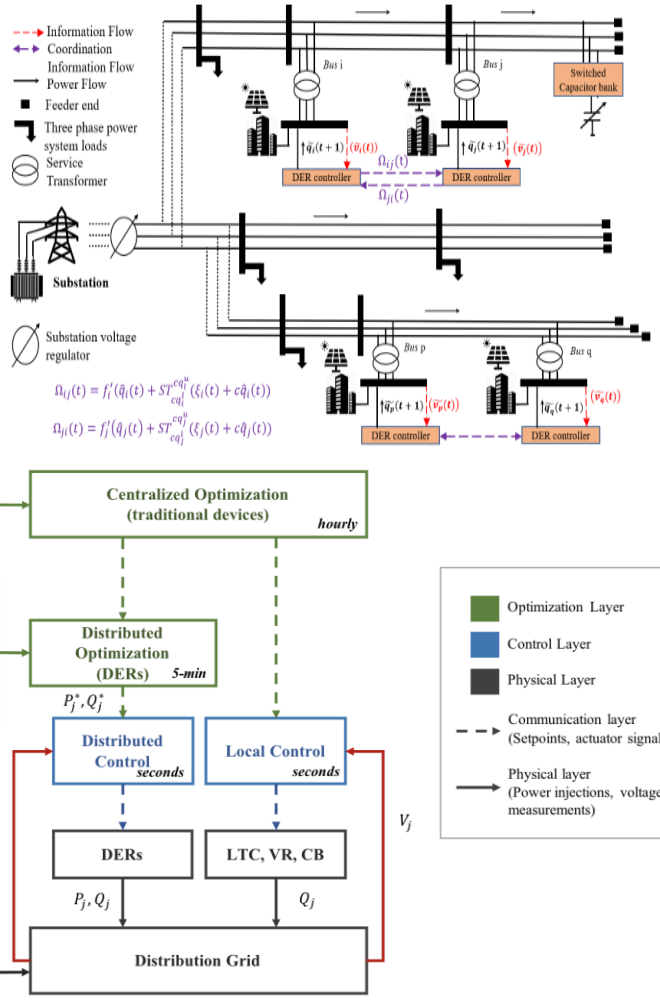


Algorithms for Volt/Var Control with Enhanced DERs
MIT, WSU, TAMU

CENTRALIZED, DECENTRALIZED, DISTRIBUTED, HOLONIC, HIERARCHAL, AND HYBRID ALGORITHMS FOR DER VOLT-VAR CONTROL

Key Activities :

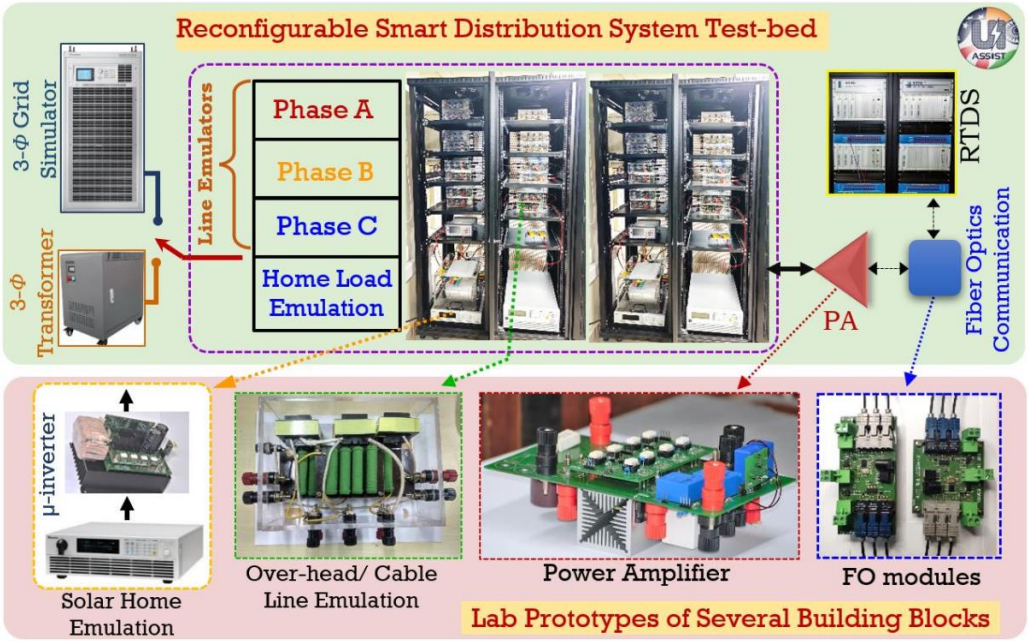
- Developed localized Volt-VAR optimization method for power loss reduction through PV inverters in IEEE 123-node system to test its capacity.
- Implemented voltage support pricing in distribution grid.
- Developed PAC (proximal atomic coordination) algorithm.
- Utilized the CI (current injection) model with PAC to implement distributed Volt-Var Optimization (VVO) for the unbalanced distribution grid,
- Extended the proposed CI model employing McCormick Envelopes to convexify the power flow equations for meshed and unbalanced networks.
- Integrated decentralized voltage control algorithm with consideration of PV generation and EV charging demand
- Developed online distributed optimal voltage control algorithm for multiphase distribution feeders
- Tested proximal ADMM-based algorithm for voltage control



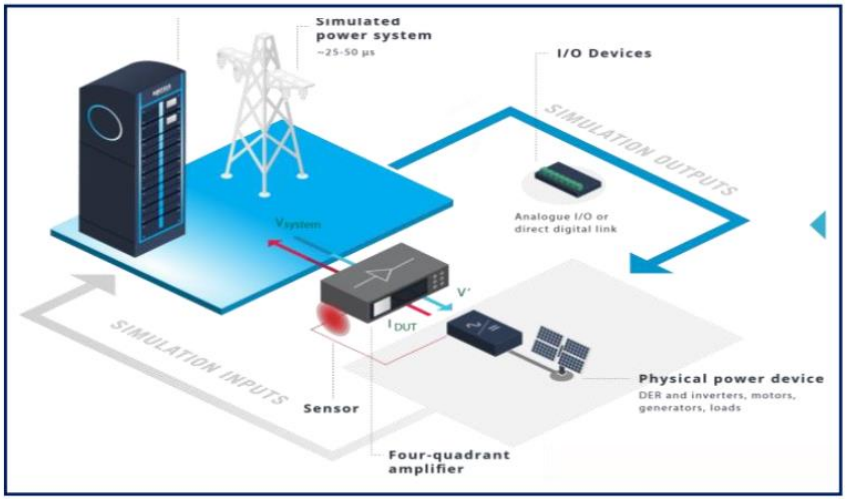
Retail Market to Support Enhanced DERs

MIT: Retail market mechanism	Optimally managing and scheduling DERs.
WSU and MIT: Retail Market Regulation (Clearance)	If distribution connected resources are cleared by ISO markets, how will federal and local regulations overlap?
WSU and MIT: TES environment	Multiple possible transactions (centralized, peer-peer).
MIT: Proximal Atomic Coordination algorithm (PAC)	Focusing on the privacy for market applications.
MIT and IITD: Retail market	Interactions of the DSO and TSO.
TAMU: n-Grid market participation	Participation of aggregator-nanogrid interaction in the wholesale market

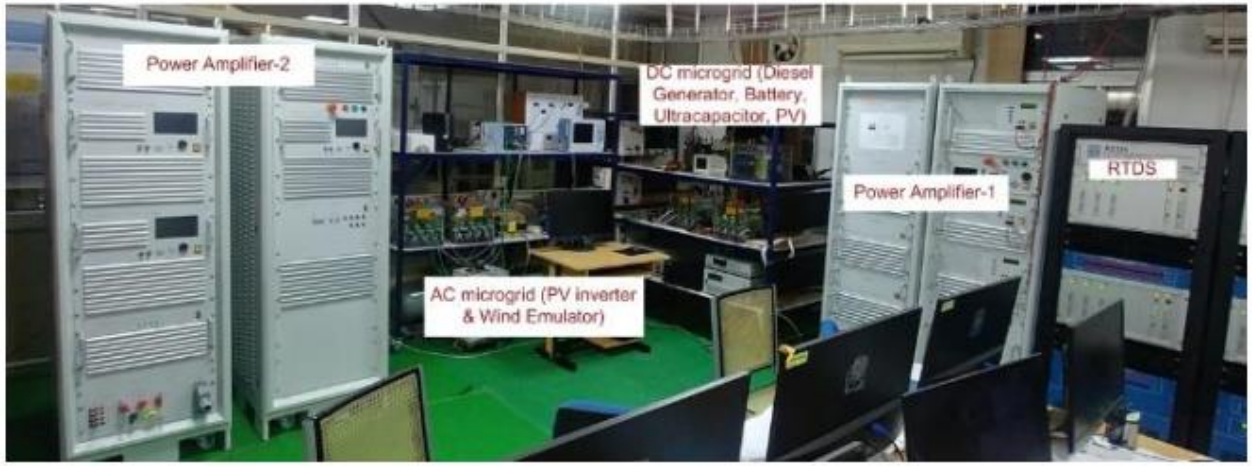
India Lab Test Beds



IITK: Reconfigurable Test Bed

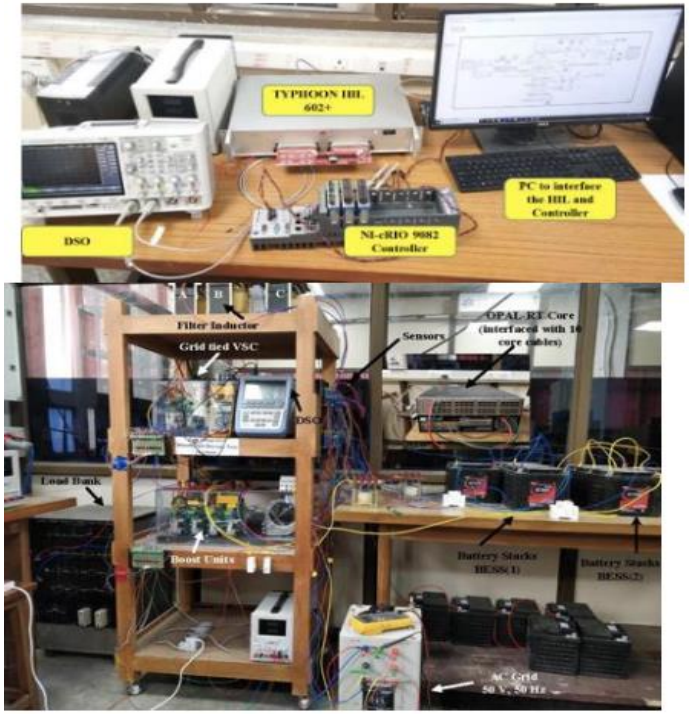


IITKBBS: Protection in Microgrids



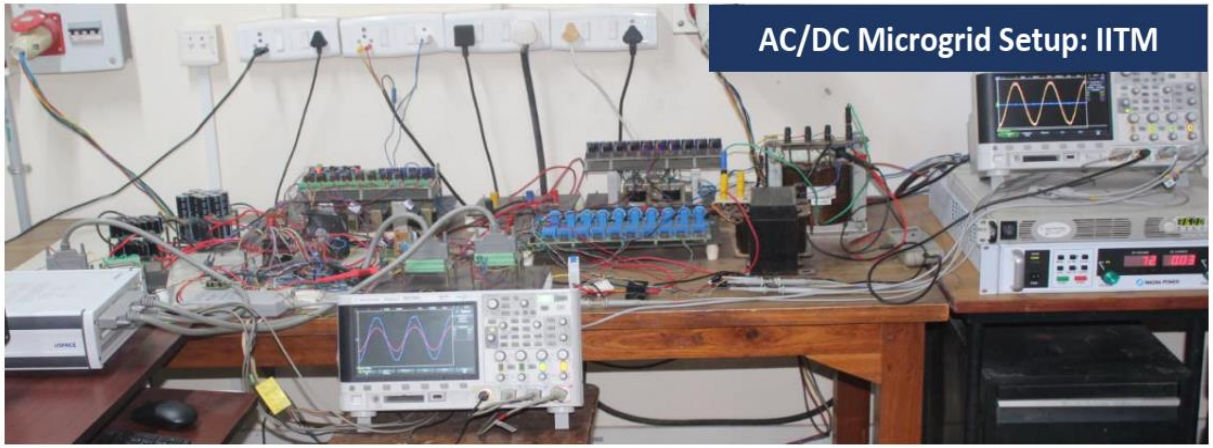
IITR: AC-DC Microgrids

India Lab Test Beds



IITD: DERs in Microgrids

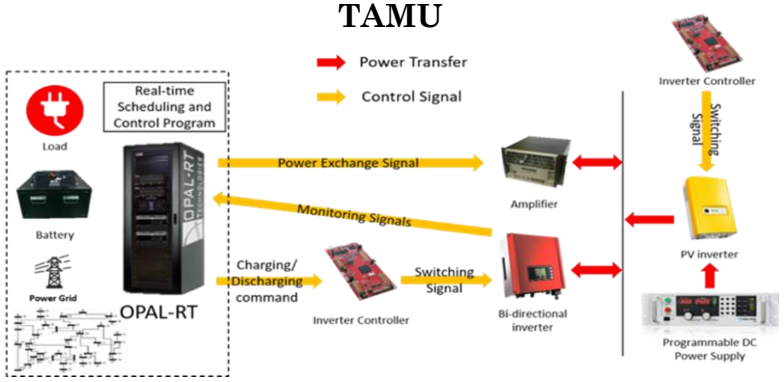
TERI: Operations and Control of Microgrids



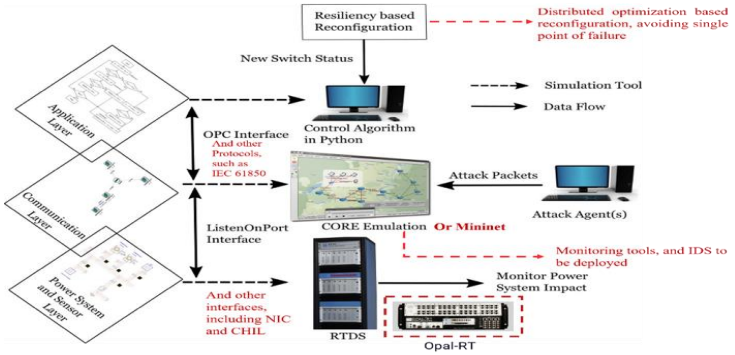
IITM: Storage in Microgrids

US- Lab Testing and Validation

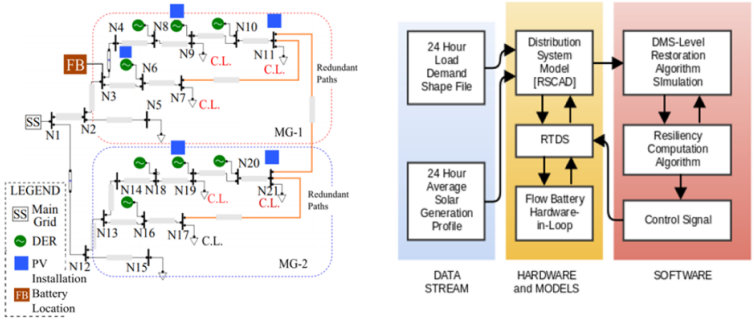
TAMU



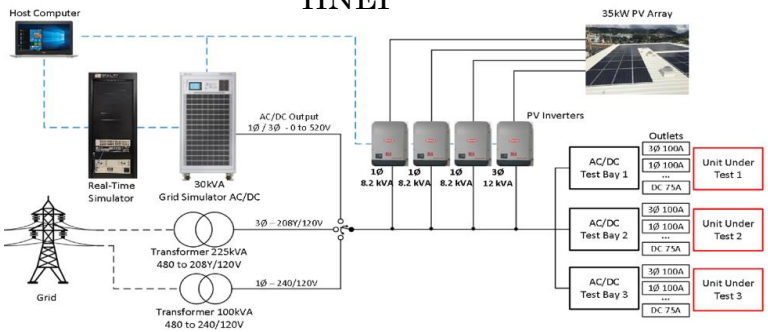
WSU



NREL



HNEI



B&McD

UI-ASSIST OUTCOMES

- Customizable cyber-physical synthetic distribution models (CP-SyNet)
- Benchmarking feeders and storage models
- Cyber-Physical Resiliency tools
- Cyber-Physical interdependency analysis framework
- Next-generation data utilization techniques
- Distribution market models
- Operation and control of MGs/Aggregated DERs/ Nanogrids
- US-India federated laboratory setup
- US-India Policy comparison and key recommendations
- Actual technology adoption and demonstrations
- International research team development and workforce advancements

Leveraging Teamwork

US ASSIST

U.S. INDIA COLLABORATIVE FOR SMART DISTRIBUTION SYSTEM WITH STORAGE

India-India Collaboration Chart

Theme-2: **Benchmark Systems**

- IITK-IITR-IITM: Rural benchmark design and simulation
- IITK-IITR: Real-time modeling of benchmark
- IITK-IITM: Solar Inverter model for benchmark

Theme-3: **Energy Storage**

- IITK-IITBBS: Storage model and simulation
- IITBBS-TERI: Storage Model in microgrids
- TERI-IITK: Sizing and Siting of storage

Theme-4: **Microgrid and Active Distribution system**

- IITM-IITK: Microinverter Design
- IITK-IITR: AC/DC microgrid Modeling
- IITD-IITBBS: Microgrid protection

Theme-5: **Cyber Security Infrastructure and Measures**

- IITD-IITK: Cyber security detection and measures

Theme-6: **Integrating Cyber-security Measures**

- IITD-IITK: DSO function Implementation
- IITR-IITK: Distribution Load Flow
- IITK-IITR: Volt-Var Control
- TERI-IITK-IITD: DSO and energy management in microgrids
- IITK-Synergy: ADMS development

Theme-7: **DSO Market and Regulatory Issues**

- TERI-IITD-IITR: DSO Market and regulation
- TERI-IITD-IITK-PGCIL: White Paper on DSO

Theme-8: **Lab Testing and Validation**

- IITK-IITM: Microgrid Implementation in Configurable Test bed
- IITK-IITBBS: Protection features in microgrid implementation
- IITK-TERI: Battery inverter design and implementation
- IITK-IITM-IITR-TERI; cross validation of R&D results

Theme-9: **Field Demonstrations**

- IITK-DVVNL:Rural pilot in Kanpur
- TERI-BRPL: Urban Pilot in Delhi
- IITK-Synergy: ADMS implementation in IITK Smart Grid control center

Theme-10: **Impact Analysis and Policy Recommendation**

- IITD-TERI-IITK: Social study and Policy recommendations for smart distribution grid

U.S. INDIA COLLABORATIVE FOR SMART DISTRIBUTION SYSTEM WITH STORAGE

US-US Collaboration Chart

Theme-2: Benchmark Systems

- WSU-NREL: HIL testing of Feeder models
- WSU-HNEI: Real feeder models
- WSU-TAMU: Offline field feeder
- WSU-MIT: Control
- WSU-AVISTA-ETAP: Testing with ETAP soft.
- WSU-NRECA: Rural feeder

Theme-3: Energy Storage

- WSU-PNNL: System level battery models
- WSU-MIT: Battery charging/discharging
- WSU-LBNL: DERCAM
- WSU-AVISTA: BESS model information

Theme-4: Microgrid and Active Distribution system

- WSU-GE: MEMS, ADMS
- WSU-AVISTA: Microgrid functionalities
- WSU-B&McD: Microgrid Case studies

Theme-5: Cyber Security Infrastructure and Measures

- WSU-WVU: Co-simulation testbed
- WVU-MIT-WSU: Transactive energy
- WSU-B&McD: Report on communication technologies

Theme-6: Integrating Cyber-security Measures

- WSU-HNEI: Solar PV forecasting and BTM DER estimation
- WSU-HNEI-ETAP: Solar and load forecasting
- WSU-ETAP: Load profiling and forecasting
- WSU-MIT: 1.Volt-var distributed control, 2.Review of distributed control

Theme-7: DSO Market and Regulatory Issues

- MIT-WSU: Distribution market models
- WSU-MIT-AVISTA:Transactive energy

Theme-8: Lab Testing and Validation

- WSU-HNEI: Lab level testing of Solar PV inverter connected system
- NREL-TAMU: Nanogrid controller
- WSU- B&McD:Lab tests of communication technologies
- WSU-AVISTA: Real time simulations of AVISTA Spokane model.
- WSU-GE: Lab scale ADMS-MEMS interaction demo

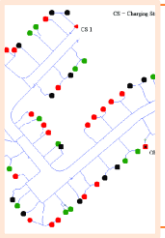
Theme-9: Field Demonstrations

- NREL-TAMU: Nanogrids connected distribution system
- WSU-AVISTA: Urban field demo
- WSU-GE-AVISTA: Semi-urban field demo
- WSU-NRECA: Rural feeder field demo

Theme-10: Impact Analysis and Policy Recommendation

- WSU-TAMU-VCS: Microgrid control and protection standards, issues and challenges
- WSU-MIT: Report on distribution market

US-India Collaboration Chart

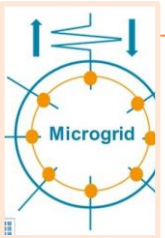


Theme-2:

- WSU-IITK-IITM-IITR: Benchmark feeder models
- WSU-IITK-IITR: Real time feeder models
- WSU-IITK: Federated co-simulation testbed

Theme-3

- HNEI-IITBBS-IITK: Battery Models
- ETAP-HNEI-WSU-IITK: Impact Study Of V2G And EV Charging
- TAMU-TERI: Transformer life
- LBNL-TERI: Maximizing the value of BESS



Theme-4

- WSU-IITR: MEMS,
- TAMU-IITBBS: Microgrid protection
- WSU-IITK: Distributed control of microgrids

Theme-5

- WSU/WVU-IITD: Smart grid Security
- WSU/WVU-IITK: Co-simulation testbed
- WSU/WVU-IITR: Cyber resilient control of microgrid cluster

Theme-6

- WSU-IITR: Volt-Var control
- WSU-HNEI-ETAP-IITK: Solar, Load forecasting
- WSU-IITK: Federated co-simulation testbed
- MIT-IITD:TSO-DSO (non-market) Interaction For Efficient System Operation

MIT-IITR: Demand Side Management And Optimal Operation Of DERs.

Theme-7

- MIT-IITD-WSU-IITK: Distribution market design
- MIT-IITD-WSU:TSO-DSO coordination
- IITD-MIT-WSU: Retail market models

Theme-8

- WSU-IITR: Real time and HIL simulations studies
- NREL-WSU-IITK: Federated testbed
- NREL-TAMU-IITK: Control and validation of nanogrid

Theme-9

- WSU-IITK: Knowledge Sharing of Semi-urban and Rural field demos
- WSU-PNNL-TERI: Knowledge Sharing of urban field demo
- WSU-IITK: Cross field demonstration of technologies

Theme-10

- WSU-TERI-IITK: Comparison of India and US policies, standards and regulations
- WSU-TERI-IITK-MIT-IITD: Review of policy regulations
- WSU-TERI: Impact analysis sharing

U.S. INDIA COLLABORATIVE FOR SMART DISTRIBUTION SYSTEM WITH STORAGE

Evolving future energy distribution grids

www.uiassist.org

India-US Interactions – Visits (2017-2020) & Virtual (2020-Present)

UI-ASSIST PACE Supported Travel 2019		
Indian Partner to US	**Organization**	**Location(s)**
Megha Gupta	IITD Graduate	MIT
Alekhya Datta and Shashank Vyas	TERI	NREL/SnoPUD/ WSU/ Avista /US Summer Workshop
Neshwin Rodrigues	TERI	NREL/WSU/Avista
Suresh Srivastava and Ankush Sharma	IITK	Texas A&M NREL/WSU/ US Summer Workshop
Santanu Mishra	IITK	Hawaii/NREL /US Summer Workshop
S.R. Samantaray	IITBBS	NREL/WSU/Avista/US Summer Workshop
Olive Ray	IITBBS	Hawaii/WSU/ Avista / US Summer Workshop
Rajarshi Dutta and Shreyasi Som	IITK Graduate	WSU
N.P. Padhy	IITR	WSU/Avista/ US Summer Workshop
US to India		
Niloy Patari	WSU Graduate	IITK/IITR/IITD

Other US Partner Visits to India Partners & Events in 2019	
Anurag Srivastava, WSU	IITD, IITK, UI-ASSIST Dec 2019 Workshop, Delhi, IEEE ICPS '19
Anu Annaswamy, MIT	IITD, IITR, UI-ASSIST Dec 2019 Workshop, Delhi, IEEE ICPS '19
Jayant Kumar, GE	UI-ASSIST Dec 2019 Workshop, Delhi, IEEE ICPS '19
Rob Hovsapian, NREL	UI-ASSIST Dec 2019 Workshop, Delhi, IEEE ICPS '19
Gary Huffman, Francisco Neto, Burns & McDonnell	UI-ASSIST Dec 2019 Workshop, Delhi, IEEE ICPS '19
Mladen Kezunovic, Miroslav Begovic, Chanan Singh, Texas A&M	IITD, IITK, IITR
Chanan Singh, Texas A&M	UI-ASSIST Dec 2019 Workshop, Delhi, IEEE ICPS '19
Noel Schulz, WSU	IITD, IITK, IITR, BRPL, NETRA, PGCIL, TERI, Rural Hamlet, UI-ASSIST Dec 2019 Workshop, Delhi, IEEE ICPS '19

UI-ASSIST Virtual Summer Internship Program 2021

Indian Partner	Indian Student(s)	Faculty Advisor	US Partner	US Student(s)	Faculty Advisor(s)
IITK	Souradip De	S.R. Sahoo	WSU/WVU	Niloy Patari	Sanjeev Pannala, Anurag Srivastava
IITR	Satabdy Jena	N.P. Padhy	WSU/WVU	Partha Sarker	Sanjeev Pannala, Anurag Srivastava
IITBBS	Smrutirekha Samal	S.R. Samantaray	TAMU	Jorge Ignacio Cisneros Saldana	Miroslav Begovic
IITBBS	Hemkesh Singh	S.R. Samantaray	TAMU	Jorge Ignacio Cisneros Saldana	Miroslav Begovic

Face to Face Update Meetings US (August 2018 & June 2019) and India (December 2019)
Virtual India-US Theme Meetings Semi-Annually and Annual Update Workshops 2020 and 2021

Joint India-US Webinars

Project Impact

US ASSIST

Immediate Impacts

Provided faculty and graduate students of five India and four US universities involved in UI-ASSIST opportunities for technical advancement and global perspectives for future workforce members.

Created a unique opportunity to transform 30 independent entities into multiple collaborative teams working to translate research and development into practical field demonstrations that create foundational work for clean energy solutions.

Made synergistic public-private partnerships where each of the partners has learned about the different perspectives and goals of other organizations.

Established a foundation of collaborators who will be leaders in the next steps of Indo-US energy activities.

Electrified two Indian Rural Hamlets and provided reliable power.

BEYOND UI-ASSIST PROJECT

Synergy between UI-ASSIST and other funded projects across all India and US partners for leveraging advances as well as additional testing and validation opportunities.

Testbeds across multiple institutions provide foundation for continued collaborations.

Field demonstration relationships enhanced ***university-research lab-technology and service provider-utility-end user relationships*** and built trust and communication channels for dialog in future.

Solutions from UI-ASSIST partners included ***modifying existing systems as well as developing new solutions for advanced distribution systems and microgrids*** providing alternatives for a variety of situations worldwide.

Identification of gaps and challenges in ***policy, market structures and interactions, technical standards and practices, and societal understanding*** in two countries helps develop priorities and roadmap for next steps.

Unique framework for ***transforming R&D activities to the field demonstrations*** including lessons learned for team dynamics and interactions especially during worldwide pandemic.

THANK YOU

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Noel.Schulz@wsu.edu

https://uiassist.org

Government of India
Department of Science & Technology
Ministry of Science & Technology

IUSSTF

IEEE Smart Village: Power a Village, Empower Community

IEEE
Advancing Technology for Humanity

Dr. Rajan Kapur
President, IEEE Smart Village

IEEE smart village


Q&A
QUESTIONS & ANSWERS SESSION