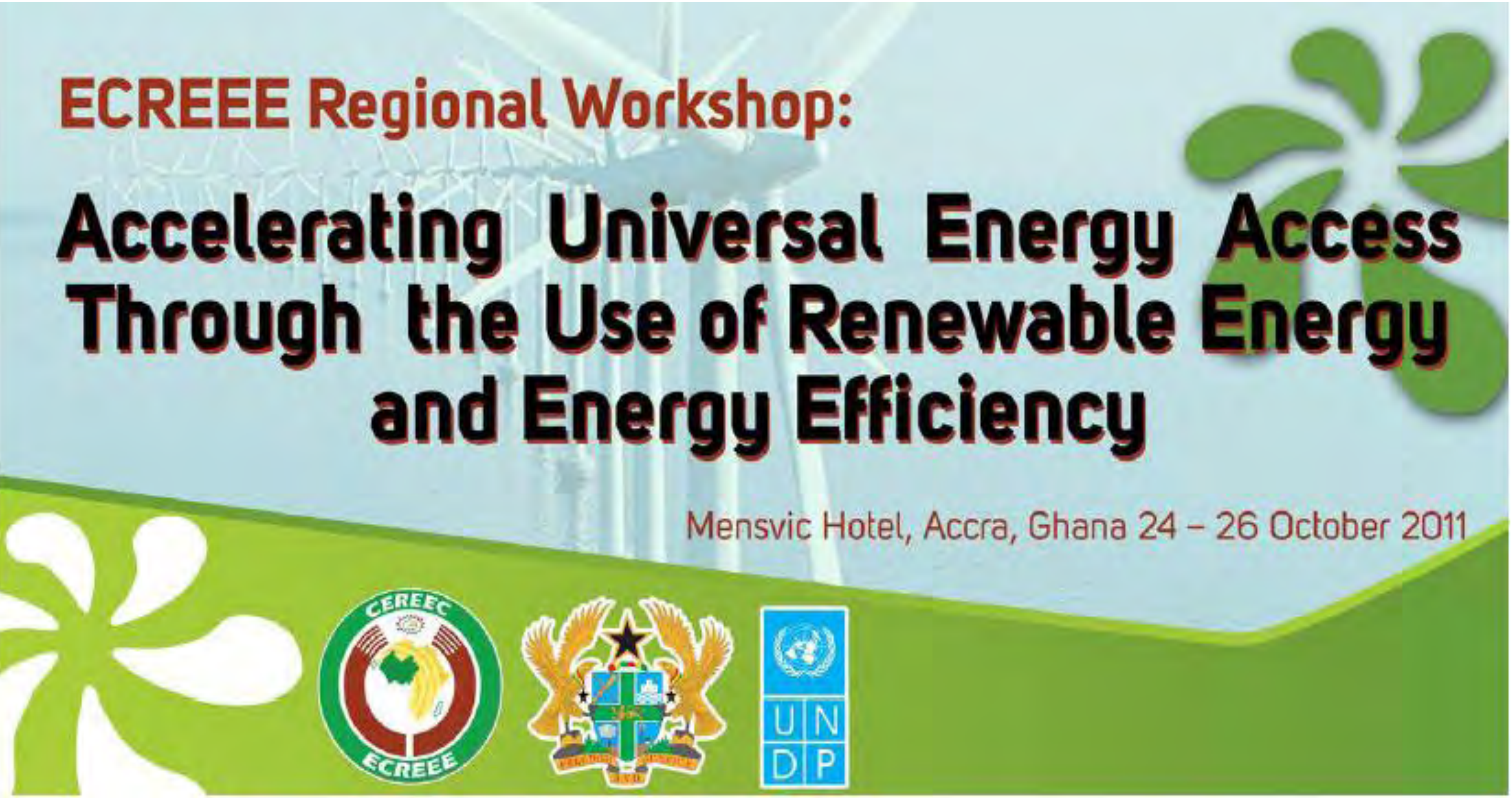
Session IV: Access to Electricity Services in Rural Areas



Mini Grids: Experience from India

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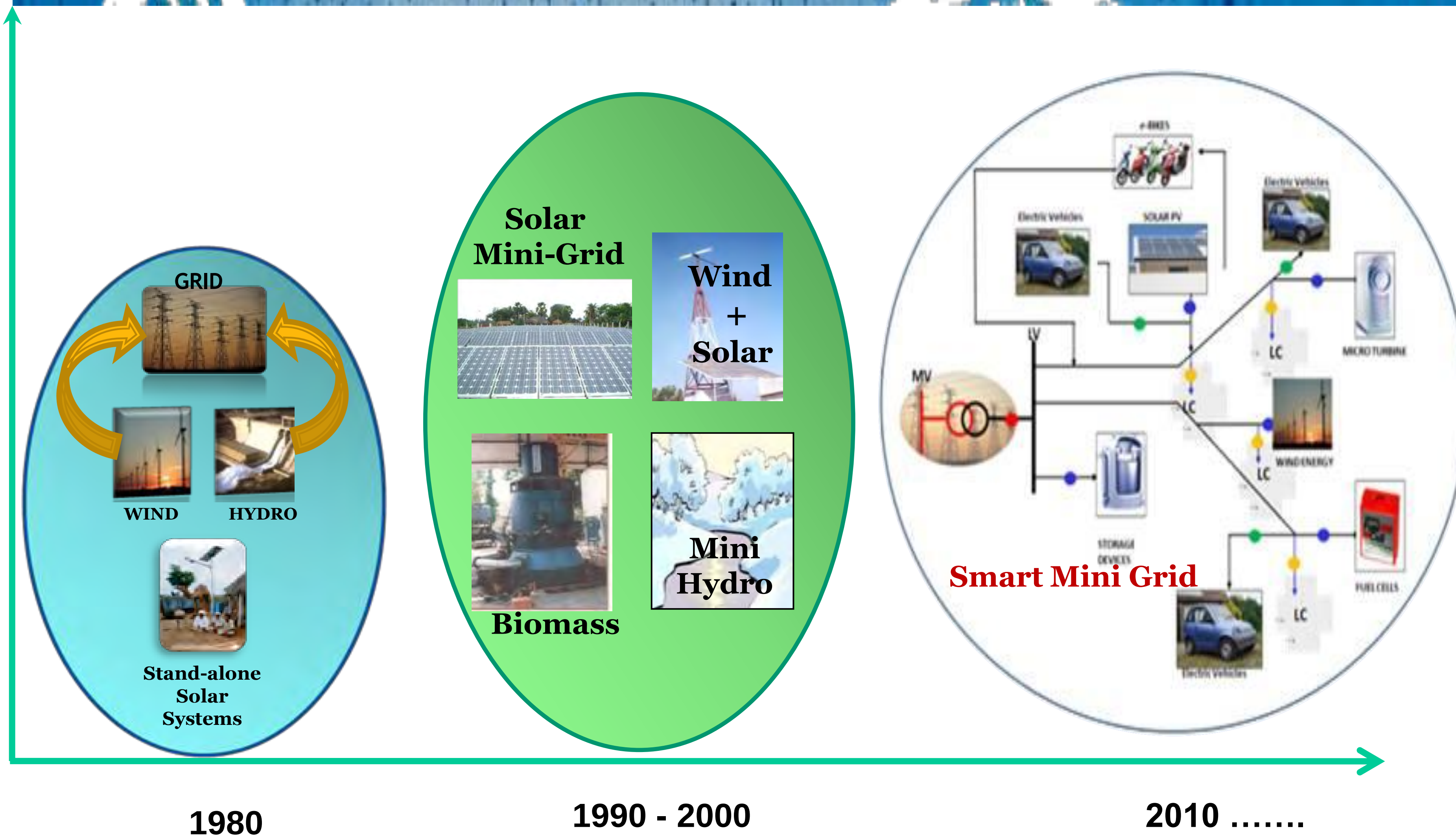
Mini-Grids in India

- Pioneer of Mini-Grid system
  - First solar mini grid commissioned in 1996 in Sunderbans Islands
- State-of-the-art system designs & use of components (converters & inverters), continuing till date
- Cooperative model of service delivery
  - Involvement of local community from planning stage
- Policy enablers from time to time
- Around 5000 villages covered through mini-grids
- Multiple technology adopted

Technology Transition



Conducive Policy framework

- **REST Mission (2001)**
  - Acknowledged the role of distributed generation/mini-grids
- **Electricity Act-2003**
  - Universal service obligation to provide electricity by both central and state Government
- **Rural Electrification Policy (2005)**
  - Decentralized Distributed Generation (DDG) to be considered where grid extension is not feasible
  - No license required for generation and distribution - tariff can be determined based on mutual consultation with consumers
- **Rajiv Gandhi National Rural Electrification Scheme (2005)**
  - Decentralized Distributed Generation (DDG) and Supply
- **National Solar Mission (2009)**
  - 1000 MW by 2017 and 2000 MW by 2022 of off-grid capacity

What is Mini/micro Grid

- A mini/micro grid is an electricity distribution network operating typically below 11 kV, providing electricity to a localized community and derives electricity from a diverse range of small local generators using both fossil fuels (diesel, gas) and renewable energy technologies with or without its own storage (batteries).

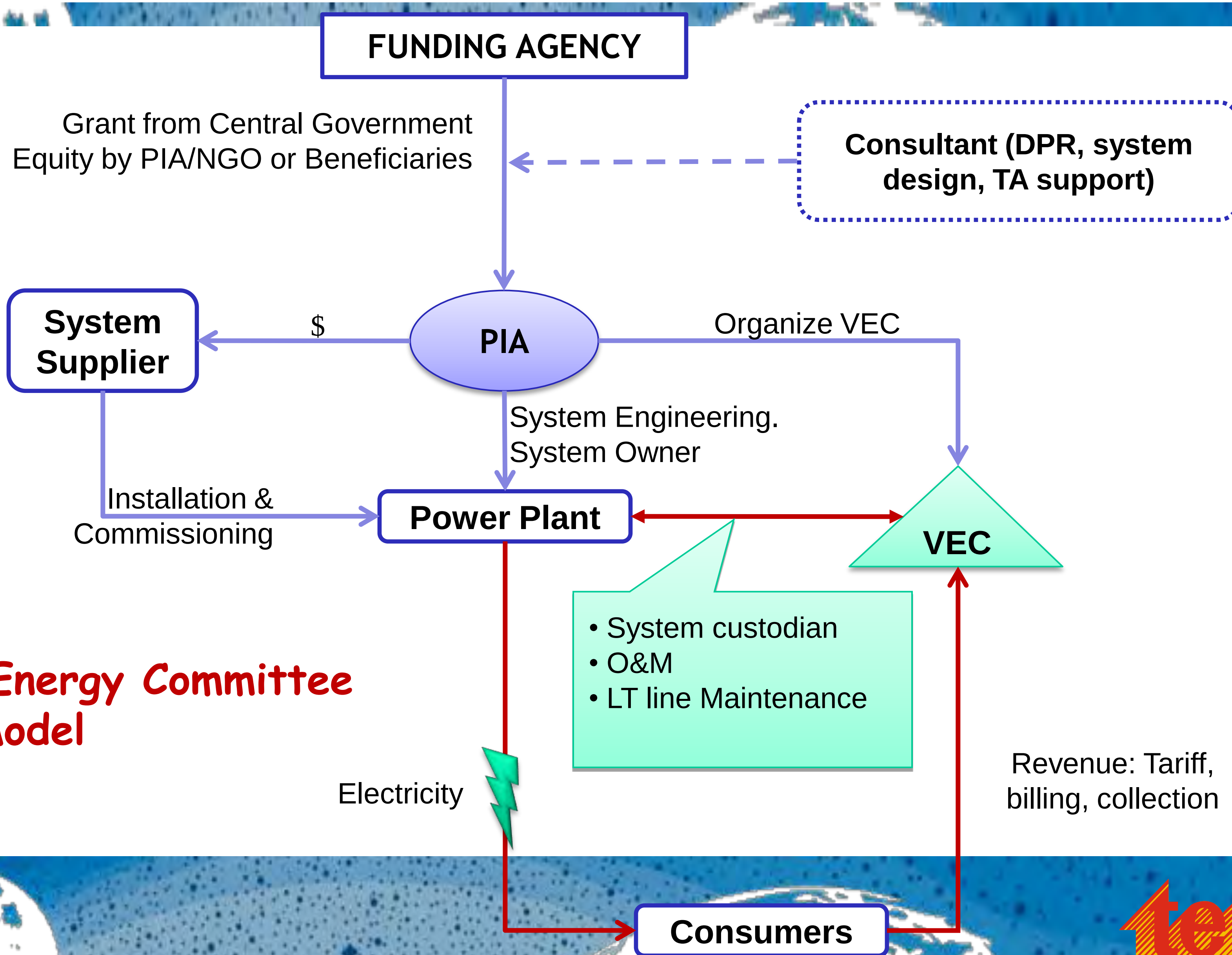
How mini grid works

- Either AC or DC
- Typically 1kWp to 500 kWp
- Technologies
  - Solar PV
  - Biomass gasifiers
  - Mini/micro hydro
  - Biogas
- Usually community managed
- Covers around 50 - 500 households

Biomass Gasifier Power System

- Fuel Preparation
- Biomass Gasifier
- Cooling cleaning train
- Engine – Alternator
- Biomass drying
- Power evacuation

Managing Mini Grids: Institutional Model

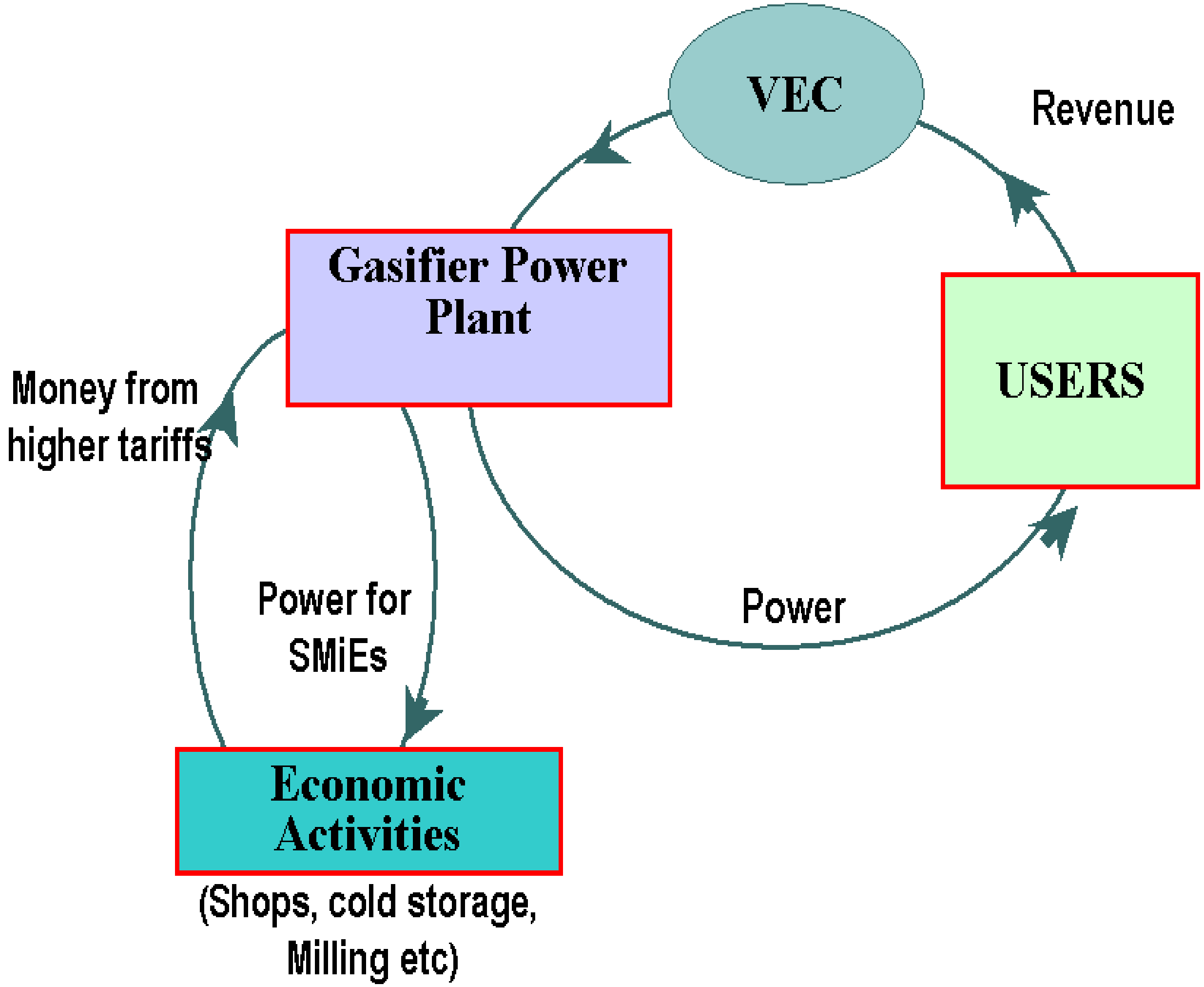


Village Energy Committee (VEC) Model

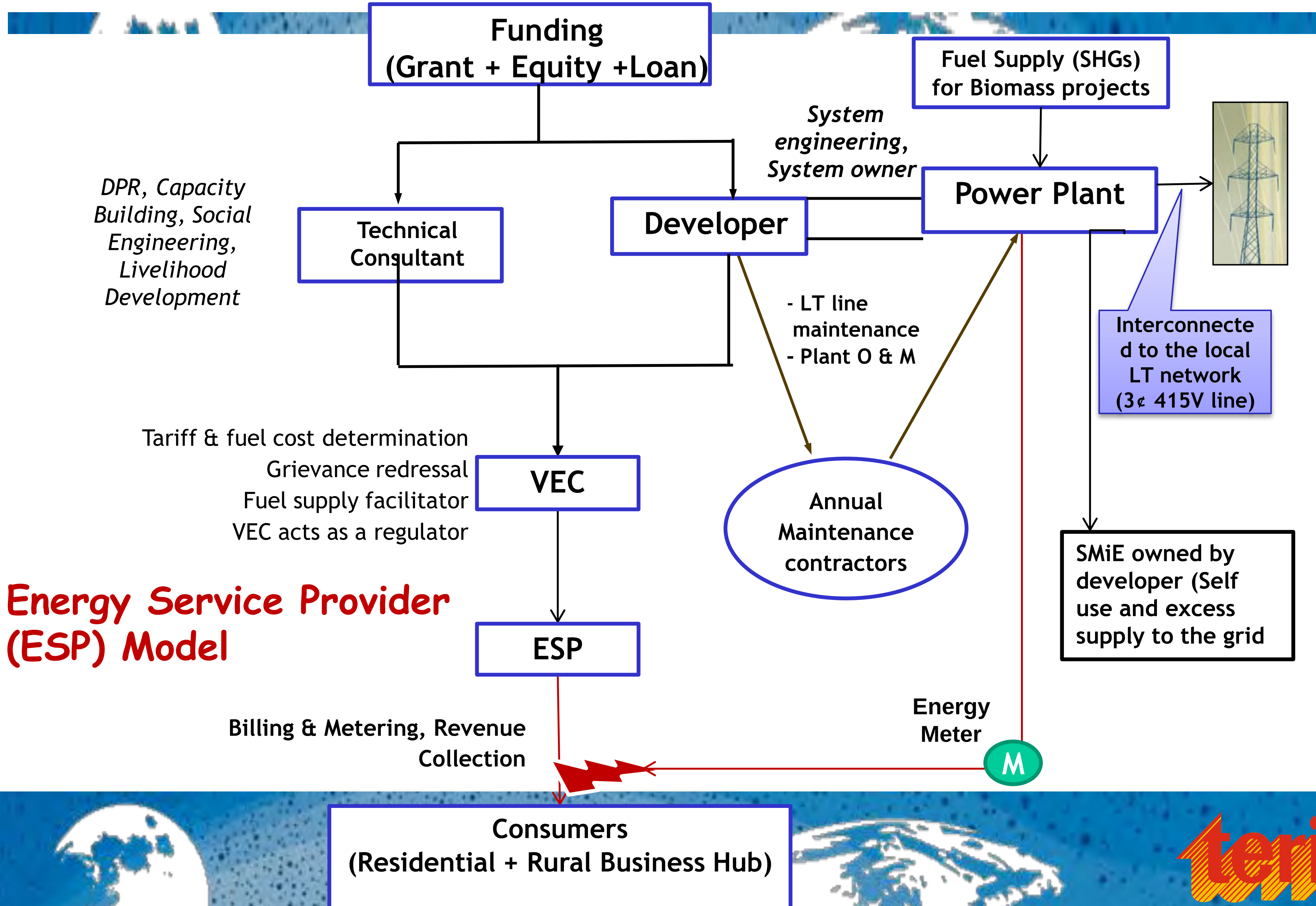
Lessons from early Mini grids

- Decentralized, usually low capacity, covering remote areas
- Usually domestic loads served
- Can be installed at remote inaccessible areas
- Community as stakeholder
- **Tariff based on flat rate**, locally decided, depending on fuel cost, O&M cost and WTP (US$ 1 per point/month)
- Non commercial in nature
- Inability to meet increased demand
- Low plant load factor
- Single energy resource catering to fixed load for fixed time
- Battery – Weakest Link, over drawl by most consumers
- Difficulty in O&M because of remoteness
- Limited technical knowledge of VEC – frequent system shutdown
- Not linked to any productive enterprise / irrigation pumpsets

Managing Mini Grids: Institutional Model



Mini Grid - Developer + VEC + ESP



Key Features - ESP Model

- Interconnected to the local LT Network - Grid can act as a balancing sink / source (where grid is available)
- Productive load / irrigation pumpsets /agri processing can be served on demand
- Villagers prefer grid connected power to off-grid - partial supply from the grid-may be cheaper
- Electricity can be consumed only locally - distributed generation and supply, only excess energy after local consumption stepped up to 11kV
- Lower AT&C losses through closer monitoring of energy sales and collections
- May interest private developers as reliability increases - Reduced risk for developers

Choice of Technology

Factors responsible

- Population and topography
- Quality and quantity of fuel
- Load pattern and power delivery area
- Local infrastructure availability
- Capital cost, means of finance and final affordable consumer tariff structure
- Environmental impact of the fuel & plant location
- Load growth and possibility of grid interconnection

Choice of Technology contd...

Selection of the technology is based on

Availability of Resources

and

Comparison of the cost of electricity from each of the feasible options

Generally, the order of priority in India is

Choice of Technology contd…

SHP plants wherever adequate perennial water resources are available and technical feasibility is established, - first priority

Biomass power plants using biomass gasification systems or bio-fuel based in conjunction with 100% gas based engines if small hydro is not feasible or not sufficient.

Solar photovoltaic power plants, if none of the above is feasible

Combination of the above in hybrid mode can also be an alternative solution

Optimal Economic Distance - An example

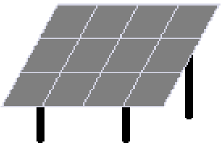
Load (kWp)	X (km)
7.5	7.7
15	15.0
25	24.1
50	47.8

The values of ‘X’ respective to different loads give the optimal economic distance (OED) from load centre to nearest 11kV line for feasibility of a solar power plant. If distance is larger than ‘X’, solar power plant will be preferable and if the distance is smaller than ‘X’, grid extension will be preferable

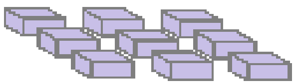
Grid vs. Mini grid - Rule of Thumb

- Based on least cost technology options and with *minimum maintenance requirements*
- Grid extension is favourable if number of connections per km of distribution line are high say more than 25
- A mini-grid based on locally available renewable energy sources is an attractive option if
  - threshold number of households is 100 and distribution network is within 2 km for system capacity of 10 kWe
- If number of consumers is less than 50 or number of connections per km of distribution line is less than 4, individual systems (SHS) are preferred

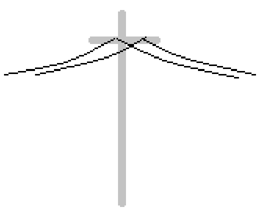
New Technology: Solar DC Micro Grid



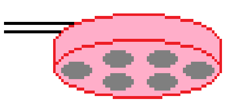
Renewable Power Generation: 100 households would require 500-700 watts-peak of solar panels. Panels are installed on the rooftop of a village house.



Battery Bank: 100 households would require around 500 Amp-hours of storage capacity. Batteries are stored in a cabinet inside the same house or distributed battery storage at individual households



Power Distribution: Distribution lines run along the rooftops from the battery bank to households within the village. Power is distributed for 8 hours each night at 24 volts direct current.



LED: Each household is installed with two or four LED modules.

New Technology: Smart Grid

Electricity delivery network modernized using latest digital/information technologies to meet key defining functions

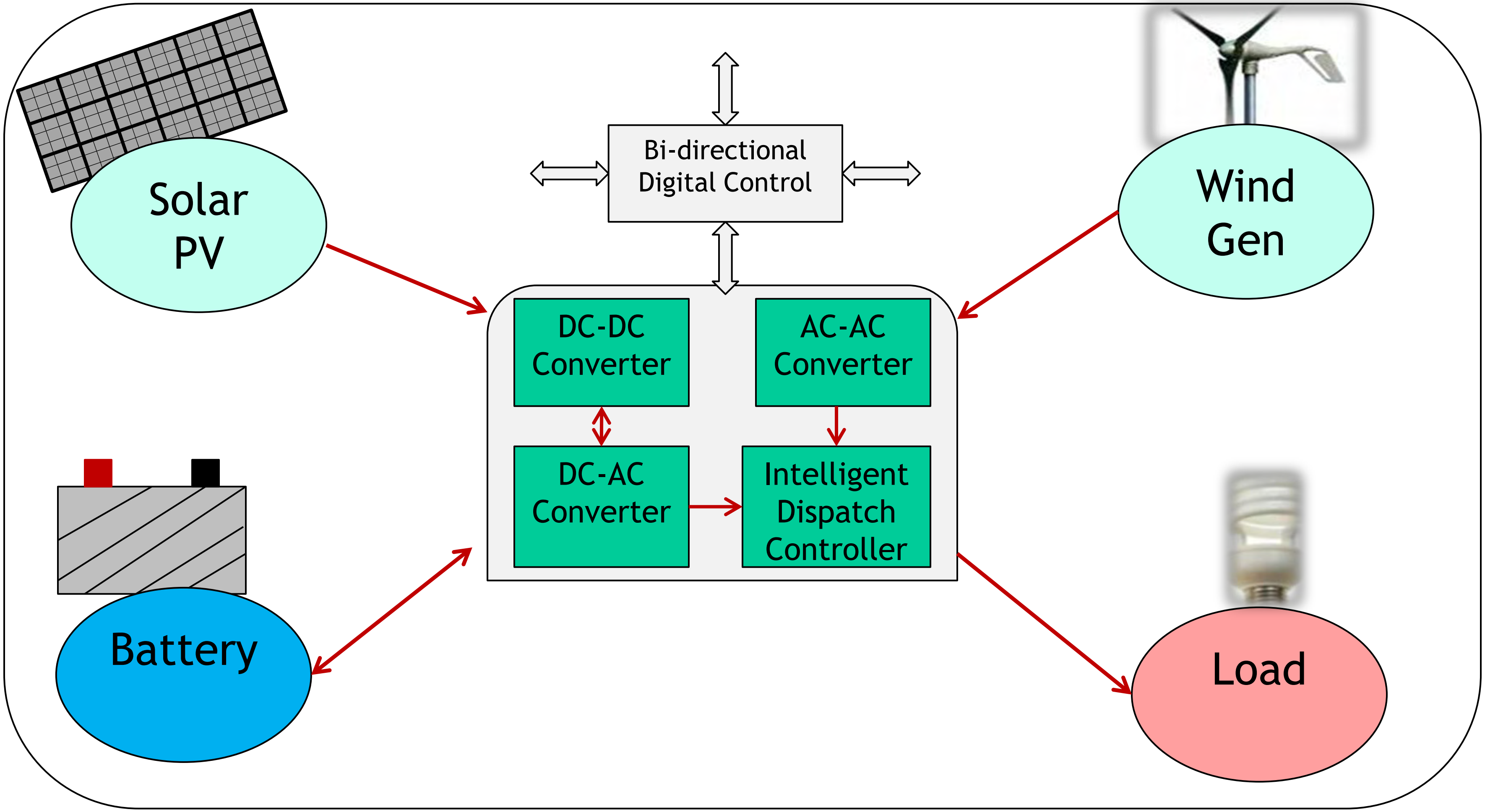
Enabling active participation by consumers	Enabling new products, services, and markets	Optimizing assets and operating efficiently	Access to quality power

The evolution of a smart grid will be one of continuous improvement

What is Smart Mini grid?

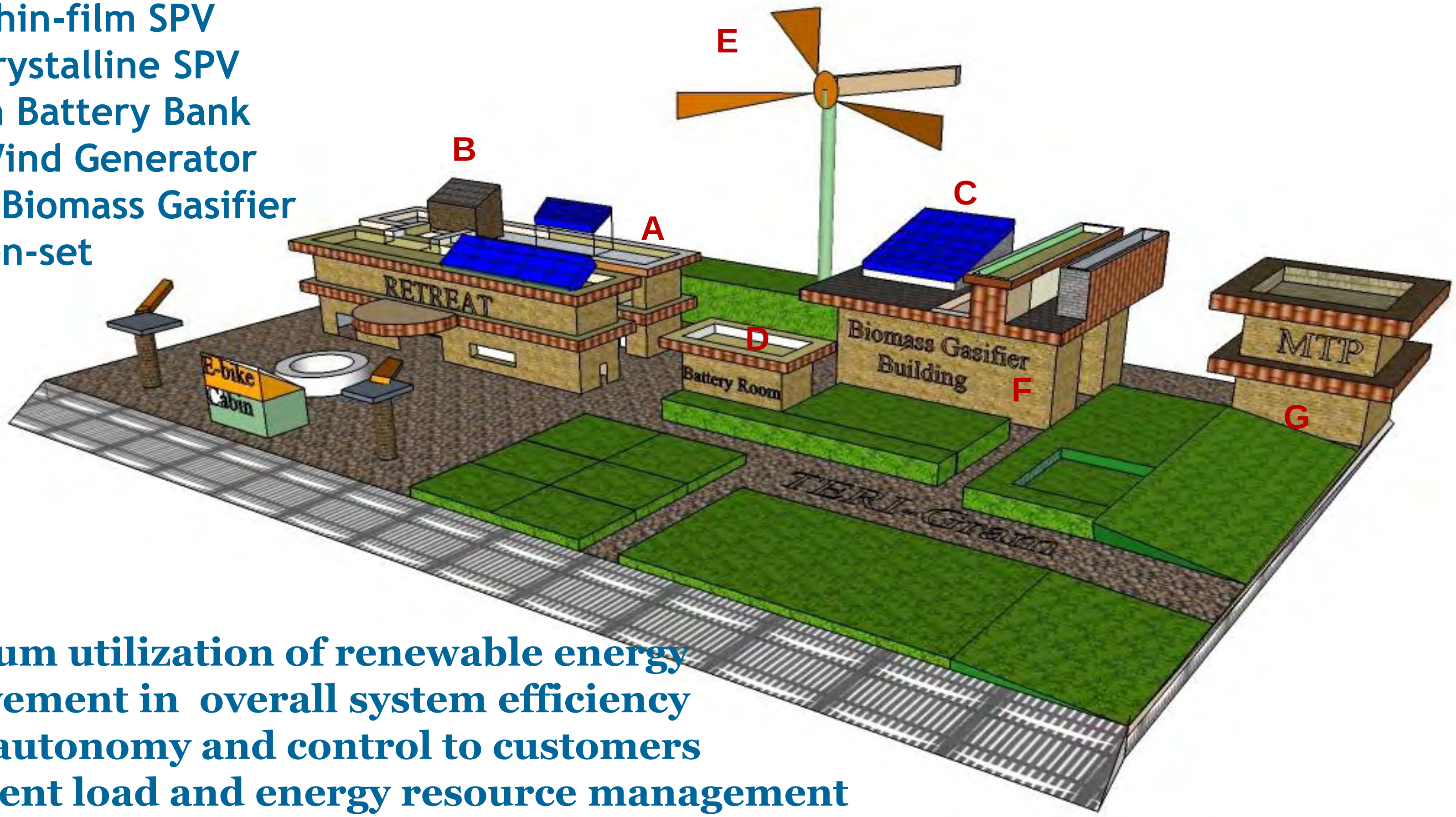
Mini grid	Smart Mini grid
• Grid involving one or more types of renewable energy sources • Operating Voltage level below 11kV • Islanded operation to power off-grid remote area	• Optimization of resources & intelligent demand management using state-of-art digital technology • Decentralized control makes the system efficient and modular

What is Smart Mini grid?



India's First Smart Mini-Grid at TERI

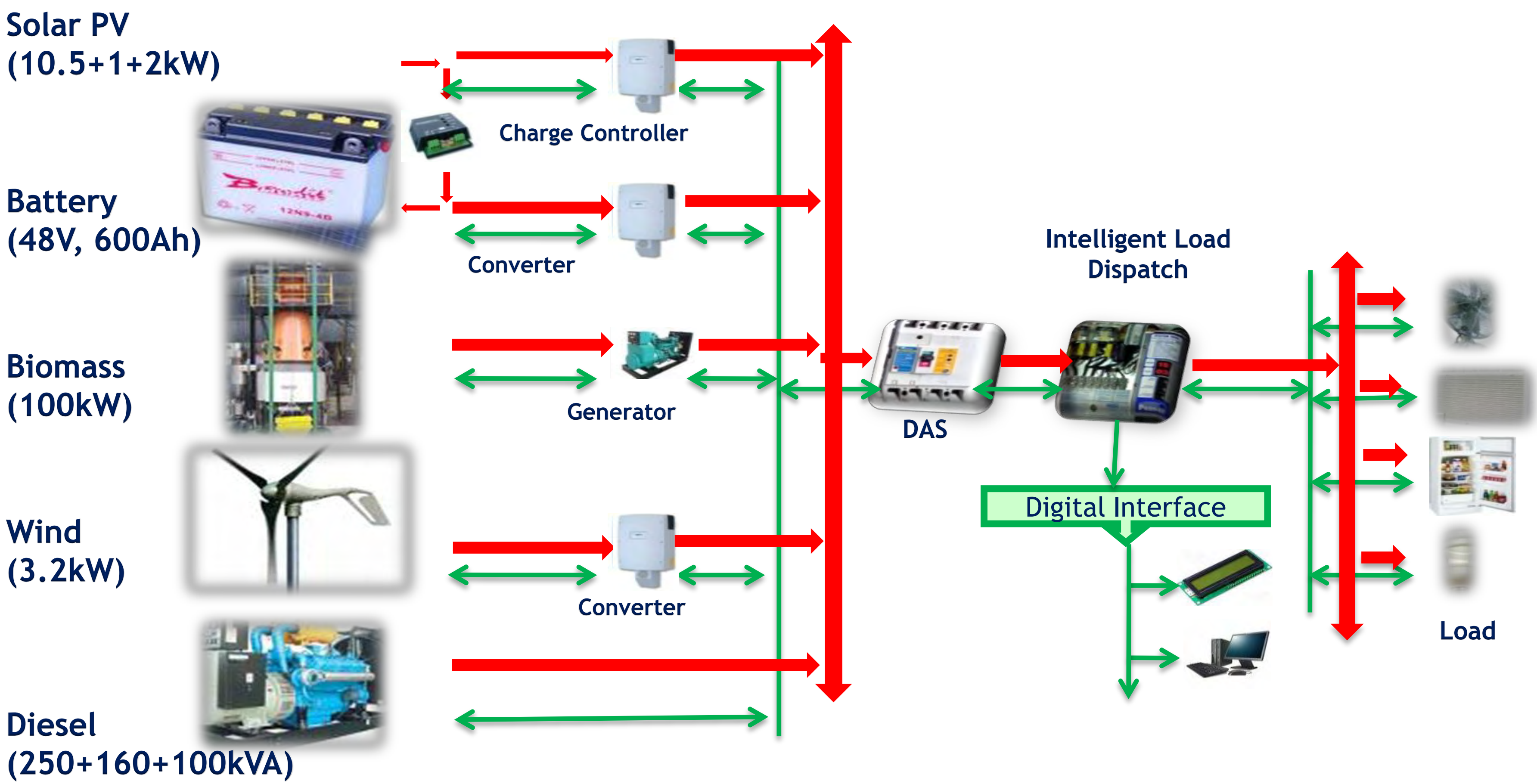
A. 10.5 kW crystalline SPV
B. 1.0 kW Thin-film SPV
C. 2.0 kW crystalline SPV
D. 28.8 kWh Battery Bank
E. 3.2 kW Wind Generator
F. 100 kWe Biomass Gasifier
G. Diesel Gen-set



Ensuring

- **Maximum utilization of renewable energy**
- **Improvement in overall system efficiency**
- **Better autonomy and control to customers**
- **Intelligent load and energy resource management**
- **Minimum network disruptions and number of blackouts**

Smart Mini grid at TERI



Challenges for Mini-grid in India

Policy

- Dissemination suffers from uncertainty in the political framework conditions
- Absence of standard set of implementation guidelines

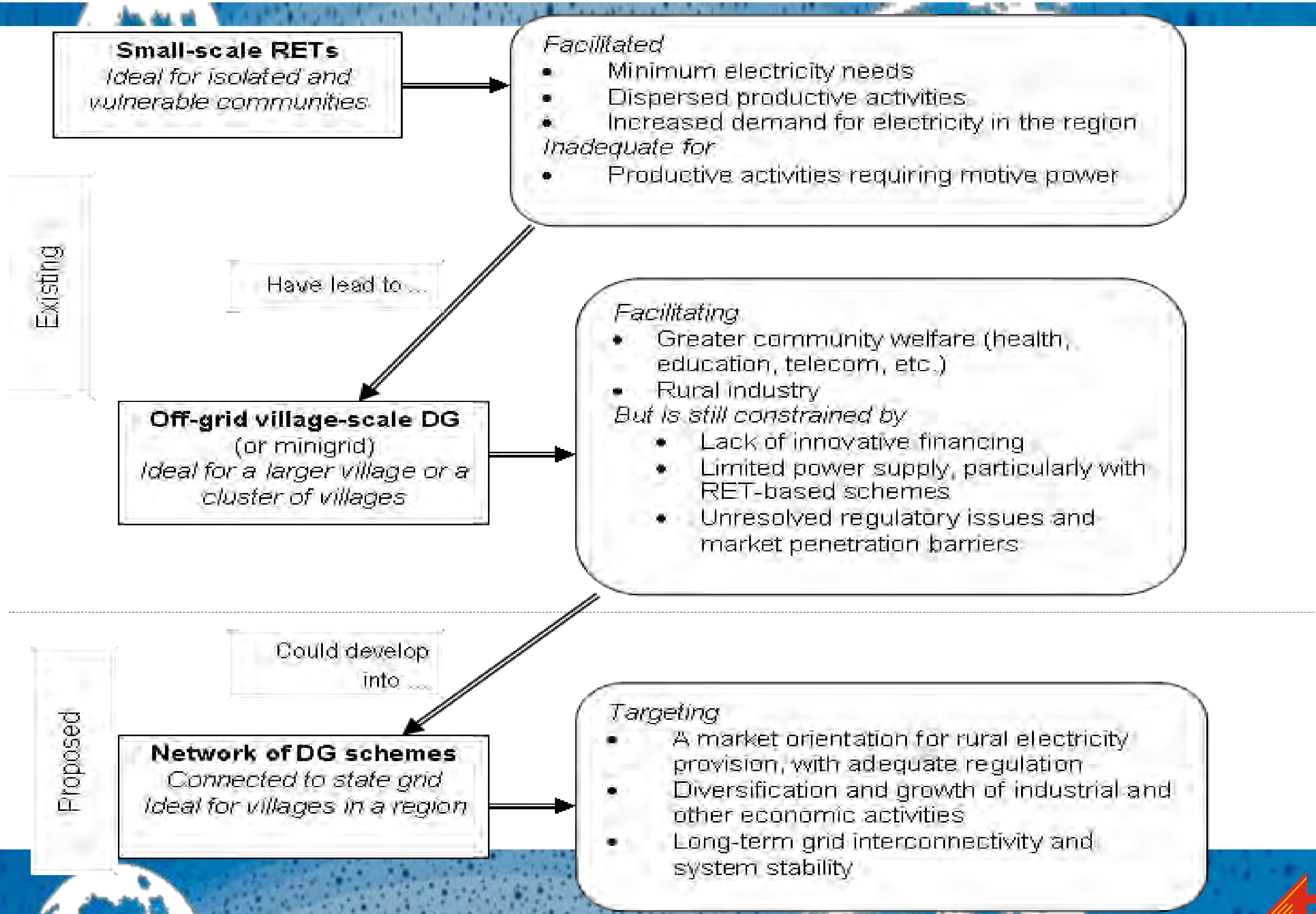
Technology

- High cost of technology and or service

Finance

- Capital subsidy inadequate for ensuring long term sustainability & replicability
- Credit provided independent of income level

Framework for Mini Grid



Off-grid Access System in South Asia

The OASYS Project Objectives:

- ✓ Are there cost-effective and reliable off-grid electricity supply solutions that can meet the present & future needs, are socially acceptable, institutionally viable and environmentally desirable?
- ✓ Do these local solutions have the scaling-up and replication potentials and can these solutions be brought to the mainstream for wider electricity access in the developing world?

www.oasyssouthasia.info

Village Scale Solar Systems: The Solar Transitions

- How can the use of new renewable energy technology be implemented and organised in ways that
  - Embed the techology in local communities and cultures;
  - Make the energy supply useful in practice, to solve sentral problem that people have;
  - Create functioning systems for operation and maintenance locally;
  - Improve opportunities for income generation and a good quality of life, and facilitate climate adaptation;
  - Give more people access to the technology;
  - Overcome vested interests, political and institutional barriers for change;

The Solar Transitions

And how can learning on such issues happen across geographical contexts?

Not ”how can we make people use these technologies”, but how can more people get access to and benefit from these technologies”

Way forward

- Catalyst for scale up
  - Improved access to capital/financial innovation
  - Development of after-sales service infrastructure
  - Customer centric market development
  - Regular stakeholder involvement
- Improved system design efficiency, economy of scale
  - Use of LEDs for lighting for minimizing cost
  - Anchor load e.g. BTS stations, productive load
  - Smart mini grid for optimum efficiency
- Adopting standard process & metrics for scaling up
  - Appropriate business models for up-scaling
  - Regional level cooperation

2012: International Year of Sustainable Energy for All

Let us together make a change