Development of MicroGrid using combination of different RE technologies

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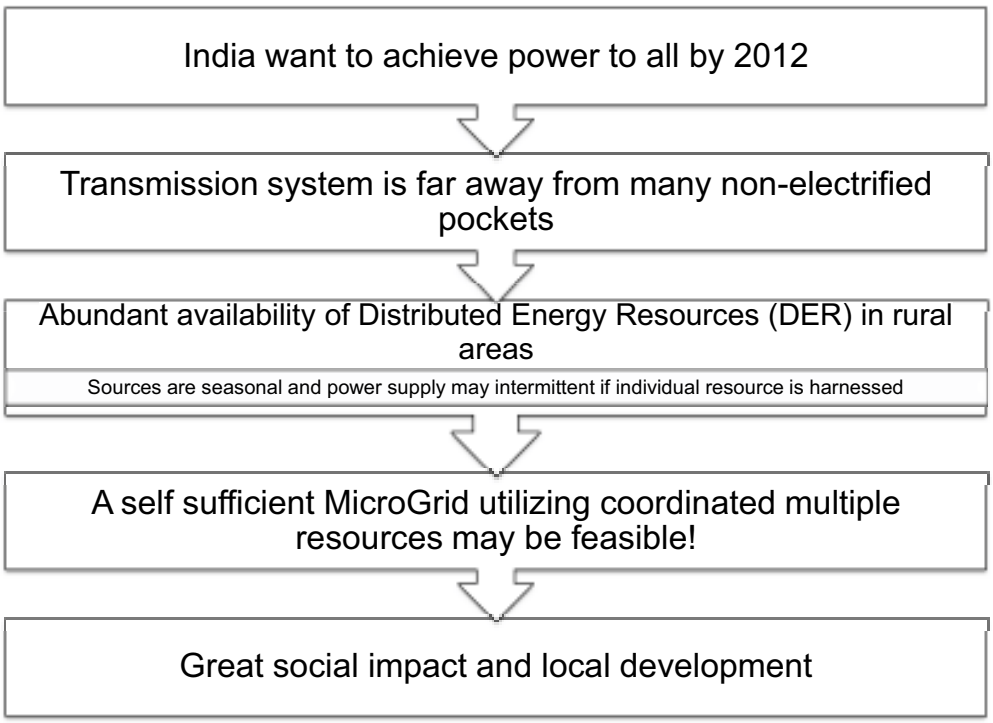
Broad Outline of the Presentation

- Motivation
- Introduction to MicroGrid
- Architecture and components
- Planning of MicroGrid
- Operational aspects
- Indian scenario with some case studies
- Conclusion

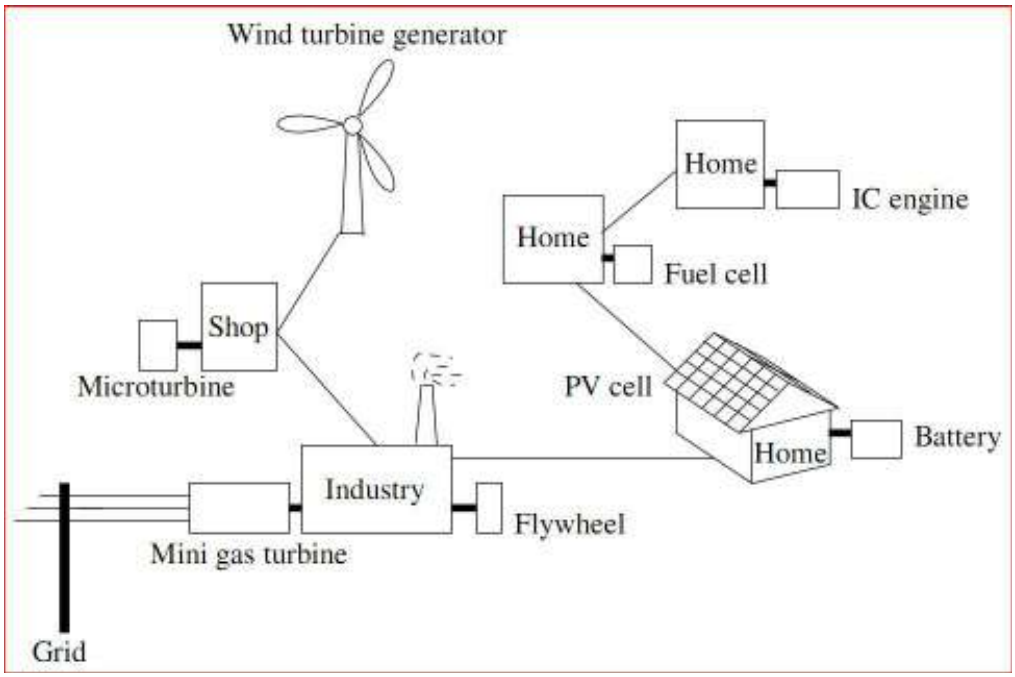
Motivation



Introduction to MicroGrid

- The idea of MicroGrid was introduced by the DoE, USA, as a distribution system with distributed energy sources
  MicroGrid is a self-sufficient cluster of local generators, loads, and storage devices which operates for benefits of the owners.
- A MicroGrid apparently achieves all the advantages of networking at mini scale.
- The DER are seasonal and to ensure continuity in supply if they are to be optimally scheduled.
- If connected to grid, with all unlike components present in a MicroGrid, still it has to have a capability of being good citizen to the host grid with which it intends to exchange power.

Architecture and Components of a MicroGrid



Planning of MicroGrid

- Why to consider multiple attributes?
  - Cost alone cannot be the criteria
  - Quantify the advantages like loss reduction, improved demand not served, saving in transmission cost, improved voltage profile etc.
- Evaluation of DG configuration plans
  - Interval based MADM
  - Data envelopment analysis (DEA) based MADM
- Analytic Hierarchy Process (AHP) is used for finding the relative importance of all the attributes
- Comprehensive Evaluation Criteria can also be used for planning

Economic Analysis

- The economic feasibility study includes calculation of cost of energy (COE), net present cost (NPC), life cycle cost (LCC), etc.
- Various tools available for the economic analysis include HOMER, RETScreen, etc.

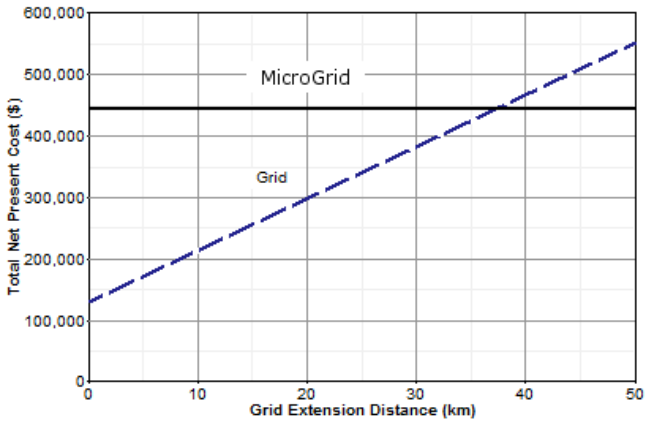
Calculation of Cost of Energy (COE)

$$COE = \frac{Total\ Annualized\ cost\ (C_{ann}^{in})\ in\ \$/year}{Total\ Annual\ Energy\ output\ (E_{ann}^{out})\ in\ kWh/year}$$

Annualized capital cost (C_{ann}^{cap}) in \$/year
Annualized replacement cost (C_{ann}^{rep}) in \$/year
Annualized O&M cost (C_{ann}^{onm}) in \$/year
Annualized fuel cost (C_{ann}^{f}) in \$/year
Annual earning by selling power to grid (C_{ann}^{grid}) in \$/year

Feasibility Analysis: Connection to grid

- Feasibility of MicroGrid for electrification of Remote Area



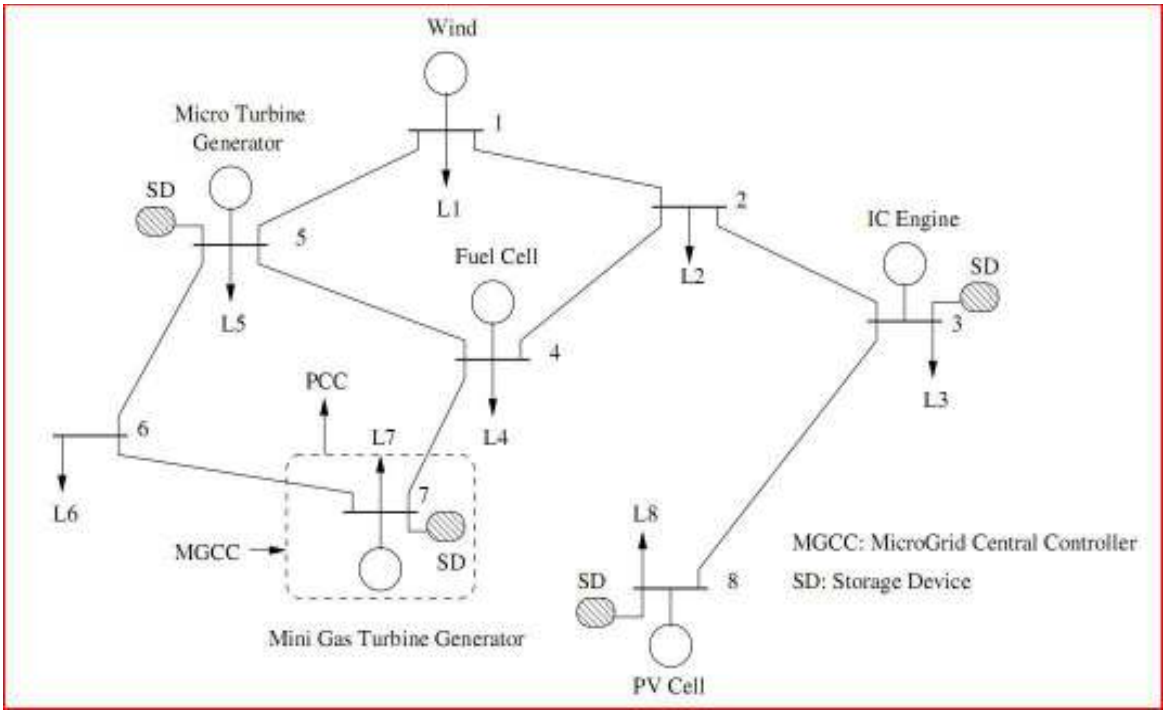
- Break-Even distance is 37 km

Operation of MicroGrid

- Stand-Alone mode of operation
  - Generators and loads are not affected by the grid disturbances
  - Forecasting of the load will be easier for smaller network
  - Generators can be dispatched as per optimal power flow in real time
- Grid connected mode of operation
  - Cost of energy can be lowered by selling power to the grid
  - Generation capacity can be optimally utilized
  - Less reserve capacity required
  - Prone to higher technical risk in case of fault on the grid side

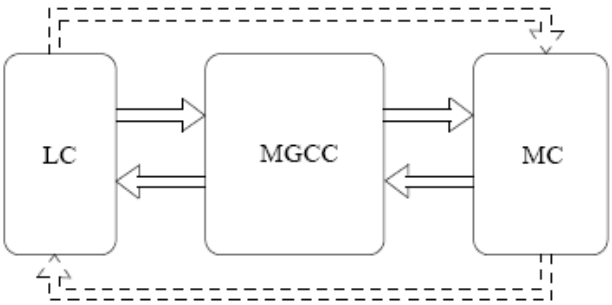
Important time is the transition between the modes

Control of MicroGrid



Need of Communication Technologies

- Information and communication technology (ICT) will play a major role in making the power grid intelligent



MGCC: MicroGrid Central Controller
LC : Load Controller
MC : Micro-source Controller

Communication in MicroGrid

- It is imperative to adopt effective communication technologies for a modern development such as a MicroGrid

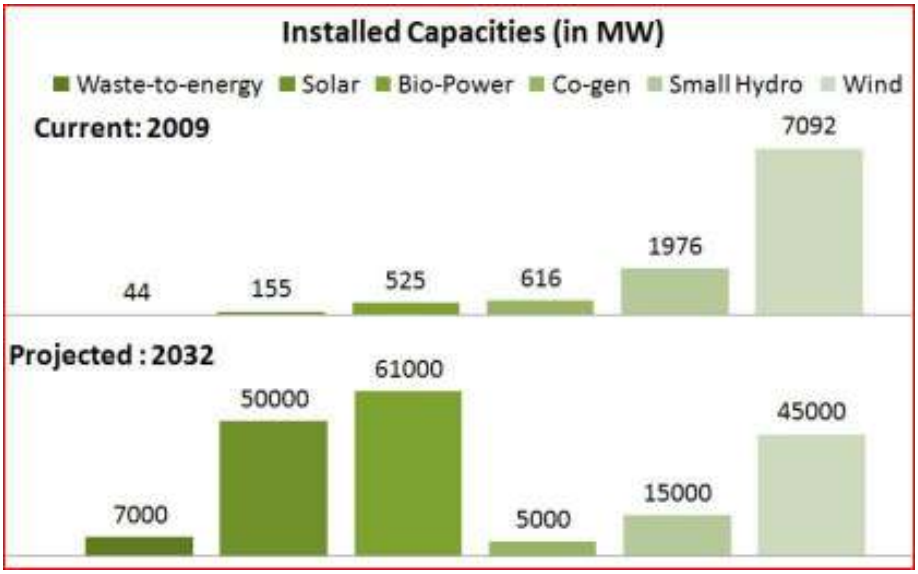
MicroGrid Central Controller

- Stand-alone mode
  - The MGCC ensures load generation balance and security of whole system
  - All the time it receives generation and load information from different MCs and LCs respectively and determines voltage magnitude and phase angle of every generator bus. These signals are sent to the MCs
  - Always tries to minimize cost at the consumer level
- Grid-connected mode
  - It controls the power exchange with the utility grid
  - It takes decisions related to interconnection of MicroGrid with the utility grid and load curtailment

Indian Scenario

- RE tariff
  - Generation based incentives
- RE regulations
  - Renewable Power Purchase Obligation
- Renewable Energy Certificates (RECs)
- Incentives and Subsidies
  - State government: Energy Development Agencies
  - Central government: MNRE

RE Installed Capacity



Case studies

- NEF-WISE scheme
- Alamprabhu pathar
- West Bengal project

NEF, Japan

- New Energy Foundation (NEF), Japan is a non-profit public organization cooperated by electric power suppliers, gas suppliers, and energy related companies
- Survey, research, introduction and guidance in promoting REs and remaining unutilized energy
- MicroGrid Projects in Japan
  - Hachinohe Project
  - Aichi Project
  - Kyotango Project

Wise-NEF (Japan) Project at Nandurbar, Maharashtra

- 11 villages, 49 communities, 1958 house hold (HH)

Stage	Demand Watts/HH	No of HH	Peak demand (kW)	Supply Hrs/day	kWh/yr
1 (current)	74	2000	150	4	2,19,000
2 (initial)	100	2000	200	24	7,30,000
3 (future)	250	2000	200	24	18,25,000

- Priority of the selection of power source for system
  - Hydro (pondage/run of river type)
  - Biomass (direct combustion/gas/bio diesel)
  - Combined Scheme 1 (Biomass + Hydro + PV or Wind)
  - Combined Scheme 2 (Biomass + PV)
  - PV or Wind (with battery)

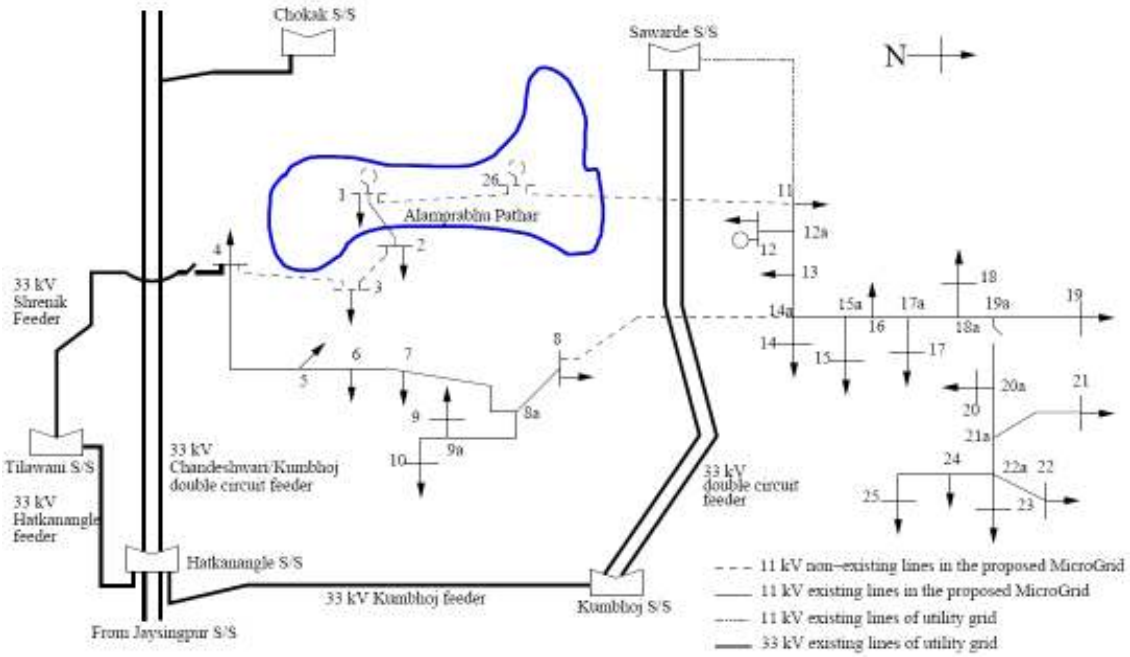
Pilot Demonstration Project with Combined RE

	Source	Capacity (kW)	Cost (INR)	Life (yr)	Annual Energy (kWh)
STAGE-1	PV (SHS)	153	5,31,15,965	20	2,19,757
STAGE-2	Hydro (run-of-river)	106	1,17,47,576	35	215,368
	Biomass	100	40,00,000	20	3,32,379
	Wind	250	1,12,50,000	20	2,87,079
STAGE-3	Hydro (run-of-river)	106	1,17,47,576	35	215,368
	Hydro (pondage)	286	9,41,56,367	35	15,31,145
	Biomass	100	40,00,000	20	3,32,379
	Wind	250	1,12,50,000	20	2,87,079

Outline of Demonstration Plan

- Leading body
  - WISE jointed with partners (IIT, NEF)
- Schedule
  - 2008 : preparation for startup of project
  - 2009 : FS study (preparation of DPR)
  - 2010 : construction of model plant
  - 2011 : O&M/management of plant
  - 2012 : transfer facilities to community

Alamprabhu Pathar MicroGrid Network



Proposed MicroGrid Details

- Analysis in the year of 2006
- Resource Identified:
  - Biomass and Bagasse: 2400 kW
  - Wind: 14250 kW
  - Natural gas: 500 kW
- Demand: 8900 kW (Electrical) 15000 kW (Thermal)
- Reserve capacity: 1900 kW
- Cost of Energy: Rs. 3.6 per kWh

Sagar Island MicroGrid: West Bengal

- Stand-alone and location specific REs can optimally harness by concept of MicroGrid
- Agencies Involved:
  - MNRE
  - Indo-Canadian Environment Facility (ICEF)
- Consumers: 1500
- Technologies:
  - Solar – 250 kW
  - Diesel – 400 kW
- Wind-Diesel (proposed)
- Tariff
  - Residential and Commercial – Rs 5.00 per kWh
  - Industrial – Rs. 5.50 per kWh

Conclusion

- Stand-alone and location specific REs can optimally harness by concept of MicroGrid using optimal scheduling of generators
- Franchisee model can be adopted for Operation and maintenance (O&M) of a MicroGrid
- A MicroGrid will be of great Socio-Economic benefit by providing electricity to remote and un-electrified areas

Thank you!

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