Distributed Generation

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Introduction

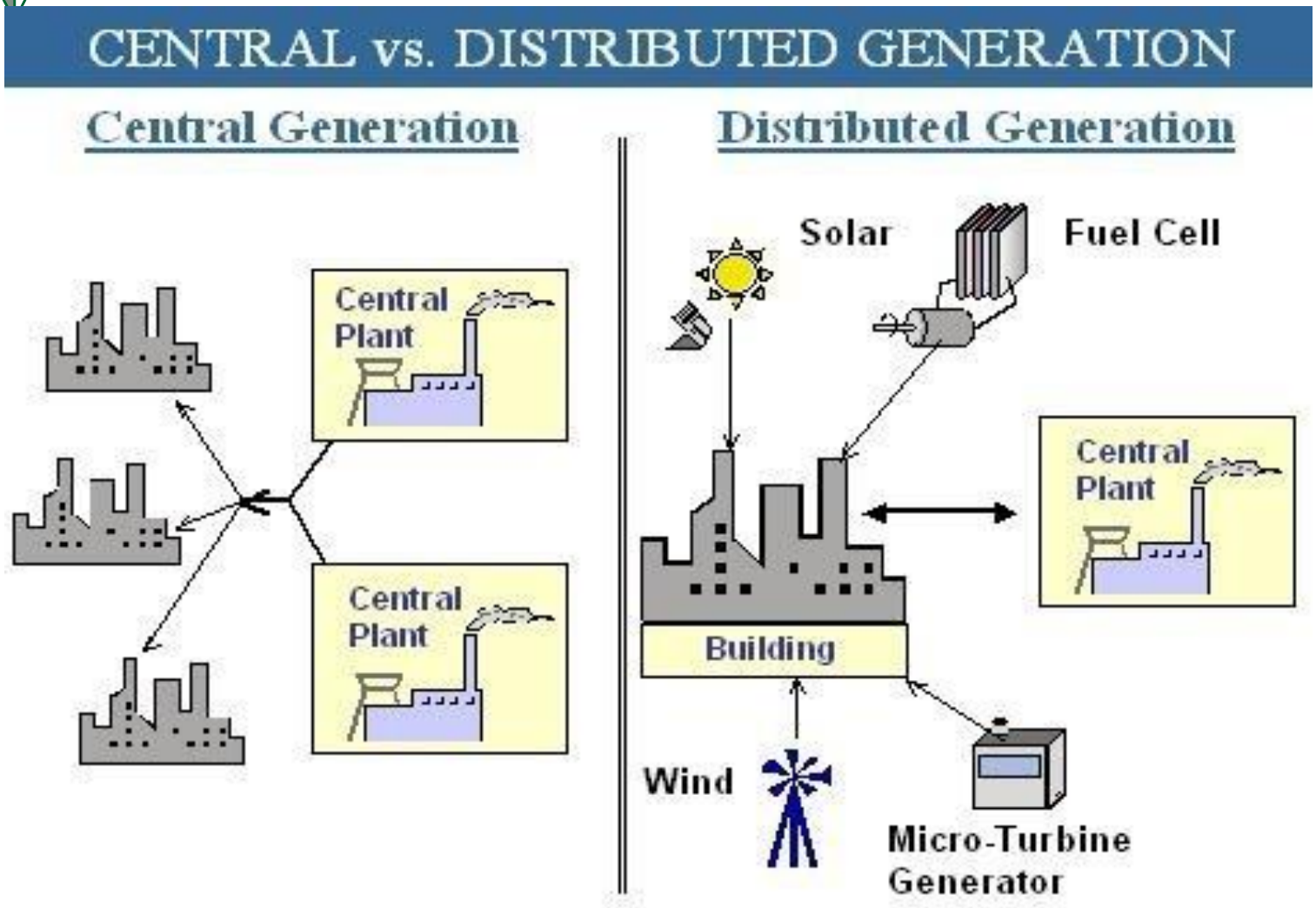
- Perspectives on DG Benefits
  - End-User Perspective
    - Back Generation to Provide Improved Reliability
    - Reduce Energy Bill
    - Participation in the Competitive Power Market
  - Distribution Utility Perspective
    - Transmission & Distribution Relief
    - Hedge Against of Uncertain Load Growth
    - Hedge Against Price Spike
  - Commercial Power Producer Perspective
    - Selling Power or Ancillary Service in the Deregulated Market
    - Integrated Resource Planning

Introduction

◊Distributed generation (DG), also known as on-site generation, distributed resources (DR), distributed energy resources (DER) or dispersed power (DP) is the use of small-scale power generation technologies located close to the load being served

- Energy Companies
- Equipment Suppliers,
- Regulators,
- Energy Users
- Financial and Supporting Companies

Comparison

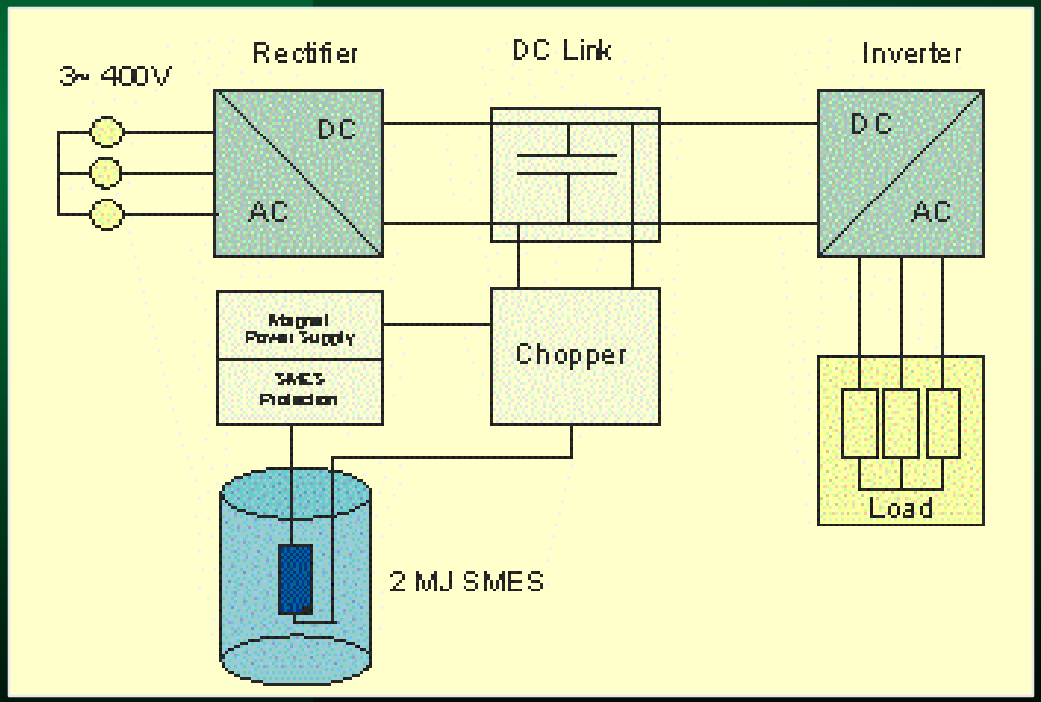

CENTRAL vs. DISTRIBUTED GENERATION
Central Generation
Distributed Generation
Central Plant
Central Plant
Solar
Fuel Cell
Central Plant
Building
Wind
Micro-Turbine Generator

DG Technologies

- Reciprocating Engine Genset
  - The Least Expensive DG Technology
  - High No_x and So_x Emission. This Severely Limits the Number of Hours the Units, Particularly Diesels, May Operate per Year.
  - Natural Gas-Fire Engine Produce Fewer Emission. However, the Natural Gas Price is Unpredictable.

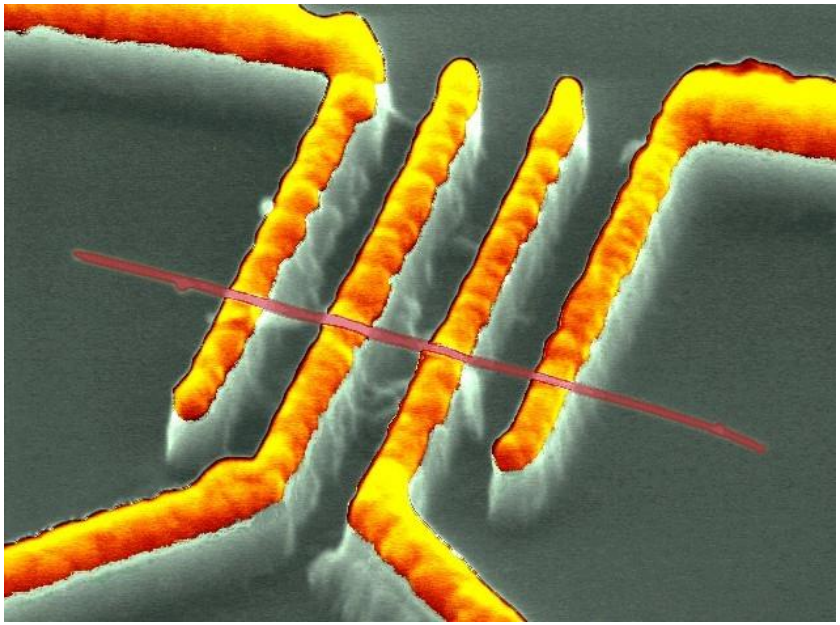
DG Technologies

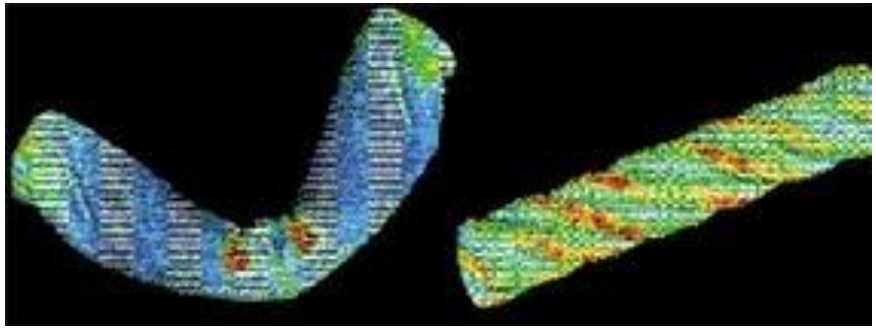
- Superconducting Magnetic Energy Storage

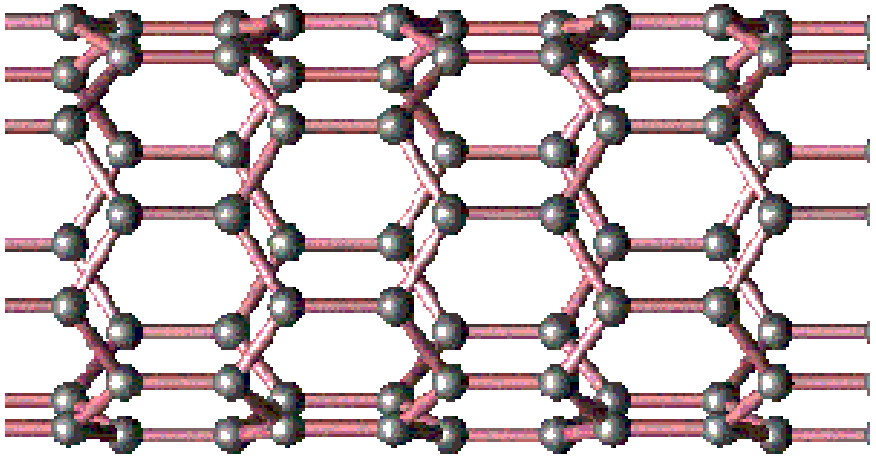


DG Technologies

- Carbon Nanotube (CNTFET)

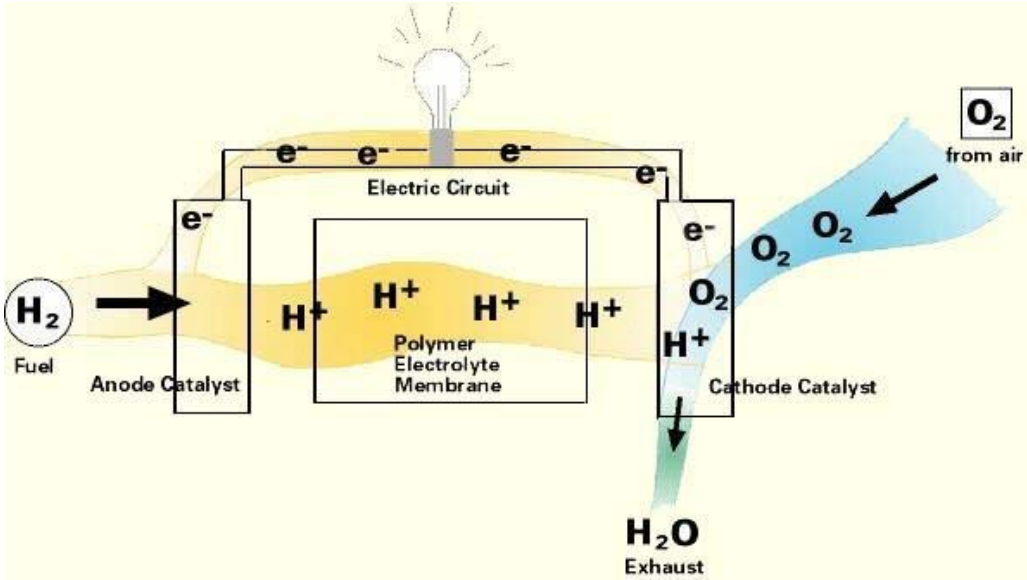






DG Technologies

- Fuel Cell



DG Technologies

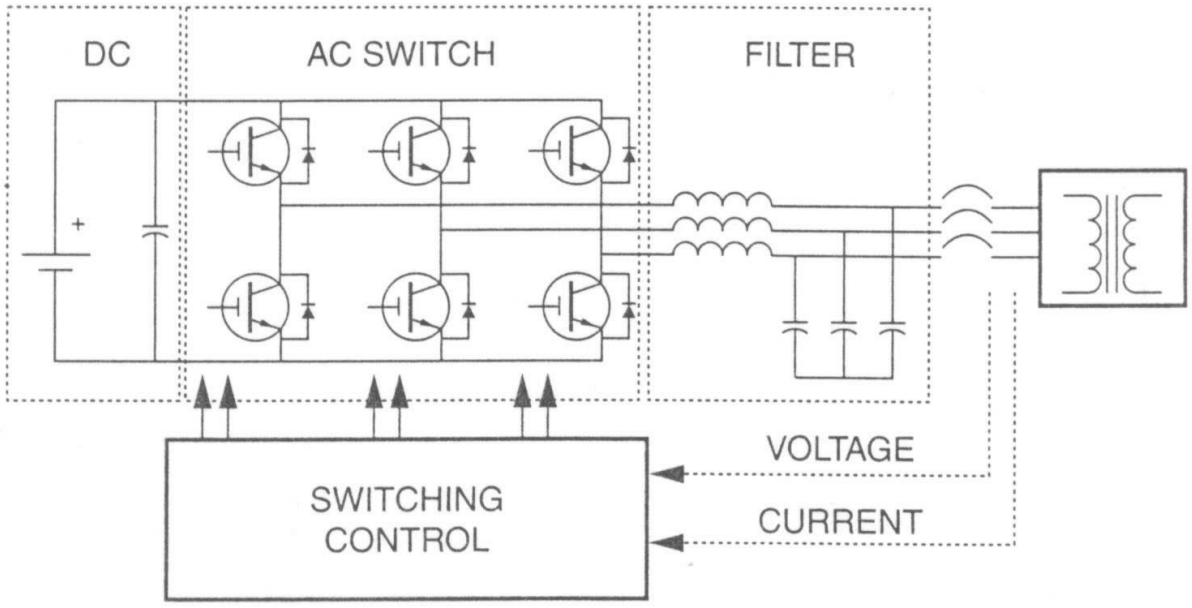
- Wind Generation

DG Technologies

- Photovoltaic

Interface to the Utility System

- Synchronous Machine
- Asynchronous Machine
- Electronic Power Inverters

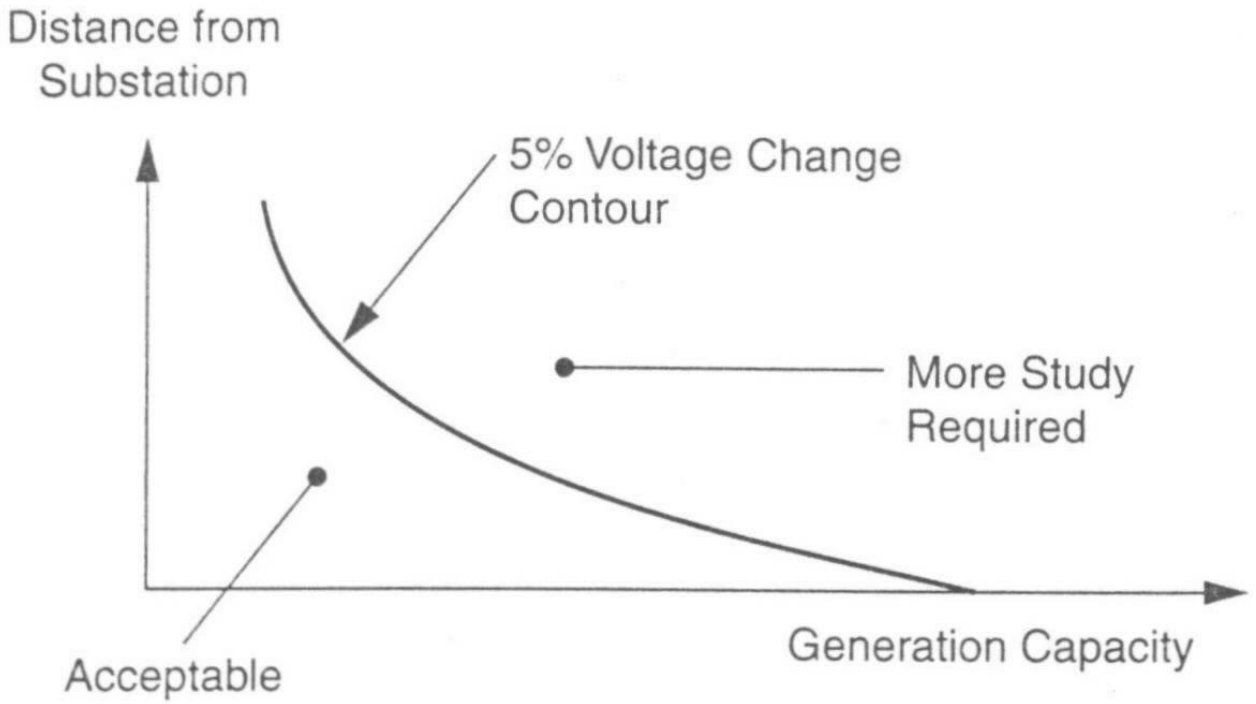


Power Quality Issues

- Sustained Interruptions
- Voltage Regulation
- Voltage Ride Through
- Harmonics
- Voltage Sags
- Load Following
- Power Variation
- Misfiring of Reciprocating Engines

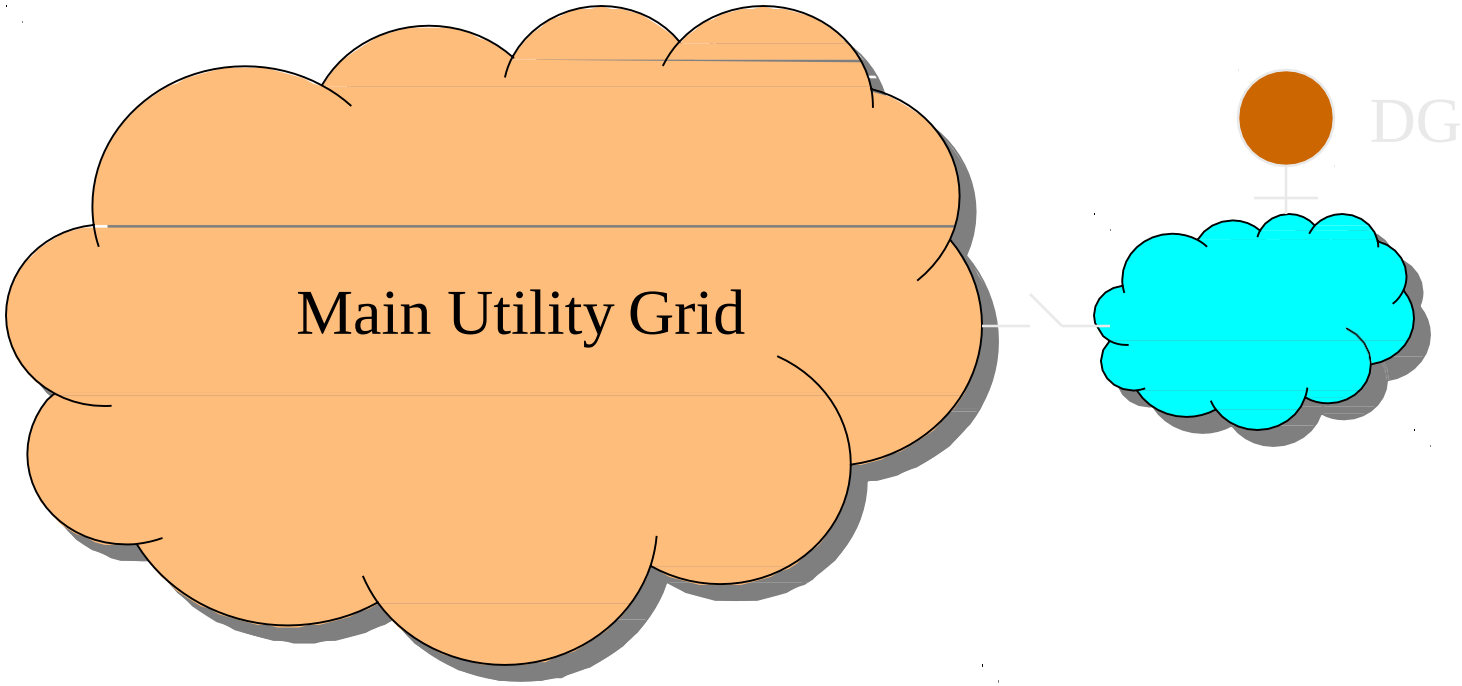
Operating Conflicts

- Voltage Drops Along the Feeder if the DG is Interrupted (Determine the Max. Capacity of DG)



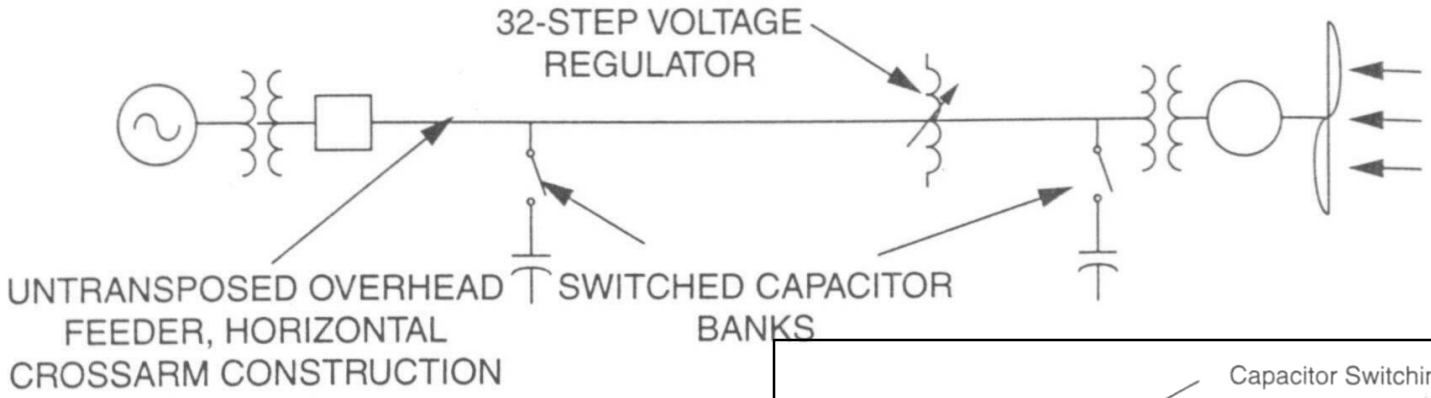
Operating Conflicts

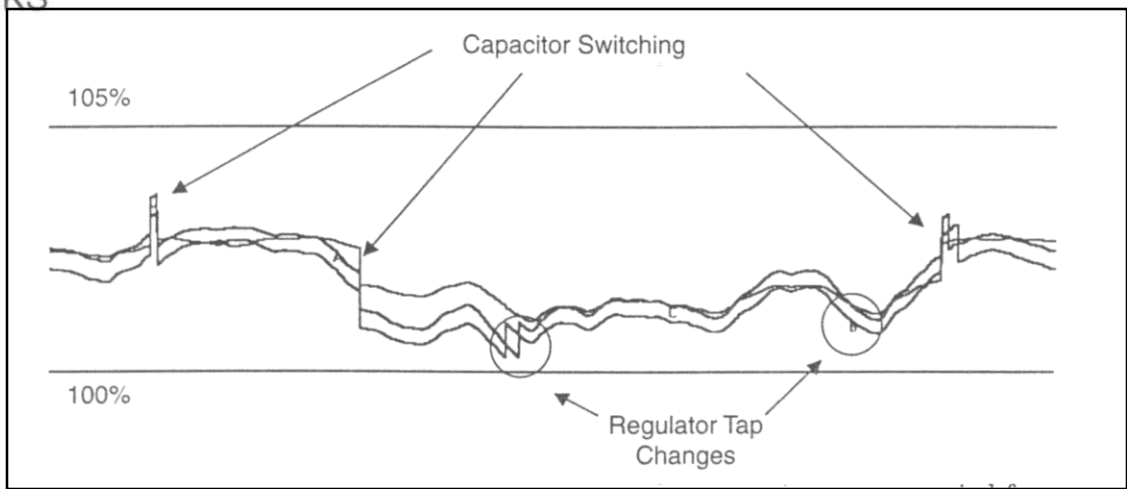
- Islanding



Operating Conflicts

- Varying DG Output can Cause Excess Duty on Utility Voltage Regulation Equipment





Operating Conflicts

- Transformer Connections
  - Grounded Y-Y Connection
    - No Phase Shift
    - Less Concern for Ferroresonance
    - Allow DG to Feed All Types of Faults on the Utility System
    - Back Feed of the Triplen Harmonic
    - Should Insert Ground Impedance to Limit the Current

- A Microcomputer Based Network ProtectorRelay

DG on Low-Voltage Distribution

DG on Low-Voltage Distribution Networks

- Operation of AMicrocomputer Based Network Protector Relay
  - Network protector relays are used to monitor and control the power flow of low voltage AC to secondary network systems
  - The purpose of the network protector is to prevent the system from backfeeding and initiate automatic reclosing when the system returns to normal

Benefits of Decentralized Generation

- *No high peak load shortages*
- *Reduced high transmission and distribution losses*
- *Linking remote and inaccessible areas*
- *Faster response to new power demands*
- *Improved supply reliability and power management*

∨ Disadvantages of DG

- Power Quality
- Cost of Operation and Maintenance
- Long Term Reliability of the Units
- Interconnection

Distributed Generation Applications

- **Continuous Power**
- **Combined Heat and Power (CHP)**
- **Peaking Power**
- **Green Power**
- **Premium Power**
- *Emergency Power System*
- *Standby Power System*
- *True Premium Power System*
- **Transmission and Distribution Deferral**
- **Ancillary Service Power**

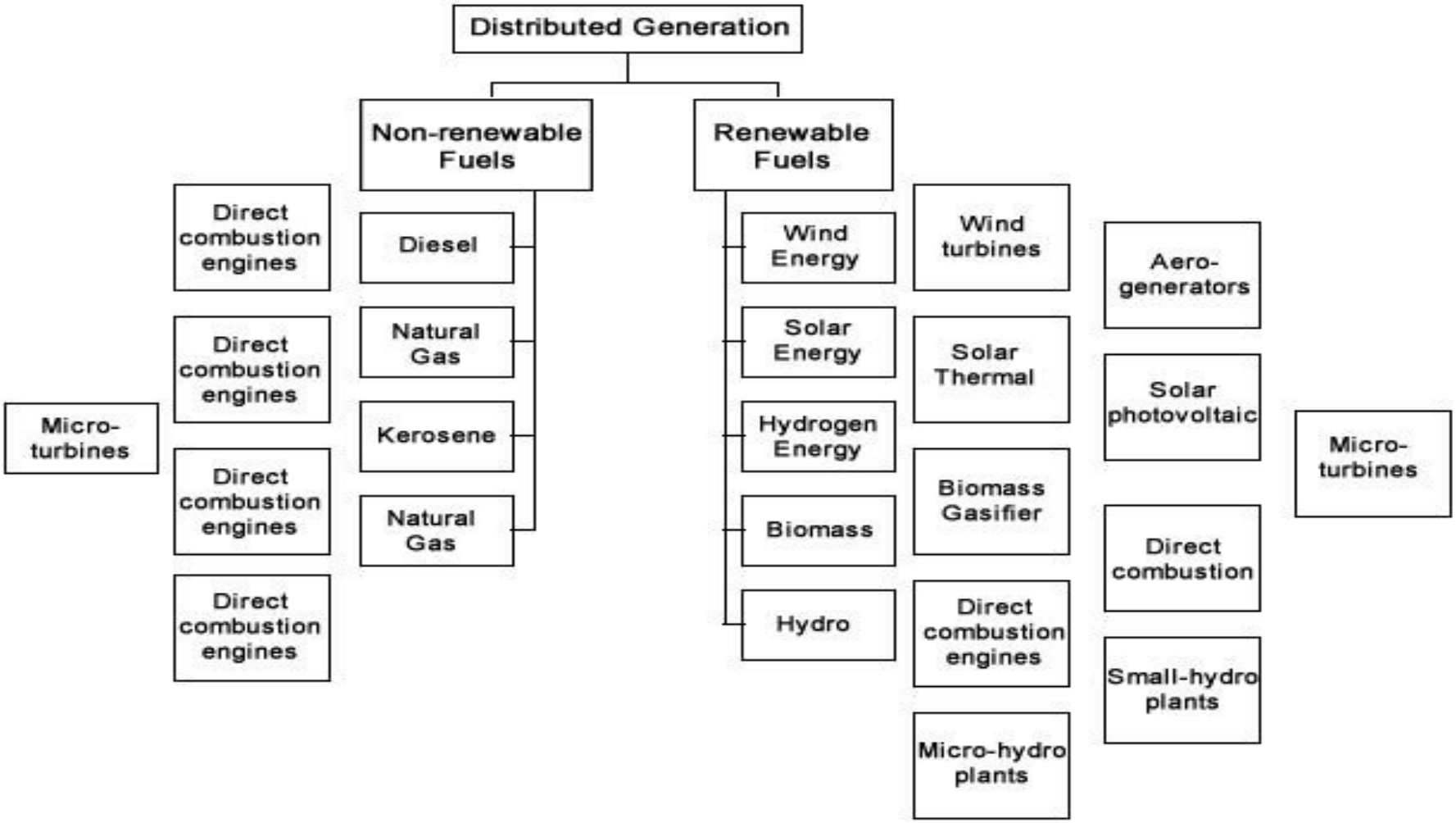
Identification of DG Installation

- Evaluation of distributed generation opportunities in end-use markets
- Assessments of distributed generation technologies
- Identification of potential sites for distributed generation applications
- Different price and Performance parameters
- Feasibility studies for distributed generation projects

Role of Decentralized Generation in Smart Grid

- Natural Extensions of Smart Grid
- Better System Management
- Additional Revenue Stream
- Less Investment and less transportation cost
- Cutting line losses
- Ease of Control from Islanding and anti islanding Scheme
- Reduces carbon emission and thus supports sustainable livelihood.
- Automatic Resynchronization.

Decentralized Generation in India



Government Policy of India

- The Electricity Act, 2003 has given a thrust to distributed generation particularly in the context of rural electrification. The Act specifies distributed generation and supply through stand-alone conventional and renewable energy systems.
- The National Electricity Policy notified on 12 February 2005 recommends under the Rural Electrification component, that to provide a reliable rural electrification system, wherever conventional grid is not feasible, decentralized distributed generation facilities (using conventional or non-conventional sources of energy) together with local distribution network be provided.
- Two specific schemes, the Rajiv Gandhi Grameen Vidyutikaran Yojna and the Remote Village Electrification Scheme, will provide up to 90% capital subsidy for rural electrification projects using decentralized distributed generation options based on conventional and non-conventional fuels.