TECHNOLOGY SUPPORT TO DECENTRALIZED DISTRIBUTED GENERATION – SIMULATION STUDIES

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INTEGRATION OF DG SOURCES INTO DISTRIBUTION NETWORKS:

- IMPROVES DISTRIBUTION NETWORK OPERATION
- GENERATES POWER CLOSER TO LOADS
- LOW LOSSES
- IMPROVES NETWORK RELIABILITY
INTEGRATION REQUIREMENTS

- SEAMLESS TRANSITION BETWEEN CONNECTION/ ISLANDING
- RESILIENCE UNDER CHANGING CONDITIONS
- RECOVERY FROM DISTURBANCES AND CONTRIBUTION TO NETWORK RECOVERY
- INTERFACING AC AND DC NETWORKS
ISSUES INVOLVED IN DG OPERATION:

- SAFETY – SAME CONCERNS AS THE UTILITY SYSTEM IN CASES OF FAULTS
- POWER QUALITY
  - VOLTAGE DISTORTION
  - SAGS, SWELLS AND UNBALANCES
  - LIGHTNING, SWITCHING AND FAULTS
- CONTROL STRATEGIES FOR VARIOUS OPERATION MODES
- PROTECTION
IMPROVEMENT IN DISTRIBUTION NETWORK OPERATION POSSIBLE:

ONLY IF APPROPRIATE MODELS & CONTROL SCHEMES CHOSEN FOR EACH CONFIGURATION OF DDG
Distributed Generation Architecture forming Micro Grid
MicroGrid Controllers
Stand-alone DG Feeding a Load
Rotating Machine Interface

Photovoltaic Array Interface
MODELING & SIMULATION OF DG

- MODELING OF GENERATOR TECHNOLOGIES
  - MICRO GENERATORS
  - BIO MASS FUELED GENERATION
  - SPV
  - WIND TURBINES
  - STORAGE
  - POWER ELECTRONICS INTERFACES
MODELING & SIMULATION OF DG

- LOAD MODELING
- UNBALANCED TRANSIENT STABILITY MODELS
- UNBALANCED DETERMINISTIC & PROBABILISTIC LOAD FLOW AND FAULT CALCULATORS
SIMULATION OF DG

- STEADY STATE AND DYNAMIC OPERATION
- INTERACTIONS BETWEEN DDG SOURCES
- INTERACTIONS BETWEEN GRID AND DG
OBJECTIVES OF SIMULATION STUDIES

- Find optimal mix of available generation resources to minimize cost of energy to consumers
- Optimize operation of local generation sources
- Study operation of DDG in normal & abnormal conditions
- Develop & demonstrate control strategies to ensure efficient, reliable and economic operation
- Define protection & grounding schemes
- Prototype testing of controllers
- Testing of power electronics interfaces
SIMULATION TOOLS AT CPRI

- REAL TIME DIGITAL SIMULATOR (RTDS)
- PSCAD/ EMTDC
- MATLAB/ SIMULINK
- EADER
REAL TIME DIGITAL SIMULATOR AT CPRI

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RTDS APPLICATION AREAS

- Modeling of Synchronous & Asynchronous Machines
- Interactions of AC and DC Systems
- Protection and Control Systems Modeling
- Control System for Synchronous Machines
- Modeling of Power Electronics Devices

Real Time Feature Essential for Developmental Studies on Prototype Controllers
STUDIES UNDERTAKEN AT CPRI

GRID RELATED ISSUES AT WIND FARMS IN PANCHAGANI & BRAMHANVEL

- ADEQUACY OF EXISTING REACTIVE POWER COMPENSATION IN THE WIND FARM
- SUGGEST SUITABLE FIXED/DYNAMIC COMPENSATION
- PROTECTIVE RELAY COORDINATION TO AVOID FREQUENT TRIP PINGS
STUDIES UNDERTAKEN AT CPRI

SIZING OF REACTIVE POWER COMPENSATION FOR A NEW WIND FARM IN KUTCH

- GRID CONNECTED WIND FARM
- MACHINES ARE OF INDUCTION GENERATOR TYPE REQUIRING REACTIVE POWER COMPENSATION
- FIXED AND DYNAMIC COMPENSATION
- OPTIMAL SIZING, LOCATION & TYPE OF REACTIVE POWER COMPENSATION TO BE ARRIVED AT
### System Influence on DG performance

| System Strength          | 1. Power transfer capability depends on this  
|                         | 2. Rising voltages as DGs are switched on. Falls as more DGs come on  
| Gen. - Load Ratio        | Changes with load and as each DG is switched on  
| Voltage Profiles         | Changes with DG penetration levels and system strengths  
| Trf Reverse Flow         | Increased back flow increases real & reactive losses in Transformers.  
| Transient Perf.          | **Stable steady state does not guarantee transient performance.**  

Typical Voltage Dip on DG Start

Source Voltage

Vs (p.u.)

Es

t(s)

0.900 0.925 0.950 0.975 1.000 1.025 1.050

0.0 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0
RURAL ELECTRIFICATION RELATED WORK IN CPRI

- LED LIGHTING
- ENERGY EFFICIENT LIGHTING
- DEVELOPMENTAL TESTING OF POWER CONVERTERS
SPONSORED & COLLABORATIVE RESEARCH AT CPRI

STUDY OF INFRASTRUCTURE AND ISSUES INVOLVED IN IMPLEMENTATION OF DISTRIBUTED GENERATION IN RURAL AREAS – IIT, BOMBAY

INVESTIGATION OF GRID – WIND TURBINE AND DG INTERACTION – CPRI

DEVELOPMENT OF A ECONOMICAL VARIABLE SPEED CONSTANT FREQUENCY GENERATOR SYSTEM SUITABLE FOR WIND POWER GENERATION – IIT, KHARAGPUR
THANK YOU!