Role of the Smart Grid in Facilitating the Integration of Renewables

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PPT slides will be available at www.saifurrahman.org
What is a Smart Grid

"Smart grid" is a concept with many elements where monitoring and control of each element in the chain of generation, transmission, distribution and end-use allow our electricity delivery and use more efficient.
Electric Power Grid

Difference Between a Normal Grid And a Smart Grid

Normal Phone  Smart Phone

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Motivation for a Smart Grid

Desire to make the grid smarter, safer, reliable and more cost-effective using advanced sensors, communication technologies and distributed computing.

Starting and End Points of a Smart Grid

From Generator to Refrigerator

- Power Plant
- Transmission
- Distribution
- Home Business
- End-use Appliances
Smart Grid Building Blocks

Evolution of the Grid

Before Smart Grid:
One-way power flow, simple interactions

After Smart Grid:
Two-way power flow, multi-stakeholder interactions

Source: Altalink, Alberta, Canada
Intelligent Interconnected Microgrids

- Intelligent Load Demand or price-driven control of appliances
- Distribution Network Interconnected micro grids
- Sensors Detect outages, fluctuations,
- Distributed Arch.
- Wind Power Park
- Smart Inverters and Storage
- Minimize voltage and power fluctuations
- Local Monitoring and Control
- Bulk Power Plant
- Control Room Functions
  - Balance electricity supply/demand across the grid

Merging Power Flow with Information Flow:

Integrated Communications
Electric Power & Communication Infrastructures

1. Power Infrastructure

- Central Generating Station
- Step-Up Transformer
- Distribution Substation
- Recieving Station
- Distribution Substation

- Gas Turbine
- Recip Engine
- Microturbine
- Flywheel
- Fuel cell

- Residential
- Photo voltaics
- Batteries

- Residential Data Concentrator
- Control Center
- Data network Users

2. Information Infrastructure

- Source: EPRI

Changing Landscape for the Electric Utility

- Residential
- Commercial
- Industrial
- Recieving Station
- Distribution Substation

- Source: EPRI
Issues with Distributed Generation

- Wind and solar are intermittent
- Hydro is space limited
- Resource is free but not always usable
BPA Wind Output and Load Mismatch (January 2013)

BPA Wind Output and Load Mismatch (April 2013)
Wind output can drop 43.7 MW in 1 minute for a single 150-MW wind farm.

Wind output can drop 113 MW in 10 minutes, and increase 106 MW in 10 minutes.
Hourly wind power variation (MW) in Texas, USA (01 and 02 Jan 2008)

Installed Capacity 4,541 MW

Hourly wind power variation (MW) in Texas, USA (03 and 04 Jan 2008)

Installed Capacity 4,541 MW
Roof-top Solar Photovoltaics in Virginia

Solar Panels in Winter
Can the Intermittency be Absorbed by the Network?

Storage?

- Batteries
- Pumped storage hydro
- Compressed air energy storage (CAES)

Demand Response?
Demand Response

“Demand Response is a customer action to control load to meet a certain target. Here the customer chooses what load to control and for how long”.

This is different from Demand Side Management (DSM) where the load is controlled by the electric utility and the customer has no control beyond the initial consent.

New Paradigm for the Power System

• Historical: Demand driven supply
• New Reality: Demand needs to be supply-driven
From Smart Buildings to Smart Grid

**Smart grid:** Bi-directional flows of energy, remote control/automation of power, integrated distributed energy...

**Smart city:** Complex system of interconnected infrastructures and services...

**Smart Campus:** A collection of buildings managed by the same facility manager...

**Smart buildings:** Intelligent building automation systems, smart devices, productive users, grid integration...

Supported by ICT and distributed networks of intelligent sensors, data centers/clouds

What Makes a City Smart

- There is **no** single consensus definition of a smart city, but there is some agreement that a smart city is one in which information and communication technology (ICT) facilitates improved insight into and control over the various systems that affect the lives of residents.

What makes a Building Smart

A single platform for monitoring and control of HVAC, lighting, water supply, sensor networks, security camera & fire emergency.


Peak Load Reduction

Peak kW reduced
Cumulative Benefits of Building Load Control

- A large number of buildings can be controlled to absorb large fluctuations of supply in the short term.
- No new storage is required
- Only investment is for monitoring and control

Thank you for your attention

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