Role of the Smart Grid in Facilitating the Integration of Renewables

Keynote Speech

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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 the electricity delivery and use to be more efficient.
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.
Difference Between a Normal Grid And a Smart Grid

Normal Phone | Smart Phone
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Starting and End Points of a Smart Grid

From Generator to Refrigerator

Power Plant | Transmission | Distribution | Home Business | End-use Appliances
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

Merging Power Flow with Information Flow:
Integrated Communications
Electric Power & Communication Infrastructures

1. Power Infrastructure

Central Generating Station
Step-Up Transformer
Distribution Substation
Receiving Station
Distribution Substation
Commercial Gas Turbine
Recip Engine
Cogeneration
Recip Engine
Fuel cell
Micro-turbine
Flywheel
Residential Data Concentrator
Batteries
Photovoltaics
Residential

2. Information Infrastructure

Data network Users
Control Center
Distribution Substation
Gas Turbine
Recip Engine
Cogeneration
Industrial
Commercial
Annual
Source: EPRI

Changing Landscape for the Electric Utility

Source: EPRI
Wind Energy

Off-shore Wind turbines, Blyth, U.K.

BPA Wind Output and Load Mismatch (January 2013)
BPA Wind Output and Load Mismatch (April 2013)

BPA Wind Output and Load Mismatch (July 2013)
BPA Wind Output and Load Mismatch (Oct 2013)

Roof-top Solar Photovoltaics in Virginia
Solar Panels in Winter

7-Day Solar PV Output
7-Day Solar PV Output (intermittent)

Daily PV Output

PV AC Power Output During One Sunny Day
Can the Intermittency be Absorbed by the Network?

- Battery storage
- Compressed Air Storage
- Pumped Storage
New Paradigm for the Power System

• Historically: Demand driven supply
  (supply responds to demand)

• New Reality: Supply driven demand
  (demand needs to adjust to meet fluctuating supply with help from storage)

THE SMART GRID ECOSYSTEM

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
Thank You

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