Role of the Smart Grid in Facilitating the Integration of Renewables

Invited Speech

IEEE PES EMI Student Branch Chapter, Morocco
22 April 2021

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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

2. Information Infrastructure

- Data network Users
- Control Center
- Residential Data Concentrator
- Residential
- Photovoltaics
- Batteries

Source: EPRI

Changing Landscape for the Electric Utility

- Wind turbines
- Solar panels
- Residential
- Electric car
Off-shore Wind turbines, Blyth, U.K.

BPA Wind Output and Load Mismatch (January 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
Daily PV Output (intermittent)

PV AC Power Output During One Cloudy 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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