The role of smart grids in integrating variable Renewable Energy sources

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How Electricity is Delivered on the Grid

Dissipated (7%, Lost as Heat) = Current^2 X Resistance (P=I^2R)
Smart Grids: Approaches

• Around the world different approaches are being adopted and a wide variety of technologies and services are being demonstrated driven by national and regional business drivers.
• In the US peak load reduction technology and dynamic pricing tariffs are being pursued.
• In Europe emphasis is on improving energy efficiency and reducing emissions through decentralised production.
• In the Asia-Pacific region China is modernising and improving grid reliability and Australia and New Zealand are exploring new techniques for load management.
• Other countries also actively pursuing smart grids are Brazil, Mexico, South Korea and Japan.
Smart Grids: Approaches

• Smart Grid as a new infrastructure for supplying power will leverage ICT technology to improve the reliability of power supplies, promote the mass introduction of renewable energy and optimize energy use by consumers.

• Based on a power supply network which is responsible for supplying power, and a communication network which supervises and controls the facilities that constitute the power supply network, ICT technology will allow power consumers to upgrade their energy management across power generations.

• Overall, Smart Grids will enable high-quality power to be supplied in a highly efficient manner and thus promote a rich, safe and low carbon society.
• Overlay electric grid with networking technology
• Price and Availability of Electricity linked to Usage
• Two-Way Communication
Smart Grids: Concepts & Integration
Advantages for Power Companies

- Enables rapid and automated incident response
- Makes frequency regulation easier and increases grid stability and power quality
- Load Leveling
Advantages to End-Users

- Distributed Generation more cost-effective, can sell back to the grid
- May decrease cost of electricity for consumers
- Enables the smart, programmable operation of important systems or appliances
Smart Meters and Smart Appliances

- The current system of energy metering as well as billing uses electromechanical and somewhere digital meter
- It consumes more time and labour
- There is an issue with billing inaccuracy
- Smart energy meter gives real power consumption as well as accurate billing
- It provides real time monitoring of electricity uses
- It is less time consuming and cost effective

- Smart appliances networked and programmed into grid demand
- Power companies can directly modulate load balance and demand
- Many communication methods, not all require new infrastructure
Smart Grids: Challenges

• New infrastructure to communicate in both directions required
• Electricity prices less transparent for consumer, adjustment from fixed price to real-time pricing
• Security concerns
• Behavioral Changes and Data Management Required…
Renewables in Cities

- In the Middle East about 50-70 % energy is consumed by buildings in a city

- Green buildings integrated with Renewable Energy and energy conservation systems can save about 30 – 40% of conventional energy used in building
Renewables in Cities

✓ Solar power generation in City & offsite
✓ Solar Water Heaters for hot water
✓ Solar PV Rooftop systems for electricity
✓ Solar street lightings
✓ Solar pumps for water lifting
✓ Solar traffic signals, solar road studs/blinkers
Grid connected SPV Roof Top Systems

World-wide

- Germany, USA and Japan are leaders in adopting grid-connected SPV Rooftop systems.
- Germany has highest PV installed capacity of over 38 GW of which 71% is in rooftop segment (2015).
- Italy has 12.7 GW PV installation with over 60% rooftop systems
- In Europe of total 50.6 GW PV installation, over 50% in rooftop segment.
Grid connected SPV Roof Top Systems

- Solar systems installed on rooftops of residential, commercial, institutional & industrial buildings
- Electricity generated could be fed into the grid at regulated feed-in tariffs or used for self consumption with net-metering approach
Grid connected SPV Roof Top Systems

Advantages

• Decrease in transmission and distribution losses
• Low gestation time
• No requirement of additional land
• Improvement of tail-end grid voltages and reduction in system congestion with higher self-consumption of solar electricity
• Local job creation
• Reduction of power bill by supplying surplus electricity to local electricity supplier
• Battery elimination makes easy installation and reduced cost of system .....
Grid connected SPV Roof Top Systems
Advantages
Grid connected SPV Roof Top Systems - Oman Case

Peak reduction for the expected case scenario

5% = 450MW
10% = 900MW
15% = 1350MW
Typically, critical periods occur only 1-2% of the hours per year, yet the infrastructure must be maintained to supply it. The whole system is engineered for these peak periods, and about 20% of the entire grid capacity exists only to manage a few hours a year of peak load. If we could spread out that peak load, we could get far more from existing infrastructure.
Renewable Generation Intermittency

- Wind, Solar and hydropower generation depend on environmental conditions
- Grid must be able to dispatch storage or generation quickly to accommodate sudden changes
- Conventional power generation has a “ramp-up” time before reaching maximum generation
Renewables Generation Challenges

• How does the power company know how much to produce?
• Electrical Power cannot easily be stored in large quantities, yet
• The load must be balanced across a grid
• Reliability and Power Quality
• Advanced Electricity Pricing (Real-Time Pricing)
• Renewable Resource Forecasting
Renewables, Storage & Smart Grids

- New sensors - synchrophasors
- Renewable energy and electric storage
- Integrated communication systems
- Distributed power generation
- Demand response utility rates
- Smart meters and building automation

Smart grid components
Renewables, Storage & Smart Grids

- Efficient Building Systems
- Utility Communications
- Dynamic Systems Control
- Distribution Operations
- Data Management
- Internet
- Consumer Portal & Building EMS
- Advanced Metering
- Plug-In Hybrids
- Distributed Generation & Storage
- Renewable PV
- Smart End-Use Devices
- Efficient Building Systems
- Control Interface
- Internet
Renewables, Storage & Smart Grids

Visions of the electricity system. Present and future flows

The four functions of smart grid technologies

Source: IRENA 2013
Key messages

- **Technologies, Systems and Services** should be **developed** to provide more flexibility, transparency and sustainability.
- Increase **awareness** about the benefits of Smart Grids & Storage (Utilities & End Users)
- The successful implementation of smart grid technologies for renewables requires **changes in policy** and regulatory frameworks to address non-technical issues.
- Incorporation into **procurement** processes/ Auctions (pilot projects,....)
Conclusion & Recommendations

• **Changes** will be essential to transform the electricity system and create the grid infrastructure to support a **sustainable energy future**.

• Technology cooperation is key to promote **innovation** and **sustain** the emerging Renewables Smart Grids market.

• The **EU GCC Clean Energy Technology Network** stands ready to cooperate with GCC countries
Thank you!

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