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.

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Electric Power Grid

Source: www.sxc.hu

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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.

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Difference Between a Normal Grid And a Smart Grid

Normal Phone

Smart Phone

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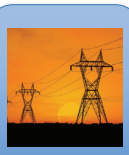
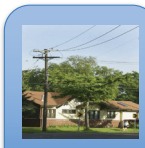
Starting and End Points of a Smart Grid

From Generator to Refrigerator

Power Plant



Transmission



Distribution

Home Business

End-use Appliances

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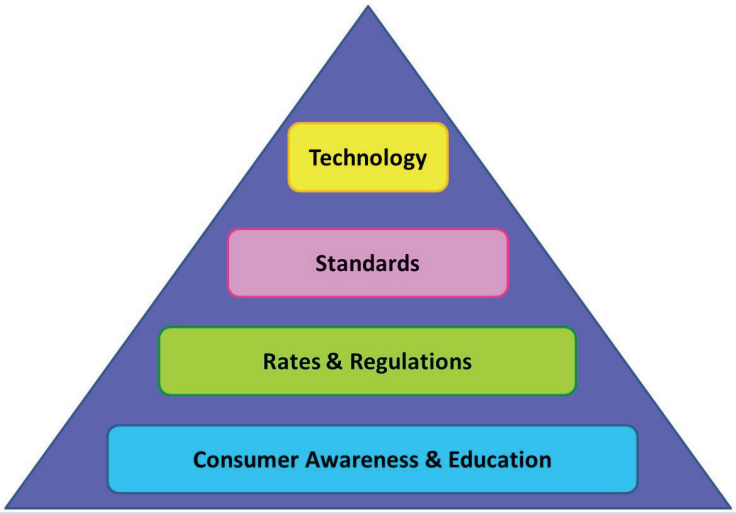
Smart Grid Building Blocks



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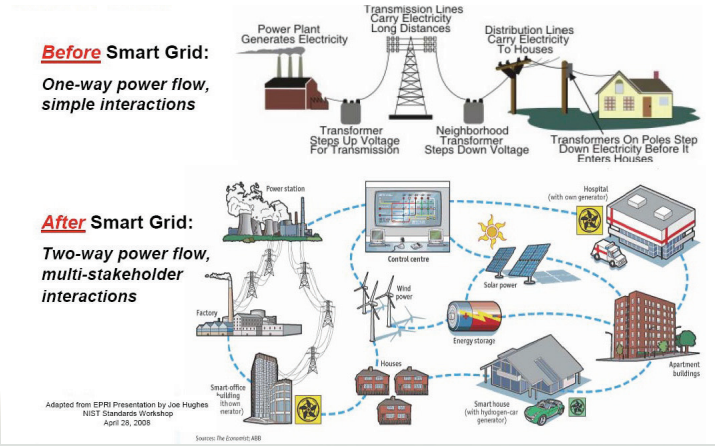
Evolution of the Grid



Source: Altalink, Alberta, Canada

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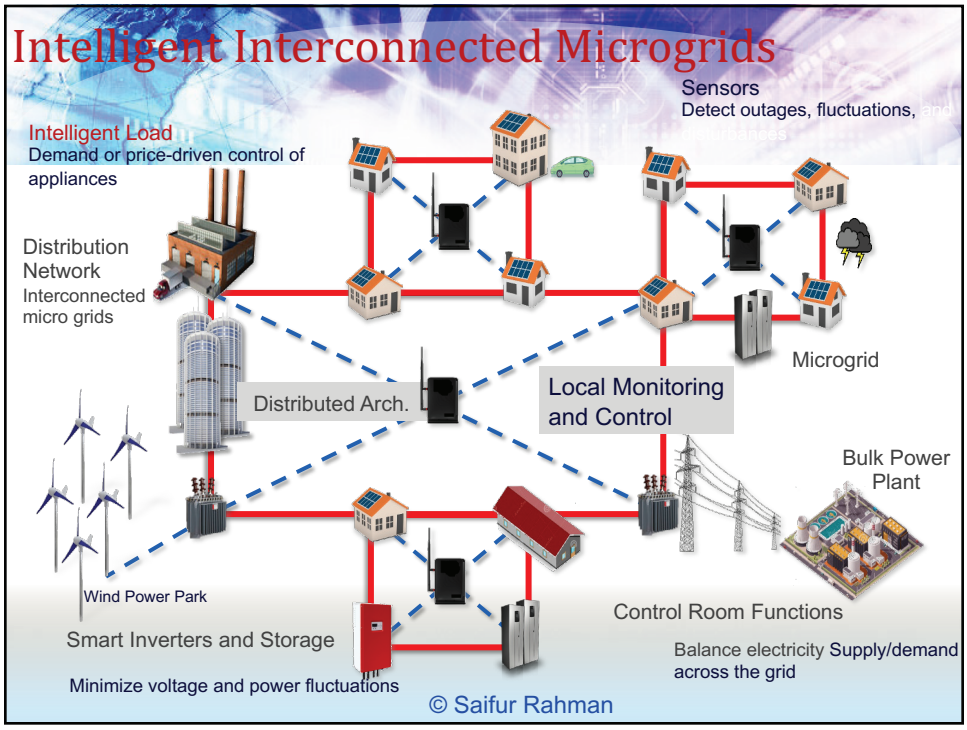
Intelligent Interconnected Microgrids
Sensors
Detect outages, fluctuations, and disturbances
Intelligent Load
Demand or price-driven control of appliances
Distribution Network
Interconnected micro grids
Microgrid
Distributed Arch.
Local Monitoring and Control
Bulk Power Plant
Wind Power Park
Control Room Functions
Smart Inverters and Storage
Balance electricity Supply/demand across the grid
Minimize voltage and power fluctuations
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Merging Power Flow with Information Flow:
Integrated Communications
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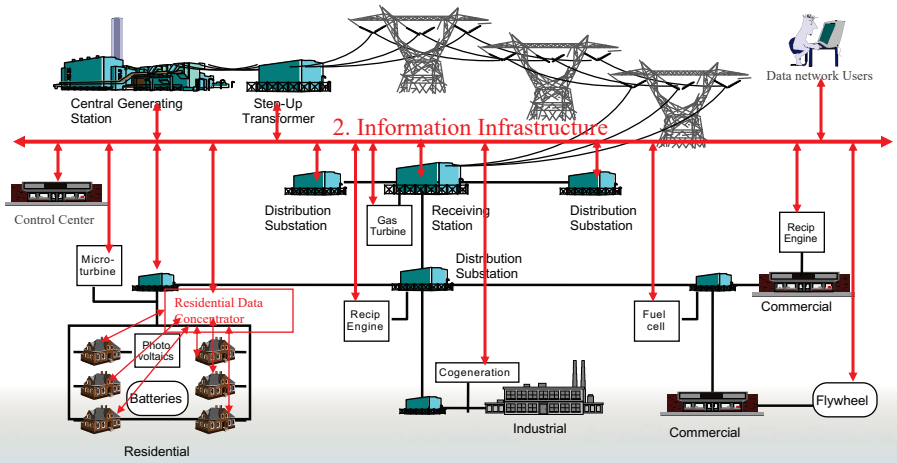
Electric Power & Communication Infrastructures

1.Power Infrastructure



Source: EPRI

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Changing Landscape for the Electric Utility

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Issues with Distributed Generation

- Wind and solar are intermittent
- Hydro is space limited
- Resource is free but not always usable

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

Wind Energy

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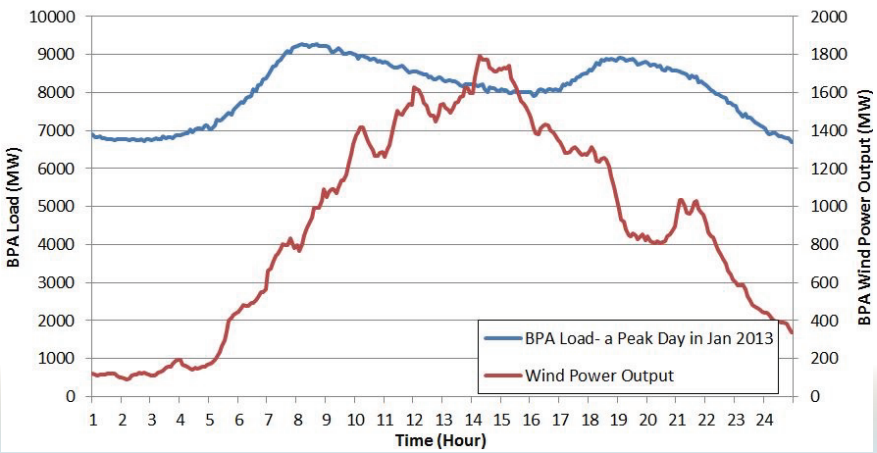
BPA Wind Output and Load Mismatch (January 2013)



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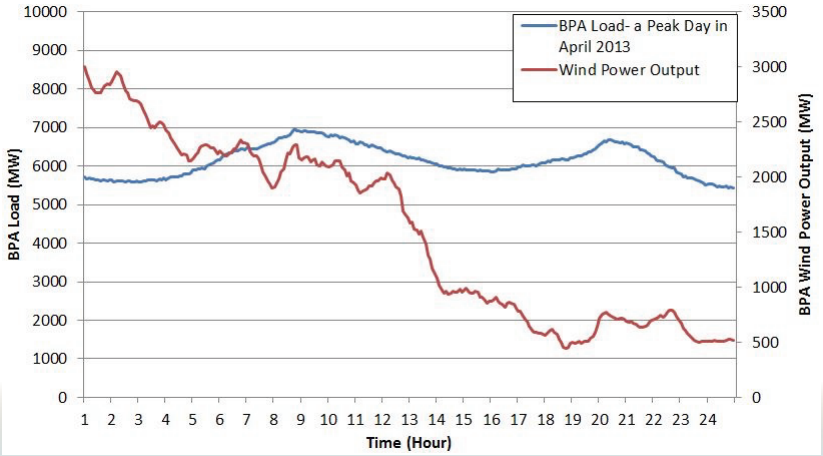
BPA Wind Output and Load Mismatch (April 2013)



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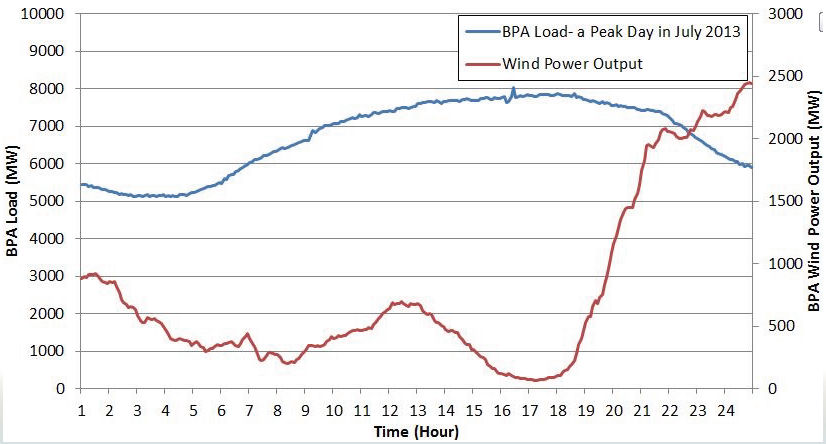
BPA Wind Output and Load Mismatch (July 2013)



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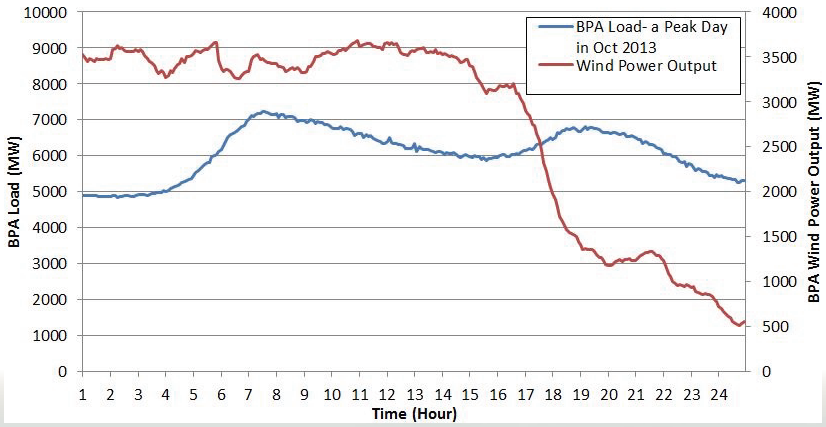
BPA Wind Output and Load Mismatch (Oct 2013)



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Roof-top Solar Photovoltaics in Virginia

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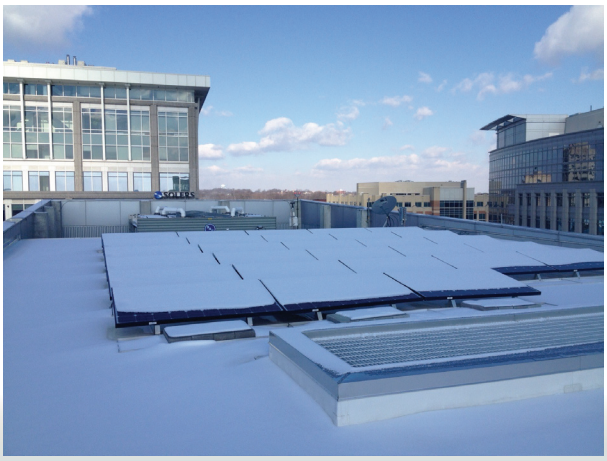
Solar Panels in Winter



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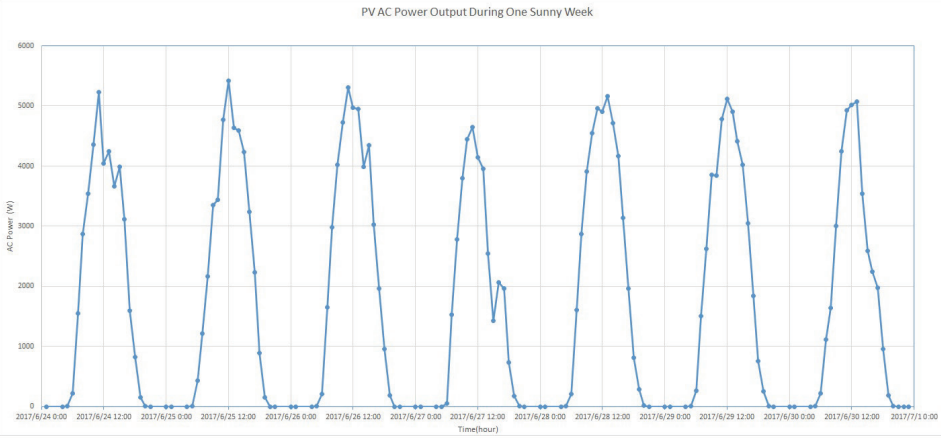
7-Day Solar PV Output



Day 1 Day 2 Day 3 Day 4 Day 5 Day 6 Day 7

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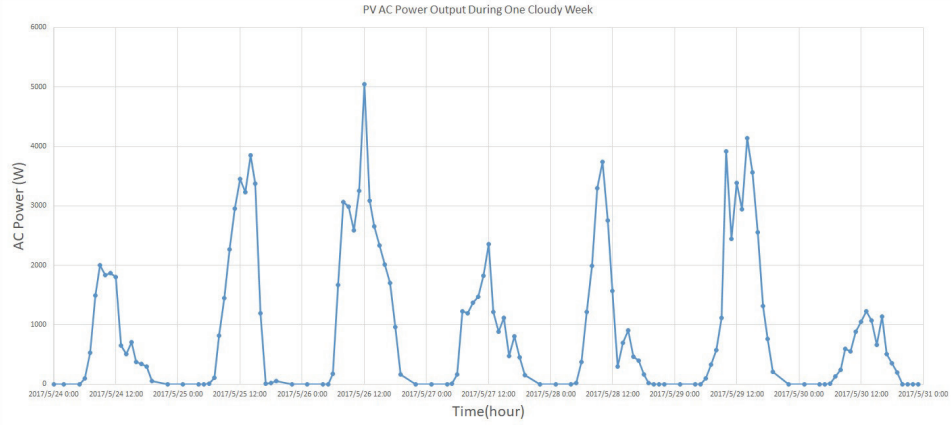
7-Day Solar PV Output (intermittent)



Day 1 Day 2 Day 3 Day 4 Day 5 Day 6 Day 7

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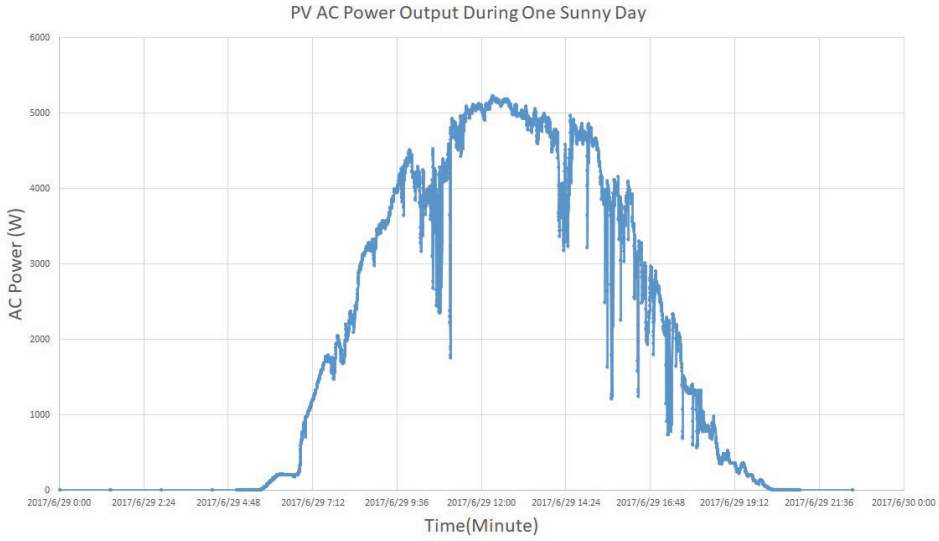
Daily PV Output



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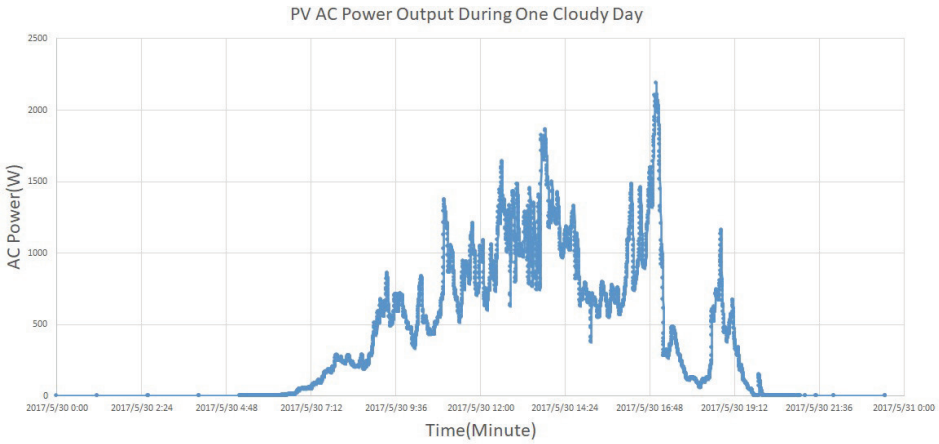
Daily PV Output (intermittent)



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In-depth look at Solar PV in KSA

2-MW Roof-top Solar PV plant at KAUST

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Solar PV Panels in Saudi Arabia

Reality Check

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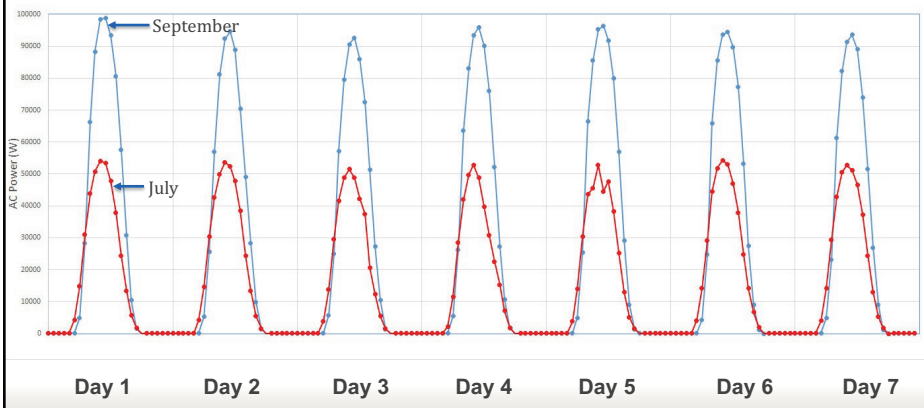
Solar PV Array (100kWp) Riyadh Area



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Solar PV Panel Cleaning Cost and Frequency

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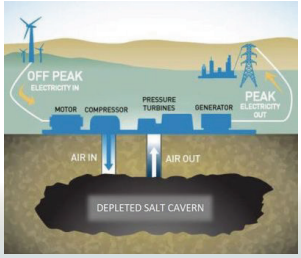
Can the Intermittency be Absorbed by the Network?

Battery storage

Pumped Storage

Compressed Air Storage



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Addressing the Intermittency in Renewable Generation

- Smart vs. not-so-smart load control

  (adjust temperature set points in an air conditioner or water heater vs. turning the unit off)
- Size the storage to take advantage of demand dynamics
- Control the renewable generation to avoid instability (output control from PV inverters)

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How Can the Smart Grid Help?

It helps to integrate intermittent sources of generation into the electric power grid.

Short term load control for a large number of end-use devices through demand response makes it possible to get quick load relief to match fluctuations in generation.

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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.

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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

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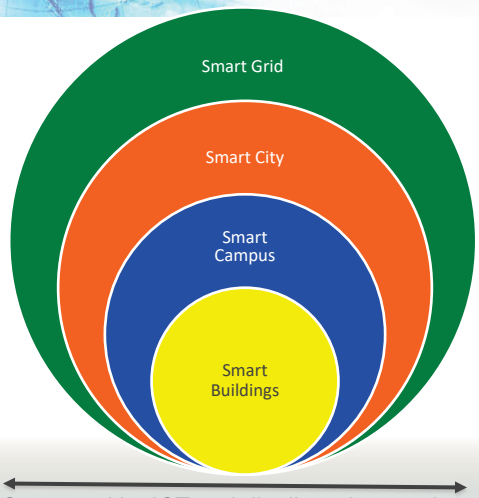
THE SMART GRID ECOSYSTEM



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

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…

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Thank You

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