IEEE Joint PES/IAS Society Chapter Meeting

How Can the Smart Grid Facilitate Distributed Generation

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Copies of slides are available from:

www.saifurrahman.org/presentations

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.

FierceSmartGrid: *There are many definitions of "smart grid" -- how do you define it?*

Saifur Rahman: "Smart grid" is a concept with many elements -- it's not a physical thing. I like to say that a smart grid starts at the generator and ends at the refrigerator.

http://www.fiercesmartgrid.com/story/smart-grid-starting-generator-ending-refrigerator/2013-02-19?utm_medium=nl&utm_source=internal

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This is the Electric Power Grid

Source: www.sxc.hu

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Difference Between a Normal Grid And a Smart Grid

Normal Phone

Smart Phone

What is the 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

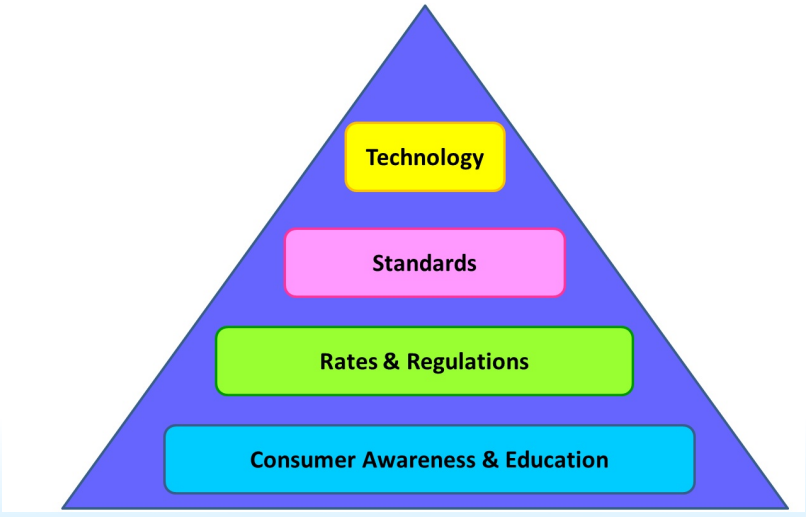

Transmission


Distribution


Home
Business


End-use
Appliances

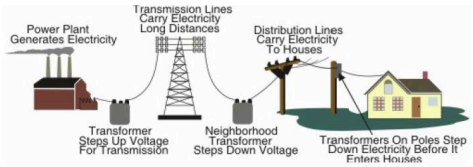
Building Blocks of the Smart Grid



Evolution of the Grid

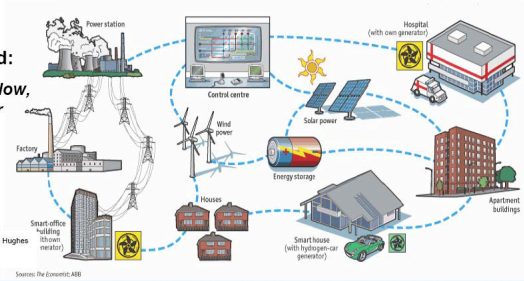
Before Smart Grid:

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

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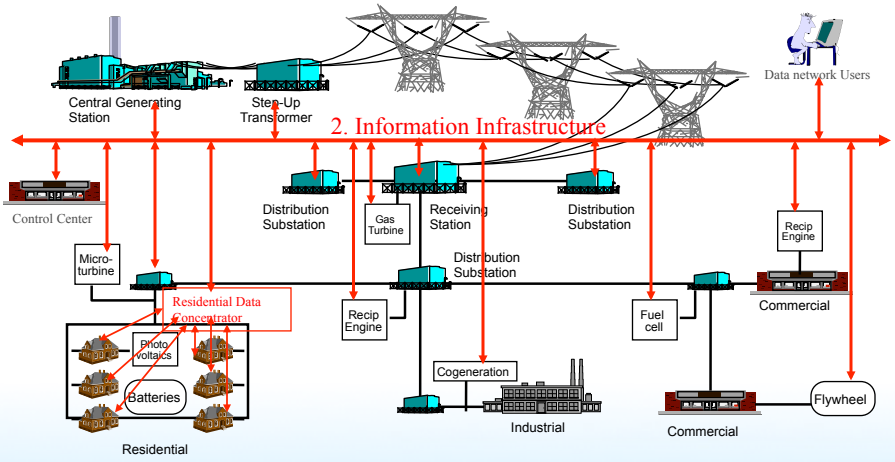
Electric Power & Communication Infrastructures

1.Power Infrastructure



Source: EPRI

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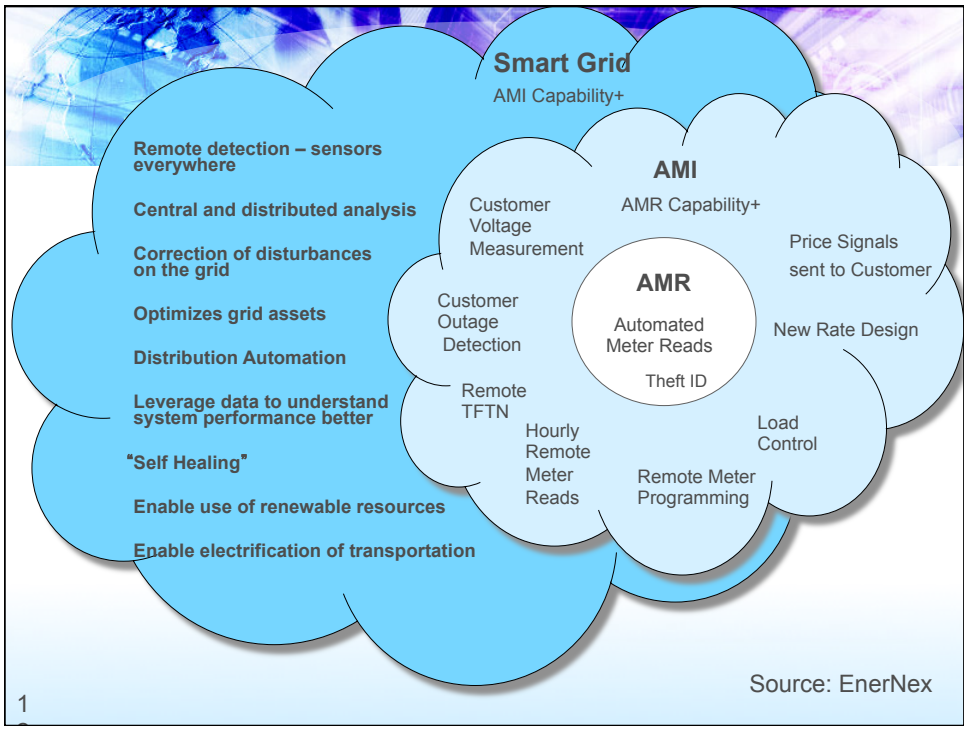

Source: EnerNex

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Issues in Smart Grid Deployment

- Technical
- Regulatory
- Business

Regulatory Issues

- Time varying rates
- Who pays the upfront costs
- Who owns the data

Business Issues

- Return on investment
- Customer acceptance
- Trained manpower

Technical Issues

- Renewables integration
- Demand response application
- Peak load reduction
- Remote meter reading & billing
- Transformer/Switchgear loading
- Service monitoring and recovery

Smart Grid Information Clearinghouse

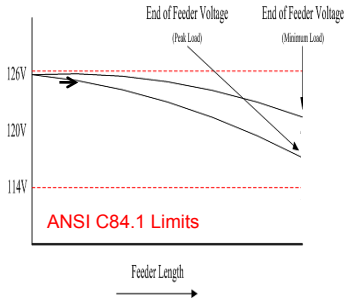
www.sgiclearinghouse.org

Technical Benefits

- Conservation Voltage Reduction
- Peak Load Reduction
- Faster Outage Recovery
- Renewables Integration

Conservation Voltage Reduction

- Customer voltages are maintained higher near the substation to provide an acceptable level near the end of the circuit.
- For each 1% reduction in voltage, there is as much as a 0.5% to 1% decrease in energy use at the customer end.



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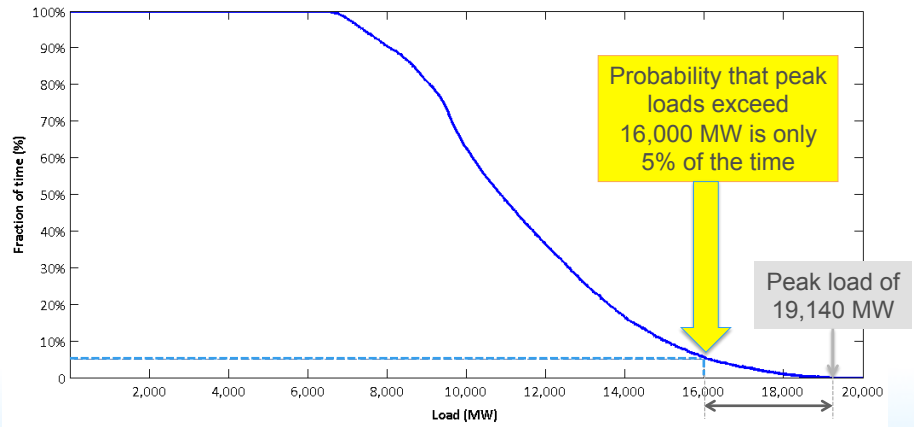
Peak Load Reduction
Dominion Virginia Power (2010)



Capacity (MW) is INVESTMENT and Energy (MWHr) is REVENUE

Several US states are regulating capacity growth (e.g., Indiana limits its capacity to negative growth)

Faster Recovery from Outages

- Smart meters allow automated outage information notification
- Distribution automation and advanced switching capability allow sectionalizing and faster distribution circuit reconfiguration to restore healthy sections to service

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

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

Wind Energy

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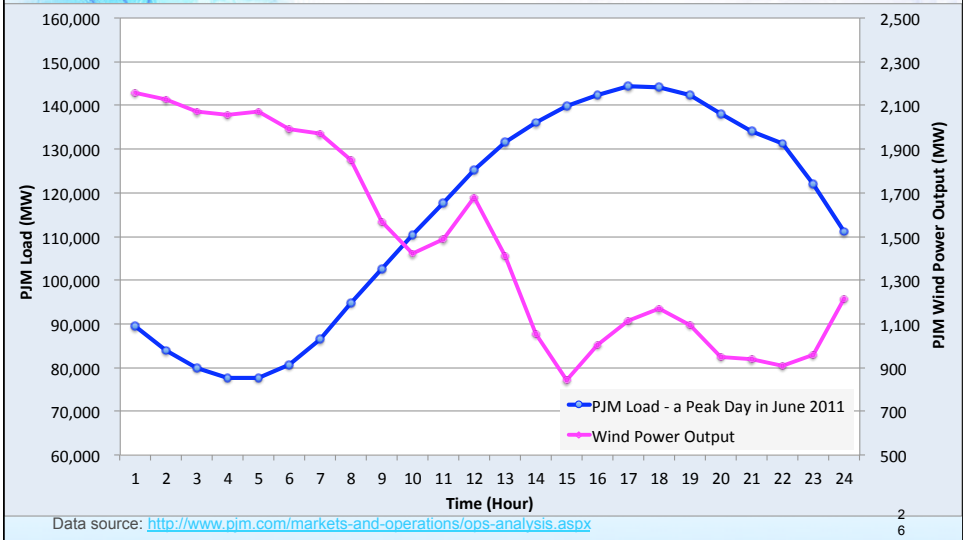
Wind Output & Load Mismatch (PJM)

(A peak day in June, 06/08/2011)



Data source: http://www.pjm.com/markets-and-operations/ops-analysis.aspx

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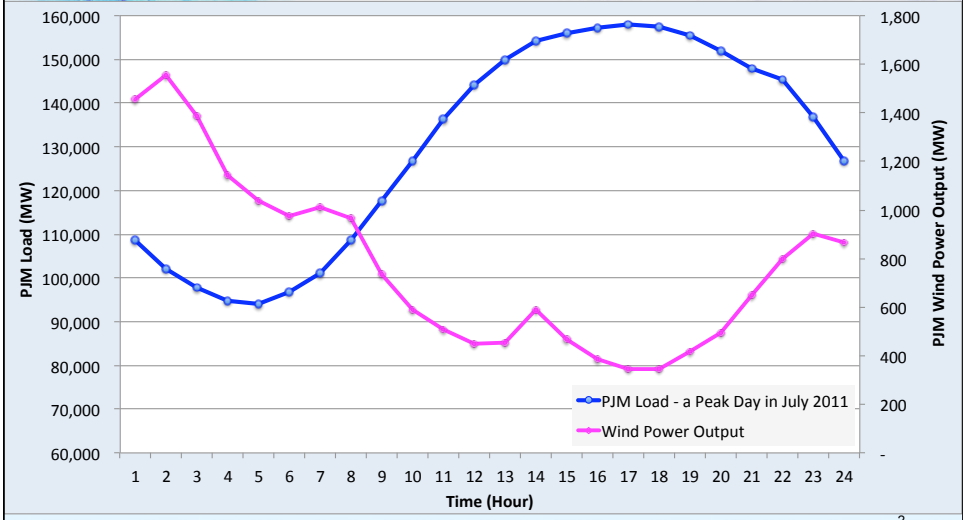
Wind Output & Load Mismatch (PJM)

(A peak day in July, 07/22/2011)



Data source: http://www.pjm.com/markets-and-operations/ops-analysis.aspx

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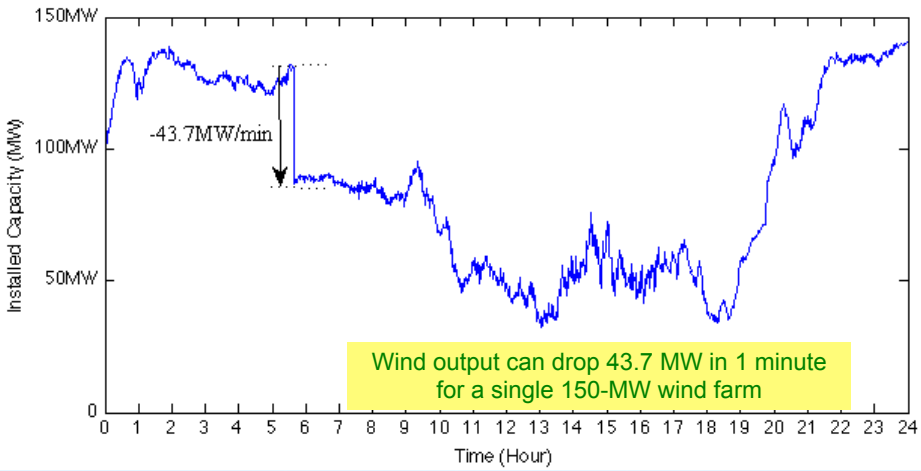
1-minute Variation of a 150MW Wind Farm Output in Texas, 2008



Wind output can drop 43.7 MW in 1 minute for a single 150-MW wind farm

Source: NREL

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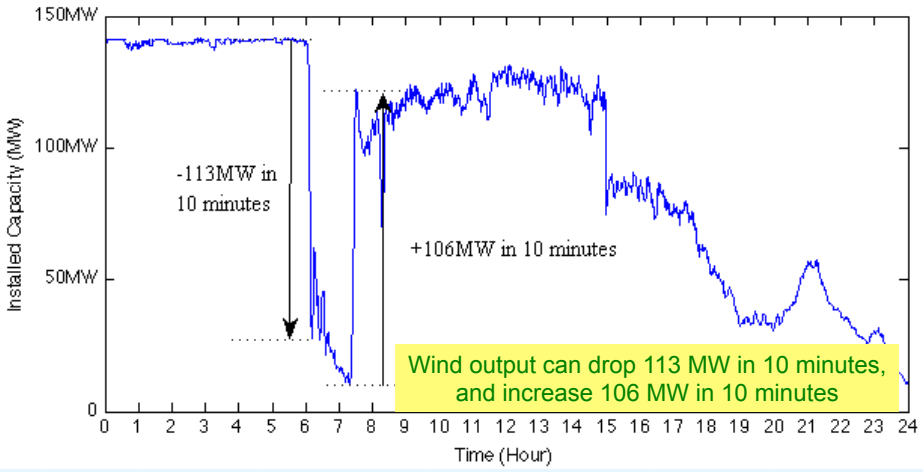
10-min Variation of a 150MW Wind Farm Output in Texas, 2008



Source: NREL

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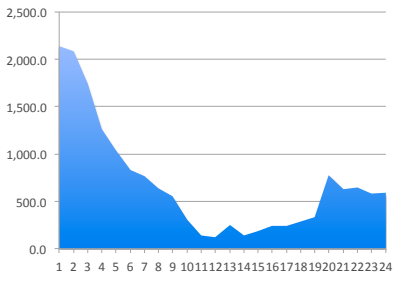
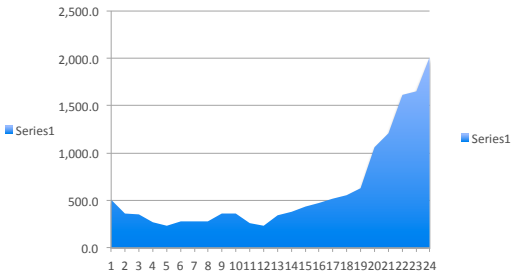
Hourly wind power variation (MW) in Texas, USA (01 and 02 Jan 2008)



01 Jan 2008



02 Jan 2008

Installed Capacity 4,541 MW

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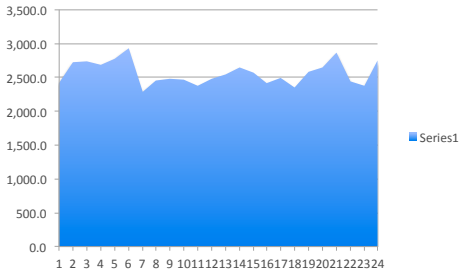
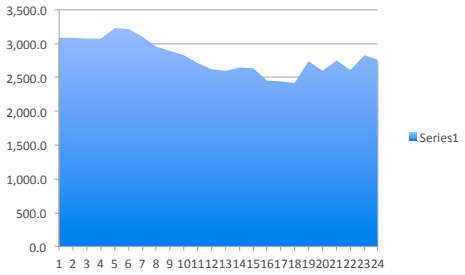
Hourly wind power variation (MW) in Texas, USA (03 and 04 Jan 2008)



03 Jan 2008



04 Jan 2008

Installed Capacity 4,541 MW

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Roof-top Solar Photovoltaics in Virginia

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Solar Panels in Winter

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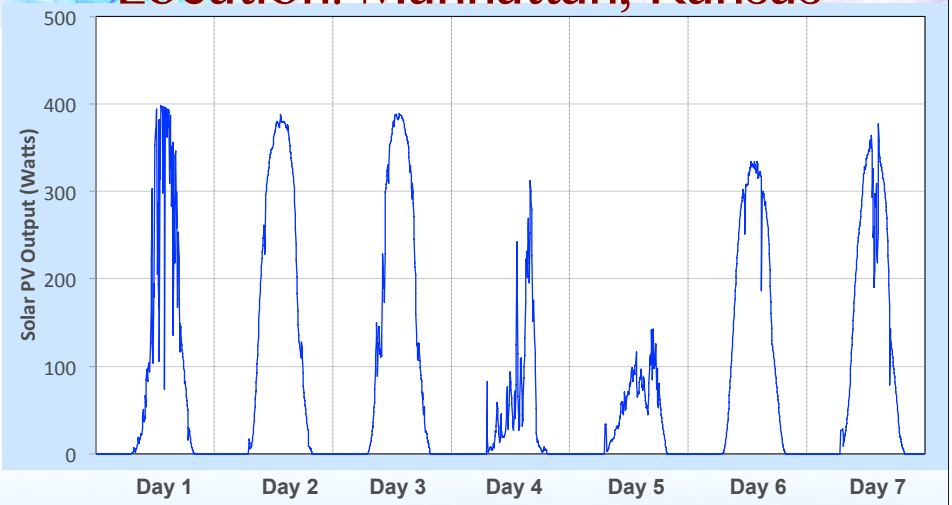
7-Day Solar PV Output Location: Manhattan, Kansas



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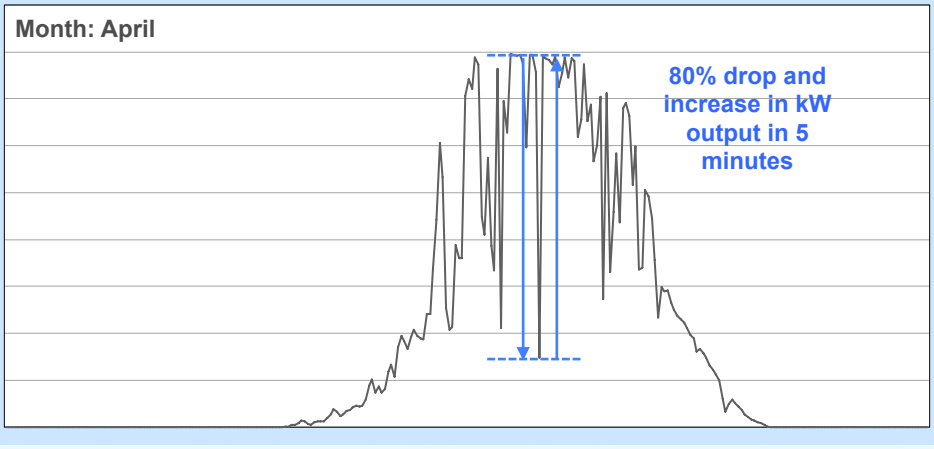
A 24-hour Solar PV Output (kW) Location: Manhattan, Kansas



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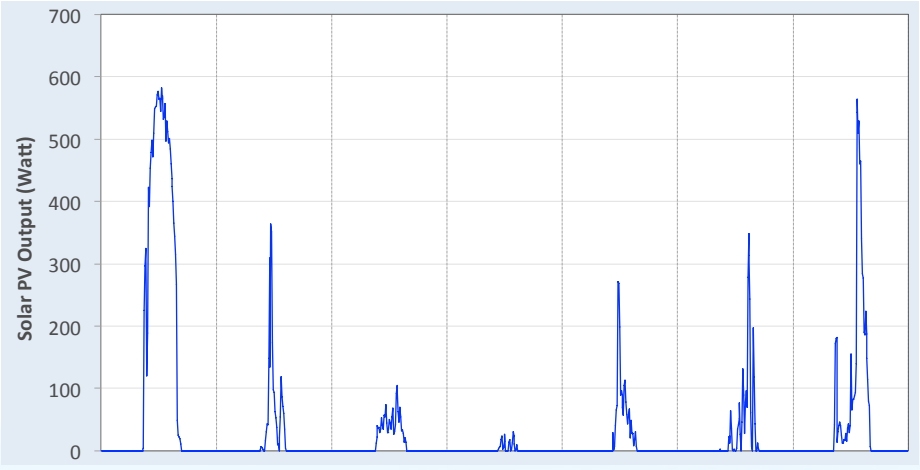
7-Day Solar PV Output Location: Blacksburg, Virginia



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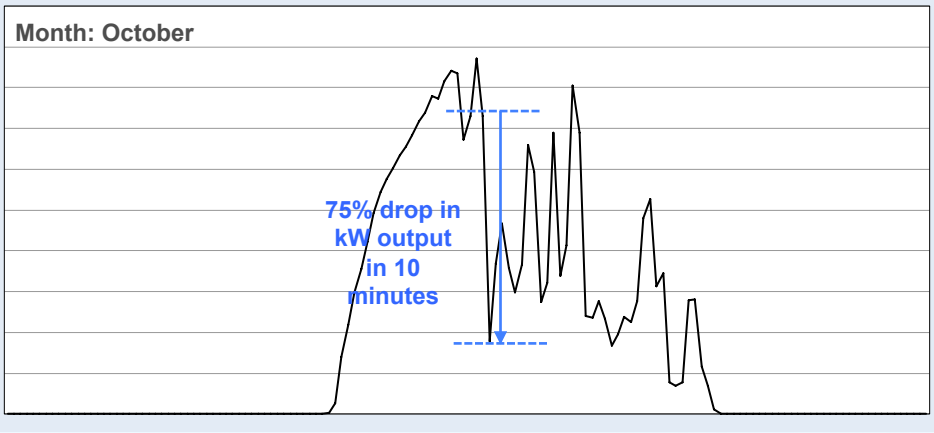
A 24-hour Solar PV Output (kW) Location: Blacksburg, Virginia



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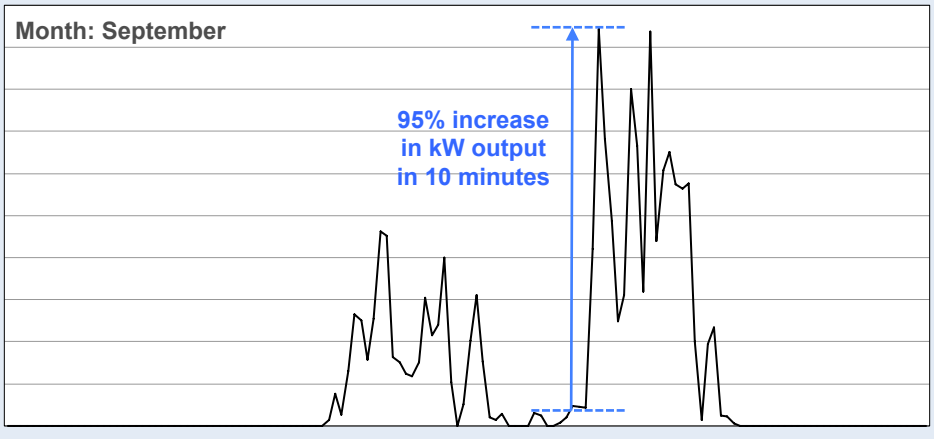
A 24-hour Solar PV Output (kW) Location: Blacksburg, Virginia



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Is there a better way to give credit to renewables?

- Can the short term intermittency be absorbed by the the network?
- Storage?
  - Batteries
  - Pumped storage hydro
  - Compressed air energy storage (CAES)
- Any other options?

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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".

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.

Benefits of the smart grid

Peak load reduction, generator efficiency improvements and distributed generation integration are major benefits of the smart grid

Demand response can provide significant peak load reductions

A smooth load shape allows better asset utilization

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Thank you

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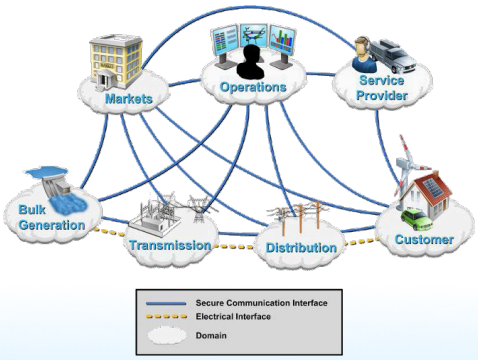
www.saifurrahman.org



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