

Smart Grid Improves the Value of Distributed Generation

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This is the Electric Power Grid



Source: www.sxc.hu

Difference Between a Normal Grid And a Smart Grid



Normal Phone



Smart Phone

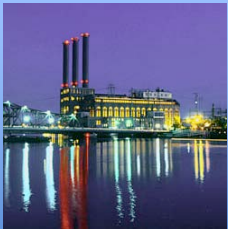
Smart Grid Definition

- According to United States Department of Energy's modern grid initiative, an intelligent or a smart grid integrates advanced sensing technologies, control methods and integrated communications into the current electricity grid.



Starting and End Points of a Smart Grid

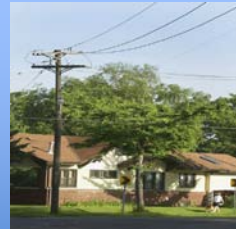
From Generator to Refrigerator



Power Plant



Transmission



Distribution

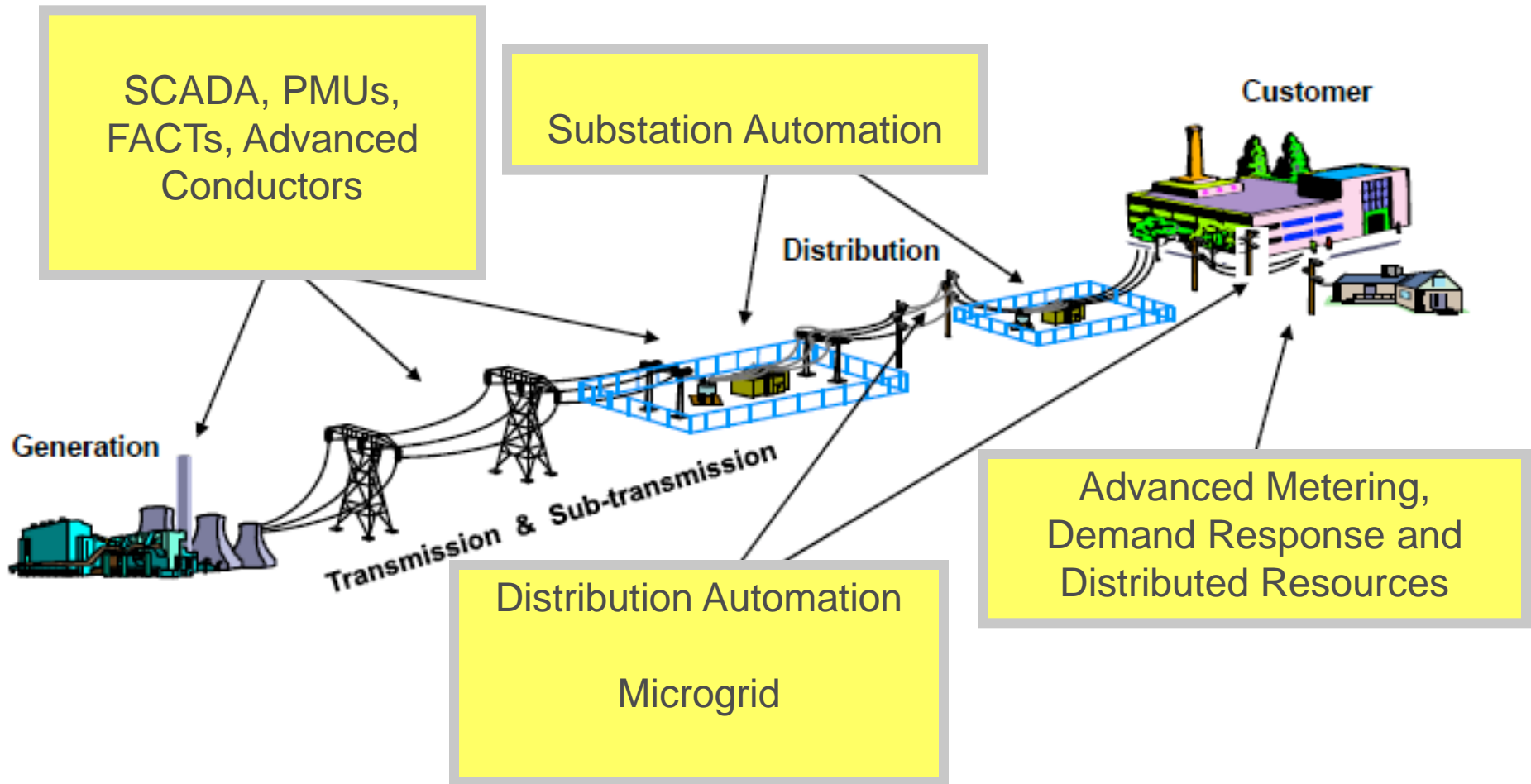


Home
Business



End-use
Appliances

Components of the Smart Grid

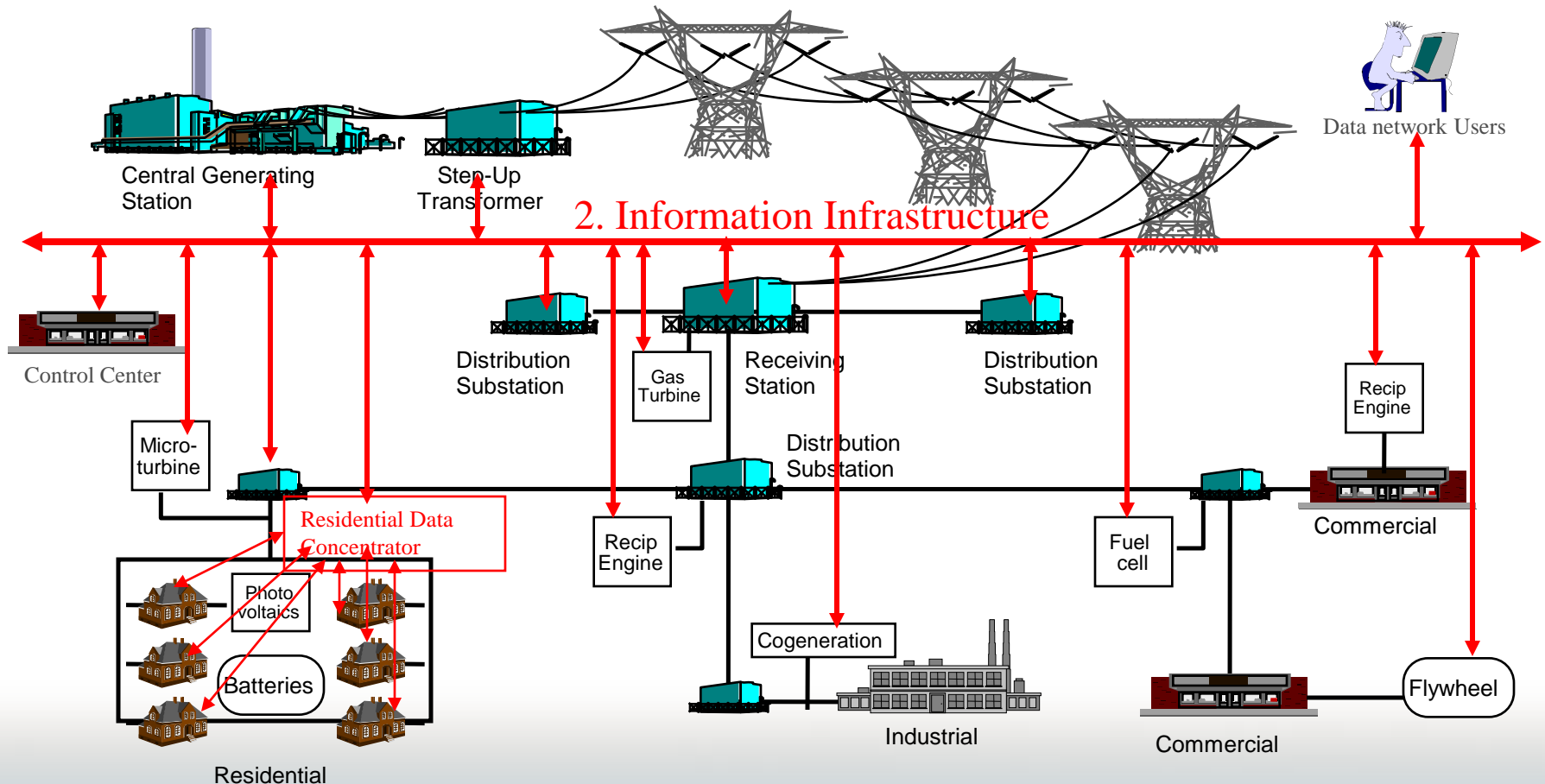




Merging Power Flow with Information Flow: Integrated Communications

Electric Power & Communication Infrastructures

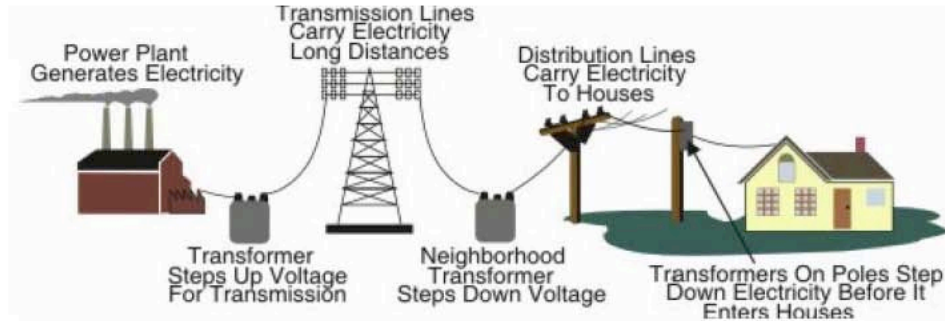
1. Power Infrastructure



Evolution of the Grid

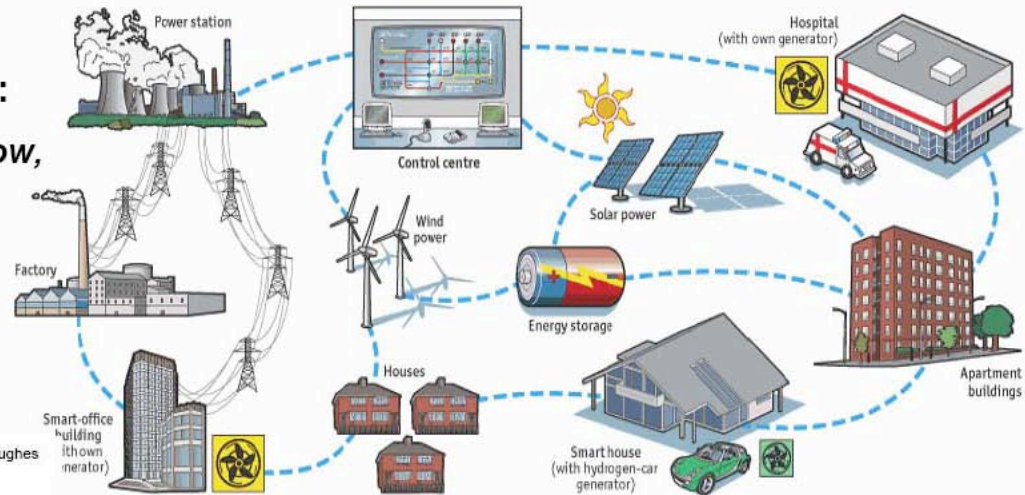
Before Smart Grid:

*One-way power flow,
simple interactions*



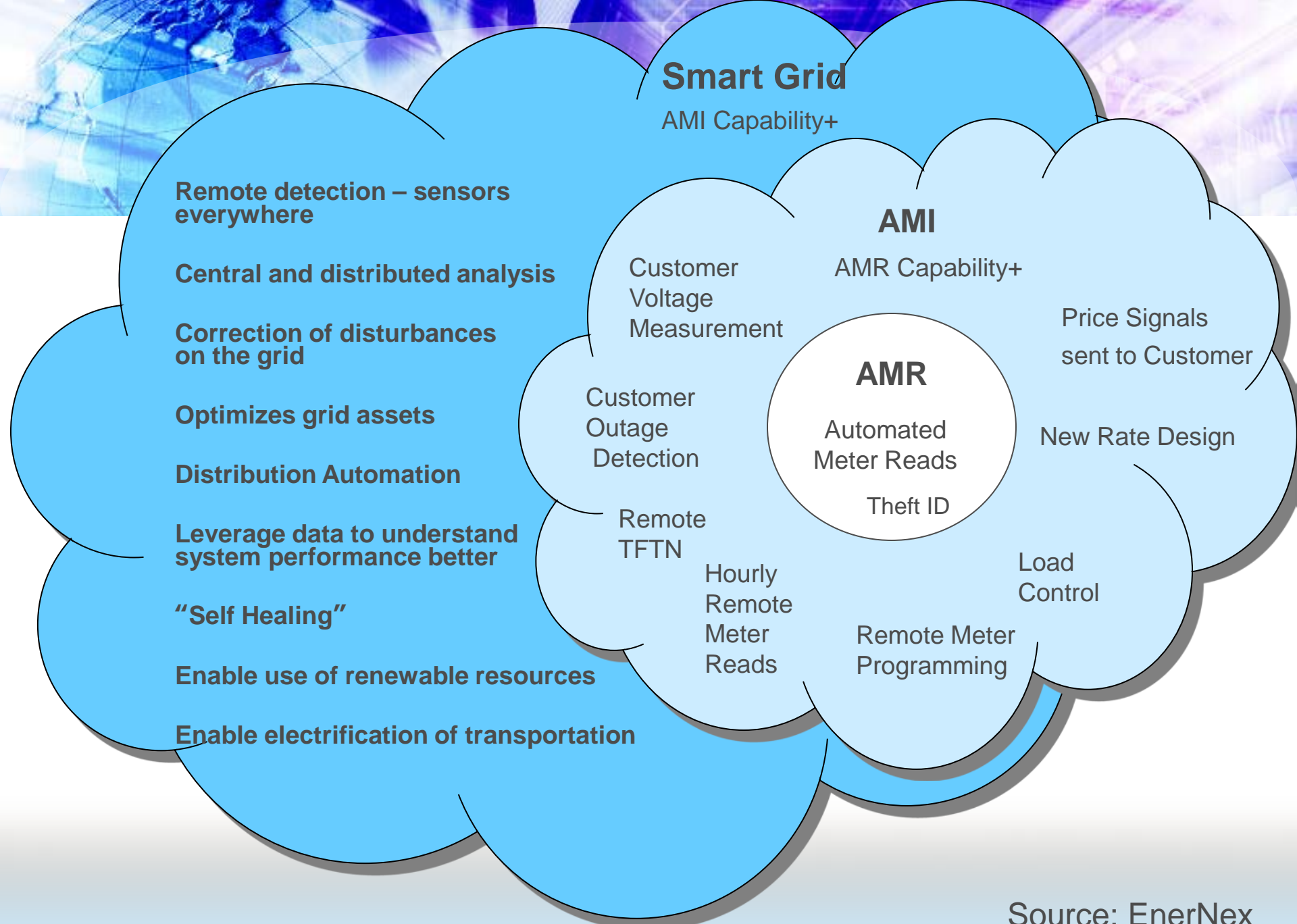
After Smart Grid:

*Two-way power flow,
multi-stakeholder
interactions*



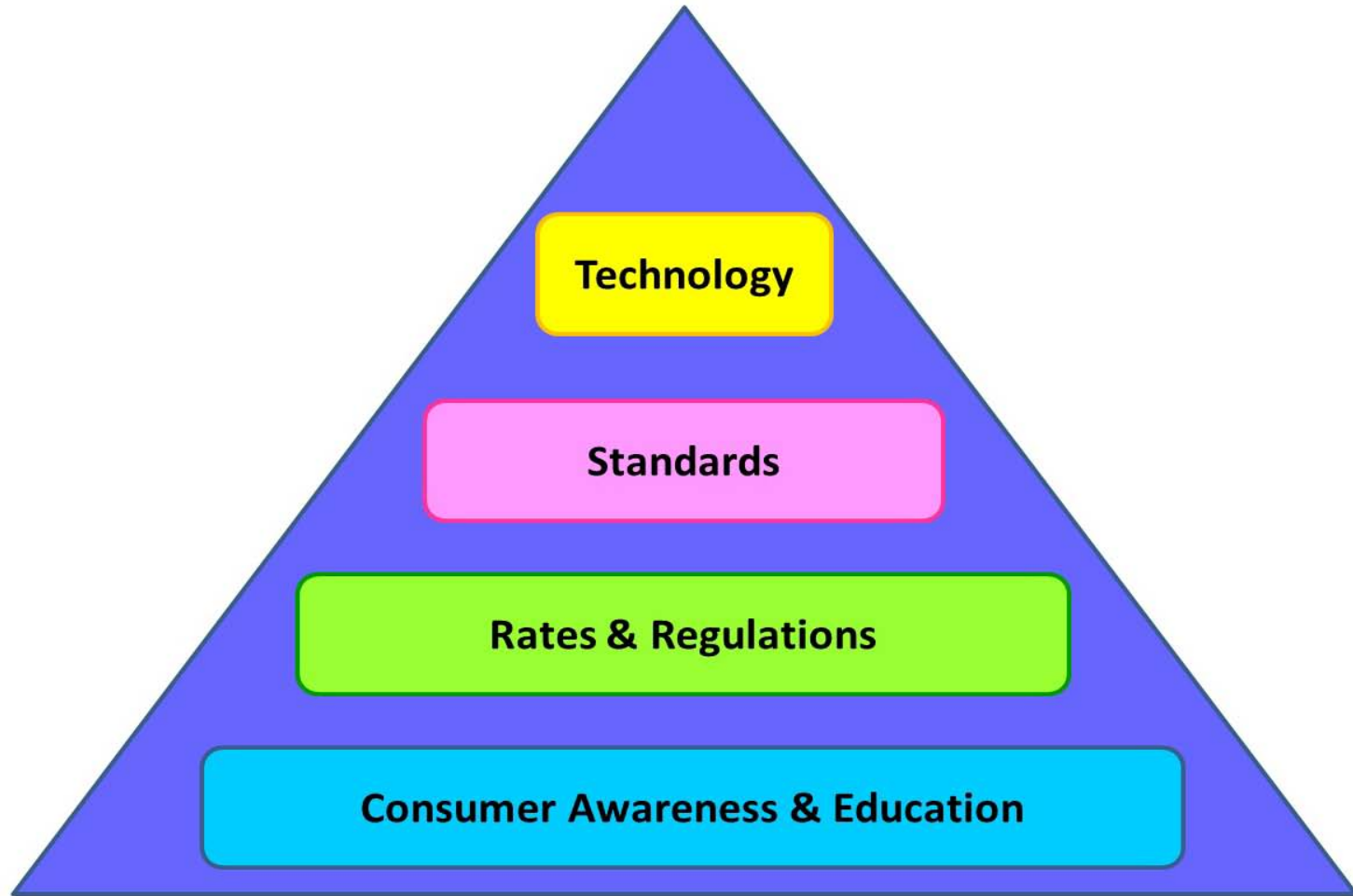
Adapted from EPRI Presentation by Joe Hughes
NIST Standards Workshop
April 28, 2008

Sources: *The Economist*; ABB



Source: EnerNex

Building Blocks of the Smart Grid



Changing Landscape for the Electric Utility



Issues with Distributed Generation

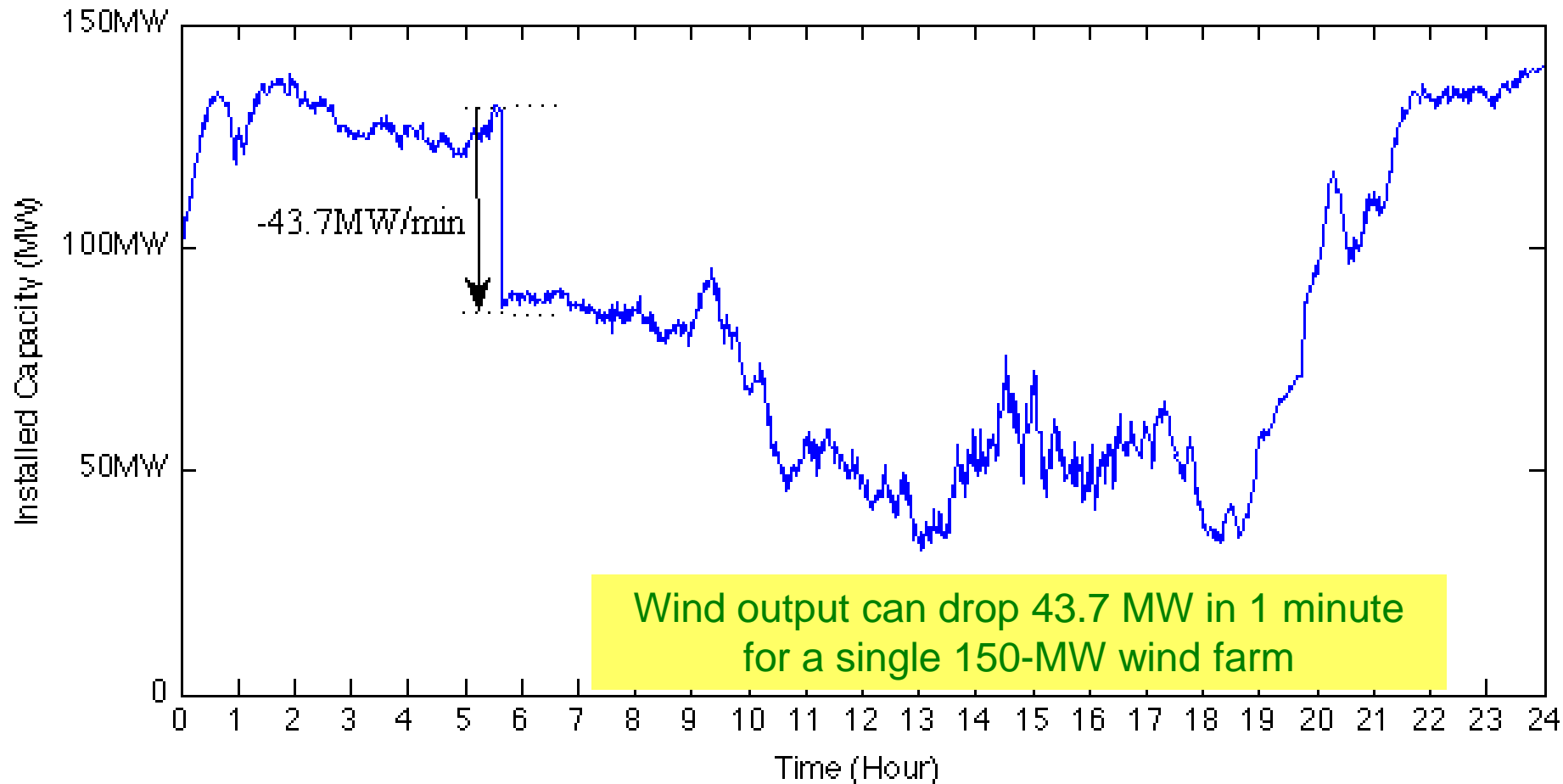
- Wind and solar are intermittent
- Hydro is space limited
- Resource is free but not always usable



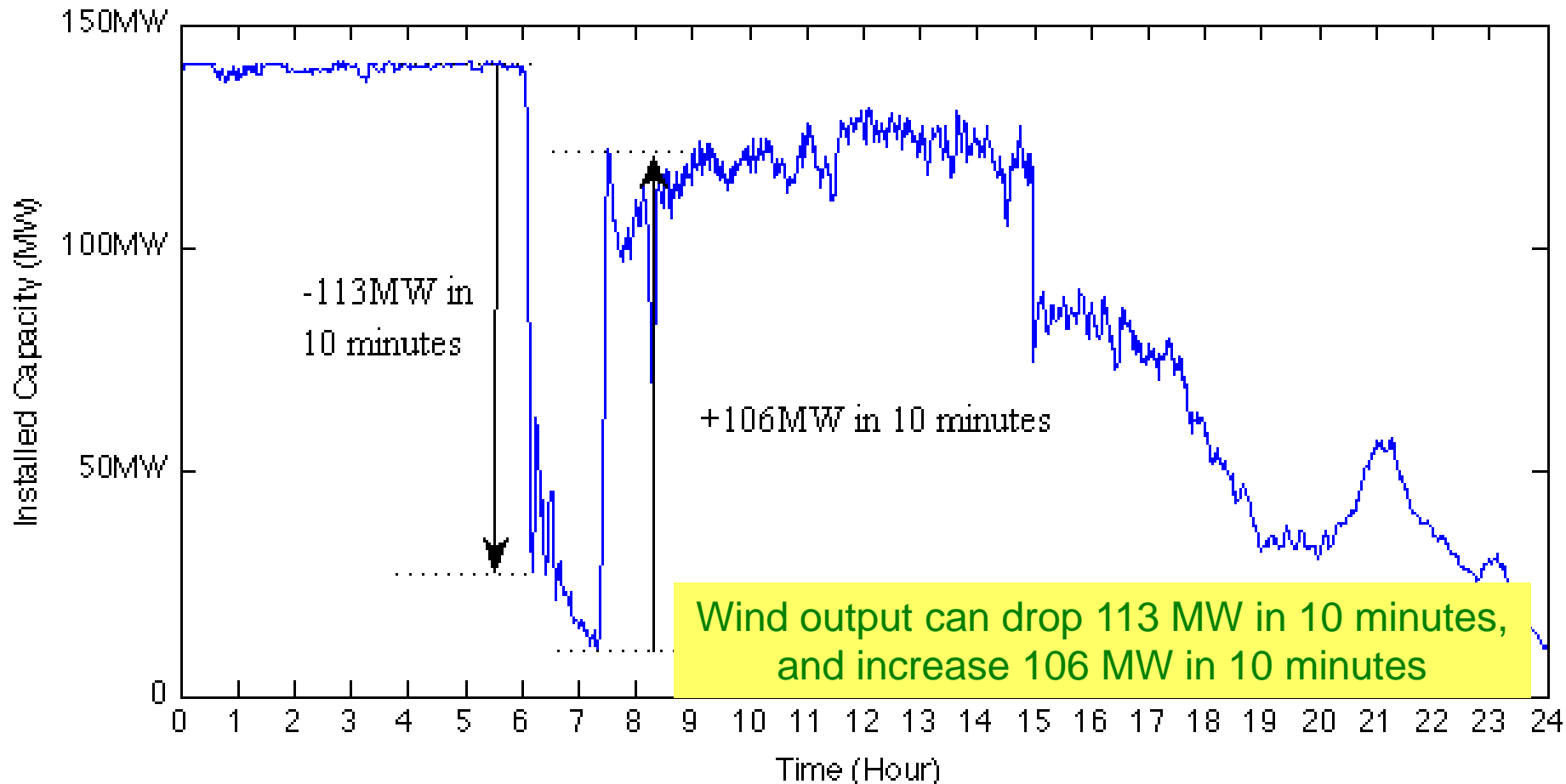
Off-shore Wind turbines, Blyth, U.K.

Wind Energy

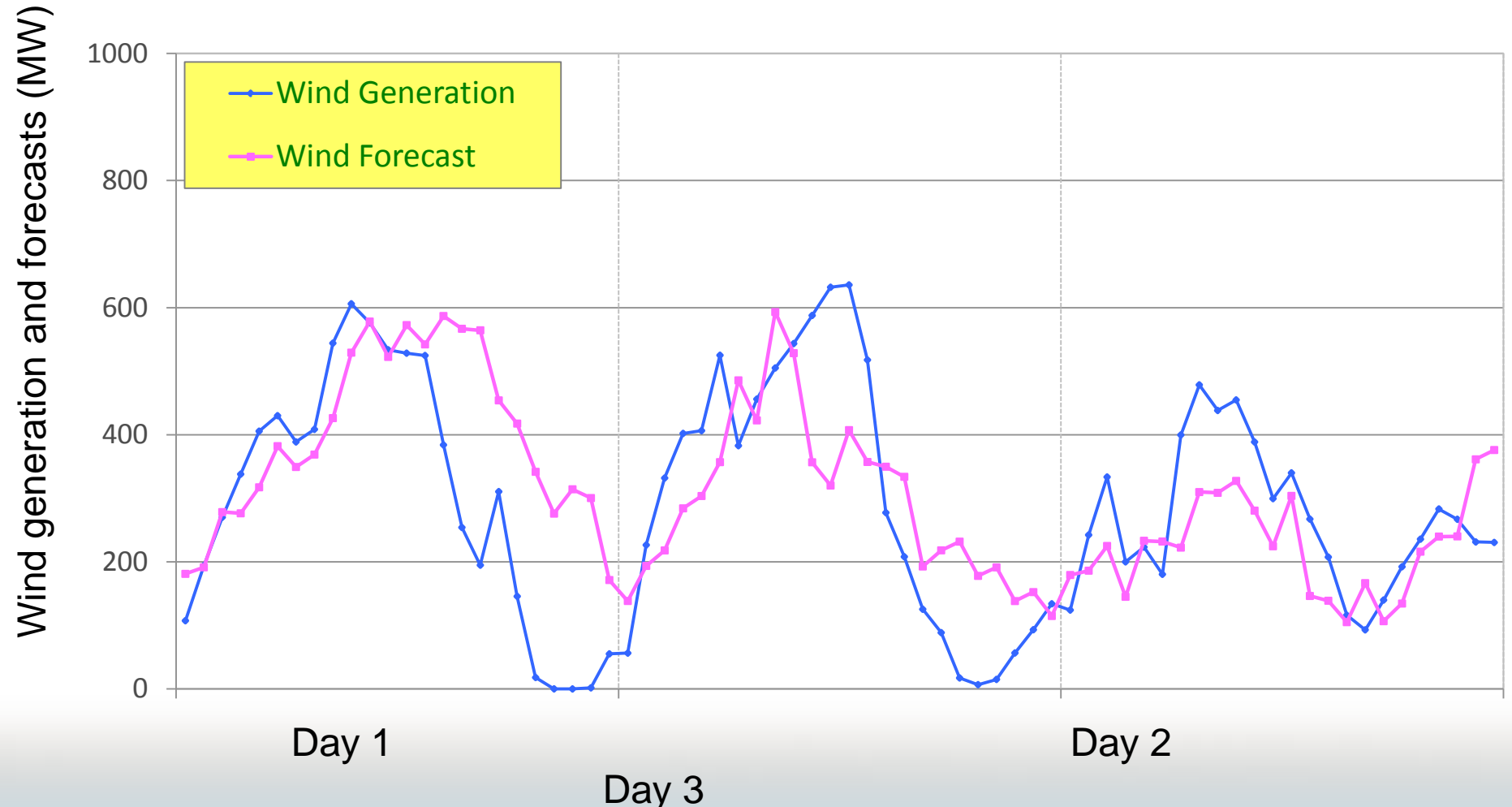
Example of 1-minute Variation of a 150MW Wind Farm Output in Texas, 2008



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

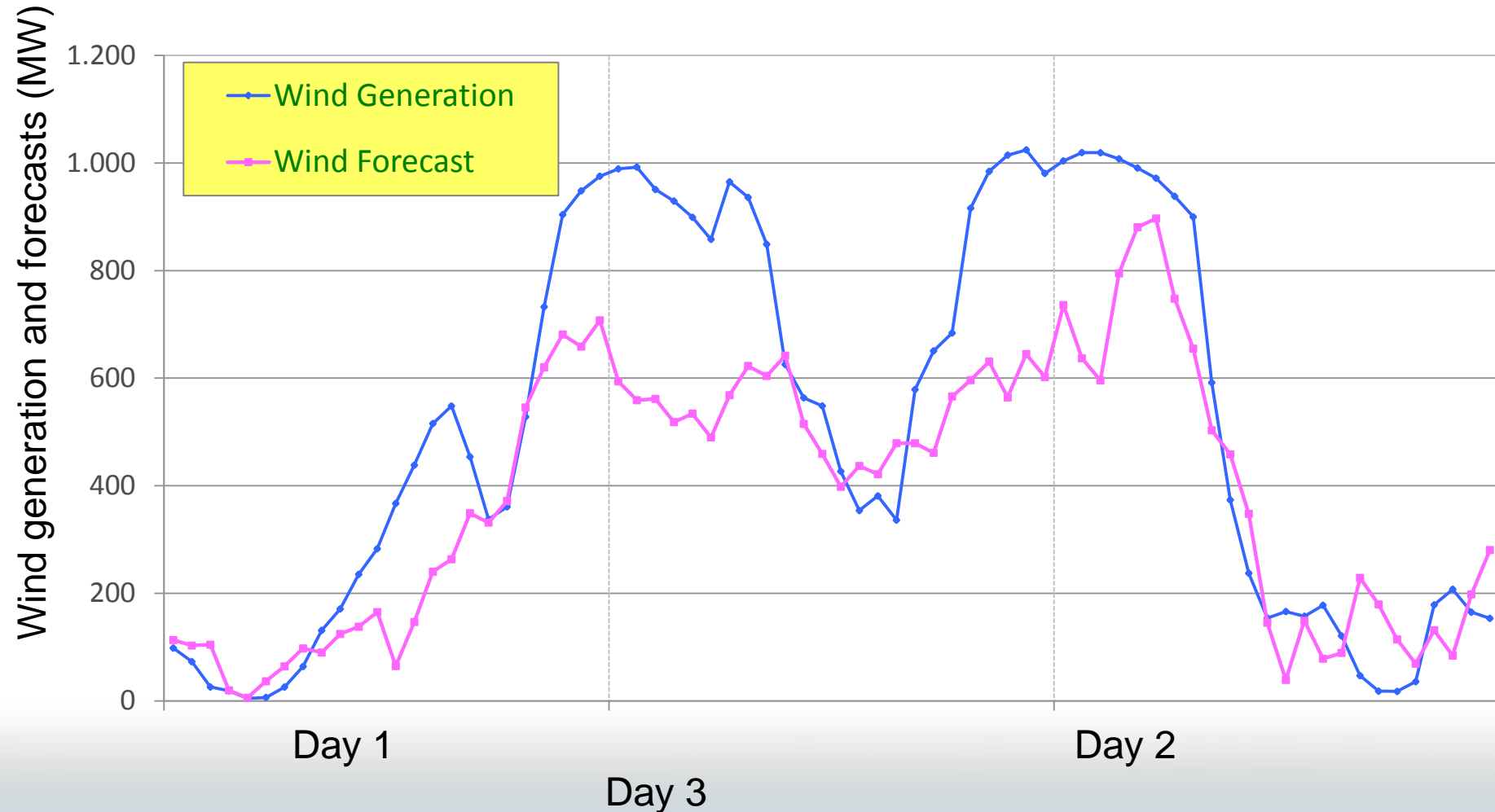


Wind Generation and 6-hour Ahead Forecasts of Wind Farm#1 in PJM



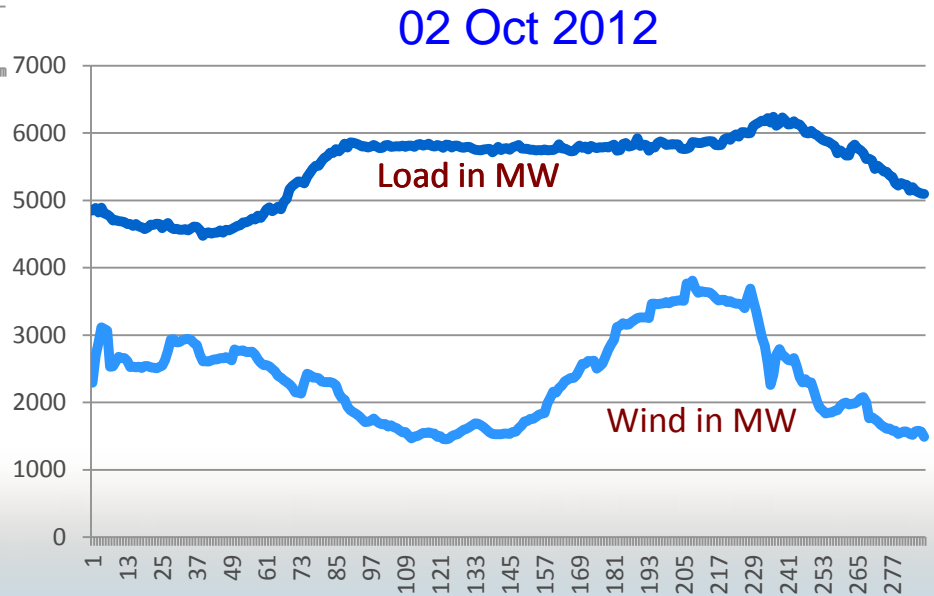
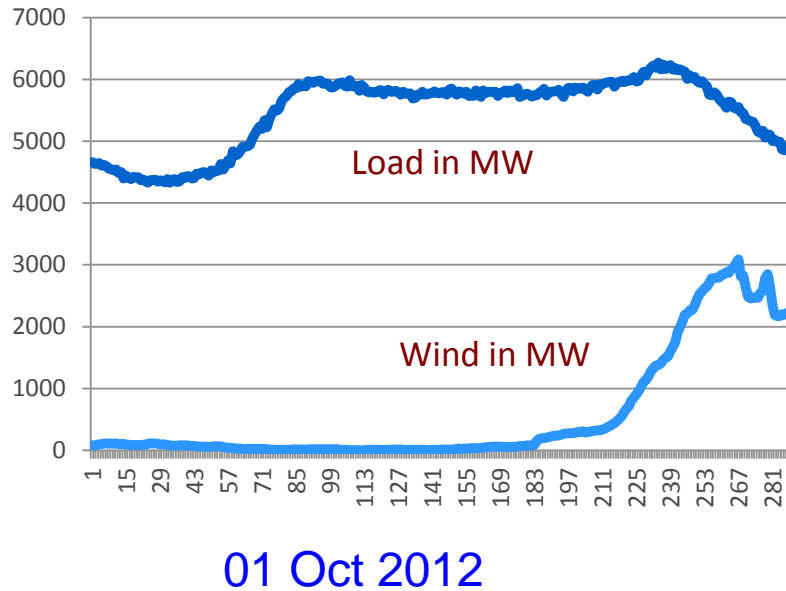
Source: PJM (Pennsylvania-New Jersey-Maryland) Independent System Operator

Wind Generation and 6-hour Ahead Forecasts of Wind Farm#2 in PJM



Source: PJM

Impact of Wind on Peak Load



Peak load and Wind unbalance will cause sharper peak and less efficient system operation



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?



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.



Summary

- Smart grid makes distributed generation more practical through demand management which can absorb large fluctuations in generator output
- Smart grid will allow higher energy sales for the same capacity, higher load factor
- Enabling technologies
 - Integrated communications
 - Sensing and measurement
 - Advanced appliances
 - Advanced control methods
 - Improved interfaces and decision support

Thank you

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