Using Advanced Storage Devices to Facilitate Integrating Renewables with System Regulation & Dispatch

Smart Grids

5th Annual Carnegie Mellon Conference on Electricity Industry

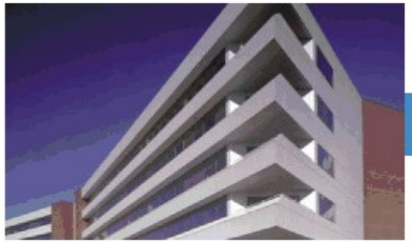
March 10 – 11, 2009

KEMA has been serving clients for more than 80 years

- Three primary business lines:
  - Consulting
  - Testing
  - Certification
- 1,700 professionals in more than 20 countries
- Annual revenue of $300+ million

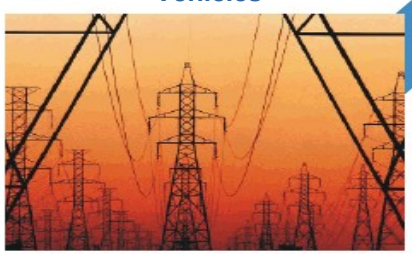
Independent experts to the global energy and utility industry

In The Future, Utilities Will Operate An Intelligent Network; One That Is Supported By A Portfolio Of Technologies And Advanced Communications

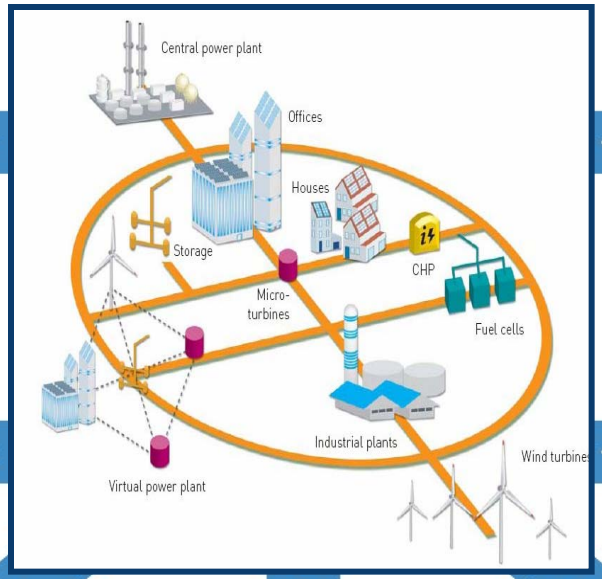


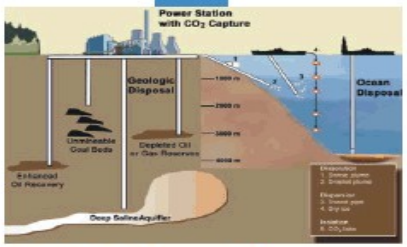
Efficiency in Buildings, Industry and End-Use Products

Plug-in Hybrid Electric Vehicles



Advanced Power Generation and Grids





CO_2 Capture and Storage

Renewable Energy Technologies

Biomass, Synfuels, CHP

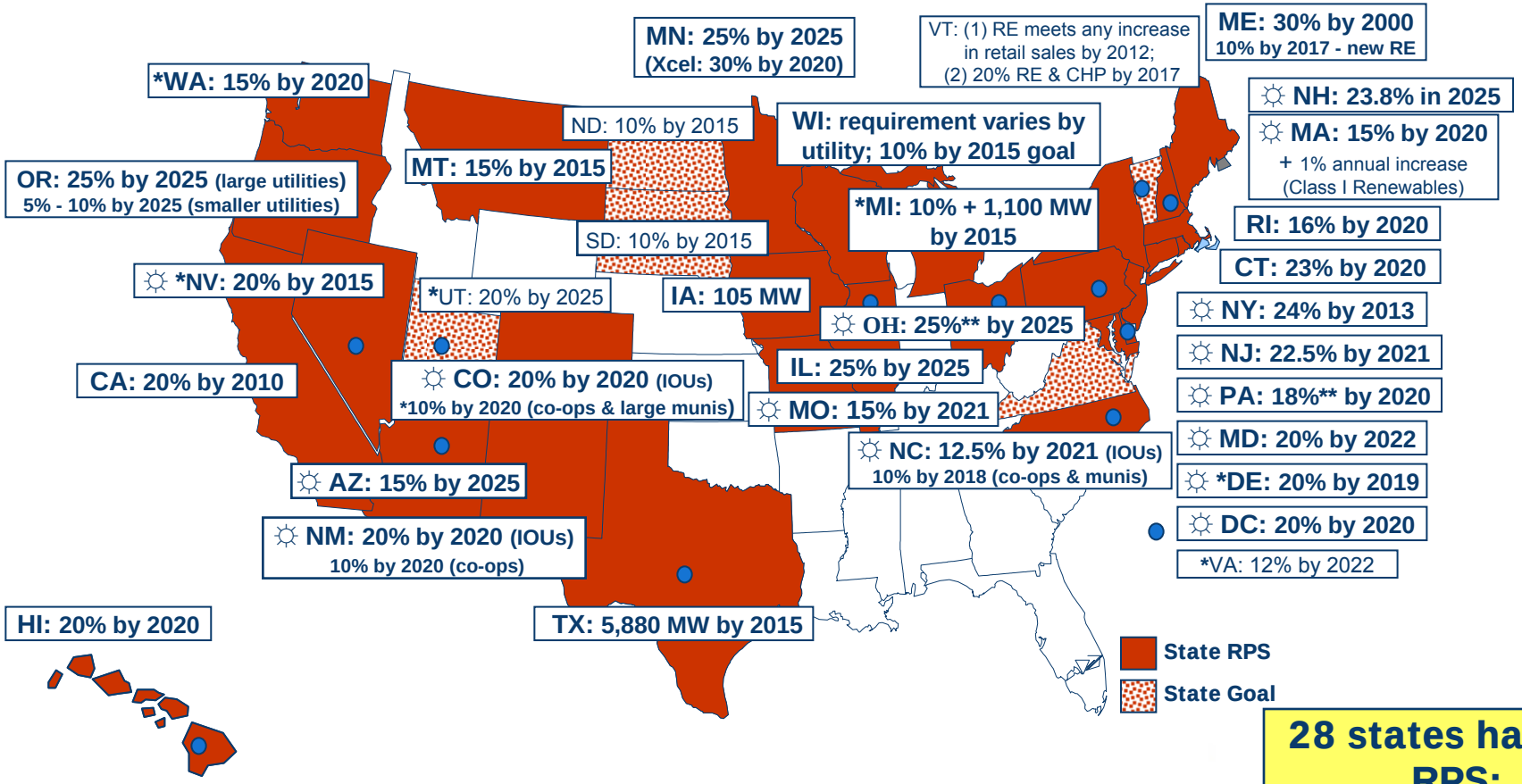
Advanced Nuclear Fission and Fusion

Source: International Energy Agency (Vigotti)

KEMA

Renewable Implementation is Increasing Across the U.S.

Chart of Renewables Portfolio Standards



28 states have an RPS;
5 states have an RE goal

DSIRE: www.dsireusa.org March 2009

Issues that Arise with Increasing Renewable Penetration

- Greater Impact of minute-to-minute volatility
  - Characteristics of storms, onset/fall of wind needs to be more closely monitored
  - Impact of renewable dynamic behavior on real time energy needs, market prices, and total real time energy costs
  - The resulting impact on traditional power plants that are required to "make up" the regulation needs imposed by renewables
  - Dynamics can place strains on maintaining grid operations

How Does Smart Grid Help With Renewables Integration?

- There are two essential aspects of Smart Grid benefits that are required to facilitate and integrate renewable resources
  - Reliability
  - Market Operations and integration

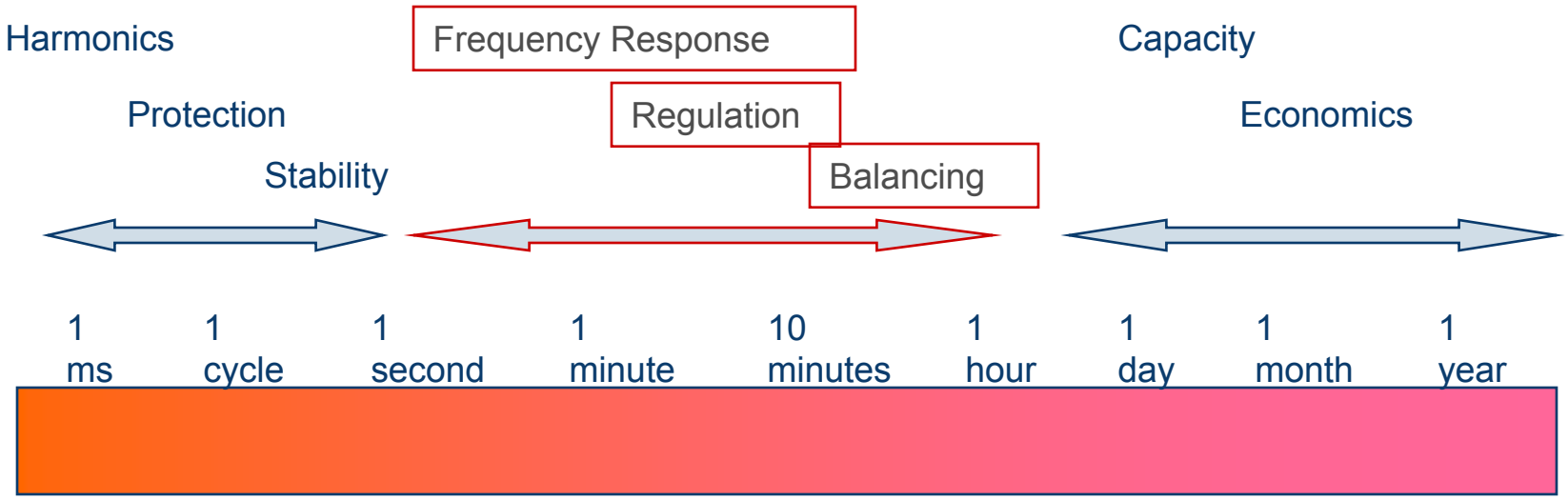
- Storage is now considered a component and tool for smart grid

- Characteristics of advanced storage that allows it to assist with renewable integration
  - Fast response characteristics for regulation and operations
  - Transportability – allows devices to be placed at any location

KEMA

How Can the Impact of Storage Be Measured as an Effective Tool?

Renewable Impacts Across Time Domains



Transient and Harmonics Analysis

Short Circuit

Power Factory

PSSE

DigSilent

Statistical Analysis of AGC and Balancing

GAP: Dynamic Simulation Tool to Analyze Performance and Design Solutions

Production Costing

Market Simulation

Expansion Planning

ProMod

GE MAPS

KEMA

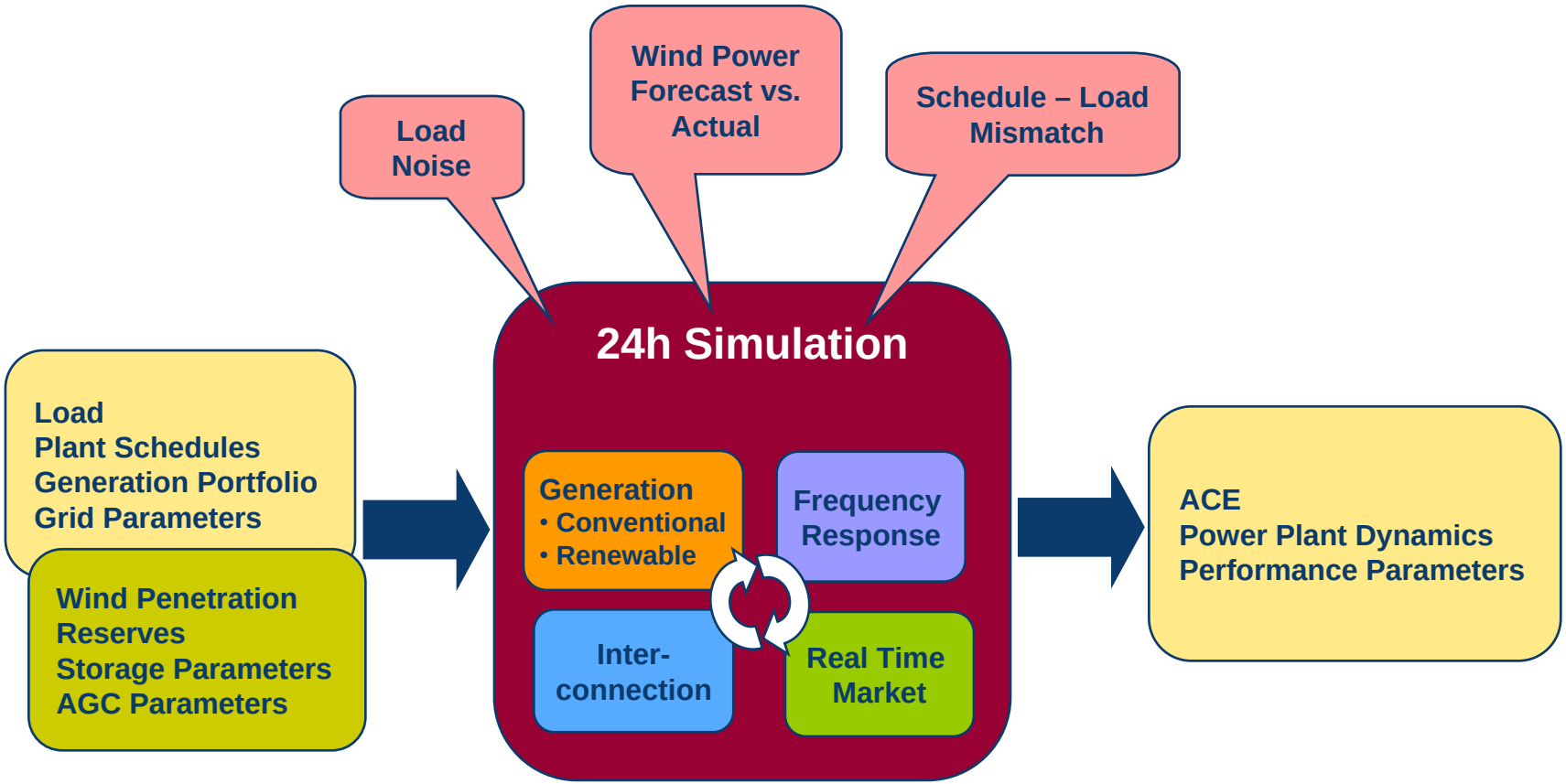
KEMA Created A Model To Help Understand These Issues

- In Netherlands, KEMA had developed a dynamic system model / simulation of the power system – generation, load, and interconnected control areas – for use in assessing the impact of wind generation on the national system of the Netherlands.
    - Case History - Analysis of TenneT (NL National Grid Operator) Systems and Wind Development Scenarios
    - Model itemized performance characteristics of generators and wind farms
- Model was adopted in the U.S. to include storage technologies and characteristics of fast-response storage to measure potential benefits

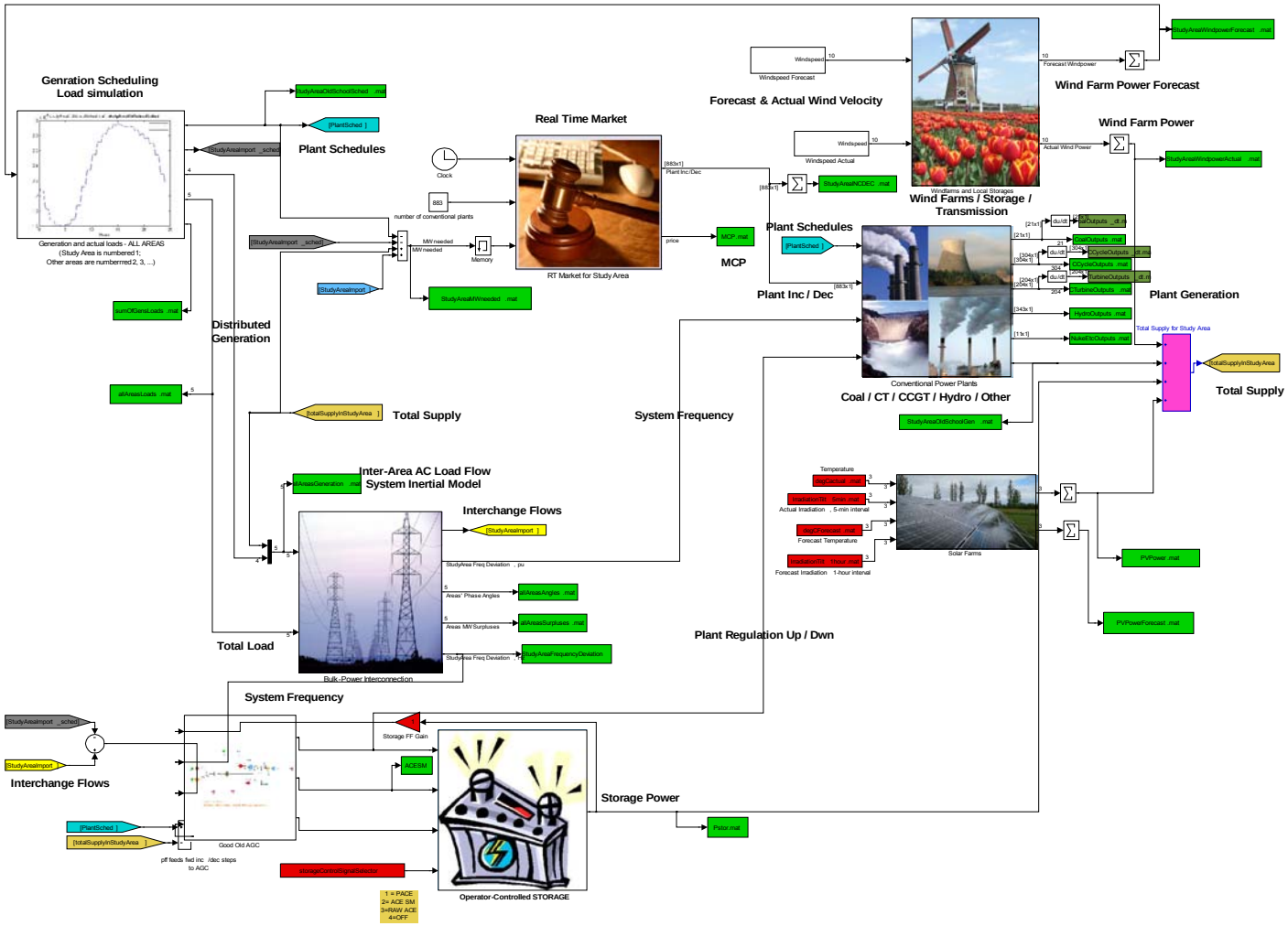
KEMA Renewable Energy Integration and Modeling Tool

- Developed by KEMA in Europe and the US
- Simulates Real Time Power System Dynamics
- Quantifies Impact of Variable Power Sources on System Operation
- Capabilities:
  - Effect on system dynamic when adding wind to the generation mix
  - Assess opportunities for storage in regulation
  - Compare operation control strategies
  - Investigate integrated approach for wind and storage

The Simulation Concept



Graphical User Interface



Simulink GUI running MATLAB code

New model is scalable and fast

Typical simulation span: midnight to midnight

KEMA

Features of our Simulation Model

- Time Varying Generation and Loads
- Balancing Market for Electricity
- Dynamics of Conventional Power Plants
- Automatic Generation Control
- Bulk Power Interconnection Dynamics
- Wind Farms
- Photo Voltaic
- Storage (Operator Controlled and Local)
- Emissions (CO2, NOx)

Model was used to evaluate answers to specific questions from stakeholders

- KEMA working with AES to model performance of new storage technologies for frequency regulation
  - Does the storage device have sufficient capacity to respond to persistent calls for regulation service in each direction?
  - Will large amounts of storage compromise overall system performance?
  - Can the AGC (Automatic Generation Control) algorithms be designed to take advantage of the “fast response” capabilities of the emerging storage technologies?
  - What are the energy economics of the storage device?
- Results were published in KEMA What Paper – *“Benefits of Fast Response Storage Devices for Regulation”*

KEMA

Areas of focus for Tool

- Continue to Explore “Fast Regulation Services” Possibilities
- Protocols for Wind Operation
  - Example: partial shut-down in anticipation of fall-off
  - Matching wind farm peak capacity plus storage to transmission limits
- Evaluate Impact of Changes in Balancing Market
  - Different look-ahead schemes
  - More Frequent Operation
- Explore Demand Side Impacts
- Model Actual Plant Regulation Activity
- Model Emissions Impact of Decreased Plant Regulation

Questions

Thank you for your time

Richard Fioravanti
Director, Storage Applications & Support
KEMA, Inc
Phone: (703) 631-8488
Email: Richard.Fioravanti@kema.com