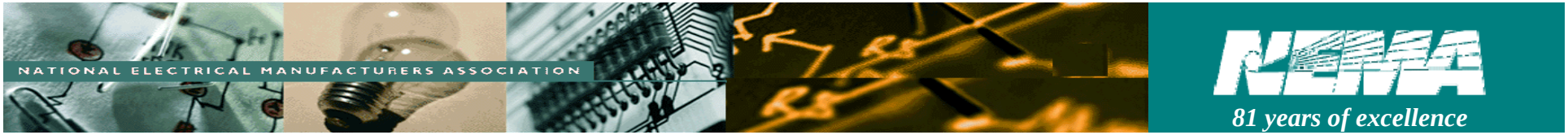

Grid Modernization and the 2007 Energy Independence and Security Act

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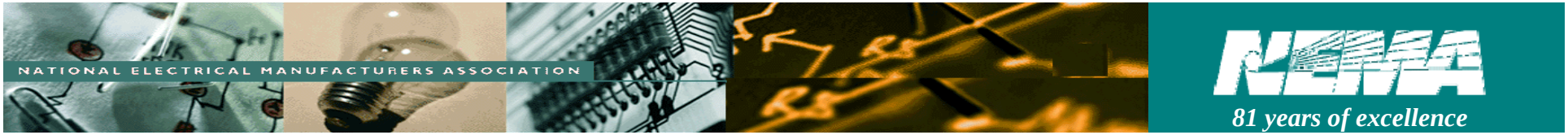
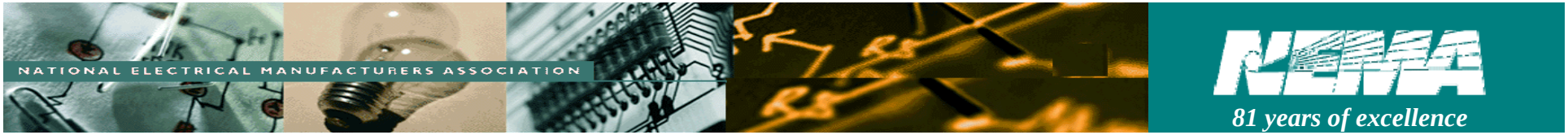
March 10, 2008



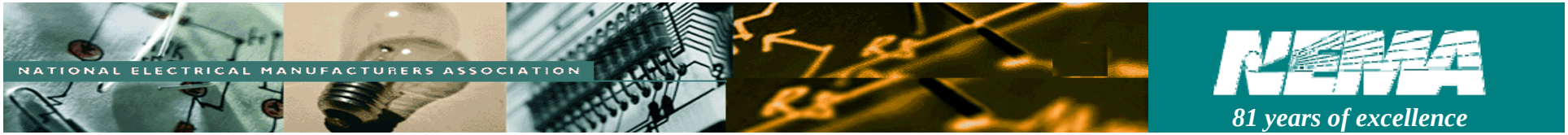
Outline

- Uncertainties in electricity systems
- Role of the IT and smart grid
- EISA 2007 provisions for grid modernization



Adapting to Uncertainties

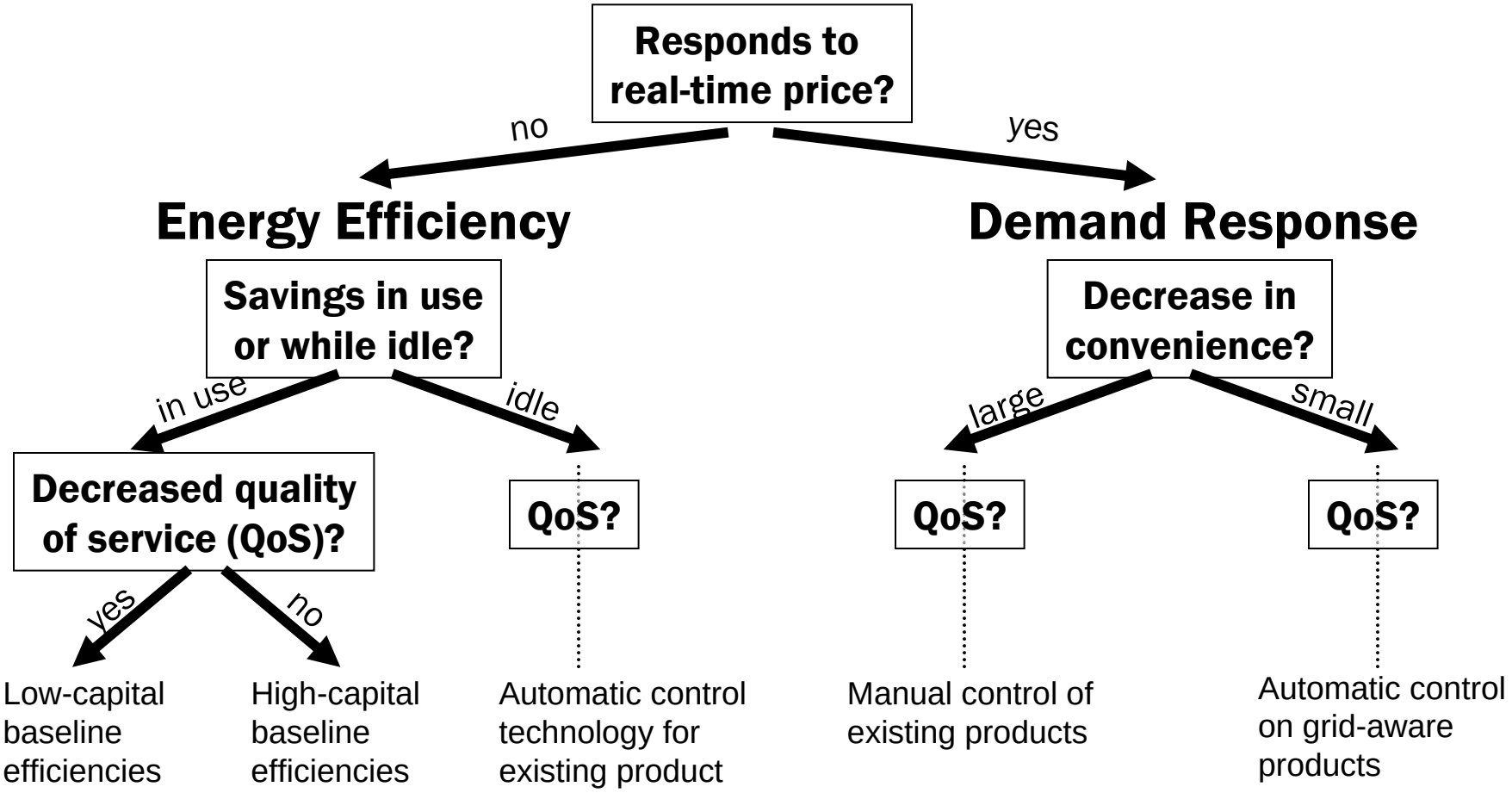
- Beyond N-1 operations or planning
- Factors that could change dispatch patterns:
  - Renewable portfolio standards
  - Rapid decrease in photovoltaic costs
  - Loss of renewable production tax credits
  - Breakthrough in energy storage systems
- Today's infrastructure must adapt to tomorrow's changes
- Start with measures to conserve energy

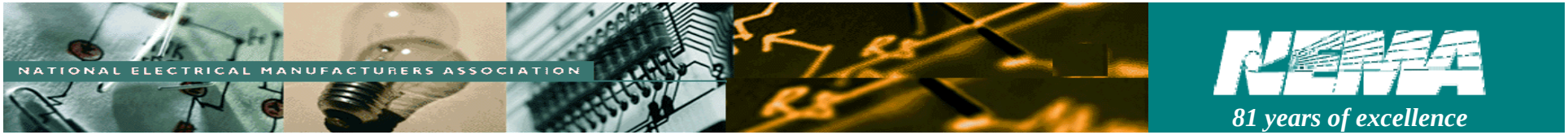


Smart Grid: IT-Enabled Conservation

- Types of Energy Conservation
  - Baseline
  - Opportunistic
  - Behavioral
- Differentiating Characteristics
  - Is their a behavioral change in response to price?
  - Is their a decrease in consumer ease of use?
  - When do savings accrue?
  - Is there a decrease in the quality of service?

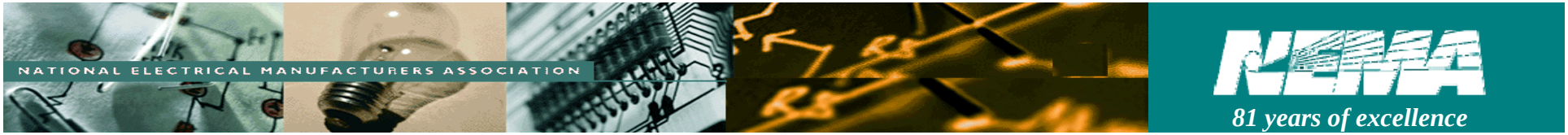
Conservation Tree





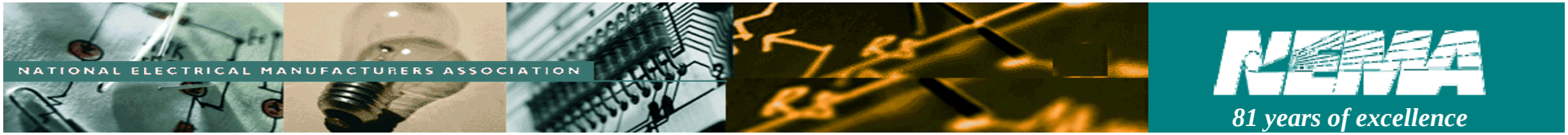
Smart Grid: Adaptability

- Renewables integration
  - Containing stresses from intermittent sources
  - New controls for energy storage
  - Dynamic transmission ratings
- Load participation
  - Demand response enabled by AMI
  - Potential for new types of rates (e.g. “green only”)



Smart Grid Enablers and Barriers

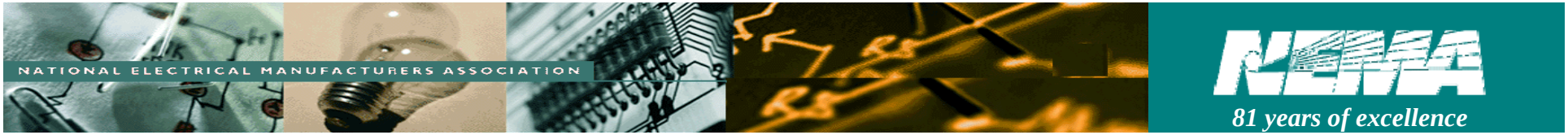
- Enablers
  - Decreasing cost of computing power
  - Increasing cost of energy
  - Need for infrastructure upgrades
- Barriers
  - Unwillingness to pay even more for energy capital
  - Implementation scale and integration
  - Outdated retail market structures



Removing Smart Grid Barriers

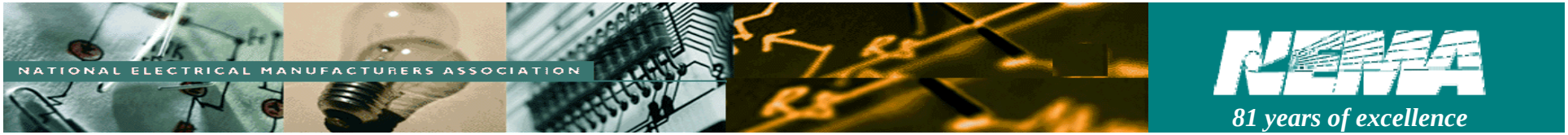
Energy Independence and Security Act of 2007

- Smart Grid and Energy Storage Technology
  - Basic and Applied Research
  - Developments and Demonstrations
  - Standards and Protocols
  - Incentives for deployment
- PURPA amendments for regulatory incentives



Smart Grid Research and Development

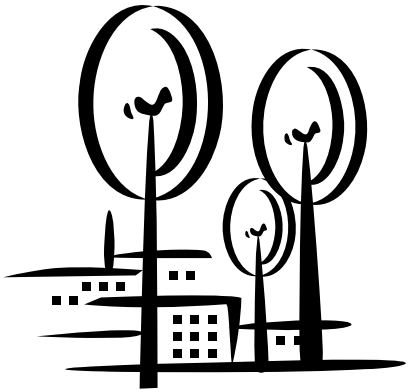
- R&D program at the Dept. of Energy
- Expanding market structures…
  - Ancillary services
  - Real-time pricing
- …through new technologies
  - Smart meters, and demand response
  - Distributed generation
  - Energy storage
  - Data mining, visualization, algorithms
  - Vehicle-to-grid interconnections
- No specific amount specified



Energy Storage Research and Development

- Another R&D program at the Dept. of Energy
- Basic
  - Underlying battery materials
  - Up to $80m annually for 10 years
- Applied
  - Ex.: flywheels, compressed air, ultracapacitors
  - Up to $80m annually for 10 years
- Research Centers
  - Move basic research to applied technologies
  - Up to $100m annually for 10 years
- Similar programs for solar, tidal, geothermal

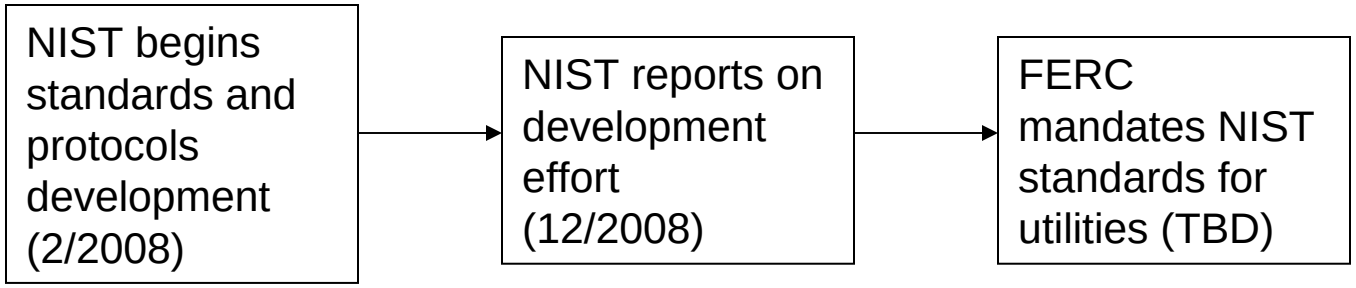
Demonstration Projects

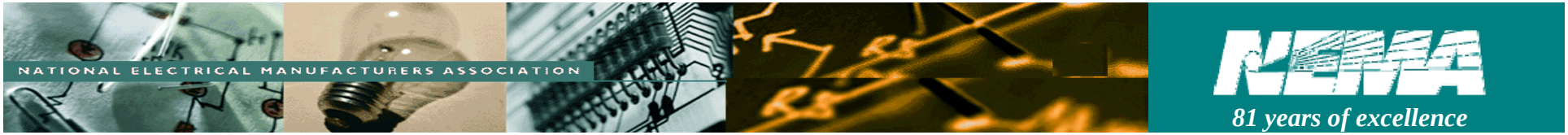


- Common Goals
  - Reliability
  - Peak shaving
  - Transmission and renewables optimization
- Utility and Vehicle Energy Storage
  - Partner with utilities, manufacturers, academia
  - Up to $60m annually for 10 years (two $30m programs)
- Smart Grid Demonstration Projects
  - Deployed in up to five control areas
  - Up to $100 million annually over five years
  - 50% cost match for advanced technology differential

National Smart Grid Standards

- Potential reduction in integration costs
- National Institute of Standards and Technology
  - Leads development of protocols and standards
  - Must be flexible, uniform, technology neutral
  - From generators to appliances
- Open Process
  - Stakeholders include IEEE, GWAC, NERC, NEMA, others
  - Should incorporate existing groups





Smart Grid Investment Match

- Up to 20% of smart grid costs
  - For manufacturers: cost of integrating smart grid functions
  - For utilities: additional cost of smart grid devices
- Equipment must follow NIST standards
- DOE to issue rules by December 2008

State-Level Smart Grid Incentives

- Public Utility Regulatory Policy Act amendments
- Cost recovery for utility smart grid investment
  - Accelerated depreciation for obsolete equipment
  - Consideration of cost-effectiveness, reliability, societal benefit
- Provide hourly price information to retail customers

Looking Ahead

- PURPA AMI amendments great, but
  - Marginal increase in AMI dockets, if any
  - Potential for conflicting requirements across states
  - Need to avoid closed, interim solutions
- Matching funds welcome, but
  - New transmission capacity still needed
  - Need solutions to siting and cost allocation
- R&D programs exactly what industry needs, but
  - Programs need to be funded
  - Pay-go rules restricts options

Conclusion

- EISA 2007 provides a roadmap for cyber-physical systems integration
  - Recognition of the IT role in energy
  - R&D→Demos→Standards→Incentives
  - Will help grid adapt to changes
  - Will help utilities plan with more certainty
- Needs careful implementation
  - Uniform implementation to ease manufacturing
  - Authorized programs need funding