Energy Intelligence

Road to the Enhancing Energy Productivity

Barriers and Challenges to Building the "Smart Grid"

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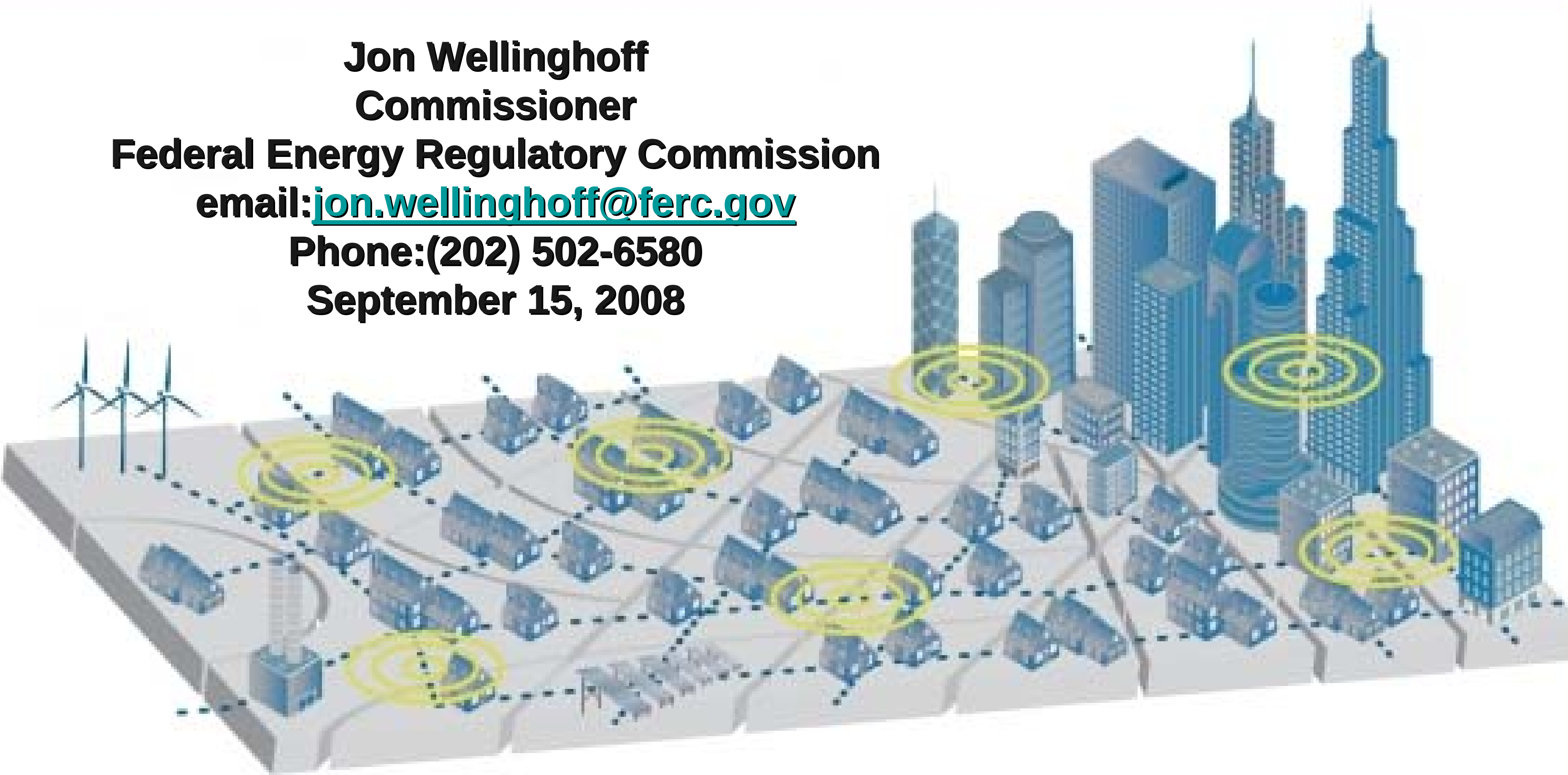
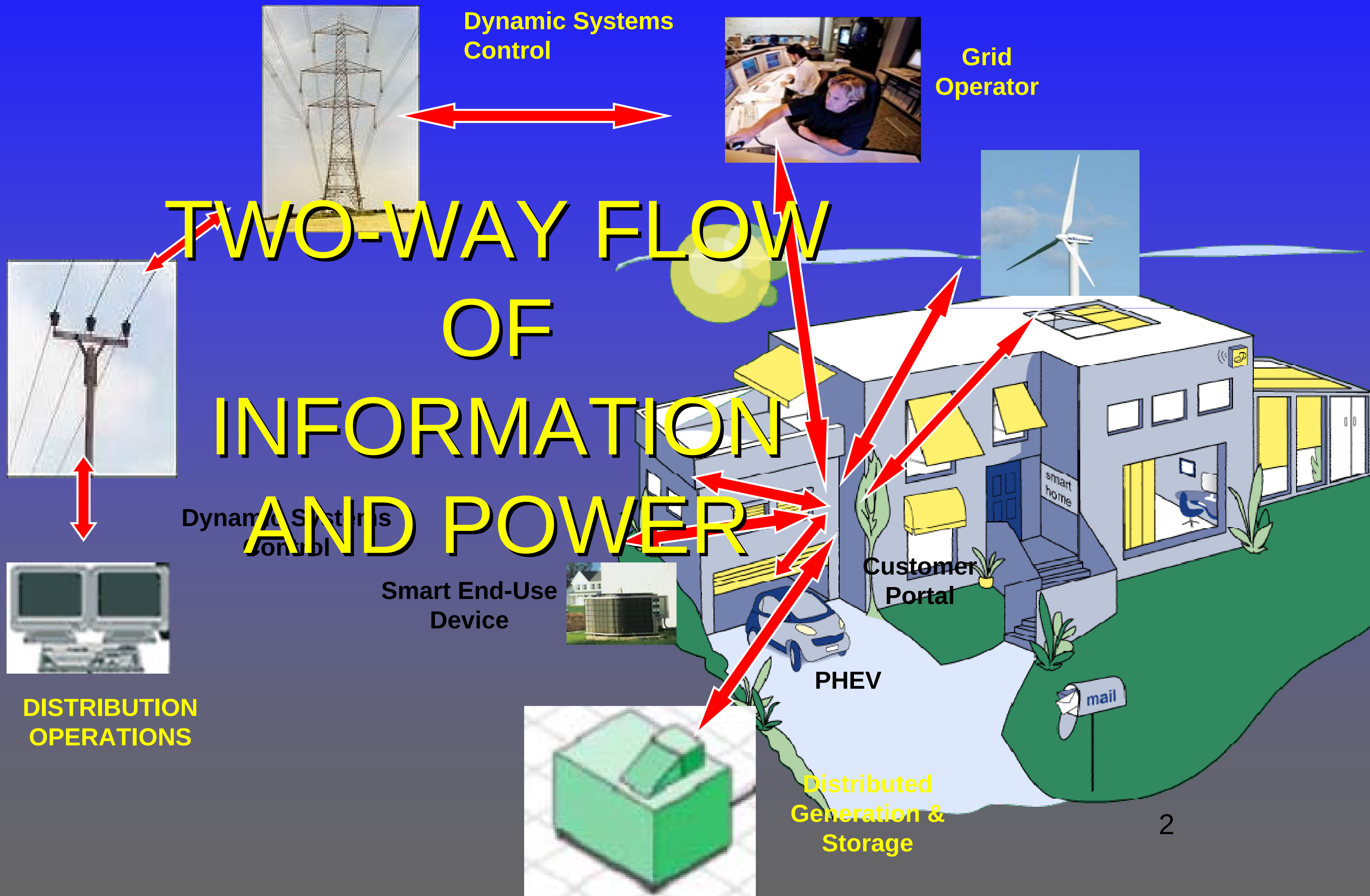
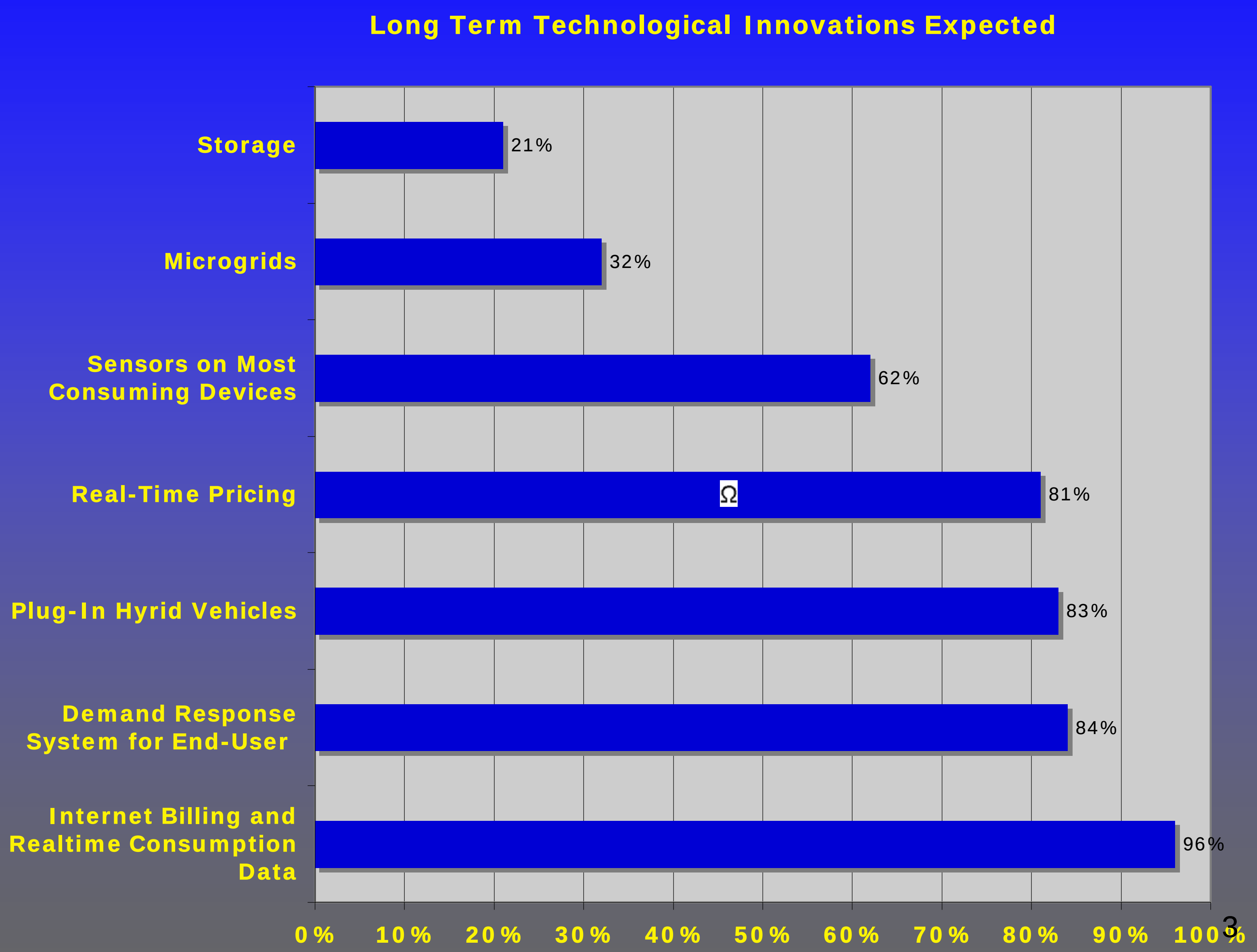


Intelligent Electric Grid



10 Year Grid Outlook



Energy Intelligence

Current Grid	Future Grid
Electromechanical	Digital
One-way communications (if any)	Two-way communication
Built for centralized generation	Accommodates distributed resources
Radial topology	Network topology
Few sensors	Monitors and sensors throughout
“Blind”	Self-monitoring
Manual restoration	Semi-Automated restoration and, eventually, self-healing
Prone to failures and blackouts	Adaptive protection and islanding
Check equipment manually	Monitor equipment remotely
Emergency decisions by committee and phone	Decision support systems, predictive reliability
Limited control over power flows	Pervasive control systems
Limited price information	Full price information
Few customer choices	Many customer choices

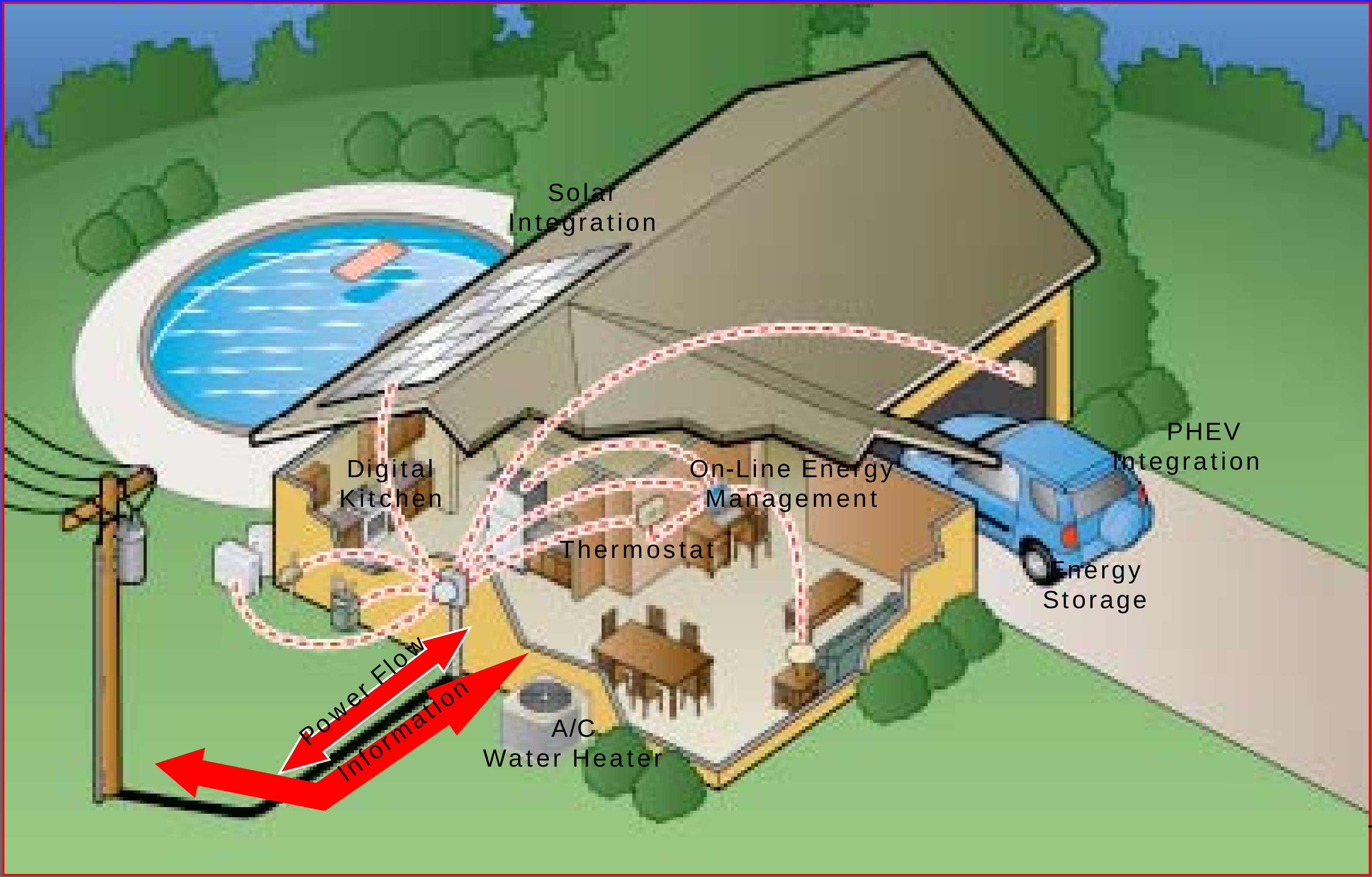
Energy Intelligence

- Intelligent Load Control (ILC)
- Intelligent Metering Infrastructure (IMI)
- Intelligent Distribution Operations (IDO)
- Intelligent Transmission Operations (ITO)
- Intelligent Asset Management (IAM)

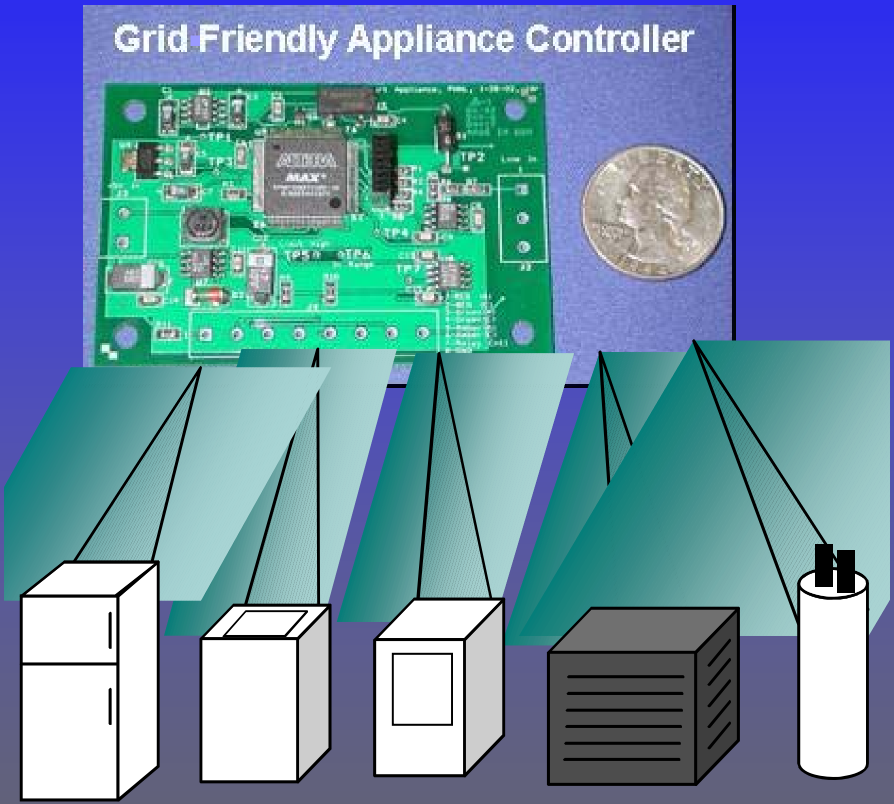
Six Key Characteristics of Intelligent Energy System

- **Self Healing-** Rapidly Detects, Analyzes Responds and Restores.
- **Empowers and Incorporates the Consumer-** Incorporates Consumer Equipment and Behavior in Design and Operation.
- **Tolerant of Attack-** Mitigates and Resilient to Physical and Cyber Attacks.
- **Provides Necessary Power-**Provides Quality Power Consistent with current Consumer and Industry Needs.
- **Accommodates Wide Variety of Supply and Demand-** (Including All Distributed Resources).
- **Fully Enables Maturing Electricity Markets-**Allows for and is Supported by Competitive Markets.

Energy Intelligence System Integration at Consumer Level (ILC & IMI)



Energy Intelligence Using Intelligent Load Control (ILC)



Grid Friendly Appliances sense grid frequency excursions & control region's appliances to act as spinning reserve – No communications required!

IMI- What Makes A Meter "Smart"

Four Characteristics of Intelligent Meter:

- Interval Measurements
  - Measuring Both Consumption & Time
- Interface w/Data Monitoring & Discrete Loads
- Automatic Transmission of Resulting Data
  - To Energy Provider- No Manual Meter Reading
  - To Consumer - Load & Usage Control
  - To Grid Operator- Grid Optimization.
- Two-Way Communications
  - Data collection
  - Monitoring
  - Ancillary Services & Load Control

IMI Deployment - Market Averages

(Source - KEMA)

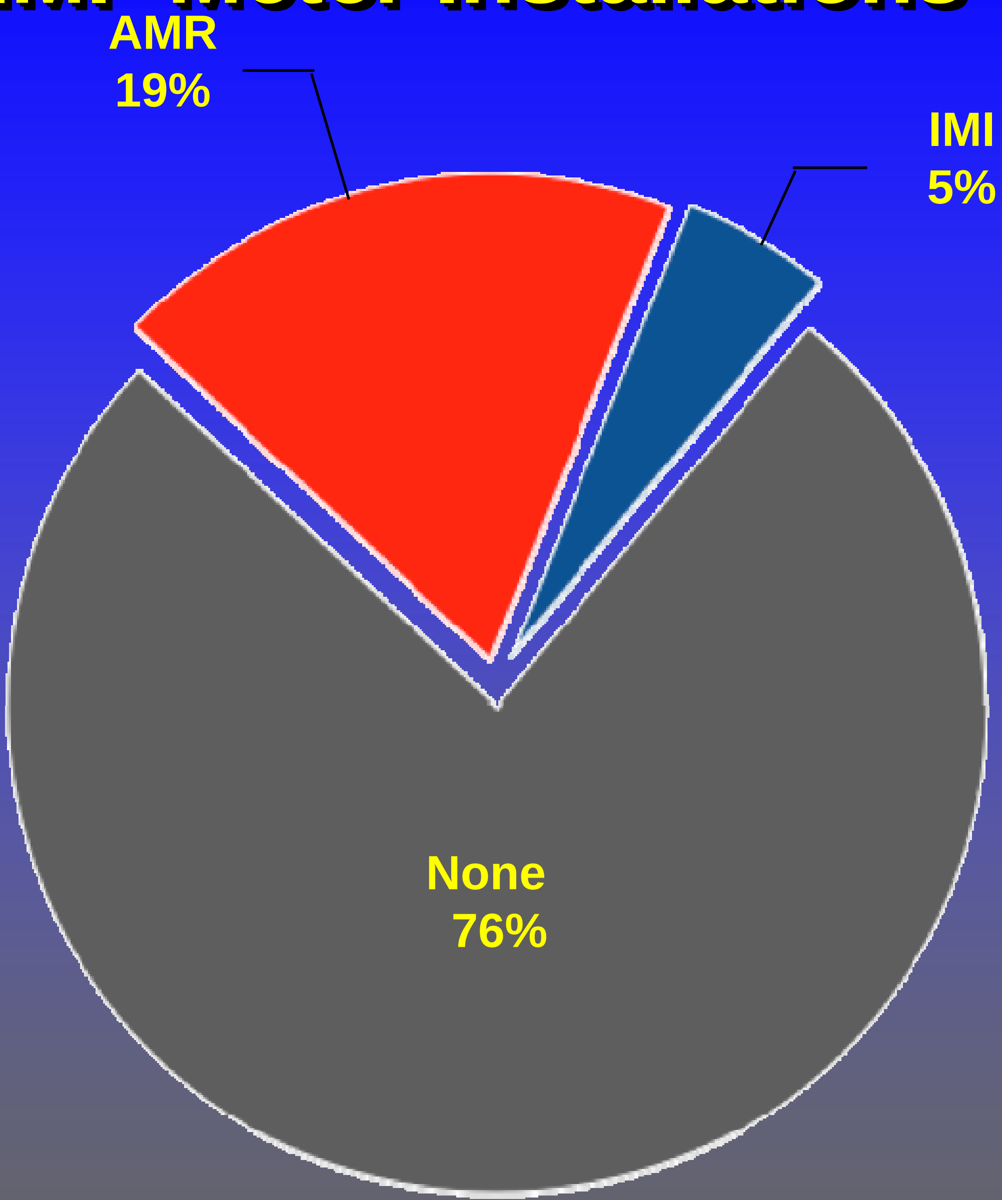
Average Length of Projects	Average Number of Total Meters	Average Number of Electric Meters	Average Length of Pilots
5.7 Years	2.6 million	2.2 million	9 months

IMI- Specific Utility Cost Data

(Source: KEMA)

Utility	Projected IMI Project Cost (total)
Con Edison	$892 million
Baltimore Gas & Electric	$400 million
CenterPoint	$1.8 billion
Southern Company	$280 million
Pepco	$128 million
San Diego Gas & Electric	$574 million
Pacific Gas & Electric	$1.7 billion
Southern California Edison	$1.3 billion
Portland General Electric	$130 million

IMI- Meter Installations



135 million

Electric meters

Energy Intelligence at the Distribution Level (IDO)

- Increased Information
- Granularity of Control
- Distribution Intelligence
- Advanced Outage Management Capability
- Enables Effective Integration of DR
- Integrated w/GIS

Energy Intelligence at the Distribution Level (IDO)

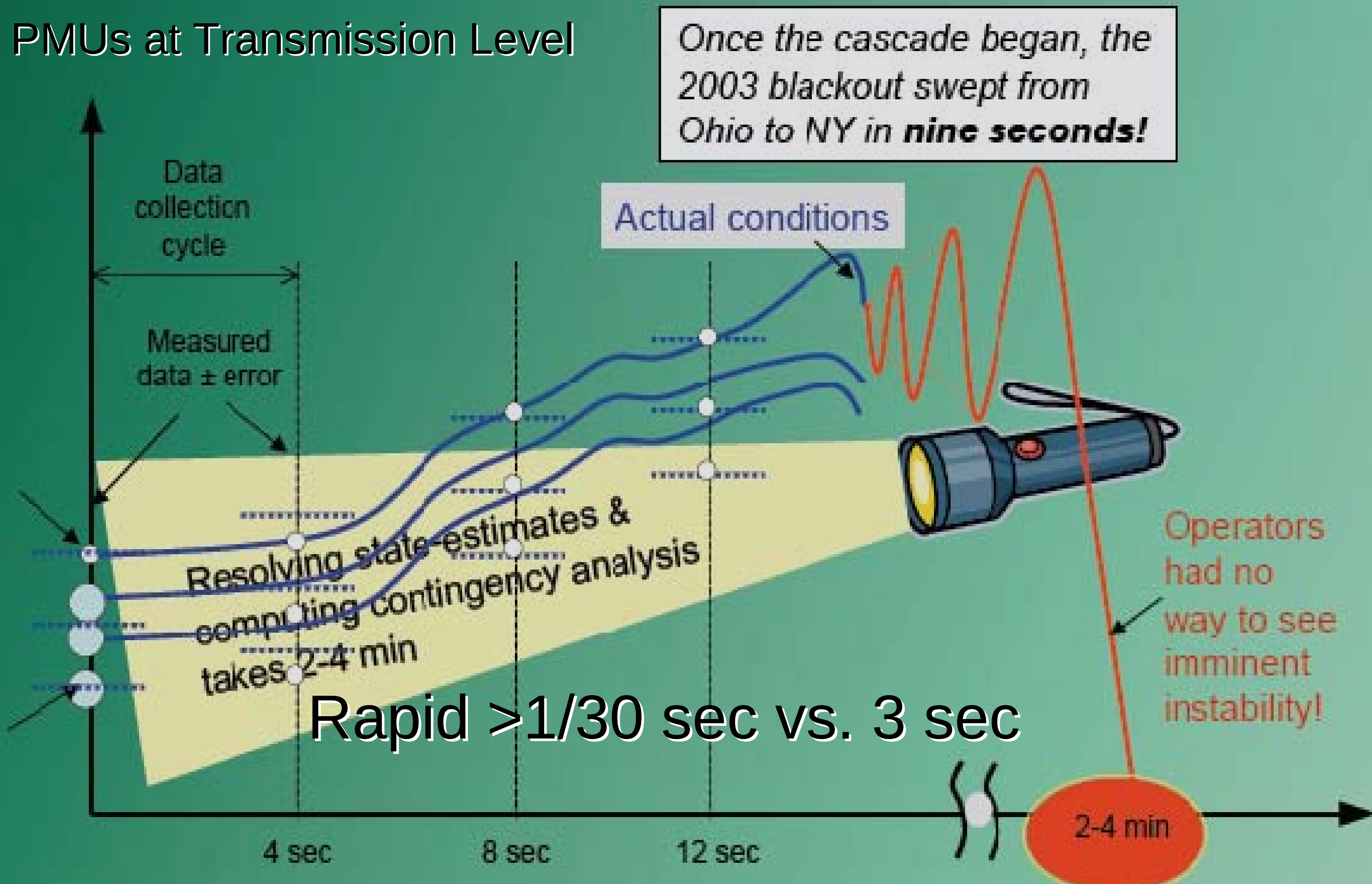
Dynamic Voltage Regulation

Energy Intelligence at Transmission Level (ITO)

- Advanced Data Collection
- Advanced Operation & Control
- Substation Automation
- Dynamic Loading Capabilities
- Non-Linear Modeling & Simulation
- Advanced Visualization Tools

ITO
Preventing the 2003 Blackout w/PMUs

PMUs at Transmission Level



Rapid >1/30 sec vs. 3 sec

Energy Intelligence Asset Operations (IAM)

- Improve Utilization of T & D
- Effectively Manages Assets from Life Cycle Perspective
- Improves Effectiveness of Asset Management Systems

Visualization Tools (IAM)

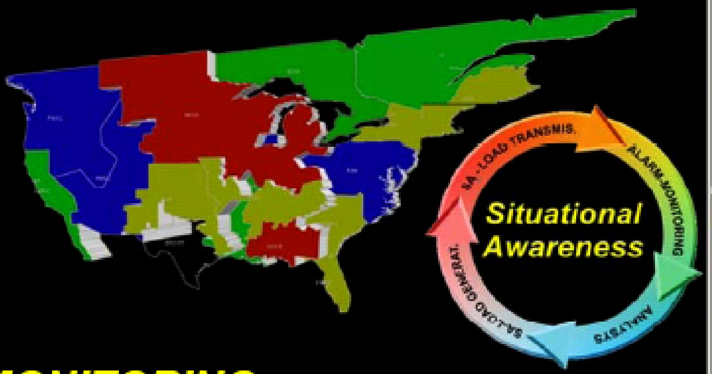
A STANDARD METRICS

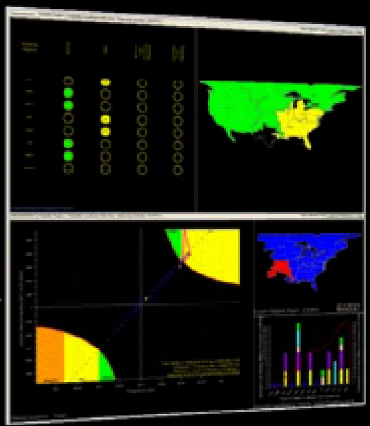
- Balance Resource and Demand
- Frequency Response

B REAL TIME ALARMING

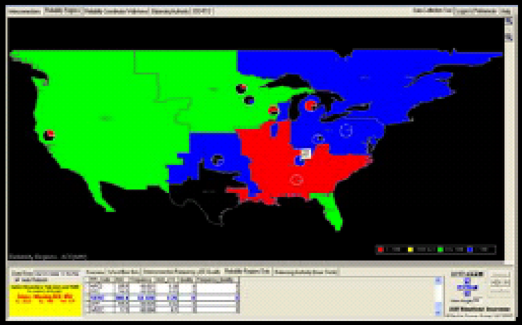
SHORT-TERM: -EAST 9/28/2006 (EDT)
Frequency Absolute value of two most recent 1-Minutes: ABS(59.979-60.027)=0.048Hz>=0.034Hz.

C WIDE-AREA SITUATIONAL AWARENESS

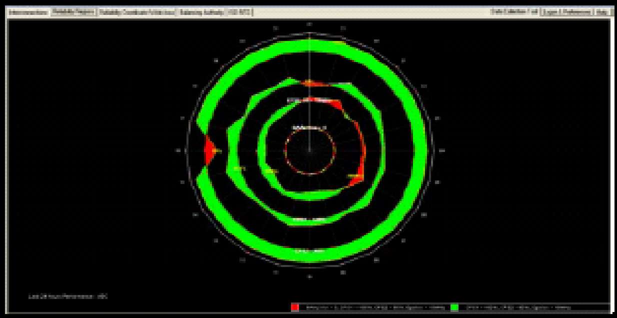


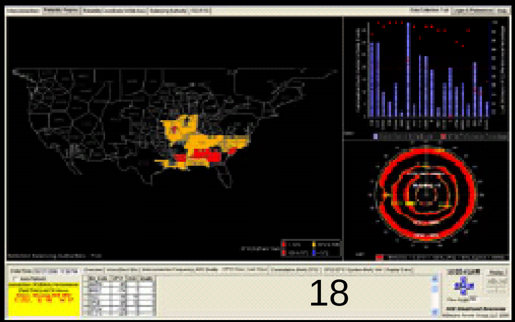


D WIDE-AREA REAL TIME MONITORING



E ANALYSIS - ASSESSMENT





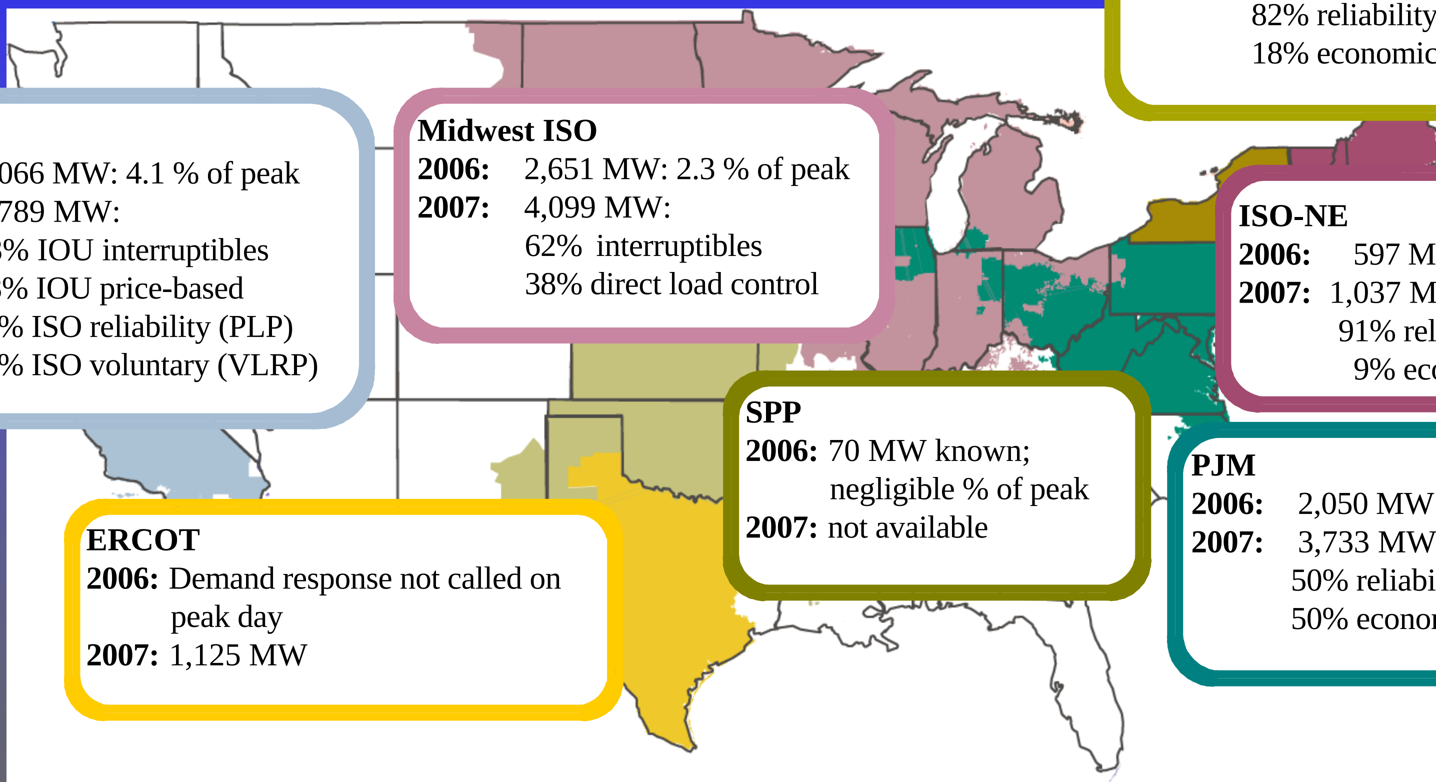
FERC Grid Intelligence Authority

- FPA (Just and Reasonable)
- EPAct 2005
  - Section 1223 (Advanced Transmission Technology)
  - Section 1221 (Reliability)
- EISA 2007
  - "Smart Grid" provisions

FERC Action on Wholesale Market Platform For Demand Resources (Requires Energy Intelligence)

- Demand Resources Participate in Energy Markets:
  - ISO-NE, NYISO, PJM Currently
  - MISO, CAISO, SSP in Development
- Demand Resources in Ancillary Service Markets:
  - ISO-NE, NYISO, PJM
  - MISO, CAISO in Development
- Demand Resources in Capacity Markets:
  - ISO-NE's Forward Capacity Market Auction
  - NY-ISO's Special Case Resource Auctions
  - PJM's Reliability Pricing Model Auctions

Summer 2006 Demand Response Contributions and Summer 2007 Program Enrollment



NYISO
2006: 948 MW: 2.8 % of peak
2007: 2,199 MW:
82% reliability
18% economic

CAISO
2006: ~ 2,066 MW: 4.1 % of peak
2007: 2,789 MW:
58% IOU interruptibles
38% IOU price-based
3% ISO reliability (PLP)
1% ISO voluntary (VLRP)

Midwest ISO
2006: 2,651 MW: 2.3 % of peak
2007: 4,099 MW:
62% interruptibles
38% direct load control

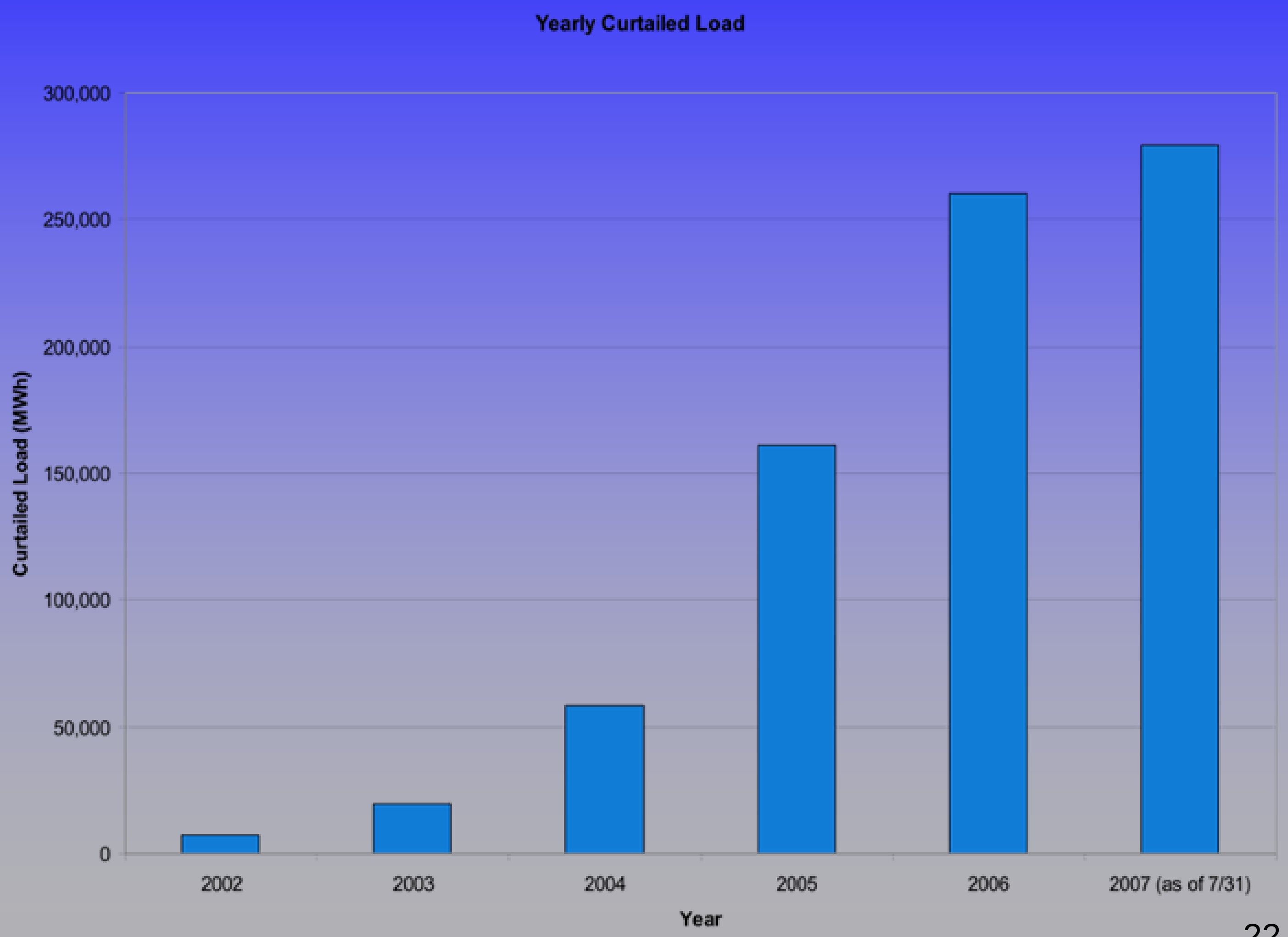
ISO-NE
2006: 597 MW: 2.1 % of peak
2007: 1,037 MW:
91% reliability
9% economic

SPP
2006: 70 MW known; negligible % of peak
2007: not available

PJM
2006: 2,050 MW: 1.4 % of peak
2007: 3,733 MW:
50% reliability
50% economic

ERCOT
2006: Demand response not called on peak day
2007: 1,125 MW

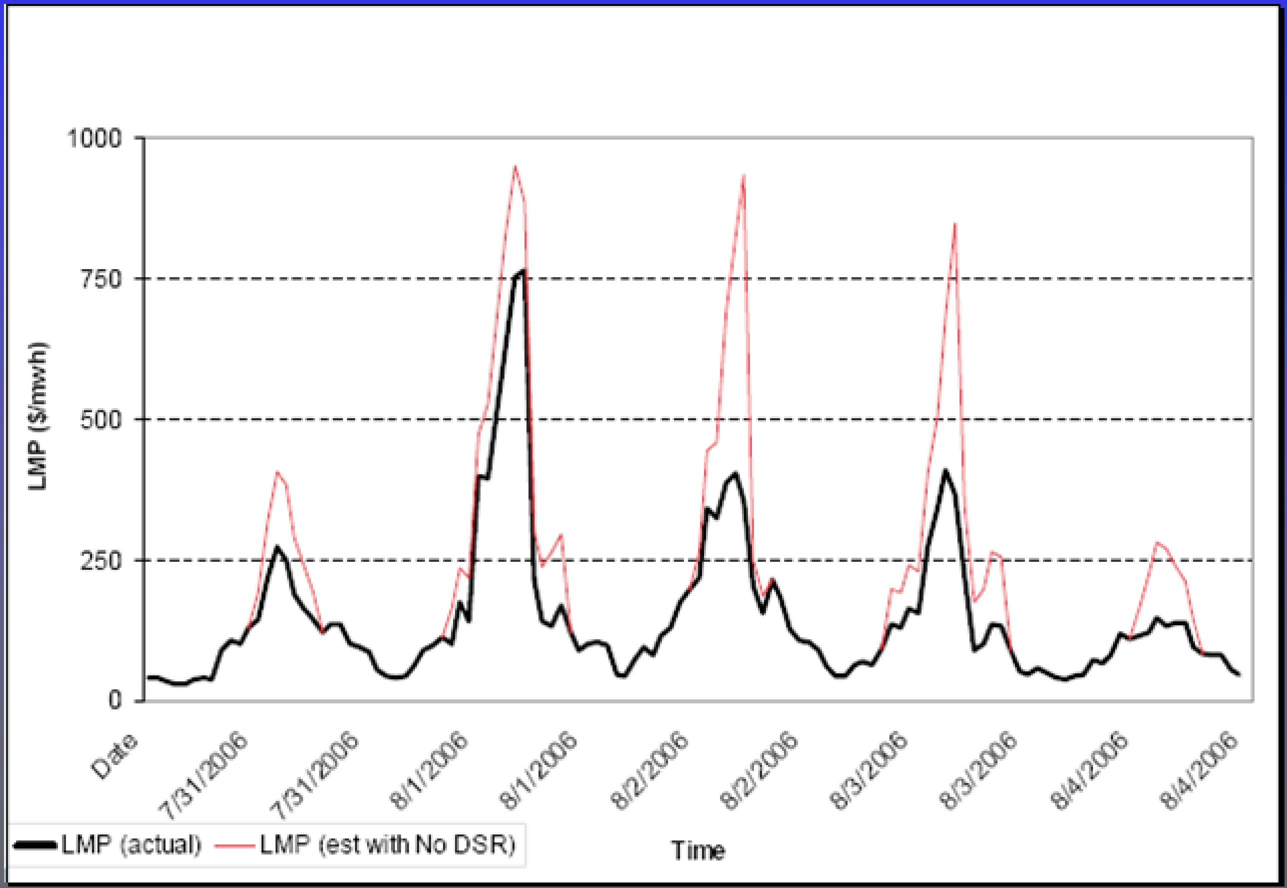
PJM Demand Response



Energy Intelligence Benefits

PJM Demand Response

$650 Million in Consumer Savings



FERC Action
Regional Transmission Planning

- Regional Transmission Planning
  - Use/Consider Comparable to Central Generation
    - Demand Response
    - Energy Efficiency
    - Distributed Generation
    - Smart Grid Upgrades and Grid Operation
    - Optimization

OATT Reform
Order 890 (February 2007)

Energy Independence and Security Act of 2007 (ESIA)

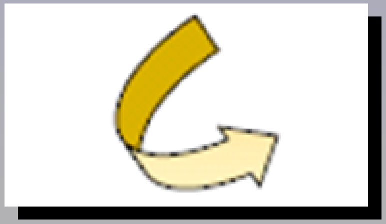
- Policy Supports the Modernization Nation's Electricity T & D Systems.
- Stops Short of Defining "Smart Grid".
- Requires DOE to Establish Smart Grid Task Force
  - Reps. from Federal Agencies.
- Requires DOE to Establish Smart Grid Advisory Committee
  - Private & Non-Fed. Public Sector Stakeholder

Energy Independence and Security Act of 2007 (ESIA)

- ESIA (Authorization Independent of the FPA)
  - FERC Issue Rule Making Adopt “Smart Grid” Standards.
  - No Explicit Limitations on FERC Authority to Adopt Rule.
  - Standards Apply Local Distribution & Transmission Facilities.
  - Standards Not Mandatory & No Enforcement.

Energy Intelligence Costs vs. Benefits

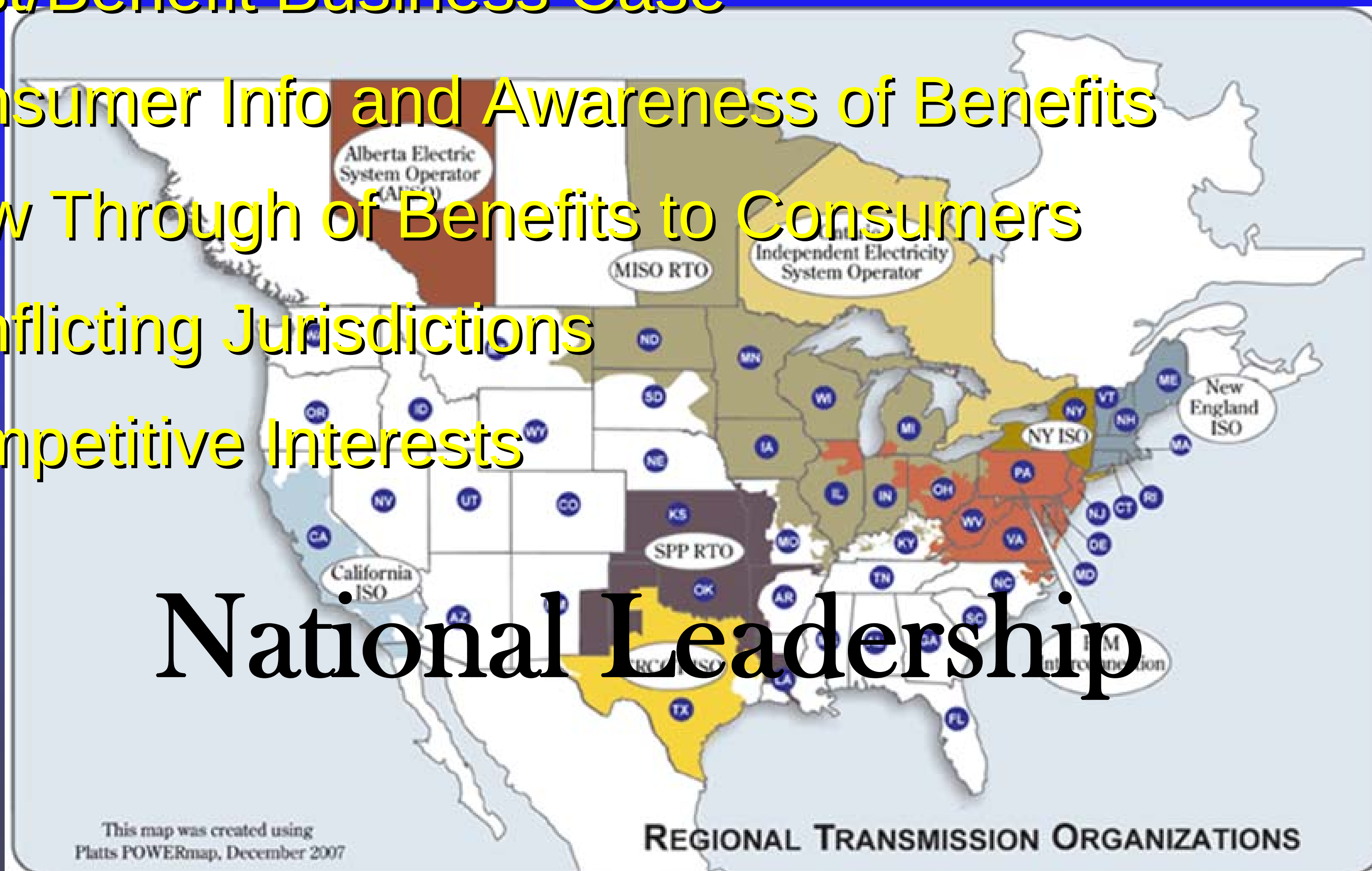
Target Sector Costs	10-Year Investment Level ($B)
Residential	**7-10**
Commercial	**13-20**
Network Infrastructure	**$25-30**
TOTAL	**45-60**



Source of Benefits	Potential Benefits/year ($B, by 2015)
“Smarting up” of customer premises (smart homes, intelligent buildings)	**$6-8**
Enabling of Demand Response and IMI deployment	**$5-8**
Investments in Intelligent grid technologies	**$2-3**
DG, interactive storage technologies and microgrids	**$1-2**
TOTAL/year	14-21

Barriers and Challenges

- Cost/Benefit Business Case
- Consumer Info and Awareness of Benefits
- Flow Through of Benefits to Consumers
- Conflicting Jurisdictions
- Competitive Interests



National Leadership

THANK YOU!