Efficient Energy Services

Road to the Smart Electric Grid

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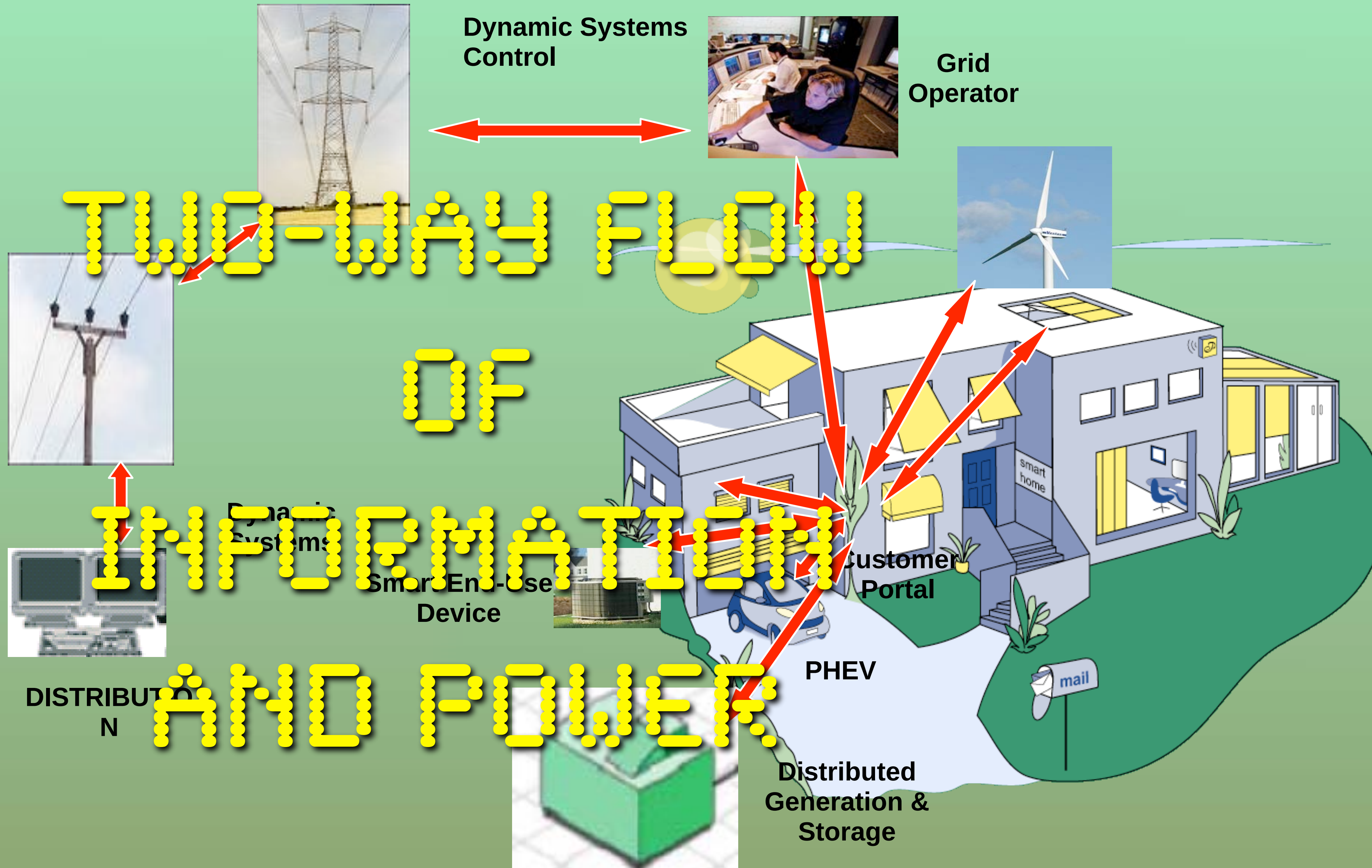
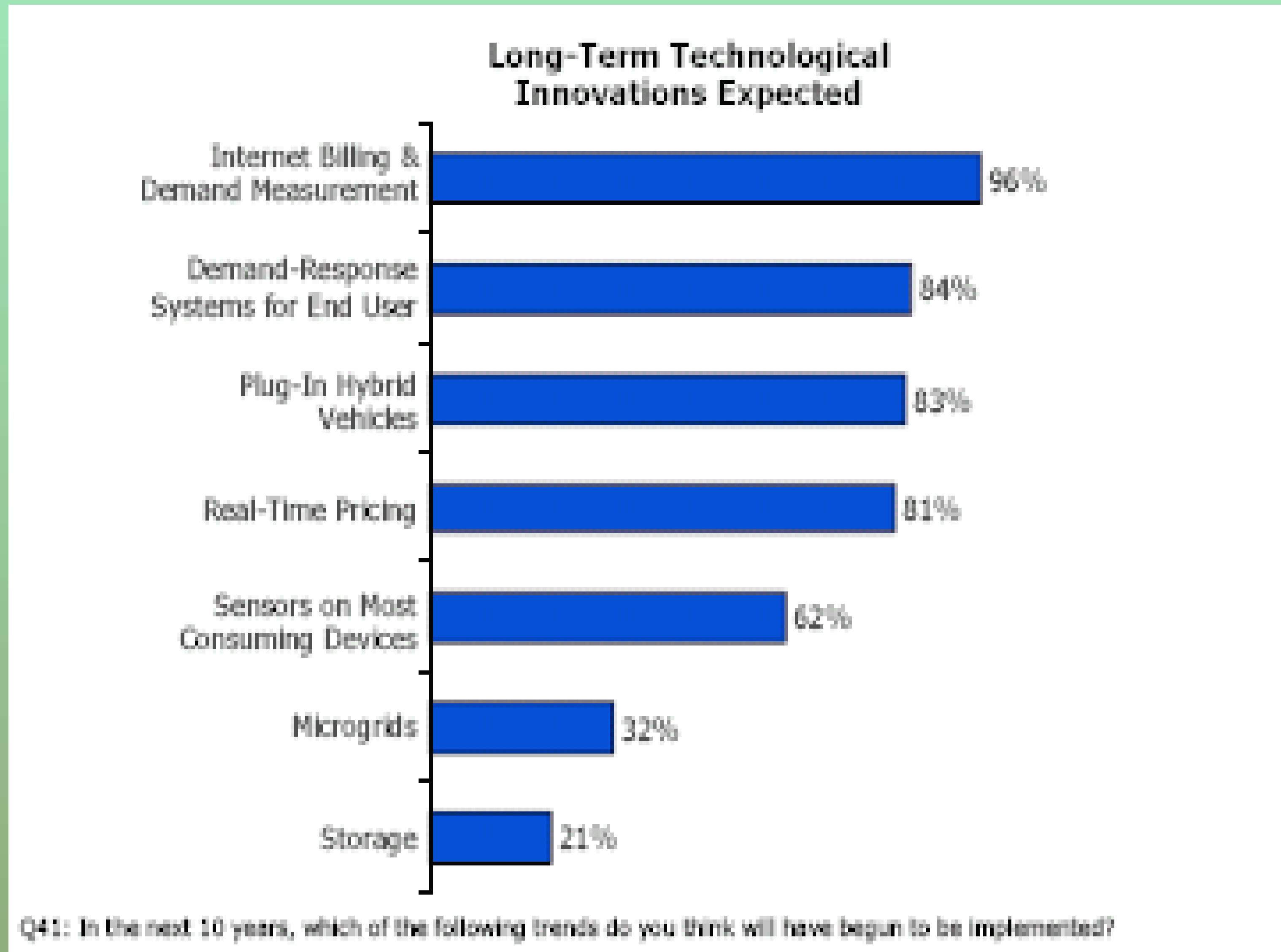
21ST CENTURY ELECTRIC GRID



10 Year Smart Grid Outlook



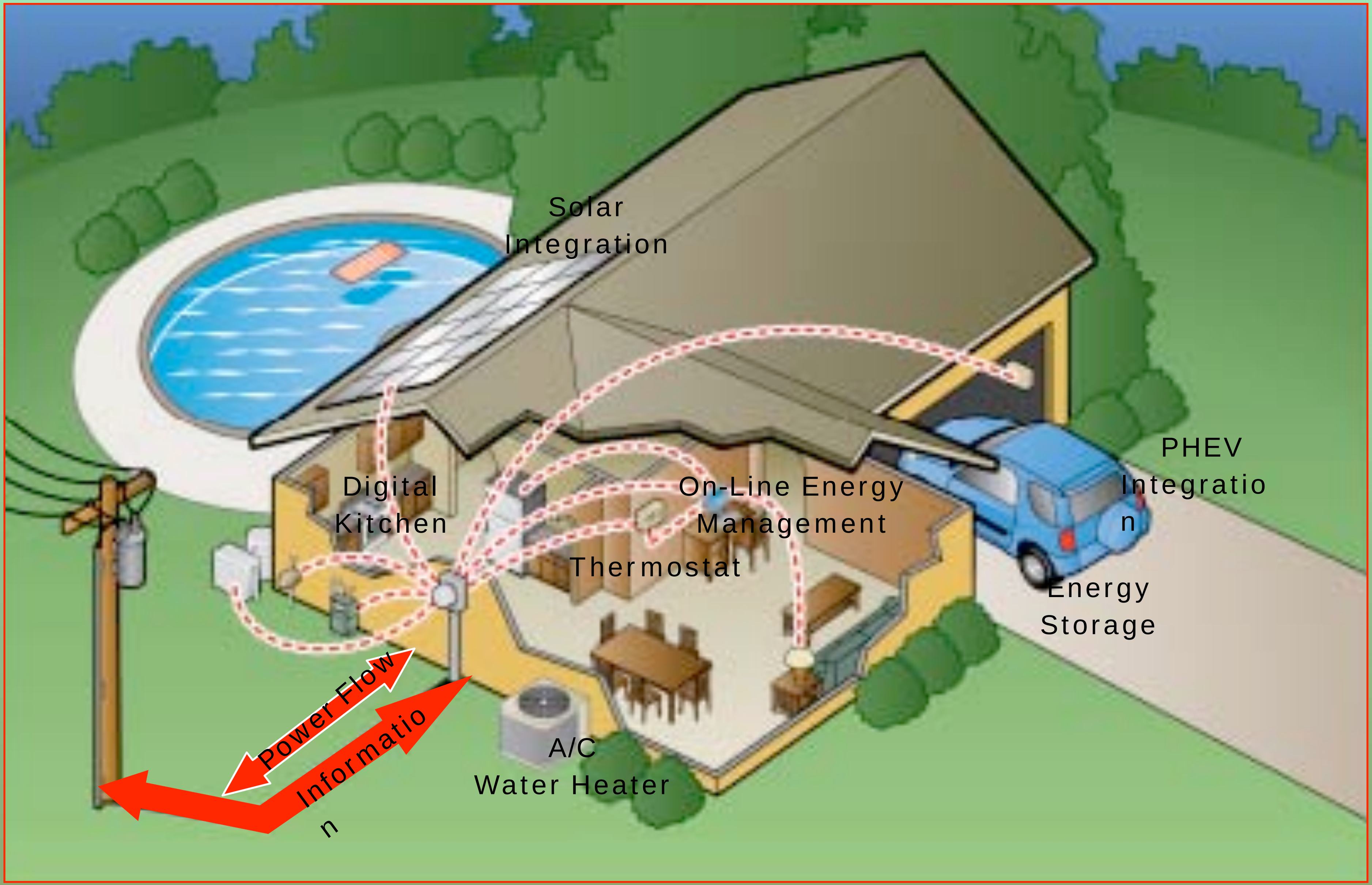
The Smart Grid

20th Century Grid	21st Century Smart Grid
Electromechanical	Digital
One-way communications (if any)	Two-way communication
Built for centralized generation	Accommodates distributed generation
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

Seven Key Characteristics of Smart Grid

- **Self-healing.** Grid Rapidly Detect, Analyze, Respond and Restore.
- **Empower and Incorporate the Consumer.** Ability to Incorporate Consumer Equipment and Behavior in Grid Design and Operation.
- **Tolerant of Attack.** Grid Mitigates and Resilient to Physical and Cyber Attacks.
- **Provides Power Quality Needed by 21st Century Users.** Grid Provides Quality Power Consistent with Consumer and Industry Needs.
- **Accommodates Wide Variety of Supply and Demand.** Grid Accommodates Variety of Resources (Including DR, CHP, Wind, PV).
- **Fully Enables Maturing Electricity Markets.** Allows for and is Supported by Competitive Markets.

Smart Grid System Integration at Consumer Level



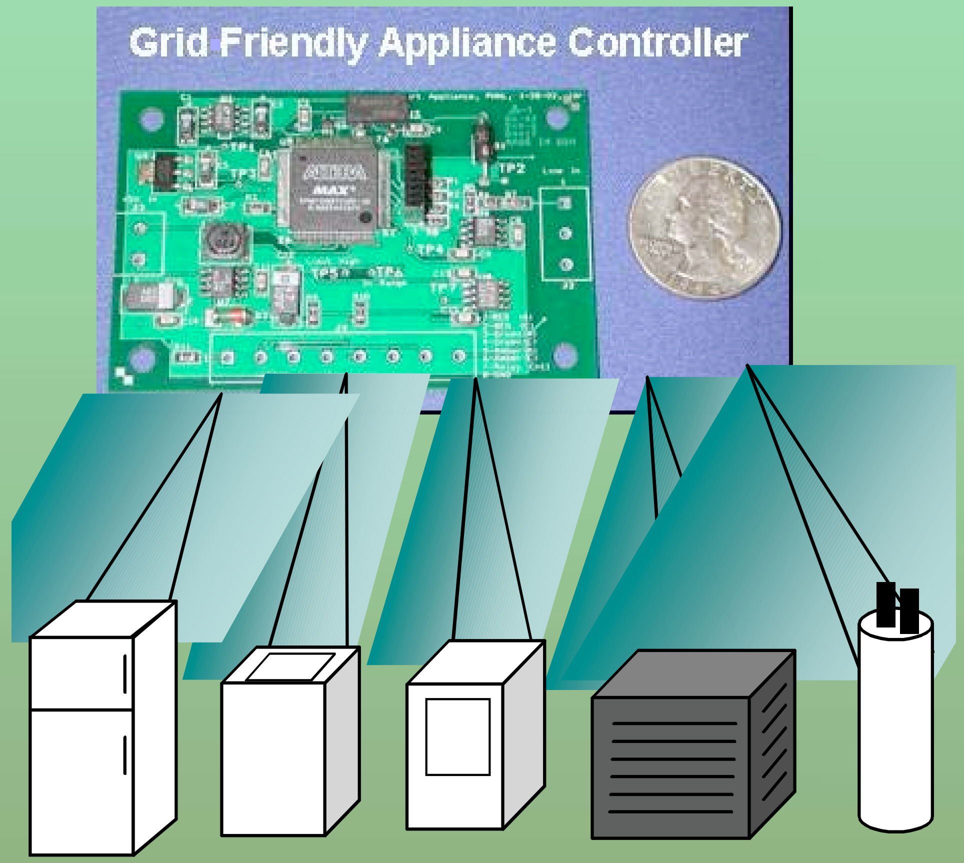
What Makes Meter "Smart" or "Advanced"

The three functions that make a meter smart are:

- The ability to take interval measurements, measuring both what was consumed and when.
- Automatic transmission of the resulting data, eliminating the need for manual reading.
- Two-way communications: the ability to both "listen" and "talk".

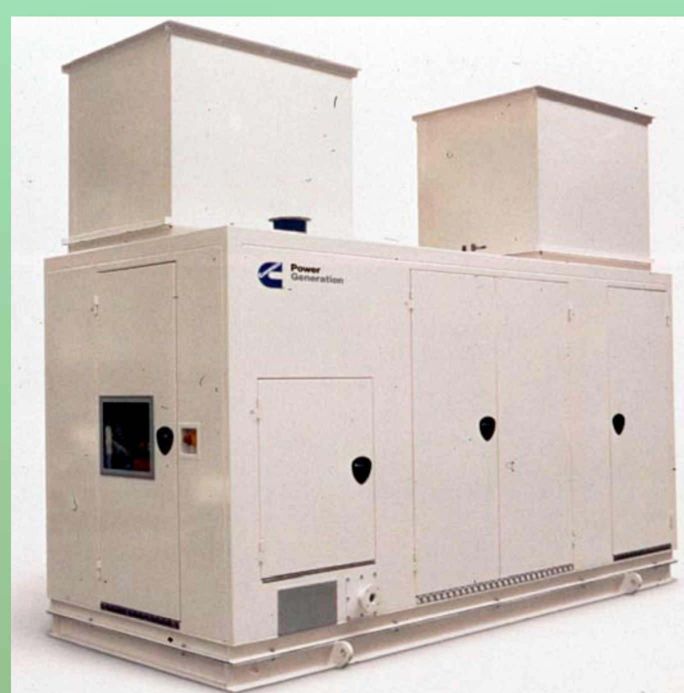
Levels of sophistication categorize meters into several types - from simply measuring consumption to helping constantly and economically regulate consumption.

Smart Grid at Residential Customer Level

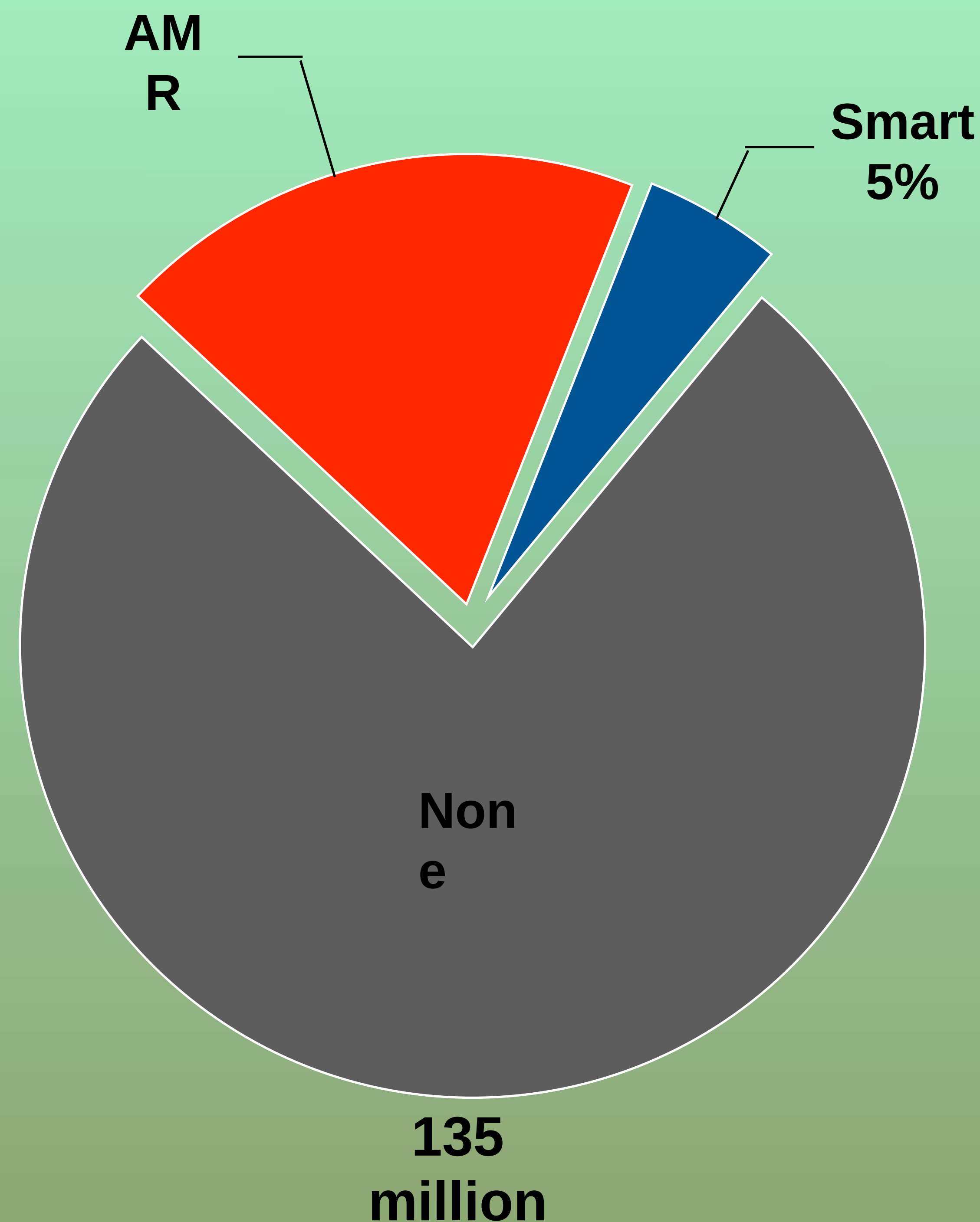


Grid Friendly Appliances sense grid frequency excursions & control region's appliances to act as spinning reserve – No communications

Smart Grid at Commercial Customer Level



Smart Meter Installations

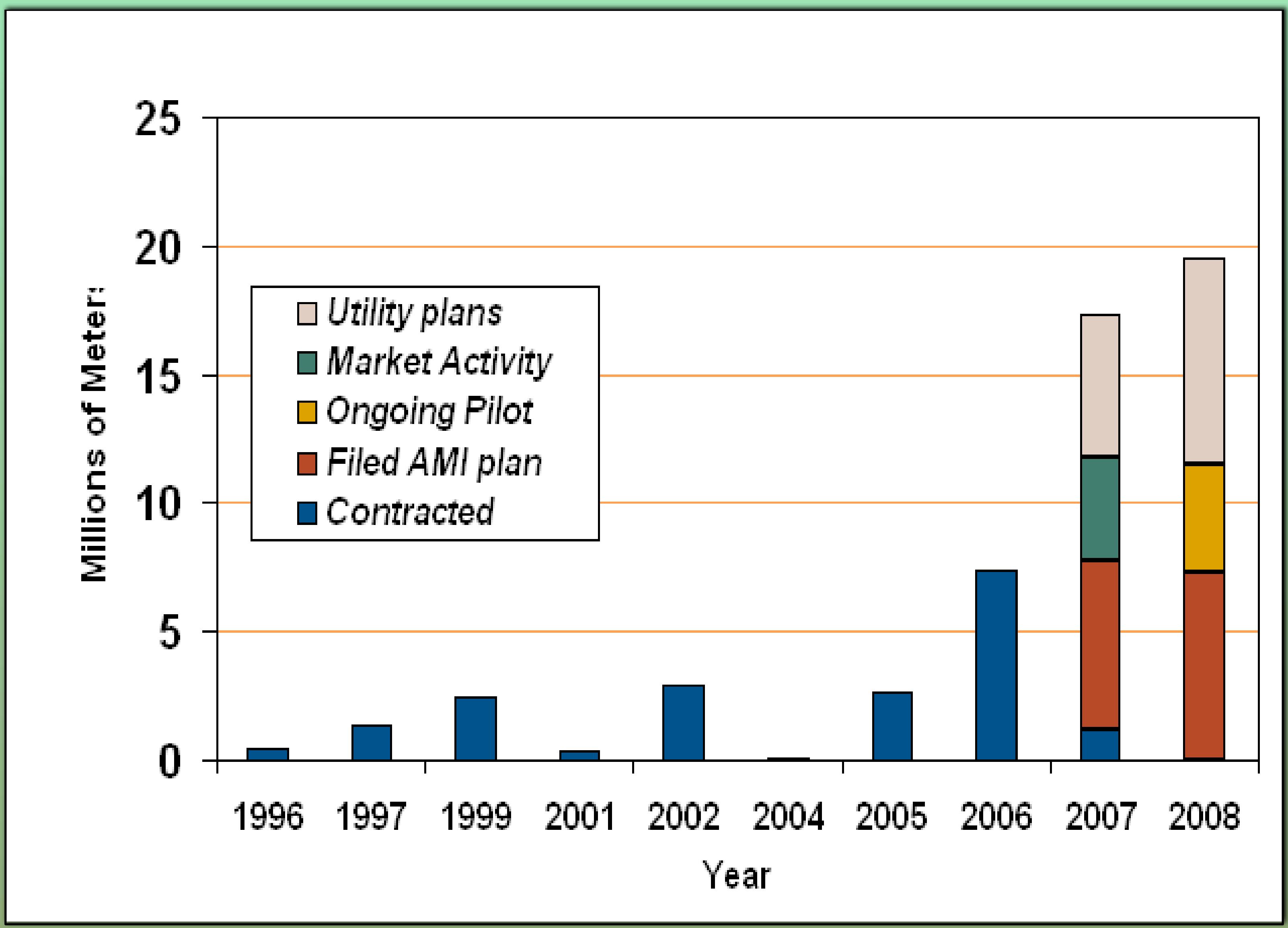


Specific Utility Cost Data

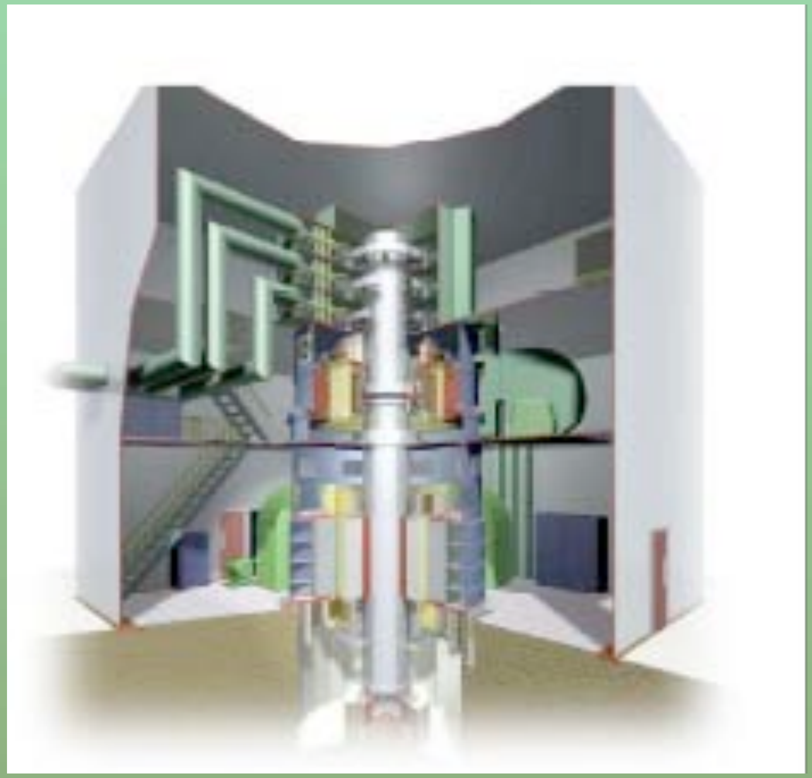
(Source: KEMA)

Utility	Projected AMI 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

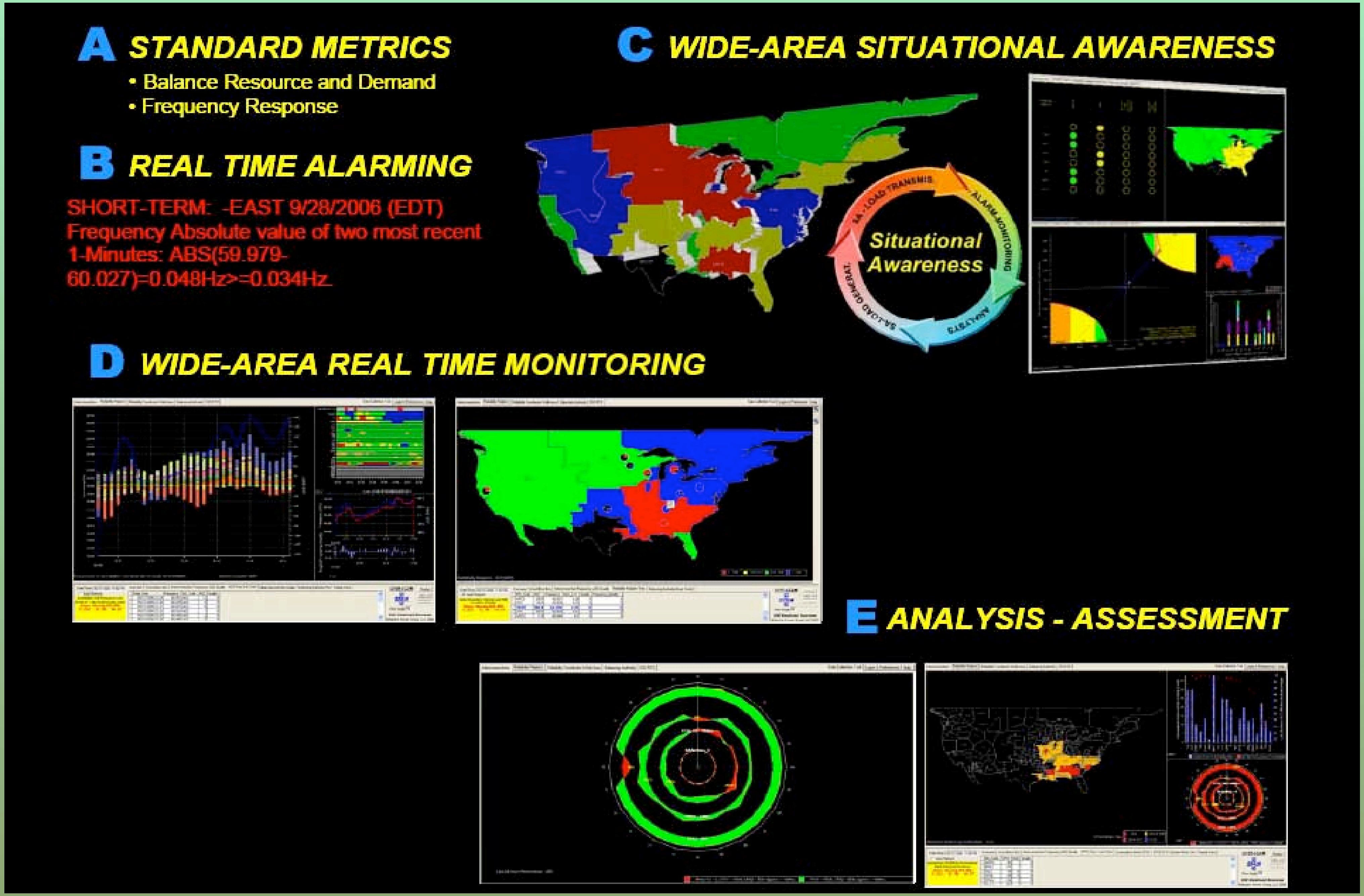
AMI Installations



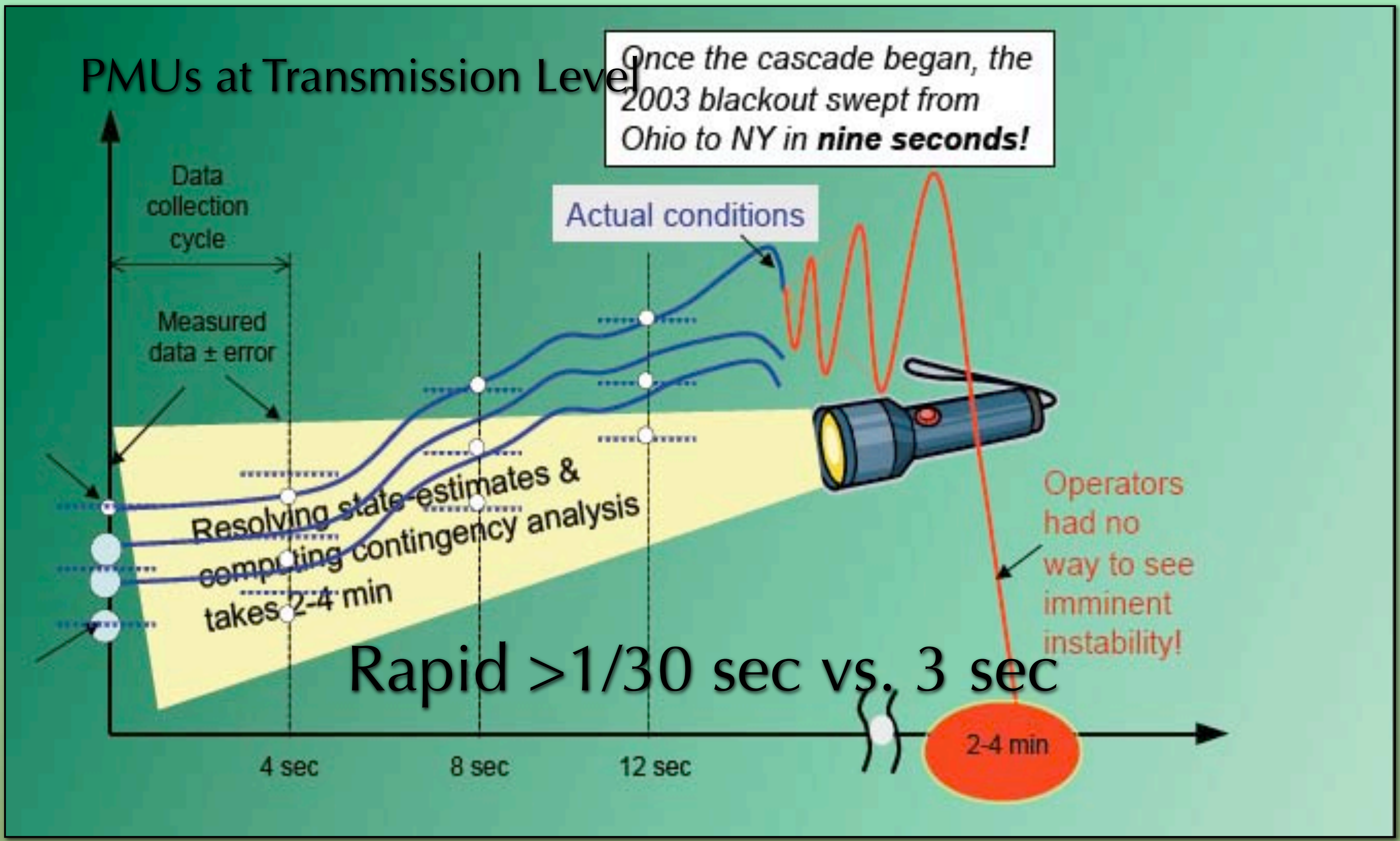
Smart Grid at Transmission Level

VFT Technology	
▪Provides continuously variable phase angle shift up to 360 degrees. ▪By adjusting phase angle, RT regulates power flow and control is steady, smooth and continuous. ▪Continuous rather than step-wise control ▪Improves grid stability ▪Low harmonic generation	

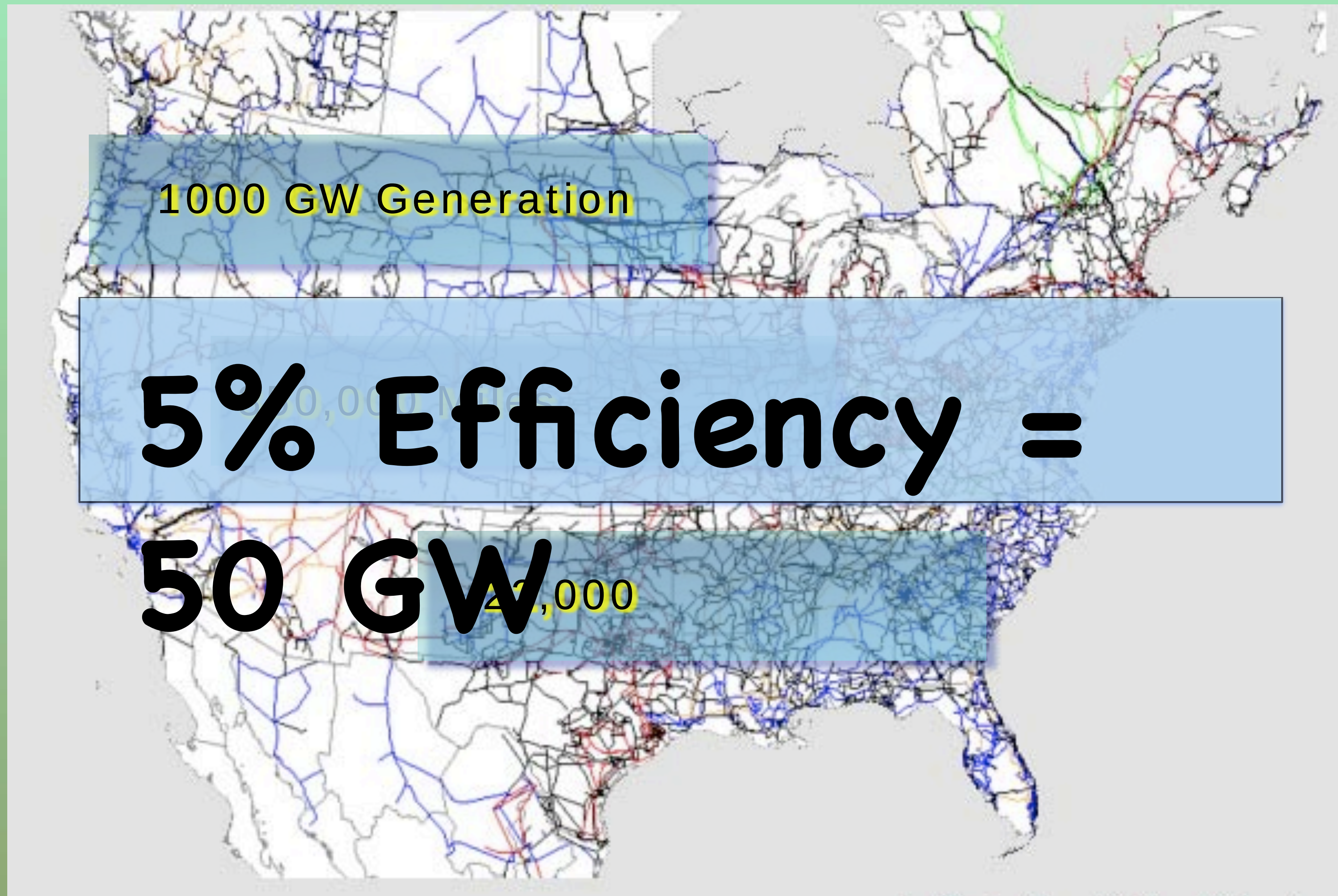
Visualization Tools



Grid Efficiency – 2003 Blackout



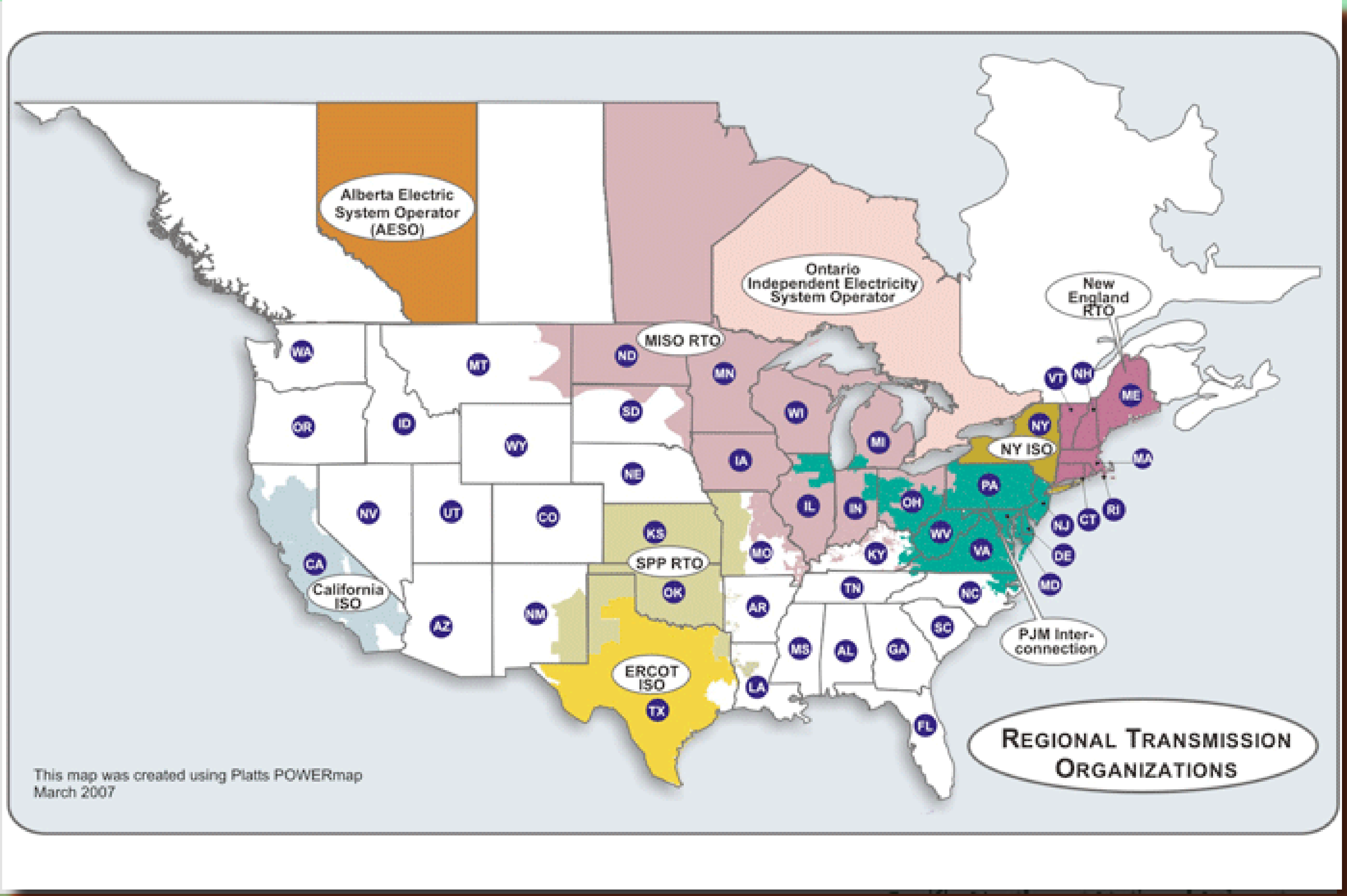
Grid Efficiency Potential



1000 GW Generation

5% Efficiency = 50 GW

Organized Wholesale Markets

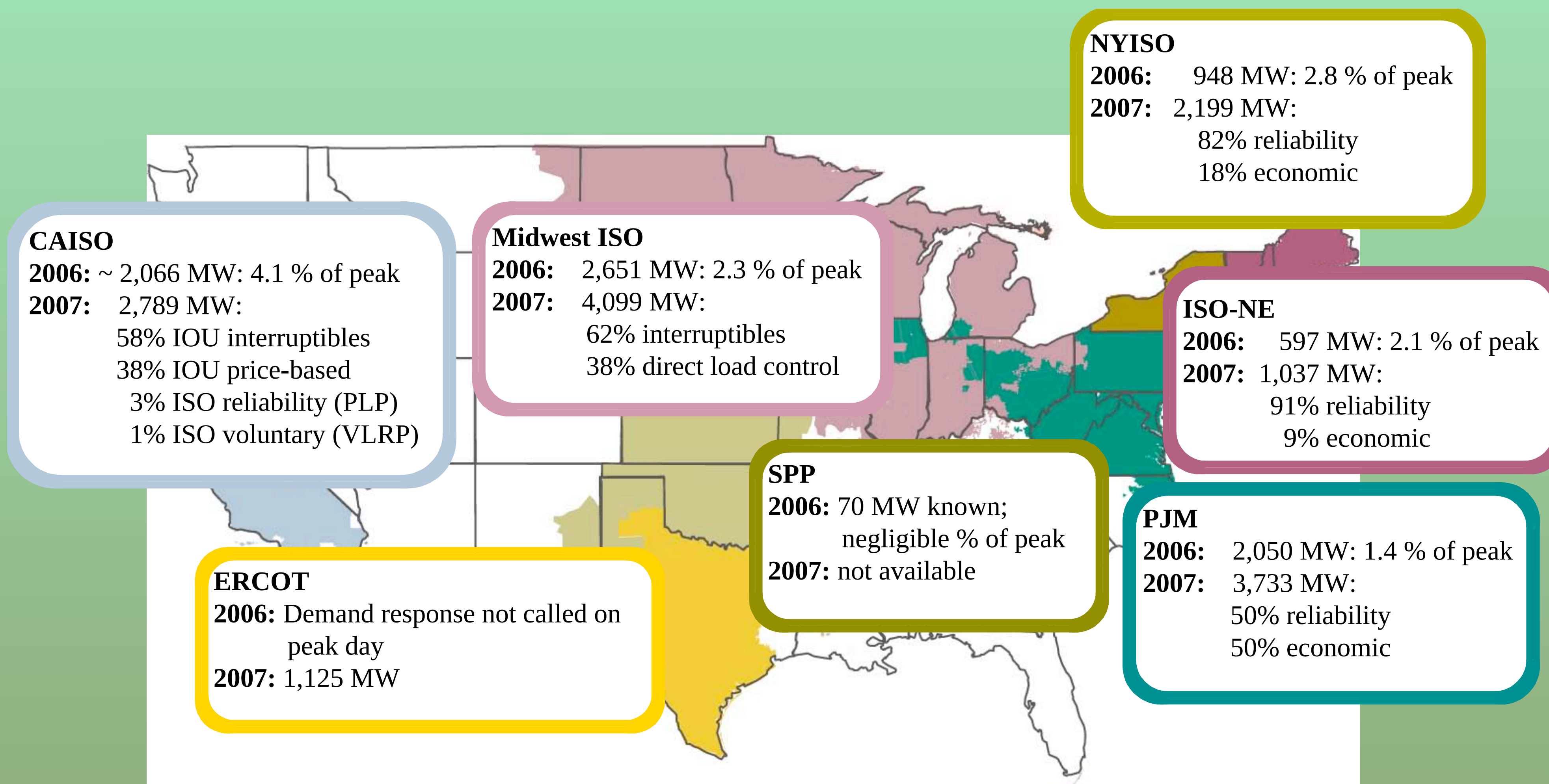


FERC Action on Wholesale Market to Enable Demand Resources

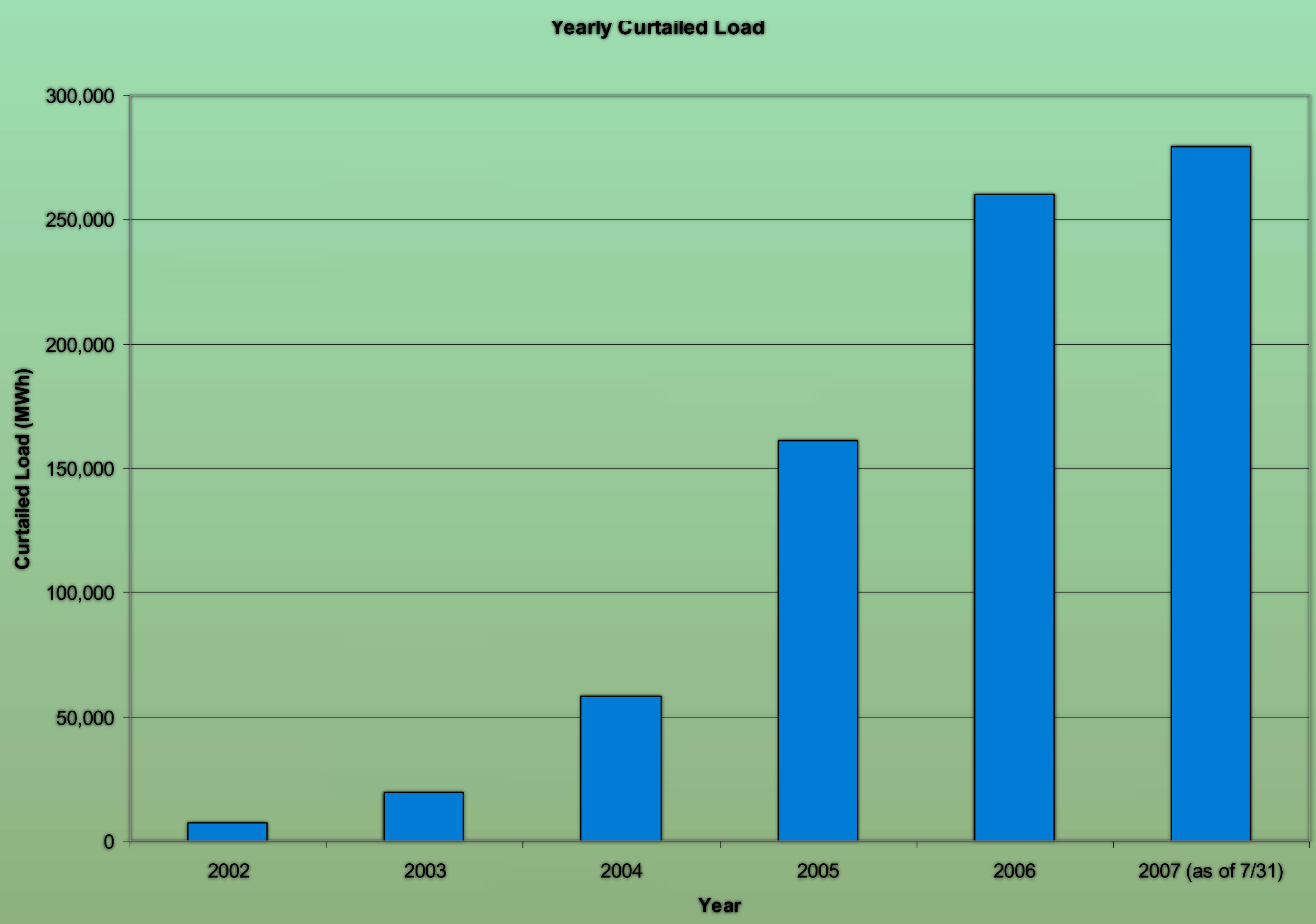
- Demand Resources Participate in Energy markets:
  - ISO-NE, NYISO, PJM Currently
  - MISO, CAISO, SPP in Development
- Demand Resources in Ancillary Services Markets:
  - ISO-NE, NYISO, PJM
  - MISO, CAISO in Development
- Demand Resources in Capacity Markets:
  - ISO-NE's Forward Capacity Market Auction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

Market Element	NYISO			ISO-NE			PJM			CAISO			MISO			SPP			ERCOT		
	H	O	I	H	O	I	H	O	I	H	O	I	H	O	I	H	O	I	H	O	I
Demand Response Program	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		
Emergency Situation DR Program	✓	·	·	✓	·	·	✓	·	·	·	·	·	·	✓			·		✓		
Real Time DR Bids	✓	✓		✓			✓			✓	✓		✓	✓			✓		✓		
Day Ahead DR Bidding into Market	✓			✓			✓	✓		·	✓			✓					✓		
Capacity Market DR Participation	✓	✓		✓	✓		✓		✓	·									✓		
DR in Long-Term Tx Planning	✓			✓			·	✓		✓			·		✓						
Bid Price Floor or Cap for DR	✓			✓																	
	·			·																	
Ancillary Services DR Participation	✓	✓		✓	✓		✓	·		✓	✓			✓					✓		
Reactive Supply & Voltage Control		·		✓	·		·	·		·	·			·					·		
Regulation		✓			·		✓	·		·				✓							
Spinning	✓	✓		✓			✓	·			✓			✓							
Non-spinning (10 Min.)	✓	✓		✓			·	·		✓				✓					✓		
Long Term Supplemental (30 Min.)	✓	·		✓			·	·		✓				✓		1					
Generator Imbalances	·	·		·	·		·	·		·				·							

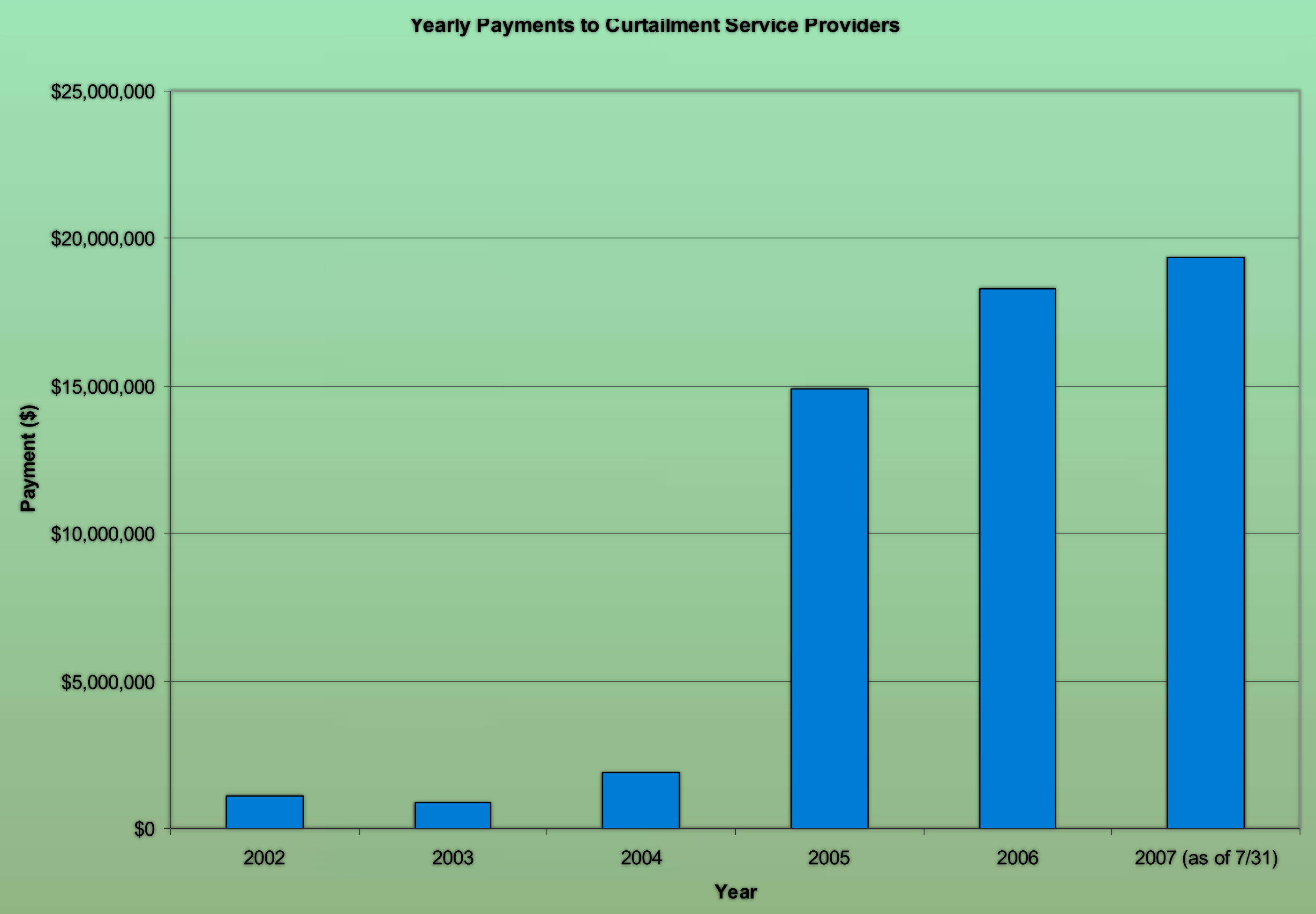
Summer 2006 Demand Response Contributions and Summer 2007 Program Enrollment



PJM Demand Response



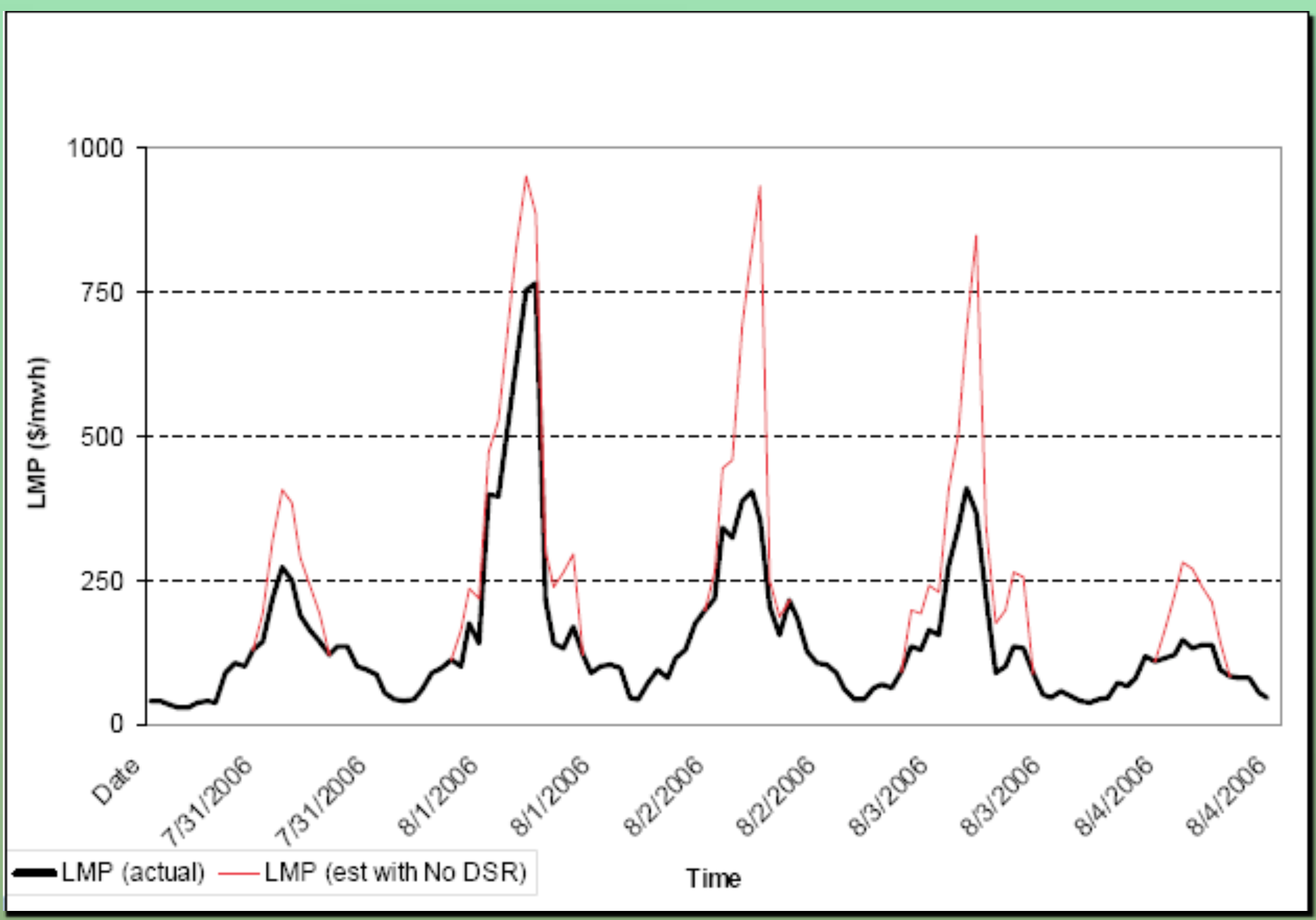
PJM Demand Response



Smart Grid 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)

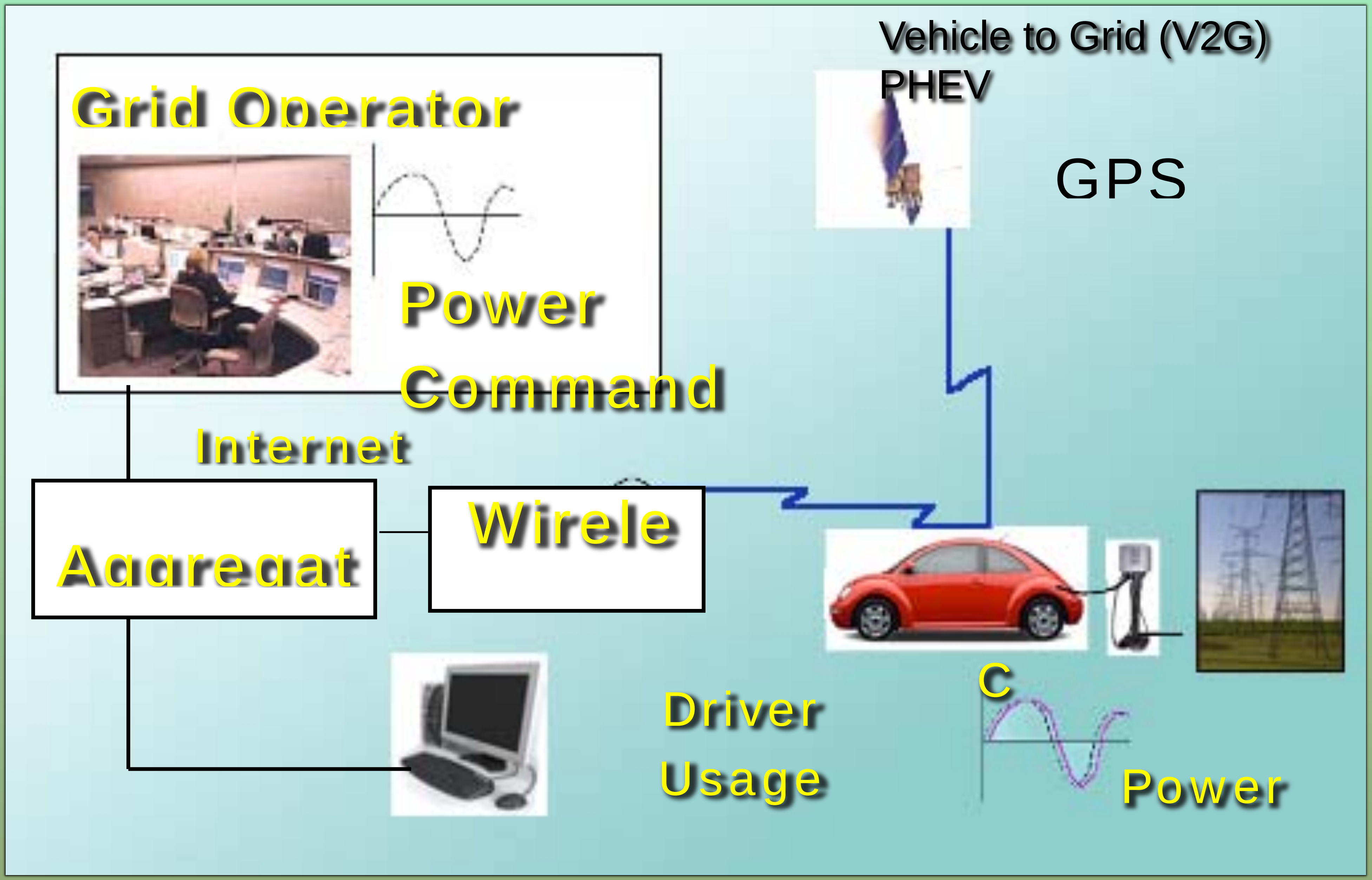
Smart Grid Costs vs. Benefits

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

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 AMI deployment	**$5-8**
Investments in smart grid technologies	**$2-3**
DG, smart grid-interactive storage technologies and microgrids	**$1-2**
TOTAL/year	14-21

Smart Transportation

Smart Transportation Interface



PHEV V2G Benefits

- **Efficient Grid Management**
  - Ancillary Services (Spinning Reserve & Regulation)
  - Dispatchable Reactive Power
  - Peak Demand Services (Demand Response)
  - Reduced Operating and Planning Reserves
  - Distribution/Substation Level Support
  - Reduced Line Losses
  - Improved Power Plant Efficiency
  - Improved Load Factor
- **Storage & Integration of Renewable**

PHEV Grid Efficiency

THANK YOU!