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Overview of the Modern Grid Initiative

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Midwest Regional Summit

15 November 2006

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Part I: Background

Overview

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- One reoccurring theme that DOE has heard from industry is the need to demonstrate the integration of state-of-the-art technologies, tools, and systems in pilot-scale projects
- The goal of our effort is to create the foundation for a large, multi-year technology integration program
- The initiative involves a broad range of stakeholders in defining both the framework and the structure of the program
- The initiative will build on the existing technology development efforts at DOE and others

The desired outcome goes beyond a shared vision to a shared understanding and agenda.

Team Charter

- **Approach the grid modernization issues from a:**
  - Systems perspective
  - National perspective
  - Societal perspective
  - Independent perspective
- **Develop a program plan for technology integration that consider these issues more comprehensively**
  - Broad stakeholder involvement
  - Diverse geographic needs
  - Diverse network topologies
  - Broad range of potential technologies

Modern Grid Program Timeline

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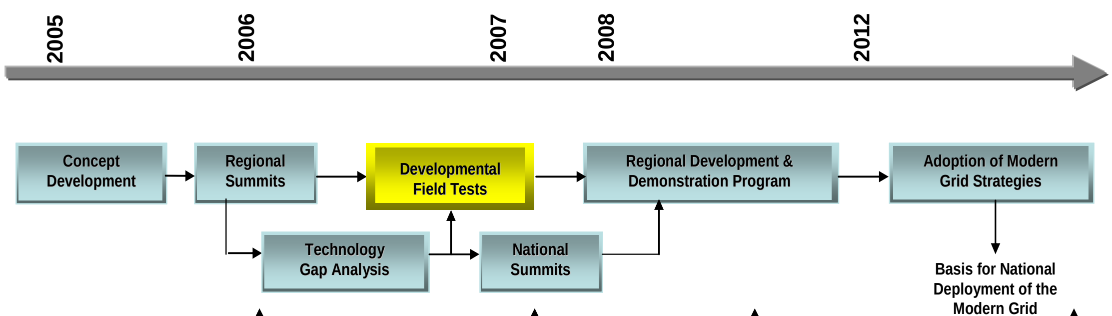

Fiscal Year 2006

•Development of the Modern Grid systems view concepts
- Stakeholder alignment
- Commencement of the initial developmental field test (DFT)

Fiscal Year 2007

•Full operation of two to three developmental field tests

•Continued stakeholder alignment

Fiscal Year 2008 - 2012

•Bid, selection, and deployment of large Technology Integration Projects

•Refinement of the Modern Grid strategies through lessons from the integration projects

Fiscal Year 2013

•Adoption of the Modern Grid strategies by appropriate national and state organizations

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Related DOE OE Support

- **Coordination of other modern grid projects**
  - West Virginia University integrated control of next generation power systems project ($1M)
  - Hawaii Sustainable Energy Security (~$2M)
  - New Mexico Sustainable Energy Security (~$1M)
  - Montana State load control system reliability ($2M)
  - University of Louisville (Genscape) Electric Grid Monitoring ($1M)
  - Pilot Energy Cost Control Evaluation at NETL ($2M)
  - S&C Electric Advanced Technology Center ($1M)
  - Cleveland State Center for Research in Electric and Aerospace Tech ($1M)
  - Nxegen Connecticut Peak Demand Management ($1M)
- **20 of 27 OE earmark projects appear to be directly related to the Modern Grid Initiative**

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Part II: Vision

Vision

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Revolutionize the electric system by integrating 21st century technology to achieve seamless generation, delivery, and end-use that benefits the nation

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A smart, integrated grid will widely:

- Detect emerging problems and fix them before they seriously impact quality of service
- Incorporate extensive measurements, rapid communications, centralized advanced diagnostics, and feedback control that quickly returns the system to a stable state
- Have the ability to re-route power flows, change load patterns, improve voltage profiles, and take other corrective steps, within seconds of detecting a problem
- Enable loads and distributed resources to participate in operations
- Use modern tools to improve design and operation with reliability, security, efficiency, and safety as fundamental values

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Modern Grid Stakeholders

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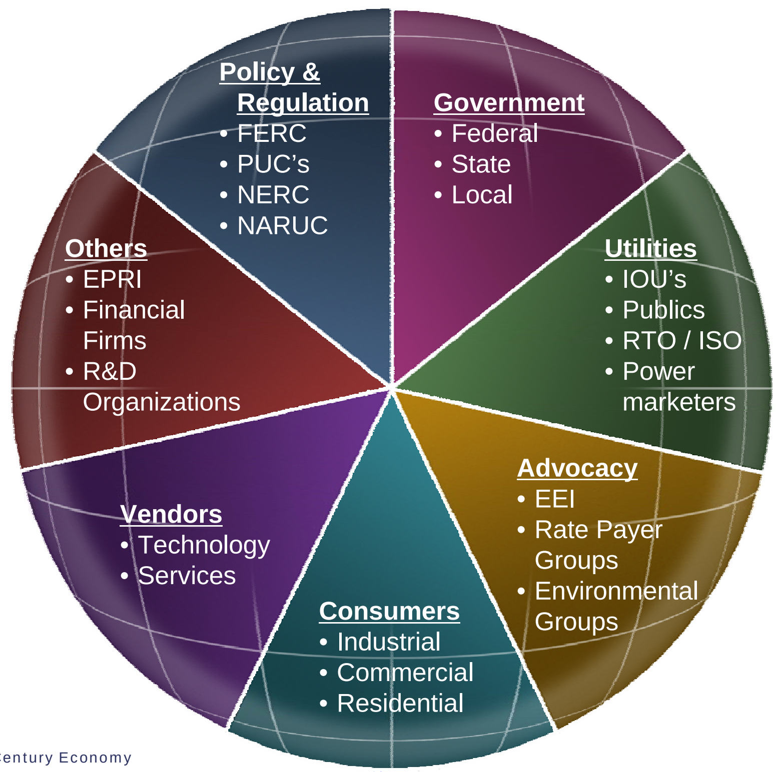

Developers of the Modern Grid

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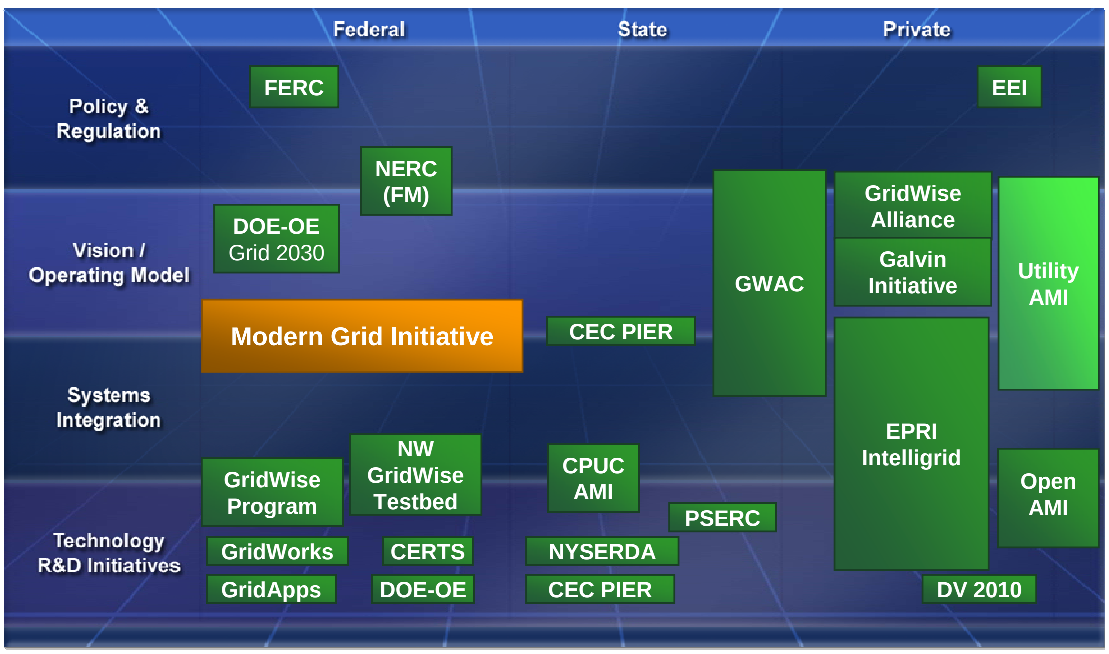

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Part III: Robust Trends

Problems and Needs

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Robust trends

- Reliability failures
- Generation mix movement
- Market movement
- GDP losses – 40% premium on electricity paid by consumers
- Cannot get over the deployment hump
- Renewables growth
- 12M DG poised for grid influence
- Loss of skills and experience
- Grid divorce

– a response, not control, scenario

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Electric Infrastructure – Growing Crisis?

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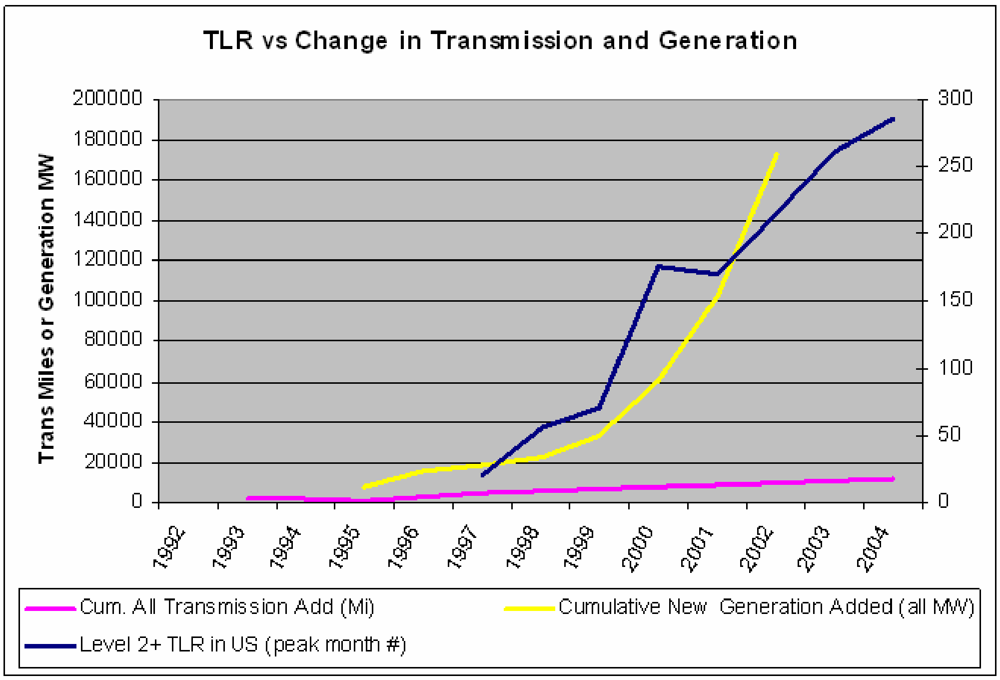

Transmission problems rocketed when generation additions outdistanced transmission additions.

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Generating Nodes on the Grid

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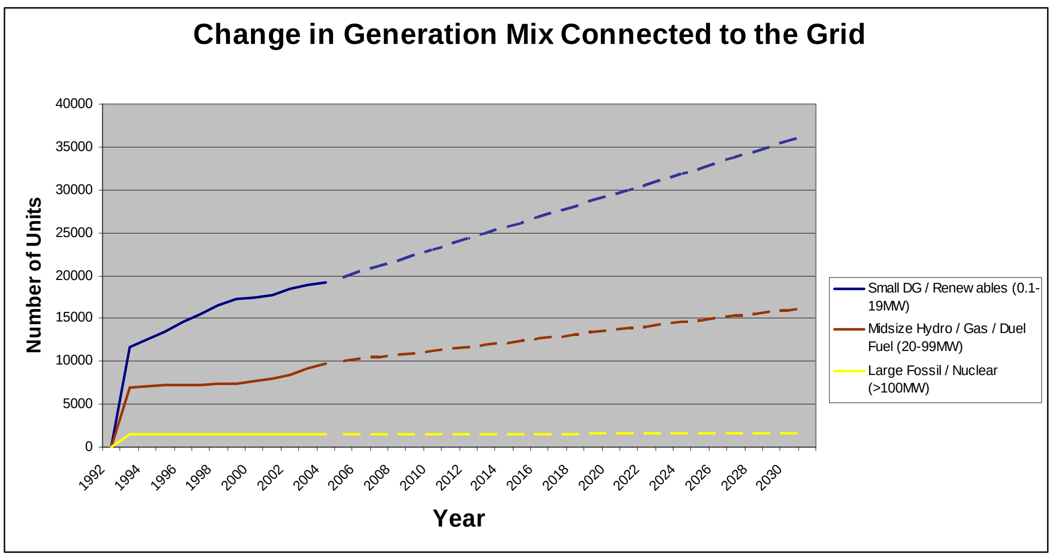

Exponential increase

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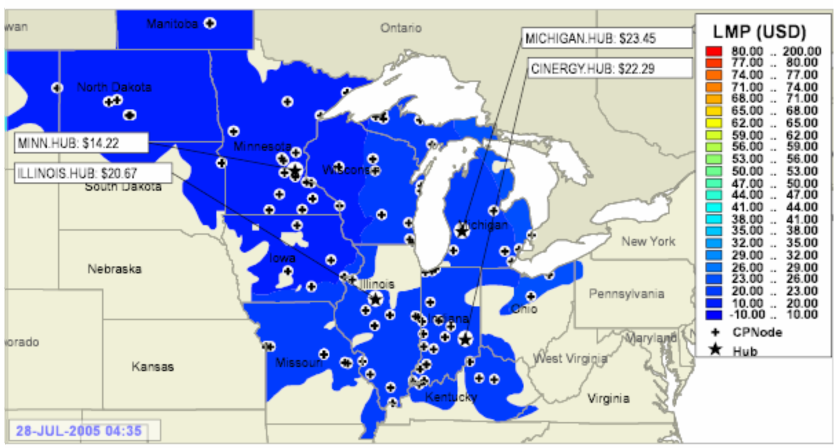
Electricity Market Paradigm Shift



Annual Business Losses from Grid Problems

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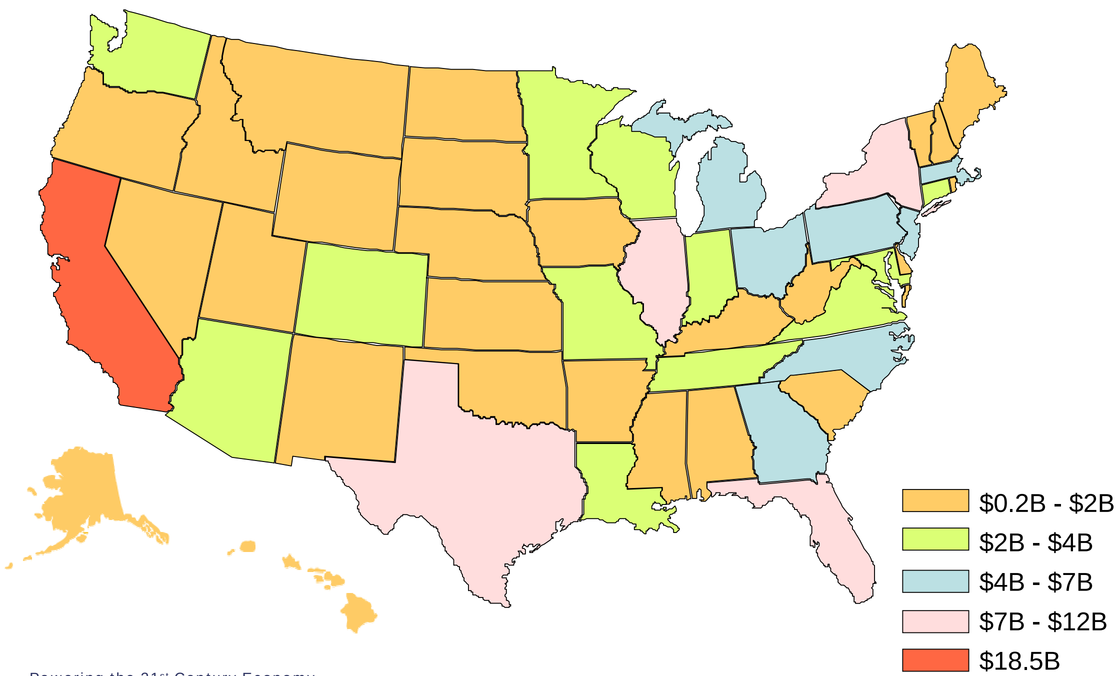
Primen Study: $150B annually for power outages and quality issues



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Do we have "Pilot-itis"?

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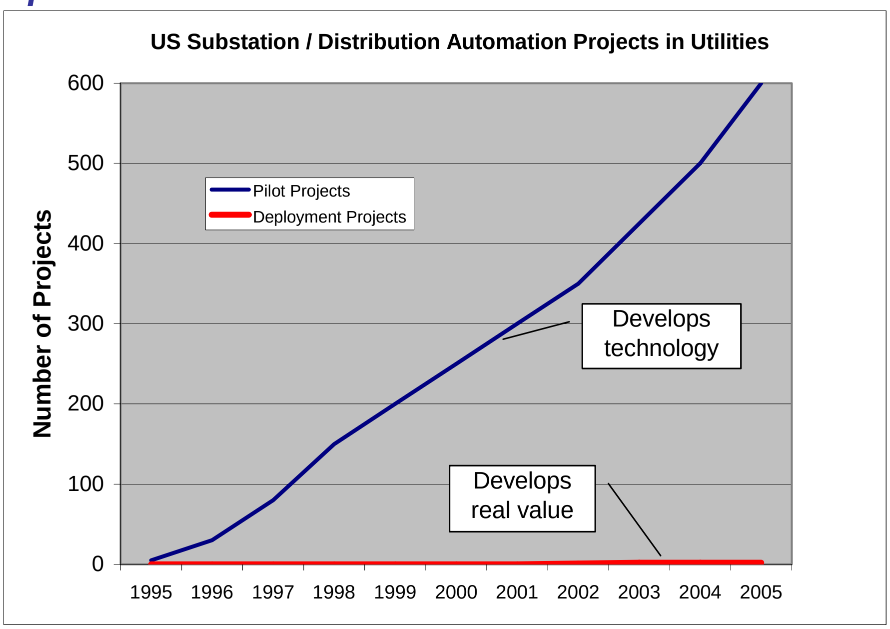
Example:



Pilot = <5% deployment into the field (substations and feeders).

Deployment = >25% deployment into the field.

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Power Industry Loss of Skills and Experience

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- Utility downsizing has reduced senior staff
- Experienced staff in the power industry is aging
- Enrollment in power engineering at universities is small
- Complexity of modern grid requires skills in advanced power system and IT
- Perceived value of technical skills has been reduced over the past 15 years
- Fundamental understanding of the power systems has been replaced by advancements in technology

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Part IV: Systems Perspective of the Modern Grid

Systems Perspective of a Modern Grid

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- A fully modern grid will be broadly judged by its reliability, security, safety, quality and cost of service to the consumer, and by its impact on the environment and economy
- These key goals, or success factors, must be evaluated with respect to a variety of power system conditions and processes
- It is from this interdependency of goals that the "systems view" of the Modern Grid forms

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“Systems View”

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The “Systems View” perspective takes a holistic and objective approach to a subject, including technical, economic, regulatory, political, and societal aspects. It includes the complete recognition of the power system as one integrated machine having many interdependent parts, a recognition that solutions can come from a wide and diverse range of sources, the desire to identify key ingredients needed to reach the desired end state and to develop those ingredients in the right sequence, and a development approach that optimizes the total system rather than the individual parts. A “Systems View” also takes account of the full range of costs and benefits to society associated with the provision of reliable power.

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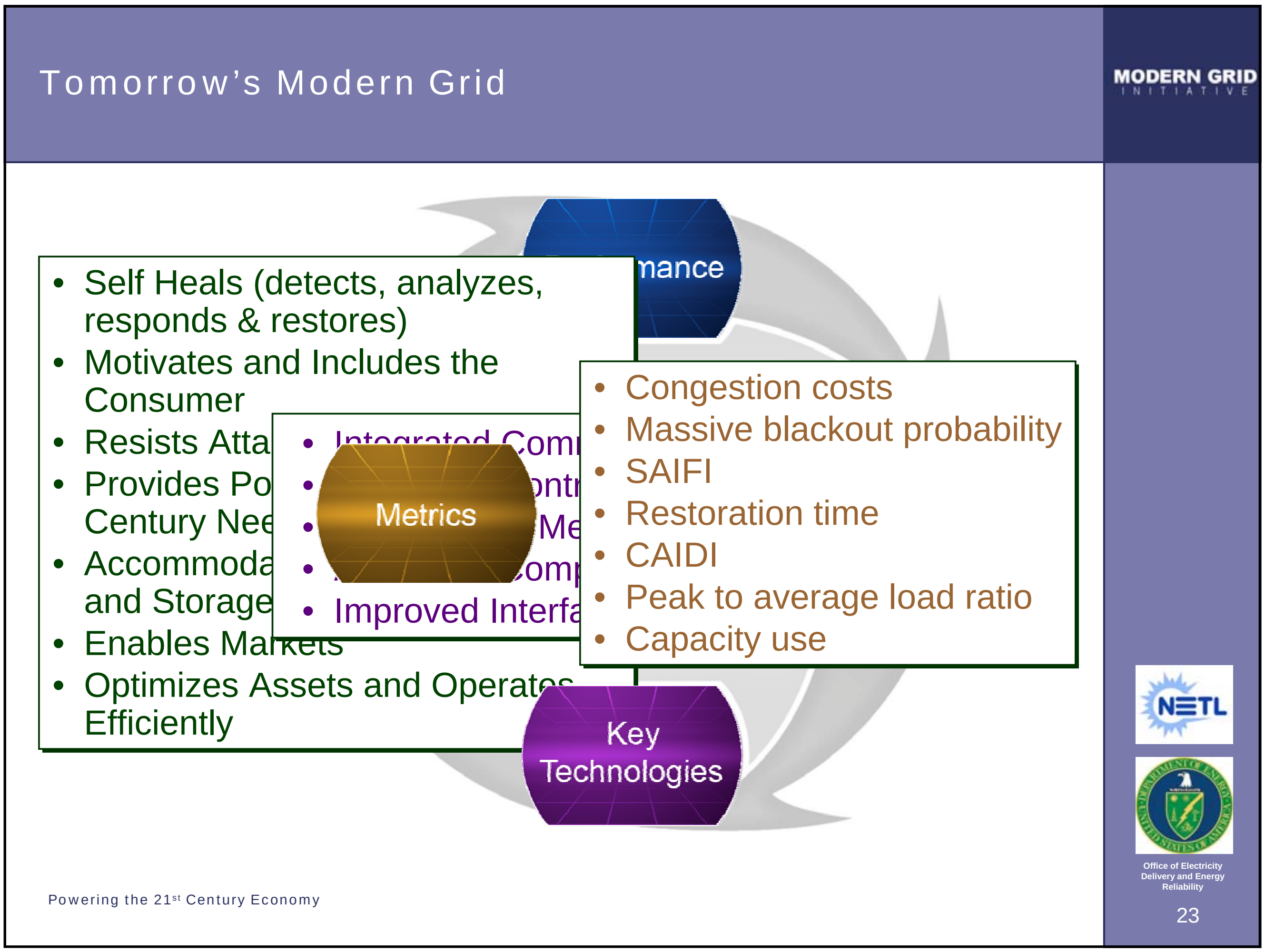

Tomorrow's Modern Grid
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mance
• Self Heals (detects, analyzes, responds & restores)
• Motivates and Includes the Consumer
• Resists Atta
• Provides Po Century Nee
• Accommoda and Storage
• Enables Markets
• Optimizes Assets and Operates Efficiently
Metrics
• Improved Interfa
• Congestion costs
• Massive blackout probability
• SAIFI
• Restoration time
• CAIDI
• Peak to average load ratio
• Capacity use
Key Technologies
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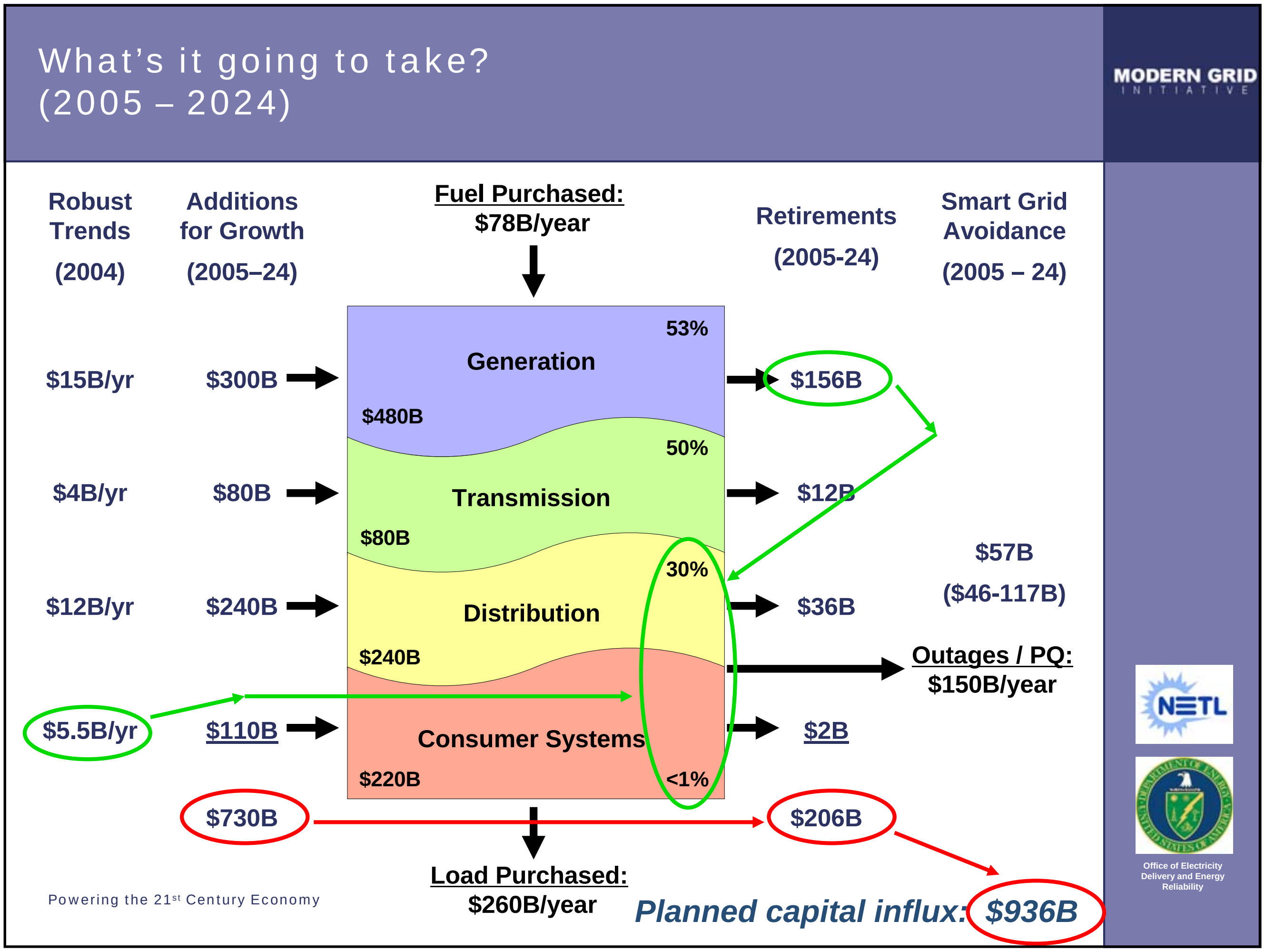
Part V: Can We Afford the Modern Grid?

Yet another Systems View…..



What's it going to take?
(2005 – 2024)
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Robust Trends
(2004)
Additions for Growth
(2005–24)
Fuel Purchased:
$78B/year
Retirements
(2005-24)
Smart Grid Avoidance
(2005 – 24)
53%
Generation
$15B/yr
$300B
$156B
$480B
50%
$4B/yr
$80B
Transmission
$12B
$80B
$57B
($46-117B)
30%
$12B/yr
$240B
Distribution
$36B
$240B
Outages / PQ:
$150B/year
$5.5B/yr
$110B
Consumer Systems
$2B
$220B
<1%
$730B
$206B
Load Purchased:
$260B/year
Planned capital influx: $936B
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