MODERN GRID
STRATEGY

Smart Grid Revolution?

ACI Revolutionizing the Smart Grid

Presented by Steve Pullins, Modern Grid Team

May 2009

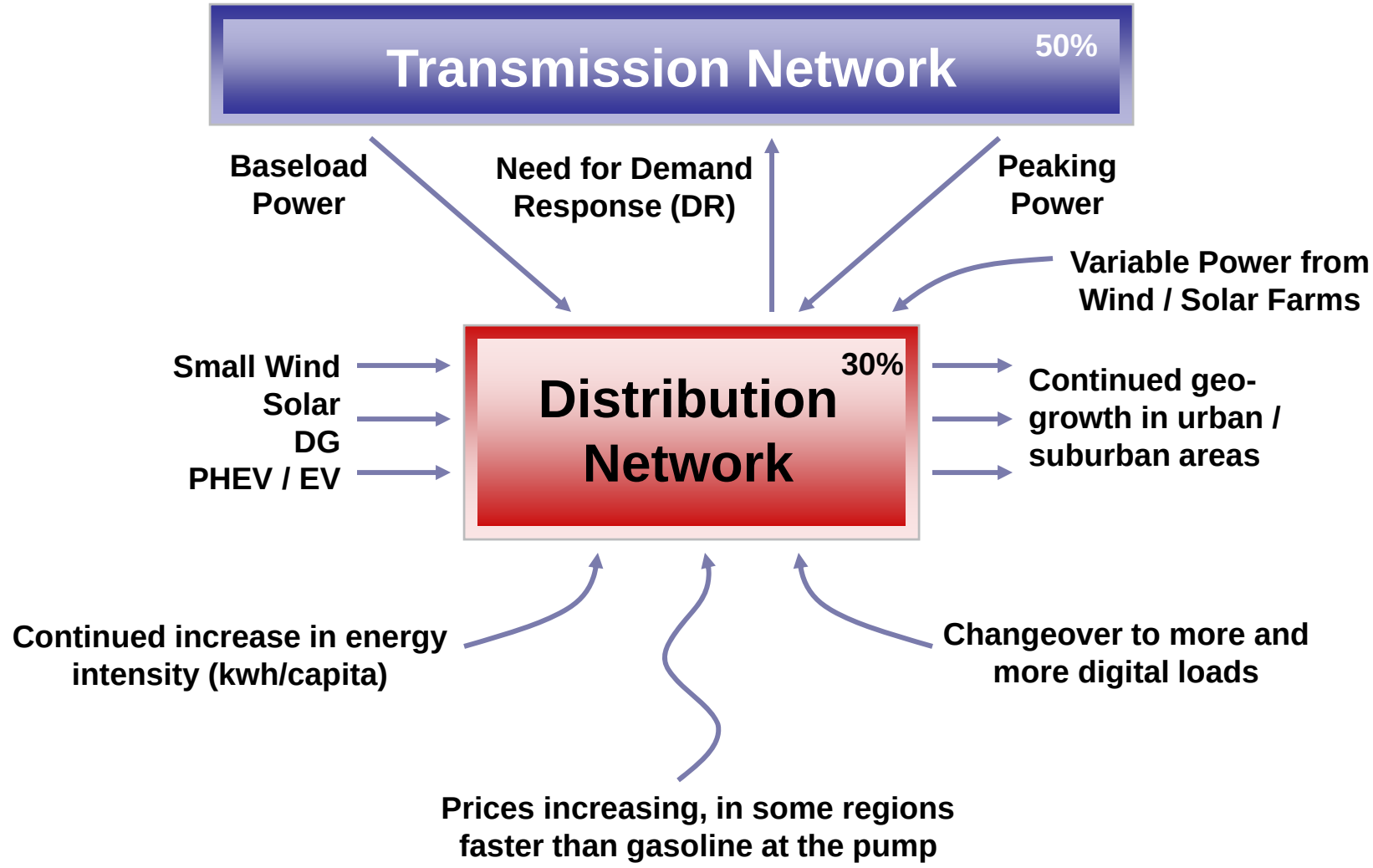
Funded by the U.S. Department of Energy,
Office of Electricity Delivery and Energy Reliability

Conducted by the National Energy
Technology Laboratory

This material is based upon work supported by the Department of Energy under Award Number DE-AC26-04NT41817

Office of Electricity
Delivery and Energy
Reliability

Stressing the System - Change



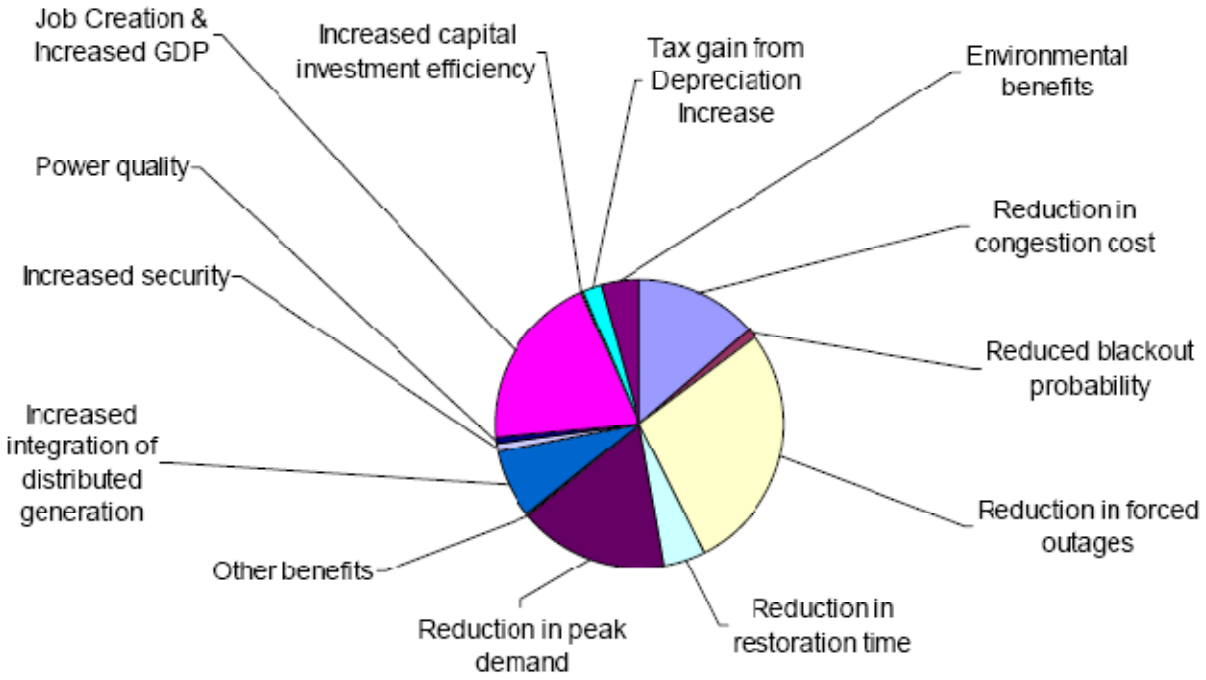
Office of Electricity Delivery and Energy Reliability

Result – Sea Change in the Network

- **Consumer engagement with resources to solve power issues locally**
- **Two-way power flow in Distribution**
- **As prices increase, local renewables will increase in residential, commercial, and industrial**
- **Imperative to transform from passive to active control in Distribution**
- **New ways for Distribution to become a Transmission resource**

Office of Electricity
Delivery and Energy
Reliability

Benefits of Transforming (San Diego Example)



Regional
"IRR" >26%

"Based on the cost-benefit analysis conducted for this study, there appear to be sufficient benefits to the utility system, to the broader region (societal), and in total, to justify a movement of the San Diego regional grid to a Smart Grid architecture." *- Bottom Line from San Diego Smart Grid Study, October 2006*

Total Annual Benefits	$141M
System Benefits (20-years)	$1,433M
Societal Benefits (20-years)	$1,396M
Total Capital Cost	$490M
Annual O&M Cost	$24M

NETL
Office of Electricity Delivery and Energy Reliability

Investment Winners

- **Technologies that enable two-way power flow control**
- **Technologies that ease the consumer integration to grid operations**
- **Technologies that accommodate, offset, or manage the exponential operational complexity coming**
- **Technologies and strategies that enable safely operating closer to design limits**
- **Technologies that enable better, cheaper sensing of all the above**
- **Broadband, secure, robust, wireless communications infrastructure for all the above**

Office of Electricity
Delivery and Energy
Reliability

Needed Investment in Technology

Things	Applications	Strategies
Storage Devices	**Advanced Control of DG**	**Microgrids / Cell Control**
Current Limiters	**Two-way Power Flow Control**	**Wind – CHP**
Low-Cost Sensors	**Interoperability Tools**	**Prices to Devices**
Smart Loads	**Vehicle to Grid Tools**	**DER for Peaking**
Stable DG Biofuels	**Consumer to Grid Tools**	
Clean Coal CHP	**Condition-Based M&M**	
WiMAX	**Home Area Networks**	
	Terabyte Data Mgmt	

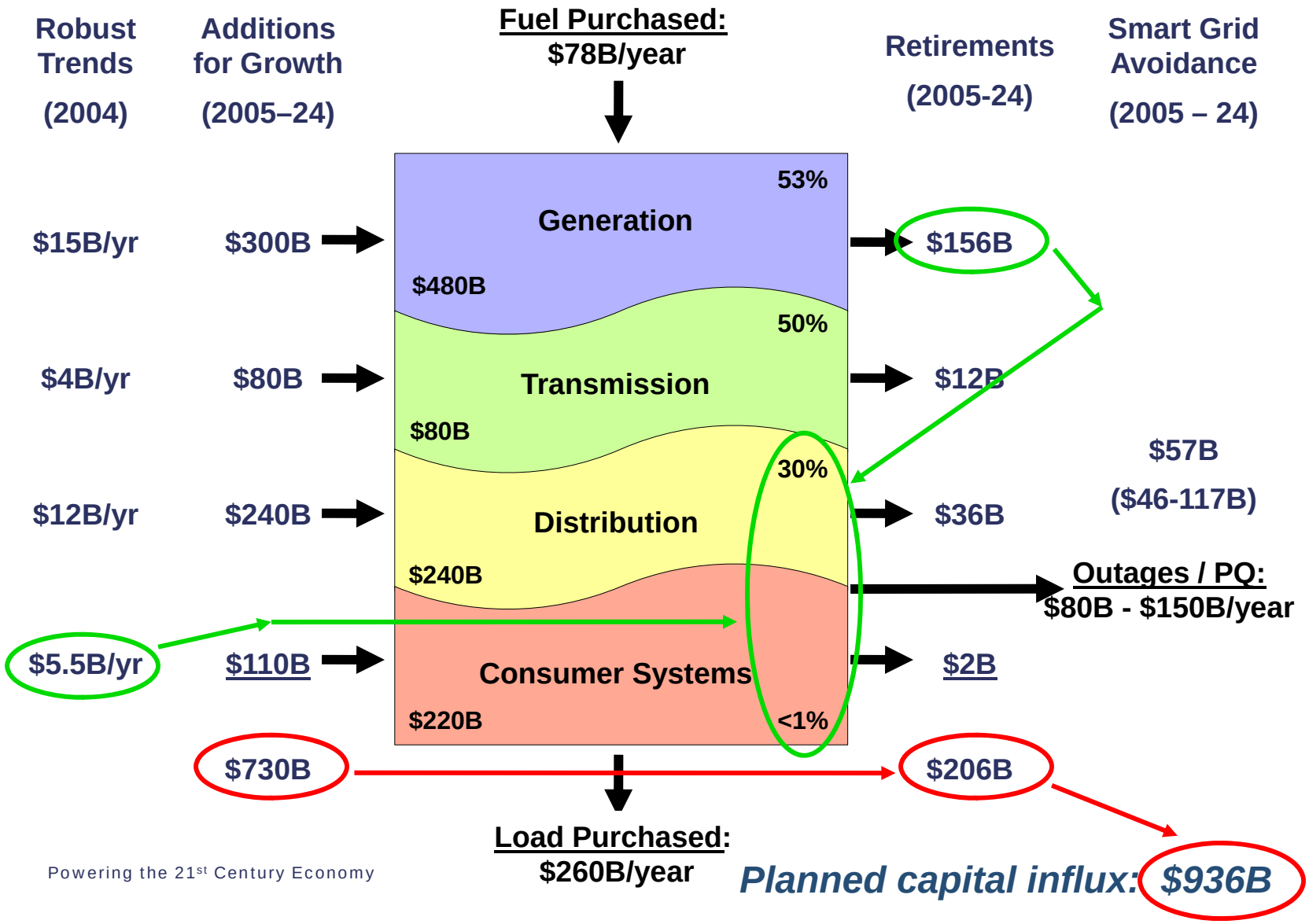
NETL
Office of Electricity Delivery and Energy Reliability

McAdams Second Theorem:

Nothing is impossible which is currently taking place.

The Financial Electric System

MODERN GRID STRATEGY



Powering the 21st Century Economy

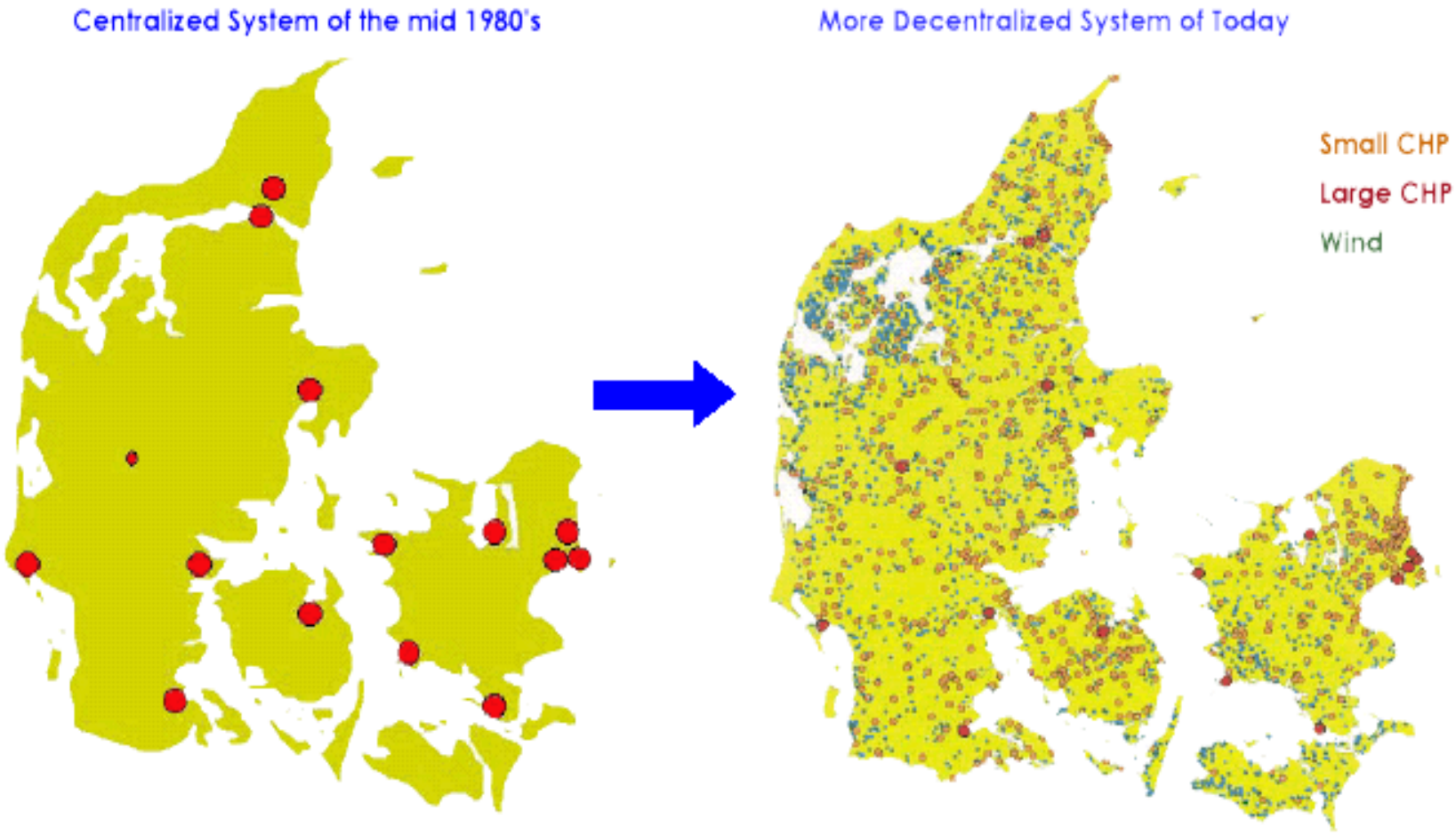
Office of Electricity Delivery and Energy Reliability

MODERN GRID
STRATEGY

Transforming the Grid:
Utilities making a difference in reliability and economics

McAdam's Second Theorem: Nothing is impossible which is currently taking place.

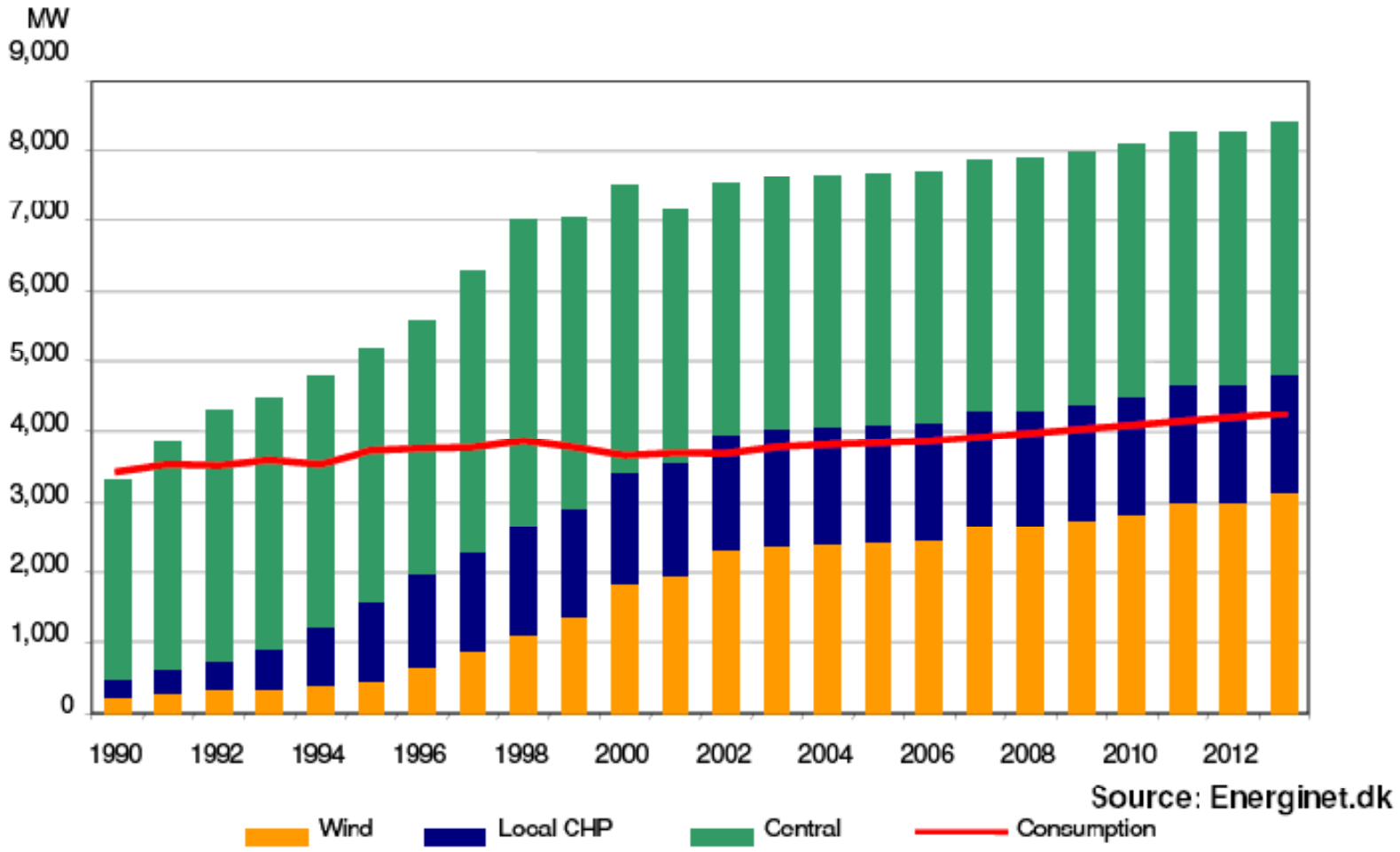
Denmark Changed in Two Decades



Source: Danish Energy Center

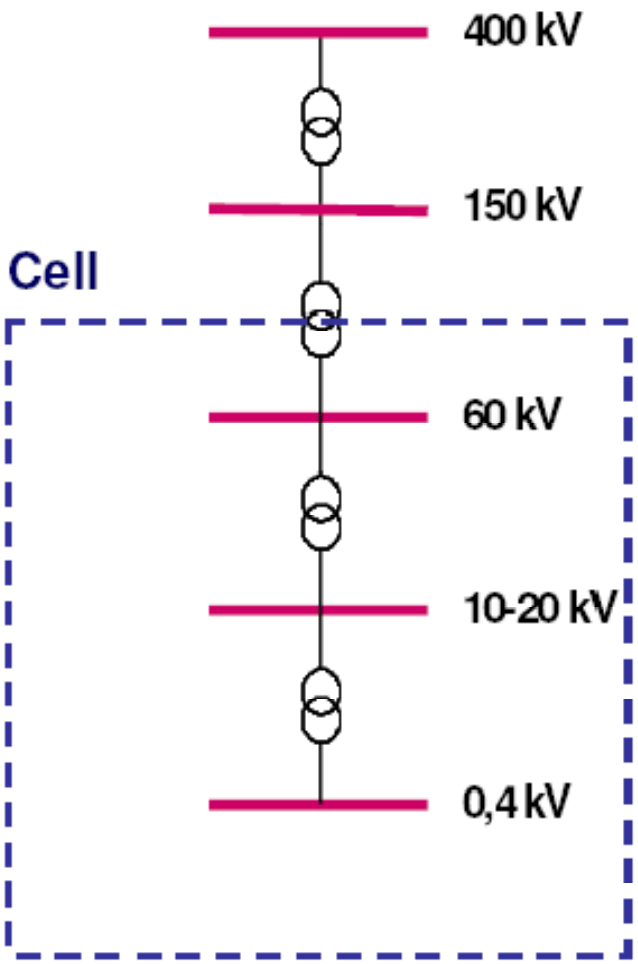
Office of Electricity
Delivery and Energy
Reliability

Denmark Energy Contribution



Office of Electricity
Delivery and Energy
Reliability

Denmark DG Penetration and Cell Structure



4 central CHP units (1488 MW)

6 central CHP units (2014 MW)
Horns Rev offshore wind farm (160 MW)

17 dispersed CHP units (569 MW)
34 wind turbines (41 MW)

475 dispersed CHP units (991 MW)
2180 wind turbines (1597 MW)

260 dispersed CHP units (83 MW)
1860 wind turbines (576 MW)

Office of Electricity
Delivery and Energy
Reliability

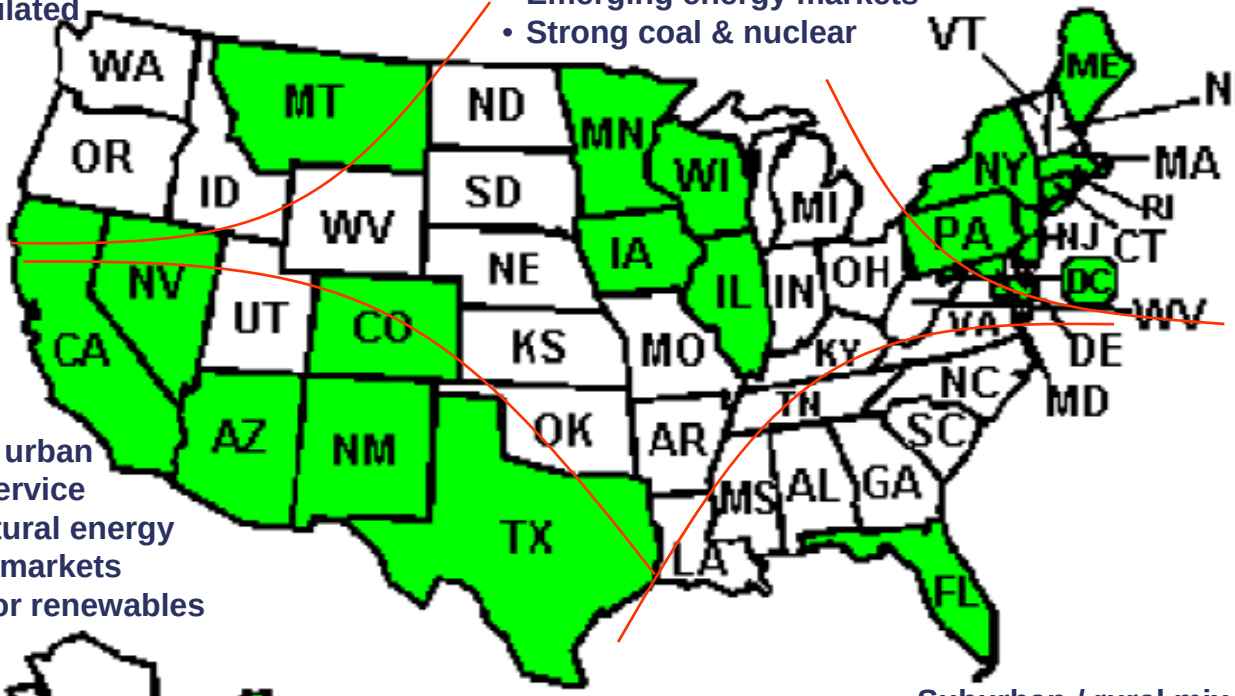
Unique Regions (Summary of MGI Summit Feedback)

MODERN GRID STRATEGY

- Suburban / rural mix
- Much natural energy
- Growing green energy policy
- Large hydro resources
- Strongly regulated

- Vast rural regions
- Heavy industry
- Good wind resource
- Emerging biofuel focus
- Emerging energy markets
- Strong coal & nuclear

- Dense urban
- Heavy commercial
- Little natural energy
- Active energy markets
- High cost of service



- Dense coastal urban
- High cost of service
- Significant natural energy
- Active energy markets
- Strong push for renewables

- Energy islands
- Much natural energy
- Strongly regulated

- Suburban / rural mix
- Warm climate
- Little natural energy
- Strongly regulated
- Large coal & nuclear focus

NETL

Office of Electricity Delivery and Energy Reliability

Big Picture

A strategy is needed that will:

- **Reduce dependency on foreign energy sources (not just oil)**
- **Reduce dependency on low asset use**
- **Increase reliance on systems and programs that reduce peak demand**
- **Increase reliance on active control to operate closer to design capacities for large capital assets**
- **Increase reliance on scalable, interoperable solutions leading to a plug 'n' play environment**
- **Increase use of portfolio strategies in generation, delivery, and end use to hedge against surprises**

The increases in costs and prices we are seeing are not temporary.

Office of Electricity Delivery and Energy Reliability

Smart Grid Characteristics

- *Enable active participation by consumers*– **Active consumer participation brings tangible benefits both to customer and overall system reliability.**
- *Accommodate all generation and storage options* **– Seamlessly integrate many types of generation and storage.**
- *Enable new products, services and markets*– **Provide detailed awareness of the factors that affect supply and demand in markets.**
- *Optimize asset utilization and operate efficiently* **– To deliver desired functionality at minimum cost.**
- *Provide power quality for the digital economy*– **Provide the quality of power required by today's users.**
- *Operate resiliently against attack and natural disaster*– **Security requires a system-wide solution that will reduce vulnerabilities and recover rapidly.**
- *Anticipate & respond to system disturbances (self-heal)* **– The modern grid will perform continuous self-assessments to detect, analyze, and respond to restore itself.**

Office of Electricity Delivery and Energy Reliability

Contact Information

For additional Information, contact

Modern Grid Strategy Team

http://www.netl.doe.gov/moderngrid/

304-599-4273 x101

Office of Electricity
Delivery and Energy
Reliability