Distributed Energy

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Presentation for:

Post Petroleum Energetics Conference/Workshop

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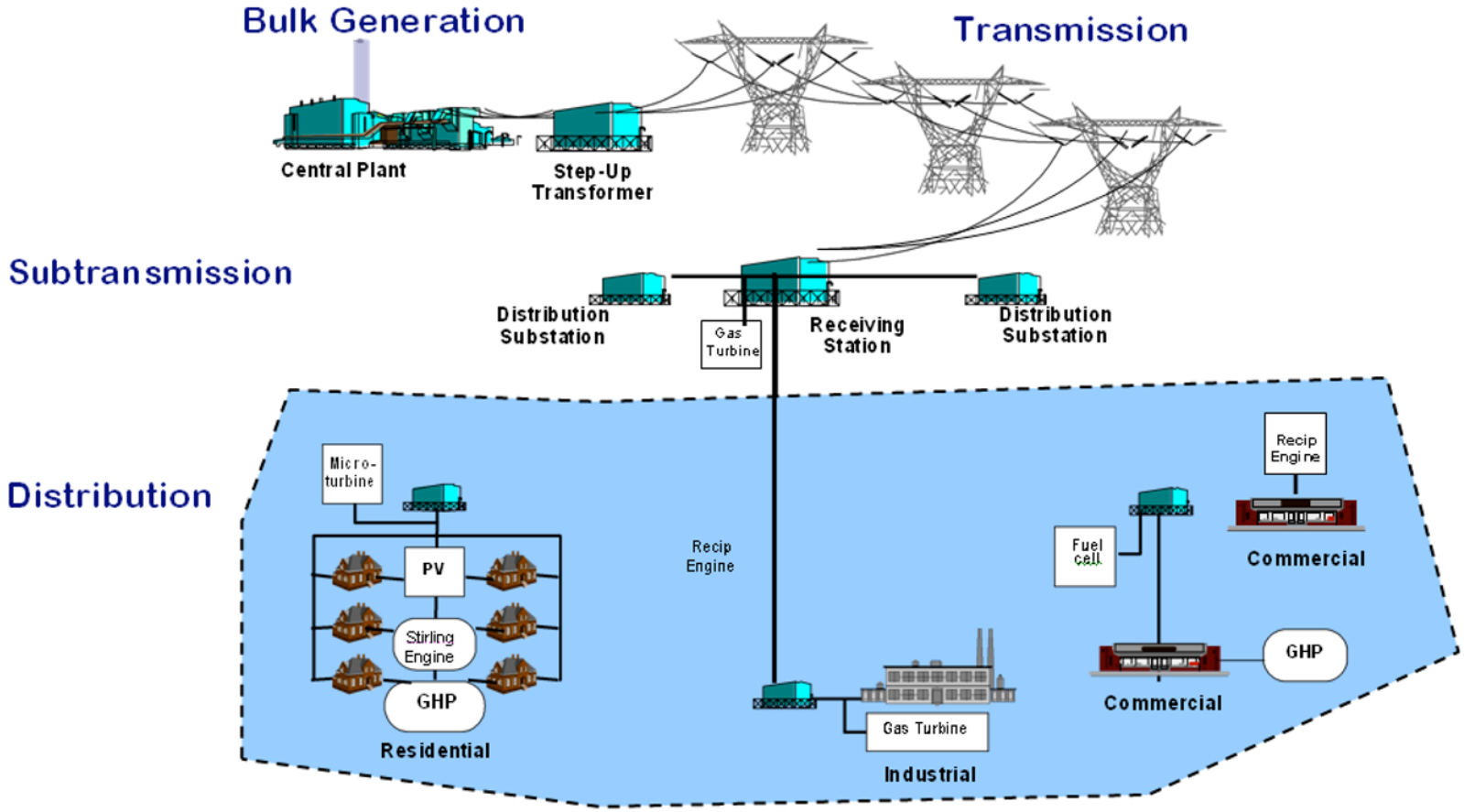
Managed by UT-Battelle
for the Department of Energy

OAK RIDGE National Laboratory

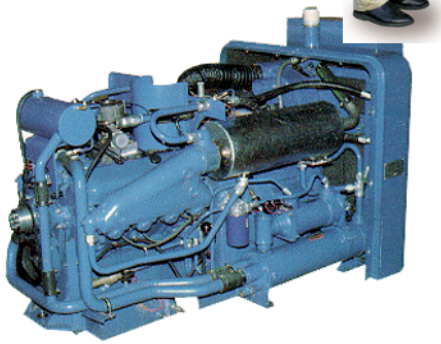
What is Distributed Energy?



Distributed energy is power generated (and often heat captured) at the point of use.

Distributed Energy Includes:

- **Electric Generation Equipment**
  - Reciprocating Engines
  - Turbines / Microturbines
  - Fuel Cells
  - Renewable Resources
- **Heat Recovery Systems**
  - Hot Water
  - Steam
  - Exhaust Gases
- **Thermally Activated Technologies**
  - Absorption Chillers
  - Desiccant Dehumidification
  - Thermal Storage



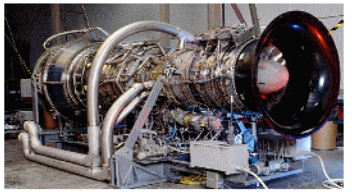
Advanced Prime Mover Status:

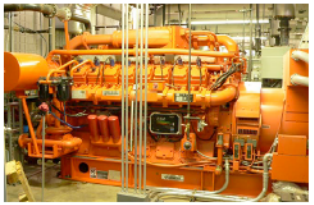
Efficiency and durability have been improved, but

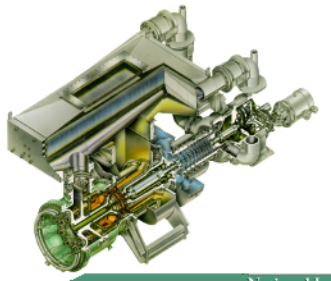
Applications and regulators "raise the bar"

- **CARB2007 emissions not achieved**
  - **but is only a point in time**
- **Storable fuels for disaster mitigation and remote sites**
- **Renewable fuels to capitalize on "free" fuel**
- **Improving electrical efficiency**







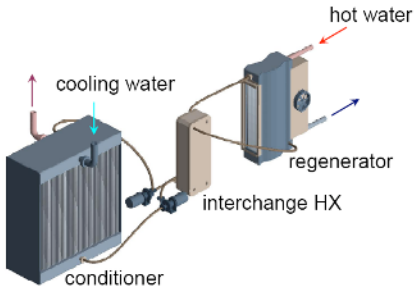


Thermal Technology Status

Long used for industrial applications and district heating

New era for compact, effective thermal devices

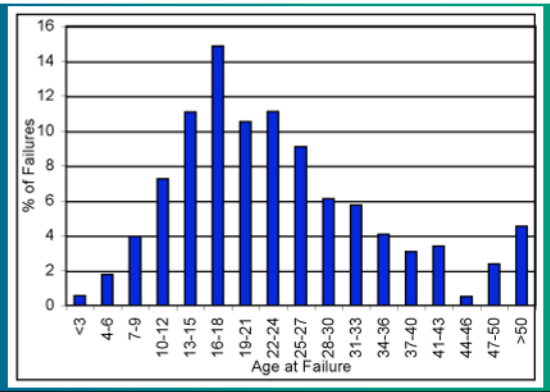
- Design for integration rather than adapt for integration
- Higher electrical efficiency means less waste heat, at lower temperature
- Widening application space: residential to industrial



Energy Reliability and the State of the Electric Grid: Aging Infrastructure &Congestion Impact Reliability

Aging Infrastructure

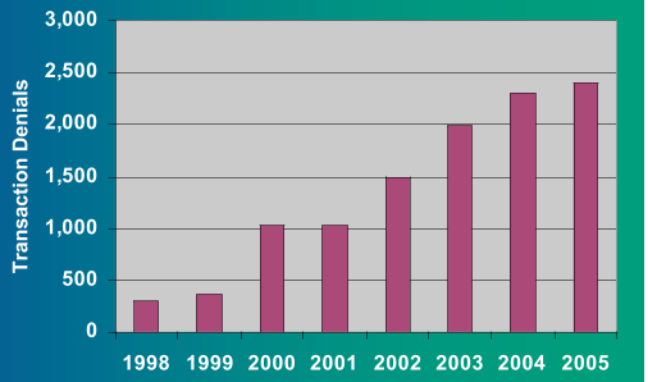
- Century old technology
- National Security issues
- $330B industry
- Estimated $100B to modernize



	Voltage Range (kV)	Power Range (MVA)	Number	Avg. Age
Large	115-765	100-1,200	5,000	40+
Medium	65-345	10-100	110,000	35+
Small	35-245	1-10	65,000	25+

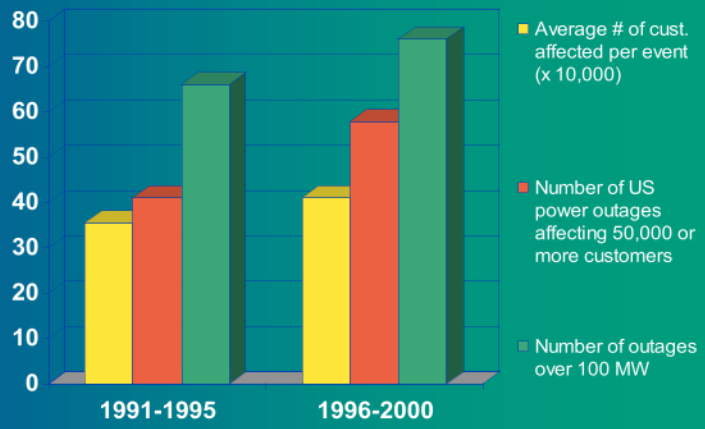
Increasing Congestion

- More expensive generators used
- Market transactions increasing



Reliability

- Customer outages significant
- Outages Average 100 – 220 min/ yr
- Impact as high as 40% of annual revenues



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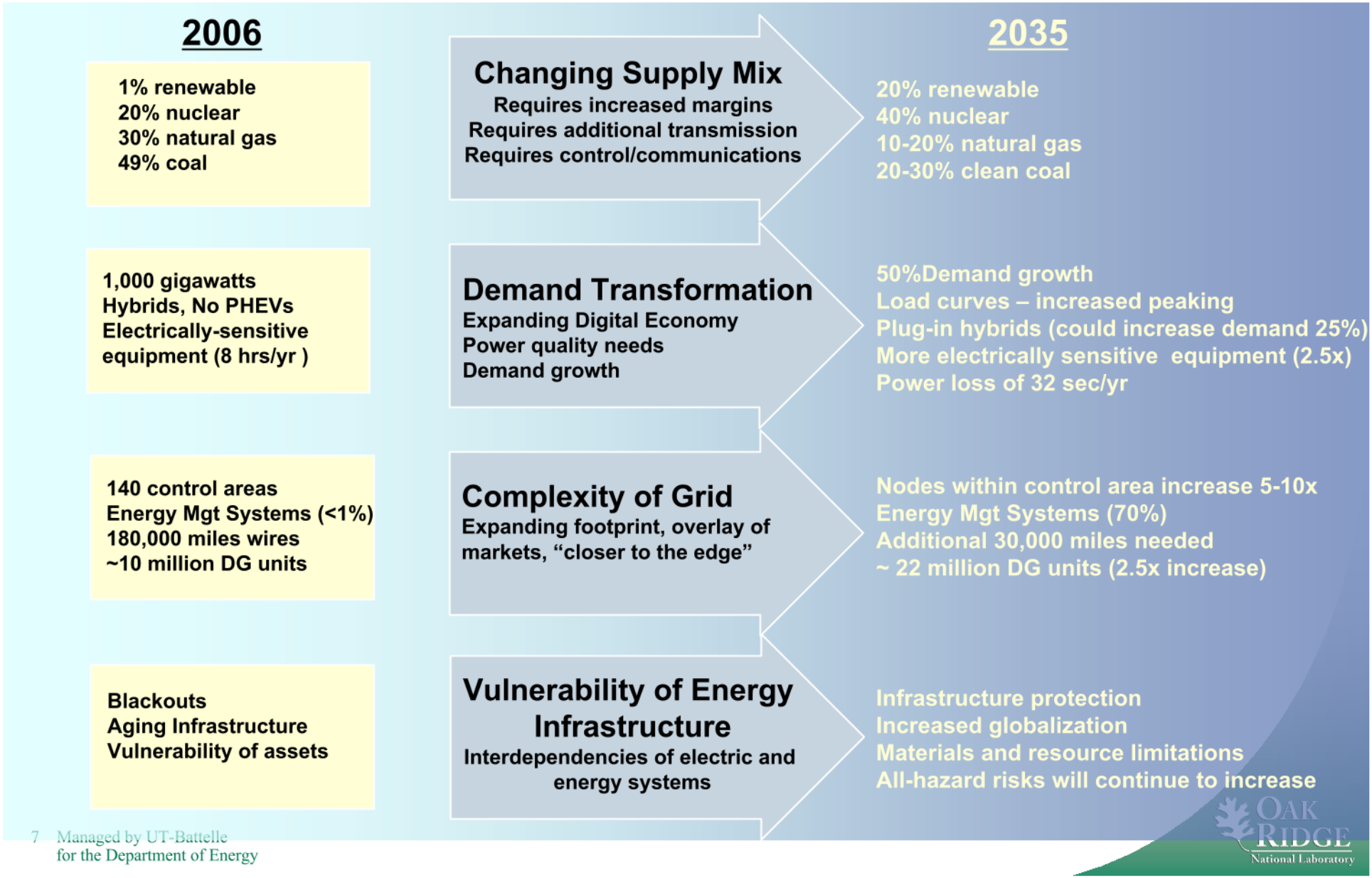
The grid faces additional challenges



Local Voltage Control Can Be Supplied by Distributed Energy to Improve:

- Power quality by correcting unbalance and harmonics.
- Load efficiency by controlling voltage to the optimum level for efficiency
- Distribution efficiency by reducing losses.
- Reliability by increasing the margin to voltage collapse.
- Transfer capability, decrease congestion, and lower prices.

Distributed Generation is Already in Place

- **Distributed Power Units in Lower Manhattan, September 2001**
  - **Grid Support**
- **Reduced Operating Costs at Ft. Bragg**
  - **5 MW turbine integrated with 1,000 Refrigeration Ton waste-heat chiller and HRSG**
  - **Supervisory control system developed to optimize cost using time of day pricing**
  - **Provision of reliable power to base**

Energy Reliability

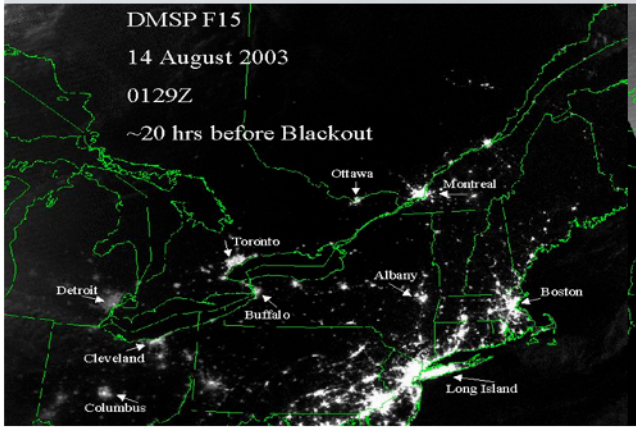
Energy Security

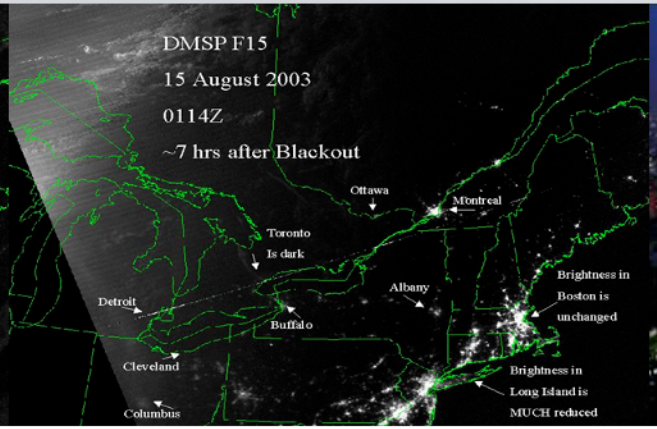
Energy Efficiency

Economic Development

Environmental Stewardship

Distributed Energy Benefits





Benefits of Distributed Energy

Energy Reliability

1. Improved power quality
2. Business continuity
3. Reduced grid congestion
4. End-of-the-wire supply
5. Short lead-time, off-the-shelf, modular technology

Energy Security

6. Reduced system vulnerability
7. Disaster Mitigation
8. Disaster Recovery

Energy Efficiency

9. Improved fuel efficiency (fuel economy)
10. Optimized use of scarce natural gas resources
11. Eliminates line losses

Economic Development

12. Lower cost for new electricity than new central generation and T&D
13. Improved energy cost predictability
14. No ratepayer investment required (generation or T&D)
15. Creates new high-tech manufacturing sector, domestic and export
16. Creates local jobs for installation, operation and maintenance
17. Supports competitive electricity market structure

Environmental Stewardship

18. Reduced emissions per unit of useful output
19. Reduces land-use impacts and NIMBY objections
20. Reduces fresh water use

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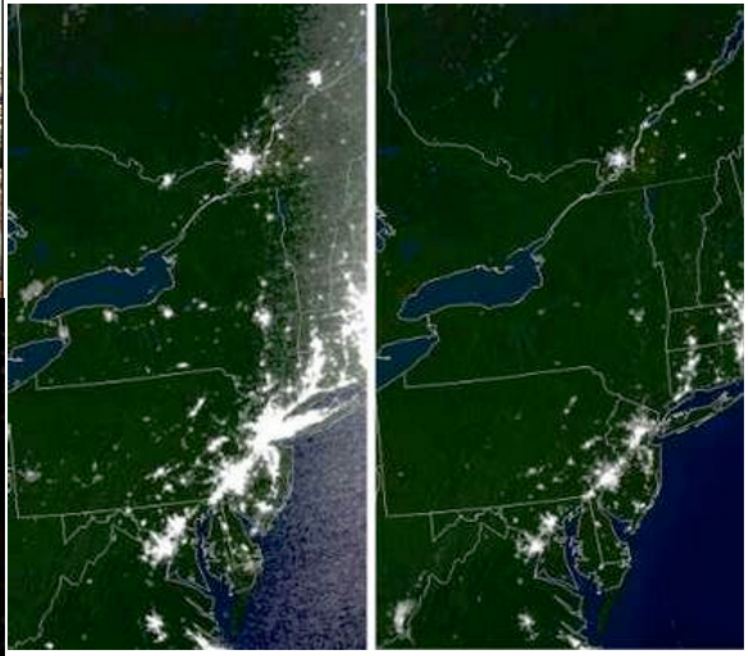
Energy Reliability

- Reliability problems come from the grid itself.
- Distributed energy does not require the grid.
- Distributed energy can, however, support the grid.

8/13/03 8/14/03



The August 2003 Blackout

Lessons Learned from August 2003 Blackout

- **Grid and population are vulnerable to large-scale disruption**
  - **50 million North Americans affected**
  - **Cell phones inoperable**
- **Cost as much as $6 billion NYC, NYSERDA and DOE post-blackout reviews:**
  - **Many emergency backup generators failed (e.g. for hospitals and communications)**
  - **CHP systems performed as designed**

Initial Report
by the
New York State
Department of Public Service
on the
August 14, 2003
Blackout

February 2004

U.S.-Canada Power System Outage Task Force

Final Report on the August 14, 2003 Blackout in the United States and Canada:

Causes and Recommendations

Canada

April 2004

With regularly used Distributed Generation, the lights and water stayed on…

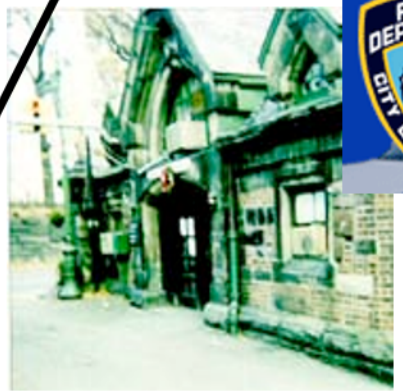
Health Care Facilities

Montefiore Medical Center, Bronx, NY

Botsford Health System Kidney Center Livonia, MI

Elderwood Healthcare - Oakwood Nursing Home Williamsville, NY

Public Services



Central Park Police Station

Britannia Water Treatment Plant Ottawa, Canada

Federal Facility

WestPoint Military Academy Residential Officer Housing

With Distributed Generation and Combined Heat and Power, manufacturing stayed on…

- Frito Lay Queens, NY
- Smoked Fish MFG, (Manhattan, NY) Saved > $300K
- Maple Lodge Farms Canada
- Oak Tree Farm Dairy (Northport Shore, NY)
- Entenmann's Bakery (Bay Shore, NY)

Conclusion on Reliability:

Distributed energy provides significantly greater reliability than central generation and T&D alone, and could prevent billions of dollars in outage losses every year.

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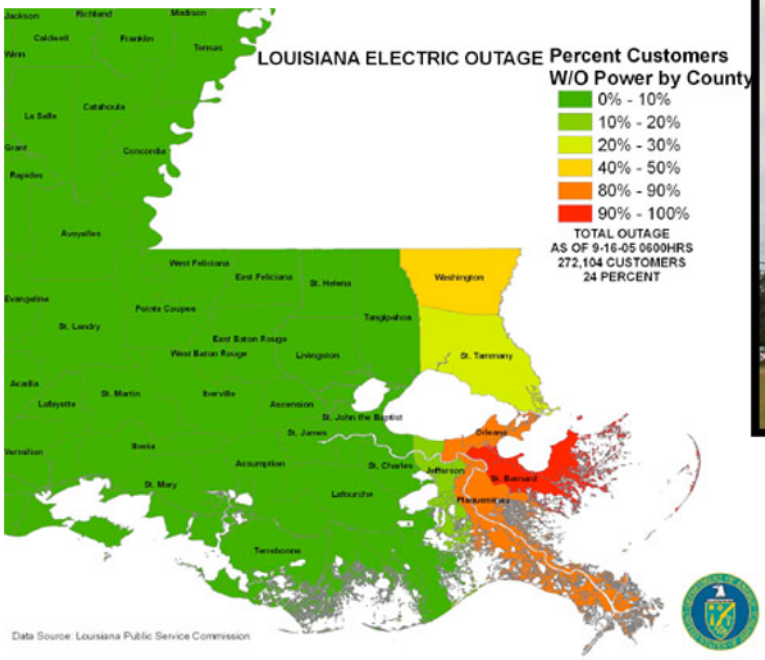
Energy Security: What Did We Learn from Katrina?



Baptist Medical Center, Jackson, Mississippi

- 624 bed hospital, 3,000 employees
- 3.2 MW gas turbine CHP system – installed 1994
- Steam regularly used for hot water, sterilization and absorption chillers

- Grid down for 52 hours starting August 29, 2005 due to Katrina
- Combined heat and power system ran islanded and provided power, hot water and air conditioning
- Baptist Medical Center remained nearly 100% operational; the only hospital in the area to do so

Conclusion on Security:

Distributed energy can keep critical health and emergency services functioning, along with vital public and economic functions, during a natural disaster or terrorist attack.

(Caveat: fuel supplies required!)

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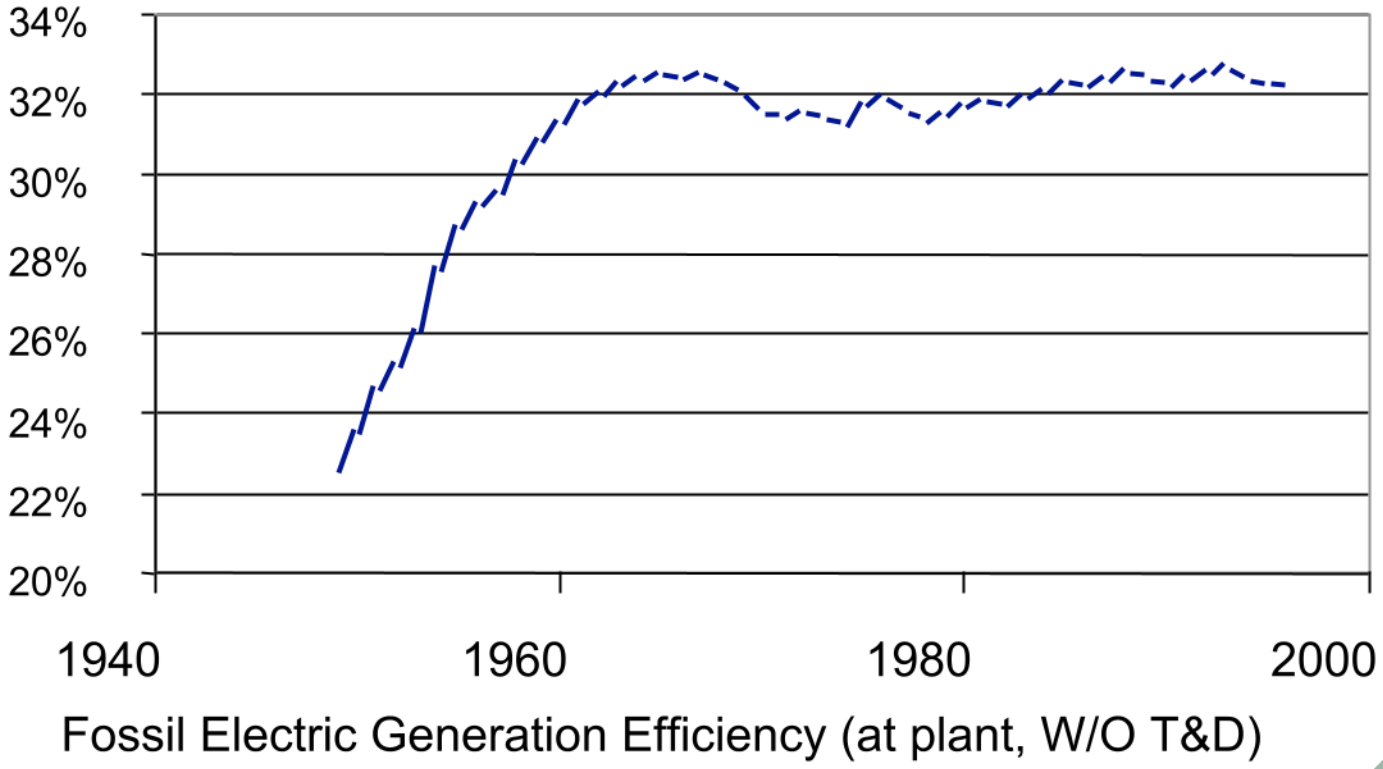
Energy Efficiency

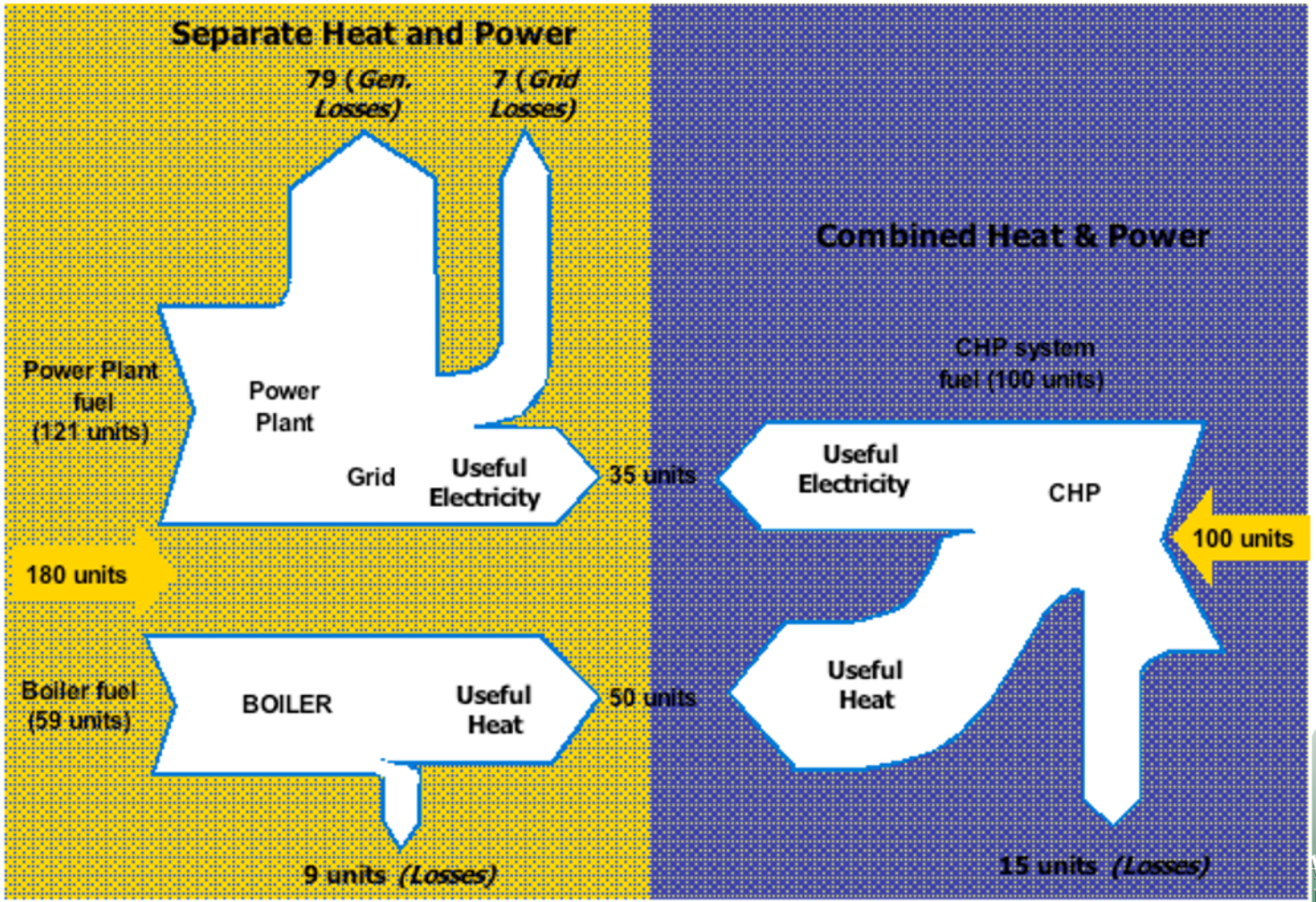
America's electric grid efficiency has stagnated at about 32% efficiency



Source: EIA, Annual Energy Review 1996

DE and Energy Efficiency

Distributed Energy as CHP more than doubles the electric grid's energy efficiency



Conclusion on Efficiency:

Distributed energy can cut fuel consumption per unit of output to half or a third of conventional usage, especially natural gas supplies now in heavy demand.

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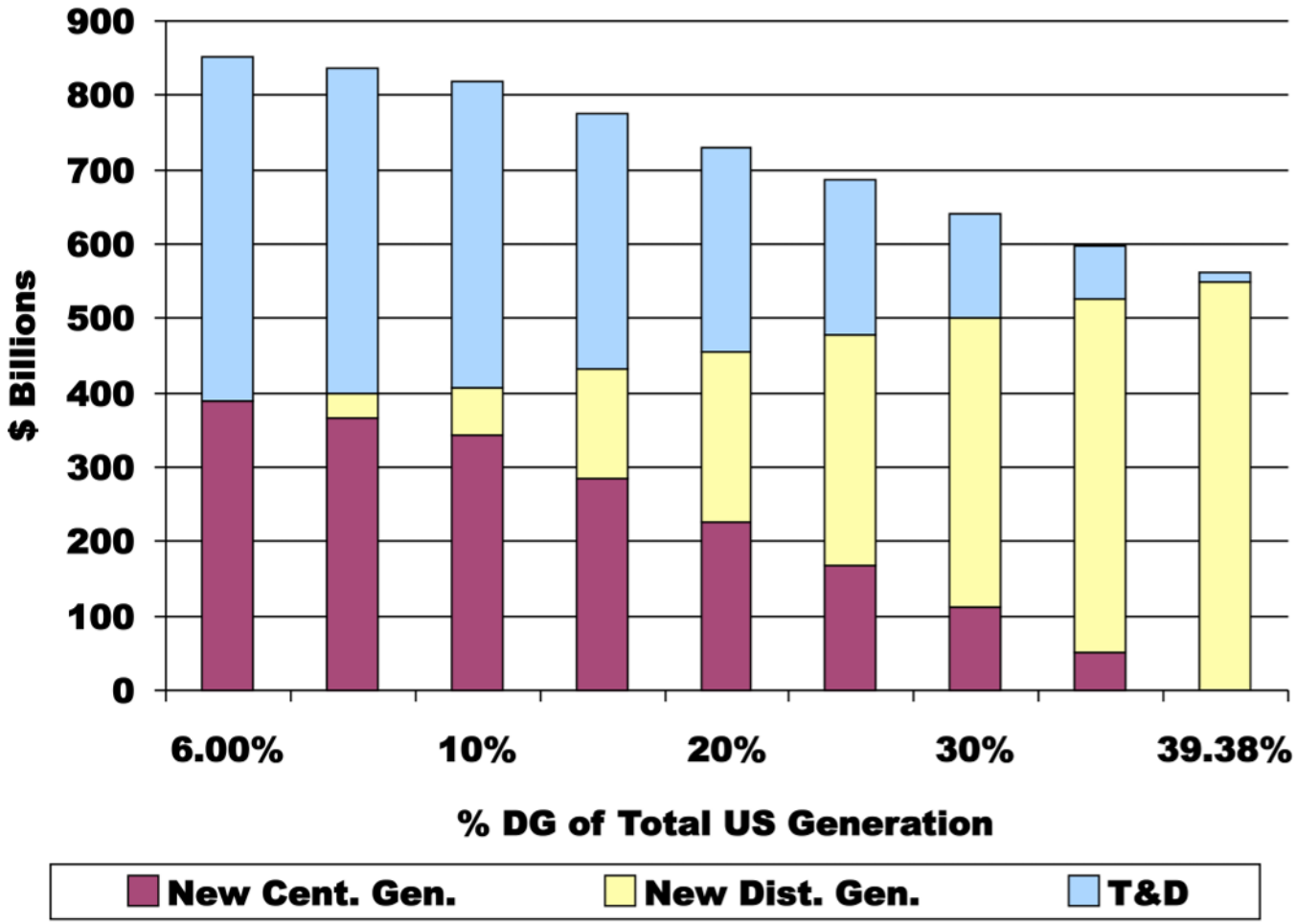
Distributed Energy Costs Less

The cost of meeting the need for new power in the U.S. in 2020:



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Environmental Stewardship

Environmental Stewardship = **Energy Efficiency**
Fuel Diversity
Distributed Energy

- Reduces greenhouse gases
- Reduces criteria pollutants
- Conserves fresh water
- Husbands fuel resources
- Ready for bio-fuels and bio-fuel creation processes
- Cuts land-use impacts and NIMBY problems

Why DG Isn't More Broadly Used: Only FOUR of the Twenty Benefits Accrue to the User

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Why DG Isn't More Broadly Used: The Others are PUBLIC Benefits

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Questions?