This Briefing is Classified

UNCLASSIFIED

Electric Energy Security in the Domestic Theater

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N-NC Energy Security WG
14 December 2009

Overview

- **Background**
  - **Development of the Electric Grid**
  - **Physical Characteristics**
  - **DOD Focus**
  - **Power Failures**
- **Engagement**
  - **Partners**
  - **Energy Initiatives**
- **Way Ahead**
  - **DOD and Electric Grid Security**

"Almost complete dependence of military installations on a fragile and vulnerable commercial power grid and other critical national infrastructure places critical military and Homeland defense missions at an unacceptably high risk of extended disruption."

- Defense Science Board, February 2008

Objective – Electric Energy Security

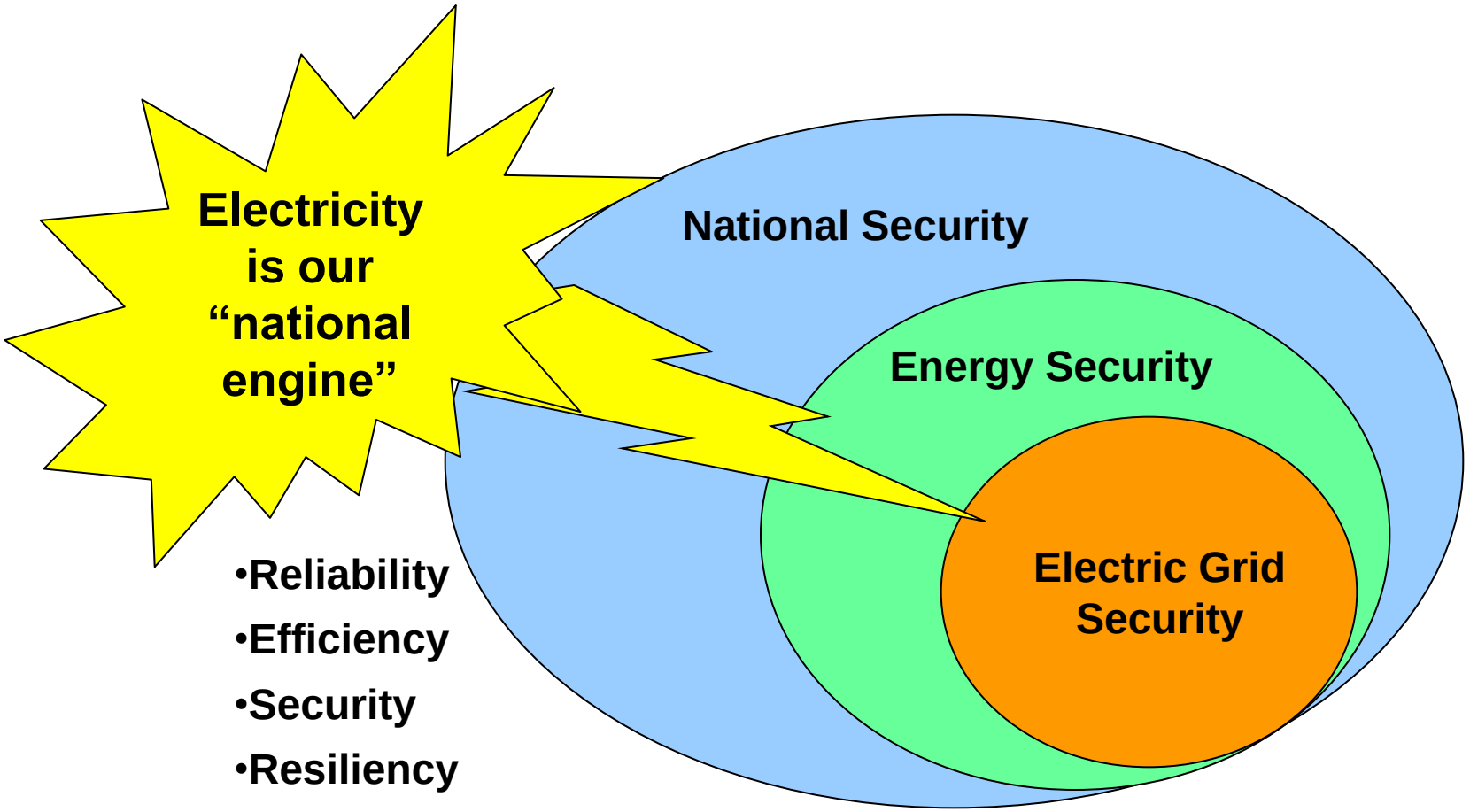
1. **Assured supply and availability of electrical energy.**

Our Focus

2. **Prevent unauthorized access affecting information, control, availability, and reliability of electric power.**

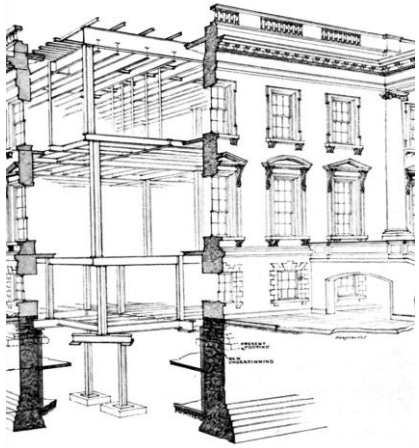
USNORTHCOM's unique focus is DOD mission assurance in the homeland

The National Engine

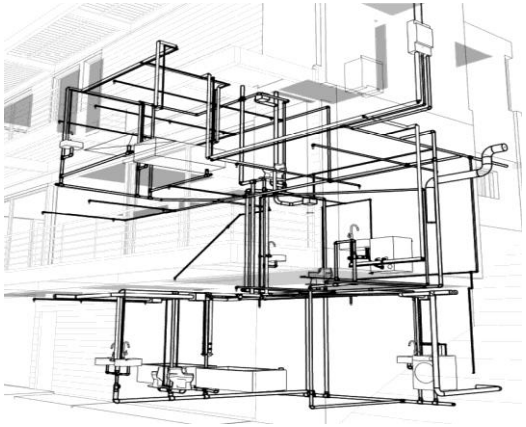


Electric Grid Development

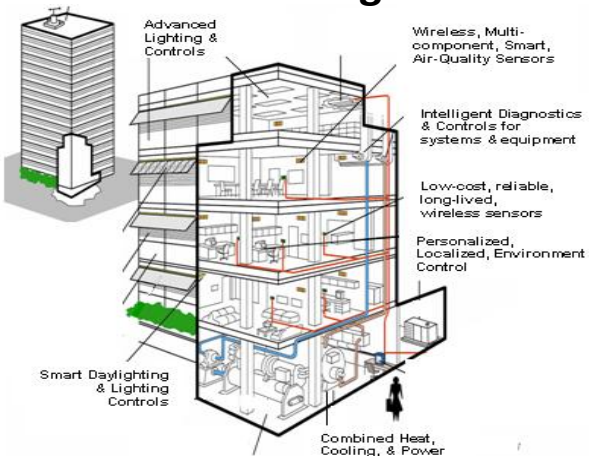
Early Urban Utilities; Like stand alone buildings



Grid interconnections to allow power to flow between utilities



Smart Grid adds in comms & intelligence

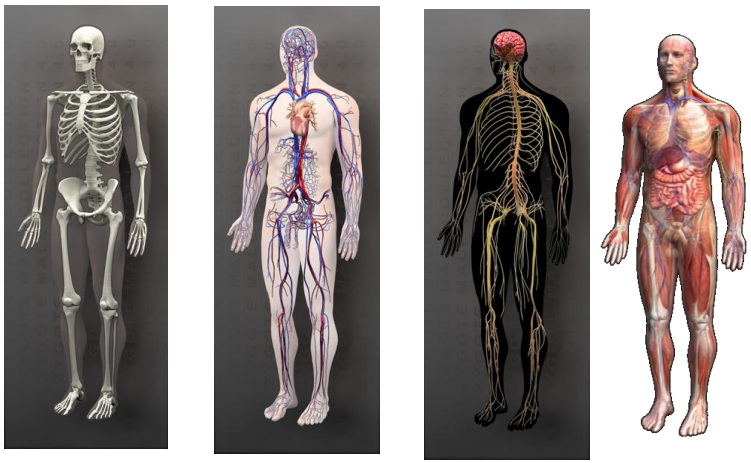


SMART GRID AS A 'HUMAN BODY'

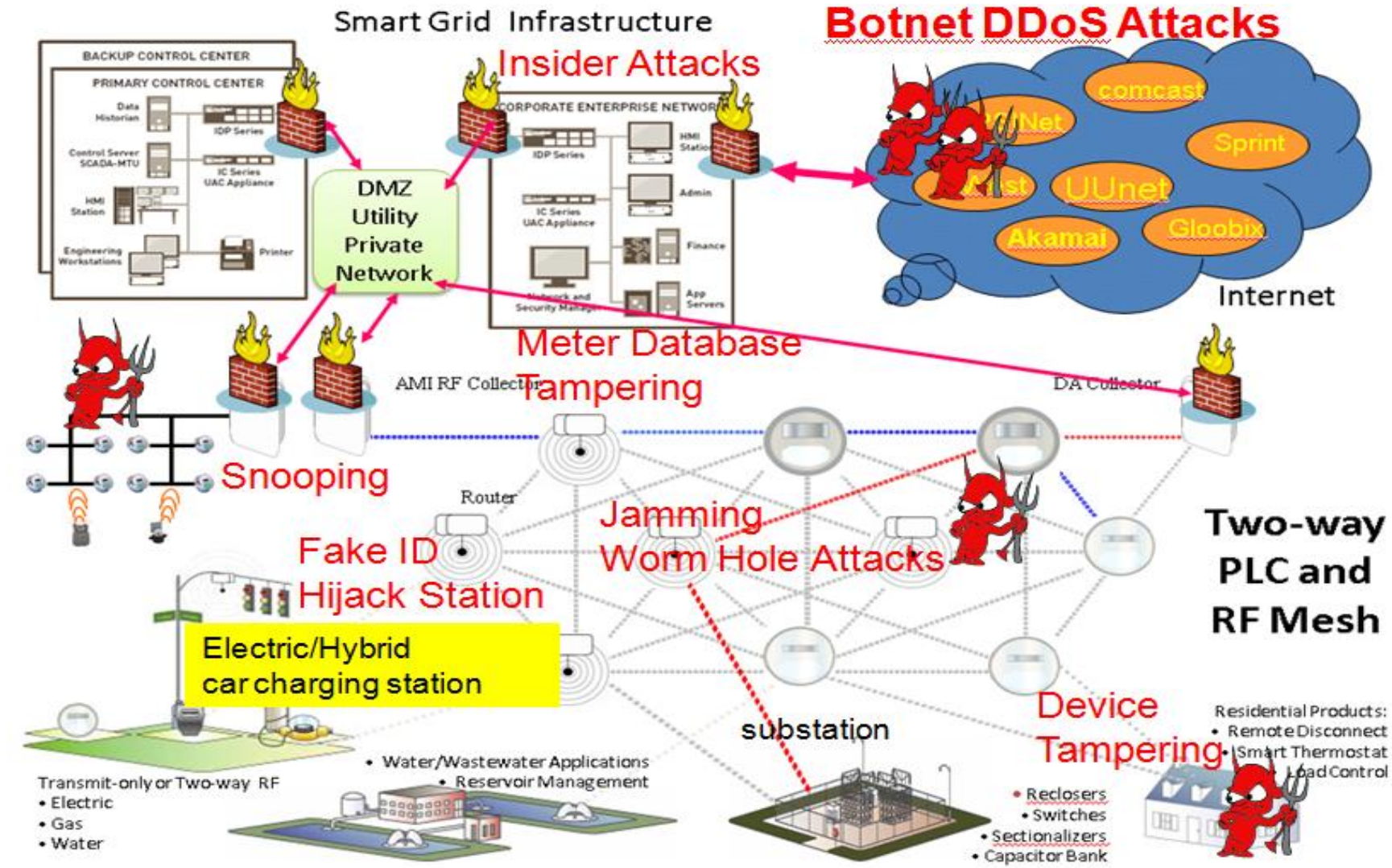
- Digital Information and Controls Technology
- Dynamic Optimization
- Distributed Generation
- Renewables Integration
- Real Time, Automated, Interactive Control Technology

- Integrate "Smart" Appliances
- Advanced Distributed Storage
- Infrastructure Standards
- Timely feedback to consumers
- Control options

skeletal **circulatory** **nervous**

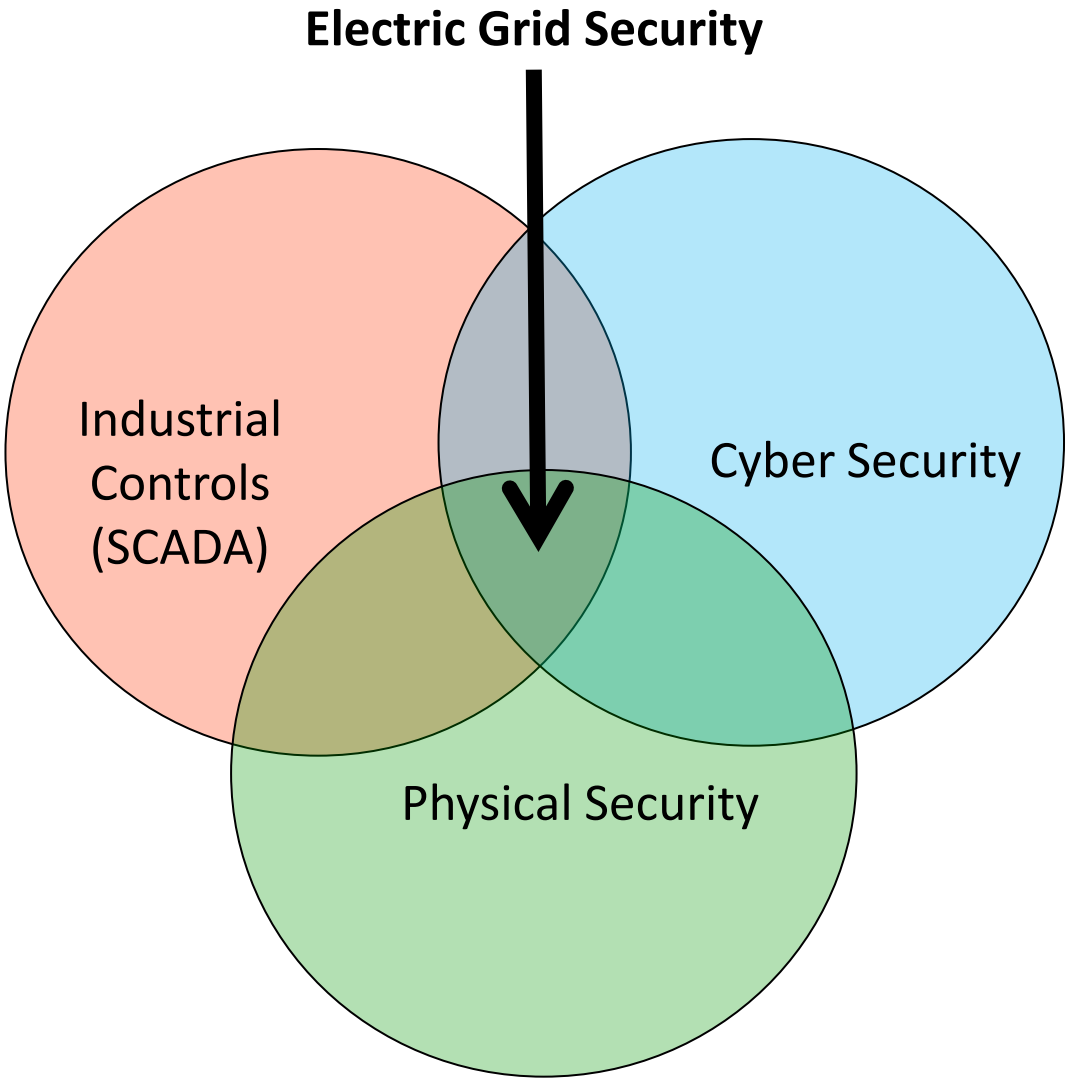


Smart Grid Cyber Vulnerabilities



Source: NIST SP 800-82

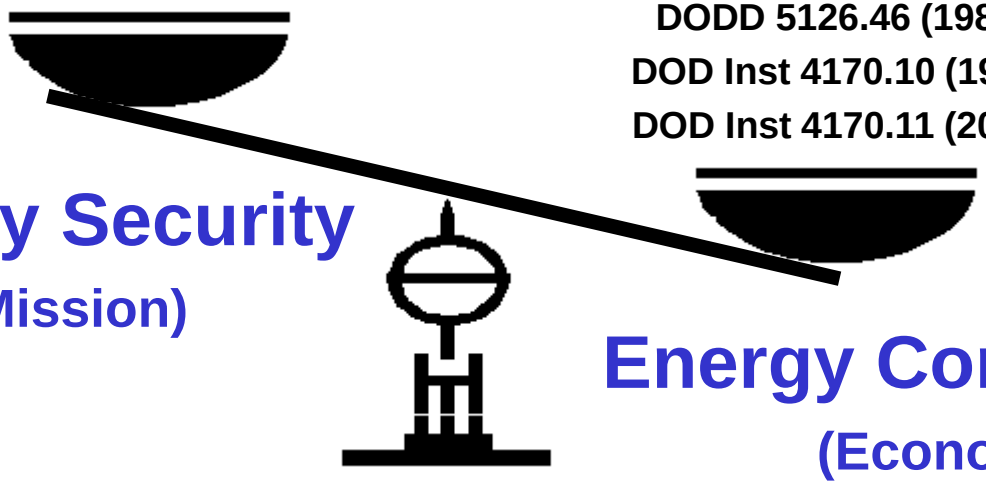
Gap in Expertise



Legislative and Policy Focus

HSPD-7
DOD Inst 4170.10 para 4.4.6
DOD Inst 4170.11 (2005)

EPAct 1992
EPAct 2005
EO 13423
EISA 2007
10 USC 2688
(Utilities Privatization)
NDAA 2008 Sec 355, 902
DODD 4140.25 (2004)
DODD 5126.46 (1987)
DOD Inst 4170.10 (1991)
DOD Inst 4170.11 (2005)



Energy Security
(Mission)

Energy Conservation
(Economics)

Northeast Blackout of 2003

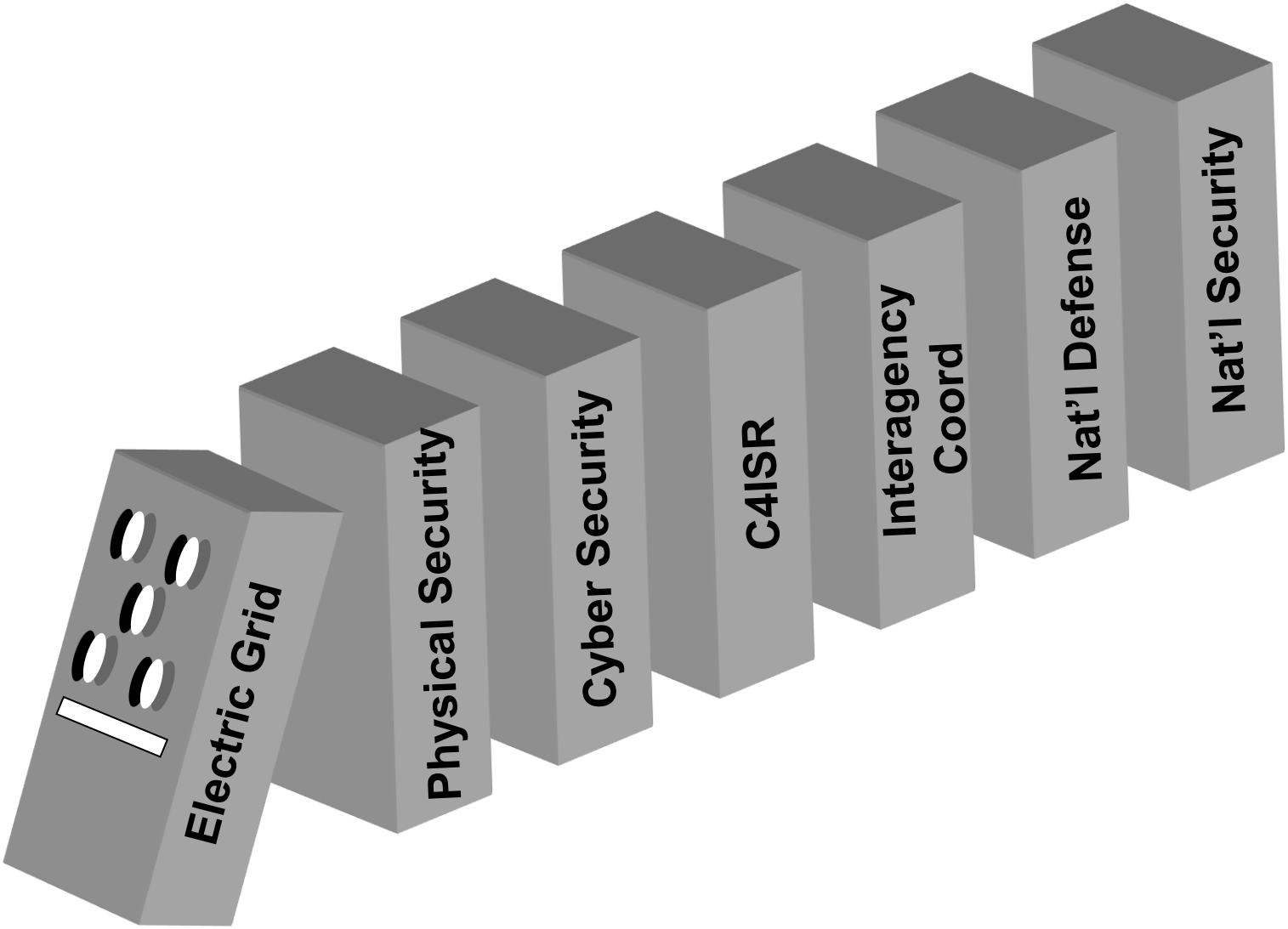
- **14 August 2003 starting at 3:41 PM EDT**
- **55 Million People**
- **New York, New Jersey, Maryland, Connecticut, Ohio, Michigan, Pennsylvania, Ontario and parts of Massachusetts**
- **Approx 48 Hours**

- **Cause:**
  - **Overgrown tree branches near Eastlake, Ohio impacted High Voltage lines during high power demand period.**

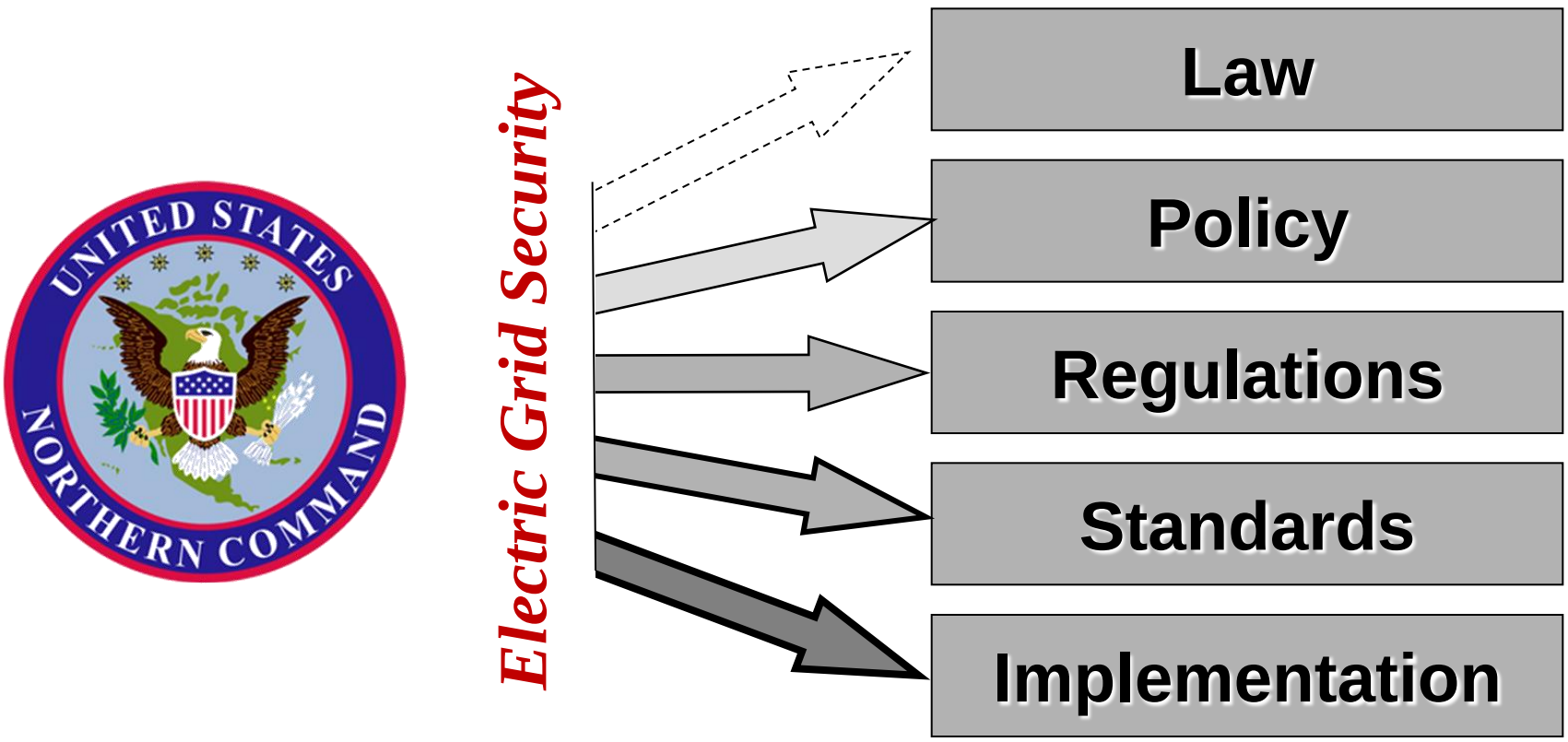
Source: Natural Resources Canada - Canada-U.S. Power System Outage Task Force Interim Report

Conclusions and the Way Ahead

Dependence on a Fragile Grid



Scope of Influence



Partnering Opportunities

Federal

State PUCs

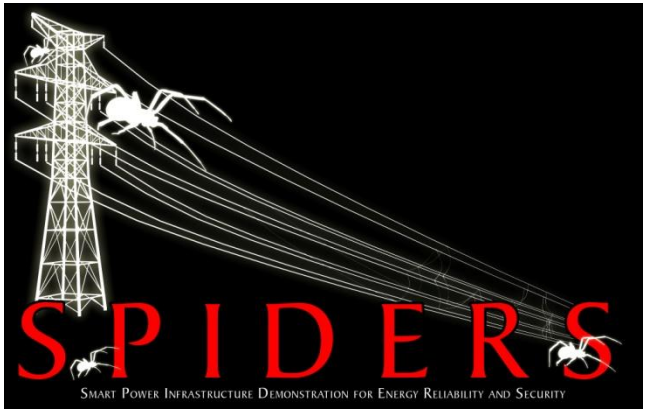
Industry

Key Engagements

- OSD (DOEP&P)– Office of Operational Energy Plans and Programs (New)
- OSD (HD&ASA) – Homeland Defense & American Security Affairs
- OSD (AT&L) – Acquisition, Technology, and Logistics
  - OSD (I&E) – Installations and Environment
- Joint Staff & Service Components
- COCOMs & Unified Commands
- Department of Energy
  - Office of Energy/Infrastructure Security and Energy Restoration (ISER)
  - National Laboratories
- DHS (NPPD & S&T)
- Department of Commerce – NIST
- Industry Associations and Public Utility Groups

Way Ahead

- Partnership in national and community initiatives
  - Smart Grid Development
    - Influence Implementation of Smart Grid in CONUS
    - JCTD – Smart Power Infrastructure Demonstration for Energy Reliability and Security (SPIDERS)
    - Rocky Mountain Secure Smart Grid Initiative (RMSSGI)
  - Renewable Energy development on military bases
- Table Top Exercise
  - Secure Grid ’10
  - May 2010



Take Aways

- **Ensure that USNORTHCOM has a seat at the table**
  - **OSD Office of Operational Energy Plans and Programs**
  - **DOD Energy Security Task Force**
- **DOD test bed / JCTD**
- **Spread the Message**
  - **Mission assurance requires electric grid security, reliability, and resiliency**
- **The time to include security is now!**
  - **Industry is moving forward with Smart Grid implementation, with or without consideration of DOD security requirements**
  - **Better to design in security now than to patch later**


UNITED STATES
NORTHERN COMMAND

BACK UP SLIDES

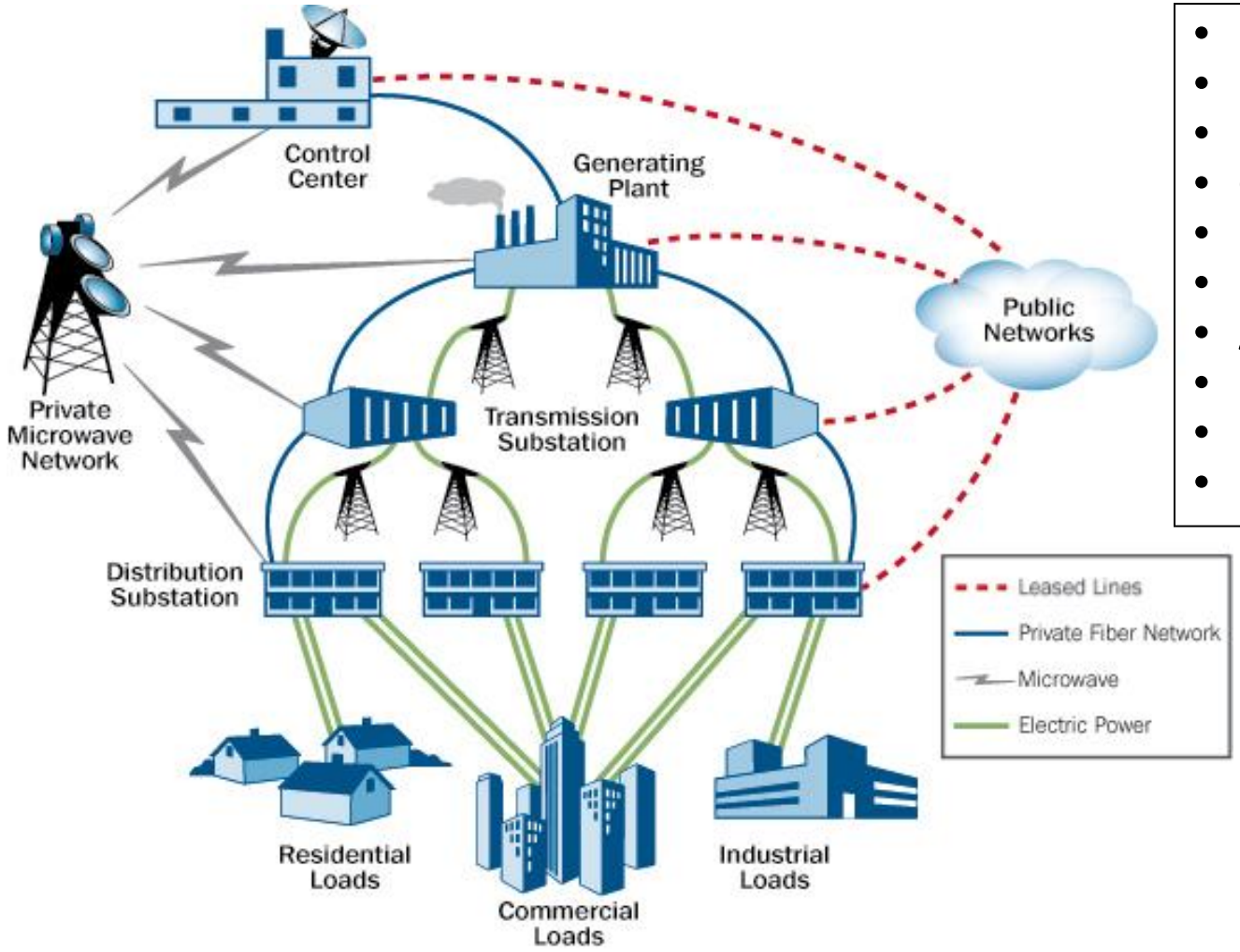
History of Early Electric Grid

Year	Event	Comments
1882	Edison Pearl Street Generating Station, New York City	59 Customers
1896	Niagara Falls Hydroelectric Plant, Westinghouse	First AC transmission to remote customers
1920	Federal Power Commission (FPC) created by Congress	Coordinate Hydroelectric projects under Federal control; ad-hoc staff from other Federal agencies
1930	Federal Power Act	Established five bi-partisan commissioners
1901-1932	Electrification of urban America	
1930-1945	Electrification of rural America	Funded through USDA stimulus funds
1935	Public Utility Holding Company Act (PUHCA)	Beginning of regional electric monopolies
1935	Federal Power Act	Gave regulatory authority to states; FPC regulated bulk power transmission across state lines

History of Electric Grid

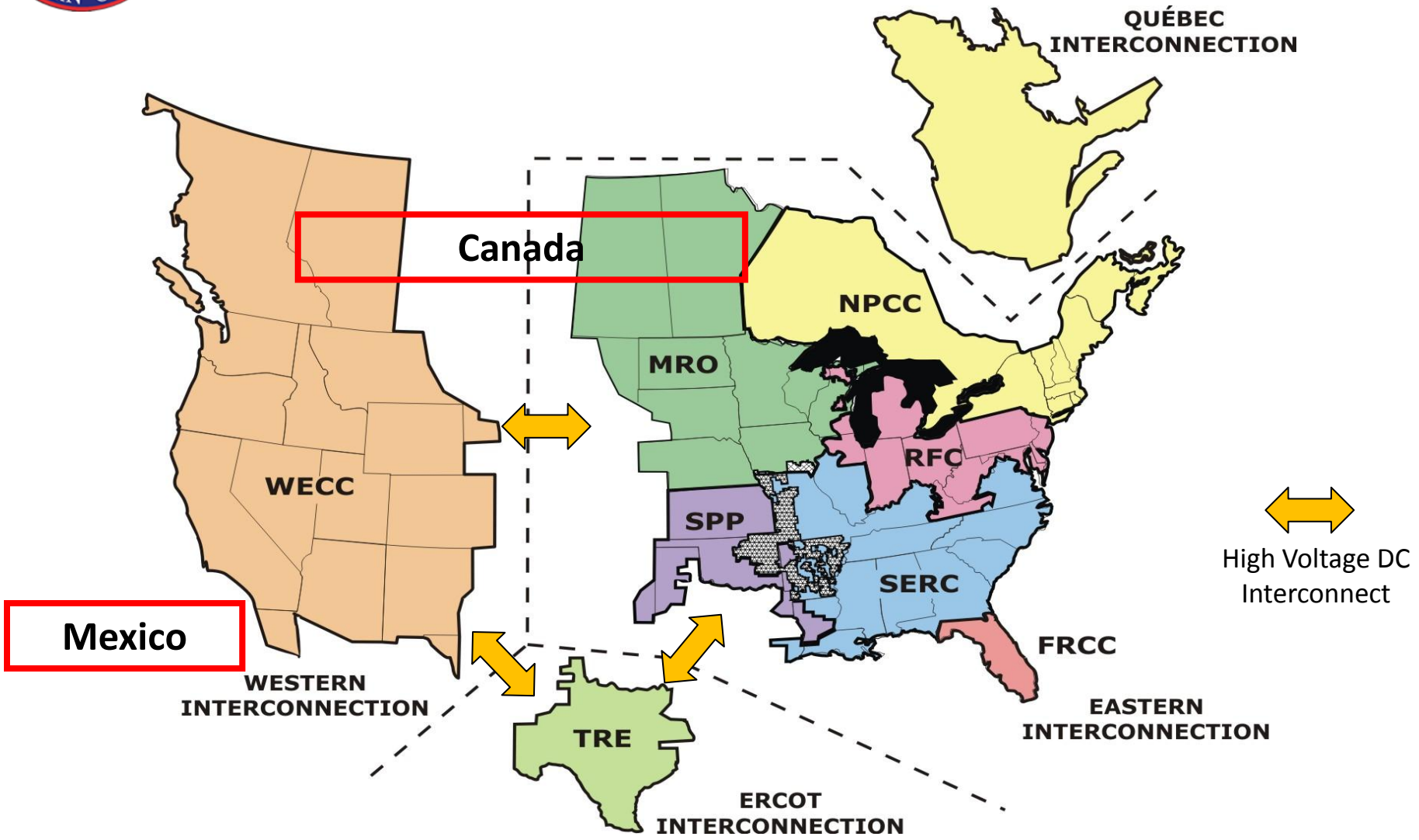
Year	Event	Comments
1965	Northeastern power blackout	Raised concerns about reliability of large interdependent power networks
1967	Electric Reliability Act	Drove establishment of electric performance standards
1968	North American Electric Reliability Council (NERC) created	Industry created non-profit self-regulating organization.
1977	Federal Power Commission (FPC) reorganized as Federal Energy Regulatory Commission (FERC)	
1978	Public Utility Regulatory Policies Act (PURPA)	Set the stage for deregulation and Independent Power Producers (IPP)
1979	Three Mile Island	Shut down nuclear plant construction
1992	Energy Policy Act (EPACT)	Bulk power transmission deregulation
2005	Energy Policy Act (EPACT)	Gave FERC punitive authority to enforce reliability standards
2007	Energy Independence & Security Act (EISA)	National grid integration and Renewable Energy initiatives
2008	FERC established 8 mandatory reliability standards	

Today's Electric Grid

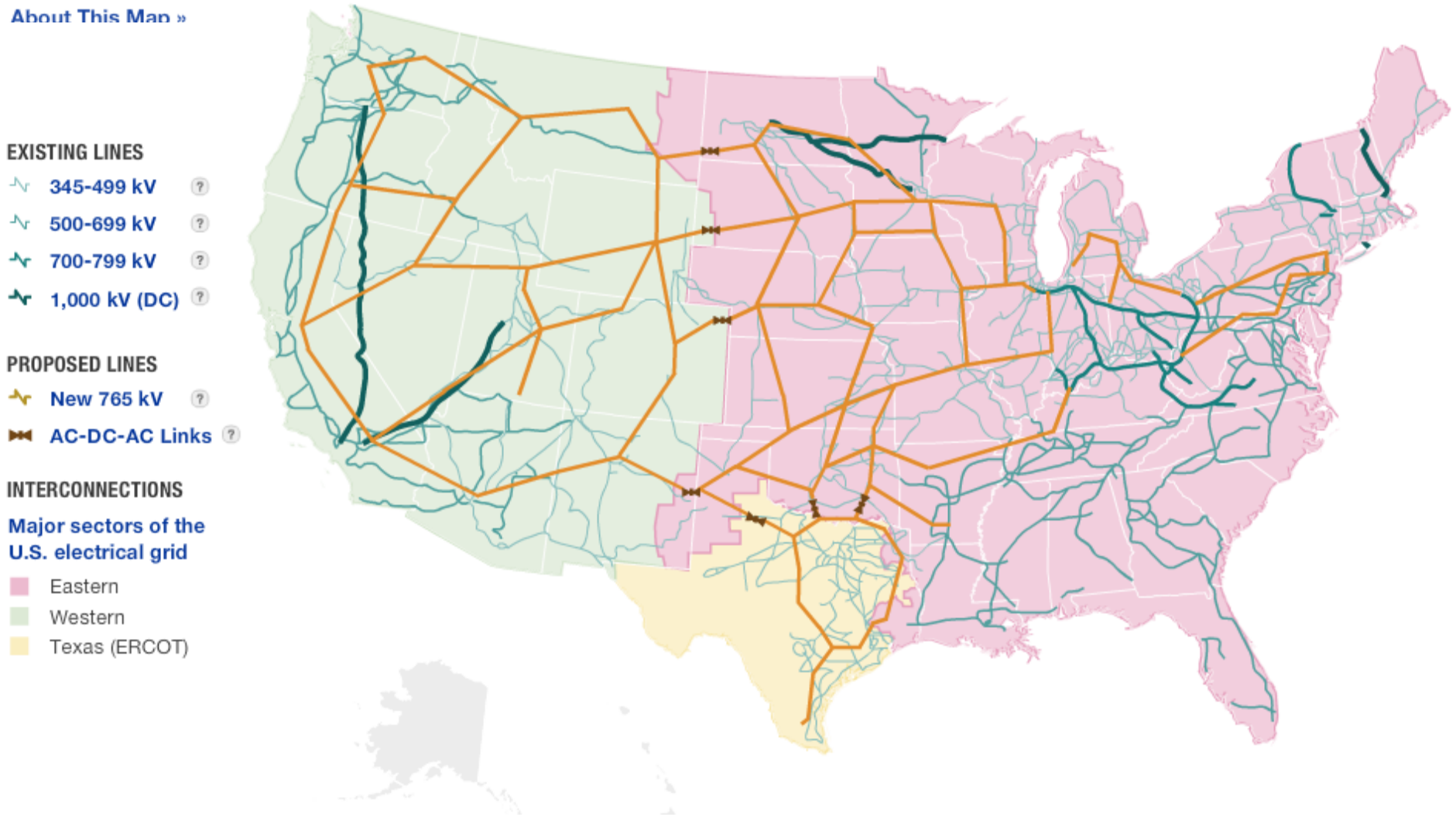


- Centralized
- One-way power flow
- Regulated Monopoly
- Generation
- Distribution
- Inflexible demand
- Aging Infrastructure
- Manual operations
- Increasing renewables
- Lacks interoperability

Electric Grid Regions and Interconnects



High Voltage Interconnects



Source: DOE Office of Electric Transmission and Distribution, "National Electricity Delivery Technologies Roadmap, Transforming the Grid to Revolutionize Electric Power in North America", Jan 2004)

Regulatory Bodies

Government

- Federal Energy Regulatory Commission
- State Public Utility Commissions

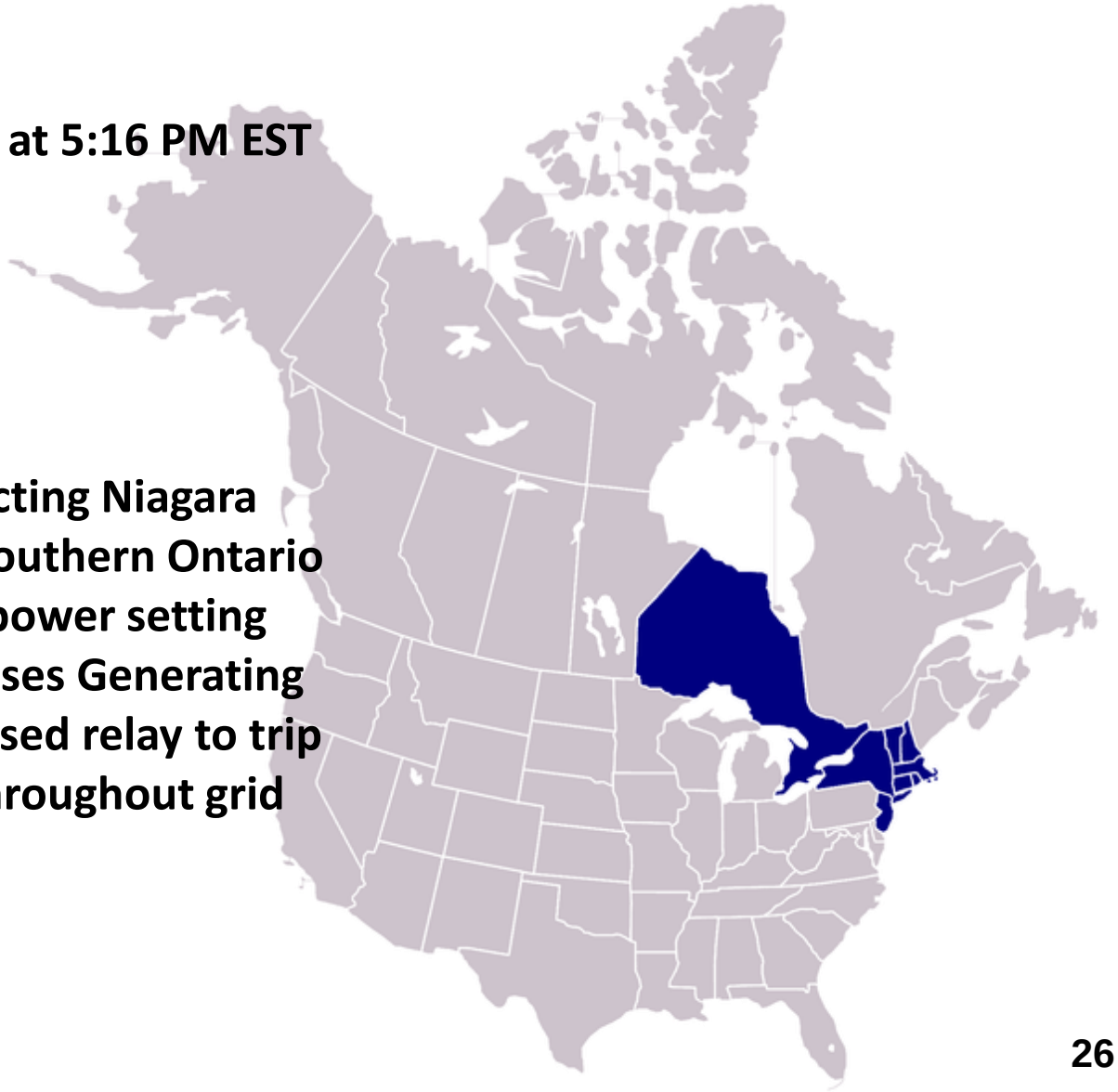
Industry

- North American Electric Reliability Corporation (NERC)
- Electric Utility Associations
  - Edison Electric Institute (EEI)
  - American Public Power Association (APPA)
  - National Rural Electric Coop Association

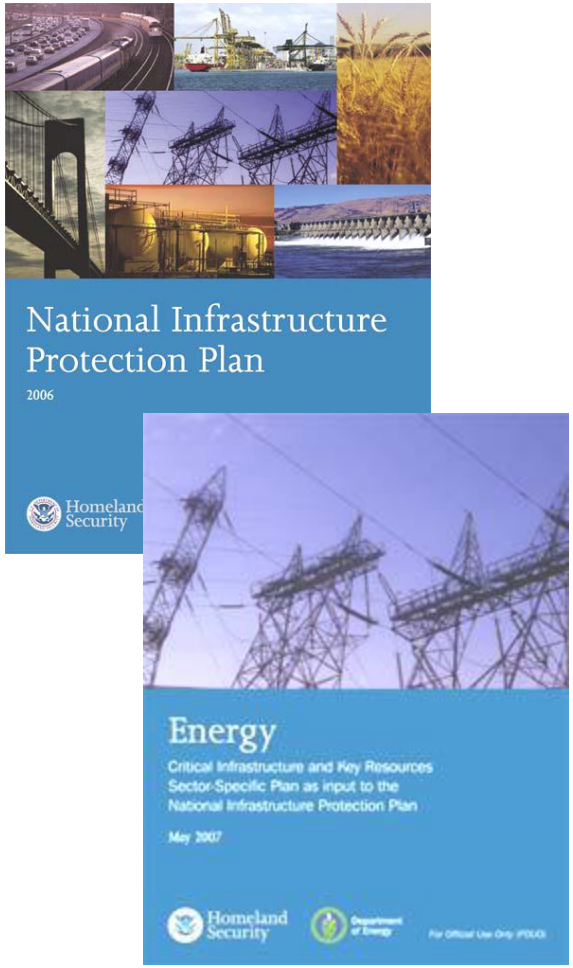
Northeast Blackout of 1965

- 9 November 1965 starting at 5:16 PM EST
- 25 Million People
- 80,000 Square Miles
- 12 Hours

- Cause:
  - •Protective relay connecting Niagara Falls hydro plant with Southern Ontario
  - •Relay set too low of a power setting
  - • Surge from Robert Moses Generating Plant, Lewiston, NY, caused relay to trip
  - •Cascading overloads throughout grid



National Infrastructure Protection Plan (NIPP)



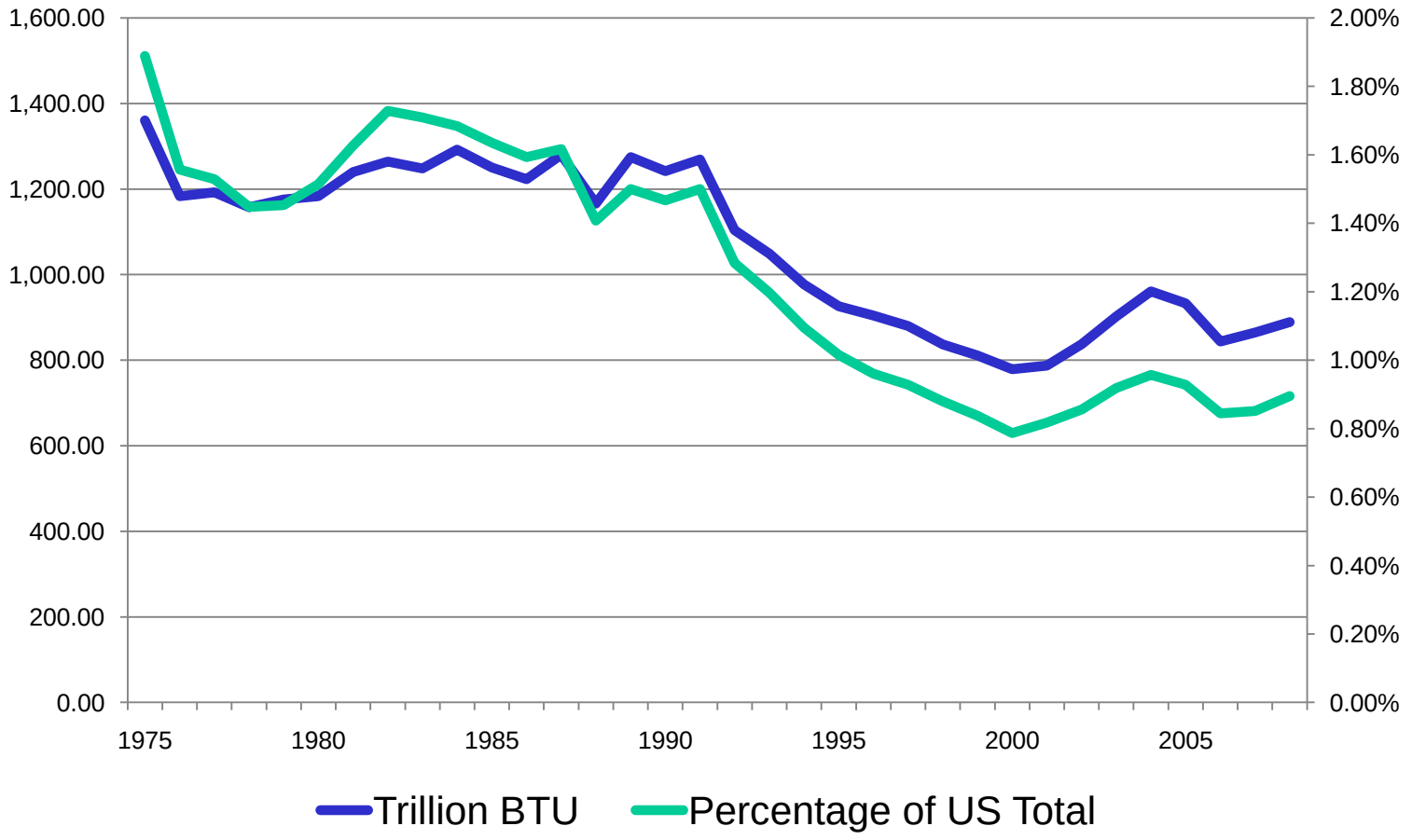
NIPP

- **Unifies effort for protection of critical infrastructure and key resources**

Energy Sector Specific Plan

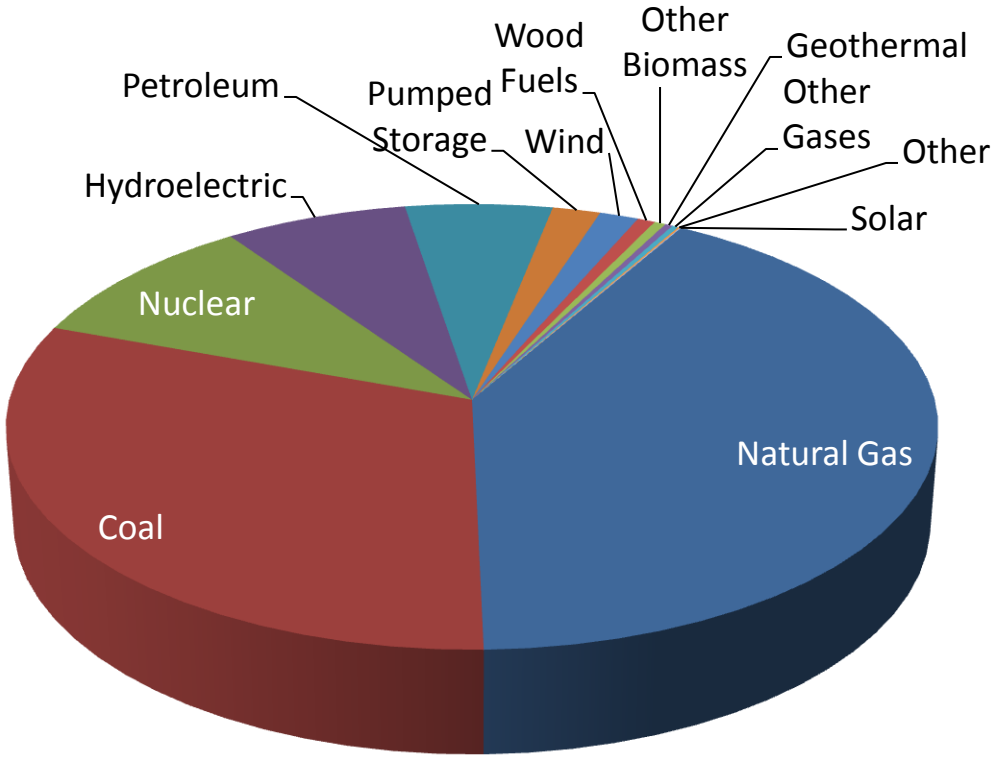
- **Collaborative process between the private sector, state, local, and tribal governments,**
- **Identify threats, mitigate vulnerabilities, minimize consequences**

DOD Energy Consumption



Source: DOE EIA Annual Energy Review 2009

Electricity Production by Energy Source

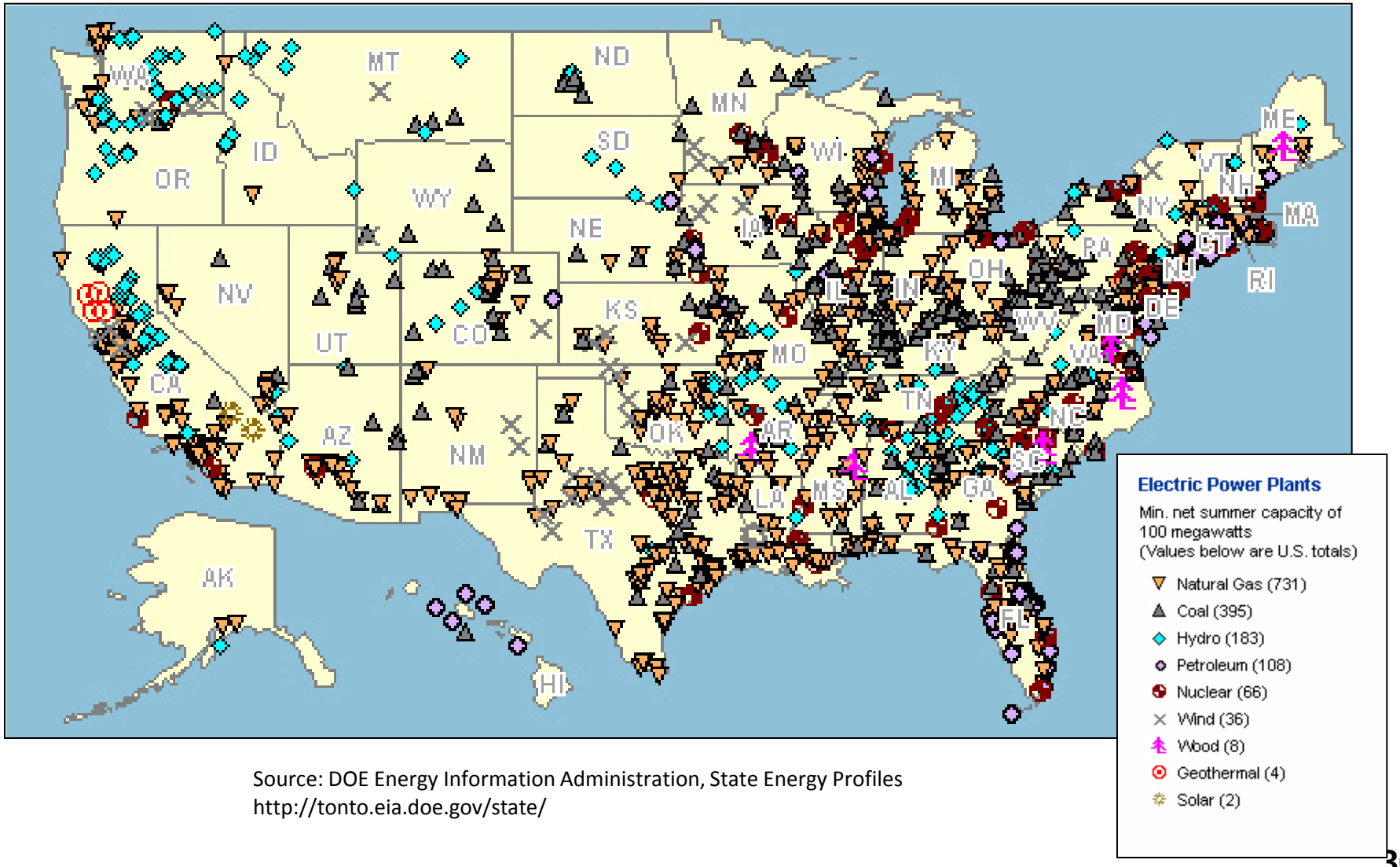


Energy Source	Capacity	Percentage
Natural Gas	449,389	41.31%
Coal	336,040	30.89%
Nuclear	105,764	9.72%
Hydroelectric	77,644	7.14%
Petroleum	62,394	5.74%
Pumped Storage	20,355	1.87%
Wind	16,596	1.53%
Wood Fuels	7,510	0.69%
Other Biomass	4,834	0.44%
Geothermal	3,233	0.30%
Other Gases	2,663	0.24%
Other	866	0.08%
Solar	503	0.05%
Total	**1,087,791**	**100.00%**

Source: DOE Energy Information Administration,
Electric Power Annual Report 2007 (Released 21 Jan 09)

Production Capacity In Megawatts (MW)

U. S. Electric Power Plants



Source: DOE Energy Information Administration, State Energy Profiles
http://tonto.eia.doe.gov/state/

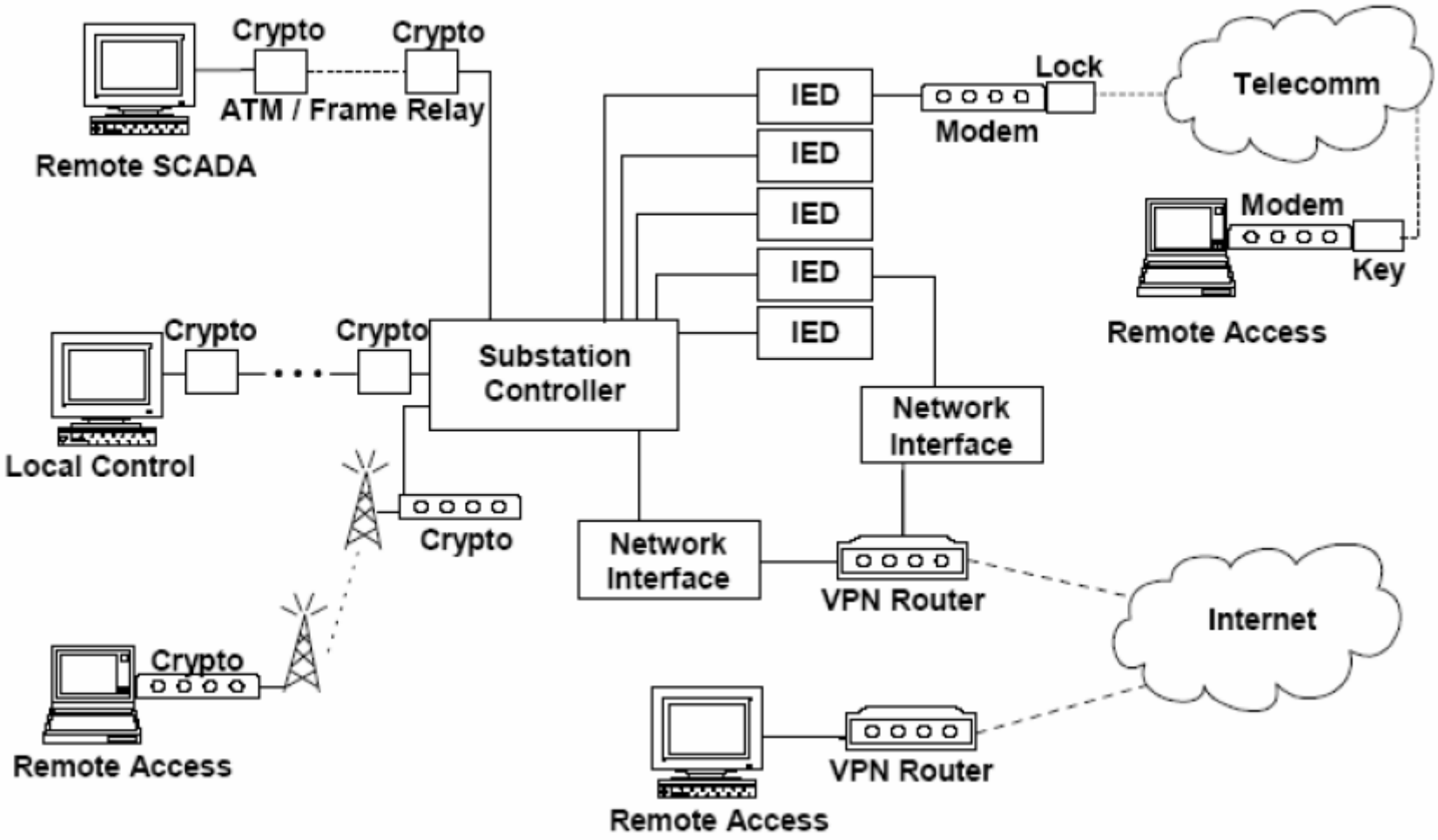
Electric Energy Initiatives

- **Advanced Metering Initiative**
- **Renewable Energy**
- **Smart Grid**

Wind Turbines at F.E. Warren AFB, WY

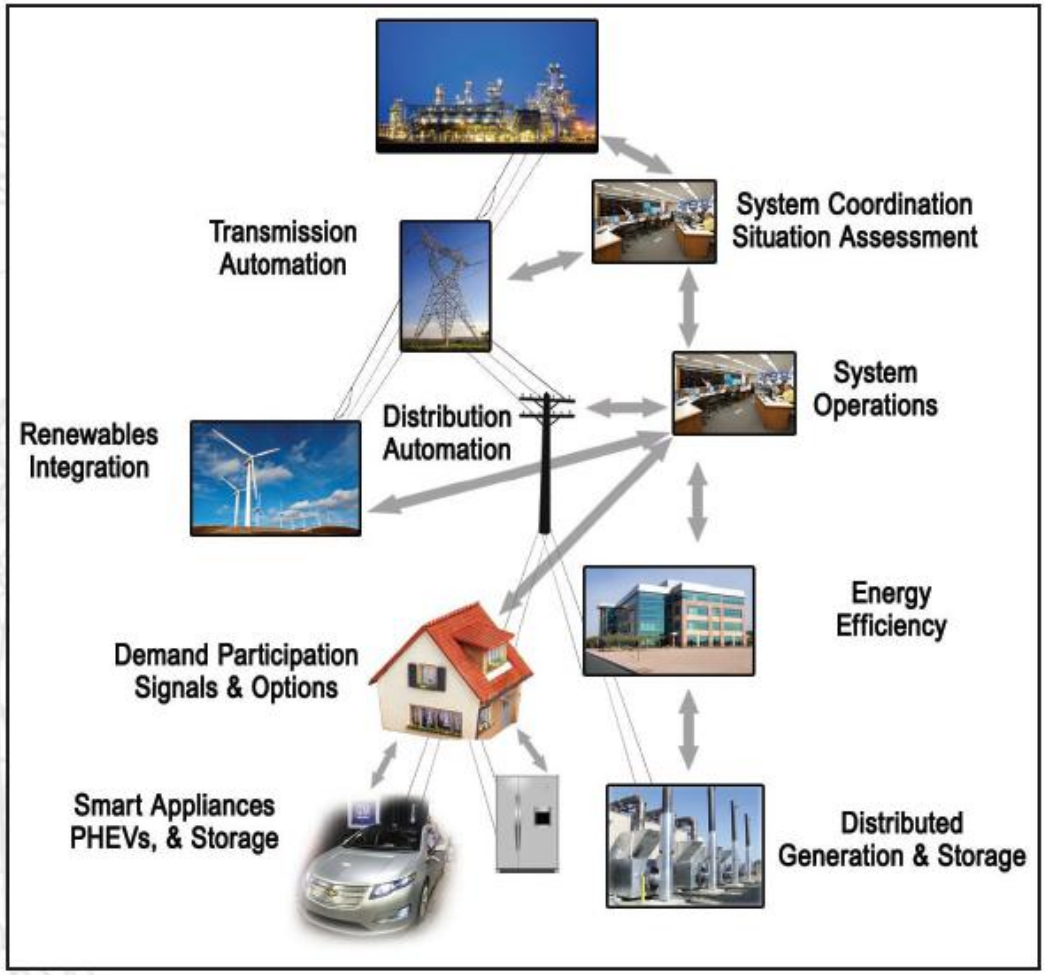
Solar Array at Fort Carson, CO

Electric Utility Control Systems



Source: DHS Characteristics and Common Vulnerabilities: Electricity Distribution Systems, October 2007

The Smart Grid



- Digital Information and Controls Technology
- Dynamic Optimization
- Distributed Generation
- Renewables Integration
- Real Time, Automated, Interactive Control Technology
- Integrate "Smart" Appliances
- Advanced Distributed Storage
- Infrastructure Standards
- Timely feedback to consumers
- Control options

Source: DHS Smart Grid System Report, July 2009

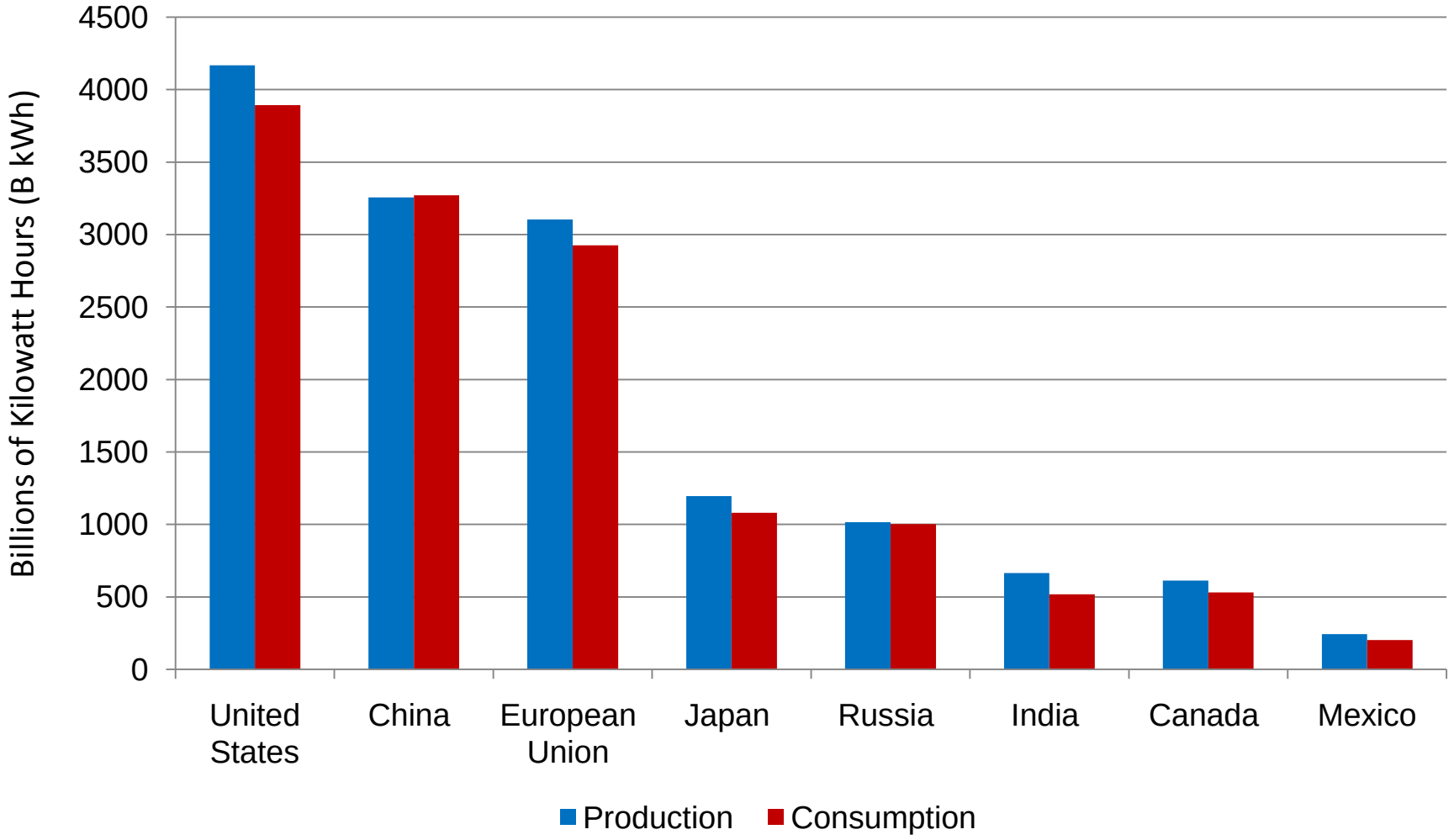
Electric Grid Security Objectives

- **Ensuring proper access control to the smart grid network and role-based access control to its operations**
- **Protecting physical access to the smart grid network and devices**
- **Protecting individual smart grid components from exploitation**
- **Maintaining functionality during adverse conditions**
- **Restoring systems and services after an incident**

Existing Standards for Smart Grid Interoperability

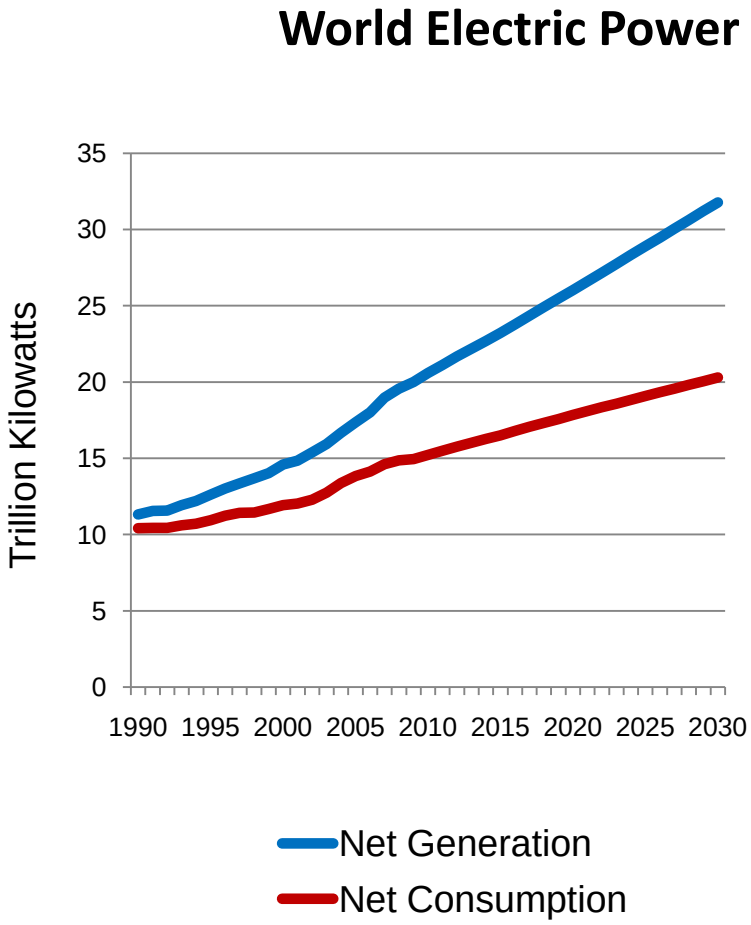
Standard	Application	Smart Grid Area
AMI-SEC System Security Requirements	Advanced metering infrastructure (AMI) and Smart Grid end-to-end security	IT
ANSI C12.19/MC1219	Revenue metering information model	IT
BACnet ANSI ASHRAE 135-2008/ISO 16484-5	Building automation	COM
DNP3	Substation and feeder device automation	COM
IEC 60870-6 / TASE.2	Inter-control center communications	COM
IEC 61850	Substation automation and protection	COM
IEC 61968/61970	Application level energy management system interfaces	
IEC 62351 Parts 1-8	Information security for power system control operations	COM
IEEE C37.118	Phasor measurement unit (PMU)communications	COM
IEEE 1547	Physical and electrical interconnections between utility and distributed generation (DG)	POWER
IEEE 1686-2007	Security for intelligent electronic devices (IEDs)	
NERC CIP 002-009	Cyber security standards for the bulk power system	COM
NIST Special Publication (SP) 800-53, NIST SP 800-82	Cyber security standards and guidelines for federal information systems, including those for the bulk power system	COM
Open Automated Demand Response (Open ADR)	Price responsive and direct load control	
OpenHAN	Home Area Network device communication, measurement, and control	
ZigBee/HomePlug Smart Energy Profile	Home Area Network (HAN) Device Communications and Information Model	

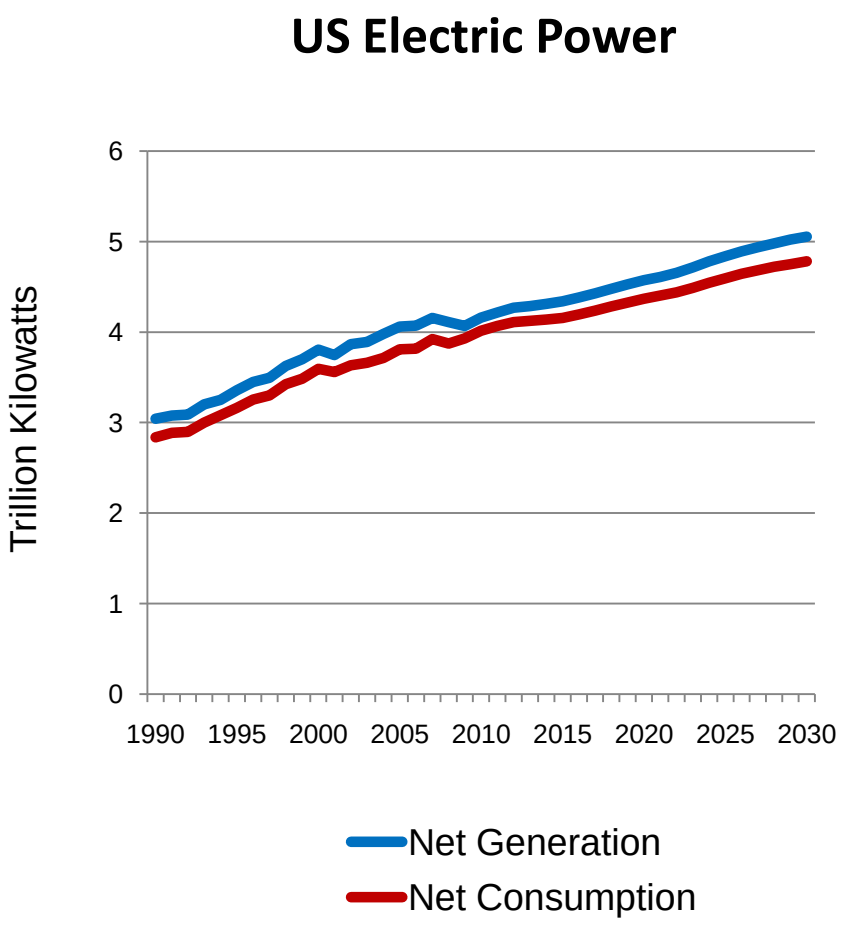
Comparison of World Electric Production and Consumption



Source: CIA World Factbook

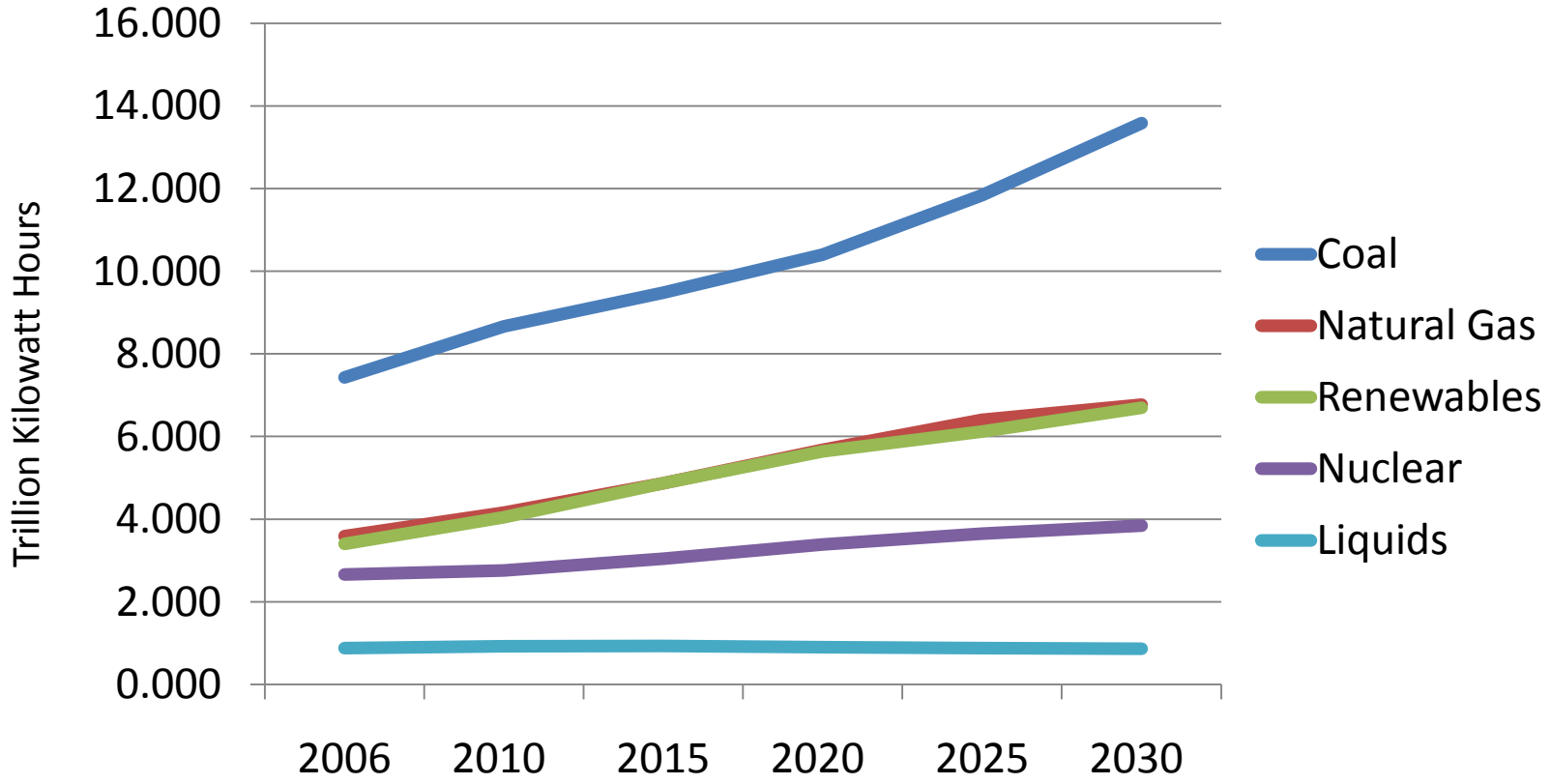
Relative Growth in Electric Generation and Consumption





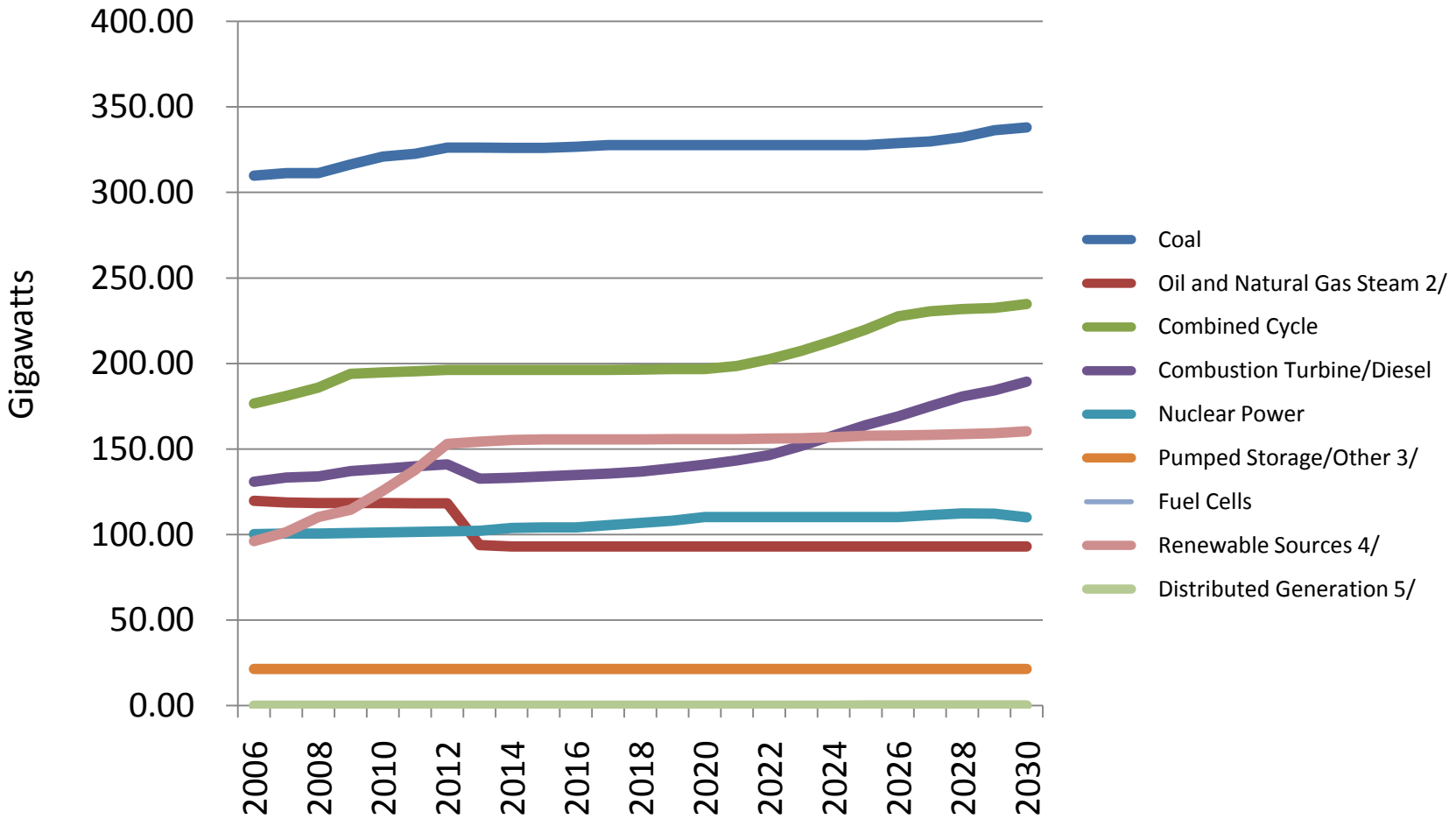
Sources: DOE EIA International Energy Outlook 2009
DOE EIA International Generating Capacity , 1980-2006
DOE EIA International Electric Projections, 1990-2030

World Electric Generation Projections By Source

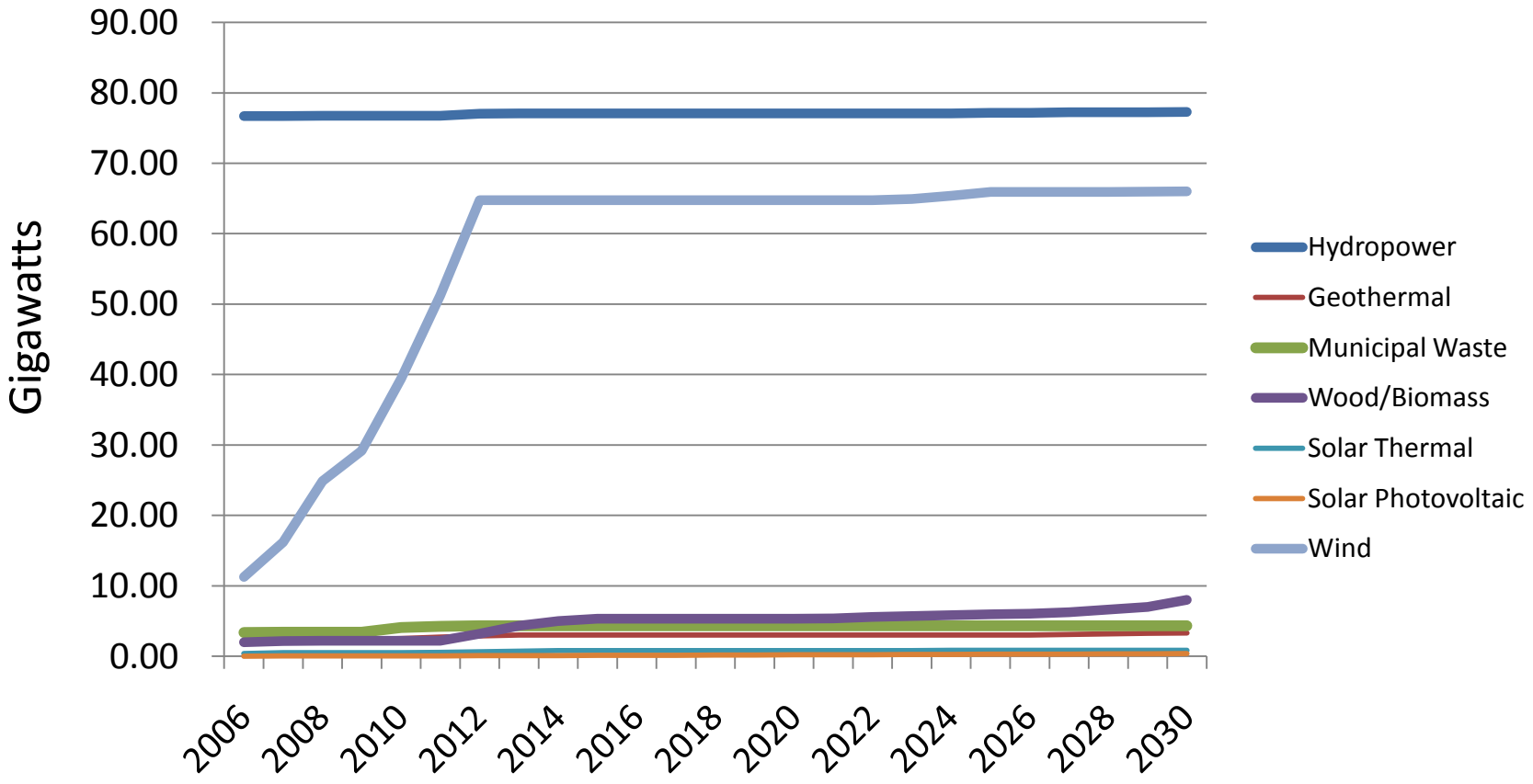


Source: DOE Energy Information Administration,
Report #:DOE/EIA-0484 (Released May 2009)

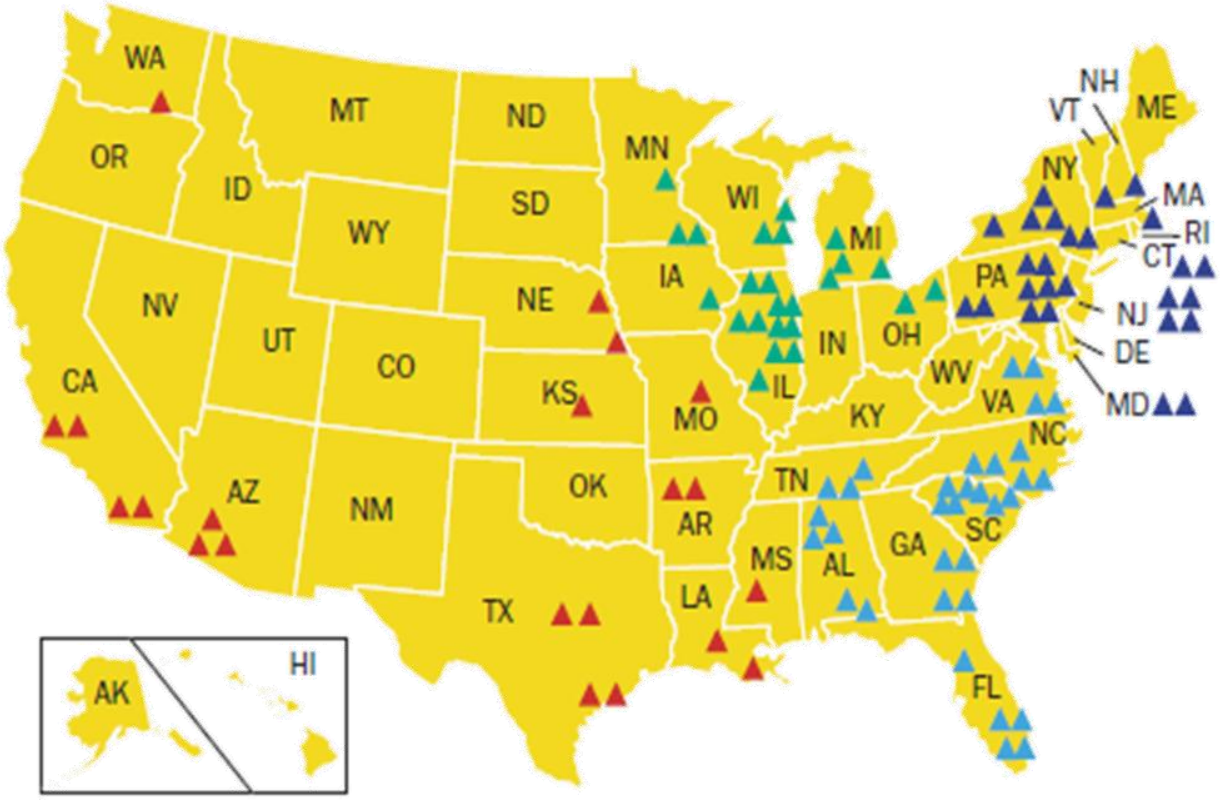
US Electric Generation Projections by Source



US Renewable Energy Projections



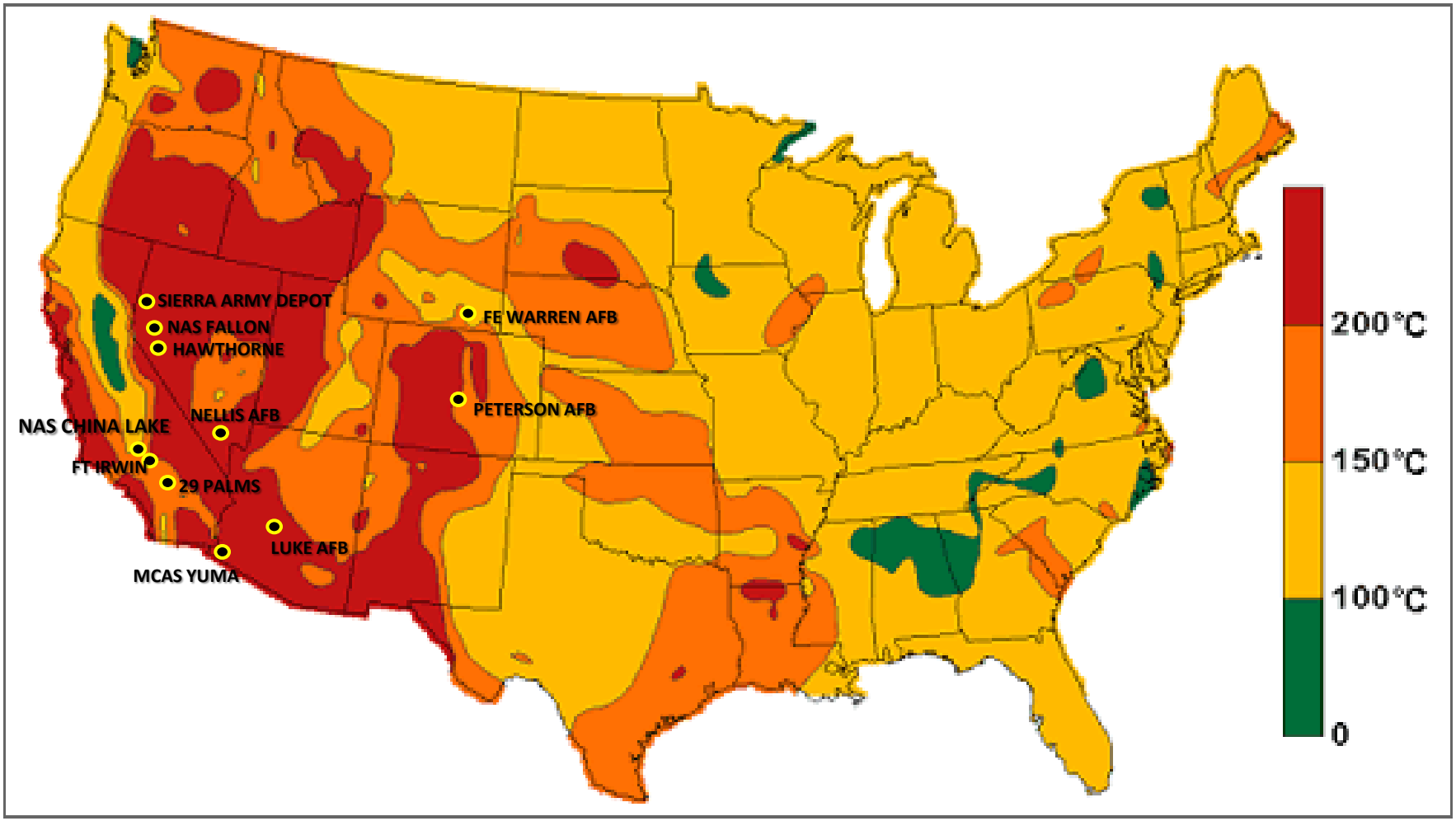
Operating Nuclear Power Reactors



- 104 Reactors Licensed to operate in U.S.
  - 32% of worldwide electric production by nuclear power
- 437 Operational Reactors Worldwide

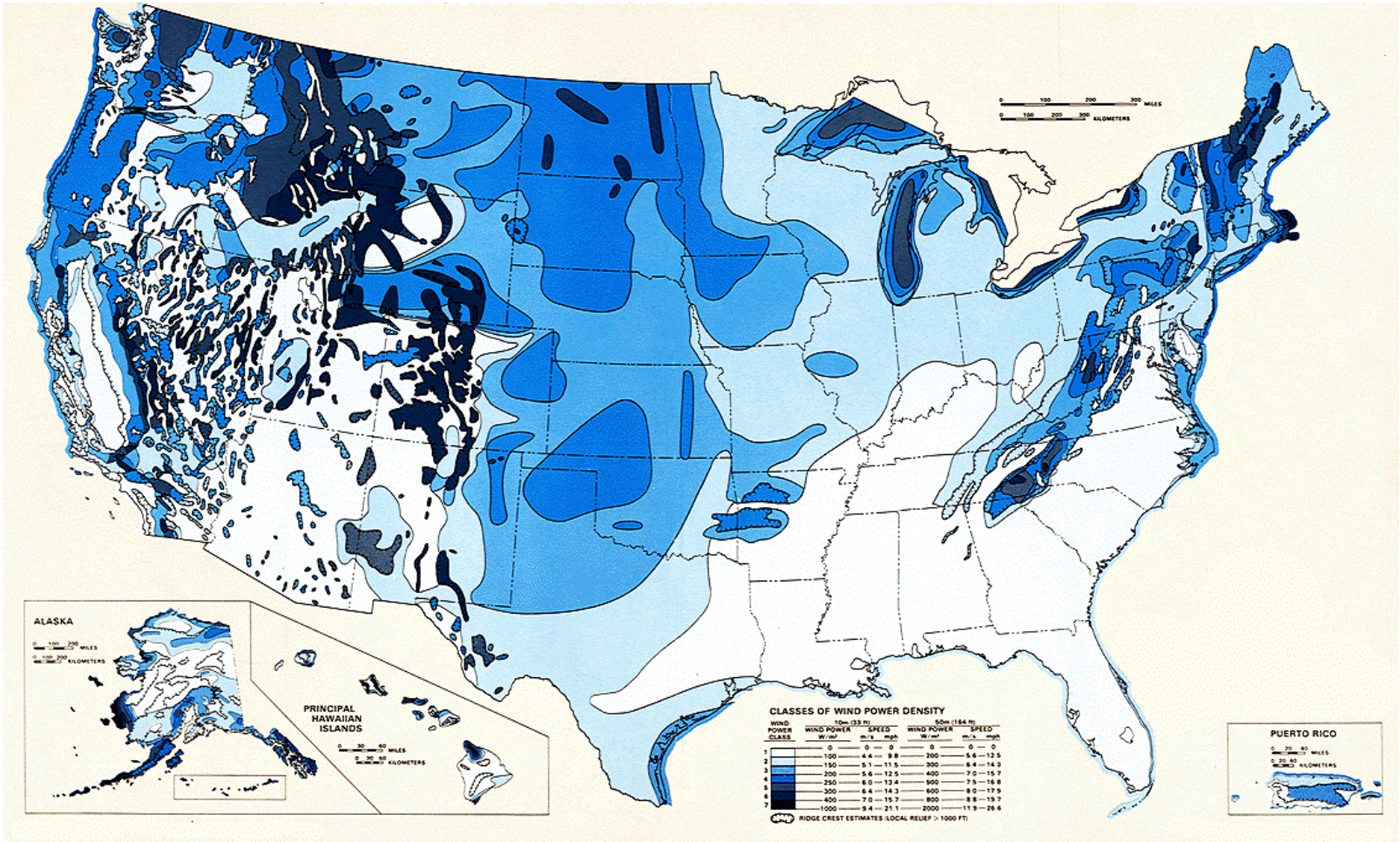
Source: Nuclear Regulatory Commission 2008-2009 Information Digest

U.S. Geothermal Energy Potential



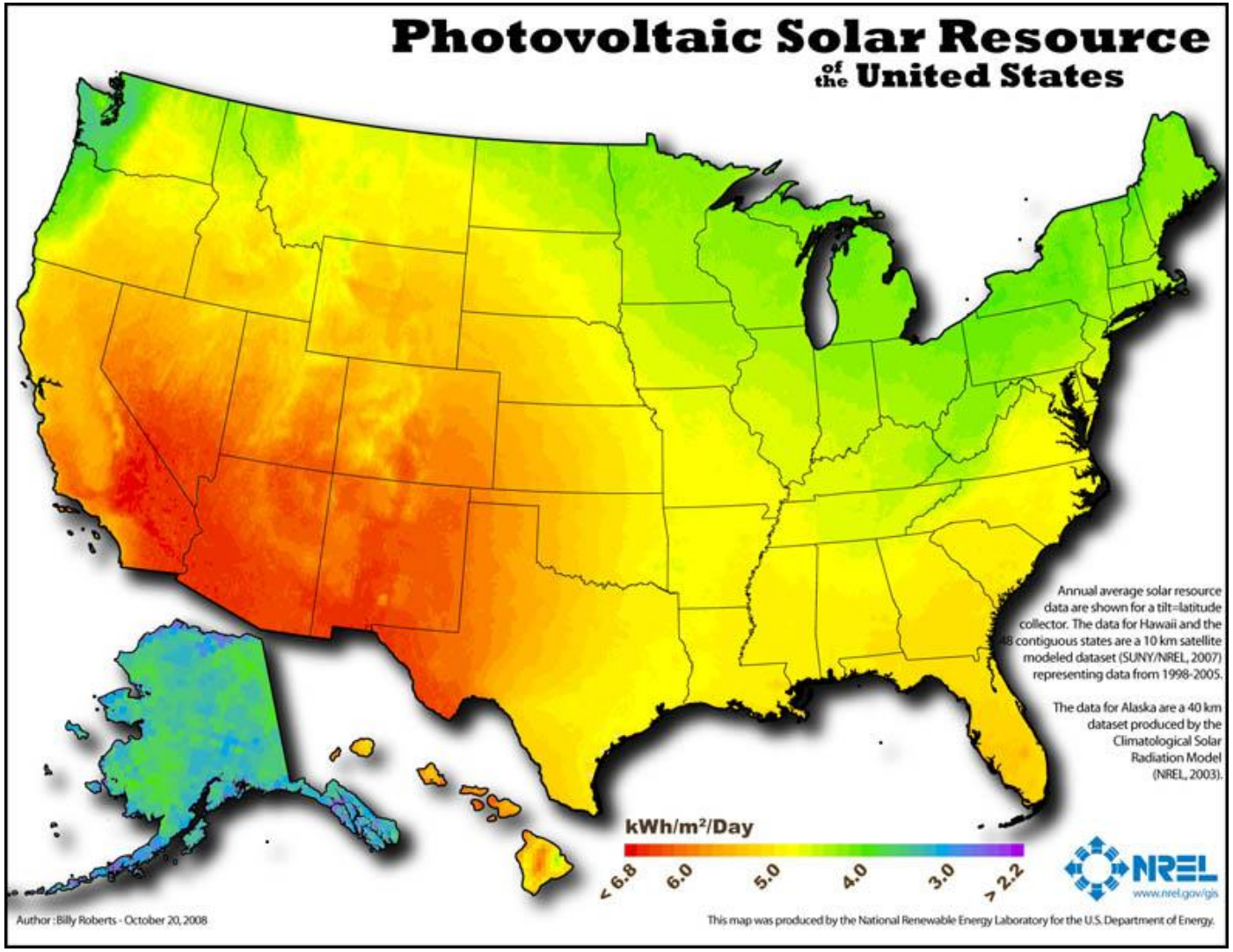
Source: DOE Energy Efficiency and Renewable Energy Program Website.
http://www1.eere.energy.gov/geothermal/maps.html

Average Annual Wind Power Potential

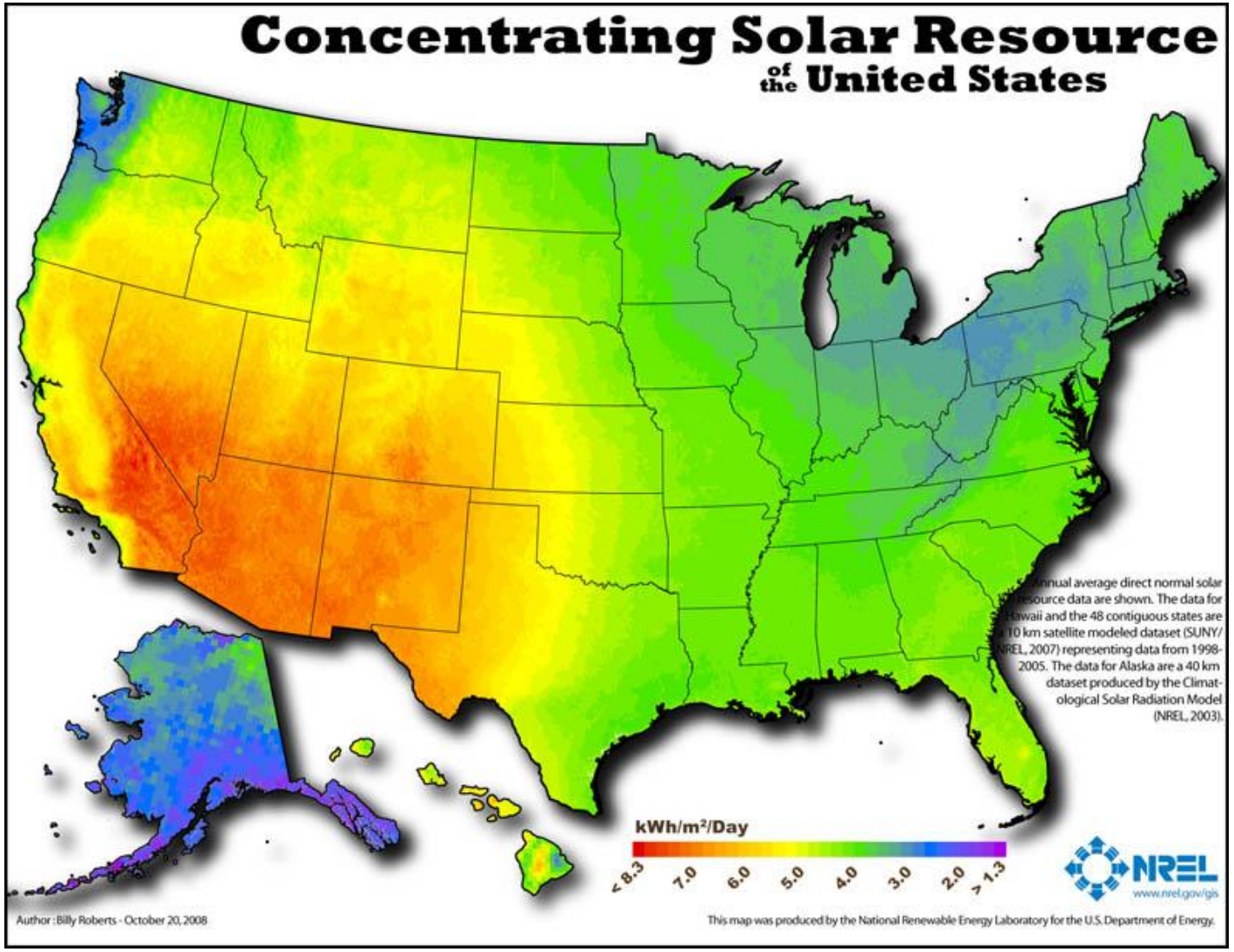


Source: National Renewable Energy Laboratory, Wind Energy Resource Atlas of the United States (Oct 1986)

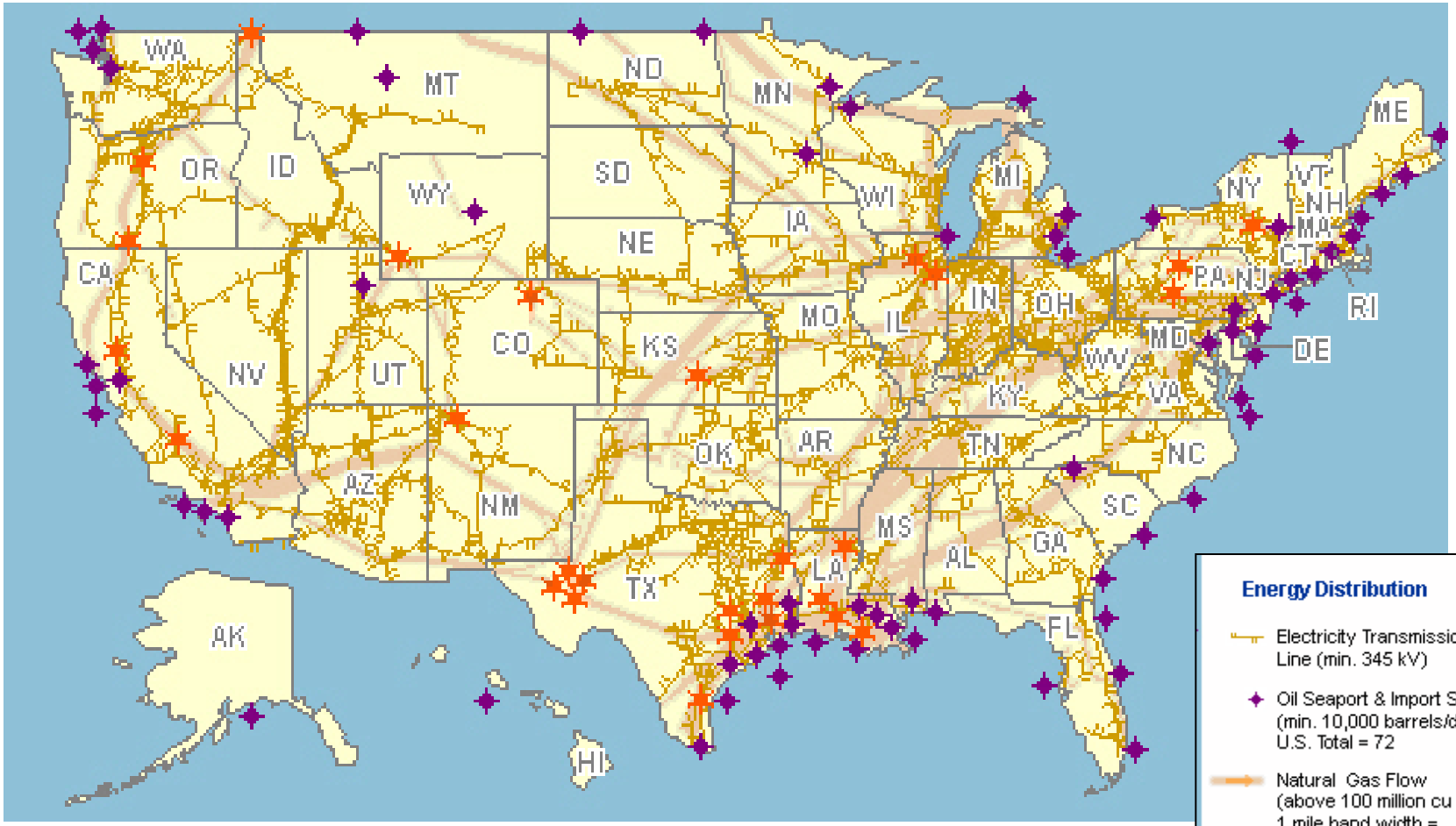
Solar Energy Potential



Solar Energy Potential



U.S. Energy Distribution Nodes



Source: DOE Energy Information Administration, State Energy Profiles
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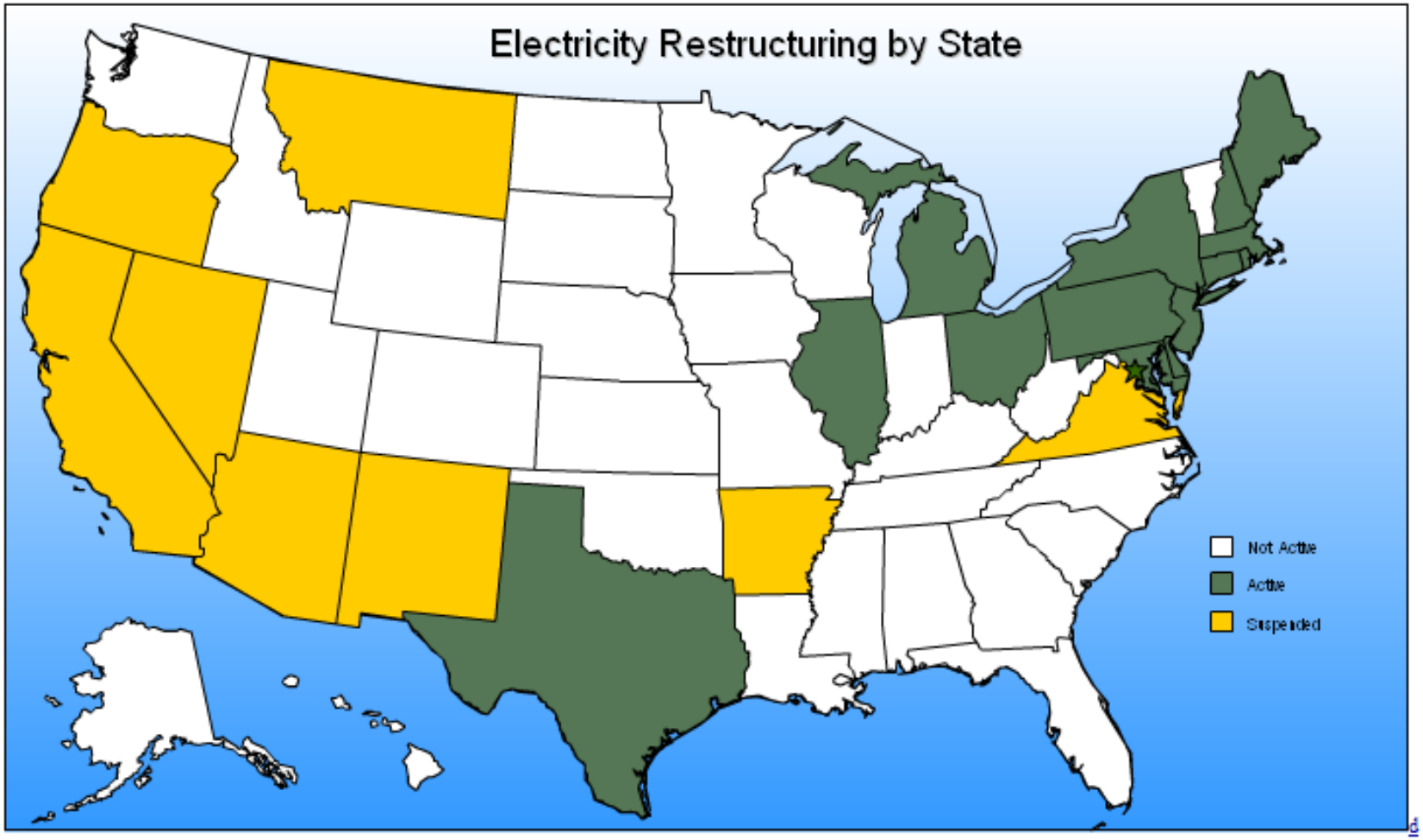
Deregulation



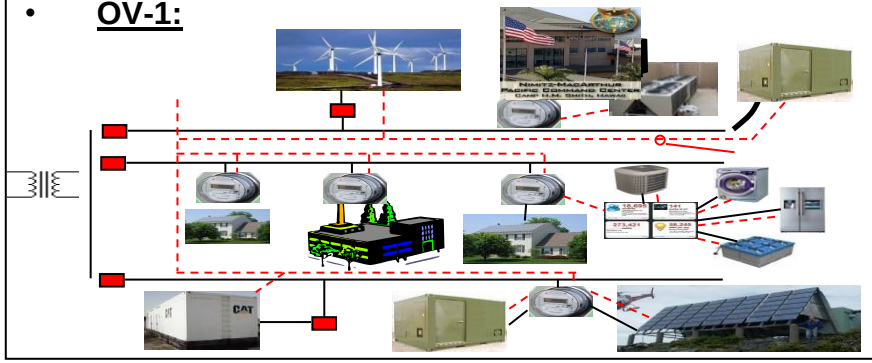
Source: Energy Information Administration

Themes and Messages

- **USNORTHCOM is a key partner within DOD advocating for a reliable, efficient, secure, and resilient electrical power grid.**
- **USNORTHCOM strongly encourages increased energy efficiency based on sound technical solutions *that fully consider security implications*.**
- **USNORTHCOM will continue to partner with DOE, DHS, and NIST to integrate electrical infrastructure security as an intrinsic element of the Smart Grid.**

Quad Chart:
SPIDERS JCTD FY11-13

- **Operational Problem:** The ability of today's warfighter to command, control, deploy, and sustain forces is adversely impacted by a fragile, aging, and fossil fuel dependent electricity grid, posing a significant threat to national security.
- **OV-1:**



Operational Capabilities:

- Combined resilient, fault and attack tolerant smart grid architecture consisting of:
  - Cyber security and smart grid equipment, renewable and conventional distributed generation, microgrids, emergency generators, energy storage, intrusion detection, rapid forensic capability

Technology:

TRL	Today	FY13
Cyber Defense	4-8	6-9
Energy Mgt Control & Ops	4-9	7-9
Integration of Renewables	5-6	7-8

Participants:

- User Sponsor: U.S. Pacific & Northern Commands
- Lead Agency: U.S. Navy
- OM: PACOM & NORTHCOM
- TM: OSD Power Surety Task Force
- Asst TM: DOE
- XM: DESC

Schedule:

- Acquisition FY11Q2 - 11Q4
- Tech Demo FY11Q4 - 12Q2
- Installation FY11Q2 - 12Q4
- Integration FY12Q4 - 13Q2
- Eval & Transition FY13Q3 - 13Q4

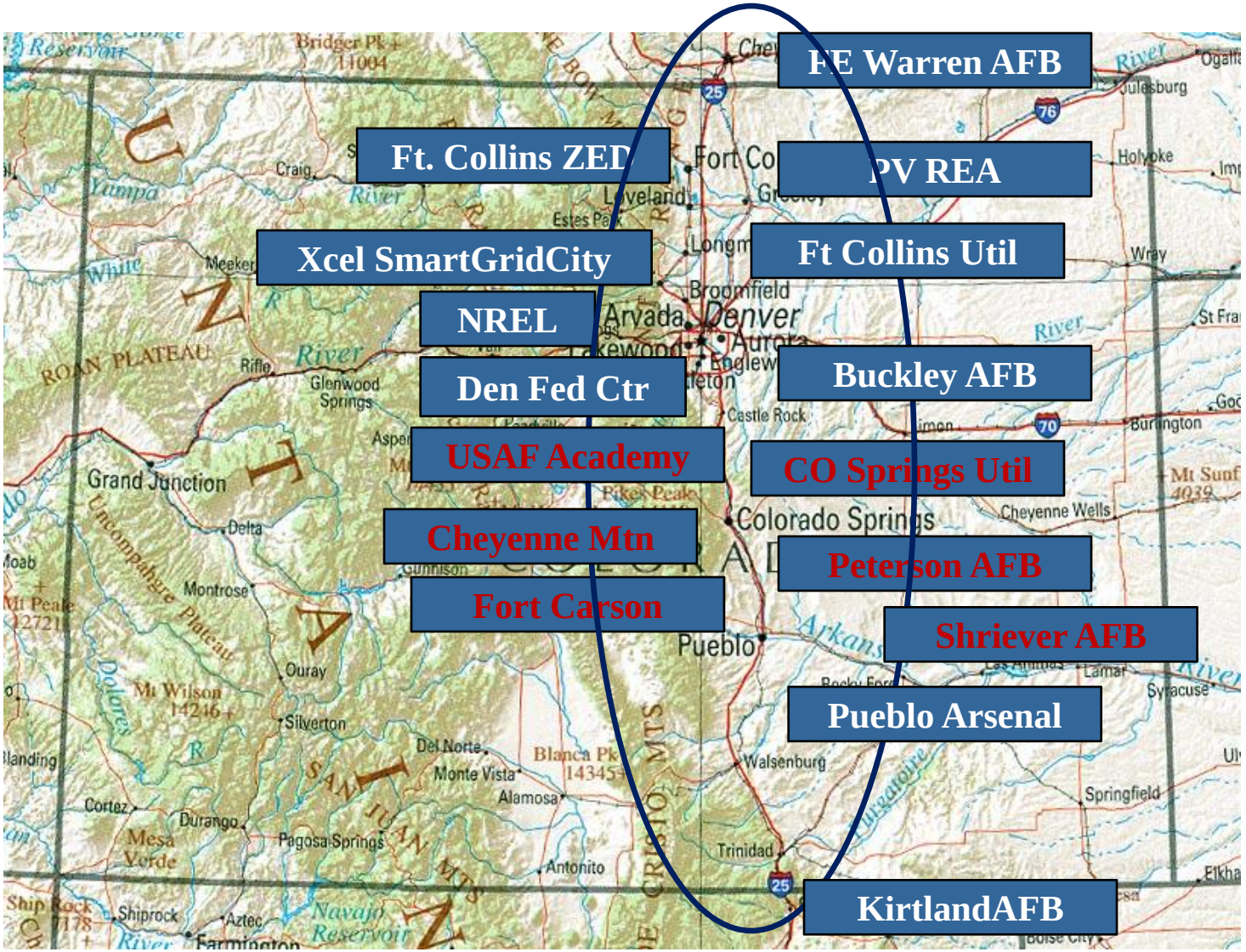
Transition:

- Results will support the creation of a regional smart grid test bed, leveraging DOD and Federal installations and renewable energy infrastructure
- Operationally exercise & validate smart grid standards
- DOD installations as the early technology adopter

Funding:

- U.S. Navy - ARRA-funded PV project + $2M PV array at Camp Smith funded by PPA . Ft Carson - 3 MW PV array
- DOE FEMP - $347K (HI) & $700K (CO) (pre JCTD)
- DHS - $1-2 M
- DOE - $2M
- Uncommitted: OSD (I&E) , USA/IMCOM - TBD
- Remaining PACOM - $53M , NC - $25 - 30M

RMSSGI OV-1


FE Warren AFB
Ft. Collins ZED
PV REA
Xcel SmartGridCity
Ft Collins Util
NREL
Buckley AFB
Den Fed Ctr
USAF Academy
CO Springs Util
Cheyenne Mtn
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