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Conference Presentation

Perspectives- Electricity Security of Supply

GovEnergy
www.govenergy.gov

Phoenix, AZ
August 3, 2008

Contents

Electricity Value Chain

Resources

Generation

Transmission & Distribution

End Users

Electric security of supply is affected by all four segments of the electricity industry value chain

Electricity Value Chain	Resources	Generation	Transmission & Distribution	End Use Customer
Infrastructure Or Assets	Coal Natural Gas Oil Uranium Water Wind Sun	Pulverized coal IGCC NGCC Nuclear reactor Hydroelectric dam Wind farm Solar panels	Transmission lines Substations Transformers Monitoring and control systems	Military bases Hospitals Office campuses Server farms

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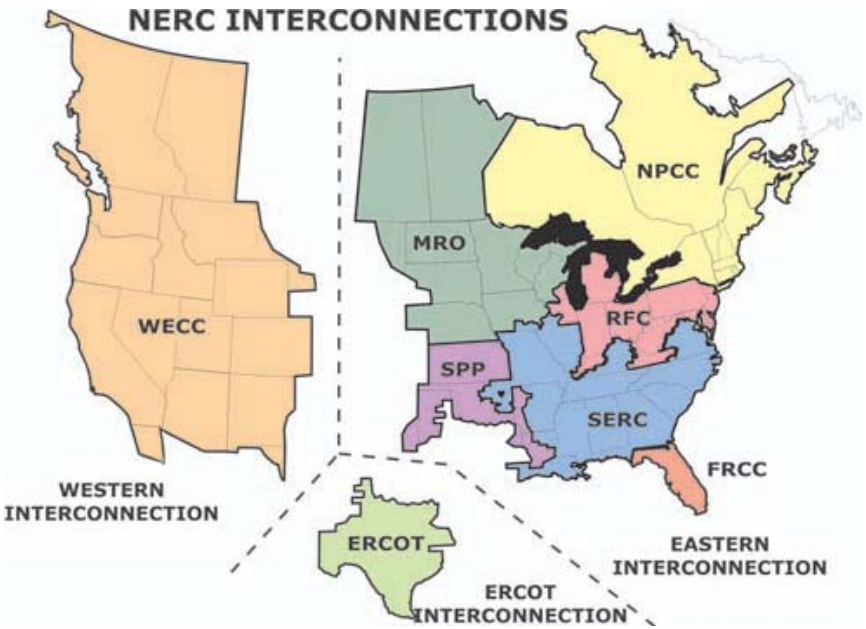
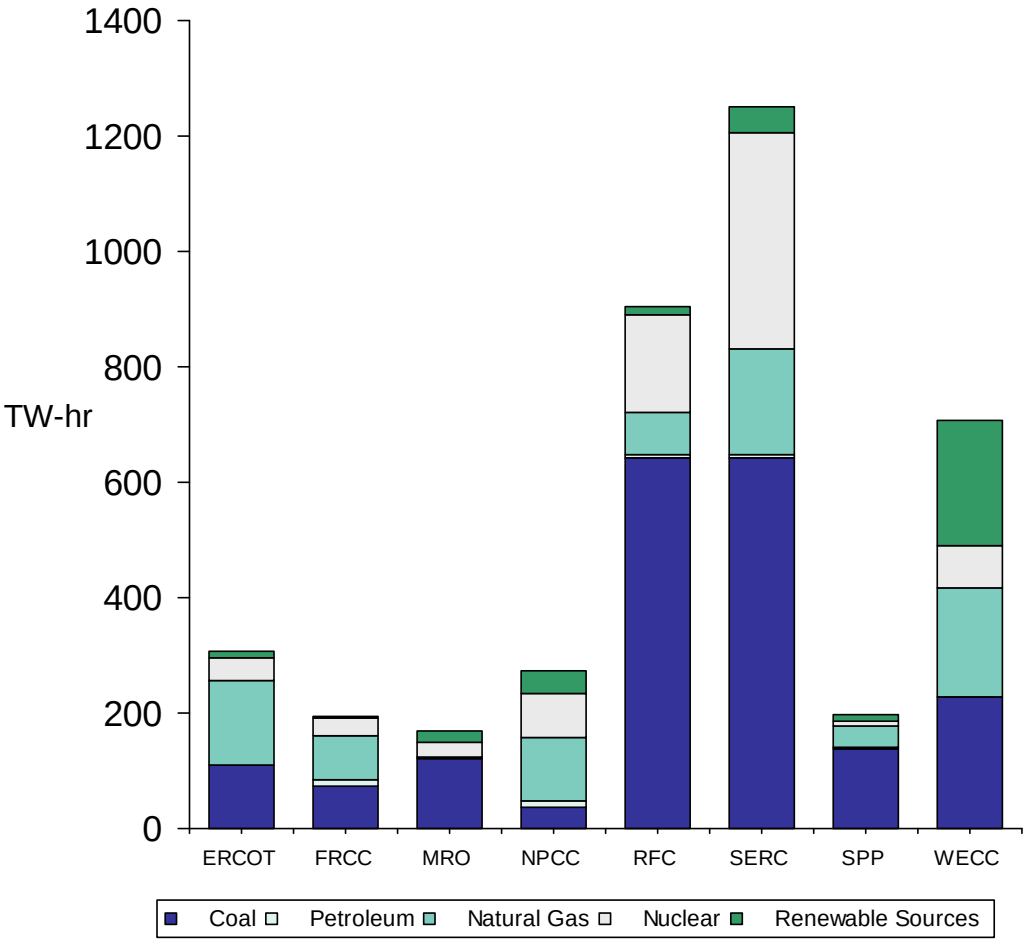
While about 50% of US electricity comes from coal, there is wide regional variation in fuel source

NERC Regions

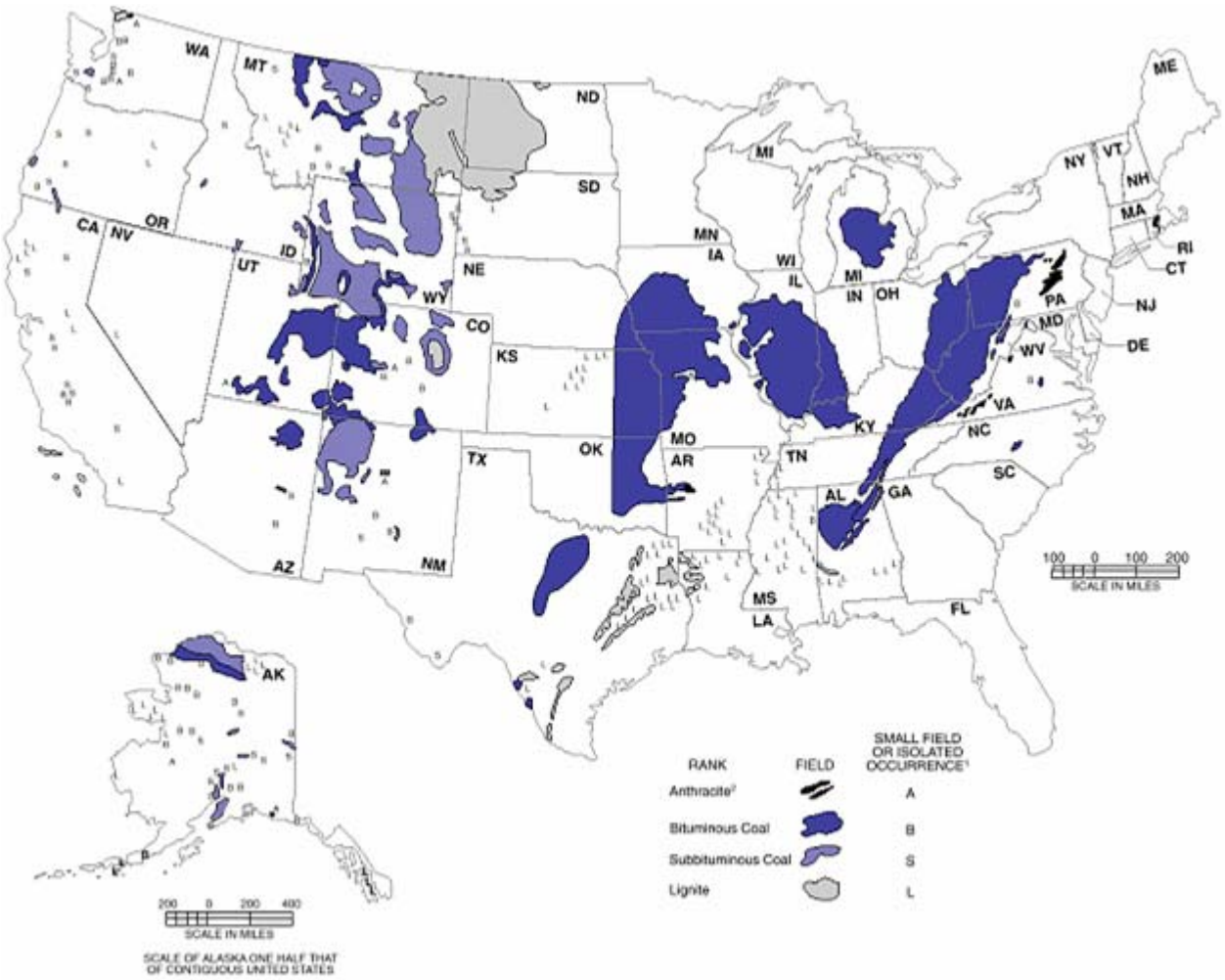


Regional Electricity Generation by Fuel

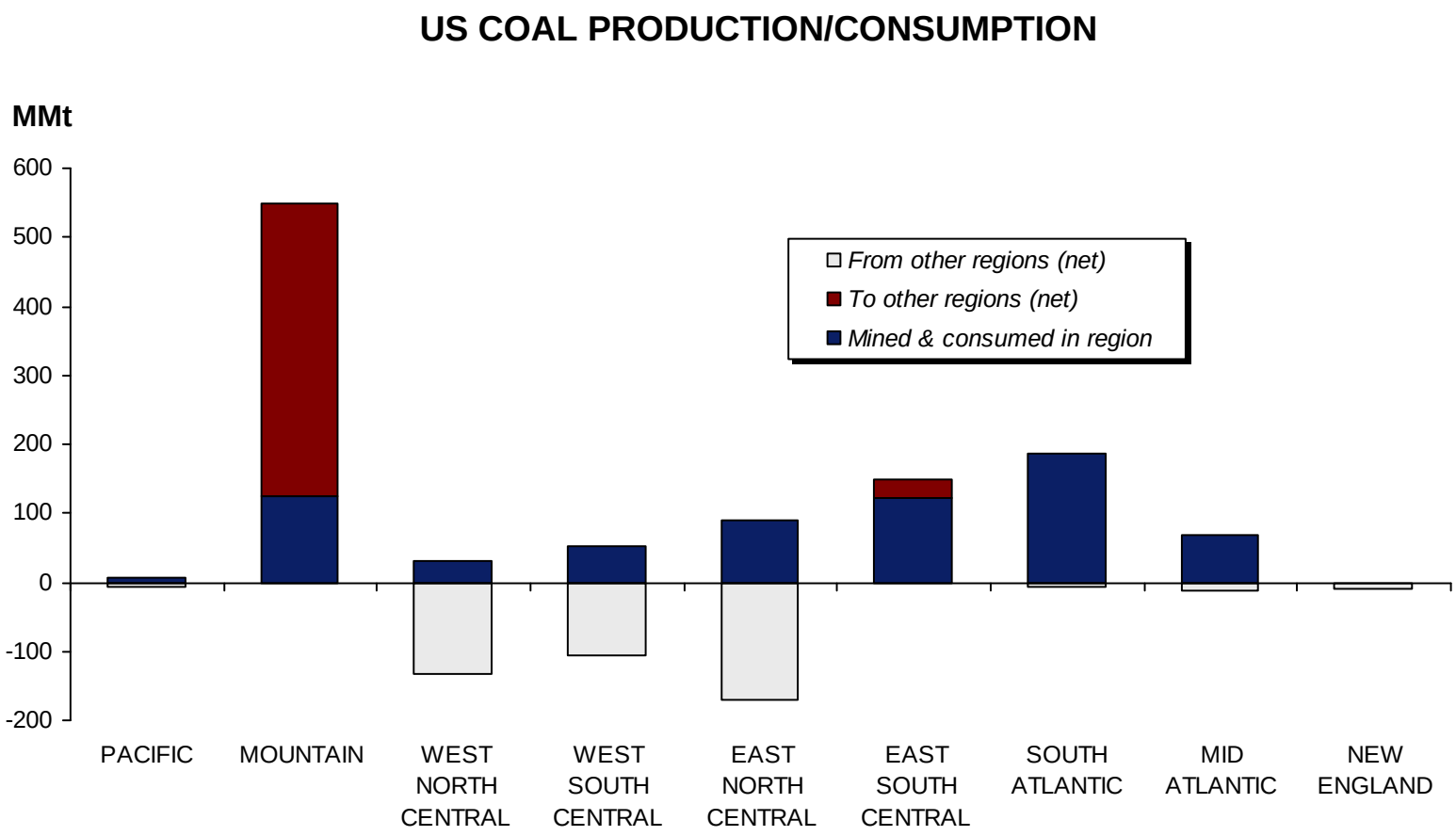


Source: EIA, BAH Analysis

US coal reserves are found in 3 primary basins- Appalachian, Illinois, and Powder River



Turning to supply—Even within the US, coal mining remains a regional business



Source: EIA (2005)

Source: EIA

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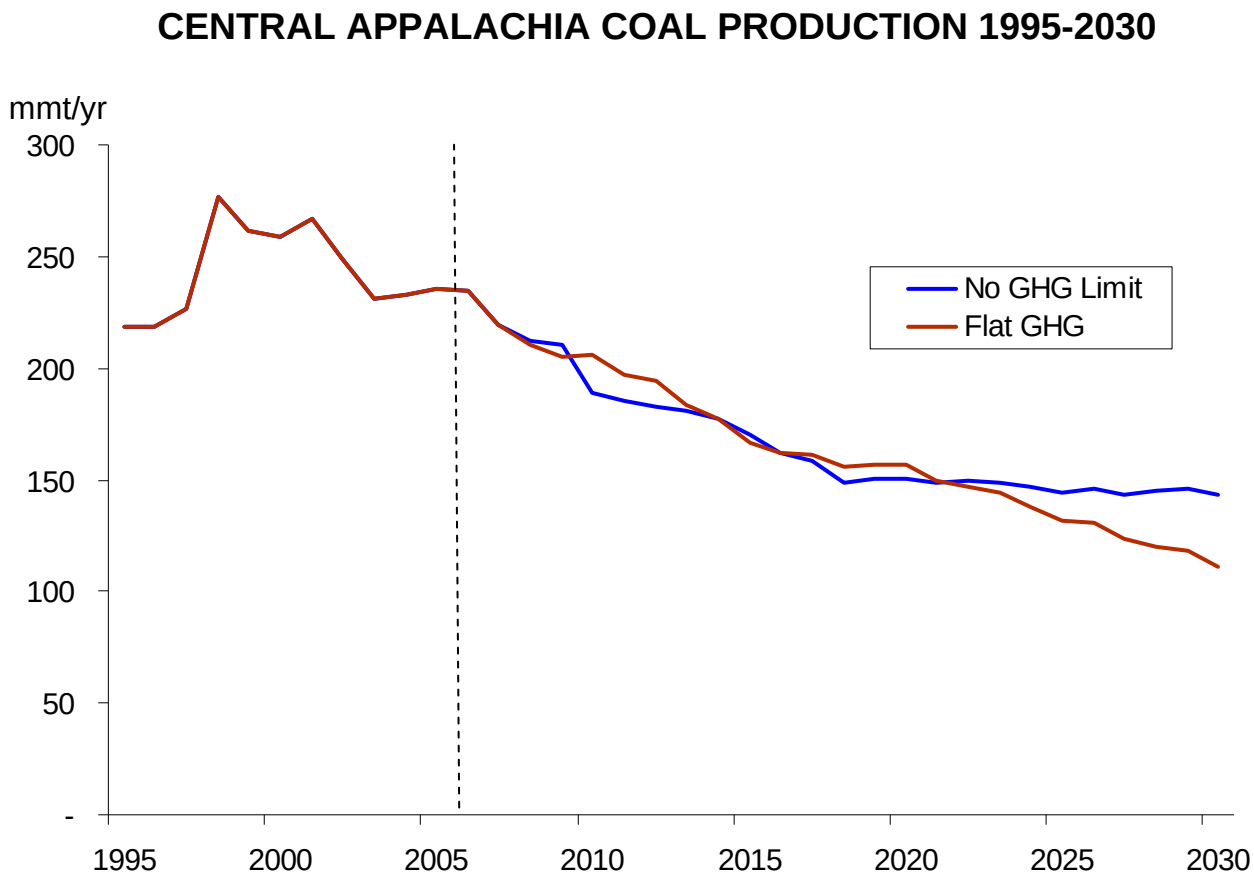
CAPP coal production is forecasted to decline, and any significant greenhouse gas limits will accelerate that decline



Implications

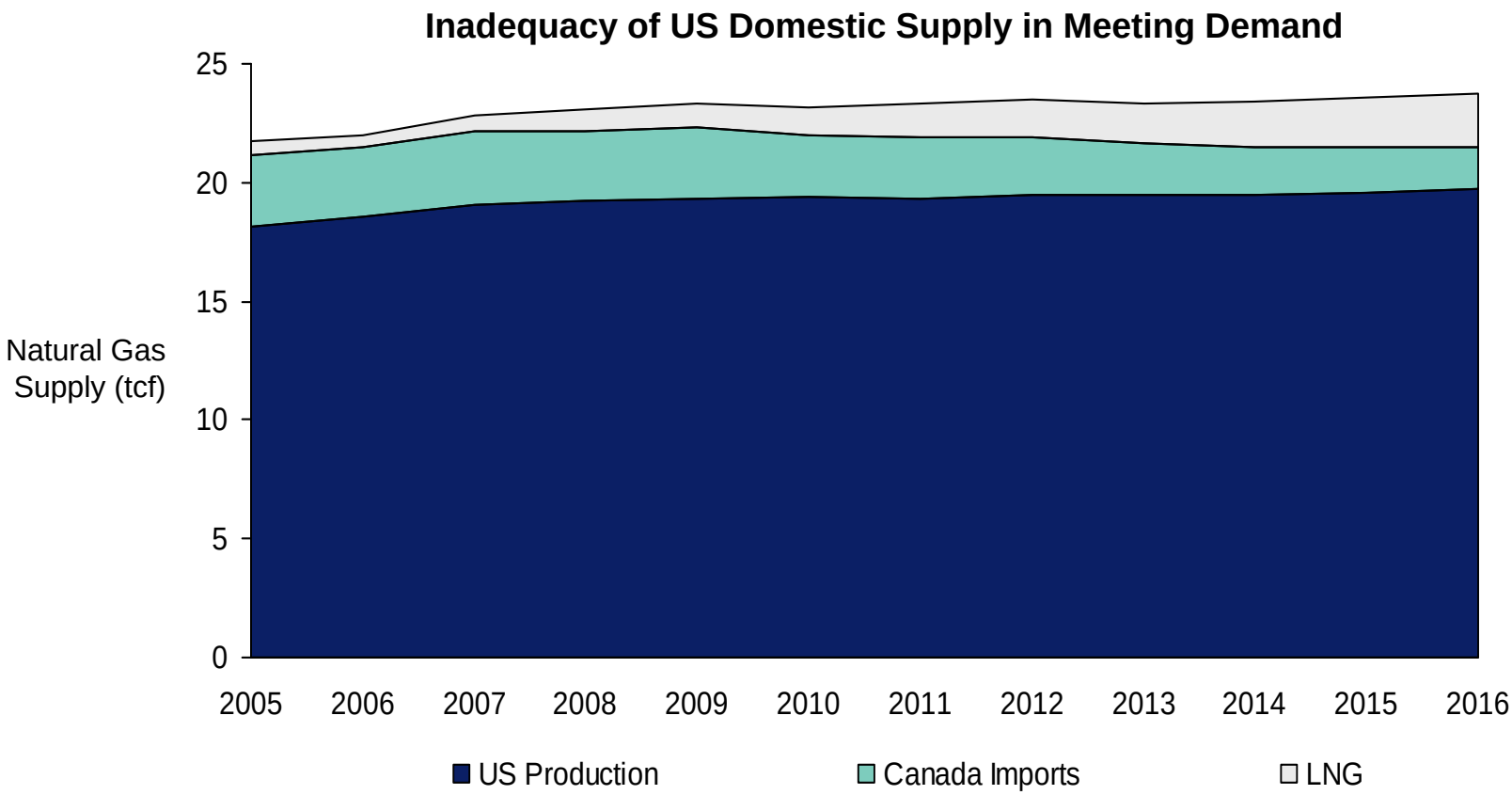
- Increased dependence on Powder River Basin
- Coal supply becomes susceptible to transport bottlenecks out of PRB
- Flooding on Mississippi River system could impact barge transport

Source: EIA NEMS model (AEO 2007)

The world's major reserves of natural gas are located outside of the US

Region	Reserves (TCF)	Share World Total	R/P Ratio (years)
US	211	3.4%	10.9
Russia	1577	25.2%	73.5
Nigeria	187	3%	>100
Iran	982	15.7%	>100
Middle East (ex. Iran)	1603	25.6%	>100
Total World	**6263**	**100%**	**60.3**

The US will become increasingly dependent upon LNG to meet natural gas demand…



Source: EIA Annual Energy Outlook 2008, Booz Allen Analysis

…The question is how much

Major Drivers for Gas Balance Uncertainty

Uncertainties Around Supply

Gas Development Constraints

- Challenges to monetizing gas reserves
  - Middle East: Gas quality, OPEC gas
  - US/Asia: Lack of equipment/resources

Political Stability for Infrastructure Investments

- Postponement of key infrastructure projects
  - Pipeline system: Central Asia/Iran–Europe
  - Pipeline system: Persian Gulf–India
  - Nationalization of gas interests

Uncertainties Around Demand

Climate Change Economics

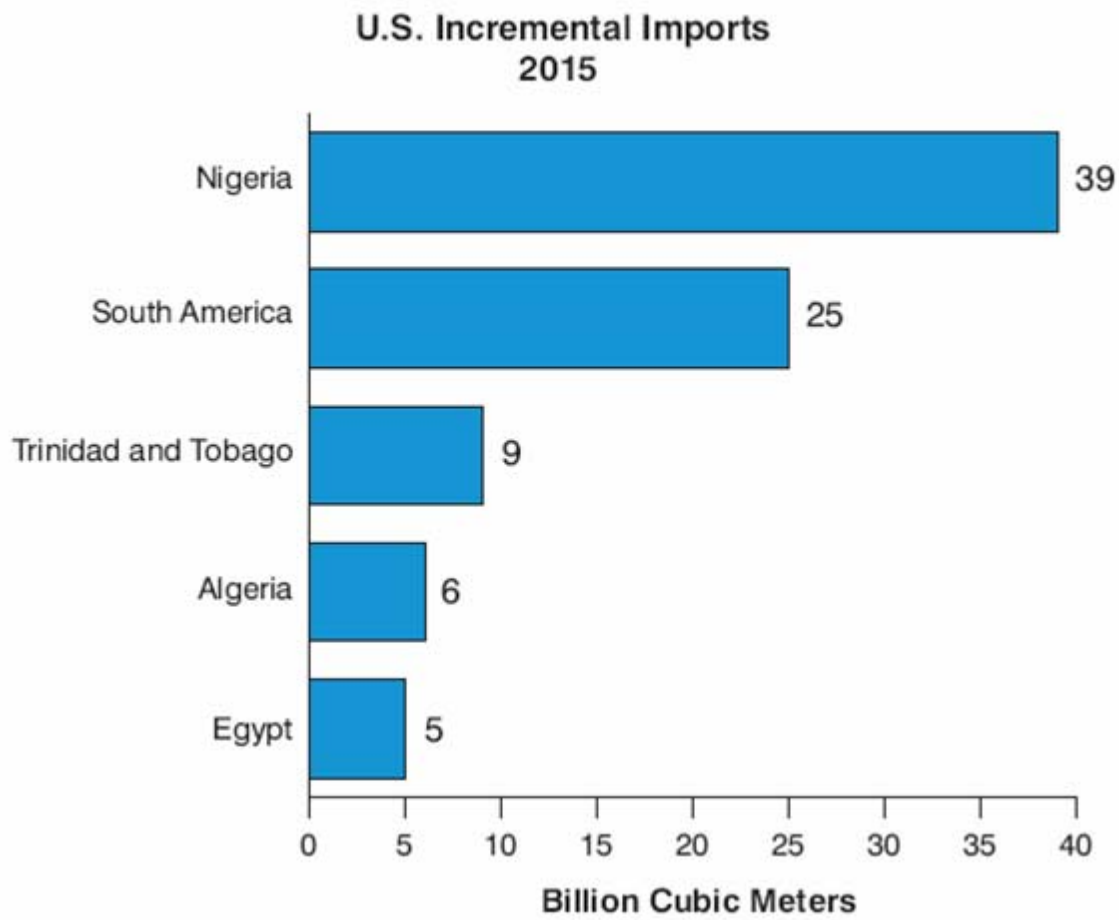
- Unclear cost of CO_2 post-Kyoto
  - Europe: Stalling of investment due to EU plans for large amount of auctioning of emission rights
  - U.S.: Unclear how and where CO_2 cost will end up
  - Rest of World: Diverse landscape of climate change economics

Stability of Economic Growth

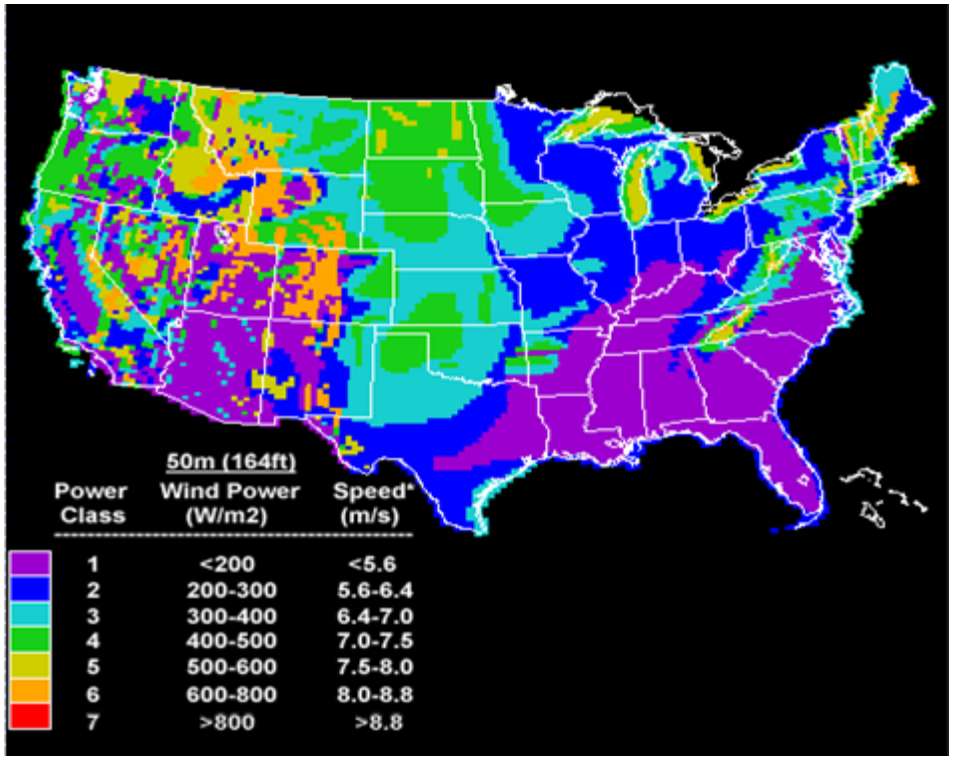
- Potential for more unstable demand growth
  - Soaring hydrocarbon prices drive substitution
  - Fragile hypergrowth of China, India

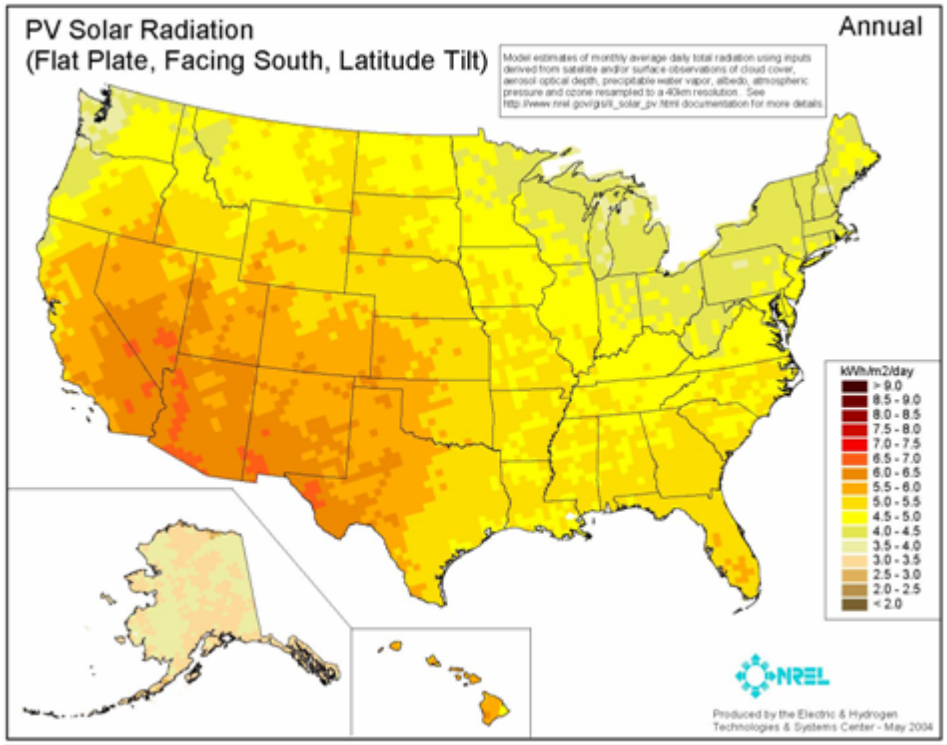
Nigeria could become the swing producer for US LNG supply

Impact of Demand-Driven Scenario on Gas Volume Flows



The quality of renewable resources vary widely across the US





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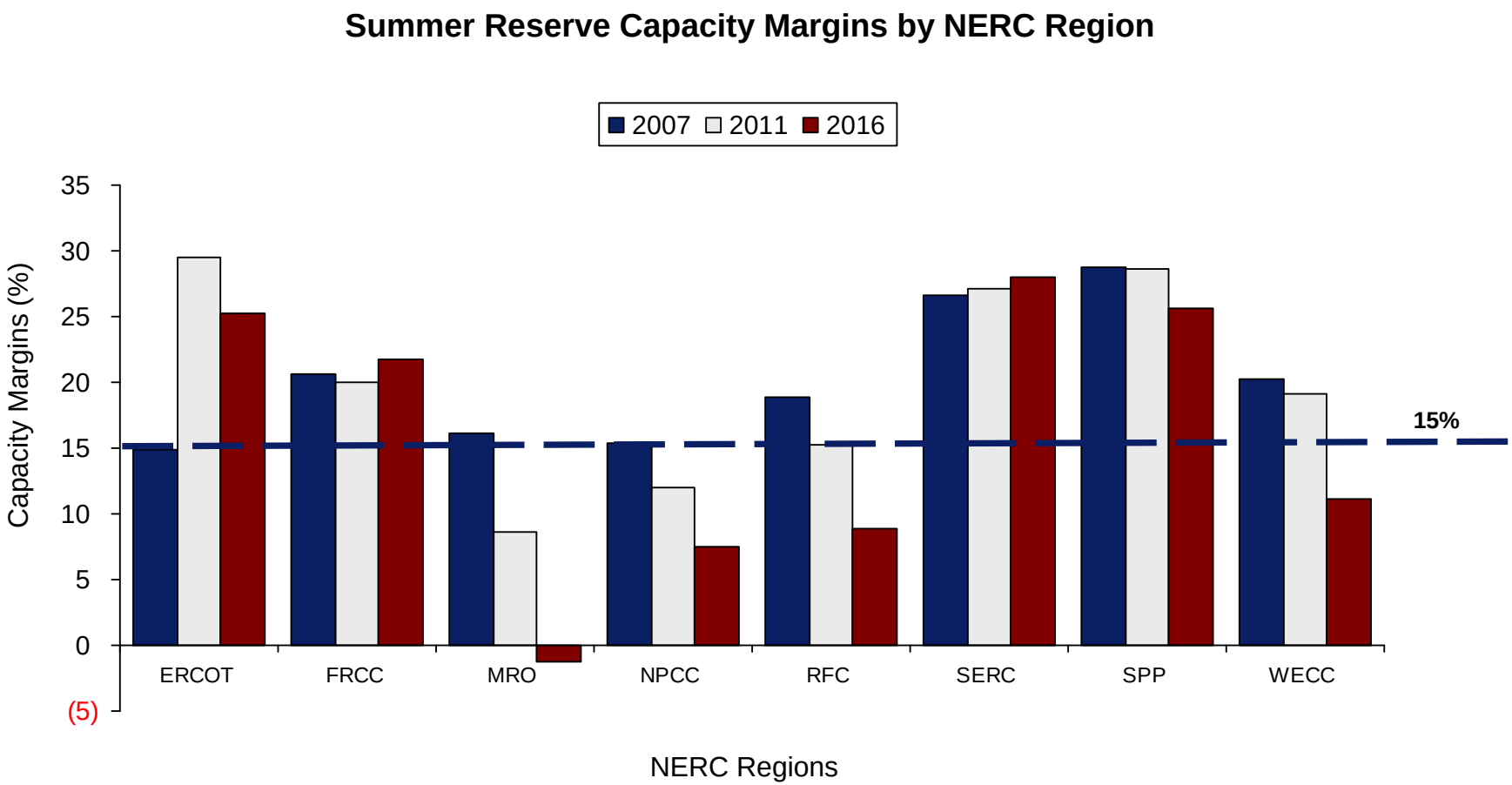
Demand forecasts show many regions of the country dropping below target reserve margins if new generating capacity is not built



Note: Includes uncommitted resources
Source: NERC, BAH Analysis

Some sub-regions face critical shortfalls, such a WECC's California and the desert southwest and NPCC's New England,

Generation Reserve Margins (%)

NWPP

2007	2011	2016
26.2	25.3	9.8

RMPP

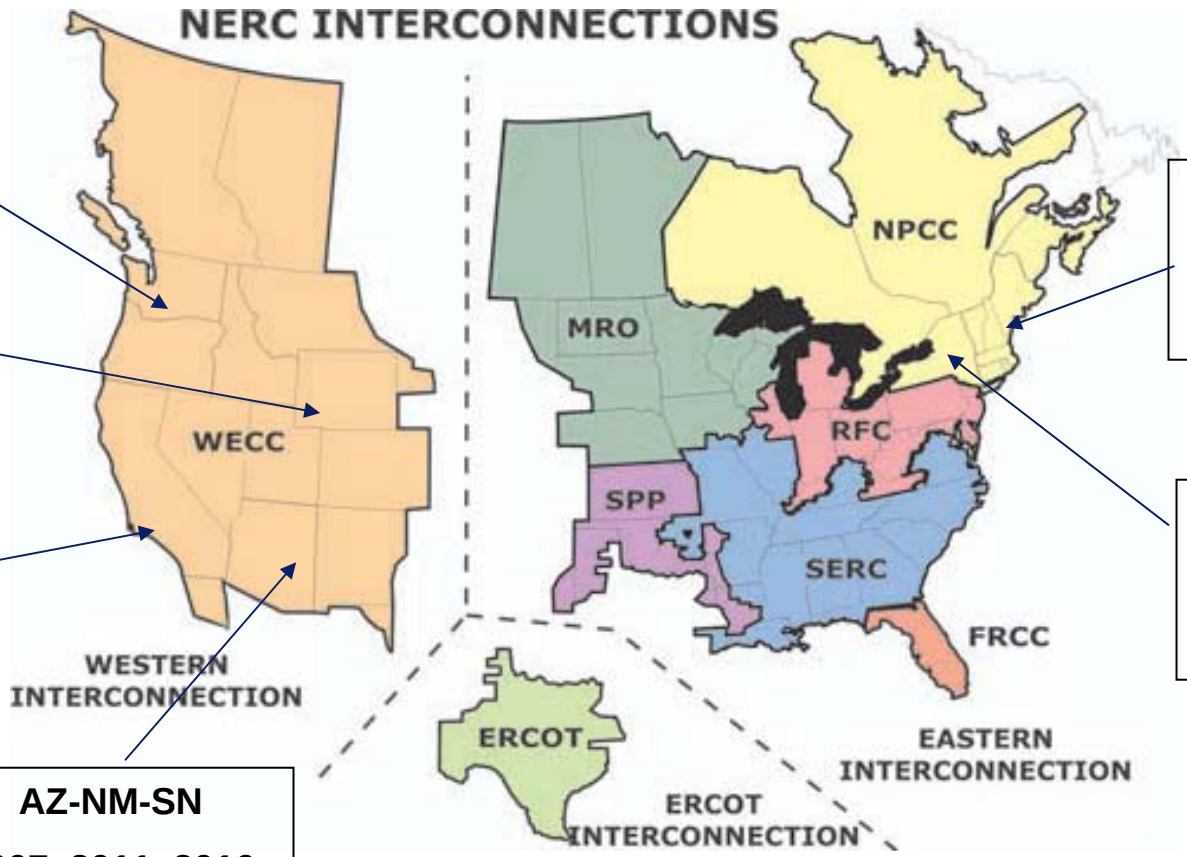
2007	2011	2016
13.5	13.5	0.8

CA-MX US

2007	2011	2016
17.2	13.1	-5.8

AZ-NM-SN

2007	2011	2016
17.2	13.1	-5.8



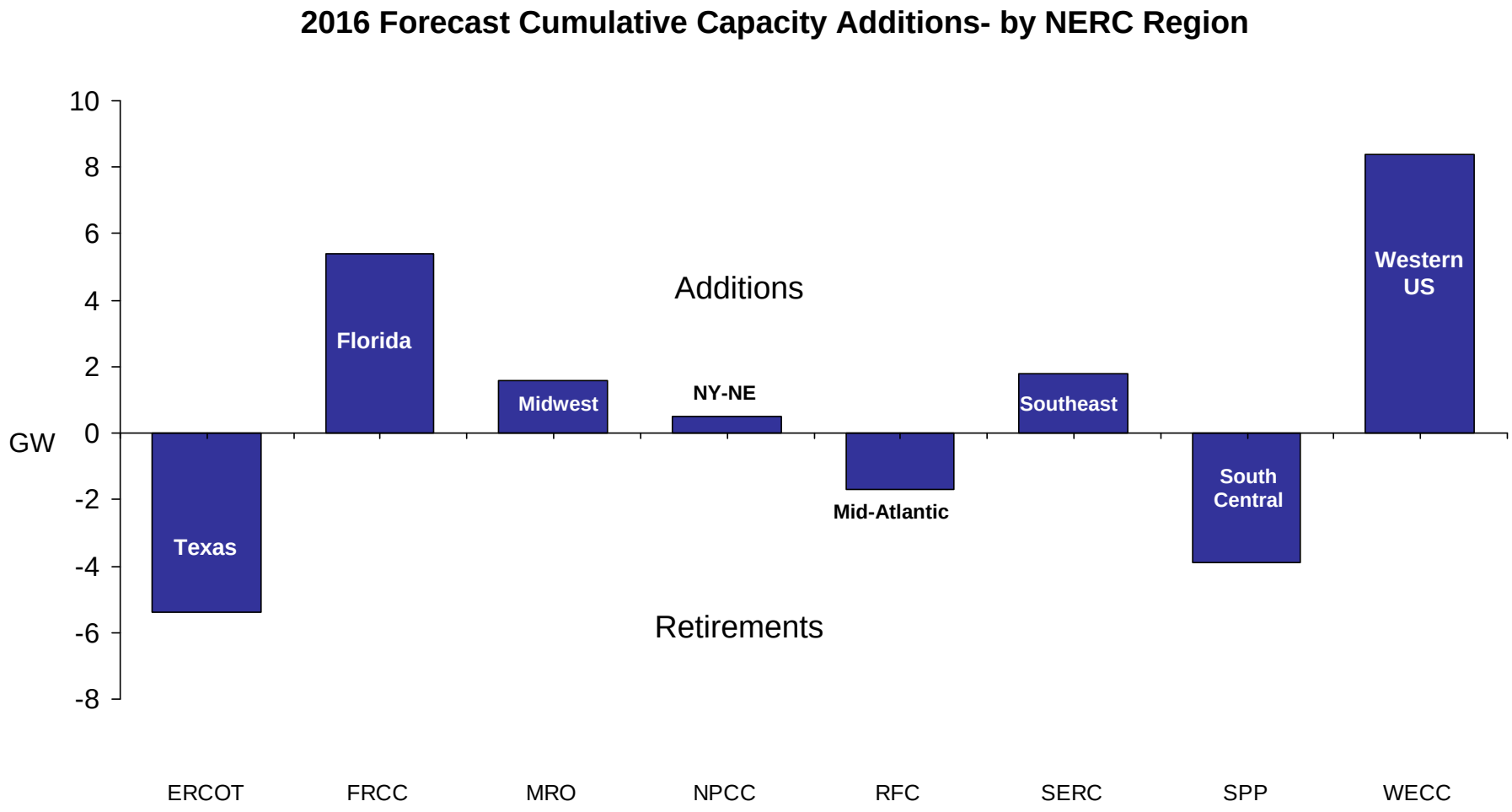
ISO-NE

2007	2011	2016
11.8	5.0	-2.2

NYISO

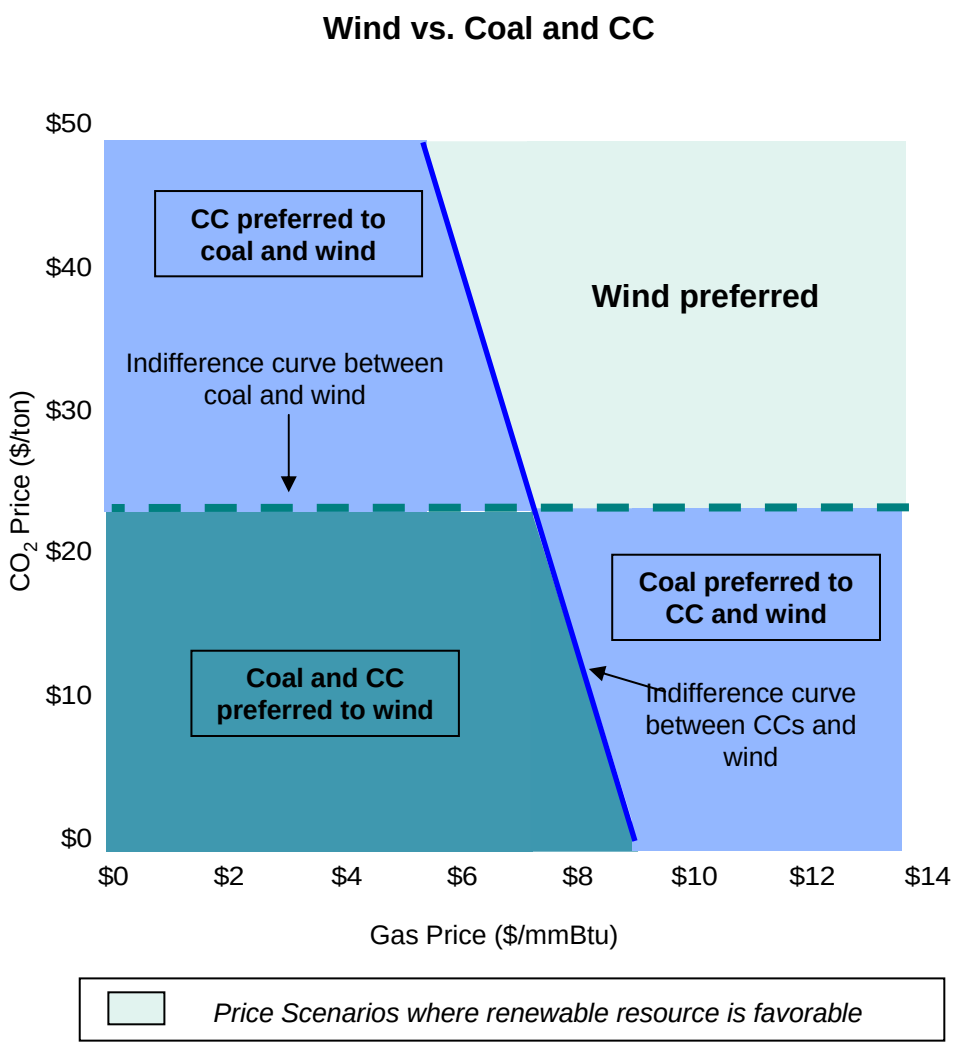
2007	2011	2016
18.3	17.3	14.6

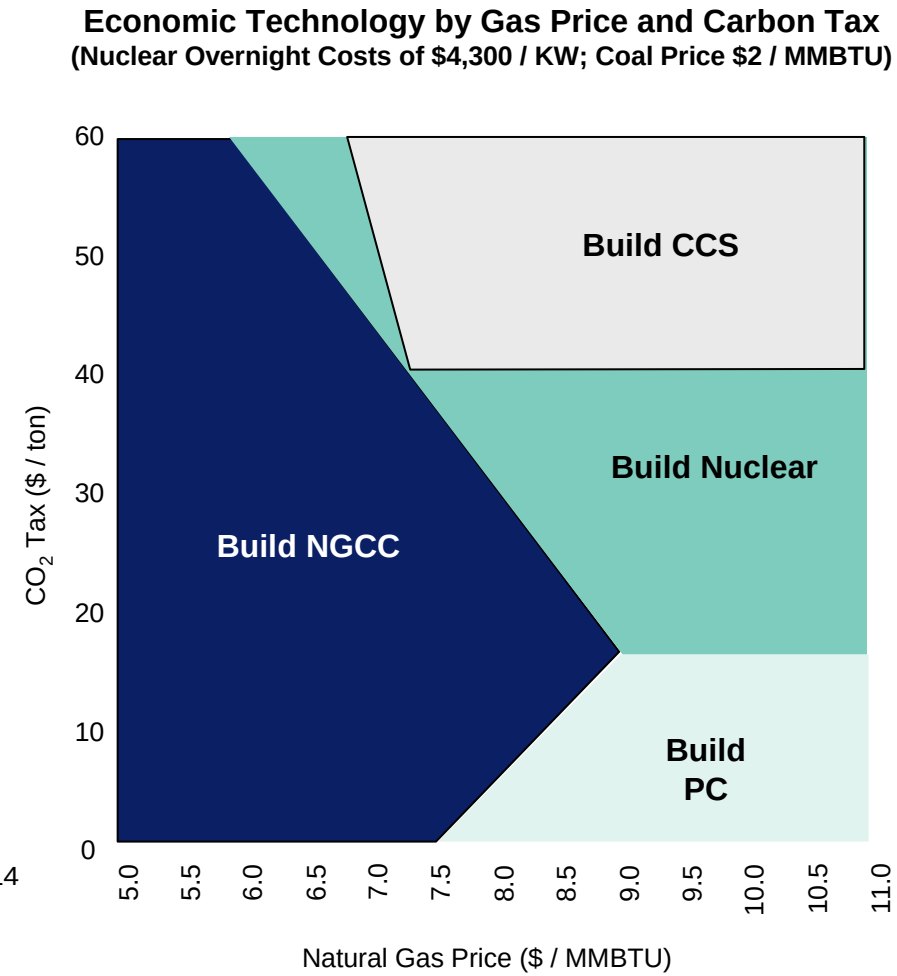
About 7 GW of net generation capacity are forecast to be added nationally to meet load growth demands by 2016



Source: EIA, BAH Analysis

Utilities face the question what to build- weighing trade-offs between cost of carbon and cost of natural gas over time





Assumptions: 15% ROE, 6.5% Debt interest rate, 40/50 Debt/Equity
Wind: 31% capacity factor, $1,750/KW installed, no production tax credit Gas: 85% capacity factor, $623/KW installed Coal: 85% capacity factor, $1,293/KW installed

Market and regulatory uncertainties are causing many utilities to defer the decision on what to build

Findings of Market Interviews

Electric Power & the Future of Coal

- Short to medium term uncertainty over what to build for new baseload capacity
  - Coal- capex escalation and regulatory pressure
  - Nuclear- long lead times, cost uncertainty, and capacity to deliver in large numbers
  - Gas- fuel price and price volatility as well as security of supply
  - Decision making deferred until last minute leads to new gas capacity as quickest and easiest to build
- In the longer term, industry believes coal will "absolutely" be a major part of the power sector

CCS

- CCS believed to be important as one way to keep coal in the mix under CO_2 regulation
- Today CCS is too expensive and not yet commercially proven with a large gap between costs and government support
- Industry uncertain on path forward and timing
  - Mechanisms needed to enable 1st generation plants to start down cost curve
  - Combination of policy and CCS cost reductions needed to bridge the "bid/ask" spread on CCS
  - Some attempting to get projects into the rate base of regulated utilities to bridge this spread
  - General consensus that CCS not likely to show significant until post-2030
- Capture technology views mixed
  - Some not picking a winner (i.e., Southern, AEP), keeping all options on the table
  - Some convinced it's not IGCC pre-combustion (i.e., AES)
  - Potential to retrofit existing plants drawing interest to post-combustion technologies

Conclusions

- With near to mid-term new builds likely to be gas, retrofit of existing plants may be best path to maximize number of first generation projects
- Scenario unfolding in which capture technology that can be used to retrofit existing plants can enable CCS
- Longer term, opportunities exist for both new and retrofit projects

Source: Booz Allen Hamilton Interviews

This will likely drive the industry to natural gas by default

New Build Considerations of Utilities

	Sequence of Considerations	Result
1 Time	■ Plans to build new power generation capacity are currently delayed due to – High uncertainty over regulatory environment – Significant drive up of Capex for power plants ■ Rising need for generation capacity will force utilities to first realize technology that can be build fastest	■ In the near future there will be mostly new gas fired power plants
2 Technology	■ When utilities do build coal power plants they aim at reducing uncertainty ■ Using well known and established technology (PC) will reduce technology uncertainty ■ CCS can always be added to PC as post combustion retrofit, but does not need to	■ Most first and second generation CCS power plants are likely to be retrofits with post combustion
3 Technology	■ Once need for CCS is proven and technology is established utilities aim to optimize profitability by reducing costs position ■ IGCC pre combustion are expected to provide the most cost efficient CCS technology in the long run, if expected technology advance materialize	■ If CCS market is established highest market share for IGCC w/ CCS is expected, but IGCC will not be the only CCS technology

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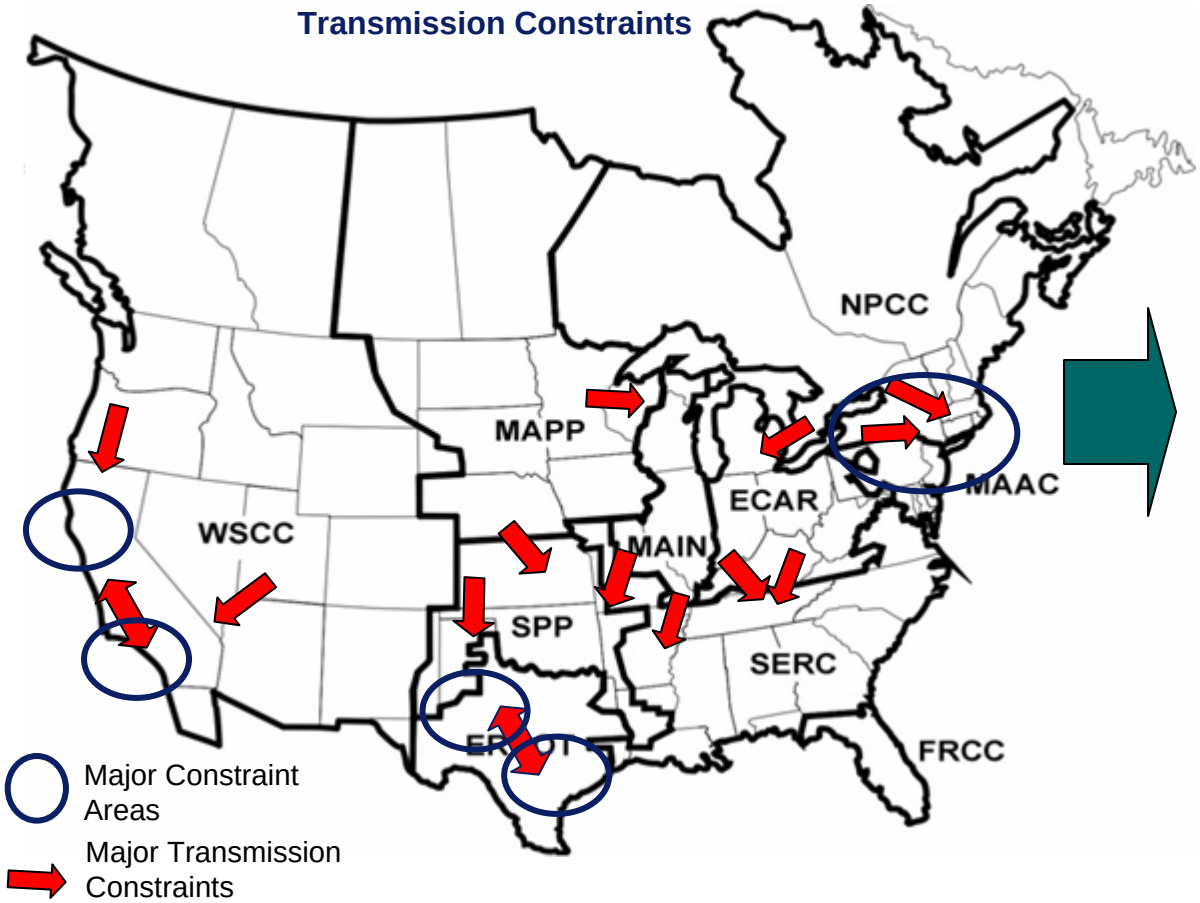
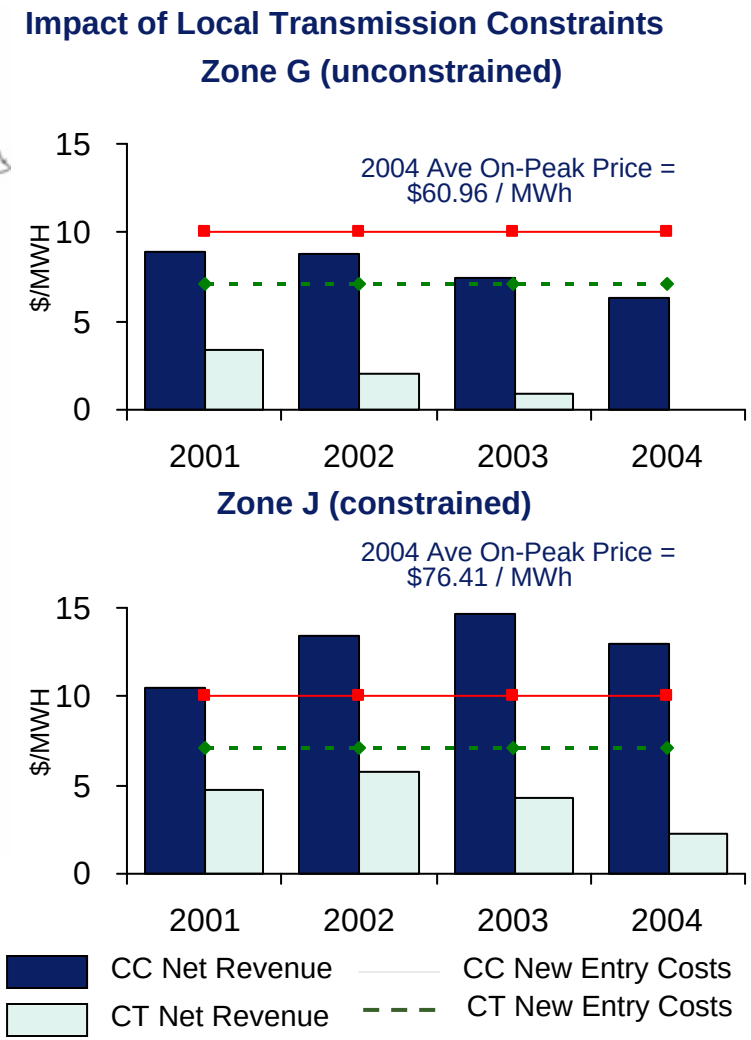
In a few regions, especially the Northeast, local transmission constraints create underserved "load pockets"

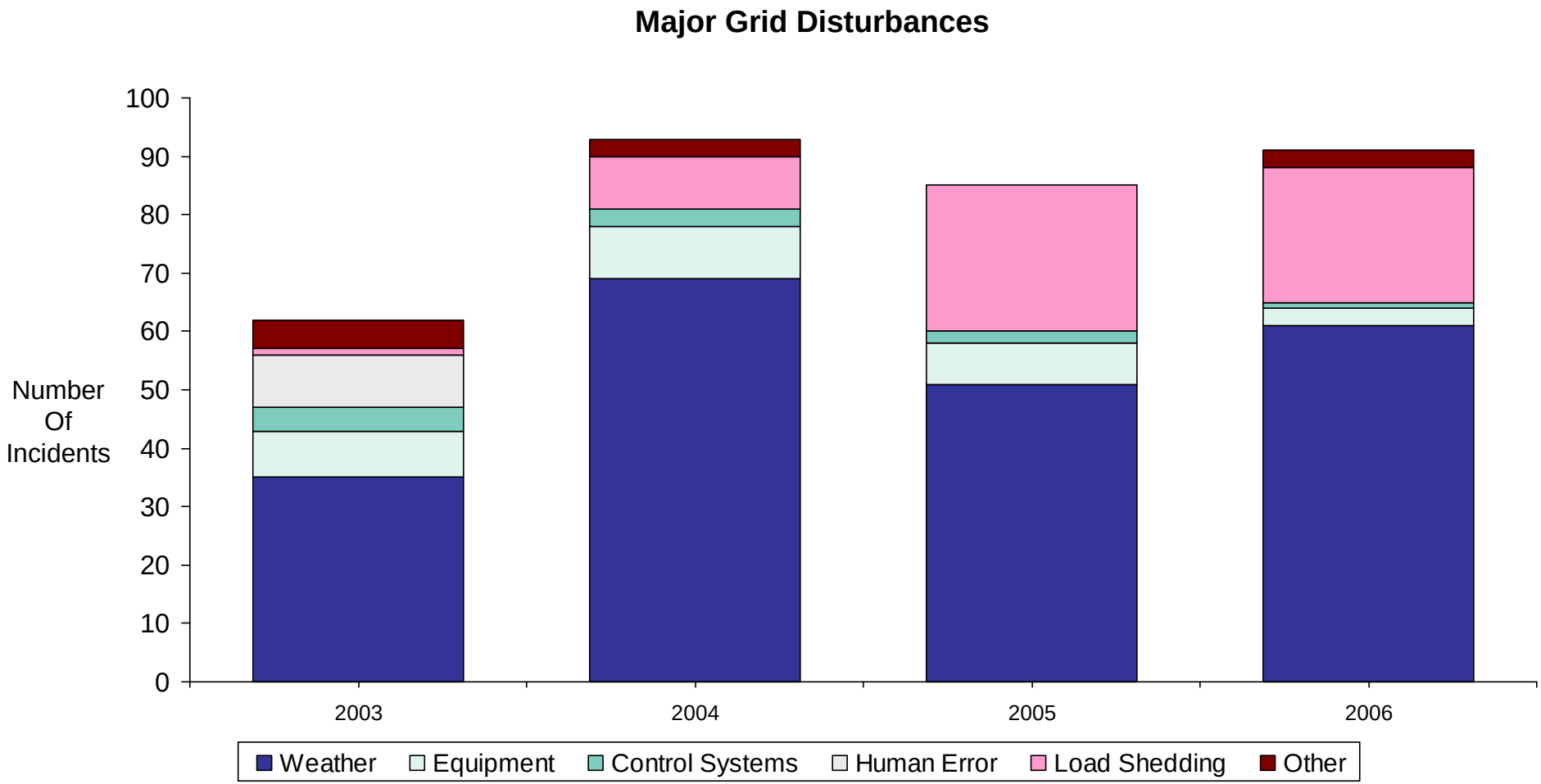




Note: Net revenue= total revenue – operating costs

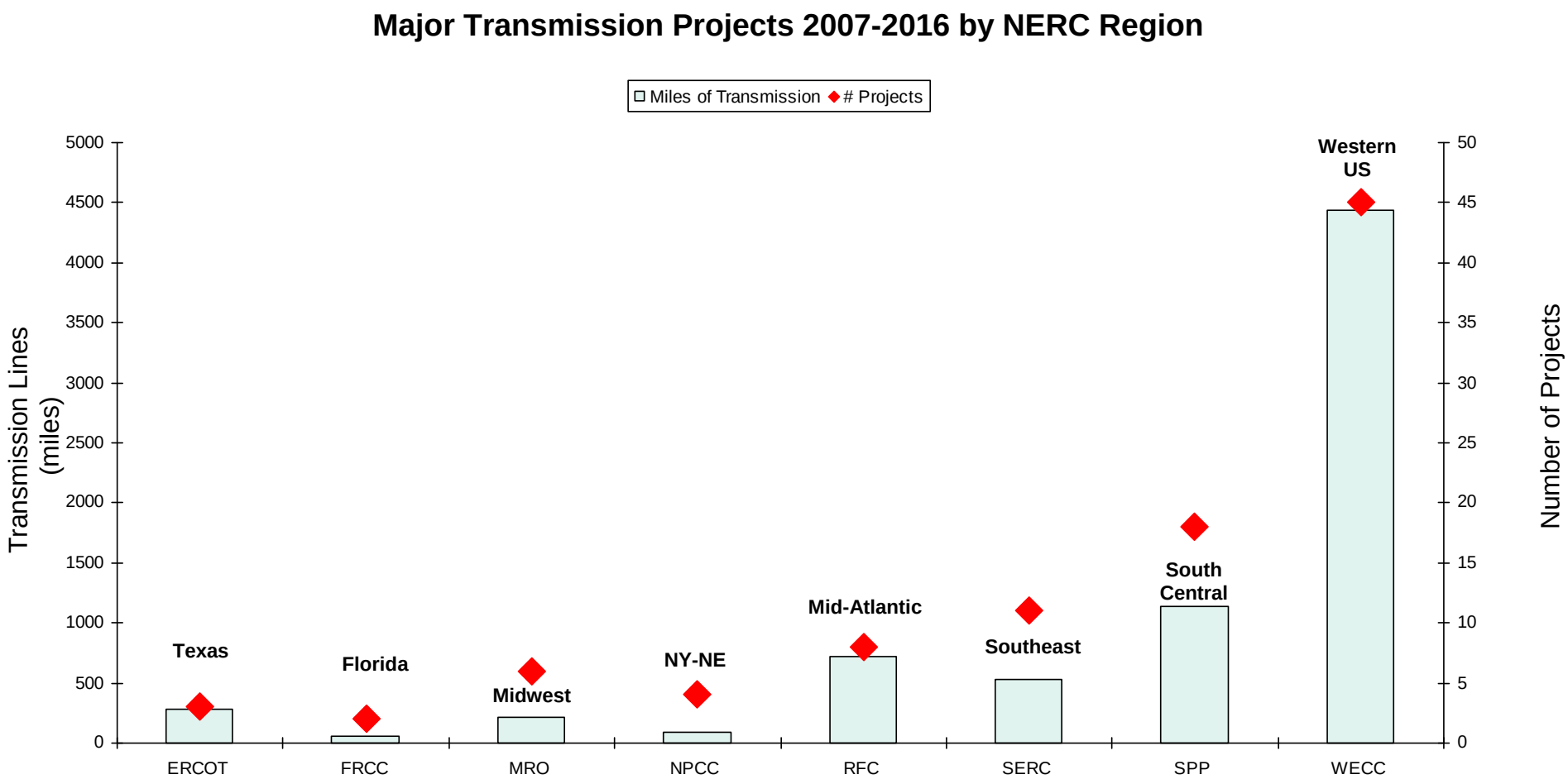
Source: Platts, Energy Velocity, Lawrence Berkeley Lab, FERC, BAH Analysis

Severe weather accounts for the majority of grid problems



Source: EIA, BAH Analysis

Projects in the 2007-2016 are expected to add over 7000 miles of new or upgraded transmission lines



Source: NERC, BAH Analysis

Key issues around T&D going forward are integration of large quantities of renewables and replacing aging infrastructure

Critical Issues

Integration of Renewables	■ Variability or uncertainty around capacity and availability – Is the wind blowing? If so how much? ■ Potential mitigation strategies – Increased reserve margins – Geographic diversity, wind is always blowing some place – Increased transmission, allows import/export of power to accommodate wind variability – Storage, cost and technology issues ■ Levelized cost of wind power increases if the cost of these strategies are included
T&D Infrastructure Investment	■ Annual investment in T&D infrastructure through the late 1980s and 1990s was roughly half the historic values ■ In that same time frame generation capacity doubled ■ Estimates suggest that over $300 billion needs to be invested in the US T&D infrastructure by 2030 to meet demand growth and replace aging infrastructure ■ While over the last several years investment has increased to around historic levels ($5-$6 Billion/yr) a lot of catch up must be done

Source: IEA, Booz Allen Hamilton analysis

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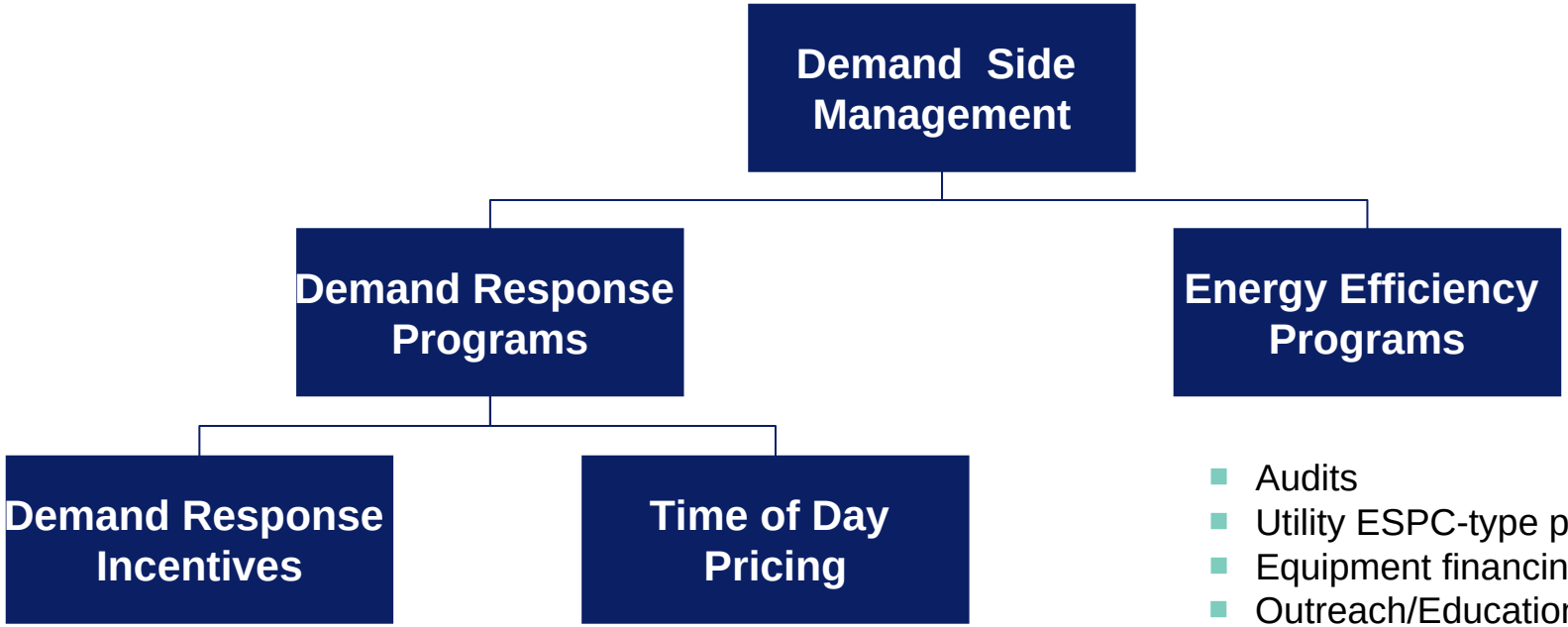
The electric industry is looking at a number of levers by which to better manage demand from its end users



- Audits
- Utility ESPC-type programs
- Equipment financing
- Outreach/Education

- Demand Bidding and Buy-Back
- Emergency Demand Response
- Load Reduction Acting as Capacity
- Ancillary Services
- Direct Control Load Management
- Interruptible Demand

- Time of use
- Critical Peak Pricing
- Real Time Pricing

What can the end user do?

- Critical infrastructure and load assessment
- Use mission criticality as a factor in energy project funding decision making process- add to the usual parameters, ROI, payback etc.
- Reduce mission critical load with energy efficiency upgrades
- Upgrade facility distribution system to “smart mini-grid
- Add distributed generation capacity based on available local resources including storage for intermittent renewables
  - Partnership with local utilities
  - Other local end-users

QUESTIONS?

Would you like to know more about this session?

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- Don’t forget to fill out and drop off your session evaluations.