Booz | Allen | Hamilton

Life Under a Carbon Cap and Trade System

Phoenix, Arizona
August 4, 2008

This document is confidential and is intended solely for the use and information of the client to whom it is addressed.

Booz | Allen | Hamilton

Table Of Contents

- The Carbon Challenge
- Overview of Booz Allen Carbon War Game
- Implications for Energy Customers/Consumers
- Issues for Consideration

Climate change and carbon legislation is receiving increasing attention in the US press

Press Articles - Examples

Global warming Bill Advances in Senate
The Associated Press
November 1, 2007

California in new carbon plan
Financial Times
17 October 2006

Global Warming Starts to Divide G.O.P. Contenders
New York Times
October 17, 2007

Carbon, costs curb growth of coal power plants – 16 have been scrapped recently; only 15 of 151 proposed have been built
Associated Press
October 18, 2007

TXU cancellation of coal plants leaves gap in Texas energy future
International Herald Tribune
March 8, 2007

Climate Is a Risky Issue for Democrats Candidates Back Costly Proposals
Washington Post
November 6, 2007

Northeastern States Launch First Regional CO2 Trading Program
4 January 2006
Chemical Week

Coal plants get burned – As concern mount about climate change, getting new coal-fired plants built is harder than ever for American businesses.
Fortune Magazine
March 2 2007

Power Plant Rejected Over Carbon Dioxide For First Time
Washington Post
October 19, 2007

The Real Climate De To Cap or to Tax
New York Times
November 2, 2007

Comments

- Climate change is a key issue for 2008 Presidential candidates
- Pending carbon legislation is receiving broad attention in the press
- Electric generators face increasing challenges due to carbon emissions
- Utilities now face cancellations of planned coal-fired power plants due to concerns over carbon emissions
- Media interest reflects the undercurrent of legislative activity at the state and federal level
- Decisions on what type and how much of new generation capacity are likely to be deferred until the shape of the impending carbon regulation becomes clearer.

GovEnergy
www.govenergy.gov

Sources: Press Articles

Booz | Allen | Hamilton

Elements of a US legal framework for CO_2 are emerging through all three branches of the federal government

US Governmental Framework

Legislative (Congress)

- Multiple proposed laws for controlling and reducing CO_2 emissions
  - Economy-wide and by market sector
  - Covering all 6 GHGs
  - EPA enforcement
  - Cap and trade with some allowances to be auctioned

Executive

- Carbon Sequestration Leadership Forum
- Regional Partnerships and FutureGen
- Core R&D program

- Groundwater protection
  - Based on Underground Injection Controls
- Air emissions regulations
  - Response to Supreme Court decision

Judicial

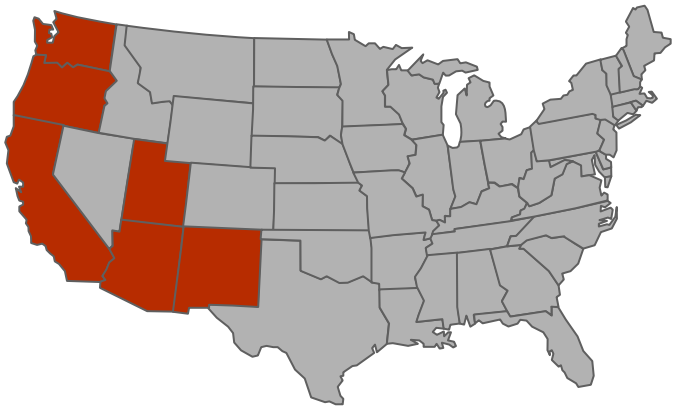
- Massachusetts et al *versus* EPA
  - April 2007 decision
  - EPA has authority to regulate CO_2 as a pollutant under the Clean Air Act

- Likely initial venue for contesting new regulations

Sources: Congressional Research Service, Time Magazine, Booz Allen Hamilton Analyses

Regional initiatives are paving the way for cap and trade systems

Western Climate Initiative States



Regional Greenhouse Gas Initiative States

Western Climate Initiative

- In 2007, Governors of Arizona, California, Oregon, New Mexico, and Washington established WCI
- Regional goal is to reduce CO2 emissions to 15% below 2005 levels by 2020
- By 2008, members will design a regional, market-based, multi-sector mechanism such as a cap and trade system

Regional Greenhouse Gas Initiative

- Started in 2003 by then-New York Governor George Pataki
- Cooperative effort to develop regional cap-and-trade system, initially covering CO2 emissions from power plants in region
- In 2006, RGGI issued a model rule for member state regulation of the CO_2 budget trading program

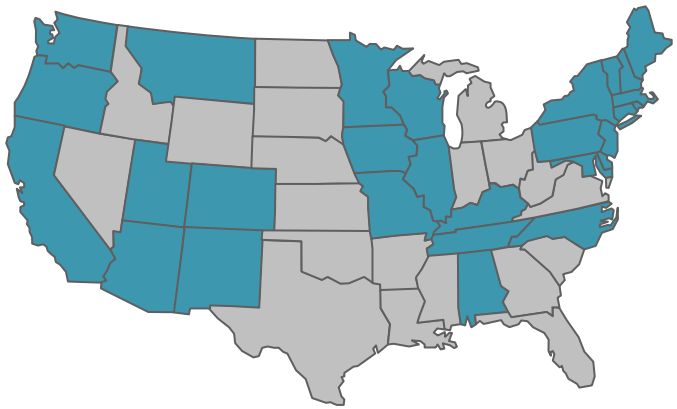
Source: Pew Center on Global Climate Change; Booz Allen Hamilton Analysis

GovEnergy www.govenergy.gov

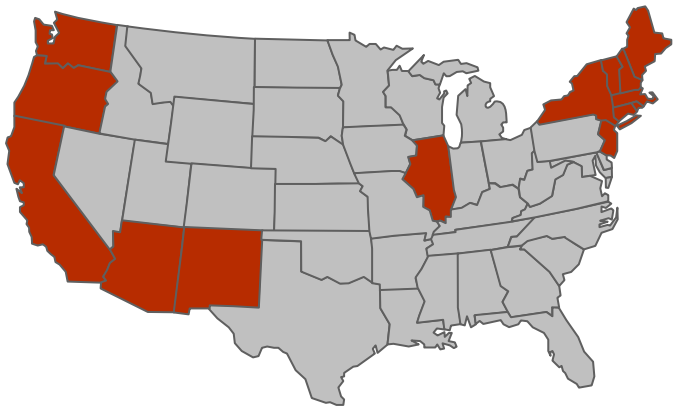
Booz | Allen | Hamilton

At least 29 states have completed climate action plans and 14 states have set GHG emission targets

States with Climate Action Plans



States with GHG Emission Targets



State Climate Action Plans

- States typically form expert advisory panels to review science and review emission sources
- May seek early actions (e.g., by 2010) and propose emission reduction goals
- Examine local reduction opportunities such as building efficiencies, uses of renewable energy, pollution prevention
- Increase public awareness and develop consensus

State GHG Emission Targets

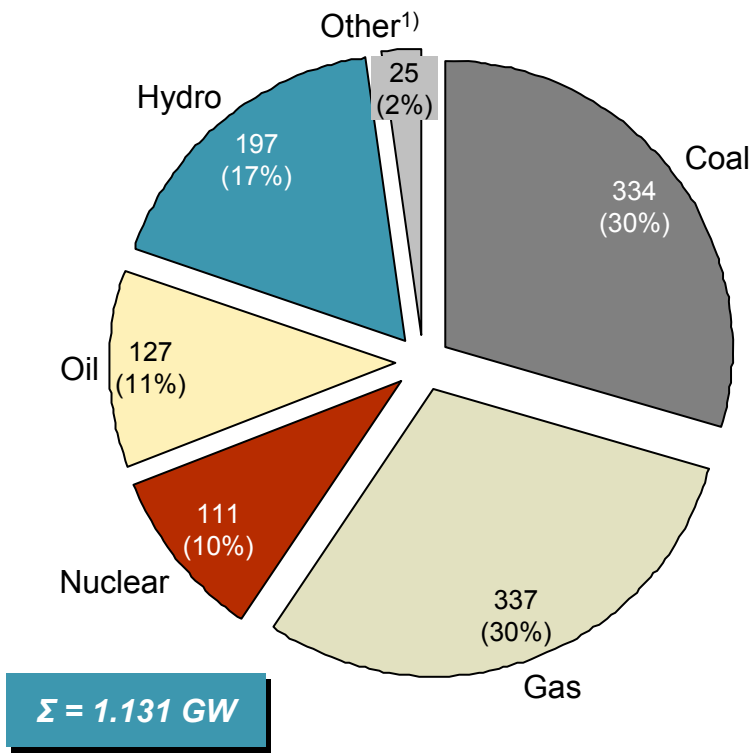
- California enacted first enforceable state-wide GHG emissions from major industries
  - Caps emissions at 1990 levels by 2020
- Most other states have targeted to reach 10% below 1990 emission levels by 2020
- States may regulate internal sources or sources consumed in state

Source: Pew Center on Global Climate Change; Booz Allen Hamilton Analysis

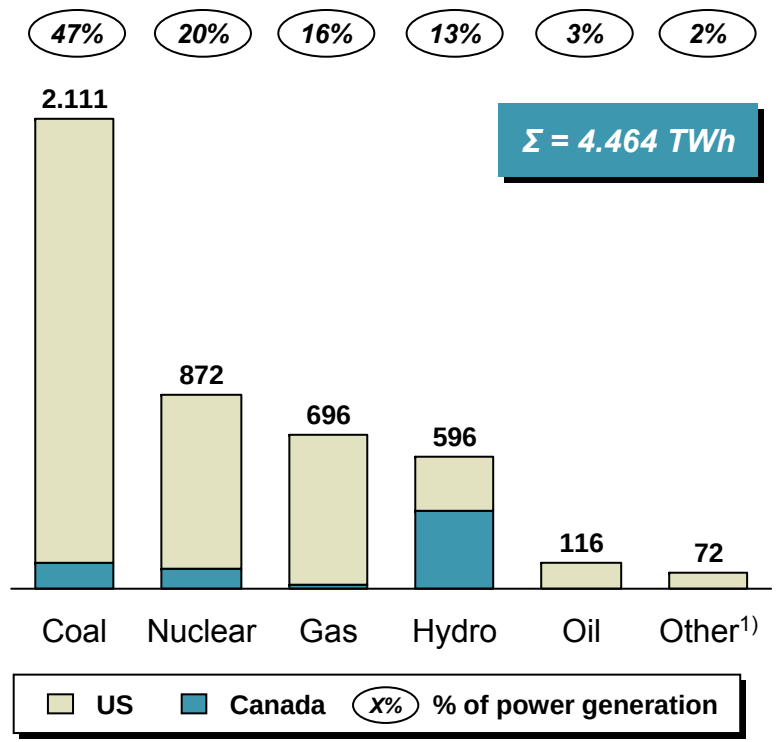
Carbon constraints will likely impact the mix of energy sources

Power Generation Market US and Canada

Installed Capacity 2005 (in GW)[2)]



Power Generation by Fuel Type 2005 (TWh)



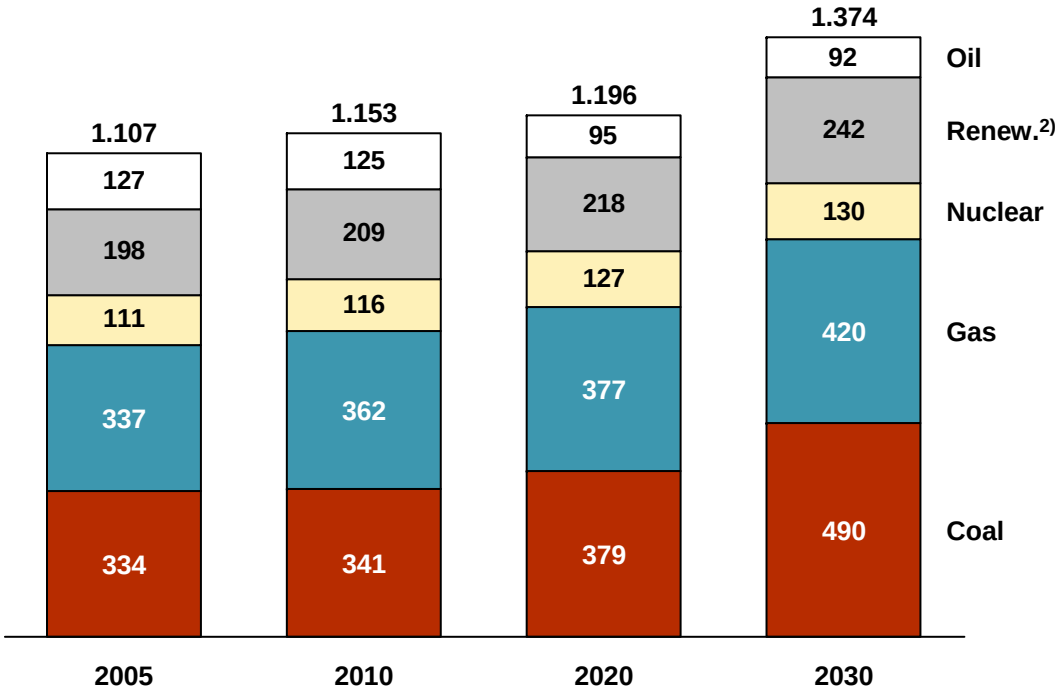
1) Mainly Renewables
2) Including End-User Generation
Source: EIA, Canadian Electricity Association, Booz Allen Hamilton Analysis

GovEnergy www.govenergy.gov

Booz | Allen | Hamilton

Under current regulation coal is expected to continue to play a significant role in power generation in the US and Canada

Projected Development of Capacity – US and Canada (GW)[1)]
EIA Reference Case



Comments

- Forecast based on EIA energy market modeling (NEMS)
- The NEMS dynamically models the entire energy market on the basis to three input parameters
  - Regulatory environment
  - Oil price
  - Cost of Power Generation Technologies (Capex, Opex, Thermal Efficiency, etc.)
- The NEMS model predicts energy flows and prices of energy sources as well as utilization of existing power generation capacity, new builds, and the fuel mix in the power generation market
- EIA Reference Case is based on current regulatory environment

1) Total installed capacity including end-customer generation
2) Renewables include Hydro
Source: EIA, Booz Allen Hamilton Analysis

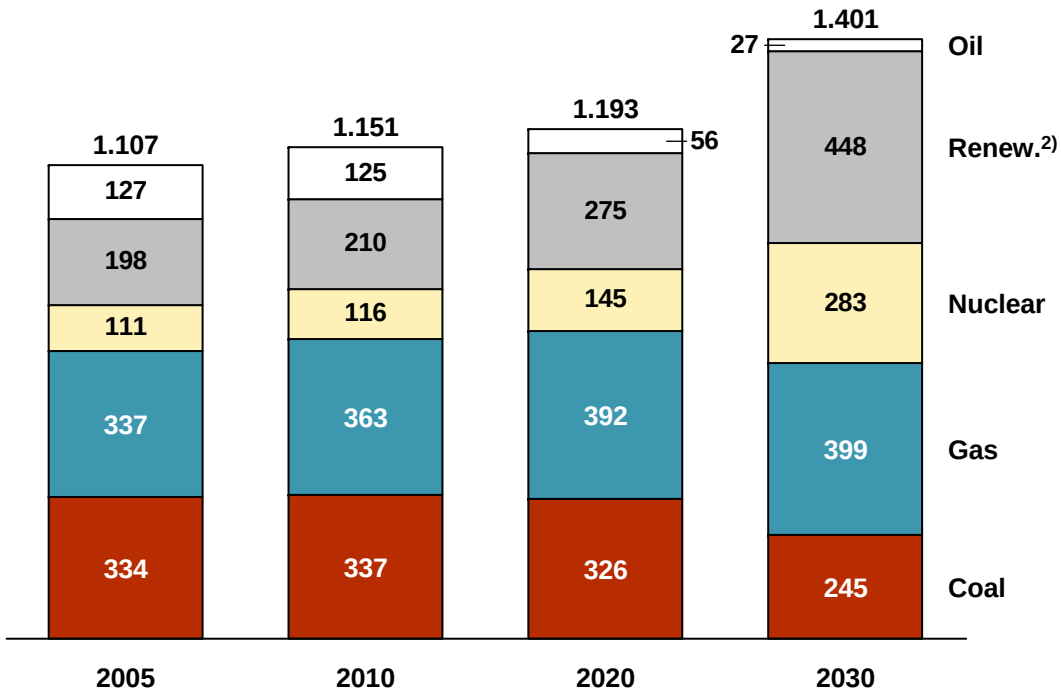
GovEnergy www.govenergy.gov

Booz | Allen | Hamilton

However, introducing strict carbon regulations may lead to a considerable decrease in coal fired generation capacity

Projected Development of Capacity – US and Canada (GW)[1)]

EIA Reference Case with Carbon Regulation



Reference Case with Carbon Regulation

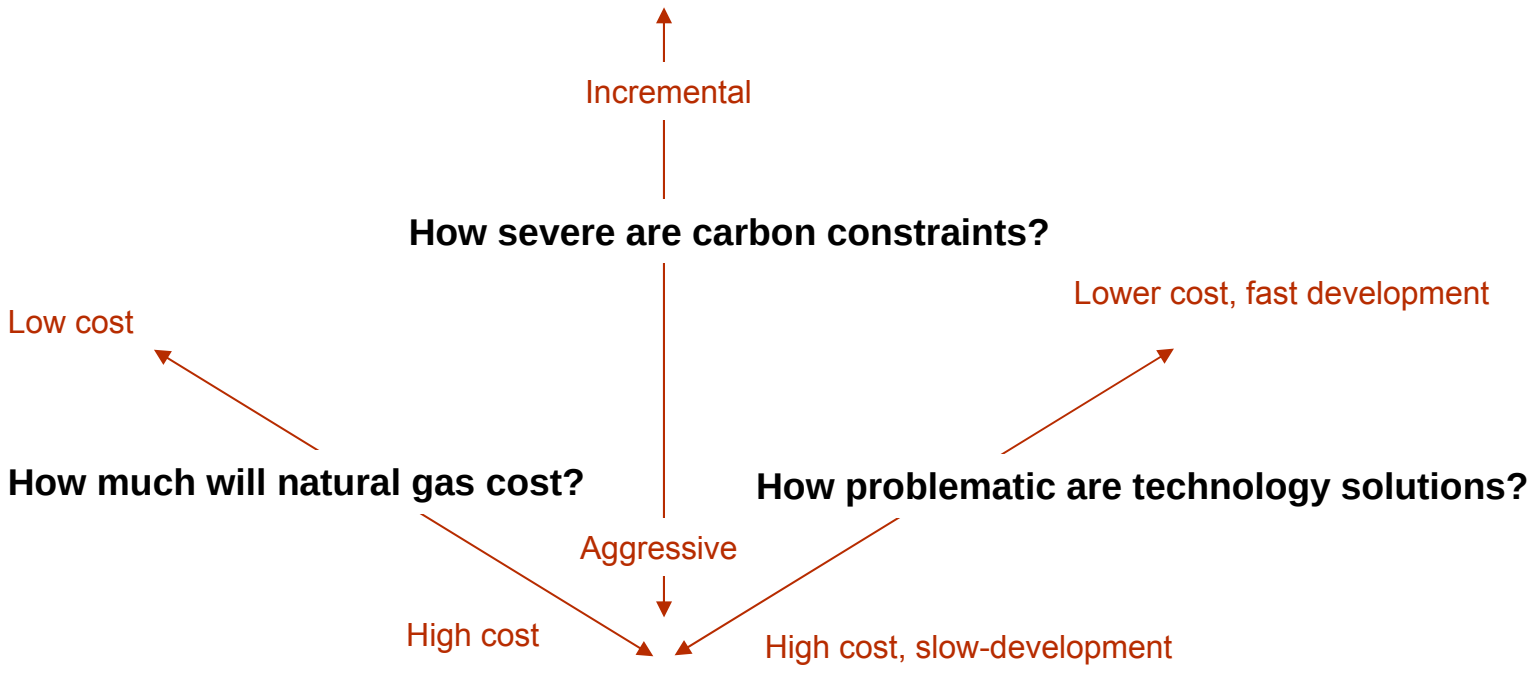
- Based on the Climate Stewardship and Innovation Act of 2007 (S.280)
- Introduction of a cap and trade system for CO_2 in 2012
- Increasingly stringent emission caps
  - 2012 to 2019 6,1 billion tons (equal to 2004 emissions)
  - 2020 to 2029 5,2 billion tons (equal to 1990 emissions)
  - 2030 to 2049 4,1 billion tons (~22% below 1990 emissions)
- Up to 30% of required emissions reduction can also be achieved through various alternative compliance options, or offsets
- EIA forecasts that CCS will not be installed in North America even in the carbon case

1) Total installed capacity including end-customer generation
2) Renewables include Hydro
Source: EIA, Booz Allen Hamilton Analysis

GovEnergy www.govenergy.gov

Booz | Allen | Hamilton

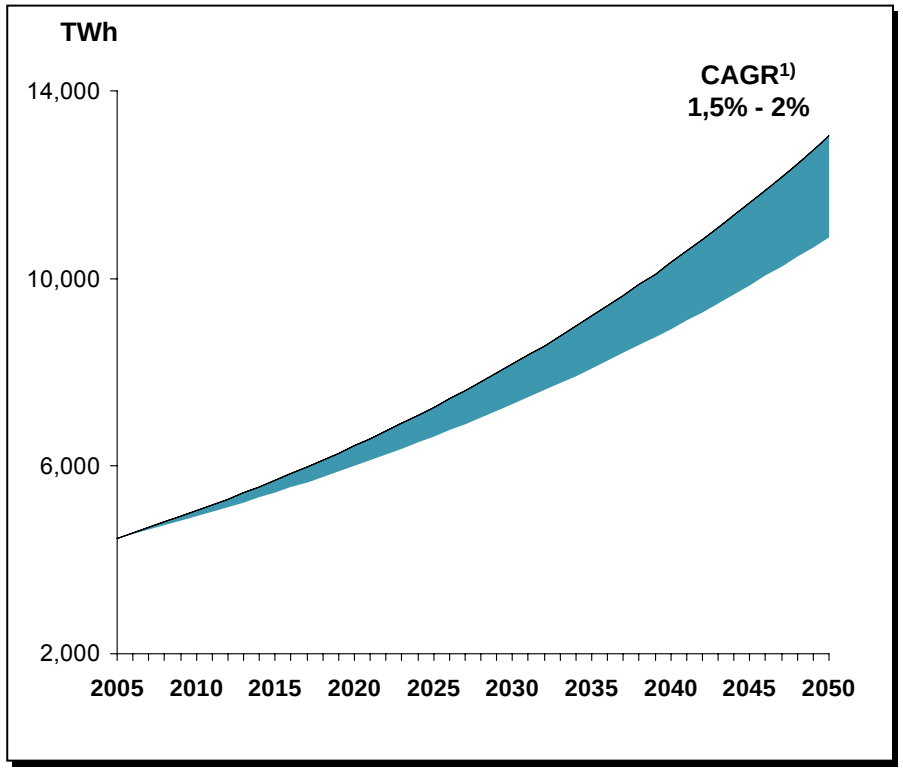
The carbon challenge presents multiple dimensions of uncertainty around generation decisions for suppliers of energy



Plus**: How will others in the industry respond?**

Increasing electricity demand requires additional base load capacity in the North American market…

Electricity Demand in US and Canada



Base Load Capacity in the US and Canada (GW)3)

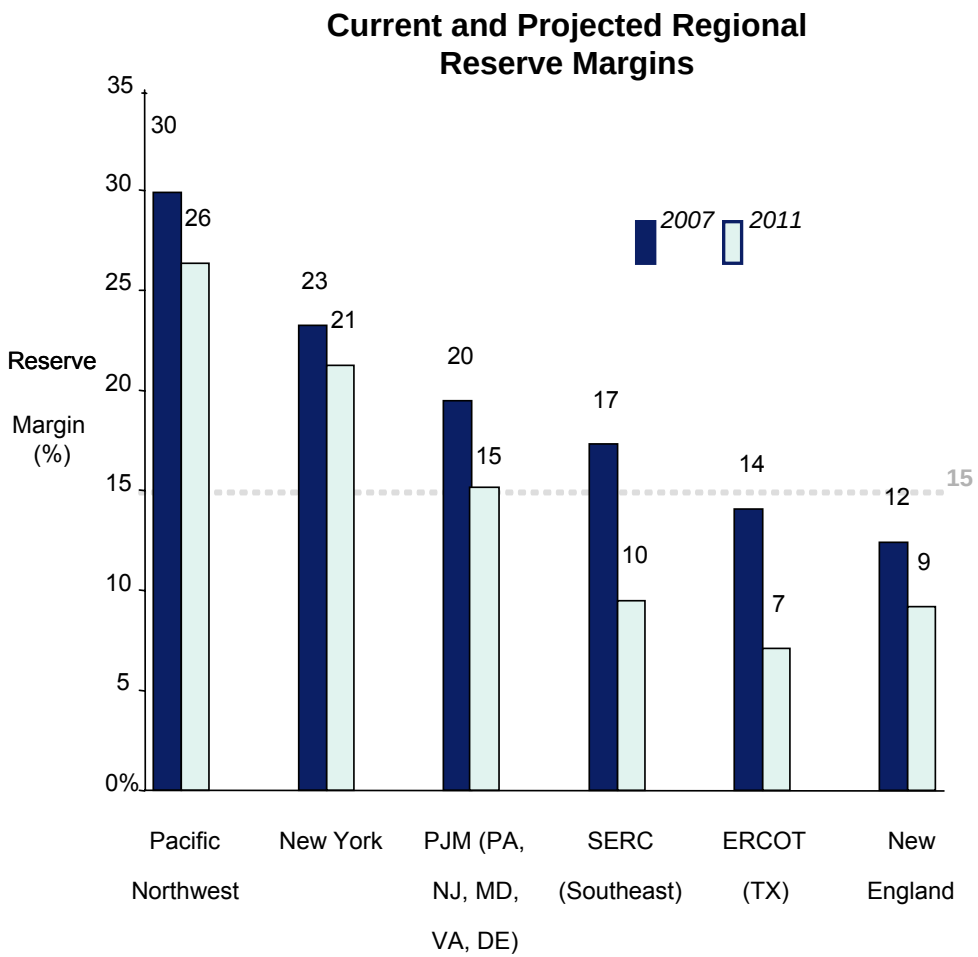
		1,5% Growth Scenario	2% Growth Scenario
Installed Base Load Capacity2)	2005	445	445
Additional Base Load Capacity Required	2025	154	216
	2050	425	640

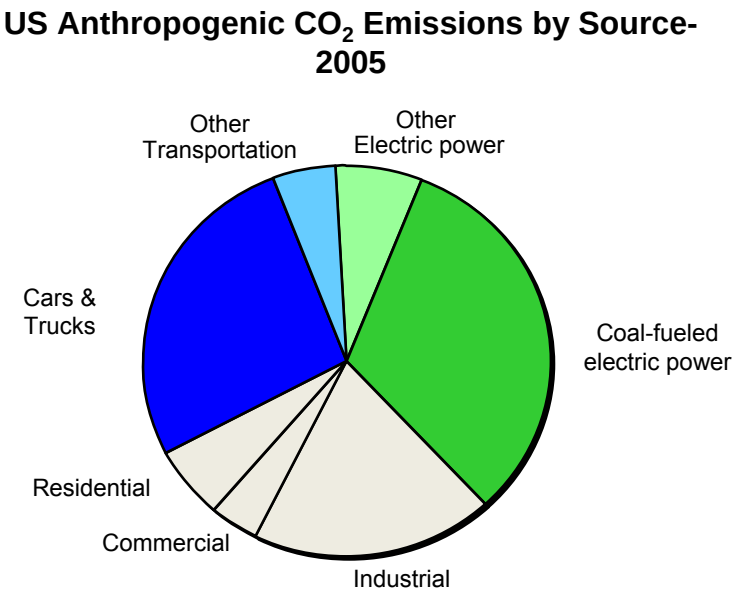
1) CAGR = Compound Annual Growth Rate
2) Assumption: Base Load Capacity in 2005 = Hard Coal and Nuclear
3) Assumption = Utilization and share of Base Load Capacity on electricity production remains constant
Source: EIA, Canadian Electricity Association, Booz Allen Hamilton Analysis

GovEnergy
www.govenergy.gov

Booz | Allen | Hamilton

With Utilities Facing Conflicting Pressures

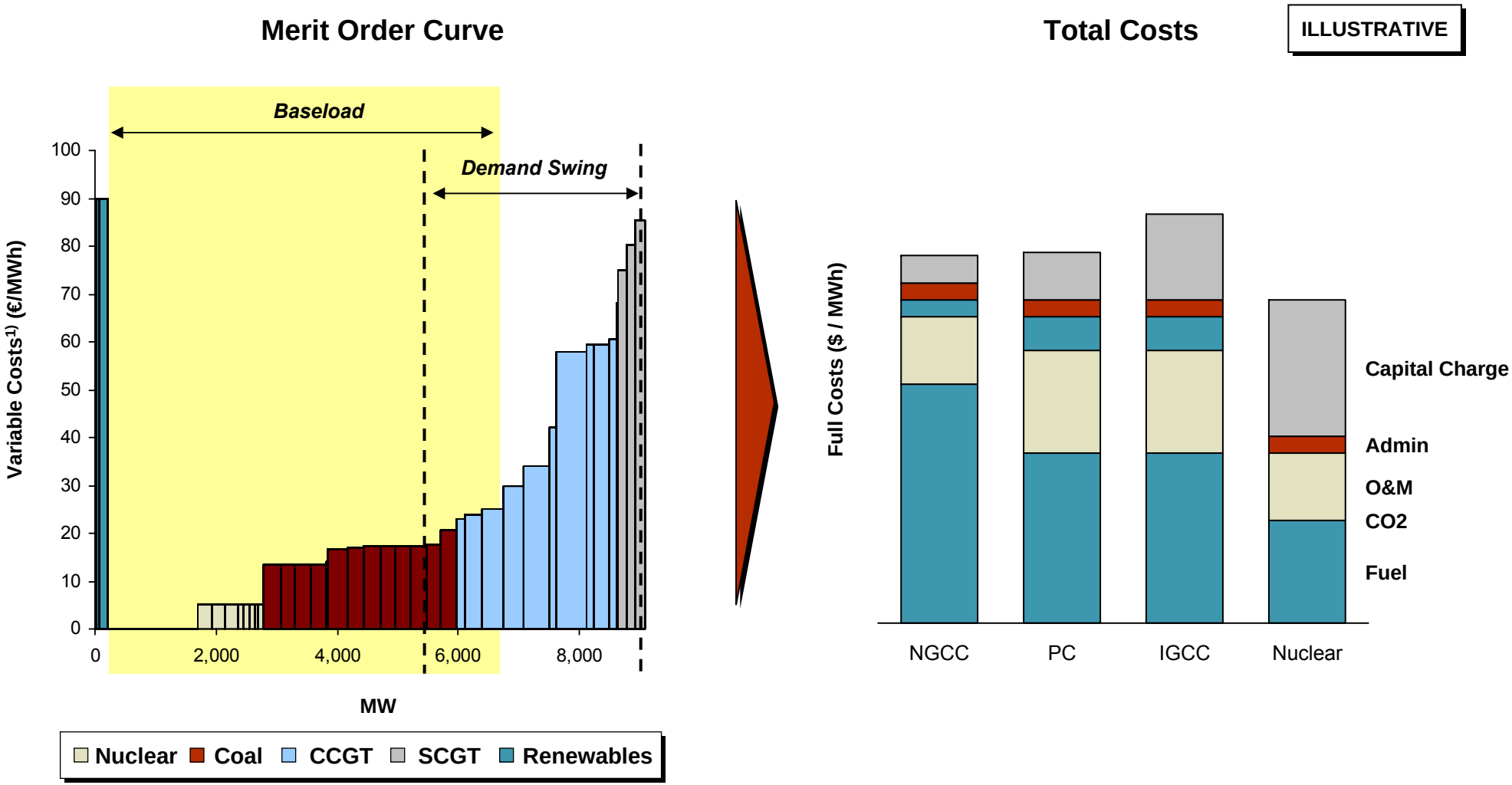




GovEnergy
www.govenergy.gov

Booz | Allen | Hamilton

Base load new build decisions aim to optimize profitability on the basis of variable and full costs of power generation



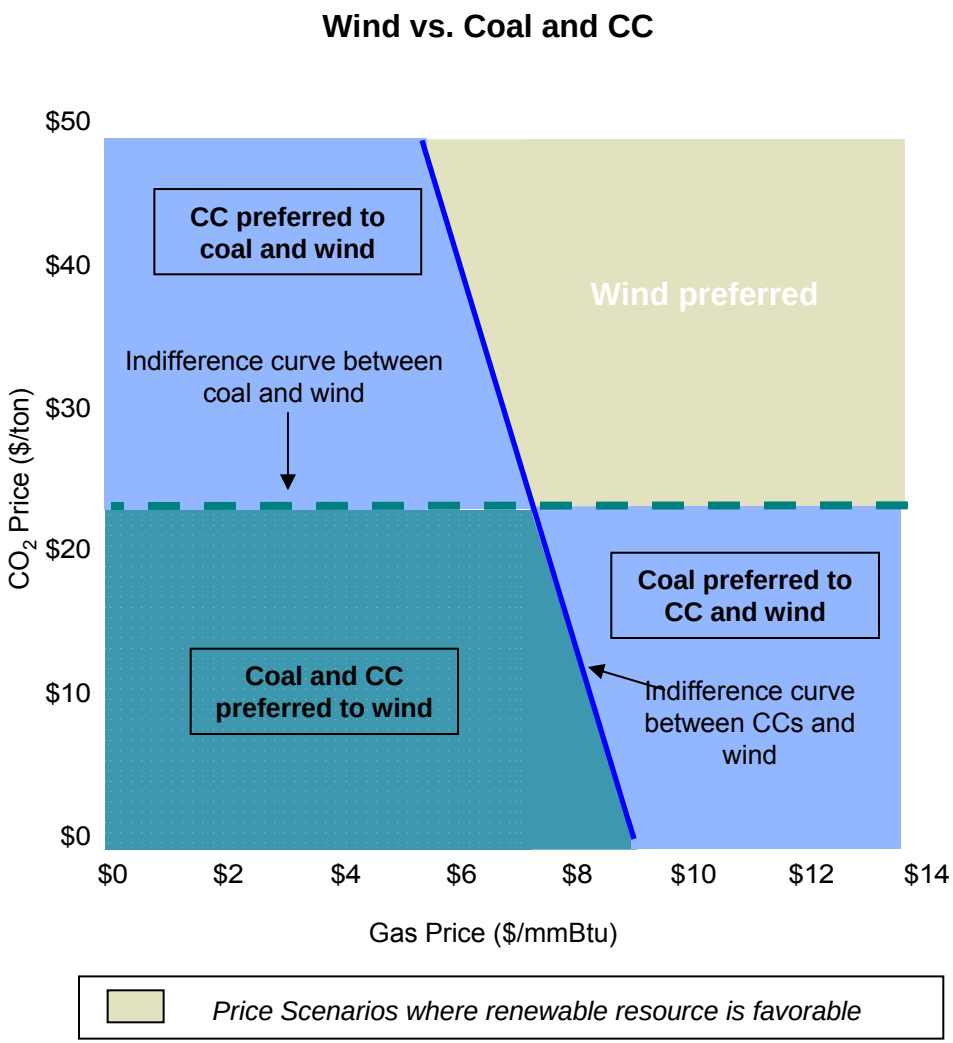
1) Including CO_2 costs

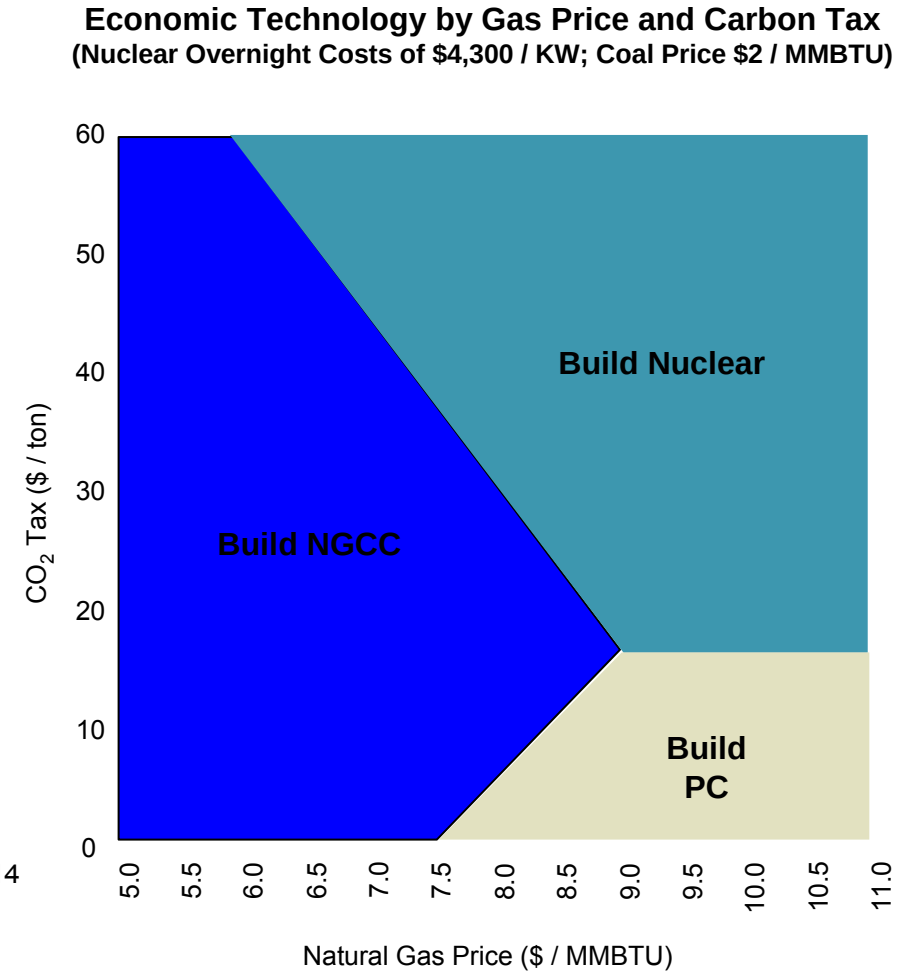
Source: Industry announcements, Booz Allen Hamilton Analysis

GovEnergy www.govenergy.gov

Booz | Allen | Hamilton

Portfolio moves involve 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

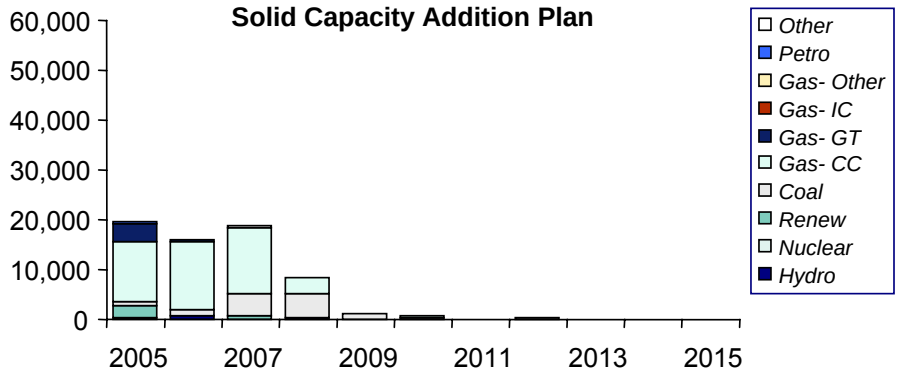
GovEnergy www.govenergy.gov

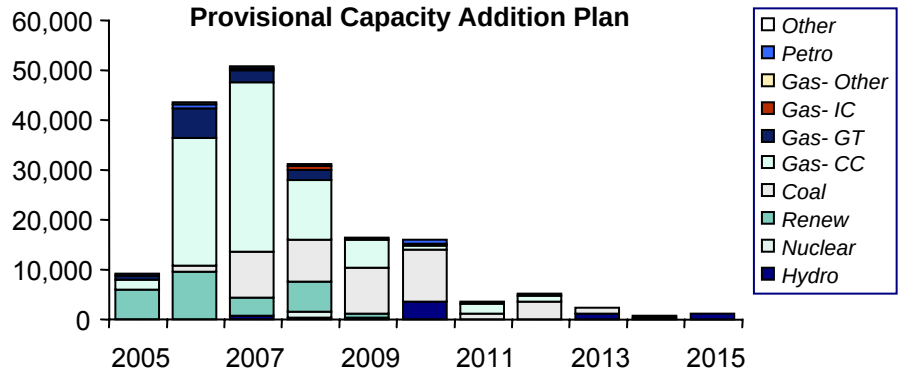
Booz | Allen | Hamilton

… and the result of the collective uncertainty is a growing reluctance to invest in generation

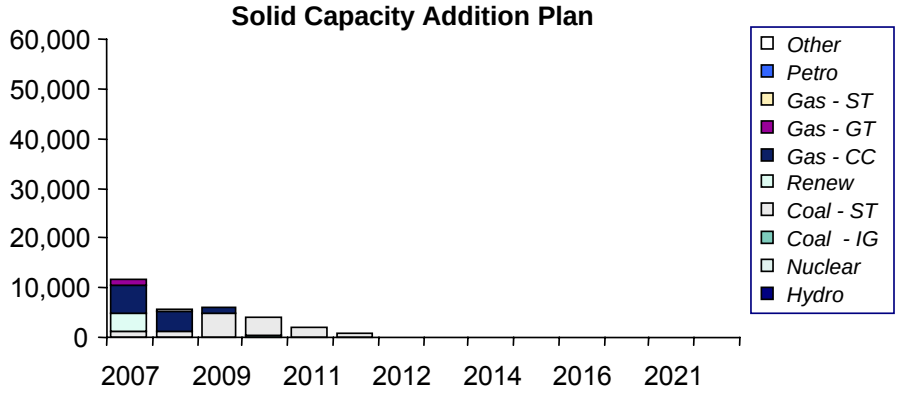
Capacity Addition Plans: 2005 and 2007

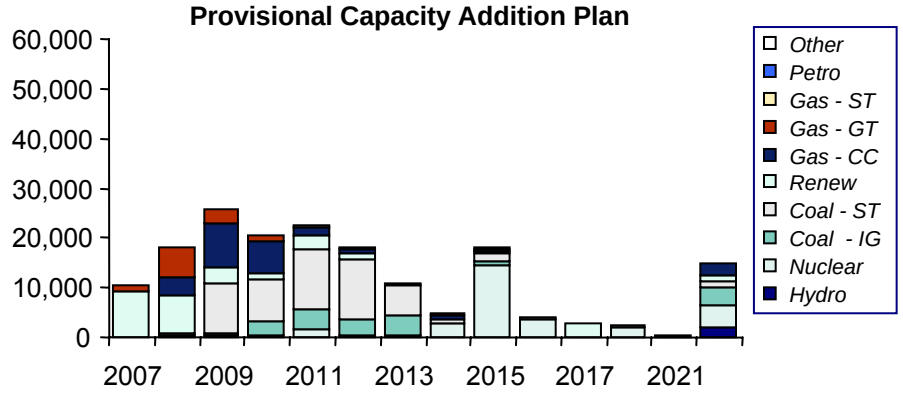
New Build Circa Spring 2005





New Build Circa Winter 2007





GovEnergy
www.govenergy.gov

Booz | Allen | Hamilton

Table Of Contents

- The Complexity of the Carbon Challenge
- Overview of Booz Allen Carbon War Game
- Implications for Energy Customers/Consumers
- Issues for Consideration

Moving Forward while Limiting Risk

War-gaming lets you test alternative futures and alternative courses of action, and see how your environment might respond

- Developed the first business game in 1956 for the American Management Association
- Foremost provider of military war games to the US Department of Defense for more than thirty years
- This past calendar year, conducted more than 100 war games for a diverse set of private and public sector clients world-wide

- Tests Critical Assumptions
- Exposes Risks
- Identifies Alternative Paths
- Exposes Fatal Flaws
- Generates New Insights

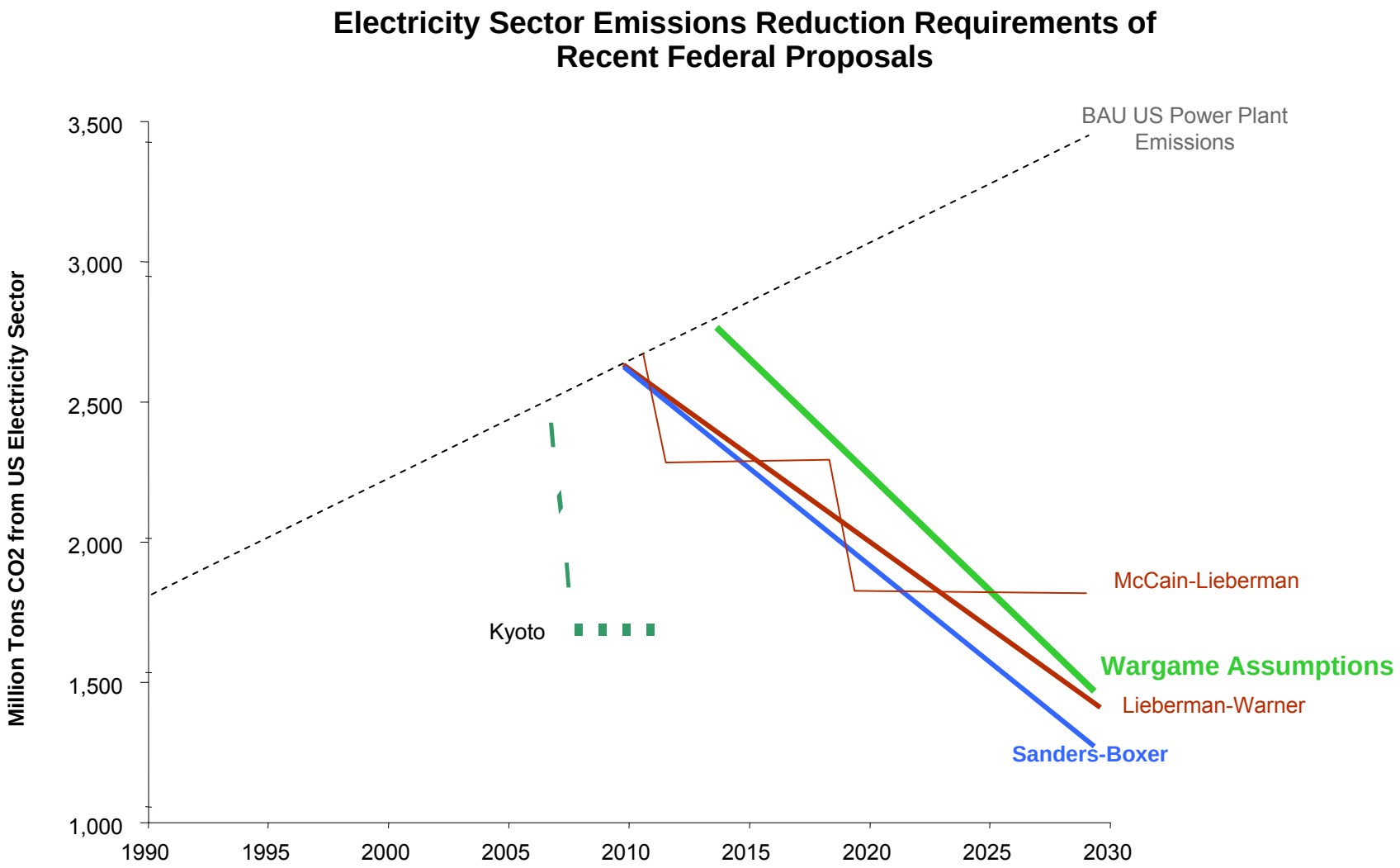
Impossibility Theorem

One thing a person cannot do, no matter how rigorous his analysis or heroic his imagination, is to draw up a list of things that would never occur to him

Thomas Schelling

University of Maryland economist, winner of the 2005 Nobel Memorial Prize in Economic Sciences for demonstrating how game theory applies to the interactions of people and nations

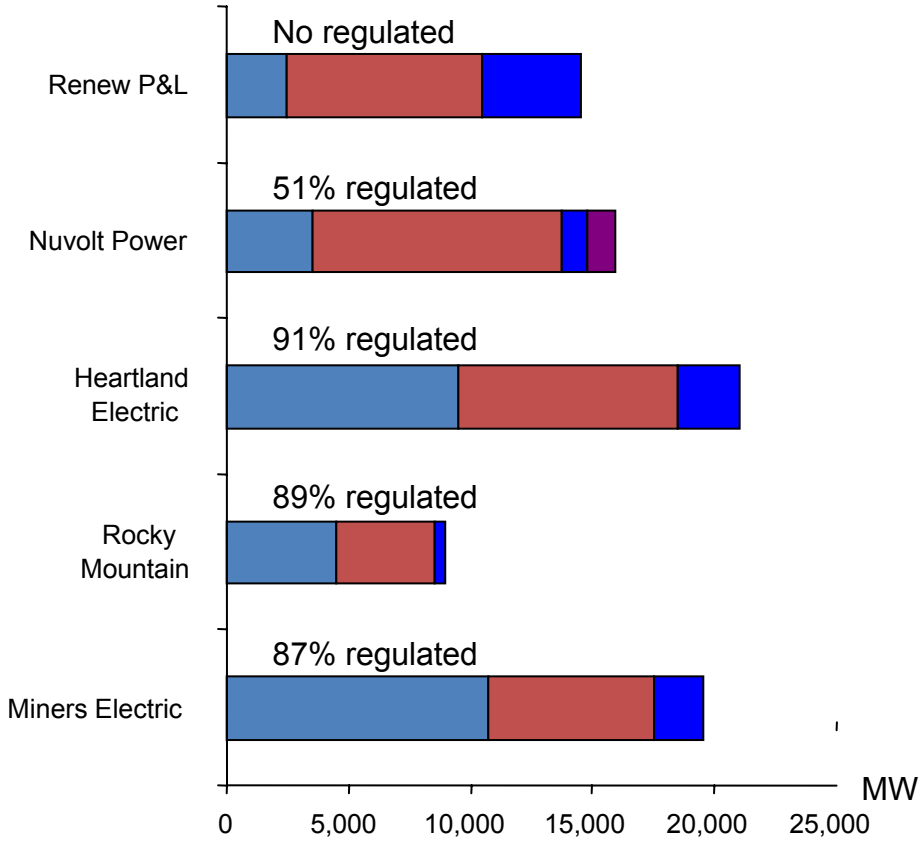
The war game was premised on a plausible "What If" regulatory scenario



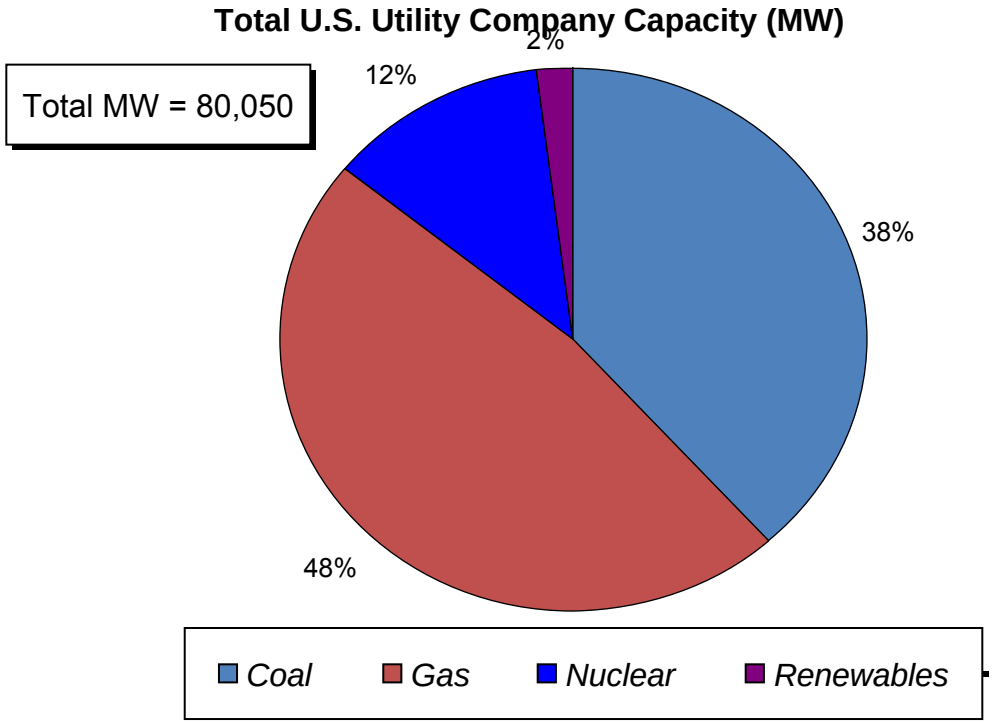
GovEnergy
www.govenergy.gov

Booz | Allen | Hamilton

A representative microcosm was created in which players could make discrete decisions and measure and understand their effects



The aggregate portfolio of all players mirrors the US national generation profile. Players operate in a closed system, in the sense that their moves alone set power prices and emissions prices and determine industry capacity levels.



The object of play for each team is to maximize shareholder return, consistent with federal policy strictures and as permitted by state regulators

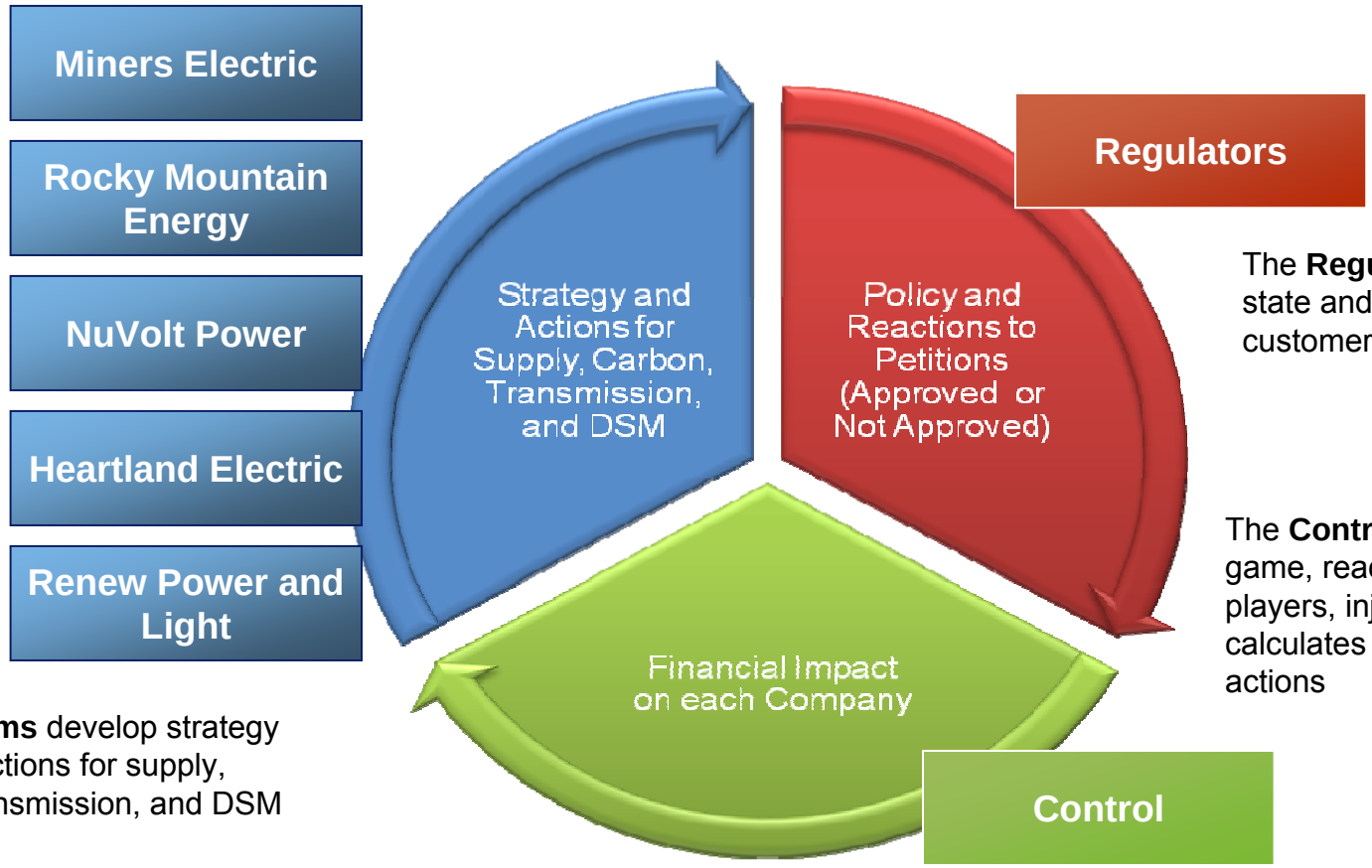
GovEnergy
www.govenergy.gov

Booz | Allen | Hamilton

Each team in the game had a distinct role…

In pursuing their chosen strategies, the utility teams interact with a Regulator Team and a Control Team

Decision Cycle



The **Regulator Team** acts for state and federal regulatory and customer interests

The **Control Team** oversees the game, reacts for all non-industry players, injects events, and calculates the impact of team actions

Utility Teams develop strategy and take actions for supply, carbon, transmission, and DSM

GovEnergy www.govenergy.gov

Booz | Allen | Hamilton

The control model calculates the impact on the market and on each fictional company at the end of each move

Utility Team Inputs

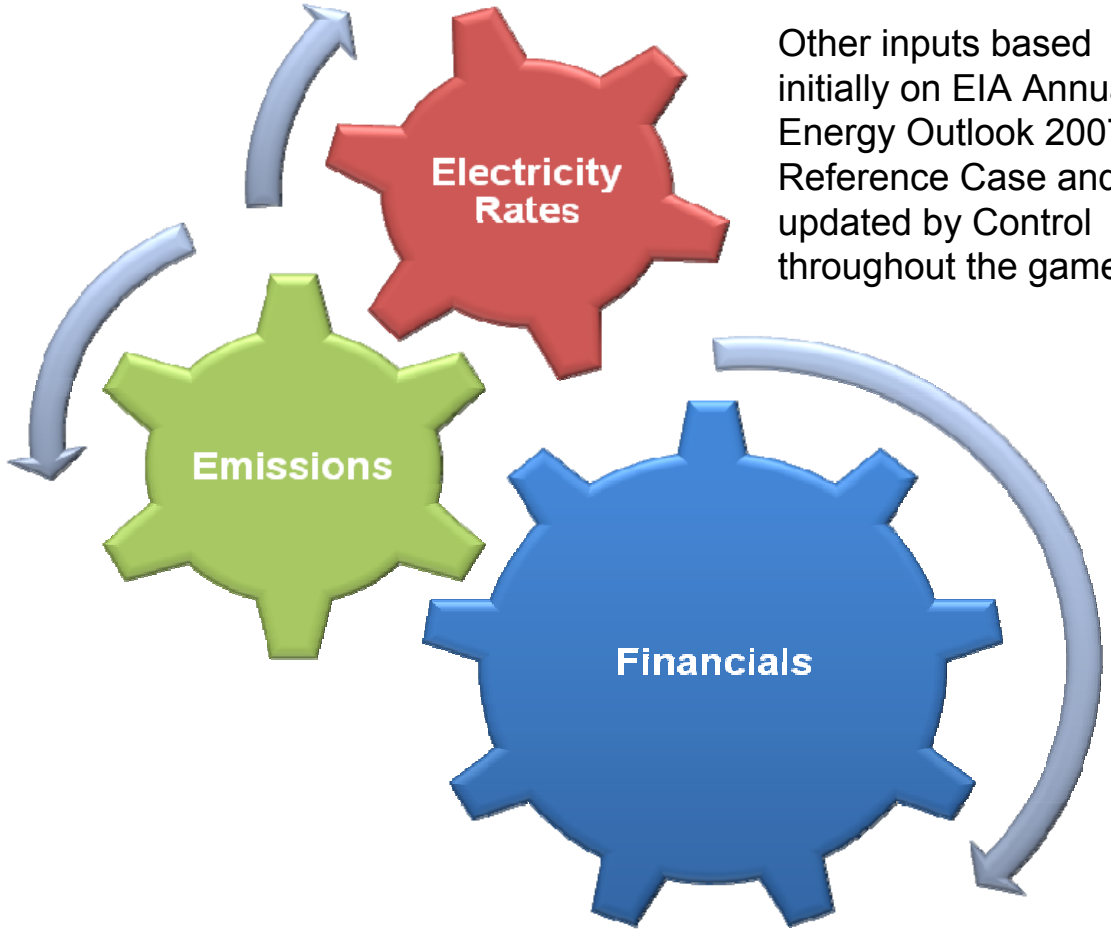
- Generation portfolio changes
- Carbon allowance policy
- Grid investments
- DSM programs

Model Outputs

- Carbon prices, emissions
- Power volume and prices
- Marginal costs, capacity factors
- SO2, NOx prices
- Company financials

Scorecard Metrics

- Electricity rates
- Carbon emissions
- Shareholder return

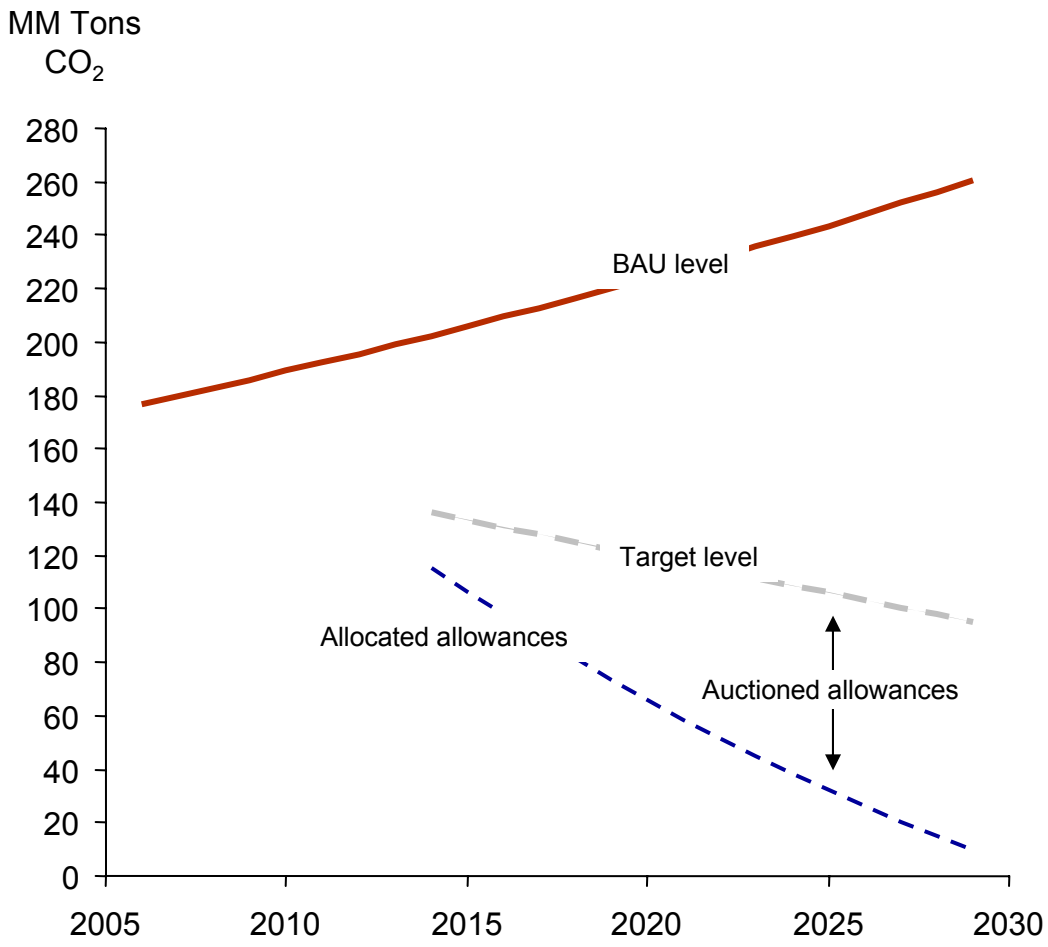


Other inputs based initially on EIA Annual Energy Outlook 2007 Reference Case and updated by Control throughout the game

GovEnergy
www.govenergy.gov

Booz | Allen | Hamilton

Carbon allowances were issued in each year at that year's target level in order to drive CO_2 reduction



Discussion

- A declining portion of those allowances is allocated proportionally to the five players.
- The remaining set of allowances is available for purchase through market processes.
- To the extent that any player banks allowances or releases previously banked allowances in any given year, the overall supply of allowances in that year shrinks or increases commensurately.

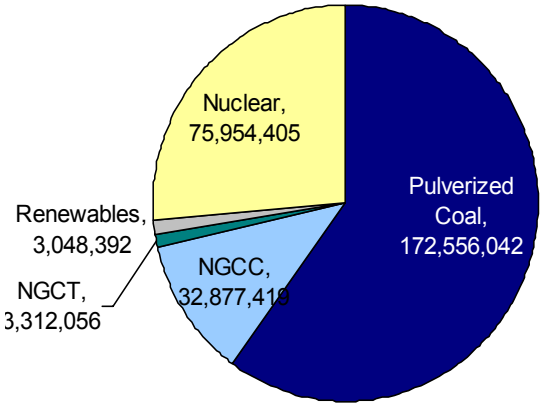
GovEnergy
www.govenergy.gov

Booz | Allen | Hamilton

The evolution of the energy supply over the course of the game showed a decline and then resurgence in the use of coal

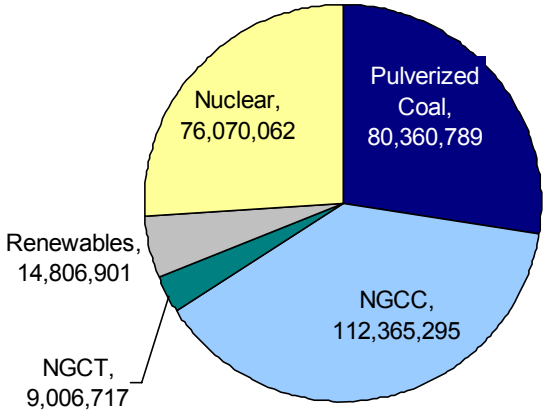
2009

288 TWH



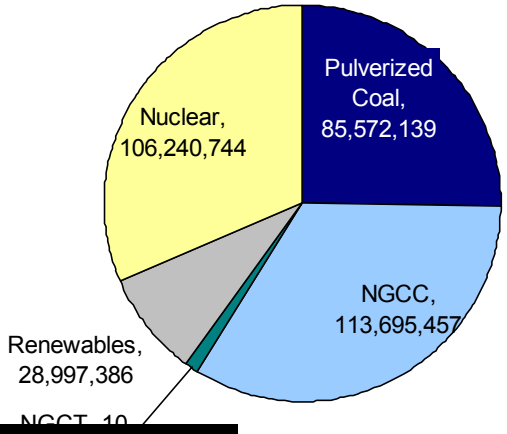
2015

293 TWH



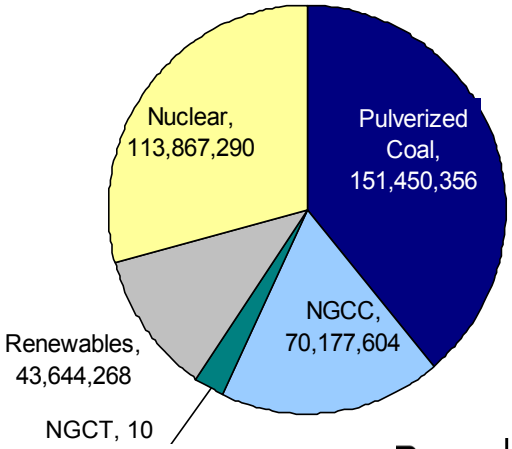
2022

338 TWH



2029

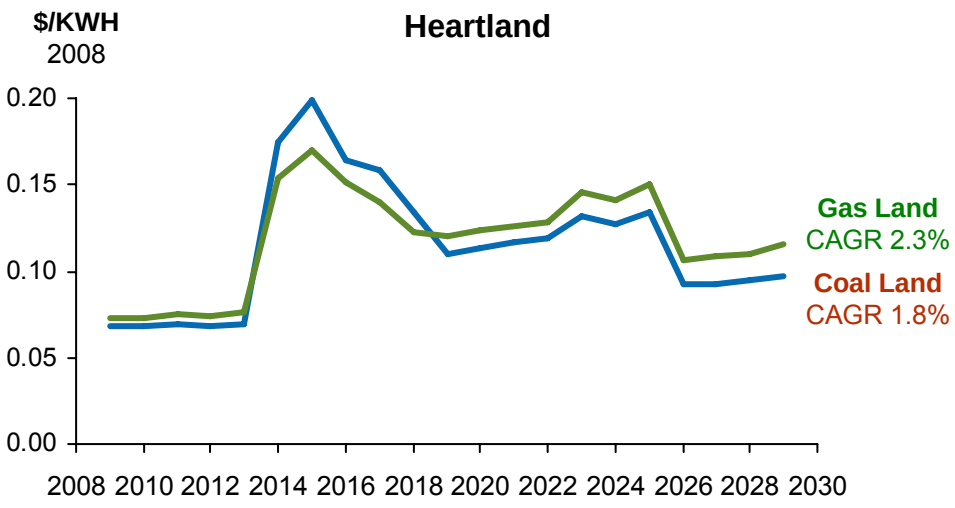
389 TWH

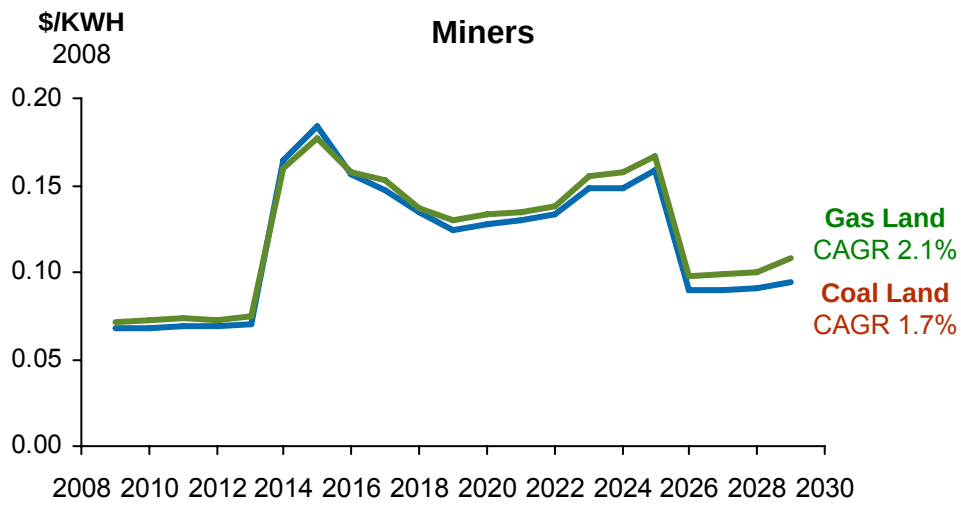


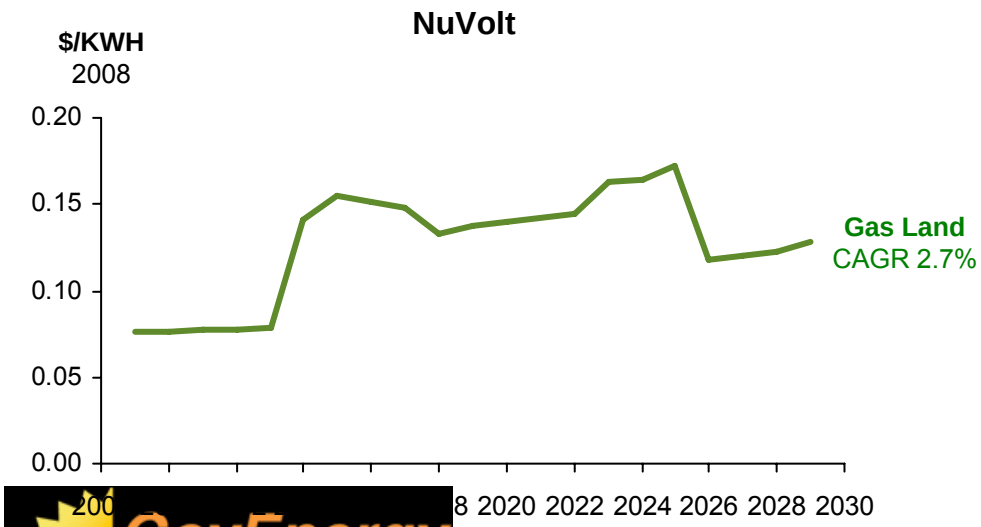
GovEnergy
www.govenergy.gov

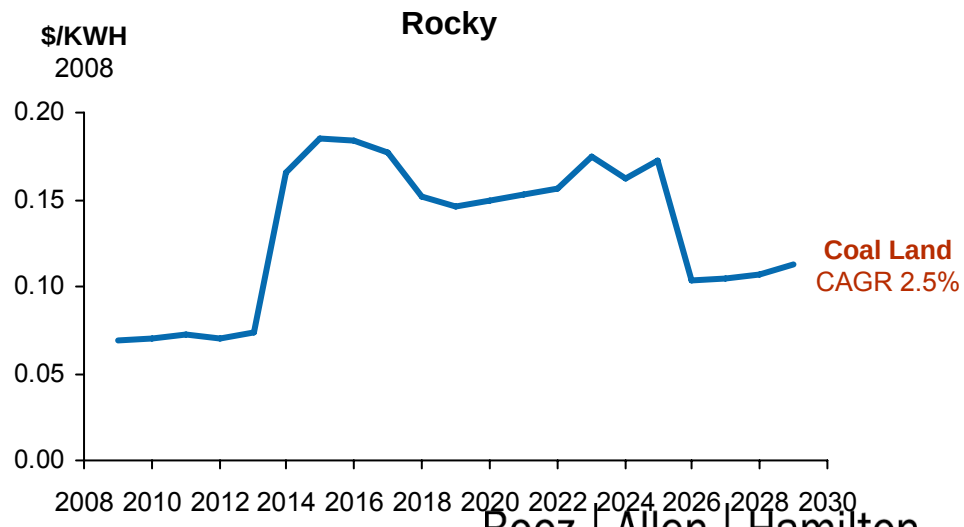
Booz | Allen | Hamilton

Retail electricity rates increased significantly and then returned to levels consistent with historic trends





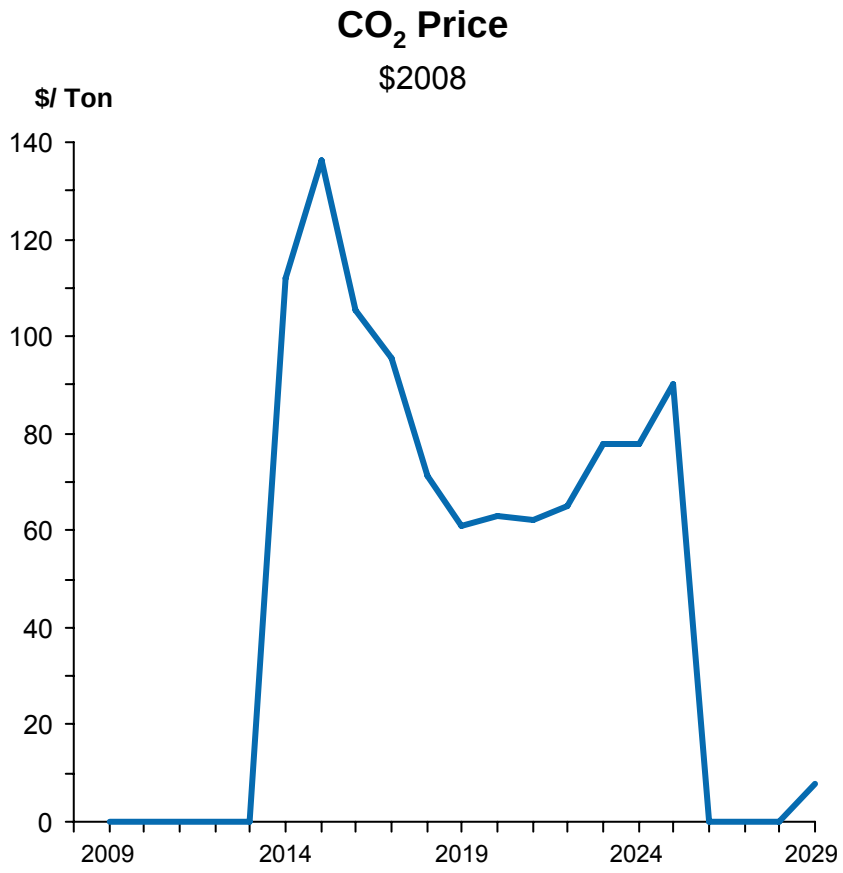


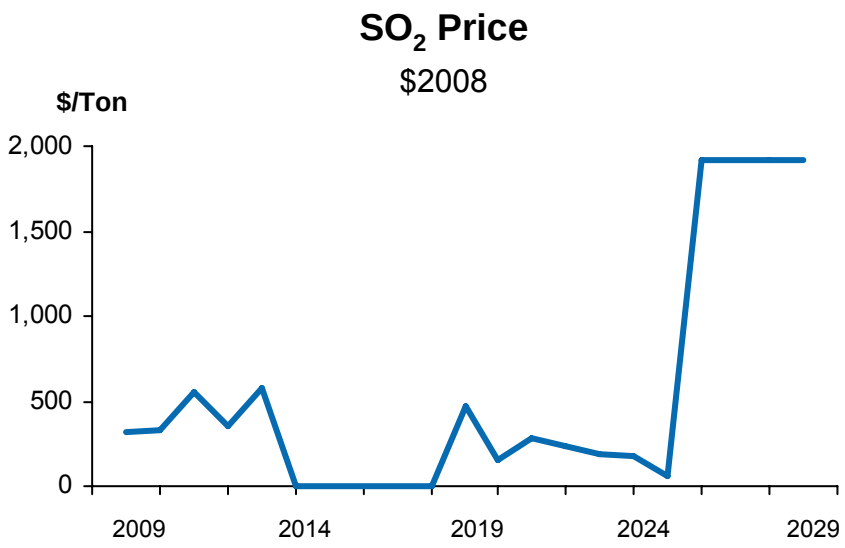


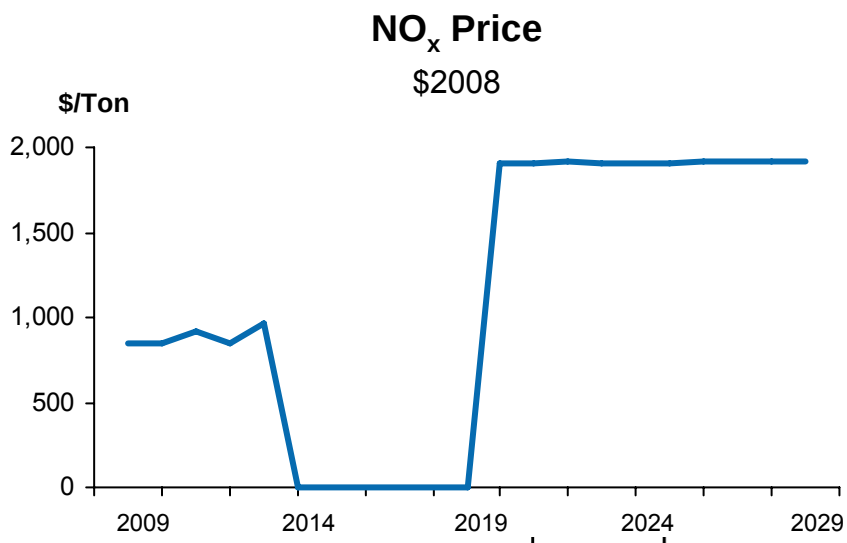
GovEnergy
www.govenergy.gov

Booz | Allen | Hamilton

Emissions prices 2009 - 2029



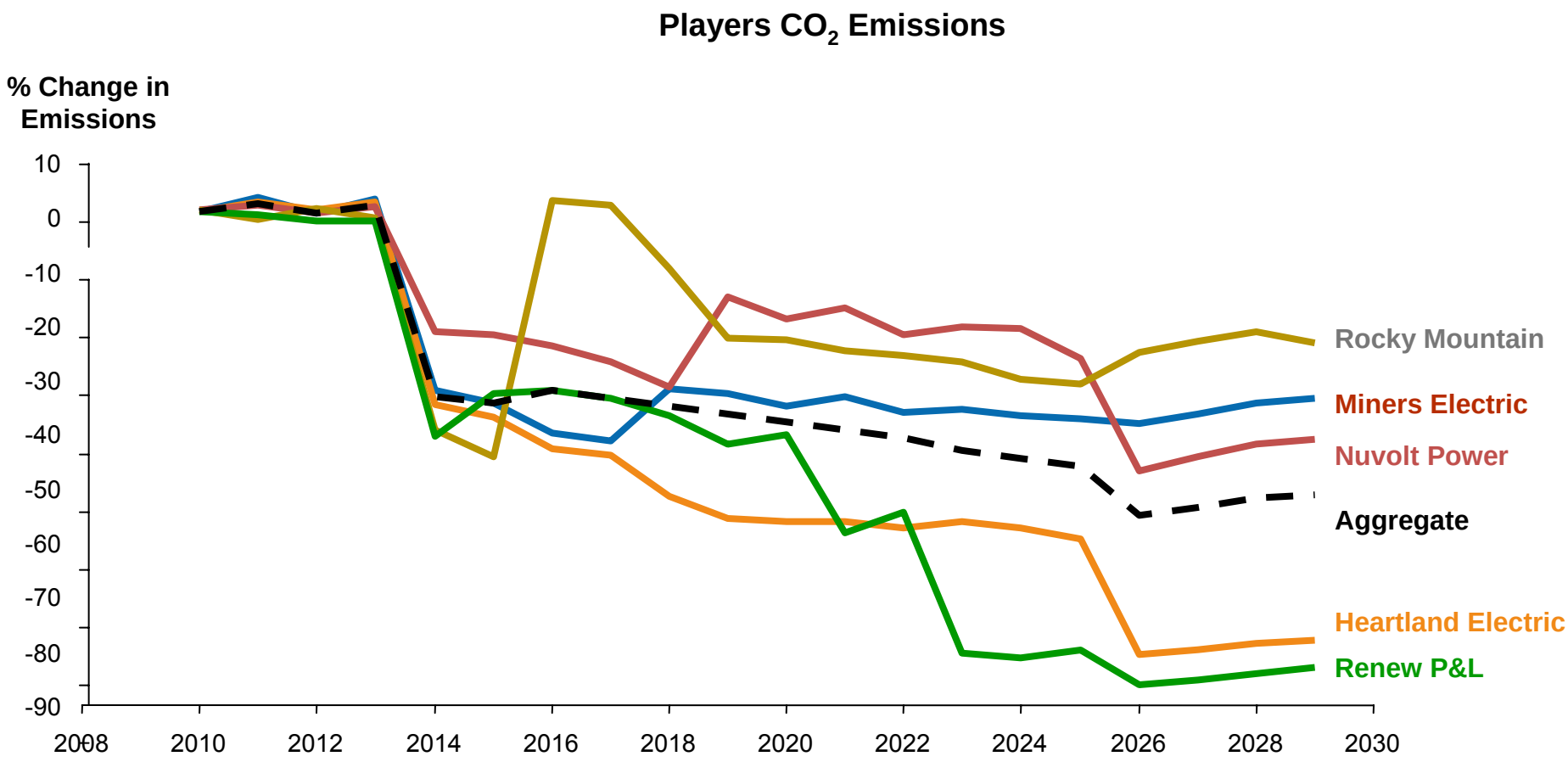




GovEnergy
www.govenergy.gov

Booz | Allen | Hamilton

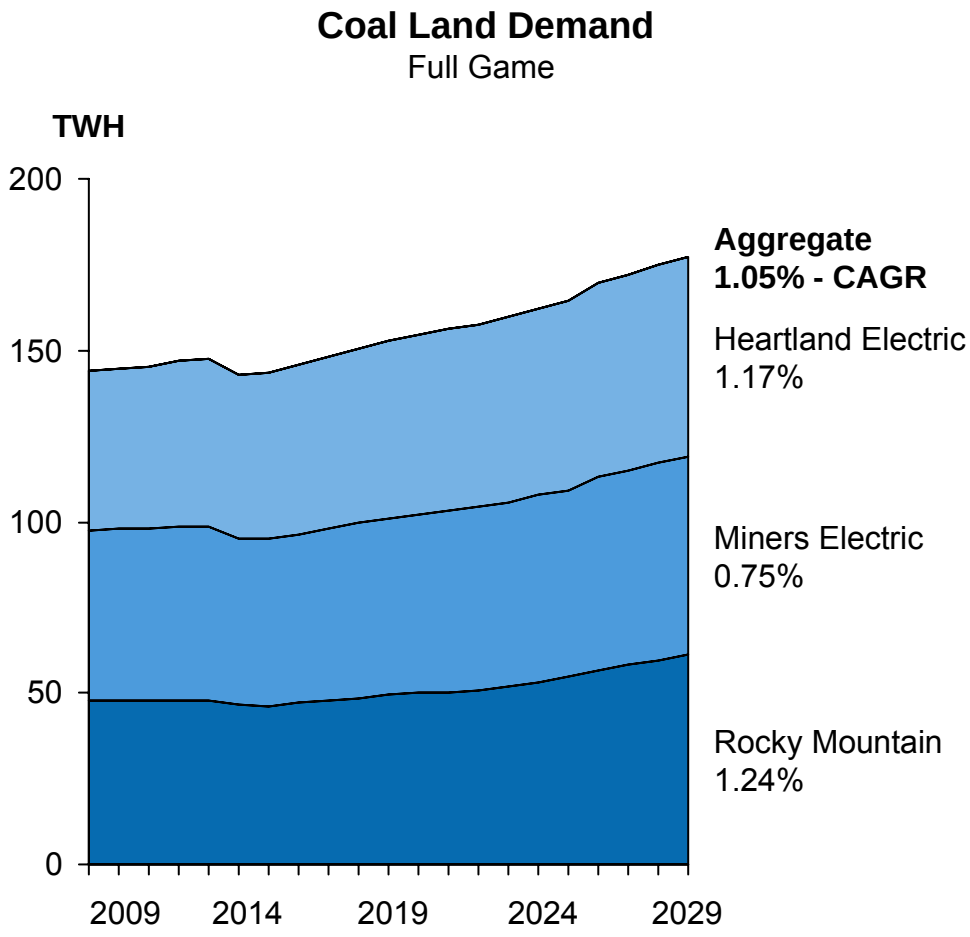
Player CO_2 positions declined from 20% to 80% over the game

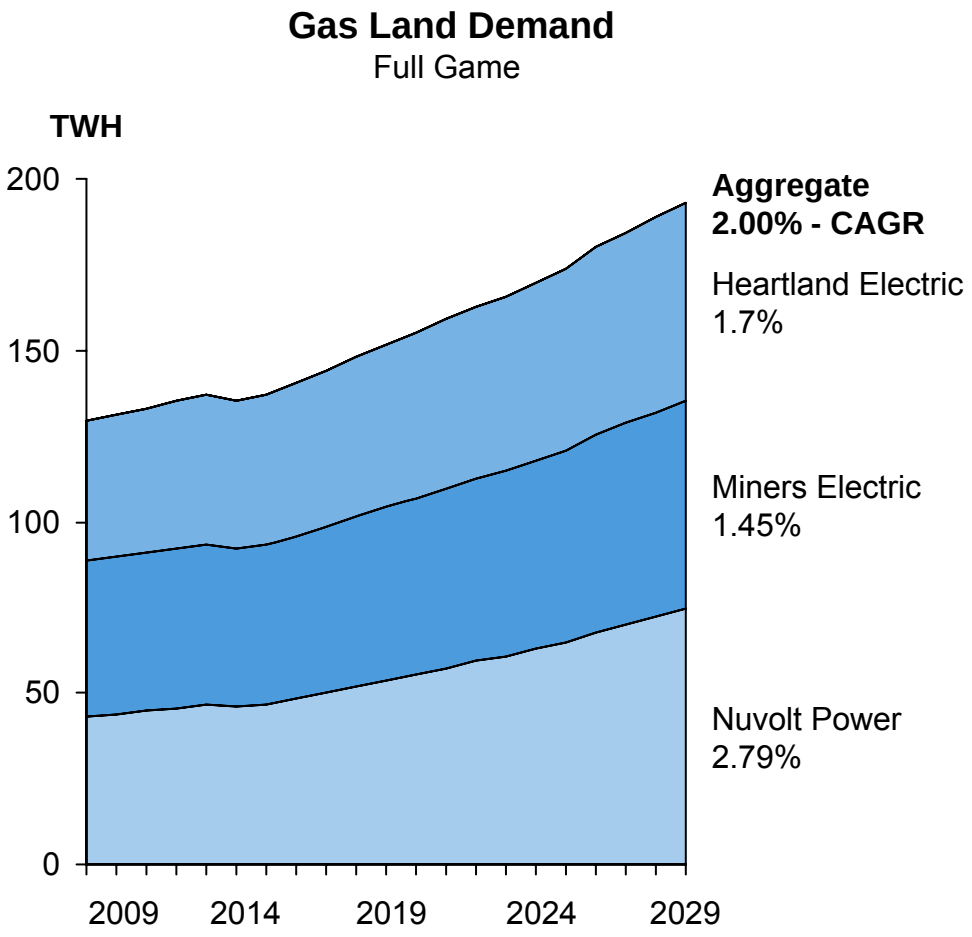


GovEnergy
www.govenergy.gov

Booz | Allen | Hamilton

Electricity demand continued to grow at historic rates, driving decisions regarding how and when to meet that demand

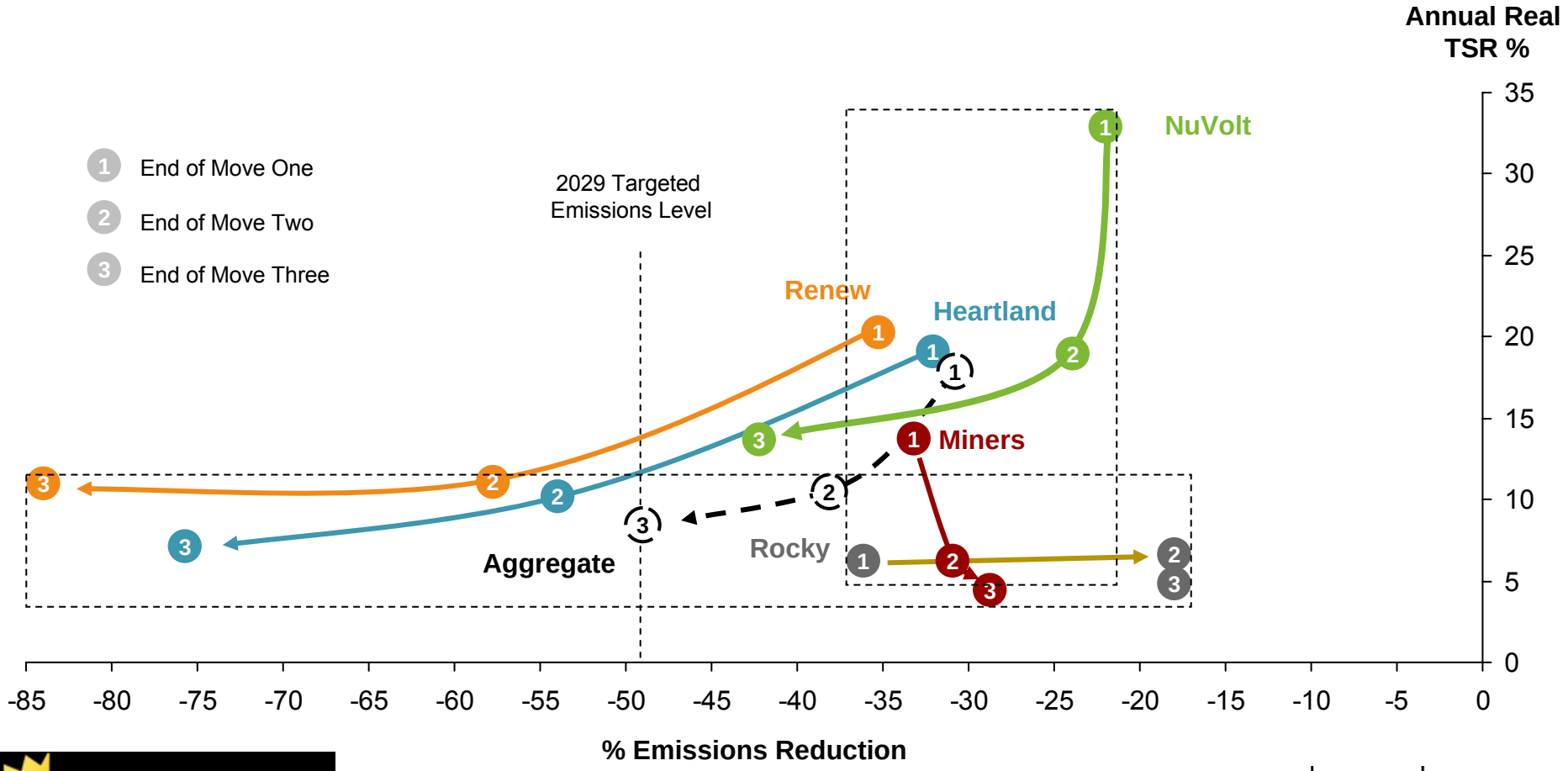




GovEnergy
www.govenergy.gov

Booz | Allen | Hamilton

Teams ended the game with similar positions for shareholder return, but very divergent positions on emissions



GovEnergy
www.govenergy.gov

Booz | Allen | Hamilton

Some strategic observations from war game

- Not surprisingly, companies tended to make similar moves. Those players that anticipated those moves and figured out how to profit from them through alternative strategies established an early advantage.

- Companies tended to plan for the long term, ignoring the short-term needs of the market. Withdrawal of coal capacity without any immediate substitutions helped drive up early costs

- The beginning of the regime was the period of maximum opportunity for contrarian moves, when the market was least settled and outcomes most in doubt. It was also the period where unregulated investments held the greatest profit potential.

- Credits were most valuable at the outset - - not a good time to buy and bank

- No company anticipated the long-term decline in carbon prices, putting “old technology” back in the money. Coal, even without CCS, staged a comeback. A possible contrarian strategy for those with patience.

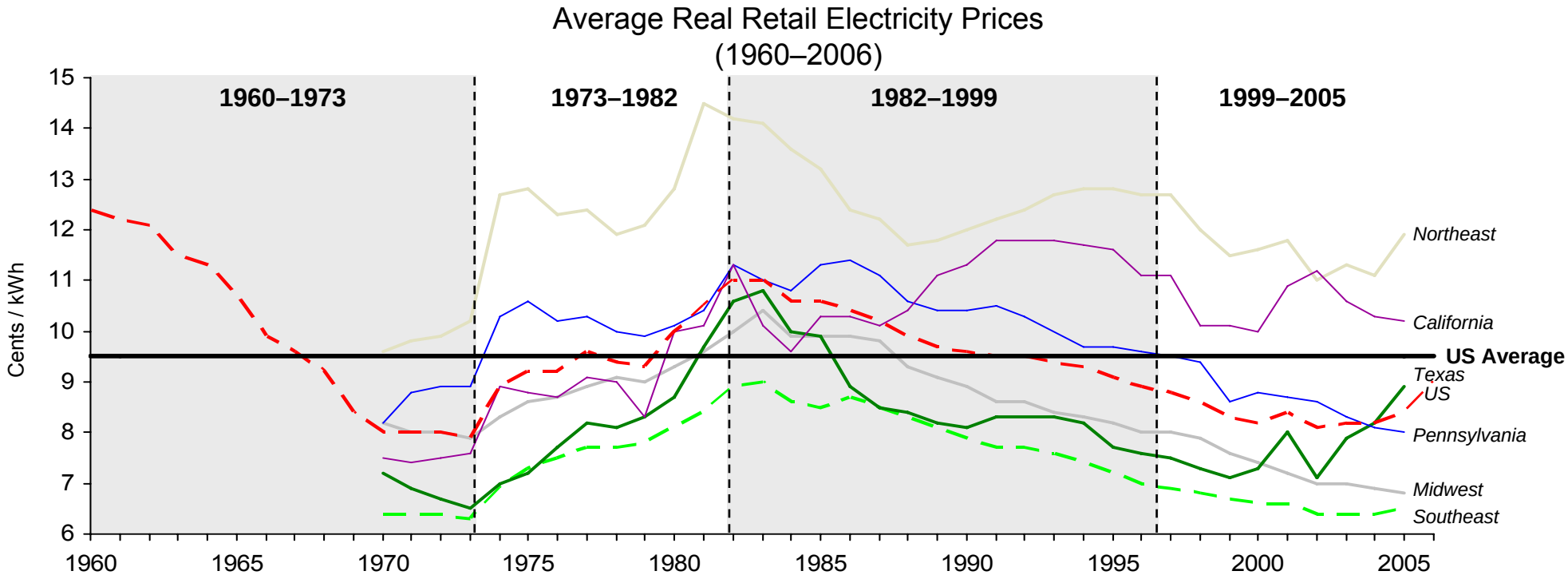
- Opportunities for above-market returns lay only in unregulated assets. Consequently, initial portfolio composition and the regulated -unregulated mix of initial assets set an early boundary on opportunities. Most companies tended to increase their regulated holdings rather than vice versa - - providing security of return but further limiting their earnings potential.

- With some exceptions, players tended to fight the last war - - assuming that the next round of play would be like the preceding round, only more so. In fact, the dynamics of each round were distinct and called for adjustments in strategy in order to reap maximum advantage.

Table Of Contents

- The Complexity of the Carbon Challenge
- Overview of Booz Allen Carbon War Game
- Implications for Energy Customers/Consumers
- Issues for Consideration

Historically, retail electricity prices have been fairly stable, but consumers could face significant increases



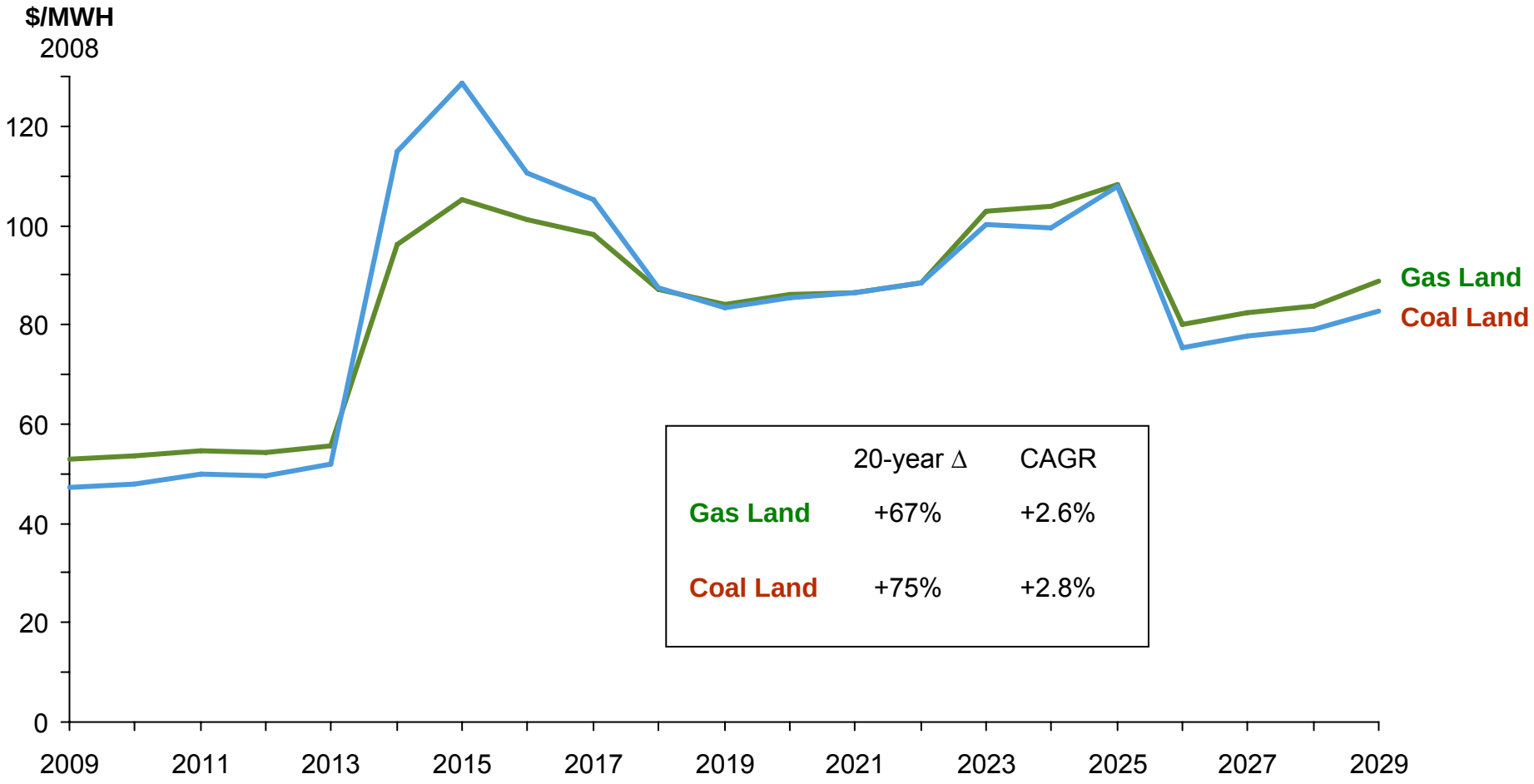
Region	1973–1982 CAGR	1982–1999 CAGR	1999–2005 CAGR	1970-2005 CAGR
Northeast	3.8%	-1.2%	0.5%	0.6%
Midwest	2.6%	-1.6%	-1.8%	-0.5%
Southeast	4.0%	-1.7%	-0.5%	0.0%
Texas	5.6%	-2.3%	3.8%	0.6%
Pennsylvania	2.6%	-1.6%	-1.1%	0.0%
California	4.4%	-0.7%	0.2%	0.9%
US	3.7%	-1.6%	1.2%*	0.3%*

* CAGR through 2005
Source: EIA; Booz Allen analysis
Note: Prices in Real 2000 dollars

GovEnergy
www.govenergy.com

Booz | Allen | Hamilton

Game calculated power prices changed dramatically



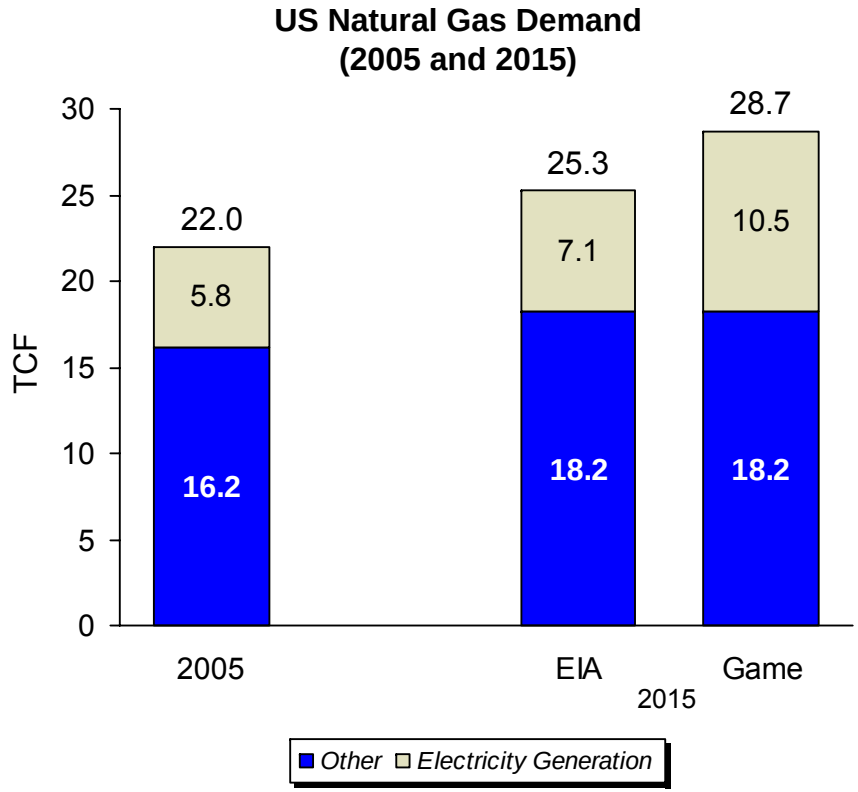
	20-year Δ	CAGR
Gas Land	+67%	+2.6%
Coal Land	+75%	+2.8%

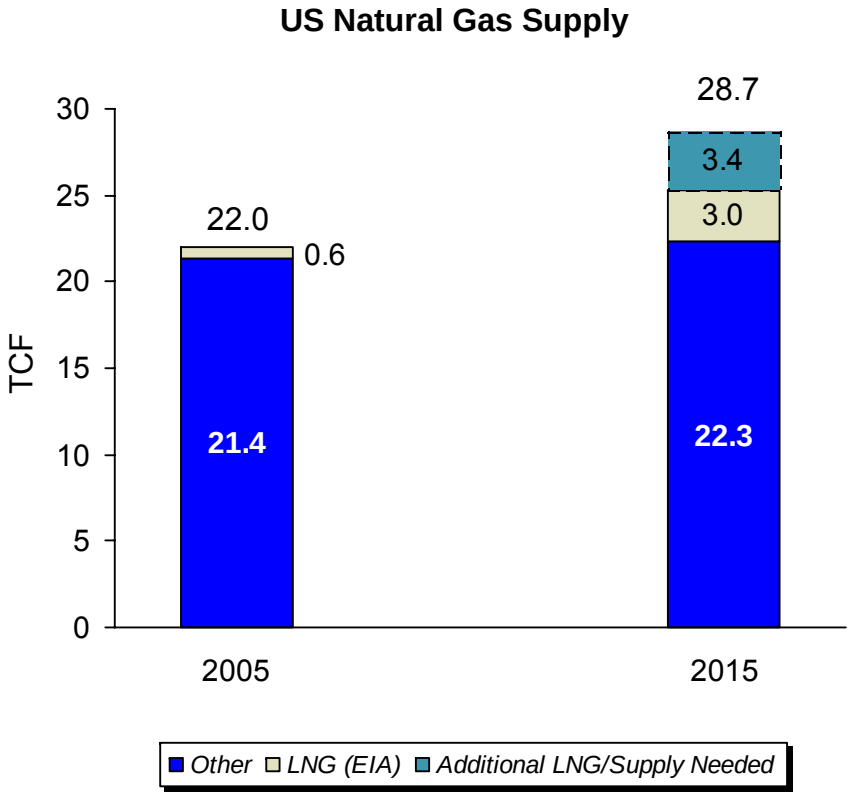
Wholesale power prices 2009-2020

GovEnergy
www.govenergy.gov

Booz | Allen | Hamilton

Natural gas, seen by many as the best choice in the face of uncertainty, is not without its own challenges





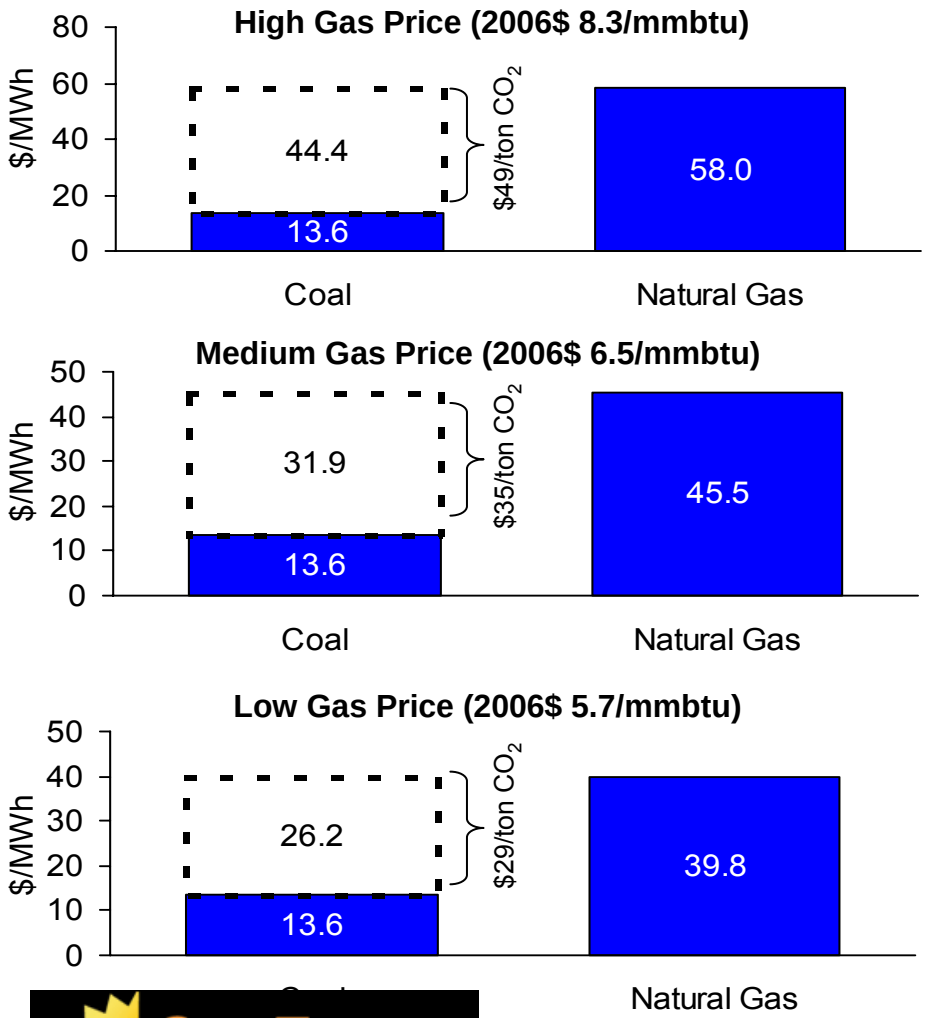
- Long lead times, regulatory uncertainty, high/risky capital costs deterred investment in clean coal, nuclear
- Natural gas capacity additions and increased utilization of existing capacity filled the gap up to 2015-2020
- Pressure on gas supply could be severe, linking US gas prices to (expensive) North Asian and European markets

GovEnergy
www.govenergy.gov

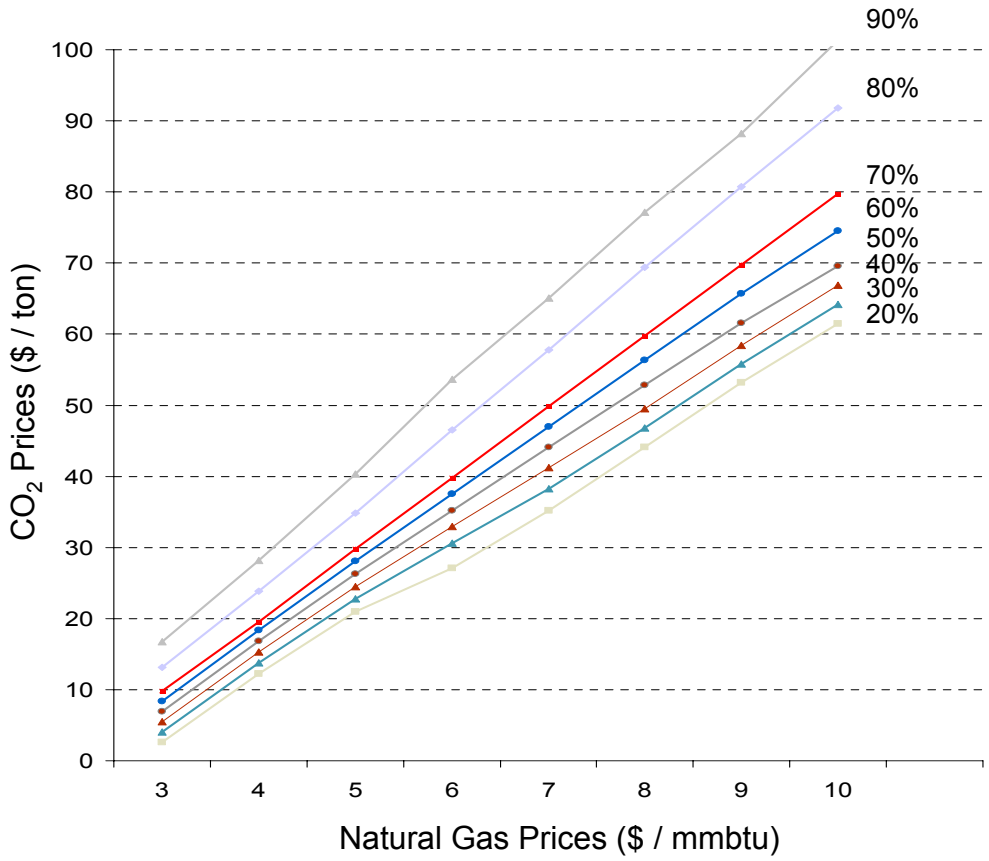
Booz | Allen | Hamilton

The linkage between natural gas and CO2 has led to further future price uncertainty for suppliers and consumers alike

Variable Cost of Electricity Production (Coal: 2006$ 2/mmbtu)



Aggregate CO2 Reduction Isoquants Based on 2007 Existing Capacity



GovEnergy www.govenergy.gov

Source: Booz Allen Analysis

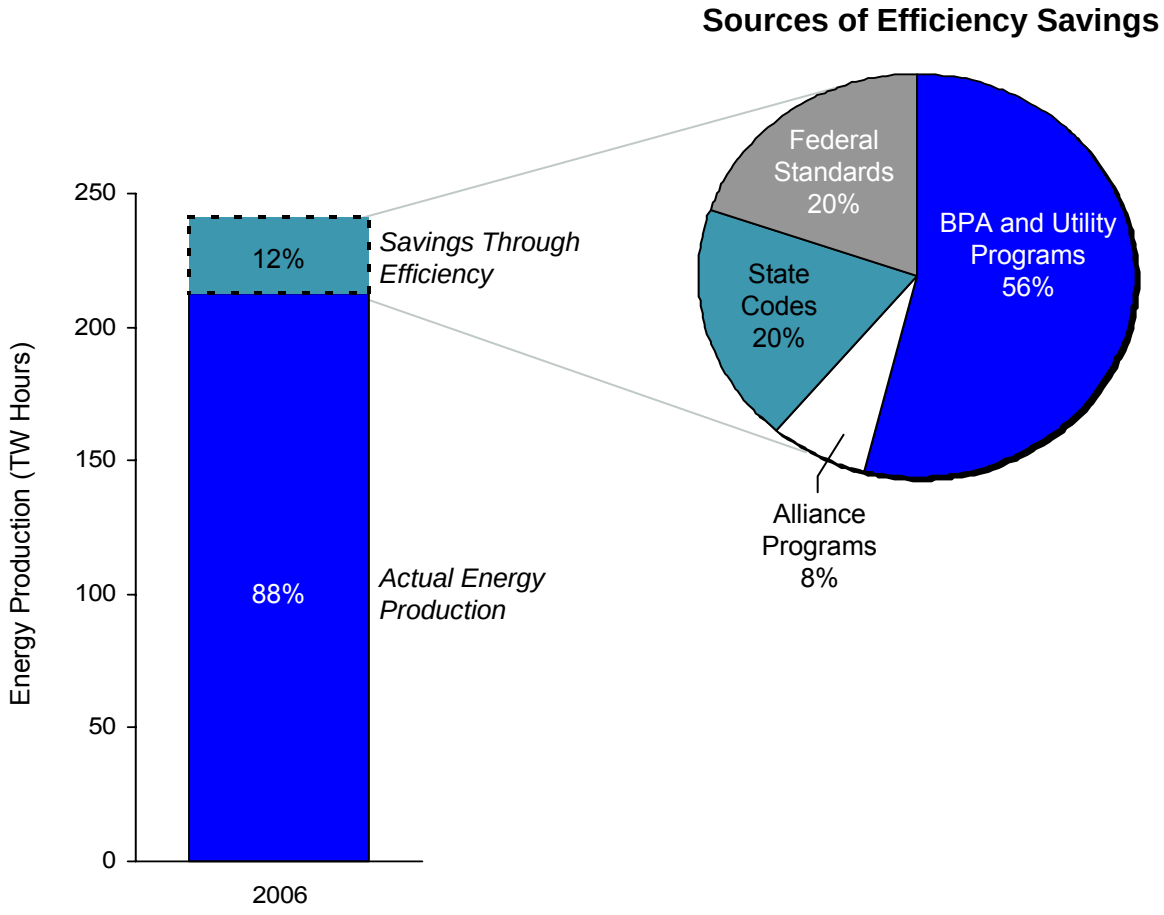
Booz | Allen | Hamilton

Energy efficiency initiatives can have some impact, but there are important barriers there as well…

Market Barriers to Energy Efficiency

- Customers demand short payback times for end-use efficiency investments
- Customers expect unreasonably high rates of return on efficiency investments (40-100%+)
- End users are not the owners (tenant vs. landlord)
- Lack of information and misconceptions about available energy efficient products
- Government efficiency standards as a response to market barriers have proven effective

Efficiency Savings in the Pacific Northwest (2006)



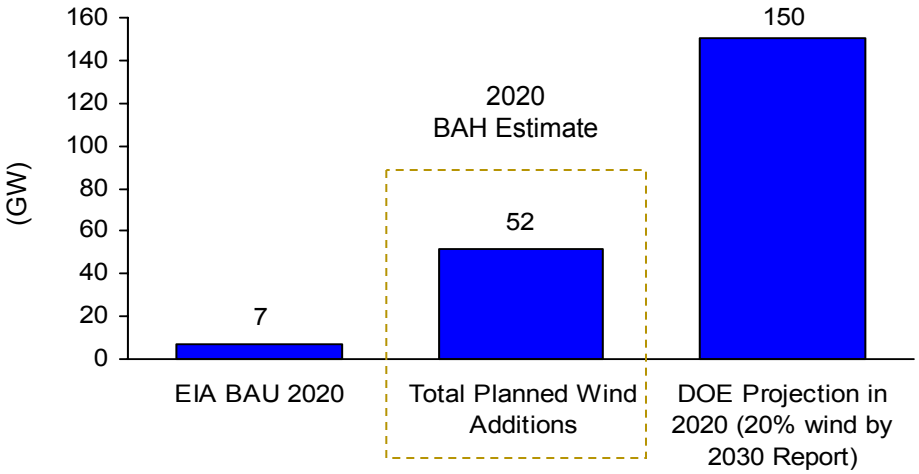
Source: "Market Barriers to Energy Efficiency in Buildings and Equipment: An Overview of Evidence and Remedies", Ralph Cavanagh, 10/03; Northwest Power and Conservation Counsel

GovEnergy www.govenergy.gov

Booz | Allen | Hamilton

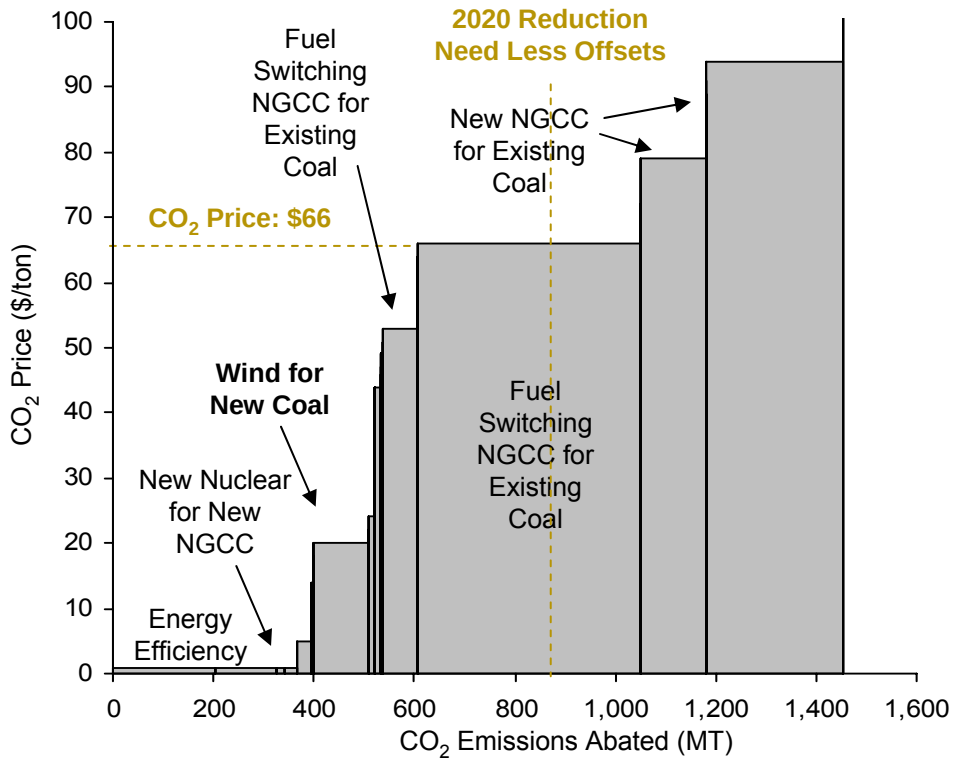
… And there remain supply chain constraints for wind and other renewable technologies

Wind Additions Perspective



- RPS requirements and favorable economics will encourage wind growth
- However, there will be wind turbine supply constraints in the near-term due to rapid demand growth
- In favorable wind farm areas, which are typically remote, transmission tie-in will face regulatory hurdles and high costs

CO_2 Supply Curve (2020)
Higher Gas Price
($10/mmBtu gas, 14 GW Nuclear Available)



GovEnergy
www.govenergy.gov

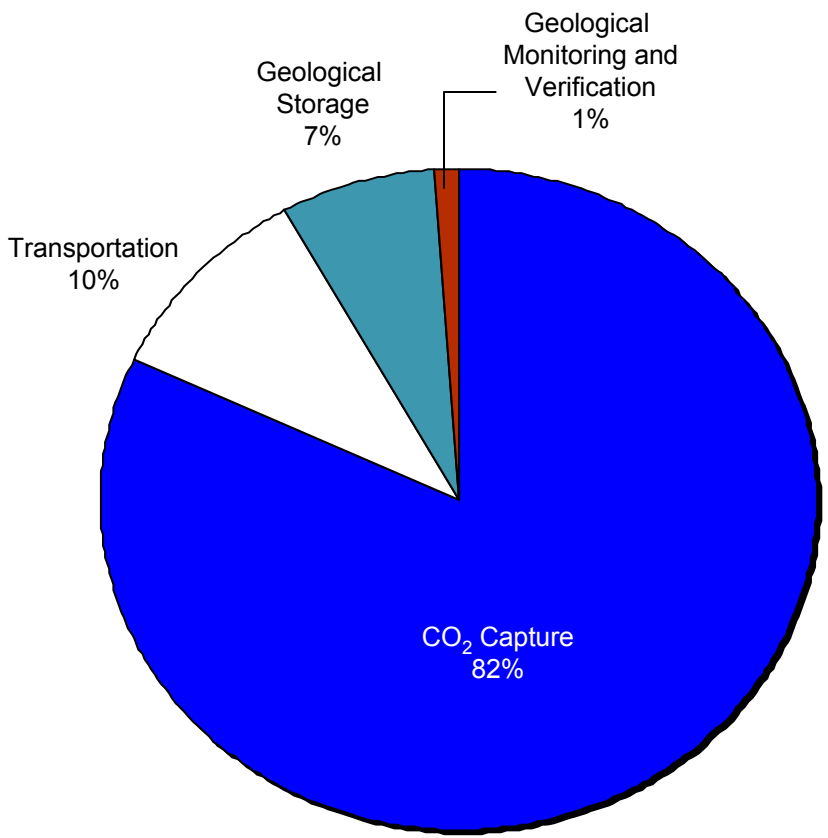
Booz | Allen | Hamilton

Prospects for carbon capture and sequestration remain uncertain due to technology and regulatory challenges

CCS Costs[1]

	CCS System Components	Cost Range (USD / tonne CO_2)
Capture	Capture From a Coal- or Gas-Fired Power Plant	15 – 75
Capture	Capture From Hydrogen And Ammonia Production	5 – 55
Capture	Capture From Other Industrial Sources	25 – 115
	Transportation	1 – 8 (per 250km)
Storage	Geological Storage	0.5 – 8
Storage	Geological Storage: Monitoring and Verification	0.1 – 0.3
Storage	Ocean Storage	5 – 30
Storage	Mineral Carbonation	50 – 100

CCS Cost Components of Coal-Fired Plant



GovEnergy www.govenergy.gov

Booz | Allen | Hamilton

Table Of Contents

- The Complexity of the Carbon Challenge
- Overview of Booz Allen Carbon War Game
- Implications for Energy Customers/Consumers
- Issues for Consideration

Many observations from the war game have broader implications for carbon regulation and potential market responses in the future

Rate Impact	▸ 20-year impact was substantial by historic standards, but not especially severe ▸ However, short-term impact was major, and could have derailed the entire scheme ▸ Takeaway: Synchronizing the technology and the law is critical. Early certainty and delayed application are both desirable.
Technology	▸ Technology drove the market: As new solutions became available, they were implemented and the market responded. ▸ At the macro level, technology investment is key. At the company level, technology optionality and expertise is a strategic necessity
Natural Gas Prices	▸ High gas prices would not only impact carbon price and power price levels, but reshape their trajectory. ▸ In such an event, gas-fired plants may not be as safe a default option for mid-term power needs as is widely assumed
Multiple Regulations	▸ At some points, SO2 and NOX were the operative constraints; at others CO2 was the operative constraint. ▸ This affected the economics of technology fixes and the value of credits ▸ The rate increases involved in this game would likely trigger substantial backlash, undermining the returns of regulated positions.