



Edison Electric Institute

Power by AssociationSM

Moving Towards a Low Carbon Power Sector: Options and Challenges

Dr. Lola Infante

Director, Generation Fuels and Market Analysis

Global Workshop on Low Carbon Power Sector Development

December 12, 2011

Washington, DC

Edison Electric Institute

The Edison Electric Institute (EEI) is the association of U.S. Shareholder-Owned Electric Companies. Our members serve 95 percent of the ultimate customers in the shareholder-owned segment of the industry, and represent approximately 70 percent of the U.S. electric power industry.

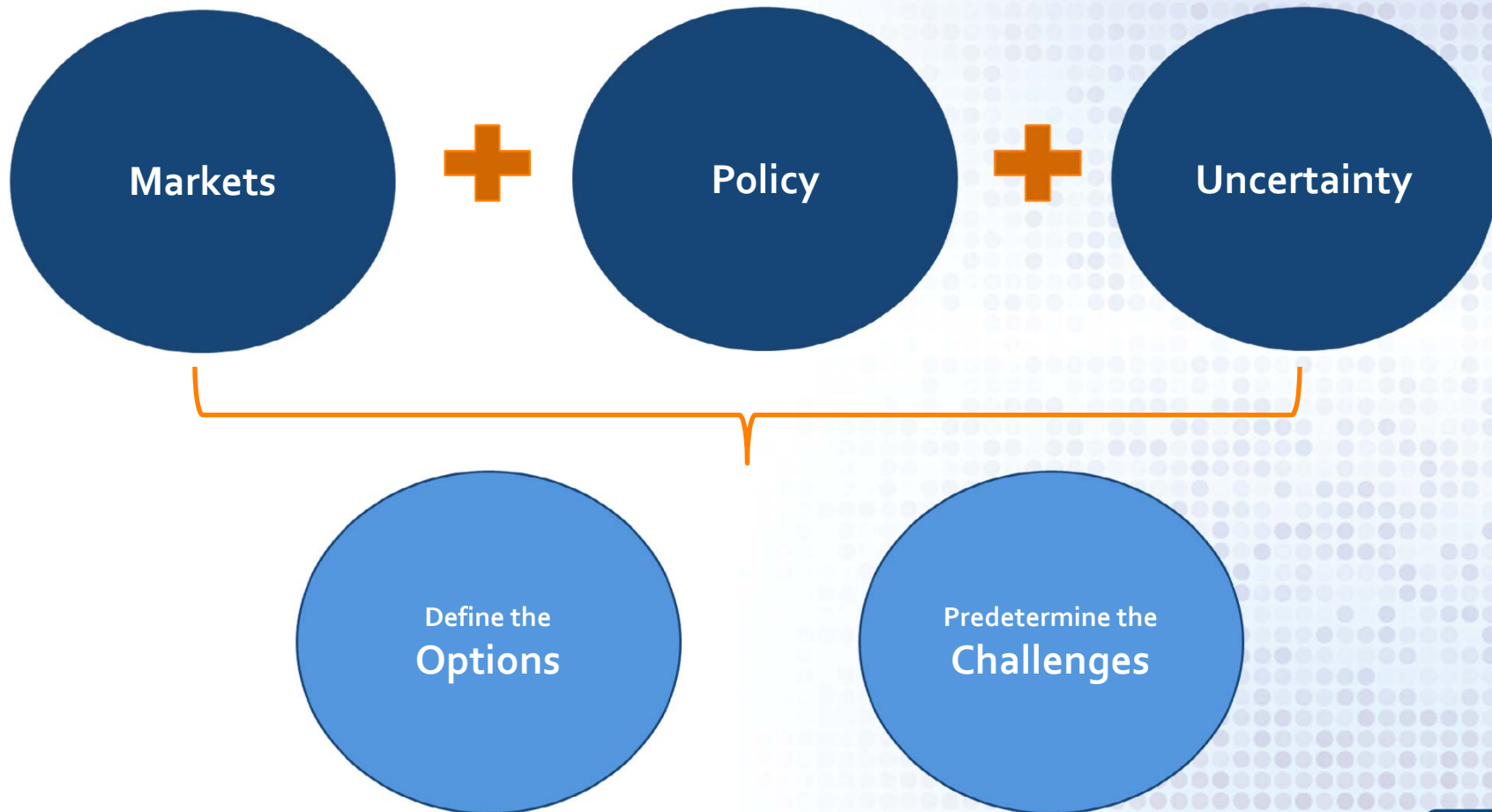
We also have more than 70 international electric companies as Affiliate Members, and more than 200 industry suppliers and related organizations as Associate Members.



Thomas A. Edison



Moving Towards a Low Carbon Power Sector

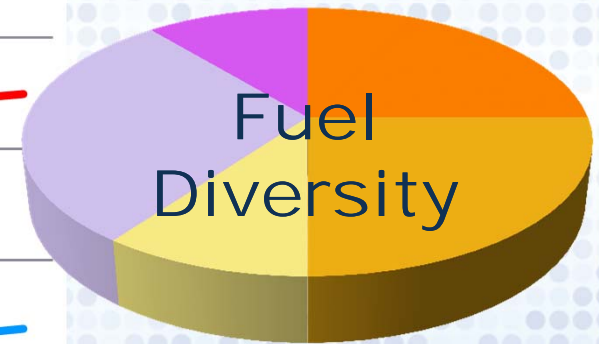
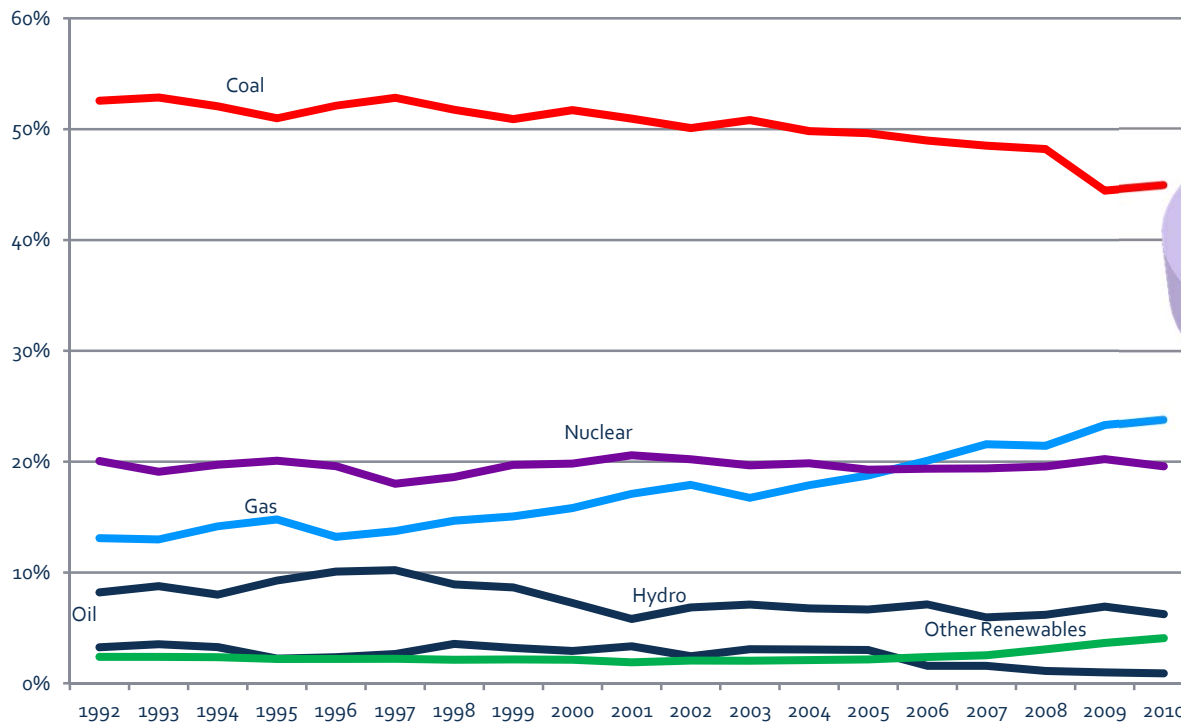


The United States

- Big
- Rich in natural resources
- Large consumer of energy
- Federalism
- Different market structures
- Lacks comprehensive energy policy

The Power Sector is Getting Cleaner

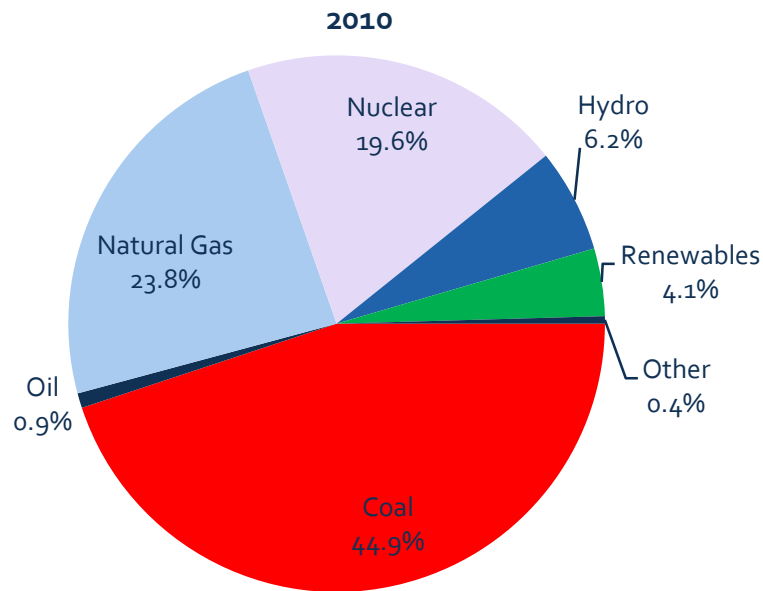
Electricity mix needs to provide **affordable, reliable** energy, **efficiently**, with minimal **environmental** impact.



Source: U.S. Department of Energy; Energy Information Administration (EIA)

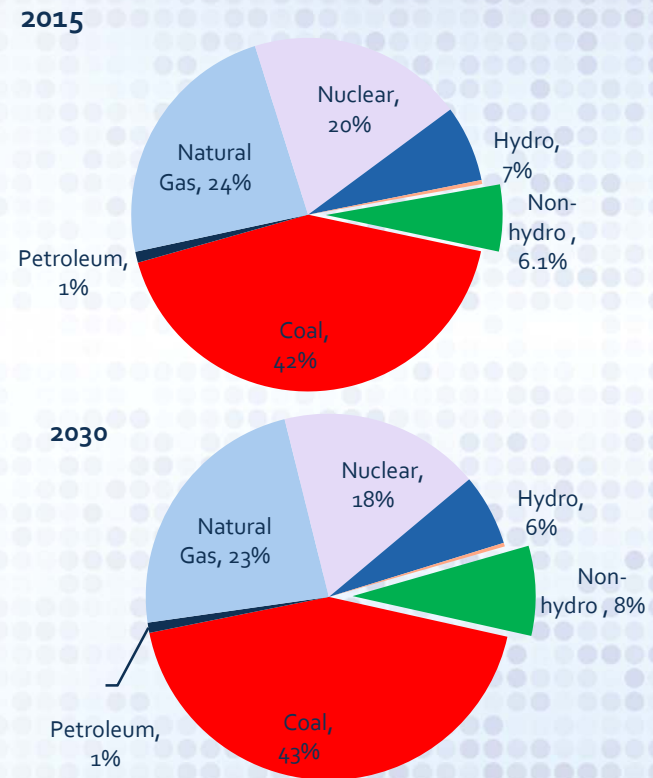


Electric Generation



Data source: DOE, Energy Information Administration

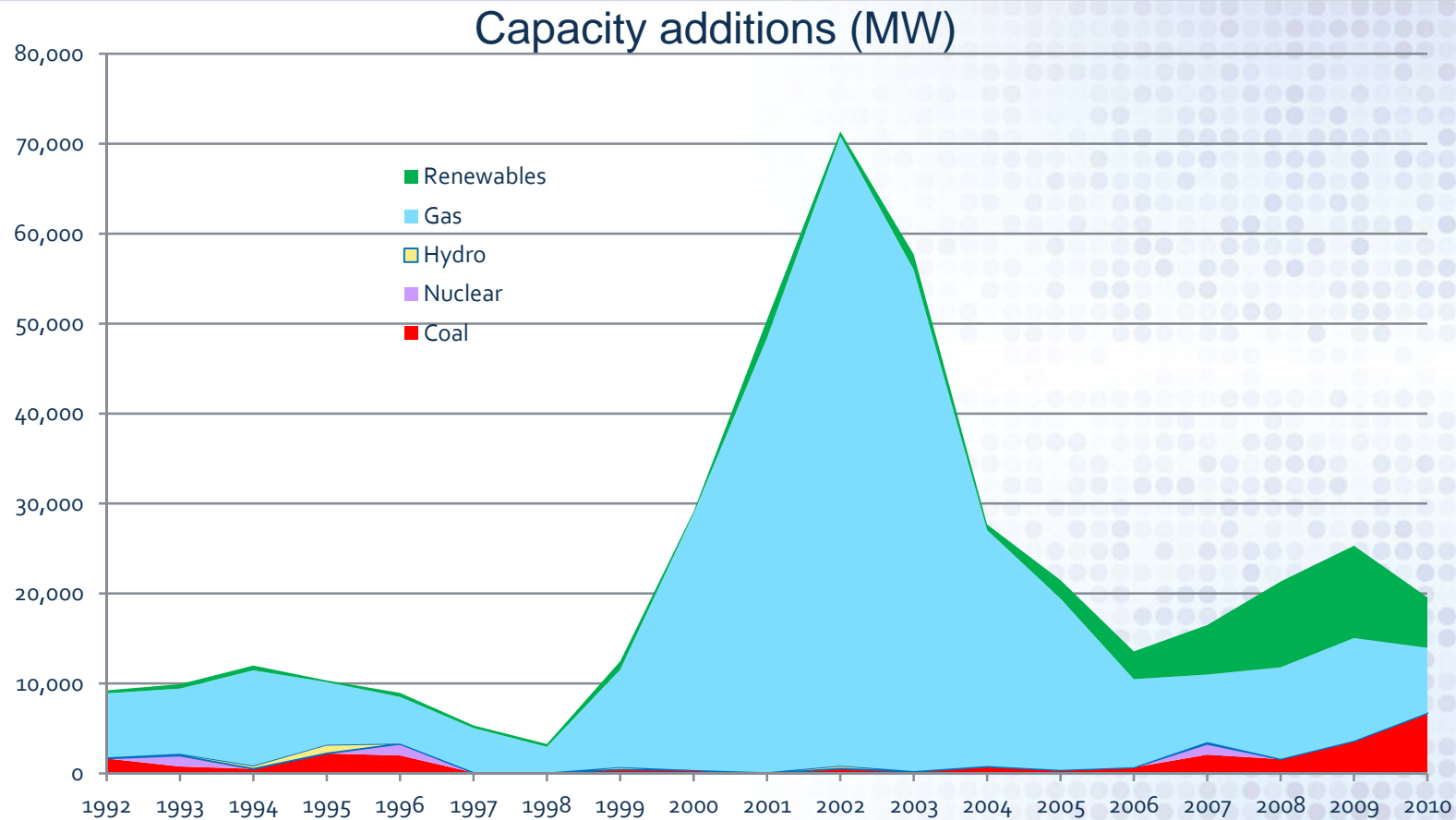
If policies change, the mix will change



Data source: DOE, Energy Information Administration, Annual Energy Outlook, 2011

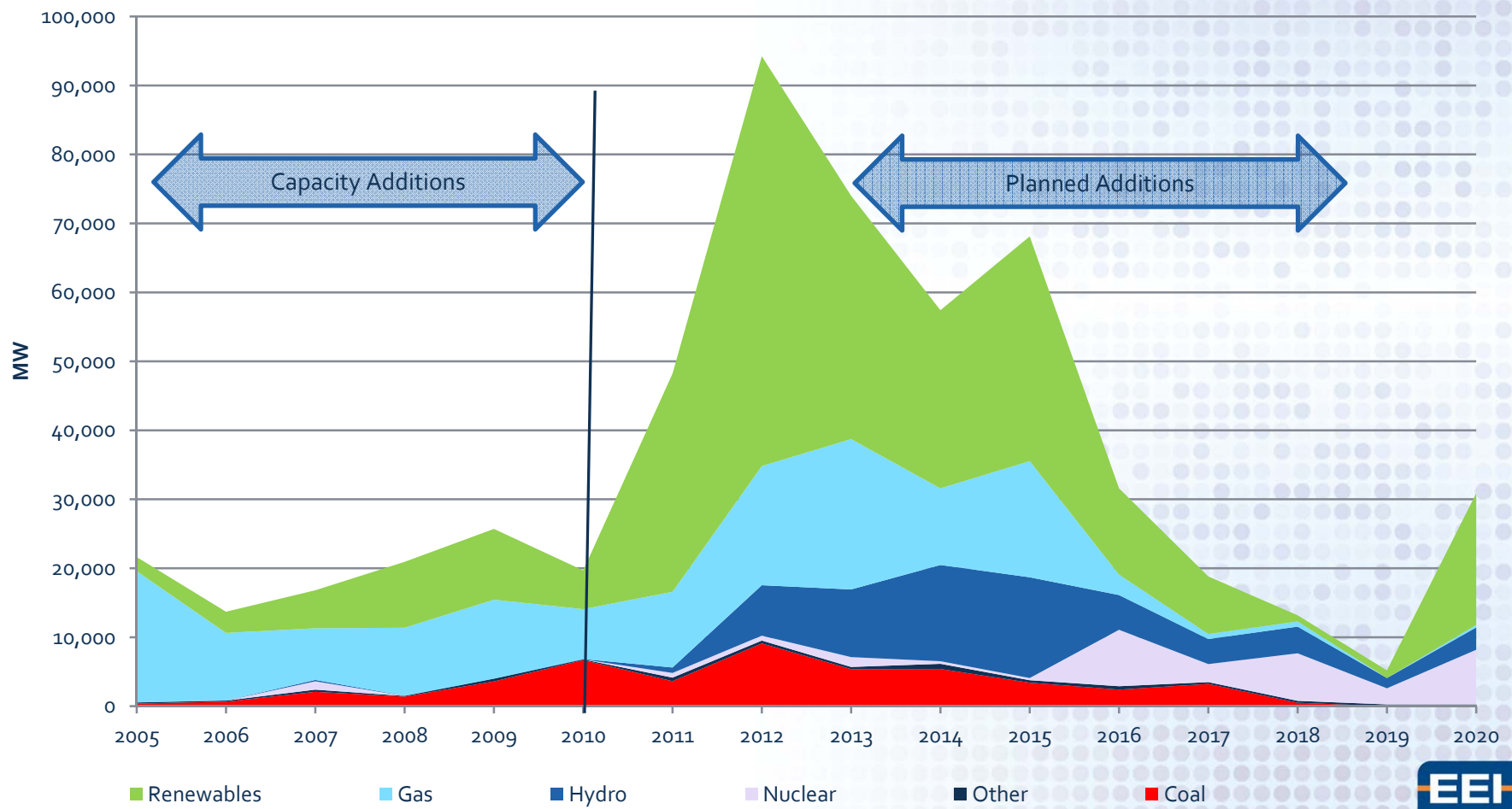
Generation Capacity Trends

Is there a winner?



Generation Capacity Trends

Anyone losing?

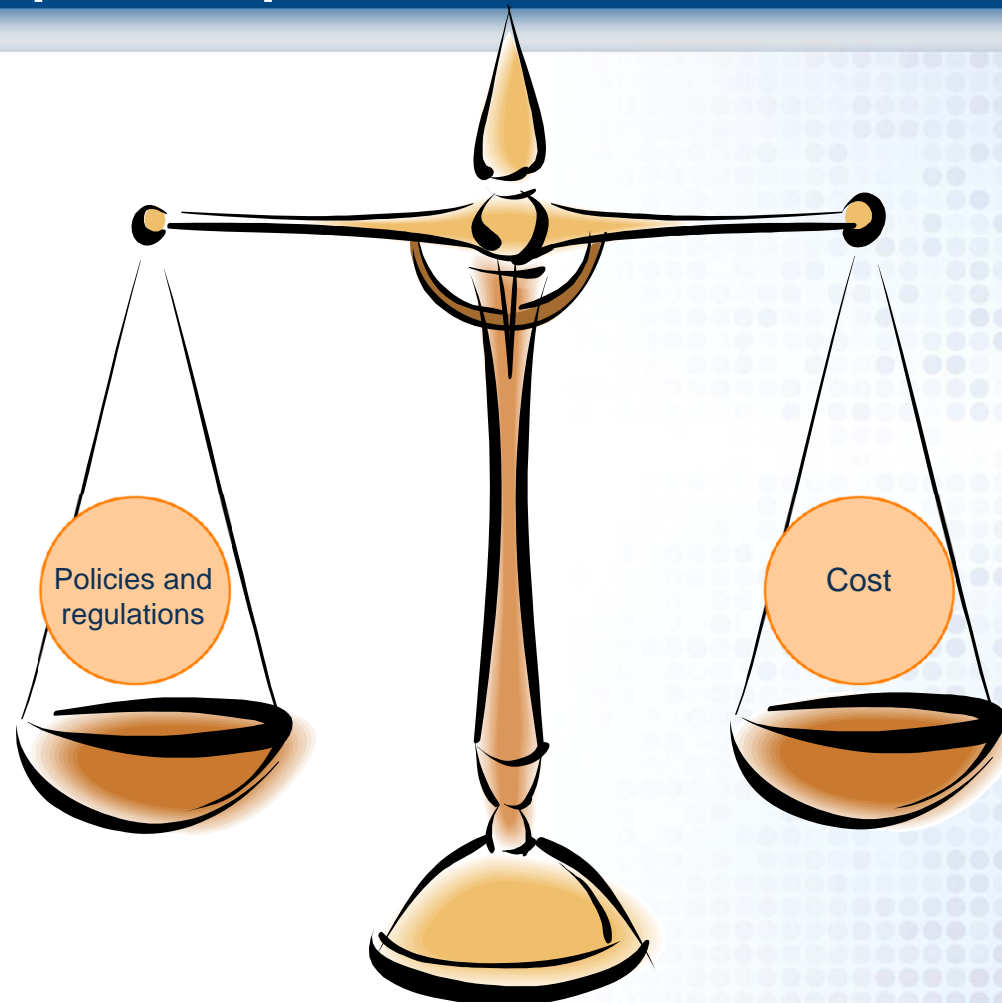


Data as of September 2011

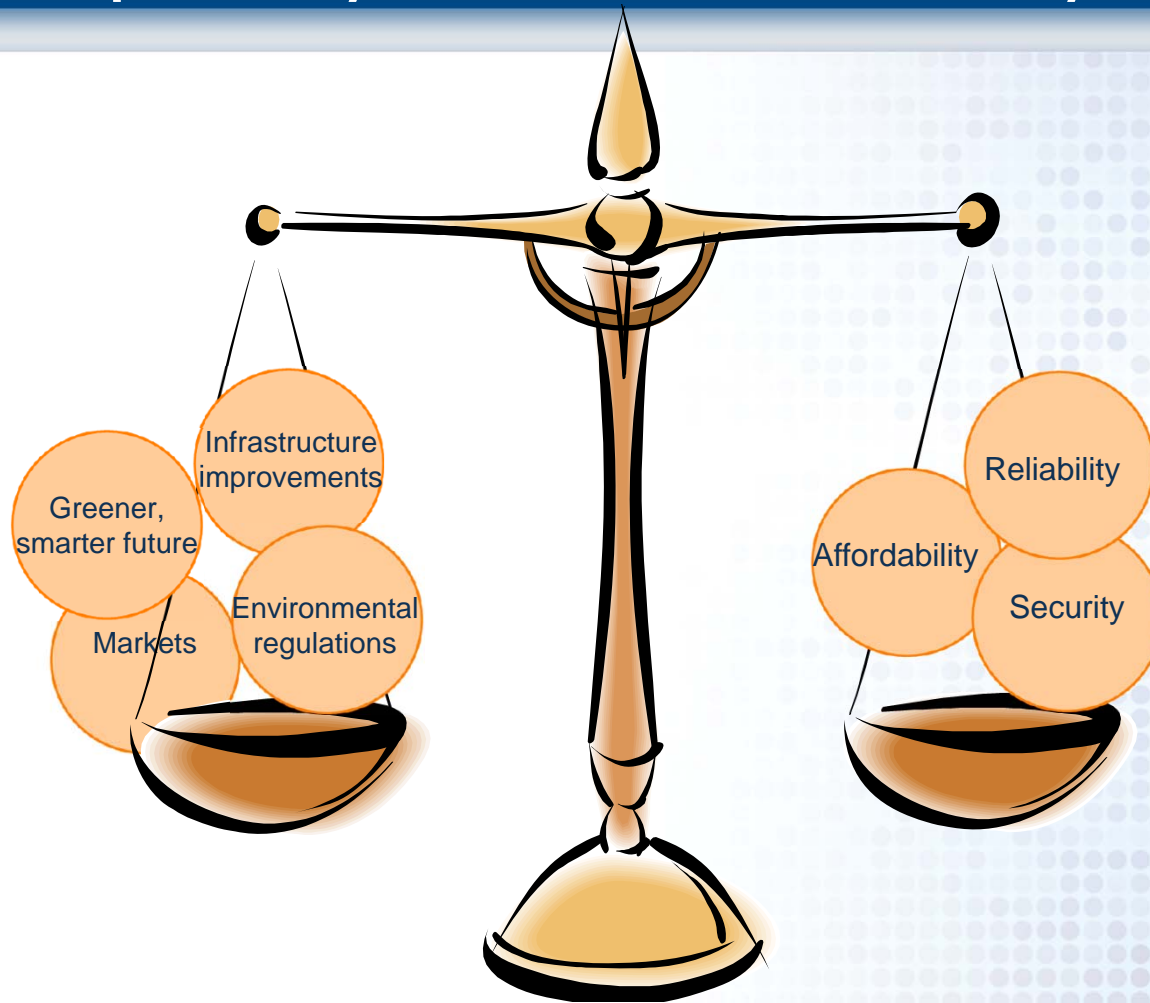
Source, Ventyx, Inc., The Velocity Suite



Drivers of Generation Capacity: A simple equation ?



The Utilities' Balancing Act: Complexity with Uncertainty



Divergent Forces



The Last Three Years Abbreviated

Robust demand growth
Technological Innovation
Investment cycle – Infrastructure improvements
Renewables and state RPS
Climate change legislation prospects
Smart grid promise & investment
Shales & the promise of natural gas
Federal RPS/CES
Economic crisis
EPA regulations
New Congress and state legislatures
Budget deficit
Hydraulic fracturing concerns
Fukushima

**FUEL
DIVERSITY**

**FUEL
INTERRELATION**

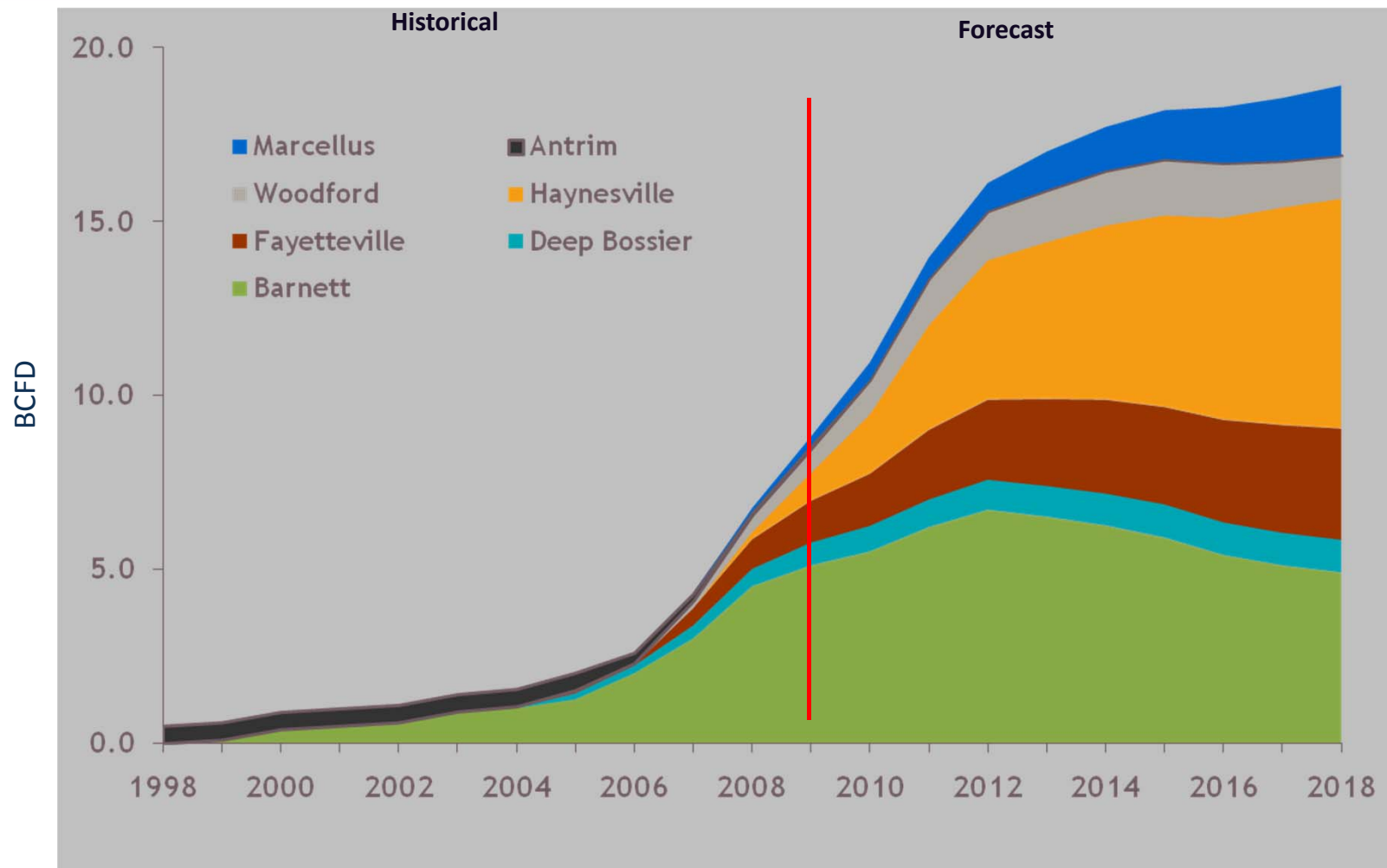
What's Shaping Energy Markets?

- Demand for electricity
- Environmental regulations
- Markets (costs and availability of fuels and technologies)
- Social realities/acceptance (renewables, nuclear, DG)
- Political realities (economic growth, budget, political preferences)
- Regulatory realities (consumer protection and preferences)

Natural Gas Trends

- Unconventional gas boom
- Prices still a factor
- **Future of gas linked to the future of coal, nuclear and renewable energy**
- Economic and regulatory new developments and uncertainty: How much and when?
 - Economic recovery
 - Climate policy and EPA regulations
 - Baseload replacement and renewables development
- **"No-regrets" investment decisions**

Natural Gas Trends



Source: Tristone Capital, Devon Energy

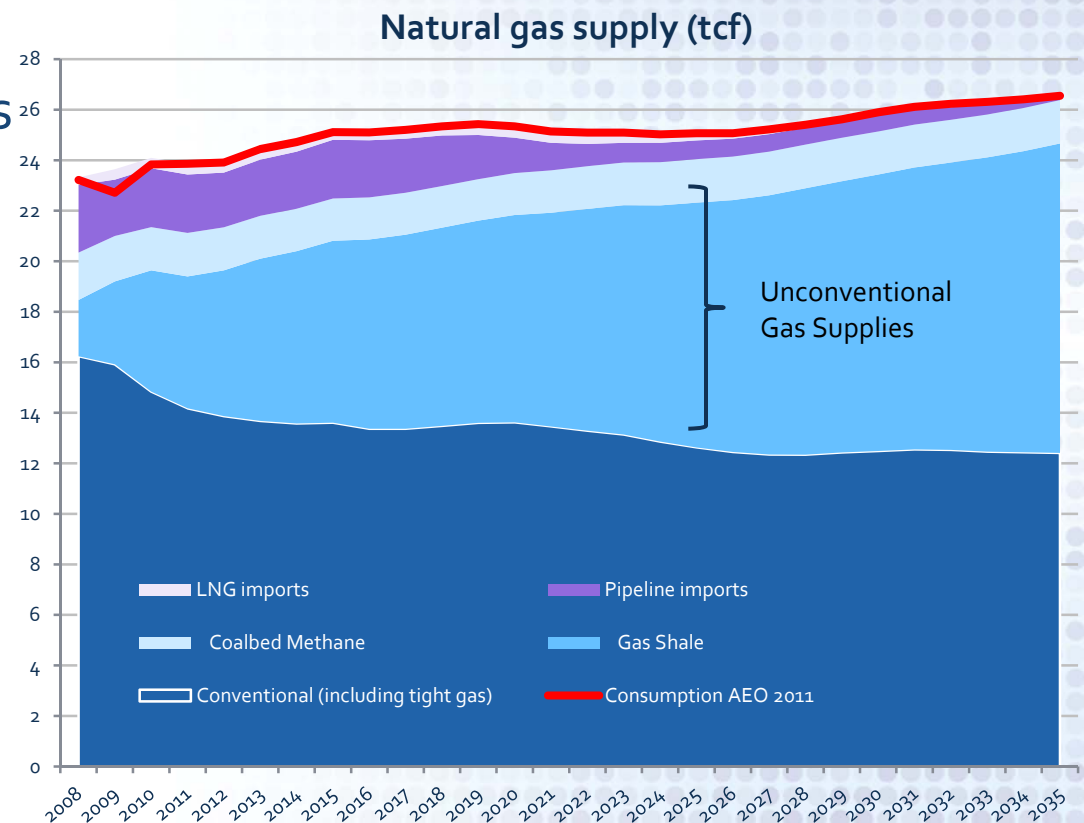


Natural Gas Trends

- CERA: Estimated recoverable shale-gas resources outside of North America at between 5,000 and 16,000 trillion cubic feet (April 2009)
- U.S. Potential Gas Committee: U.S. gas resources estimated at 2,074 trillion cubic feet – the highest resource evaluation in the committee's 44 history (June 2009)
- EIA: Natural gas proved reserves increased 11% over the year (Nov 2010)
- In the U.S., shale formations now account for more than 70% of total new production

Natural Gas Trends

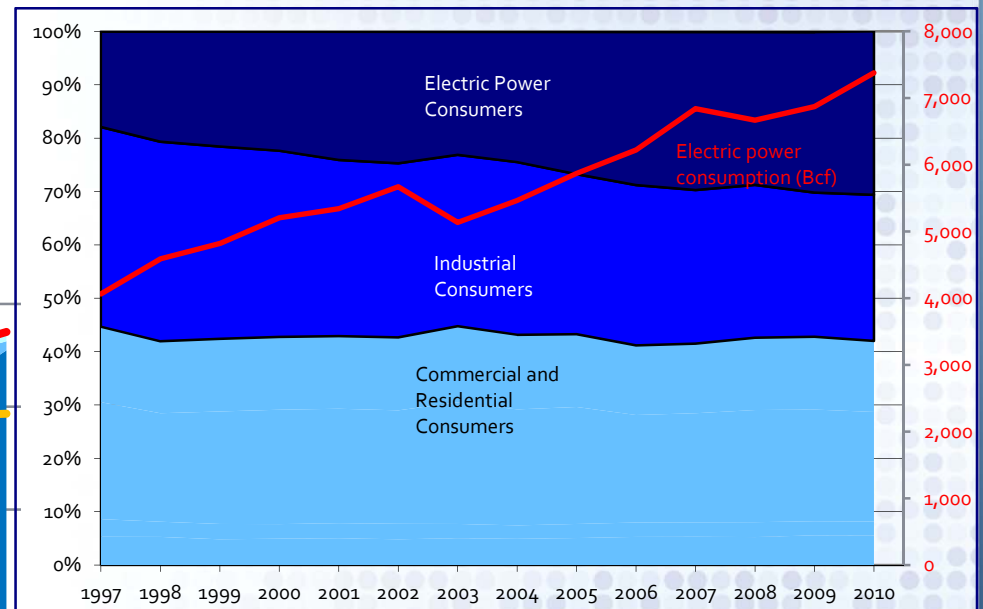
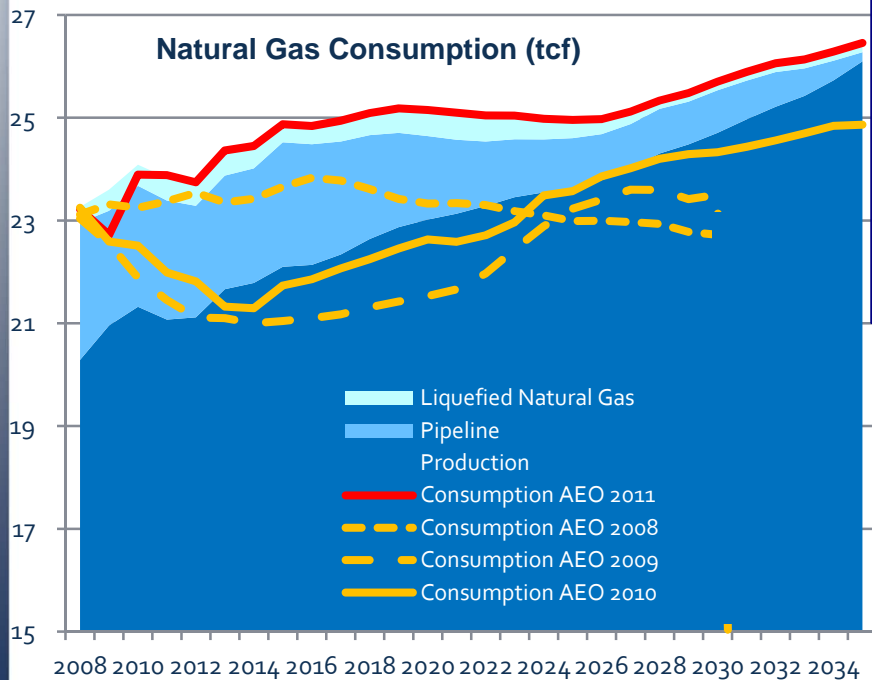
- Abundant shale resources
- Shale formations now account for more than 70% of total new production



Natural Gas Trends

Natural gas' many aka's:

- Bridge fuel
- Destination fuel
- Swing fuel

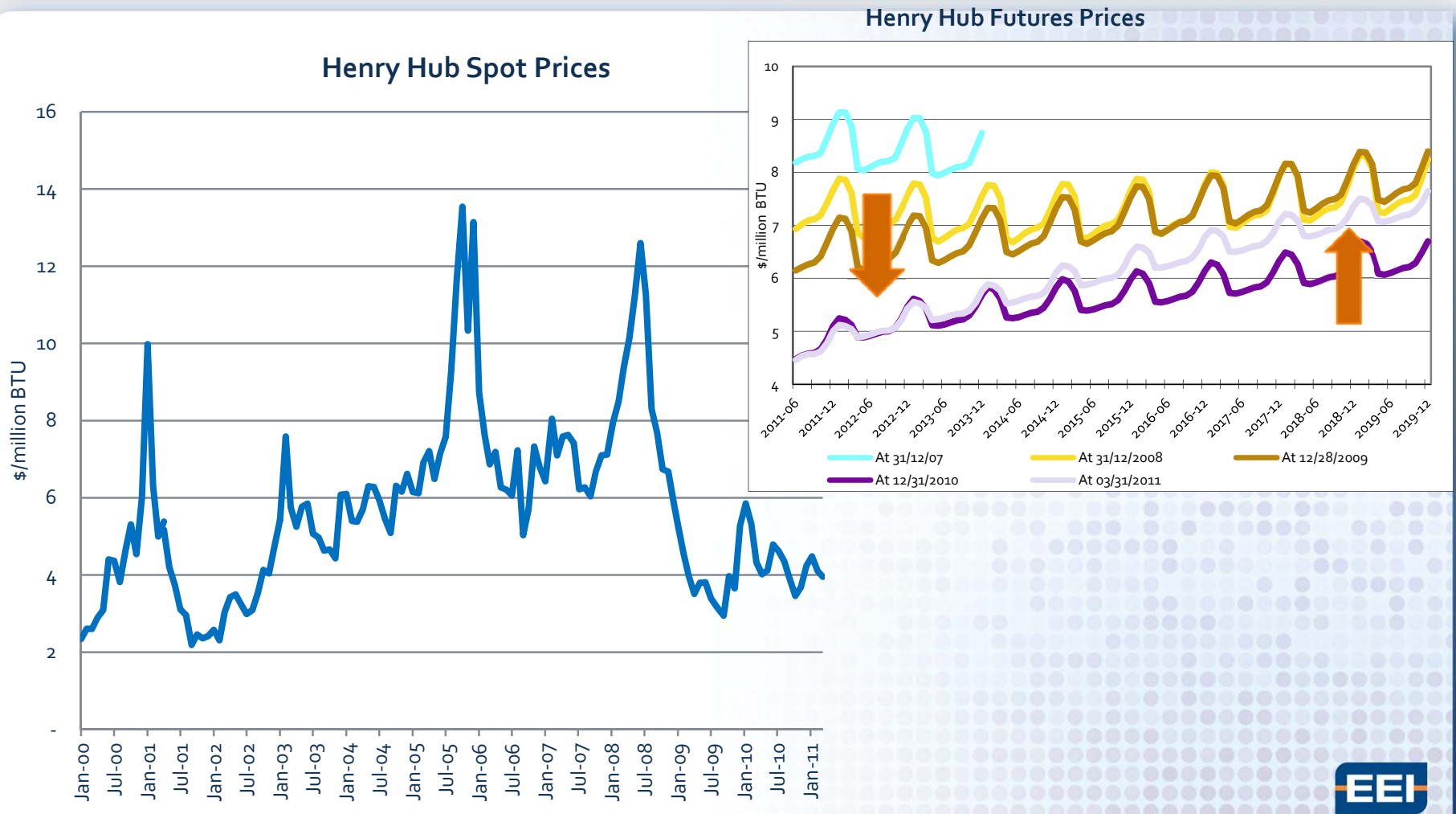


- Largest growth potential from electric sector



Source: Department of Energy, the Energy Information Administration - AEO 2007, AEO 2008, AEO 2009, AEO 2010 and AEO 2011.

Natural Gas Trends



Source: NYMEX - Henry Hub Natural Gas Spot Prices (Monthly Average), and futures



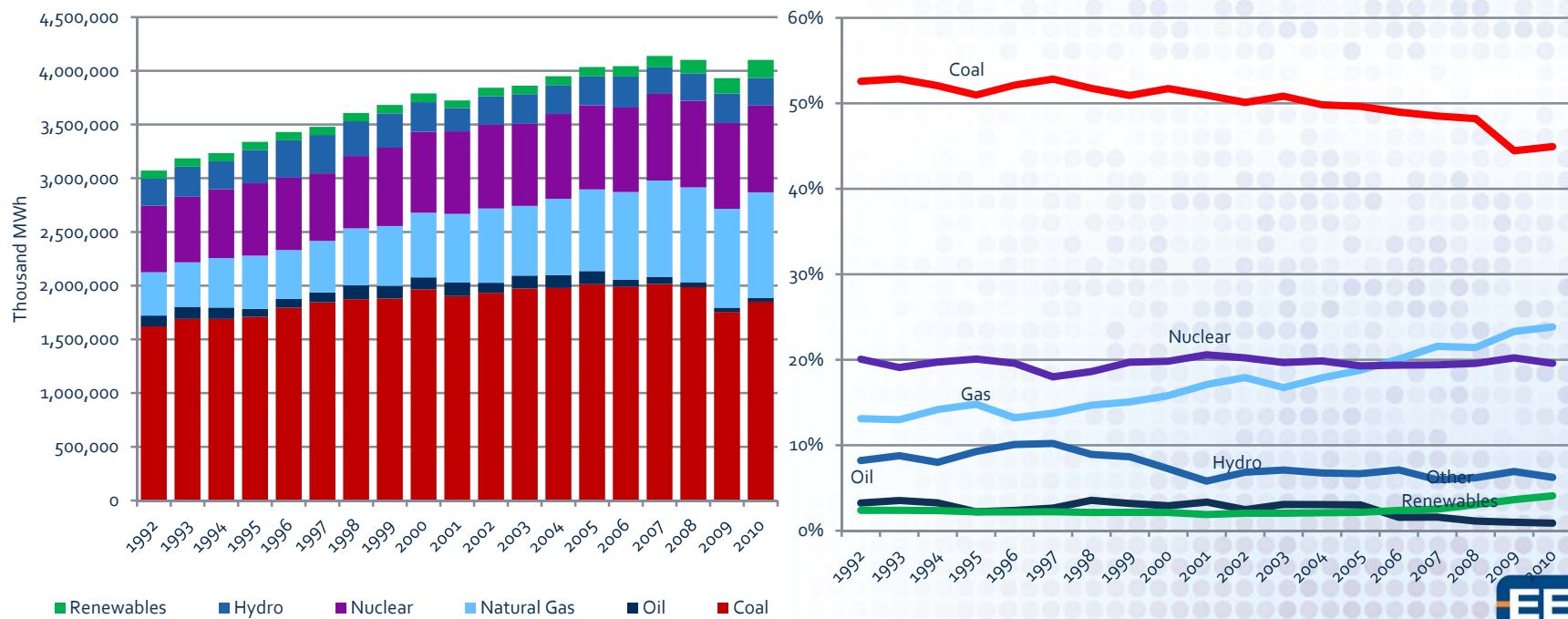
Natural Gas Trends

Challenges ahead

- Regulatory challenges
 - Hydraulic fracturing – EPA and state regulations
- Public opposition
 - Drinking water contamination concerns and waste water/surface contamination
- GHG reduction implications
- Price level and volatility
- Pipeline access/availability

Coal Trends

- Coal use remains high, but share in electricity mix declining

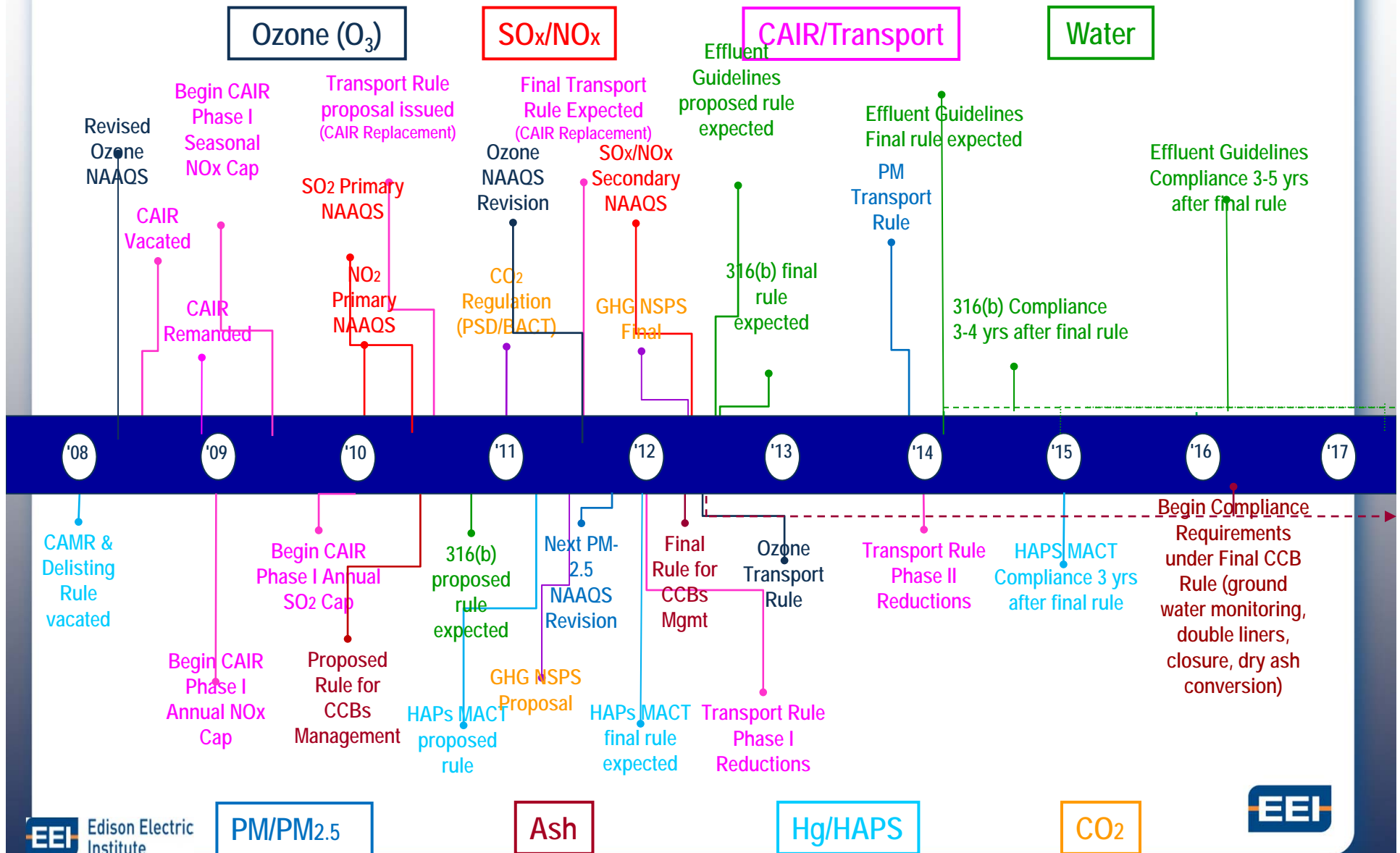


Sources: Department of Energy, Energy Information Administration

Coal Trends

- Coal's future is uncertain, dependent on timing of policy and technology developments
 - Climate change
 - Developments in CCS
 - EPA: Transport Rule, Air Toxics Rule, 316b
 - Numerous analyses on potential impacts of EPA rulemaking
 - Every analysis uses different assumptions making comparison difficult
 - Estimates of coal plant retirement range from ~30 to 70 GW
 - None of the analyses consider future regulation of CO₂
 - Cost competitiveness

Possible Timeline for Environmental Regulatory Requirements for the Utility Industry



Coal Trends: the Big Unknown

Carbon Capture and Storage

Cost

Technology

Infrastructure

Market

Regulations

...

Nuclear Trends

- Capacity and generation have remained relatively constant
 - Before and after Fukushima
 - From the *Nuclear Renaissance* to a nuclear skepticism?
- Increased scrutiny of existing nuclear plants, particularly the older ones.
- Applications for new reactors will most likely undergo an even more robust review, but safety design features in new reactors should obviate issues raised by Fukushima.

Nuclear Trends

- Germany: temporary closure of its two oldest nuclear power plants. Suspension of plans to extend the life of all of the country's remaining plants.
- Switzerland: plans to build and replace nuclear plants on hold
- Austria: calls for atomic stress tests throughout Europe
- European Union: plans to assess Europe's preparedness in case of an emergency.
- Italy: one year moratorium on nuclear plans
- USA: talks of closing nuclear plants. Increased scrutiny of existing nuclear plants. Applications for new reactors will most likely undergo an even more robust review.

Nuclear Trends

Proposed New Nuclear Plants - U.S. Shareholder-Owned Electric Utilities

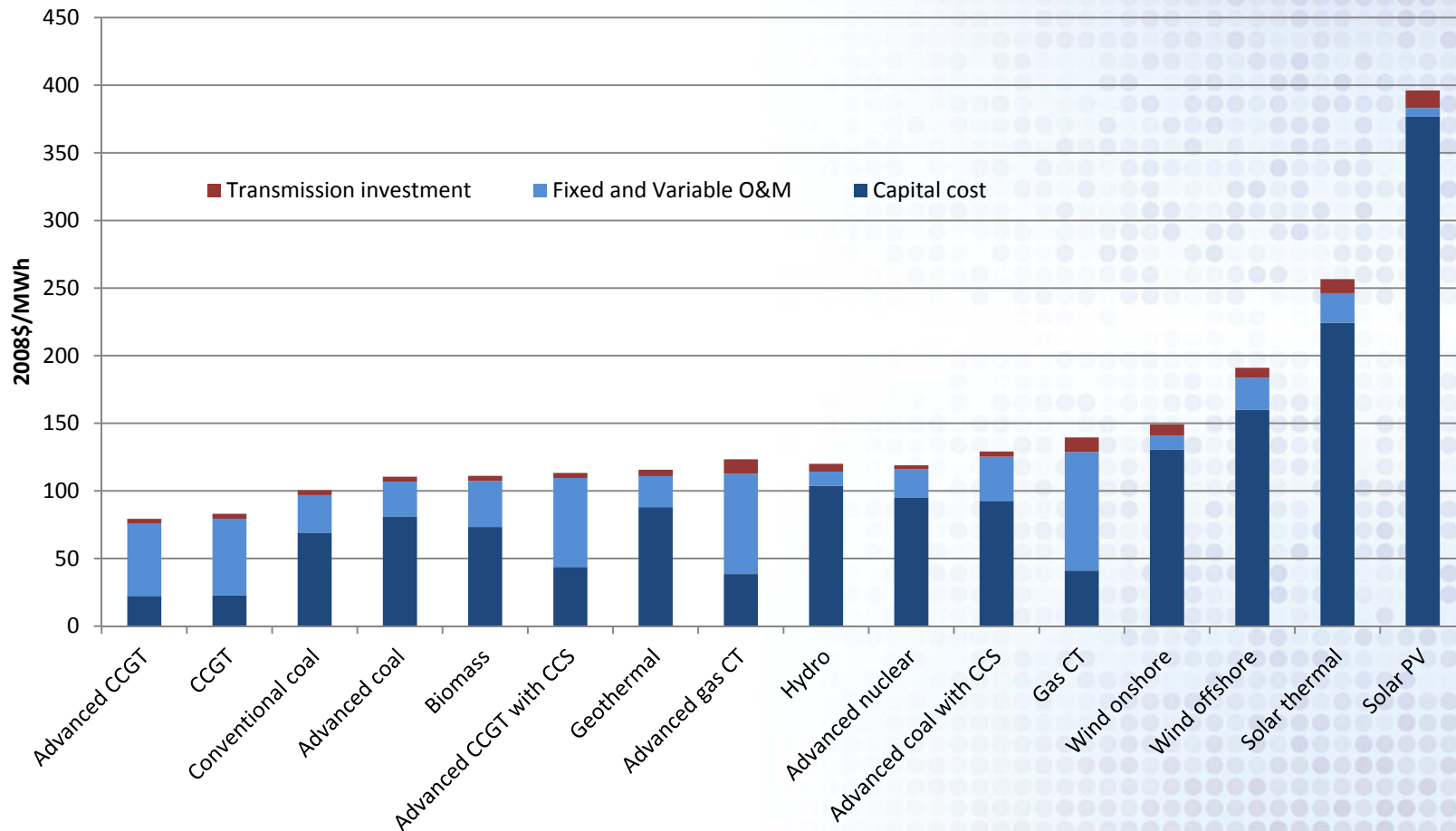
Company	Site (State)	Early Site Permit	Design (# of Units)	Expected Construction & Operating License Submittal	Units under NRC Review
DTE Energy Co.	Fermi (MI)	TBD Approved November 2007.	ESBWR (1)	September 2008	1
Dominion Resources Inc.	North Anna (VA)	-	ESBWR (1)	November 2007	1
Duke Energy Corp.	William States Lee (SC)	-	AP1000 (2)	December 2007	2
Entergy Corp.	River Bend (LA)	-	TBD	September 2008	
Exelon Corp.	Clinton (IL)	Approved March 2007.	TBD	TBD	
Exelon Corp.	Victoria County (TX)	Submitted March 2010	TBD	TBD	
Florida Power & Light	Turkey Point (FL)	TBD	AP1000 (2)	June 2009	2
NuStart (Consortium) - TVA Site	Bellefonte (AL)	-	AP1000 (2)	October 2007	
NuStart (Consortium) -Entergy Site	Grand Gulf (MS)	Approved April 2007.	TBD	February 2008	
PPL Corp. / Unistar	Susquehanna, PA	-	EPR (1)	October 2008	1
Progress Energy	Shearon Harris (NC)	-	AP1000 (2)	February 2008	2
Progress Energy	Levy County (FL)	-	AP1000 (2)	July 2008	2
PSEG	Lower Alloways Creek (NJ)	Submitted May 2010	TBD	TBD	
SCANA Corp.	V.C. Summer (SC)	-	AP1000 (2)	March 2008	2
Southern Co.	Vogtle (GA)	Approved August 2009	AP1000 (2)	March 2008	2
Southern Co.	TBD	TBD	TBD	TBD	
Energy Future Holdings Inc. (Luminant)	Comanche Peak (TX)	-	APWR (2)	September 2008	2
UniStar (Constellation & Areva)	Calvert Cliffs (MD)	-	EPR (1)	July 2007 & March 2008	1
UniStar (Constellation & Areva)	Nine Mile Point (NY)	-	EPR (1)	September 2008	
NRG Energy/STPNOC	Matagorda (TX)	-	ABWR 2)	September 2007	2

Source: Nuclear Energy Institute, Nuclear Regulatory Commission, EEI
Last updated May 2011



Nuclear Trends

Estimated Levelized Cost of New Generation, 2016



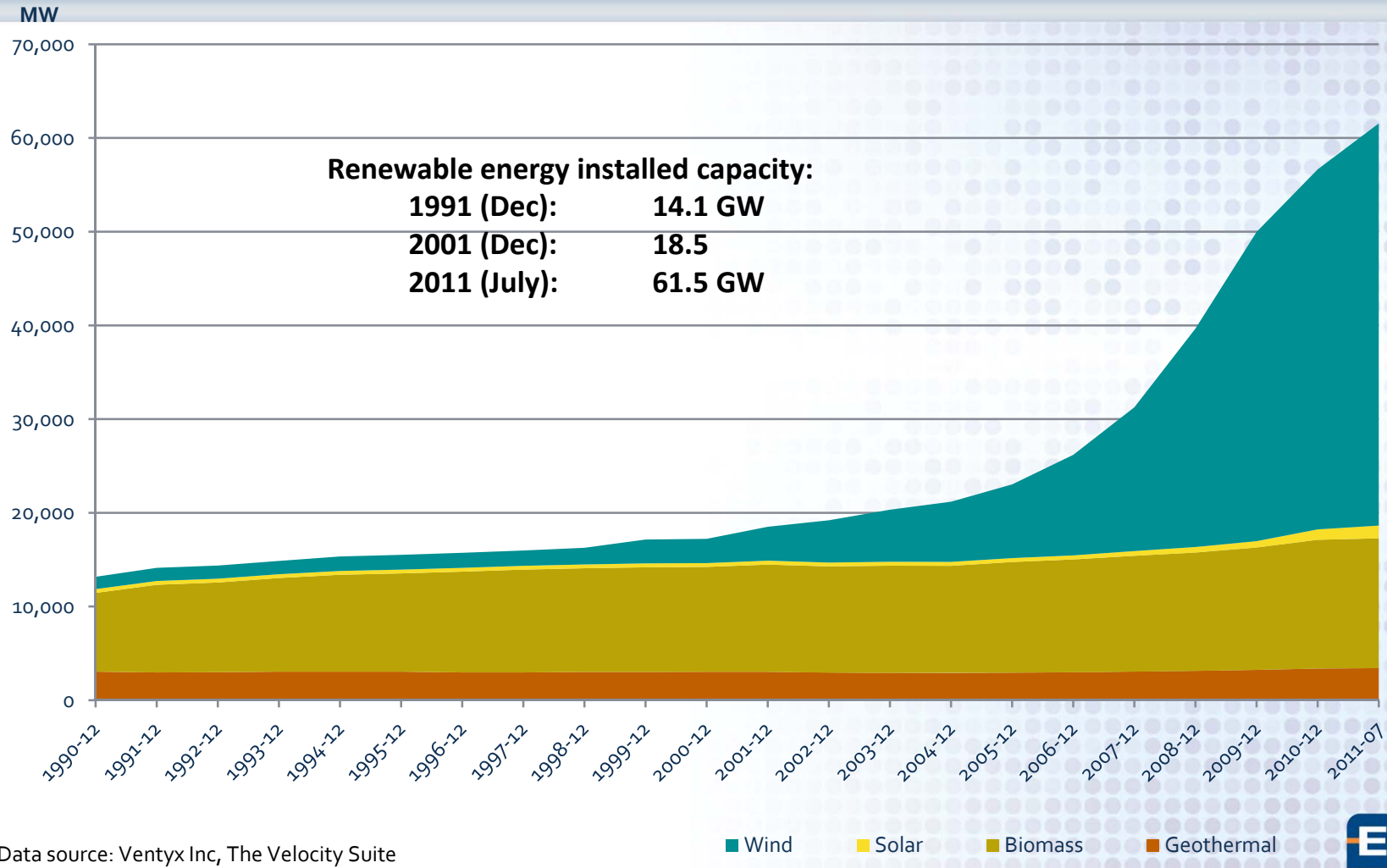
Source: DOE-Energy Information Administration, Annual Energy Outlook, 2010



Renewable Energy Trends

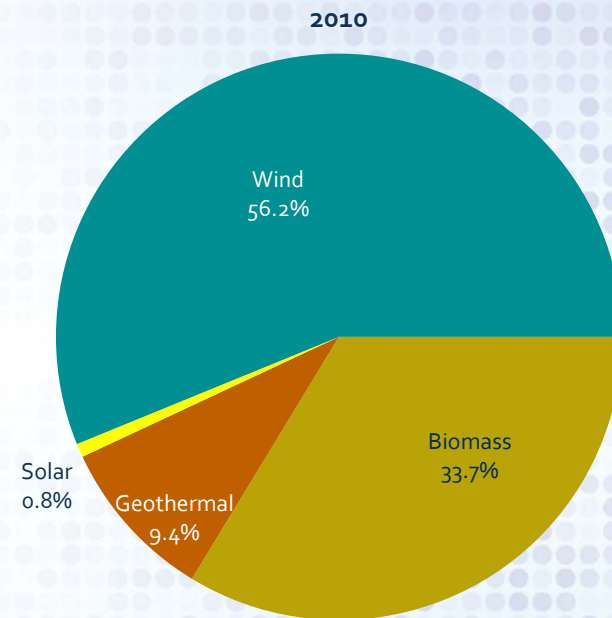
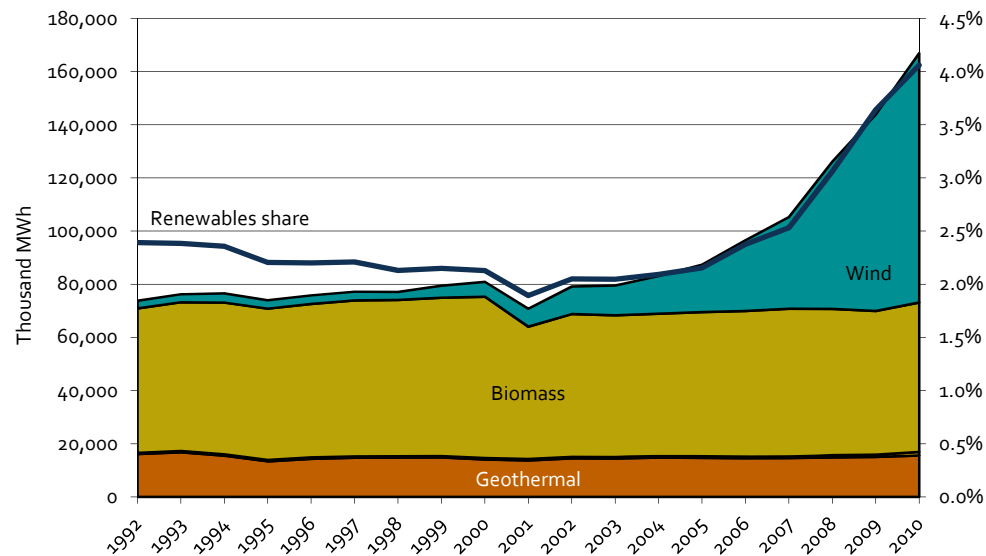
- Rapid growth (2010-11 hiccup?)
- Biggest share of projects in the pipeline, but ...
- ...market saturation, cost, ...
- ...dependent on public support (policies, incentives)
 - Budget considerations
 - Increasing political and regulatory concern over the impact of high-cost renewable generation on rates
 - Increased pressure in other areas (i.e. EPA regulations) increases uncertainty and makes investment decisions all the more difficult

Renewable Energy trends: Rapid Growth in New Operating Capacity



Renewable Energy Trends: Rapid Growth in Electricity Generation

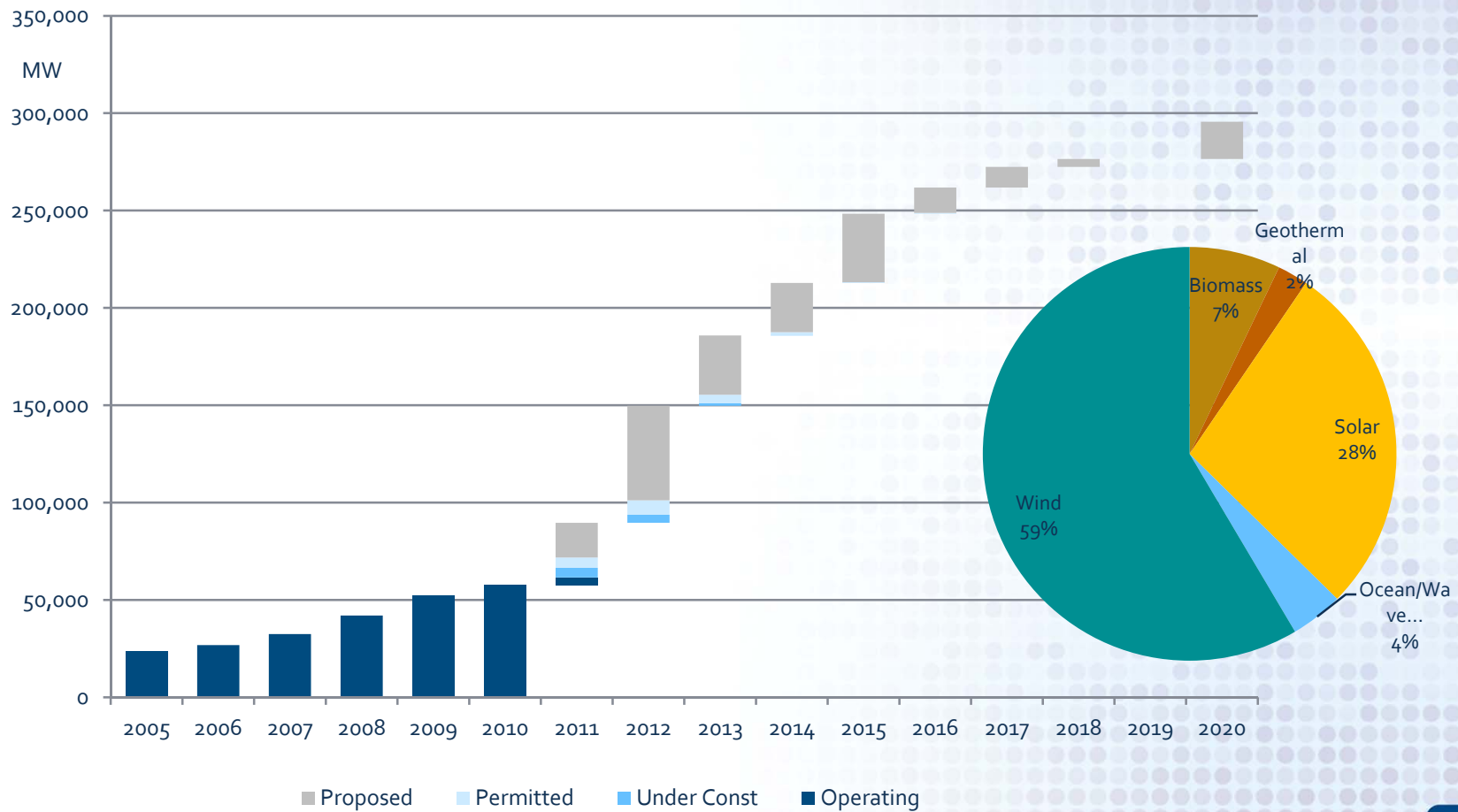
Generation



Data source: Department of Energy, Energy Information Administration



Expected Online Schedule of Existing Renewable Project Announcements



Data source: Ventyx Inc., The Velocity Suite
Data and status as of September 19, 2011

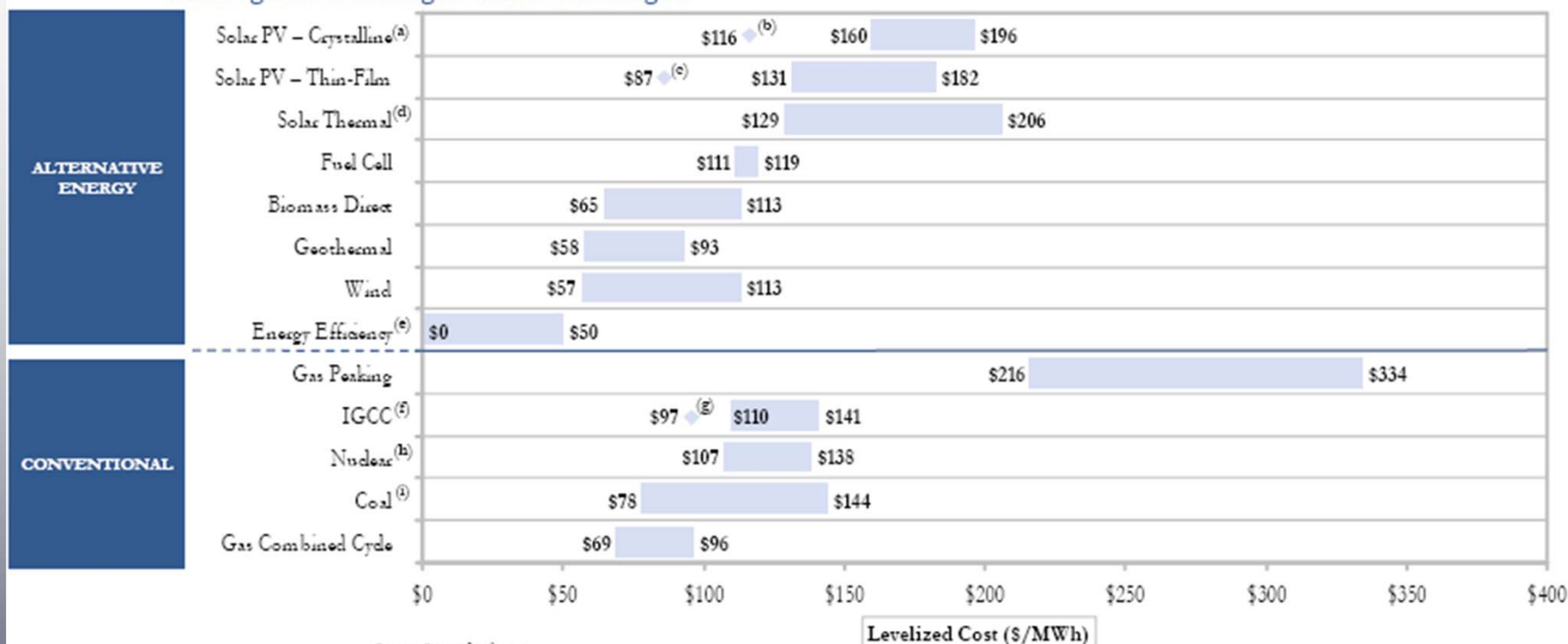


Renewable Energy Trends

	Opportunities	Challenges
Supply	Prices for wind and solar falling Financial Incentives	Financial Incentives? Cost even if declining
Demand	State RPS Economic and technological environment	Overall demand low Low natural gas prices Low wholesale market prices
Out of market considerations	Political and social acceptance	Regulatory/consumer push back Integration costs and challenges Transmission Developments in other fuels

Levelized Cost of Energy Comparison

Certain Alternative Energy generation technologies are becoming increasingly cost-competitive with conventional generation technologies under some scenarios, before factoring in environmental and other externalities (e.g., RECs, potential carbon emission costs, transmission and back-up generation/system reliability costs) as well as construction and fuel costs dynamics affecting conventional generation technologies



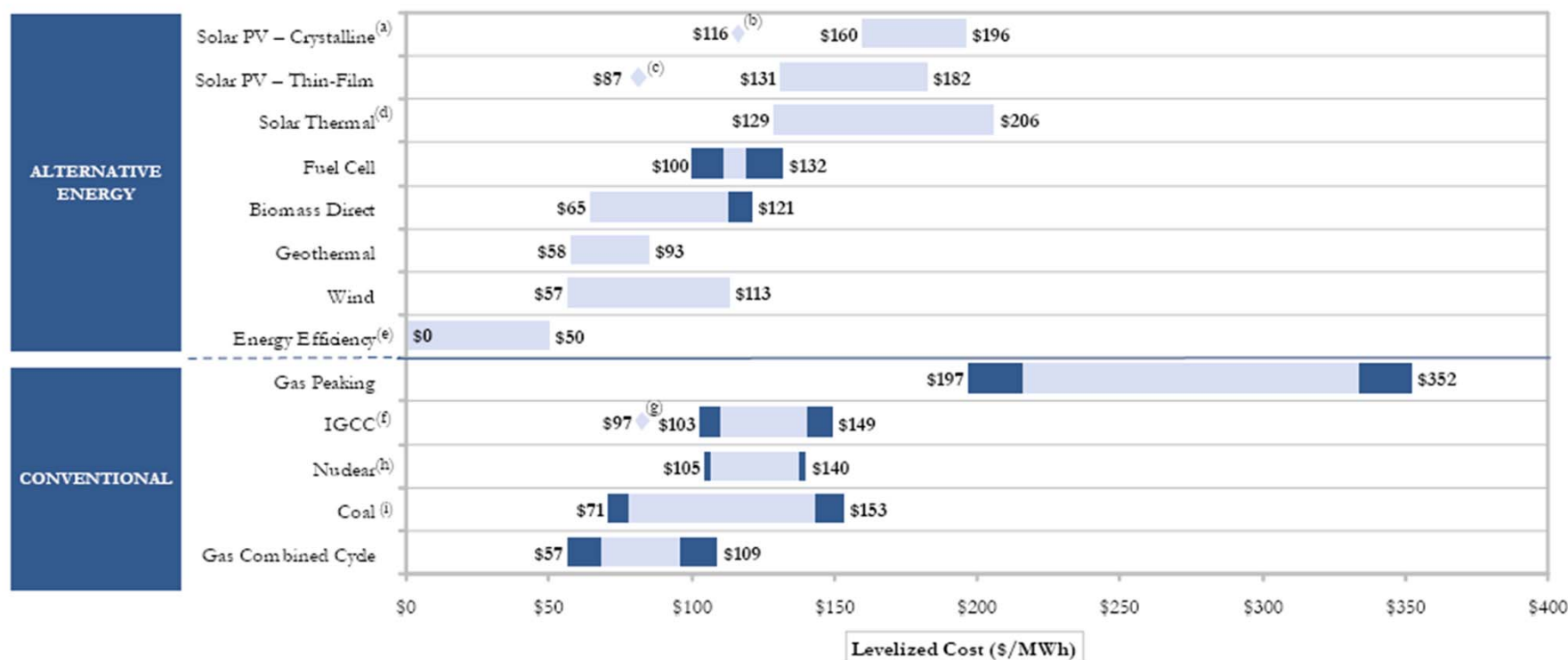
Source: Lazard estimates.

Note: Reflects production tax credit, investment tax credit and accelerated asset depreciation, as applicable. Assumes 2008 dollars, 20-year economic life, 40% tax rate and 5-20 year tax life. Assumes 30% debt at 8.0% interest rate, 40% tax equity at 8.5% cost and 30% common equity at 12% cost for Alternative Energy generation technologies. Assumes 60% debt at 8.0% interest rate and 40% equity at 12% cost for conventional generation technologies. Assumes coal price of \$2.50 per MMBtu and natural gas price of \$6.00 per MMBtu.

- (a) Low end represents single-axis tracking crystalline. High end represents fixed installation.
- (b) Represents estimated implied levelized cost of energy in 2012, assuming a total system cost of \$3.50 per watt for single-axis tracking crystalline.
- (c) Represents a leading thin-film company's targeted implied levelized cost of energy in 2012, assuming a total system cost of \$2.00 per watt.
- (d) Low end represents solar tower. High end represents solar trough.
- (e) Estimates per National Action Plan for Energy Efficiency; actual cost for various initiatives varies widely.
- (f) High end incorporates 90% carbon capture and compression.
- (g) Represents estimated implied levelized cost of energy for Southern Company's proposed IGCC facility in Mississippi that is expected to be in service in 2013, assuming a total system cost of \$3.00 per watt and 50% carbon capture, per Southern Company public comments.
- (h) Does not reflect decommissioning costs or potential economic impact of federal loan guarantees or other subsidies.
- (i) Based on advanced supercritical pulverized coal. High end incorporates 90% carbon capture and compression.

Levelized Cost of Energy Comparison – Sensitivity to Fuel Prices

Variations in fuel prices can materially affect the levelized cost of energy for conventional generation technologies, but direct comparisons against “competing” Alternative Energy generation technologies must take into account issues such as dispatch characteristics (e.g., baseload and/or dispatchable intermediate load vs. peaking or intermittent technologies)



Source: Lazard estimates.

Note: Darkened areas in horizontal bars represent low end and high end levelized cost of energy corresponding with $\pm 25\%$ fuel price fluctuations.

(a) Low end represents single-axis tracking crystalline. High end represents fixed installation.

(b) Represents estimated implied levelized cost of energy in 2012, assuming a total system cost of \$3.50 per watt for single-axis tracking crystalline.

(c) Represents a leading thin-film company's targeted implied levelized cost of energy in 2012, assuming a total system cost of \$2.00 per watt.

(d) Low end represents solar tower. High end represents solar trough.

(e) Estimates per National Action Plan for Energy Efficiency; actual cost for various initiatives varies widely.

(f) High end incorporates 90% carbon capture and compression.

(g) Represents estimated implied levelized cost of energy for Southern Company's proposed IGCC facility in Mississippi that is expected to be in service in 2013, assuming a total system cost of \$3.00 per watt and 50% carbon capture, per Southern Company public comments.

(h) Does not reflect decommissioning costs or potential economic impact of federal loan guarantees or other subsidies.

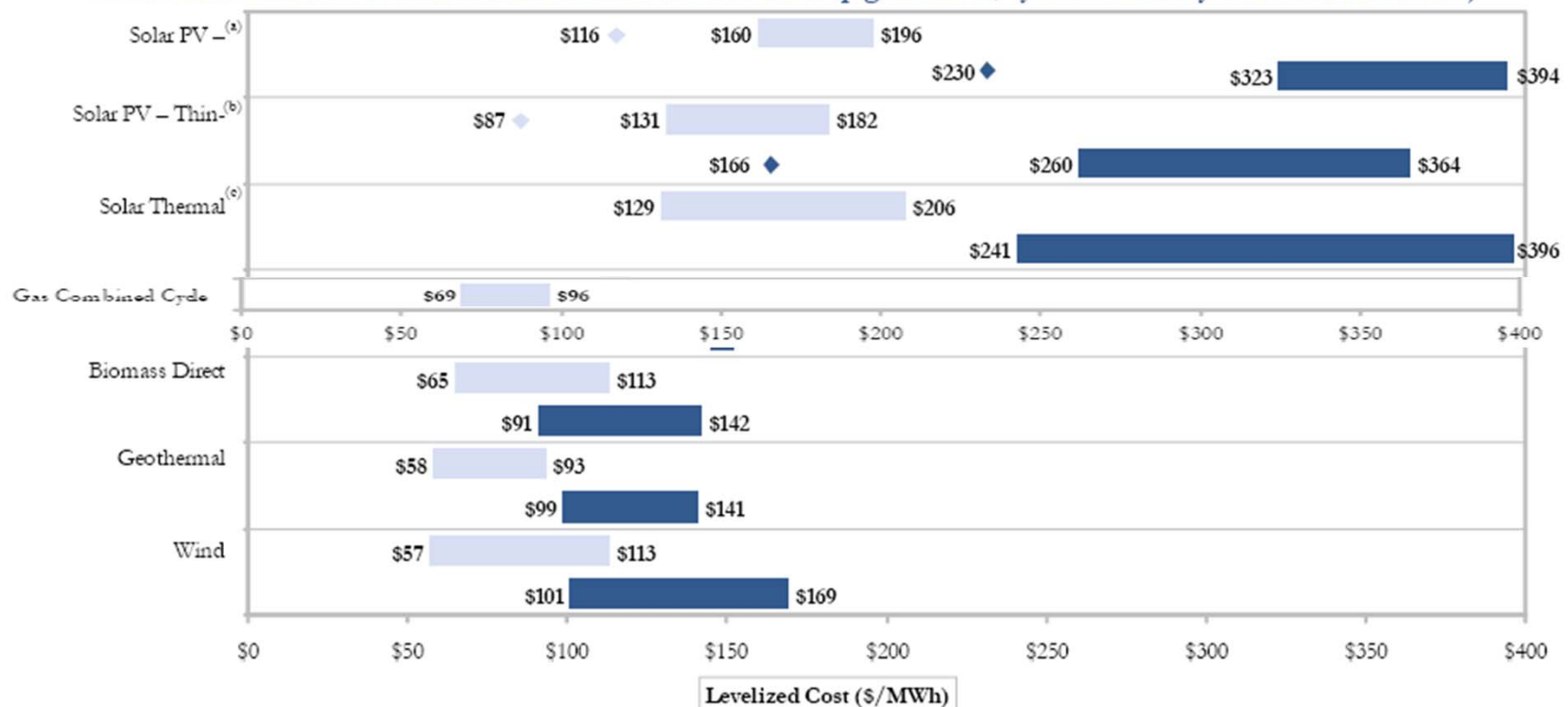
(i) Based on advanced supercritical pulverized coal. High end incorporates 90% carbon capture and compression.

Renewable Energy Trends-Incentives

- Tax credits (1603) were extended in December 2010 for one year. Set to expire Dec. 12, 2011.
- Increased pressure in Washington to reduce the fiscal deficit and streamline the tax code, possibly leading to the elimination of renewable tax credits: PTC?
- End of DOE loan guarantee program

Levelized Cost of Energy – Sensitivity to U.S. Federal Tax Incentives

U.S. federal tax subsidies remain an important component of the economics of Alternative Energy generation technologies (and government incentives are important in all regions), notwithstanding high prevailing fossil fuel prices; future cost reductions in technologies such as fuel cells, solar PV and solar thermal have the potential to enable these technologies to approach “grid parity” without tax subsidies (albeit such observation does not take into account issues such as dispatch characteristics the cost of incremental transmission and back-up generation/system reliability costs or other factors)



Source: Lazard estimates.

Note: Assumes 2008 dollars, 30% debt at 8.0% interest rate, 40% tax equity at 8.5% cost and 30% common equity at 12% cost, 20-year economic life and 40% tax rate. Assumes natural gas price of \$6.00 per MMBtu.

- (a) Low end represents single-axis tracking crystalline. High end represents fixed installation. Diamonds represent estimated implied levelized cost of energy in 2012, assuming a total system cost of \$3.50 per watt for single-axis tracking crystalline.
- (b) Diamonds represent a leading thin-film company's targeted implied levelized cost of energy in 2012, assuming a total system cost of \$2.00 per watt.
- (c) Low end represents solar tower. High end represents solar trough.
- (d) Reflects production tax credit, investment tax credit, and accelerated asset depreciation, as applicable.
- (e) Illustrates levelized cost of energy in the absence of U.S. federal tax incentives such as investment tax credits, production tax credits and assuming 20-year tax life.

Trends Beyond Fuels

- Energy Storage Technologies
- Demand Response
- Energy Efficiency
- Distributed Generation
- Plug-In Hybrid Electric Vehicles
 - Drivers of demand and load shape
 - Generation options and technology needs might change

Uncertainty is Driving Energy Choices

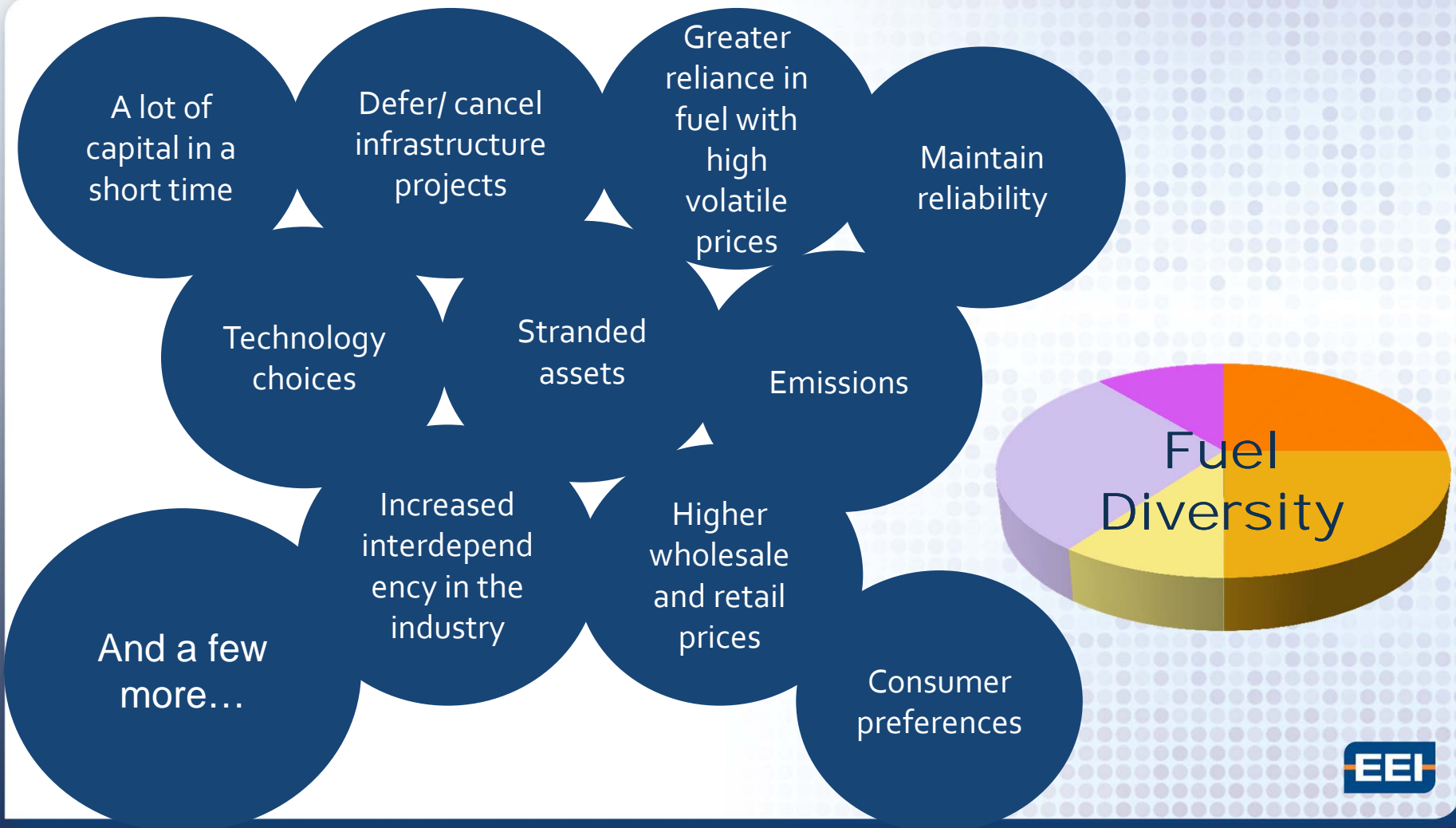
- Economic uncertainty
- Regulatory and legislative uncertainty
- Technological uncertainty
- Social acceptance uncertainty
- ...



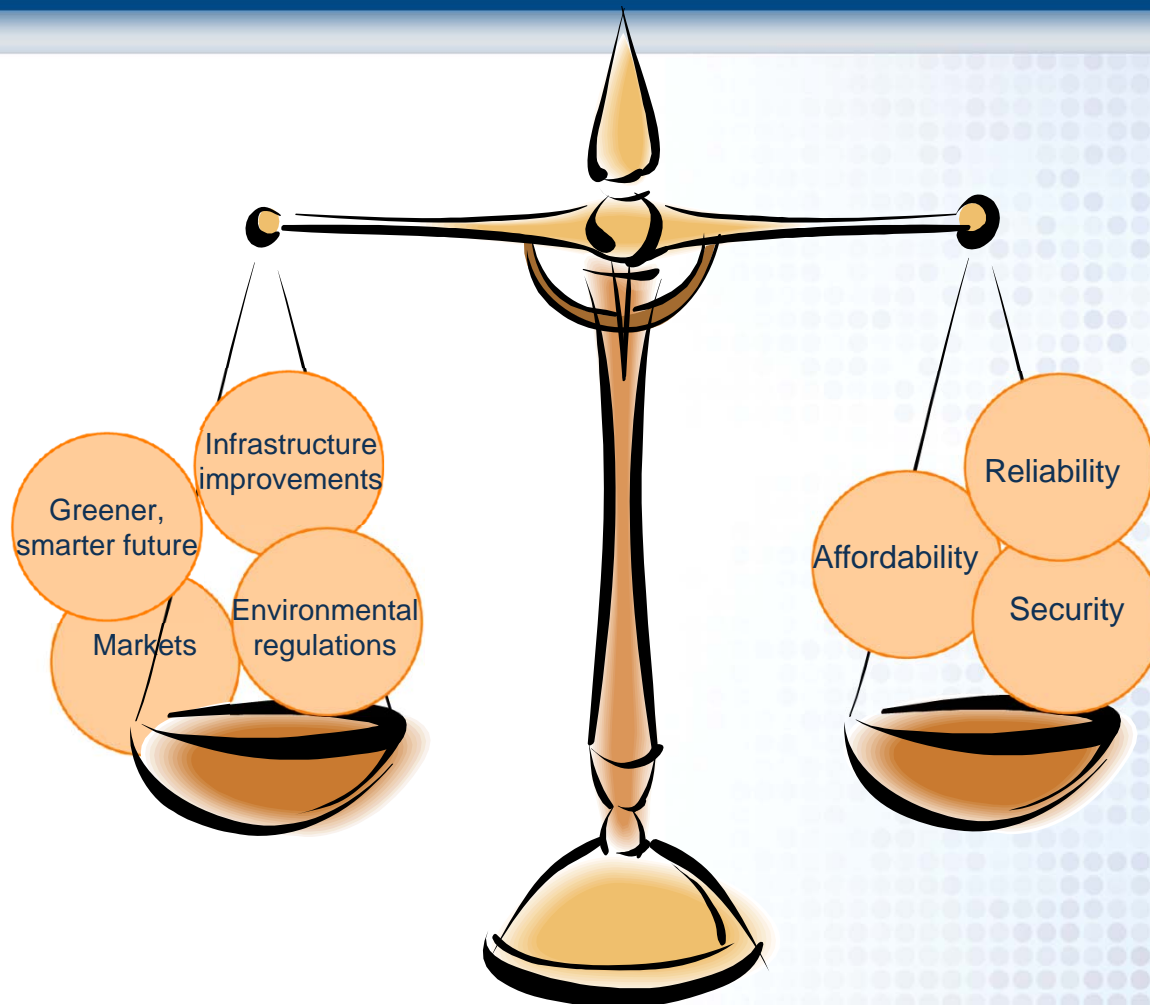
What are the Risks and the Challenges?

- Natural gas
 - Price level and volatility
 - Hydraulic fracturing
 - Other risks affecting availability and/or cost: pipeline, exports...
- Renewable energy
 - Cost and incentives
 - Acceptance and legislation/regulation uncertainty
- Nuclear risks and uncertainties
 - How much and when?
- Coal CCS
 - ??????

The Challenge: Low Carbon, Fuel Diversity, and Core Mission



The Real Challenge



Thank you!

Lola Infante

linfante@eei.org

(202)508-5133

