



Presentation for the Public Utility Law Section of
the State Bar of Texas

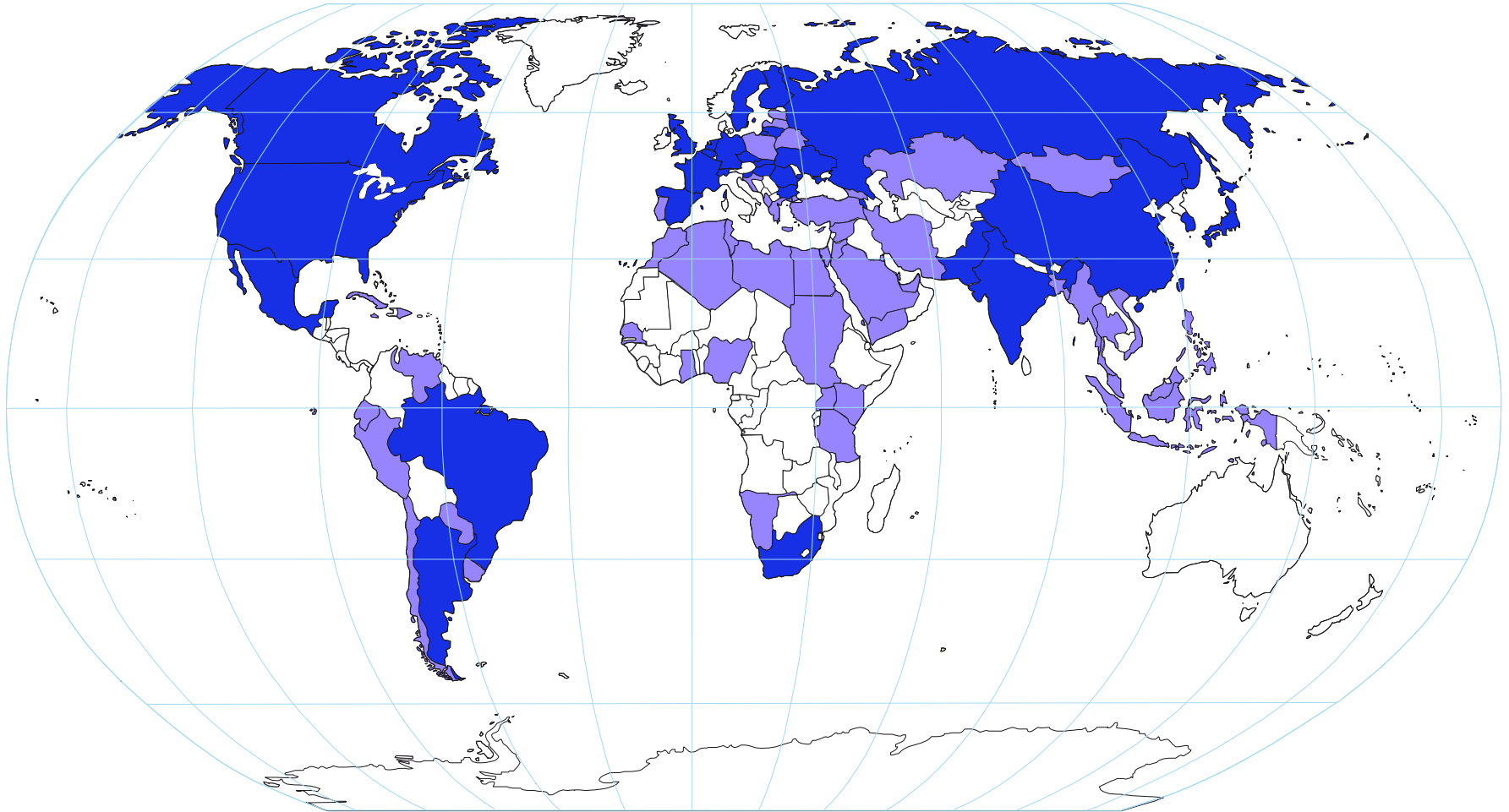
Current state of the US Nuclear
Renaissance

by Bob Temple

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- World Nuclear Renaissance
- State of the US Nuclear Renaissance
 - Nuclear Development 2006 – Present
 - Nuclear in Texas
- Future of US Nuclear Development

There is a world-wide Nuclear Renaissance

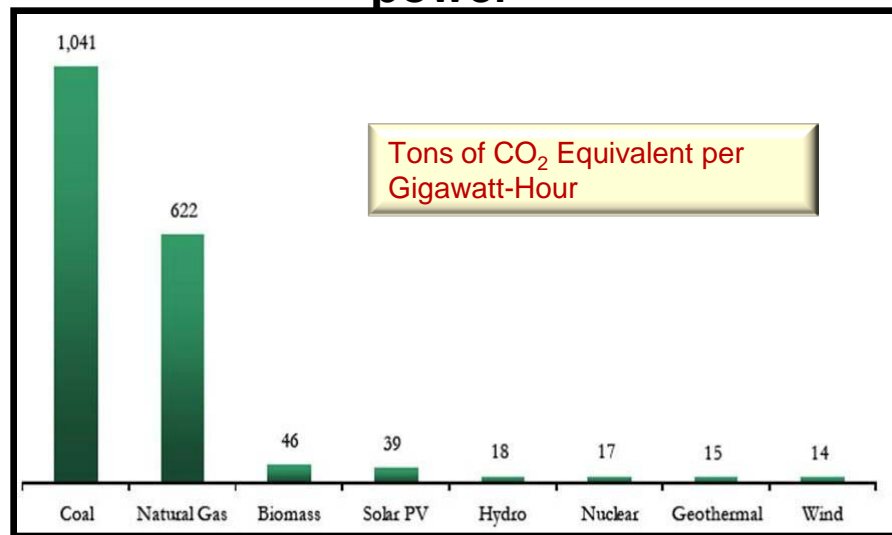
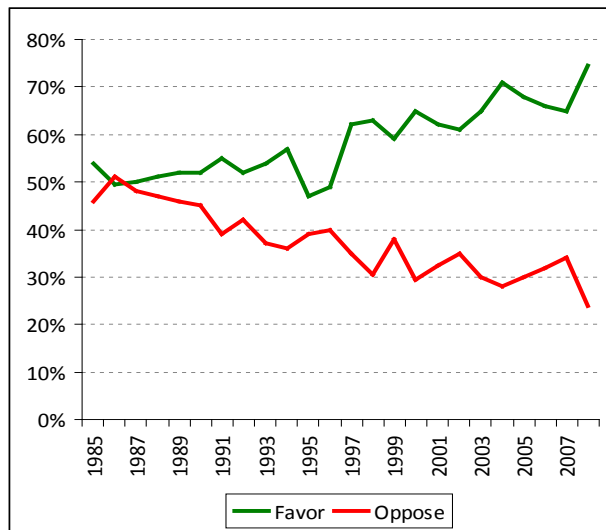


Source: International Atomic Energy Agency

- Convergence of market, environmental, performance and political forces
 - Capacity factors in excess of 90% for the past decade
 - Carbon and public opinion
 - Conservation and renewables cannot replace utility scale baseload alternatives: nuclear, coal or natural gas
 - Changes to the US Nuclear Regulatory Commission (NRC) commercial reactor licensing process
 - Energy Policy Act of 2005
 - Economics when compared with baseload alternatives
 - Volatile natural gas market (80% volatility in any given year of the past decade +)

Low carbon emission baseload power

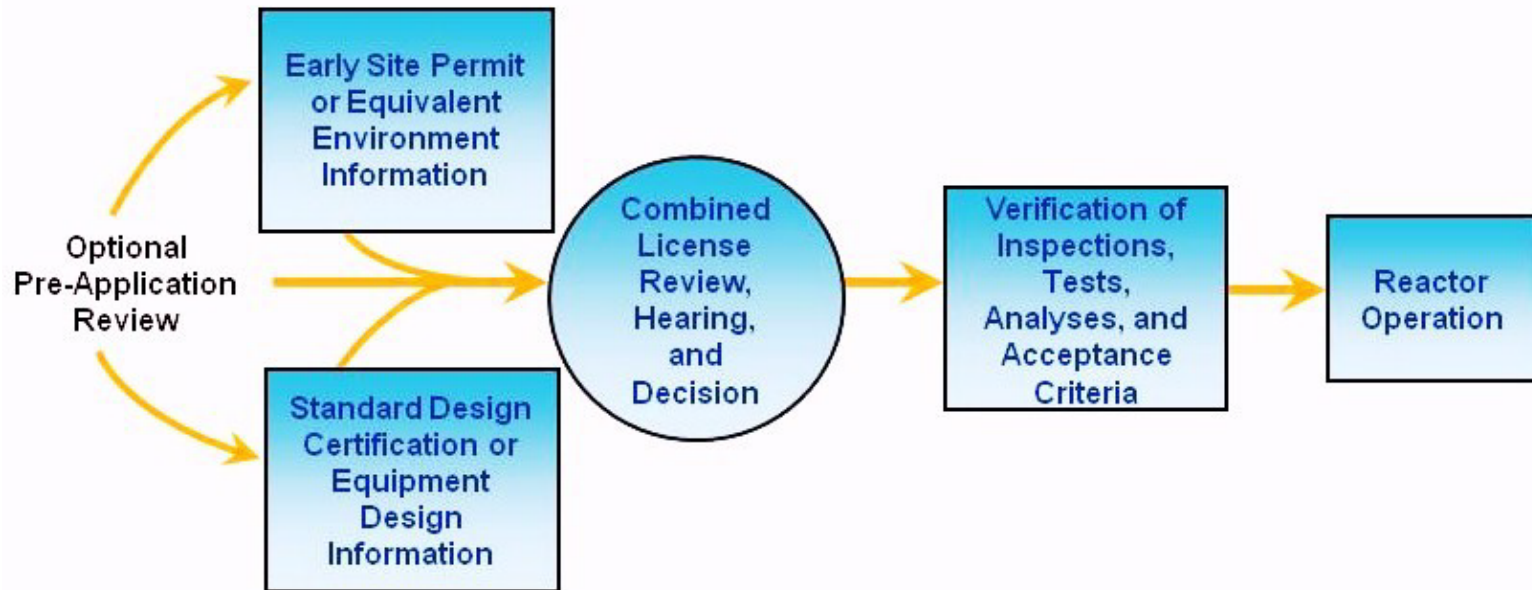
Nuclear power attitudes



Source: "Life-Cycle Assessment of Electricity Generation Systems and Applications for Climate Change Policy Analysis," Paul J. Meier, University of Wisconsin-Madison, August, 2002

Market fundamentals

- Non-carbon-emitting baseload needed for sustainable climate change
- Energy security – locally sourced power
- Performance of existing plants exceeding 90% capacity factor



- The **Design Certification (DC)** is prepared by the vendor and is valid for 15 years. Once a design is certified (by rulemaking), its safety cannot be challenged.
- The **Construction and Operating License (COL)** is prepared by the developer (utility) and is required for construction and operations of each nuclear plant. Once approved, it's valid for 40 years.
- The **Design Certification** is incorporated by reference on the **COL**.
- An **Early Site Permit** may be obtained in advance of a licensing proceeding and “banked”, or included in the **COL** application.

- One-step licensing – combined construction and operating license (COL)
- Standardized Designs
 - Reference plant: R COL
 - Subsequent plants: S COL
- Intervention and hearing opportunities limited
 - Initial hearing opportunity once the COL application is docketed
 - No second hearing unless there is a demonstrated failure to comply with the COL ITAAC (Inspections, Tests, Analyses, and Acceptance Criteria) and, as an operational consequence, the non-compliance could jeopardize public health and safety (10 CFR 52.103(a))

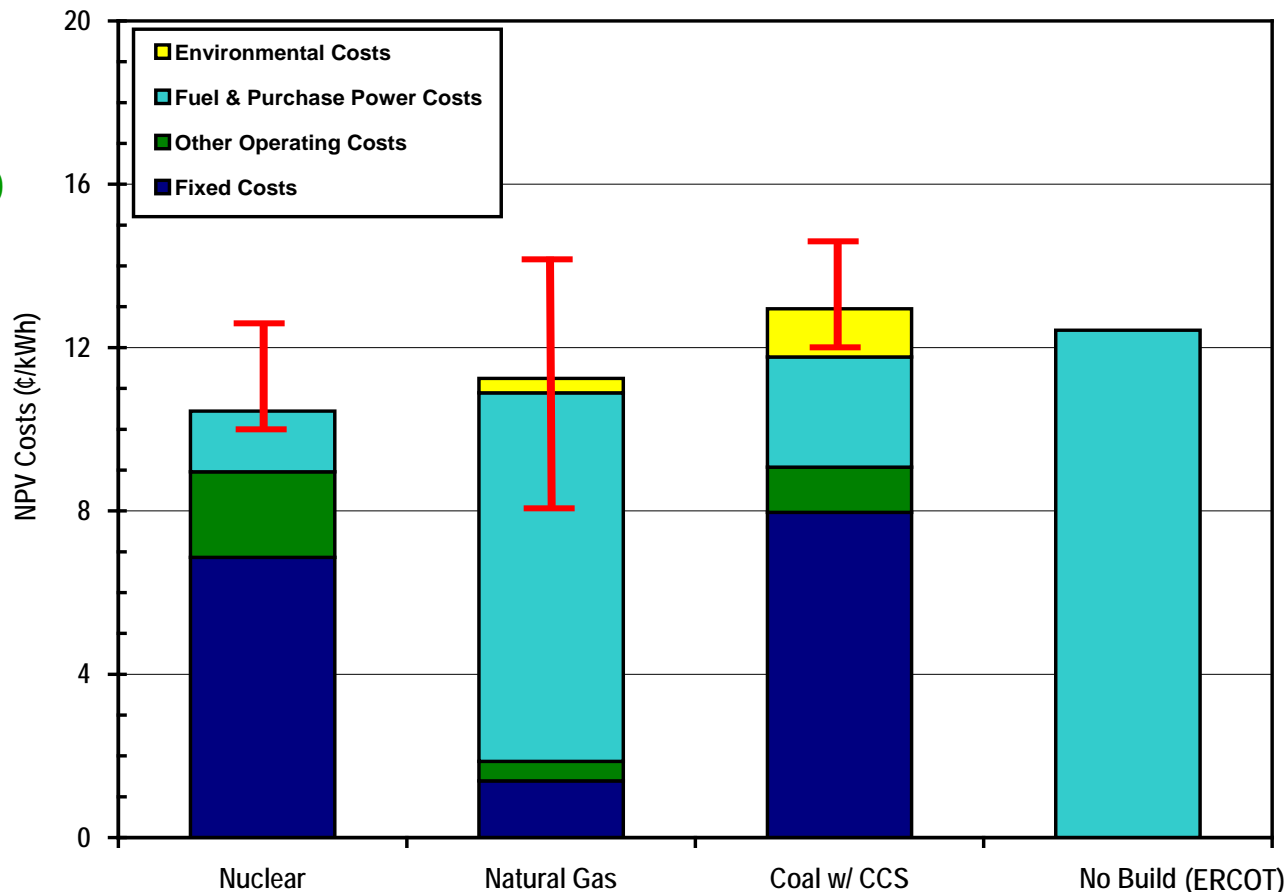
Certification of standardized designs is one element of the Nuclear Regulatory Commission's single-step licensing

Standardized Reactor Design Type	Developer	Safety Design Type	US NRC Approval Status for certified design	Units in Operation	Units in Construction	Technology selected by others in US*	Size In MWe (nominal)
Advanced Boiling Water Reactor (ABWR)	General Electric-Hitachi (GEH)/ Toshiba	Active	Approved	4 in Japan	2 in Taiwan	Yes (South Texas Project)	1350
AP1000 – Pressurized Water Reactor	Westinghouse (acquired by Toshiba)	Passive	Approved	0	4 in China	Yes (Vogtle, VC Summer, Levy County, Shearon Harris, Turkey Point, William States Lee III)	1154
Economic Simplified Boiling Water Reactor (ESBWR)	General Electric-Hitachi (GEH)	Passive	Pending (Sept. 2011)	0	0	Yes (Fermi)	1575-1600
European Pressurized Reactor (EPR)	Areva	Active	Pending (June 2012)	0	1 in Finland & 1 in France	Yes (Calvert Cliffs, Bell Bend)	1600
US Advanced Pressurized Water Reactor (USAPWR)	Mitsubishi Heavy Industries (MHI)	Active	Pending (Dec. 2011)	0 (related PWR design operating in Japan)	2 in Japan	Yes (Comanche Peak, North Anna)	1700

- Production Tax Credits
- Insurance
- DOE Loan Guarantees

- Capital at Risk (“All-in” Project Cost)
 - Total of all costs incurred before commercial electricity production starts
 - Often expressed in \$/kW(e) (dollars per unit of electrical capacity)
 - These costs are sometimes called “up front” costs
- Levelized Unit Electricity Cost (LUEC)
 - Expressed in \$/megawatt-hour (\$/MWh) or cents (or mills)/kilowatt-hour (¢/kWh)
 - Four major components
 - Capital recovery
 - Nonfuel Operations and Maintenance (O&M)
 - Fuel Cycle
 - Contribution to Decontamination and Decommissioning Fund (which can be bundled with fuel or environmental costs for comparison)
 - LUEC sometimes called “busbar generation cost”
- Generation “cost” not the same as “price” charged by utility

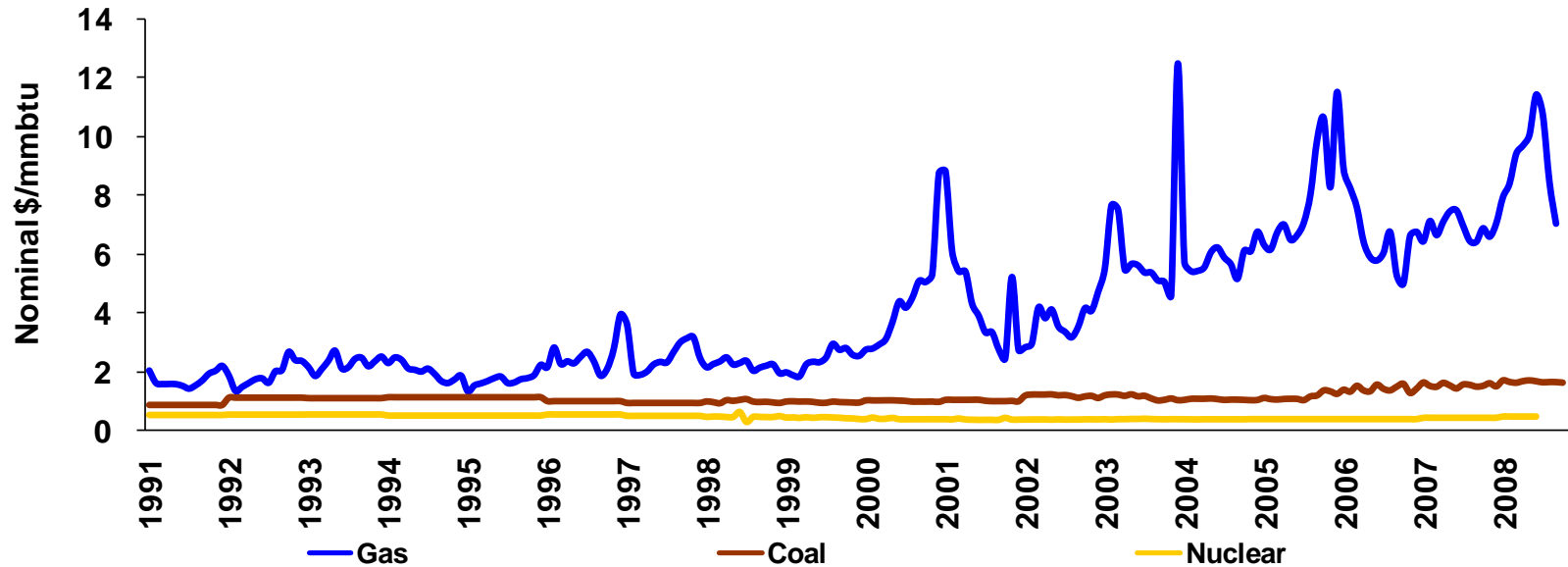
How costs
looked < 2009



Based upon \$5.50/MMBtu natural gas and \$4,800/kW(e) project cost for brown field nuclear (carbon penalty will only improve the relative standing of nuclear)

Fuel Price Volatility

How fuel prices
looked < 2009



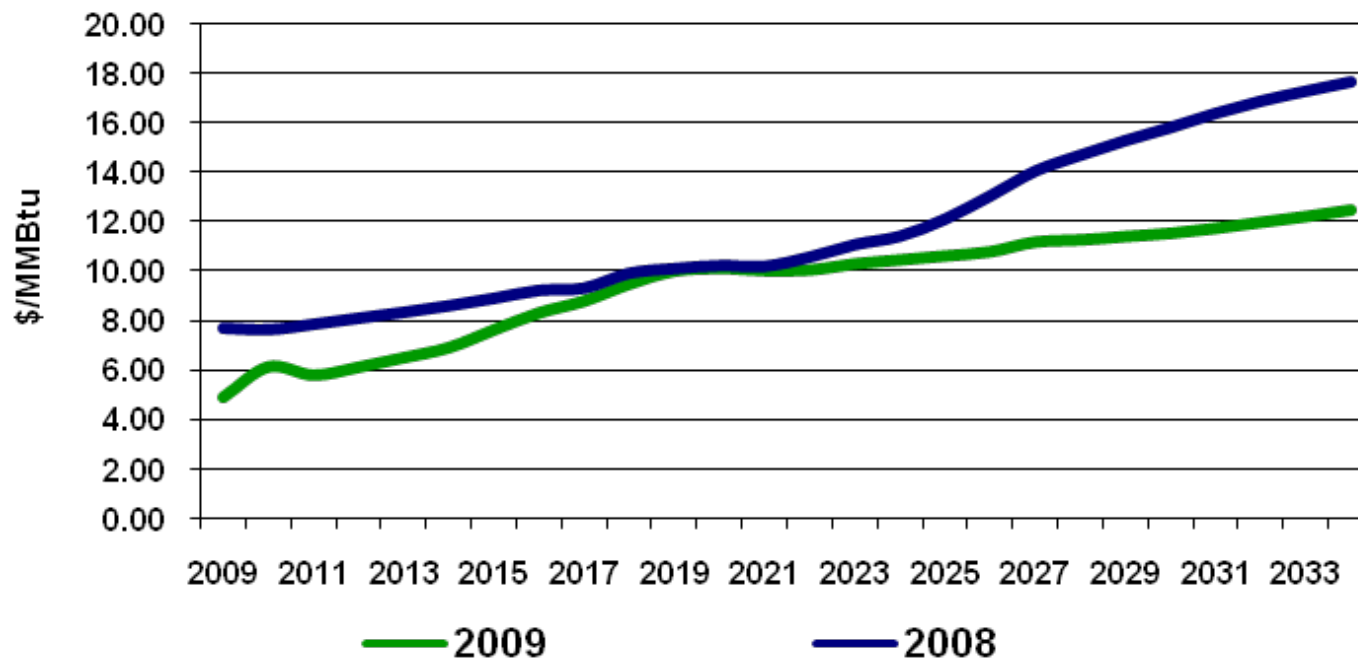
How comparative risk looked < 2009

Increasing Risk Duration 

	Capital	Technology	Carbon	Fuel Cost
Nuclear				
Natural Gas				
Coal w/CCS				

What changed in 2009

Natural Gas Prices



Given historic market conditions a 60 year bet on new nuclear is still reasonable, just margins over alternatives lower in the near term

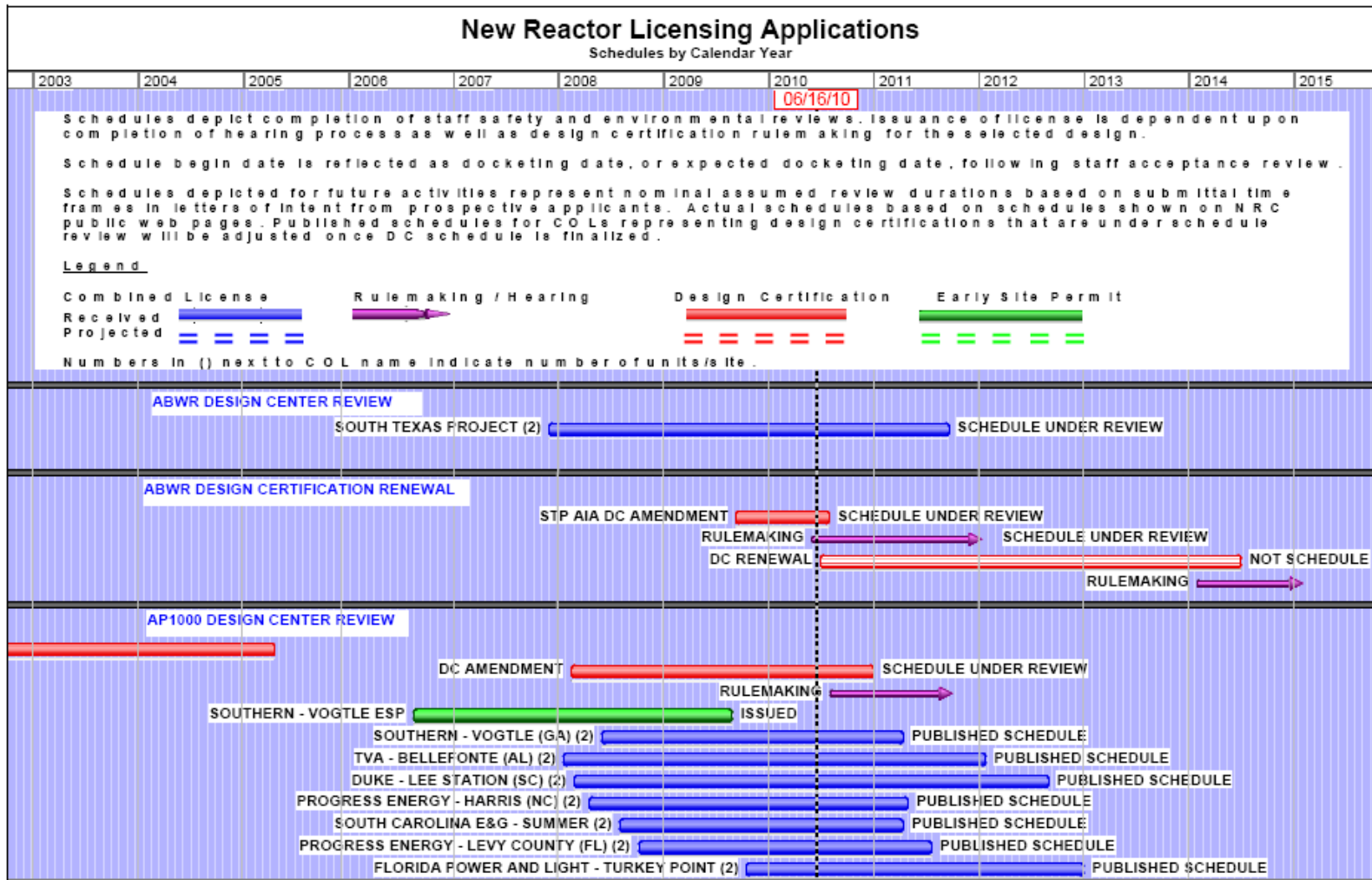
NRC Map of Proposed Nuclear Projects



*Review Suspended by Applicant

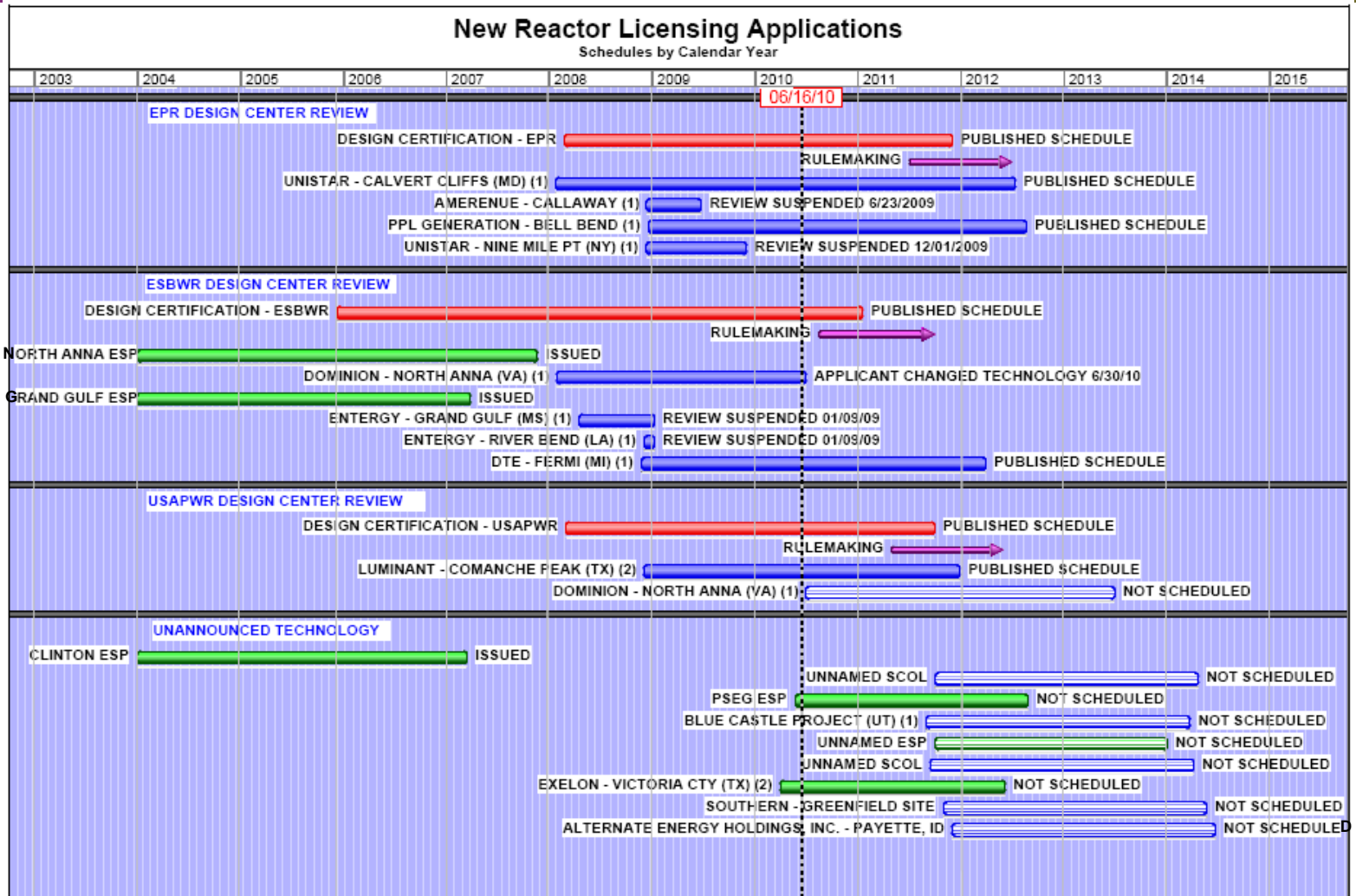
** COL Application Amended by Applicant to ESP on 03/25/2010

<http://www.nrc.gov/reactors/new-reactors/col/new-reactor-map.html>



<http://www.nrc.gov/reactors/new-reactors/new-licensing-files/new-rx-licensing-app-legend.pdf>

NRC License Review Schedule (cont.)



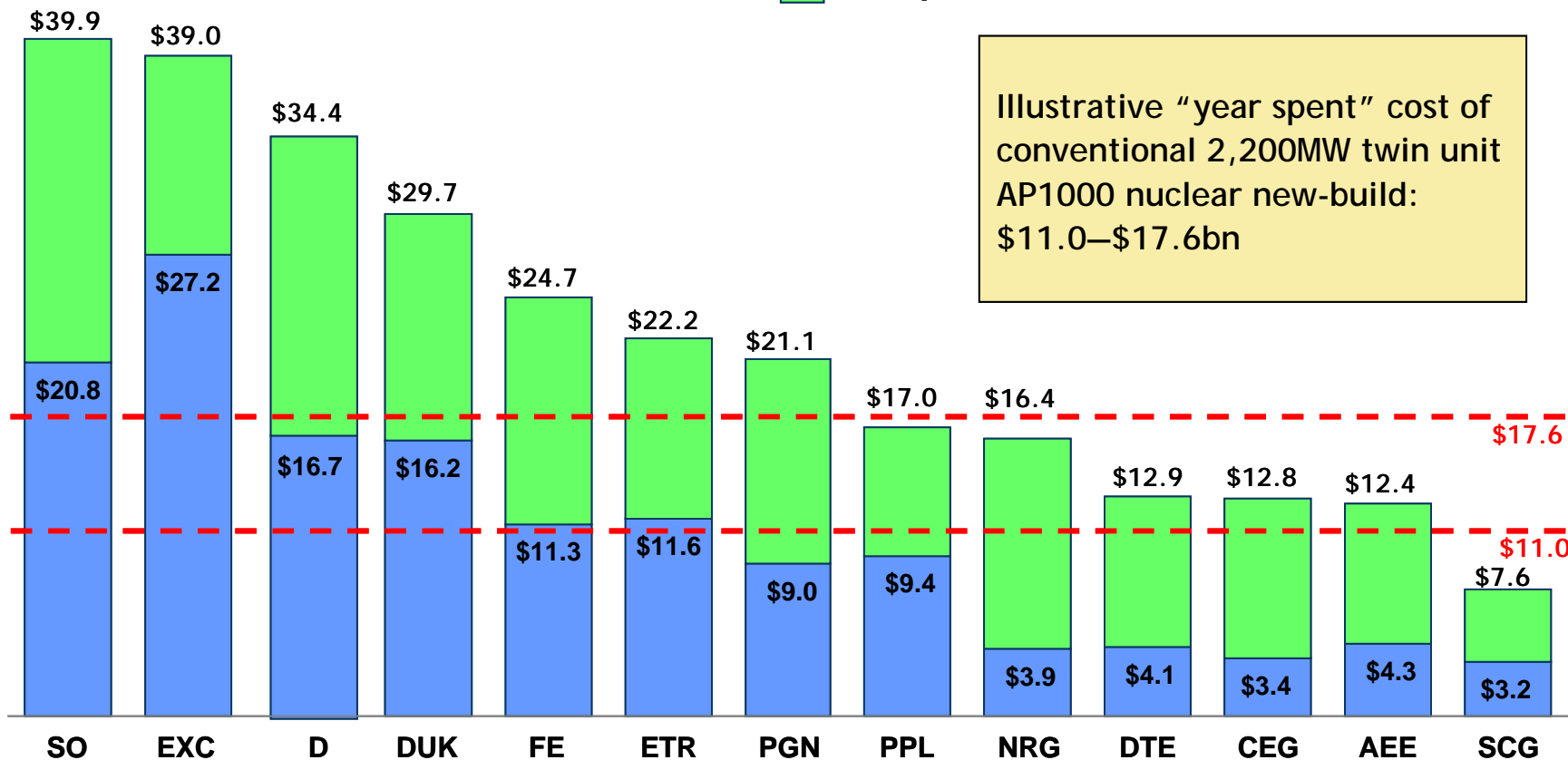
Old Nuclear	New Nuclear
Every plant is different	NRC “Design Certification” standardizes plant designs
Separate licenses for Construction and Operation	Combined Construction & Operating License issued before construction begins
Capacity factors less than 70%	Capacity factors routinely exceed 90%
Active safety systems require emergency power to operate	Improved designs; passive safety systems available in some designs
All plants > 1000 MWe require large financial commitment	All plants > 1000 MWe requiring really large financial commitment

The financial risks of large nuclear plants may be huge relative to the value of an enterprise

(All figures are in billions of US\$'s)

 Equity value

 Enterprise value



Illustrative "year spent" cost of conventional 2,200MW twin unit AP1000 nuclear new-build: \$11.0–\$17.6bn

"You can always get a good deal financed, no matter the size of the deal relative to the enterprise value"

Source: JPMorgan; FactSet as of 3/13/09

DOE Loan Guarantees

- Only four projects selected by DOE for final evaluation to receive the \$18.5B allocation of Loan Guarantees (LGs).
- Conditional commitment for Vogtle to use about \$8.3 B (or 45%) of that capacity.
- DOE is expecting selected projects, especially South Texas Project and Calvert Cliffs, to also obtain financial support from OEM source countries (Japan & France).
- Various bills proposing an additional \$9 to \$35.5 billion in nuclear LG capacity.
- None of the ten DOE loan guarantee applications were rejected, just four were selected as preferable when screened against criteria.
 - DOE, through issuance of loan guarantees, should encourage development of diverse technologies to be built in diverse locations within the US.

Owners	Technology	Project/State
Southern/MEAG	AP1000	Vogtle (GA)
SCANA/Santee Cooper	AP1000	Summer (SC)
NINA/CPS Energy	ABWR	South Texas Project (TX)
Constellation	EPR	Calvert Cliffs (MD)



Proposed New Reactor(s), Docket	Design	Applicant	COL Status
<u>Bell Bend Nuclear Power Plant, 52-039</u>	<u>U.S. EPR</u>	PPL Bell Bend, LLC	Initial intervention denied. Final Safety Evaluation Report (FSER) expected by August 2012, but NRC COL schedule tied to review of the application for the EPR reference plant, Calvert Cliffs 3
<u>Bellefonte Nuclear Station, Units 3 and 4, 52-014 & 52-015</u>	<u>AP1000</u>	Tennessee Valley Authority (TVA)	NRC completion of the COL application review process will not be completed pending TVA's evaluation of the viability of completing Bellefonte Nuclear Plant Units 1 and 2 rather than proceeding with Units 3 and 4
<u>Callaway Plant, Unit 2, 52-037</u>	<u>U.S. EPR</u>	AmerenUE	On June 23, 2009, AmerenUE requested that the NRC suspend its review of the Callaway Plant, Unit 2 application ^[1]
<u>Calvert Cliffs, Unit 3, 52-016</u>	<u>U.S. EPR</u>	Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC	NRC reviews continue for this the reference COL for the US EPR. Intervenors had one contention admitted that is subject to further hearings
<u>Comanche Peak, Units 3 and 4, 52-034 and 52-035</u>	<u>US-APWR</u>	Comanche Peak Nuclear Power Company, LLC	NRC reviews continue for this the reference COL for the US-APWR. Intervenors had two contentions admitted that are subject to further hearings

State of COL Applications (cont.)

Proposed New Reactor(s), Docket	Design	Applicant	COL Status
Fermi, Unit 3 , 52-033	ESBWR	Detroit Edison Company	While not the reference COL, Fermi 3 is currently the sole applicant continuing to pursue ESBWR development
Grand Gulf, Unit 3 , 52-024	ESBWR	Entergy Operations, Inc. (EOI)	On January 9, 2009, EOI requested that the NRC suspend its review of the Grand Gulf, Unit 3 application ^[2]
Levy County, Units 1 and 2 , 52-029, 52-030	AP1000	Progress Energy Florida, Inc. (PEF)	Intervenors had three contentions admitted that are subject to further hearings
Nine Mile Point, Unit 3 , 52-038	U.S. EPR	Nine Mile Point 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC (UniStar)	On December 1, 2009, UniStar requested that the NRC suspend its review of the Nine Mile Point, Unit 3 application ^[3]
North Anna, Unit 3 , 52-017	US-APWR	Dominion Virginia Power (Dominion)	Originally Dominion selected the ESBWR as its reactor design. One party and one contention were admitted related to the COL based on that design. On May 18, 2010, Dominion announced it was changing its choice of reactor design to the MHI US-APWR. ^[4]
River Bend Station, Unit 3 , 52-036	ESBWR	Entergy Operations, Inc. (EOI)	On January 9, 2009, EOI requested that the NRC suspend its review of the Grand Gulf, Unit 3 application ^[5]
Shearon Harris, Units 2 and 3 , 52-022, 52-023	AP1000	Progress Energy Carolinas, Inc. (PEC)	While one party met the standing criteria, no admissible contentions based on review of initial filings

State of COL Applications (cont.)



Proposed New Reactor(s), Docket	Design	Applicant	COL Status
<u>South Texas Project, Units 3 and 4</u> , 52-025, 52-026	<u>ABWR</u>	South Texas Project Nuclear Operating Company (STPNOC)	NRC reviews continue for this the reference COL for the (Toshiba) ABWR. Three groups have a single contention admitted for additional hearings
<u>Turkey Point, Units 6 and 7</u> , 52-040, 52-041	<u>AP1000</u>	Florida Power and Light Company (now NextEra Energy)	COL application originally accepted for docketing in October 2009, however, the deadline to petition to intervene is currently August 17, 2010
<u>Victoria County Station, Units 1 and 2</u> , 52-042	<u>ESBWR</u>	Exelon Nuclear Texas Holdings, LLC (Exelon)	COL application review suspended at the Applicant's request; changed to an Early Site Permit application ^[6]
<u>Virgil C. Summer, Units 2 and 3</u> , 52-027, 52-028	<u>AP1000</u>	South Carolina Electric & Gas (SCE&G)	Two intervenors and at least one contention were admitted; however, the contention was subsequently dismissed
<u>Vogtle, Units 3 and 4</u> , 52-025, 52-026	<u>AP1000</u>	Southern Nuclear Operating Company (SNC)	NRC reviews continue for this the reference COL for the AP1000. At least one contention raised by five groups was admitted, but that contention was subsequently dismissed.
<u>William States Lee III, Units 1 and 2</u> , 52-018 & 52-019	<u>AP1000</u>	Duke Energy	At Duke Energy's request, the NRC has altered its COL application review schedule to support a new commercial operation date for this project of 2021 ^[7]

- Texas already has 4 nuclear units that produce 8.8% of the state's electricity (Comanche Peak and South Texas Project)
- Four projects proposed – [Developing Company]
 - Amarillo – Amarillo Power
 - Comanche Peak – Comanche Peak Nuclear Power Company (CPNPC) (Luminant Generating and MHI)
 - South Texas Project – Nuclear Innovation North America (NRG Energy, Inc. & Toshiba)
 - Victoria County – Exelon Nuclear Texas Holdings
- Three Texas projects filed COL Applications and requested DOE Loan Guarantees

- One Texas project made the initial short list for DOE Loan Guarantees (South Texas Project)
 - Amarillo Power never got to the COL or loan guarantee application filing steps in development
 - CPNPC parent Energy Future Holdings has a business plan that “appears unsustainable” along with an “untenable capital structure”*
 - Exelon’s Victoria County is no longer a COL application but an application for an Early Site Permit – to “bank” the site for possible future development if “conditions become favorable”

* Report by Moody’s Investors Service, 7/19/10

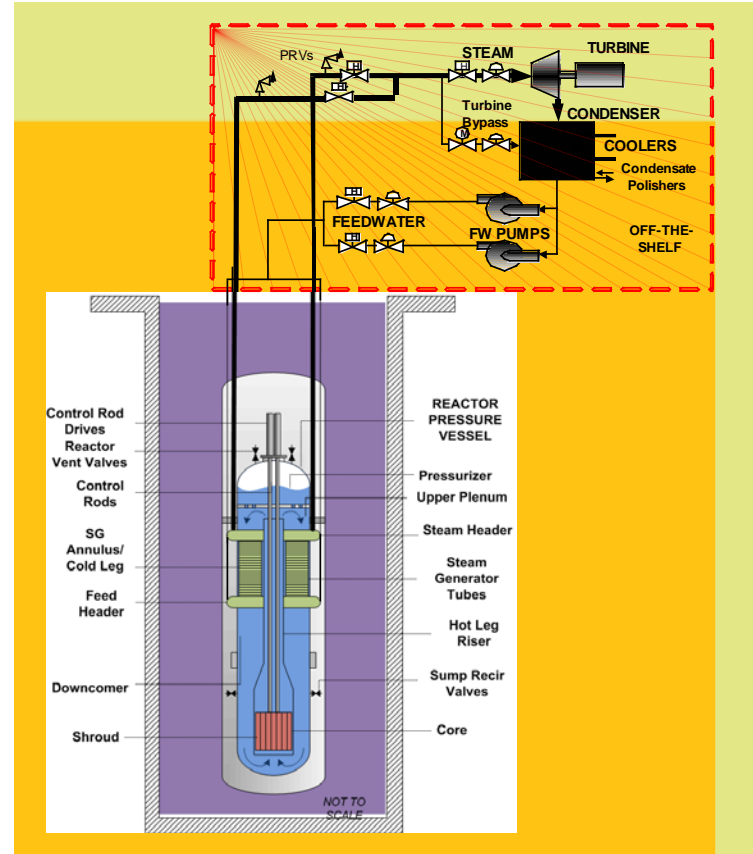
- Current market conditions, even for South Texas Project, not favorable for new nuclear development in ERCOT
 - Financial hurdles, near-term forward gas curve, carbon tax or cap-and-trade
 - Politics and public-private partnership
 - Prospects absent significant public-private partnerships and/or off-take commitments?

- Modular scalable nuclear plants reduce financial risks
 - Factory manufacturing lowers costs and on-site construction risks
 - Smaller plants can be served by multiple domestic suppliers
 - New capacity can be added to match load growth – incremental build out lowers initial investment
- Bi-partisan legislation being proposed to fund development of new SMR's
 - DOE including \$40 Million in FY 2011 for cost sharing on two light water SMR designs
 - Help work out first-of-a-kind engineering (FOAKE) issues and demonstrate that serial no. 1 works

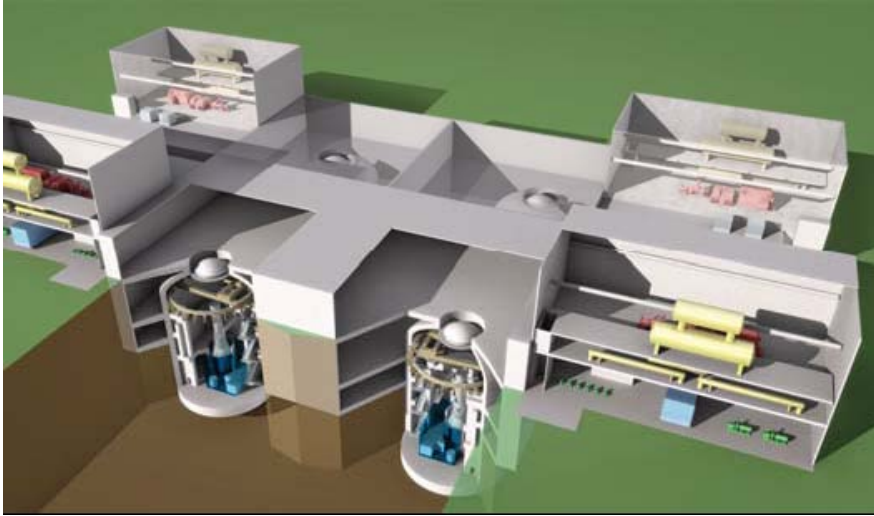
Examples of SMR designs



B&W mPower Reactor

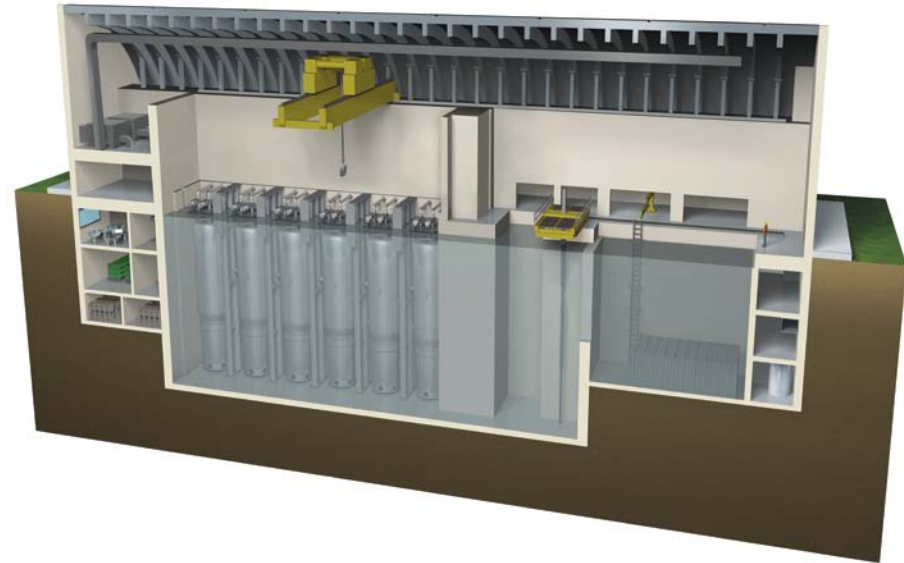


NuScale Power Reactor



500 MWe from 4 B&W mPower Reactors

12 NuScale Power Reactors = 540 MWe



- 25-350 MWe (versus 1,100 – 1,700 for large light water reactors (LWRs))
- In theory, lower capital cost, lower risk, easier licensing and modular deployment
 - Potentially use initial reactor(s) output to finance development of remaining project
- To date, no certified design applications submitted and a variety of regulatory hurdles
 - Small LWRs: Price Anderson, Emergency Planning, Security, Staffing, NRC Oversight, Speed of Licensing (S-COLs)
 - High Temperature Gas-Cooled Reactors: Current regulatory scheme addresses only LWRs

Leading the Pack

- B&W's mPower (125 MWe)
- Hyperion Power Generation Module (25 MWe)
- NuScale Power Reactor (45 MWe)
- Toshiba 4S (10-140 MWe)
- Westinghouse IRIS (100 & 300 MWe)

Also Running?

- Areva Antares*
- General Atomics GTMHR*
- GE-H Prism (311 MWe)
- Pebble Bed Modular Reactor Ltd. (105 MWe)

* Size not determined

- Nuclear is a proven, non-carbon-emitting electricity generating technology
- First LWR projects will be expensive; financing is major issue
 - Increased DOE Loan Guarantee capacity critical for large LWR development (especially in merchant markets)
 - Many projects announced; few with more than COL development absent loan guarantees
 - In regulated markets some projects (e.g., Progress Energy, MEAG) forgoing loan guarantees
- First new nuclear projects showing greatest progress in regulated markets
- Existing projects need to demonstrate that the regulatory process, supply chain and construction risks can be successfully managed

- Current forward gas curve affecting the ability of merchant operators to get commitments for output and project financing
 - Given challenges of coal, prospects for carbon, and historic volatility in the gas market, nuclear remains a reasonable long-term electricity generating technology choice; helps utilities maintain a diversified generation portfolio
- Carbon tax or “cap-and-trade” will help relative economics (compared to other baseload alternatives)
- Small modular reactors projected to tie up less capital to get started and may be scaled to demand needs
 - Easier to finance; however...
 - Regulatory scheme and FOAKE risks still to be addressed

**Resurgence of nuclear development in the US;
continued progress needed to achieve a US Nuclear Renaissance**

Questions & Discussion