

White Paper:
THE FUTURE OF NUCLEAR POWER IN THE WEST

Western Interstate Energy Board

April 6, 2009

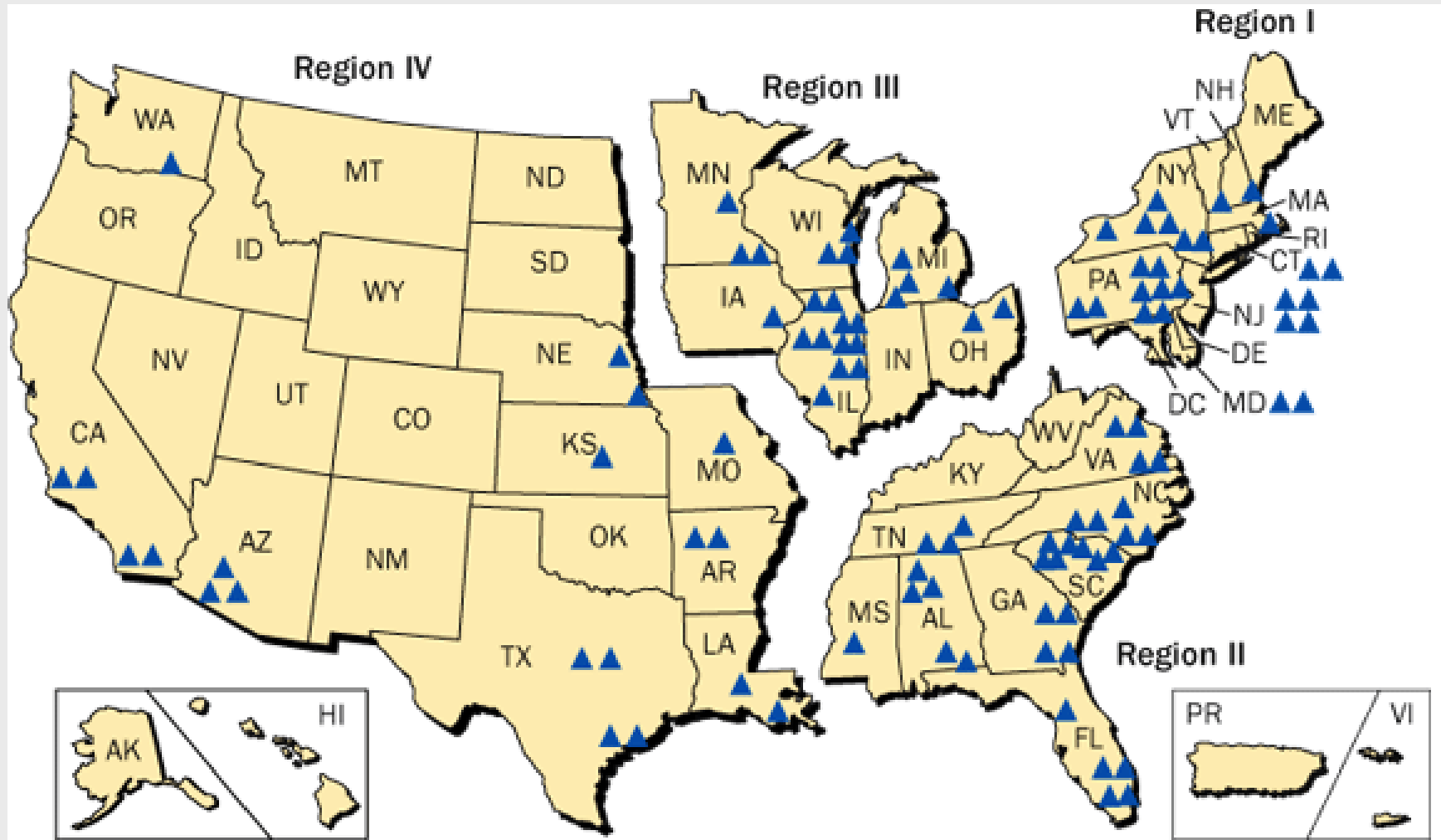
Power Generation in 2006 (EIA)

	West 11	Rest of Cont. US
Fossil fuels	58.3%	73.3%
All other:	41.7%	28.8%
Hydro	27.6%	2.6%
Nuclear	8.9%	21.8%
Renewables	4.8%	1.9%
Emissions (tons CO₂/GWh)	442	640

The Contribution of Nuclear Power: 2006 (EIA)

	West 11	Rest of Cont. US
Nuclear power as % of:		
Total generation	8.9%	21.8%
Low-carbon generation	21.4%	81.1%
Low-carbon excluding hydro	63.5%	89.8%

OPERATING NUCLEAR POWER REACTORS (NRC)

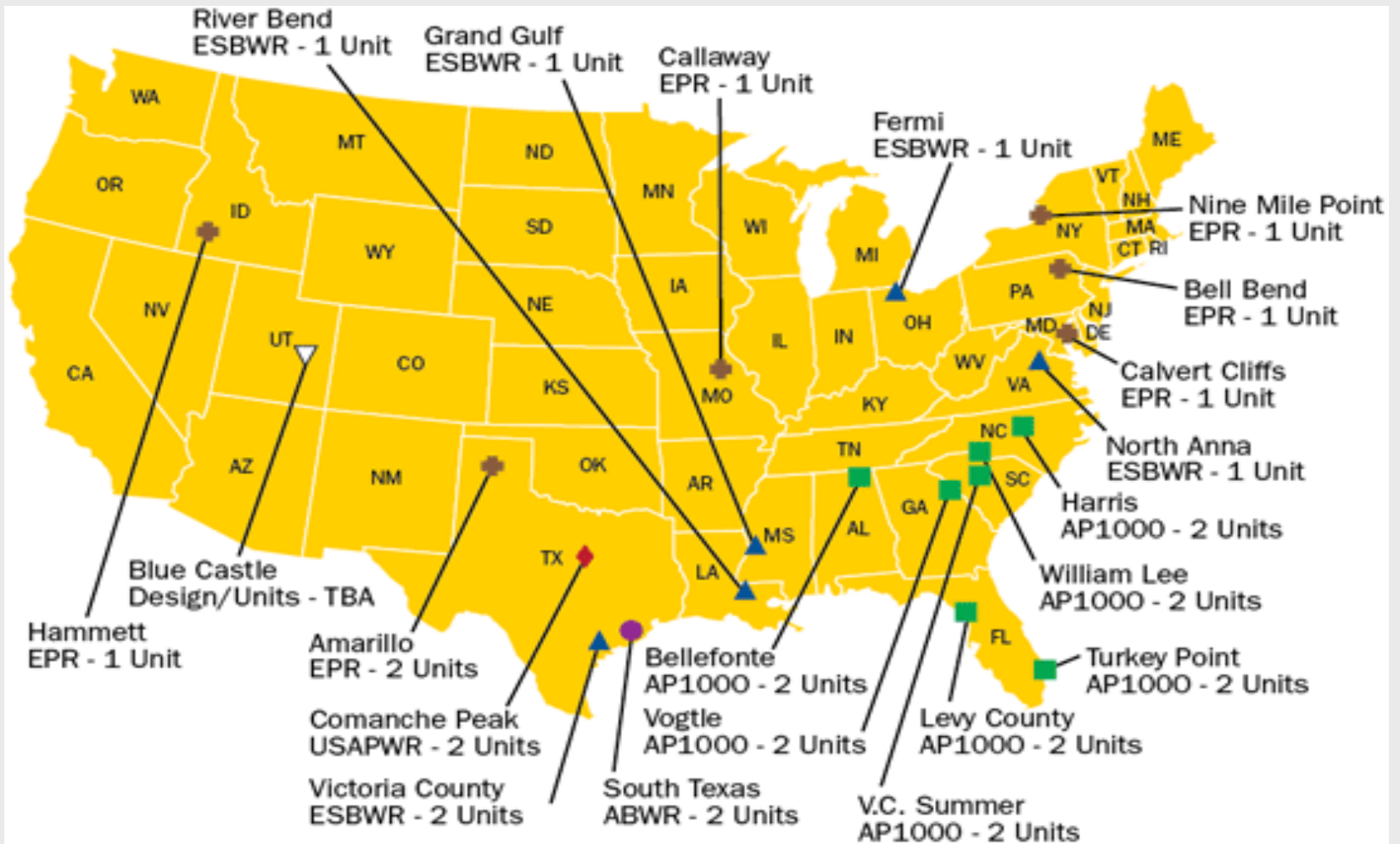


▲ Licensed to Operate (104)

OPERATING NUCLEAR PLANTS IN THE WEST

	Columbia	P.Verde:3	Diablo C.:2	SONGS:2	Current	After 2025
Type	BWR(GE)	PWR(CE)	PWR(W)	PWR(CE)		
Capacity (MW)	1131	3875	2240	2150	9396	5006
Avg. Cap. (2002-07)	87.0%	82.9%	90.4%	89.0%	86.6%	83.8%
Est Gen (Mil MWh)	8.62	28.15	17.74	16.75	71.2	36.76
Ex. Lic. Term	Dec 2023	2025-2027	2024-2025	2022		
Lic Ext App?	Dec 2010	In Process	Uncertain	Uncertain		

COMBINED LICENSE APPLICATIONS FOR NEW REACTORS (NRC: Nov. 2008)



You may click on a design name to view the NRC's Web site for the specific design.

● ABWR
 ■ AP1000
 ⊕ EPR
 ▲ ESBWR
 ◆ USAPWR
 ▽ Design/Units - TBA

White Paper Topics

Factors considered

- Costs
- Water requirements
- Security
- Siting
- Waste confidence
- Generation IV

Related factors of interest

- Safety
- Uranium mining, milling, enrichment
- Reprocessing
- SNF/HLW transportation

COST (1)

NEI: “even at capital costs in the \$4,000/kW to \$6,000/kW range, the electricity generated from nuclear power can be competitive with other new sources of baseload power, including coal and natural gas.

Keystone: Expected levelized cost between 8 and 11 cents per kWh delivered to the grid, before transmission and distribution costs. (2007\$, next 10 years)

With transmission & distribution: 11-15 cents/kWh

2008 price: 9.6 cents/kWh (13 cents in CA; 6 cents in ID)

Nuclear power relatively expensive (but with carbon pricing?)

COST (2)

EPAct: Title XVII Loan Guarantee Program

\$18.5 billion for nuclear energy projects (for up to 80%)

\$122 billion applications (by 16 companies; \$7.6 bil/appl)

UniStar: Constellation Energy + EDF of France

- Calvert Cliffs: Evolutionary Power Reactor (1600 MW)
- Cost estimate: \$4,000-6,000/kW.....\$8-10 billion
- 80%: Loan guarantee via EPAct
- 20%: Loan from COFACE (French import-export bank)
- If either not available: no go.

WATER REQUIREMENTS

Plant Cooling Water Withdrawals (gal/MWh)

<u>Cooling system type:</u>	Closed-	Hybrid	Dry
<u>Plant Type/Fuel:</u>	cycle, wet	(wet/dry)	cooling
Nuclear	825	???	???
Coal (steam)	675	500	0
Biofuel (exclu crop irrig)	675	525	0
Solar thermal	675	525	0
Nat. gas comb cycle	215	145	0
Wind	0	0	0
Solar-PV	0	0	0

Source: EPRI, 2009; ranges averaged

Nuclear: High, comparable to coal with scrubbers;

Lagging in applic. of hybrid & dry cooling; Generation IV potential.

SECURITY (in aftermath of 9/11)

- **NRC Advisories/Orders:** enhance capabilities to detect and respond
- **Engineering studies:** assess likelihood, potential consequences
- **EPA Act Title VI:** background checks, force-on-force exercises.

Results:

- More secure than 9/10/01? **Yes.**
- More secure than other power gen/transmission: ???
(More resilient; higher possible consequence)
- As secure as need be: ???

SITING

A major Achilles heel in 1980s: Seabrook; Shoreham

Since 1980:

- Improved safety of operations
- Increased confidence in plant management
- Increased concern re climate change

Public Opinion:

- Favor nuclear energy: 74% (vs 51% in 1983)
- Favor nuclear energy: West (68%); South (80%)
- Oppose nuclear energy: 24% (vs 49% in 1983)
- 71% living w/in 10 miles of a nuke plant: another OK

Recent Evidence:

- Nukes on new sites in South: no extreme response

WASTE CONFIDENCE

NRC:

- **Current rule:** Permanent repository avail in 2025
- **Proposed rule:** Permanent repository avail w/in 50 years after shutdown of all licensed plants.....on-site storage safe in interim.

States: Some are revising new reactor bans

DOE Vision of Generation IV Nuclear Power

Goals: efficiency; safety; minimal waste; proliferation resistant; smaller units; reduced water consumption (???)

Means:

Thermal reactors

- Very high temperature reactor (VHTR)
- Supercritical water cooled reactor (SCWR)
- Molten salt reactor (MSR)

Fast reactors

- Gas-cooled fast reactor (GFR)
- Sodium-cooled fast reactor (SFR)
- Lead-cooled reactor (LFR)

Status:

- A federal (DOE/NE) program
- Moderate support in FY'10 budget
- Commercial application: w/in 15 years? early 2020s?

SAFETY

In general, nuclear plants operate much more safely than prior to TMI (Davis-Besse, Palo Verde notwithstanding).

One reason: Institute of Nuclear Plant Operations (INPO)

- Industry-sponsored
- Conducts evaluations
- Shares lessons learned
- Promotes safety culture

Future challenge: License extensions

- Older plants & equipment

URANIUM MINING, MILLING, ENRICHMENT

1994-2006 Patterns

- Uranium: 81% of foreign origin
- Enrichment: Portsmouth/Paducah gas diffusion plants

Recent trends

- Permitting: Active in Wyoming, Colorado
- Centrifuges: Eunice (NM); Atomic City (ID); Portsmouth (OH)
- Purchases: Increased 5.0% annually (1994-2006)

REPROCESSING

GNEP PEIS:

Alternatives for once-thru & closed nuclear cycle

Closed cycle alternatives:

- Reduce thermal heat & radiotoxicity
- Also produce GTCC wastes
- Costs (R&D or implementation) unspecified; uncertain results

Status:

- FY'10 budget: zeroes out the GNEP program
- Yet, reprocessing will be part of Nuclear Waste program reconsideration.

SNF/HLW TRANSPORTATION

NAS: Going the Distance? (2006)

- No fundamental technical barriers to safe transport
- Full implementation of dedicated train decision
- Shipment of older fuel (removing x-ray; accident risk)
- Success difficult given current organizational structure

Status:

- OCRWM embraced #1 only
- OCRWM institutional program AWOL
- Consultation in SNF/HLW transportation system design (???)
- Letter to Secretary Chu
- WIEB FY'09 contributions: Acceptance Queue;
Integrated Assessment Tool

ELECTRIC POWER GENERATION UNDER S.2191 (EIA)

	WEST 11		Rest of US	
	2006	2030	2006	2030
Fossil Fuels	58.3%	59.8%	73.3%	9.8%
All Other	41.7%	40.2%	28.8%	90.2%
• Hydro	27.6%	18.2%*	2.6%	2.3%*
• Nuclear	8.9%	8.2%	21.8%	76.1%
• Renewables	4.8%	13.9%*	1.9%	15.0%*
Emissions				
Mil tons CO2	323	475	2122	2645
Tons/GWh	442	473	640	658

Questions:

- Are the nuclear assumptions reasonable, in the East or the West?
- Can nuclear % be achieved without Diablo Canyon & SONGS?
- Can 14% reduction (below 2005) in GHG emissions by 2020 be achieved?
- Might Generation IV nuclear contribute after 2025?

QUESTIONS ???