Examining Nuclear Power in Idaho

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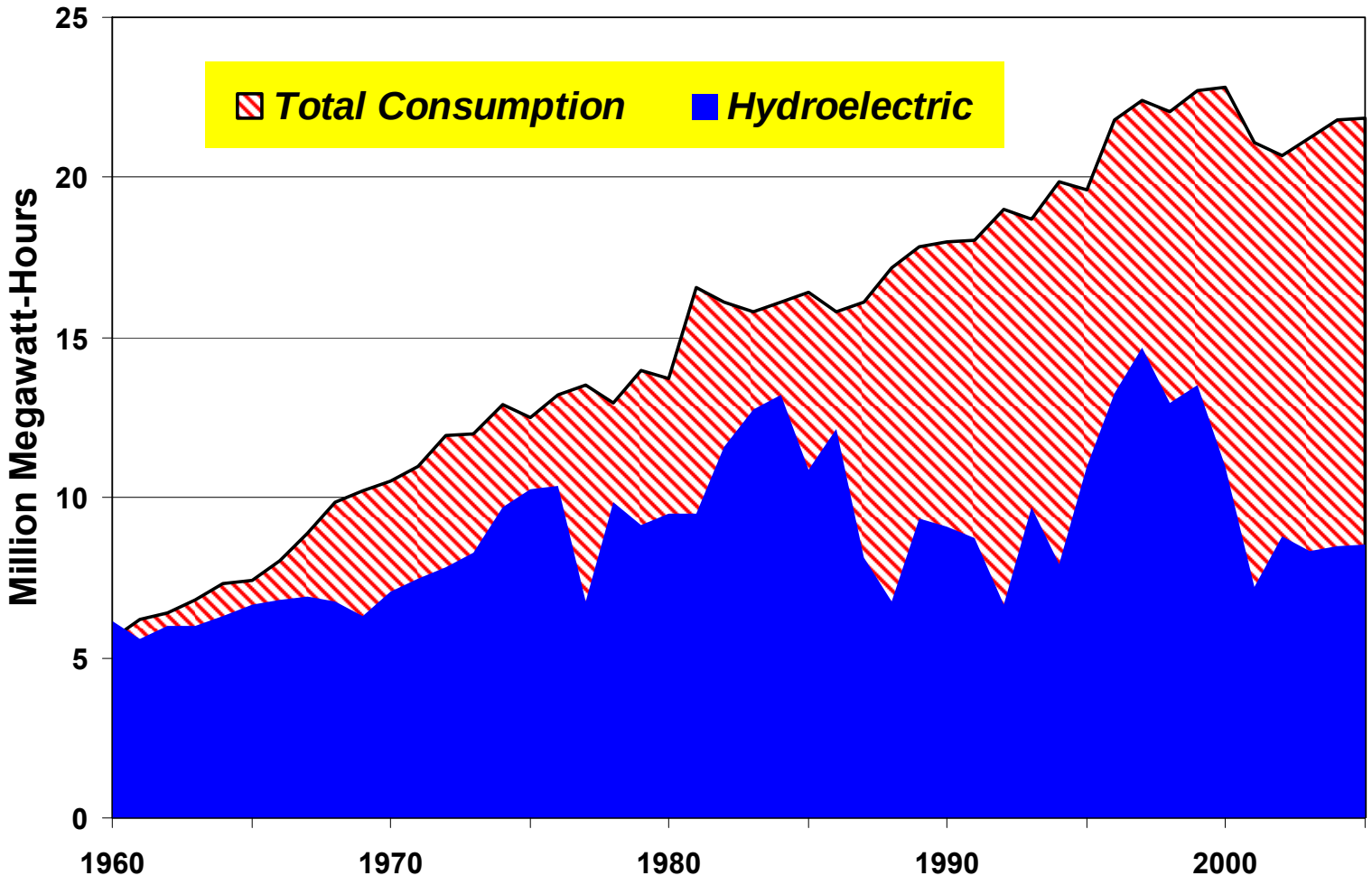
This presentation is available for download at http://nuclear.inl.gov/papers.shtml

Subjects to Explore

- ***Idaho's energy picture***
- ***Nuclear power in the U.S.***
- ***Potential for a nuclear power plant in Idaho***

Idaho's Electricity Supply



Energy Information Administration (EIA)

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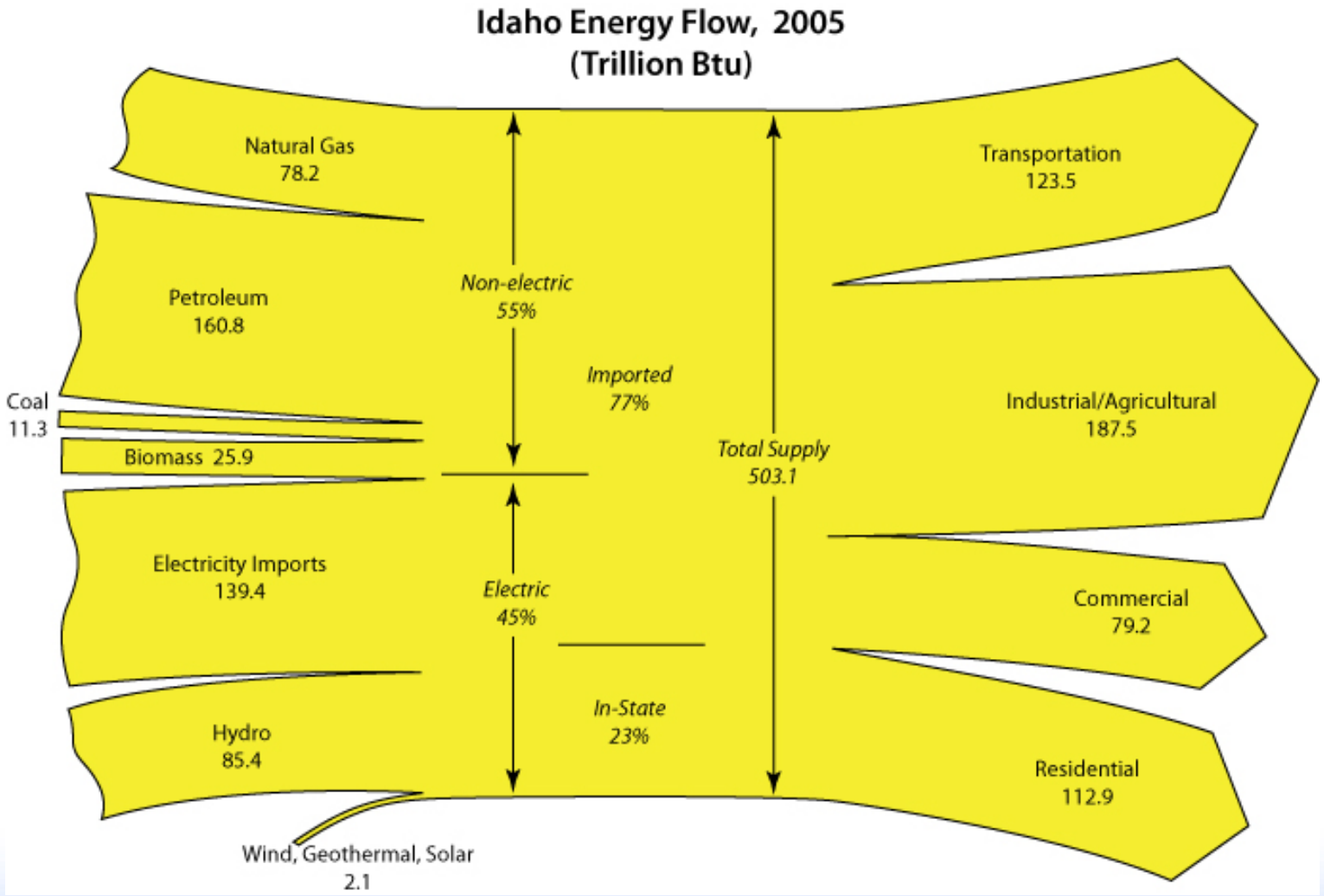
Idaho's Energy Flow – current (total)



EIA Annual Energy Review

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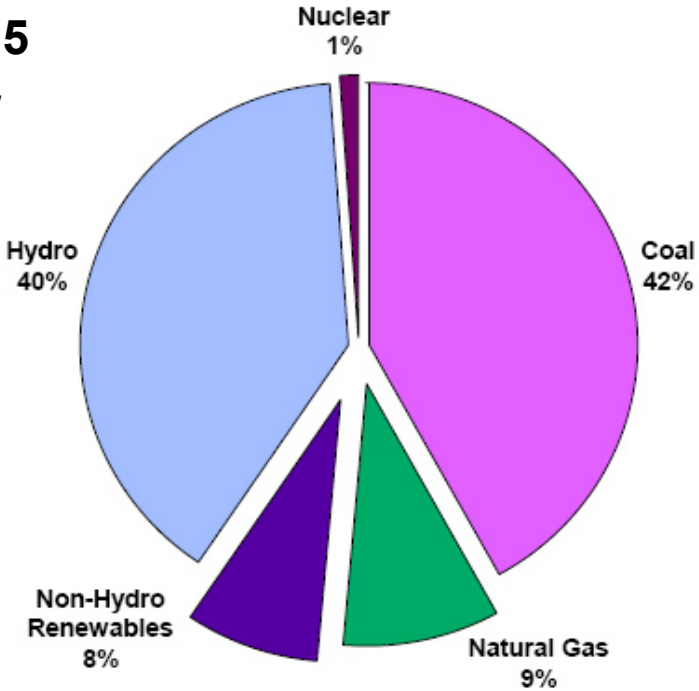
Idaho's Energy Picture – 2015 (electric)

- **Idaho 2007 Energy Plan: 3,240 aMW by 2015**
  - **Projects need for an additional 550 aMW**
  - **Conservation avoids a further 190 aMW**
  - **Hydro ↓8 points (flat aMW)**
  - **Coal flat % (+230 aMW)**
  - **Wind ↑7 points (+230 aMW)**
  - **Nat gas ↑1 point (+75 aMW)**

Figure 3.2. 2015 Fuel Mix for Electricity Production



2007 Idaho Energy Plan

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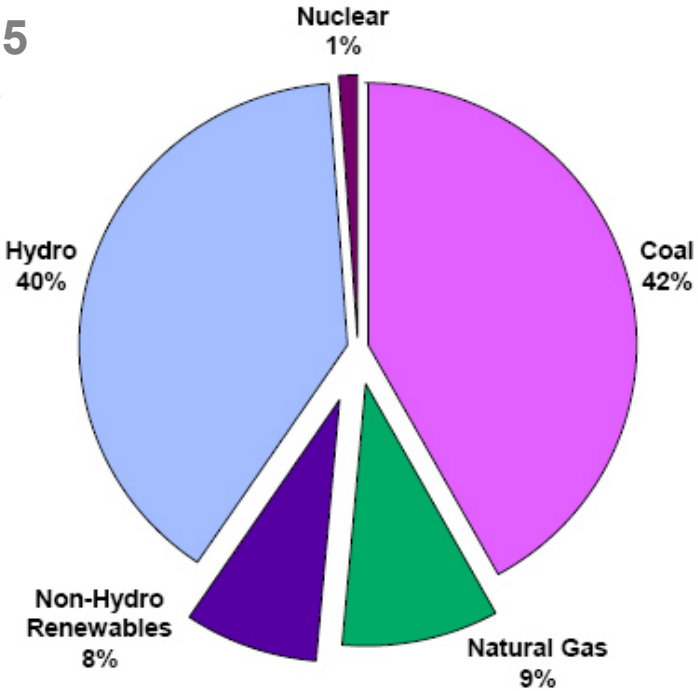

- **Regional long-term additions** (by 2015)
  - **PacifiCorp +3820 MW (1600 wind)**
  - **Idaho Power +358 MW (250 wind)**
  - **Avista +357 MW (100 wind)**

Projected Regional Additions: 2500 Baseload and 2000 Wind

Utility Integrated Resource Plans, evaluated in Spring 2008

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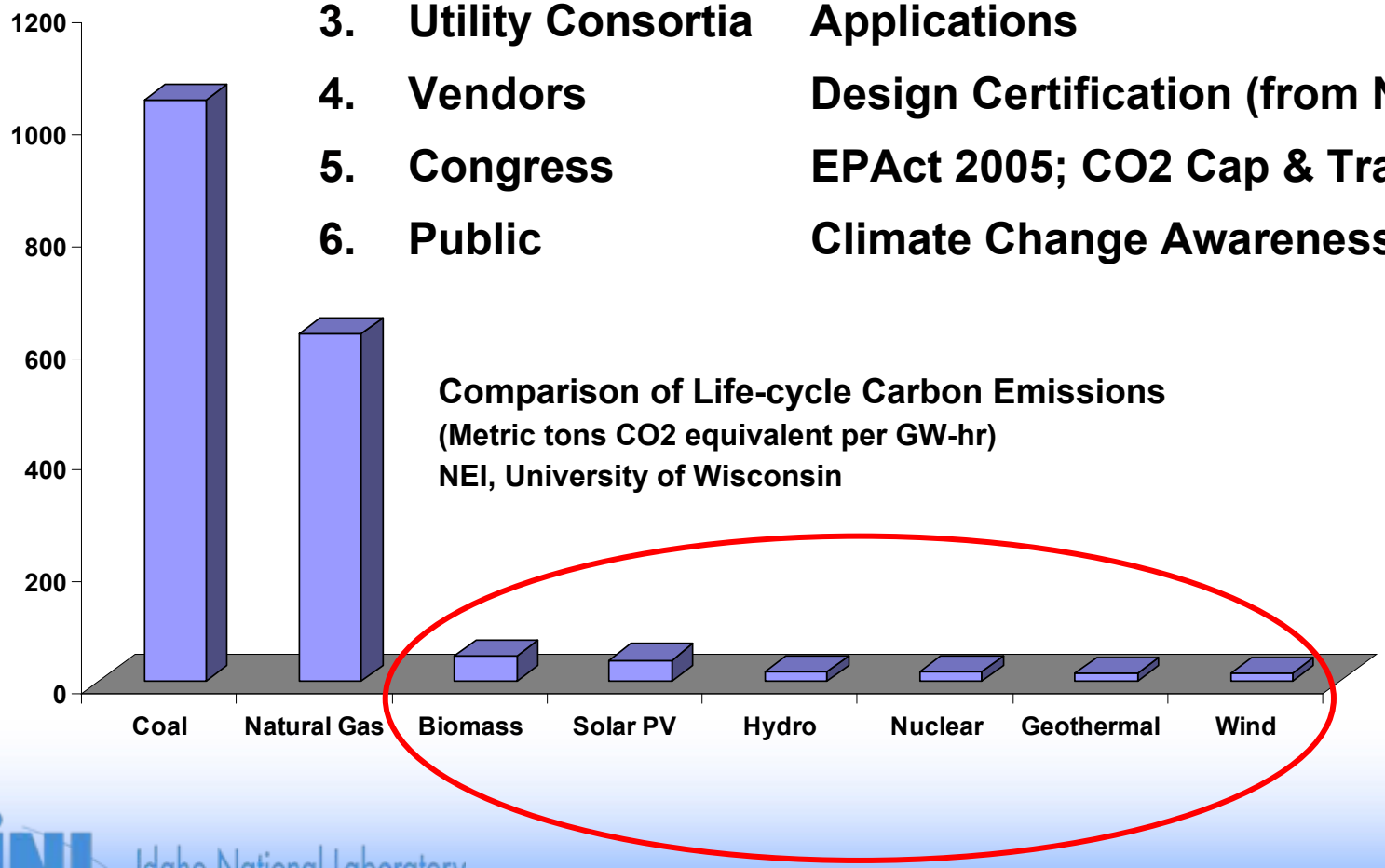
Nuclear: What's been Changing?

1. NRC — Licensing (Part 52)
2. DOE — Sponsorship (NP2010)
3. Utility Consortia — Applications
4. Vendors — Design Certification (from NRC)
5. Congress — EPAct 2005; CO2 Cap & Trade (?)
6. Public — Climate Change Awareness



Comparison of Life-cycle Carbon Emissions
(Metric tons CO2 equivalent per GW-hr)
NEI, University of Wisconsin

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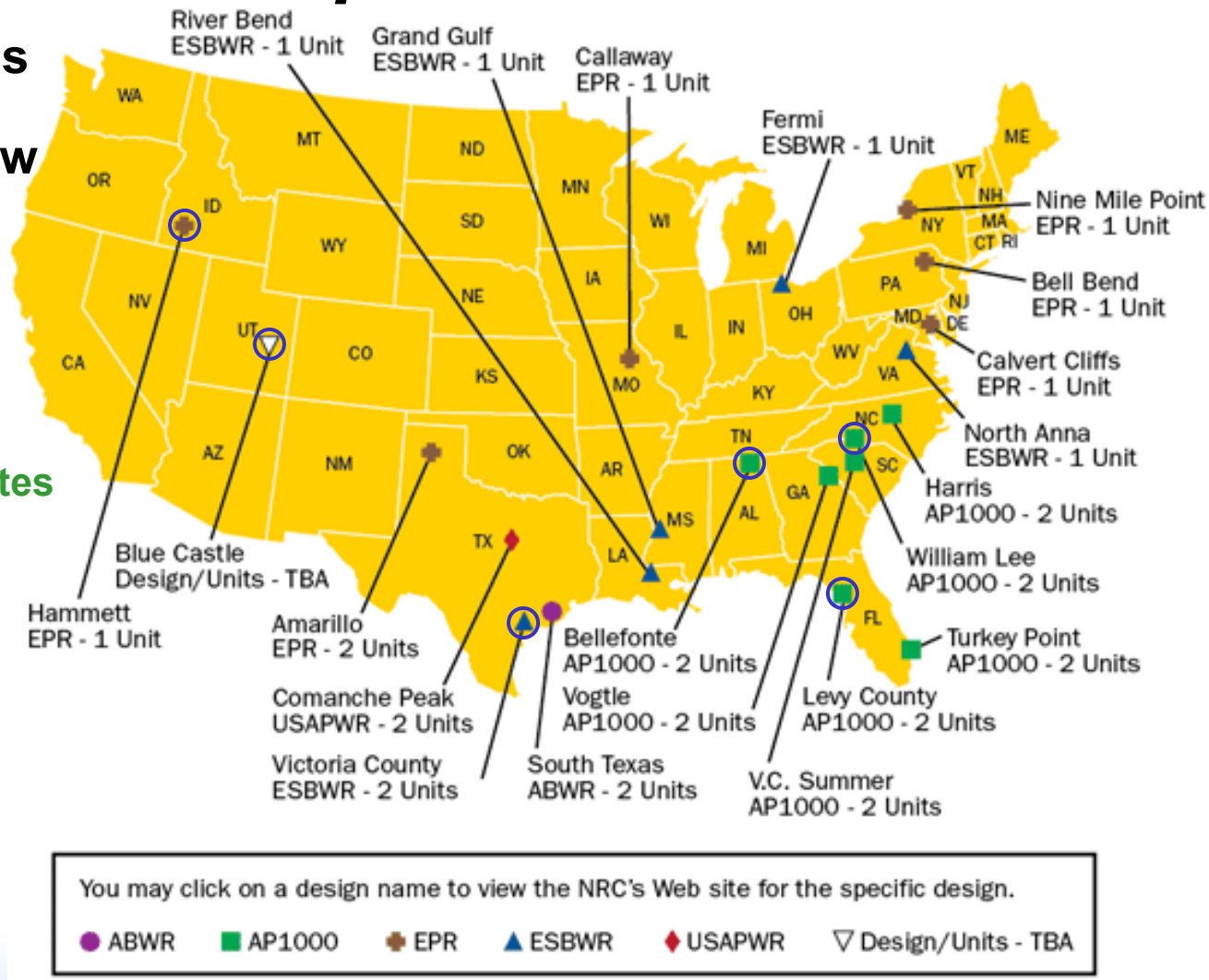
Distribution of Proposed New Plants

- **23 applications submitted to NRC for 34 new units**
- **104 units operating in U.S. today**

○ **Greenfield Sites**



US NRC, Nov 2008

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Today's Nuclear Plant Designs

Name	Vendor	Type	Size (MWe)
ABWR [a, b, c(1997), d] Advanced Boiling Water Reactor	GE/Hitachi, or Toshiba	BWR	1300
AP1000 [b, c(2006), d, e] Advanced Pressurized (Water Reactor)	Westinghouse	PWR	1150
ESBWR [c(2009), d, e] Economic Simplified Boiling Water Reactor	GE/Hitachi	BWR	1400
EPR [b, c(2010), d] Evolutionary Pressurized (Water) Reactor	Areva	PWR	1600
APWR [b, c(2010), d] (US-)Advanced Pressurized Water Reactor	Mitsubishi	PWR	1700

a: Plants in operation worldwide

b: Plants under construction worldwide

c: Design certification by NRC (year certified or expected)

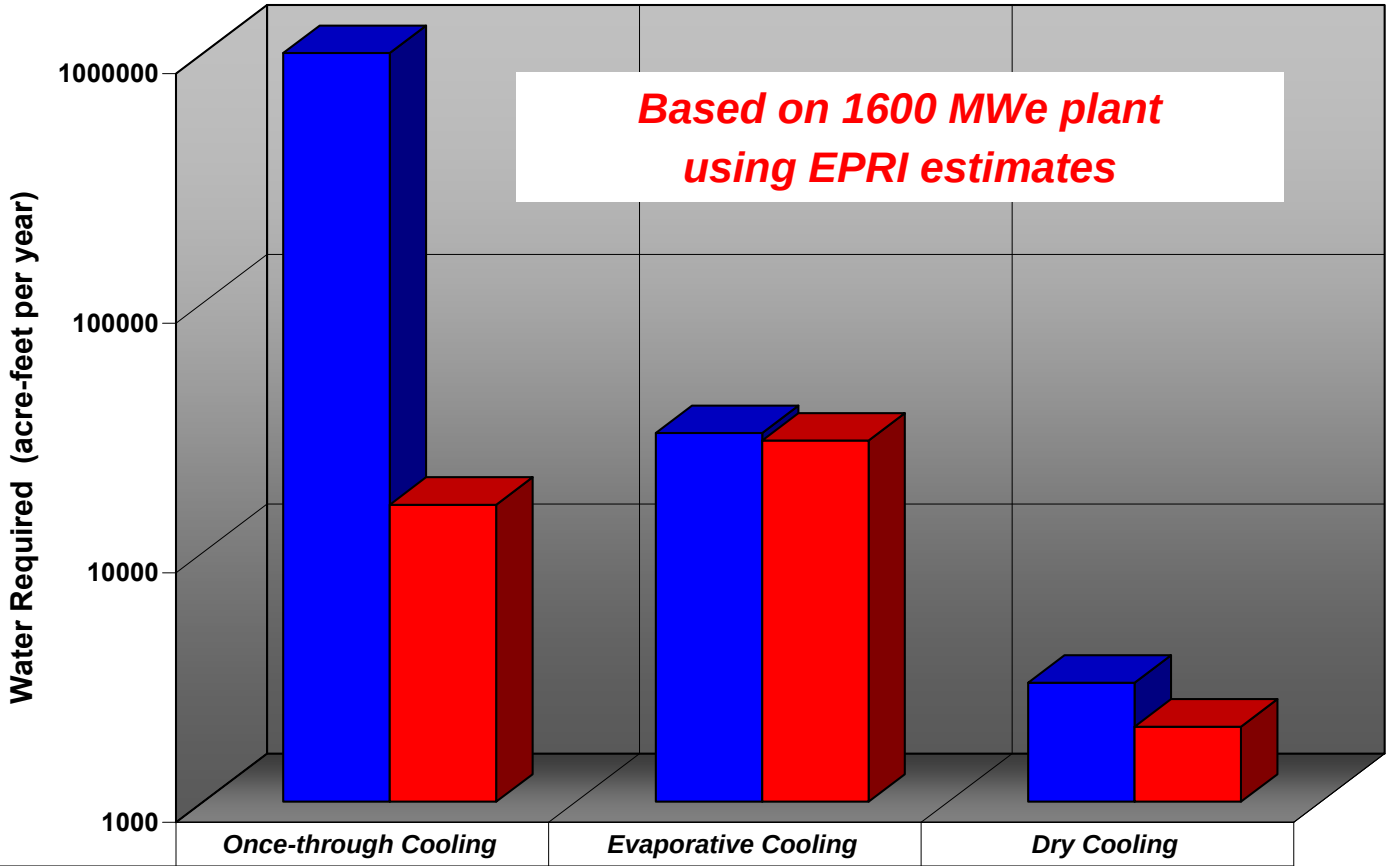
d: Plant named in a license application in the US

e: Passively safe design

Two Sets of Important Issues

- **Public acceptance**
  - **Water use**
  - **Spent nuclear fuel**
  - **Safety**
  - **Merchant plant perceptions**
  - **Nonproliferation**
  - **Seismic**
- **Owner costs, financing and schedule**
  - **Cost of new plants**
  - **Infrastructure to produce heavy components and nuclear-grade equipment**
  - **Transportation of heavy components**
  - **Construction/operation workforce**

Water Needed for Cooling



	Once-through Cooling	Evaporative Cooling	Dry Cooling
Withdrawl	1000000	30000	3000
Consumption	15500	28000	2000

Alternative technologies can make a big difference

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Cooling Technology

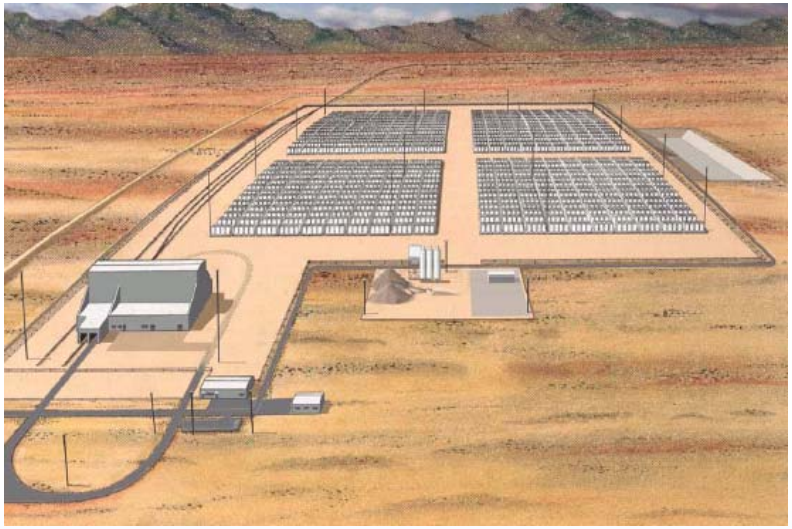
- **Once-through cooling**
  - **High withdrawal / moderate consumption**
  - **Water returns 10–15C warmer**
- **Evaporative towers**
  - **Moderate withdrawal and consumption**
  - **Can use degraded water**
  - **A plant needs ½% of the water used to irrigate the Snake River Plain**
- **Dry cooling towers**
  - **Low withdrawal and consumption**
  - **Established technology**
  - **Parasitic power losses: (average 2%, peak 15-25%)**
  - **North Anna plans first 'hybrid' cooling**

Rancho Seco (900 MWe) cooling towers near Sacramento, CA in 1980s

Yucca Mountain Going Slowly

- **All plants contract with DOE to take their waste**
- **DOE has not received any spent fuel to date, but has collected 1 mill per kWhr from the utilities to pay for it**
- **Waste Fund is now $20.5B, and growing $750M yearly**
- **Yucca application submitted in Jun 2008 (begins 4 yr decision)**
- **Congress directed DOE to consolidate SNF at 1 or 2 sites**

Yucca Mountain, Nevada

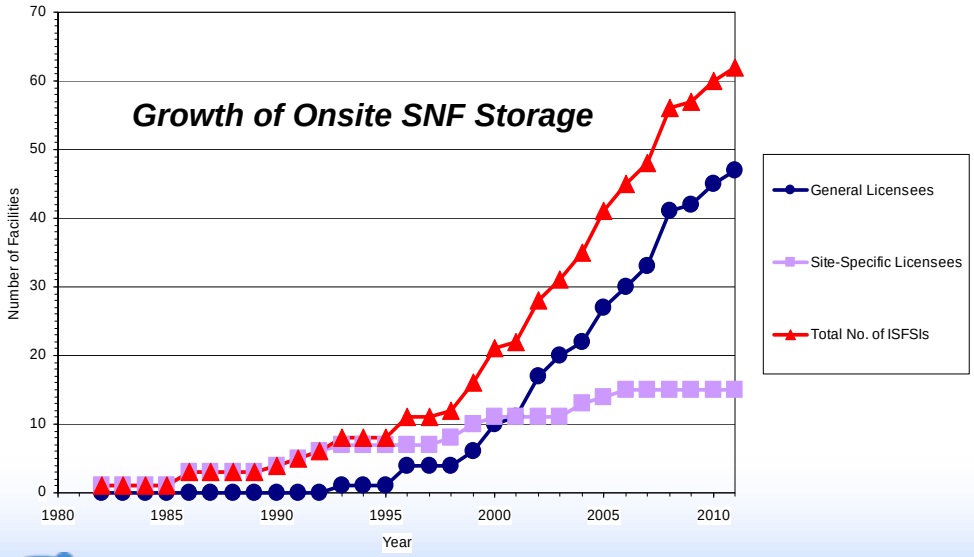


Interim Above-Ground Storage Concept

On-Site Storage Steps Up

- **Most plant owners are now storing spent fuel on-site in above ground dry storage casks**
- **The largest casks store about one year's worth of spent fuel**
- **The practice is likely to continue indefinitely**

On-site storage buys decades for a repository to open



Dry storage at at Connecticut Yankee

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Public and Worker Safety

Public exposure and accident risk

– **Routine exposure about 1/10,000th your natural exposure**

Average annual natural background radiation dose	3.0 mSv
additional from man-made sources	0.66
10,000 miles air travel (for example)	0.1
living within 50 miles of a nuclear plant (avg)	0.00009
living near a coal plant (stack emissions)	0.00030

– **Accident risk less than 1/1,000th your other risks**

- **For people near a nuclear plant, NRC policy is to keep the risk of immediate or latent fatality less than 1/1000th the sum of all other risks they are normally exposed to**

Worker safety

- **US nuclear plants achieved a record in 2006: 0.12 injuries or illnesses per year per 100 workers — about one-tenth that of office workers**

BEIR VII, 2006 and NRC Qualitative Safety Goals, 1986

Merchant Plant Concerns and Benefits

Merchant plants are sometimes painted as unscrupulous

- **Nuclear plants must operate at full capacity**
  - **Long term power contracts are essential**
  - **PUC would review Idaho's for need and value**
  - **FERC and PUC would oversee access to transmission**
- **All 17 nuclear plants sold since 1998 are merchants**
  - **Good experience with them**

Significant revenues to the local citizens and State

- **~500 jobs at the plant, 50% more in surrounding area**
- **~$40M plant payroll**
- **~$15M income and indirect taxes**
- **~$25M annual property taxes**

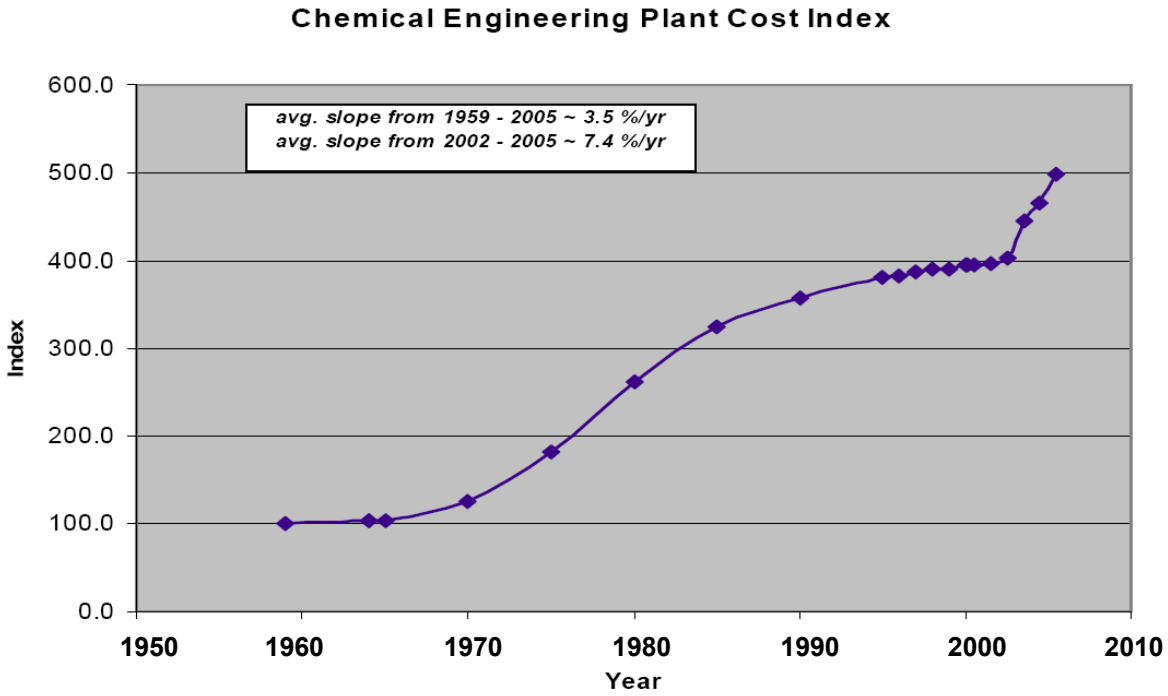
Infrastructure for Components

- **Only one steel works in the world capable of ultraheavy forging**
  - **Japan Steel Works is doubling their capacity by 2010**
- **Many others are upgrading/building capabilities**
  - **6 countries at 9 locations; 3-10 years to get online**
  - **France, Korea, US, UK, China, Russia, India**

JSW Muroran plant near Sapporo, Japan

ABWR reactor pressure vessel

Escalation of Materials & Construction



(% per year)	Escalation 1986-2003	Escalation 2004-2007
Cement	2.7	11.6
Iron/Steel	1.2	19.6
Heavy Constr.	2.2	10.5

Source: American Electric Power

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Cost of a New Nuclear Plant

	Capital Cost $/kW	LCOE* ¢/kWh
MIT (2003)	2000–2500	5–6
University of Chicago (Aug 2004)	1853	5–8
Standard & Poor's (May 2007)	4000	9–10
Keystone Study (Jun 2007, updated)	3600–4000	9–14
Moody's (Oct 2007; Jun 2008)	5000–6000; 7000	

LCOE: Levelized cost of electricity

These reports have many differing assumptions

Economic Factors in Play

- **Escalation of construction costs**
- **Recession tightens credit**
- **Not enough loan guarantees available**
- **Low cost of electricity in Idaho**
- **Recession may lower construction cost escalation**
- **Higher cost of renewables**
- **Application of carbon cap & trade**
- **Loan guarantees reduce the cost of borrowing**

Hinders nuclear

Favors nuclear

Summary

- **New nuclear plants will likely begin construction in a few years, in the Southeast**
- **If the 'first wave' is successful (especially the cost & schedule), the potential may arise for development in Idaho**
- **Public acceptance in Idaho very dependent upon addressing water, as well as the sensitivity to undue impact on the citizens**