Pumped Storage
Historical and Global Trends

BLM conference at Golden CO,

Bruno Kaelin, Sales and Marketing Director

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Snapshot of US Operating Pumped Storage

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US PS Growth

- Mainly occurred 1955-95
- 20,000MW new Pump Storage added

Reasons for Growth

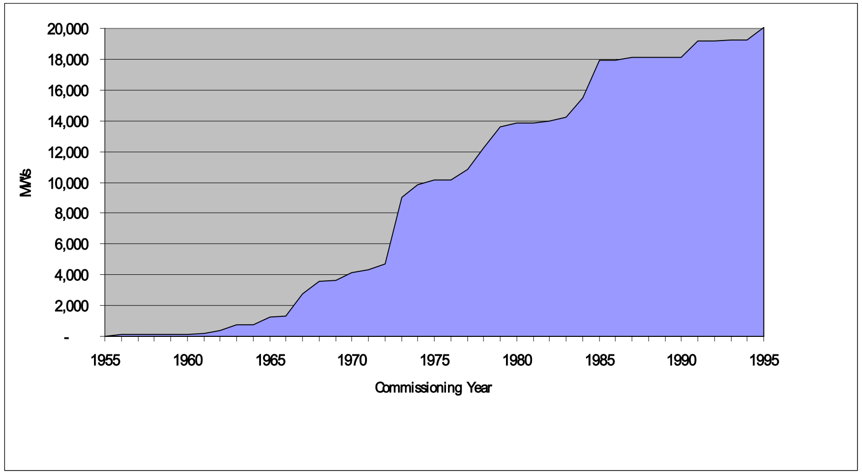
- Load Balancing for Nuclear/Fossil

Why it stopped

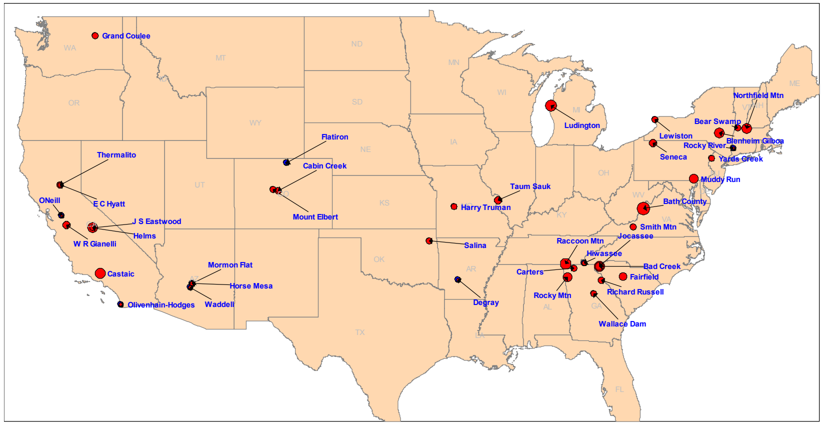
- Deregulation
- No new Nuclear (TMI)

US Historical PS Growth

Cumulative MW's



US Operating PS Plants



Snapshot of Operating Pumped Storage Globally

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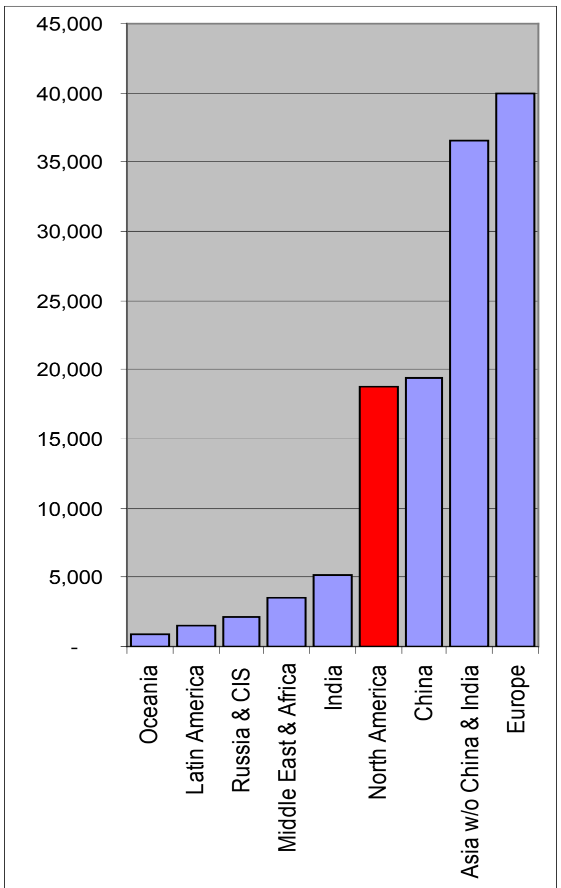
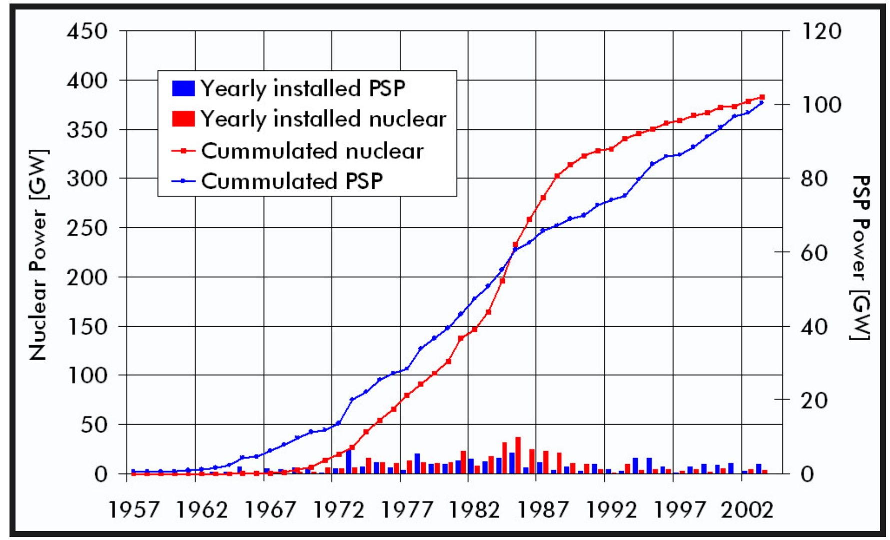
Pump Storage Units in Operation (MW) by Country/Continent

- 127,961MW Worldwide
- Totaling 922 PS Units





Reasons for Growth

- Load Balancing for Nuclear/Fossil in (Europe)
- Need to control electrical network frequency
- Need for reserve generation (China)

Source: Various Published Data + MWH internal DB

So what is happening now globally?

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New Global Pump Storage Construction

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Globally 65 Pump Storage Projects are under construction

Region	Total MW	% Total
Europe	5,297	33%
Asia excl. China & India	4,250	26%
China	3,480	22%
Middle East & Africa	1,368	8%
India	900	6%
Russia	856	5%
Grand Total	**16,151**	**100%**

Country	Total MW	% Total
CHINA	3,480	22%
JAPAN	3,450	21%
SWITZERLAND	1,900	12%
SOUTH AFRICA	1,368	8%
PORTUGAL	1,211	7%
SPAIN	1,027	6%
AUSTRIA	959	6%
INDIA	900	6%
RUSSIA	856	5%
KOREA SOUTH	800	5%
LUXENBOURG	200	1%
Grand Total	**16,151**	**100%**

<u>But – no construction in North America!!!!!</u>

Reasons for PS Boom in Europe

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- Stronger Push for Carbon Free Generation (including off shore wind)
- Europe does not have the gas reserves as North America does – they rely on Gas from Russia
- There are European Incentives for Storage
  - Portugal – an increase in output increases the term of the license
  - Germany – no connection fees for storage
- Strong Ancillary Markets
- High volatility between selling and buying prices of electricity – thus driving storage

Reasons for PS Boom in China

- Transmission Companies (ISO’s) develop and operate the PS Plants
- Major driver is "load following close to the load while base load generation is far away (1000km+)"

So what about the US?

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Strong Interest in US Pump Storage Development

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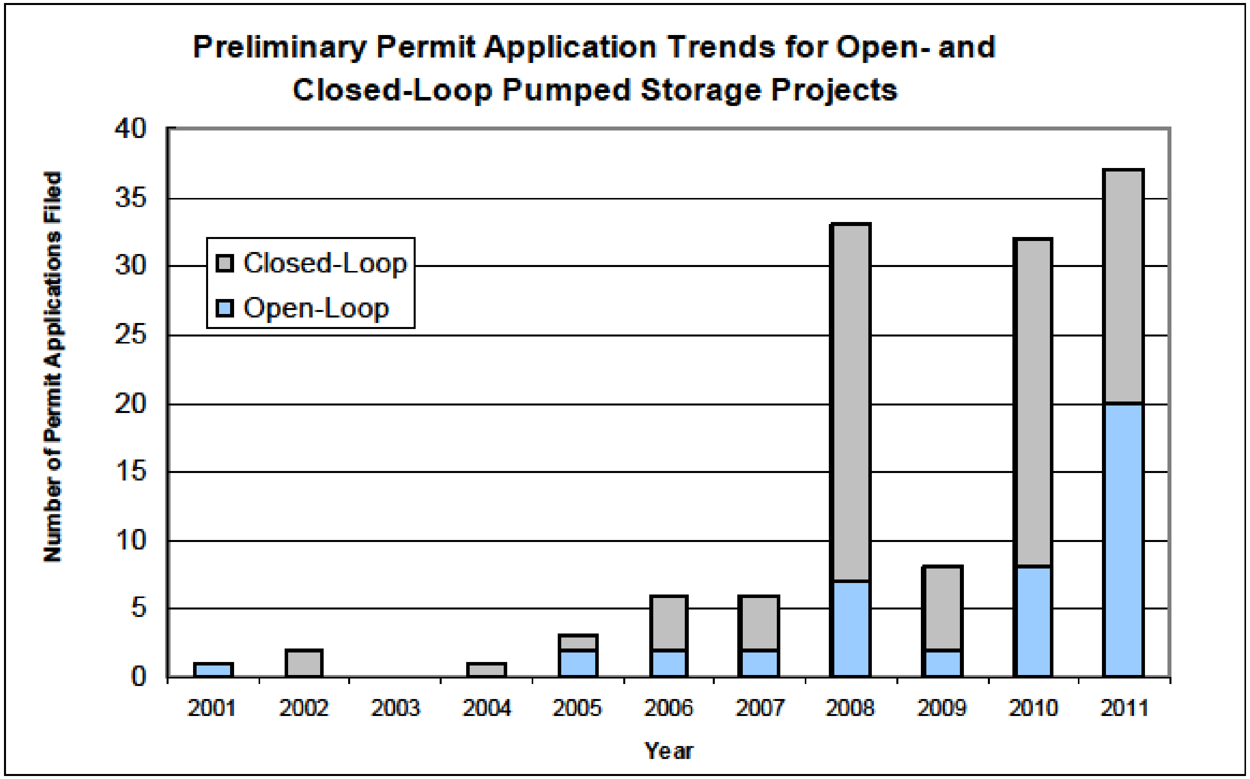

Source: FERC Staff

Market Trends

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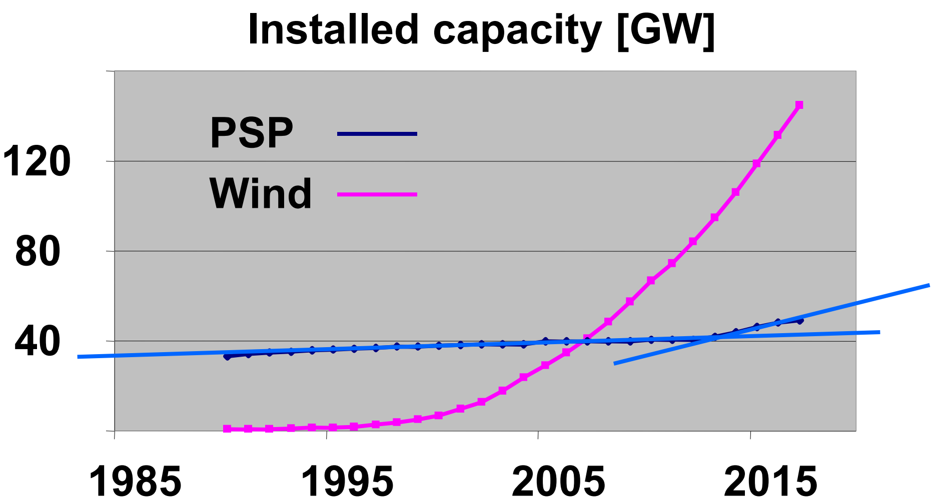
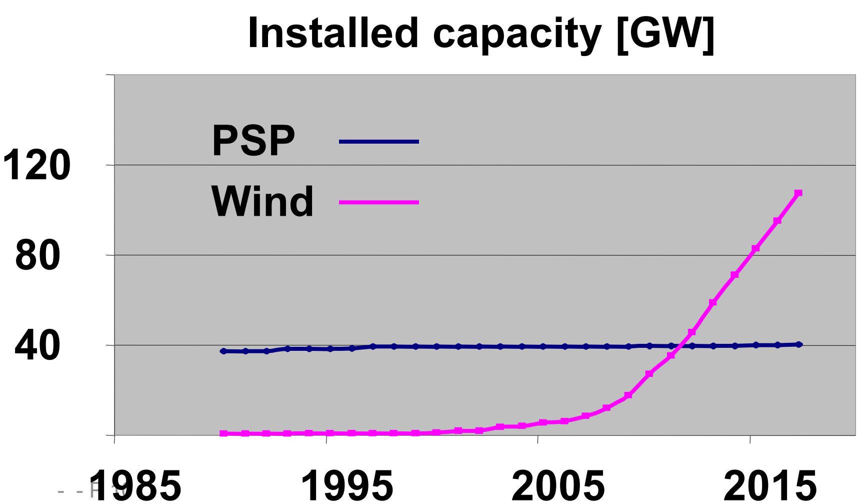
Correlation between Wind and PSP ?

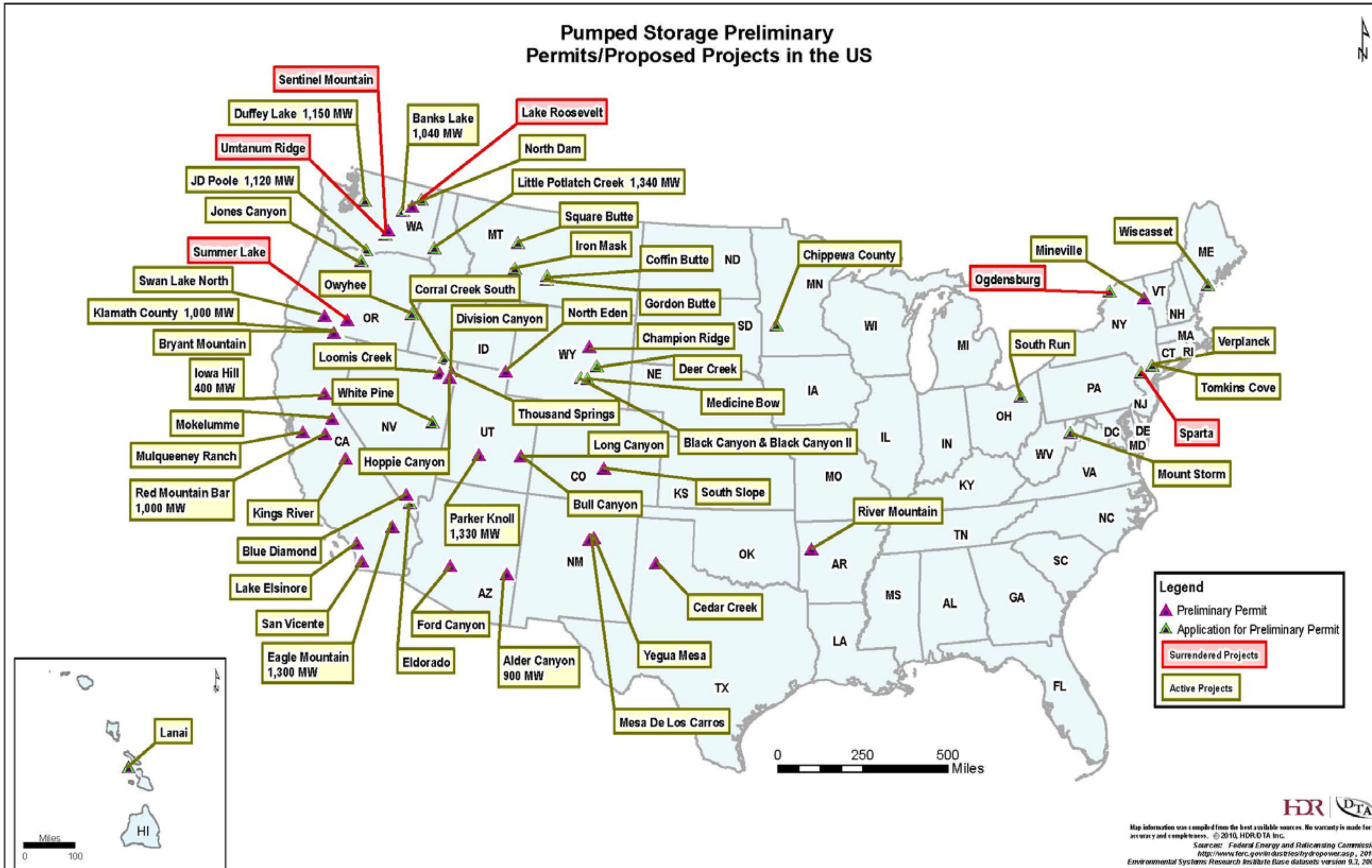


- Europe PSP
  - ~20% increase in the last 20 years
  - ~20% increase expected in the next 5 years



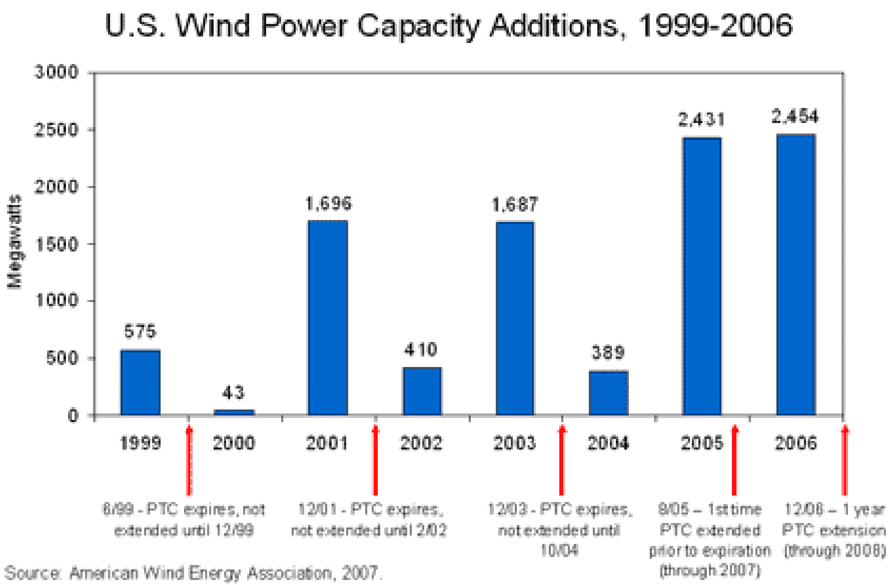
- What is going to happen in USA?

Proposed Pumped Storage Projects



But – what is needed in the US?

- Expedited License Process
- Different Requirements for Closed Loop
- Government Incentives – comparable to other renewable generation



- Compensation markets for developers