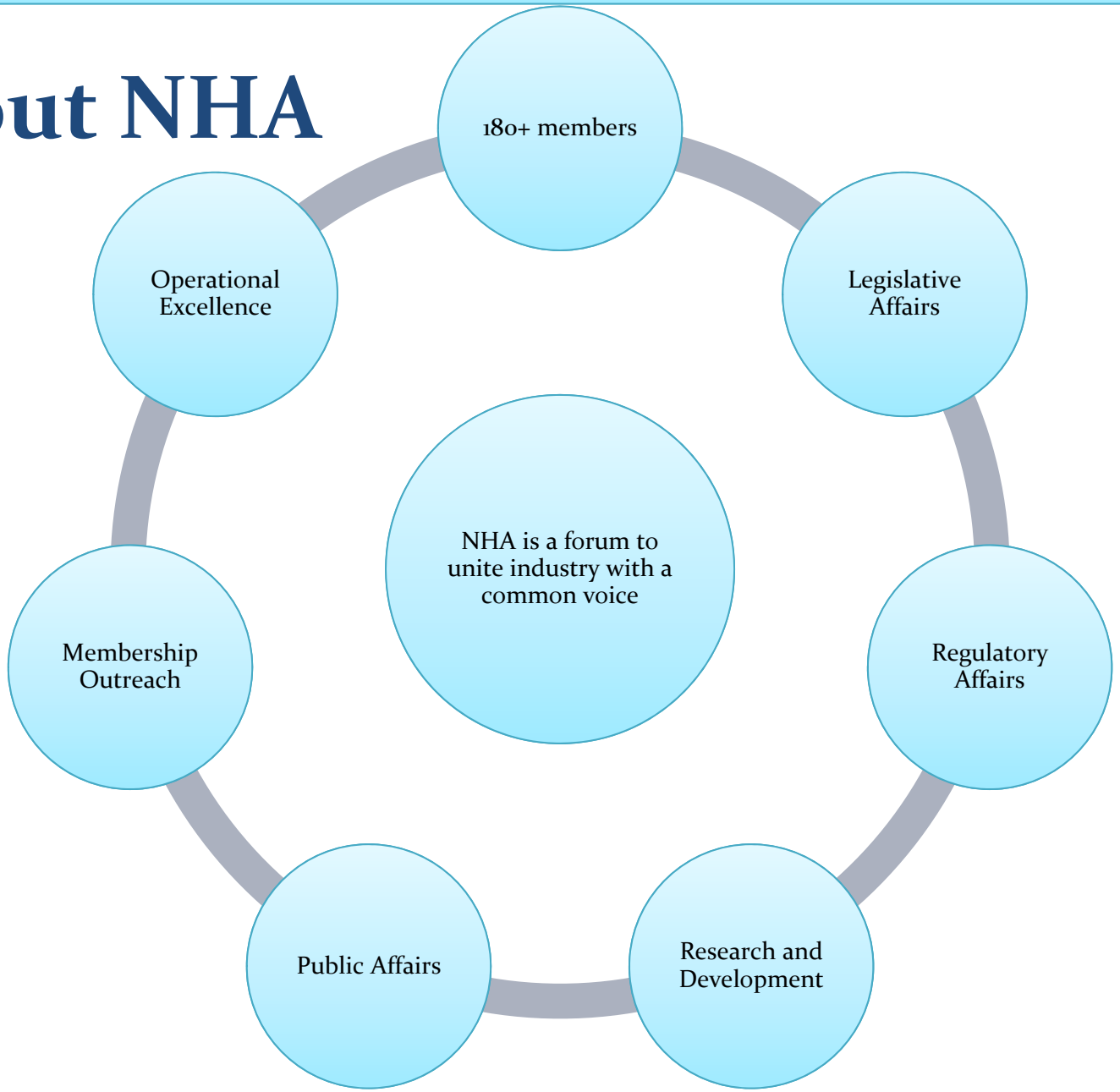
# National Hydropower Association

## An Overview of Hydropower

**Arkansas Alternative Energy Commission**
**March 20, 2014**

# About NHA


180+ members
Legislative Affairs
Regulatory Affairs
Research and Development
Public Affairs
Membership Outreach
Operational Excellence
NHA is a forum to unite industry with a common voice

# NHA: Looking to the Future

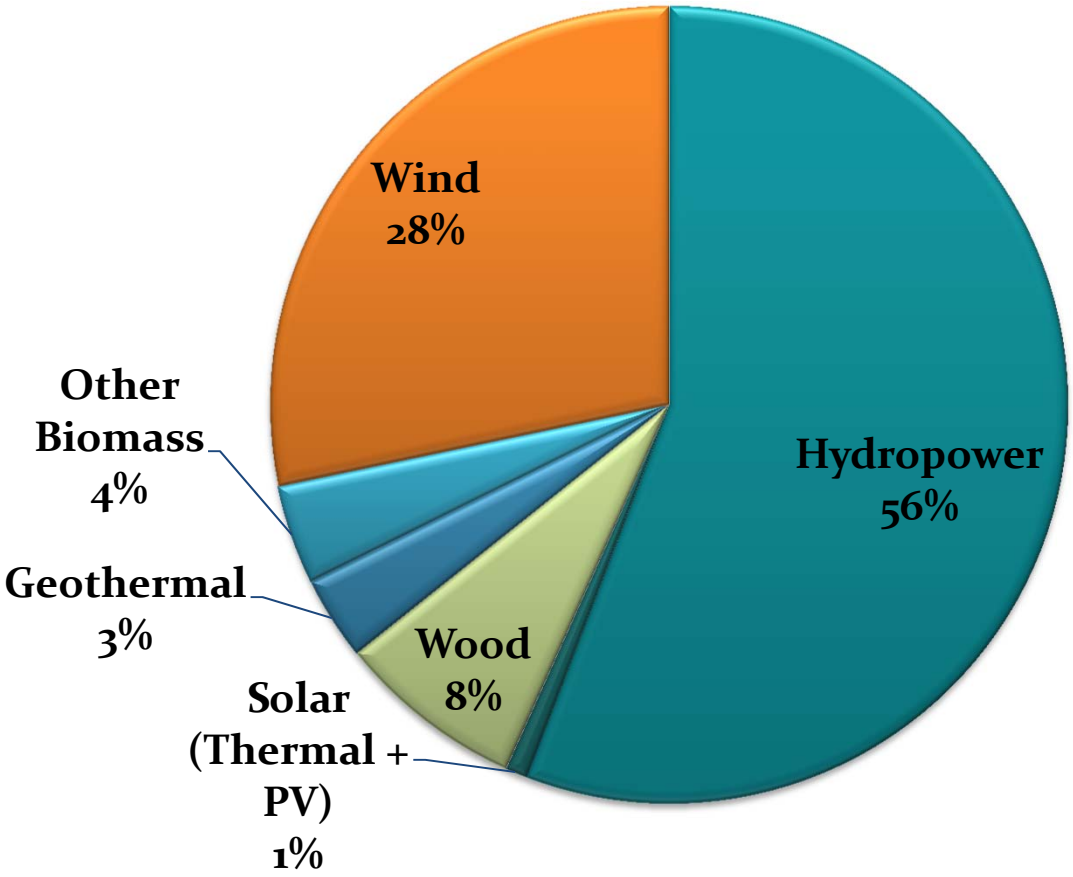
## Vision

- Double America's largest renewable energy resource – hydropower – in support of a sustainable and secure clean energy future.

## Mission

- Champion hydropower, in all of its forms, as America's premier clean and renewable energy resource.
- Focus on growth, operational excellence and environmental stewardship.

## U.S. Renewable Electricity Generation 2012

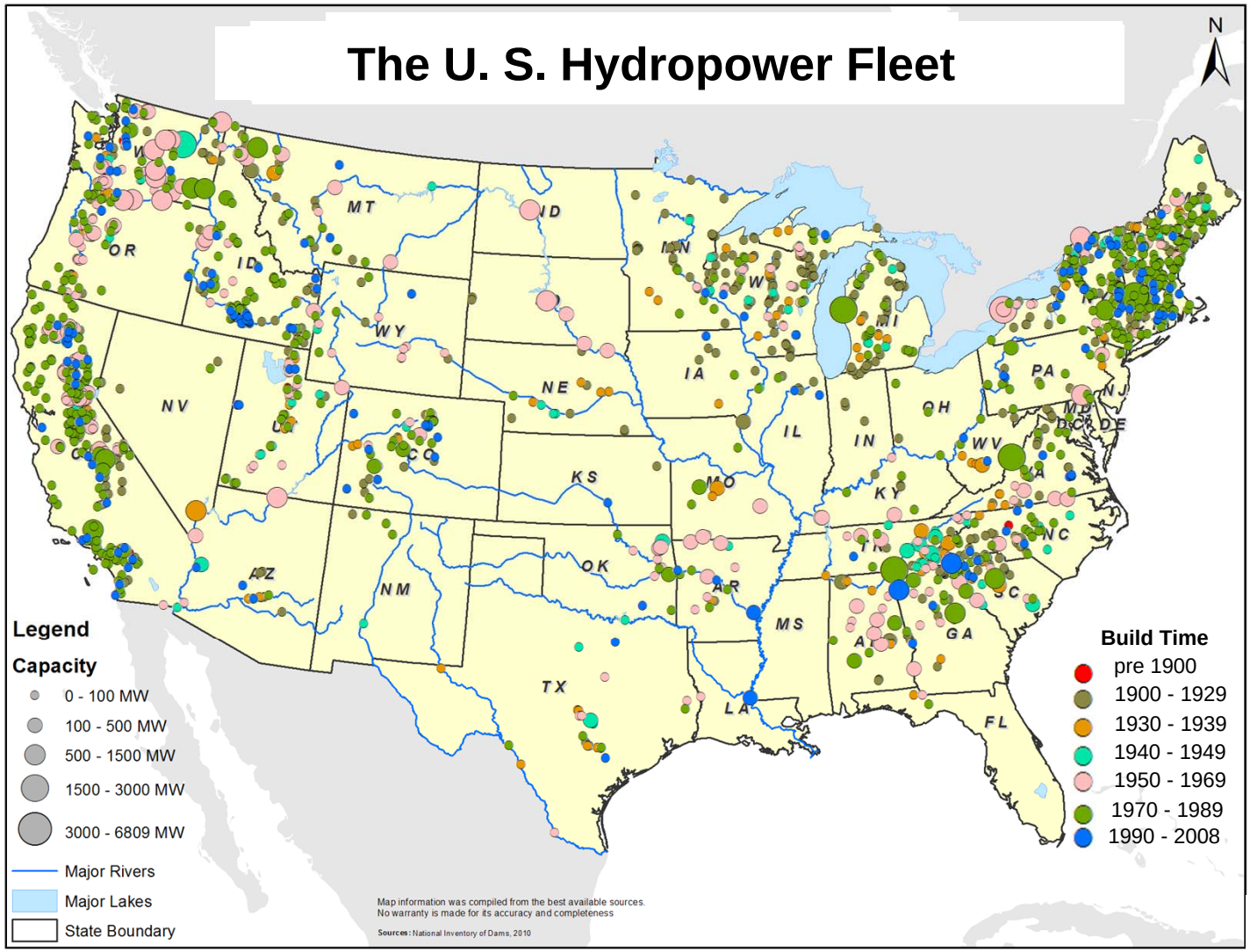



**Hydropower is available.**

It is the largest source of renewable electricity in the U.S., and made up **7 percent** of overall electricity generation and the majority of renewable electricity in 2012.

In Arkansas, hydro made up **3.4 percent** of total generation and about **57 percent** of renewable generation.

Approximately **100GW** of existing capacity, includes **22GW** of pumped storage.



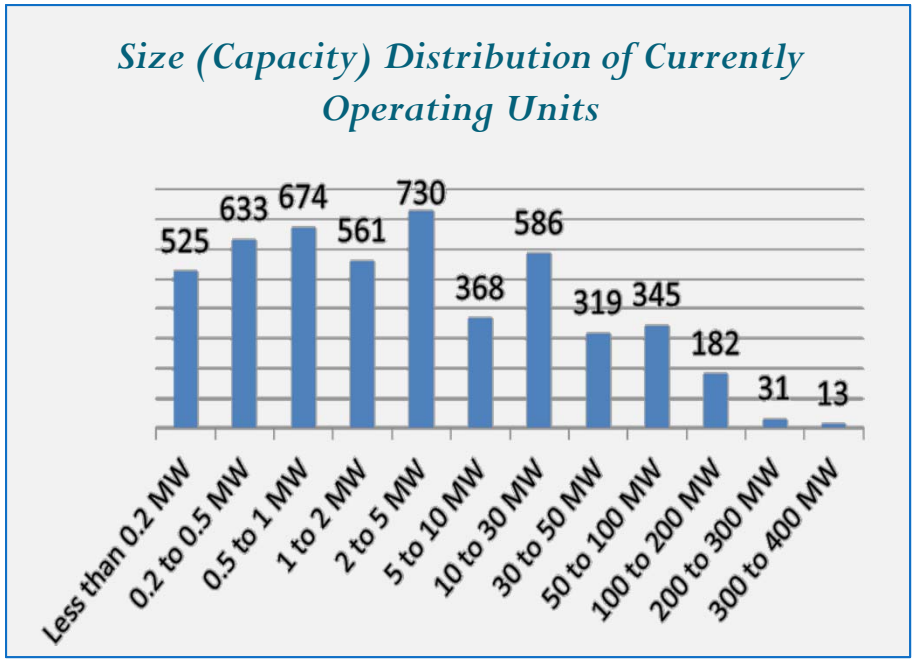

*Sources: ORNL, NID*

# Non-federal Arkansas hydro projects

| | | | | | |
|---|---|---|---|---|---|
| P- | 3044 | LOCK & DAM NO 9 | 32400 | ARKANSAS ELECTRIC COOP CORP | ARKANSAS RIVER |
| P- | 3033 | DAM NO 2 | 102600 | ARKANSAS ELECTRIC COOP CORP | ARKANSAS RIVER |
| P- | 3449 | MURRAY LOCK & DAM | 39000 | NORTH LITTLE ROCK CITY OF | ARKANSAS RIVER |
| P- | 3043 | LOCK AND DAM NUMBER 13 | 33200 | ARKANSAS ELECTRIC COOP CORP | ARKANSAS RIVER |
| P- | 4660 | WHITE RIVER L & D NO 2 | 6307 | INDEPENDENCE COUNTY OF | WHITE RIVER |
| P- | 4659 | WHITE RIVER LOCK & DAM NO. 3 | 10500 | INDEPENDENCE COUNTY OF | WHITE RIVER |
| P- | 4204 | WHITE RIVER LOCK & DAM NO. 1 | 6029 | BATESVILLE CITY OF | WHITE RIVER |
| P- | 271 | CARPENTER-REMMEL | 65300 | ENTERGY, ARKANSAS, INC. | OUACHITA RIVER |

## Close to 300 MW of capacity

# Key Characteristics of the Hydro Fleet




**Only 3% of the 80,000 U.S. dams generate electricity – there is significant room for growth.**

**Hydropower is generated in every region and benefits every state, employing up to 300,000 workers around the U.S.**

# Additional Hydro Industry Information

Of total U.S. hydro generation – about half comes from the federal hydropower system (USACE, BuRec, TVA) and the other half from private industry.

Federal projects tend to be larger with Grand Coulee being the largest electric generating asset in the country at **almost 7,000 MW** of capacity.

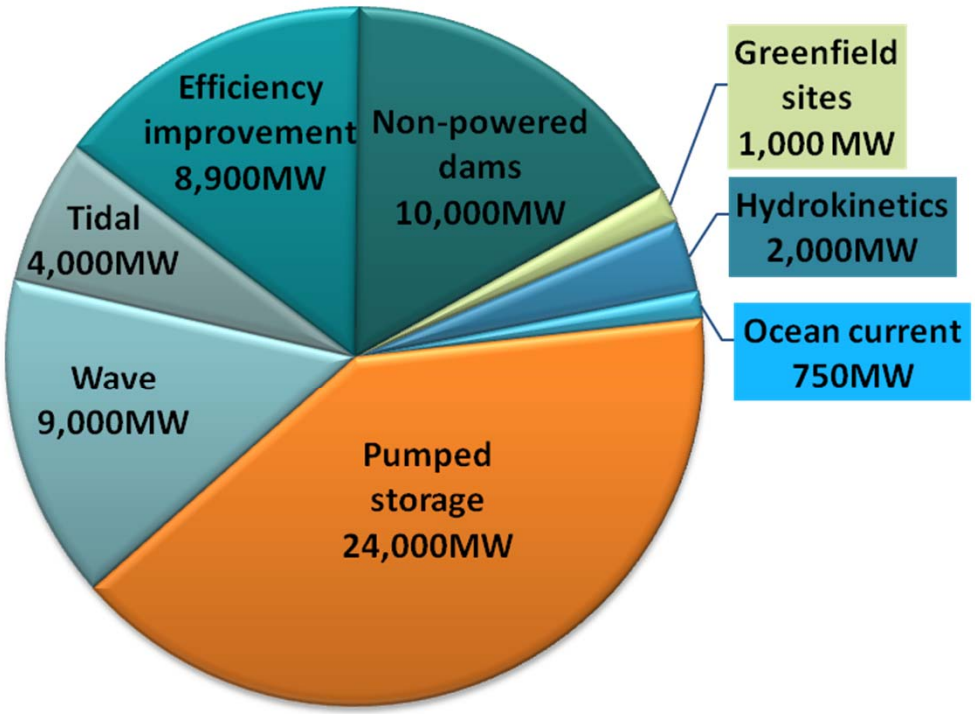
The private projects tend to be smaller, with **71 percent** of FERC projects under **5 MW** of capacity.

# Future availability

With the right policies in place, **the U.S. could add 60,000 MW** of new hydro capacity by 2025, much of which can be created by maximizing existing infrastructure or with low-impact projects.

There are also some greenfield project opportunities.

**Hydro Capacity Growth by Technology**




Navigant Consulting Study, 2009

# Hydro Projects In Line

## The FERC pipeline tops 64,831 MW across 399 projects

- **Pending Licenses/Relicenses/ Exemptions: 100 projects, 2,900 MW, 31 states**
- **Preliminary Permits Issued: 257 projects, 51,123 MW, 43 states**
- **Preliminary Permits Pending: 43 projects, 10,808 MW, 15 states**

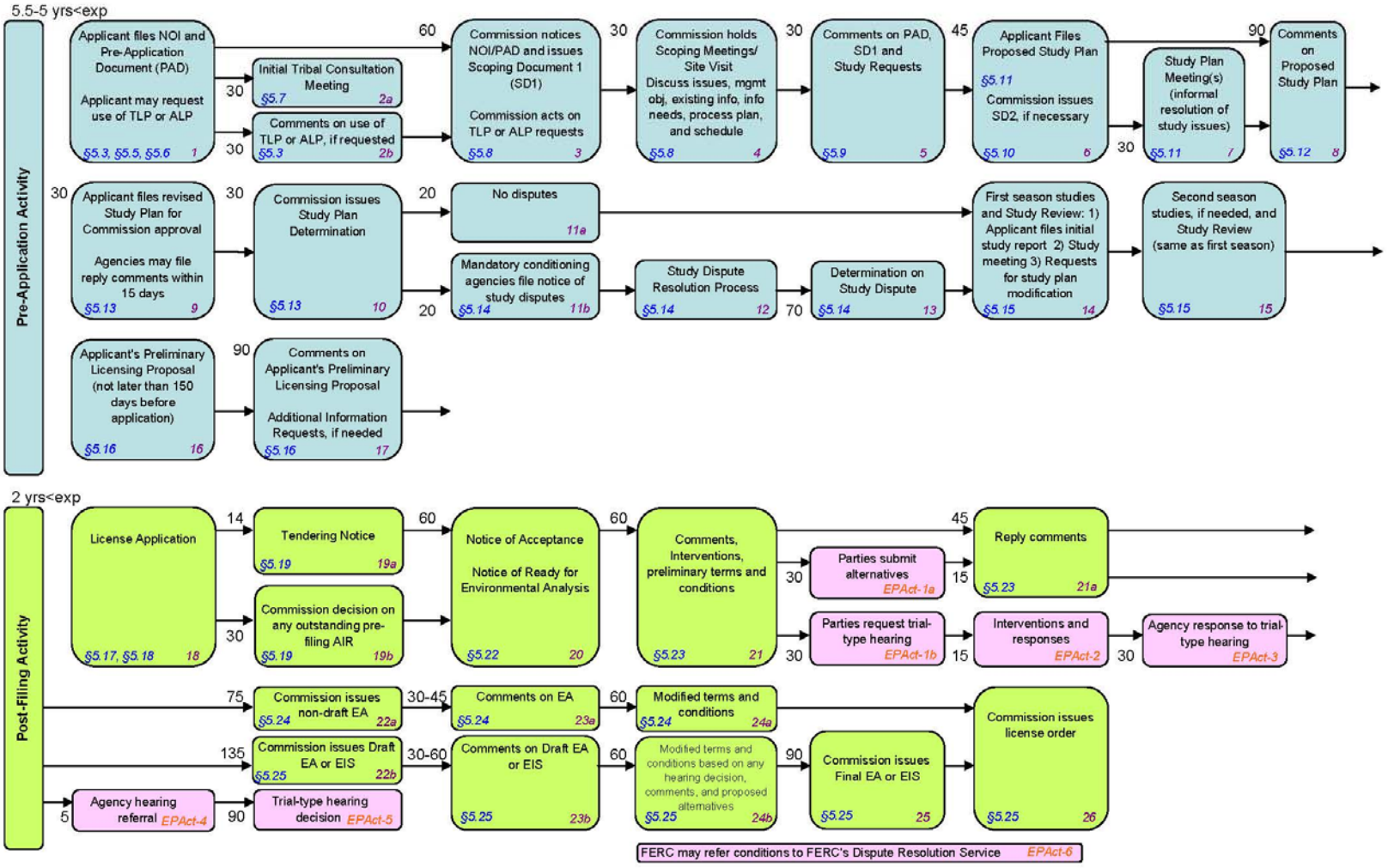
# Arkansas projects under consideration

| | | | | | | |
|---|---|---|---|---|---|---|
| P- | 14137 | OTTO | 28000 | LOCK HYDRO FRIENDS FUND XXXVI | ARKANSAS RIVER | Conventional Permit |
| P- | 14178 | MAD MAX | 22500 | LOCK+HYDRO FRIENDS FUND XLVII | KENTUCKY RIVER | Conventional Permit |
| P- | 14184 | ALAMO | 20000 | LOCK+HYDRO FRIENDS FUND XXXVIII | ARKANSAS RIVER | Conventional Permit |
| P- | 14179 | BIG PIG | 25000 | LOCK+HYDRO FRIENDS FUND XLIV | ARKANSAS RIVER | Conventional Permit |
| P- | 14180 | DAVID D. TERRY LOCK & DAM | 20000 | LOCK+HYDRO FRIENDS FUND XLV | ARKANSAS RIVER | Conventional Permit |
| P- | 14525 | FELSENTHAL LOCK AND DAM | 5000 | FFP PROJECT 131, LLC | QUACHITA RIVER | Conventional Permit |
| P- | 14472 | RIVER MOUNTAIN ADVANCED PUMPED STOR | 600 (MW) | CONTROL TECHNOLOGY, INC. | ARKANSAS RIVER | Pumped Storage Permit |

# Challenges to Growth

| | |
|---|---|
| **Long development lead times** | • Permitting and licensing can take over 5 years, followed by construction.<br>• Incentives generally extended on short-term basis.<br>• Numerous stakeholder involvement can add to time and cost<br>• Hard to attract investment |
| **Large up-front capital investment required** | • In addition to licensing costs, study costs, projects can require significant up front capital. (New pumped storage projects - $1-2 billion).<br>• Projects economic over long-term, but have high immediate start-up costs. |
| **Uncertainty re: support, incentives, and regulatory policy** | • Financial community concerned that incentives for hydro may not be renewed before project comes online.<br>• Affects both utilities and small developers abilities to pursue projects (conventional and new). |

## Integrated Licensing Process and Section 241 of the Energy Policy Act of 2005




*Section 241 of the Energy Policy Act of 2005 in pink.

# Applicable Federal and State Laws

- Clean Water Act (delegated state 401 water quality certificate)
- Endangered Species Act
- Federal Power Act
- Magnuson-Stevens Fishery Conservation & Management Act
- Marine Mammal Protection Act
- Coastal Zone Management Act
- National Historic Preservation Act (state NEPA laws)
- Migratory Bird Treaty Act
- National Environmental Policy Act
- State water right
- State fish and wildlife laws
- State removal/fill permit
- State lease
- State shoreline permit
- State coastal zone management plan

# Federal Legislative Success for Hydro

**Hydro bills signed into law**

On August 9, 2013, President Obama signed two bills into law promoting regulatory improvements and hydropower project development.

These bills had overwhelming bipartisan support as well as agreement with the environmental community.

# Hydropower Regulatory Efficiency Act

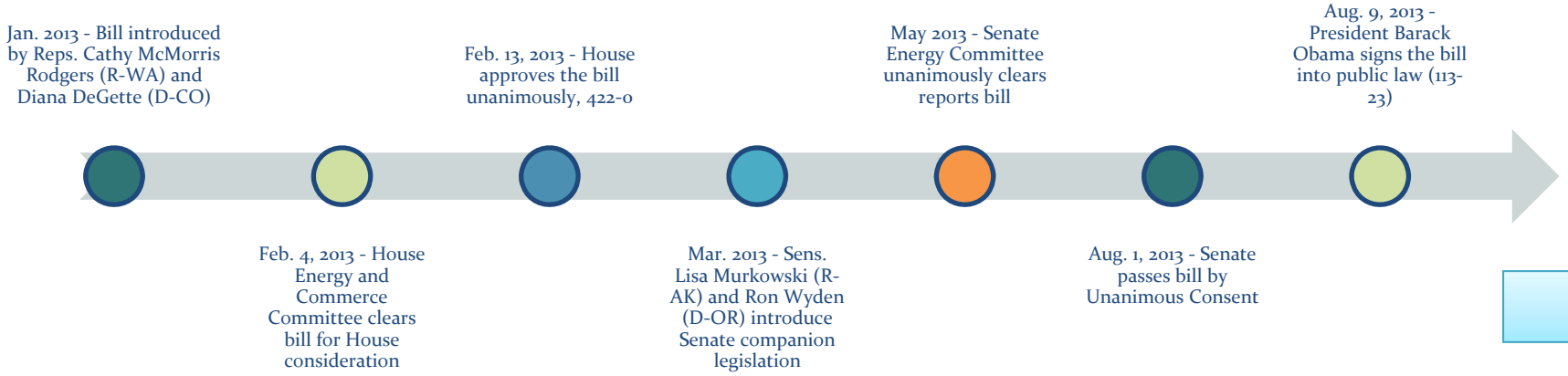
**Non-powered Dams and Pumped Storage**: Directs the Federal Energy Regulatory Commission (FERC) to explore a potential two-year licensing process for hydropower development at existing non-powered dams and closed-loop pumped storage projects.

**Small Hydro**: Increases the FERC small hydro exemption from 5 to 10 MW.

**Conduit Hydro:** Removes conduit projects 5 MW and under from FERC jurisdiction while preserving public review and increases the FERC conduit exemption to 40 MW for all projects.

**Preliminary Permits:** Authorizes FERC to grant developers preliminary permit extensions to allow continued site investigation and license preparation work for projects that are proceeding in good faith and with reasonable diligence.

**Studies**: Directs the Department of Energy to study pumped storage project opportunities to support integration of intermittent renewable resource development and provide grid reliability benefits, as well as a study of hydropower potential from existing conduits.

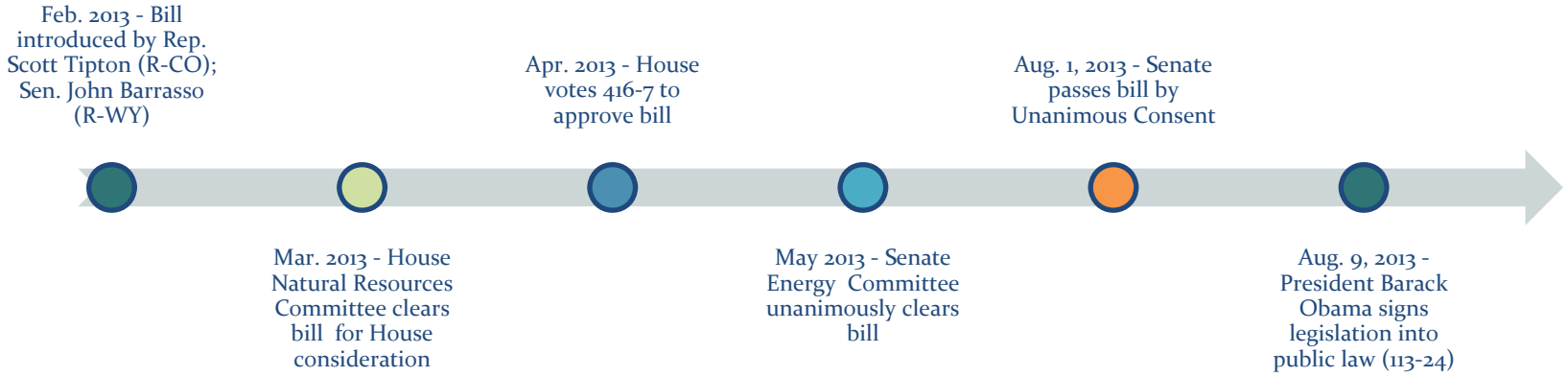


# Bureau of Reclamation Small Conduit Hydropower Development and Rural Jobs Act

The law authorizes small conduit power project (5 MW and under) on Reclamation-owned infrastructure, while providing irrigation districts and water users associations the first right to develop the projects.

The law also reinforces the water supply priority for Reclamation facilities used for hydropower development.

Additionally, it directs Reclamation to use its National Environmental Policy Act (NEPA) categorical exclusion (CE) process for small conduit applications and grandfathers existing FERC conduit applications on Bureau facilities.



# Status of Federal Incentives and Policies

## Tax Incentives and Bonds Programs

**Production Tax Credit** (PTC) – must have started construction by end of 2013 (hydro only gets ½ credit). Program now lapsed.

**Investment Tax Credit** (ITC)/– must have started construction by end of 2013. Program now lapsed.

**Clean Renewable Energy Bonds** (CREBS) – program oversubscribed, no additional allocations.

**Section 1603 Grants –** Monetized the PTC and ITC with a direct payment from the federal government. Program terminated end of 2013.

# Status of Federal Incentives and Policies

## Policies and Programs

**Climate Policy –** None at the moment, though EPA currently working on carbon regulations for existing and new facilities. Hydro was included in President's 2013 Climate Action Plan.

**Clean/Renewable Energy Standards** – None, though several proposals have been made in Congress.

**Federal RE Procurement Standards** – some hydro eligible.

**Rural Energy for America Program** – Current Department of Agriculture program that has awarded over $8 million to conduit and irrigation power projects in 2011 and $300,000 in 2012

# What States are doing

Investigating ways to speed up state permit and other decision-making processes.

Better coordinating state wildlife and water quality staff participation in the federal licensing process.

Providing developers with state tax incentives or low-interest loan programs to assist projects.

Including hydropower in state renewable energy standards and other clean/renewable programs and initiatives.

# State-FERC MOU Case Studies

**Colorado** – Signed MOU to streamline and simplify the authorization of small scale hydro projects (mainly conduits).

**California** – Signed MOU on coordinating the pre-application activities for non-federal hydro project proposals.

**Oregon** and Washington – Signed MOUs to coordinate state review of hydro projects using emerging marine and hydrokinetic technologies.

**Other Actions:** Alaska, Maine, Massachusetts, Rhode Island, and Vermont all have all passed laws or have created administrative or legislative workgroups to examine ways to grow their hydro resources.

**Governors' Energy Offices are also taking the lead.**

# NHA Messages to Federal Policymakers

| | |
|---|---|
| Regulatory Improvements | • Provide for a more efficient regulatory process for hydropower licensing, both new and existing projects. |
| Incentives | • Provide continued tax policies that incentivize hydropower growth recognizing the specific needs of the industry due to the long lead time for project deployment. |
| Funding | • Support technology advancement and project deployment through continued robust appropriations in FY 2014 for the DOE Waterpower R&D program and the federal hydropower owners' budgets. |
| Clean Energy Programs | • Include hydropower in programs designed to spur clean electricity growth. |

# An Overview of Hydropower – Part Two

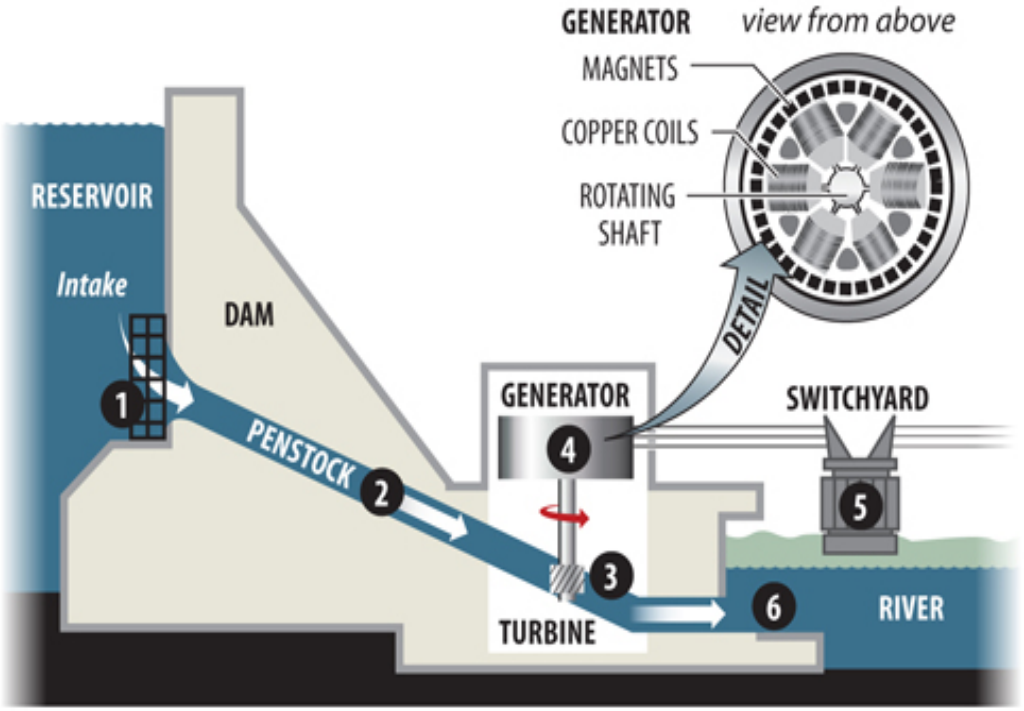
# Technologies

**Arkansas Alternative Energy Commission**
**March 20, 2014**

# Conventional Hydro

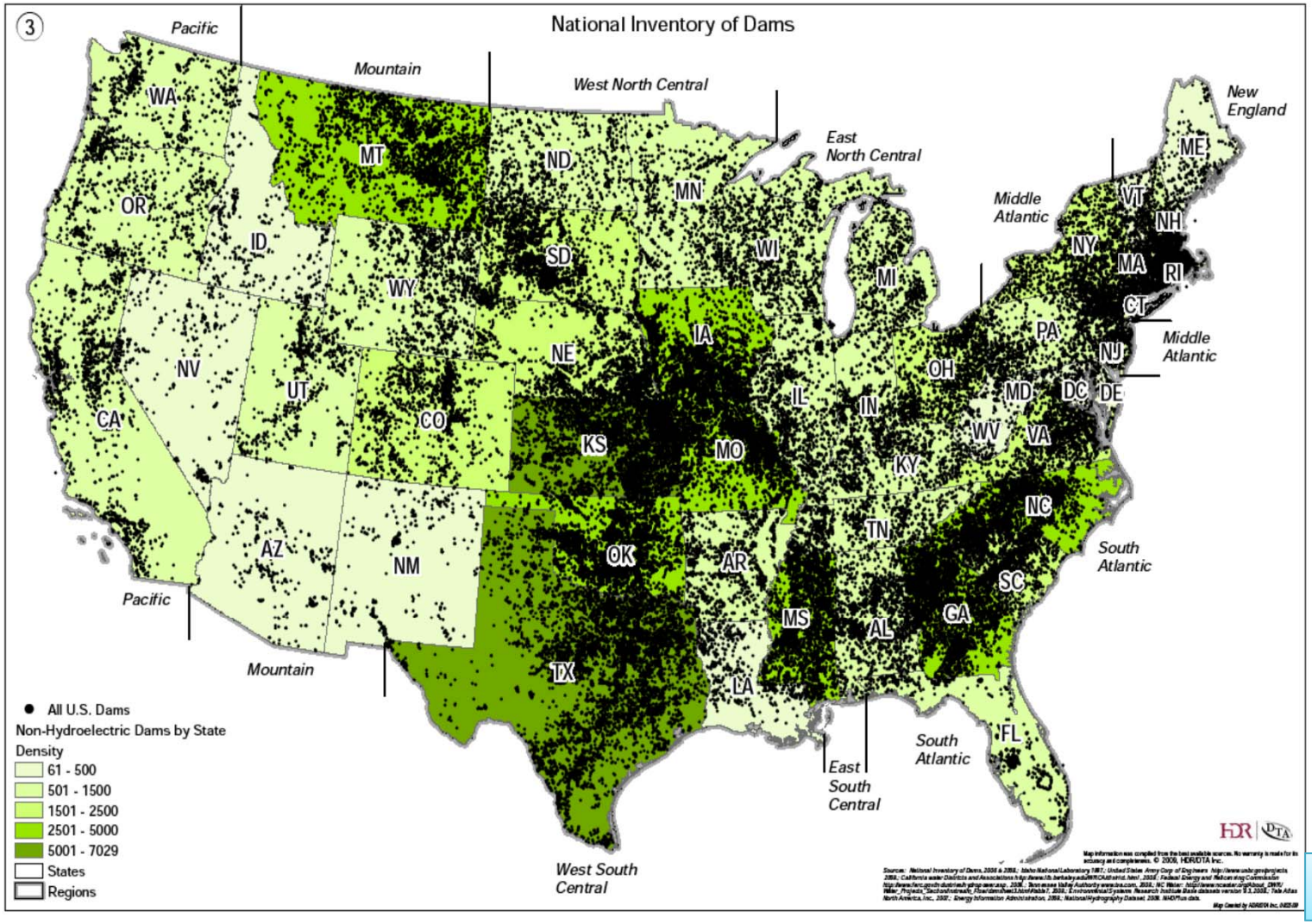
Modes of Operation
- Reservoir Storage
- Run of River

There are over 80,000 dams in the U.S., but only three percent of them currently generate electricity.




1. Water in a reservoir behind a hydropower dam flows through a large intake structure, which filters out debris.
2. The water travels through a large pipe, called a penstock.
3. The force of the water spins a turbine which is connected to a generator.
4. Inside the generator, the shaft spins coils of copper wire inside a ring of magnets. This creates an electric field, producing electricity.
5. Electricity is sent to a switchyard, where a transformer increases the voltage, allowing it to travel through the electric grid.
6. Water flows out of the turbine into the downstream river.

# 80,000 Dams Across the U.S

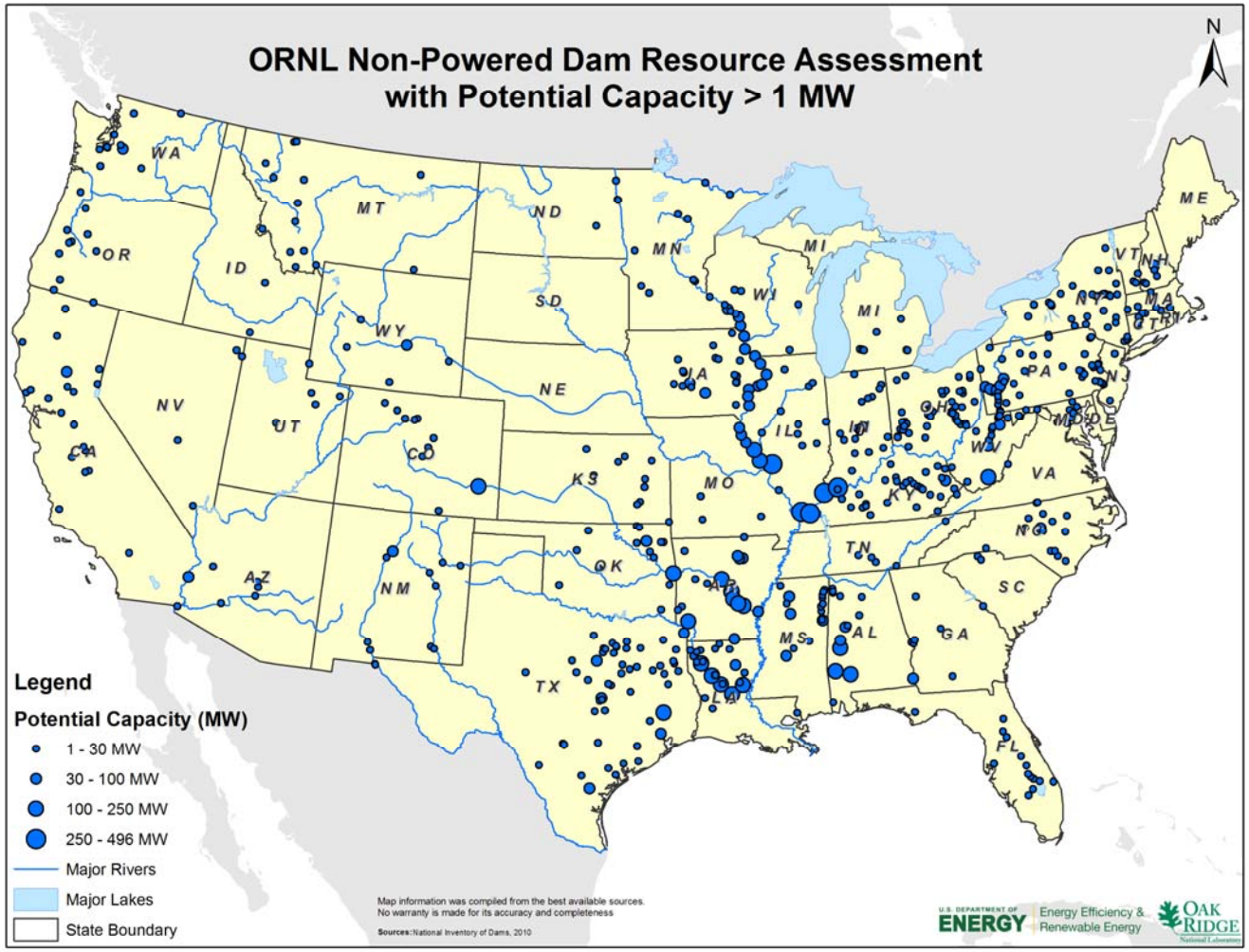



*Source: USACE, ORNL*

# DOE/ORNL: 12 GW at over 54,000 sites

8 GW in top 100 sites

81 of top 100 sites are dams owned by the U.S. Army Corps of Engineers




*Source: ORNL*

## Table 4. Summary of NPD Assessment by State Totaling 12 GW of Potential (P.25)

| State | Potential Capacity (MW) | State | Potential Capacity (MW) | State | Potential Capacity (MW) |
|---|---|---|---|---|---|
| AL | 922 | ME | 19 | OH | 288 |
| AZ | 80 | MD | 48 | **OK** | **339** |
| **AR** | **1136** | MA | 67 | OR | 116 |
| CA | 195 | MI | 48 | PA | 679 |
| CO | 172 | MN | 186 | RI | 13 |
| CT | 68 | **MS** | **271** | SC | 38 |
| DE | 3 | **MO** | **489** | SD | 12 |
| FL | 173 | MT | 88 | **TN** | **40** |
| GA | 144 | NE | 7 | **TX** | **658** |
| ID | 12 | NV | 16 | UT | 40 |
| IL | 1269 | NH | 63 | VT | 17 |
| IN | 454 | NJ | 33 | VA | 50 |
| IA | 427 | NM | 103 | WA | 85 |
| KS | 92 | NY | 295 | WV | 210 |
| KY | 1253 | NC | 167 | WI | 245 |
| **LA** | **857** | ND | 31 | WY | 45 |

# Conventional Hydro Growth – Upgrades at Existing Facilities

The potential for new conventional hydro generation is not just about adding capacity at non-powered dams.

Existing hydro facilities are expanding through **upgrades and efficiency improvements.**

In fact, since EPAct 2005 and the inclusion of hydro in the production tax credit (PTC), almost **130 projects** have received PTC certification. These projects have seen, on average, close to a **10 percent gain in generation**.

# Conduit Power

Existing tunnels, canals, pipelines, aqueducts and other manmade structures that move water are fitted with electric generating equipment.

Conduit projects are often small hydro, and are able to extract power from water without the need for a large dam or reservoir.

**Natel Energy Project (www.natelenergy.com)**

# BuRec: Conduit Opportunities

| Region | Canal Sites | Potential Installed Capacity (kW) | Potential Annual Energy (kWh) |
|---|---|---|---|
| GP | 175 | 38,525 | 122,204,196 |
| LC | 28 | 5,239 | 29,283,867 |
| MP | 39 | 4,392 | 17,550,289 |
| PN | 74 | 22,755 | 85,385,703 |
| UC | 57 | 32,717 | 110,794,792 |
| **Total** | **373** | **103,628** | **365,218,846** |

Enough electricity for approximately 33,000 homes

**A Voith Hydro tidal current turbine. (www.voith.com)**

## Marine and Hydrokinetic Technologies

Industry made up of many different sectors: ocean wave, tidal, in-stream hydrokinetic.

Each of the different sectors have various technology applications.

Examples:

Ocean wave = attenuators, buoys, overtopping

Tidal = barrages, vertical axis turbines

# Pumped Storage Basics

Pumped storage projects move water between two reservoirs located at different elevations (i.e., an upper and lower reservoir) to store energy and generate electricity.

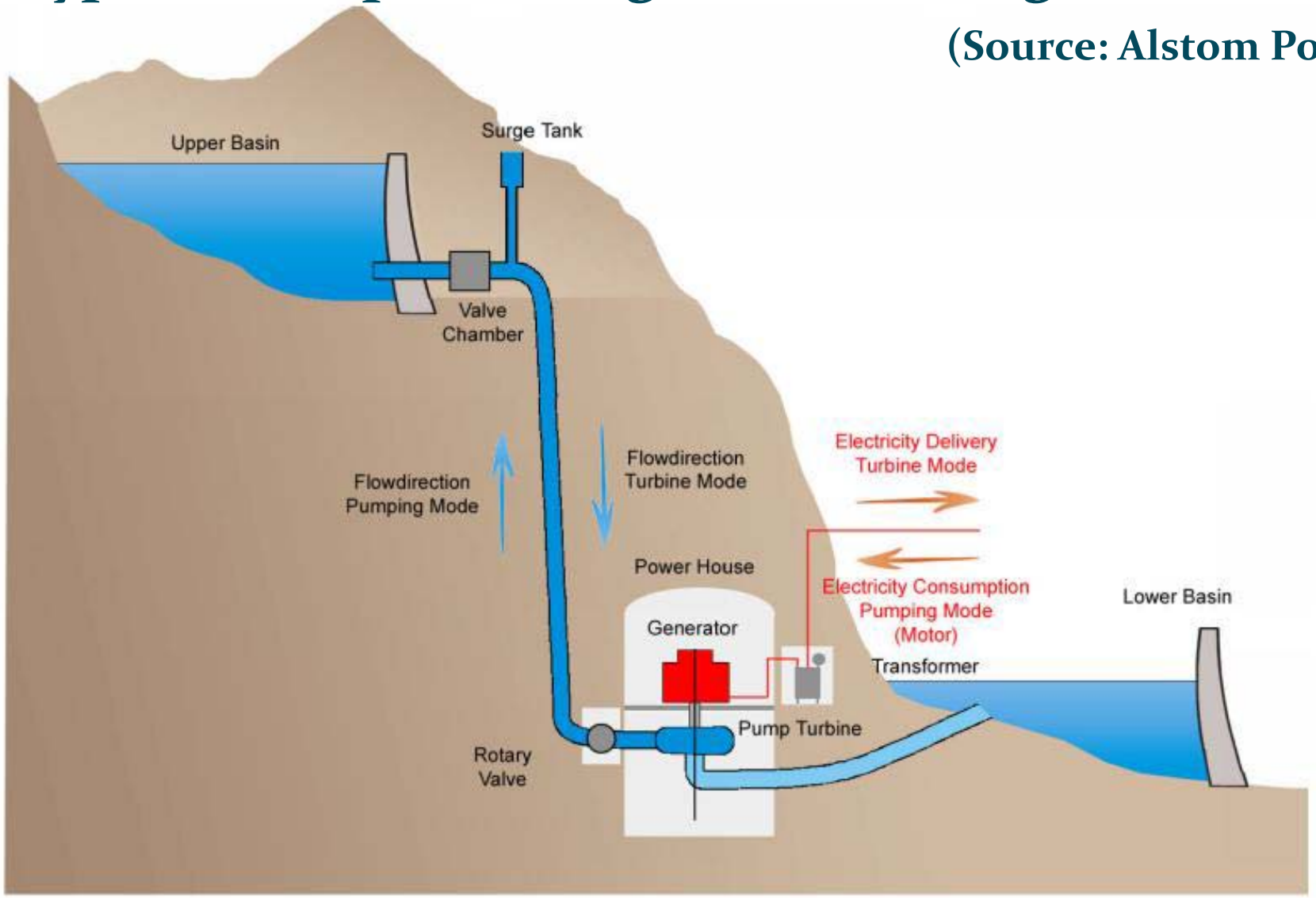
Generally, when electricity demand is low (e.g., at night), excess electric generation capacity is used to pump water from the lower reservoir to the upper reservoir.

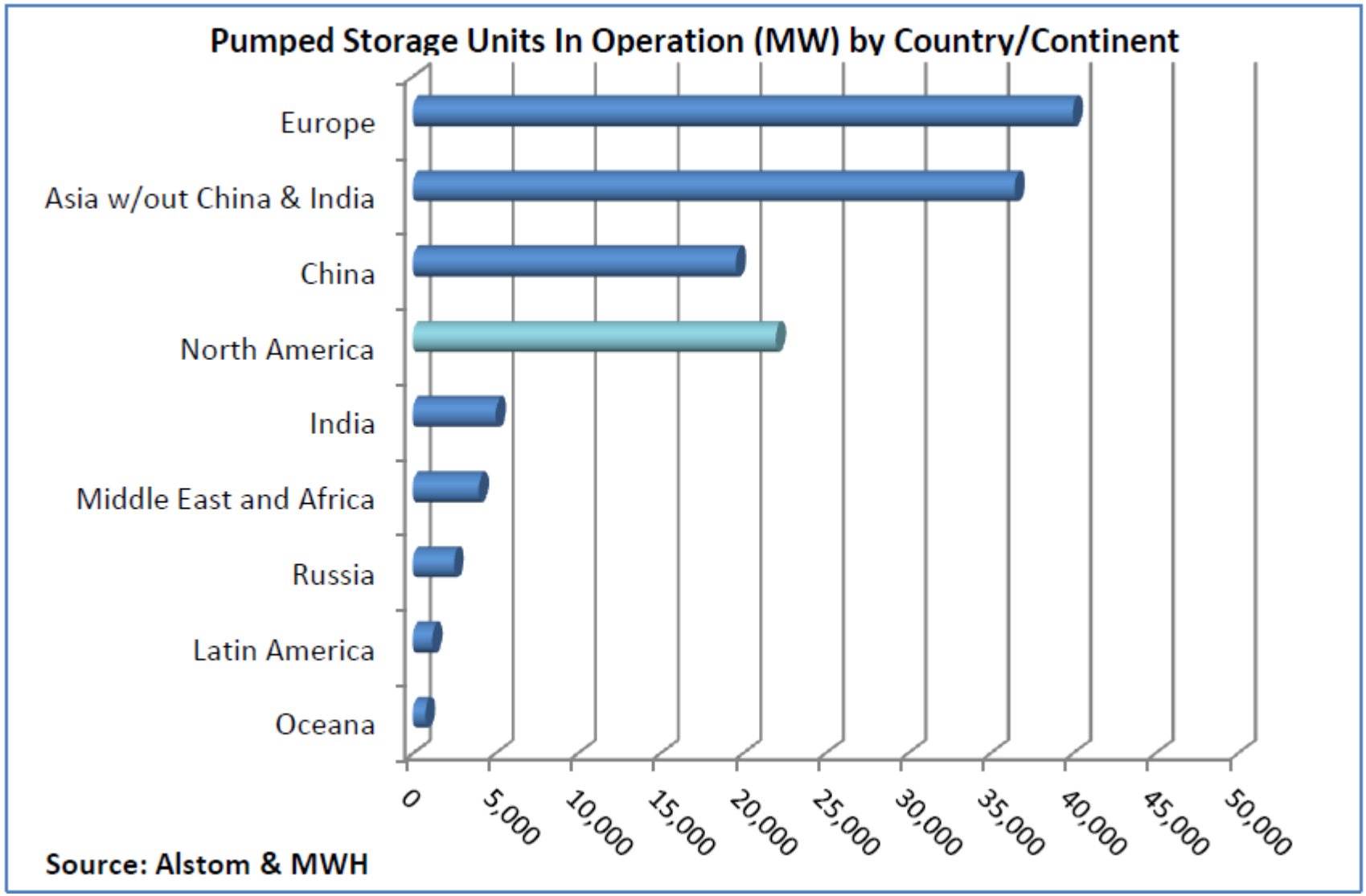
When electricity demand is high, the stored water is released from the upper reservoir to the lower reservoir through a turbine to generate electricity.

Pumped storage projects are also capable of providing a range of ancillary services to support the integration of renewable resources and the reliable and efficient functioning of the electric grid.

# Typical Pumped Storage Plant Arrangement

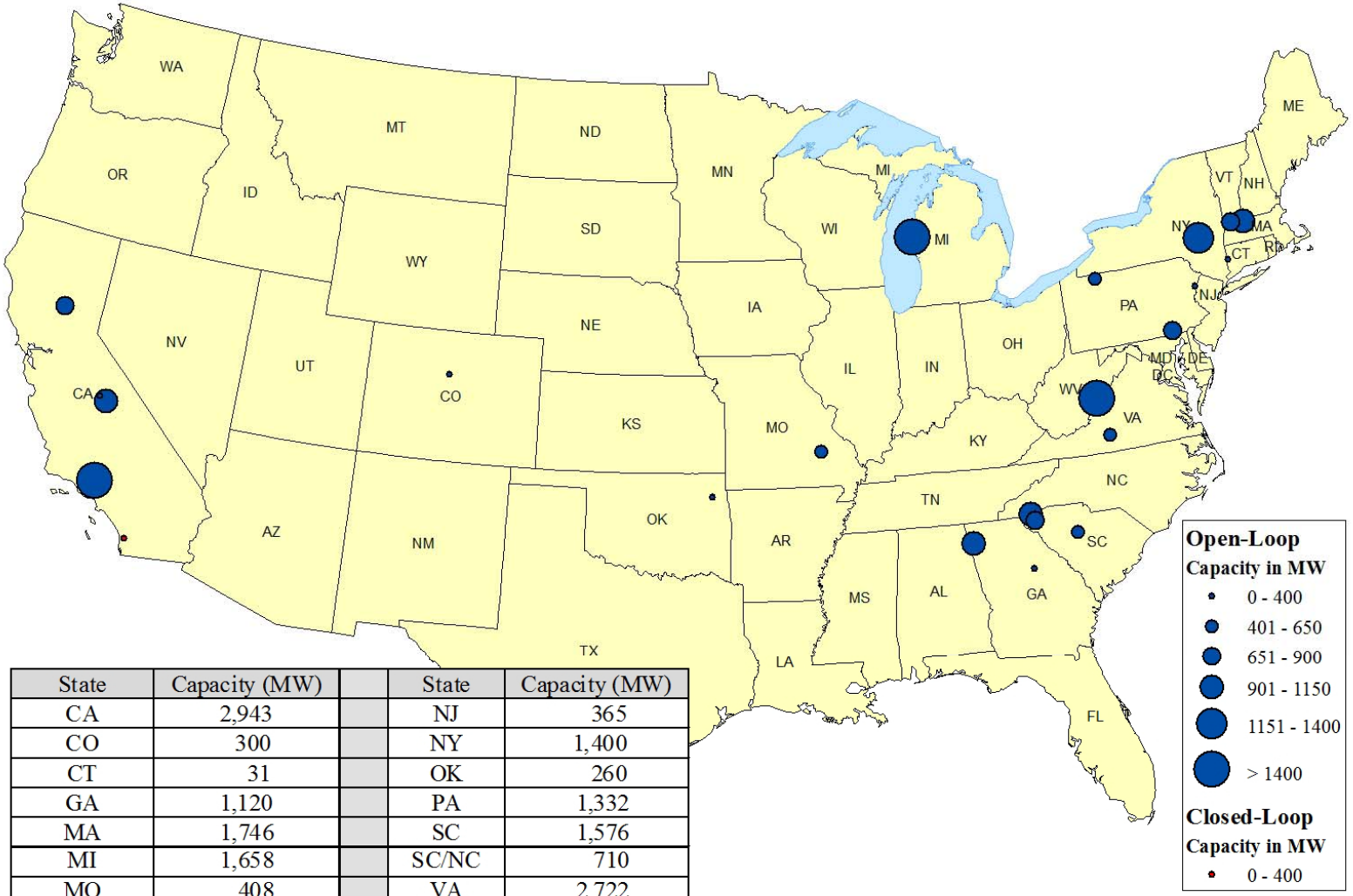
**(Source: Alstom Power)**





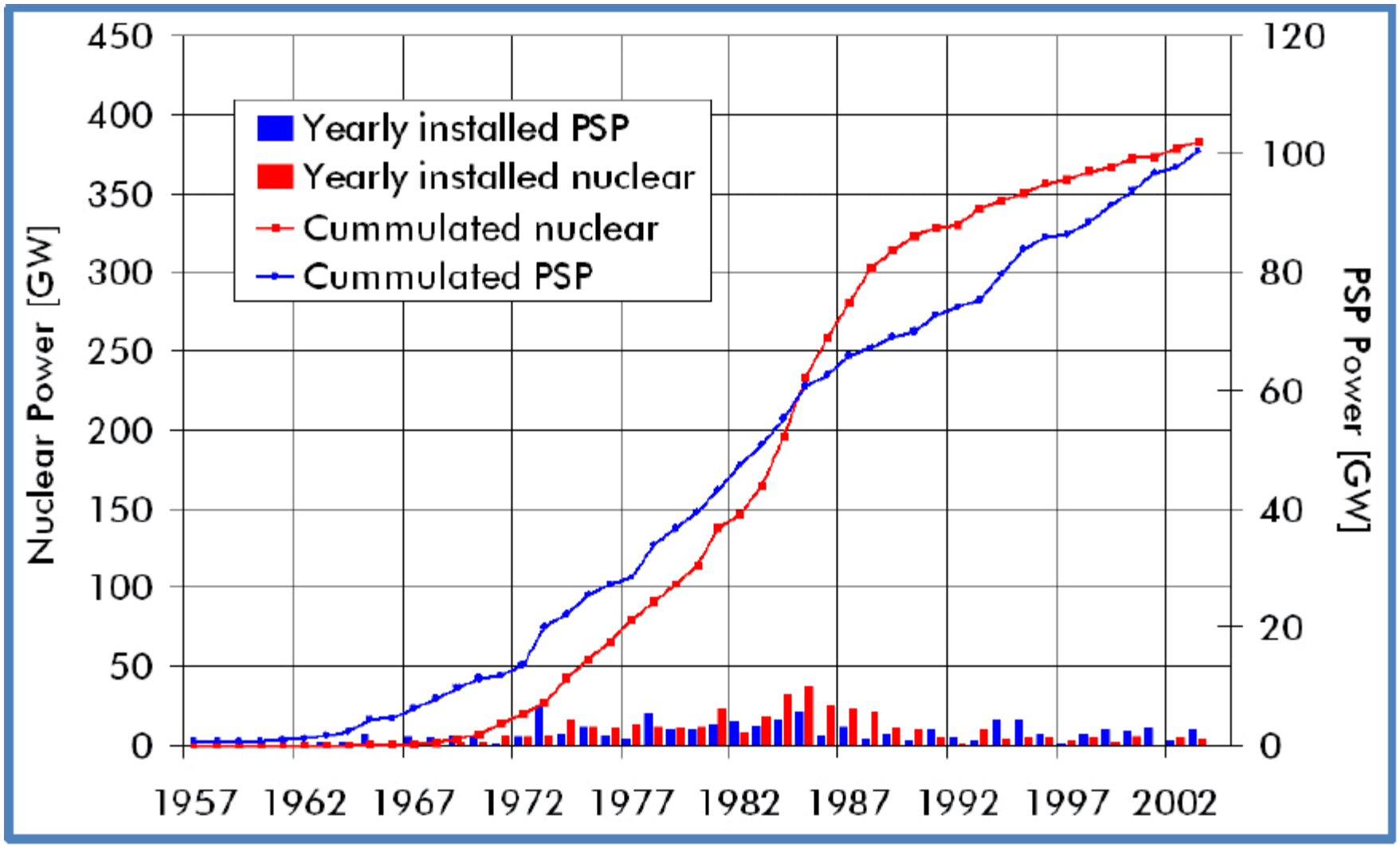

## International Distribution of Pumped Storage by Country/Continent

# Licensed Pumped Storage Projects



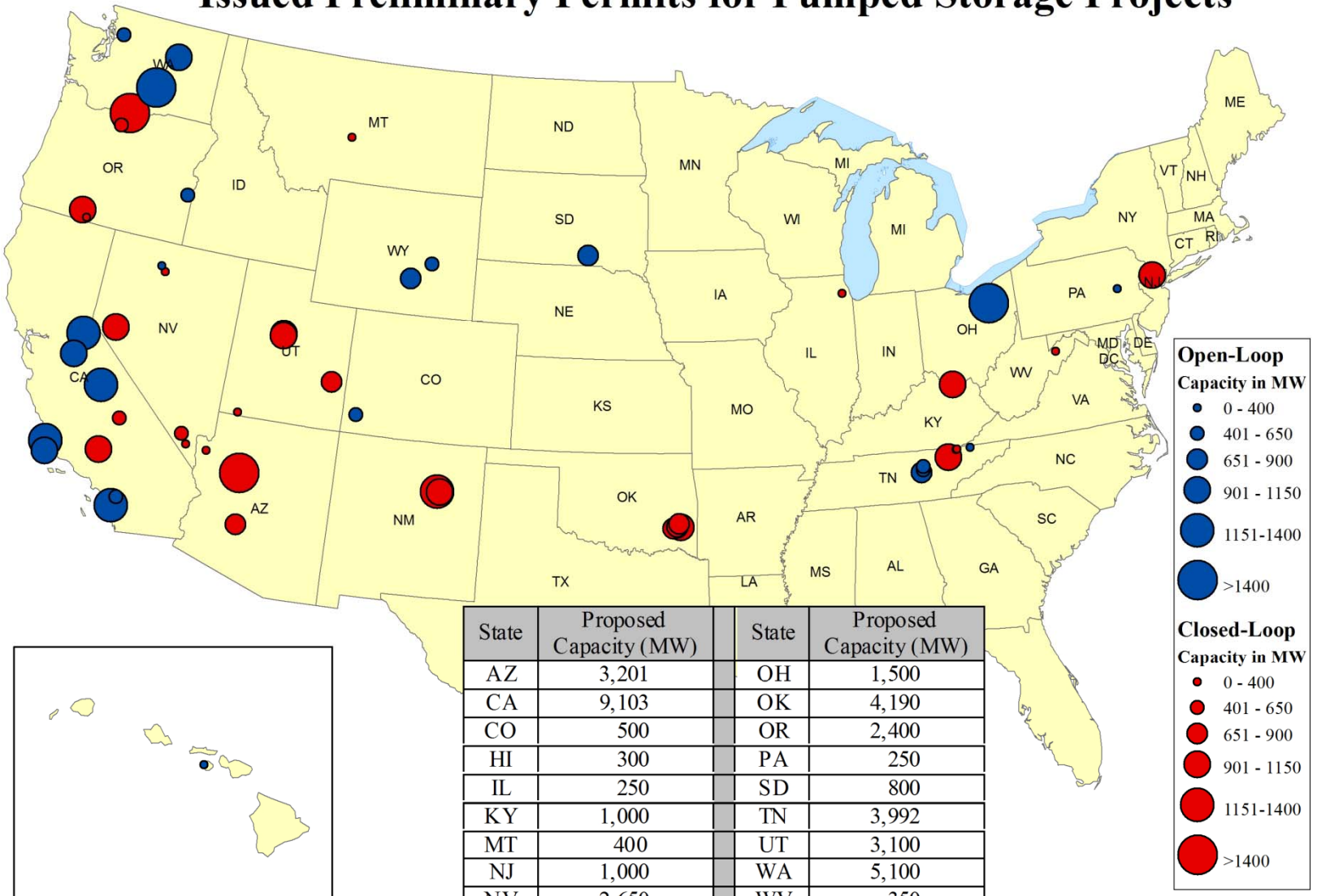

| State | Capacity (MW) | | State | Capacity (MW) |
|---|---|---|---|---|
| CA | 2,943 | | NJ | 365 |
| CO | 300 | | NY | 1,400 |
| CT | 31 | | OK | 260 |
| GA | 1,120 | | PA | 1,332 |
| MA | 1,746 | | SC | 1,576 |
| MI | 1,658 | | SC/NC | 710 |
| MO | 408 | | VA | 2,722 |
| **TOTAL CAPACITY** | | | | **16,571 MW** |

Source: FERC Staff, August 1, 2013




**Worldwide Installed Nuclear and Pumped Storage Project Development History (Source: Alstom Power and UDI database).**

# Issued Preliminary Permits for Pumped Storage Projects



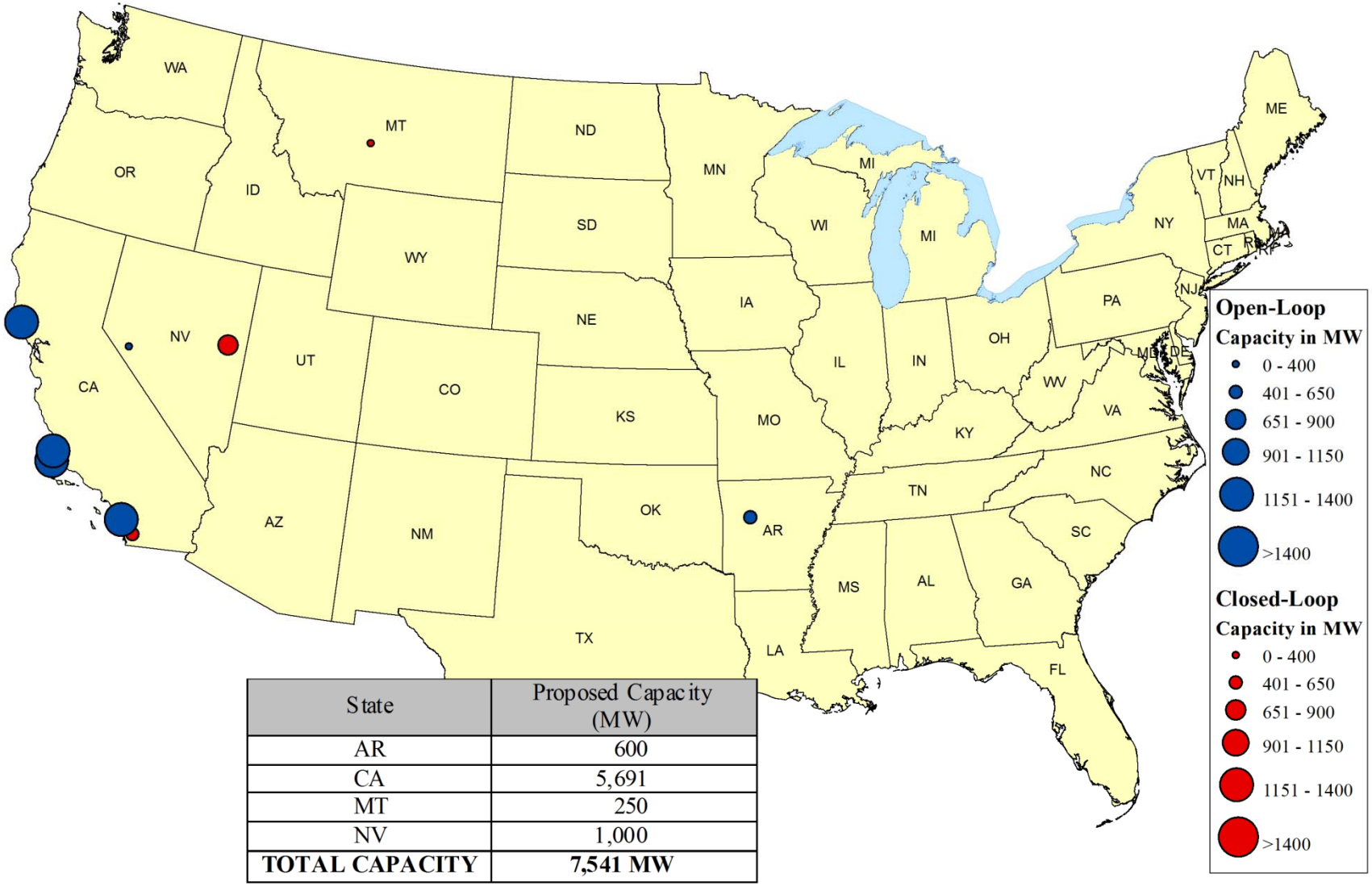



| State | Proposed Capacity (MW) | State | Proposed Capacity (MW) |
|---|---|---|---|
| AZ | 3,201 | OH | 1,500 |
| CA | 9,103 | OK | 4,190 |
| CO | 500 | OR | 2,400 |
| HI | 300 | PA | 250 |
| IL | 250 | SD | 800 |
| KY | 1,000 | TN | 3,992 |
| MT | 400 | UT | 3,100 |
| NJ | 1,000 | WA | 5,100 |
| NV | 2,650 | WV | 350 |
| NM | 2,254 | WY | 1,200 |
| **TOTAL CAPACITY** | | | **43,540 MW** |

Note: Preliminary determination of open- vs. closed-loop classification based on preliminary permit application.

Source: FERC Staff, January 1, 2014

# Pending Preliminary Permits for Pumped Storage Projects

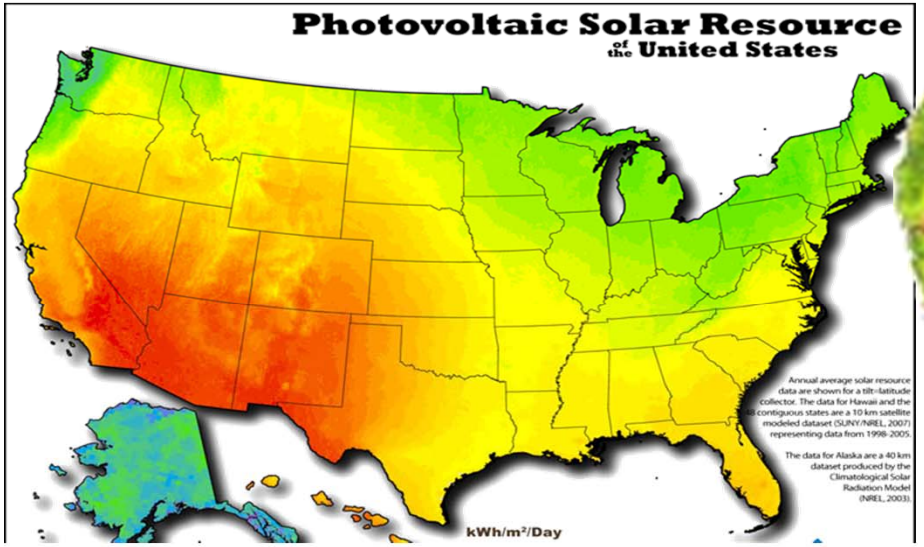



| State | Proposed Capacity (MW) |
|---|---|
| AR | 600 |
| CA | 5,691 |
| MT | 250 |
| NV | 1,000 |
| **TOTAL CAPACITY** | **7,541 MW** |

Note: Preliminary determination of open- vs. closed-loop classification based on preliminary permit application.

Source: FERC Staff, January 1, 2014

## Question: Why pumped storage and why now?





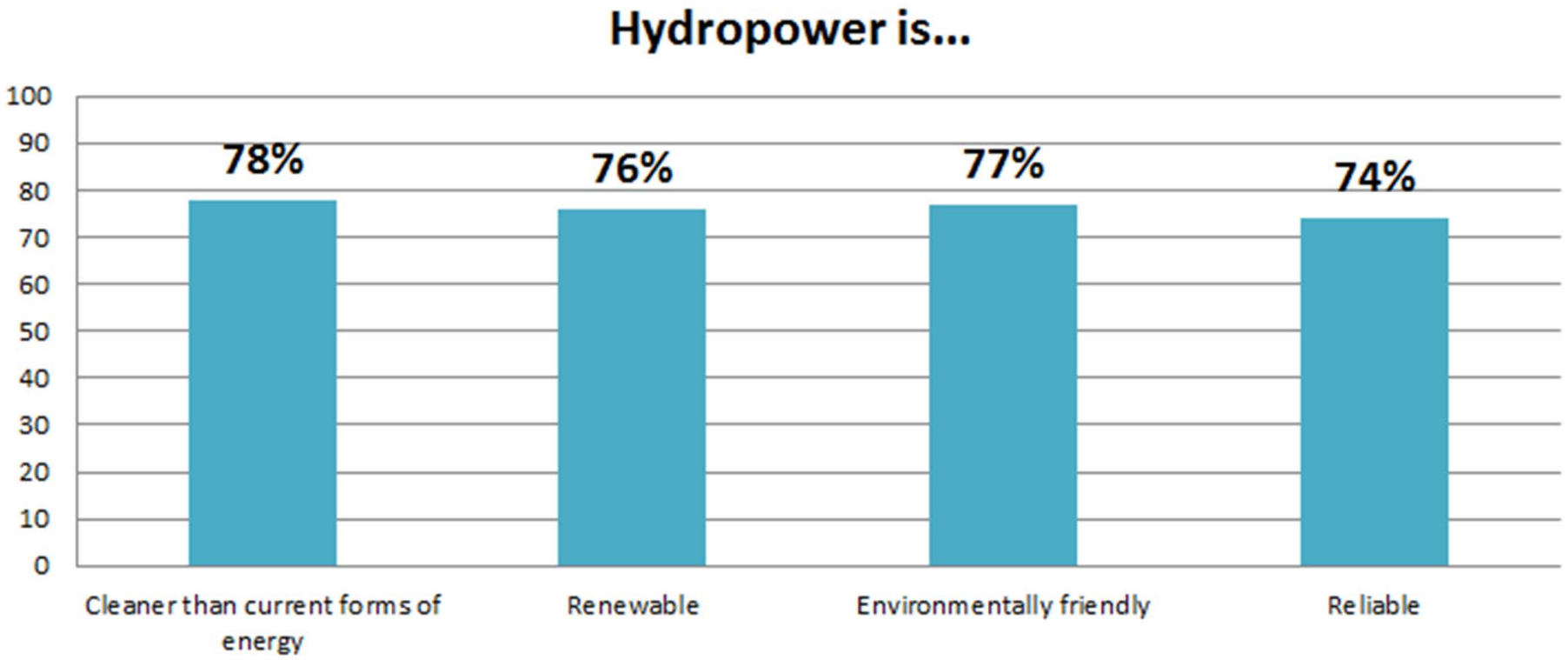
## Answer: Integration of variable renewable resource potential and grid reliability

# An Overview of Hydropower – Part Three

# Telling Hydro's Story

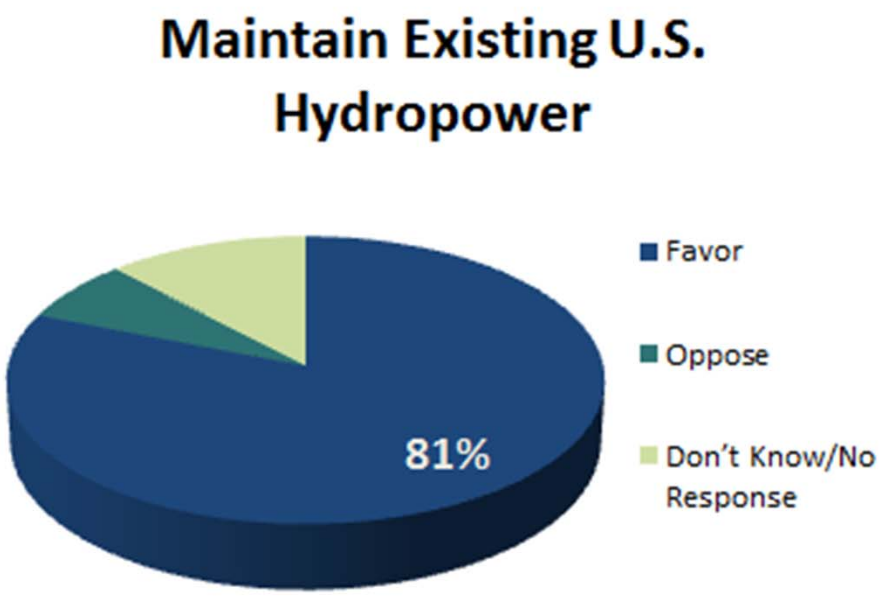
**Arkansas Alternative Energy Commission**
**March 20, 2014**

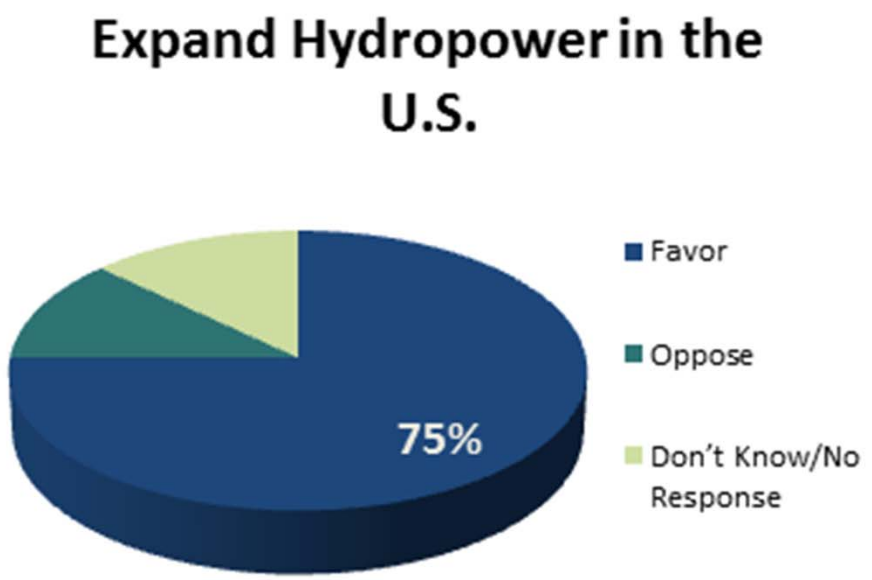
# Public Support for Hydropower




The January 2013 survey was conducted by Princeton Survey Research Associates International (PSRAI).

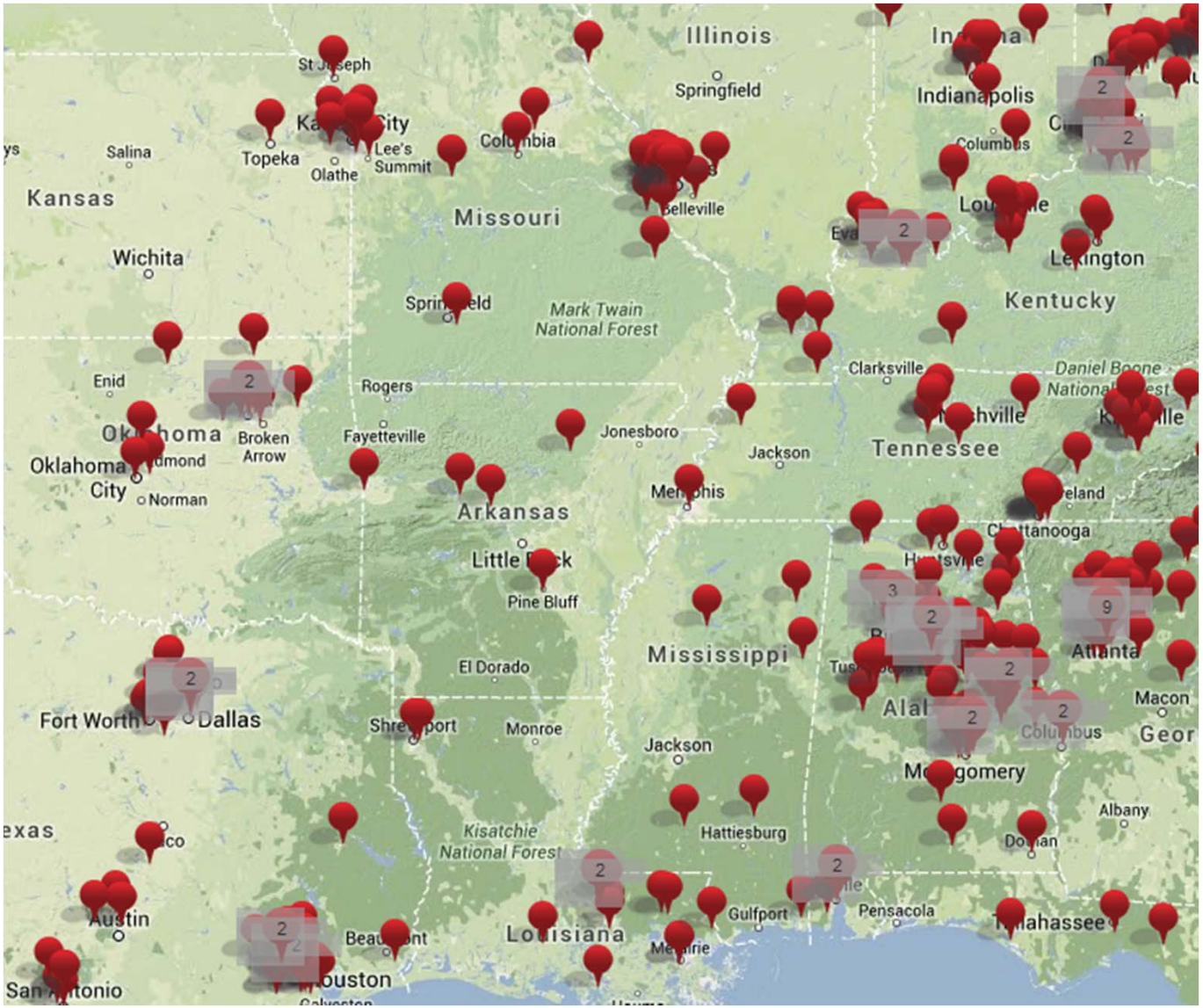
# Public Support for Hydropower continued…



# U.S. Hydropower Supply Chain Snapshot

# Arkansas and Regional Snapshot



# Hydro is:

The largest generator of renewable electricity in the U.S. and globally.

The largest employer in the renewable electricity sector – up to 300,000 employees.

Providing local economic opportunities to communities across the United States. Low power prices and cleaner air in regions with more hydro. New job creation for those communities where hydro is being built.

# Final Thoughts for the Commission:

Break the myth that hydropower is tapped out.

Hydro – existing and new – provides grid reliability benefits and helps integrate intermittent renewable energy resources.

Hydro is a long–lived asset and over its life helps to lower costs to ratepayers and consumers.

Include hydropower in state policies to promote renewables – all too often hydro is the "forgotten" renewable.

## Contact

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# Questions?