National Hydropower Association

Hydropower –A New Look at Opportunities for America's First Renewable Energy Resource

Environmental and Energy Study Institute Briefing

April 24, 2019

Presentation Overview

- About NHA
- Current state of hydropower
- Growth potential
- Benefits – climate, environmental, grid reliability
- Federal and state policy, market and valuation challenges
- Q&A

VISION + MISSION+ VALUES

NHA'S VISION

Hydropower, in all of its forms, is valued as America's first, and most flexible renewable energy resource to achieve a sustainable, clean, and secure electric system in North America.

NHA'S MISSION

Champion waterpower as America's premier carbon-free renewable energy resource. Inform public policy to protect, enhance and expand waterpower within the U.S. electric system. Share technological advancement and encourage operational excellence among our members.

NHA'S VALUES

NHA will achieve its goals through a culture of:

- Organizational Excellence:
  - A competent, responsive and committed staff
  - Strong, forward thinking leadership
  - Excellent stewardship of resources
  - Inclusiveness of its member companies
- Collaboration:
  - Water users and other stakeholders
  - The environmental community
  - The regulatory community
  - National and regional industry associations

Current state of hydropower

NHA
National Hydropower Association

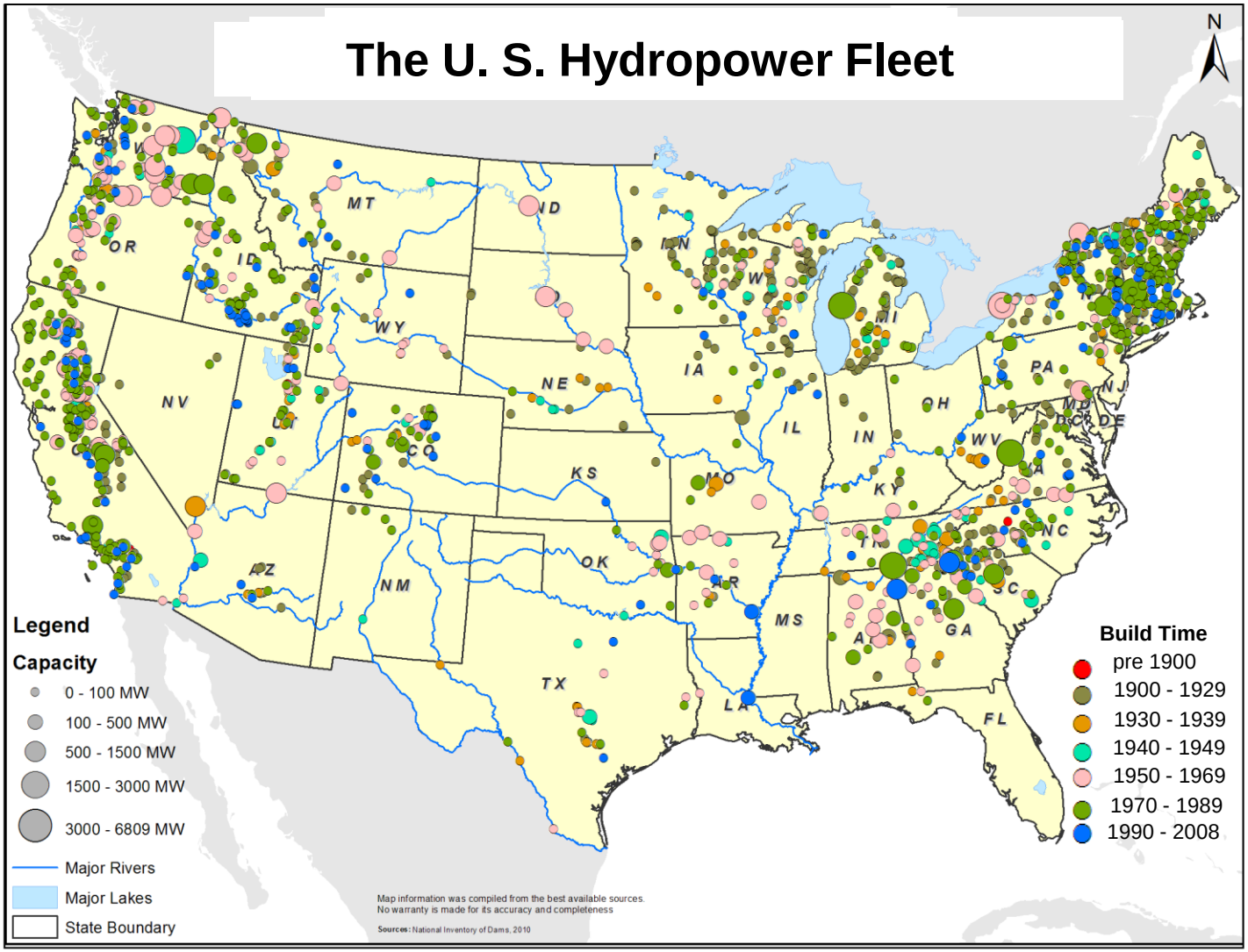
2018 Hydropower Renewable Generation

In 2018, hydropower made up **7 percent** of total U.S. electricity generation and 39.5 **percent** of renewable electricity generation.

While hydro generation declined slightly by 3.3% (from 300 TWh in 2017 to 292 TWh in 2018) due to a drier year in the west, it still remains the largest source of renewable generation.

Approximately **102 GW** of existing capacity, includes 23 GW of pumped storage – 95 percent of U.S. energy storage

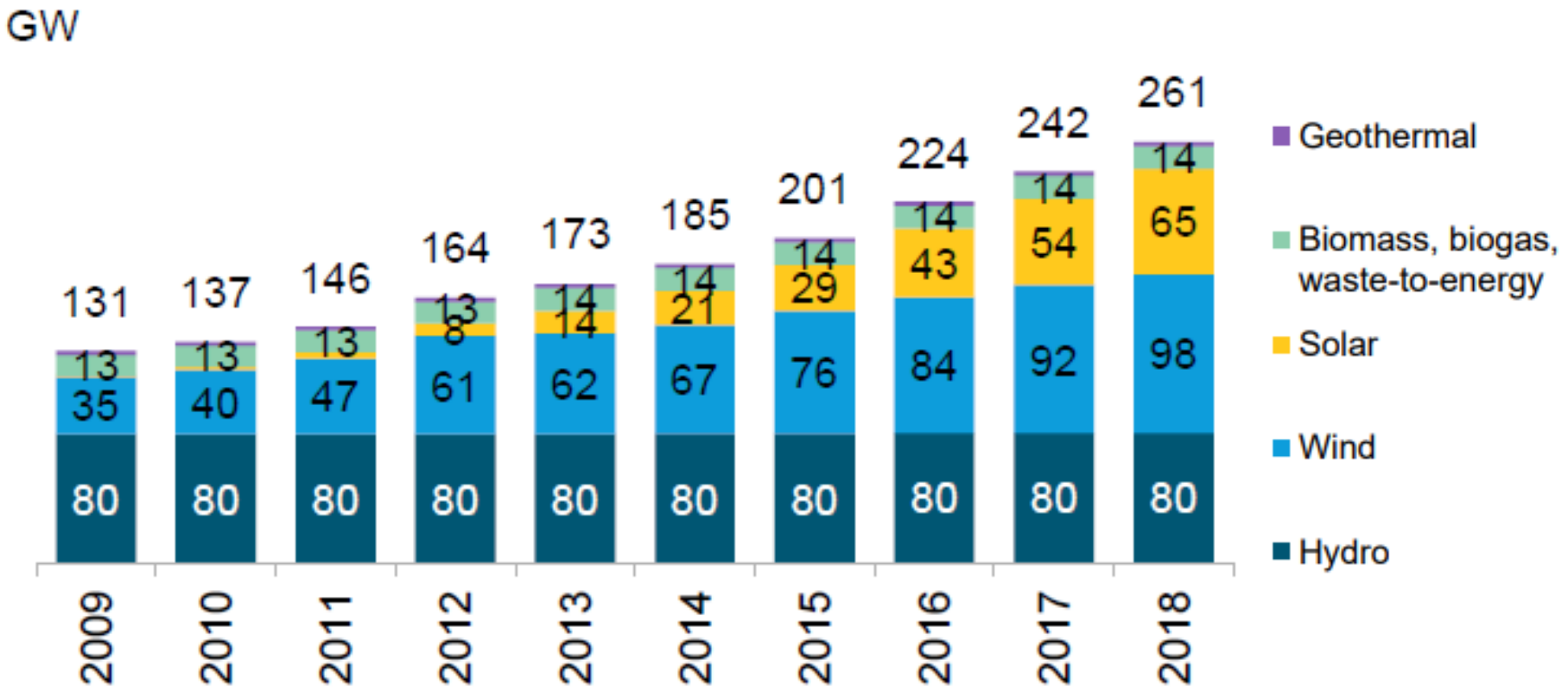
Source: 2019 Sustainable Energy in America Factbook, BloombergNEF, Business Council for Sustainable Energy



Sources: ORNL, NID

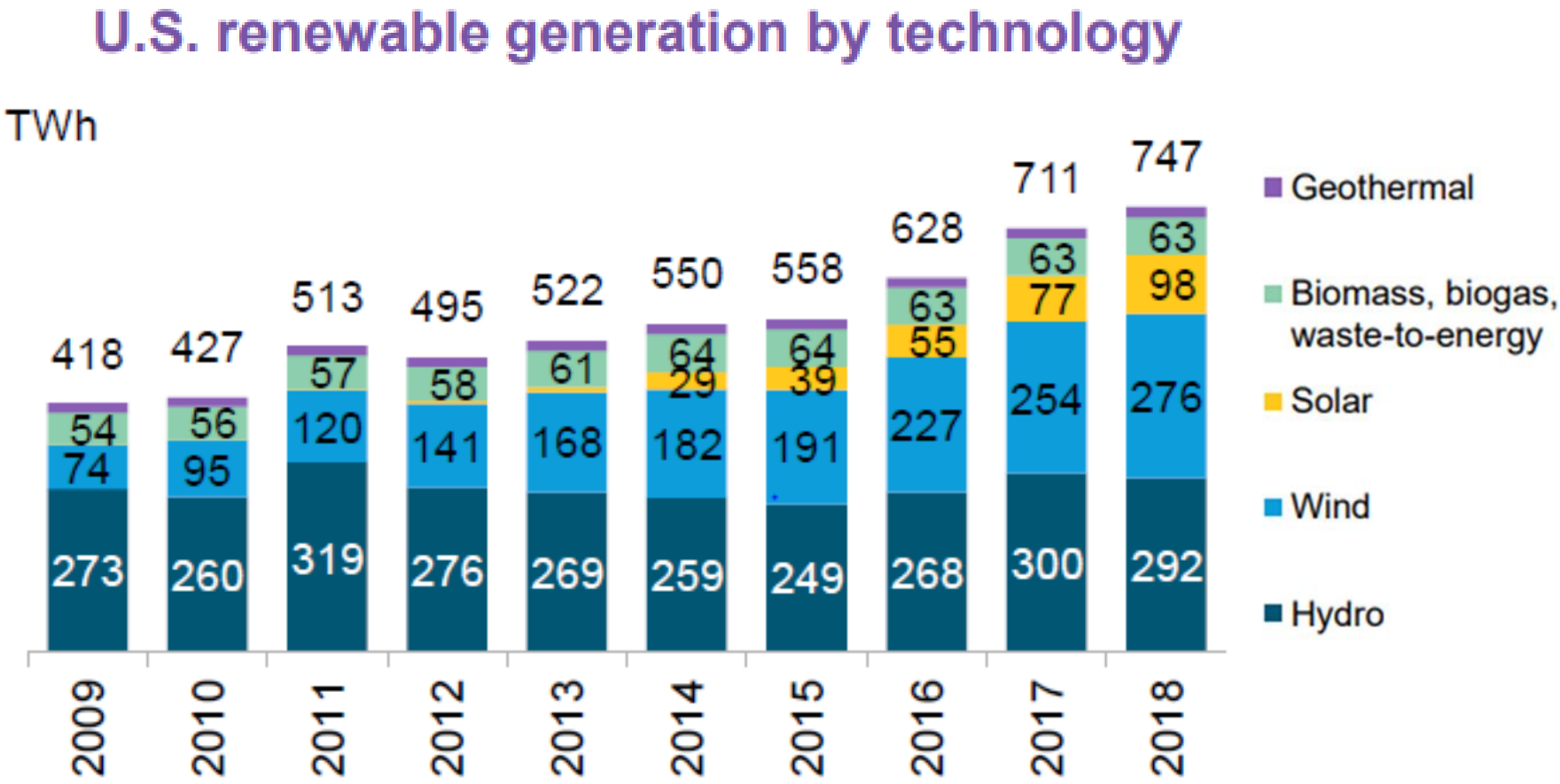
Wind surpassed hydro in capacity in 2016.

U.S. cumulative renewable capacity



2019 Sustainable Energy Factbook. Bloomberg Finance LP 2018. Developed in partnership with The Business Council for Sustainable Energy. P.22

Hydro still top generator of RE power.



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RE comparisons

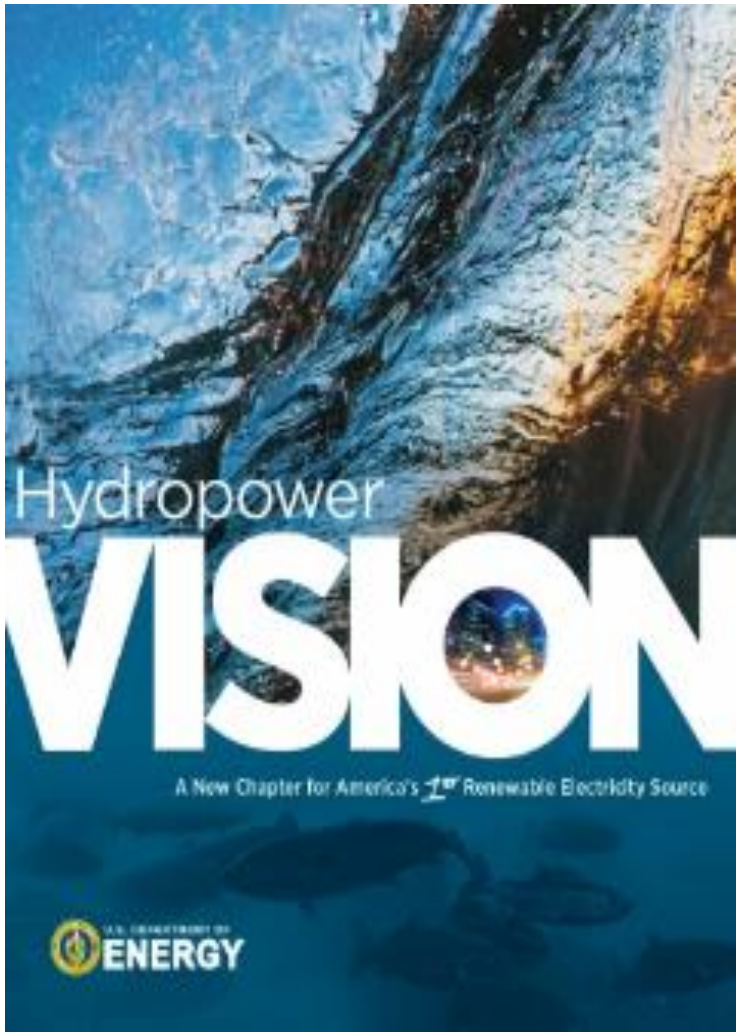
Total renewable capacity has nearly doubled since 2008, reaching 239GW in 2017 (excluding pumped hydro).

Nearly all the growth has come from **wind and solar, which together jumped 471%** during that period while **other technologies held flat**, in part due to weaker tax policy support. Wind and solar have also benefited from state-level renewable portfolio standards (RPS) and rapidly declining system costs.

2018 Sustainable Energy Factbook. Bloomberg Finance LP 2018. Developed in partnership with The Business Council for Sustainable Energy. P.25

Growth Potential

DOE Hydropower Vision



With NHA as the lead partner, DOE issued a first-of-its kind report in 2016 of hydro's contributions to the nation's energy portfolio as well as its future growth.

Hits the reset button on hydropower.

The Report finds upwards of **26 GW by 2030** and almost **50 GW by 2050**.

https://energy.gov/eere/water/articles/hydropower-vision-new-chapter-america-s-1st-renewable-electricity-source

Hydro is not tapped out.

AS A NATION, WE HAVE A CLEAR CHOICE TO MAKE ABOUT OUR CLEAN ENERGY FUTURE:

STAND STILL OR UNLOCK HYDROPOWER'S POTENTIAL

1.75 GW

New Stream-reach development

6.3 GW

Upgrades at existing hydropower projects

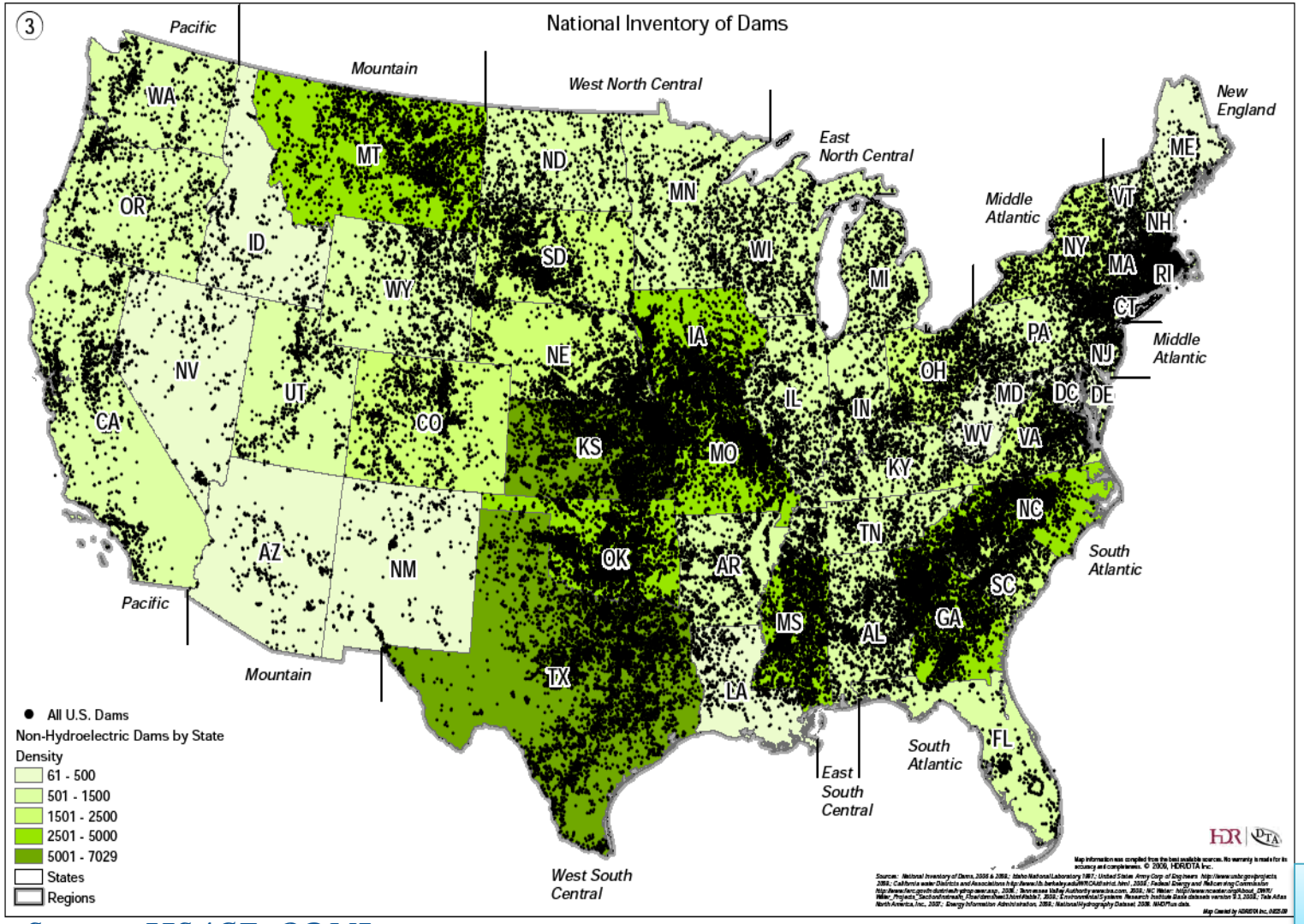
4.8 GW

Developing on existing non-powered dams

35.5 GW

New pumped storage projects, along with upgrades at existing facilities.

80,000+ U.S. Dams – only 3% powered



Source: USACE, ORNL

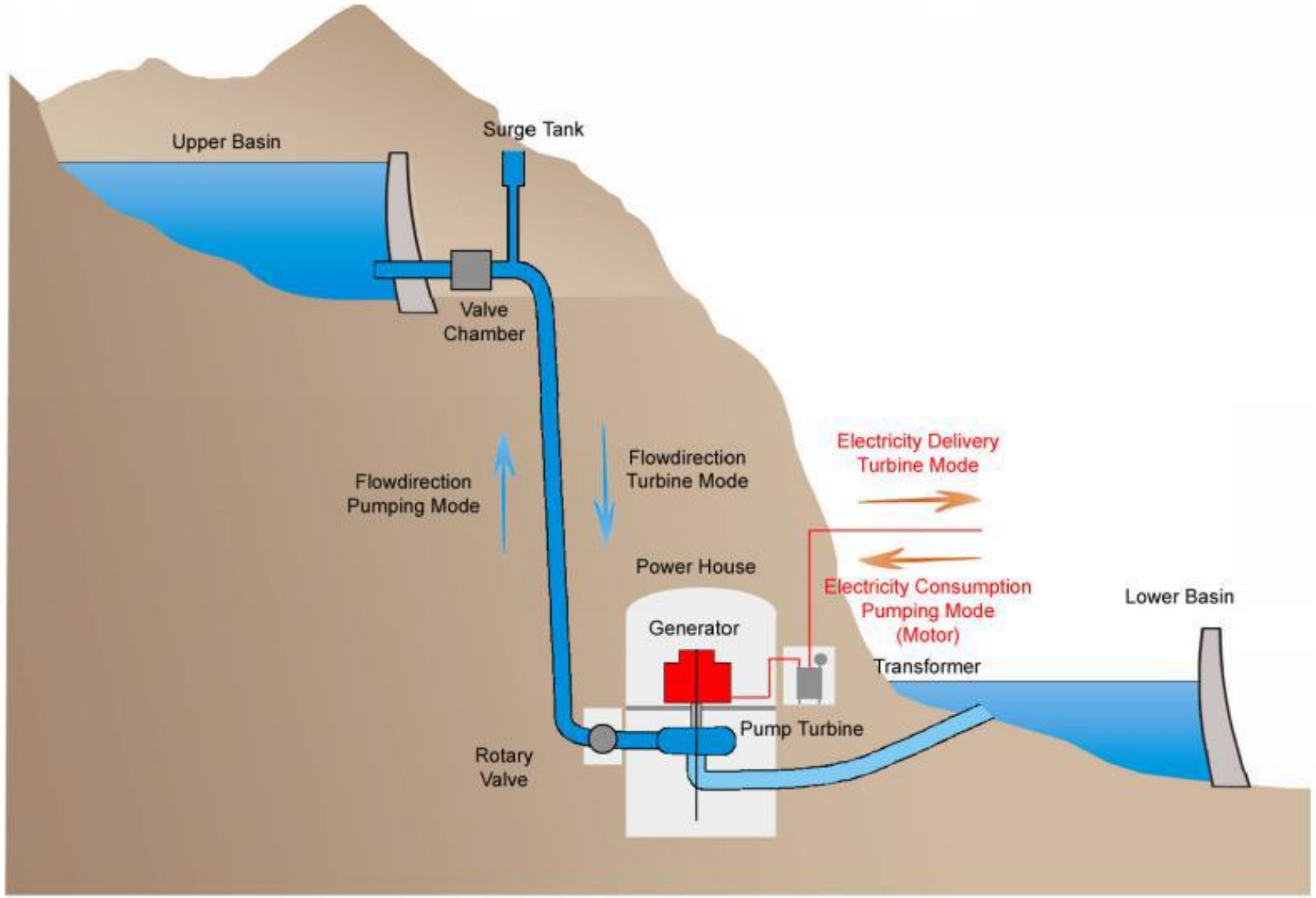
Conventional Hydro Growth – Upgrades at Existing Facilities

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

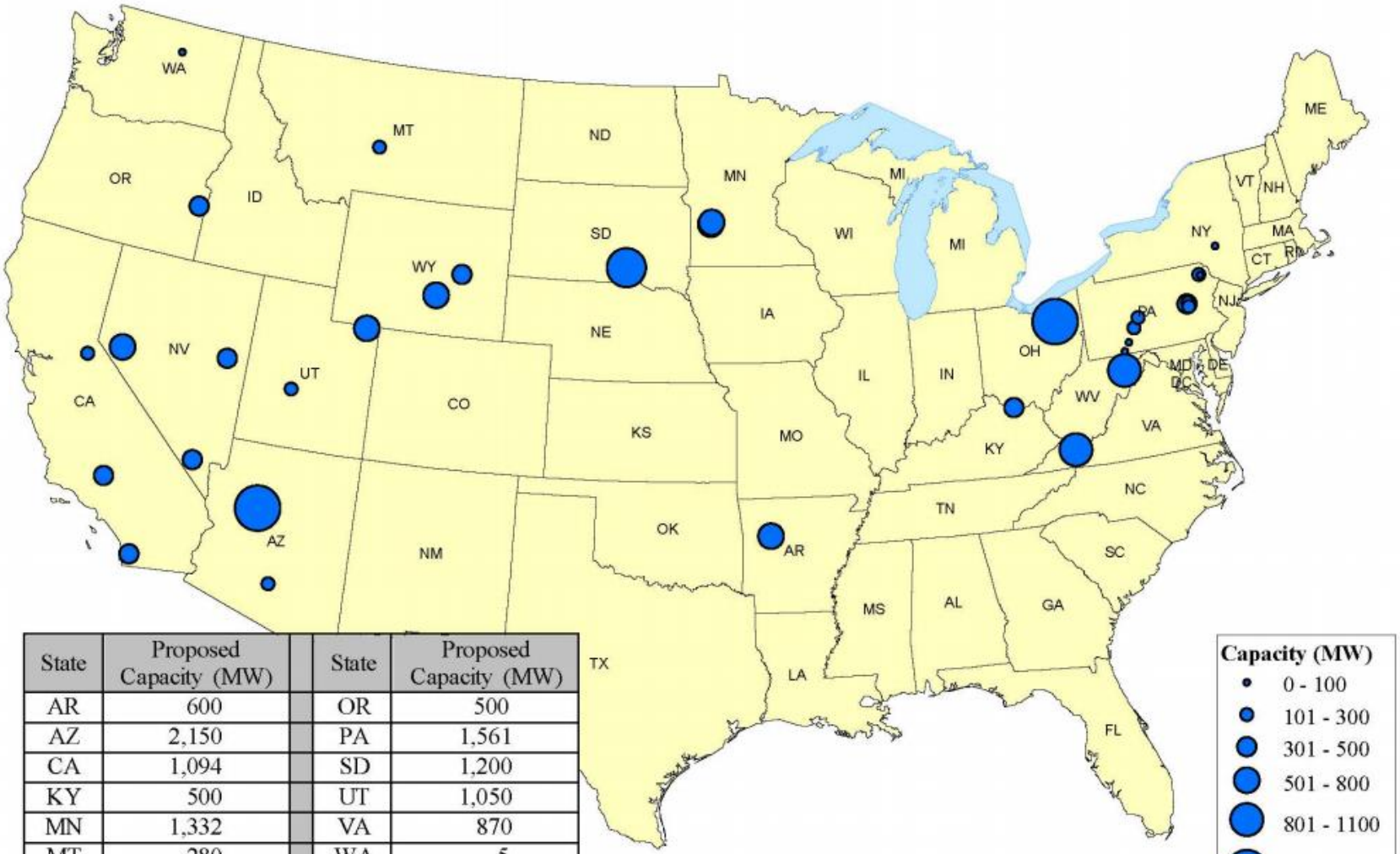
Existing hydro facilities are expanding through upgrades and efficiency improvements.

In fact, since EPAct 2005 and the inclusion of hydro in the production tax credit (PTC) and later the investment tax credit (ITC), **150+ projects** have seen, on average, **about a 9 percent gain in generation.** (FERC data)

Typical Pumped Storage Plant Arrangement (Source: GE)



Issued Preliminary Permits for Pumped Storage Projects



State	Proposed Capacity (MW)	State	Proposed Capacity (MW)
AR	600	OR	500
AZ	2,150	PA	1,561
CA	1,094	SD	1,200
KY	500	UT	1,050
MN	1,332	VA	870
MT	280	WA	5
NV	1,550	WV	1,000
NY	49	WY	1,100
OH	1,500		
TOTAL CAPACITY			**16,341 MW**

Source: FERC Staff, February 1, 2019

Marine and Hydrokinetic Resource Potentials

RESOURCE ASSESSMENT	RESOURCE POTENTIAL[1]
Waves[2]	*Theoretical:* 1,594–2,640 TWh/year[3] *Technical:* 898–1,229 TWh/year
Tidal streams	*Theoretical:* 445 TWh/year *Technical:* 222–334 TWh/year
Ocean currents	*Theoretical:* 200 TWh/year *Technical:* 45–163 TWh/year
River currents	*Theoretical:* 1,381 TWh/year *Technical:* 120 TWh/year

From DOE Waterpower Technologies Office
https://www.energy.gov/eere/water/marine-and-hydrokinetic-resource-assessment-and-characterization

Benefits: climate, environmental, and grid reliability

Climate, environmental benefits

GROWING HYDROPOWER BY 50 GW BY 2050 MEANS...

SIGNIFICANT ECONOMIC AND SOCIAL BENEFITS:

GHG — **$209 billion savings** from avoided global damages from GHG emissions

AIR POLLUTION — **$58 billion savings** in avoided mortality, morbidity, and economic damages from emissions reduction (SO_2, NOx, and PM2.5)

WATER — **30 trillion gallons** of avoided water use

JOBS — **195,000 jobs supported**

A HEALTHIER AMERICA - REDUCTIONS IN:

Fewer cases of lower respiratory symptoms (age 7-14)	217,000
Fewer cases of upper respiratory symptoms (asthmatics age 9-11)	323,000
Fewer minor restricted-activity days (age 18-65)	8,203,000
Fewer lost work days (age 18-65)	1,363,000
Fewer cases of asthma exacerbation (age 6-18)	757,000
Fewer cases of acute respiratory symptoms (ages 18-65)	4,965,000

DOE 2016 Hydropower Vision Report

Grid reliability and resiliency benefits

Hydropower is a premiere flexible generating resource.

It provides the following reliability components including:

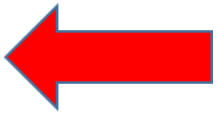
energy,
peak capacity,
voltage support,
regulation,
spinning and non-spinning reserves,
storage,
black start capability, and
inertia.

For more details see House E&C Committee testimony of Steve Wright, General Manager of Chelan County PUD. October 2017

Figure 6. Generator Reliability Attribute Matrix

● = Exhibits Attribute
◐ = Partially Exhibits Attribute
○ = Does Not Exhibit Attribute

Resource Type	Essential Reliability Services (Frequency, Voltage, Ramp Capability)					Fuel Assurance		Flexibility			Other		
	Frequency Response (Inertia & Primary)	Voltage Control	Ramp: Regulation	Ramp: Contingency Reserve	Ramp: Load Following	Not Fuel Limited (> 72 hours at Eco. Max Output)	On-site Fuel Inventory	Cycle	Short Min. Run Time (< 2 hrs.)/ Multiple Starts Per Day	Startup/ Notification Time < 30 Minutes	Black Start Capable	No Environmental Restrictions (That Would Limit Run Hours)	Equivalent Availability Factor
Hydro	●	●	●	●	●	○	◐	●	●	●	●	◐	●
Natural Gas - Combustion Turbine	●	●	◐	●	◐	●	○	●	●	●	●	◐	◐
Oil -Steam	●	●	●	●	●	●	●	●	○	○	○	○	◐
Coal - Steam	●	●	●	●	●	●	●	◐	○	○	○	◐	◐
Natural Gas - Steam	●	●	●	●	●	●	○	●	○	○	●	◐	◐
Oil/ Diesel - Combustion Turbine	●	●	○	●	○	○	●	●	●	●	●	○	◐
Nuclear	◐	●	○	○	◐	●	●	○	○	○	○	◐	●
Battery/ Storage	◐	◐	●	●	○	○	○	●	●	●	◐	●	●
Demand Response	○	○	◐	◐	◐	◐	◐	●	●	◐	○	●	●
Solar	◐	◐	○	○	◐	○	○	●	●	●	○	●	●
Wind	◐	◐	○	○	◐	○	○	●	●	●	○	◐	●



Source: PJM 2017

Federal and state policy, market, and valuation challenges

Challenges to Hydro Growth

Long development lead times

- Permitting and licensing can take up to/longer than a decade, followed by construction.
- Incentives expired, or extended on short-term basis.

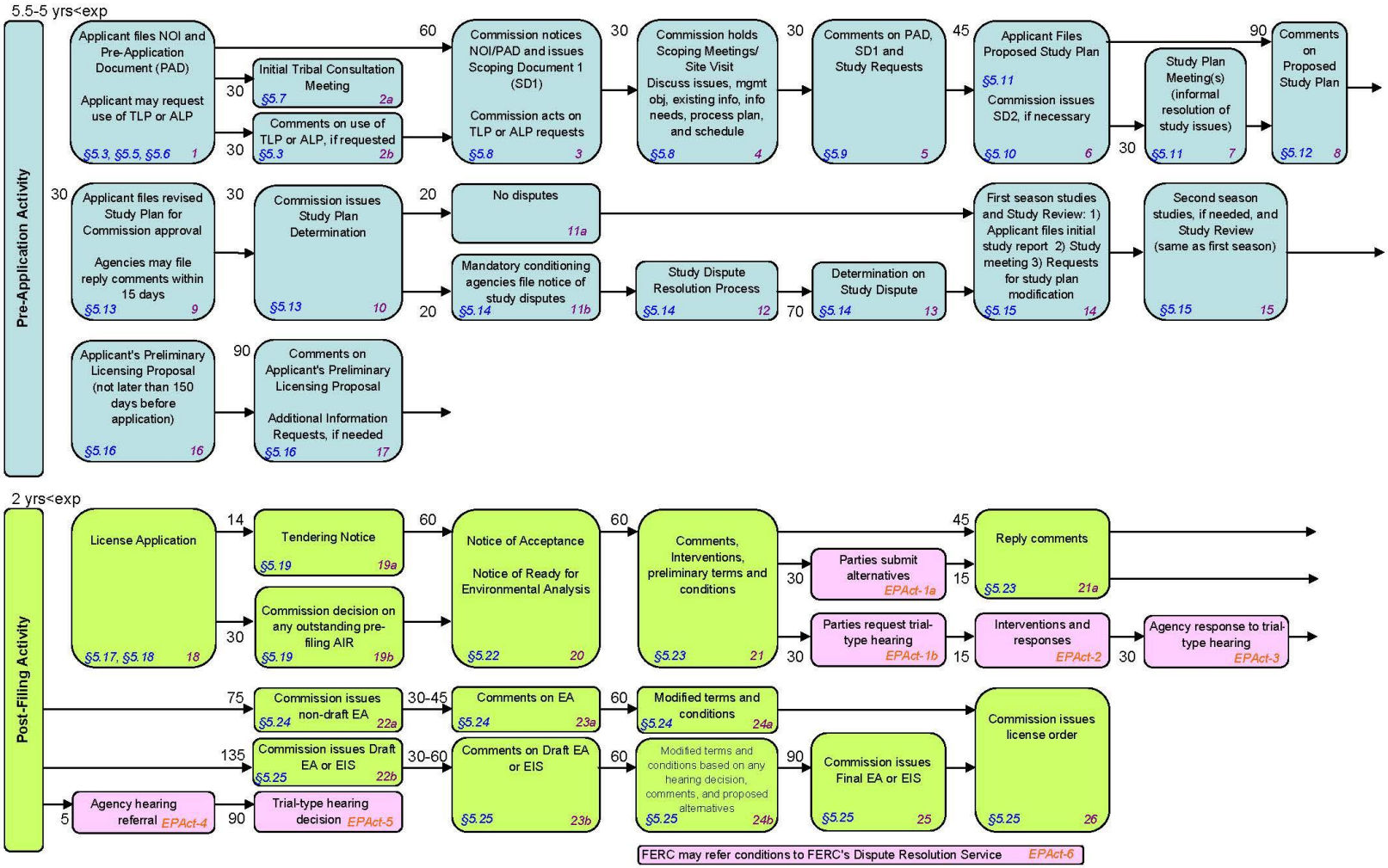
Large up-front capital investment required

- Beyond licensing, studies, PM&E costs, projects require significant capital. (new pumped storage - $1-2 billion).
- Projects economic over long term, but high upfront costs.

Uncertainty re: incentives, markets and regulatory policy

- Financial community concerned that incentives for hydro are not be renewed before project comes online.
- Market policies don't fully compensate hydro's services.
- Affects utilities and developers (large & small) alike.

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



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

Relicensing Pipeline

Over 300+ existing hydro projects will have licenses that expire over the next 10+ years.

Many of these projects are small.

Areas of concentration include New York, New England and Upper Midwest.

See a listing at FERC at: https://ferc.gov/industries/hydropower.asp

Additional Policy Challenges

Federal Example – Production & Investment Tax Credits (PTC and ITC)

- Current tax policy is picking winners and losers, driving investment away from hydro, pumped storage and marine energy.

- **Today, tax incentives (PTC/ITC) for hydropower and marine energy have lapsed,** while the credits for other renewables, industries with which hydro competes have enjoyed long-term extensions.

  This puts hydro at a severe competitive economic disadvantage in the marketplace, particularly for investors seeking clarity and certainty.

Also, there is no federal tax incentive for energy storage.

State Example – RPS Eligibility

- Current state RPSs do not value existing hydro commensurate with other renewables. This reflects original design intent and targets.
- Excluding Federal capacity, and assuming $5/REC in states w/o price data, a value gap for hydro of about **$1.5 billion per year exists** versus if hydro was supported similarly to wind and solar under State RPSs.
- The policy decision to exclude existing hydro may have made sense 25 years ago when there was significant existing hydro and minimal generation from other RE resources. But that has now changed. Yet, all of the now existing other RE generation continues to receive the financial benefit of RECs going forward, where existing hydro remains excluded.

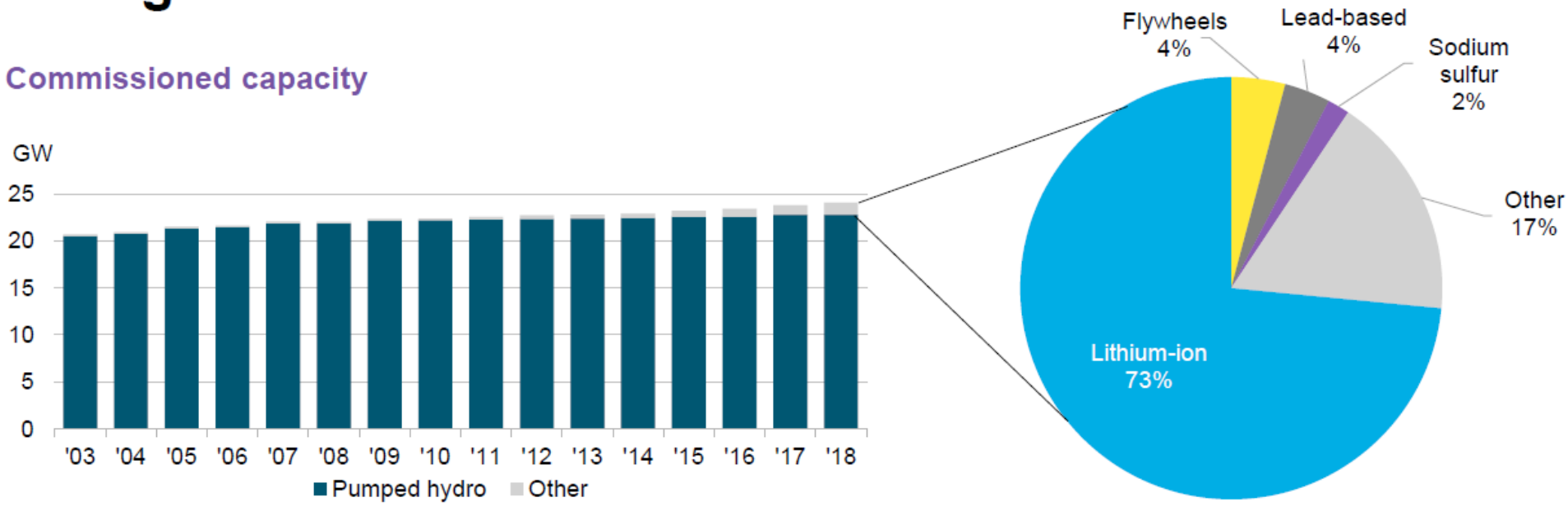
State Example – energy storage targets and treatment of pumped storage

- There is an inconsistent treatment of pumped storage in energy storage policy (deadlines that do not account for longer development timelines, project size restrictions, technology definitions).

- Example - the CA Public Utilities Commission established 1,325 MW of energy storage by 2020, but severely limited pumped storage eligibility.

- **"However, the sheer size of pumped storage projects would dwarf other smaller, emerging technologies; and as such, would inhibit the fulfillment of market transformation goals.** The majority of pumped storage projects are 500 MW and over, which means a single project could be used to reach each target within a utility territory. Therefore, we find it is appropriate to exclude large-scale pumped storage projects from the procurement mechanism outlined in this decision. **Accordingly, large-scale pumped storage projects greater than 50 MW will not be eligible to bid…"**

Deployment: U.S. cumulative energy storage



2019 Sustainable Energy Factbook. Bloomberg Finance LP 2018. Developed in partnership with The Business Council for Sustainable Energy. P.94

Market Policy Example – compensation of grid services

NHA agrees with the analysis by the DOE in the 2016 Hydropower Vision Report:

"Changes and trends in the electric sector call for a fresh look at the future role for hydropower. Lower natural gas prices, as well as coal and nuclear power plant retirements, contribute to a changing generation mix and potential markets for new generation sources. An increasing need to integrate variable generation resources, such as solar and wind, will lead to greater demand for grid flexibility and balancing services. Hydropower generation and PSH provide these needed services due to their consistent availability and their capability for rapid response to changes in demand."

DOE Hydropower Vision Report. Executive Summary P.12

The Vision Report goes on:

"**Inherent market and regulatory challenges must be overcome to realize hydropower's potential to improve grid flexibility and facilitate integration of variable generation resources.** The full valuation, optimization, and compensation for hydropower generation and ancillary services in power markets is difficult, and not all benefits and services provided by hydropower facilities are readily quantifiable or financially compensated in today's market framework. In traditional and restructured markets, as well as in emerging environmental markets, many hydropower services and contributions are not explicitly monetized. In some cases, market rules undervalue operational flexibility, which is important to maintaining grid reliability and is a prime attribute of hydropower."

DOE Hydropower Vision Report. Executive Summary P.12

NHA Messages to Policymakers

Regulatory Improvements	• Provide for a more efficient regulatory process for hydropower licensing, both new and existing projects.
Markets/Incentives	• Properly value the grid benefits that hydropower and pumped storage provides (PUCs, RTOs and ISOs) • Provide continued federal tax policies that incentivize hydropower growth.
Funding	• Support technology advancement and project deployment with continued robust appropriations in FY 2020 for the DOE Water Power Technologies Office and the federal hydropower owners' budgets.
Clean Energy Programs	• Include hydropower in programs designed to spur clean electricity growth (e.g. RPS, CES, climate, federal renewable power procurement, etc.)

NHA Conclusions

- Hydro is an important tool in the addressing climate challenges, not only for its own clean, renewable generation, but for its ability to integrate more renewables and for grid reliability services.
- Hydro is **not** tapped out - capacity additions/efficiency improvements at existing plants, building on existing infrastructure (dams and conduits), pumped storage, and marine energy.
- However, significant policy and market barriers prevent the full utilization of this growth, and the preservation of existing assets.
- Attention needed by all levels of government - federal, state, regional.

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Questions?