Hydropower's Promise: The Opportunities and Challenges of Hydropower for Mitigating Climate-Driven Scarcity

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I. INTRODUCTION

Water power, harnessed for the production of electricity by hydroelectric projects, is a critical resource for mitigating climate change-driven energy supply challenges. As recognized by the United States Bureau of Reclamation's 2021 SECURE Water Act Report, "Conflict escalates

particularly during droughts, which are expected to be more frequent and severe with climate change."[1] Though water unavailability is a constraint on hydroelectric project operations, it should not overshadow this carbon-free resource's ability to advance state and Federal de-carbonization goals in the face of retiring baseload resources,[2] and in the face of more frequent extreme weather events. This Article will examine the impacts of climate change on the nation's reliance on electric power, and the unique role that hydropower must play in managing those impacts.

For example, despite California regulators' focus on low hydrological conditions as contributing to the need for additional procurement in Summer 2021, hydropower is among the resources the state's grid operator procured to be available as a backstop for reliability purposes.[3] Notwithstanding its important contribution to total on-peak electricity capacity in North America, more hydroelectric capacity has not been added to the resource mix since 2010, while resources that contribute less to on-peak electricity

1. U.S. DEP'T OF THE INTERIOR, BUREAU OF RECLAMATION, WATER RELIABILITY IN THE WEST: 2021 SECURE WATER ACT REP., at 1 (Jan. 2021), https://www.usbr.gov/climate/secure/docs/2021secure/2021SECUREReport.pdf [https://perma.cc/8SUT-ZZNL].

2. For example, the Diablo Canyon Power Plant, the last nuclear facility in California, is slated to retire in 2024 and 2025, and its retirement creates a need for significant replacement generation. *See* CAL. ENERGY COMM'N ET AL., FINAL ROOT CAUSE ANALYSIS, at 23 (Jan. 13, 2021) [hereinafter FINAL ROOT CAUSE ANALYSIS] (noting, the most severe single contingency that could destabilize the California Independent System Operator Corporation (CAISO) Balancing Authority Area, is the loss of either the Diablo Canyon Power Plant or the Pacific DC Intertie transmission line).

3. *See* CAL. INDEP. SYS. OPERATOR, JUL. AND AUG. 2021 SIGNIFICANT EVENT AND EXCEPTIONAL DISPATCH CAPACITY PROCUREMENT MECHANISM DESIGNATIONS REP., at 2–3 (Aug. 6, 2021), http://www.caiso.com/Documents/JulyandAugust2021 SignificantEventand ExceptionalDispatchCPMReport.pdf [https://perma.cc/Y2T2-759D] (designating two "KRNCY_6 Units" as Capacity Procurement Mechanism (CPM) Significant Event capacity, and with regard to the "INTKEP_2_Units" and other resources procured under the grid operator's Exceptional Dispatch CPM, explaining the capacity deficiency was "exacerbated by the factors . . . that created the CPM Significant Event[,]" which included, ironically, "significantly reduced hydroelectric production due to worsening drought conditions," a driver identified by the California Energy Commission and California Public Utilities Commission in their June 29, 2021 request for CAISO to procure additional resources); *see also* CAL. INDEP. SYS. OPERATOR, FINAL NET QUALIFYING CAPACITY REP. FOR COMPLIANCE YEAR 2021 (Oct. 7, 2021), http://www.caiso.com/Documents/NetQualifying CapacityList-2021.xlsx [https://perma.cc/9G4L-DPTK] (information available on "2021 NQC List" tab) (identifying the generator names of the Resource IDs included in the CPM reports, in relevant part identifying "INTKEP_2_Units" as "CCSF- Hetch_Hetchy Hydro Aggregate" and "KRNCY_6 Unit" as Kern Canyon, a hydroelectric project).

capacity due to their variable output have experienced additions.[4] In the Western Interconnection,[5] the percentage of hydroelectric generation relative to total on-peak electricity capacity by all resource types declined between 2010 and 2020 from 30.4% to 23%.[6] This reduction in capacity does not comport with the growing need for reliable and flexible resources on a system that, across the country, is comprised increasingly of fluctuating resources, e.g., wind and solar, that create uncertainty for system planning and daily operations.[7] While anticipating a trajectory of more frequent extreme weather events and resulting grid reliability events, the Western Electricity Coordinating Council (WECC), an organization that oversees reliability for much of the West, points to an issue of "reduced generation availability to accommodate rising demand in extreme circumstances."[8] Hydroelectric projects with dams, as well as pumped storage, can contribute significant generation to the resource mix, with ability to provide ancillary services to the grid when flexibility is most needed. While some hydroelectric projects (such as reservoir-based projects or run-of-river projects combined with storage systems) may be suited for replacement of retiring baseload plants, pumped storage projects may be best suited to complement variable energy resources similar to natural gas peaker plants' attributes.[9]

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4. NORTH AM. ELECTRIC RELIABILITY CORP., *2021 State of Reliability: An Assessment of 2020 Bulk Power System Performance*, at 50–52 fig.5.2 (Aug. 2021), https://www.nerc.com/pa/RAPA/PA/Performance%20Analysis%20DL/NERC_SOR_2021.pdf [https://perma.cc/LHC7-F5L9] [hereinafter *NERC 2021 State of Reliability Rep.*] (an outlier is the Quebec Interconnection, where total hydro has increased from 87% in 2010 to 94.8% in 2020).

5. *See* U.S. DEP'T OF ENERGY, OFFICE OF ELECTRICITY, *Learn More About Interconnections*, https://www.energy.gov/oe/services/electricity-policy-coordination-and-implementation/transmission-planning/recovery-act-0 [https://perma.cc/DH4P-43VN] ("North America is comprised of two major and three minor alternating current (AC) power grids or 'interconnections," of which the Western Interconnection is one).

6. *NERC 2021 State of Reliability Rep*., *supra* note 4, at 51–52 fig. 5.2.

7. *Id.* at 52. *See, e.g.,* NAT'L HYDROPOWER ASS'N, *2018 Pumped Storage Rep.*, at 8 (2018), https://www.hydro.org/wp-content/uploads/2018/04/2018-NHA-Pumped-Storage-Report.pdf [https://perma.cc/XB54-273W] [hereinafter *2018 NHA Pumped Storage Report*] (observing the benefits baseload generation like hydropower provides over variable resources that create challenges for grid operators).

8. W. ELECTRICITY COORDINATING COUNCIL, STATE OF INTERCONNECTION INSIGHTS AND TAKEAWAYS, at 7 (Aug. 2021), https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/SOTI%202021%20Final%20for%20posting.pdf&action=default [https://perma.cc/ZE2C-F4H3] (focusing on the rising number of Energy Emergency Alerts issued by Balancing Authority Areas from 2017 through 2020).

9. *See* NAT'L HYDROPOWER ASS'N, *2021 Pumped Storage Rep.*, at 32 (2021), https://www.hydro.org/wp-content/uploads/2021/09/2021-Pumped-Storage-Report-NHA.pdf [https://perma.cc/P7AT-RMRZ] [hereinafter *2021 NHA Pumped Storage Report*] (noting pumped storage is not intended to replace baseload resources, but can replace natural gas peakers used to mitigate large evening ramps); David Wagman, *Virtual reservoirs could*

In particular, pumped storage hydro can provide reliability benefits during the challenging peak net load hours when solar output is diminishing and additional load is returning to the grid.[10] Pumped storage hydro, as an electric storage resource, can also help avoid curtailment of solar and wind resources by absorbing their output during periods of oversupply. Further, "closed-loop" pumped storage systems do not rely on connected water bodies, and thus can be conveniently situated near existing transmission and can take environmental considerations into account.[11] An example is the San Vicente Energy Storage Facility, a planned closed-loop pumped storage project in San Diego County with anticipated capability to provide up to 500 MW of long-duration energy storage. The project is also an example of how hydroelectric projects may utilize existing infrastructure (in this case, an existing reservoir) to lessen environmental impacts.[12]

Additionally, hydroelectric resources have provided services to wholesale markets across the country. The ability to provide these services has been furthered by market operators' and federal regulators' push to harness the

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boost hydro's baseload viability, ENGINEERING360, (Mar. 19, 2019), https://insights.globalspec.com/article/11457/virtual-reservoirs-could-boost-hydro-s-baseload-viability [https://perma.cc/P8V4-KEBC] (pointing to an Idaho National Laboratory study researching run-of-river hydropower combined with integrated energy storage technologies, which may have flexibility benefits that rival natural gas in terms of load following services). *See generally* Atle Harby et al., *Flexible hydropower providing value to renewable energy integration*, IEA HYDROPOWER ANNEX IX // WHITE PAPER NO 1 – OCT 2019 (Atle Harby & Linn Emelie Schäffer eds., 2019), https://www.ieahydro.org/media/51145259/IEA HydroTCP_AnnexIX_White%20Paper_Oct2019.pdf [https://perma.cc/K222-5BKX] (observing several countries that rely extensively on hydropower for baseload generation).

10. *See* FINAL ROOT CAUSE ANALYSIS, *supra* note 2, at 44 (explaining the issue in California where "as the sun sets, demand previously served by behind-the-meter solar generation is coming back to the CAISO system while load remains high", contributing to the net demand peak around 7 p.m. following the earlier peak demand hour of the day).

11. NAT'L HYDROPOWER ASS'N, *Challenges and Opportunities for New Pumped Storage Development,* at 9 (2017), https://www.hydro.org/wp-content/uploads/2017/08/NHA_PumpedStorage_071212b1.pdf [https://perma.cc/Y2SL-2P49] [hereinafter *2017 NHA Pumped Storage Report*].

12. SAN DIEGO COUNTY WATER AUTHORITY, *Request for Proposals Issued to Develop San Vicente Energy Storage Facility*, SDCWA.ORG (Sept. 14, 2021), https://www.sdcwa.org/request-for-proposals-issued-to-develop-san-vicente-energy-storage-facility/?mc_cid=9ec606bc2c&mc_eid=71e4e8d507 [https://perma.cc/X5X3-8V9B] (pointing to the benefits that the existing reservoir is nearby major electricity transmission interconnection facilities, and asserting the project would be "largely immune to the challenges faced by some conventional hydropower facilities because it is a closed-loop system that mainly holds imported water and is not reliant on runoff that can fluctuate significantly from year to year and hamper power production").

services hydropower can provide—including through enhanced market participation models and regional market structures. An example of the latter is the Western Energy Imbalance Market's ability to facilitate the economic and efficient use of Pacific Northwest hydroelectric production elsewhere in the West.[13] However, the West continues to grapple with transmission disruption due to extreme weather events, as well as transmission access issues during scarcity conditions. Currently, California's largest grid operator and its stakeholders are focused on developing mechanisms to enhance transmission access, which will facilitate the delivery of hydroelectric resources in the Pacific Northwest southward to areas heavily reliant on imports.

This Article examines hydroelectric resources' ability to assist states throughout the West and across the country in meeting their statutory and policy goals of reduced or zero carbon emissions, while maintaining reliability. Extreme weather events, and associated costs, are not isolated to the Western Interconnection, but rather increasingly impact other regions and their end-use customers. In its 2021 U.S. Hydropower Market Report, the Department of Energy (DOE) noted that, in nearly every Balancing Authority Area assessed, hydropower was more extensively used for hourly ramping flexibility than any other resource.[14] Additional services hydroelectric resources provide, including storage capacity and black start service to restore power without assistance from the grid,[15] are critical in a context where extreme weather is the new norm.

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13. *See generally* HYDROPOWER MARKET REP., *infra* note 14, at 15, 75 (discussing how many Federal Power Marketing Administrations with hydropower fleets have joined imbalance markets in order to access liquid markets for selling surplus power in wet years and buying replacement power in dry years, and pointing to Bonneville Power Administration's motivation to join CAISO's Western Energy Imbalance Market in part to optimize the Federal Columbia River System's flexibility to help balance fluctuations in California's variable renewable resources).

14. U.S. DEP'T OF ENERGY, U.S. HYDROPOWER MARKET REP., at iv (Jan. 2021), https://www.energy.gov/sites/prod/files/2021/01/f82/us-hydropower-market-report-full-2021.pdf [https://perma.cc/4JNR-AXN2] [hereinafter HYDROPOWER MARKET REP.]. *Glossary of Terms Used in Reliability Standards*, N. AM. ELEC. RELIABILITY CORP., https://www.nerc.com/files/glossary_of_terms.pdf [https://perma.cc/QYX9-EK97] ("Balancing Authority Area" is the "collection of generation, transmission, and loads within the metered boundaries of the Balancing Authority[,]" which is the entity that "maintains load-resource balance" within the Balancing Authority Area). Herein, the authors sometimes use the colloquial term, "grid operator." This term not only can encompass the entity that performs the duties of a "Balancing Authority," but also an entity that performs certain market and administrative functions for the electric grid. The authors also, at times, use the informal term "grid," which generally encompasses the transmission, distribution, and generation assets and infrastructure necessary to transmit and deliver electricity.

15. *See, e.g.*, Jose R. Gracia et al., *Hydropower Plants as Black Start Resources*, U.S. DEP'T OF ENERGY, at iv–v, 6.1–6.2 (May 2019) (explaining the characteristics that make hydroelectric resources well-suited to provide black start service; for example, they

II. THE PRESENT CRISIS

Recently, climate change has manifested itself in the form of increasingly frequent and more severe extreme weather events and, correspondingly, more power outages. With frequent headlines illustrating the shocking results of climate change and its impact on electrical grids worldwide, utilities need resources that can help keep the lights—and other necessities—on. Furthermore, the negative effects of climate change reach far beyond private households, also threatening national security and the economy (both domestic and global). In light of the present climate crisis, hydropower can offer some solutions to the myriad of problems induced by climate change given its carbon-free and grid stabilizing attributes.

A. Availability of Electric Power Is Severely Threatened by Accelerating Climate Change

As climate change continues to alter our weather and landscape, the reliability of our electric grid becomes more vulnerable. More frequent droughts and changing rainfall patterns may limit the availability of hydroelectric power in some seasons, wildfires increasingly damage transmission and distribution lines, and warmer temperatures are reducing the existing transmission system's capacity.[16] Extreme weather events have increased power outages' frequency and duration in the United States, as most of the nation's energy infrastructure was engineered and built for historic climate patterns and may not adequately account for, nor be resilient to, continued changes.[17]

Recent events have dramatically demonstrated the impact severe weather has on the electric grid and electricity users. In February 2021, freezing conditions in Texas left more than 4.5 million customers (over ten million

do not require much station power relative to other resource types like combined cycle units that require equipment cooling systems).

16. *See generally* U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-21-423T, ELECTRICITY GRID RESILIENCE: CLIMATE CHANGE IS EXPECTED TO HAVE FAR-REACHING EFFECTS AND DOE AND FERC SHOULD TAKE ACTIONS (Mar. 2021) [hereinafter ELECTRICITY GRID RESILIENCE]. Droughts can also reduce the water available for cooling generating units, causing these units to go offline. Higher temperatures may also trigger environmental requirements that force power plant shutdowns. *Id*. at 3, 8.

17. *Id*. at 1–2. *See* Presidential Policy Directive 21 (PPD-21), *Critical Infrastructure Security and Resilience* (Feb. 12, 2013) (defining resiliency as the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions, including naturally occurring threats or incidents).

people) without electricity, in some cases, for several days.[18] Economic losses for these freezing conditions have been estimated to amount to $130 billion in Texas alone and $155 billion for the country as a whole.[19] In 2020, Hurricane Isaias left over two million people on the East Coast without power (causing Consolidated Edison, Inc.'s second largest outage in its history after Superstorm Sandy in 2012), while Hurricane Laura caused some 600,000 outages by destroying electrical equipment, which will cost approximately $1.4 billion to repair and replace in Louisiana alone.[20] More recently, in summer 2021, Hurricane Ida knocked out power for much of Louisiana, leaving residents exposed to extreme heat and humidity, and damaging or fully destroying Entergy's (the state's largest utility company) electrical poles and towers.[21] Overall, it is estimated that major power outages from weather-related events have increased sixty-seven percent since 2000, and that two-thirds of states have experienced an increase in outages caused by extreme weather since that time.[22]

Aside from impacting the grid, climate change has more direct impacts on electricity generation at its sources. Hydroelectric power production in the West has been severely curtailed due to low water conditions.[23] In summer 2021, Lake Oroville (the heart of the California Department of Water Resources' (CDWR) water supply and electric generation functions)

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18. J.W. Busby et al., *Cascading Risks: Understanding the 2021 Winter Blackout in Texas,* ENERGY RESEARCH & SOCIAL SCIENCE 77, at 1–2 (2021) (noting that, in part, the outages were based on Texas' failure to winterize its electricity and gas systems).

19. *Id*.

20. Jan Webster Childs, *Power Outage Repairs in Louisiana After Hurricane Laura Costs Up to $1.4 Billion,* THE WEATHER CHANNEL (Sept. 24, 2020), https://weather.com/news/news/2020-09-24-hurricane-laura-power-outages-billion-dollars-entergy [https://perma.cc/BD3V-R6YD]; *see also* Rachel Treisman, *Majority of Hurricane Laura Deaths Linked to Improper Use of Portable Generators,* NAT'L PUB. RADIO (Sept. 1, 2020), https://www.npr.org/2020/09/01/908515238/majority-of-hurricane-laura-deaths-linked-to-improper-use-of-portable-generators [https://perma.cc/SN45-93JK] (reporting that eight of fifteen deaths were caused by carbon monoxide poisoning from portable generators).

21. Peter Eavis et al., *Why Louisiana's Electric Grid Failed in Hurricane Ida*, N.Y. TIMES (Sept. 17, 2021), https://www.nytimes.com/2021/09/17/business/energy-environment/hurricane-ida-entergy-power-outage-new-orleans.html [https://perma.cc/A46W-JULH] (reporting that Hurricane Ida damaged or destroyed 31,000 poles that carry lower-voltage distribution lines, nearly twice as many as Hurricane Katrina, but Louisiana's largest utility company, Entergy Corporation, reported that its investment in transmission was working, as Ida destroyed or damaged 508 transmission structures, compared with 1,909 during Laura and 1,003 during Katrina).

22. *Power OFF: Extreme Weather and Power Outages*, CLIMATE CENTRAL (Sept. 20, 2020), https://medialibrary.climatecentral.org/resources/power-outages [https://perma.cc/43MM-MBXL] (defining "major power outages" as those that affect more than 50,000 customers).

23. Henry Fountain, *Climate Scientists Forecast High Temperatures Into the Fall*, N.Y. TIMES (Sept. 15, 2021), https://www.nytimes.com/2021/09/16/climate/climate-change-drought-temperature.html [https://perma.cc/W63A-4R4S].

was reduced to twenty-three percent capacity, causing the first shutdown of the Hyatt Powerplant in its history, as well as curtailment of water and power deliveries.[24] The U.S. Bureau of Reclamation reported that water levels in Lake Mead (the mammoth reservoir created by the Hoover Dam that supplies the Lower Colorado Basin) were down to about thirty-four percent of capacity in mid-January 2022, which comes even amidst substantial snowfall in the region.[25] "We are seeing the effects of climate change in the Colorado River basin through extended drought, extreme temperatures, expansive wildfires, and in some places, flooding and landslides," said Tanya Trujillo, the U.S. Department of the Interior's Assistant Secretary for Water and Science.[26] Tom Davis, President of the Agribusiness and Water Council of Arizona, described the drought as "a boa constrictor . . . [that] keeps getting tighter every year."[27]

On top of tight water conditions, increasing water temperatures may also pose problems. For example, in 2007, 2010, and 2011, the Tennessee Valley Authority reduced power output from a nuclear power plant because the river water's temperature was too high to receive discharge water without increasing ecological risks.[28] Warming temperatures also impact the transmission system, as warmer temperatures in the Southwest

24. *Lake Oroville Community Update – Aug. 6, 2021*, CAL. DEP'T OF WATER RES. (Aug. 6, 2021), https://water.ca.gov/News/Blog/2021/August/Oroville-Update-8-6-21 [https://perma.cc/VV6U-VADV]. The Hyatt Powerplant resumed operations on January 4, 2022, following storms that "boosted lake levels and provided colder water in the reservoir to allow operations to resume." CAL. DEP'T OF WATER RES., *Hyatt Powerplant at Oroville Dam Resumes Operation* (Jan. 4, 2022), https://water.ca.gov/News/News-Releases/2022/Hyatt-Powerplant-at-Oroville-Dam-Resumes-Operation [https://perma.cc/W8N3-ZA2T].

25. U.S. DEP'T OF THE INTERIOR, BUREAU OF RECLAMATION, LOWER COLORADO WATER SUPPLY REP. (Jan. 10, 2022), https://www.usbr.gov/lc/region/g4000/weekly.pdf [https://perma.cc/3FNK-N5K9]; *see* U.S. DEP'T OF THE INTERIOR, BUREAU OF RECLAMATION, *Reclamation modifies monthly water releases from Lake Powell to protect reservoir's critical elevations* (Jan. 7, 2022), https://www.usbr.gov/newsroom/#/news-release/4073 [https://perma.cc/MK6G-XBWH] (pointing to challenges facing the Colorado River Basin despite substantial snowfall in December 2021).

26. Morning Edition, *States in the West Face Water Cuts After Colorado River Shortage is Announced*, NAT'L PUB. RADIO (Aug. 17, 2021), https://www.npr.org/2021/08/17/1028357871/states-in-the-west-face-water-cuts-after-colorado-river-shortage-is-announced [https://perma.cc/72CH-BXHM].

27. Karin Brulliard et al., *First-ever water shortage declared on the Colorado River, triggering water cuts for some states in the West*, WASH. POST (Aug. 16, 2021), https://www.washingtonpost.com/nation/2021/08/16/colorado-river-water-cuts-drought/ [https://perma.cc/NAU6-NM9J].

28. ELECTRICITY GRID RESILIENCE, *supra* note 16, at 16.

are estimated to decrease transmission line capacity by approximately 1.5 - 2.5%.[29] Impacts from temperature increases and the resulting decline in snowmelt may negatively impact hydroelectric operations in the longer term;[30] in the Pacific Northwest, projected changes in temperatures and precipitation induced by climate change are anticipated to increase winter hydroelectric generation and reduce summer hydroelectric generation, with inverse impacts on electricity prices.[31]

Ominously, eight of the ten warmest years on record have occurred since 1998 and average temperatures in the contiguous forty-eight states have risen at an average rate of 0.16°F per decade since 1901.[32] In 2021, several states in the West experienced the warmest summer on record.[33] In a 2021 report, the Intergovernmental Panel on Climate Change estimated that the total human-caused global surface temperature increase from 1850-1900 to 2010-2019 is about 0.8°C to 1.3°C, with a best estimate of 1.07°C.[34] Heatwaves are occurring three times more often than they did in the 1960s, and the average heat wave is forty-seven days longer.[35] As a vivid example, in June 2021, the Pacific Northwest experienced record-breaking heat that one study suggested was virtually impossible without human-caused climate change.[36]

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29. In addition, higher temperatures cause expansion of transmission line materials, which causes permanent damage and increases the likelihood of power outages. *Id*.

30. NORTHWEST POWER AND CONSERVATION COUNCIL, UPDATED DIRECT AND INDIRECT IMPACTS OF CLIMATE CHANGE, 14 (Feb. 2020), https://nwcouncil.app.box.com/s/p9cdzd3hvh8kb0ni9ie23hgcs9jes0wd [https://perma.cc/98AN-BQ45].

31. NORTHWEST POWER AND CONSERVATION COUNCIL, THE 2021 NORTHWEST POWER PLAN: DRAFT PLAN, at 6-46, 6-47 (Sept. 2021), https://www.nwcouncil.org/sites/default/files/2021powerplan_2021-5.pdf [https://perma.cc/VJB6-KH3L] [hereinafter 2021 DRAFT NORTHWEST POWER PLAN] (equating higher hydropower conditions with lower electricity prices, and lower hydropower generation with high electricity prices).

32. *Climate Change Indicators: U.S. and Global Temperature,* U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/climate-indicators/climate-change-indicators-us-and-global-temperature [https://perma.cc/S2YC-BE9A].

33. U.S. DEP'T OF COMMERCE, NAT'L OCEANIC & ATMOSPHERIC ADMIN., SUMMER 2021 NECK AND NECK WITH DUST BOWL SUMMER FOR HOTTEST ON RECORD (Sept. 9, 2021), https://www.noaa.gov/news/summer-2021-neck-and-neck-with-dust-bowl-summer-for-hottest-on-record [https://perma.cc/V8AV-6H53].

34. INTEL. PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2021: THE PHYSICAL SCIENCE BASIS. CONTRIBUTION OF WORKING GROUP I TO THE SIXTH ASSESSMENT REPORT, at SPM-5 - SPM-6, (2021), https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Full_Report.pdf [https://perma.cc/BVM6-7H8U].

35. *Climate Change Indicators: Heat Waves*, U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/climate-indicators/climate-change-indicators-heat-waves [https://perma.cc/6KWE-M2YL].

36. *See* SJOUKJE Y. PHILLIP ET AL., RAPID ATTRIBUTION ANALYSIS OF THE EXTRAORDINARY HEATWAVE ON THE PACIFIC COAST OF THE US AND CANADA, 2 (2021), https://www.worldweatherattribution.org/wp-content/uploads/NW-US-extreme-heat-2021-scientific-report-WWA.pdf [https://perma.cc/TTR7-MVTD].

Cumulatively, these events illustrate the increasingly severe climate-related vulnerabilities facing the United States and its electric system.[37] Climate change is expected to have far-reaching effects on the grid that could cost billions of dollars.[38] Between 2003 and 2012, weather-related power outages caused an estimated eighteen billion to thirty-three billion dollars in damages to the U.S. economy.[39] Meanwhile, warmer temperatures and heat waves may increase electricity demand,[40] and such demand will likely be compounded by strategies involving mass electrification to achieve de-carbonization policies.[41]

B. Climate Change Has Negative Implications for National Security and the Economy

As climate change progresses, it also threatens national security. In early 2021, the U.S. Secretary of Defense issued a statement reflecting President Biden's direction "to include climate considerations as an essential element of our national security and to assess the impacts of climate change on our security strategies, operations, and infrastructure."[42] While the Department of Defense has recognized climate change's adverse effects for over a decade,[43] this clear and unambiguous statement from the Secretary of Defense is a strong affirmation and recognition of the climate-related national security issues at stake. In particular, increased temperatures and rising sea levels threaten U.S. military infrastructure, similar to how extreme storms and wildfires have significantly impacted civilian infrastructure, as discussed

37. ELECTRICITY GRID RESILIENCE, *supra* note 16, at 2.
38. *Id*. at 15, 19.
39. EXEC. OFF. OF THE PRESIDENT, ECONOMIC BENEFITS OF INCREASING ELECTRIC GRID RESILIENCE TO WEATHER OUTAGES 3 (Aug. 2013), https://www.energy.gov/sites/prod/files/2013/08/f2/Grid%20Resiliency%20Report_FINAL.pdf [https://perma.cc/YM24-WPGG].
40. *Id.* at 17.
41. *See, e.g.,* INTEL. PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2014 MITIGATION OF CLIMATE CHANGE WORKING GROUP III CONTRIBUTION TO THE FIFTH ASSESSMENT REPORT (2014), https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_full.pdf [https://perma.cc/7HAF-Q36C] (finding that the most cost-effective strategy to achieve deep de-carbonization will involve mass electrification).
42. U.S. DEP'T OF DEFENSE, *Statement by Secretary of Defense Lloyd J. Austin III on Tackling the Climate Crisis at Home and Abroad* (Jan. 27, 2021), https://www.defense.gov/Newsroom/Releases/Release/Article/2484504/statement-by-secretary-of-defense-lloyd-j-austin-iii-on-tackling-the-climate-cr/ [https://perma.cc/U3R8-9X3A].
43. *Id*. ("Since 2010, the Department of Defense has acknowledged that the planet's changing climate has a dramatic effect on our missions, plans, and installations.").

above. Also, the U.S. National Intelligence Council identified that national security could be threatened by: climate change-induced instability in foreign countries; heightened social and political strains; food scarcity and prices; and increased threats to human health.[44] As such, there is a need to "prioritize, communicate, and respond to climate security threats . . . ."[45]

In addition to national security issues, climate change will have negative implications for the national and global economy. In 2018, the Fourth National Climate Assessment warned, "[w]ithout substantial and sustained global mitigation and regional adaptation efforts, climate change is expected to cause growing losses to American infrastructure and property and impede the rate of economic growth over this century."[46] Specifically, economic sectors dependent on natural resources are extremely susceptible to climate change's negative effects, and experts project multiple sectors of the U.S. economy could have over one hundred billion dollars in annual climate change-related damage by the end of this century if no mitigation measures are taken.[47] The financial losses could be compounded with lower general wealth, and a reduced growth rate of the U.S. Gross Domestic Product.[48] Globally, experts predict climate change could cost the world economy twenty-three trillion dollars by 2050.[49]

By contributing carbon-free power and services supporting grid reliability, hydropower can help mitigate the aforementioned impacts of climate change on the front-end (by lowering greenhouse gas emissions) and on

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44. THE NAT'L SEC., MIL., & INTEL. PANEL ON CLIMATE CHANGE, A SECURITY THREAT ASSESSMENT OF GLOBAL CLIMATE CHANGE, HOW LIKELY WARMING SCENARIOS INDICATE A CATASTROPHIC SECURITY FUTURE 18 (Feb. 2020), https://climateandsecurity.org/wp-content/uploads/2020/03/a-security-threat-assessment-of-climate-change.pdf [https://perma.cc/W5YR-UDHZ].

45. *Id.* at 72. *See, e.g.*, John Conger, *Thirty Days to Hurricane Season: Tyndall Air Force Base Recovery and Preparation at Risk*, THE CENTER FOR CLIMATE AND SECURITY, https://climateandsecurity.org/2019/05/01/thirty-days-to-hurricane-season-recovery-and-preparation-at-tyndall-air-force-base/ [https://perma.cc/3PWH-DNFM] ("The Department of Defense . . . is facing more than [eight] billion [dollars] in recovery costs to address extreme weather damage at Tyndall Air Force Base, Offutt Air Force Base, and Marine Corps Base Camp Lejeune, installations that are very important for U.S. military capabilities and livelihoods.").

46. U.S. GLOB. CHANGE RSCH. PROGRAM, FOURTH NATIONAL CLIMATE ASSESSMENT, VOL. II, IMPACTS, RISKS, AND ADAPTATIONS IN THE UNITED STATES 25 (2018) (revised 2021), https://nca2018.globalchange.gov/downloads/NCA4_2018_FullReport.pdf [https://perma.cc/5V6G-2GC9].

47. *Id*. at 1358.

48. CONG. BUDGET OFF., CBO'S PROJECTION OF THE EFFECT OF CLIMATE CHANGE ON U.S. ECONOMIC OUTPUT 2 (Sept. 2020), https://www.cbo.gov/system/files/2020-09/56505-Climate-Change.pdf [https://perma.cc/S23P-Q799].

49. Christopher Flavelle, C*limate Change Could Cut World Economy by $23 Trillion in 2050, Insurance Giant Warns,* N.Y. TIMES (Apr. 22, 2021), https://www.nytimes.com/2021/04/22/climate/climate-change-economy.html [https://perma.cc/7RQW-PSKQ].

the back-end (by stabilizing the grid during extreme or unpredictable weather events), which could ultimately help mitigate negative effects on national security and the economy.

C. Fossil Fuel Emissions and Storage Issues Present Severe Environmental Challenges

Fundamentally, greenhouse gases trap heat in the Earth's atmosphere and contribute to the warming of the Earth's surface temperature.[50] Greenhouse gases consist of carbon dioxide, methane, nitrous oxide, and fluorinated gases.[51] Fossil fuels, which include natural gas, oil, and coal, are "non-renewable resources."[52] According to the U.S. Environmental Protection Agency, burning fossil fuels is the primary human activity that emits carbon dioxide, and carbon dioxide contributes to approximately seventy-six percent of the country's total greenhouse gas emissions.[53] The U.S. Energy Information Administration arrived at approximately the same conclusion when it found that carbon dioxide accounted for about eighty percent of total greenhouse gas emissions and that burning fossil fuels was responsible for seventy-four percent of the United States' greenhouse gas emissions in 2019.[54] Methane is the second highest emitted greenhouse gas and its emissions are attributable to, in part, energy use. According to the U.S. Department of Energy, fossil fuels generated about sixty-three percent of the electricity in the United States in 2019.[55]

A major benefit fossil fuels have in the energy sector is their storage capability. Fossil fuels do not have to be consumed when the fuel is "produced," as is the case with wind and solar, where wind creates "fuel" only when the wind blows, and solar creates "fuel" only when the sun

50. U.S. ENVTL. PROT. AGENCY, *Overview of Greenhouse Gases*, https://www.epa.gov/ghgemissions/overview-greenhouse-gases [https://perma.cc/2JS7-APPV].

51. U.S. ENVTL. PROT. AGENCY, *Global Greenhouse Gas Emissions Data*, [hereinafter *Global Greenhouse Gas Emissions Data*] https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data [https://perma.cc/JP5N-NQMB].

52. *See* U.S. DEP'T OF ENERGY, *Fossil*, https://www.energy.gov/science-innovation/energy-sources/fossil [https://perma.cc/FG3C-UWMN].

53. *Global Greenhouse Gas Emissions Data*, *supra* note 51.

54. U.S. ENERGY INFO. ADMIN., *Energy and the Environment Explained. Where Greenhouse Gases Come From*, https://www.eia.gov/energyexplained/energy-and-the-environment/where-greenhouse-gases-come-from.php [https://perma.cc/Q6NH-M2A9].

55. U.S. DEP'T OF ENERGY, *Developing Robust Energy Storage Systems for Fossil Fuel Plants*, https://www.energy.gov/fe/articles/developing-robust-energy-storage-systems-fossil-fuel-plants [https://perma.cc/RJX9-MZJM].

shines. Entities can drill or mine for fossil fuels and store the extracted material for later energy use. Coal can be stockpiled, oil can be stored in oil drums, and natural gas can be stored underground in reservoirs. However, in addition to emissions from burning fossil fuels, storing fossil fuels can come with its own environmental concerns. For example, natural gas stored in reservoirs can leak into the ground,[56] and oil can leak during storage and while being transported.[57] With the negative environmental consequences becoming more obvious, fossil fuels are falling increasingly out of favor policy-wise, while their dependability continues to be important to maintaining reliability.[58] To help bridge this gap, many forms of hydroelectric power, as described below, provide a carbon-neutral storage benefit.

III. THE BENEFITS AND PROMISE OF HYDROELECTRIC PROJECTS

Hydroelectric projects turn the potential energy of water into electricity.[59] Flowing water turns a turbine, which is connected to a generator, and that

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56. *Many U.S. Underground Natural Gas Storage Wells at Risk for Leaks*, HARV. UNIV., SCH. OF PUB. HEALTH, https://www.hsph.harvard.edu/news/hsph-in-the-news/underground-gas-leak-risk/ [https://perma.cc/3MPX-AJM8]; *see also* CARBON BRIEF, *Aliso Canyon: How bad is the California gas leak disaster?* (Feb. 26, 2016), https://www.carbonbrief.org/aliso-canyon-how-bad-is-the-california-gas-leak-disaster [https://perma.cc/5WEG-BLK9] (describing a rupture at the Aliso Canyon Natural Gas Storage Field that resulted in a release of 97,100 tonnes of methane, amounting to the second largest methane leak recorded in the United States).

57. *See, e.g.,* Hannah Knowles, *Keystone Pipeline leaks 383,000 gallons of oil in second big spill in two years*, WASH. POST (Nov. 1, 2019), https://www.washingtonpost.com/climate-environment/2019/10/31/keystone-pipeline-leaks-gallons-oil-second-big-spill-two-years/ [https://perma.cc/CDU9-EV6Z]; Joan Meiners, *Ten years later, BP Oil spill continues to harm wildlife—especially dolphins*, NAT'L GEOGRAPHIC (Apr. 17, 2020), https://www.nationalgeographic.com/animals/article/how-is-wildlife-doing-now—ten-years-after-the-deepwater-horizon [https://perma.cc/S6T5-LZLK].

58. *See*, *e.g.*, BERKELEY, CAL. HEALTH & SAFETY Ch.12.80.010, Ch.12.80.040 (2020) ("Scientific evidence has established that natural gas combustion, procurement and transportation produce significant greenhouse gas emissions that contribute to global warming and climate change" and "Natural Gas Infrastructure shall be prohibited in Newly Constructed Buildings."); PALO ALTO, CAL. ORDINANCE 16.17.100, §§ 150.0(e),(h),(n),(s) (2019); MENLO PARK, CAL., ENERGY CODE AMENDMENTS Ch. 12.16.010 (2019). *See DMM 2020 Annual Report, infra* note 104, at 16 (Aug. 2021) (noting trends in available nameplate capacity from June 2014 through 2021, and replacement of gas capacity primarily by solar, wind, demand response, and batteries, though noting "variable energy and demand response resources generally have limited energy and availability compared to gas capacity"); *see id*. at 17 ("The [CAISO] has emphasized the need to maintain adequate flexibility from both conventional and renewable generation resources to maintain reliability as more renewable resources come on-line.").

59. FED. ENERGY REGULATORY COMM'N, *Hydropower Primer: A Handbook of Hydropower Basics*, at 4 (Feb. 2017), https://www.ferc.gov/sites/default/files/2020-05/hydropower-primer.pdf [https://perma.cc/C9FN-XKCX] [hereinafter *2017 FERC Hydropower Primer*].

generator produces electricity.[60] That electricity is then ultimately transmitted to an end-use customer.

Hydroelectric projects can come in several forms, each exhibiting their own unique benefits. For instance, traditional run-of-river hydropower projects "go with the flow." Specifically, these projects divert part of the flow of a waterway through a penstock[61] or canal to spin a turbine.[62] Run-of-river projects without dams can offer continuous electricity supply and reduced environmental impact, but power generation fluctuates with river flow. Hydroelectric projects featuring storage-and-release dams and water reservoirs offer considerable flexibility for regulating water flow and, thus, electricity generation. Hydroelectric projects with dams and reservoirs can shut down and start up on short notice, allowing operations to coordinate with peak demand. Because the water is released from a reservoir, hydroelectricity from stored water can be generated even when there has not been significant hydrological inflow for weeks, or even months—unlike run-of-river projects.

Pumped storage hydroelectric projects maximize the enhanced benefits storage has to offer. Pumped storage involves pumping water from a lower reservoir to one at a higher elevation during times of low demand and corresponding low prices (usually at night).[63] When demand is higher (generally during the day, though also during other hours depending on the region),[64] water is released from the upper reservoir to flow through hydroelectric generators into the lower reservoir, providing energy to the system while preserving the water source for re-use.

Pumped storage can be configured as either "closed-loop" or "open-loop." Closed-loop pumped storage projects have been perceived as less

60. *Id*.

61. A "penstock" is "an enclosed pipe-like structure that typically conveys water directly from a reservoir to a powerhouse." *2017 FERC Hydropower Primer*, *supra* note 59, at 7.

62. *Types of Hydropower*, INT'L HYDROPOWER ASS'N, https://www.hydropower.org/iha/discover-types-of-hydropower [https://perma.cc/P2PG-WEMW].

63. *Pumped Storage*, NAT'L HYDROPOWER ASS'N, https://www.hydro.org/policy/technology/pumped-storage/ [https://perma.cc/6RB3-6J77]; *Most Pumped Storage Electricity Generators in the U.S. were Built in the 1970s*, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/todayinenergy/detail.php?id=41833 [https://perma.cc/3MLE-68LH].

64. *See, e.g.,* CAL. INDEP. SYS. OPERATOR, FAST FACTS: WHAT THE DUCK CURVE TELLS US ABOUT MANAGING A GREEN GRID, at 2–3, https://www.caiso.com/documents/flexibleresourceshelprenewables_fastfacts.pdf [https://perma.cc/4U5A-TS2E] (pointing to net demand rising between the four-a.m. and six-a.m. hours, and four-p.m. and six-p.m. hours in California).

environmentally intrusive because their "reservoirs are not connected to an outside body of water."[65] An additional benefit the National Hydropower Association observes of closed-loop pumped storage systems is their ability to "be located where needed to support the grid."[66] As of September 2021, the Federal Energy Regulatory Commission (FERC) reports many of the preliminary permit and license applications filed for pumped storage projects are using a closed-loop system.[67] On the other hand, open-loop pumped storage projects have an ongoing hydrological connection to a natural body of water.[68] All pumped storage projects currently operational in the United States are open-loop except for the 40 MW Olivenhain-Hodges project in San Diego, California.[69]

Hydropower has had a long and sometimes controversial history in the United States.[70] For instance, dams that are not environmentally conscious can have substantial, adverse ecological impacts. Such environmental harm can elicit opposition to new development or to retrofitting existing facilities, stimulating support for dam decommissioning. In recent years, state and Federal agencies have removed several power-generating dams.[71] However, hydroelectric projects (those with and without dams) provide several benefits to respond to the ongoing climate crisis that demands near-term solutions. As discussed above, with climate change impacts becoming more severe, the environment, national security, national and global economies, and

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65. *Pumped Storage Hydropower*, DEP'T OF ENERGY, OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY, https://www.energy.gov/eere/water/pumped-storage-hydropower [https://perma.cc/P4JL-592U] (defining open-loop and closed-loop storage); *see 2017 NHA Pumped Storage Report, supra* note 11, at 9 (describing closed loop pumped storage as a "relatively new approach" presenting "minimal to no impact to existing river systems").

66. *2017 NHA Pumped Storage Report, supra* note 11, at 9.

67. FED. ENERGY REGULATORY COMM'N, *Pumped Storage Projects*, https://www.ferc.gov/industries-data/hydropower/licensing/pumped-storage-projects [https://perma.cc/S6X5-MY7Z].

68. Bo Saulsbury, *A Comparison of the Environmental Effects of Open-Loop and Closed-Loop Pumped Storage Hydropower*, at 1.1, DOE HYDROWIRES (Apr. 2020).

69. U.S. DEP'T OF ENERGY, HydroWIRES, *Pumped Storage Hydropower FAST Commissioning Technical Analysis*, at 2.5 (2020) https://www.energy.gov/sites/prod/files/2020/07/f76/PSH_FAST_Commissioning_Technical_Report_ORNL.pdf[https://perma.cc/54SZ-BJ2Q]; *see id*. at iii (stating that there are forty-three pumped storage projects in the United States).

70. *See History of Hydropower*, U.S. DEP'T OF ENERGY, https://www.energy.gov/eere/water/history-hydropower [https://perma.cc/NB8U-ZLXP]; *see also Hydropower explained: Hydropower and the environment*, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/energyexplained/hydropower/hydropower-and-the-environment.php [https://perma.cc/EE8R-U5TQ].

71. *See, e.g., Dam Removal*, U.S. NAT'L PARK SERVICE, https://www.nps.gov/olym/learn/nature/dam-removal.htm [https://perma.cc/2KFL-Y5YE] (describing the removal of the Elwha and Glines Canyon Dams).

basic access to the electrical grid are all at risk. While acknowledging the complicated issues surrounding hydroelectric resources, recognition must be given to the tangible and immediate benefits hydropower can contribute to a clean energy future.

A. Environmental Benefits

Many states across the country are vowing to reduce their greenhouse gas (GHG) emissions by utilizing reduced carbon or carbon-free energy sources. As of September 2021, approximately twenty states have stated goals of 100% carbon-free electricity, 100% renewable energy, or net-zero GHG emissions under a variety of timelines.[72] In striving to meet such goals and mitigate the effects of climate change, states have found hydropower to be a reliable and cost effective way to increase renewable clean energy production and/or carbon-free energy production.[73] In order for states to achieve 100% clean energy portfolios, an increase in hydropower resources is essential.

The West relies heavily on hydroelectric resources located in the Pacific Northwest.[74] In particular, Washington generates the most hydroelectricity of any state, with typically over two-thirds of its electricity generation comprised of hydropower,[75] thanks in large part to the Columbia River that runs the length of the state. Washington is also home to the largest hydroelectric dam with the largest generating plant in the Northwest region,[76] the Grand Coulee Dam. Second to Washington in Western hydroelectric contribution is Oregon. Almost fifty percent of Oregon's utility-scale new electric generation in 2019 was sourced from hydroelectric power.[77] With Washington and

72. *100% Clean Energy Collaborative – Table of 100% Clean Energy States*, CLEAN ENERGY STATES ALLIANCE, https://www.cesa.org/projects/100-clean-energy-collaborative/guide/table-of-100-clean-energy-states/ [https://perma.cc/W34M-KRC7].

73. *See generally* Lofthouse et al., *Reliability of Renewable Energy: Hydro*, INST. OF POL. ECON., UTAH STATE UNIV. (2015).

74. 2021 DRAFT NORTHWEST POWER PLAN, *supra* note 31, at 4-24, 25 (reporting the Pacific Northwest hydroelectric system nameplate capacity at 35,000 MW, though generating about 16,000 MW per year on average and 12,000 MW during very dry years); *see also id*. at 6-51 (showing hydropower has been the most predominant energy generation in the Pacific Northwest consistently each year).

75. *Washington: State Profile and Energy Estimates*, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/state/analysis.php?sid=WA [https://perma.cc/6EBA-8AMK].

76. 2021 DRAFT NORTHWEST POWER PLAN, *supra* note 31, at 6-52.

77. *Oregon: State Profile and Energy Estimates*, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/state/?sid=OR [https://perma.cc/AD9Y-UCGC].

Oregon pledging 100% clean energy by 2045 and 2040, respectively, hydro resources could contribute greatly to these states' ability to comply with their statutory clean energy goals.[78] Moreover, export of Washington's and Oregon's hydro resources will be pivotal in allowing other Western states to meet their own clean energy commitments.[79] The Pacific Northwest and the remainder of the Western region share a symbiotic relationship when it comes to meeting demand, in that the Northwest is traditionally winter peaking whereas other Western states are summer peaking.[80] The Western Energy Imbalance Market is one example of a successful market structure facilitating the use of excess hydropower in one Balancing Authority Area[81] to meet demand needs in another Balancing Authority Area economically, with the added benefit of avoiding resource curtailment.[82]

More broadly, hydropower accounts for fifty-two percent of the United States' renewable electricity generation, though comprising only seven percent of the United States' total electricity generation.[83] Even at that low level, hydropower has shown it can compete with fossil fuel resources when consumers need power most. In 2020, hydropower contributed 13.5% of North America's total on-peak capacity, behind only natural gas and coal generation sources.[84] By region, hydroelectricity represents a much greater percentage of the total installed capacity in the Western Interconnection at 26.7% in 2020.[85] As exhibited by the crucial role of Western states' hydropower, there is considerable opportunity for hydropower to expand to increase the United States' overall usage of this clean, renewable resource. Indeed, the Federal and state government have recognized this opportunity by passing legislation for hydropower research, development, and demonstration activities.[86] Hydropower expansion is an issue and opportunity of national interest, as hydropower is generated in every region of the United States.[87]

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78. 2021 DRAFT NORTHWEST POWER PLAN, *supra* note 31, at 6-52.

79. *See* W. ELECTRICITY COORDINATING COUNCIL, *supra* note 8, at 3, Fig. 1 (showing the six Western states with clean energy commitments).

80. *SB 100 Joint Agency Report: Charting a path to a 100% Clean Energy Future,* CAL. ENERGY COMM'N ET AL., at 131–32 (Mar. 15, 2021) (explaining this allows "each region to rely on the other for a share of its seasonal peak capacity needs.") [hereinafter *SB 100 Joint Report*].

81. N. AM. ELEC. RELIABILITY CORP., *supra* note 14.

82. *SB 100 Joint Report*, *supra* note 80, at 132.

83. NAT'L HYDROPOWER ASS'N, *Why Hydro: Available*, https://www.hydro.org/waterpower/why-hydro/available/ [https://perma.cc/K4WY-3KKH].

84. *NERC 2021 State of Reliability Rep.*, *supra* note 4, at 51.

85. W. ELECTRICITY COORDINATING COUNCIL, *supra* note 8, at 5, Fig. 2; *see id*. at 6, Fig. 3 (showing hydroelectric resources comprised 25.7% of the net generation (GWh) mix in 2019 in the Western Interconnection).

86. *See infra* section IV.A.

87. NAT'L HYDROPOWER ASS'N, *Why Hydro: Available*, *supra* note 83.

The U.S. Department of Energy determined in 2012 that the highest potential for hydropower expansion was located in Alabama, Arkansas, Illinois, Kentucky, Pennsylvania, Texas, and Louisiana, largely due to the series of Ohio and Mississippi Rivers locks, dams, and high river flow.[88] According to a FERC Staff report issued in 2017, hydropower potential is concentrated in the Atlantic and Pacific coast mountain regions, the Great Lakes drainage, the Mississippi River Basin, and in Alaska.[89] Some of that potential could be harnessed at existing non-powered dams, presenting a more environmentally conscious solution,[90] as discussed later in Section V. Pumped storage hydroelectric facilities' particular ability to operate over a long period offers another environmental benefit, with the Niagara Power Project serving as a recent example, demonstrating ability to extend even beyond its initial fifty-year FERC license term following upgrades.[91]

Particularly in California, hydroelectric resources have the potential to contribute to the state's zero-carbon targets mandated in the 100 Percent Clean Energy Act of 2018 (Senate Bill 100),[92] an opportunity historically inhibited by state legislation limiting the resource's ability to assist in meeting California's clean energy goals. For example, California's Renewables Portfolio Standard (RPS) generally limits hydroelectric resources that qualify as an "eligible renewable energy resource" to existing small facilities no greater than 30 MW.[93] Limiting the state's RPS program to "small hydro" was intended to promote investment in new, renewable resources. When

88. HADJERIOUA ET AL., AN ASSESSMENT OF ENERGY POTENTIAL AT NON-POWERED DAMS IN THE UNITED STATES, U.S. DEP'T OF ENERGY 24 (2012), https://www.energy.gov/sites/prod/files/2013/12/f5/npd_report_0.pdf [https://perma.cc/S63T-D5RF].

89. *2017 FERC Hydropower Primer*, *supra* note 59, at 3.

90. *Id.*

91. *2021 NHA Pumped Storage Report*, *supra* note 9, at 30, 33 (discussing longevity of pumped storage assets); *1.6 billion clean energy investment to extend operating life of Niagara Power Project*, NIAGARA FRONTIER PUBLICATIONS (Sept. 22, 2021), https://www.wnypapers.com/news/article/current/2021/09/22/148010/1.6-billion-clean-energy-infrastructure-investment-to-extend-operating-life-of-flagship-niagara-power-project [https://perma.cc/ATF5-Y4GF] (describing the Niagara Power Project in New York, in operation for over sixty years, having obtained a new fifty-year license in 2007, and most recently modernization upgrades at one of its pump generating plants).

92. S. 100, 2018 Leg., 2017-2018 Sess. (Cal. 2018), (adding § 454.53 to the California Public Utilities Code to read, in part: "It is the policy of the state that eligible renewable energy resources and zero-carbon resources supply 100 percent of all retail sales of electricity to California end-use customers and 100 percent of electricity procured to serve all state agencies by December 31, 2045.").

93. Cal. Pub. Util. Code § 399.12(e) (2016); Cal. Pub. Res. Code § 25741(a)(1) (2012).

the California Legislature passed the initial RPS, the exclusion of larger hydro from qualifying as meeting the RPS was in recognition of the fact many utilities already had significant hydroelectric resources in their portfolios.

As utilities met their RPS goals, and as investments were made in wind, solar, and other renewable resources, the California Legislature shifted focus toward meeting carbon-free goals, and not only RPS goals. Accordingly, more recent legislation has signaled an openness to valuing large hydro to meet state goals. Senate Bill (SB) 100 still limits California's nearer-term goals to electricity generated from "eligible renewable energy resources," which excludes large hydro.[94] However, in its targets for 2045, SB 100 expanded California's clean energy mandates beyond eligible renewable energy resources to also encompass "zero-carbon resources," thus opening the door to allowing large hydro to assist the state in meeting its longer-term clean energy targets.[95] State agencies charged with drafting a report under SB 100 have interpreted the term "zero-carbon resources," which is not defined in the statute, to include energy resources that qualify as "renewable," as defined by the California Energy Commission in its *Renewables Portfolio Standard Eligibility Guidebook*, or as those generating zero GHG emissions on-site.[96]

Even though SB 100 continues the state's limitations on hydro facilities that can qualify towards meeting California's nearer-term RPS goals,[97] SB 100 may improve certain local publicly owned electric utilities' (e.g., cities and counties) ability to rely on their in-state hydroelectric generation to meet California's near-term RPS goals by reducing their need to procure eligible renewable energy resources.[98] Namely, by contrast to provisions

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94. *See, e.g.*, Cal. Pub. Util. Code § 399.11(a) (2019) (amended by Stats. 2018, Ch. 312, Sec. 2. (SB 100)) (outlining, *inter alia*, a target of generating sixty percent of total retail sales of electricity in California from eligible renewable energy resources by Dec. 31, 2030).

95. *See* CALIFORNIA STATE SENATE, *SB 100: FAQs*, https://focus.senate.ca.gov/sb100/faqs [https://perma.cc/2J6D-68J6].

96. *SB 100 Joint Report, supra* note 80, at 7, 54.

97. *See also* Kavya Balaraman, *Proposed bill would include large hydro, nuclear in California's renewable portfolio standard*, UTILITYDIVE (Jan. 23, 2020), https://www.utilitydive.com/news/proposed-bill-include-large-hydro-nuclear-power-californias-rps/570919/ [https://perma.cc/Y25T-G9LB] (discussing a bill—Assembly Bill 1941, which ultimately died—that would have expanded the definition of "eligible renewable energy resource" to include hydroelectric and nuclear facilities as eligible to help California meets its RPS goals); Legis. Counsel's Dig., Assem. Const. Amend. No. 17 (2019-2020 Reg. Sess.) ch. 190 Stats. of 2017 (proposing to amend California's Constitution to allow all hydro resources to, *inter alia*, be considered as eligible renewable energy resources).

98. *But see CALmatters Commentary: California saying hydropower isn't 'renewable' is silly. Let's change that*, DESERT SUN (July 15, 2019), https://www.desertsun.com/story/opinion/2019/07/15/california-saying-hydropower-isnt-renewable-silly-costly-calmatters-

applicable to investor-owned utilities and other "retail sellers,"[99] SB 100 contains the following provisions that may improve certain local publicly owned electric utilities' ability to rely on their large hydroelectric generation: (1) for cities and counties receiving over sixty-seven percent of their electricity sources from in-state hydroelectric generation that does not meet the definition of "renewable electrical generation facility,"[100] only requiring said municipalities to procure eligible renewable energy resources annually to meet electricity demand not satisfied by the non-qualifying hydroelectric generation;[101] (2) for publicly owned utilities receiving more than forty percent of retail sales from certain in-state "large hydroelectric generation," only requiring procurement of eligible renewable energy resources up to the lesser of the portion of its retail sales unsatisfied by the large hydro generation, or an annual target adopted by the California Energy Commission;[102] and (3) treating as compliant with the statute's renewable energy procurement requirements, a public utility district receiving all of its electricity as a preference right under Section Four of the Trinity River Division Act of 1955, which prioritizes certain customers in Trinity County using additional electric energy available from the Central Valley Project power system.[103]

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commentary/1740080001/ [https://perma.cc/K25X-FCCG] (noting Turlock Irrigation District estimates SB 100's exclusion of hydro from eligible renewables to meet the state's RPS targets will cost the publicly-owned utility's 100,000 customers an additional $300 million).

99. Cal. Pub. Util. Code § 399.12(j) (defining "retail sellers" to include electrical corporations, community choice aggregators, and electric service providers, though expressly excluding from the definition local publicly owned electric utilities among others); Legis. Counsel's Dig., Sen. Bill No. 100 (2017-2018 Reg. Sess.) ch. 312 Stats. of 2018, Sec. 5 (amending § 399.15 as applicable to retail sellers, whereas amended § 399.30 applies to local publicly owned electric utilities).

100. Cal. Pub. Res. Code § 25741(a)(1) (2012) (including only hydroelectric generation 30 MW or less in the definition of "renewable electrical generation facility," and not larger hydro facilities).

101. *See* Cal. Pub. Util. Code § 399.30(j) (2020) (amended by Stats. 2020, Ch. 305, Sec. 2. (SB 702)).

102. *See* Cal. Pub. Util. Code § 399.30(k), (k)(1) (2020) (amended by Stats. 2020, Ch. 305, Sec. 2. (SB 702)) (defining "large hydroelectric generation" for purposes of this sub-division as limited to in-state hydro facilities not qualifying as an "eligible renewable energy resource and, as of January 1, 2018, owned by a publicly-owned utility, the Federal government as part of the Central Valley Project, or a joint powers agency formed under the Joint Exercise of Powers Act). *But see* Cal. Pub. Util. Code § 399.30(k)(5) (noting its provision does not modify the publicly-owned utility's obligation to meet requirements in § 399.16(c), which requires all retail sellers to meet certain portfolio content requirements).

103. Cal. Pub. Util. Code § 399.30(g) (2020) (amended by Stats. 2020, Ch. 305, Sec. 2. (SB 702)); H.R. Res. 4663, 84th Cong. (1995) (enacted) (authorizing the Secretary of

With California laser-focused on de-carbonization, while facing the impending 2025 retirement of one of the state's most crucial carbon-free generating facilities comprising roughly ten percent of California's total generation,[104] hydroelectric resources are well-positioned to fill the void of carbon-free reliable power.[105] Already, according to the National Hydropower Association, California's largest pumped storage hydroelectric facilities are greater than 1,500 MW in size, with typically eight hours of storage.[106] Because closed-loop pumped storage, in particular, could ideally be sited near existing transmission paths, it promotes California's focus on the "Garamendi Principles," summarized in the California agencies' recent SB 100 joint report as "encouraging strategies to maximize the use of the existing transmission system and existing rights-of-way before considering the expansion or creation of new rights-of-way."[107]

Nonetheless, while recognizing small and large hydro's ability to meet SB 100's criteria for RPS and zero-carbon resources, respectively, California's state agencies (charged with reporting to the legislature every four years on the alternative scenarios by which SB 100's policy can be achieved)[108] excluded modeling new small hydro (due to "inadequate data on new capacity cost and resource availability for modeling purposes") and new large hydro (due to "limited development feasibility at this time and

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the Interior to construct, operate, and maintain the Trinity River division, Central Valley project, California, under Federal reclamation laws—and, in relevant part, authorizing hydroelectric power plants up to a total generating capacity of about 235,000 kW).

104. *See* FINAL ROOT CAUSE ANALYSIS, *supra* note 2, at 23 (noting that, for CAISO, the most severe single contingency that could destabilize the Balancing Authority Area, is the loss of either the Diablo Canyon Power Plant or the Pacific DC Intertie transmission line); *see also* CAL. INDEP. SYS. OPERATOR, DEP'T OF MARKET MONITORING, *2020 Annual Report on Market Issues and Performance* (Aug. 2021), at 35–36, Fig. 1.7, http://www.caiso.com/Documents/2020-Annual-Report-on-Market-Issues-and-Performance.pdf [https://perma.cc/NV67-H35Z] [hereinafter *DMM 2020 Annual Report*] (showing nuclear comprised roughly ten percent of the CAISO Balancing Authority Area's average hourly generation in 2020, though nearing the five percent range in October through December 2020).

105. *See, e.g.*, *2018 NHA Pumped Storage Report*, *supra* note 7, at 8, 15; *see also* 2021 DRAFT NORTHWEST POWER PLAN, *supra* note 31, at 10-101 ("Since hydropower has a low variable cost and is flexible, [Northwest Power and Conservation Council's] analysis shows that it is well positioned to help the region absorb increasing renewable generation and ensure adequacy in the region."). *See also DMM 2020 Annual Report, supra* note 104, at 164, Fig. 5.5 (showing the CAISO Balancing Authority Area, over the 2018 through 2020 period, relied heavily on the natural gas fleet for ancillary services, though hydroelectric resources also contributed significantly especially in terms of spinning reserves).

106. *2021 NHA Pumped Storage Report, supra* note 9, at 30.

107. *SB 100 Joint Report*, *supra* note 80, at 112 & n.135 (citing California's Senate Bill 2431, ch. 1457); *see 2017 NHA Pumped Storage Report, supra* note 11, at 9 (observing closed-loop pumped storage systems, because they do not rely on a nearby water body, are beneficial in that they can "be located where needed to support the grid").

108. Cal. Pub. Util. Code § 454.53(d).

environmental concerns") from their initial 2021 SB 100 joint report.[109] However, the 2021 SB 100 joint report does acknowledge the value hydro, as energy storage—in particular, long-duration storage such as pumped hydro—would add to the system in terms of providing stability and reliability as a counterbalance to increasing variable resources.[110]

Pumped storage hydro provides similar flexibility benefits as long-duration battery storage, while avoiding several of its downsides that the 2021 SB 100 joint report points out necessitate further research and innovation (i.e., "environmental issues . . . including reliance on rare earth minerals," "fire potential at storage facilities," and "end-of-life disposal and recycling of the battery.").[111] The 2021 SB 100 joint report's focus on anticipated reduction in hydropower availability due to projected decline in spring and summer snowmelt,[112] should not overshadow the key grid services that flexible hydro resources have provided during extreme heat events even during low hydrological condition years, as discussed below in Section III.D. The National Hydropower Association points out pumped storage systems are resilient to drought and other unanticipated weather patterns because "the water used for generation is recycled from upper to lower reservoir, and not released to the natural stream flow . . . ."[113] California's trajectory in failing to replace natural gas with dependable resources like hydro may become a cautionary tale, as the rise in additions of intermittent wind and solar capacity cannot be relied on during evening hours when flexible capacity is most needed.[114] Europe has already shown the danger of overreliance on intermittent resources, where, in September 2021,

109. *SB 100 Joint Report, supra* note 80, at 9 (Table 4), 58–59. *But see id*. at 75 (assuming 1.7 GW pumped storage added for the sixty percent RPS scenario).

110. *Id.* at 108–09.

111. *Id.* at 109; *see also 2021 NHA Pumped Storage Report*, *supra* note 19, at 30 (comparing the fifty-year life cycle of pumped storage equipment assuming up to ten stops per day, with the ten-year life cycle of modern battery systems assuming one start and stop per day); *2021 NHA Pumped Storage Report*, *supra* note 19, at 33 (pointing to pumped storage's benefit over lithium-ion batteries' cell replacement costs and waste).

112. *SB 100 Joint Report*, *supra* note 80, at 128.

113. *2018 NHA Pumped Storage Report*, *supra* note 7, at 24.

114. *See DMM 2020 Annual Report, supra* note 104, at 16 (Aug. 2021) (noting trends in available nameplate capacity from June of 2014 through 2021, and replacement of gas capacity primarily by solar, wind, demand response, and batteries, though noting "variable energy and demand response resources generally have limited energy and availability compared to gas capacity."); *see id*. at 17 ("The [CAISO] has emphasized the need to maintain adequate flexibility from both conventional and renewable generation resources to maintain reliability as more renewable resources come on-line").

energy prices soared when wind resources in the North Sea halted, requiring coal and natural gas to fill in as replacement supply and revealing a need for back up resources going forward.[115]

Further, to the extent many Western states desire to replace fossil fuels with equally-reliable resources, the demonstrated trend of more frequent and extreme weather events across the West Coast demands nearer term solutions that can utilize existing infrastructure and transmission paths. Hydropower presents one significant partial solution, especially as other resource types are still being developed. For example, while offshore wind has gained much attention in recent years as a resource with potential to contribute to de-carbonization and economic goals,[116] for many parts of the United States too many obstacles lie in the way of development to make this resource type a dependable solution in the near future. As of 2021, California has only just begun to assess the needs for transmission to make offshore wind development viable in its transmission planning studies.[117] The National Renewable Energy Laboratory anticipates a need for significant and costly upgrades to the bulk transmission system to accommodate commercial-scale offshore wind in California.[118] By contrast, because it does not rely on a connected waterway, as discussed above, closed-loop pumped storage hydro can be sited in proximity to existing transmission. Further, because it acts as a battery, pumped storage can avoid the need

115. Joe Wallace, *Energy Prices in Europe Hit Records after Wind Stops Blowing*, WALL ST. J., (Sept. 13, 2021), https://www.wsj.com/articles/energy-prices-in-europe-hit-records-after-wind-stops-blowing-11631528258?page=1 [https://perma.cc/C4K3-UXW9].

116. *See, e.g.*, *Fact Sheet: Biden Administration Jumpstarts Offshore Wind Energy Projects to Create Jobs* (Mar. 29, 2021), https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/29/fact-sheet-biden-administration-jumpstarts-offshore-wind-energy-projects-to-create-jobs/ [https://perma.cc/WJ2M-5666].

117. *SB 100 Joint Report, supra* note 80, at 108 (noting the California Public Utilities Commission's plan to propose that the state's grid operator study offshore wind's transmission needs in its next transmission planning process commencing in February 2021). CAL. INDEP. SYS. OPERATOR, *Final 2021-2022 Study Plan*, at 27 (Mar. 31, 2021) ("[California] will be conducting an offshore wind study as defined in the sensitivity study provided by the [California Public Utilities Commission] for the Policy Assessment. . . .").

118. NAT'L RENEWABLE ENERGY LAB., *The Cost of Floating Offshore Wind Energy in California between 2019 and 2032,* at vii-viii, 78 (Nov. 2020), https://www.nrel.gov/docs/fy21osti/77384.pdf [https://perma.cc/QY3G-3DFP]; *see id*. at 41–42 (discussing the high costs of transmission upgrades needed to support offshore wind in California, and the risks that merchant transmission developers and conversely offshore wind developers face if the generation or transmission is not built, respectively); *see also* CAL. INDEP. SYS. OPERATOR, Board Approved 2020-2021 Transmission Plan, at 28 (Mar. 14, 2021), http://www.caiso.com/Documents/BoardApproved2020-2021TransmissionPlan.pdf [https://perma.cc/P538-JQHR] (noting the central coast can accommodate approximately 5-6 GW of offshore wind generation, but the north coast area would require transmission development).

for additional transmission.[119] Beyond transmission obstacles, overlapping stakeholder interests in the coastal areas,[120] and floating wind turbines' location further offshore present financial, environmental, and aesthetic uncertainties that may inhibit investment,[121] suggesting a substantial need for nearer-term solutions to provide flexibility on the West Coast.

B. Hydropower Storage Potential

Hydroelectric resources are a critical form of energy storage due to their ability to store large quantities of water in reservoirs (excluding run-of-river projects) to call on when demand rises. Energy storage encompasses a broad range of resources, which include what one often thinks of when mentioning storage, the lithium-ion battery. However, hydroelectric energy is itself a form of storage, with the ability to convert purposefully built up potential energy into kinetic energy when called upon.[122] Hydroelectric pumped storage goes one step further by recharging reservoirs in time periods when the hydroelectric generators are not being used to produce electricity.

With the increase of renewable resources interconnecting to the grid, entities are recognizing the benefits—and the necessity—of "long-duration" energy storage.[123] Long-duration energy storage can offer certain complementary services: (1) meeting peak load needs; (2) providing time varying energy management; (3) improving reliability; and (4) alleviating the intermittence of renewable resource power generation.[124] While the

119. *See* 2021 DRAFT NORTHWEST POWER PLAN, s*upra* note 31, at 101–02 ("Battery storage and targeted demand response, for example, can provide significant value to deferring the need for adding transmission.").

120. *See, e.g.,* U.S. DEP'T OF THE INTERIOR, BUREAU OF OCEAN ENERGY MGMT., *Outreach Summary Report: California Offshore Wind Energy Planning*, at 4 (Sept. 2018), https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/CA/Outreach-Summary-Report-September-2018.pdf [https://perma.cc/SR2D-ZB55]; *SB 100 Joint Report*, *supra* note 80, at 107 (noting the following factors "severely limit the feasible resource potential" of offshore wind: transmission requirements, shipping, fishing, recreation, marine conservation, and Department of Defense activities).

121. *See SB 100 Joint Report, supra* note 80, at 107–08.

122. *2017 FERC Hydropower Primer*, *supra* note 59, at 4.

123. *See, e.g.,* CAL. PUB. UTILITIES COMM'N, 2019-2020 ELECTRIC RESOURCE PORTFOLIOS TO INFORM INTEGRATED RESOURCE PLANS AND TRANSMISSION PLANNING, at 41 (" . . . the new resource buildout . . . identifies a need for roughly 1 GW of pumped storage, or other long-duration storage with similar attributes, by 2026.").

124. CAL. ENERGY COMM'N, COMMENTS OF LONG DURATION ENERGY STORAGE ASSOCIATION OF CALIFORNIA, CEC Docket No. 19-ERDD-01, at slide 10 (Jan. 25, 2021); *2018 NHA Pumped Storage Report*, *supra* note 7, at 13.

definition of long-duration energy storage may be evolving,[125] a community choice aggregator in California recently issued a call for long-duration energy storage, defining long-duration energy storage as 50 MW or greater and able to discharge electrons at that level for eight hours or more.[126] As of September 2019, almost ninety-four percent (i.e., 22.5 GW) of energy storage operating in the United States comes from pumped hydro storage,[127] and, as of September 2021, there is roughly 22.9 GW of pumped storage capacity in the United States spread across approximately forty facilities.[128]

The high voltage transmission grid operator and balancing authority for the majority of California load and a small part of Nevada load, the California Independent System Operator Corporation (CAISO),[129] identifies storage, in general, as a solution to manage California's oversupply issues, resulting from the vast addition of renewable resources to the CAISO grid in response to California's policy and statutory de-carbonization goals.[130] California is a clean energy world leader, at one point meeting nearly ninety-five percent of energy needs within the CAISO Balancing Authority Area with renewable resources.[131] However, many renewable resources

125. *See generally* Julian Spector, *So, What Exactly Is Long-Duration Energy Storage?*, GREENTECH MEDIA (Oct. 26, 2020), https://www.greentechmedia.com/articles/read/so-what-exactly-is-long-duration-storage-explained [https://perma.cc/P24F-HTLB] ("But beyond the high-level predictions, it's hard to find a consistent definition….").

126. *See Request for Offer Proposal*, SILICON VALLEY CLEAN ENERGY ET AL. (Oct. 2020), https://www.svcleanenergy.org/joint-lds-rfo/ [https://perma.cc/M5NY-33CS] ("Eight community choice energy agencies jointly seek to procure Long-Duration Storage . . . to cost-effectively enhance renewable energy portfolios and aid in achieving California's aggressive greenhouse gas reduction targets.").

127. CAL. INDEP. SYS. OPERATOR, *Energy Storage: Perspectives from California and Europe* (Oct. 2019), https://www.caiso.com/Documents/EnergyStorage-PerspectivesFrom California-Europe.pdf [https://perma.cc/4SYS-T7PJ].

128. *2021 NHA Pumped Storage Report*, *supra* note 9, at 34; *see also id.* at 30 (providing pumped storage comprises ninety-five percent (95%) of the globally installed energy storage systems).

129. CAISO is a "state chartered, California non-profit public benefit corporation that operates the transmission facilities of all Participating [Transmission Owners] and dispatches certain Generating Units and Loads." CAISO Tariff, app. A. The CAISO Balancing Authority Area covers a footprint of about eighty percent of California and some of Nevada; as the "balancing authority," CAISO operates a transmission control area, and matches generation and demand. CAL. INDEP. SYS. OPERATOR, *The ISO Grid*, http://www.caiso.com/about/Pages/OurBusiness/The-ISO-grid.aspx [https://perma.cc/E3JL-YVZQ].

130. CAL. INDEP. SYS. OPERATOR, *Managing Oversupply*, http://www.caiso.com/Documents/ManagingOversupply-Solutions.pdf [https://perma.cc/A6EV-WGKZ]; CAL. INDEP. SYS. OPERATOR, *Managing Oversupply: Oversupply and curtailments*, http://www.caiso.com/informed/Pages/ManagingOversupply.aspx [https://perma.cc/V7AJ-QR8Y].

131. OFFICE OF THE GOVERNOR OF CALIFORNIA, Gavin Newsom, *California's Electricity System of the Future*, at 4 (July 2021), https://www.gov.ca.gov/wp-content/

are necessarily bid into the CAISO markets only during limited time periods when they are available, for example, in mid-afternoon for solar. Accordingly, CAISO must curtail[132] significant amounts of renewable energy when generation exceeds demand.[133] For example, in March, the month with the highest curtailments in 2021, CAISO curtailed 341,959 MWh of wind and solar generation.[134] Moreover, the U.S. Energy Information Administration reports CAISO curtailed five percent (i.e., 1.5 million MWh) of the Balancing Authority Area's total utility-scale solar production in 2020.[135] Storage resources, in the form of hydroelectric resources, can decrease the need for curtailment by reducing oversupply risk and increasing grid flexibility (without relying on other flexible fossil fuel generation)—specifically, during potential oversupply events where variable resources otherwise would be curtailed, because that output can be stored and re-dispatched,

uploads/2021/07/Electricity-System-of-the-Future-7.30.21.pdf [https://perma.cc/B9E8-E5PW].

132. CAISO explains solar and wind resources are able to "curtail," or reduce, their production output during conditions when supply exceeds customer demand, whereas other renewable resources such as small-conduit hydroelectric, geothermal, biomass, and biogas, cannot; this reduction of output can occur through "market-based" curtailments when CAISO's market software automatically adjusts supply, or through "manual" curtailments as a last resort where CAISO "exceptionally dispatches" specific solar and wind facilities to reduce their output. CAL. INDEP. SYS. OPERATOR, FAST FACTS: IMPACTS OF RENEWABLE ENERGY ON GRID OPERATIONS, at 1–2 (May 2017), https://www.caiso.com/documents/curtailmentfastfacts.pdf [https://perma.cc/888L-2P9N]; Bentham Paulos, *Too Much of a Good Thing? An Illustrated guide to solar curtailment on California's grid*, GREENTECH MEDIA, (Apr. 3, 2017), https://www.greentechmedia.com/articles/read/an-illustrated-guide-to-solar-curtailment-in-california [https://perma.cc/3PQ6-Q7NP] (suggesting "curtailment" can also be characterized as deviations from forecasted output).

133. David G. Victor, *Pumped Energy Storage: Vital to California's Renewable Energy Future*, at 4–5 (May 21, 2019). In 2018, CAISO stopped or curtailed about 460,000 MWh of renewable energy, which equals about 80,000 households' total annual energy consumption and is equal to a $150 million solar project sitting idle all year. Avoiding this 460,000 MWh curtailment of renewable energy would have cut about 720 million pounds of GHG, which is the equivalent of 800 million miles driven by the average American passenger car. *Id.*

134. CAL. INDEP. SYS. OPERATOR, *Managing Oversupply*, http://www.caiso.com/Documents/ManagingOversupply-Solutions.pdf [https://perma.cc/A6EV-WGKZ].

135. U.S. ENERGY INFO. ADMIN., *California's curtailments of solar electricity generation continue to increase*, https://www.eia.gov/todayinenergy/detail.php?id=49276 [https://perma.cc/YT3E-6ZSV]; Eric O'Shaughnessy et. al., *Too Much of a Good Thing? Global Trends in the Curtailment of Solar PV*, at 1074, SOLAR ENERGY 208 (2020) 1068–77 (estimating that adding 1,000 MW of storage capacity to Nevada's grid may reduce renewable energy curtailment by fifty percent).

obviating the need for curtailment while storing electricity for when it is needed.[136]

By providing flexibility, pumped storage hydro can help manage CAISO's oversupply challenges.[137] Flexibility is important because of the sudden shifts in resource availability experienced by grid operators like CAISO. For example, electric load often increases or remains high in the evening as the sun goes down and solar resources' output decreases.[138] Other resources must be dispatched rapidly to meet this higher demand. A graphical depiction of this phenomenon appears like a duck, and has been described as the "Duck Curve," where the neck of the duck reflects the need to ramp up other resources to meet the evening demand when solar is no longer available.[139] Pumped storage hydro resources may be well-suited to meet demand during the evening ramp, and can replace reliance on gas-fired facilities to meet this ramp.[140] Such flexibility helps explain why CAISO found that a 500 MW pumped storage project in Southern California would provide ratepayers with savings of up to fifty-one million dollars per year due to improved system operation.[141] One other study concluded California cannot meet its renewable and climate goals reliably without large-scale energy storage.[142]

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136. O'Shaughnessy et al., *supra* note 135, at 1074; *see* Paul Denholm and Trieu Mai, *Timescales of Energy Storage Needed for Reducing Renewable Energy Curtailment*, 130 RENEWABLE ENERGY 388 (2019).

137. CAL. INDEP. SYS. OPERATOR, *Managing Oversupply*, http://www.caiso.com/Documents/ManagingOversupply-Solutions.pdf [https://perma.cc/A6EV-WGKZ]; *see, e.g.*, *2018 NHA Pumped Storage Report, supra* note 7, at 15–16 (pointing to the value of pumped storage hydro in the CAISO to help manage oversupply issues).

138. *See* FINAL ROOT CAUSE ANALYSIS, *supra* note 2, at 44.

139. *See, e.g.,* CAL. INDEP. SYS. OPERATOR, FAST FACTS: WHAT THE DUCK CURVE TELLS US ABOUT MANAGING A GREEN GRID, at 1, https://www.caiso.com/documents/flexibleresourceshelprenewables_fastfacts.pdf [https://perma.cc/4U5A-TS2E].

140. *2021 NHA Pumped Storage Report*, *supra* note 9, at 32 (noting pumped storage can replace natural gas peakers used to mitigate large evening ramps). *See 2018 NHA Pumped Storage Report, supra* note 7, at 3 ("Pumped storage hydropower (PSH), also referred to as a "water battery", has continued to advance its technology in recent years, including the capability for very fast response to grid signals. . . ."); *see also* Wagman, *supra* note 9 ("Integrated storage could enhance [run-of-river hydro] power by making it possible to ramp power up or down on demand.").

141. CAL. INDEP. SYS. OPERATOR, *Bulk Energy Storage Resources Case Study Updated from 40% to 50% RPS*, 2015-2016 Transmission Planning Process, https://www.caiso.com/Documents/BulkEnergyStorageResource-2015-2016SpecialStudyUpdatedfrom40to50Percent.pdf [https://perma.cc/SX8P-9JA7]; *see also* Water News Network, *Water Authority Supports Bill to Spur Pumped Storage Projects*, SAN DIEGO COUNTY WATER AUTH. (May 15, 2019), https://www.waternewsnetwork.com/water-authority-supports-bill-spur-pumped-storage-projects/ [https://perma.cc/T6PP-KRUL].

142. Victor, *supra* note 133, at 3.

While, as noted above, the basic case for pumped storage is to pump at night and release water into the turbines during the day to provide electricity during higher demand times, pumped storage also has the capability to quickly respond to grid signals, allowing it to act as a flexible, long-duration storage resource.[143] In addition, pumped storage is efficient—current pumped storage round-trip efficiency exceeds eighty percent and can typically provide ten hours of electricity.[144] Pumped hydro is the cheapest energy storage technology in the world, in terms of cost per installed kilowatt-hour of capacity.[145] As the World Bank figures show, the total project costs for pumped storage vary between $106 and $200 per kilowatt-hour compared with between $393 and $581 per kilowatt-hour for lithium-ion battery storage.[146]

C. Ancillary Services Benefits

Hydroelectric facilities provide valuable services to the grid that support "transmission of capacity and energy from resources to loads," while ensuring the grid's reliable operation, referred to as "ancillary services."[147] The electric grid must be balanced at all times, which means supply must meet demand, or load. Maintaining this balance requires fast-responding resources to manage minor variances in electric load and requires electricity to be flowing at a stable frequency. Ancillary services are those services that power generation can provide in addition to its basic production of energy (megawatt-hours) for consumption. Hydroelectric resources, including pumped storage, also provide these ancillary services, and in some cases,

143. *2018 NHA Pumped Storage Report*, *supra* note 7, at 7; *see also 2021 NHA Pumped Storage Report*, *supra* note 9, at 29 ("In addition, [Pumped Storage Hydro]'s flexibility provides the grid with fast ramping capability, minimum run times and multiple quick starts.").

144. *2018 NHA Pumped Storage Report*, *supra* note 7, at 7.

145. Jason Deign, *Pumped Hydro Moves to Retain Storage Market Leadership*, GREENTECH MEDIA (Nov. 4, 2020), https://www.greentechmedia.com/articles/read/pumped-hydro-moves-to-retain-storage-market-leadership#:~:text=Pumped%20hydro%20is%20already%20the,batteries%2C%20World%20Bank%20figures%20show [https://perma.cc/CT2K-4EJJ]; *2018 NHA Pumped Storage Report*, *supra* note 7, at 18.

146. Deign, *supra* note 145; *see also 2021 NHA Pumped Storage Report*, *supra* note 9, at 17 (stating pumped storage hydropower is nearly two to three times less expensive, and annual O&M costs three times less, than lithium-ion batteries).

147. *See* N. AM. ELEC. RELIABILITY CORP., *supra* note 14, at 2 (defining "Ancillary Service" as "[t]hose services that are necessary to support the transmission of capacity and energy from resources to loads while maintaining reliable operation of the Transmission Service Provider's transmission system in accordance with good utility practice").

are especially suited to do so.[148] For example, the Bureau of Reclamation can vary water releases from its Glen Canyon Dam in order to respond to forced outages or system emergencies.[149] Hydropower's ability to generate power instantaneously is viewed not only as a benefit during system outages, but also as a benefit in terms of incorporating variable energy resources.[150] One limitation is that the pumped storage hydro subset of hydroelectric facilities has physical constraints on their transition times from pumping to generating modes.[151]

One of the most important ancillary services hydroelectric resources are known for providing is "black start" service—provided by resources capable of starting without support from the grid or capable of staying energized while isolated from the rest of the system—given that waterways and reservoirs are generally available at any time (recognizing limitations due to environmental factors and otherwise).[152] Black start

148. *See, e.g., DMM 2020 Annual Report, supra* note 104, at 164, Fig. 5.5 (showing hydroelectric resources contributed the most spinning reserves to the CAISO Balancing Authority Area of any resource type over the 2018 through 2020 period, while also contributing other ancillary service types).

149. U.S. DEP'T OF THE INTERIOR, BUREAU OF RECLAMATION, *Glen Canyon Dam,* https://www.usbr.gov/uc/water/crsp/cs/gcd.html [https://perma.cc/XJ9G-8NMM] ("Depending on the severity of the system emergency, the response from Glen Canyon Dam can be significant, within the full range of the operating capacity of the power plant for as long as is necessary to maintain balance in the transmission system. Glen Canyon Dam currently maintains 30 [MW] (approximately 800 cfs) of generation capacity in reserve in order to respond to a system emergency even when generation rates are already high.").

150. *2017 FERC Hydropower Primer*, *supra* note 59, at 3, 9; *see also 2021 NHA Pumped Storage Report*, *supra* note 9, at 9–10 (pointing to pumped storage hydro projects that exhibited shifts from nighttime to daytime pumping in recent years, corresponding with the rise in solar and wind resources).

151. *See* CAL. INDEP. SYS. OPERATOR, *Compliance Filing*, FERC Docket No. ER19-468, Transmittal Letter at 4-5 (Jan. 21, 2020), http://www.caiso.com/Documents/Jan21-2020-Response-Order-FurtherCompliance-Order841-ElectricStorageParticipation-ER19-468.pdf#search=ER19%2D468 [https://perma.cc/P32R-ZGZ5] (noting that, because pumped-storage hydro relies on gravity and water flow to generate energy or demand, it has physical constraints on how quickly it can transition from charging to discharging, unlike battery technologies using CAISO's Non-Generator Resource participation model that can do so "near instantaneously"). *See also* CAL. INDEP. SYS. OPERATOR, *Compliance with Order No. 841*, FERC Docket No. ER19-468, Transmittal Letter at 21 (Dec. 3, 2018), http://www.caiso.com/Documents/Dec3-2018-Compliance-OrderNo841-ElectricStorage Participation-ER19-468.pdf#search=ER19%2D468 [https://perma.cc/6CRL-RH77] (noting FERC observed in Order No. 841 that pumped-hydro resources need charge time and run time limits to account for slow transition speeds).

152. *See* N. AM. ELEC. RELIABILITY CORP., *supra* note 14, at 5 (defining "Blackstart Resource"); *see* Gracia, *supra* note 15, at vi ("[H]istorically, power systems have relied heavily on hydropower plants for black start capability" because of ability to start quickly with minimal local energy needed to start-up internal equipment and because "'fuel' from waterways and reservoirs is constantly available."); *see also* FED. ENERGY REGULATORY COMM'N, *Energy Primer: A Handbook for Energy Market Basics*, 57 (Apr. 2020) (noting

service is important for restoring the grid after an outage, and is similar to an ignition switch. While hydropower represents less than ten percent of the nation's electric generation capacity, it provides approximately forty percent of black start resources, and more than seventy percent of hydropower capacity can perform a black start within ten minutes.[153] One caveat is that the pumped storage subset of hydroelectric facilities will only be able to provide black start service to the extent some water is always held in reserve in the upper reservoir.[154] Though combustion turbine technology provides most of the nation's black start service, its dependence on available fuel supply[155] may make it a less reliable option overall, as events like the February 2021 extreme cold weather front showed the vulnerability of natural gas fuel supply in certain regions.[156]

Other ancillary services hydroelectric facilities provide, particularly in the Western Interconnection, are operating reserves—including spinning reserves (i.e., when hydro resources are already online and able to adjust output) and non-spinning reserves (i.e., when hydro resources are capable of coming online within a specified period of time, typically within ten minutes).[157] For example, a FERC Staff Report noted that, during normal operation, pumped storage facilities can reduce their load to provide spinning reserves.[158] The Northwest Power and Conservation Council's Draft 2021 Northwest Power Plan notes that "as more intermittent or variable

hydroelectric facilities and diesel generators are the predominant resources with black start capability) [hereinafter *Energy Primer: A Handbook for Energy Market Basics*].

153. HYDROPOWER MARKET REP., *supra* note 14, at 19.

154. Gracia, *supra* note 15, at v (observing pumped storage hydro units may be incapable of providing black start if economic dispatch depletes the upper reservoir, thus some water must always be held in reserve to provide this service).

155. *Id.* at 6.2.

156. FED. ENERGY REGULATORY COMM'N ET AL., FEBRUARY 2021 COLD WEATHER GRID OPERATIONS: PRELIMINARY FINDINGS AND RECOMMENDATIONS, at slide 9 (Sept. 23, 2021), https://www.ferc.gov/media/february-2021-cold-weather-grid-operations-preliminary-findings-and-recommendations-full [https://perma.cc/YQT8-URFV] ("From February 8 through February 20, 2021, of the 1,293 unplanned generating unit outages, derates, and failures to start that were due to fuel issues, 1,121 [eighty-seven percent] were due to natural gas fuel supply issues.").

157. ELECTRIC POWER RSCH. INST., QUANTIFYING THE VALUE OF HYDROPOWER IN THE ELECTRIC GRID: FINAL REPORT at 2–3 – 2–4 (2013) [hereinafter QUANTIFYING THE VALUE OF HYDROPOWER IN THE ELECTRIC GRID]; *id*. at Table 2-1 (outlining the energy and ancillary services hydro resources can provide). *See Energy Primer: A Handbook for Energy Market Basics*, *supra* note 152, at 57.

158. *See Energy Primer: A Handbook for Energy Market Basics, supra* note 152, at 57.

generation from wind and solar power are [sic] added to the system, a corresponding increase in reserves is necessary[,]" which the Northwest region relies on, in part, from existing hydropower generation.[159]

Further, hydroelectric resources are capable of maintaining system frequency through "regulation" service, by responding to a dispatcher's Automatic Generation Control signal to address short-term changes in load.[160] CAISO has flagged its concerns about frequency response capabilities as conventional generation is displaced with renewable resources lacking automated capability.[161] In addition, hydro resources can provide load-following assistance (although an energy service, rather than ancillary service) by providing energy to follow load.[162] The National Hydropower Association emphasizes the value of pumped storage as capable of providing load-following and regulation services at night, which can accommodate net load[163] changes on the system associated with increasing variable energy resources.[164] This is useful in maintaining reliability when solar generation decreases in the late afternoon without a commensurate decrease in load (i.e., peak net load), a challenge the CAISO footprint faced in August 2020 that resulted in rotating outages.[165] In general, hydropower's ability to meet demand in peak net load hours could avoid the need for CAISO operators' manual load forecast adjustments that serve to increase imports and commit additional units within the CAISO Balancing Authority Area,

159. 2021 DRAFT NORTHWEST POWER PLAN, *supra* note 31, at 1-1; *see id.* at 4-22.

160. *See Energy Primer: A Handbook for Energy Market Basics*, *supra* note 152, at 56; QUANTIFYING THE VALUE OF HYDROPOWER IN THE ELECTRIC GRID, *supra* note 157, at 2-3 to 2-4, Table 2-1; *see* N. AM. ELEC. RELIABILITY CORP., *supra* note 14 (defining "Regulation Service" as "[t]he process whereby one Balancing Authority contracts to provide corrective response to all or a portion of the [Area Control Error] of another Balancing Authority. . . .").

161. CAL. INDEP. SYS. OPERATOR, FAST FACTS: WHAT THE DUCK CURVE TELLS US ABOUT MANAGING A GREEN GRID, at 4, https://www.caiso.com/documents/flexibleresources helprenewables_fastfacts.pdf [https://perma.cc/4U5A-TS2E].

162. QUANTIFYING THE VALUE OF HYDROPOWER IN THE ELECTRIC GRID, *supra* note 157, at 2-3 to 2-4.

163. Net load is the "difference between forecasted load and expected electricity production from variable generation resources." CAL. INDEP. SYS. OPERATOR, FAST FACTS: WHAT THE DUCK CURVE TELLS US ABOUT MANAGING A GREEN GRID, at 1, https://www.caiso.com/documents/flexibleresourceshelprenewables_fastfacts.pdf [https://perma.cc/4U5A-TS2E].

164. *2017 NHA Pumped Storage Report*, *supra* note 11, at 14; *2018 NHA Pumped Storage Report*, *supra* note 7, at 16; *2021 NHA Pumped Storage Report*, *supra* note 9, at 20.

165. FINAL ROOT CAUSE ANALYSIS, *supra* note 2, at 4. *See also* Atle Harby et al., *supra* note 9 (describing how hydropower generation profiles closely follow net load profiles in the CAISO footprint). Herein, the authors used the colloquial term "footprint" interchangeably with the technical term "Balancing Authority Area." *See* N. AM. ELEC. RELIABILITY CORP., *supra* note 14.

and which have contributed to increased wholesale energy costs.[166] A 2021 National Renewable Energy Laboratory report reinforces hydropower's ability to "contribute substantially when energy production has the most value to the grid (high net load) and reduce generation when it has the least (low net load)[,]" helping to reduce intermittent resource curtailment during the low net load hours.[167]

Beyond the Western Interconnection, in the PJM Interconnection (PJM) in the Mid-Atlantic region, hydropower supplied a larger percentage of regulation, non-synchronized reserve and day-ahead scheduling reserve in 2014-2019 than the installed capacity it represents within the PJM footprint.[168] Based on its operational experience, PJM found that hydropower offers the most complete set of reliability attributes for flexibility and essential reliability services including frequency response, voltage control, ramping, and black start capability.[169] In addition, hydropower contributes to the supply of most of PJM's reserve products.[170] In ISO New England, at least two-thirds of hydropower capacity provides reserves and voltage control.[171] In its 2021 U.S. Hydropower Market Report, the Department of Energy also noted that, in nearly every Balancing Authority Area assessed, hydropower was more extensively used for hourly ramping flexibility than any other resource.[172]

D. Dependability During Extreme Weather Events: CAISO Case Study

Hydroelectric resources have proven dependable during extreme weather events, especially in the CAISO Balancing Authority Area. For example, during the Western United States' extreme heat wave in Summer 2020, a one-in-thirty year weather event, CAISO relied on hydro and pumped storage resources participating under its Resource Adequacy (RA) program,

166. *See DMM 2020 Annual Report, supra* note 104, at 2 (Aug. 2021) (pointing to manual adjustments to CAISO system loads of roughly 1,000 MW in peak net load ramp hours in 2020, as one contributing factor that increased wholesale energy costs in 2020); *id.,* at 10 (explaining CAISO operators regularly uses load adjustments to increase ramping capacity during morning and evening hours when net loads sharply increase).

167. NAT'L RENEWABLE ENERGY LAB., *The North American Renewable Integration Study: A U.S. Perspective*, at 68–70, Fig. 51 (June 2021).

168. HYDROPOWER MARKET REP., *supra* note 14, at 18.

169. *Id*. at 117.

170. *Id*. at 120.

171. *Id*. at 119.

172. *Id*. at iv.

including through provision of ancillary services,[173] even though California hydro conditions for Summer 2020 were below normal.[174]

In California, hydroelectric resources may provide capacity under the state's RA program, a regulatory compliance program[175] that serves to ensure the CAISO footprint is supported by sufficient resources under contract to essentially keep the lights on.[176] The RA program requires entities within the CAISO footprint to demonstrate procurement of several classifications of resources, with which hydroelectric resources may assist. Namely, hydroelectric resources may be eligible to provide "local RA" if located within certain areas defined by CAISO, "flexible RA" if able to provide certain ramping capability, and "system RA" no matter where the resource is located on the CAISO system or if imported into the CAISO footprint.[177]

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173. FINAL ROOT CAUSE ANALYSIS, *supra* note 2, at 97 (stating real-time ancillary services awards for shown RA hydro ranged from 600-1,500 MW during August 14, 2020 peak demand); *but see id.* at 87-90 (showing the hydro MW on outage during August 14 and 15, 2020, explaining hydro generation was affected by derates, and a lack of day-ahead bids on RA capacity that did not have any must-offer obligation or only had a must-offer obligation on part of the resource's capacity).

174. *Id*. at 21–22. Although the many ancillary services hydro resources are capable of providing are detailed above in Section III.C, for purposes of the CAISO markets, "Ancillary Services" refers to regulation, spinning and non-spinning reserves, and voltage support services and "other interconnected operation services . . . to support the transmission of Energy from Generation resources to Loads while maintaining reliable operation of the CAISO Controlled Grid in accordance with WECC standards and Good Utility Practice." CAL. INDEP. SYS. OPERATOR, Tariff at app. A: Master Definition Supplement (Dec. 15, 2021), http://www.caiso.com/Documents/AppendixA-MasterDefinitionSupplement-asof-Dec15-2021.pdf [https://perma.cc/6SCG-JLM9].

175. RA rules vary across California's Local Regulatory Authorities—the largest of which is the California Public Utilities Commission (CPUC), which has jurisdiction over approximately thirty-eight Load-Serving Entities that serve ninety percent (90%) of load within the CAISO footprint. CAL. PUB. UTIL. COMM'N, *Decision on Track 3B.2 Issues: Restructure of the Resource Adequacy Program* (D.21-07-014), CPUC Docket No. R.19-11-009, at 6 (July 15, 2021); FINAL ROOT CAUSE ANALYSIS, *supra* note 2, at 14.

176. *See generally* CAL. INDEP. SYS. OPERATOR, *Tariff Amendment to Implement the Resource Adequacy Enhancements Phase 1 Initiative- Summer 2021 Provisions*, FERC Docket No. ER21-1551, Transmittal Letter at 2 (Mar. 29, 2021), http://www.caiso.com/Documents/Mar29-2021-Tariff-Amendment-ResourceAdequacyRAEnhancements-ER21-1551.pdf#search=ER21%2D1551 [https://perma.cc/MSR6-72GN] [hereinafter *CAISO ER21-1551 Initial Filing*]; CAL. INDEP. SYS. OPERATOR, *California ISO launches new tools for more refined grid outlook* (Aug. 27, 2021), http://www.caiso.com/Documents/California-ISO-Launches-New-Tools-for-More-Refined-Grid-Outlook.pdf [https://perma.cc/Q423-WNC6] ("Resource adequacy (RA) is capacity owned or contracted by utilities and other load- serving entities and obligated for the reliable operation of the grid. Any energy needed beyond that must be procured in the market.").

177. *See CAISO ER21-1551 Initial Filing, supra* note 176, at Transmittal Letter at 6 n.10.

Under the RA program, variable resources (e.g., solar and wind) also may qualify as RA capacity, but may not be able to show up to the same extent as more dependable resource types, such as hydroelectric resources. Resources providing capacity under the state's RA program are subject to "must-offer obligations" to bid into CAISO's day-ahead and real-time markets, and may be subject to non-availability charges and availability incentive payments depending on their performance.[178] Variable resources, which are among the resource types that enjoy certain exemptions from this performance mechanism,[179] have exhibited changes in their bidding on high load days that can trigger a need for other resources during the evening load ramp.[180]

During the Summer 2020 reliability challenges in the CAISO footprint, hydro resources accounted for the second highest amount of RA capacity of any resource type on August 14 and 15, 2020, at 6,700 MW (behind only natural gas), although not all of it was made available in CAISO's day-ahead and real-time markets.[181] In general, the California agencies' root cause analysis on the August and September extreme heat events reported that "RA hydro resources provided above their RA amounts and various hydro resources across the state managed their pumping and usage schedules to improve grid reliability."[182] While the CAISO Balancing Authority Area was not able to avert the need to curtail load in rotating outages conducted on August 14 and 15, 2020, it was able to do so during August 16 through 19, 2020, in part due to the demand response actions taken by CDWR and the Bureau of Reclamation to shift on-peak pumping load,[183] as well as supply side actions taken by the City and County of San

178. *CAISO ER21-1551 Initial Filing, supra* note 176, Transmittal Letter at 7.

179. Under CAISO Tariff § 40.9.2, Variable Energy Resources, along with run-of-river hydro and other resources, are exempt from the Resource Adequacy Availability Incentive Mechanism when providing System and Local RA capacity.

180. *DMM 2020 Annual Report, supra* note 104, at 15.

181. CAL. INDEP. SYS. OPERATOR, DEP'T OF MARKET MONITORING, *Report on system and market conditions, issues and performance: August and September 2020*, at 3, 27-28 (Nov. 24, 2020), http://www.caiso.com/Documents/ReportonMarketConditionsIssuesandPerformanceAugustandSeptember2020-Nov242020.pdf [https://perma.cc/VJ4A-Z86P] (providing about nine percent (9%) of hydro RA capacity, or 572 MW, was not available to the CAISO markets on August 14 and 15, 2020).

182. FINAL ROOT CAUSE ANALYSIS, *supra* note 2, at 6. *But see id*. at 49 (noting, "[a]dditional analysis is needed to accurately characterize the level of generation from shown RA resources above the shown capacity level").

183. *Id*. at 68 (stating CDWR's and Reclamation's shifting of on-peak pumping load resulted in 72 MW of load flexibility).

Francisco, CDWR, and the Metropolitan Water District of Southern California through adjusted water operations.[184]

Hydroelectric resources have also answered the call for supplementary power supply during summer shortage periods. During Summer 2021, in response to a letter from the California Public Utilities Commission (CPUC) and the California Energy Commission requesting that CAISO exercise its authority to procure additional capacity,[185] CAISO designated several resources to be available in July and August 2021, including three hydroelectric resources for roughly 130 MW total,[186] pursuant to its Capacity Procurement Mechanism (CPM) tariff authority, which essentially serves as a backstop when the RA program is insufficient.[187] Significantly, as of the end of October 2021, the third greatest amount of capacity designated of any resource (121.42 MW) was the City and County of San Francisco's Hetch Hetchy hydroelectric facility (behind only the Genesis McCoy Battery Energy Storage System at 132.5 MW, and the Russell City Energy Center combined-cycle natural gas facility at 350 MW).[188] CAISO procured the

184. *Id*. at 68–69 (providing the City and County of San Francisco maximized power output at the Hetch Hetchy hydroelectric facility, allowing 150 MW of additional generation during the peak load period, and that CDWR and the Metropolitan Water District adjusted water operations to shift 80 MW of electricity generation to the peak period). One caveat to the root cause analysis' reference to assistance from hydro is it does not identify whether such hydro resources were performing under an RA contract during the August 16-19, 2020 days.

185. *See* CAL. INDEP. SYS. OPERATOR ET AL., *Joint Statement from the CPUC President Maybel Batjer, CEC Chair David Hochschild, and California ISO CEO Elliot Mainzer on decision to procure additional energy resources for summer* (July 1, 2021), http://www.caiso.com/Documents/CapacityProcurementMechanismSignificantEvent-JointStatementandLetter.pdf [https://perma.cc/WLZ8-TGZC].

186. *See* CAL. INDEP. SYS. OPERATOR, *July and August 2021 Significant Event and Exceptional Dispatch Capacity Procurement Mechanism Designations Report* at 2–3 *(*Aug. 6, 2021), http://www.caiso.com/Documents/JulyandAugust2021SignificantEvent andExceptionalDispatchCPMReport.pdf [https://perma.cc/G99L-UM2U] (designating two "KRNCY_6 Units" as CPM Significant Event capacity (cumulatively 8 MW), and the "INTKEP_2_Units" as Exceptional Dispatch CPM (cumulatively 121.42 MW)). *See* CAL. INDEP. SYS. OPERATOR, *Final Net Qualifying Capacity Report for Compliance Year 2021*, http://www.caiso.com/Documents/NetQualifyingCapacityList-2021.xlsx (information available on "2021 NQC List" tab) (identifying the generator names of the Resource IDs included in the CPM reports, in relevant part identifying "INTKEP_2_Units" as "CCSF- Hetch_Hetchy Hydro Aggregate" and "KRNCY_6 Unit" as Kern Canyon, a hydroelectric project).

187. Under CAISO's Tariff § 43, capacity eligible for Capacity Procurement Mechanism designation is capacity not already committed as Resource Adequacy capacity but must be operationally available. CAISO runs a Competitive Solicitation Process in which offers are subject to a "Soft Offer Cap" of $6.31/kW-month, unless the resource owner submits cost-justification at FERC per a formula in the CAISO Tariff. *See also CAISO ER21-1551 Initial Filing, supra* note 176, Transmittal Letter at 8.

188. *See* CAL. INDEP. SYS. OPERATOR, *July and August 2021 Significant Event and Exceptional Dispatch Capacity Procurement Mechanism Designations Report*, at 2 (Aug. 6, 2021), http://www.caiso.com/Documents/JulyandAugust2021SignificantEventand

Hetch Hetchy units' hydroelectric capacity effective July 9, 2021, in response to a capacity deficiency within the CAISO footprint "that risked [CAISO] not being able to meet load and reserve obligations."[189] To a lesser extent, CAISO relied upon hydro as CPM capacity (15 MW) during the mid-August 2020 heat wave.[190] Thus, despite the attention on drought conditions as impeding capabilities of hydropower resources in Summer 2021, CAISO appears to have relied on hydroelectric resources for CPM resources in Summer 2021 to an even greater extent relative to Summer 2020.

While hydroelectric resources have proven dependable during reliability events, grid operators are taking steps to better account for their availability upfront as part of resource planning. California's RA program is evolving to improve planning mechanisms and avoid future reliability challenges.[191]

ExceptionalDispatchCPMReport.pdf [https://perma.cc/G99L-UM2U]; CAL. INDEP. SYS. OPERATOR, *August and September 2021 Significant Event Capacity Procurement Mechanism Designations Report* (Sept. 9, 2021), http://www.caiso.com/Documents/AugustandSeptember2021SignificantEventCPMReport.pdf [https://perma.cc/X2GZ-J8YL] (covering CPM designations through September 1, 2021); *see* CAL. INDEP. SYS. OPERATOR, *Final Net Qualifying Capacity Report for Compliance Year 2021*, http://www.caiso.com/Documents/NetQualifyingCapacityList-2021.xlsx (open document and select "2021 NQC List") (identifying the generator names of the Resource IDs including in the CPM reports, in relevant part identifying "INTKEP_2_Units" as "CCSF- Hetch_Hetchy Hydro Aggregate"); *see* CAL. INDEP. SYS. OPERATOR, *October 2021 Significant Event Capacity Procurement Mechanism Designations Report*, http://www.caiso.com/Documents/October2021SignificantEventCPMReport.pdf [https://perma.cc/6EHP-EYYJ] (showing that there were no CPM designations above 8 MW in October 2021).

189. *See* CAL. INDEP. SYS. OPERATOR, *July and August 2021 Significant Event and Exceptional Dispatch Capacity Procurement Mechanism Designations Report,* at 2–3 (Aug. 6, 2021), http://www.caiso.com/Documents/JulyandAugust2021SignificantEventandExceptionalDispatchCPMReport.pdf (regarding the "INTKEP_2_Units" and other resources procured for Exceptional Dispatch CPM in July 2021, explaining the capacity deficiency was "exacerbated by the factors. . .that created the CPM Significant Event[,]" which included, ironically, "significantly reduced hydroelectric production due to worsening drought conditions. . .").

190. *See* CAL. INDEP. SYS. OPERATOR, *August 2020 Significant Event and Exceptional Dispatch CPM Designations Report*, http://www.caiso.com/Documents/August2020SignificantEventandExceptionalDispatchCPMReport.pdf [https://perma.cc/NYK8-EKNN] (showing BIGCRK_2_EXESWD designated for 15 MW of CPM capacity beginning August 19, 2020); CAL. INDEP. SYS. OPERATOR, *Final Net Qualifying Capacity Report for Compliance Year 2020*, at row 72, http://www.caiso.com/Documents/NetQualifying CapacityList-2020.xls (identifying the resource ID "BIGCRK_2_EXESWD" is the Big Creek Hydro Project).

191. *See, e.g.*, FINAL ROOT CAUSE ANALYSIS, *supra* note 2, at 4 (noting, as one of three contributing factors to the CAISO's August 2020 rotating outages, that "resource

In 2021, CAISO's Department of Market Monitoring recommended CAISO continue to work with stakeholders to clarify and revise the RA counting rules, especially as they apply to hydro resources and other "use-limited" resources.[192] As illustrated by this recommendation, an element of focus for California are the counting mechanisms to determine the amount for which resources may qualify under the RA program (i.e., "Qualifying Capacity").[193] These mechanisms can vary across the Local Regulatory Authorities that implement the RA program in California.[194] Entities procuring or selling RA resources seek to maximize Qualifying Capacity in order to more rapidly meet their compliance requirements or increase the value of the resources sold, respectively. In 2020, the CPUC adopted a new RA counting mechanism for hydro resources,[195] anticipated

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planning targets have not kept pace . . . to meet demand in the early evening hours" given the State's transition to a "reliable, clean, and affordable resource mix[.]"); CAL. PUB. UTIL. COMM'N, *Decision on Track 3B.2 Issues: Restructure of the Resource Adequacy Program* (D.21-07-014), CPUC Docket No. R.19-11-009, at 7 (July 15, 2021) (explaining the evolution of California's RA program since its 2006 implementation and recognizing, in light of recent trends, "an urgent need to reexamine the RA program as it was originally structured to ensure that the RA program can continue to provide grid reliability at all times of the day and achieve California's environmental policy goals").

192. *DMM 2020 Annual Report, supra* note 104, at 4. "Use-Limited Resources" are characterized as limited by certain criteria under the CAISO Tariff, including limitations affecting the resource's number of starts or its Energy output, which cannot be recognized by the CAISO Market Process in dispatching the resource. For hydro resources, water use restrictions are one factor that may render such resources "Use-Limited." CAL. INDEP. SYS. OPERATOR, Tariff at § 30.4.6.1.1 (Use-Limited Resource Criteria) (Nov. 1, 2021), http://www.caiso.com/Documents/Section30-Bid-and-Self-ScheduleSubmission-in-CaliforniaISOMarkets-asof-Nov1-2021.pdf [https://perma.cc/Z5YZ-S3Y8].

193. Once a Load-Serving Entity calculates the Qualifying Capacity value for the resource based on the Local Regulatory Authority's criteria, then CAISO determines the resource's final Net Qualifying Capacity value following tests, such as a deliverability test, that may result in derating the Qualifying Capacity value. *See* CAL. INDEP. SYS. OPERATOR Tariff §§ 40.4.4, 40.4.5, 40.4.6, http://www.caiso.com/Documents/Section40-Resource AdequacyDemonstration-for-SchedulingCoordinatorsintheCaliforniaISOBalancing AuthorityArea-asof-Dec15-2021.pdf [https://perma.cc/PD66-T72D].

194. *See generally* CAL. INDEP. SYS. OPERATOR Tariff § 40. If the Local Regulatory Authority does not have Qualifying Capacity criteria for certain resource types, CAISO's default Qualifying Capacity criteria is in its Tariff § 40.8. Similarly, under default criteria in Tariff § 40.10.4.1(a), CAISO will calculate the Effective Flexible Capacity (EFC) value for RA resources providing Flexible RA capacity if the Local Regulatory Authority has not already established criteria for calculating the resource type's EFC value, except for certain resource types in § 40.10.4.1(b) through (f) for which CAISO prescribes a EFC calculation method, including for hydroelectric generating units (calculated, generally speaking, based on "the amount of capacity from which the resource can produce Energy consistently for [six] hours. . .").

195. CAL. PUB. UTIL. COMM'N, *Decision Adopting Local Capacity Obligations for 2021-2023, Adopting Flexible Capacity Obligations for 2021, and Refining the Resource Adequacy Program* (D.20-06-031), CPUC Docket No. R.19-11-009, at 22–24 (June 30, 2020). As a result of the CPUC's 2020 Decision, beginning in 2021, its jurisdictional

to be refined further by CAISO (which develops tariff rules for other Local Regulatory Authorities within California, including publicly-owned electric utilities) as CAISO intends to incorporate forced outages and derates into RA counting.[196] This may increase pressure to maintain hydro facilities to avoid outages and derates.[197] CAISO's counting proposal would only take into account the hydro resource's availability during the top twenty percent of tightest supply cushion hours,[198] although resource owners will not know which hours these will be, thereby incentivizing resource owners to be available in all hours.[199]

RA challenges are not unique to California, but extend across the Western Interconnection, in large part due to the changing resource mix, but also due to increasingly unpredictable weather events.[200] Accordingly, RA counting mechanisms for hydro resources are not only evolving in the CAISO Balancing Authority Area. The Northwest Power Pool (which is developing its own RA program spanning several states) is considering a similar counting mechanism for "Storage Hydro" (i.e., "hydro resources with the capability to store at least one hour worth of water") that would take into account constraints over the prior ten years and assess the historical

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entities may opt to use a monthly RA counting method incorporating the hydro resource's availability bid into the CAISO market over the prior ten years. In adopting this new counting methodology, the commission acknowledged it may result in a reduction of the monthly Net Qualifying Capacity values for hydro resources, while finding the values will be more reliable. *Id.*

196. CAL. INDEP. SYS. OPERATOR, *Resource Adequacy Enhancements: Draft Final Proposal- Phase 1 and Sixth Revised Straw Proposal,* at 91–94 (Dec. 17, 2020), http://www.caiso.com/InitiativeDocuments/DraftFinalProposal-SixthRevisedStrawProposal-ResourceAdequacyEnhancements.pdf [https://perma.cc/LSS8-2Z9G].

197. *See, e.g., id*. at 88 ("Most contract terms are also set at a $ per MW of [Net Qualifying Capacity or "NQC"]. By incorporating [Unforced Capacity or "UCAP"] into the resource's NQC values, any changes in the NQC value caused by increases in the resource's forced and urgent outage rates will result in decreased capacity payments. This provides the financial incentives to invest in proper maintenance of facilities to keep capacity payments high.").

198. *See, e.g., id*. at 80-81 (explaining, generally, that a "low RA supply cushion indicates the system has fewer assets available to react to unexpected outages or load increases," and providing the calculation for how CAISO proposes to derive the RA supply cushion).

199. *Id*. at 81, 91.

200. W. ELECTRICITY COORDINATING COUNCIL, *supra* note 8, at 2.

actual generation occurring during a given Critical Capacity Hour, as well as incorporating forced and planned outages' impact.[201]

E. Hydro Resources Provide Expansive Flexibility for Wholesale Markets

Hydroelectric resources benefit electricity markets, as evidenced by how their participation in such markets has been encouraged by the transmission grid operators, Regional Transmission Organizations (RTOs) and Independent System Operators (ISOs), as well as by FERC.[202] RTOs and ISOs can enhance the value hydroelectric resources can provide to the transmission grid by developing rules that facilitate their participation in wholesale markets. For example, in terms of cost development for purposes of cost based offers, PJM calculates special variables to better accommodate pumped storage resources, where the standard heat rate variables become "pumping efficiency," fuel cost becomes "pumping cost," and incremental energy cost is calculated by dividing pumping cost by pumping efficiency.[203] In the CAISO Balancing Authority Area, pumped storage resources may reflect their unique characteristics in their bid components, such as "maximum and minimum daily energy limits for both their pumping (charging) and generation (discharging) functions over the operating day."[204]

In Order No. 841, FERC recognized pumped hydro as a type of electric storage resource that has been participating in RTO and ISO markets for many years, and acknowledged RTOs/ISOs have found new mechanisms to facilitate pumped hydro participation.[205] FERC also noted participation

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201. NORTHWEST POWER POOL, *NWPP Resource Adequacy Program: Detailed Design*, at 74–75 (July 2021), https://www.nwpp.org/private-media/documents/2021-08-30_NWPP_RA_2B_Design_v4_final.pdf.

202. FERC has authority under Federal Power Act section 202(a) (16 U.S.C. § 824a) to divide the United States into "regional districts for the voluntary interconnection and coordination of facilities for the generation, transmission, and sale of electric energy." In Order No. 888 (1996) and Order No. 2000 (1999), FERC promoted the concepts of ISOs and RTOs, respectively, to operate the transmission systems. FED. ENERGY REGULATORY COMM'N, *Electric Power Markets: National Overview*, https://www.ferc.gov/electric-power-markets [https://perma.cc/56SB-QQBF].

203. PJM Manual 15, *Cost Development Guidelines*, Section 7 (effective June 6, 2021) (Revision 38), https://www.pjm.com/-/media/documents/manuals/m15.ashx [https://perma.cc/ 7W8S-XD8K].

204. CAL. INDEP. SYS. OPERATOR, *Compliance with Order No. 841*, FERC Docket No. ER19-468, Transmittal Letter at 19 (Dec. 3, 2018), http://www.caiso.com/Documents/Dec3-2018-Compliance-OrderNo841-ElectricStorageParticipation-ER19-468.pdf#search=ER19%2D468 [https://perma.cc/J9A9-B63V].

205. Order No. 841, 162 FERC ¶ 61,127, at Paragraph (P) 7 (Feb. 28, 2018 errata notice), FERC Docket Nos. AD16-20 and RM16-23, accessible at: https://ferc.gov/sites/default/files/2020-06/Order-841.pdf [https://perma.cc/AF58-Z8KT].

models in some RTOs and ISOs may be so specific that they limit "electric storage resources from providing the full range of services they are technically capable of providing[,]" a barrier Order No. 841 strives to dismantle.[206] As an example of one valuable service, in a compliance filing with Order No. 841, CAISO explained that, "Charging during periods of high supply and low demand is a critical reliability service that mitigates system ramping challenges and helps avoid negative pricing and curtailment during oversupply . . . ."[207] Still, the National Hydropower Association observes that many RTOs and ISOs do not go far enough in valuing the services pumped storage hydroelectric resources are capable of providing.[208]

CAISO's wholesale markets include a participation model specifically to accommodate pumped storage's unique operational characteristics (i.e., the "Pumped-Storage Hydro Unit" model).[209] Resources utilizing this model can operate as a "Generating Unit"[210] or as "Participating Load"[211] in CAISO's wholesale markets, with ability to submit bid components for both modes.[212] One example of a unique parameter available to Pumped-Storage Hydro Units is the "Pump Ramping Conversion Factor," which CAISO explains is intended to address these resources' ramping complexities

206. *Id.* at 19.

207. CAL. INDEP. SYS. OPERATOR, *Compliance with Order No. 841*, FERC Docket No. ER19-468, Transmittal Letter at 27 (Dec. 3, 2018).

208. *2021 NHA Pumped Storage Report*, *supra* note 9, at 16.

209. *See* CAL. INDEP. SYS. OPERATOR Tariff, at app. A, at 148 (June 30, 2021), (defining "Pumped-Storage Hydro Unit" as "[a] hydroelectric dam with the capability to produce electricity and the ability to pump water between reservoirs at different elevations to store such water for the production of electricity."); *see also* CAL. INDEP. SYS. OPERATOR, *Compliance with Order No. 841*, FERC Docket No. ER19-468, Transmittal Letter at 16 (Dec. 3, 2018), (noting "Pumped-Storage Hydro Units have participated in the CAISO markets since the CAISO's inception").

210. CAL. INDEP. SYS. OPERATOR Tariff at app. A at 83. Generating Units are "capable of producing and delivering net Energy" or "Energy in excess of a generating station's internal power requirements." *Id*.

211. *Id.* at 51, 137. Participating Load is capable of providing "Curtailable Demand"—though that exact term is not defined in the CAISO Tariff, the term "Curtailed Demand" is generally defined as Demand that "can be curtailed at the direction of the CAISO" in its real-time markets. *Id*.

212. *Cal. Indep. Sys. Operator*, 169 FERC ¶ 61,126, at P 19 (2019); *see* CAL. INDEP. SYS. OPERATOR, *Business Practice Manual for Market Operations,* version 75, § 2.1.6.1, at 35, https://bpmcm.caiso.com/BPM%20Document%20Library/Market%20Operations/BPM_for_Market%20Operations_V75_clean.doc [https://perma.cc/NLR8-2GLK].

and enables the resource's Scheduling Coordinator to adjust the factor to account for its ramp rate to pump water.[213]

In addition, hydroelectric resources can participate under CAISO's Non-Generator Resource (NGR) model, a participation model added to the grid's profile in 2012.[214] CAISO explains, to qualify for the NGR model, "the resources simply must be able to 'operate as either Generation or Load and that can be dispatched to any operating level within their entire capacity range but are also constrained by a MWh limit to (1) generate Energy, (2) curtail the consumption of Energy in the case of demand response, or (3) consume Energy."[215] Participating Load, such as hydroelectric pumps, may participate in the CAISO markets under the NGR model.[216] However, CAISO explains hydroelectric dams that can produce energy generally use the Pumped-Storage Hydro Unit model because it captures their unique operational characteristics, including the "non-instantaneous transition from load to generation."[217]

Between 2018 and 2020, in response to FERC's Order No. 841 intended to facilitate electric storage resources' participation in wholesale markets,[218] CAISO refined the Pumped-Storage Hydro Unit model and the NGR model, under which pumped storage hydro resources can participate in CAISO's wholesale markets. Examples of these refinements illustrate the benefits Order No. 841 extended to pumped storage resources desiring to participate in the CAISO markets. One example is CAISO now exempts

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213. CAL. INDEP. SYS. OPERATOR, *Compliance with Order No. 841*, FERC Docket No. ER19-468, Transmittal Letter at 22–23 (Dec. 3, 2018).

214. CAL. INDEP. SYS. OPERATOR, *Energy Storage and Distributed Energy Resources Phase 4 Tariff Revisions*, FERC Docket No. ER21-2779, Transmittal Letter at 3 (Aug. 27, 2021), http://www.caiso.com/Documents/Aug27-2021-TariffAmendment-EnergyStorage DistributedEnergyResource-Phase4-ER21-2779.pdf#search=ER21%2D2779 [https://perma.cc/R9TR-ZCP6].

215. CAL. INDEP. SYS. OPERATOR, *Compliance with Order No. 841*, FERC Docket No. ER19-468, Transmittal Letter at 10 (Dec. 3, 2018) (quoting the definition of "Non-Generator Resource" in CAISO Tariff app. A); *see also Cal. Indep. Sys. Operator Corp.*, 169 FERC ¶ 61,126, at P 38 (2019) (finding the qualification criteria in CAISO's tariff for its NGR and Pumped-Storage Hydro Unit models comply with Order 841 requirements, and do not limit participation to any particular type of electric storage resource or other technology).

216. CAL. INDEP. SYS. OPERATOR, *Non-Generator Resource Participation Agreements*, FERC Docket No. ER21-1487, Transmittal Letter at 5 (Mar. 19, 2021) (accepted by FERC Letter Order on May 14, 2021), http://www.caiso.com/Documents/Mar19-2021-TariffAmendment-EnergyStorage-DistributedEnergyResource-ESDER-Phase4-ER21-1487.pdf#search=ER21%2D1487 [https://perma.cc/Y3TM-3ZWQ] (explaining "Participating Load" generally refers to participating wholesale loads with curtailable demand (such as hydroelectric pumps), though distinguished from Demand Response resources; while Participating Loads do not supply energy, they can use the NGR model if desired).

217. *Id.* at 5 n.23.

218. Order No. 841, *supra* note 205.

NGRs and Pumped-Storage Hydro Units from transmission access charges under the CAISO Tariff.[219] Prior to CAISO's Tariff revisions to comply with Order No. 841, CAISO assessed such transmission access charges to the pumping load of Pumped-Storage Hydro Units; however, in its December 3, 2018 compliance filing,[220] CAISO proposed a Tariff revision to exempt from such charges storage resources, including NGR and Pumped-Storage Hydro Units, "withdrawing Energy for later resale to the CAISO Markets or to provide Ancillary Services."[221] In a November 21, 2019 Order on CAISO's compliance with Order No. 841, FERC accepted CAISO's proposed tariff exemption as "consistent with [CAISO's] existing rate structure, and thus . . . consistent with the requirements of Order No. 841 as clarified in Order No. 841-A."[222]

Another example of how CAISO's Order No. 841 compliance measures reduce the barriers to electric storage resource participation in wholesale markets, including pumped storage hydro, is the lowered threshold for such resources to provide ancillary services in CAISO markets. To comply with Order No. 841, FERC directed CAISO to revise its Tariff to impose no greater than a 100 kW minimum size requirement on electric storage resources providing ancillary services.[223] In response, CAISO revised

219. CAL. INDEP. SYS. OPERATOR Tariff § 26.1(a) (2021).

220. In Order No. 841, FERC found, *inter alia,* that "electric storage resources that are dispatched to consume electricity to provide a service in the RTO/ISO markets (such as frequency regulation or a downward ramping service) should not pay the same transmission charges as load during the provision of that service"—finding "this would be consistent with the treatment afforded traditional generation resources that provide ancillary services. . ." Order No. 841, 162 FERC ¶ 61,127, at P 298 (Feb. 28, 2018 errata notice). On rehearing in response to CAISO's request for clarification, FERC declined to find that charging pursuant to economic dispatch will *always* qualify as a service, but found that "services do *not* need to be limited to ancillary services; they could include any service defined in an RTO/ISO tariff." Order No. 841-A, 167 FERC ¶ 61,154, at P 120 (2019) (emphasis added). Further, FERC clarified: (1) RTO/ISO compliance filings may propose to subject electric storage resources when charging at wholesale (but not dispatched to provide a service) to the same charges applicable to wholesale load under the RTO/ISO's existing rate structure; and (2) to the extent the RTO/ISO opts *not* to apply such transmission charges to the storage resource, "then the RTO/ISO must demonstrate that exempting such a resource from these charges is reasonable given its existing rate structure for transmission charges." *Id.* at P 121.

221. CAL. INDEP. SYS. OPERATOR Tariff § 26.1(a) (2021); CAL. INDEP. SYS. OPERATOR, *Compliance with Order No. 841,* FERC Docket No. ER19-468, Transmittal Letter at 27 (Dec. 3, 2018).

222. *Cal. Indep. Sys. Operator Corp.*, 169 FERC ¶ 61,126, at PP 137, 138 (2019).

223. *Id.* at P 116.

Appendix K to its Tariff to allow electric storage resources 100 kW or greater (in lieu of 500 kW or greater as previously required) to be certified to provide Regulation, Spinning Reserve, or Non-Spinning Reserve.[224]

CAISO's Order No. 841 compliance measures also allow electric storage resources to have their operational and technical constraints reflected in CAISO markets through additional electable parameters.[225] Specifically, FERC directed CAISO to include in its Tariff, rather than merely its business practice manuals (which do not require FERC approval to amend), the physical and operational characteristics Order No. 841 mandates each RTO/ISO tariff account for as part of its electric storage resource participation model(s) in order to "improve the ability of electric storage resources to provide all of the services that they are technically capable of providing and allow RTOs/ISOs to procure these services more efficiently, which will enhance competition and, in turn, help to ensure that ISO/RTO markets produce just and reasonable rates."[226] In response, CAISO revised its Tariff to explicitly allow Scheduling Coordinators for electric storage resources participating under CAISO's NGR model or Pumped-Storage Hydro Unit model to submit certain operational and technical constraints to CAISO (for example, for Pumped-Storage Hydro Units, this could include "pump minimum down time," or the "minutes a pump cannot return to pumping after shutting down").[227]

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224. CAL. INDEP. SYS. OPERATOR, *Compliance Filing,* FERC Docket ER19-468, Transmittal Letter at 8 (Jan. 21, 2020); *Cal. Indep. Sys. Operator Corp.*, 172 FERC ¶ 61,050, at P 15 (2020) (accepting CAISO's proposed tariff revisions to comply with the minimum size requirement).

225. *See generally* Order No. 841, 162 FERC ¶ 61,127, at PP 191, 192 (2018) (directing RTO/ISOs to account for electric storage resources' certain physical and operational characteristics through bidding parameters or other means, but leaving it to the RTO/ISOs' discretion whether they would require resources to submit such information or rather allow submission of such information at the resource's discretion); *see, e.g.*, *Cal. Indep. Sys. Operator Corp.*, 169 FERC ¶ 61,126, at P 70 (2019).

226. *Cal. Indep. Sys. Operator Corp.*, 169 FERC ¶ 61,126, at P 69 (2019); *id.* at PP 99, 100 (finding that, other than requirements to account for State of Charge under both the NGR and Pumped-Storage Hydro Unit models, as well as to account for the Minimum Charge/Discharge Limits, CAISO did not account for the other ten required parameters in its tariff, but rather only in its business practice manuals).

227. CAL. INDEP. SYS. OPERATOR, *Compliance Filing*, FERC Docket ER19-468, Transmittal Letter at 3–4 (Jan. 21, 2020); *Cal. Indep. Sys. Operator Corp.*, 172 FERC ¶ 61,050, at P 15 (2020) (accepting CAISO's proposed tariff revisions to comply with Order 841's physical and operational characteristics requirements).

IV. PROSPECTIVE DEVELOPMENTS TO ENCOURAGE AND IMPROVE HYDROELECTRIC RESOURCES

Recognition of the benefits of hydroelectric generation can be seen in recent legislative and regulatory efforts intended to incentivize and invest prospectively in hydroelectric development and reinforcement. This growing recognition of hydro's potential has manifested in Federal legislative efforts, particularly from FERC and DOE, Federal regulatory incentives, and widespread state legislation. From these initiatives, it is apparent that legislators and policymakers see the value hydroelectric development has toward supporting a carbon-neutral electric grid.

A. Federal Legislative Initiatives

In 2020, the Consolidated Appropriations Act of 2021 (Appropriations Act) authorized approximately forty-nine million dollars to hydropower research, development, and demonstration activities.[228] Under the Appropriations Act, the Department of Energy was tasked with establishing a program to "improve the capacity, efficiency, resilience, security, reliability, affordability, and environmental impact . . . of hydropower systems."[229] This Act calls for the "efficient and reliable integration of hydropower and pumped storage systems with the electric grid by improving methods for operational forecasting of renewable energy systems to identify opportunities for hydropower applications."[230] To this end, the Appropriations Act also established the Energy Storage Research, Development, and Deployment Program within the Department of Energy, which will, *inter alia*, focus on advanced pumped storage technologies and help reduce the cost and construction time for hydropower and pumped storage systems.[231]

The Appropriations Act also extended the eligibility window under Section 242 of the Energy Policy Act of 2005 to provide that qualified hydroelectric facilities[232] that begin operation by the end of 2027 are eligible for production incentive payments up to $750,000 per year for a ten-year

228. H.R. 133, 116th Cong. §§ 634, 639 (2020).
229. *Id*. at § 634.
230. *Id.*
231. *Id.* at § 3201(b)(2)(G).
232. A "qualified hydroelectric facility" is defined as "a turbine or other generating device owned and solely operated by a non-Federal entity which generates hydroelectric energy for sale and which is added to an existing dam or conduit." Energy Policy Act, Pub. L. No. 109-58, § 242(b)(1), 119 Stat. 594 (2005).

period.[233] In addition, the Appropriations Act extended the incentive period under Section 243 to provide that hydroelectric facilities are eligible for a one-time efficiency improvement incentive payment up to $750,000 through December 31, 2036.[234] Further, the Appropriations Act extended the availability of renewable energy tax credits (i.e., production tax credits and investment tax credits) from 2020 through the end of 2021.[235]

In 2021, President Biden signed the Infrastructure Investment and Jobs Act (Infrastructure Act) into law.[236] The Infrastructure Act amended Section 242 of the Energy Policy Act of 2005 to increase the amount of production investment credits from $750,000 to $1 million.[237] Section 243 of the Energy Policy Act of 2005 was also amended to allow the Secretary of Energy to make incentive payments of up to thirty percent (as opposed to the previously available ten percent) of costs incurred by owners or operators of hydroelectric facilities for capital improvements that improve efficiency of such facilities by at least three percent.[238] Such payments may not exceed $5 million per facility in any one fiscal year (the previous limit was $750,000 per facility).[239] The Infrastructure Act also allows for incentive payments for facility capital improvements related to improving grid resiliency (i.e., providing ancillary services and integrating other variable sources), improving dam safety, and environmental improvements (i.e., improving safe and effective fish passage and water quality).[240] Such incentive payments may not exceed thirty percent of capital improvement costs and shall not exceed $5 million per facility per fiscal year.[241] Finally, the Infrastructure Act authorizes the Secretary of Energy to enter into agreements with eligible entities[242] to provide financial assistance for the entity to carry out project design, transmission studies, power market

233. *Id.* at § 242(e).

234. H.R. 133, 116th Cong. § 3005 (2020); Energy Policy Act, Pub. L. No. 109-58, § 243(b), 119 Stat. 594 (2005).

235. H.R. 133, 116th Cong. § 147 (2020); *see also* Energy Credit, 26 U.S.C. § 48 (2021) (stating qualified hydropower is eligible for renewable energy credits).

236. Infrastructure Investment and Jobs Act, H.R. 3684 (2021).

237. *Id*. at § 40331. Congress appropriated $125 million to the Secretary of Energy to carry out this section. *Id*.

238. *Id*. at § 40332.

239. *Id*. Congress appropriated $75 million to the Secretary of Energy for such efficiency improvement incentives. *Id*.

240. *Id*. at § 40333.

241. *Id*. Congress appropriated $553,600,000 to the Secretary of Energy for such capital improvement incentives. *Id*.

242. *Id*. at § 40334 (defining eligible entity as a municipally owned electric utility, electric cooperative, investor-owned utility, Indian Tribe or Tribal organization, State energy office, or an institution of higher education).

assessments, and permitting for pumped storage hydropower projects[243] "to facilitate the long-duration storage of intermittent renewable electricity."[244]

In addition, as of September 2021, the 117th Congress introduced a variety of bills to further incentivize hydroelectric projects, including pumped storage. For example, the Clean Energy for America Act would extend the existing Production Tax Credit for hydroelectric projects through December 31, 2022.[245] Thereafter, the bill would consolidate over forty different tax credits into three emissions-based incentives.[246] Renewable energy projects, including hydropower and pumped storage, could then select from either a 1.5 cent per kWh Production Tax Credit or a thirty percent Investment Tax Credit.[247] The new incentives would remain in effect until nationwide GHG emissions decrease by twenty-five percent, at which point the incentives will be phased out.[248] Another example of Federal initiatives is the Maintaining and Enhancing Hydroelectricity and River Restoration Act of 2021, introduced in the Senate as of the date of this Article, which would create new tax breaks for upgrading existing dams and to support dam removal.[249] The bill would create a thirty percent Investment Tax Credit to support dam safety, environmental improvements, and grid resilience at existing dams.[250] This credit would apply to a broad range of expenditures including upgrading dam components, mitigating environmental

243. *Id*. To be eligible for such funding, projects must be designed to provide not less than 1,000 MW of storage capacity, be able to provide energy and capacity for use in more than one organized electricity market, be able to store electricity generated by intermittent renewable electricity projects located on Tribal land, and have received a preliminary permit from FERC. *Id*.

244. *Id*. Congress appropriated two million dollars to the Secretary of Energy each fiscal years 2022 through 2026 to carry out this funding. *Id*.

245. Clean Energy for America Act, S. 1298, 117th Cong. § 45U (2021).

246. Ashley Schapitl, *Wyden, Colleagues Introduce Legislation to Overhaul Energy Tax Code, Create Jobs, Combat Climate Crisis,* UNITED STATES SENATE COMMITTEE ON FINANCE (Apr. 21, 2021), https://www.finance.senate.gov/chairmans-news/-wyden-colleagues-introduce-legislation-to-overhaul-energy-tax-code-create-jobs-combat-climate-crisis [https://perma.cc/P6XJ-9X5C].

247. Clean Energy for America Act, S. 1298, 117th Cong., at §§ 45U(a) and 48D(a); *and see* NAT'L HYDROPOWER ASS'N, *Clean Energy for America Act will Spur New Hydropower/ Pumped Storage Development* (May 26, 2021), https://www.hydro.org/news/clean-energy-for-america-act-will-spur-new-hydropower-pumped-storage-development2/ [https://perma.cc/AQ8T-SN52].

248. Clean Energy for America Act, S. 1298, 117th Cong., at § 45U(d) and 48D(e).

249. Maintaining and Enhancing Hydroelectricity and River Restoration Act of 2021, S. 2306, 117th Cong. (2021).

250. *Id*. at § 48D(a).

impacts arising from dam operation, and enhancing a facility's capacity to provide grid resilience.[251] In addition, the proposed Growing Renewable Energy and Efficiency Now (GREEN) Act of 2021 would extend the Production Tax Credit for hydropower through 2026 and would extend the Investment Tax Credit for energy storage, including pumped hydro, through 2025.[252] As of the date of this Article, standalone energy storage facilities, such as pumped hydro, are not eligible for the Investment Tax Credit.[253]

B. Federal Regulatory Initiatives

Under the Federal Power Act (Part I),[254] FERC regulates non-Federally owned hydroelectric projects which comprise over half of the United States' total hydropower capacity.[255] FERC was created by the Department of Energy Organization Act of 1977 and is nominally a part of DOE. FERC's predecessor agency—the Federal Power Commission—was created in 1920 by the Federal Water Power Act to advance development of the nation's hydroelectric potential.[256] In addition to regulating non-Federal hydroelectric facilities, FERC's jurisdiction was expanded by an amendment to the Federal Power Act in 1935 to include the transmission and sale of electric energy at wholesale in interstate commerce, and the regulation of natural gas pipelines.[257]

1. FERC

FERC recently has taken several measures to streamline the hydroelectric licensing process. For example, in 2018 FERC removed the requirement for licensees to file a Licensed Hydropower Development Recreation Report (Form 80).[258] In addition, FERC amended its regulations in 2021 to extend

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251. *Id*. at § 48D(d).

252. GREEN Act of 2021, H.R. 848, 117th Cong. (2021).

253. *See* Energy Storage Tax Incentive and Deployment Act, H.R. 1684, 117th Cong. (2021). If passed, standalone storage systems, such as pumped hydro, would be eligible for an Investment Tax Credit.

254. 16 U.S.C. §§ 791-823g.

255. *2017 FERC Hydropower Primer*, *supra* note 59, at 1.

256. *Id*. at 17; *see* Federal Power Act, 16 U.S.C. § 791a (2021) ("An Act to create a Federal Power Commission; to provide for the improvement of navigation; the development of water power; [and] the use of public lands in relation thereto….").

257. 16 U.S.C. § 824 (2021).

258. *See* FERC Order No. 852, *Elimination of Form 80 and Revision of Regulations on Recreational Opportunities and Development at Licensed Hydropower Projects*, 165 FERC. ¶ 61,256, at PP 1, 6–7 (2018). Form 80 solicited information on the use and development of recreation facilities at hydropower projects licensed by FERC. Specifically, Form 80 was a report that provided an inventory of the use and development of recreational

to projects up to 10 MW the more lenient licensing requirements that previously applied only to projects up to 5 MW, which was consistent with the amended definition of a small hydroelectric power project in the Hydropower Regulatory Efficiency Act of 2013.[259]

Importantly, in 2019, FERC issued two final rules to comply with the America's Water Infrastructure Act of 2018 (Water Infrastructure Act). First, FERC amended its rules so that it may issue preliminary permits for four years and extend a permit once for an additional four years, instead of its past practice of issuing preliminary permits for a three-year term with a possible two-year extension.[260]

Second, FERC established an expedited process for issuing original licenses for qualifying facilities at existing non-powered dams and for closed-loop pumped storage projects, ensuring that a final decision is issued no later than two years after a completed license application is received.[261] Under FERC's final rule, an applicant interested in participating in the expedited process must file a request for authorization along with its license application.[262] To qualify as an eligible existing non-powered dam, the applicant must demonstrate that its construction was completed on or before October 23, 2018 and, as of that same date, the dam was not generating electricity with hydropower generating works that were licensed or exempt from being licensed under the Federal Power Act.[263] In addition, the applicant must demonstrate that the facility will generate electricity by

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facilities, which was to be submitted to FERC on April 1 of every sixth year. FERC eliminated this requirement since, *inter alia*, recreational considerations are now part of license conditions and new technology (i.e., websites) allow interested parties to access recreation information.

259. FERC Order No. 877, *Removing Profile Drawing Requirement for Qualifying Conduit Notices of Intent and Revising Filing Requirements for Major Hydroelectric Projects 10 MW or Less*, 176 FERC ¶ 61,030, at PP 14–16 (2021) (since FERC's regulations could be burdensome to projects greater than 5 and up to and including 10 MW, and in order to expedite hydroelectric development, FERC amended its regulations to extend the licensing and amendment filing requirements that applied to major projects up to 5 MW to projects 10 MW or less); *see also* FERC Order No. 800, *Revisions and Technical Corrections to Conform the Commission's Regulations to the Hydropower Regulatory Efficiency Act of 2013*, 148 FERC ¶ 61,197, at P 6 (2014).

260. FERC Order No. 857, *Revisions and Technical Corrections to Conform the Commission's Regulations to the America's Water Infrastructure Act of 2018*, 166 FERC ¶ 61,143, at PP 3–4 (2019).

261. Order No, 858, *Hydroelectric Licensing Regulations Under the America's Water Infrastructure Act of 2018*, 167 FERC ¶ 61,050, at P 1 (2019).

262. *Id*. at 8.

263. *Id*. at 33.

using withdrawals, diversions, releases, or flows from the associated qualifying non-powered dam and its operations will not make any material changes to the storage, release, or flow operations of the non-powered dam.[264] To be eligible for expedited treatment as a closed-loop pumped storage project, the project must demonstrate it causes little or no change in existing surface and groundwater flows and uses.[265] The pumped storage project must also be considered unlikely to adversely affect threatened or endangered species or their designated critical habitat under the Endangered Species Act.[266] FERC added additional qualifying criteria to ensure the projects use only reservoirs situated at locations other than natural waterways, lakes, wetlands, and other natural surface water features and relies only on temporary withdrawals from surface waters or ground waters for the sole purpose of initial fill and periodic recharge needed for operation.[267]

Hydroelectric resources are often not located adjacent to or in population centers. Instead, they are more likely found in remote areas, on hilly or mountainous terrain, and rely on transmission lines to deliver the electricity generated by the hydropower plant to serve customer load. Recognizing this circumstance pertains to renewable resources generally, FERC recently initiated two key proceedings. First, FERC issued an Advanced Notice of Proposed Rulemaking (ANOPR), where FERC targets its focus on how the nation's evolving generation resource mix will change future transmission needs, as FERC's current regulations and policies may not be up to the task.[268] FERC recognizes "regional transmission planning process may not adequately model future scenarios" and "the generator interconnection process is not designed to consider how to address anything beyond the reliability interconnection-related network upgrades required for a specific interconnection request."[269]

Generally, in the ANOPR, FERC is considering whether to mandate or improve interregional planning, whether to broaden the set of benefits and beneficiaries of new transmission facilities potentially to socialize the cost of such facilities, and whether to remove some of the costs from remote renewable energy generators interconnecting to the electric grid. For example, FERC asks whether it should require transmission providers in each transmission planning region to establish a process to identify geographic zones suited for development of large amounts of renewable

264. *Id*.
265. *Id*. at 29.
266. *Id*.; *see* 16 U.S.C. §§ 1531–1544 (2012).
267. FERC Order No. 858, *supra* note 261, at P 31.
268. Building for the Future Through Electric Regional Transmission Planning and Cost Allocation and Generator Interconnection, 176 FERC ¶ 61,024, 86 Fed. Reg. 40, 266, at PP 3, 30 (2021) (ANOPR).
269. *Id.* at PP 31–32.

generation and to plan transmission to facilitate the integration of renewable resources in those zones.[270] As an example of a viable construct, FERC points to a variation from FERC's normal policy of requiring generators to pay costs of generation-tie lines where FERC approved recovery through the CAISO Transmission Access Charge (paid by all Participating Transmission Owners in the CAISO footprint) for transmission facilities providing access to areas rich in renewable energy.[271]

The second transmission initiative FERC recently launched is a joint Federal and State Task Force which will explore transmission-related issues, including how to plan and pay for new transmission infrastructure and how to navigate shared Federal and state regulatory authority and processes.[272] The Task Force will be comprised of all FERC Commissioners, as well as representatives from ten state commissions.[273] In a subsequent statement, FERC Chairman Glick and Commissioner Clements expressed that they anticipate transmission reform will be FERC's principal focus in the near future.[274]

2. Other Department of Energy Initiatives

In 2019, DOE's Water Power Technologies Office began a new initiative to "understand, enable, and improve hydropower and [Pumped Storage Hydropower]'s contributions to reliability, resilience, and integration in a rapidly evolving electricity system."[275] The Hydropower and Water Innovation for a Resilient Electricity System, or "HydroWIRES" initiative, involving five DOE national laboratories, provides helpful publications and includes funding opportunities for technology enhancements such as those focused

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270. *Id.* at 54–57.

271. *Id.* (reasoning that there were significant barriers to developing renewable generation resources in California since such resources were typically smaller than fossil-fuel projects and located in remote areas that require construction of long-distance high-voltage generation-tie lines).

272. *Order Establishing Task Force and Soliciting Nominations*, 175 FERC ¶ 61,224 (2021).

273. *Id*. at P 3.

274. *See* Joint Statement from Chairman Glick & Commissioner Clements on Building Transmission for the Future (July 15, 2021), https://www.ferc.gov/news-events/news/joint-statement-chairman-glick-commissioner-clements-building-transmission-future [https://perma.cc/S56T-MPFV].

275. *HydroWIRES Overview,* U.S. DEP'T OF ENERGY (July 2019), https://www.energy.gov/sites/prod/files/2019/08/f65/Hydrowires%20Overview%202019.pdf [https://perma.cc/UWN6-8J2J].

on improving the hydropower fleet's operations flexibility to accommodate the influx of renewable resources.[276] Beyond the HydroWIRES initiative, the DOE's Water Power Technologies Office promotes development of innovative hydropower technology; for example, on August 24, 2021, the Water Power Technologies Office issued a Request for Information on "unmet needs for hydropower testing capability within the U.S. and challenges that technology developers face in accessing testing capabilities" and "insights into how federal water infrastructure can be repurposed, refurbished, upgraded, or enhanced to provide testing capability that is needed and does not already exist."[277]

In addition, the DOE's Solar Energy Technologies Office currently funds "American-Made Challenges," a program intended to support innovation in clean energy technologies.[278] Any energy technology innovator may apply to enter a competition, and prizes are awarded in the form of cash or vouchers, the latter of which gives winners access to tools, equipment, and expertise at national labs and approved organizations and facilities.[279] Recent challenges included innovation in hydropower facility foundations,[280] as well as accelerating pumped storage development to reduce commissioning time from the average ten years to less than five years.[281] Further, the DOE's Loan Programs Office contains a $4.5 billion Innovative Energy Loan Guarantee Program, whereby renewable project developers may obtain Federal loans of up to eighty percent of their renewable facility's costs.[282]

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276. *Id.*; *see EERE Announces Selectees for Technical Assistance and Upcoming Funding Opportunity on Hydropower Operational Flexibility*, U.S. DEP'T OF ENERGY (July 14, 2021), https://www.energy.gov/eere/articles/eere-announces-selectees-technical-assistance-and-upcoming-funding-opportunity [https://perma.cc/ADK8-DTPJ].

277. *Request for Information: Testing Capabilities and Facilities to Validate Hydropower Technology Innovations,* U.S. DEP'T OF ENERGY, WATER POWER TECHNOLOGIES OFFICE (Aug. 24, 2021), https://eere-exchange.energy.gov/FileContent.aspx?FileID=8f0ed1ec-a754-4f8b-b1bd-e3971e16dbb6 [https://perma.cc/U7CU-WLSA].

278. *Our Prize Challenges*, American Made Challenges, NAT'L RENEWABLE ENERGY LAB. & U.S. DEP'T OF ENERGY, https://americanmadechallenges.org/ [https://perma.cc/T8DM-EQNC].

279. *See, e.g., American-Made Solar Prize Voucher Guidelines*, U.S. DEP'T OF ENERGY, https://americanmadechallenges.org/solarprize/docs/American-Made_Solar_Prize_Voucher_Guidelines.pdf [https://perma.cc/H86Y-RQHP].

280. *American-Made Challenges: Groundbreaking Hydro Prize*, U.S. DEP'T OF ENERGY, https://www.herox.com/GroundbreakingHydro [https://perma.cc/KW43-NV8P].

281. *Halving the Commissioning Timeline for Pumped-Storage Hydropower Development-FAST Prize Successfully Produces Promising Technical Solutions*, DEP'T OF ENERGY, WATER POWER TECHNOLOGIES OFFICE, (Jan.13, 2021), https://www.energy.gov/eere/water/articles/halving-commissioning-timeline-pumped-storage-hydropowerdevelopment-fast-prize [https://perma.cc/3LGZ-63RE].

282. *Renewable Energy and Efficient Energy Loan Guarantees*, DEP'T OF ENERGY, LOANS PROGRAMS OFFICE (Jan. 2020), https://www.energy.gov/sites/default/files/2020/01/f70/DOE-LPO-Renewable-Energy-Efficient-Energy-Jan2020.pdf [https://perma.cc/

These loans are available for hydro facility upgrades and the powering of non-powered dams. On September 30, 2021, DOE announced it would offer $8.5 million in funding, whereby DOE's Water Power Technologies Office would provide up to six awards to promote hydro and pumped hydro technologies that enhance grid resilience and reliability.[283]

C. State Legislation

Supplemental to the above-described Federal initiatives, several Western states are memorializing the importance of hydropower and encouraging hydropower through supportive legislation. California is a leader in renewable resources, but variable generation without storage can cause problems for California's grid.[284] As such, California enacted legislation designed to competitively solicit the procurement of long-duration energy storage. The Idaho Legislature has recognized hydropower as one of the state's best sources of energy, along with recognizing that hydropower plays a noteworthy role in several other areas of the state's economy. Additionally, Washington—another state with historic hydropower usage—is recognizing the benefits of pumped storage. The Washington Legislature has gone so far as to appropriate money for studies associated with a closed-looped pumped storage project within one of its counties. Finally, following the lead of Federal legislation, Colorado enacted legislation giving the Colorado Office of Energy a role to support small hydropower projects.

1. California

California has passed several bills to promote hydropower resources' continued viability within the state. For example, the Water Quality, Supply, and Infrastructure Improvement Act of 2014 authorized $7.545

P597-ZANK]; Energy Policy Act of 2005, Pub. L. No. 109-58, §1701, 119 Stat. 514 (2005).

283. *DOE Announces $8.5 Million to Increase Hydropower Flexibility*, U.S. DEP'T OF ENERGY, OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY (Sept. 30, 2021), https://www.energy.gov/eere/articles/doe-announces-85-million-increase-hydropower-flexibility [https://perma.cc/R55T-9B6M].

284. *See, e.g.,* CAL. INDEP. SYS. OPERATOR, FAST FACTS: WHAT THE DUCK CURVE TELLS US ABOUT MANAGING A GREEN GRID, at 3–4 (pointing to issues caused by the influx of renewable resources—associated with both: (1) oversupply, including necessitated manual intervention by CAISO operators to maintain reliability, and negative wholesale prices requiring generators to pay utilities to take energy; and (2) absence of resources with automated frequency response capability, heightening exposure to blackouts).

billion in general obligation bonds to fund ecosystems and watershed protection and restoration, water supply infrastructure projects (including surface and groundwater storage), and drinking water protection.[285] The Water Quality, Supply, and Infrastructure Improvement Act, in part, aims to balance competing water uses, including hydropower and fishery protection.[286] In 2019, California also passed a measure requiring the California Natural Resources Agency, in collaboration with CDWR, to assess opportunities and constraints for potential operational and structural upgrades to the State Water Resources Development System with the objective of helping California achieve its climate and energy goals.[287] In addition, the California Legislature is considering establishing the Water Conveyance Restoration Fund to minimize losses in water conveyance capacity caused by damaged water conveyance infrastructure.[288]

California has also focused on legislation incentivizing pumped storage projects. For example, in 2019 the California Legislature attempted to pass SB 772, which would have required CAISO to create a competitive solicitation process, by June 2022, for procuring long-duration energy storage projects, which aggregate to at least 2,000 MW.[289] SB 772 identified pumped storage as a well-established and proven form of long-duration storage that has shown to be reliable over a useful life exceeding fifty years. However, SB 772 drew opposition because, *inter alia*, it was perceived as an attempt to bail out one specific pump storage project: the Eagle Mountain Project.[290] On the other hand, in July 2021, the San Vicente Energy Storage

285. AB-1471, 2013-14 Sess. (Cal. 2014).

286. CAL. NAT. RES. AGENCY ET AL., CALIFORNIA WATER ACTION PLAN 2016 UPDATE, at 10, https://resources.ca.gov/CNRALegacyFiles/docs/california_water_action_plan/Final_California_Water_Action_Plan.pdf#page=18&view=fit [https://perma.cc/Q23N-8GE2].

287. S.B. 49, 2019 Leg., Reg. Sess. (Cal. 2019).

288. S.B. 559, 2021 Leg., Reg. Sess. (Cal. 2021) (pending).

289. S.B. 772, 2019 Leg., Reg. Sess. (Cal. 2019) (rejected).

290. *See Letter in Opposition to Eagle Crest Legislation,* MBCONSERVATION (Feb. 3, 2020), https://www.mbconservation.org/letter_coalition_v_eagle_crest_legislation [https://perma.cc/LAN3-KRMG]; Sammy Roth, *An Abandoned Mine Near Joshua Tree Could Host a Massive Hydropower Project*, L.A. TIMES (May 22, 2019); *The Coalition to Protect America's National Parks*, *Letter Opposing Large Scale Pumped Storage Budget Proposal – "Eagle Crest Bailout,"* PROTECT NPS, (June 25, 2021), https://protectnps.org/2021/06/26/oppose-large-scale-pumped-storage-budget-proposal-eagle-crest-bailout/ [https://perma.cc/RC75-AHX2]; *see* A.B. 2255, 2020 Leg., Reg. Sess. (Cal. 2020) (rejected); *see Opposition to NextEra's Eagle Crest Pumped Storage Project Bailout* (June 23, 2020), https://d3n8a8pro7vhmx.cloudfront.net/mbca/pages/2472/attachments/original/1593210406/Coalition_letter_to_Gov_and_TF_CoChairs_re_Oppose_NextEra_Bailout_6-23-20.pdf?159321 0406 [https://perma.cc/9NSQ-SSEB] (identifying opposition, for the same reasons, to AB 2787 (2018), AB 2255 (2020), and AB 2736 (2020)).

Facility received eighteen million dollars in the California budget.[291] California's 2022-2023 budget provides $240 million over two years to build a temperature management project to address temperature issues at the Oroville Dam that will allow a pumped storage project to operate at greater capacity.[292] In addition, the California Legislature specifically recognized pumped storage for its ability to serve as a fast-ramping and flexible resource to balance the grid and to mitigate the effects of over-generation from renewable energy resources.[293] Such legislation and funding shows California's recognition of the need for additional long-duration storage as the state integrates more renewable resources.

2. Idaho

Idaho has passed legislation expressing strong support of hydropower. In March 2021, the Idaho Legislature passed a new version[294] of previous Joint Memorials[295] identifying hydropower as one of the state's best energy sources. In its 2021 Joint Memorial, the Idaho Legislature recognized hydropower's storage potential as well by stating that Idaho's hydropower generation is "clean, reliable, renewable baseload generation" and "act[s] as a battery to integrate other intermittent renewable energy resources on the system . . . ."[296] This legislation also opposed dam removal from the

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291. Press Release, SAN DIEGO COUNTY WATER AUTHORITY, *Request for Proposals Issued to Develop San Vicente Energy Storage Facility* (Sept. 14, 2021), https://www.sdcwa.org/request-for-proposals-issued-to-develop-san-vicente-energy-storage-facility/?mc_cid=9ec606bc2c&mc_eid=71e4e8d507 [https://perma.cc/KNN7-N29U].

292. *Governor's Budget Summary – 2022-23*, at 85 (Jan. 10, 2022), https://www.ebudget.ca.gov/FullBudgetSummary.pdf [https://perma.cc/X7FW-9LGU].

293. A.B. 33, 2016 Leg., Reg. Sess. (Cal. 2016) (requiring the California Energy Commission, in coordination with the CPUC to analyze the potential for long-duration bulk energy storage to help integrate renewable energy).

294. *See* 2021 Idaho Sess. Laws, Vol. 2 at 1148 (S.J.M. No. 103), https://legislature.idaho.gov/wp-content/uploads/sessionlaws/sessionlaws_vol2_2021.pdf [https://perma.cc/96U3-RNBK].

295. *See* 2020 Idaho Sess. Laws, Vol. 2 at 1006-07 (S.J.M. No. 110), https://legislature.idaho.gov/wp-content/uploads/sessionlaws/sessionlaws_vol2_2020.pdf [https://perma.cc/96U3-RNBK]. The 2021 Senate Joint Memorial No. 103 is largely identical to the Senate Joint Memorial No. 110 from 2020. *Compare* S.J.M. No. 103, *supra* note 294, *with* S.J.M. No. 110, *supra* note 295. Also, a similar joint memorial was passed in 2015. *See* 2015 Idaho Sess. Laws, Vol. 2 at 1315-16, H.J.M. No. 11, https://legislature.idaho.gov/wp-content/uploads/sessionlaws/sessionlaws_vol2_2015.pdf [https://perma.cc/HS2M-3EKV].

296. S.J.M. 103*, supra note* 294, at 1149.

Columbia-Snake River System and its Tributaries.[297] The Joint Memorial adopted in March 2020 identified hydropower as "the most efficient, environmentally favorable form of electrical generation."[298] Similarly, a Joint Memorial adopted in March 2019 recognized hydropower as Idaho's "greatest renewable resource," which provides Idaho with "a carbon-free, inexpensive electrical power source."[299] Notably, the 2019 Joint Memorial recognized the expansive role hydropower plays as a driver for tourism, recreation, and agriculture in Idaho.[300]

3. Washington

Washington has also encouraged hydropower improvement, particularly pumped storage projects, via state legislation. Specifically, in 2020, Washington added "pumped storage project[s] using water rights approved by the legislature for that purpose" as "projects of statewide significance."[301] Washington too recognized hydropower's reach beyond clean energy by deeming these projects as ones that "merit special designation and treatment by governmental bodies" because of their significance to the state and local economies.[302] To be sure, the Washington Legislature added certain pumped storage projects as projects of statewide significance to "encourage local governments and state agencies to expedite their completion."[303]

Washington also demonstrates its commitment to hydroelectric projects by financially supporting studies for a closed-loop pump storage hydropower project in Klickitat County. The Washington Legislature appropriated $1.1 million to be paid in the form of a grant to Klickitat County Public Utility District 1 "for the remediation, survey, and evaluation of [the Goldendale Energy Storage Project] at the John Day pool."[304] Memorialized support

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297. *Id*.

298. *See* S.J.M. No. 110, *supra* note 295.

299. 2019 Idaho Sess. Laws, Vol. 2 at 1011 (H.C.R. No. 9), https://legislature.idaho.gov/wp-content/uploads/sessionlaws/sessionlaws_vol2_2019.pdf [https://perma.cc/TGH3-J68E].

300. *Id.*

301. WASH. REV. CODE § 43.157.010(5)(a)(vi) (2020); *see also* WASH. REV. CODE § 43.157.005 (2009) ("It is the intention of the legislature to recognize projects of statewide significance and to encourage local governments and state agencies to expedite their completion."); H.B. 2819, 66th Leg., Reg. Sess. (Wash. 2020).

302. WASH. REV. CODE § 43.157.005 (2009).

303. *Id.*

304. S.B. 6248, 66th Leg., Reg. Sess. (Wash. 2020). On June 23, 2021, the Washington Department of Ecology submitted to FERC a Water Quality Certification Denial for the Goldendale Energy Storage Project in FERC Docket No. P-14861. *See Washington Department of Ecology Water Quality Certification*, FERC Docket No. P-14861 (June 23, 2021), https://elibrary.ferc.gov/eLibrary/filedownload?fileid=020DC96F-66E2-5005-8110-C31FAFC91712. Courtney Flatt, *Washington Denies Permit For Goldendale Pumped*

and the funding of studies will help encourage development and further recognize hydropower's benefits, while bearing in mind that projects must meet certain ecological standards.

Washington is also aware that new diversions or impoundments of water may result in environmental consequences while producing clean hydropower generation. To balance its goal of 100% clean electricity by 2045 against the undesirable impacts hydropower potentially could have on waterways, Washington allows existing hydroelectricity generation to qualify as clean energy, but hydroelectric generation associated with new diversions or impoundments, including expansions of existing reservoirs, does not qualify.[305] However, Washington again recognizes pumped storage's unique benefits because this law makes a notable exception for pumped storage facilities that may create new diversions and impoundments to still qualify as clean electricity, as long as the facilities comply with state and Federal fish recovery plans.[306]

4. Colorado

In 2010, Colorado entered into a Memorandum of Understanding (MOU) with FERC to encourage the development of small scale hydropower, particularly at existing infrastructure.[307] Subsequently, in 2014, following

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Hydro Project, But It's Not The End Of The Road, NORTHWEST PUBLIC BROADCASTING (June 24, 2021), https://www.nwpb.org/2021/06/24/washington-denies-permit-for-goldendale-pumped-hydro-project-but-its-not-the-end-of-the-road/ [https://perma.cc/PE9J-W9U4]. However, a spokesperson for the Department of Ecology stated that this was "in no way a denial of the project," and the Washington Department of Ecology will "keep working with the company." *Id*. On August 10, 2021, FERC requested more information in the development company's licensing application. *See Request for Additional Information Letter*, FERC Docket No. P-14861-002 (Aug. 10, 2021), https://elibrary.ferc.gov/eLibrary/filedownload?fileid=23C37256-2431-CC3C-94B4-7B3077300000.

305. S.B. 5116, 66th Leg., Reg. Sess., § 4(d) (Wash. 2019) ("Hydroelectric generation used by an electric utility in meeting the standard under (a) of this subsection may not include new diversions, new impoundments, new bypass reaches, or expansion of existing reservoirs constructed after the effective date of this section unless the diversions, bypass reaches, or reservoir expansions are necessary for the operation of a pumped storage facility that: (i) Does not conflict with existing state or federal fish recovery plans; and (ii) complies with all local, state, and federal laws and regulations.").

306. *Id*.

307. *Memorandum of Understanding Between the Federal Energy Regulatory Commission and the State of Colorado Through the Governor's Energy Office to Streamline and Simplify the Authorization of Small Scale Hydropower Projects,* at 3 (Aug. 24, 2010), https://www.ferc.gov/media/mou-2010-state-colorado [https://perma.cc/6N7W-AXQQ].

the lead of the Hydropower Regulatory Efficiency Act of 2013 at the Federal level (providing exemptions from FERC licensing requirements to qualifying hydropower facilities of up to 10 MW),[308] Colorado passed legislation to streamline state agencies' consultation regarding new hydroelectric facilities' proposed construction and operation by entities applying for a FERC license or exemption.[309] By statute, the Colorado Energy Office is now the coordinating state agency responsible for reviewing proposed projects seeking a FERC license or exemption, and serves as the liaison between FERC and other Colorado agencies.[310] In 2013, as revised in 2015, the Colorado Energy Office published a handbook to guide developers of small hydropower projects.[311]

As an example of a small hydroelectric project in Colorado, in early 2012,[312] the Town of Basalt, Colorado developed a project with generating capacity of 40 kW in one year's construction time.[313] Basalt's project was financed in part through the Colorado Energy Office and through the electric cooperative Holy Cross Energy.[314] At that time, the Colorado Energy Office reported that Basalt would await pending Federal small hydro permitting reform legislation before pursuing additional small hydro projects.[315]

In terms of pumped storage hydroelectric projects in Colorado, as of a June 2019 report prepared for the Colorado Energy Office, there were only two such facilities (Xcel's 324 MW Cabin Creek Generating Station and Bureau of Reclamation's 200 MW Mt. Elbert Pumped-Storage Powerplant), representing four percent of Colorado's total generating capacity, with other types of hydroelectric capacity representing another four percent of total generating capacity.[316]

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308. *See* Hydropower Regulatory Efficiency Act of 2013, 113 Pub. L. No. 23, 127 Stat. 493 (2013) (amending, in Section 3 of the Act, 16 U.S.C. § 2705(d)).

309. H.B. 14-1030, 69th Gen. Assemb., 2nd Reg. Sess., (Colo. 2014), https://leg.colorado.gov/sites/default/files/images/olls/2014a_sl_287.pdf [https://perma.cc/ES8H-VDFW].

310. *Id.* at § 2(e)(2)(d) and (3)(c).

311. Kurt Johnson et.al., *The Small Hydropower Handbook*, COLORADO ENERGY OFFICE (rev. Oct. 2015), https://drive.google.com/file/d/1hH2GGtQgEW7CfRiBF9N9a1iXEDV2NpO7/view.

312. The Associated Press, *Town of Basalt finishes micro-hydroelectric plant*, DENVER POST (Mar. 30, 2012), https://www.denverpost.com/2012/03/30/town-of-basalt-finishes-micro-hydroelectric-plant/ [https://perma.cc/H7NM-8VLG].

313. *Small Hydropower Case Study: Town of Basalt Small Hydro Project*, COLO. ENERGY OFFICE, https://drive.google.com/file/d/1I-wyIMEnDiitdsmqXDWtHa3ILaNiSRUB/view.

314. *Id.*

315. *Id*. at 3.

316. Erin Camp et al., *The Future of Energy Storage in Colorado,* SYNAPSE ENERGY ECONOMICS, INC., at 19, 55–56 (June 28, 2019), https://drive.google.com/file/d/1eiUOtYI-3-VE27Nch843ITvUaymP-RYx/view.

V. IMPROVED TECHNOLOGIES AND ADVANCES IN HYDROELECTRIC PROJECT DEVELOPMENT AND UTILIZATION

Hydroelectric resource owners, operators, and developers are undertaking innovative approaches to ensure this important resource is harnessed in the most efficient and least environmentally intrusive manner, while accounting for climate-induced setbacks such as drought. One such approach is retrofitting existing dams. Only about 2,500 of the nation's 90,000 dams generate power, though thousands more could be retrofitted to generate hydroelectricity, which environmentalists favor over building new dams.[317] Continuing innovations include new techniques being developed for reducing evaporation, promoting water conservation, and running equipment more efficiently, as well as incorporating climate change impacts into resource planning and forecasting.[318]

An example of an existing non-powered dam retrofitted to develop a hydroelectric project consequent to the Hydropower Regulatory Efficiency Act of 2013 is Rye Development's L&D 11 Project on the Kentucky River. The 2013 Act in part directed FERC to investigate the feasibility of issuing hydro licenses at non-powered dams and closed-loop pumped storage projects in a two-year licensing process, as discussed above in Section IV(B)(1).[319] FERC's investigation was to include pilot projects' development to test the two-year process in collaboration with any applicable Federal or state agencies. In May 2017, FERC issued its findings in

317. James Dinneen, *Can Retrofitting Dams for Hydro Provide a Green Energy Boost?,* YALEENVIRONMENT360 (July 27, 2021), https://e360.yale.edu/features/can-retrofitting-dams-for-hydro-provide-a-green-energy-boost?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+YaleEnvironment360+%28Yale+Environment+360%29&utm_source=Energy+News+Network+daily+email+digests&utm_campaign=72b88869dc-EMAIL_CAMPAIGN_2020_05_11_11_36_COPY_01&utm_medium=email&utm_term=0_724b1f01f5-72b88869dc-89241407 [https://perma.cc/35XW-S559]; *see also 2017 FERC Hydropower Primer*, *supra* note 59, at 3 (estimating the resource potential for non-powered dams to be 4,800 MW, after accounting for environmental considerations, and suggesting hydropower potential in the U.S. is focused in Atlantic and Pacific coast mountain regions, the Great Lakes drainage, Mississippi River Basin, and Alaska).

318. *See, e.g.*, NORTHWEST POWER AND CONSERVATION COUNCIL, UPDATED DIRECT AND INDIRECT IMPACTS OF CLIMATE CHANGE (Feb. 2020), https://nwcouncil.app.box.com/s/p9cdzd3hvh8kb0ni9ie23hgcs9jes0wd [https://perma.cc/98AN-BQ45] (reviewing the effects of climate change in order to study the impacts on load forecast in the Pacific Northwest).

319. Hydropower Regulatory Efficiency Act of 2013, Pub. L. No. 113-23, 127 Stat. 493 (2013), https://www.ferc.gov/sites/default/files/2020-04/bills-113hr267enr.pdf [https://perma.cc/A4PF-7W4B].

response to the legislation, including that Rye Development met FERC's criteria for proposing a project at an existing non-powered dam on the Kentucky River, and that the project had successfully met the two-year licensing process timeline.[320] Rye Development's L&D 11 Project's total installed capacity is 5 MW and generates 18,500 MWh annually, sold to a local utility.[321] As a result of the pilot process, Rye Development recommended FERC develop a new process called the "Existing Dam Process," involving adding new generating capacity to non-powered dams.[322] A more recent example of a FERC-licensed project utilizing an existing dam retrofitted to generate hydroelectricity is the Red Rock Dam on the Des Moines River in Iowa, originally constructed in 1969 by the Army Corps of Engineers and upgraded to provide up to 55 MW of renewable capacity.[323] The Red Rock project's size illustrates substantial undeveloped capacity at existing dams waiting to be developed.

Regarding operational efficiency and reducing environmental impacts at reservoirs, the U.S. Bureau of Reclamation (Reclamation) is seeking to mitigate evaporation impacts by deploying pilot floating evaporation pans at several of its reservoirs, including Lake Powell.[324] To promote water conservation in hydroelectric plant operations, Reclamation and the U.S. Army Corps of Engineers developed a technology, "HydrOS," for use at Reclamation hydro plants, which uses algorithms to develop power water output requirements based on water input.[325] At the state level, CDWR recently installed an emergency salinity drought barrier, which negates the need to "send large volumes of water into the Delta to repel salinity . . . ."[326]

Hydroelectric resource operators have also employed innovative technology to understand how and when their facilities operate, and to

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320. FED. ENERGY REGULATORY COMM'N, *Report on the Pilot Two-Year Hydroelectric Licensing Process for Non-Powered Dams and Closed-Loop Pumped Storage Projects and Recommendations Pursuant to Section 6 of the Hydropower Regulatory Efficiency Act of 2013*, at i, ii, 8–9 (May 26, 2017), https://www.ferc.gov/sites/default/files/2020-05/final-2-year-process.pdf [https://perma.cc/YD8S-RPAT] [hereinafter *HREA 2017 Report*]. FERC reported only one closed-loop pumped storage project applicant had requested to be considered as a pilot project to test the two-year licensing process, though FERC staff determined the project did not meet the criteria to participate as a pilot project. *Id.* at 10.

321. *Id.* at 11.

322. *Id.* at 29, n.104.

323. *Red Rock Hydroelectric Project: Project Overview*, MISSOURI RIVER ENERGY SERVICES, https://www.redrockhydroproject.com/project-overview/ [https://perma.cc/96EF-DBR2]; *see* Dinneen, *supra* note 317.

324. U.S. DEP'T OF THE INTERIOR, BUREAU OF RECLAMATION, WATER RELIABILITY IN THE WEST - 2021 SECURE WATER ACT REPORT 13 (Jan. 2021).

325. *Id.* at 47.

326. *DWR Completes Installation of Emergency Salinity Drought Barrier,* CAL. DEP'T OF WATER RES. (July 28, 2021), https://water.ca.gov/News/Blog/2021/July/DWR-Completes-Installation-of-Emergency-Salinity-Drought-Barrier [https://perma.cc/BD3E-4SC5].

promote efficient operation. For example, Reclamation uses "Machine Condition Monitoring" at many of its hydro plants to monitor equipment in real-time, mitigating the impact of stressed conditions, i.e., flood and drought, on turbine blades.[327] Another recent example of modernizing enhancements to extend the operating life of a hydroelectric facility is the digitization of a pumping plant comprising the Niagara Power Project referenced above (in operation for over sixty years), with up to 2,675 MW of capability.[328] Additionally, in July 2021, Reclamation and CDWR deployed two computer models to simulate operations at the State Water Project and Central Valley Project "to examine project operations under various assumptions for hydrologic conditions, project facilities and regulatory requirements[,]" and to model climate change impacts.[329]

In terms of incorporating climate change impacts into resource planning, in its Draft 2021 Northwest Power Plan, the Northwest Power and Conservation Council (Council) utilized climate change projections to forecast future demand and river flows for the first time in its annual adequacy assessments.[330] Additionally, the Council stated its intent to launch an investigation into changing river flows' environmental impacts and to explore different hydroelectric system operations to identify a balanced path forward, recognizing hydroelectric generation is well positioned to offer increasing renewable generation while considering that daily river flow fluctuations have uncertain impacts on fish.[331] Due to increasing renewables on the system, the Draft 2021 Northwest Power Plan explains

327. U.S. DEP'T OF THE INTERIOR, BUREAU OF RECLAMATION, WATER RELIABILITY IN THE WEST – 2021 SECURE WATER ACT REPORT 43 (Jan. 2021).

328. *1.6 billion clean energy investment to extend operating life of Niagara Power Project,* NIAGARA FRONTIER PUBLICATIONS (Sept. 22, 2021), https://www.wnypapers.com/news/article/current/2021/09/22/148010/1.6-billion-clean-energy-infrastructure-investment-to-extend-operating-life-of-flagship-niagara-power-project [https://perma.cc/HLY8-4SX3].

329. *Updated Computer Models Released for Key California Water Project,* CAL. DEP'T OF WATER RES. (July 30, 2021), https://water.ca.gov/News/News-Releases/2021/July-21/Updated-Computer-Models-Released-for-Key-California-Water-Projects [https://perma.cc/VQ93-44AY]. *See generally 2021 NHA Pumped Storage Report*, *supra* note 9, at 34 ("New advanced computer models are helping to produce pump turbines with much higher efficiencies and power output.").

330. 2021 DRAFT NORTHWEST POWER PLAN, *supra* note 31, at 4-24, 11-118.

331. *Id.* at 10-101, 11-119 (explaining the intent to collaborate with Bonneville Power Administration, system operators, federal and state fish and wildlife agencies, and tribes in the Northwest region).

the Council redeveloped its system adequacy models to reflect more "hourly-specific hydroelectric system constraints."[332]

Technological and environmental advances specific to pumped storage hydroelectric projects have also enhanced the benefits of this specific resource type. A technological advancement noted by the National Hydropower Association is "adjustable-speed pumped storage"; the National Hydropower Association observes this technology can offer reliability and economic advantages over single-speed pumped storage hydro by adjusting the rate at which water is pumped to the upper reservoir, which can be integrated with intermittent renewable generation, or timed to provide frequency regulation during system disturbances.[333] Another innovative technology that DOE's Water Power Technologies Office has funded is "geo-mechanical pumped-storage," whereby the developer proposed a "bi-directional injector-generator (INGEN) . . . that stores energy by pumping water into existing rock fissures at high pressures."[334] The DOE notes the benefits of this technology include the ability to operate at higher temperatures than traditional pumped storage, a ninety-five percent mechanical efficiency, cost reduction, and the capability to be sited where traditional pumped storage may not due to geographical constraints in flat areas.[335]

VI. CHALLENGES TO RELIANCE ON NEW HYDROELECTRIC AND PUMPED STORAGE PROJECTS

While hydroelectric resources present a carbon-free, renewable resource providing the range of advantages described above, such resources face obstacles to development, or criticism as to whether they help more than they harm. However, ongoing regulatory developments are being brought to fruition to address those criticisms and challenges.

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332. *Id*. at 4-24.

333. *2017 NHA Pumped Storage Report*, *supra* note 11, at 30–33; *2018 NHA Pumped Storage Report*, *supra* note 7, at 7, 15.

334. U.S. DEP'T OF ENERGY, OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY, *Funding Selections Announced for Innovative Design Concepts for Standard Modular Hydropower and Pumped Storage Hydropower* (Apr. 1, 2019), https://www.energy.gov/eere/articles/funding-selections-announced-innovative-design-concepts-standard-modular-hydropower [https://perma.cc/J34X-ZEX6].

335. *Id.; see also* U.S. DEP'T OF ENERGY, WATER POWER TECHNOLOGIES OFFICE, *A New Approach to Pumped Storage Hydropower* (June 7, 2019), https://www.energy.gov/eere/water/articles/new-approach-pumped-storage-hydropower [https://perma.cc/423P-RWNZ].

A. Licensing, Permitting, and Other Project Development Issues

A significant challenge confronting development of hydroelectric and, in particular, pumped storage hydro projects is the lengthy and uncertain regulatory processes that can deter investment in such projects.[336] This section focuses on FERC licensing and the U.S. Bureau of Reclamation leasing processes—however, several other agencies will be involved in authorizing a hydro project, depending on its scope and location.[337] In a 2021 report, the National Hydropower Association estimated that a seven- to ten-year range reflects "[a]n optimistic licensing and construction timeline for a new [pumped storage hydroelectric project] from inception to generation."[338]

Hydroelectric resources are capital intensive projects. They require years of lead-time, planning, and development to construct and bring online, even for smaller facilities. Reclamation states the average production cost per MWh of Federal hydropower has trended upward as a result of environmental regulations and challenging hydrologic conditions.[339] Meanwhile, the cost of new natural gas, solar, and wind resources has plummeted and hydropower tends to be omitted from key Federal incentives for renewable energy (but see Section IV.A, showing the 117th Congress' focus on hydroelectric incentives).[340] In terms of pumped storage within the United States, only one new pumped storage project (the 40 MW Olivenhain-Hodges Plant in California), has become operational in the past twenty years.[341] Notable challenges for new pumped storage development include lengthy regulatory periods, market and investment uncertainty, unrecognized energy storage and ancillary services valuation, as well

336. *2021 NHA Pumped Storage Report*, *supra* note 9, at 10; *see 2018 NHA Pumped Storage Report*, *supra* note 7, at 13 (recapping the results of a 2020 survey by the National Hydropower Association, showing licensing as the biggest challenge viewed by hydropower developers).

337. *See, e.g., HREA 2017 Report*, *supra* note 320, at app. A (summarizing the many Federal agencies and requirements involved in FERC's hydropower licensing process; in addition, state, tribal, and local requirements must be considered).

338. *2021 NHA Pumped Storage Report*, *supra* note 9, at 31.

339. U.S. DEP'T OF THE INTERIOR, BUREAU OF RECLAMATION, *Hydropower Strategic Plan Fiscal Year 2021-2026*, at 1 (Dec. 11, 2020).

340. Connor Bevan, *Dammed if you Don't: Industry Perspectives on Regulatory Obstacles to and Policy Incentives for the Electrification of Non-Power Federal Dams in the United States,* at 4, NAT'L HYDROPOWER ASS'N (Apr. 1, 2021).

341. U.S. DEP'T OF ENERGY, ORNL/SPR-2019/1299, *Pumped Storage Hydropower FAST Commissioning Technical Analysis*, at iv (Jul. 2020).

as unforeseen circumstances (i.e., subsurface, geological, environmental, and other site-specific issues), large up-front capital costs and typically long return periods.[342] The National Hydropower Association observes greater financing issues for pumped storage relative to other storage technologies; in particular, difficulty securing power purchase agreements with utilities.[343] In California, the trend towards shorter contracts for Resource Adequacy resources (the state's reliability program discussed above)[344] may present an obstacle to pumped storage projects, requiring longer term contracts to attract investors.[345] However, as can be seen in the discussion below, as well as above in Section IV.B, there have been many regulatory changes put in place to help streamline the licensing process.

1. FERC Licensing Process for Non-Federal Facilities

FERC maintains ultimate responsibility for issuing preliminary permits and licenses, as well as enforcing any project conditions throughout the project's lifetime.[346] Under the Federal Power Act, licenses may be issued for a period of up to fifty years,[347] and are subject to numerous license conditions. FERC's current policy is to issue licenses for a maximum of forty years.[348] FERC imposes a standard set of conditions on all licenses (L-Forms), but each license is additionally subject to specific conditions as may be imposed by various state and federal agencies that are statutorily conferred with conditioning authority.

The process has been streamlined somewhat, as in 2003 FERC implemented the Integrated Licensing Process, which is now FERC's default licensing process.[349] Under the Integrated Licensing Process, the

342. *Id.* at 2.33, 3.2-3.3 (noting that, since pumped storage projects typically face construction lead times exceeding four years, financial institutions may be reluctant to offer long-term financing throughout this period).

343. *2021 NHA Pumped Storage Report*, *supra* note 9, at 12.

344. *See DMM 2020 Annual Report, supra* note 104, at 15 (summarizing the trend in California from RA requirements being met by the investor-owned utilities' long-term tolling contracts to dozens of load-serving entities' short-term RA-only contracts).

345. *See 2018 NHA Pumped Storage Report*, *supra* note 7, at 11 (observing many RTOs/ISOs have "realtime or day-ahead markets and there are no long-term market products where a bulk storage project can attract investors seeking revenue certainty through long-term power purchase agreements or defined value streams").

346. 16 U.S.C § 797(e)-(f) (2021).

347. 16 U.S.C. § 799 (2021).

348. *Policy Statement on Establishing License Terms for Hydroelectric Projects,* 161 FERC ¶ 61,078, at P 14 (2017).

349. *See Hydroelectric Licensing Under the Federal Power Act*, 104 FERC ¶ 61,109, Order No. 2002 (2003), *on rehearing*, 106 FERC ¶ 61,037, Order No. 2002-A (2004). By comparison, the Traditional Licensing Process and the Alternative Licensing Process must both be requested by the applicant.

potential license applicant's pre-filing consultation and FERC's scoping pursuant to the National Environmental Policy Act (NEPA) are conducted concurrently, rather than sequentially.[350] The Integrated Licensing Process entails public comments, scoping meetings to identify potential NEPA issues, and maximized coordination among Federal, state, and tribal permitting and certification processes, consultation with potentially affected tribes, a site visit, and a study process.[351] Potential applicants must also file a Preliminary License Proposal or a draft license application to provide FERC the opportunity to comment before an application is formally filed.[352] The formal application must contain extensive information required in FERC's regulations, including maps and drawings that allow FERC staff to determine the project location, land area affected, and the proposed design of all power-producing structures and equipment.[353] The applicant must file an "Environmental Report" as Exhibit E of the license application, as discussed in FERC's 2008 guidelines for preparing environmental documents.[354]

Once FERC deems the application and approved studies complete, deficiencies in the application cured, and that there is no other information outstanding to process the application, FERC will publish a "Notice of Acceptance" (providing notice the application is accepted for filing), and a "Notice of Ready for Environmental Analysis."[355] In the ensuing proceedings, parties may comment, protest, and provide recommendations on the application.[356] The Departments of Agriculture, the Interior, and Commerce may also submit preliminary conditions and fishway prescriptions to be attached to the FERC license (FERC may conduct a trial-type hearing to evaluate whether the departments' preliminary conditions/prescriptions or any proposed alternative conditions/prescriptions are consistent with the Federal Power Act and should be included in the license).[357] At this stage, the applicant must also provide FERC with a copy of the state water quality certification pursuant to the Section 401 of the Clean Water Act,

350. Order No. 2002, *supra* note 349, at P 1.
351. *See* 18 C.F.R. §§ 5.5-5.15 (2021).
352. 18 C.F.R. § 5.16.
353. 18 C.F.R. § 5.18.
354. *See generally* FED. ENERGY REGULATORY COMM'N, OFFICE OF ENERGY PROJECTS, *Preparing Environmental Documents: Guidelines for Applicants, Contractors, and Staff* (Sept. 2008).
355. 18 C.F.R. § 5.22.
356. 18 C.F.R. § 5.23.
357. *See* 16 U.S.C. § 797(e) (2021); 16 U.S.C. § 811 (2021); 16 U.S.C. § 823d (2021).

a copy of the request for the Section 401 water quality certification, or evidence of waiver of the water quality certification.[358] There is no statutory time frame within which FERC must act on the license application; rather, FERC will issue its decision once it has everything it needs to complete processing.[359] For a project with no exceptional issues or major modifications, an applicant can expect FERC's licensing process, following years of pre-filing studies and exploring financing options, to last another two to three years. However, some estimates indicate it takes over a decade for hydropower projects to get licensed or relicensed, and licensing costs can reach millions of dollars.[360]

Although projects involving Federal infrastructure may trigger additional requirements, to streamline non-Federal hydropower development impacting the Army Corps of Engineers' (Corps) projects (namely, non-powered dams), FERC and the Corps have entered into Memoranda of Understanding (MOU)—most recently in 2016, establishing a two-phased framework comprised of a Phase I coordinated environmental review, and a Phase II engineering and technical review.[361] Under the 2016 MOU, FERC and the Corps serve as lead and cooperating agency, respectively, for purposes of the NEPA review, although the MOU does not preclude other coordination arrangements.[362] In the Phase I environmental review process, FERC issues the license and status letters on the Corps' environmental review; in Phase II, the Corps issues its decisions under the Clean Water Act Section 404 (concerning the Corps' permitting authority over discharge of dredged or fill material into waters of the United States)[363] and the Rivers and Harbors Act Section Fourteen (concerning the Corps' permitting authority over alteration or occupation of certain public works built by the United

358. 18 C.F.R. § 5.23.

359. *See generally* FED. ENERGY REGULATORY COMM'N, *Handbook for Hydroelectric Project Licensing and 5 MW Exemptions From Licensing*, at 2-23 – 2-28 (2004), https://www.ferc.gov/sites/default/files/2020-04/licensing-handbook.pdf [https://perma.cc/7T36-TVLJ].

360. Rebecca Kern, *Permit Delays Dam Up Hydro Projects, Relicensing Costs Millions*, BLOOMBERG LAW (Oct. 30, 2018), https://news.bloomberglaw.com/environment-and-energy/permit-delays-dam-up-hydro-projects-relicensing-costs-millions [https://perma.cc/SK7L-A9HD]; *see also* GBADEBO OLADOSU ET AL., OAK RIDGE NATIONAL LABORATORY, ORNL/TM-2019/1245, AN ASSESSMENT OF HYDROPOWER ENVIRONMENTAL MITIGATION COSTS 6 (Aug. 2019).

361. *Memorandum of Understanding between United States Army Corps of Engineers and the Federal Energy Regulatory Commission on Non-Federal Hydropower Projects* (executed July 20, 2016), https://www.ferc.gov/sites/default/files/2020-04/07-21-16.pdf [https://perma.cc/G9N2-XBLH] [hereinafter *2016 FERC USACE Hydropower MOU*].

362. *Id.* § 2 at 1; *id.* at attach. A at 4.

363. 33 U.S.C. § 1344 (2021).

States),[364] and FERC administers the license requirements.[365] The Corps may also recommend that FERC require the project's licensee to enter into a Memorandum of Agreement with the Corps "describing the mode of hydropower operation acceptable to the Corps."[366]

2. Reclamation's Lease of Power Privilege Process for Federal Facilities

In addition to the FERC licensing process, projects using a Reclamation facility for electric power generation trigger additional requirements.[367] Reclamation must issue a Lease of Power Privilege (LOPP) to non-Federal entities, for a maximum term of forty years, to use a Reclamation facility for electric power generation.[368] The LOPP process can be initiated by the non-Federal developer or by Reclamation.[369] In either case, Reclamation will initiate a public LOPP competitive solicitation process

364. 33 U.S.C. § 408 (2021).

365. *2016 FERC USACE Hydropower MOU*, *supra* note 361, Attach. A, at 5. *See generally 2017 FERC Hydropower Primer*, *supra* note 59, at 19 (providing an overview of the Corps' requirements of non-Federal hydroelectric project developers under section 14 of the Rivers and Harbors Act of 1899, and discussing the 2016 MOU between the Corps and FERC).

366. *2016 FERC USACE Hydropower MOU*, *supra* note 361, § 7(A)(9), at 12. *See, e.g.*, *CRD Hydroelectric LLC, Iowa*, 135 FERC ¶ 62,055, ordering para. E (2011) (providing in Article 310 of the license a requirement that the licensee, prior to hydroelectric plant's operation at the Corps' existing Red Rock Dam, enter into a Memorandum of Agreement with the Corps to describe the facilities' detailed operation and any restrictions needed to protect the Corps' project's primary purposes for "navigation, recreation, water quality, and flood control."); *City of Woonsocket*, 165 FERC ¶ 62,140, at P 3 (2018) (noting FERC lacks authority to license Federally-owned facilities, but is required to license non-Federal projects using surplus water or water power from a Federally-owned dam, and that for project located at the Corps' Woonsocket Falls dam, the license included a requirement to develop an operating plan and a memorandum of agreement between licensee and the Corps "describing powerhouse operation that is acceptable to the Corps").

367. *See, e.g.*, NAT'L RENEWABLE ENERGY LAB., *Bureau of Reclamation Hydropower Lease of Power Privilege: Case Studies and Considerations*, at 4 (May 2018), https://www.nrel.gov/docs/fy18osti/71092.pdf [https://perma.cc/88PS-628Z] [hereinafter *NREL 2018 Report*] (noting a non-Federal project using multiple Federal assets can require both a LOPP and authorization from FERC, with one asset under Reclamation's jurisdiction and the other under FERC's jurisdiction).

368. 43 U.S.C. § 485h(c) (2021).

369. *See NREL 2018 Report, supra* note 367, at 10.

to award a Preliminary Lease.[370] After the Preliminary Lease is awarded, the developer must complete certain requirements, including under NEPA, the Endangered Species Act (ESA), and the National Historic Preservation Act (NHPA), prior to executing a LOPP Contract with Reclamation.[371] Following execution of the LOPP Contract, the developer must complete final project designs and construction.[372] Each of these steps must be met within timelines specified in Reclamation's regulatory manual FAC 04-08, and Reclamation may withdraw or revoke Preliminary Leases or LOPPs.[373] As of December 2017, projects using Reclamation's LOPP process required between 6.5 and 13 months from the project initiation date to the LOPP Contract execution date.[374]

In an effort to streamline non-Federal hydroelectric projects at Reclamation sites and minimize issues between the dual permitting agencies, FERC and Reclamation entered into a MOU in 1992 that provides procedures for coordinating on preliminary permits, license applications, and requests for a LOPP.[375] The MOU includes several presumptions for determining whether FERC or Reclamation has jurisdiction, though the presumptions may be challenged.[376] For purposes of environmental review of such projects that are wholly or partially subject to FERC's jurisdiction, the 1992 MOU designates FERC as the lead agency for preparing environmental impact statements under NEPA.[377] Recent projects with Federal and non-Federal elements suggest the 1992 MOU is working effectively at reducing disagreements between Reclamation and FERC over which agency should guide the NEPA process.[378]

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370. FAC 04-08, Reclamation Manual: Directives and Standards, at 7–8, 10, 12 (last updated Dec. 20, 2016) https://www.usbr.gov/recman/fac/fac04-08.pdf [https://perma.cc/KF8R-3P9L] [hereinafter FAC 04-08].

371. *Id.* at 13; *id.* at app. B; *see* U.S. DEP'T OF THE INTERIOR, BUREAU OF RECLAMATION, *Lease Of Power Privilege (LOPP) Flowchart*, https://www.usbr.gov/power/LOPP/PL%20113-24%20Revision/Dam%20-%20Request%20through%20Preliminary%20Lease.pdf [https://perma.cc/N83R-AKTM].

372. FAC 04-08, *supra* note 370, at 12 (noting a four-year timeframe is allowed from Preliminary Lease execution to construction commencement, and Reclamation's Regional Director will determine maximum construction timeframes).

373. Reclamation's Regional Director has discretion to withdraw issued Preliminary Leases or LOPPs for good cause (e.g., due to cybersecurity or physical security concerns). FAC 04-08, *supra* note 370 at 13. The Regional Director's written approval is also needed to transfer LOPPs or sell facilities, and Reclamation will have a right of first refusal to purchase the powerplant. *Id.* at 16.

374. *NREL 2018 Report*, *supra* note 367, at 25–27, 30.

375. Notice of Memorandum of Understanding, 58 Fed. Reg. 3269, 3269 (Jan. 8, 1993).

376. *Id*. at 3270.

377. *Id*. at 3271.

378. *See, e.g.*, Letter Response on the Halverson Canyon Pumped Storage Project, Bureau of Reclamation, to David Turner, FERC (Apr. 8, 2021) (in FERC Docket No. P-

Conversely, for small conduit hydropower projects (i.e., facilities capable of producing 5 MW or less of electric capacity, and operated for the distribution of water for consumption rather than primarily for electricity generation) at Reclamation facilities, Reclamation serves as lead agency.[379] Separately, facilities 40 MW and under that use only non-Federally owned conduits for generation may qualify for exemptions from FERC licensing requirements per the Hydropower Regulatory Efficiency Act of 2013.[380] As it pertains to small hydroelectric projects more generally, the Act raised the threshold from 5 MW to 10 MW for projects to take advantage of exemptions from FERC's licensing requirements in FERC's discretion.[381]

B. Water Rights Issues and the Clean Water Act

Water rights issues can present obstacles to hydropower development—affecting large hydropower operations, e.g., the Central Valley Project and State Water Project in California, and small hydropower operations alike.[382] While FERC regulates non-Federal hydropower projects comprising over half of the United States' total hydropower capacity, Federal projects authorized by Congress are owned primarily by Reclamation, the Army Corps of Engineers, and the Tennessee Valley Authority,[383] and can present complexities for hydropower developers seeking to use Federal facilities. Layering onto these complexities, state and tribal laws may necessitate further permits and approvals to utilize water for hydropower projects. As shown below, efforts to harmonize water rights are essential in facilitating hydropower operation and development. Furthermore, the uncertainty

15088) (involving a Reclamation lake as the lower reservoir, whereas FERC retains jurisdiction over the project facilities outside of Lake Roosevelt including the upper reservoir; and indicating that when a project enters the licensing proceeding at FERC, FERC and Reclamation will enter into an agreement outlining Reclamation's participation as a cooperating agency, whereby FERC will act as lead agency on NEPA review).

379. 43 U.S.C. § 485h(c)(2)-(9) (2021). DEVIN HARTMAN AND TOM RUSSO, EBBING THE FLOW OF HYDROPOWER RED TAPE 7 (2017), https://www.rstreet.org/wp-content/ uploads/ 2017/08/105.pdf [https://perma.cc/NB7P-XYJY].

380. 16 U.S.C. § 823a (2021); *see* Pub. Law 113-223 at § 4.

381. 16 U.S.C. § 2705 (2021); *see* Pub. Law 113-223 at § 3.

382. *See, e.g.,* THE COLORADO ENERGY OFFICE, *Small Hydropower Case Study: Town of Basalt Small Hydro Project* at 2, https://drive.google.com/file/d/1I-wyIMEnDiit dsmqXDWtHa3ILaNiSRUB/view [https://perma.cc/L269-D42P] (noting the 40 kW small hydro project's biggest challenge related to water rights, inhibiting the project from operating at full capacity).

383. *2017 FERC Hydropower Primer*, *supra* note 59, at 1.

surrounding FERC's implementation of the Clean Water Act during its licensing process and the U.S. Environmental Protection Agency's hotly debated regulatory interpretation of "waters of the United States" as used in the Clean Water Act add additional hurdles to overcome.

1. Issues Concerning Reclamation Contracts for Water Rights in General

Reclamation's contracts with water users associations[384] operating hydro projects have been the subject of litigation. A 2009 case involving a water users association holding several contracts with Reclamation illustrates the complex arrangements that can convolute hydropower development at Reclamation facilities. In *Strawberry Water Users Association*, an organization representing water users entered into contracts with the United States to assume the water users' repayment obligations related to Reclamation's Strawberry Valley Project in Utah—comprised of a dam and reservoir, and constructed pursuant to the Reclamation Act of 1902.[385] In exchange for operating and maintaining the Strawberry Valley Project power facilities, the water users association received revenues from power generation; importantly, the United States maintained legal title to the power plants.[386] Subsequently, Reclamation entered into a repayment contract with a water conservancy district (a political subdivision of Utah) to construct, maintain and operate the Central Utah Project to expand upon the Strawberry Valley Project, which included the Diamond Fork System to deliver Strawberry Valley Project water from a reservoir to its water users.[387] Reclamation, the water conservancy district, and the water users association thereafter negotiated a contract (1991 Contract) that, *inter alia*, allocated water from the Central Utah Project facilities to the water users association, but expressly reserved the issue of power development to negotiation of a separate contract.[388]

In 2001, the water users association sought a declaration from the Federal district court that it possessed a right to develop and receive revenues from power generation in the Diamond Fork System.[389] However, in recognizing the 1991 Contract, the district court declined to opine on the power

384. FAC 04-08, *supra* note 370, at 3 (defining "Water Users Association" as an organization that has a contract with Reclamation for the use or delivery of Reclamation project water).

385. *Strawberry Water Users Ass'n v. United States*, 576 F.3d 1133, 1135–37 (10th Cir. 2009).

386. *Id*. at 1137.

387. *Id*.

388. *Id*. at 1138–39.

389. *Id*. at 1139–40.

development rights issue, observing that the water rights association did not have an outstanding proposal to obtain a "lease of power privilege" from Reclamation (as discussed above in Section VI.A.2) needed to develop hydroelectric power at the Central Utah Project facilities.[390] On appeal, the Tenth Circuit refused to declare the water user association's purported property right to power development in the Diamond Fork System—instead distinguishing the water users association's rights under an earlier repayment contract with Reclamation (i.e., to net profits associated with its operation of the Strawberry Valley Project power system, over which Reclamation retained title), from the right to develop power pursuant to a lease of power privilege in Diamond Fork at the Central Utah Project.[391]

In addition to distinguishing the different arrangements water rights holders may obtain from Reclamation, *Strawberry Water Users Association* illustrates that the courts will defer to the United States' authority to approve water rights holders' changes in use of their water rights. In that case, the water users association sought to update its 1933 water right from Reclamation (Reclamation had received the Utah State Engineer's approval of the water appropriation in 1906), in part to permit municipal and industrial water use, and to add hydropower generation at certain facilities.[392] The district court, affirmed by the Tenth Circuit, found that both the Reclamation contracts and Federal law "reserved to the United States the authority to change the use of Reclamation project water or points of diversion."[393] While recognizing, under Utah state law, the water users association could initiate applications for changed uses because its shareholders were the beneficial users of Reclamation's Strawberry Valley Project water, the court found that the United States must, at a minimum, join in such an application before the Utah State Engineer, and further, the United States retained ultimate authority to approve the water users association's filed application.[394]

390. *Id*. at 1140–41.
391. *Id*. at 1141–44. *See id.* at 1135 (explaining Congress permitted only two forms of power development on Reclamation facilities when enacting the Town-sites and Power Development Act of 1906: (1) Federally-developed power facilities associated with repayment contracts under which water users assumed operation and maintenance of the facilities; and (2) leases of power privilege at Reclamation facilities to non-Federal developers).
392. *Id*. at 1139.
393. *Id*. at 1140, 1145.
394. *Id*. at 1146–49.

2. *Water Rights Issues Surrounding the Central Valley Project and State Water Project, and Their Coordinated Operations*

Drought in the West has aggravated water rights issues that impact hydropower resources' operations—for example, requiring renegotiation of operations agreements, including as it relates to the Central Valley Project (CVP) and State Water Project (SWP). The CVP includes eleven hydroelectric power plants that produce roughly 4.5 million MWh per year on average.[395] Among other purposes, the Federally-owned CVP is operated for the "generation and sale of electric energy"; however, power is prioritized behind several other uses for the project's dams and reservoirs.[396] The California-owned SWP, managed by CDWR, includes five hydroelectric plants (and several other pumping plants), and produces roughly 6 million MWh per year on average.[397] The 1986 Coordinated Operations Agreement governs the CVP and the SWP and coordinated operations have been the subject of negotiation and litigation between the Federal and state governments.[398]

Reclamation has contracts with CVP contractors[399] in which Reclamation charges users based on water amount delivered, in contrast to Reclamation's repayment contracts under which users are charged based on the amount of water storage allocated to a contractor.[400] Reclamation's annual water deliveries to CVP contractors are often impacted by drought and other

395. U.S. DEP'T OF THE INTERIOR, BUREAU OF RECLAMATION, California-Great Basin Region, Central Valley Project, https://www.usbr.gov/mp/mpr-news/docs/factsheets/cvp.pdf [perma.cc/5TBV-FYX4].

396. H.R. 7051, 75th Cong., 50 Stat. 844 § 2 (1937) *amended by* Reclamation Projects Authorization and Adjustment Act of 1992, Pub L. No. 102-575, 106 Stat. 4714, § 3406(a) (1992) (maintaining power as the third and last accorded use for the dam and reservoirs, but amending this last priority to also encompass power "and fish and wildlife enhancement."). *See* U.S. DEP'T OF THE INTERIOR, BUREAU OF RECLAMATION, RECORD OF DECISION: REINITIATION OF CONSULTATION ON THE COORDINATED LONG-TERM MODIFIED OPERATIONS OF THE CENTRAL VALLEY PROJECT AND STATE WATER PROJECT 8 (Feb. 2020) (summarizing the uses under the original 1937 authorization for the CVP, and as amended under the 1992 Central Valley Project Improvement Act).

397. CAL. DEP'T OF WATER RES., *Producing and Consuming Power,* Cal. Dep't of Water Res., https://water.ca.gov/What-We-Do/Power [perma.cc/93HH-UHBM]. *State Water Project*, CAL. DEP'T OF WATER RES., https://water.ca.gov/Programs/State-Water-Project [perma.cc/U4JG-D79E].

398. CHARLES V. STERN, PERVAZE A. SHEIKH, CONG. RSCH. SERV., R45342, CENTRAL VALLEY PROJECT: ISSUES AND LEGISLATION 7, 11, https://fas.org/sgp/crs/misc/R45342.pdf [https://perma.cc/HBR5-BFGC] [hereinafter CVP 2021 CONGRESSIONAL REPORT].

399. The largest CVP water contract holder category is the Sacramento River Settlement Contractors who had entitlements to the Sacramento River prior to when Reclamation constructed the CVP, and entered into a settlement with Reclamation regarding water rights allocation. *Id*. at 7; *see also id*. at 8 fig.3 (showing the Sacramento River Settlement Contractors hold 22.16% of the total maximum contracted CVP supplies).

400. *Id*. at 6 n.12.

factors,[401] an issue receiving much attention at both Federal and state levels.[402] CDWR delivers SWP water to twenty-nine users under long-term contracts that specify the maximum annual water amount a contractor can request, varying based on hydrologic conditions among other factors.[403] Under a 2018 amendment to the 1986 Coordinated Operations Agreement, the sharing of regulatory restrictions on storage withdrawals between CVP and SWP varies depending on the type of water year—for example, withdrawals are split sixty percent and forty percent between CVP and SWP, respectively, during "Critically Dry" years relative to eighty percent CVP and twenty percent SWP during a "Wet & Above Normal" water year.[404]

In February 2020, Reclamation issued changes to the CVP and SWP coordinated operations, in part due to multiple drought years.[405] Reclamation explains, of the alternatives considered in the environmental impact statement, "Each alternative responded to the overall purpose and need of providing operational flexibility by addressing the status of listed species, with the goal of enabling Reclamation to maximize water deliveries and optimize power generation."[406] One aspect of the ultimately determined preferred alternative to update the CVP/SWP coordinated operations that Reclamation highlights is "[r]eal-time monitoring and analyses to support increased flexibility to more efficiently use available water supplies."[407]

401. *Id.* at 6*; see id*. at 8–10, Table 1 (showing some of the CVP contractors had their water allocations reduced to 0% in 2021 due to extremely dry conditions).

402. *See id*. at 27 (pointing to policymakers "proposals to build new or augmented CVP and/or SWP water storage projects" and California's pursuit of "a major water conveyance project, the California WaterFix, with a nexus to CVP operations").

403. *SWP Management,* CAL. DEP'T OF WATER RES., https://water.ca.gov/Programs/State-Water-Project/Management [perma.cc/4LMA-47W7]; *see, e.g.,* CAL. DEP'T OF WATER RES., Notice to State Water Project Contractors (Mar. 23, 2021), https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/State-Water-Project/Management/SWP-Water-Contractors/Files/NTC_21-06_032321.pdf [perma.cc/Z7Q6-JFKY] (decreasing SWP long-term contractors' allocations to five percent of their 2021 requested amounts, due to persistent dry conditions).

404. CVP 2021 CONGRESSIONAL REPORT, *supra* note 398, at 11–12, tbl. 3.

405. U.S. DEP'T OF THE INTERIOR, BUREAU OF RECLAMATION, *Consultation on the Coordinated Long-Term Operation of the CVP and SWP* (last updated Sept. 22, 2021), https://www.usbr.gov/mp/bdo/lto/index.html [perma.cc/3LZU-TTQA]; *see also* CVP 2021 CONGRESSIONAL REPORT, *supra* note 398, at 19.

406. *See* U.S. DEP'T OF THE INTERIOR, BUREAU OF RECLAMATION, RECORD OF DECISION: REINITIATION OF CONSULTATION ON THE COORDINATED LONG-TERM MODIFIED OPERATIONS OF THE CENTRAL VALLEY PROJECT AND STATE WATER PROJECT 2 (Feb. 2020).

407. *Id*. at 5.

Reclamation points to "water right seniority" and dry years characterized by "insufficient water to meet all authorized purposes," as among the constraints hamstringing its ability to improve conditions for listed species.[408] Subsequent to Reclamation issuing its final Record of Decision, California and nongovernmental organizations separately sued the Federal government (i.e., Reclamation, National Marine Fisheries Service, and Fish & Wildlife Service) over the updated plan for long-term operation of the CVP and SWP, under the Administrative Procedure Act, Endangered Species Act, NEPA, and the California Endangered Species Act—specifically as it relates to the underlying biological opinions.[409] Litigation surrounding the updated long-term operations plan is ongoing in the Federal district court, but the Federal agencies defending the case have indicated they will reinitiate consultation under the Endangered Species Act; an Interim Operations Plan proposing how CVP and SWP should be operated in the meantime is currently before the court.[410]

3. Harmonizing Water Rights, Environmental Considerations, and Hydropower Generation in the Klamath River Basin

Another illustration of the complexities implicated in water rights disputes is PacifiCorp's Klamath Hydroelectric Project (FERC Project No. 2082). The Klamath River Basin is located on the Northern California-Southern Oregon border. While this dispute ultimately ended in a settlement agreement executed in 2010 and amended in 2016,[411] it was a long and tumultuous path to resolution, and it is still an ongoing process. Adding to the intricacy of the issues at play, multiple private, state, Federal, and tribal

408. *Id*. at 18.

409. CVP 2021 CONGRESSIONAL REPORT, *supra* note 398, at 19-23. *Cal. Nat'l Res. Agency v. Ross*, 2020 U.S. Dist. LEXIS 83612 at 5–7 (E.D. Cal. May 11, 2020) (summarizing the plaintiffs' claims); *id*. at 10-11 (granting plaintiffs' request for a preliminary injunction to enjoin export operations in the South Delta and reinstate aspects of NMFS's 2009 biological opinion, finding operations carried out pursuant to the 2020 plan for long-term operation of the CVP and SWP will "irreparably harm threatened [California Central Valley] steelhead").

410. *See Pac. Coast Fed'n. of Fishermen's Ass'ns v. Ross*, 2021 U.S. Dist. LEXIS 158069, at 7 (E.D. Cal. Aug. 19, 2021) (granting plaintiffs' motion to stay the action until September 30, 2021, and directing a status report on October 1, 2021 as to how the actions should proceed); *Pac. Coast Fed'n of Fishermen's Ass'ns v. Raimondo*, 2021 U.S. Dist. LEXIS 234515, at 12-13 (E.D. Cal. Dec. 7, 2021) (noting Federal defendants and state plaintiffs submitted to the court in October 2021 an "Interim Operations Plan" proposing how the CVP and SWP should be operated through September 30, 2022 pending the reinitiated consultation under the Endangered Species Act).

411. KLAMATH HYDROELECTRIC SETTLEMENT AGREEMENT (Feb. 18, 2010) (as amended Apr. 6, 2016), https://www.doi.gov/sites/doi.gov/files/uploads/FINAL%20KHSA%20PDF.pdf [perma.cc/5G6C-YVPM].

interests were implicated throughout the path to settlement and beyond.[412] Typically, with water rights proceedings, a variety of interests need to be properly balanced and discussed among stakeholders to reach successful resolution. In general, water rights issues tend to be complex, but the complexity is compounded when water rights are discussed in the context of the heavily regulated hydroelectric generation sphere.

In the early 1900s, dams began to be built on the Klamath River[413] and construction ultimately resulted in a total of seven hydroelectric developments on the Klamath River and one of its tributaries.[414] In 1954, FERC issued the original license for the Klamath Hydroelectric Project.[415] In 1976, the Oregon Water Resources Department began its Klamath River Basin water rights adjudication process, which implicated private water rights and environmental concerns.[416] In 1998, stakeholders of Klamath River Basin water interests (e.g., the Klamath River Basin tribes, state agencies, the Federal government) partook in the first set of negotiations that ultimately proved unsuccessful.[417] In 2004, PacifiCorp filed a relicensing application for the Klamath Hydroelectric Project, as the original license was set to expire.[418] In 2005, the Klamath Hydroelectric Settlement Agreement negotiations began, which resulted in no fewer than forty-eight parties executing a final Settlement Agreement in 2010 that called for the

412. Some of the interested parties included: PacifiCorp; the Federal Energy Regulatory Commission; the Karuk Tribe; the Yurok Tribe; the State of California; California Department of Fish and Wildlife; California Natural Resources Agency; the State of Oregon; Oregon Department of Environmental Quality; Oregon Department of Fish and Wildlife; Oregon Water Resources Department; Klamath Water Users Association; American Rivers; California Trout; Trout Unlimited; National Marine Fisheries Service; U.S. Department of the Interior; U.S. Department of Commerce; the Bonneville Power Administration; the Western Area Power Administration; and several environmental groups.

413. *Klamath River Basin Chronology*, WATER EDUC. FOUND., https://www.watereducation.org/aquapedia/klamath-river-basin-chronology [perma.cc/4D26-VJ2H].

414. PACIFICCORP, KLAMATH HYDROELECTRIC SETTLEMENT AGREEMENT IMPLEMENTATION REPORT 2, (2020), https://www.pacificorp.com/content/dam/pcorp/documents/en/pacificorp/energy/hydro/klamath-river/khsa-implementation/implementation-plans/2020.04.23_KHSA_ImpRptUpdate_2019.pdf [perma.cc/85XA-D42B].

415. *See PacifiCorp*, 162 FERC ¶ 61,236, at P 4 (Mar. 15, 2018).

416. Disturbed salmon runs and lower water quality were some of the major environmental concerns.

417. *Klamath River Basin Chronology*, *supra* note 413.

418. *PacifiCorp*, 175 FERC ¶ 61,236, at P 3 (June 17, 2021).

decommissioning of four hydroelectric developments.[419] In 2010, parties also executed the Klamath Basin Restoration Agreement.[420] Both agreements required Federal approval legislation, but the necessary legislation was never passed, and the Klamath Basin Restoration Agreement expired at the end of 2015.[421] In 2016, parties amended the Klamath Hydroelectric Settlement Agreement to specify that a decommissioning plan did not necessitate Federal approval.[422]

Specifically, the Klamath Hydroelectric Settlement Agreement addresses, among other things, trust obligations, tribal rights, and PacifiCorp's water rights. The Settlement Agreement does not itself assign water rights to PacifiCorp but states that the "water rights will be processed and adjusted in accordance with the principles of Oregon law and the Water Rights Agreement between PacifiCorp and the State of Oregon."[423] The Water Rights Agreement is included as Exhibit One to the Settlement Agreement, which allows PacifiCorp to "divert a maximum of 3,000 cubic feet per second (cfs) of water, for purposes of power generation at J.C. Boyle hydroelectric plant prior to the decommissioning and removal of the J.C. Boyle facility."[424]

Additionally, the Klamath Hydroelectric Settlement Agreement, as amended in 2016, directs PacifiCorp to transfer ownership of four hydroelectric developments[425] to a Dam Removal Entity, and the Dam Removal Entity would submit an application to FERC to surrender the license for the four hydroelectric developments that would then be decommissioned. On September 23, 2016, PacifiCorp requested that the license for the four developments be transferred to the Dam Removal Entity. That same day, the Dam Removal Entity filed an application to surrender the license and remove the developments.[426] On June 17, 2021, FERC approved PacifiCorp's request to transfer the four hydroelectric developments to the Dam Removal Entity and the states of Oregon and California. As of January 2022, the application of surrender is still pending before FERC.[427]

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419. *Id.* at no. 4 (2021); *see also* Letter from Michael A Swiger, Coun. for PacificCorp, to Kimberly D. Bose, Sec'y, Fed. Energy Regulatory Comm'n (Mar. 5, 2010).

420. *PacificCorp*, 162 FERC ¶ 61,236, at P 9, n.9 (Mar. 15, 2018).

421. *Id.*

422. KLAMATH HYDROELECTRIC SETTLEMENT AGREEMENT IMPLEMENTATION REPORT, *supra* note 414, at i.

423. *Id.* at 14.

424. *Id.* at Exhibit 1.

425. The J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate developments. Today, the Klamath Hydroelectric Project consists of eight developments.

426. *PacificCorp*, 175 FERC ¶ 61,236, at P 7 (June 17, 2021). The application was later amended to add the State of Oregon and California as co-licensees. *Id.* at 13.

427. In its September 2021 Order Addressing Arguments Raised on Rehearing, FERC stated that "before making a decision on the application to surrender the Lower Klamath

The Klamath River Basin hydroelectric developments and the selected dam removals are prime examples of harmonizing water rights, environmental protection, and hydroelectric generation. The four developments selected for removal were all built before NEPA was enacted,[428] so the environmental safeguards in place today did not exist at the time of construction. However, in the intervening years, environmental protection has rightfully garnered support, and hydroelectric technologies have improved to generate environmentally sensitive power. The four developments that likely will be removed beginning in 2023 will enable salmon runs and other fish passages to return to areas of the Klamath River.[429] In addition, water quality will likely be improved.[430] This can all be accomplished while allowing the three remaining developments to continue to provide electricity to the citizens of Oregon and California. Indeed, the remaining hydroelectric developments on the Klamath River will help provide affordable, reliable, clean energy that is critical in combating the severe threats of climate change while maintaining reliability as significant thermal generating facilities retire in the Pacific Northwest region.[431]

4. Uncertainty Surrounding Clean Water Act Implementation and the Definition of "Waters of the United States"

As noted above, a license applicant must provide FERC with a copy of the state water quality certification pursuant to Clean Water Act Section 401, a copy of the request for Section 401 water quality certification, or evidence of waiver of the water quality certification.[432] The water quality certification must be issued from the state in which the discharge originates

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Project license, the Commission will comply with NEPA and fully consider the environmental impacts associated with the proposed decommissioning and removal of project facilities." *PacificCorp*, 176 FERC ¶ 61,202, at P 14 (Sept. 23, 2021).

428. Copco 1 was completed in 1918; Copco 2 became operational in 1925; J.C. Boyle was completed in 1958; and Iron Gate was completed in 1962. *Klamath River Basin Chronology*, *supra* note 413.

429. Letter from U.S Secretary of the Dep't of the Interior to Fed. Energy Regulatory Comm'n on Project Nos. P-2082, P-14803, at 2 (June 10, 2021).

430. *Id.*

431. *See, e.g.*, 2021 DRAFT NORTHWEST POWER PLAN, *supra* note 31, at 6–37 (noting "increased competitive pressure and clean energy policies" resulted in early retirements of thermal generators, estimating that the coal-fired generation fleet in the Northwest region will be reduced by over sixty percent over the next decade, and noting uncertainty remains over the role of existing natural gas-fired power plants).

432. 18 C.F.R. § 5.23.

or from an interstate water pollution control agency with jurisdiction over navigable waters at the point the discharge originates.[433] Water quality certifications may set out conditions that must be included in the Federal license.[434]

However, in light of a recent Fourth Circuit case, obtaining a Section 401 water quality certification may also extend the licensing process. Specifically, FERC deems that a state has waived its water quality certification authority if it fails to act on a request for certification within a year after the receipt of such a request.[435] The Fourth Circuit found that, while a state agency must "*act"* in some fashion on a request for certification within a year of receipt, it is not required to take *final action* on a request for certification.[436] The Court made clear that when a state, in good faith, takes timely action to review and process a section 401 certification request, it should not lose its statutory authority to ensure that licensed projects comply with the state's water quality standards, even if it takes the state longer than one year to make a final decision.[437]

Adding to uncertainty regarding Section 401, in October 2021, the U.S. District Court for the Northern District of California vacated the Environmental Protection Agency's Certification Rule.[438] The Environmental Protection Agency's Certification Rule, promulgated in 2019, made a variety of substantive changes to the Environmental Protection Agency's procedures for implementing Section 401, including: (1) narrowing the scope of certification to ensuring that a discharge from a point source into a water of the United States from a Federally licensed or permitted activity will comply with "water quality requirements"; (2) authorizing the Environmental Protection Agency to establish the reasonable amount of time for a certifying authority to certify a request; and (3) authorizing the Environmental Protection Agency to determine whether a certifying authority's denial has complied with the rule's procedural requirements, and to deem certifications

433. 33 U.S.C. § 1341(a)(1) (2021) (explaining that if no state or interstate agency has authority to grant such certifications, the Administrator of the Environmental Protection Agency will grant such).

434. *N.C. Dep't of Envtl. Quality v. FERC*, Nos. 20-1655, 20-1671, 2021 U.S. App. LEXIS 19841, at *6 (4th Cir. July 2, 2021).

435. 33 U.S.C. 1341(a)(1) (2021).

436. *N.C. Dep't of Envtl. Quality v. FERC*, Nos. 20-1655, 20-1671, 2021 U.S. App. LEXIS 19841, at *28 (4th Cir. July 2, 2021).

437. *Id.* at 30.

438. *In re Clean Water Act Rulemaking*, No. C 20-04636 WHA, 2021 U.S. Dist. LEXIS 203567 (N.D. Cal. Oct. 21, 2021). As of January 13, 2022, there has been no appeal of this case. *See In re Clean Water Act Rulemaking*, No. C 20-04636 WHA, 2021 U.S. Dist. LEXIS 234470 (N.D. Cal. Dec. 7, 2021) (denying motion to stay the vacatur).

waived if not.[439] The District Court determined that the Certification Rule narrowed the certifying authority's scope of certification without reasonable explanation while the Clean Water Act does not place any constraint on a state's power to regulate the quality of its own water more stringently than Federal law requires.[440] Accordingly, the District Court vacated the Certification Rule, which the Environmental Protection Agency has applied nationwide.[441] The Environmental Protection Agency is working on establishing a new certification rule.[442]

Uncertainty under the Clean Water Act is further exacerbated with regard to "waters of the United States." Generally, the Clean Water Act establishes Federal jurisdiction over any discharge of pollutants into "navigable waters."[443] The Clean Water Act defines navigable waters as "waters of the United States."[444] The Clean Water Act also allows the Environmental Protection Agency and the Corps (within the Department of the Army) to define waters of the United States in their regulations.[445] If water is determined

439. *See* U.S. ENVTL. PROT. AGENCY, Certification Rule, 85 Fed. Reg. 42,210 (July 13, 2020), https://www.epa.gov/sites/default/files/2020-07/documents/clean_water_act_section_401_certification_rule.pdf [https://perma.cc/7EHE-2CT3]; *and see* Executive Order 13,868, Promoting Energy Infrastructure and Economic Growth, 84 Fed. Reg. 15,495 (Apr. 10, 2019), https://www.federalregister.gov/documents/2019/04/15/2019-07656/promoting-energy-infrastructure-and-economic-growth [https://perma.cc/YND9-WAEC] (asserting that Federal guidance and regulations regarding Section 401 are causing confusion and uncertainty and instructing the Environmental Protection Agency to review and issue new guidance regarding Section 401). *In re Clean Water Act Rulemaking*, No. C 20-04636 WHA, 2021 U.S. Dist. LEXIS 203567, at *21-22 (N.D. Cal. Oct. 21, 2021).

440. *Id*. at 34–37.

441. *Id*. at 39; *and see* U.S. ENVTL. PROT. AGENCY, 2020 Clean Water Act Section 401 Certification Rule, https://www.epa.gov/cwa-401/2020-clean-water-act-section-401-certification-rule [https://perma.cc/Y7E2-7TJ3] (noting that the nationwide vacatur requires a temporary return to EPA's original 1971 certification rules until EPA finalizes a new certification rule).

442. U.S. ENVTL. PROT. AGENCY, Notice of Intention To Reconsider and Revise the Clean Water Act Section 401 Certification Rule, EPA Docket No. EPA–HQ–OW–2021–0302 (2021) https://www.epa.gov/system/files/documents/2021-10/fr_notice-of-intent-to-reconsider-and-revise-cwa-section-401-certification-rule.pdf [https://perma.cc/PBC9-6Q5D].

443. 33 U.S.C. § 1252 (2018) ("The Administrator shall, after careful investigation, and in cooperation with other Federal agencies, State water pollution control agencies, interstate agencies, and the municipalities and industries involved, prepare or develop comprehensive programs for preventing, reducing, or eliminating the pollution of the navigable waters and ground waters and improving the sanitary condition of surface and underground waters.").

444. 33 U.S.C. § 1362(7) (2021).

445. U.S. ENVTL. PROT. AGENCY, *About Waters of the United States*, https://www.epa.gov/wotus/about-waters-united-states [https://perma.cc/97DD-CUNG].

to be a water of the United States, it is subject to Federal jurisdiction, and the entity must obtain a Federal permit for any discharge from a point source into a body of water at issue. If the body of water is not a water of the United States, regulation remains with the state. Binding official determinations of whether a water properly is categorized under waters of the United States are called "Approved Jurisdictional Determinations," and are administratively appealable.[446] "Preliminary Jurisdictional Determinations" are not binding, but they can be requested to expedite the agency review during the permit process.[447]

The definition of waters of the United States has been a hot topic of debate for years and, on June 9, 2021, the Environmental Protection Agency and the Army Corps of Engineers announced a rulemaking to redefine waters of the United States.[448] Acting in accordance with President Biden's Executive Order,[449] the Environmental Protection Agency reviewed the Navigable Waters Protection Rule, which was the 2020 rendition for defining waters of the United States.[450] Upon review, the Environmental Protection Agency and the Corps determined that the Navigable Waters Protection Rule significantly reduced clean water protections because "nearly every one of over 1,500 streams assessed [in New Mexico and Arizona] has been found to be non-jurisdictional[,]"[451] and thus not subject to permitting requirements. The Environmental Protection Agency and the Corps also found that 333 projects would have required Section 404 permitting[452] prior to the Navigable Waters Protection Rule becoming effective.[453] Additionally, on August 30, 2021, the United States District Court for the District of Arizona vacated and remanded the Navigable Waters Protection Rule.[454] This District Court order caused the Environmental Protection Agency to cease implementation of the Navigable Waters Protection Rule and to revert back to interpreting "waters of the United

446. U.S. DEP'T OF THE ARMY, ARMY CORPS. OF ENGINEERS, Regulatory Guidance Letter No. 16-01, at 2 (Oct. 2016).

447. *Id*. at 3.

448. U.S. ENVTL. PROT. AGENCY, *Intention to Revise the Definition of "Waters of the United States"*, https://www.epa.gov/wotus/intention-revise-definition-waters-united-states [https://perma.cc/Z9KP-VYFS].

449. Executive Order No. 13990, *Protecting Public Health and the Environment and Restoring Science To Tackle the Climate Crisis* (Jan. 20, 2021).

450. *See* 85 Fed. Reg. 22,338 (Apr. 21, 2020).

451. U.S. ENVTL. PROT. AGENCY, *EPA, Army Announce Intent to Revise Definition of WOTUS*, https://www.epa.gov/newsreleases/epa-army-announce-intent-revise-definition-wotus [https://perma.cc/K5YH-5CLP].

452. *Id.*

453. *Id*.

454. *Pasqua Yaqui Tribe et al., v. U.S. Envtl. Prot. Agency*, No. CV-20-00266-TUC-RM (D. Ariz. Aug. 30, 2021).

States" consistent with the pre-2015 regulatory regime while the current rulemaking is in progress.[455] On December 7, 2021, the Environmental Protection Agency and the Department of the Army published a proposed rule to better define what waters are protected under the Clean Water Act.[456] The publication was followed by an open comment period and public hearings.[457]

The ultimately determined definition of "waters of the United States" will play an important role in the development of hydropower, and the extent of permits that must be obtained. As noted above, to the extent a hydroelectric project results in any discharge into navigable waters (i.e., waters of the United States),[458] before FERC acts on the license application, the applicant must obtain a water quality certification under Section 401 of the Clean Water Act from the state in which the discharge originates, or from an interstate water pollution control agency with jurisdiction over navigable waters at the point the discharge originates.[459] States' objections to FERC issuing a hydroelectric license on the basis that the state's water quality requirements will be violated can result in FERC conditioning the license accordingly, or denial of the license application.[460] If a certification is granted, it will contain any effluent limitations and other limitations, any necessary monitoring requirements, and any applicable state or tribal law requirements, all of which will be conditions in the FERC license.[461] In addition to water quality certifications, hydroelectric developers may need to obtain permits for dredged or fill material from the Corps under Section

455. U.S. ENVTL. PROT. AGENCY, *Waters of the United States*, https://www.epa.gov/wotus [https://perma.cc/BDZ9-2PBC].

456. *Revised Definition of "Waters of the United States"*, 86 Fed. Reg. 69,372 (Dec. 7, 2021) (to be codified at 33 C.F.R. pt. 328).

457. *See* U.S. ENVTL. PROT. AGENCY, Public Outreach and Stakeholder Engagement Activities, https://www.epa.gov/wotus/public-outreach-and-stakeholder-engagement-activities?mc_cid=f965597118&mc_eid=80172f93f2 [https://perma.cc/LYH2-ZFDN].

458. 33 U.S.C. § 1362(7) (2021) (definitions for Chapter twenty-six of the Clean Water Act).

459. 33 U.S.C. § 1341(a)(1) (2021) (explaining that the Environmental Protection Agency may approve a cooperative agreement between the state(s) and a tribe whose lands the states are located in, in order for the tribe to administer such water quality certification requirements or may otherwise treat the tribe as a state if certain requirements are met.

460. 33 U.S.C. § 1341(a)(2) (2021).

461. 33 U.S.C. §§ 1341(d), 1377(e) (2021) (allowing the Environmental Protection Agency Administrator to treat an Indian tribe as a state for purposes of section 1341, among other sections, if certain statutory requirements are met).

404 of the Clean Water Act, to the extent dredged or fill material may be discharged into waters of the United States.[462]

Also related to hydropower development, but distinct from the discussion above regarding the Environmental Protection Agency's and the Corps' governing statutes and implementing regulations, the Federal Power Act defines "navigable waters" as "parts of streams or other bodies of water over which Congress has jurisdiction under its authority to regulate commerce with foreign nations and among the several States . . . ."[463] Similarly, the Federal Power Act conferred on FERC the authority to license hydroelectric projects located on "any of the streams or other bodies of water over which Congress has jurisdiction under its authority to regulate commerce with foreign nations and among the several States . . . ."[464] In the intervening 100 years since the enactment of the Federal Power Act, the definition of interstate commerce has expanded such that virtually all bodies of water capable of supporting hydropower have been considered to meet the statutory definition of navigable waters, i.e., waters over which Congress has jurisdiction. Nevertheless, FERC's authority to license a hydroelectric project must be consistent with the Secretary of the Army's authority to approve projects that affect the navigability of the "navigable waters of the United States."[465] However, as used in the Federal Power Act, "waters of the United States" would only apply as interpreted and implemented by FERC and would not be defined according to the Environmental Protection Agency's and Department of Army's newly-initiated waters of the United States rulemaking under the Clean Water Act, discussed above. Said differently, "navigable waters" and "waters of the United States" as used in the Federal Power Act and implementing regulations govern FERC's authority to issue licenses for non-Federal hydroelectric projects, whereas the distinct definition of those two terms as used in the Clean Water Act govern the Environmental Protection Agency's and Army Corps' authority over discharges into jurisdictional bodies of water, including when those discharges originate from a hydroelectric project.

462. *See* 33 U.S.C. § 1344. U.S. ENVTL. PROTECTION AGENCY, *Statutory and Regulatory Requirements for Assumption under CWA Section 404*, https://www.epa.gov/cwa404g/statutory-and-regulatory-requirements-assumption-under-cwa-section-404 [https://perma.cc/QJC4-XUN6].

463. 16 U.S.C. § 796(8) (2021).

464. 16 U.S.C. § 797(e).

465. *Id*.

C. Environmental Concerns

As discussed, hydroelectric projects, including pumped storage projects, can provide clean electricity, ancillary services, and much needed storage capacity. Dams can also provide valuable services in terms of water supply, irrigation, and flood control.[466] However, dams may have negative impacts on river navigability, fish and wildlife, water quality, and fragmentation of habitat.[467] For example, dams block or impede anadromous fish migration and create deep pools of water that inundate or block access to spawning habitat and cause an increase in water temperature. Further, sediment buildup at dams after many years of operation can pose unique environmental concerns. As such, there has been appetite for dam removal, as exemplified by the Klamath River Basin discussion above. In the United States, over 1,400 dams have been removed since the 1970s, commonly to restore ecosystem function.[468] Studies have shown that, for example, dam removal in the Midwestern and Eastern United States resulted in increased numbers of fish species, where up to ninety-five percent of all species found downstream of the dams migrated upstream within one to three years.[469] The world's largest dam removal was completed in 2014 on the Elwha River in Washington State with the removal of the Elwha Dam and the Glines Canyon Dam.[470] Along with other environmental benefits, within the first three years after the dams were removed, adult chinook recolonized and began spawning upstream of the former dam sites.[471]

There are ongoing calls to remove four lower Snake River dams (located in the Pacific Northwest) as all Snake River salmon and steelhead populations are listed under the Endangered Species Act.[472] Further, it has

466. OLADOSU ET AL., *supra* note 360, at 14.

467. *Id*.; MICHAEL SCHRAMM ET AL., OAK RIDGE NATIONAL LABORATORY, A SYNTHESIS OF ENVIRONMENTAL AND RECREATIONAL MITIGATION REQUIREMENTS AT HYDROPOWER PROJECTS IN THE UNITED STATES 1 (2016).

468. Bellmore, J.R. et. al., *Conceptualizing Ecological Responses to Dam Removal: If You Remove It, What's to Come?*, BIOSCIENCE, Vol. 69: 26–39, 26 (Jan. 2019).

469. *Id*. at 28 (internal citation omitted).

470. Linda V. Mapes, *The Elwha Dams are Gone and Chinook are Surging Back, But Why are so Few Reaching the Upper River?*, SEATTLE TIMES (Oct. 18, 2020).

471. Ryan J. Bellmore et. al., *Conceptualizing Ecological Responses to Dam Removal: If You Remove It, What's to Come?*, 69 BIOSCIENCE 26, 29 (2019).

472. Letter from Jack E. Williams et al., to Governors of Washington, Oregon, Idaho, and Montana (Jan. 12, 2021), https://wildsnakeriversalmon.medium.com/snake-

been estimated that each of these Snake River dams reduce salmon survival by twenty to twenty-five percent regarding wild spring chinook, and only 0.8% of the fish that migrate out as juveniles make it through the dams and back.[473] Scientists have opined that there is no chance of restoring Snake River salmon and steelhead with the lower Snake River dams in place—and the more than seventeen billion dollars spent on efforts to recover the fish does not appear to have been successful.[474] To mitigate dams' detrimental environmental effects, Federal agencies may apply conditions on hydropower licenses and related permits. For example, during FERC's licensing (and relicensing process), it may impose environmental measures such as critical habitat conservation, fish passages, wetland protection, sediment/erosion plans, recreational flow releases, and water quality monitoring, to name a few.[475]

In addition, states may require compliance with additional environmental procedures. As discussed below in Section VI.E, state fish and wildlife agencies have mandatory conditioning authority under the Federal Power Act. Aside from Federally conferred authority, state environmental requirements also may also apply. For example, delays in relicensing hydroelectric projects are particularly common in California, which conducts its own environmental review under the California Environmental Quality Act (CEQA), in addition to the Federal government's NEPA requirements.[476] In fact, FERC and the State Water Resources Control Board of California (SWRCB) entered into an MOU to ensure accommodation of both NEPA and CEQA, as well as coordination regarding the SWRCB's issuance of a water quality certification.[477] However, the Supreme Court of the United States has held that, at least in terms of minimum flow requirements, a

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river-salmon-headed-for-extinction-without-drastic-action-e9f0d196eddc [https://perma.cc/UW3D-QETC].

473. Helen Neville, *The Science is Clear: Snake River Dams Kill Too Many Fish*, TROUT UNLIMITED (June 17, 2021).

474. Letter from Jack E. Williams et al., to Governors of Washington, Oregon, Idaho, and Montana, *supra* note 472.

475. SCHRAMM ET AL., *supra* note 467, at 5, tbl. 1; *see id*. at 8 ("Out of the 447 plants in the database, biodiversity mitigation was required at [seventy-one percent], fish passage at [forty-eight percent], habitat at [fifty-seven percent], hydrology at [ninety-five percent], recreation at [eighty-two percent], and water quality at [fifty-three percent] of plants.").

476. Rebecca Kern, *Permit Delays Dam Up Hydro Projects, Relicensing Costs Millions*, BLOOMBERG L. (Oct. 30, 2018), https://news.bloomberglaw.com/environment-and-energy/permit-delays-dam-up-hydro-projects-relicensing-costs-millions [https://perma.cc/JW86-FWXG].

477. *Memorandum of Understanding Between the Federal Energy Regulatory Commission and the California State Water Resources Control Board Concerning Coordination of Pre-Application Activities for Non-Federal Hydropower Proposals in California* (2013), https://www.hydro.org/wp-content/uploads/2017/08/mou-caswb-11-2013.pdf [https://perma.cc/DQ4U-NG6M].

state may not impose significantly higher minimum flow requirements on the basis it would be contrary to FERC's licensing authority under the Federal Power Act.[478]

Environmental mitigation measures imposed on licensees are costly. Most projects licensed by FERC have roughly twenty to thirty environmental measures, and several have more than one hundred such measures.[479] Notably, environmental mitigation measures can be more expensive for low capacity projects, which constitute most of the remaining undeveloped hydropower potential in the nation.[480] Environmental mitigation costs are generally highest for relicensed hydropower dams that lacked environmental standards when they were built.[481] Closed-loop pumped storage has the potential to avoid many environmental mitigation measures since such projects are not connected to natural water bodies.[482] Specifically, closed-loop systems present minimal to no impact to existing river systems or anadromous fish species, which reduces the most significant aquatic impacts associated with project development.[483] However, closed-loop systems that use groundwater may have a higher environmental impact than open-loop systems.

D. Climate Change Adaptation Considered During Permitting Processes

As described above, the impacts of climate change are being experienced today and have far-reaching impacts. It is no surprise that regulatory agencies and license applicants are now accounting explicitly for climate change in their licensing and permitting decisions and efforts. However necessary accounting for climate change during the permitting process may be given the increase in extreme weather events, additional considerations

478. *California v. FERC,* 495 U.S. 490, 506 (1990); *see City of Butte v. Dep't of Water Res.*, 256 Cal. Rptr. 3d 318 (2019) (ordering briefing on: (1) the extent to which the Federal Power Act preempts application of CEQA when the state is acting on its own behalf, and exercising its discretion, in deciding to pursue licensing for a hydroelectric dam project; and (2) whether the Federal Power Act preempts state court challenges to an environmental impact report prepared under CEQA to comply with the Federal water quality certification under section 401 of the Clean Water Act).

479. OLADOSU ET AL., *supra* note 360, at 6; *but see* SCHRAMM ET AL., *supra* note 467, at 9 (finding a mean of 11.5 mitigation requirements per hydropower plant).

480. OLADOSU ET AL., *supra* note 360, at 26.

481. *Id.*

482. *Id.*

483. *2017 NHA Pumped Storage Report*, *supra* note 11, at 9.

could potentially add to the complexities of the already complicated permitting procedures. For example, the SWRCB made recommendations for how to incorporate climate change into its water rights permitting policies, procedures, and methodologies.[484] The SWRCB recognizes historical data may be losing some of their value as the climate becomes more unpredictable. This is particularly challenging because the required water availability analyses[485] generally use historical data sets. Accordingly, the SWRCB recommends certain adaptations to their permitting process, including: (1) require more rigorous analytical methods to estimate supply; (2) expand existing network of stream and precipitation gages; (3) reevaluate the existing instream flow metrics and criteria; (4) prepare for and capitalize on capturing flood flows; (5) plan for droughts; and (6) coordinate with other agencies.[486]

On a national level, FERC Chairman Glick and the FERC General Counsel have opined that FERC should take into account zero-emission sources of electricity when licensing hydro projects.[487] Chairman Glick and the General Counsel posit that a hydro project's ability to generate zero-emissions and integrate other zero-emissions resources should be factored into the licensing decision.[488] They believe it is in the public interest that FERC take climate change seriously and appropriately consider how a new project will help reduce emissions that are contributing to climate change.

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484. *See* STATE WATER RESOURCES CONTROL BOARD, DIVISION OF WATER RIGHTS, *Recommendations for an Effective Water Rights Response to Climate Change* (Feb.2021), https://www.waterboards.ca.gov/waterrights/water_issues/programs/climate_change/docs/water_rights_climate_change_report_feb2021.pdf [https://perma.cc/7CKX-4RWT].

485. *Id.* at 6 ("In deciding whether to issue permits, the State Water Board considers the features and needs of the proposed project, all existing and pending rights, and instream needs to determine whether water is available for appropriation. The State Water Board must make a finding that there is unappropriated water to supply the applicant. This finding is made by relying on the water availability analysis and other information developed during application processing.").

486. *Id*. at 24–28 (Other recommendations include: (7) leverage existing climate change data in permitting water availability analyses; (8) develop adaptive permit terms; (9) implement tiered requirements for climate change analysis in permitting; and (10) strengthen the minimum period of record requirement for streamflow data and storing them underground).

487. Rich Glick and Matthew Christiansen, *FERC and Climate Change*, 40 ENERGY L.J. 1, 44 (2019).

488. *Id*.

E. Jurisdictional Disputes: Challenges to FERC Determinations Against Fish/Wildlife Agencies' Recommendations Under Federal Power Act Section 10(j)

Non-governmental organizations, Federal agencies, and tribes have previously challenged FERC's determinations to license or re-license hydroelectric projects under Section 10(j) of the Federal Power Act (16 U.S.C. § 803(j)). However, case law shows the Federal Power Act has been interpreted as granting FERC vast discretion to consider and disregard agency recommendations if FERC's determination is substantially supported and well-reasoned. Section 10(j) states that hydro licenses must "include conditions for [the] protection, mitigation, and enhancement" of fish and wildlife, which are based on recommendations from the National Marine Fisheries Service, the United States Fish and Wildlife Service, and state fish and wildlife agencies.[489] Section 10(j) also allows FERC to reject agencies' recommendations if deemed inconsistent with the Federal Power Act (Part I) or other applicable law, but FERC must publish its findings and ensure the adopted conditions still protect, mitigate, and enhance fish and wildlife status. Agencies are able to contest FERC's findings and ultimate license conditions in court.[490]

In *American Rivers v. FERC*,[491] the Oregon Department of Fish and Wildlife and several environmental organizations challenged FERC's decision to relicense the Eugene Water and Electric Board's (Eugene Water) hydroelectric projects.[492] Petitioners argued the requisite NEPA analysis was not conducted and therefore FERC violated Section 10(j). The Ninth Circuit denied the petition relating to Section 10(j) because, under the Ninth Circuit's *Chevron*[493] analysis, it found that "Congress has ordained that [the deference FERC is required to give to recommendations

489. 16 U.S.C. § 803(j) (2018).
490. *See American Rivers v. FERC,* 201 F.3d 1186 (9th Cir. 1999).
491. *See id.*
492. *See generally id*. The Eugene Water hydroelectric projects were the 14.5 MW Leaburg Hydroelectric Project and the 8 MW Walterville Hydroelectric Project for a duration of forty years. The new license authorized Eugene Water to increase the hydroelectric projects' generation capacity from 22.5 MW to 23.2 MW. *Id*. at 1190–91.
493. *Chevron U.S.A., Inc. v. Nat. Res. Def. Council., Inc.*, 467 U.S. 837 (1984) (setting out a two-part test for the courts to follow when reviewing an administrative agency's interpretation of a statute that agency administers). First, the court must answer whether Congress has directly spoken to the precise question at issue. *Id*. Second, if Congress has not directly spoken to the issue, the court must decide whether the agency's interpretation is reasonable. *Id*.

from state and Federal agencies] must yield to [FERC's] reasoned judgment in those instances where the parties cannot agree."[494]

Under the renewed license's terms, Eugene Water would raise Leaburg Lake by eighteen inches, increase the power generation from both facilities, and increase the minimum flows. FERC did not incorporate the state agencies' recommendations but prescribed a plan where Eugene Water would consult with agencies and FERC would approve its final designs of fish ladders and passageways. The Ninth Circuit found that, while FERC must address each recommendation, "the [Federal Power Act] establishes a delicately balanced process by which the Commission decides whether or how to incorporate a given agency recommendation into a license,"[495] and "represent[s] a vital part of [the Federal Power Act] regime."[496] The Ninth Circuit held that Section 10(j) was not ambiguous and was only open to one interpretation. Therefore, FERC properly interpreted its statutory mandate and properly used its discretion to not incorporate the recommendation from the statutorily listed agency.[497] While FERC is required to offer "significant deference to recommendations made by state (and [F]ederal) fish and wildlife agencies[,]" ultimately, FERC's reasoned judgment wins the day.[498]

As a second illustration, in *United States Department of the Interior v. FERC*,[499] the D.C. Circuit denied petitions challenging FERC's decision to issue new licenses to the Allegheny Electric Cooperatives and others regarding hydroelectric projects in the Upper Ohio River Basin. In approving the licenses, FERC prepared an Environmental Impact Statement to ensure protection of water quality and fish entrainment, and fish sporting opportunities. The D.C. Circuit found that FERC's decision to license was based on sound reasoning and a substantial record. Ultimately, the D.C. Circuit held that "FERC liberally used license conditions to protect against unknown risks" regarding flow maintenance, reduction of fish mortalities, and conservation of resources.[500]

F. Transmission Access Concerns

Entities in the West have cited issues regarding transmission capacity as an obstacle to accessing hydroelectric supply in the Pacific Northwest—this issue's contentious and important nature is illustrated through recent

494. *See American Rivers*, 201 F.3d at 1205.
495. *Id*. at 1198.
496. *Id*. at 1202.
497. *Id.* at 1205.
498. *Id.* (citation omitted).
499. 952 F.2d 538 (D.C. Cir. 1992).
500. *Id.* at 547.

developments and debates in the CAISO footprint. As a result of the August 2020 reliability challenges in its Balancing Authority Area, CAISO commenced a stakeholder initiative in early 2021, in part to improve the relative scheduling priorities of load internal to, exports from, and wheeling through the CAISO footprint during tight system conditions when CAISO must cut self-schedules[501] due either to insufficient transmission or generation.[502] The discussion that ensued reveals the scarcity of transmission capacity in the West,[503] and the likely development of a process to incentivize transmission upgrades that could facilitate delivery of resources, including hydroelectric, to footprints heavily reliant on imports.

One aspect of CAISO's 2021 stakeholder initiative established several requirements that self-scheduled wheeling transactions must meet to ensure their schedules receive priority equal to CAISO's internal load-serving entities[504] relying on resource adequacy (RA) imports into the CAISO footprint during tight conditions. One of the most controversial requirements CAISO proposed, and FERC approved, is that wheeling transactions must obtain monthly "firm" transmission from the source to the CAISO boundary in order to receive the high priority "wheeling through" status.[505] In

501. *See* CAL. INDEP. SYS. OPERATOR, Tariff at app. A: Master Definition Supplement (Dec. 15, 2021), http://www.caiso.com/Documents/AppendixA-MasterDefinitionSupplement - asof-Dec15-2021.pdf [https://perma.cc/DU3G-A8MN] (defining, in general, Self-Schedules as bids into the CAISO markets without a price, and rather only a MWh quantity, making them a "price taker" in the CAISO markets).

502. *See* CAL. INDEP. SYS. OPERATOR, *Market Enhancements for Summer 2021 Readiness*, at 7 (Jan. 6, 2021), http://www.caiso.com/InitiativeDocuments/Presentation-MarketEnhancements-Summer2021Readiness-Jan6-2021.pdf [https://perma.cc/73C2-TSQ5]; *see* CAL. INDEP. SYS. OPERATOR, *Exports and Loads Scheduling Priorities: Policy*, at 16-7 (Jan. 6, 2021), http://www.caiso.com/InitiativeDocuments/Presentation-MarketEnhancements-Summer 2021Readiness-Jan122021Workshop.pdf [https://perma.cc/Z6PS-QVWU].

503. *See, e.g.*, NEVADA POWER CO. ET AL., *Motion to Intervene and Protest of NV Energy*, at 39–40, FERC Docket No. ER21-1790 (May 17, 2021), https://elibrary.ferc.gov/eLibrary/filedownload?fileid=020D4004-66E2-5005-8110-C31FAFC91712 (explaining the lack of available transmission in Northern Nevada likely until 2027, and the Southwest's resulting reliance on California's transmission pathway to reach generation in the Northwest).

504. Generally speaking, load-serving entities are entities that serve electricity to end-use customers in a Balancing Authority Area pursuant to a governing authority. *See, e.g.*, CAL. INDEP. SYS. OPERATOR, Tariff at app. A: Master Definition Supplement (Dec. 15, 2021) (defining "Load Serving Entity (LSE)" as that term is used in the CAISO Balancing Authority Area).

505. *See* CAL. INDEP. SYS. OPERATOR, *Tariff Amendment to Implement Market Enhancements for Summer 2021: Load, Export, and Wheeling Priorities*, FERC Docket No. ER21-1790, at Attach. B (Marked Tariff), at § 30.5.1(z) and app. A (Apr. 28, 2021), http://www.caiso.com/Documents/Apr28-2021-Tariff-Amendment-Load-Exports-and-

general, "firm" transmission under FERC's Open Access Transmission Tariff framework refers to transmission that will be prioritized over "non-firm" transmission, and is thus more costly and requires further notice by transmission customers to reserve than non-firm transmission.[506] In arguing CAISO's proposal violates open transmission access principles and is unduly discriminatory against load-serving entities external to the CAISO footprint, the external entities asserted that high priority wheeling transactions supported by firm transmission on external systems would unjustifiably share priority with CAISO load-serving entities' RA import deliveries that are not required to be supported by firm transmission and could be supported by non-firm transmission on external systems.[507] The external entities also argued this could allow CAISO load-serving entities to access energy in the Pacific Northwest at the expense of Desert Southwest entities,[508] and would frustrate existing contracts—namely Southwest load contracting for Northwest supplies that relies on the ability to wheel such deliveries through the CAISO transmission system.[509] On the other hand, CAISO load-serving entities argued the previous priority that wheeling transactions automatically held over deliveries to CAISO load did not

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Wheeling-Tariff-Amendment-ER21-1790.pdf [https://perma.cc/77J4-YEK6] [hereinafter *CAISO ER21-1790 Initial Filing*] (defining Priority Wheeling Through, in general, as a self-schedule that is part of a Wheeling Through transaction that is supported by both a firm power supply contract to serve an external Load Serving Entity's load, as well as monthly firm transmission the external Load Serving Entity has procured from the source to a CAISO Scheduling Point); *Cal. Indep. Sys. Operator*, 175 FERC ¶ 61,245 at PP 141, 149 (2021) (FERC sided with CAISO that this requirement serves as a reasonable proxy to ensure external load-serving entities use CAISO's transmission system to serve load in a manner comparable to internal load-serving entities that regularly rely on CAISO's transmission system).

506. *See, e.g.*, *CAISO ER21-1790 Initial Filing, supra* note 505, at Transmittal Letter at 18 ("[Balancing Authority Areas] curtail deliveries on non-firm transmission service before deliveries on firm transmission service, which [Balancing Authority Areas] curtail last."). By contrast to the traditional Open Access Transmission Tariff framework, CAISO has "no transmission reservations, no classes of transmission service, and a volumetric wheeling through rate[,]" and rather handles scheduling priorities in its footprint based on penalty price parameters in CAISO's market optimization. *Id*. at 10.

507. *See, e.g., Cal. Indep. Sys. Operator*, 175 FERC ¶ 61,245, at PP 61, 64, 86 (2021), (summarizing discriminatory treatment allegations by utilities in Nevada and Arizona, among others, concerning the firmness of transmission).

508. *See, e.g.,* Arizona Public Service Co. et al., Motion to Leave to Intervene and Protest of the Arizona Utilities at 8–11, FERC Docket No. ER21-1790 (May 17, 2021), https://elibrary.ferc.gov/eLibrary/filedownload?fileid=020D4072-66E2-5005-8110-C31FAFC91712.

509. *See, e.g., id*. at 31-32, 38, 50-54; *see, e.g., Cal. Indep. Sys. Operator*, 175 FERC ¶ 61,245, at PP 115–19, 121 (2021).

comport with internal load's payment of transmission costs on a long-term basis.[510]

FERC found CAISO's proposal presented a balanced solution to allocate scarce transmission capacity in the CAISO footprint, rejecting the external entities' protests that the new requirements for wheeling transactions to receive priority status would "result in increased costs or have adverse impacts on external load serving entities' bilateral contracting ability."[511] FERC's Order was subject to two ultimately unsuccessful[512] rehearing requests by several Desert Southwest entities (including both utilities in Arizona[513] and its state utilities commission),[514] and has also gained lawmakers' attention, all of which raise concern with Arizona's ability to

510. Southern California Edison Co. et al., Motion for Leave to Answer and Answer, at 27–34, FERC Docket No. ER21-1790 (June 4, 2021), https://elibrary.ferc.gov/eLibrary/filedownload?fileid=020D9D83-66E2-5005-8110-C31FAFC91712 .

511. *Cal. Indep. Sys. Operator*, 175 FERC ¶ 61,245, at PP 140-44, 153, 156, 158, 160 (2021).

512. *Cal. Indep. Sys. Operator*, 178 FERC ¶ 61,180 at P 22 (2022) (upholding, on rehearing, FERC's 2021 Order that accepted CAISO's proposal, but acknowledging rehearing parties' ongoing concerns and potential impacts on neighboring Balancing Authority Areas and, accordingly, urging CAISO to "work with stakeholders to design and file a just and reasonable and not unduly discretionary or preferential long-term solution as expeditiously as possible").

513. Arizona Public Service Co. et al., Request for Rehearing of the Arizona Utilities at 3, FERC Docket No. ER21-1790 (July 26, 2021), https://elibrary.ferc.gov/eLibrary/filedownload?fileid=020E2B07-66E2-5005-8110-C31FAFC91712 (arguing in the five Arizona utilities' rehearing request, *inter alia*, FERC's Order results in the Arizona utilities no longer enjoying "equivalent access to generation in the Pacific Northwest that would need to be wheeled-through CAISO to reach Arizona" and instead the utilities will be limited to resources in the Desert Southwest region, driving up already high market prices); *id*. at 47 (alleging forward market prices at Palo Verde trading hub for Summer 2021 have already skyrocketed as a result of CAISO's proposal regarding wheel through priorities, explaining that "because CAISO's proposed tariff changes prevent reliance on Pacific Northwest generation to serve load in the Desert Southwest the scope of firm generation available to the Arizona Utilities is materially smaller than had been available to them in prior years[,] causing the cost of generation to soar because 'power is now a seller's market'").

514. Arizona Corp. Comm'n, Request for Rehearing of the Arizona Corporation Comm'n at 7–8, FERC Docket No. ER21-1790 (July 26, 2021), https://elibrary.ferc.gov/eLibrary/filedownload?fileid=020E2B5C-66E2-5005-8110-C31FAFC91712 (arguing, *inter alia*, FERC's Order "frustrates the legitimate expectations of [loadsServing entities] and suppliers outside of the CAISO footprint, creates uncertainty in the market, and ultimately reduces the reliability in the CAISO system for external load serving entities[,]" explaining that Arizona Utilities already purchased energy under contract for Summer 2021 prior to the CAISO's tariff changes).

access Pacific Northwest generation needed to ensure adequate energy supply.[515]

CAISO filed its tariff revisions to implement the wheeling through scheduling priority changes at issue on an interim basis only until June 1, 2022 (though more recently, on January 27, 2022, CAISO filed, and FERC accepted on March 15, 2022, a tariff amendment in FERC Docket No. ER22-906 to extend the interim framework until June 1, 2024). Accordingly, the long-term transmission solutions CAISO endeavors to develop in its ongoing stakeholder initiative[516] will be paramount to both external entities' ability to rely on the CAISO transmission system to access hydroelectric resources from suppliers external to the CAISO footprint,[517] as well as to CAISO load-serving entities' ability to rely on the CAISO transmission system to import deliveries from hydroelectric resources they rely on during reliability events.[518] Where CAISO does not currently have a process to reserve firm transmission in advance, CAISO and stakeholders began working on developing such a process, which ideally would incentivize upgrades to the CAISO transmission system by revealing when it cannot accommodate long-term service requests and where entities must invest in upgrades to secure service.[519] If such efforts

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515. Letter from Congress at 1–2 (Aug 6, 2021), (on file in FERC Docket No. ER21-1790), https://elibrary.ferc.gov/eLibrary/filedownload?fileid=11EB1382-DA49-C173-A61E-7B3196200000 (requesting rehearing of FERC' s July 2021 Order, alleging it, *inter alia*, frustrates the Arizona Utilities' existing contracts for firm transmission "to wheel-through energy from the Pacific Northwest, through CAISO's transmission system, and ultimately to Arizona in order to ensure adequate[sic] energy supply during summer 2021").

516. In mid-July 2021, CAISO launched a new initiative titled the "External load forward scheduling rights process," which was later re-named "Transmission service and market scheduling priorities."

517. *See* Bonneville Power Administration Comments in the "External load forward scheduling rights process" initiative (Aug. 5, 2021), https://stakeholdercenter.caiso.com/Comments/AllComments/134505f1-b137-4fb9-a58d-1222af70e4e2#org-31abfc68-260a-4358-8e91-a4f91ee0caf7 [https://perma.cc/AU6V-CMWA] (stating it is a federal power marketing administration that markets electric power from thirty-one hydroelectric projects and some non-Federal projects, supporting the presentation made by the Desert Southwest entities, and noting "[w]heel-throughs in the West are not only necessary to support resource adequacy in the West, but also the inter-seasonal flow of energy around the West that has been the foundation for inter-regional transmission investments connecting the Pacific Northwest with the Southwest").

518. *See, e.g.,* Barbara Cenalmor, External Load Forward Scheduling Rights Process at 2, 7 (July 13, 2021), http://www.caiso.com/InitiativeDocuments/SRP-APS-TEP Presentation-ExternalLoadForwardSchedulingRightsProcessWorkshop-Jul13-2021.pdf [https://perma.cc/57EE-WHGL] (noting California and the Desert Southwest are expected to be net importers in the future, and stating "[w]heel-through energy is common and necessary across the West, especially for net import regions, including California and the Desert Southwest").

519. *See* MILOS BOSONAC, EXTERNAL LOAD FORWARD SCHEDULING RIGHTS PROCESS INITIATIVE: ISSUE PAPER 23 (California ISO, 2021), http://www.caiso.com/Initiative

result in advance firm transmission reservations, theoretically, net importers' reliance on transmission to deliver hydroelectric resources throughout the West may be made more feasible in the long-term.

G. Wildfires and Other Extreme Weather Events Interrupting Deliveries

Warmer temperatures and drier conditions are projected to increase wildfires in the Northern Great Plains, Northwest, and Southwest, threatening critical transmission infrastructure.[520] As a recent example, the 2021 Bootleg wildfire in Oregon reduced power line capacity to California from the Pacific Northwest's hydroelectric dams by as much as 3,500 megawatts.[521] In 2020, California recorded five of its six largest fires in history,[522] and the North American Reliability Electric Corporation (NERC) reports fire as the top cause of transmission outages in the Western Interconnection on the fourteen days NERC found qualified as "extreme days" in 2020.[523] Transmission has been affected by both utility-caused wildfires during extreme weather events, and utilities' de-energization of transmission lines to avoid potential fires.[524]

In addition to wildfires, other weather events may disrupt transmission of energy—for example, a May 2020 storm caused a forced outage on a Pacific Northwest major transmission line and aggravated California's reliability challenges in August 2020 by disrupting delivery of energy supply in the north to the CAISO Balancing Authority Area.[525] In the Texas Interconnection, an October 28, 2020 ice storm event resulted in several outages on transmission lines.[526] On the same day, Hurricane Zeta caused 153 transmission outages in the Eastern Interconnection.[527] The devastating

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Documents/IssuePaper-ExternalLoadForwardSchedulingRightsProcess.pdf [https://perma.cc/L386-ZK8L].

520. U.S. GOV'T ACCOUNTABILITY OFFICE, *Electricity Grid Resilience: Climate Change is Expected to Have Far-Reaching Effects and DOE and FERC Should Take Actions,* at 16–17 (Mar. 2021).

521. Peter Behr, *Report: Create DOE Transmission Agency to Fight Climate Threat*, (July 15, 2021), https://www.eenews.net/articles/report-create-doe-transmission-agency-to-fight-climate-threat/ [https://perma.cc/K49K-S9BY].

522. *See* W. ELECTRICITY COORDINATING COUNCIL, *supra* note 8, at 4.

523. *NERC 2021 State of Reliability Rep*., *supra* note 4, at 62, 66, tbl. 5.2.

524. *Id.* at 8–10.

525. FINAL ROOT CAUSE ANALYSIS, *supra* note 2, at 8, 48, 88.

526. *NERC 2021 State of Reliability Rep*., *supra* note 4, at 62, 64, fig. 5.16.

527. *Id.* at 68.

impact of these outages, beyond creating transmission issues, is discussed further above in Section II.A.

H. Drought

Reliance on hydroelectric projects comes with challenges due to drought conditions with which the Western United States is well acquainted. In 2020, California's "annual hydroelectric generation fell by forty-four percent from 2019 levels to 21,414 GWh," according to the California Energy Commission (CEC).[528] A June 29, 2021 letter from the CPUC and CEC notes drought conditions reduced hydro capacity in Summer 2021, cited as one of the actions triggering the CPUC's and CEC's call on CAISO to procure additional resources.[529] As of mid-June 2021, storage in both Lake Mead and Lake Powell fell to around thirty-five percent of capacity, posing challenges for power production.[530] Beginning in July 2021, Reclamation released water upstream of Lake Powell from the Colorado River Storage Project in order to maintain sufficient water levels for power generation, while reduced flows in 2022 are anticipated to further reduce power generation at Lake Powell and Lake Mead.[531] In August 2021,

528. CAL. ENERGY COMM'N, 2020 Total System Electric Generation, https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/2020-total-system-electric-generation [https://perma.cc/7C7D-8364]. In the CAISO footprint alone (which does not encompass all of California's load), total hydroelectric production in 2020 decreased forty-three percent from the prior year. *See DMM 2020 Annual Report, supra* note 104, at 44; *id.* at 35 (noting the percentage of hydroelectric generation relative to the total generation mix in the CAISO footprint decreased by roughly six percent in 2020 relative to 2019, primarily due to below average snowpack level, making hydroelectric generation eight percent of supply in the CAISO's footprint in 2020).

529. Letter from Cal. Pub. Util. Comm'n and Cal. Energy Comm'n at 2 (June 29, 2021), http://www.caiso.com/Documents/CapacityProcurementMechanismSignificantEvent-JointStatementandLetter.pdf [https://perma.cc/J8QE-DZXL].

530. CAL. DEP'T OF WATER RES., *Drought + Heat= Increased Impacts* (June 17, 2021), https://water.ca.gov/News/Blog/2021/June/Drought-Heat-Increased-Impacts [https://perma.cc/D9PY-S8BJ]; Sonal Patel, *Drought-Crippled Hoover Dam, Glen Canyon Hydropower Plants Operating at Substantially Decreased Capacity* (Sept. 2, 2021), https://www.powermag.com/drought-crippled-hoover-dam-glen-canyon-hydropower-plants-operating-at-substantially-decreased-capacity/ [https://perma.cc/DCE3-J2G8].

531. U.S. DEP'T OF THE INTERIOR, BUREAU OF RECLAMATION, *Glen Canyon Dam* (Nov. 15, 2021), https://www.usbr.gov/uc/water/crsp/cs/gcd.html [https://perma.cc/GQL6-UE7X]; *Colorado River Water Shortages Forces First-Ever Cutback to Southwest States*, WALL ST. J. (Aug. 16, 2021). *See also* U.S. DEP'T OF THE INTERIOR, BUREAU OF RECLAMATION, *Reclamation modifies monthly water releases from Lake Powell to protect reservoir's critical elevations* (Jan. 7, 2022), https://www.usbr.gov/newsroom/#/news-release/4073 [https://perma.cc/MK6G-XBWH] (describing Reclamation's adjustments to monthly water releases from Glen Canyon Dam in an effort to protect Lake Powell's target elevation of 3,525 feet, which serves as a buffer above the 3,490-foot elevation below which hydropower cannot be generated at Glen Canyon Dam); U.S. DEP'T OF THE INTERIOR,

Reclamation announced downstream water releases from Glen Canyon Dam and Hoover Dam would be reduced in 2022, and announced a Level One Shortage Condition at Lake Mead for the first time in history that will impact water allocations to Arizona, Nevada, and Mexico.[532]

Drought has resulted in complete shutdown of hydro projects at times. On July 30, 2021, CDWR projected Lake Oroville storage, the largest of the State Water Project's storage projects,[533] would fall below its historic low last reached in September 1977, with anticipated impact on power generation at CDWR's Hyatt Powerplant.[534] On August 1, 2021, Lake Oroville reached its historic low, and on August 5, 2021, CDWR took the Hyatt Powerplant offline due to low lake levels for the first time in history.[535]

During drought conditions, hydroelectric power must compete with several other water uses. For example, on May 17, 2021, CDWR and Reclamation petitioned California's SWRCB, requesting a temporary urgency change under California Water Code Section 1435 to modify the terms of the

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BUREAU OF RECLAMATION, *December 2021 24-Month Study*, https://www.usbr.gov/lc/region/g4000/24mo/2021/DEC21.pdf [https://perma.cc/E8J4-TTQM] (noting that, under a 2007 Record of Decision on Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations of Lake Powell and Lake Mead, a "Shortage Condition" will govern Lake Mead's operation for the 2022 calendar year, and noting Hoover Dam's generator capacity is impacted by changing Lake Mead elevations).

532. U.S. DEP'T OF THE INTERIOR, BUREAU OF RECLAMATION, *Reclamation announces 2022 operating conditions for Lake Powell and Lake Mead* (Aug. 16, 2021), https://www.usbr.gov/newsroom/#/news-release/3950 [https://perma.cc/B468-5MVP]. *But see* Alex Hager, *Lower basin states sign deal to put water back in Lake Mead amid dropping levels*, NPR FOR NORTHERN COLORADO (Dec. 15, 2021 at 6:24 PM MST), https://www.kunc.org/environment/2021-12-15/lower-basin-states-sign-deal-to-put-water-back-in-lake-mead-amid-dropping-levels [https://perma.cc/VN65-YNMF] (describing an agreement entered into by Arizona, Nevada, and California water agencies, and the Bureau of Reclamation, to contribute money to induce voluntary conservation measures in 2022 and 2023 to increase Lake Mead's water level).

533. CVP 2021 CONGRESSIONAL REPORT, *supra* note 398, at 4.

534. CAL. DEP'T OF WATER RES., *Lake Oroville Community Update- July 30, 2021* (July 30, 2021), https://water.ca.gov/News/Blog/2021/July/Oroville-Update-7-30-21 [https://perma.cc/57Y2-LHDQ].

535. CAL. DEP'T OF WATER RES., *Lake Oroville Community Update: August 6, 2021* (Aug. 6, 2021), https://water.ca.gov/News/Blog/2021/August/Oroville-Update-8-6-21 [https://perma.cc/VV6U-VADV]. The Hyatt Powerplant resumed operations on January 4, 2022, following storms that "boosted lake levels and provided colder water in the reservoir to allow operations to resume." CAL. DEP'T OF WATER RES., *Hyatt Powerplant at Oroville Dam Resumes Operation* (Jan. 4, 2022), https://water.ca.gov/News/News-Releases/2022/Hyatt-Powerplant-at-Oroville-Dam-Resumes-Operation [https://perma.cc/W8N3-ZA2T].

Central Valley Project's and State Water Project's water rights permits.[536] The petitioners' requested changes sought to relax certain flow requirements intended for fish and wildlife protection, and agricultural purposes, in order to preserve water storage in upstream reservoirs going into the next year.[537] The SWRCB's June 1, 2021 Order, granting the changes through August 15, 2021, recognizes the changes would promote needed minimum storage levels in the Oroville Reservoir for "critical hydropower production," among other purposes.[538] Conversely, as an example of where hydropower may not always emerge as a priority when water usage must be scaled back, under the Navajo Nation Water Code, water use for an economically driven project will fall below several other priorities such as agricultural use, to the extent "insufficient water supplies are present."[539]

To minimize the impacts of drought on hydroelectric production, several innovative measures have been advanced to reduce evaporation from and conserve water in reservoirs, and to more efficiently operate facilities based on real-time monitoring and forecasting that incorporates historical patterns such as river flows, as discussed above in Section V (though, some have questioned the value of relying on historical data given the climate's increasing unpredictability, as discussed above in Section VI.D). Further, transmission could be deployed to reach hydroelectric resources in less drought-stricken regions, and this development may be spurred by new transmission procurement processes under consideration in the CAISO Balancing Authority Area, as discussed above in Section VI.F.

VII. CONCLUSION

Renewable hydropower generation can assist in mitigating the severe impacts brought on by climate change, while also assisting grid operators with delivering reliable electricity to customers. As climate change impacts

536. Letter from Karla A. Nemeth and Ernest A. Connant to Eileen Sobeck, Exec. Dir., CA State Water Res. Control Bd. (May 17, 2021), https://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/tucp/docs/2021/20210517_dwr_usbr_tucp.pdf [https://perma.cc/UK7L-W2DK]. The State Water Resource Control Board's 1999 Decision D-1641 governs implementation of the Bay-Delta Plan by Reclamation and CDWR. CVP 2021 CONGRESSIONAL REPORT, *supra* note 398, at 14.

537. STATE WATER RES. CONTROL BD., *Order Conditionally Approving a Petition for Temporary Urgency Changes to License and Permit Terms and Conditions Requirement Compliance with Delta Water Quality Objectives in Response to Drought Conditions* at 2, 4 (June 1, 2021), https://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/tucp/docs/2021/20210601_swb_tuco.pdf [https://perma.cc/V4T7-FSJN].

538. *Id.* at 27.

539. *See* NAVAJO NATION CODE ANN. tit. 22, § 1501(D) (1984) (prioritizing economic development uses including industrial and power uses last after domestic and municipal uses, stock watering uses, agricultural uses, and instream needs for fish, wildlife conservation and recreational uses).

continue to manifest in the form of extreme weather events increasing in frequency and gradually increasing temperatures, affecting public health, environment, national security, and the economy, the energy sector will continue to be a vehicle of change and adaptation—driven by policies, but also forced to action by the immediate threat weather events pose to energy supply and utility equipment.[540] Increased outages and decreased reliability will have far-reaching implications.

Hydroelectric resources provide a means by which the energy sector can adapt to a world threatened by climate change, by contributing to the reduction of GHG emissions, and supporting utilities' response to extreme weather events—both in the immediate timeframe through providing ancillary services to restore grid stability, and in the longer-term by providing invaluable energy storage and reducing reliance on fuel supply that has proven vulnerable during extreme weather events. The United States can considerably increase its hydropower generation in regions that have not historically utilized this resource to its full potential, and may find it has unlocked several benefits in other regions, as discussed in this Article. While several noted obstacles face hydroelectric project developers and operators (especially during drought conditions), there are also numerous regulatory, market-based, and technological tools that can be employed to overcome these challenges and further the benefits this resource provides the electric grid—primarily by way of offering the flexibility needed to allow intermittent resources to interconnect to the electric grid when extreme weather events are the new norm. Thoughtful planning in hydroelectric development (e.g., use of existing infrastructure and environmental mitigation measures) and in operating hydroelectric facilities (e.g., the Northwest Power Conservation Council's intent to study and incorporate changing river flows) will lead to more efficient projects with greater benefits to society. On the regulatory front, measures to streamline permitting processes (such as the Memoranda of Understanding discussed above) can bring projects online faster. On the market side, with encouragement from regulators, ISOs and RTOs can continue to enhance participation models that hydroelectric resources can utilize to participate in wholesale markets most effectively.

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540. *See, e.g.,* U.S. GLOBAL CHANGE RSCH. PROGRAM, FOURTH NATIONAL CLIMATE ASSESSMENT: IMPACTS, RISKS, AND ADAPTATION IN THE UNITED STATES 175 (vol. 2, 2018), https://nca2018.globalchange.gov/downloads/NCA4_2018_FullReport.pdf [https://perma.cc/ZZZ5-S8S2] ("The reliability, security, and resilience of the energy system underpin virtually every sector of the U.S. economy. Cascading impacts on other critical sectors could affect economic and national security.").

Extreme weather events pose inevitable harm to the energy sector, but the ability to carefully coordinate and plan future resource development, regulatory frameworks, and market structures, to best meet the needs of an evolving grid, is within society's control. Hydroelectric power production can play a crucial role in meeting these challenges.