"Dammed if you don't"

Industry perspectives on regulatory obstacles to and policy incentives for the electrification of non-powered federal dams in the United States

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Abstract

Non-powered dams (NPDs) present policymakers with low-impact opportunities for carbon-free, reliable clean energy production. This paper studies policy incentives for and regulatory barriers to NPD development by non-federal developers working on federal dams. Presenting case studies and interviews with industry voices working on dams owned by the US Army Corps of Engineers and Bureau of Reclamation, this paper explores common pitfalls undermining hydroelectric development at NPDs, as well as state and federal policy levers that have encouraged development. This project finds that arduous regulatory reviews, declining power purchase rates and insufficient policy recognition for hydropower have hindered development since 2005. Conversely, access to low-interest financing, supplemental income streams and expedient permitting processes, such as the Lease of Power Privilege, have presented a model to encourage future NPD development.

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List of Abbreviations

ALP..Alternative Licensing Process
ARRA...American Recovery and Reinvestment Act
C-BT...Colorado-Big Thompson
CREB...Clean Renewable Energy Bond
CWCB..Colorado Water Conservation Board
CWRPDA...Colorado Water Resources and Power Development Authority
DOE...Department of Energy
EPA..Environmental Protection Agency
ESA...Endangered Species Act
FERC...Federal Energy Regulatory Commission
FIT...Feed-In Tariff
IBWC...International Boundary and Water Commission
ILP...Integrated Licensing Process
ITC...Investment Tax Credit
kWh...Kilowatt Hour
LIHI..Low-Impact Hydropower Institute
LOPP...Lease of Power Privilege
MOU...Memorandum of Understanding
MRES...Missouri River Energy Services
MW..Megawatt
NEPA...National Environmental Protection Act
NHPA...National Historical Preservation Act
NMFS...National Marine Fisheries Services
NPD...Non-Powered Dam
NSD...New Stream-Reach Development
PPA...Power Purchase Agreement
PTC...Production Tax Credit
PURPA..Public Utilities Regulatory Policy Act
REC...Renewable Energy Credit
RPS...Renewable Portfolio Standard
TLP...Traditional Licensing Process
TVA...Tennessee Valley Authority
USACE..United States Army Corps of Engineers
USFWS...United States Fish and Wildlife Service
WMMPA...Western Minnesota Municipal Power Agency

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Executive Summary

As a carbon-free, reliable, baseload source of energy, hydropower offers policymakers a unique solution in the fight to decarbonize the energy sector. While concerns over the environmental footprint of new stream-reach dams have steered energy advocates away from hydropower, the electrification of non-powered dams (NPDs) offers hydro developers a low-impact alternative. The industry's interest in federal NPDs - either under the ownership of the US Army Corps of Engineers or the Bureau of Reclamation - has led to the installation of hundreds of MW of new capacity on federal infrastructure since 2005.

However, as the cost of new natural gas, solar and wind facilities has plummeted, hydropower developers face increased pressure from carbon-emitting sources and intermittent renewables. Both tedious licensing processes and hydropower's omission from key federal incentives for renewable energy compound private competition with public constraints.

This project conducted interviews with leading industry developers to examine seven case studies in non-federal hydropower development at federal NPDs since 2005. The cases presented vary - from municipal water districts working on small Reclamation dams to large utilities electrifying major Army Corps projects. Taken together, the case studies constitute a representative sample of the contemporary NPD industry, one where capacity limitations and distinct considerations from public and private developers result in an uneven policy landscape. From low-interest loan programs helping major projects achieve critical financing to indefinite structural reviews that sideline projects for years, this project explored thematic commonalities in both successful and failed NPD electrification efforts.

This paper found that successful projects are empowered by long-term, low-cost financing that allows developers time to navigate lengthy permitting and construction processes. Supplemental income streams, facilitated by federal and state policies, help projects remain competitive in markets with declining rates. While successful projects tended to navigate permitting with the buy-in of stakeholders, failed projects saw regulatory risk as a chief obstacle to development. The intersection of long permitting timelines, lack of access to low-cost financing and declining power purchase rates have doomed recent NPD developments, and remain a principal barrier to future development.

This project recommends a number of state and federal policy changes informed by industry experiences in NPD development. States may consider adopting Colorado's regulatory and financing models, directing agencies to coordinate environmental permitting while opening up grant and low-interest loan programs for municipal developers. Federal policymakers, meanwhile, may consider extending appropriations for Section 242 funds, which have proven to be a valuable complement to power revenues. Federal agencies should seek to directly purchase NPD output in rural areas, while seeking to harmonize policy incentives for hydropower with those extended to wind and solar. Finally, Congress should direct the Army Corps to undertake internal reforms to accelerate and standardize hydropower licensing at NPDs.

Background

Introduction

The alarming 2018 report from the Intergovernmental Panel on Climate Change (IPCC) warned of significant impacts to human and natural systems should anthropogenic emissions drive global warming above 1.5°C.[1] Consistent with these warnings and the commitments of the Paris Climate Accord, the Biden Administration has set the lofty goal of realizing net-zero emissions by 2050.[2] Plunging solar and wind energy costs have driven the exponential growth of carbon-free energy in the American portfolio, and the Administration has signaled its intent to pursue demand-side policies to accelerate its rollout. However, often overlooked in energy policymaking is hydropower, which until 2018 was the country's largest source of carbon-free electricity.[3]

Responsible for nearly 40% of current US renewable generation, hydropower has provided the lion's share of historical clean energy. Yet, the 290 TWh generated by hydroelectric sources in 2018 represented a slight decrease from annual output in the mid-1970s.[4] While new US capacity installations have drastically slowed in recent decades, a 2018 Department of Energy report found that hydroelectric stagnation need not continue. Modeling several scenarios, the *Hydropower Vision Report* found that, with limited policy inventions and market evolutions, installed capacity could jump from 101 to nearly 150 GW by 2050.[5] The impact of 50% capacity growth in a renewable generation market this large is difficult to overstate; the *Vision Report* estimates that the value of mitigated social costs from emissions reductions numbers in the hundreds of billions.[6]

Given hydropower's potential, policymakers' comparative disinterest in new hydropower appears conspicuous. Yet, environmentalists' hesitations over the deployment of new hydropower are not unwarranted. Dam and reservoir construction is understood to "not only harm biological diversity, but also cause flooding of land, fragmentation of habitats, isolation of species, interruption of nutrient exchange between ecosystems, and blockage of migratory routes."[7] New stream-reach development (NSD) may also spell considerable social and cultural costs for communities impacted and displaced by reservoir filling and construction activities. The substantial capital costs of NSD, compared with the relative lack of high-capacity greenfield waterways in the US, adds economic obstacles to the social and environmental concerns over the deployment of new impoundment facilities.[8] In light of these considerations, the *Vision Report* cautioned "projects at previously undeveloped sites and waterways [are] likely to remain limited without innovative—even transformational—advances in technologies and project development methods to meet sustainability objectives."[9]

Within the contemporary American hydropower industry, developers are primarily interested in installing additional capacity at hydroelectric dams, deploying pumped-storage hydro (PSH) and electrifying non-powered dams (NPDs). In particular, dams currently operating without hydropower present an opportunity for low-impact hydropower development. Evading the type of criticism lobbied at NSD projects, NPDs have already internalized most environmental and capital costs. Commenting on a 2016 study, the Department of Energy's Jose Zayas reported that over half the capital costs of NSD dams are realized in NPDs, and that the cost per kW at NPDs may be as much as 40% lower than that of new dam generation.[10]

The scale and distribution of this existing infrastructure also makes NPDs an attractive candidate for capacity additions. Only 3% of the United States' 83,000 dams produce electricity, as NPDs have historically been constructed for purposes ranging from navigation and flood control to irrigation and water supply. A 2013 Department of Energy (DOE) study found that these structures, despite their original purposes, maintain considerable potential capacity. An assessment of 54,000 such NPDs estimated cumulative capacity at 12 GW and 45 TWh, over 15% of current hydropower generation.[11] However, most NPD capacity is captured in a small sample of facilities - the 50 dams with the highest potential capacity represent 55% of NPD potential; electrifying the ten largest dams could add as much as 3 GW.

Roughly 600 NPDs scattered across the country have assessed potential capacity over 1MW. Due to historical construction for internal navigation and irrigation, NPDs are largely concentrated in the upper Mississippi River area, lower Red River basin, lower Ohio River basin and Arkansas River basin.[12] These regions are also home to some of the largest NPDs by assessed potential capacity. Federally-owned NPDs can be found in nearly all 50 states, and large numbers of low-potential capacity dams populate waterways in the Northeast and along the West Coast.

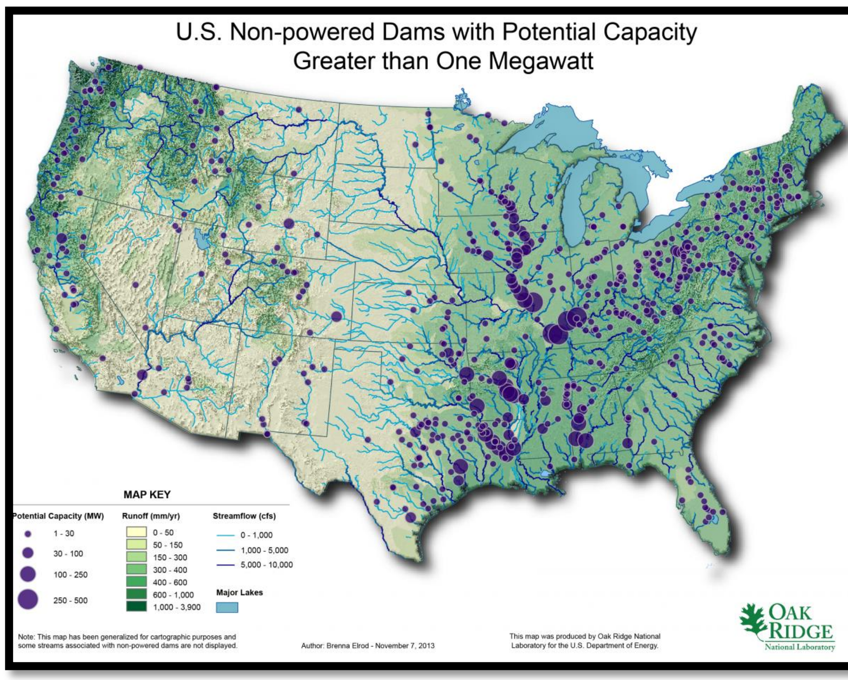

Figure 1: NPDs with >1MW of Potential Capacity

Of the NPDs that have garnered the most interest from private developers, an overwhelming share are concentrated in states with negligible reliance on renewable fuel sources. As of 2017, the five states with the highest licensed capacity - Louisiana, Pennsylvania, Kentucky, West Virginia and Ohio - were in the lowest quintile of states by renewable electricity generation.[13,14]

Ownership and Regulation

While public and private entities both maintain considerable shares of these existing facilities, energy policymakers and private developers have explored the electrification of the federal fleet in recent years. Federal NPDs are often actively stewarded and operated, assuring non-federal developers of structural soundness while alleviating potential concerns surrounding removal. The US Army Corps of Engineers (USACE) owns the overwhelming share of federal NPDs, while dozens of NPDs in Western states fall under the jurisdiction of the Department of Interior's Bureau of Reclamation. The Tennessee Valley Authority (TVA) maintains a handful of Southeastern NPDs above 1MW of potential capacity, while the International Boundary and Water Commission (IBWC) presides over several NPDs along the US-Mexico border.[15]

USACE and Reclamation, the two largest public owners of NPDs, maintain distinct licensing processes for non-federal developers seeking to add generative capacity to existing facilities. Firms exploring projects on Army Corps sites must seek permitting, then licensing through the Federal Energy Regulatory Commission (FERC), while Reclamation administers its Lease of Power Privilege (LOPP) through the Department of the Interior.

Permitting and Licensing on USACE Dams

To secure a FERC license sanctioning construction activities, developers must first apply and obtain a preliminary permit through the Commission. These permits authorize hydropower developers to explore designs, engage stakeholders, arrange project financing and prepare a license application.[16] These three-year stays on USACE sites may be extended for an additional two years, or revoked should a competing public developer invoke municipal privilege.

To file a license application, developers can choose between three regulatory courses - the integrated licensing process (ILP), the traditional licensing process (TLP) or the alternative licensing process (ALP). Since the ILP's debut in 2003, FERC has steered applicants towards this channel as the default licensing option. Under the ILP, FERC opens semi-informal channels for stakeholder input early in the pre-application stage, inviting Tribes, USACE, state and federal agencies to identify conflicts, environmental challenges and issues needing further study.[17] TLP instead asks developers to publish public notices and formalized written comments to invite and facilitate dispute resolution among involved agencies and Tribes. The ALP, meanwhile, offers developers more flexibility in shaping pre-filing consultation mechanisms, as it allows the developer to consolidate pre-filing consultation and environmental reviews under the National Environmental Policy Act (NEPA).[18]

Depending on the chosen licensing process, completion of the reviews listed in the applicants' Study Plan take between one to three years to complete, eventually informing the project design specifications laid out in license applications. Studies commissioned in the pre-application period typically include facility condition assessments, safety evaluations, economic studies on market feasibility and power needs, fisheries studies, environmental reviews, studies concerning specific threatened and endangered species, and recreational facility evaluations.[19] State and federal agencies, tribes and the USACE itself can employ review mechanisms to trigger secondary evaluations and dispute resolution processes. Once resolved, applicants may file licence applications. If accepted, FERC may then issue applicants a license and begin preparing environmental analyses for review under NEPA, Endangered Species Act (ESA) and the National Historic Preservation Act (NHPA). Stakeholders may request hearings throughout the environmental analysis period, modifying the project's terms and environmental obligations throughout the review period. While FERC offers licensing exemptions for hydro projects on small conduits, or for projects adding less than 5 MW on non-federal dams, few federally-owned NPDs qualify for exemptions.[20]

Alongside FERC's in-house licensing processes, the USACE conducts its own public interest and environmental compliance reviews, often coordinating with the Environmental Protection Agency (EPA), US Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS) and state entities that have assumed oversight authority.[21] In particular, USACE's regulatory staff evaluates project compliance under Section 404 of the Clean Water Act, which specifies that discharged waters may not present significant adverse environmental impact, and tasks developers with demonstrating steps taken to mitigate impacts to local habitats.[22] Review, approval and enforcement fall under the EPA's authority, while USFWS and NMFS may evaluate proposals and raise issues to the attention of USACE and the EPA. Section 408, an outgrowth of the 1899 Rivers and Harbors Act, stipulates that any modification to an existing civil work be approved by the USACE, which evaluates proposals through a dam safety and public interest framework. Compliance under both Sections 404 and 408 requires USACE-disbursed permits that must be secured before construction, with review under 404 contingent on first receiving approval under 408. Parallel permitting processes have presented administrative challenges to developers who find progress towards licensing and construction contingent on distinct authorities and review processes. FERC and USACE attempted to resolve discrepancies and harmonize review processes in a non-binding 2011 Memorandum of Understanding that sought to facilitate early inter-agency cooperation.[23]All told, hydropower developments requiring FERC licensing often extend well over ten years from the beginning of permitting to the finalization of construction activities.

Figure 2: USACE's RC Byrd Lock and Dam, on the Ohio River near Apple Grove, WV

Lease of Power Privilege

Reclamation, evaluating hydroelectric proposals on facilities under its own ownership and operation, offers applicants a unique licensing process. Non-federal developers seeking a Lease of Power Privilege (LOPP) on a NPD must approach Reclamation with a proposal, or respond promptly to a Bureau request for proposal. Developers must prepare preliminary information about their proposed project, financing model, technical expertise, management plan, cost estimates, title arrangements for auxiliary facilities and a letter of stated cooperation from area tribes. If satisfactory, Reclamation will extend the developer a preliminary lease, which firms have up to 24 months to sign. Upon signing, the developer's timeline shrinks - firms have one year to finalize project designs, and must break ground no later than two years after signing.[24]

Once a preliminary lease is signed, Reclamation works closely with developers to coordinate environmental and structural studies ensuring minimal damage to existing infrastructure and surrounding habitats and wildlife. While developers are required to ensure compliance with NEPA, ESA, and NHPA, non-federal firms utilizing existing dams with minimal impact on flow patterns may be eligible for a Reclamation Categorical Exclusion, curtailing evaluation needs.[25]

Once assured of the project's structural integrity and irrevocable financing, Reclamation and the developer sign on to a LOPP, authorizing construction. Like FERC and USACE, Reclamation seeks to recoup associated administrative costs from developers, but imposes indexed, annual charges on a per-kWh basis, rather than lump-sum compensation.[26]

NPDs: A Contemporary Policy History

Despite the relative public and private disinterest in new hydro development in recent decades, since 2000, some policymakers have again begun exploring regulatory reforms and policy incentives for the development of NPDs. Bipartisan lawmakers at the state and federal levels have highlighted the potential of NPDs to not only reduce emissions, but also to advance energy independence through greater domestic energy production.

Federal Tax Credits

First created in 1992 for wind and biomass production, the federal renewable energy production tax credit (PTC) offers tax relief to private renewable energy producers on a per-kWh basis. Since 1992, the PTC has been expanded, and renewed several times, most recently in December 2020 at 0.025 $/kWh.[27,28] The PTC has lowered the costs of renewable energy, helping green energy sources compete with hydrocarbons and achieve lower costs through scale. However, the PTC only partially extends to hydropower production, offering qualified facilities just half of the baseline credits at 0.013 $/kWh.[29]

The Business Energy Investment Tax Credit (ITC), meanwhile, lowers tax obligations on private investment in facilities and associated equipment and materials. Hydropower has typically been eligible for the full 30% ITC, a particularly efficacious incentive considering the high capital costs incurred by hydro development and the relatively costly equipment expenses.[30] This tax credit was extended through FY2021 along with the PTC in the Taxpayer Certainty and Disaster Tax Relief Act of 2020. Accelerated depreciation on 5-year schedules allows hydro owners further tax relief in depreciating values on projects early in assets' life cycles.[31] The depreciation rates were bolstered in FY2009 under the ARRA, and again temporarily strengthened in 2010 and 2013.[32]

Recent Federal Legislation

Energy independence drove the passage of the 2005 Energy Policy Act, an omnibus bill now largely remembered in the environmental community for regulatory exemptions for hydraulic fracturing. Beyond the expansion of the PTC, hydropower featured prominently in the bill, as capacity additions tax credits offered tax relief to developers installing additional capacity at hydroelectric projects and previously NPDs.[33] Section 242 of the Act created a payments mechanism for public and private developers installing generation at non-powered sites.[34] The Act further galvanized development of renewables at large with $42 billion in loan guarantees, an authorization that the 2009 American Recovery and Reinvestment Act strengthened with a further $6 billion in offset loan guarantee premiums.[35] Section 1603 of the Recovery Act allowed renewable producers and incremental hydropower developers to receive a refundable ITC in the form of a cash grant, a program that supported dozens of hydro developers between 2009 and the program's cessation in 2012.[36] Clean Renewable Energy Bonds (CREBs) were authorized for renewable projects led by public developers. CREBs were amended and reauthorized in a 2010 law before the bond program's closure under the 2017 Tax Cuts and Jobs Act.[37]

Perhaps the high-water mark of federal interest in NPD development arrived through the notoriously gridlocked 112th and 113th Congresses. The era's seminal legislation, the 2013 Hydropower Regulatory Efficiency Act, amended the licensing structures of both FERC and Reclamation. The Act, which received unanimous support in both the House and Senate, raised FERC's small hydropower threshold from 5 MW to 10 MW, enabling expedited consideration of dozens of NPDs.[38] The bill further directed the Reclamation to extend LOPP eligibility to all Reclamation dams, ending a prior condition restricting leases to facilities previously authorized for hydropower, enabling a surge of NPD electrification projects by non-federal developers.[39] The bipartisan act directed the Department of Energy to undertake a study into NPD electrification, evaluating and estimating the potential generation capacity of federal NPDs.[40]

The Water Resources Reform and Development Act of 2014 further pressed USACE to explore ways to expedite NPD approval, cementing NPD electrification as a stated policy objective of the Corps. The Act created reporting mechanisms to assess the adoption of regulatory streamlining initiatives and directed the USACE to compile information regarding the financial obstacles behind and environmental impacts of NPD development. Beyond the bill, in 2014, Congress authorized funds for Section 242 of the Energy Policy Act, empowering the Act's incentive system for the first time.[41]

Several pieces of failed legislation were also proposed in the divided Congresses of the Obama presidency. The Hydropower Improvement Act, introduced initially by Washington Senators Patty Murray and Maria Cantwell and later by Senator Lisa Murkowski, sought to install considerable new hydropower capacity through expedited regulatory processes and grants for research and development. Successive versions aimed to reduce FERC licensing approval timeline for nonfederal development to two years after an application's filing.[42] That final provision was included in the 2018 America's Water Infrastructure Act, which directed FERC to convene an interagency task force to evaluate opportunities to consolidate various approvals.[43] The act further promoted NPD development by directing FERC to use its discretion to exempt certain, qualified facilities from limited licensing requirements.

On top of Congressional legislation, recents changes undertaken by FERC to the Public Utility Regulatory Policy Act (PURPA) are also likely to affect NPD development. As utilities have contested that declining power rates have made PURPA obligations to purchase fixed-rate output from renewables too costly, FERC has explored amending its administration of the law. Steps taken in 2019 and 2020 to modernize PURPA permitted states to have increased flexibility in setting avoided cost rates, including allowing energy rates to fluctuate over the span of a contract.[44] However, with small power production qualifications reduced from 20 MW to 5 MW, recent changes are likely to undermine the development of NPDs, as income from power production will be less lucrative, and hydropower producers are less likely to be able to compel states to purchase output.[45]

Figure 3: Sen. Patty Murray (D-WA) visits the Howard Hanson Dam

State Policies

At the state level, governments have gravitated towards Renewable Portfolio Standards (RPS) as an industry-level regulatory framework for steering power producers towards carbon-free sources. RPSs mandate a specific target of clean energy generation to be adopted by a certain year, often using the carrots and sticks of Renewable Energy Credits (RECs) and emissions penalties to bend producers towards compliance. RPS policies vary dramatically from state-to-state in terms of the target years, the target share of renewable generation, and the incentive structures to enforce the framework. In general, most of the 29 states with RPS policies create marketplaces to trade RECs, creating additional mechanisms for further valuation of renewable output. The targets set by states since 2000 represent 60% of all renewable energy deployment through 2016, and remain a major driver of hydropower development.[46]

RPS are most widely adopted and have the strictest targets in Western and Northeastern states, where standards adopted prior to 2000 have been updated in recent years. States in the Southwest and Midwest also bear RPS policies, though targets generally remain lower, and few recent revisions have strengthened standards.[47] While eight states maintain voluntary, non-binding goals, lower Appalachian and Southeastern states have not adopted any statewide portfolio goals or standards. In particular, the states of West Virginia, Kentucky, Arkansas, Alabama and Louisiana, home to many of the largest NPDs, have no statewide framework.[48]

While renewables generally are thought to have benefitted from RPS policies, the impact on NPD development is obfuscated by geographic applicability and varying recognition for hydropower. The most common barriers to hydropower recognition under RPS are size limitations, age restrictions, additional environmental certifications and partial inclusion of hydropower output under REC schemes. Due to environmental concerns over the impacts of large dams on wildlife and natural habitats, the majority of state RPS recognize exclusively small hydropower projects. Size qualifications place the upper limit of small hydro around 30 MW of generating output, though some states consider hydropower projects up to 60MW as "small."[49] Many RPSs also exclude older hydroelectric facilities from qualification, instituting cutoff years before which installed capacity is not considered under state policy. Some states have introduced additional environmental reviews to certify hydro projects' environmental impact. Four states mandate certification from the Low Impact Hydropower Institute, a nonprofit, often requiring recertification every 5-10 years.[50] New York maintains its own additional environmental evaluation, ensuring hydro projects comply with an in-house environmental assessment for RPS inclusion.[51]

Limitations on RPS eligibility also impact hydropower's accessibility to REC markets. RECs offer hydropower developers a key source of liquidity, as 2016 credit values ranged from $1/MWh in voluntary credit markets, to roughly $60/MWh in some New England compliance markets.[52] Variability and uncertainty - both of project access and price continuity within credit markets - present a further challenge for hydropower developments that take on high-capital costs for long-term production and sales.

Some states have gone beyond Renewable Portfolio Standards to develop hydropower-specific policy incentives. States like Colorado, Oregon and Vermont offer small hydro projects a combination of regulatory, financing and credit solutions, typically aimed at small, in-conduit development or the installation of generation at non-powered dams.

The Colorado Model

Colorado's hydro policy regime has encouraged industry-leading small hydro development over the last decade. In 2010, Colorado state authorities developed an MOU with FERC, aiming to consolidate and accelerate regulatory review while directing Colorado state authorities to pre-screen developments at existing dams. Later state legislative changes spurred by Colorado's collaboration with FERC boosted exemption thresholds, while leading the Colorado Energy Office to establish a process for comment coordination among state agencies.[53] A 2014 law additionally directed state agencies to streamline small hydropower environmental reviews on a 60-day schedule.[54] Utilization by developers of this framework has been low, however, as most Colorado NPDs are owned by Reclamation.

The Colorado Water Conservation Board (CWCB) offers municipal NPD developers attractive loans to help public developers access low-interest financing. Financed through taxes on hydrocarbon extraction, the Water Project Loan Program offers developers 30-year loans at 2% interest, and has funded over $1 billion in project equity through 2017, leading to 22 new MW of hydropower.[55] The long-term, low-interest loans are uncapped, and allow public developers to secure favorable, reliable financing, mitigating a common stumbling block for projects in the licensing stage.

The Colorado Water Resources and Power Development Authority (CWRPDA) builds on the CWCB loan program, offering grants to public developers to assist in feasibility studies, permitting needs and design reviews on <10MW dams.[56] While grants are limited to $15,000, with an additional 50% match for contributions from local governments, this funding has been a boon to municipalities and small private developers who may otherwise hesitate to explore projects for fear of stranding investments in overhead costs.

The Oregon Model

Oregons's hydropower incentives are largely focused on developing generation at conduits such as irrigation canals. In 2007, the Oregon state legislature passed H.B. 2785, allowing water rights holders to apply for change-of-use permits without sacrificing priority dates from original rights or taking on higher usage rates.[57] While most of the bill's potential application lies in-conduit at private or municipal-owned sites, rather than at federally-owned dams, the law expedites review processes and offers regulatory exemptions for <5MW non-powered dams. Qualification under the law precludes developers from approvals from four different state bodies as well as compliance reviews under additional state laws such as the "No Dead Fish rule," instead allowing for a streamlined process ensuring upstream and downstream environments will not be impacted.[58]

Oregon also maintains a trust fund for small hydropower developers, financed through a 3% tariff on electricity consumers.[59] The state's Energy Trust, like CWRPDA, offers matching funds on developer contributions to finance feasibility and design studies, utility interconnection needs, project overhead expenses and outside consultant costs up to $200,000.[60] While this program has traditionally been utilized by in-conduit developers, NPD developments under 20 MW also qualify, so long as developers sell to PGE or PacifiCorp.

The Vermont Model

In 2009, Vermont passed the Vermont Energy Act, introducing a feed-in tariff (FIT) mechanism to the state's energy market. One of the first US FIT policies, Vermont's regime remains unique in its recognition of small hydropower as an eligible renewable. Offering 20-year contracts to hydropower developments under 2.2 MW, Vermont's FIT provides hydropower producers avoided costs up to $0.130 per kWh.[61] To date, the FIT has supported the development of four hydropower projects at non-powered Army Corps dams.[62] A 2017 revision to the 2009 law raised Vermont's total wattage cap on FIT contracts from 50MW to 127MW, ensuring the program will continue to support renewable development as Vermont's clean energy production grows.[63]

A 2012 law recognizing the 434 MW of small hydro potential in the state developed a permitting assistance program that charged the Vermont Public Service Department to forge an MOU with other state agencies involved in hydro permitting. Drawing from Colorado's experience, Vermont convened the Vermont Agency of Natural Resources and the Vermont Agency of Commerce and Community Development to coordinate comments and engage developers early in permitting processes. The MOU directed agencies to select an in-house point of contact for small hydropower development, as well as to identify projects primed for expedited approval.[64] While the program has created a promising framework for interagency coordination and regulatory streamlining, the hydropower industry has shown little interest in the Small Hydropower Assistance Program. Larger firms like Eagle Creek Renewable Energy, the developer behind Vermont's recent hydroprojects at nonpowered Army Corps dams, have sufficient regulatory experience and approval, while smaller developers have not sought assistance through the program because of prohibitive financing barriers.[65]

Figure 4: Vermont's Ball Mountain Dam, electrified by Eagle Creek in 2016

Other Hydropower Incentives

Massachusetts operates a grant program similar to Colorado's, as the Massachusetts Clean Energy Center's Commonwealth Hydropower Program has issued over a dozen grants to small hydropower developers since its introduction in 2009.[66] The Program, however, is largely limited to upgrades as existing hydropower facilities, and eligibility has not yet been extended to developers seeking to electrify NPDs.[67]

Rhode Island has also developed a FIT structure accessible to hydropower and projects at NPDs, as the state tasks its foremost utility service, National Grid, with long-term power purchases from renewable energy sources. While the initiative has been successfully utilized by solar and wind developers, the absence of attractive project sites has led to low uptake from the hydro industry.[68]

Literature Review

Since 2005, non-powered dam development has been hailed as an pragmatic, low-impact solution to the urgent needs for renewable energy and energy independence. Bipartisan and industry momentum behind NPD development has directed federal agencies to study capacity potential and compile lists of brownfield sites retaining water for irrigation, navigation or flood control where hydroelectric development could take place. A 2013 study by the Department of Energy, *An Assessment of Energy Potential at Non-Powered Dams in the United States* charted potential generating capacity at federally-owned NPDs with more than 1 MW of potential output, measuring regional runoff flows, historic stream flows, head heights and facility characteristics.[69] The 2018 America's Water Infrastructure Act directed DOE to build on this study with *Nonpowered Federal Dams with Potential for Non-Federal Hydropower Developement*, updating the list of non-powered dams and adding historical permitting and licensing information.

Hydropower Vision, a 2018 DOE study, took a wider look at the industry, modeling distinct economic and political scenarios to evaluate several pathways for the industry's growth prior to 2050. This publication built on the *Assessment,* identifying opportunities for capacity installation at non-powered dams under scenarios with greater environmental regulation, low-cost financing and industry innovation.[70] Under every scenario modeled, non-powered dam development outpaced new stream-reach development, suggesting existing infrastructure offers the more economical route to new hydroelectric development.[71] Development at only limited locations could drive substantial growth, as NPD development "contains the greatest opportunity for adding hydropower capacity on a per-dam basis."[72] However, *Hydropower Vision's* scenario modeling warned of a severe pitfall for the future of NPD development. The study's "Business-as-Usual" scenario cautioned that virtually no new capacity would be developed at NPDs should financing opportunities, subsidies and incentives remain constant. This stagnation contrasts with the roughly 5 GW of potential installed capacity that low-cost financing and environmental policy interventions could bring.[73]

DOE's Tennessee-based Oak Ridge National Laboratory has further studied the electrification potential of federal non-powered dams through a number of publications over the last decade. In 2012, Oak Ridge published a technical analysis of over 54,000 non-powered dams, building graphics and datasets mapping out potential at sites with assessed potential capacity over 1 MW.[74] In a 2018 study, the Laboratory analyzed development trends of recent NPD projects, identifying common structural and technical features of conversion projects along with market drivers and cost comparisons between projects.[75] This paper, "United States Trends in Non-Powered Dam Electrification," reveals quantitative insights on developers' considerations for identifying attractive sites development, considering the types of dams developed, market motivations, and environmental mitigation tendencies.

The National Renewable Energy Laboratory (NREL) examined case studies developers working on Bureau of Reclamation sites in its 2018 "Bureau of Reclamation Hydropower Lease of Power Privilege: Case Studies and Considerations."[76] Drawing from two cases - one of which is presented in this study - NREL investigates regulatory efficiencies in the wake of Reclamation's 2012 efforts to streamline its LOPP process. Blending step-by-step reviews of project development details along with an overview of permitting timelines before and after regulatory reform, NREL finds that Reclamation LOPP reforms reduced average project development timelines over 50%.[77]

While DOE has produced and sponsored much of the seminal literature on the subject, private scholarship has also probed the subject of installing clean energy generation at NPDs. Regional studies, such as Christopher Sandt and Martin Doyle's 2013 publication in *Energy Policy*, evaluated feasibility opportunities at low-head dams in North Carolina's Piedmont region. The study found that most facilities were not economically viable for development, though subsidies and financing opportunities akin to those supporting wind and solar could change developer considerations.[78]

The call by some American progressives for a mass public mobilization to fight climate change under the banner of a "Green New Deal" has fostered some conversation of renewed federal involvement in hydroelectric development at existing infrastructure. Matt Bruenig's People's Policy Project laid out a vision for an emboldened TVA to assume a Depression-era level of public power deployment and provision.[79] Under Bruenig's plan, the TVA, owners of several NPDs, would decarbonize its own power supply through the installation of hydropower and other renewable energy in its own service area and in energy markets across the country.[80]

Interest in converting NPDs has taken root in European scholarship as well, as a 2016 study explored the electrification of rural irrigation dams in Greece, while a 2019 publication highlighted the energy potential of NPDs in Romania.[81,82]

Reports and studies by the DOE and outside scholars have substantially raised the salience of NPD electrification within the hydropower industry and in the greater clean energy movement. Technical assessments have provided non-federal developers with accessible resources for project identification. However, with the exception of Oak Ridge's "Trends in Non-powered Dam Electrification," and NREL's "Case Studies and Considerations," much of the literature on NPD electrification has been forward-looking, or limited in scope to a narrow subset of cases. While datasets and regional studies have created powerful tools for developers and facilitated greater understanding from the clean energy community at large, relatively few studies have examined the myriad of NPD electrification projects undertaken across infrastructure under varying federal authorities over the last 15 years.

Since 2005, federal and state interest in NPD conversion has created new policy models for hydropower developers working on federal dams. Beyond regulatory changes, financing schemes and subsidies, profound changes in the energy market have driven prices lower, changing the calculations of power purchasers and providers. Meanwhile, dozens of hydroelectric projects have been installed on Reclamation and Army Corps dams, and an even greater number of preliminary permits have been issued to developers exploring NPD electrification. This paper aims to fill a gap in existing literature by looking at a representative cross-sample of recent hydroprojects by non-federal developers, highlighting avenues for successful construction and identifying common stumbling blocks that have slowed and halted progress. This paper will use these insights to inform several recommendations to policymakers, developers and clean energy advocates seeking to install clean, reliable energy with minimal environmental impact at existing federal dams.

Methods

This paper constructs a picture of non-powered dam electrification projects since 2005 on federal dams. Drawing from a series of interviews undertaken in February and March 2021 with project leads from Independent Power Producers, Public Power Entities and Investor-Owned Utilities, this paper compares disparate NPD electrification projects to articulate common experiences and structural factors in both successful and failed NPD projects. The seven case studies below will focus largely on regulations and licensing, project financing and subsidies and economic factors that either hinder or encourage the deployment of hydropower.

This paper elected to study the phenomena of NPD development through a case study framework primarily due to the marked incongruity between projects. Developers working to electrify NPDs are a diverse group - parties seeking and holding FERC licenses and LOPPs include large companies and small firms of two engineers. Public utilities and private developers both have sought to develop NPDs, operating with highly dissimilar policy and economic considerations. In recent years, developers have electrified NPDs with installations as large as 105 MW, while others explore projects as small as 1 MW. Dams selected for electrification may have initially been installed for flood control, irrigation or navigation purposes, and structural characteristics including flow and head height vary accordingly. NPDs fall under the jurisdiction of both FERC and the Bureau of Reclamation, with each owner adhering to distinct licensing and approval processes.

As each NPD electrification project operates under a unique set of characteristics and circumstances, few commonalities permit comparison on contiguous criteria. Qualitative research via case studies allow this paper to explore in detail the idiosyncratic considerations of each project, and how these factors intersect with one another. While one case study examines a small, private firm's proposal to install capacity at a large, low-head Army Corps dam, another will detail the experience of a water district working to electrify irrigation impoundments on Reclamation's structures.

The seven case studies in this paper, taken together, constitute a representative sample of developers working on federal NPDs. Interviews primarily survey project leads from firms large and small, public and private, working on Reclamation and USACE dams, to build a narrative supplemented by project documents and communications. The paper explores regulatory complications in both LOPP and FERC licenses, covering projects operating primarily in the post-Energy Policy Act context. Project insights from interviews will chart the impacts of policy changes, subsidies and financing and regulatory assistance programs instituted at the federal and state levels, identifying common challenges and opportunities among the diverse developers within the industry.

The case studies addressed in this paper are as follows:

- Mahoning Creek Dam (USACE) [Operational]
  - Interviewee: David Sinclair, Advanced Hydro Solutions
- Granby Dam (Reclamation) [Operational]
  - Interviewee: Carl Brouwer, Northern Water Conservatory District
- Pine Creek Lake Dam (USACE) [License Surrendered]
  - Interviewee: WB Smith, Hydropower International Services
- Red Rock Dam (USACE) [Operational]
  - Interviewee: Tom Heller, Missouri River Energy Services
- Demopolis Lock & Dam (USACE) [Under Development]
  - Interviewees: Ted Sorenson Sr. and Teddy Sorenson Jr., Sorenson Engineering
- Ridgway Dam (Reclamation) [Operational]
  - Interviewee: Mike Berry, Tri-County Water
- Green River Lake Dam (USACE) [Permit Surrendered]
  - Interviewee: Craig Dalton, Watterra Energy

Case studies are structured to detail the circumstances and timeline of developers, dam structures and project details before exploring the project's permitting and compliance process, financing choices, and power sales. Insights from case studies are first used to evaluate common themes between successful and failed projects. The derived conclusions further consider three principal themes pertaining to the impact of current policy and regulatory structures on NPD electrification today. This second section considers developer feedback in light of whether:

- NPD development is hindered by arduous permitting and licensing timeframes that pressure feasibility.
- Increasing uncertainty in power sales markets is not mitigated by policy incentives at the state and federal levels.
- NPD electrification is unlikely to remain viable under the current policy, regulatory and market conditions.

Industry experiences with public policy incentives, financing options and obstacles encountered throughout the project's development will inform a series of state and federal policy recommendations.

Case Studies

Mahoning Creek Dam (USACE) - Advanced Hydro Solutions, LLC

The Mahoning Creek Dam stands 162 feet tall against the backdrop of Western Pennsylvania's rolling hills. Since its completion in 1941, the flood control dam has impounded the winding Mahoning Creek, a tributary of the Allegheny River. Under the management of the Pittsburgh District of the US Army Corps of Engineers, the project resides in rural Armstrong County, roughly 50 miles northeast of Pittsburgh.

The dam had received substantial interest from the hydropower community throughout the 1980's and 1990's, as FERC issued a license in 1990 to Mahoning Hydro Associates to develop a 5 MW project.[83] When the firm surrendered the license four years later, multiple preliminary permits were issued to developers competing for the right to explore hydroelectric development at the site. In 2004, Advanced Hydro Solutions secured a preliminary permit from FERC for Mahoning Creek Dam, proposing a 6 MW hydroelectric project that would eventually reach operation in 2015.

Figure 5: The Mahoning Creek Dam

FERC Licensing

In the two years following the issuance of the permit, Advanced Hydro began formulating advanced project details, contacting and engaging stakeholders and assembling scoping documents for environmental assessments. The nearby Seneca Nation welcomed an invitation to participate in the licensing process, citing its interest in ensuring cultural resources within aboriginal territory remained intact.[84] Adducing the bureaucratic need to draw on past studies for similar projects on the same site, the Nation deferred to recent documents from past licenses indicating that the footprint of the project was unlikely to impact cultural resources.[85] The Pennsylvania Bureau of Historic Resources echoed Seneca, concluding that the project would have little to no impact on nearby cultural heritage sites.[86] A regional planning commission found nothing worthy of objection.

The Corps's Pittsburgh District, however, objected to FERC and Advanced Hydro's consultation process concerning historical sites, arguing that the Corps was not sufficiently involved in identifying historical sites. The Corps' office was "disappointed" that it was not elevated to the role of a signatory party, and called for a number of revisions, including consultations with the 40 other Native American groups with cultural affiliation to the greater

Western Pennsylvania area.[87] A FERC response later that year clarified the issue, communicating that Advanced Hydro had followed the appropriate engagement processes under the ILP.[88]

Soliciting comments from the USFWS, a 2006 Study Plan Determination by FERC incorporated the agency's analysis to conclude that mussel populations were unlikely to be impacted by the hydro project, as water levels and quality would remain consistent with those of pre-project discharges.[89] Environmental scoping and recreational surveys proceeded throughout 2007 and 2008, culminating in a 2010 Environmental Assessment. The document proposed a number of project measures to strengthen the immediate ecosystem of the project, including dissolved oxygen sensors, draft tube ventilation equipment, trash racks on the intake structure and restoration and reseeding activities along the banks of the reservoir and tailrace.

The hydro project, operating in a run-of-release mode, proposed to maintain flow through a Corps bypass structure. While FERC recommended a 30 cfs bypass flow, drawing from studies conducted for the 1990 license, the Army Corps called for limited withdrawals enabling higher minimum flows.[90] Citing that "what was appropriate in 1990 may not be appropriate in 2010 since both water quality and the lake and tailwater fisheries have improved," the Corps also took exception with FERC's call for a 40 cfs minimum flow in winter months, arguing that such a level would not serve the joint aims of water quality and protection from freeze.[91] When the 30 cfs minimum was stricken from the proposal later in 2010, the Corps continued its call for an incremental instream flow study. The Corps held reservations on a number of other project aspects, questioning the EA as prepared by FERC staff.[92] Minimum flow thresholds were eventually raised to the Corps' proposed levels, though greater bypass flows hindered potential hydroelectric output.

While Advanced Hydro was issued a license by FERC in 2011, disagreements between the developer, FERC and the Army Corps concerning dissolved oxygen levels persisted into late 2011. Consultation with USFWS regarding impacts to surrounding wetlands culminated in the timely approval under Section 404, as the agency found Advanced Hydro's protection measured to be efficacious.[93] After securing this authorization, Advanced Hydro sold its license to Enduring Hydro, another private developer. Enduring Hydro made limited project modifications to Advanced Hydro's proposal before beginning construction activities in 2013. Enduring Hydro applied for, and received a certificate from the Low-Impact Hydropower Institute in June of 2014, complying with the stipulation for external review under Pennsylvania state law.[94] A joint agreement between Enduring Hydro and Corps on water quality monitoring was not reached until the summer of 2014.[95] Construction activities were finalized on the 6MW project early in 2015, and a sales agreement was cemented in a 10-year PPA inked with Penn State University.

Federal Regulation and Policy - Interview Findings

In this project's 2021 interview, Advanced Hydro's project lead, David Sinclair expressed his view that FERC's participation in licensing was productive, and that the Commission actively sought to move the project towards completion. Sinclair highlighted the Integrated Licensing Process (ILP) as one example of a useful internal organizational reform.

Early communications with stakeholders identify “major risk elements,” preempting calls for new studies later in project life cycles. In anticipating major disagreements, the ILP provides a platform for developers to articulate their own interests in consulting with FERC to draft study plans, pushing back against perceived superfluous studies.

While FERC’s organizational orientation was amenable to hydroelectric installation, Sinclair noted that other agencies and stakeholders were far more obstructionist. Sinclair observed that across his firm’s many projects on Army Corps dams, that involvement and participation from Corps districts was highly unpredictable. While some Corps offices maintain tenured staff with years of experience collaborating on NPD electrification projects, Sinclair observed, other offices have little familiarity, or lose substantial expertise with the departure or rotation of key staff members. Beyond experience, Sinclair stressed the importance of individuals’ beliefs and orientations to hydropower. In the example of Mahoning Creek, the Pittsburgh District on multiple occasions required authorizations in excess of those mandated by FERC. As the Seneca Nation concluded that the hydro project would have negligible impact on cultural and historical resources, the Army Corps district’s call to engage a substantially larger, and less relevant, audience of stakeholders far exceeded the developer’s compliance obligations under the ILP. The discrepancies between Corps districts and divisions, he stated, were indicative of the interagency limitations of initiatives such as the FERC-Army Corps MOU. Implementation challenges of similar projects are likely to remain challenged as organizational structures remain stratified.

Sinclair observed the bevy of financing challenges faced by small developers like Advanced Hydro. ITC refundability under Section 1603 was instrumental in providing cash flow during the project’s construction, as accelerated depreciation schedules limited the impact of a tax credit. Sinclair noted that while tax credits have been a boon to larger developers able to deduct greater investments, smaller developers comparatively benefit more from cash incentives. He welcomed Congressional funding of Section 242, as the Mahoning Creek project was nearly wholly constructed in the interim between legislation and appropriations, but cautioned that larger projects could capture higher shares of funding, omitting smaller developers from lucrative payments.

With an eye to future NPD projects, Sinclair suggested that developers were facing increasing pressure in power markets, as lower rates limited developers’ ability to recoup investments and secure long-term PPAs. While low interest rates throughout the 2010s had helped hydroprojects get off the ground, Sinclair vocalized the need for greater subsidies to enable the competitiveness of NPD projects.

Granby Dam (Reclamation) - Northern Colorado Water Conservancy District

In Colorado’s Rocky Mountains, the Granby Dam is part of the greater Colorado-Big Thompson project (C-BT). An array of dams, dikes and diversions, the C-BT complex includes a dozen reservoirs, capturing mountain runoff and diverting water to Colorado's eastern agricultural communities. Lake Granby is the largest such reservoir in the C-BT project, and one of Colorado's largest bodies of water.

Reclamation, which built and currently manages the C-BT project, installed six hydroelectric facilities throughout the 20th Century. The Granby Dam, with little water and variable flow from season to season, was built sans hydropower, as most upstream water is diverted for irrigation.[96] Yet, despite flow limitations, the 300-foot high dam offers more than enough head to make the release attractive for hydropower development.

The Northern Colorado Water Conservancy District, commonly referred to at Northern Water, is a water utility serving much of Colorado's Northeastern slope. Created in the late 1930's to co-manage the C-BT, Northern Water's extensive history working on the site was instrumental in allowing the utility to secure a LOPP and bring the hydro project to operation.

LOPP Licensing

Northern Water's first NPD electrification project at Carter Lake, another impoundment in the C-BT project, was underway when American Renewables filed a Formal Request for Development with Reclamation on the Granby Dam, initiating the Lease of Power Privilege process in September 2010.[97] While Northern Water was "not quite ready" to undertake a secondary project, the utility saw fit to file a competing proposal on the facility it oversaw.[98] Nearly a year later, Reclamation awarded Northern Water a preliminary lease for a hydroelectric project, with the district's municipal preference, NPD experience and detailed project proposal separating its bid from that of American Renewables.[99]

After receiving the preliminary lease, Northern Water and Reclamation undertook internal scoping processes to identify potential obstacles warranting studies. A relatively small project on existing infrastructure, the Granby Hydroelectric Project did not significantly raise the alarm of nearby landowners and stakeholders. However, Northern Water worked closely with state and federal agencies to account for historical, cultural and recreational considerations in project design. Located within the Arapaho National Recreation Area, the Granby Dam project liaised with USFS to reduce the project's visual footprint, and ensure long-term recreational access to Lake Granby.[100]

Figure 6: The Granby Dam Spillway

Northern Water took extensive steps to ensure the project's environmental feasibility and minimize its impact to nearby wildlife. Concerns regarding nearby nesting osprey precipitated the limitation of some construction activities between May and September, while Northern Water worked to comply with the USFWS Avian Protection Plan.[101] To avoid adverse impacts on fisheries, Northern Water pursued an intergovernmental agreement with Grand County establishing water quality standards. As the project's construction involved the discharge of disturbed and dredged waters, Northern Water sought a Section 404 permit from the USACE, documenting compliance with the Clean Water Act.

While the Granby Dam qualified for a Categorical Exclusion under NEPA, Northern Water instead elected to complete an Environmental Assessment, as both Reclamation and Northern Water staff had comparatively more experience with the traditional approval process, and the developer found the EA avenue "more defined" than the alternative.[102] Northern Water prepared its EA through Reclamation; after completion of the Assessment and of parallel studies, Reclamation issued a LOPP to Northern Water in March of 2015.

Working with an engineering firm versed in Reclamation's technical standards and health and safety regulations, Northern Water completed the installation of the 1.2 MW project on the Granby Dam just a year later.[103] The project installed two 600 kW Frances turbines capable of collectively generating 5 million kWh annually.[104] From the utility's initial application through the completion of construction activities, the Granby hydroelectric project needed only five and a half years to move from proposal to operational reality. Northern Water noted this window was slightly longer than comparative NPD developments at Reclamation sites, as minor delays elongated the project timeline, such as Reclamation's investigation into establishing a fiber optic cable along transmission lines. However, the developer's sentiment on permitting was overwhelmingly positive, citing Reclamation's expertise and the efficiency of the LOPP process.[105] In a 2016 interview, Grand County Commissioner Merritt Linke highlighted the "spirit of collaboration and cooperation" between agencies and governments in bringing the project to completion. "Even if just one [institution] would have said, 'no, we don't like that', it would not have gone through," Linke said. "I think that would have been a tragic mistake to not see that mutual benefit for the future."[106]

Power Sales and Financing - Interview Findings

The Granby Dam hydroelectric project cost $5.7 million in incurred capital costs between 2010 and its completion in 2016. The project was overwhelmingly financed with a loan from the Colorado Water Conservation Board, which offered Northern Water a $5.1 million agreement at the program's standard 2% annual interest rate.[107] Northern Water project manager Carl Brouwer, noting private developers' access to generous tax incentives, observed that developments by public agencies were instead contingent on attractive financing. As the CWCB loan program offers substantially more competitive financing than private alternatives, Brouwer praised the state loan program as "critical" in the project's success.[108]

Low-cost financing only became more critical to the project's completion as power rates fell. Natural gas prices in Colorado dropped precipitously between the Granby hydroelectric proposal in 2010 and the signing of Northern Water's PPA with Mountain Parks Electric in

2015, and installed wind capacity more than doubled.[109,110] Cheap power from non-hydro sources drove down purchase rates by nearly a third, causing correlated REC values to plummet.[111] Expecting the last decade's trends to hold, Brouwer believes that low-cost financing will remain essential for project developments, particularly for smaller projects. As many non-powered dams lie in rural areas, Brouwer notes that small energy markets make developers captive to the demand of a limited market of buyers. Small projects, like Granby, are not able to install long-distance transmission lines to access other energy markets, pressuring energy producers' ability to seek competitive rates.

While Brouwer celebrated Colorado's hydropower loan programs in enabling the project's success, he noted that federal hydropower incentives played less of a role in ensuring viability and profitability. As the project was completed in 2016, Granby missed the cutoff date for payments under Section 242, which sunset hydro projects' eligibility after 2015. Northern Water's Carter Lake project, eligible under the fund, has received compensation from the DOE, helping the project remain "secure financially."[112] However, while the program "has helped" Northern Water's hydroelectric projects, competition for funds, eligibility limitations and long-term uncertainty about the continuation of the appropriations preclude any consideration of the program as a catalyst for future NPD development.[113]

Pine Creek Lake Dam (USACE) - City of Broken Bow, OK

The Pine Creek Lake Dam, operated by the USACE's Tulsa District, impounds the Little River in Oklahoma's rural McCurtain County. 30 miles east of the dam is Broken Bow; the town of roughly 4000 rests in former Choctaw land near the Arkansas border. Broken Bow has long sought independent energy, exploring several hydro projects both at the Pine Creek Lake site and at Broken Bow Lake. Its interest in the Pine Creek Lake facility dates back to the 1970s, when the city first probed the installation of hydroelectric capacity at the Army Corps dam, only to run into financing limitations.

FERC Licensing

In both instances, Broken Bow contracted the help of WB Smith, the founder and President of the boutique hydropower consultancy Hydropower International Services. In 2004, the public-private partnership led the city to secure a preliminary permit for the Pine Creek Lake

Figure 7: Pine Creek Lake, in McCurtain County, Oklahoma

Dam site, beginning initial scoping activities under the Traditional Licensing Process.[114] The project proposed to operate in a run-of-release fashion according to the USACE's determined releases, while installing reinforcing lining on the dam's conduit to support the addition of two turbines capable of generating 6.4MW.[115] Broken Bow submitted its license application in 2006, and began convening stakeholders to start pre-EA scoping activities. Oklahoma's Department of Environmental Quality issued a Water Quality Certification in late 2007, offsetting a concern from the nearby city of Irabel, which sourced its water supply from an intake valve 20 miles downstream.[116]

EA progress continued throughout 2007 and 2008. Concerns over whether project activities would disturb the habitats of the American Burying Beetle led to license conditions stipulating Broken Bow's obligation to gently "bait away" and relocate beetle species on-site and near transmission line facilities.[117] Broken Bow and FERC met with Native American tribes and Oklahoma state historical preservation and archeological agencies from 2007-08, forging a Programmatic Agreement for procedures in the event that ground disturbances uncovered artifacts.[118] With interagency agreements surrounding environmental and historical impacts in place, a license was issued to Broken Bow in 2009. However, the project's progress was put on hold in 2010, when a safety inception by the USACE "revealed a potentially serious issue with the Pine Creek embankment and conduit."[119] Despite Broken Bow's proposal to line the conduit with reinforcing steel, letters from USACE state that the Corps would first undertake internal dam safety studies, working to identify the location and extent of potential leakage, before considering any modifications to the underlying structure.[120] The project, still continuing to receive approvals from stakeholding agencies, was essentially "on-hold" until the USACE's Risk Management Center could approve the study. "Due to other high-priority projects" USACE's correspondence warned, it would likely be "several years" until the study was completed.[121]

Broken Bow and Hydropower International Services attempted to engage USACE, proposing cost-sharing alternatives to solve underlying structural issues. However, USACE declined to consider the alternative, writing three years after the initial issues were raised to alert the developer that appropriations for remediation would likely take another few years to be issued.[122] In late 2015, the City of Broken Bow surrendered the license. Extended delays in project development from the initial 2004 license application mandated that the City renew its power agreement with the Public Service Company of Oklahoma, "negating the original concept of self-generation."[123] New rates offered by the utility motivated the abdication of the project, as city councilors grew impatient with the pace of the Pine Creek Lake Dam project.[124]

Permitting and Regulatory Compliance - Interview Findings

WB Smith, a mainstay in the hydropower industry, has been involved in interagency conversations on hydropower licensing for decades. While noting the progress made by FERC's internal streamlining, Smith stated that, in the case of the Pine Creek Lake Dam, processes remained far too arduous. Processes extrinsic to FERC, Smith noted, were largely culpable for major delays and drawn-out timelines. As developers work to comply with the stipulations of several authorities, FERC's leadership in the licensing process is largely "unrecognized" by other agencies, opening up spaces for redundancies between different review stages.[125] Smith noted that duplicitous compliance measures are most apparent in environmental permitting between disparate agencies.

Smith observed that FERC's MOU with USACE had not sufficiently sparked changes at the bottom of the organizational structure. The rigidity of the Corps review processes prevented flexible, ad hoc solutions like the cost-sharing scheme proposed by Broken Bow, as the project was placed on a several-year hold upon the identification of structural issues. Smith also commented on staffing changes and the progressive loss of hydropower expertise within Corps offices. Reflecting on his career working across Corps districts, Smith recalled greater experience with, and enthusiasm for, hydropower among staff members in decades past. As the rate of hydropower development slowed, Smith notes, younger members of the USACE did not receive the same hands-on education, and internal USACE training programs were not sufficient in replacing technical experience working on hydro projects.

Financing and Sales

The Broken Bow City Council's decision to renew its existing power sales agreement at lower rates was indicative of a larger trend. Oklahoma's natural gas boom reverberated in states across the country, dropping energy prices for consumers. Quick timelines in bringing natural gas facilities online, Smith noted, place major competitive pressure on hydropower, which abides by slower approval and construction procedures and longer-term life cycles. Exacerbating the shift toward cheaper energy are solar and wind, which enjoyed massive growth in Oklahoma in the 2010's due to federal subsidies and shorter debt servicing periods.[126]

In light of this competition, NPD development heads into an uncertain future, Smith said. While accelerated depreciation schedules, PTCs and ITCs have been helpful for private developers leading NPD projects, the subsidy portfolio behind hydropower is outpaced by that of wind and solar. Absent substantial state-level intervention from Oklahoma, power purchasers seeking low-cost power continue to find more attractive rates and contracts from non-hydro sources. Smith recommended that states and the federal government explore fully extending renewable subsidies to hydro, while also observing that federal efforts to deregulate production from natural gas and coal sources have exacerbated pressures on hydropower.

Red Rock Hydroproject - Missouri River Energy Services

Central Iowa's Red Rock Dam, situated between the towns of Pella and Knoxville, is one of the state's largest dams. Completed in 1969, the Dam was built alongside nearby Saylorville Dam to control flooding along the Des Moines River. Shortly after the Army Corps completed the installation, a number of developers began exploring the installation of hydroelectric facilities. After FERC issued a series of preliminary permits to public and private developers throughout the late 1980's and 1990's, CRD Hydroelectric LLC, a subsidiary of Nelson Energy, applied for a preliminary permit in 2005.

FERC Licensing

CRD's proposal for the earth fill dam - 110 feet high and over a mile wide - was one of the largest non-powered dam hydro projects in the region's history. Doug Spalding's consulting firm proposed the installation of two 21-foot diameter penstocks through generating units with a cumulative capacity of 30 MW.[127] CRD Hydroelectric requested to use the Traditional Licensing Process, proposing that scoping activities and environmental assessments could borrow from past project documents from a license issued to Seaward Development in 1987.[128] After a competing permit was denied, few issues rose throughout the pre-application period. Stakeholders like the Marion County Soil and Water District and the Sac and Fox of the Mississippi tribe found no objections for initial proposals, with the former writing that it was "proud that a clean source of renewable energy be generated on Marion County soil."[129] Public meetings and notices were held and issued in late 2007 and throughout 2008, culminating in CRD's major license application in 2009. Plans for the project changed in the run-up to the application, with the developer proposing a three-turbine powerhouse, raising the installed capacity to 36.4 MW.[130] With agreements in place to take steps to minimize impacts on the endangered Indiana bat, and environmental scoping declaring that the installation of hydropower would have minimal impact on fisheries, a license for the project was issued in April of 2011.

Figure 8: An aeriel of Red Rock Dam in Central Iowa

In August of that year, Nelson Energy and CRD took a step back from the project, transferring their recently acquired license to Western Minnesota Municipal Power Agency (WMMPA). WMMPA pledged its output to utility Missouri River Energy Services (MRES) and its membership network of 61 cities.[131] Financial forecasts changed in late 2010, when rising energy prices pressed the developer to reevaluate potential revenues. Concluding that prices in Minnesota and Iowa for hydroelectric power would climb to the $63/MWH range by the projected construction midpoint in 2013, CRD anticipated a 12% increase in potential revenues.[132] WMMPA financed the project with municipal bonds, taking advantage of attractive rates under 4%.[133]

A Section 408 Dam Safety Review application was prepared in late 2011, and submitted to the USACE in October of that year. Compliance under 408 tasked WMMPA with finalizing project and procurement details, pressing the developer to front capital expenses prior to the completion of subsequent permitting. Section 401 and 404 approval documents under the Clean Water Act were submitted in 2012, but could not be evaluated until the completion of the 408 review.[134] Approval of CWA permits from the USACE was not granted until the spring of 2014, pushing back the beginning of construction, and requiring MRES to seek an extension from FERC. While upon acquiring the license, MRES forecast a start date for construction activities in early 2013, with a target completion date by 2016, the firm was not able to break ground until late in 2014.[135]

Construction welcomed the manpower of hundreds of employees, installing turbines on the east side of the dam, building an inlet through the Red Rock's western flank, and revitalizing the lake's recreational facilities.[136] While consecutive, historically wet years and flooding halted project activities, pushing back deadlines over two years, construction proceeded without major issues until its completion in 2020. The second largest hydroelectric facility in Iowa, MRES' power sales to nearby Pella prompted the city to close an old, coal-burning power facility.[137]

Interview Findings - Compliance, Financing and Policy

Tom Heller, CEO of MRES, conveyed the project's difficulty with elongated permitting times and the lengthy regulatory delays that pushed back construction activities. Heller reported that the Army Corps's Rock Island office, which oversees and operated Red Rock, was a helpful, cooperative actor in the permitting and licensing stage, actively working to advance the project toward completion. However, Heller noted that the installation of structural safety measures, as directed by USACE, significantly inflated the project's budget. While Heller cited the need for structural integrity and safety, he observed that the installation of steel liners in concrete penstocks and cutoff walls were incommodious obligations for the developer.

The most substantial regulatory issue, Heller stated, was the sequential staggering of USACE permits. Approval on the 404 permitting were contingent on approvals under Section 408, drawing out deadlines as permits could not be evaluated simultaneously.[138] In keeping with FERC's own licensing deadlines, MRES had to take on substantial financial obligations without the certainty of permit approval, opening considerable financing risk for the developer.

After the acquisition of the license, WMMPA financed Red Rock Hydro exclusively through tax-exempt municipal bonds. Because the developers opted not to use an ad hoc private firm to hold the license and lead project activity under its name, Red Rock Hydro was not eligible for accelerated depreciation or PTC and ITC tax credits. Due to its ability to raise substantial sums through municipal bond offerings, as well as its excellent credit rating, WMMPA received competitive financing for the project. A law passed in Iowa granting sales tax exemptions on hydropower output offered the developer tax relief, as hydropower generation gained equal footing with wind for exemptions under state law.

With further regard to state policy, Heller reported that while Iowa's RPS were not a motivator in developing the project, the project received recognition under Minnesota's small hydro limit under its RPS. Minnesota law requiring generators to have a 25% share of renewable energy by 2025 was a driving consideration, Heller stated. Iowa's 10% standard, on the other hand, not only omitted generation by municipal entities like MRES and WMMPA, but had long been realized by the deployment of wind turbines across the state.

On federal policy, Heller expressed his belief that federal action to streamline USACE review processes was an essential step in accelerating NPD development. Heller called on FERC to explore avenues to increase price signals to accelerate the development of renewable energy at this infrastructure, primarily through continuing to modernize regulation. Heller encouraged regulators and policymakers to incorporate the "true value" of hydropower into public policy, stating that hydropower's reliability, and potential to supply long-term, low-cost power makes hydro a far more valuable source on a per-kW basis than variable generators like wind and solar. To that end, policy harmonization with benefits extended to other renewables, and potential incentives beyond, can help future development of NPDs. Heller communicated that while hydropower development faces considerable short-term financing barriers, the long-term benefits of cheap power and baseline reliability ensure hydropower's viability into the future, particularly as utilities are taking on more output from variable sources. Full recognition of hydropower as a "stabilizing force," and policy incentives to match, will help NPD output compete with natural gas, which faces relatively expedient permitting and construction windows.

Demopolis Lock & Dam - Sorenson Engineering

The Demopolis Lock and Dam is one of the Tomigbee River's five Army Corps dams. Initially created for the commercial navigation or barges on the river, today the dam largely serves recreational navigation, opening and closing sparingly throughout the year to traffic coming in and out of Alabama's Demopolis Lake. The Lake, at the convergence of the Tomigbee and the Black Warrior Rivers, is the largest body of water with active operation under the Corps' Black Warrior-Tombigbee Project Office.[139]

FERC Licensing

In early 2008, Ted Sorenson's Sorenson Engineering, via the subsidiary Birch Power Company, filed for a preliminary permit to explore a 48 MW hydroelectric project at Demopolis. The permit application proposed the installation of two turbine units and two 90-foot penstocks on the tailrace side of the dam.[140] Working on an NPD with only 20-30 feet of head, depending on seasonal water levels, the developer proposed to build a conduit around the dam, rather than construct a penstock in the impoundment structure itself. Sorenson's firm was awarded the preliminary permit at the end of the year over a competing application, which proposed the installation of greater capacity, but was filed after Sorenson's application.[141]

Utilizing the TLP, few points of tension emerged during project development and initial scoping throughout 2009-10. In 2011, the USFWS contended that GeoSense, a consultant assistant Sorenson's team in preparing filing for the application, had not sufficiently taken into account the impact on a number of nearby populations of threatened and endangered species.[142] A number of nearby Native American tribes were contacted for input, but few identified specific resources or landmarks that could be impacted by the project.

However, as Sorenson's Birch Power worked closer to environmental assessments and a license application, pulp and paper manufacturer Georgia Pacific began raising concerns about the hydroelectric project's impact on its downstream paper mill.[143] Georgia Pacific's hesitations persisted into 2013, when it opposed Birch Power's license application, citing its belief that a potential degradation in dissolved oxygen (DO) might impact Georgia Pacific's operations. A study by AquAeTer, performed prior to the submission of the license application, found that hydropower's discharge would have minimal effect on DO quality 40 miles downstream at the mill.[144] In 2015, these concerns were echoed and championed by RockTenn, a separate, closer paper mill. Only eight miles downstream, RockTenn expressed its concerns that further DO loss would push the company under its environmentally permitted limit, imploring Birch and FERC to undertake further studies assessing the exact impact at its bend in the Tomigbee before the mill would remove its objection from a water quality certificate.[145]

Disagreements over an acceptable DO level continued into 2016, with FERC granting extensions to allow Birch and RockTenn time to settle on an agreement.[146] In April of that year, Birch and WestRock (which RockTenn formed in a merger) settled on terms directing Birch to install an oxygen aeration system and monitors in the tailrace and downstream to ensure oxygen levels did not dip below 5.0 mg/L. In return, WestRock withdrew its objection to the issuance of a license.[147] A CWA 401 application under these terms was prepared and filed by Birch later in 2016. In late 2018, over five years after Birch Power had submitted its initial license application, FERC issued the company a license.[148] FERC and fellow stakeholders completed the final environmental assessment that year, after some requests for additional studies into impacts on sturgeon by the USFWS. As of this study's writing, Sorenson Engineering is working with USACE on securing a 408 permit certifying dam safety, a critical final step separating the firm from undertaking construction.

While Sorenson Engineering continues to seek final permitting for the Corps' Demopolis project, the Idaho Falls-based firm reported it had comparatively more experience working in Western states on Reclamation dams. Ted Sorenson Sr., comparing the processes of each agency, remarked that while the LOPP was by far the easiest regulatory process to navigate, Reclamation's financial requirements made developments at its NPDs less financially rewarding. Sorenson Sr. celebrated FERC's conduit exemption, highlighting the "45-day wonder" as a regulatory victory for small hydro developers. While FERC's licensing requirements outside the exemption remain far more arduous than do Reclamation's, Sorenson Sr. reflected, the greatest challenges are extrinsic to the Commission. Regulatory capture by interest groups, particularly in clean water certification by state agencies, challenged not only the Demopolis project, but past projects as well. Beyond WestRock's firm objections to downstream DO levels, Sorenson Sr. cited a past project in Washington state in which clean water certification was contingent on a number of costly but unrelated recreational upgrades for boaters.

Financing and Sales - Interview Findings

As of this paper's drafting, a PPA has not been signed with a power purchaser, and the firm is currently exploring rates with buyers in the area. In this project's interview, Teddy Sorenson Jr. relayed that the firm was aiming to sell its generation to a corporate buyer interested in securing carbon-free electricity. Sorenson Jr. noted that premium rates from a private buyer may help offset some of the precipitous drop in power purchase rates the firm had overseen throughout the proposed project's lifespan. When Sorenson Engineering initially applied for a preliminary permit, power rates remained at roughly \$0.06/kWh, a rate that has since fallen by over 50%. Sorenson Jr. observed that low power rates were likely to remain a barrier to NPD development going forward, and that policy incentives were crucial to facilitating future NPD developments in low-rate markets. Linking market pressures to political pressure, Sorenson Jr. further highlighted that lobbying efforts to individual state Public Utility Commissions, on the part of large utilities, had artificially lowered some states' calculated avoided cost rate, diminishing the value of public purchase rates by the state and making small hydropower increasingly uncompetitive.

Figure 9: The Tomigbee's Demopolis Lock and Dam

State and Federal Policy

While Sorenson Jr. observed that his firm had not secured low-cost financing through Colorado's public-only programs, that state-level policy had "made the difference" on both his firm's and other developers' hydro projects. Colorado state agencies' regulatory expediency had enabled the firm to undertake construction activities mere months after the securing of a LOPP on a past project.

On federal policy, Sorenson Jr. celebrated Reclamation's WaterSMART grants, which he had previously used to cover hundreds of thousands in expenses related to engineering design and on-site testing.[149] This grant program, launched by Reclamation in 2010 to support a range of water conservation, energy efficiency and infrastructure modernization projects, cost-shares primarily with municipalities, districts and water delivering authorities to incentivize resource redevelopment in Western states. Sorenson Sr. similarly emphasized the impact of WaterSMART as a program critical to past NPD developments. Sorenson Jr. and Sr. both commented on the need for sustained payments under DOE's Section 242 scheme. "When the market's down," Sorenson Sr. commented, Section 242 payments "are the difference between 'go' and 'no-go.'"[150] Sorenson Jr. was in agreement with his father's assessment, but cautioned that unpredictability over future appropriations limited the firm's ability to rely on federal funding streams for future projects. Both Sorenson Sr. and Jr. called for increased recognition of hydropower under federal tax credits, reporting that benefits incentivizing wind and solar development must be fully extended to hydropower.

Ridgway Dam - TriCounty Water

Built by the Bureau of Reclamation in 1987, Colorado's Ridgway Dam creates the Ridgway Reservoir on the Uncompahgre River. At an altitude of nearly 7000 feet, the reservoir was formed to limit floods and provide irrigation to farmers and ranchers in the Uncompahgre Valley. Beyond agriculture, Tri-County Water Conservancy District, a utility owning the rights to the reservoir's storage, delivers water to customers throughout Ouray County and the surrounding region. The earthen dam is over 300 feet high, and the reservoir it impounds is a popular recreational attraction in the region.

Lease of Power Privilege

Interest in installing hydroelectric generation at the dam began in its initial construction throughout the late 1970's and 1980's, but power rates remained too low to consider the development of power generation at the site. The City of Aspen, long invested in making a jump to full reliance on renewable energy, became a driving financial motivator in installing hydroelectric generation at Ridgway. A 2003 proposal to shift the city's energy reliance to 100% renewables prompted an interest in hydropower, which could offer the city a baseload source to end its reliance on coal.[151] Hailed as a "holy grail" source for its lack of emissions and reliability, hydropower today constitutes roughly half of the city's energy.[152]

Despite Aspen's interest in the mid-2000's, concerns surrounding foundational issues at Ridgway delayed the exploration of hydroelectricity by several years. In 2010, Reclamation began soliciting proposals for a hydroelectric project at the site, limiting construction activity to one side of the dam, as the Bureau reserved the right to make structural changes to other sections.[153] Tri-County Water, already actively managing operations at the reservoir, was selected to proceed with development, and was issued a preliminary lease.

The $18 million project proposed to install two turbines - an 800kW system producing power through constrained winter flows, and a 7.2 MW system operating in summer months with irrigation releases.[154] The project likewise proposed a substation and a 0.8 mile transmission line to connect the project to the grid. Slated to operate in a run-of-release mode, Tri-County's hydroelectric project avoided compromising or modifying the dam's underlying purposes and historic operations.

After the issuance of the preliminary lease, scoping activities between Tri-County and other stakeholders developed rapidly throughout the utility's 24-month window to comply with preliminary lease stipulations and sign a LOPP. Approaching the completion of an environmental assessment, few issues were raised from nearby stakeholders and state agencies. No cultural or historical resources were identified in the immediate area, and the dam's distance from nearby population centers created no property disputes or risks.[155] Downstream the Uncompahgre, fisheries experienced nitrogen supersaturation. The Colorado Water Quality Control Commission, and other concurring environmental agencies, posited that the installation of the "hydropower facility has the potential to improve downstream fisheries at Ridgway State Park and should have no effect on the reservoir fishery."[156] With no affected endangered or threatened species on site, and anticipation of only minor, temporary turbidity, the project was broadly hailed as presenting no adverse impacts, and offering a potential benefit to downstream water quality. With NEPA requirements satisfied, Reclamation issued a LOPP in February of 2012.[157] Construction began less than a year later, as Tri-County broke ground on the power station in November of the following year, completing construction just two years later in the spring of 2014.


Figure 10: Colorado's Ridgway Dam, owned by Reclamation

Financing and Policy - Interview Findings

Mike Berry, General Manager of Tri-County Water and the project lead behind the Ridgway Dam electrification, celebrated the pace of the project's certification and approval. A former Reclamation employee, he touted the Bureau's expertise and efficiency in moving NPD projects towards completion.

The Ridgway electrification project took advantage of a number of state financing and incentive programs. Ridgway primarily financed the project through a $13 million loan from the CWCB, on a 30-year schedule at a 2% rate. Further funding included a $2 million, 20-year loan from the CWRPDA, which also provided an attractive, low interest rate. Public financing options, Berry said, were far more attractive than private alternatives, both in terms of interest rates and loan schedules. Berry noted that while power purchase rates were more attractive when Aspen first announced its interest in buying hydropower, financing opportunities through Colorado state programs were crucial in realizing project success.[158]

In addition to Aspen's purchases, Ridgway provides surplus power during summer months to Tri-State Generation and Transmission, a wholesale supplier for regional power associations. Revenue from Tri-County's PPAs are supplemented by income from RECs. The nearby city of Telluride purchases tens of thousands of dollars in credits from the Ridgway's output, offsetting some of the city's emissions in compensating the hydropower.

Beyond state policy, Ridgway receives compensation for its renewable production through Section 242 funding. The direct payments have been successful in ensuring the project's bottom line, as the public agency is not able to leverage other federal tax incentives and credits.

Figure 21: Kentucky's Green River Lake Dam

Berry offered few additional recommendations for state policy incentives, and suggested federal agencies begin taking their own steps to streamline regulatory processes and support the competitiveness of hydropower. Berry further celebrated the Colorado state policy regime and the LOPP process, highlighting financial incentives and expedient review and compliance timelines as catalysts behind the project's success.

Green River Lake Dam - Watterra Energy

Green River Lake Dam, an Army Corps flood control project, was completed in 1969 on the Green River in Kentucky's Taylor County. Green River Lake, created by the Corps' impoundment, also supplies water to nearby municipal areas and manages stormwater. The earth and rock fill dam stands 141 feet high, and the DOE's 2018 study estimated the dam's maximum potential installed capacity at 20.2 MW.

In 2016, an upstart hydro developer, Watterra Energy LLC, filed for a preliminary permit to explore a 6MW project at the dam. The proposed project aimed to install a single Francis turbine in an existing conduit. The proposal would bifurcate the conduit, with one channel leading to a new powerhouse, and another branch releasing floodwaters.[159] Operating in a run-of-river capacity, the project would install a short transmission line to connect the dam's power to an existing regional power grid.[160]

Craig Dalton's firm not only sought permitting for Green River Lake; permit applications were likewise filed for Iowa's Saylorville Dam and Indiana's Brookville Dam, both among the nation's larger federal NPDs. While Watterra was simultaneously working on Reclamation conduits in Western states, Dalton reported that larger NPDs under Corps ownership offered a more attractive opportunity, as FERC licensing fees are paid upfront, rather than Reclamation's per-kW tariff.[161]

After highlighting some initial deficiencies in Watterra's proposal, FERC issued a preliminary permit in January 2017.[162] The project's proposal changed in 2017, with Watterra instead petitioning to install two turbines with 10.6 MW of cumulative capacity. FERC directed Watterra to begin exploring environmental impacts on nearby vulnerable and threatened species, suggesting the developer begin studying impacts on fish and wildlife populations, as well as the hydro project's contribution to DO levels and water temperatures.

Interview Findings

In 2019, Dalton reported that the firm was modeling water flows, calculating year-round water availability to anticipate cumulative generation. Dalton, in this project's 2021 interview, revealed that these studies conclusively showed the project to be unfeasible, as variable flows throughout the year precluded the possibility of consistent, lucrative generation. These studies prompted Dalton to surrender the preliminary permit in January of 2020, along with permits held on other Army Corps NPDs.

In studying other projects, Dalton stated, the length of project development timelines, coupled with uncertainty surrounding financing and power sales, deterred Watterra from continuing to pursue NPD developments. Singling out Red Rock, Dalton reflected that even a project that eventually found success endured regulatory precariousness, project delays and expenses potentially jeopardizing project financing. For small developers like Watterra, the financial and regulatory barriers to entry appeared insurmountable given potential revenue.

Watterra's proposal sought power sales to private, corporate buyers rather than to local power providers. Dalton reported that such buyers, invested in decreasing their carbon footprint, were likely willing to pay higher rates for green, reliable hydropower. However, unable to find an attractive PPA that guaranteed above-market rates for a long duration, Watterra could not proceed in securing financing. Private equity options for the project, Dalton stated, would likely be contingent on the length of a possible PPA - as power purchasers increasingly seek shorter PPAs with power prices falling, finding long-term, low-cost financing options in Kentucky proved difficult.

Dalton noted the absence of federal and statewide incentives as a further complication in realizing NPD development. Without public incentives and support that could artificially lower rates, Dalton remarked, price competition through NPDs would likely remain a "losing effort." In projects outside of Green River, compensation through REC markets would have been an important revenue stream for the small developer. While Watterra's site selections weighed potential generation capacity over the availability of statewide financing and incentive options, Dalton cited loan programs such as Colorado's as major opportunities for small hydro developers. With longer debt servicing cycles and lower rates, Dalton remarked that friendly loan offerings would allow NPD developers to discount rates in the short-term, as debt servicing needs would be less onerous.

Analysis

The seven case studies presented above differ substantially. Whether it is municipal entities in Colorado adding hydroelectric capacity to small irrigation projects under their oversight, or boutique private engineering firms installing conduits on large, low-head NPDs, the contemporary landscape of NPD development sees a diverse range of actors working through different regulatory channels to electrify highly dissimilar infrastructure.

Despite the discrepancies between the case studies presented in this project, a qualitative analysis can identify commonalities between successful and failed ventures. The first subsection will highlight common regulatory, policy and financing themes among successful and failed projects; the second subsection will evaluate thematic commonalities among developer experiences under the three issue areas presented on page 18. "Success" in this context signifies that a project has been constructed and is currently operational; "failure" conversely reflects that a project's license or permit was surrendered or terminated.

Characteristics of successful projects

Of the four successful projects presented here - Mahoning Creek, Granby, Ridgway and Red Rock - three cited their access to low-cost financing avenues as a critical factor in the project's completion. In the case of Granby and Ridgway, both projects on Reclamation dams were carried out by public developers, qualifying both for 30-year loans through the CWCB. The Granby project went further, securing additional financing through the CWRPDA. Northern Water and Tri-County Water accessed 2% loans at rates considerably more attractive than private sector alternatives, helping the water districts offer competitive pricing without the pressure of recovering investments early into project life spans to service debt. Red Rock, meanwhile, saw WMMPA raise hundreds of millions through a municipal bond offering. In both cases, unique abilities to raise capital outside of private equity offered developers below-market interest rates. Mahoning Creek, on the other hand, financed its construction with over $12.8 million in private equity loans. With the project's financing plan certified by FERC in 2013, Enduring Hydro may have leveraged low interest rates and comparatively higher power purchase rates to complete its project.[163]

In each successful project, demand for hydropower sales offered the crucial revenue streams to help project cover expenses. In particular, buyers willing to pay above-market rates for hydropower generation helped the Ridgway and Red Rock projects secure attractive PPAs. In the Ridgway example, the city of Aspen's initiative to transition to 100% renewable energy offered TriCounty a reliable buyer willing to pay a premium for the reliability and baseload capacity of hydropower. In the Red Rock example, MRES' relationships with utilities reliant on a number of sources allowed the developer to consider hydropower sales in the context of other sources. MRES' Tom Heller remarked that the project produced 5% of WMMPA's energy portfolio; should it have been 50%, power rates would have skyrocketed. However, the consideration of hydropower along with WMMPA's wind, solar and hydrocarbon output offered the developer a reliable, green complement to other sources. Hydropower International Services likewise designed its project around accessing premium rates from a city interested in energy independence; when that agreement concluded, the project was left with other viable routes for power sales.

Beyond power sales, alternative and supplementary revenue streams - via private or public funding mechanisms - also drove project success. As power rates have declined, developers have seen access to secondary revenues as one mechanism to offset declining rates. Tri-County Water, for instance, sold RECs to the city of Telluride as the district sold its power to the city of Aspen. Northern Water, meanwhile, sold RECs to Tri-State Generation & Transmission. Beyond participation in the REC marketplace, the water district receives direct payments from DOE through the Section 242 program. While income streams from each source remain marginal in comparison to power sales, even modest revenue can give developers greater reliability in project design and pre-construction stages. The importance of Section 242 payments was echoed by a number of other developers. Furthermore, ITC refundability - a short-lived incentive administered as part of the ARRA stimulus bill - offered developers like Hydro direct payments while accelerated depreciation minimized the project's tax bill. Refundability of 30% of the benefit allowed Enduring Hydro and Advanced Hydro to generate cash flow during the construction period, leading David Sinclair to remark on the Section 1603 law, saying "this is how Mahoning got built."[164]

Finally, and perhaps most importantly, collaboration and eager engagement from regulators and stakeholders is a key variable in determining the project's success. In both Reclamation projects surveyed above, a history of collaboration between the water districts and the Bureau itself prompted a spirit of trust and cooperation. Expedient input from state agencies, directed by Colorado law to accelerate project permitting and approval, helped projects quickly move towards construction and operation. In the Red Rock case, Heller reported that the Army Corps district was an engaged, enthusiastic partner - despite the USACE's grinding procedural processes - and actively looked to encourage the project's completion.

Some developers were able to work around the inflexibility and reluctance of regulators, but only at great expense to the developer and with significant project delays. Sinclair's Mahoning Creek project encountered resistance from the Army Corps, who pressed the firm for broader inclusion of tangentially-concerned stakeholders and for greater environmental measures than those proposed by FERC staff. However, with the support of FERC and the Pennsylvania Fish and Boat Commission, pushback onto the Corps' calls for additional measures and facilitation by FERC to reach agreements on project details allowed Advanced Hydro to overcome regulatory roadblocks. However, some projects labored to overcome such uncertainties and obstacles.

Characteristics of failed projects

While this study only draws from one case of a failed licensee and one case of a firm failing to proceed with its preliminary license, this subsection will leverage details from other case studies to identify areas of risk that may undermine NPD electrification projects. A sentiment universally shared among the hydropower developers surveyed was that greater timelines open up greater risk. The adage that "time is money" is unmistakably apparent in the Broken Bow case, where the Army Corps' identification of structural issues within the dam prompted an indefinite hold on project activity.[165] Progress was halted until structural issues could be studied and remediated, but without a definitive timeline, project expenses continued to accumulate as the developer's agreement with the city to pursue a new PPA had weakened. Project lead WB Smith cited the overregulation of hydropower licensing as a key hindrance to non-powered dam development.

Wattera surrendered its permits out of caution of finding itself in a similar predicament. Craig Dalton's studies of similar NPD projects revealed the degree to which project timelines were delayed and budgets were routinely exceeded. In looking at projects like Red Rock, and larger ventures such as American Municipal Power's series of major developments along the Ohio River, Dalton conveyed his hesitation that even projects led by the largest, most experienced firms still struggled to deliver NPD developments on time. Speaking of the financing challenges inherent in the development of such long-term projects, Dalton asked "how are you going to finance the permitting of a 10-year project not knowing the end?"[166]

Regulatory risk was the driving factor behind the elongation of project timelines, and a key contribution to the failure of the two projects examined as case studies. In successful projects, unforeseen regulatory hurdles further hindered progress. In the Granby case, a project that otherwise paced the industry in its time to market was tasked with mapping a six-inch strip of "wetlands" around the reservoir's bank to comply with Section 404 of the CWA. Sorenson Engineering, working in Demopolis, experienced a multi-year delay due to holds on its permits from state agencies acting on the concerns of downstream paper mills. In the Mahoning Creek case, the "personal roadblocks" of individual staff members at the overseeing Army Corps district introduced progressive delays in the pre-license application period.

Beyond regulatory risk and drawn-out timelines, demand-side constraints for power sales affected NPD developments. In smaller, rural markets with comparatively fewer buyers, failure to secure a PPA left developers with few fallback options. In the Broken Bow example, the city's withdrawal from the project, cemented by the renewal of its power agreement with PSC, left WB Smith's firm without other markets for sales. In Watterra's Pine Creek project, the absence of interest from local corporate buyers, as well as the disinterest in long-term PPAs, convinced the developer of the project's unviability. Accessing distant markets where developers could command higher rates involves the installation of costly long-distance transmission lines whose deployment raised regulatory issues of their own. The constrained size of power markets where hydro developers can command attractive power purchase rates will likely remain an issue with current projects and future projects at NPDs, as the overwhelmingly rural distribution of federal non-powered dams suggests that hydropower sales from such projects will continue to operate in markets with limited buyers.

Thematic Analysis

To evaluate the three thematic questions posited on page 18, a thematic, qualitative sentiment analysis will compare the feedback of the various developers surveyed in this study.

> ***Theme #1*****:** *NPD development is hindered by arduous permitting and licensing timeframes that pressure feasibility.*

Developers - large and small, public and private - widely cited their frustration with what they perceive to be unnecessary and counterproductive overregulation. A view shared by five of the seven respondents, developers believe that licensing and regulatory compliance obligations far exceed necessary review.

The five developers sharing this view all worked on Army Corps dams, where respondents voiced frustrations with the participation of the numerous stakeholders. However, a sentiment shared by four of the five held that FERC was a sympathetic and supportive actor in hydropower licensing. Sinclair reported the Commission was interested in facilitating the success of projects, saying "their process is to get you to 'yes.'"[167] Sinclair hailed FERC's ILP as a helpful forum for identifying potential areas of conflict, and preempting potential issues early in a project's application.

However, Smith conveyed the limitations of FERC's support for hydropower, claiming the Commission was "unrecognized as the lead agency" because of the unique and distinct approval processes of other agencies. In satisfying the permitting needs of each sovereign agency, Smith added, FERC's authority over licensing processes is diminished, inviting redundancy between projects.

While Sorenson Sr. identified state water quality agencies as a principal source of regulatory delay, four of the five respondents working on Army Corps dams singled out the

USACE itself as a chief regulatory obstacle. Sinclair highlighted the variation in experiences working with different Army Corps districts; operating independently, some districts enthusiastically engage hydropower developers, while others "just don't like hydro."[168] Whether calling for excessive reviews, tasking developers with supposedly gratuitous structural repairs, or maintaining sequential review procedures at odds with developers' urgency, USACE's involvement in hydropower licensing can grind projects to a halt. Because of the organization's diffused structure, interagency memoranda such as the joint MOU between FERC and USACE has had little impact on the ground. Revolving staff and a progressive exodus of in-house engineers with firsthand hydropower experience continues to exacerbate structural dilemmas.

Beyond the USACE, the proliferation of stakeholders involved in hydropower licensing invites inconsistencies and regulatory risks, such as duplicitous reviews or capture by political interests. While interviewees often pointed at agencies outside of FERC as the principal cause for regulatory delays, some identified procedural issues FERC could adjust within the Commission, such as not requiring the petitioning of extensions and permit renewals when developers await the sanction of other agencies.

The two respondents who did not share the others' frustration with permitting were Tri-County Water and Northern Water - the two developers working on Bureau of Reclamation dams. Northern Water navigated the LOPP process in three years, while Tri-County's project secured a lease in just over a year. Mike Berry of Tri-County hailed the LOPP as "one of the best [regulatory] processes we went through," citing reclamation's quick timelines, transparency and hydropower expertise.[169]

Theme #2: *Increasing uncertainty in power sales markets is not mitigated by policy incentives at the state and federal levels.*

A January 2021 hydropower market survey found that "33 of the 41 FERC license applications in the past decade cite economic reasons as the main cause for surrender."[170] The report later found that, by 2018 prices, hydropower PPAs had fallen by nearly 33% from a 2008 peak. Hydropower's previous advantages over other technologies, in generation-weighted terms, vanished over the same time period.

The report's findings were echoed in this study's conversations with developers. Hydropower, which balances its short-term capital intensity with long-term reliability and the absence of fuel costs, has faced steep price competition from plummeting natural gas prices and newly-competitive solar and wind.[171] Not only are these technologies challenging sales from existing facilities, falling electricity prices are jeopardizing projects currently under development - particularly those at NPDs. While solar and wind energy benefitted from ambitious federal and state policies that helped the industries innovate and achieve price reductions at scale, hydro developers reported that policy incentives surrounding NPD development fell short of mitigating market pressures.

Six of seven developers reported that falling market rates for power sales increased economic pressures on project feasibility. The lone exception, Tom Heller of MRES, observed that "the cost of power from Red Rock is more than a solar or wind project would be today," but

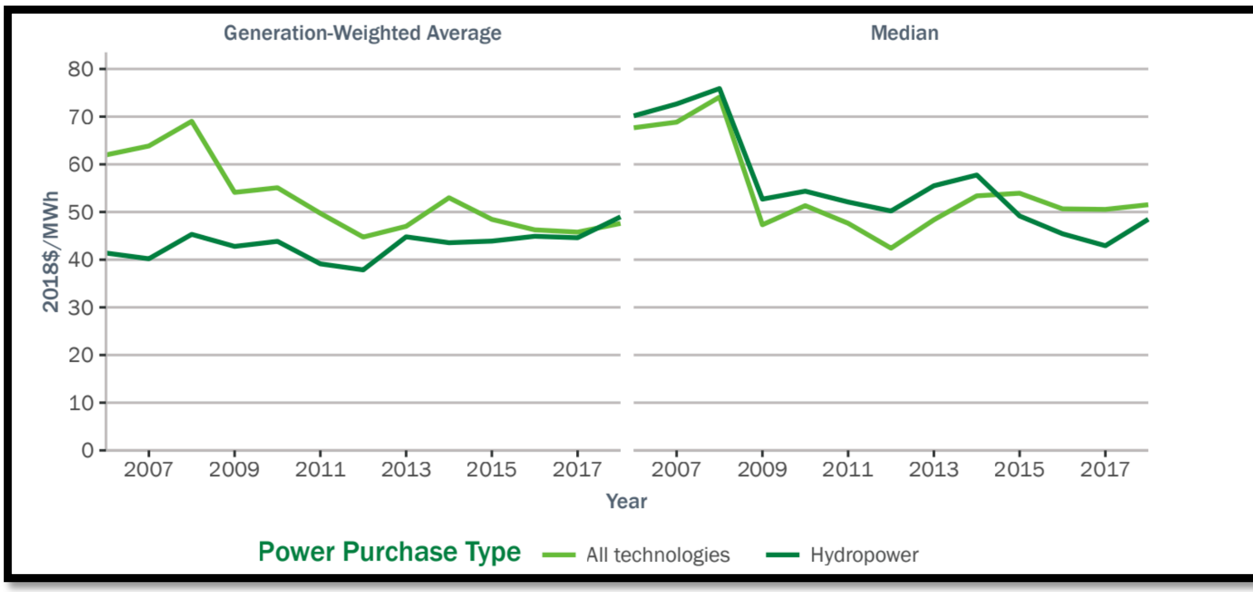

Figure 12: PPA Rates since 2006, comparing hydropower to all sources

consideration of hydropower as a "reliable" input attracted his firm to the NPD in spite of costs.[172]

Sinclair reported that his firm, advising the completion of the Mahoning Creek project, struggled to find attractives rates in power sales markets. While the dam eventually sold its output to Penn State University through a 10-year PPA, the 2021 market report suggests that Sinclair's experience was more the exception than the rule. The market report states "some potential buyers express uneasiness about the environmental impact of hydropower; low-impact hydropower development approaches like NPD projects are not widely familiar to corporate energy buyers."[173]

Sinclair additionally discussed the insufficiency of current federal policy in enabling NPD generation to compete on power sales markets. Section 242 funds, Sinclair said, are captured by larger developers with greater output, imperiling smaller developer's access to substantive income. Uncertainty surrounding future appropriations further complicates developers' ability to factor in payments. Sinclair added that recent tariffs levied on machinery and steel inflate procurement costs, mandating developers hold out for higher PPA prices in sales.

Brouwer echoed Sinclair's concerns, saying PPAs "are not getting better in terms of rates."[174] Brouwer reported that while power buyer Tri-State paid a premium for a clean, baseload source of energy, that rural Colorado's smaller markets made the developer captive to the limited buyers. Brouwer attributed some of Granby's feasibility to state policy, saying that low-interest financing helped the project reach completion, even as anticipated power rates and REC values plunged during its development.

Sorenson Jr. spoke of the compounding issues of falling prices and delayed projects, noting that longer timelines incurred more pre-operation costs, requiring hydropower developers to secure increased revenue to service increased debts. Sorenson Jr. further noted sharply falling PPA rates for hydropower in Alabama, a region in which the 2021 Market Report specifies that wholesale electricity prices have continued to remain cheaper than median hydropower prices.[175] Sorensen Jr. believed that RPS policies had driven hydro developments in other states, though the absence of such a policy in Alabama did not offer the Demopolis project the same support.

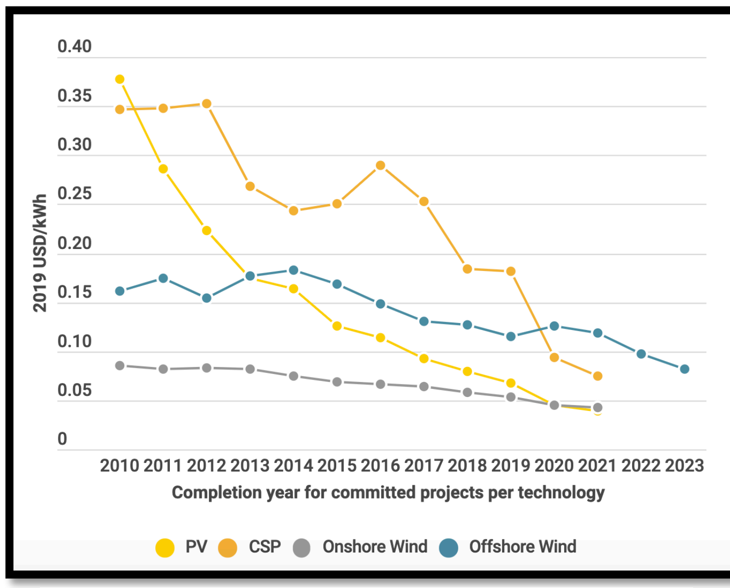

Figure 13: Declining wind and solar rates since 2010

Dalton, whose firm surrendered several permits, began power sales discussions with a corporate prospect and an industrial center regarding Pine Creek, only to conclude the power sales from NPDs were likely to be unviable. While Dalton remarked that site selection weighed potential output above regulatory supports, he remarked that NPD financial viability would be a "losing effort" without public assistance. Dalton relayed that his firm explored projects in Colorado, only to conclude that the most compelling NPDs had already been electrified. Hailing the state's loan programs and regulatory assistance grants, Dalton added that public support could help hydro generation compete at lower rates. Dalton added that REC markets in states Watterra had explored projects were generally not lucrative enough to offer substantial compensation for carbon-free production.

Developers widely encountered challenges in accessing PPAs that could help capital-intensive NPD electrification projects balance out their bottom line. The industry recognizes that public policy can play a critical role in empowering NPD projects; as current policy structures do not substantially mitigate cost pressures, developers called for additional public assistance.

Theme #3**:** *NPD electrification is unlikely to remain viable under the current policy, regulatory and market conditions.*

The “business-as-usual” scenario, as quantitatively modeled in the Hydropower Vision Report, sees virtually no new capacity installed at non-powered dams should policy and financing options for developers remain unchanged. However, with targeted policy interventions, the hydropower industry may add as many as 4 GW at NPDs over the next 30 years. The insights from the case studies prepared here build on that forecast, demonstrating a picture of a sub-industry struggling to compete in market conditions of increasingly low rates, with investor and power purchaser appetites leaning closer towards cheap but intermittent wind and solar and dispatchable but emission-laden natural gas.

Developers surveyed in this article who had worked on Army Corps dams, under FERC licensing, suggested a contested future for non-powered dam development at federal sites. Sinclair suggested that, between prohibitive regulatory processes, few financing opportunities and a dwindling market for power sales, that small developers in particular would continue to face headwinds. While he posited that low-interest rates would offer short-term relief through greater access to capital, he called for more aggressive policy incentives to encourage hydropower development. Sorenson Sr. echoed Sinclair’s sentiment, claiming that federal and state policy was a defining axis around which the future of NPD development would revolve. Sorenson Sr. in particular called for policy incentives on par with those currently and previously extended to wind and solar, saying “Whatever credits wind and solar have, we have to have, or we’re dead.”[176] Dalton’s Watterra Energy, which closed following the developer’s unfruitful foray into a number of project and power markets, offers the most stark example communicating the difficulties ahead facing NPD developers. Unable to compete in wholesale markets and struggling to find corporate or institutional buyers, Dalton’s firm offers a cautionary tale for the future of NPD development should federal and state policy adhere to the status quo.

However, other developers acknowledged the moment’s current challenges, but staked out a middle road. Heller singled out hydropower’s competition with natural gas as a defining challenge for NPD development. As new natural gas facilities can be quickly approved and finalized, power purchasers can secure dispatchable power at rates below hydropower’s. Heller suggested that should regulators and policymakers decide to take action to reflect hydropower’s “true value” in market signals, that federal NPD development could endure short-term pains to deliver long-term, sustainable and cost competitive-power. While Smith lamented hydropower’s exclusion from the types of policy incentives bolstering wind and solar, he remarked that the 2021 Texas energy crisis signified hydropower’s importance and resilience, as both hydrocarbon and renewable sources were unable to generate in a wholesale grid shutdown.

Developers surveyed in this project with experience working on Army Corps dams offered a fraught portrait of future prospects for NPD development. While it is difficult to confirm that future projects may amount to only marginal increases in installed capacity, the feedback in this project's interviews adds merit to Hydropower Vision's findings. The joint partnership between Rye Development and Climate Adaptive Infrastructure, announced in early 2021, to explore the electrification of 22 federal NPDs in Kentucky, Louisiana, Mississippi, Ohio, Pennsylvania and West Virginia, will offer a definitive glance into whether NPD projects can remain competitive absent public support.[177] While non-powered dam development at Army Corps sites may not yet be "dead," this study finds near-universal recognition among industry voices that policy changes are critical to maintaining financial viability in current and future markets.

Policy Recommendations

The installation of hydroelectricity at NPDs presents an exceptional opportunity for American policymakers. Within the hydropower industry, NPDs offer a low-impact avenue for the installation of reliable, baseload, carbon-free electricity. Federal dams, particularly those under the oversight of the Army Corps, are unlikely to be removed, and their structures have been proven to be compatible with hydropower development. Whereas current additions of carbon-free energy are often intermittent, mandating the reliance on and continuation of dispatchable, carbon-intensive sources, low-impact hydropower from NPDs presents a dependable and resilient source of energy every bit as green as output from wind and solar. Whatsmore, the distribution of high-capacity federal NPDs finds the most compelling infrastructure residing in states highly reliant on hydrocarbons, suggesting the marginal kWh of hydroelectricity will serve to displace emission-heavy sources.

Developers report that the paramount challenges facing NPD development are regulatory, financial and cost-competitive in nature. However, any one of these challenges need not rule out NPDs as a potential climate solution. Licensing processes can be streamlined without sacrificing critical environmental reviews, or excluding the voices of area tribes and stakeholders. Financial obstacles can be overcome with perspective and patience; NPDs can recover capital costs if extended low-cost, long-term financing. In considering the full value that reliable, carbon-free hydropower uniquely provides, market signals can again make power sales from NPDs competitive in PPA markets. The strong history of bipartisan support for hydropower development and NPD electrification suggests that climate- and infrastructure-minded lawmakers may welcome policy changes. This section will articulate a set of state and federal policies that industry voices celebrate as potential relief to current challenges, ensuring existing infrastructure can be leveraged to produce clean energy.

State Policy Recommendations

Many of the largest NPDs by assessed potential capacity are found in Louisiana, Pennsylvania, Kentucky, West Virginia and Ohio - states that not only rank low in renewable energy generation, but also in employment rates.[178] Many of these states maintain scant policy incentives for renewable energy. Adoption of policies accelerating NPD development may not only decrease states' reliance on fossil fuels, but create short-term and long-term employment.

Regulatory Relief

States looking to add hydropower to existing federal dams should emulate the Colorado model. Colorado's efforts to streamline permitting through pre-screening and interagency collaboration have drastically reduced project timelines on NPD projects in the state. Developers report expedited approvals from water quality certification agencies and environmental stakeholders. States can direct agencies to prepare pre-application information for relevant NPD sites, identifying threatened and endangered species, area historical and cultural landmarks and information developed as part of past permit and license applications. Interagency preparation and knowledge sharing would not only help inform developers, but would mitigate administrative needs and prime agencies to begin undertaking more substantive evaluation earlier in project lifetimes. Colorado's 2010 MOU with FERC led the Commission to waive early steps in its licensing process; the state further acted as a "permitting hub" providing technical assistance and liaison services to other stakeholders.[179] Colorado's regulatory pre-screening has substantially driven down project timelines, mitigating financial and regulatory risks for developers.

States requiring LIHI certification may streamline regulatory reviews by adapting distinctive elements from the Institute's evaluation process, incorporating them in existing environmental reviews, or outright waiving the requirement for NPDs. As NPDs are often low-impact by nature as development occurs on existing structures at brownfield sites, LIHI certification often adds redundancy and undue compliance measures on developers.

Stronger Standards

Beyond streamlining regulatory procedures, states must consider adopting, renewing and strengthening RPSs. While current iterations of these standards vary substantially from state to state, developers broadly stressed that standards were insufficiently binding and ambitious, not serving as a strong directive for the development of clean energy. States with voluntary RPS targets should consider instituting binding policies, creating REC markets to facilitate private trading and valuation of clean energy generation. As declining wind and solar prices have driven pronounced deployments of new renewables, states with clean energy output approaching or exceeding current RPSs may consider raising targets. More ambitious standards should broadly strengthen REC markets, driving utilities to not only consider additional wind and solar, but hydropower output as well.

Beyond blanket RPS strengthening, counterproductive hydropower qualification restrictions have limited the impact of RPS on the encouragement of NPD development. Restrictions like those of Maryland, limiting recognition of hydropower to facilities generating power before 2004 can unjustly exclude low-impact green energy from newly-developed NPDs.[180] Limits on qualifying output from hydro - as restrictive as 7.5 MW in Massachusetts - also hinders the potential lucrativeness of electrifying larger NPDs. State RPS should waive sunset dates and capacity thresholds for NPD development, allowing low-impact hydropower producers to access REC markets with a project's full output.

Public Provision

States can stimulate development at federal dams by public entities through low-cost, long-term financing. Colorado's 30-year loans have been instrumental in facilitating affordable financing at Reclamation dams, and its 2% interest model enables lower power rates, as public developers face less pressure to service debt early in project lifetimes. States may consider financing such a loan program with taxes levied on fossil fuel extraction and production, a policy that not only generates revenue, but creates additional price signals discouraging fossil fuel use.

To further encourage NPD development by entities like water and irrigation districts, who have applied experience working on NPDs for non-hydropower purposes, states may look to Colorado and Alaska to adopt similar regulatory assistance grant programs. These grants need only distribute up to several tens of thousands of dollars per award to offer significant assistance to public or municipal entities who may lack the in-house technical hydro experience to determine the viability of projects at existing dams. Grants should be extended to utilities, tribal groups, IPPs and municipalities to explore initial permitting and feasibility studies through in-house management or consultancy. Successful projects funded through such grants may be tasked with long-term repayment of the feasibility assistance awards upon project completion.

Federal Policy Recommendations

As most high-capacity potential, structurally-sound non-powered dams are under the oversight of the US Army Corps of Engineers and the Bureau of Reclamation, federal policymakers should actively consider procedural and policy changes to encourage power development on its infrastructure.

Federal Funds

Payments to hydropower facilities under Section 242 have offered NPD developers crucial revenue diversification that has helped offset declining power purchase rates. Hydropower producers electrifying NPDs can qualify for per-kWh payments up to $750,000 for a maximum of ten consecutive years. However, projects developed after September 2015 are ineligible to receive funds, limiting the program's ability to catalyze future development. Congress ought to direct the DOE waive this sunset clause, or extend it to 2025 to qualify projects beginning development under a new incentive structure.

Developers working within the 2005-2015 qualification window were then hesitant to operate under the assumption that authorization of the program would continue past its expiration in 2016. While appropriations have been extended until 2025, NPD projects, as demonstrated in this study, have permitting and construction timelines regularly in excess of ten years. For developers to consider Section 242 payments as a likelihood upon project completion, Congress should appropriate funds until at least 2035. The number of applicants receiving funding under the program is likely to decline over the next five to ten years as early adopters maximize their benefits. With fewer applicants, long-term appropriations may be more lucrative on a per-kWh basis, as a smaller pool of developers shares the fixed appropriations.

A longstanding policy plank of the hydropower industry has been the call for full recognition under the Production Tax Credit. As hydropower is only extended half of the benefit solar and wind producers receive, the industry with the highest capital costs receives the least tax relief. Congress should further seek to renew an ARRA provision - cash grants and Investment Tax Credit refundability - to generate cash flow early in project life cycles when accelerated depreciation schedules reduce taxable investment.

Congress should further seek to expand and develop existing renewable energy programs for NPD development. The Department of Energy currently offers low-interest loans through its Title 17 program, a fund that has lent to a number of solar, wind, advanced nuclear and geothermal projects. Title 17 has not publicized its financing of hydropower or NPD programs to date; explicit extensions of long-term loans may spark interest and uptake from the industry. DOE should model its hydropower loan criteria around a low-rate, long-term schedule to empower hydroprojects bearing long project runways.

Federal agencies may further encourage the development of NPDs through direct power purchase. Hydropower developers maintain their interest in selling output to corporate or institutional buyers; similarly, climate-minded lawmakers increasingly herald federal procurement as a vehicle for emissions reduction. Congress should direct agencies to explore the purchase of hydroelectric output from area NPDs. As rural power sales markets often feature few buyers, depressing potential premium rates for reliable, clean energy, federal agencies should seek to mitigate carbon emissions by directly purchasing NPD output at slightly above-market rates.

Trade and Tribulations

Congress and federal agencies have significant regulatory authority and discretion that may be optimised for hydropower development. As developers working on USACE dams unanimously reported regulatory delays and obstacles from the Corps, Congress should direct the Corps to undertake internal procedural changes for hydropower licensing approval. Interagency MOUs have consistently revealed their limitations, as decentralized districts have varied in the implementation of agreements forged at the top of the Corps' structure.

Congress should appropriate a small fund for the commissioning of a new panel of national hydropower experts. Lawmakers should direct the Corps to amend its internal regulatory processes to invite this body to participate in permitting and licensing traditionally handled at the local district level. This body will collaborate with districts, offering technical guidance and administrative support to lower levels of the organization structure. This new, permanent bureaucracy would enable the Corps to share responsibility of licensing reviews with technical experts from within the organization, accelerating dam safety, 401 and 404 reviews. With additional administrative support, the Corps could undertake simultaneous permit studies and reviews, drastically shortening the length post-license, pre-construction compliance. The Corps commission may also have the bandwidth to pre-screen NPDs that have received interest from private and public developers, further assessing hydroelectric viability and identifying glaring structural issues that may forbid hydropower development. In compiling information to be shared with developers, this body could assemble findings from past permits and licenses held on NPDs.

Finally, the US Trade Representative and the Department of Commerce should move to repeal recently levied tariffs, duties and non-tariff barriers to the importation of hydroelectric equipment. As tariffs on such equipment inflate project costs, ostensibly protecting a domestic manufacturing industry heavily integrated into transnational supply chains, the hydropower industry broadly stands to benefit from lower equipment costs. Similarly, the repeal of tariffs placed on raw materials, such as steel and aluminum, will lower costs across critical hydropower supply chains.

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