Business & Technology Report

June 2020

Small Hydropower Opportunities in Rural America

NRECA

America's Electric Cooperatives

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NRECA
America's Electric Cooperatives

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Contributions for this report were in part from participants at:

- The CEO Roundtable on Small Hydropower held on January 13, 2020 at the NRECA CEO Close-Up in Palm Springs, California.
- The Small and Micro Hydropower Workshop held on March 1, 2020 at the NRECA Annual Meeting/TechAdvantage® Conference in New Orleans, Louisiana.

We would like to thank these industry stakeholders for sharing their experiences and ideas.

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Introduction

Small hydropower refers to hydropower systems less than 10 MW, or less than 40 MW if built in conduit, as they qualify for the Federal Energy Regulatory Commission (FERC) hydropower license exemptions[1]. These systems could be connected directly to the distribution grid or on the customer side of the meter. Currently, small hydropower may be an untapped resource in rural America. Analysis by NRECA suggests there are currently 218 non-powered dams located in co-op service areas (Figure 1), and 517 electric co-ops with additional untapped stream potential. Beyond traditional deployments, there are substantial opportunities to integrate hydropower with other cooperative and community assets.

This report explores the substantial opportunities for electric cooperatives, irrigation districts, municipal water systems, developers, and other rural stakeholders to derive value from small hydropower. However, barriers exist, including: lack of awareness of small hydropower technology and value streams, high development costs as a result of customized technology designs, and lack of financial products tailored to small hydropower projects. These barriers can be overcome with successful collaboration between NRECA, its member electric cooperatives, the U.S. Department of Energy (DOE), small hydropower solution providers, municipal entities, irrigation districts, and other rural stakeholders.

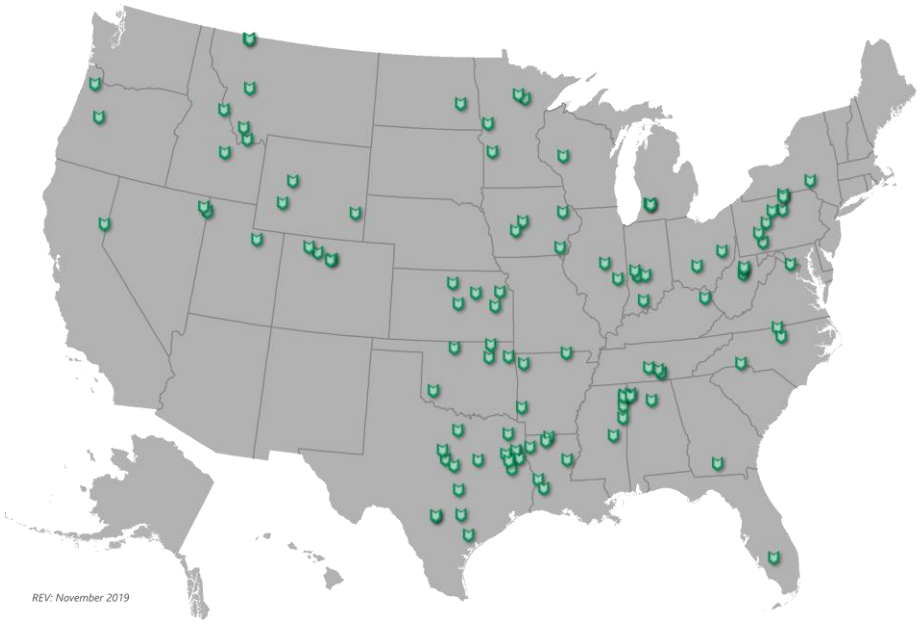

Figure 1: Non-powered Dams in Co-op Territories

[1] https://www.ferc.gov/industries/hydropower/gen-info/licensing/exemptions.asp

NRECA represents more than 900 rural electric utilities responsible for keeping the lights on for more than 42 million people across 48 states. America's Electric Cooperatives serve 56 percent of the nation's landmass, 88 percent of all counties, and 12 percent of the nation's electric customers, while accounting for approximately 11 percent of all electric energy sold in the United States.

As democratically governed and not-for-profit businesses, cooperatives are a unique segment of the energy industry. Electric cooperatives have a rich tradition of harnessing the power of water resources. Currently, 10 percent of the electric cooperative retail fuel mix comes from hydropower resources.

The U.S. Department of Energy's (DOE's) Water Power Technologies Office (WPTO) sought to understand how the office can best support rural electric utilities with evaluating and integrating small hydropower systems. As a result, NRECA held two events with electric cooperative leaders to discuss the challenges and opportunities of small hydropower. The first event was a roundtable discussion with electric cooperative CEOs, NRECA staff, a representative from the National Hydropower Association, and a small hydropower development company. The second was an in-depth workshop at NRECA's Annual Meeting/TechAdvantage Conference. This meeting brought together invited representatives from the U.S. government, national laboratories, financial lenders, and electric cooperatives from around the country. Both events created a platform for electric cooperative leaders to share information about their unique needs, challenges, and experiences with small hydropower, particularly in rural areas.

The goals of the co-op events were to develop an understanding of:

1) opportunities and challenges rural electric utilities face regarding small hydropower resources,
2) research and development (R&D) pathways that could enable small hydropower to be more valuable for electric cooperatives, and
3) improvements that DOE WPTO, in partnership with electric cooperatives and stakeholders, could make to the deployment process of small hydropower.

This report captures key challenges, opportunities, and possible federal government R&D activities identified by the stakeholder participants at the CEO Roundtable and Workshop.

CEO Roundtable and Workshop Formats

The CEO roundtable and the subsequent workshop were designed to build off each other. The CEO roundtable was intended to spur new thinking amongst electric cooperative CEOs and gain a baseline understanding of how electric cooperatives view small hydropower resources. The workshop was a longer event that provided educational presentations from DOE WPTO and an open discussion of the intricacies of hydropower deployments and the challenges and opportunities for electric cooperatives.

The CEO roundtable included roughly 30 electric cooperative CEOs, NRECA staff, a representative from the National Hydropower Association and a small hydropower development company. The workshop at the NRECA Annual Meeting/TechAdvantage Conference included technical and analytical presentations from DOE WPTO and the Pacific Northwest National Laboratory (PNNL), as well as a facilitated round table discussion between DOE WPTO, PNNL, Idaho National Laboratory, NRECA, and the electric cooperatives. See Table 1 for a participant listing.

Table 1: CEO Roundtable and Workshop Participants

Participant Type	Participants
U.S. Government	U.S Department of Energy Water Power Technologies Office
National Laboratories	Idaho National Laboratory Pacific Northwest National Laboratory
Electric Cooperatives	40 (see Appendix C for list of participants)
National Associations	National Rural Electric Cooperative Association, National Hydropower Association
Hydropower Industry	NLine Energy
Financial Community	National Rural Utilities Cooperative Finance Corporation

Participants at both events were asked to provide individual feedback based on their own experiences, not to seek consensus. Through these discussions and exercises, participants provided feedback in three basic categories:

1) **Key challenges** related to small hydropower development in electric cooperative systems and communities;
2) **Key opportunities** to ease development; and
3) **Federal government R&D solutions** for DOE WPTO to consider as related to supporting electric cooperatives and communities with evaluating, optimizing and integrating small hydropower resources.

Key Takeaways

Key takeaways arrived at during the CEO Roundtable and the Workshop, representing the individual feedback of participants, include the following:

- **Multiple constituencies could stand to benefit from small hydropower projects.**

  Within the electric cooperative sector, benefits should always accrue, to the extent possible, to:

  a) electric cooperative consumer-members,

  b) electric distribution cooperatives, and

  c) electric generation and transmission cooperatives.

  Electric cooperatives are integral to their local communities. These local communities could benefit from increased economic activity and job creation potential. Local communities and technology providers could benefit from the opportunity to improve operational efficiencies and develop new solutions that reduce electricity bills for consumers. Beyond the electric cooperative community, collaboration between electric cooperatives and the DOE offers the possibility of technology transfer to other segments of the electric utility sector, agriculture sector, municipal water systems, and beyond. In short, small hydropower has the potential to not only benefit electric cooperatives, but also their local communities, technology companies, the entire electric utility sector, as well as municipal entities and agriculture operations.

- **An expanded NRECA-led small hydropower program would be beneficial**.

  There are several gaps that exist in the small hydropower market in rural areas. First, there is a general lack of awareness of the potential use cases and technology among electric cooperatives. Second, small hydropower technology is highly customized, which increases costs relative to other resource options. Finally, there are no financial products specifically tailored to monetize the value of small hydropower.

  The intended NRECA-led program would address these educational, technical and financial gaps, in order to reduce the barriers to small hydropower deployment in rural areas. This program could include, among other items:

  - **Hydropower information resources for co-ops** on topics such as use cases, value streams, general technical resources, standardized system designs, financial products, insurance, zoning and permitting, field manuals, and business plans. Resources and knowledge exchange forums for rural stakeholders could also be developed and include peer networks, communications toolkits, and online videos.

  - **Pilot/demonstration projects** at electric cooperatives and other rural stakeholders, in order to standardize and simplify technologies. NRECA would create toolkits and guidance documents for rural stakeholders based on the learnings from the demonstration projects. The focus of these projects would be on four use cases, including:
    - irrigation canals/ditches
    - municipal water systems
    - streams
  - **Development of financial products** with electric cooperative financial institutions.

- **Partnerships with irrigations districts and municipal entities** can yield multiple benefits. There are a number of under-utilized assets, such as water delivery conduits, drainage ditches, water treatment facilities, and water towers, that could be ripe for a hydropower asset.

- **Hybrid hydropower-energy storage projects** could unlock additional value for electric cooperatives and the consumer-members they serve.

- **Education and outreach on small hydropower resources** are needed, including providing information about new technologies and business models.

Discussion Items

In addition to the primary challenges listed earlier, additional key challenges, opportunities, and research and development (R&D) issues were brought up at the CEO Roundtable and the resulting Workshop.

Key Challenges

- **Education/Information/Perception** – Many co-ops are not aware of the potential for small hydropower resources in their territories. They also may not be aware of the new technologies that have made small hydropower more feasible to build and operate. More educational resources – such as pamphlets, webinars, white papers, workshops, and others – are needed to inform and educate utility resource planners and decision makers.

- **Financial/Cost/Economics** – The upfront costs to build and develop hydropower resources can be high, and partnerships with government entities, municipal systems and universities can help defray expenses. In addition, with low kWh energy prices (natural gas and solar), it is hard for hydropower to compete. Value stacking, (i.e., with storage, ancillary services) could make small hydropower more compelling.

- **Legal/Contractual/Policy** – Smaller organizations may not have the resources to identify and research local policy, legal implications, and contractual obligations of developing hydropower resources in their community. There may be policies in place that are prohibitive or that favor other types of resources over hydropower. These policies will vary by locale.

- **Interconnection/Zoning/Permitting** – These activities take time and resources that many smaller co-ops may lack. Guidance documents tailored to small hydropower development could ease some of this burden.

- **Use Case/Value Case** – Use cases for small hydropower are needed to develop and define goals for implementation. What are these systems capable of, and what other impacts could developing these resources have (societal, environmental)? Use cases and pilots could also provide additional information about different value streams that small hydropower resources can deliver. These use cases need to be documented and distributed to decision makers and stakeholders. This will require resources and a concerted effort amongst key stakeholders.

- **Business Case Questions** – The use and value cases can be used to develop compelling business cases for co-ops and communities. They can help local businesses and stakeholders decide if developing small hydropower assets will benefit their community and provide guidance about how to start planning. As part of the

business case, cost and benefits and the complexity of small hydropower vs. other resource alternatives will need to be considered.

Key Opportunities

- **Education/Information** – Co-ops can leverage the DOE and the NRECA network to provide education resources for other co-ops, technology providers, utilities (electric and water) and government entities.

- **Leadership** – Many co-ops are in areas that are ripe for small hydropower development. Since many co-ops are not regulated and can be more agile once a decision is made, embarking on a small hydropower project is an excellent opportunity to lead the industry in small hydropower development.

- **Deployment** (funding from federal government)
    - Small waterways
    - Value stacking (resiliency, energy storage, grid services, broadband)
    - Moving from customized to standardized solutions

- **Coordination/Partnership** with local entities (irrigation districts, municipal entities), large corporate buyers, developers, universities and college campuses.

Federal Government R&D Solutions

Federal Government could play a key role, including:

- Funding and support for an NRECA-led program for small hydropower
- Technical assistance from DOE's national laboratories

Conclusion

Opportunities exist for small hydropower to provide significant value to several stakeholders, including:

a) electric cooperative consumer-members,

b) electric distribution cooperatives,

c) electric generation and transmission cooperatives,

d) small hydropower developers,

d) municipal entities, and

e) irrigation districts.

There is significant potential for hydropower deployments to add value to existing rural assets when electric cooperatives partner with local entities. Achieving these wins may necessitate visionary leadership from the DOE, NRECA, strategic deployments, improved education and outreach, and increased coordination and partnerships.

NRECA is interested in exploring work with their members and the DOE to support opportunities for small hydropower. NRECA has significant experience in managing and leading similar DOE-funded programs that focus on education/outreach and driving down costs through effective technology development and deployment. Some of these successful projects include SUNDA, RC3[2], and the Smart Grid Demonstration Project[3]. The SUNDA program helped lower the barriers to entry for co-ops interested in owning and deploying solar PV projects. Tools and resources were developed to help co-ops, and peer-to-peer networks were established to foster mutual learning. The RC3 program is focused on developing tools and resources for improving cybersecurity capabilities of electric cooperatives, as well as providing collaboration, education and training opportunities. Finally, the $68 million Smart Grid Demonstration Project allowed participating co-ops to implement smart grid technologies, learn how to use them effectively, and to share best practices and lessons learned with the rest of the co-op family.

The CEO Roundtable and Workshop with electric cooperative leaders represent the first step in forming a partnership of stakeholders to work together toward ways to enable greater value from small hydropower for rural electric utilities in the form of clean energy, renewable energy integration, resiliency, economic development, and community and industry leadership.

[2] RC3 Program: https://www.cooperative.com/programs-services/bts/rc3/Pages/default.aspx
[3] Smart Grid Demonstration Project: https://www.cooperative.com/programs-services/bts/smart-grid/Pages/default.aspx

Appendix A – Workshop Agendas

Agenda for CEO Close-Up Roundtable:

1. Introductions:

   Go around the room, brief description of each co-op, experience (if any) with hydropower, awareness of opportunities within the co-op's service territory, etc.

2. Informal presentation/discussion from DOE/Matt Swindle on hydropower innovations

3. Discussion with co-ops regarding potential, degree of interest, opportunities/challenges

Agenda for NRECA Annual Meeting/TechAdvantage Pre-Conference Workshop:

I. Introduction of Topics and Speakers
   a. Jan Ahlen, NRECA
   b. Allison Hamilton, NRECA
   c. Paul Breakman, NRECA
   d. Maria Kanevsky, NRECA
   e. Patti Metro, NRECA
   f. Marisol Bonnet - Department of Energy
   g. Miles Hall - Department of Energy
   h. Madden Sciubba - Department of Energy
   i. TJ Heibel – Pacific NorthWest National Laboratory (PNNL)
   j. Shiloh Elliott – Idaho National Laboratory (INL)

II. Overview of Small Hydropower Opportunities and Benefits – DOE / PNNL

III. New and emerging technology presentations DOE / PNNL

IV. Roundtable Discussion with co-op representatives

Appendix B – Workshop Participants

NRECA CEO Close-Up Participants

Thomas	Walch	Grand Valley Rural Power Lines, Inc.	CO
Stephanie	Horst	Bon Homme Yankton Electric Assn. Inc.	SD
Libby	Calnon	Hood River Electric Cooperative	OR
Edward	Gerak	Ak-Chin Energy Services	AZ
Devin	Brundage	Central Nebraska Public Power	NE
Roman	Gillen	Consumers Power, Inc.	OR
Richard	Lemonds	South Central Power Co.	OH
Lynn	Thompson	Consolidated Electric Co-op	MO
Kerry	Kelton	Mid-South Synergy	TX
Timothy	Lindahl	Wheat Belt PPD	NE
Alan	Michalewicz	White River Electric Assn., Inc.	CO
Kevin	Owens	Beartooth Electric Cooperative, Inc.	MT
Jasen	Bronec	Delta-Montrose Electric Assn.	CO
Scott	Odegard	Sun River Electric Cooperative, Inc.	MT
Jeffrey	Wadsworth	Poudre Valley REA, Inc.	CO
George	Weaver	Central Georgia EMC	GA
Benjamin	Thomason	Central Georgia EMC	GA
Bryan	Hannegan	Holy Cross Energy	CO
Kristin	Dolan	Runestone Electric Association	MN
Kathleen	O'Brien	Nemaha-Marshall Electric Cooperative Assn., Inc.	KS
Gary	Wood	Central Virginia Electric Cooperative	VA
Loren	Howard	San Luis Valley REC, Inc.	CO
Kory	Johnson	Agralite EC	MN
Ted	Case	Oregon ECA	OR

NRECA Annual Meeting / TechAdvantage Pre-Conference Workshop

Amy	Grice	Peninsula Light Co	WA
Brad	Bauman	Sun River Electric	MO
Peter	Muhoro	NRUCFC	VA
Derrick	Dean	Jackson Electric	KY
Carol	Wright	Jackson Electric	KY
Troy	Morris	Mid-South Electric	TX
Jeff	Pratt	Greenpower EMC	GA

Appendix C – Summary of Meeting Notes

CEO Close-Up Small Hydropower Notes: 01-13-2020

Matt Swindle presentation:

- History of hydropower power
- Bellwether technologies
- Case Study - market drivers

(History - moving water; then turbines; then bulk hydropower like the big dams, Grand Coulee & Hoover; then PURPA, QF - smaller mid-size hydropower up to 30MW)

Mill Creek hydropower — in continuous operation since 1893;

Niagara Falls - originally completely dammed up, prize offered for longline transmission

Modern electric grid started with hydropower - the Niagara Falls line to Buffalo

Classification:

- dammed rivers, usually big or little; FERC license required
- DOE study identified ~ 80,000 Non-powered dams, ~ 5000 are developable, ~ 50 GW potential- a lot in co-op service territories
- "Run of River" - challenge is the water rights & environmental impact; low head, 400 - 450 cubic feet per second (CFS); new turbine is safer for fish, flatter and fatter blades — testing result - 100% safe fish passage
- 10MW or less, exemption
- run of river
- HREA (hydropower regulatory efficiency act of 2013)
- QCF (qualified conduit facility) - 30 day process (see below)
- "Qualifying conduit facility" - pipelines, canals, flues - now exempt from FERC licensing as long as meet the 4 reqmts:
    - 40MW or less
    - Is it in a conduit
    - Is the water used for anything else
    - Is it licensed, never before

- 175 kw turbine at a CA water treatment - Sandhill-two pumps in reverse "Pumps as turbines" PATs
    - all this bill powers the water treatment plant, they haven't had a bill from SoCal Ed since 2013;
    - partnering with a municipality
- Once you put hydropower in, if well maintained will last 3 - 4 generations; long-term investment
- Conduit hydropower as an efficient play b/c recovering waste energy
- Typical payback, 15 years or less
- 18 by 16ft powerhouse - as much power as a 5-acre solar array; works 24 hours
- DOE "enticement" - 1.8 cents per kWh, DOE sec 242 credit
    - Hydropower included in 30% ITC in last year's tax extender bill
    - can be used to retrofit or upgrade existing
    - cannot be applied to new development
- Hydropower - the lowest levelized cost of energy of all resources; resiliency - hydropower can provide black start resource;
- Hydropower puts VARS on the system - voltage support; unlike solar & wind
- Farmers Conservation Alliance - irrigation modernization strategy in Oregon; new fish screens, pipe all the canal, add hydropower, provide farmers with pressurized water
- Irrigation district easements - water districts; ask them if they've done an assessment of hydropower potential; would co-op consider being a partner?

Benefits/Opportunities Identified During Discussion:

- DOE study identified 80,000 non-powered dams (5,000 developable), many in co-op territories
- Hydropower Regulatory Efficiency Act (HREA) of 2013 eases permitting/licensing processes for small hydropower conduits that qualify
- DOE offers 1.8 cents per kWh credit per DOE section 242

- Long-term investment, well-maintained hydropower facilities can last 3 to 4 generations
- Safer (fish friendly) turbines have been developed
- Typical payback is about 15 years
- Hydropower is the lowest levelized cost of energy of all resources
- Can provide ancillary services – black start, voltage support
- Hydropower eligible for 30% ITC as part of tax extender
- Can be used for retrofit, upgrade or new development
- Less space required for small hydropower conduit (18 by 16ft powerhouse can provide as much power as 5 acres of solar, 24 hours)
- Low maintenance costs
- Potential partnerships with water districts, irrigation districts, municipal water systems that may be planning to put in their own generation behind the meter. Irrigation districts looking to modernize
- Co-locating small hydropower with energy storage could provide additional value

Barriers/Challenges Identified During Discussion:

- Low head flow (35 ft or less), need at least 18 ft
- Local irrigation district easements, need irrigation modernization (pressurized water, new fish screens, dredging canals, etc.)
- Difficult to capture value in some regions/markets, especially where power is cheap. Organized markets don't recognize flexibility of hydropower
- Some areas the water only runs hard a few months and need at least 5 months
- Need to be near distribution and transmission infrastructure
- Rates structures to support participation and value (i.e. peak shaving)
- Existing long-term power supply contracts
- Hydropower does not qualify for RPS in most states
- Flexibility, capacity, resiliency value not recognized
- Issues with the Forest Service and Bureau of Reclamation
- Difficult for distribution co-ops to take advantage of ancillary services
- Financing mechanisms – ITC and co-op access to tax free financing

Small Hydropower Pre-Conference Workshop Notes: 03-01-2020

Co-op #1

- Exploring the potential for a **water treatment system** in a city
- Great relationship with the city but **don't have the technical understanding of small hydropower** opportunities in order to go to city and suggest a project. Would risk relationship.

Co-op #2:

- Must keep the cost below the G&T to introduce a new energy project (PSC rule). There's no upfront cost to the co-op for the project, the responsibility lies on the company that's installing the project. The company is working with a tax equity investor and two colleges and using RECS to fund the project. Trying to get the project installed in the next couple of years.
    - New projects need to be **cost competitive**. Members don't want to pay more for their energy when there are cheaper options. **Funding opportunities are greatly important**, and if they can be used for **transmission or distribution lines**, to make improvements to the actual hydropower project.
    - Co-op role in small hydropower project: purchasing the power from them. Since it's accepted on their distribution facilities, the company that's doing it has to accept any changes in the costs. Co-op needed to factor in if the cost burden is on the co-op or the installing company. State chose the less risky option in the end.
    - Value: renewable energy project, **public relations** type of thing. They have other renewable energy projects too. Hoping the hydropower will increase up to 1.5-2 MW of total renewable energy for the co-op. Depends on the water flow, which depends on the season as well.

Co-op #3

- Trying to work with an **irrigation district** for 15 years; 8-8.5 cents is what need, paying 2-2.5 cents; it all turns into an economics problem. There are 8 irrigation districts in service territory. **Economics is main barrier**. DOE should fund projects to make them economical
    - Done two smaller 7.5MW projects that sell into the IOU; they like the revenue stream; they're paying them to update the distribution line but the planned hydropower project currently does not pencil out

- Looking into capacitors
    - One going in at national park

Co-op #4

- Have a certified run-of-river (ROR) facility; few old facilities that are getting repurposed; really hard to finance; ROR is 30-40% capacity factor, solar is the same and half the cost; **economics are the biggest factor**; would like to think about **value stacking; other values you can stack on top of generation** (process opportunities, local incentive to do work onsite; head to head competition with solar/wind isn't going to work for hydropower).
    - Lining up the canals could save water; however, **sometimes the wells dry up** so that's a problem
    - **Pressurized systems** would not be good for the utility

Co-op #5

- Zero hydropower really, one small facility for peaking but that's about it; **economics** again make it hard especially with natural gas

Co-op #6

- Exploring using some of the **small waterways** in service territory
- Reliability is king for local IOU and **we need help on reliability**; transmission-based outages are the biggest issue; small scale generation could be helpful, they have some solar; community solar sold out in a couple hours, **incentive** for them isn't necessarily all about cost but the idea for **membership supporting the environment**
    - **Tidal generation** could be a potential solution
    - **Water towers** and pumped storage hydropower are something they'd like to see some studies on. If a water tower is being built, why not put in turbine?

Co-op #7

- Lots of discussion on reliability; **hybrid systems have potential** for reliability, microgrids, easier to look at the bankability when there's a couple of different technologies at the table
- **Access to water is the key to where houses are being built**; Co-ops can partner with cities to find solutions to increase growth; aging infrastructure will play in increasing role
- **Value stack**-add broadband at same time when installing hydropower in ditch

Co-op Participant resource needs in the future:

- Natural gas feeling pressure from carbon mitigation groups
- **With small hydropower, it's so customized it's hard for it to pencil; low head opportunities could be doable if there was outside support;** microgrid is where it's going
- Rocky Mountain facility; great for grid management, could not imagine building it today; if we can find storage like that, we would take it; hard to know how to plan for future energy needs
- SUNDA project by NRECA — utility scale solar, effort to reduce soft costs. Potential for repeat with small hydropower?
- Really only storage option is LI-ION, short duration, looking at other options as we will need longer duration
    - 4-6 hours isn't good enough; pumped storage hydropower is great except for the up-front cost and environmental issues; can't put all eggs in one basket
    - PNNL has tool that compares storage costs
- **Educational materials** could be helpful; everyone wants cheap, reliable power and many co-ops are unaware of the what else there is beyond their traditional power mix
- **Large corporate buyers** — they will spend money in the name of CSR even if it's not economical; **greenfield sites** could be done at these campuses. Look for opportunities of **when new things are being built and if you can add value –** add broadband to a ditch, turbine to new water tower, small hydropower to new subdivision, etc.
    - (Cooling for) data centers could be one value stacking item of consideration
- Need to keep disseminating unbiased information on the economics of projects
- **Technical assistance** could be really valuable; co-ops don't know about it
    - **Communications** materials that can be handed to constituents
    - **Permitting** easement is necessary
    - Need some **real-life examples** of conduit projects that are getting built, some case studies; need a deeper dive with success stories into why this project worked
- Feedback
    - More **case studies** would be helpful
    - **Links to useful reports** would be helpful
    - Have **TechAdvantage show off some technologies**
    - Small co-ops don't have resources to write grants