Barriers and Opportunities for Distributed Energy Resources in Minnesota's Municipal Utilities and Electric Cooperatives

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All errors are our own.

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ABBREVIATIONS AND ACRONYMS

APPA	American Public Power Association
CIP	Conservation Improvement Program
CMPAS	Central Municipal Power Agency/Services
Co-op	Cooperative Utility
CSS	Community-shared solar
DERs	Distributed energy resources
DG	Distributed generation
DOC	(Minnesota) Department of Commerce
EIA	U.S. Energy Information Administration
EV	Electric Vehicle
G&T	Generation and transmission (cooperative utility)
GRE	Great River Energy
IOU	Investor-owned utility
JAA	Joint action agency
kW, kWh	kilowatt, kilowatt-hour
LED	light-emitting diode
MISO	Midcontinent Independent System Operator
MMPA	Minnesota Municipal Power Agency
MMUA	Minnesota Municipal Utility Association
MREA	Minnesota Rural Electricity Association
Muni	Municipal Utility
MW	megawatt (1MW = 1,000 kW)
NMPA	Northern Municipal Power Agency
NRECA	National Rural Electric Cooperative Association
PUC	(Minnesota) Public Utilities Commission
PV	Photovoltaic solar power
RPS	Renewable portfolio standard
RPU	Rochester Public Utilities
SMEC	Southern Minnesota Energy Cooperative
SMMPA	Southern Minnesota Municipal Power Agency
WAPA	Western Area Power Administration

EXECUTIVE SUMMARY

Minnesota has a complex electricity system, with more than 170 electric utilities, the third highest total of any state in the country. Minnesota has taken numerous steps in the past decade to become more efficient and better able to incorporate more renewable resources. While investor-owned utilities have received significant policy attention, the vast majority of the state's land-area and over one-third of the state's electricity is delivered by nonprofit, locally controlled utilities: **municipal utilities** (munis) and **rural electric cooperatives** (co-ops).

This report summarizes our findings from a two-year research project to investigate the landscape of Minnesota's munis and co-ops. Our focus is on how these utilities are confronting new challenges and opportunities emerging from smaller-scale, often-more sustainable **distributed energy resources** (DERs), such as rooftop solar, community shared solar, LED light bulbs, controllable water heaters, and electric vehicles. Because munis and co-ops were built to serve their communities through participatory governance and local authority, they make decisions in fundamentally different ways than for-profit utilities. These decisions matter in the context of emerging technologies as actors across the state aim to create a fair and sustainable energy system for all members of the public.

As Minnesota's energy system continues to evolve to meet new societal needs and incorporate new technologies, it is critical for local and state decision makers to understand the opportunities and challenges faced by munis and co-ops. Our project involves data analysis that paints a comprehensive picture of the electricity landscape in Minnesota's munis and co-ops and interviews with over 50 executives from utilities across the state. This report aims to provide context for local and state decision makers, enabling them to respond to new internal and external pressures to find ways forward that best align with muni and co-op organizational goals, while also negotiating the possibilities for a more sustainable, fair, and empowering energy system.

Munis and co-ops were established over the past century to provide affordable and reliable electricity to Minnesota residents. In fact, many of these utilities (particularly co-ops) have their origin in the New Deal and the Progressive Era and are responsible for having brought the first electricity access to rural areas to support economic development and rural life.

Understanding the history of munis and co-ops utilities helps explain how they make decisions which guide today's operations. It also highlights the opportunities and constraints of their decision making. Generally, munis and co-ops are smaller than investor-owned utilities, and as power generation was increasingly deployed by larger, more centralized fossil fuel power plants decades ago, munis and co-ops had to work together to benefit from economies of scale. This led to a number of decisions that reduced costs for customers/members while ensuring reliability—for example by creating joint action agencies and generation and transmission cooperatives that collectively invest and procure large amounts of generation. However, these same decisions, optimized for lowering cost and improving reliability in a different technological era, have left a legacy of institutional and contractual relationships that are constraining some opportunities today.

In the past decade, as DERs have become more economic, munis and co-ops have approached DERs in different ways than investor owned utilities. Across munis and co-ops, there is a wide diversity of responses to DERs. New pressures on electric utilities are highlighting existing differences. The large variation across Minnesota's 125 munis and 45 co-ops is driven by where they are located, whether or not their load and revenues are increasing or decreasing, from which organizations—and under what contractual restrictions—they purchase power, the degree to which they have already invested in DERs, their internal staff capacity and resources, and local demand for cleaner forms of energy, among other factors.

A key theme of our research, explored in Section 3, is that the diversity of muni and co-op decision-making approaches for DERs can be helpfully characterized by four "**implementation strategies**," summarized in Figure ES.1. The implementation strategies framework provides a taxonomy for understanding the approaches munis and co-ops are deploying to manage the opportunities and challenges of DERs. Recognizing differences in implementation strategies suggests the need for a diversity of engagement strategies to facilitate learning across utilities, building on the muni and co-op tradition of cooperation that bridges, but acknowledges, differences in individual local contexts.

A second key theme of our research, explored in Section 4, is that munis and co-ops hold a unique position to be important agents in **creating more sustainable, fair, and empowered local communities** through their engagement with DERs. This potential is being shaped by multiple factors; we highlight three: (1) the potential re-structuring of the relationships between distribution utilities and their generation and transmission providers, (2) engagement of distribution utilities with local policy goals through participatory governance, and (3) addressing fairness across a utility's customers/members and across distribution utilities that co-own generation resources.

FIGURE ES.1. **Four Implementation Strategies for Managing DERs**

The figure presents a taxonomy of "implementation strategies" utilized by municipal and cooperative utilities for managing the opportunities and challenges of distributed energy resources.

MONITORING AND PLANNING

An implementation strategy focused on monitoring changes in the industry, planning for the integration of DERs, and making strategic infrastructure investments in anticipation of future deployment. For example, several munis and co-ops explain their approach to DERs by discussing how higher levels of DER would require them to first upgrade their billing technology. Others emphasized the importance of deploying an outage management system, completing advanced metering infrastructure investments, or distribution system upgrades before taking on higher levels of distributed generation.

How utilities using this strategy negotiate competing interests:

- Prioritize community benefits
- Protect overall affordability and reliability

Policy and implementation implications:

- Policies or implementation assistance to mitigate costs or risks of new technologies
- Learning networks to share implementation practices and communication approaches

REINFORCING TRADITIONAL RELATIONSHIPS

An implementation strategy characterized by the view that generation is primarily the responsibility of the energy-service providers (i.e., either a JAA or G&T co-op). When developing new programs, these utilities may partner with their energy-service provider and rely on their more extensive administrative capacity and resources. Many of these munis and co-ops discuss their obligation to educate and protect customers/members in making decisions about distributed generation investments, safety considerations, the importance of maintaining reliability, and the distribution-utility business model.

How utilities using this strategy negotiate competing interests:

- Prioritize community benefits
- Protect overall affordability and reliability
- Active in local regulation
- Rely on existing energy-services and customer/member relationships

Policy and implementation implications:

- Policies and implementation assistance designed with consideration of existing third-party energy-service provider relationships
- Shared efforts to vet developers, educate consumers, and identify interconnection fees and procedures around rates to ensure safety, reliability, and a fair distribution of costs

COMMUNITY ENGAGEMENT AND LEARNING

An implementation strategy focused on efforts to engage customers/members in outreach around DERs and new programs. For example, these munis and co-ops describe how individuals, civil-society stakeholders, or local political actors have a commitment to clean energy. Others discuss the importance of attracting businesses and clean energy jobs, while some emphasize that their customers/members are motivated primarily by the tax benefits and net-metering reimbursements that are associated with customer-sited solar.

How utilities using this strategy negotiate competing interests:

- Enable individual interests
- Engagement to learn about and deliberate community interests to create new business and service models
- Reshaping the services and terms of contracts with energy-service providers

Policy and implementation implications:

- Remove barriers or enable new financing mechanisms
- Policy flexibility or assistance to enable community engagement

REDEFINING THE DISTRIBUTION UTILITY

An implementation strategy in which the distribution utility is leading new initiatives and taking more control over energy services. These utilities have customers/members that are interested in a 'cleaner grid,' and they are implementing solar offerings with a variety of different ownership and reimbursement schemes. These munis and co-ops are either skeptical of solar projects installed by their energy-service providers or seek flexibility in their energy-service contracts. Some of these munis and co-ops are investing in advanced metering infrastructure and pursuing new forms of demand management.

How utilities using this strategy negotiate competing interests:

- Prioritize community benefits
- Respond to varied community demands
- Actively create innovative new programs and business models to deliver services
- Negotiate increased flexibility or terminate existing service-provider contracts

Policy and implementation implications:

- Policies to enable renegotiation or buy-out from existing power supply contracts
- Policy flexibility or assistance to enable building networks to efficiently share communication and data management technology and to access wholesale markets

Five Key Takeaways

Munis and co-ops rely on a complex set of relationships to deliver services: energy service providers, other distribution utilities, consultants, nonprofits, and local and state agencies all have a role. DERs are disrupting these institutional relationships and the rules and practices that munis and co-ops have relied on for decades. DERs expand the "solution space" for munis and co-ops to create community benefit. But DERs also create a need for policy, cooperation, and assistance.

Policy and engagement efforts with munis and co-ops should target the appropriate scale for intervention, compliance, and participation—from the state-level, to the utility level (the generation and transmission level or the distribution level), to the customer/member or community level. The findings of our report inform a set of five key takeaways that can inform program design and policy options at these different scales (detailed in Section 5):

1. The diversity of munis and co-ops creates an opportunity for learning across utilities, experimentation, and more effective collaboration. The common shared principles of munis and co-ops can create common ground for exchanges even when implementation strategies vary.

2. Long-term power supply contracts present a constraint for many munis and co-ops. Understanding these constraints and potential for change may require technical assistance or other support.

3. As demographics and communication technologies continue to change, munis and co-ops are likely to see increasing pressure for information sharing, transparent decision making, structures for representation, and modes of participation.

4. DERs bring notions of fairness to the fore, and any internal or external intervention should engage with stakeholders to understand the realities and perceptions of fairness across scales (between customers/members, utilities, and wholesale market participants).

5. Many munis and co-ops face limits to their internal capacity and may require new financing, risk reduction, and joint ownership opportunities before taking a more active role in incorporating DERs to their utility system.

1. INTRODUCTION

Electricity system change is driven by new technology, environmental concerns, changing consumer preferences, and public policies. In the electricity sector, state-of-the-art communication and management technologies are now more prominent than they were, reduction of greenhouse gas emissions is a long-term goal for many, more intermittent generating resources are being adopted, and distributed generation and management technologies are creating new options for decentralized control and ownership.

Innovative technologies and programs at the "grid edge" are often referred to as distributed energy resources (DERs). DERs include distributed generation (DG), such as rooftop solar photovoltaic (PV) panels, community shared solar (CSS) projects, small-scale wind generation, small-scale geothermal generation, and customer-sited diesel generators or gas turbines. DERs also include demand-side innovations that reduce or shift electricity demand and industrial equipment or home appliances that a utility can remotely operate to reduce demand or enable system balancing.

Anticipation of DERs is changing how utilities and other stakeholders envision the future energy system. DERs enable energy consumers and distribution utilities to generate and more deliberately manage their energy, changing institutional relationships between distribution utilities, consumers, and power-suppliers in important ways. DERs also hold the potential to reduce greenhouse gases and provide other environmental benefits, improve resilience and system efficiency, create jobs, encourage economic development, and empower individuals and communities. But these benefits are not guaranteed, and integration of DERs into the electricity system has been uneven, especially among municipal utilities (munis) and electric cooperatives (co-ops). Munis and co-ops face different barriers and opportunities in deploying DERs than do investor-owned utilities (IOUs), due to differences in operating conditions, organizational structures, financial capacity, and their relationship with their customers/members[i] (see box 1).

Our research examines how munis and co-ops perceive the barriers and opportunities for DERs, and how their local experiences, circumstances, and vision of the electricity industry's future drive the way they interact with DERs. This report is focused on Minnesota, where munis and co-ops span a wide range of local circumstances that affect positions toward DERs: some Minnesota munis and co-ops have ambitious programs to support DERs, others express no interest in these technologies and have actively blocked projects or policies, and many more fall between these two extremes. While our work is contextualized in Minnesota's utility landscape, many of the opportunities and challenges we explore are relevant for utilities in other parts of the Midwest and nationally.

Munis and co-ops play a critical but under-recognized role in the changing national energy landscape. Understanding the factors shaping how these organizations are engaging with energy system transitions is important in crafting future energy policies and initiatives at the local, state, and federal levels.

Some Minnesota munis and co-ops have ambitious programs to support DERs, others express no interest in these technologies and have actively blocked projects or policies, and many more fall between these two extremes.

BOX 1

Box 1. What are munis and co-ops?

In the United States, electric power is provided by entities with different ownership structures that can be broadly grouped into three categories: (1) private investor-owned utilities (IOUs) and retail power marketers, (2) cooperative utilities (co-ops), and (3) government utilities, which include municipal utilities (munis).

Private utilities are financed by shareholder equity and bondholder debt and are subject to regulation by state and federal authorities. In contrast, munis and co-ops are consumer-owned and were created with an ideal of serving the public through participatory governance and local authority. Munis are owned and operated by local governments, as either a municipal department or governmental authority. Co-ops are member-owned non-profit organizations. In most states, munis and co-ops are not subject to state or federal rate regulation; instead, a local board determines rates. Munis and co-ops are also often exempt from many (but not all) state energy policies. Munis and co-ops share a common concern for community that is established through norms of democratic accountability and cooperative principles (see Section 2.3).

Nationally, IOUs and power marketers serve more than 70% of customers and account for a comparable fraction of electricity sales and revenues. Consumer-owned utilities, including government utilities and co-ops, collectively provide electricity to more than one-quarter of electricity customers and account for a similar fraction of total electricity sales and revenue (see Figure 1.1). Table 2.1 provides comparative organizational characteristics for munis, co-ops, and IOUs as relevant for Minnesota.

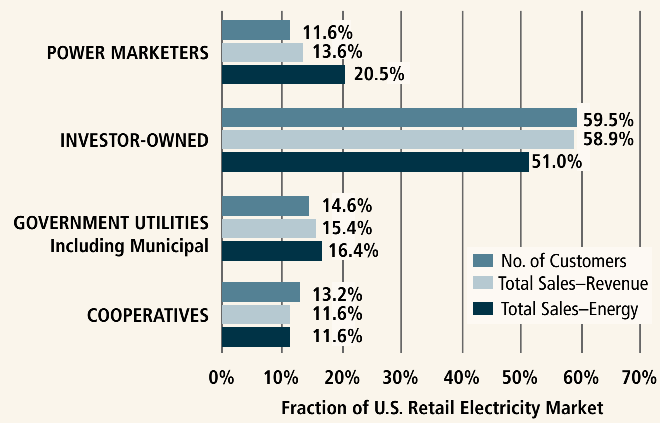


Figure 1.1 Landscape of Utilities in the United States by Ownership Type

Fraction of U.S. retail electricity market in 2017 by utility ownership type, disaggregated by fraction of total customers, fraction of total electricity revenue (i.e. sales in terms of monetary value), and fraction of total energy sales (i.e., sales in terms of megawatt-hours). Government utilities include municipal utilities, a focus of our study, along with public utility districts, and a relatively smaller share of federally and state-owned utilities. An additional 1% of U.S. customers, representing nearly 0.5% of total energy and sales, receive power from community choice aggregation or behind-the-meter generation and are not depicted. Data compiled from the U.S Energy Information Administration's forms EIA-861 and EIA-861S (EIA, 2018).

1.1. Report Structure

This report is built on analysis of publicly available datasets, document review, and interviews with over 50 Minnesota muni and co-op managers conducted from 2016–2018. Detail on our methodological approach is summarized in Appendix A and in two forthcoming academic articles.

Following the introduction, Section 2 provides background context on the experience of Minnesota's munis and co-ops with DERs. Section 3 introduces a taxonomy of implementation strategies to understand the diversity of approaches to managing DERs. This section applies the taxonomy to explore three prominent DER technology configurations: community-shared solar (Section 3.2), customer-sited renewables (Section 3.3), and load management/energy efficiency (Section 3.4). Section 4 synthesizes three of the large themes that guide how Minnesota munis and co-ops are considering their role in creating more sustainable, fair, and empowered local communities. This section discusses the constraints of long-term power supply contracts (Section 4.1), ways utilities engage with local policy through democratic local decision-making (Section 4.2), and conceptualizations of fairness and cross-subsidy within and across utilities (Section 4.3). Section 5 presents a set of takeaways from our analysis for local and state decision makers. Section 6 suggests directions for future research.

Throughout the report, we draw on analysis of third-party data and detailed coding and analysis of qualitative interview data. Our findings are illustrated in this report using quotes from Minnesota muni and co-op managers and longer vignettes. The presentation of interview quotes maintains the confidentiality of the interviewees, unless permission was obtained to use specific statements. Vignettes of specific utilities do not indicate that they participated in the study.

2. BACKGROUND

This section describes the context for Minnesota municipal and cooperative utilities and their current experience with distributed energy resources. Section 2.1 describes the Minnesota landscape of munis and co-ops and current patterns of change over the last five years. Section 2.2 provides background information on the deployment of DERs within Minnesota munis and co-ops. Section 2.3 introduces the principles and values of munis and co-ops, as described by national organizations of these types of utilities.

2.1. Minnesota Municipal and Cooperative Utility Landscape

In the United States, private IOUs and retail power marketers are a central feature of an increasingly complex electricity system. These utilities are financed by shareholder equity and bondholder debt and are subject to regulation by state and federal authorities. In contrast, munis and co-ops are consumer-owned and were created with an ideal of serving the public through participatory governance and local authority. Munis are owned and operated by local governments, as either a municipal department or governmental authority. Co-ops are member-owned nonprofit organizations. In most states, munis and co-ops are not subject to state or federal rate regulation; instead, a local board determines rates. Munis and co-ops are often exempt from many (but not all) state energy policies. Finally, munis and co-ops share a common concern for community that is established through norms of democratic accountability and cooperative principles (see Section 2.3).

While many munis and some co-ops own some generation units (referred to as "self-generation"), munis and co-ops are primarily distribution utilities that obtain generation and transmission services through contractual relationships with municipal marketing authorities (referred to as "joint action agencies" or "JAAs" in Minnesota), generation and transmission co-ops (G&Ts or G&T co-ops), or federal power marketing administrations. Historically, these contracts included "all-requirements provisions," which restrict local utilities from procuring power from alternative generation providers and typically set limits on self-generation (see Section 4.1).

In Minnesota, about half of the munis are governed by a city council and half are governed by a local utility commission appointed by the mayor. In contrast, Minnesota's co-ops are governed by locally elected boards[ii]. Additionally, the munis and co-ops in Minnesota are subject to some state clean energy policies. These policies generally include distinct standards and implementation requirements for munis and co-ops to differentiate them from IOUs. The most prominent of these policies are the Conservation Improvement Program (CIP), Minnesota's mandatory energy efficiency resource standard that has been in place since 2007; a renewable portfolio standards (RPS); and mandatory net energy metering provisions (North Carolina Clean Energy Technology Center, 2018). Table 2.1 below provides a high-level summary of the distinguishing characteristics of munis, co-ops, and IOUs. For a detailed overview of DERs (including their policy landscape and financial hurdles), see the interim report prepared under this same grant, summarized in Appendix B and available upon request (Mullins et al., 2017).

In Minnesota, many more munis and co-ops are in operation than IOUs, but IOUs manage the majority of electricity sales (see Figure 2.1) and receive the most political and regulatory attention. By count, municipal utilities are more numerous in Minnesota. Minnesota also has the most municipal utilities of any other state beside Iowa (EIA, 2018) and the third-most total number of utilities of any state behind Iowa and Texas. Area-wise, co-ops are the most expansive, covering about 85 percent of Minnesota's land mass (see Figure 2.2 and MREA, 2018).

FIGURE 2.1.
Minnesota's Electric Utility Landscape

Shares of total customers/members served, revenue, energy sales, and number of retail utilities. Data compiled from the U.S. Energy Information Administration's forms EIA-861 and EIA-861S and the Minnesota Legislative Energy Commission (EIA, 2018; Minnesota Legislative Energy Commission, 2016).

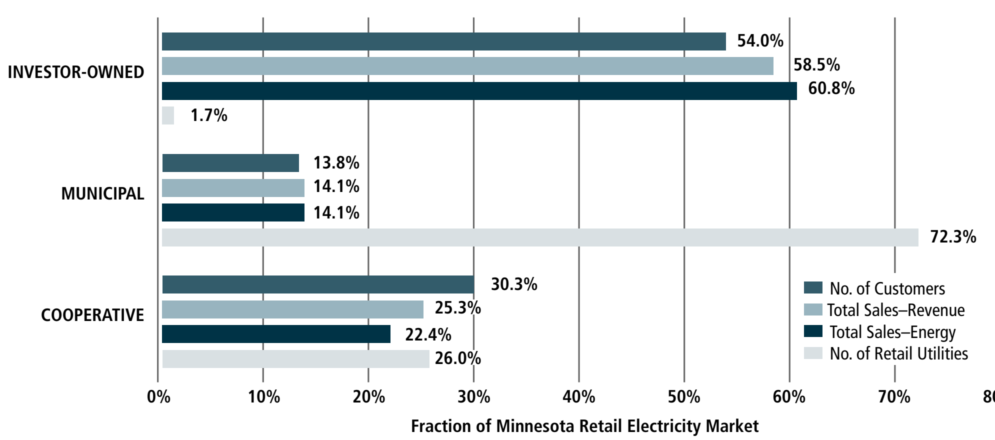


TABLE 2.1. **Minnesota Electric Utility Characteristics**

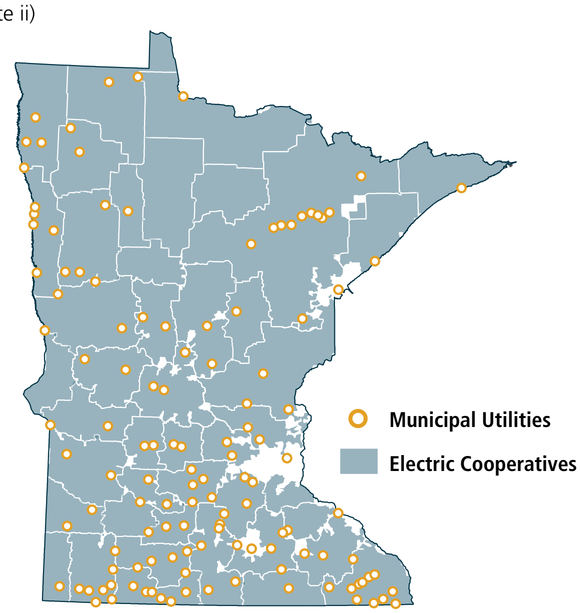
Minnesota's utilities are vertically-integrated and end-users do not have choice in their retail electricity service provider. This table describes key characteristics of municipal, cooperative, and investor-owned utilities in Minnesota, but characteristics vary in other states.

	MUNICIPAL	COOPERATIVE	INVESTOR-OWNED
Ownership	Public (municipality)	Consumer members	Shareholders
Tax status	Nonprofit	Nonprofit	For-profit
Utilities served	Electric and multiple other possiblities (e.g., water, sewer, gas, internet, phone, waste)	Electric with other possibilities (e.g., internet, gas)	Electric and gas
Rate regulation	City council or city utilities commission	Board of directors*	Minnesota Public Utilities Commission
Method of selecting regulators	Approx. half have elected councils; other half have commissions appointed by city government	Elected by members	Appointed by state governor
Funding	Tax-exempt bonds	USDA's Rural Utilities Service, CoBank, other private and federal entities	Shareholder equity, debt
Power sources	Joint action agencies (JAAs); sometimes own generation; sometimes investor-owned utilities, cooperatives, other municipal utilities, independent power producers, wholesale market (see Figure 4.3)	Generation and transmission cooperatives (G&Ts), rarely own generation, sometimes investor-owned utilities, independent power producers, wholesale market (see Figures 4.1 and 4.2)	Own generation, independent power producers, wholesale market
Origin date	1880s	1910s	1880s
Number of utilities in Minnesota offering retail electricity sales	125	45	3

* One cooperative is rate-regulated by the state Public Utilities Commission (see note ii)

FIGURE 2.2.
Minnesota Municipal and Cooperative Utility Service Area

There are 125 municipal utilities (orange points) and 45 cooperative utilities (blue areas) in Minnesota. These utilities cover the vast-majority of the state's land area and deliver over one-third of the state's electricity. Minnesota's three investor-owned utilities serve the remaining area (unshaded), which may also be unshaded because of lakes or other natural boundaries. Data compiled from Minnesota Geospatial Commons (2015).



Minnesota munis and co-ops are evolving. The majority of munis (72%) and co-ops (61%) have experienced decreased retail sales of electricity over 2013–2017 (see Figure 2.3). Yet over the same time period, 68% of munis and 98% of co-ops saw increasing revenue (see Figure 2.4). These patterns illustrate a trend toward increasing utility revenue per kWh of electricity sold, sometimes through larger fixed charges, indicating that the way utilities generate revenue is changing. Over the last five years, the majority of both munis (70%) and co-ops (93%) saw increases to their total number of customers/members (see Figure 2.5). Additionally, 40% of munis and 77% of co-ops saw increases to their peak demand, but both utility types showed significant heterogeneity in this dimension (see Figure 2.6). The figures below illustrate the breadth of conditions facing Minnesota's munis and co-ops. While sector averages show decreasing retail sales of energy and increasing revenue, these trends do not hold for all munis and co-ops. Changes to energy sales, revenue, number of customers, and peak demand help explain why munis and co-ops have different levels of internal capacity (e.g. staffing levels and ability to finance projects) and offer one view into why utilities are approaching DERs differently.

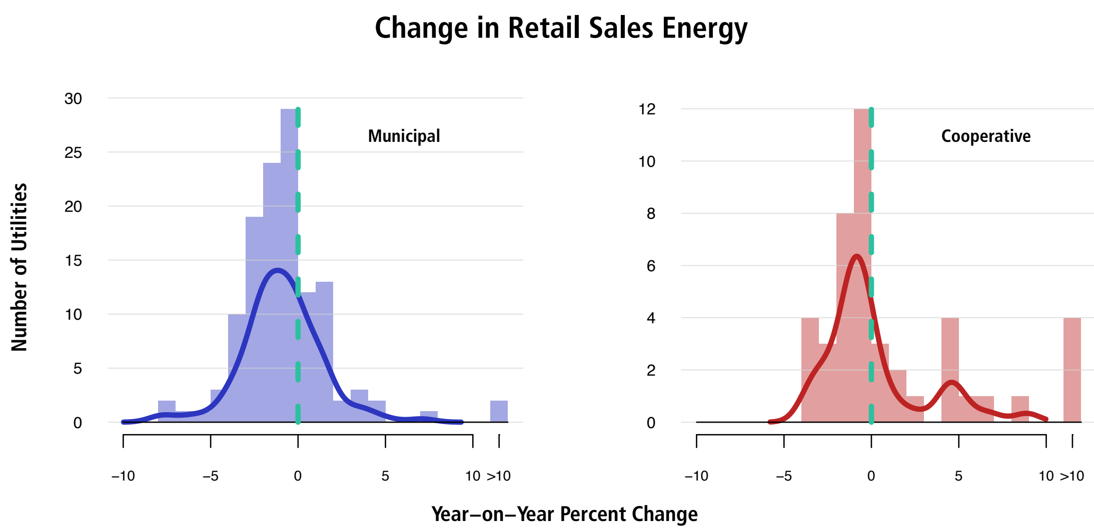


FIGURE 2.3.
Change in Utility Retail Sales

Average year-on-year percent change in Minnesota municipal and cooperative utility retail sales of energy for 2013–2017. Data compiled from U.S Energy Information Administration form EIA-861 (EIA, 2018).

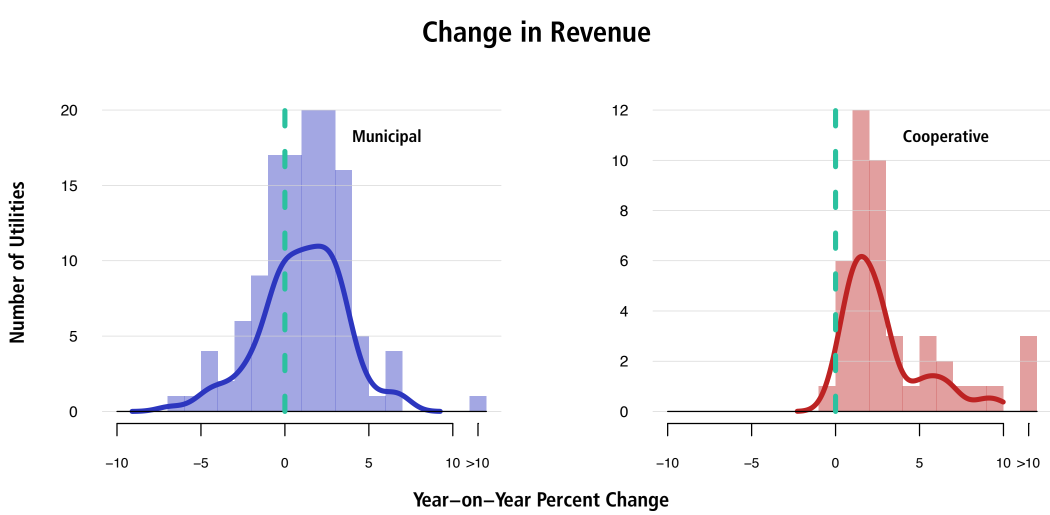


FIGURE 2.4.
Change in Utility Revenue

Average year-on-year percent change in Minnesota municipal and cooperative utility revenue for 2013–2017. Data compiled from U.S Energy Information Administration form EIA-861 (EIA, 2018).

FIGURE 2.5.
Change in Utility Customers/Members

Average year-on-year percent change in Minnesota municipal and cooperative utility customers/members for 2013–2017. Data compiled from U.S Energy Information Administration form EIA-861 (EIA, 2018).

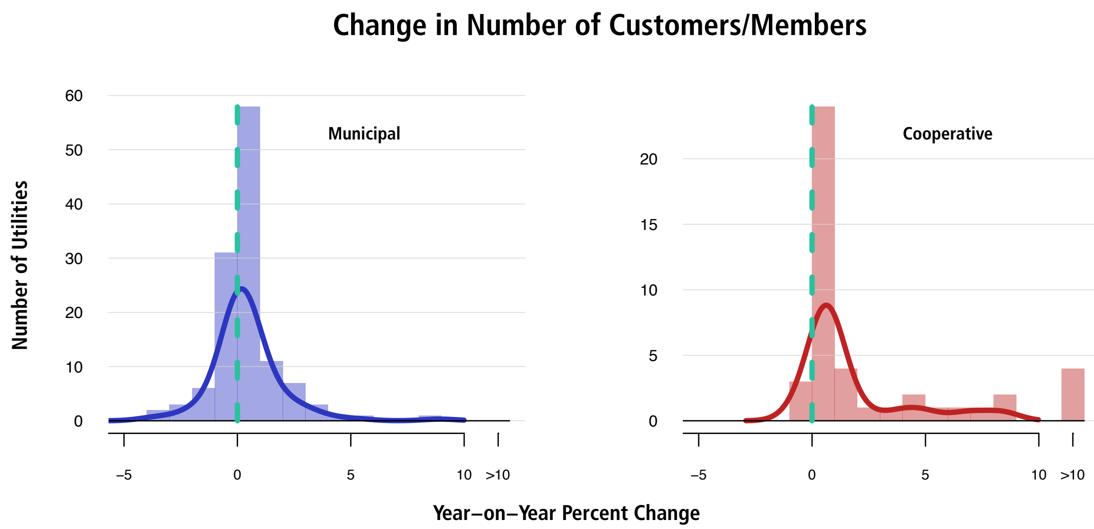
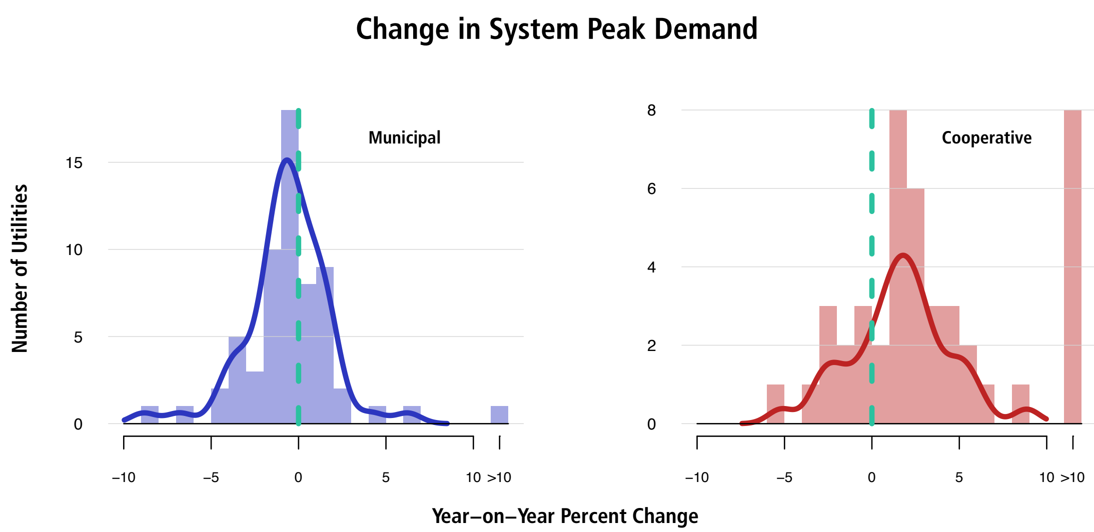


FIGURE 2.6.
Change in Utility Peak Demand

Average year-on-year percent change in Minnesota municipal and cooperative utility peak demand for 2013–2017. Data compiled from U.S Energy Information Administration form EIA-861 (EIA, 2018).



2.2. Distributed Energy Resources in Minnesota

There is no universally agreed-upon definition of DERs. The term generally refers to electricity generation technologies at the distribution-grid level but can also include non-generating technologies, such as energy storage, energy efficiency, and demand response. DERs can even include programs that affect customer/member behavior, such as time-of-use tariffs, which encourage peak shaving or load shifting (see Box 2).

BOX 2

Box 2. What are distributed energy resources?

There is no universally agreed upon definition of distributed energy resources (DERs). The term generally refers to electricity generation technologies at the distribution-grid level, such as customer-sited solar and diesel distributed generators. DERs can also include non-generating technologies, such as energy storage, energy efficiency, and demand response, as well as programs that affect customer/member behavior, such as time-of-use tariffs which encourage peak shaving or load shifting (Schwartz et al., 2017; SEPA, 2016; Weinrub, 2017).

DERs are often framed as alternatives to centralized generation and are broadly characterized by relatively smaller scale, new ways of connecting to the grid, or being located close to consumption. Unlike traditional generation that connects to the system at the transmission level, DERs impact the electricity system at the distribution level, and therefore require different system-management considerations.

Some DERs have long been part of the electricity system, and distribution utilities have experience managing these resources. However, new renewable generation resources and technologies that reduce demand or facilitate system balancing have the potential to fundamentally alter the configuration of the electricity system.

DERs disrupt the conventional configuration of electricity systems in which power flows in a single direction from centralized generation, challenge the idea that centralized supply must always follow load, and fundamentally change the way grid operators and managers think about reliability (Perez-Arriaga, 2016; SEPA, 2016). For distribution utilities, DERs create new functions and raise new questions about the relationship of these utilities with their wholesale generation providers and their customers. For individuals and communities, DERs create new choices in how they manage their energy use and new opportunities to enhance self-reliance and local resilience (Fairchild and Weinrub, 2017).

2.2.1. Distributed Generation

Municipal and cooperative utilities have a long history of deploying DERs. This experience includes small generation (particularly diesel/petroleum and natural gas generation owned by distribution munis) and load management (see Section 2.2.2). Distributed solar and wind resources have been on the rise in many Minnesota utilities over the last decade; munis and co-ops are no exception. Figure 2.7 illustrates trends in cumulative capacity for distributed wind and solar installations at Minnesota's distribution munis and co-ops (not inclusive of generation deployed by G&Ts and JAAs). Figure 2.8 breaks out the solar component of the previous figure over a longer time period and by solar technology configuration categories.

Figure 2.7 shows the near tripling of wind and solar in Minnesota munis and co-ops between 2013–2017. Not shown in this figure is the relative breakdown of munis and co-ops within these totals. Distribution co-ops have installed more wind and solar than distribution munis: in 2017, 83% of the distributed solar capacity and 95% of the distributed wind capacity installed in Minnesota distribution munis and co-ops was installed in co-ops (MN PUC, 2018).

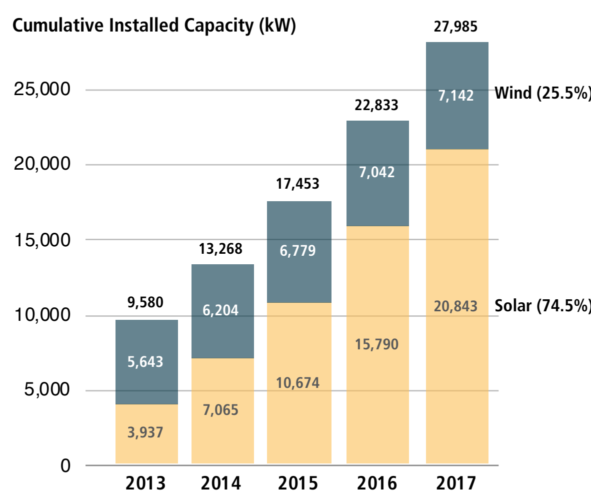


FIGURE 2.7.
Installed Wind and Solar in Minnesota Distribution Munis and Co-ops

Cumulative installed wind and solar in Minnesota distribution munis and co-ops (not inclusive of generation deployed by generation and transmission co-ops and joint action agencies). Data compiled from the Minnesota Public Utilities Commission (MN PUC, 2018).

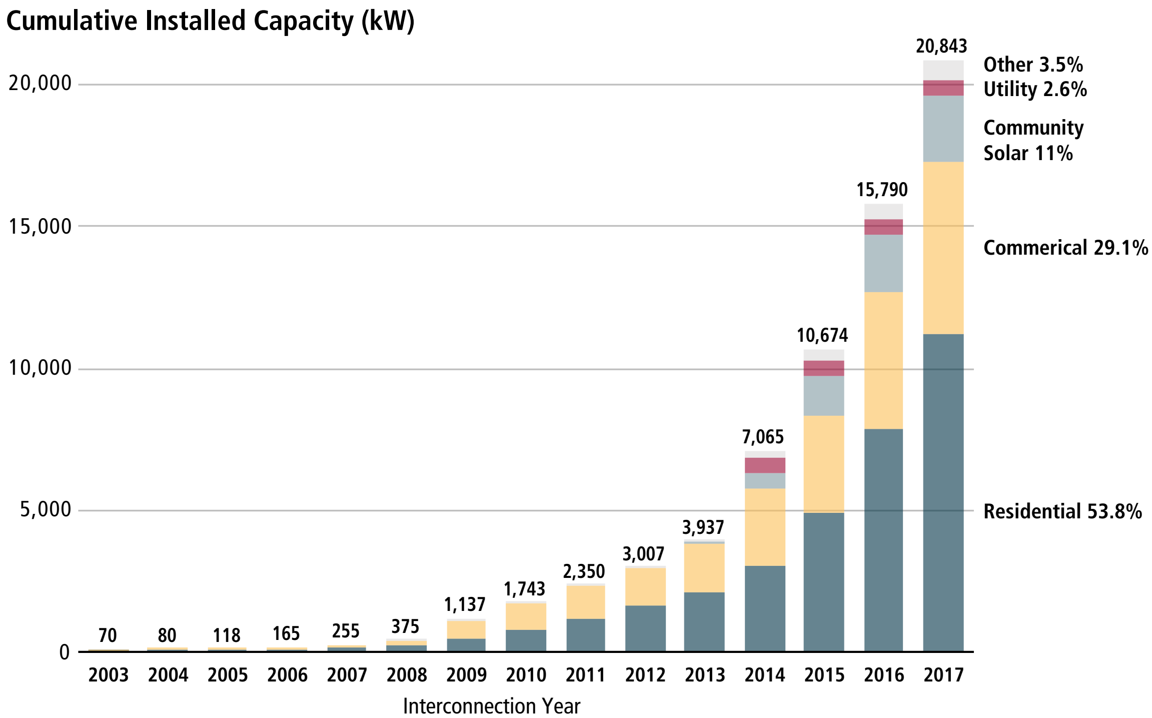


FIGURE 2.8.
Installed Solar by Type in Minnesota Distribution Munis and Co-ops

Cumulative installed solar in Minnesota distribution munis and co-ops by ownership/customer type (not inclusive of solar deployed by generation and transmission co-ops and joint action agencies). Data compiled from the Minnesota Public Utilities Commission (MN PUC, 2018).

Over 10 MW of solar is deployed by residential customers/members in munis and co-ops (Figure 2.8). In addition, 19 co-ops and 14 munis in Minnesota have community-shared solar (CSS) programs, and several more are in the planning stages (see Figure 2.10). CSS is a prominent technology configuration in munis and co-ops nationally (NRECA, 2018), and Minnesota is no exception. CSS enables a solar array to generate energy that is subscribed to by customers/members, creating an opportunity for an energy user to contribute to, and in some cases benefit from, solar deployment without having to install and maintain any equipment themselves.

Although the munis were later to embrace CSS, they now have more installed capacity than the co-ops (see Figure 2.9), in large part because of a 6.5 MW (DC) joint utility-scale/community shared solar project that is owned by the Southern Minnesota Municipal Power Agency (SMMPA) and provides power to member municipal utilities in both SMMPA and Central Municipal Power Agency/Services (CMPAS).

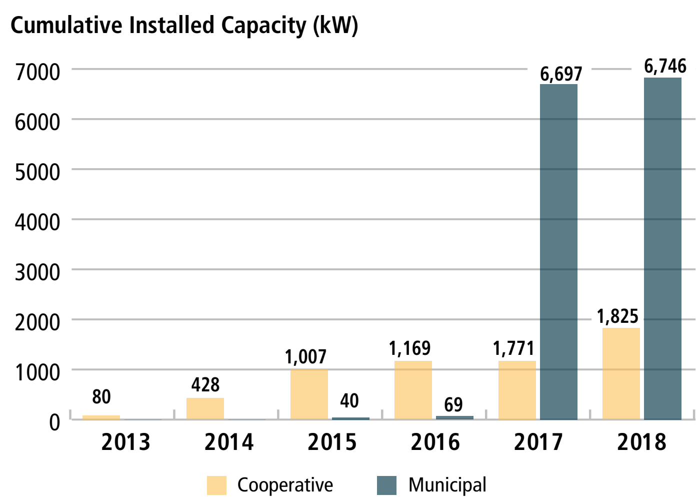


FIGURE 2.9.
Cumulative Capacity of Community Shared Solar in Munis and Co-ops

Cumulative community shared solar installations by utility type and year, inclusive of community shared solar deployed by distribution co-ops, munis, generation and transmission co-ops, and joint action agencies. Data compiled from Chan et al. (2018) and available upon request.

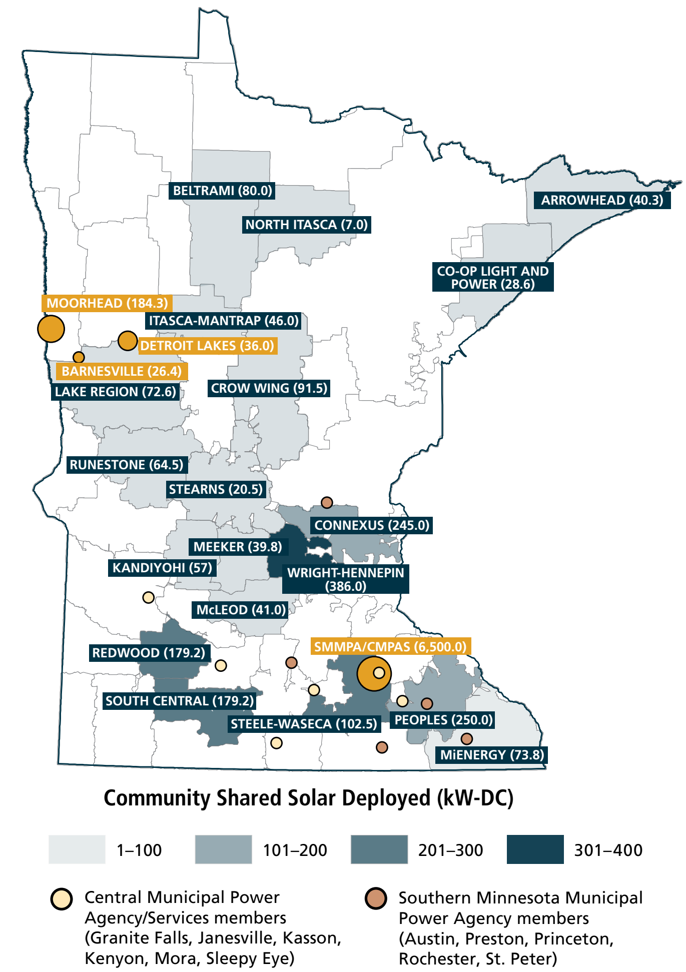


FIGURE 2.10.
Location of Community Shared Solar in Munis and Co-ops

Location of community shared solar (CSS) projects developed with Minnesota munis and co-ops. All utilities offering CSS subscriptions are named on their service areas with total capacity available for subscription (in kilowatt-DC). One CSS project was developed by the joint action agencies Southern Minnesota Municipal Power Association (SMMPA) and Central Municipal Power Agency/Services (CMPAS) and is subscribed to by 11 member municipal utilities. Revised December 2018. Data compiled from Minnesota Public Utilities Commission dockets, utility websites, FERC Form 556 filings, and the Minnesota Geospatial Commons (2015) and available upon request.

2.2.2. Load Management and Energy Efficiency

DERs also include energy efficiency resources (see Box 2). Many co-ops use their generation and transmission service providers as an "aggregator" to meet state utility efficiency standards, streamlining workflows across many distribution utilities. A report from the Minnesota Department of Commerce (DOC) shows different levels of energy savings among these aggregators in 2013, the details of which are in Appendix D (MN DOC, 2016).

Load management resources are another important form of DER for Minnesota's munis and co-ops. Like distributed generation, load management resources also can be aggregated by power suppliers. Figure 2.11 shows totals of the potential load management managed by major G&T co-ops that operate in Minnesota and that, for the most part, centrally manage their member utilities' load management devices. The numbers represent the total for each G&T co-op across its entire multi-state service territory for specific seasonal or annual averages based on data availability and are thus not directly comparable. With the exception of Great River Energy, these G&T co-ops stretch into adjacent states.

Munis also utilize load management but generally manage these systems internally instead of aggregating and using central coordination. In 2017, Minnesota's munis had access to nearly 130 MW of demand response potential across some 58,000 customers (EIA, 2018).

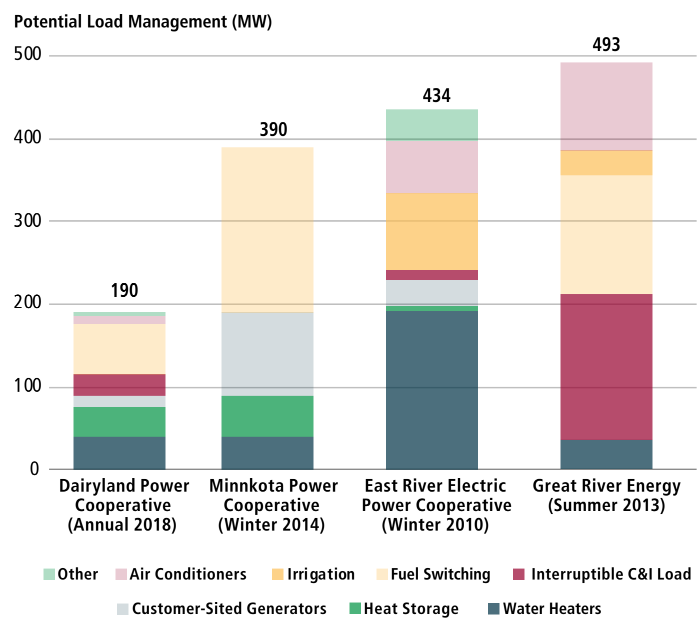


FIGURE 2.11.
Load Management Potential by Generation and Transmission Co-op

Load management potential by generation and transmission (G&T) cooperatives operating in Minnesota and by technology type. Note differences in data reporting period due to data availability. Approximate member devices under load control by G&T: 115,000 (Dairyland), 55,000 (Minnkota), 68,000 (East River), and 240,000 (Great River Energy). Totals for Dairyland, East River, and Minnkota are inclusive of these G&T's resources located in both Minnesota and neighboring states. See also Figure 4.1 for G&T service territories. Data sources compiled from Grimley (Forthcoming) and available upon request.

2.3. Shared Municipal and Cooperative Values

Munis and co-ops were founded on the ideals of participatory governance and local control. Most are small distribution utilities with a strong focus on their local communities and a tradition of coordinating with other public or cooperative service providers for much of their transmission and generation. Electric cooperatives in Minnesota—and around the country—operate on a set of seven shared principles. Taken together, these principles aim to "put the needs of their members first" (NRECA, 2016). Table 2.2 below offers an overview of the seven principles, as explained by the national organization of co-ops, the National Rural Electric Cooperative Association (NRECA). While these cooperative principles are ostensibly shared across all co-ops in the country, the interpretation of these values and their prioritization varies.

Municipal utilities are not quite as explicit about shared principles, but the national organization of munis, American Public Power Association (APPA), has articulated five priorities, outlined in Table 2.3.

Because both munis and co-ops operate locally as nnprofit entities, they have a similar customer-centric focus and value local agency and member well-being. Although munis and co-ops face slightly different organizational challenges (see Table 2.1), from a values perspective, munis and co-ops are more similar than different. The overlap of APPA's priority areas with NRECA's cooperative principles is seen most clearly across APPA's priority areas 1 and 5 with NRECA's principles 2 and 7.

TABLE 2.2. **NRECA's Seven Cooperative Principles**

The Seven Cooperative Principles, as articulated by the National Rural Electric Cooperative Association (NRECA). Adapted from NRECA (2016).

	Cooperative Principle	Overview
1	Open and Voluntary Membership	"Membership in a cooperative is open to all persons who can reasonably use its services."
2	Democratic Member Control	"Cooperatives are democratic organizations controlled by their members, who actively participate in setting policies and making decisions."
3	Members' Economic Participation	"Members contribute equitably to, and democratically control, the capital of their cooperative."
4	Autonomy and Independence	"Cooperatives are autonomous, self-help organizations controlled by their members."
5	Education, Training, and Information	"Education and training for members, elected representatives, CEOs, and employees help them effectively contribute to the development of their cooperatives."
6	Cooperation Among Cooperatives	"By working together through local, national, regional, and international structures, cooperatives improve services, bolster local economies, and deal more effectively with social and community needs."
7	Concern for Community	"Cooperatives work for the sustainable development of their communities through policies supported by the membership."

TABLE 2.3. **APPA's Five Priorities**

Five priorities articulated by the America Public Power Association (APPA). Adapted from APPA (2018).

	Priority Area	Overview
1	Local Governance and Regulation	"Public power utilities are owned by the community and run as a division of local government. These utilities are governed by a local city council or an elected or appointed board. Community citizens have a direct voice in utility decisions and policymaking."
2	Affordable	"Public power utilities are not-for-profit entities that provide electricity to customers at the lowest rates."
3	Reliable	"Customers of public power utilities lose power less often."
4	Diverse Sources	"Public power utilities buy or generate electricity from natural gas, coal, and nuclear, as well as renewable energy sources such as solar, water, and wind."
5	Giving Back	"When customers are the utility's shareholders, serving the community is the utility's top priority."

3. IMPLEMENTATION STRATEGIES AND DER TECHNOLOGY CONFIGURATIONS

Minnesota's munis and co-op apply a diversity of approaches for making decisions on how to manage DERs. This section introduces a framework developed from our data analysis for understanding muni and co-op implementation strategies for managing DER technology configurations. This section then reviews examples of how munis and co-ops frame challenges, opportunities, and implementation strategies associated with three prominent DER technology configurations: **community shared solar, customer-sited renewables,** and **load management and energy efficiency**.

3.1. Four Implementation Strategies

While munis and co-ops operate under a set of shared principles (Section 2.3), their decision-making reflects local context and capacity and is shaped by how utilities interpret and apply their shared values. In this section, we explore the different implementation strategies munis and co-ops are taking, with a focus on the implementation strategies that frame specific DER technology configurations.

Through this framework, it can be seen that some utilities are revisiting past assumptions about their relationships with their power suppliers–either reinforcing those relationships or redefining what it means to be a distribution utility. Other utilities are taking a more gradual path forward, monitoring for bottom-up demand for changes and planning for far-off futures. Yet others are more proactively engaging their communities in creating new business models, offering smart technology options to enable members/customers to co-produce electricity with their utility. How utilities navigate among these implementation strategies depends on their internal capabilities (e.g. tendency to reinforce or redefine institutional relationships) as well as their external conditions (e.g. community interest in DERs).

Implementation strategies are not mutually exclusive. While some utilities return to a similar implementation strategy repeatedly, others apply different strategies in different contexts, for different technologies, and at different points in time. Still, recognizing differences in implementation strategies suggests the need for a diversity of engagement strategies for working with these locally controlled utilities.

Figure 3.1 presents our framework of four implementation strategies Minnesota munis and co-ops are applying to confront the opportunities and barriers posed by DERs. A more detailed explanation of this framework is discussed in Appendix C and in a forthcoming academic paper from our research group.

FIGURE 3.1. **Four Implementation Strategies for Managing DERs**

The figure presents a taxonomy of "implementation strategies" utilized by municipal and cooperative utilities for managing the opportunities and challenges of distributed energy resources. This taxonomy is based on identified patterns of decision-making in coded interviews with utility managers. For methodological detail, see Appendix C.

MONITORING AND PLANNING

An implementation strategy focused on monitoring changes in the industry, planning for the integration of DERs, and making strategic infrastructure investments in anticipation of future deployment. For example, several munis and co-ops explain their approach to DERs by discussing how higher levels of DER would require them to first upgrade their billing technology. Others emphasized the importance of deploying an outage management system, completing advanced metering infrastructure investments, or distribution-system upgrades before taking on higher levels of distributed generation.

How utilities using this strategy negotiate competing interests:

- Prioritize community benefits
- Protect overall affordability and reliability

Policy and implementation implications:

- Policies or implementation assistance to mitigate costs or risks of new technologies
- Learning networks to share implementation practices and communication approaches

REINFORCING TRADITIONAL RELATIONSHIPS

An implementation strategy characterized by the view that generation is primarily the responsibility of the energy-service providers (i.e., either a JAA or G&T co-op). When developing new programs, these utilities may partner with their energy-service provider and rely on their more extensive administrative capacity and resources. Many of these munis and co-ops discuss their obligation to educate and protect customers/members in making decisions about distributed generation investments, safety considerations, the importance of maintaining reliability, and the distribution-utility business model.

How utilities using this strategy negotiate competing interests:

- Prioritize community benefits
- Protect overall affordability and reliability
- Active in local regulation
- Rely on existing energy-services and customer/member relationships

Policy and implementation implications:

- Policies and implementation assistance designed with consideration of existing third-party energy-service provider relationships
- Shared efforts to vet developers, educate consumers, and identify interconnection fees and procedures around rates to ensure safety, reliability, and a fair distribution of costs

COMMUNITY ENGAGEMENT AND LEARNING

An implementation strategy focused on efforts to engage customers/members in outreach around DERs and new programs. For example, these munis and co-ops describe how individuals, civil-society stakeholders, or local political actors have a commitment to clean energy. Others discuss the importance of attracting businesses and clean energy jobs, while some emphasize that their customers/members are motivated primarily by the tax benefits and net-metering reimbursements that are associated with customer-sited solar.

How utilities using this strategy negotiate competing interests:

- Enable individual interests
- Engagement to learn about and deliberate community interests to create new business and service models
- Reshaping the services and terms of contracts with energy-service providers

Policy and implementation implications:

- Remove barriers or enable new financing mechanisms
- Policy flexibility or assistance to enable community engagement

REDEFINING THE DISTRIBUTION UTILITY

An implementation strategy in which the distribution utility is leading new initiatives and taking more control over energy services. These utilities have customers/members that are interested in a 'cleaner grid,' and they are implementing solar offerings with a variety of different ownership and reimbursement schemes. These munis and co-ops are either skeptical of solar projects installed by their energy-service providers or seek flexibility in their energy-service contracts. Some of these munis and co-ops are investing in advanced metering infrastructure and pursuing new forms of demand management.

How utilities using this strategy negotiate competing interests:

- Prioritize community benefits
- Respond to varied community demands
- Actively create innovative new programs and business models to deliver services
- Negotiate increased flexibility or terminate existing service-provider contracts

Policy and implementation implications:

- Policies to enable renegotiation or buy-out from existing power supply contracts
- Policy flexibility or assistance to enable building networks to efficiently share communication and data management technology and to access wholesale markets

3.2. Community Shared Solar

Community shared solar (CSS) is a new technology configuration for solar deplooyment that varies across many dimensions, including size, ownership, control, and reimbursement schemes. Decision making by utilities deploying CSS reflects local context, institutional capacity, and distinct interpretations of their organizational identity. CSS is now available to members/customers in 19 cooperatives and 14 municipal utilities around Minnesota, with several more either in construction or development stages (see Figure 2.10). Many munis and co-ops see CSS as an opportunity to ease the administrative burden of responding to customers/members, engaging the community, and improving reliability. For example:

We have to administer seven different customers right now, one-on-one, through net metering. If that grew exponentially and we had a thousand, I would just as soon handle a thousand collectively as part of a community solar project than one-on-one net metering for a thousand different people. We want to stay ahead of that. —Interviewee

I do think it's a good idea to have community solar because I think it gets a lot of your members involved. You can potentially strategically place that set of panels to also help with reliability, maybe put it right by a substation that is maxing out.—Interviewee

Other munis and co-ops discussed how questions of fairness and limits in administrative capacity create barriers to deploying CSS. For example:

Our thought is, solar is coming down [in price] every year, so let's say we build a community solar garden today, and we sell you…four panels at $5,000 a panel. You got $20,000 in it. Five years from now, we build another one because there's more interest, and they're cheaper. Now, we sold this person four panels at $3,000 a panel. They got $12,000 in their four panels, you got $20,000. They're going to come to us and go, 'What the heck? I want my $8,000 back.' —Interviewee

Community solar would be a manual process...In fact, that's the barrier. That's why we don't have a community solar program, the billing system. —Interviewee

Munis and co-ops across Minnesota are responding differently to these opportunities and barriers. Depending on local context and interpretation, utilities are engaging in different combinations of implementation strategies that shape a wide range of CSS technology configurations.

Cases A-C highlight examples of three distinct CSS technology configurations.

CASE A: COMMUNITY SHARED SOLAR

Uncertainty and Risk Perceptions Mitigated by "Monitoring and Planning"

CSS, by definition, requires individuals to participate, but individuals aren't always sufficiently motivated to participate at a level that makes projects viable. CSS projects offered by munis and co-ops can be left unsubscribed. The additional risk of a discrepancy between expected and realized subscriptions may stymie plans for CSS completely. One utility described:

We actually have one [community shared solar project] right now and only about 50% of it has been sold…We did a survey on the front end and said, 'Would you be interested in Community Solar?' We got of course a very positive response. We did those numbers, 'Would you be willing to pay all of that?' Once it was operational, we haven't had as many members sign up for it as we thought. We even offer a payment plan…and we still have only sold about 50% of the panels that are available. —Interviewee

As reported by munis and co-ops in other states, the problem of customer acquisition and management is common. It can often leave the utility's members holding the bill for the project, which may or may not be cost-competitive with current power-supply sources (NREL, 2016). The threat of under-subscription coupled with upfront costs for infrastructure and management systems, leads some utilities to not build until a certain pre-energization subscription level is reached. Other utilities see low survey response rates as an indication of prospective project failure.

I think we had less than five people respond to the survey… When it's just a survey and you don't have to pull out your checkbook, a lot of people will say they'll build more than when they really pull out their checkbook. —Interviewee

Furthermore, when some CSS project do move forward, their subscriptions are priced too high to generate high subscription levels. Adding on additional uncertainties around declining solar prices, lack of staff to develop or manage the project, and a need to work with solar developers, the growth of CSS among consumer-owned utilities means engaging with new stakeholders and fitting together networks that, for many utilities, have never existed before. Many utilities are weighing these uncertainties and risks and are taking a precautionary approach to protect affordability and reliability. This approach reflects an acceptance of limits on individual agency for the benefit of the community as a whole and a strategy of ***monitoring and planning*** as they consider decisions about CSS.

CASE B: SOUTHERN MINNESOTA MUNICIPAL POWER AGENCY

Large-Scale CSS by "Reinforcing Traditional Relationships"

External circumstances, such as strong institutional ties or lack of internal capacity, can lead utilities to implement CSS in new ways. This was the case in 2015 when the JAA Southern Minnesota Municipal Power Agency (SMMPA) and its member distribution utilities started looking into CSS. With two of its larger member utilities, Austin and Rochester, looking for alternative power supply arrangements in the future, the importance of designing a project to meet the needs of small member munis became critical (Jossi, 2015).

The community shared solar project SMMPA designed is utility-scale—five megawatts-AC (or 6.5 MW-DC) in total, more than 100-times larger than the only other municipal CSS in Minnesota at the time. It was "controversial" in the words of SMMPA's renewable energy program manager, because it is not a traditional CSS project. Instead, the project blends utility-scale solar development and CSS, allowing JAA member utilities to purchase shares of the centralized facility, complemented with local programs in member munis to engage their own retail customers to subscribe to shares. The project represents the "nesting doll" of CSS development: both selling power into the MISO wholesale power market while providing retail net-metering returns to residential subscribers (Meyer, 2017).

The five-MW size of the project was large enough for another JAA, Central Municipal Power Agency/Services (CMPAS) to sign a sub-power purchase agreement for 280 kW of the array (SMMPA, 2018). SMMPA is also using CMPAS's subscription to work toward an internal goal: if 2,481 panels of the more-than 20,000-panel community shared solar project were to be sold by SMMPA member utilities, the agency would build another three MW solar facility for its membership.

This unique CSS technology configuration enabled experimentation and learning across member utilities. Five participating distribution munis developed 40 different subscription offerings for customers. Most of these reflected variations on initial pay-upfront and lease offerings from Austin Public Utilities, who developed easily replicable marketing materials (SMMPA, 2018). In addition, six CMPAS members all used one particularly innovative contract style. In return for a yearly payment of $42.50 per panel, customers receive the value of energy from MISO, not net-metered reimbursement (as SMMPA members received). This design sought to lower customer costs and avoid cross-subsidization associated with customer-sited generation and net metering. In the words of the agency (CMPAS, 2016):

As a proactive and defensive strategy, we should be offering retail customers a more economical alternative to installing rooftop solar by making utility-scale cost advantages available to retail customers. By doing so, we will be able to avoid the potential negative consequences of net metering, rate cross-subsidization, and erosion of our retail revenues.

SMMPA and the small distribution munis that are members of and govern SMMPA developed a CSS model in which utilities with limited capacity continue to rely on joint ownership of generation. In developing this project, munis and the JAAs demonstrate an implementation strategy of ***reinforcing traditional relationships.***

CASE C: WRIGHT-HENNEPIN COOPERATIVE ELECTRIC ASSOCIATION

Providing Many Options in CSS Offerings by "Redefining the Distribution Utility"

Wright-Hennepin Cooperative Electric Association was the first utility in Minnesota to build CSS. The utility's first project was initiated in 2013 and with successive deployments of solar arrays, this co-op has proved out CSS schemes in mutually beneficial ways for the utility and their members.

At Wright-Hennepin, 85 participants currently subscribe to more than 360 kW of CSS across four projects (Wright-Hennepin Cooperative Electric Association, 2018). Each project offered an opportunity to redefine what Wright-Hennepin could do. The first CSS project tested solar-and-storage technology and third-party integration. The second project used financing solely from the customer, taking no investment tax credit. Finally, the third and fourth projects were financed by a unique loan product from CoBank, a cooperative financier, with each project nearly quintupling the size of past projects (Chan et al., 2018). Along with these differences in ownership and financing, the CSS contract offerings grew more diverse in how members paid for and were reimbursed for their participation, transforming from a pay-up-front model to a flat pay-as-you-go option alongside a 4-percent discount for subscription. Finally, an important step in this expansion of CSS was Wright-Hennepin's peaking power supply contract with Basin Electric Power Cooperative, which provided them with some ability to self-generate. Through member surveys and outreach performed at community meetings, online, and even through television and radio advertisements, Wright-Hennepin facilitated and drove consumer interest in solar. Interestingly, the utility also offered waiting lists between projects, perhaps helping to spur future projects (Chan et al., 2018).

By actively providing new services, experimenting with new financing, ownership, and subscription options, reshaping their institutional relationships, and privileging CSS options over customer-sited distributed generation, these decisions by Wright-Hennepin demonstrates a strategy of ***redefining the distribution utility.***

3.3. Customer-Sited Renewables

Customer-sited renewables can take many forms, including rooftop solar, ground-mounted solar, and distributed wind. Muni and co-op decisions about how to integrate these technologies, like decisions about CSS, reflect local context, capacity, and values. In Minnesota, many munis and co-ops are not actively addressing customer-sited renewables beyond responding to customer interconnection requests or providing information. While some are actively working with customers/members to facilitate these technologies, others are creating procedures and fees that are perceived as barriers to customer-sited solar.

Concerns about the net metering laws for customer-sited renewables in Minnesota came up frequently during the interview process. Many small utilities fear that if large numbers of their customers install behind-the-meter renewables, they will have to raise their fixed monthly charges for all customers to account for lost sales. Were customer-sited renewables to significantly increase, utilities are concerned about increased cross-subsidization in which lower-income customers who cannot afford customer-sited renewables end up subsidizing their higher-income neighbors.

Concerns about cross-subsidization and fairness came up consistently in our interviews: the concepts of "subsidizing" and "fairness" came up in the large majority. It is worth reiterating that for most munis and co-ops in Minnesota, concerns about cross-subsidization from customer-sited renewables are future-looking and not based on the present system impacts. These concerns nevertheless have driven efforts to readjust fixed charges and energy rates.

We also found diverging views about whether customer-sited renewables are a smart financial investment for residents or businesses; these views reflect important differences in local context. Some utilities expressed skepticism about renewable salespeople and felt a need to protect their customers from misleading information on prices and payback periods. However, most utilities acknowledged responsiveness to the customer. For customers who have both available land and financial means to take advantage of generous federal tax subsidies, customer-sited renewables are a reasonable and attractive investment. In this section, we have selected several quotes to illustrate the diversity of perspectives we heard on customer-sited renewables.

The munis and co-ops in our research most often frame fairness in relation to the long-standing ideas about distributing energy system costs according to responsibility (i.e., cost causation) and in relation to an explicit or implicit presumption that the status-quo distribution of benefits, costs, and risks is already fair. For example:

For a long time the PUC pushed for utilities to not have a big facilities charge so that the poor grandma who's living on a fixed income can afford to have energy...So if this DG thing [in reference to the DG fee (Minnesota Public Utilities Commission, 2017)] wouldn't have went through, what it basically would have meant for [our utility] is that we would have gone out and increased our facilities charge to what our cost-of-service studies show and lowered our energy rate. And then nobody would be subsidizing anybody. And, like I say, I'm not against it, but it's...a sense of fairness, if you will, that if you want something, you can have it. You just have to pay for it. —Interviewee

I think subsidization is a big one. There's been a lot of pushes out there on value of solar and things like that....That the costs are reflected. As long as it's good for all of the customers and not just one of the customers. Subsidizing rates is something that we're very, very sensitive to. Some people lose sight of that. One-person gains on the back of somebody else. —Interviewee

Other utilities highlighted the tension between individuals receiving compensation at a high enough rate to provide a certain payback period and what might promote sustainability or efficiency for the entire community. For example:

For a lot of people, buying their own solar system is a better payback, in a pure payback sense, but the question is, are you worried about payback or are you also worried about making all the systems more efficient for everyone? You know, most people will land on 'well, I need to get the best return on investment of my money that I can,' which is normal. I'm not arguing with that. On the flipside, it is important for people to consider what they're asking the utility to do. It's kind of, and I hate to say it this way, but you can't have your cake and eat it too. —Interviewee

Finally, other utilities highlighted concerns about engaging with new energy system stakeholders and a sense of obligation to ensure their customers/members are fully informed. For example:

Well, I would say the thing that I hear the most about, whether it's wind or solar, is that they never produce as much as what the sales people claimed that they would. —Interviewee

Munis and co-ops across Minnesota are responding differently to these tensions and different implementation strategies are shaping the technology configurations for customer-sited renewables.

Cases D–F highlight examples of three distinct approaches shaping customer-sited technology configurations.

CASE D: ROCHESTER PUBLIC UTILITIES

Prioritizing Customer Benefits in Customer-Sited Solar for "Community Engagement and Learning"

Rochester Public Utilities (RPU) in Southern Minnesota is by far the largest municipal in the state with over 50,000 customers and a system peak of 266 MW in 2017 (EIA, 2018). Although RPU's retail sales have fluctuated over the last five years, they have added more than 3,700 new customers since 2013 (EIA, 2018). With such a large and diverse customer base, RPU quickly recognized that they needed to support a variety of renewable options for their customers, many of whom may have the financial means to install renewables at their home, and others who cannot feasibly install a home system—due to location or financial restrictions.

RPU announced a community shared solar program in 2016 called "Solar Choice." Subscriptions for the program closed in December of 2017 with 210 residential subscribers and 288 kW fully subscribed (RPU, 2018a). In parallel with the community solar offering, RPU offers a solar rebate program to encourage customers to install solar at their homes. The rebate program encourages customers to first look for energy efficiency upgrades before turning to solar, but then offers a rebate of $0.50 per installed watt that can be claimed for systems between 0.5kW and 10kW (RPU, 2018b). Most notably, RPU also offers semi-regular educational opportunities for their customers to learn about customer-sited renewables at free sessions titled "Solar Energy for Your Home or Business" ("Community Education Classes," 2018).

Although RPU has a large cumulative distributed solar capacity (upwards of 1 MW), DER remains a small percentage of their overall load (U.S. EIA, 2018), which likely prevents DERs from being perceived as a larger threat to their overall viability. In addition, RPU is actively planning for a future that does not involve their current power supplier, SMMPA, beyond 2030 (Killion, 2009). In part, this seems to be due to a desire to provide more renewables, and simply more options, for their members. During our interview, board member Michael Wojcik explained that the push for renewables is coming from the customers:

When we did a community survey, a majority of our customers preferred clean energy even if they had to pay a slight premium. Clean local energy remains more popular than fossil fuel based energy.

RPU's large size, load growth, and strong community support for renewables make it unique compared to many munis and co-ops in Minnesota. However, there are still transferable lessons for smaller utilities. Customer education sessions on rooftop solar, for example, lead to more informed customers who understand the pros and cons of customer-sited renewables and are more likely to choose installers and other equipment providers that have been vetted by the utility. Munis and co-ops should also watch RPU closely as they negotiate a power supply contract beyond 2030. Their contract could serve as an important reference point for utilities looking for more flexibility at the distribution level. The breadth of these efforts, the active involvement of community leaders, efforts to educate customers and learn about customer preferences, and the negotiations to reshape their energy service relationships demonstrates an implementation strategy around customer-sited solar of ***community engagement and learning***.

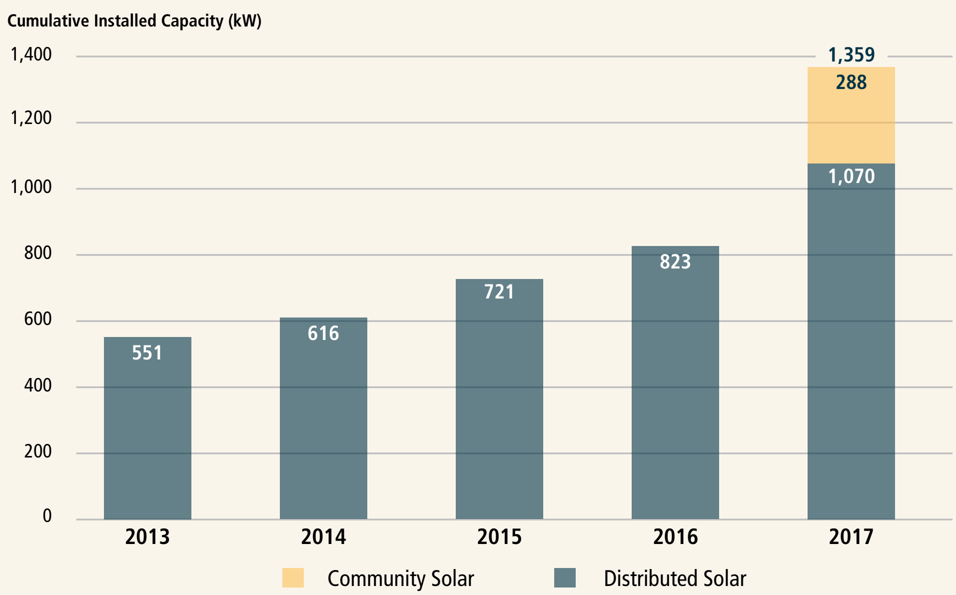


FIGURE 3.2.
Distributed Solar Capacity in Rochester Public Utilities

Cumulative solar capacity in Rochester Public Utilities (RPU). RPU also has 2.6 kW of installed wind. Data compiled from the Minnesota Public Utilities Commission and Rochester Public Utilities (MN PUC, 2018; RPU, 2018a)

CASE E: STEELE-WASECA COOPERATIVE ELECTRIC

Exploring Creative Options for Multiple Benefits and "Community Engagement and Learning"

Steele-Waseca Cooperative Electric has recently launched a program to avoid the impacts of cross-subsidization from customer-sited renewables. Concerns about cross-subsidization emerged most consistently when discussing net metering and a system configuration in which the customer installs much more capacity than required to meet their own load in order to profit off the net metering rate. Steele-Waseca, recently experiencing a boom in customer-sited renewable installations, described a new program in which customers could receive a solar rebate from the utility for their rooftop solar system, but would only be eligible for the rebate if their system was sized to match their load. The utility described:

It actually saves money for everybody...We'll still pay the net metering amount [the retail rate subtractive of fixed charges] for the entire load, and at the same time, have a rebate incentive to not over-produce. That helps everybody. It helps us not have back-feeding on the transmission facilities, and that helps the co-op structure. Members will get a higher return on their investment; aka, more money for producing less...Everybody wins…We started with one member as a pilot project in 2017, and launched the official "POWRE" project (Power Optimized With Renewable Energy) in June of 2018; as of October, 2018, we have a total of 17 members participating. Everyone that has added a distributed generation system since the inception of the program has modified their size to fit within the rebate initiative. In the past we mostly saw the more well-to-do members putting in systems because they are expensive. Now, by giving a rebate, it helps the little guy do it. And we really are about trying to benefit all our members—we like to provide the same service to all our members, give them the same opportunity...There are just no drawbacks to the new idea.

Size-to-load is not a new concept, but in the muni and co-op world it is very popular and helps utilities move past the perceived threat of customer-sited renewables. A size-to-load rebate redefines how the utility engages with customers by taking a proactive role to explore new implementation strategies, while working to respond to the interests of individuals and benefiting the community as a whole. Encouraging creativity and pilot programs of this sort could help munis and co-ops explore additional options for DER implementation. The decision making by Steele-Waseca reflects a strategy of seeking opportunities to create overall value, balancing concern for individual agency and community benefits, and reshaping institutional relationships and thereby, demonstrates characteristics of two strategies: ***redefining the distribution utility*** and ***community engagement and learning***.

CASE F: LAKE REGION ELECTRIC COOPERATIVE

Building In-House Capacity to Install Rooftop Solar by both "Reinforcing Traditional Relationships" and "Redefining the Distribution Utility"

Lake Region Electric Cooperative is a mid-sized electric cooperative based in Pelican Rapids, Minnesota with a reputation for progressive programs and strategy. In summer 2017, Lake Region launched an in-house solar installation business called "GoWest Solar" which provides customer-sited solar installation services to Lake Region customers (Lake Region Electric Cooperative, 2018). The panels are ground-mounted at 240 degrees, which puts them at an ideal southwest tilt to capture sunlight in the late afternoon/early evening when it is most useful for the utility and also most profitable for the customer (Rutter, 2018). As an added incentive, Lake Region is providing members who sign up for a GoWest Solar system with a 100-gallon water heater free of charge (Thompson, 2017). At least one customer participated in the GoWest program last year, and several more are expected to be online by the end of 2018 (Rutter, 2018). The program is a unique method to both protect customers from aggressive or misinformed renewable sales people while also building new knowledge and capacity within the utility.

Creating an in-house solar installation unit unlocks a new potential business model and revenue stream for the utility. It also reclaims local authority for the utility by keeping unknown developers at bay and prevents miscommunications between the customer, developer, and utility. The design of the program rewards individuals with a summer peak demand credit and supports the needs of the community by positioning systems to face southwest to meet late afternoon demand. Encouraging small utilities to explore new revenue streams and business models of this sort can provide win-win-win opportunities for the utility, the community, and the individual member. However, not all small munis and co-ops will have the internal resources and capacity to develop creative programs of this sort. State or institutional support may be helpful to encourage other utilities to follow Lake Region's example. This strategy of both expanding the utility role to protect customers/members and empowering local authority is reflective of decision making that is ***reinforcing traditional relationships*** and ***redefining the distribution utility***.

3.4. Load Management and Energy Efficiency

Load management is central to many consumer-owned utilities' identity in Minnesota. Some distribution utilities, when prompted for examples of DERs, immediately listed load management as a DER that they have been confidently using for decades (see Section 2.2.2). Some even expressed frustration that nonprofit or research groups (like us!) were discussing DERs as a new phenomenon, when in fact the co-ops were well versed in managing distributed resources. Still, in several other interviews with munis and co-ops, load management was not mentioned and was taken for granted, an "invisible" part of their everyday infrastructure.

Load management is where we saw the strongest distinction between munis and co-ops. Co-ops have performed load management 'forever' and many readily discuss their experience with and the benefits of DERs, for example:

Cooperatives, by nature of how they're made, we're forced to be as productive and efficient as we can, or our rates would not be competitive. Cooperatives have been doing load control for over 30 years. It's probably closer to 40 years. That's because we have to find those ways or those types of innovations in order to be competitive with our rates. —Interviewee

The membership all wanted an opportunity to avoid demand charges, and so right from the beginning, the membership wanted these demand response programs in place, and the result is we have decades, almost 40 years of having a demand response program. We have a lot of megawatts under our control…it's a very large share. It's I think somewhat unusual in the industry to have that much demand response. It was all driven by members trying to get out from under that peak. —Interviewee

Let's say we have a one-megawatt solar farm located at a substation. The loads are low, and the one-megawatt facility is generating at full output. If we can dispatch other loads to soak up that energy rather than sending it up onto the transmission system and taking whatever the wholesale power rate is for it, that's an advantage to us. So, we'd be able to better utilize those intermittent resources by dispatching loads to follow it. At the same time, it gets to nighttime, and the loads suddenly go up. And the solar is gone. If we have water heaters that we can now turn off, to keep that load down for a little while till more generation resources become available, that certainly helps us a lot with being able to accommodate those intermittent generation resources. —Interviewee

In contrast, a smaller proportion of munis have a load management program in place and they are more likely to face multiple, conflicting priorities as part of the overall city government. For example:

They [co-ops] obviously push electric water heaters in very big programs. They have programs tied to community solar to drive customers to install electric water heaters. Obviously, we're not going do that because we sell gas. It takes away a lot of that. We try to make all our utilities stand on their own and not get pulled from each other. —Interviewee

Cases G-I illustrate three different experiences with energy efficiency, load management, and electrification.

CASE G: ENERGY EFFICIENCY

Uncertainties and Risk Limiting Investments for the Long-Term and Putting a Focus on "Monitoring and Planning"

In many interviews, we asked what mattered most to the utility customers or member-owners. Often the options narrowed to reliability and cost: customers were aware of nearby utility rates or had fears of losing access to electricity.

Controlling costs is especially important for co-ops, who have fewer customers per mile of line than other utilities, and munis, who have fewer customers in general. That's where energy efficiency comes in. Utilities often resist spending money to reduce volumetric energy sales, yet for consumer-owned utilities, the opportunity to lower customer costs while potentially also lowering utility costs can be a win-win for customers and utilities. However, when expectations are focused both on preserving low rates and perfecting reliability, energy efficiency can be viewed as too much of a risk. Uncertainty about the costs and benefits of energy efficiency investments, results in many smaller utilities biding their time and simply meeting their Conservation Improvement Program (CIP) requirements, but knowing there may be more value to be captured. According to one municipal utility manager:

We've added a lot of customers in the last five years, but our load's really been stable. We just haven't seen the big peaks in both demand and energy sales and a lot of it's got to do with the conservation that has been done…we've got expansion costs, we've got infrastructure costs, but we're not seeing the revenue driven because our sales volume isn't there to recoup some of those costs. We've just got to be really careful about what investments we make and where. The reduction in demand, reduction in energy has probably helped us defer some of our large capital costs and substation expansion. That becomes problematic for trying to get cost recovery without continuing to drive those rates to recoup those costs. —Interviewee

In this example the utility describes how shifting load patterns are creating uncertainty in how to plan for future infrastructure investments. In considering significant load management or energy efficiency investments, many small utilities described a precautionary approach to affordability and reliability that reflects an implementation strategy of ***monitoring and planning***.

CASE H: GREAT RIVER ENERGY

History of Co-op Load Management through "Reinforcing Traditional Relationships"

With nearly 300,000 controlled loads and more than 350 MW of peak shaving, Great River Energy's (GRE) load management program took years to develop. Across our interviews, that history emerged, tying in several strings from the history of energy in the Midwest. Today GRE's infrastructure of smart meters and big data is pushing the cooperative's distribution-utility members toward a more integrated, real-time grid.

In the late 1970s and early 1980s, the G&T co-op that preceded GRE made investments of more than $1 billion in generation and transmission assets and implemented demand charges to recover these costs. This created an incentive for member distribution utilities to initiate demand response programs to avoid peak demand charges. As one interviewee explains the history and the potential transition:

We've had that [demand response] forever. It's a dumb demand response system. You push a button, and everything gets controlled, and that's about it. Probably has a 20 percent failure rate but we don't know because we don't know. The new demand response system will be smart, and so it's like a Nest thermostat. Which just kind of gets used to your lifestyle, and then soon it just makes decisions on its own. The new smart demand response system will be able to do control at much more granularity than we can now...We're just building this. This is in anticipation of chasing down economies where we can find them… As we imagine in the future, and demand response and other DERs as they become more and more a part of our system… there will be value for the membership, too, instead of having a zero-sum game among the members to control and offer that as a resource into the market. —Interviewee

Today, many member co-ops on fixed contracts with GRE also run their own voluntary load management programs, as opposed to the centrally-run load management program. These voluntary load reduction programs have their own constraints. Still all co-ops face sometimes-conflicting signals between wholesale markets, customer needs, and contractual obligations.

GRE's strategy of using centralized demand charges reinforces current service roles and existing institutional relationships that developed over a long period of time and is consistent with an implementation strategy that is ***reinforcing traditional relationships***.

CASE I: EXPANDING ELECTRIFICATION

Electrification's Potential for "Redefining the Distribution Utility"

"Electrification" was mentioned only 9 times across 8 interviews, yet its presence was felt as utilities bemoaned flat or decreasing sales, described the impacts of lost revenue from DER, or reflected on the potential changes coming with items such as electric vehicles or energy storage. In our interviews, "electric vehicles" were mentioned 19 times across 11 interviews, "EV" 12 times across 7 interviews, and "storage" was mentioned 97 times across 36 interviews. Several respondents expressed concern that existing state policy is at odds with these coming changes, and some respondents even suggested changing efficiency programs to match not energy saved, but carbon emissions prevented.

The crux of optimizing the grid services from these electrification devices, ranging from water heaters to storage and electric cars, is load factor. A load factor is a ratio of peak demand to kilowatt-hours sold. The higher the load factor, the more these DERs are being used to shift peak electricity usage to other times of the day, growing shoulder and off-peak loads, and thus mitigating the need for additional power plants and cutting expensive peak power.

As many of these munis and co-ops only see energy and demand charges from their power suppliers, and subsequently have little wholesale market exposure or opportunity, increasing the load factor of their system becomes a matter of utility health. Electrification offers the potential to increase utility load factor, decrease costs, and grow sales. Below are representative quotes highlighting the positive view many consumer-owned utilities have of the potential for demand management:

I can see with batteries, solar and [demand side management] coming together to basically run your load flat line 24/7 instead of seeing the peaks come up during the day and falling away at night, use those DGs to take that edge off during the day and use your base resources to close that gap up during the night and your load profile changes significantly because of that. That's one of the things that got me a little bit excited about battery storage. Better storage. I think we can change our load profile throughout the day, flatten that out, make better use of our resources and provide a lower-cost product by doing that. Keep our reliability high. Keep our costs down and just do some cool stuff besides. —Interviewee

Being a commuter town, it's great to have them come back, charge up their vehicle all night at the off-peak rate. It increases our load factor. Maybe at some point, we can incorporate two-way with the car batteries. If they are able to charge it off-peak, and then give us back if we push the button—pushback into the home or back out onto the grid during times of high demand during the day. That may be another form of our version of DG. —Interviewee

We have one industrial consumer that accounts for approximately half our kilowatt-hour sales. We're not big enough to absorb the swings in their business, primarily relating to load factor for the coincident demand that's used to determine our wholesale power cost. There's a 30-minute window in a given month that drives about half our power bill. For this large consumer, we have tier pricing for energy and pass through the power factor and demand charges from our wholesale power provider. This rate design allows for a more stable gross margin for our cooperative. I would say our most significant risk as far as coincident demand swings comes from grain drying loads. Depending on if they hit our peak or not, it is feast or famine. This October, the timing of the grain drying ate up half of our budgeted margins for the year. We will continue to have this risk until we move to a demand and energy rate for these consumers. That's something we've never done and would have to investigate to protect the overall financial health of our cooperative. —Interviewee

The positive view expressed around the potential for expanding electrification or providing new services, and reshaping their institutional relationships demonstrates interest in a strategy of ***redefining the distribution utility***.

4. SUSTAINABLE, FAIR, AND EMPOWERED LOCAL COMMUNITIES

As DERs are deployed, relationships among generation and transmission service providers, distribution utilities, customers/members, and technology configurations are shifting in a wide variety of ways with distinct implications for utility operations. DERs can either exacerbate or mitigate constraints on municipal and cooperative utilities' capabilities to support more sustainable, fair, and empowered local communities. In this section, we explore three key tensions that arise in how munis and co-ops are responding to the opportunities and challenges of DERs to support their local communities[iii]: the restrictions of **power supply contracts**, the extent to which utilities incorporate other **local policy** goals into energy decision making, and concerns about **cross-subsidization** between a utility's customers and across utilities.

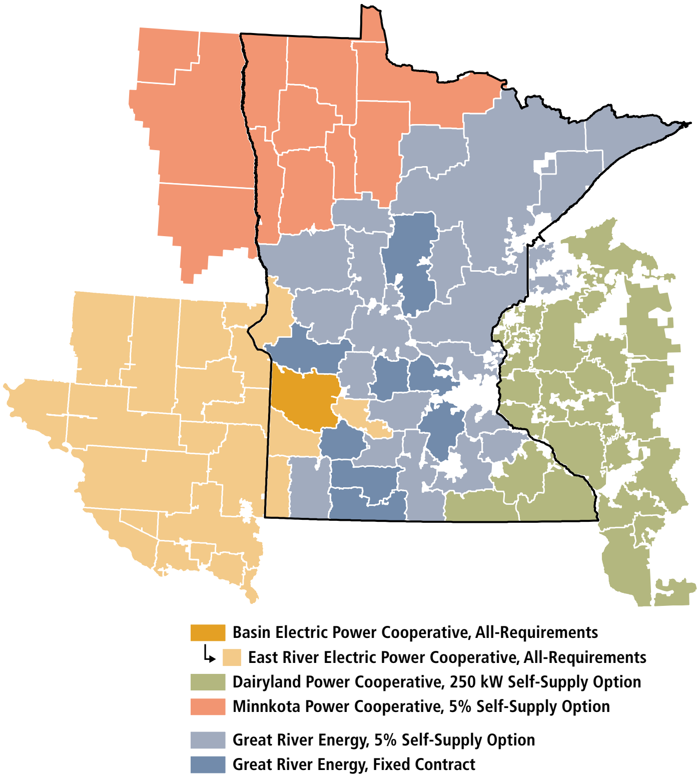
4.1. Power Supply Contracts: Local Ownership and Control

Power supply contracts strongly influence opportunities for local ownership and control. As noted in Section 2.1, munis and co-ops in Minnesota are primarily distribution utilities that obtain generation, transmission, and other services through contractual relationships. The majority of these distribution utilities have chosen to form JAAs or G&T co-ops. These organizations are owned and governed by the member distribution utilities and provide a range of programs and services. This structure allows member distribution utilities to co-own generation and transmission infrastructure. However, power supply contracts vary and are complex. Munis and co-ops often have power supply contracts with more than one JAA or G&T co-op, many qualify for preference energy from the federal Western Area Power Administration (WAPA), and others contract for power with IOUs, independent power producers, or other distribution munis and co-ops.

Historically, muni and co-op power supply contracts often included "all-requirements provisions." These provisions were designed to create more financial certainty for large centralized generation and long-distance transmission projects by limiting self-generation at the distribution level and restricting local utilities from procuring power from alternative providers. Because power supply contracts have traditionally been used to support financing of long-lived infrastructure, they typically span multiple decades. Generally, the all-requirements contracts run until the 2040s in Great River Energy's case, or 2075 for Basin Electric Power Cooperative's downstream co-ops, which include East River Electric Power Cooperative's member co-ops. These embedded contractual relationships constrain integration of distributed generation, but they are being challenged by new opportunities presented in evolving bilateral arrangements and wholesale markets. Based on initial research on major power supply contracts in Minnesota, we map the embedded institutional relationships among munis, co-ops, JAAs, G&T co-ops, IOUs, and WAPA in Figure 4.1, Figure 4.2, and Figure 4.3.

The co-ops in Minnesota are joined together as partners governing G&T co-ops that co-own generation and transmission infrastructure in a complex set of institutional arrangements. Figure 4.1 maps the G&T co-ops serving Minnesota. These large, often multi-state service providers generally use two types of contracts: (1) all-requirements contracts with or without self-supply carve outs; or (2) 'fixed' contracts for a set amount of energy. For example, of the 28 co-ops served by Great River Energy, 20 have all-requirements contracts with self-supply provisions and eight co-ops have fixed contracts. Co-ops with fixed contracts pair these contracts with another fixed contract or a 'peaking' contract for capacity or energy above the fixed contract amount, or self-supply generation. These secondary contracts are used in conjunction with primary contracts with one or more G&T co-op. Figure 4.2 maps two important fixed contracts and the major peaking contracts of Minnesota's co-ops. The co-ops west of the WAPA boundary have fixed contracts for a preference allotment of mostly low-cost hydroelectric power. Some-co-ops have direct contracts with WAPA, and others' contracts were absorbed by G&T co-ops in past decades. In addition, Southern Minnesota Energy Cooperative (SMEC) is a newly formed G&T co-op that provides a fixed contract that serves members adjacent to the members served through other G&T co-ops. Finally, the Basin Electric Power Cooperative, East River Electric Power Cooperative, and L&O Power Cooperative are G&T co-ops that provide peaking contracts to eight distribution co-ops in Minnesota.

Minnesota's munis are also in a complex network of institutional relationships through their power supply contracts. Figure 4.3 illustrates the diversity and geographic clustering of power supply contracts entered into by distribution munis in Minnesota. Most munis are joined together as partners in JAAs. Many JAAs use all-requirements contracts that limit self-generation and the ability to procure power from alternative generation providers. Other JAAs, such as the Central Municipal Power Agency/Services, have project-based contracts, that allow member distribution utilities to select specific generation projects to invest in, rather than establishing an obligation to co-own all generation investments. Yet other JAAs use fixed contracts to supply a certain amount of capacity or energy, leaving distribution utilities to supply the balance of their needs through self-generation, other power supply contracts, or the wholesale market. Some munis, particularly in small towns, source power from a local co-op, an investor-owned utility, or even another municipal utility. For example, munis around the northern mining towns almost exclusively source power from an investor-owned utility, Minnesota Power, with some allowance for self-supply. Those that are west of the WAPA boundary have fixed contracts for a preference allotment of hydroelectric power, similar to co-ops with territory west of the boundary.



Note: Basin and Dairyland serve additional co-ops in Iowa, Illinois and in other states out west. These co-ops were not visualized due to lack of data.

FIGURE 4.1.
Minnesota Electric Cooperative Primary Power Supply Contracts

Electric cooperatives in Minnesota, and across the nation, co-own generation and transmission (G&T) co-ops. In Minnesota, five G&T co-ops (Basin Electric Power Cooperative, Dairyland Power Cooperative, East River Electric Power Cooperative, Minnkota Power Cooperative, and Great River Energy) provide energy services to distribution co-ops.

Primary power supply contracts between G&Ts and distribution co-ops vary in their provisions for self-supply. Basin Electric Power Cooperative (dark yellow) and East River Electric Power Cooperative (light yellow) provide all-requirements contracts to distribution co-ops that allowed a capped share of self-supply on a regional basis, but that cap has been reached. Dairyland Power Cooperative (green) provides a 250kW self-supply option. Minnkota Power Cooperative (red) provides a 5% self-supply option. Great River Energy also offers a 5% self-supply option for its 20 members under all-requirements contracts (light blue). Great River Energy provides fixed energy for eight other members (dark blue), for which variable amounts of self-supply are allowed.

Basin Electric Power Cooperative is unique in Minnesota in that it directly serves one distribution co-op but also provides wholesale power to a G&T co-op, East River Electric Cooperative, which in turn sells power to four distribution co-ops.

Data sources compiled from Minnesota Geospatial Commons (2015), U.S. Department of Agriculture's Rural Utilities Services Form 7, and utility annual reports. Wisconsin and South Dakota co-op service areas recreated from publicly available shapefiles on their public utilities commissions' websites. North Dakota co-op service areas hand drawn from public Minnkota documents. Information on Basin Electric Power Cooperative self-supply provisions from LaCreek Electric Association (2017). Data available upon request.

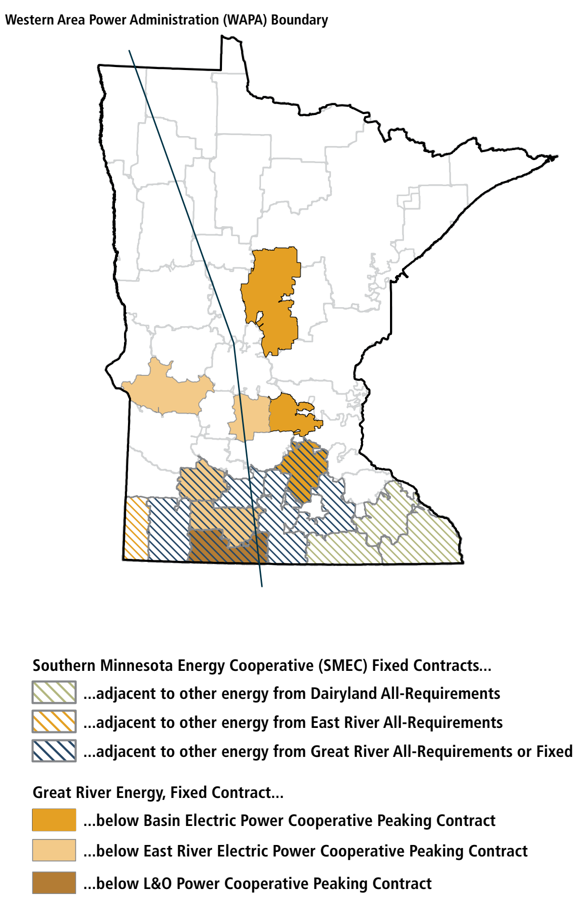


FIGURE 4.2.
Minnesota Electric Cooperative Secondary Power Supply Contracts

While all-requirements contracts with self-supply carve-outs are common in Minnesota and other regions of the U.S., many distribution co-ops in Minnesota use "fixed" contracts for set amounts of energy and capacity and "peaking" contracts for all energy above their fixed contracts. In Minnesota's case, there are at least three secondary power suppliers that supply distribution co-ops (sometimes simultaneously):

1) Western Area Power Administration (WAPA) allocations: WAPA is a federal agency that allocates set amounts of mostly low-cost hydroelectric resources to participating utilities. Some co-ops have direct contracts with WAPA; others' contracts were absorbed by generation and transmission (G&T) co-ops in past decades. Utilities eligible for WAPA allocations must fall (roughly) west of the 94th parallel, as indicated by the "WAPA Boundary" line that goes through Minnesota.

2) Southern Minnesota Energy Cooperative (SMEC) Membership: In 2015, 12 co-ops in the south of Minnesota joined together to purchase Alliant Energy Corporation's Minnesota service area, forming their own G&T, SMEC, in the process. Their contracts with Alliant run until 2024, at which point the co-op's other power suppliers will either take over previously contracted load by negotiation or automatically.

3) Peaking Contract with Basin Electric Power Cooperative or member G&Ts: Some Minnesota co-ops have "peaking contracts" that cover marginal power supply above fixed contracts with other power providers. Basin Electric Power Cooperative and its member G&T co-ops, L&O Power Cooperative and East River Electric Power Cooperative are in peaking contracts with Minnesota distribution co-ops. Like their all-requirements contracts, these peaking contracts allow for limited self-supply, though the exact terms are not publicly available.

Data sources compiled from Minnesota Geospatial Commons (2015), U.S. Department of Agriculture's Rural Utilities Services Form 7, and utility annual reports. Data available upon request.

FIGURE 4.3.

Minnesota Municipal Utilities by Primary Power Supply Contract

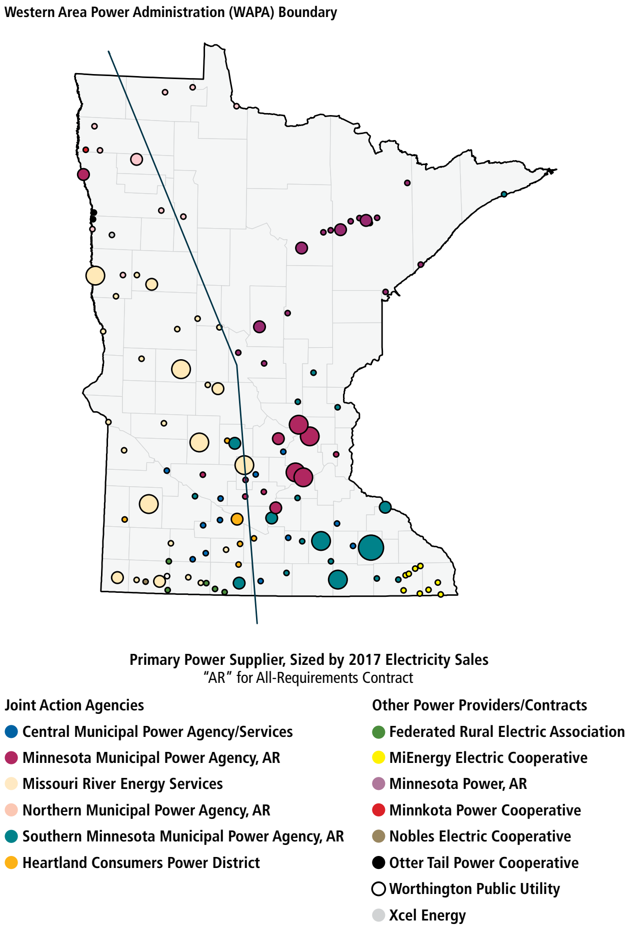
There are 125 munis in Minnesota. This figure highlights different types of power supply contracts, the full extent of which deserve further research:

1) Western Area Power Administration (WAPA) allocations: WAPA is a federal agency that allocates set amounts of mostly low-cost hydro-electric resources to participating utilities. Utilities eligible for WAPA allocations must fall (roughly) west of the 94th parallel, as indicated by the "WAPA Boundary" line that goes through Minnesota. Nearly 60 munis west of the WAPA boundary receive a set amount of preference energy from WAPA;

2) Joint Action Agency (JAA) contracts: Three JAAs; Southern Minnesota Municipal Power Agency (SMMPA), Minnesota Municipal Power Agency (MMPA), and Northern Municipal Power Agency (NMPA); serve 42 munis through all-requirements contracts. One JAA, Central Municipal Power Agency/Services (CMPAS), serves 12 munis through project-based contracts. And other JAAs (such as Missouri River Energy Services and Heartland Consumers Power District) serve munis through contracts whose terms we were not able to identify; and

3) Various generation and transmission contracts: at least three IOUs (Minnesota Power, Xcel Energy, and Otter Tail Power), one muni (Worthington Public Utility), and three distribution co-ops (Federated Rural Electric Association, MiEnergy Electric Cooperative, and Nobles Electric Cooperative) provide power to, or otherwise support, munis through various contract provisions.

Data sources compiled from Minnesota Geospatial Commons (2015), the U.S. Energy Information Administration's form EIA-861 (2018), power supplier websites, Minnesota Public Utilities Commission -10 dockets, Minnesota Municipal Utilities Association (MMUA, 2013), and municipal utility websites. Data available upon request.



The institutional ties and contractual relationships of Minnesota's munis and co-ops with generation providers demonstrate that while these utilities are relatively small, they are part of large, multi-state, centralized organizations. JAAs and G&T co-ops are exempt from many state and federal regulations and have a complex nested decision-making structure without direct representation of all affected members/customers. The interdependencies among distribution utilities driven by power supply contracts also highlight differences in the locus of decision making for DER implementation. For example, some distribution munis and co-ops have the ability under existing self-supply provisions to expand distributed generation. Others may be constrained by these provisions and in a position to consider negotiating a fixed contract to allow more flexibility. Still other munis and co-ops may be able to integrate more distributed generation by adjusting secondary or peaking contracts.

In practice, while many power supply contracts extend for decades and are often cited as constraints for DER deployment, the combination of different contracts, different contract lengths, and different debt positions, means the ability to negotiate more flexibility for DERs differs substantially across utilities.

In Minnesota, we found a wide range of responses to DERs. In some places, munis and co-ops are negotiating contract flexibility and deploying community solar (see Section 3.2). These configurations enable communities to take advantage of economies of scale while retaining local authority and community identity. In other places, larger utility-scale installations by a JAA or G&T co-op concentrate ownership at a higher level. In other communities, power supply contracts have precluded community solar, which has led to additional customer-sited solar instead. Case J illustrates how power supply contracts shape DER technology configurations. In this case, new DER technologies, net-metering and tax policies, and community members with ample resources have contributed to a relatively high penetration of customer-sited solar. The expansion of customer-sited solar and an ongoing all-requirements contract also appear to be crowding out considerations of power supply contract negotiations to enable community solar, despite the potential reliability and fairness benefits of this technology configuration. This example highlights the critical importance of power supply contracts and other institutional interdependencies for these relatively small consumer-owned utilities.

CASE J: RENVILLE-SIBLEY COOPERATIVE POWER ASSOCIATION

Balancing High DER Penetration and Restrictive Power Contracts

Renville-Sibley Cooperative Power Association, located in Danube, Minnesota, is the smallest cooperative utility in the state with just under 2,000 retail members (EIA, 2018). Renville-Sibley's small size, relatively high DER penetration levels, and restrictive power contracts make it an interesting case study when considering DER deployment. From 2013 to 2017, Renville-Sibley saw the installed capacity of distributed solar on their system increase from 9.2 kW to 761.8 kW. In combination with 99.8 kW of distributed wind, Renville-Sibley has distributed renewables capacity levels at almost 2% of their system peak (EIA, 2018).

Speaking on the large increase in distributed solar Renville-Sibley has seen over the last five years under the state's net-metering policy, CEO DeeAnne Newville explains:

In our particular case, we have members who have the means, both with physical land and financially, to put in their own [customer-sited solar]. And based on the Minnesota statutes, especially if they have a tax appetite, it's pretty attractive for our individual members.

For Renville-Sibley, the current solar installation rates are meaningful enough to lead to losses for the cooperative:

In our case it isn't a break-even for us. We actually lose money. It isn't, "Oh you just lost a profit." No, it's even bigger than that. It isn't even helping cover all our fixed expenses associated with the DG accounts. So that will negatively impact the rates of our other members. A subsidy to one group of consumers has to be covered by other consumers since we are a not for profit cooperative.

In parallel with the challenges of increasing distributed solar on a small co-op system, Renville-Sibley operates under an all-requirements contract with Basin Power Cooperative (via East River Electric Power Cooperative) that offers little flexibility to experiment with DER options:

We have a 100 percent all-requirements contract, not a 95 or 90. We're 100 percent…In my opinion, we're hindered a little bit by the rules of the G&T's, not simply because we are a distribution cooperative. We don't have much flexibility to try certain things.

Renville-Sibley now finds itself in a situation where distributed generation is growing based on opportunities their members see to individually gain from tax and net-metering policy. Even without a restrictive power supply contract, Newville expressed doubts that the co-op's small membership base could fill enough subscriptions to warrant community solar or another approach that might better prioritize sustainability, fairness, and community-wide benefit. Still, Newville is exploring alternatives. Newville was the only interviewee we spoke with who mentioned considering the value of solar on her distribution system:

For example, we had five DG's come on at the same time—same phase, same feeder. We had to have an engineer revamp our distribution system to handle that. If a utility has high density where they have many people on the line and have a line where they are running over 100 percent capacity, solar installations on that line may help. We have low density with only 1.6 consumers per mile. Our system is already built robust enough to handle the swings from grain drying and weather related loads. It may not add distribution level value for us, but to just say that anecdotally isn't fair. So that's why we wanted to have an engineer actually review the solar on our system. Maybe there is something that we just aren't aware of that we can put on the list of advantages. I don't know. I don't know what that would be.

It will be important to watch Renville-Sibley's trajectory over the next five to ten years to see if they can find opportunities for flexibility with limited resources and a context that favors customer-sited solar.

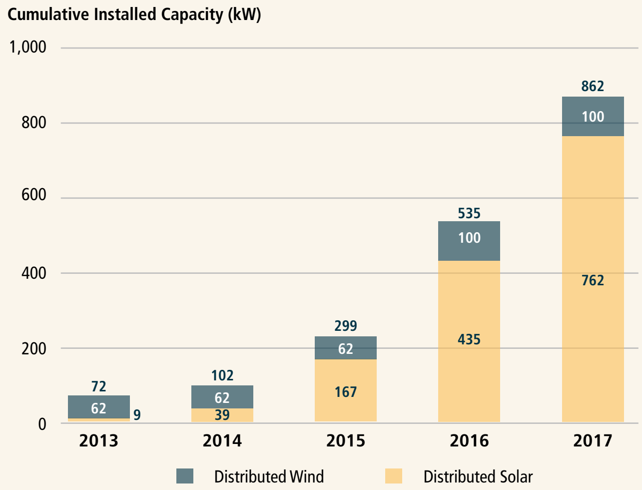


FIGURE 4.4.
Distributed Wind and Solar Capacity in Renville-Sibley

Distributed wind and solar generation growth from 2013–2017 for Renville-Sibley Cooperative Power Association. Over this period, Renville-Sibley's peak demand grew from 38.0 MW to 43.3 MW. Data compiled from the U.S. Energy Information Administration's form EIA-861 (EIA, 2018).

4.2. Local Policy Goals: Participatory Governance

Munis and co-ops, established based on the ideal of participatory governance, are governed by locally elected or politically appointed representatives (see Section 2.1). In addition, these utilities often engage in events and projects for the benefit of their community. Yet opportunities for meaningful participation in the decision making of munis and co-ops vary in practice. Turnout for utility leadership elections varies, as does the pay and benefits associated with these positions. The ability of local utilities to further local policy goals was mentioned in several of our interviews as both a blessing (when policy unlocks new action) and a curse (when slow-moving politics stall change). We found that some munis and co-ops are challenged to maintain connections with members and differentiate themselves from IOUs. But we also found that some munis and co-ops are actively creating opportunities for voluntary participation and many more are enabling expression of community values through material or symbolic activities.

Rapid changes in energy-system technologies can pose challenges for local board members. New innovations are changing the modes and expectations for customer interactions and responsiveness. For example:

One of the harder things is to keep up with the way technology is changing because, of course, we have a lot of things going on right now with interaction with MISO markets and stuff like that. Where we're going to take our generation going forward now.

We actually had one commission member, been down there for quite a while, that just resigned because he felt it was getting in over his head and didn't know if he wanted to put that much effort into it…he had served in city government, either city council or commission for a lot longer than I've been around here, like 35 years. It's not totally a surprise, but one thing he did say was some of the things coming now he felt a little out of place and a little overwhelmed…There's the wholesale market, retail market. We're doing rate studies so rate adjustments and stuff like that right now. Then the long term strategic planning of how we're going to build this stuff out and trying to keep the lowest possible price we can to the consumer and still being relevant to modern generation or technology. —Interviewee

As demographics and communication technologies have changed, the traditional means of customer/member participation in local utilities is also changing. Traditional forms of engagement with community members (e.g. informal meetings at the coffee shop or grocery store or paying bills in person) are dwindling in some places. For example:

There's another 60 percent or more of their customer base… which wants to do business on their phone or on the website or without interacting with utility people. That's a trickier one for our member [utilities] because they don't see them and they don't really understand that as well. —Interviewee

Many munis and co-ops in Minnesota are seeking to develop new ways for their customers/members to participate in decision-making and maintain their legitimacy. While DERs are creating new forms of participation in the energy system, other new technologies, such as universal broadband and mobile

CASE K: GRAND MARAIS PUBLIC UTILITIES COMMISSION

Local Climate Policy and Municipal Utilities

One small utility in Minnesota is using city government and policy to drive climate action at both the local level and the generation and transmission level. Grand Maraisis a small town with slightly more than 1,300 residents. It is isolated from the rest of the members of its joint action agency, the Southern Minnesota Municipal Power Agency (SMMPA), and at the end of a transmission line owned by the G&T co-op Great River Energy (Downer, 2016). Grand Marais once studied how to self-supply its generation needs with a biomass-fueled district heating system but decided against the investment. The town's mayor owns solar panels on his bed-and-breakfast. The city itself owns solar panels at the municipal golf course (interconnected to an electric cooperative). Through myriad small actions, along with direct input from the community and local government, Grand Marais was able to take some action toward its local policy goals, announcing this past spring the hiring of a climate change coordinator (Silence, 2018a).

Part of Grand Marais' approach has been to engage its power provider, SMMPA, as well as their peer SMMPA members. In early 2018, the Grand Marais Public Utilities Commission asked SMMPA to acknowledge that climate change is real (Grand Marais Public Utilities Commission, 2018). The activism wasn't new: in 2016, the utility passed a resolution seeking a carbon fee program at the federal level (Grand Marais Public Utilities Commission, 2016); and in 2017, the Grand Marais City Council adopted a "climate inheritance resolution," to create local climate planning in response to a handful of young students having graded the town with a D+ for its environmental performance (Jossi, 2017).

Responding to Grand Marais in 2018, a SMMPA representative invited a local community group to take a tour of its coal plant, stated that the SMMPA board didn't want to "politicize" the issue, and offered that actions speak louder than words (Silence, 2018b). As Grand Marais moves toward its city's climate goals, SMMPA has expressed some willingness to provide more renewable energy to Grand Marais, as well as onsite solar installations and an allotment from its community shared solar project. In this case, Grand Marais's municipal utility has been able to use local policy to shape its own system and nudge other adjacent parts of the energy system towards the community's policy goals. Because Grand Marais is a small utility with limited ability to separate itself from the shared infrastructure offered by SMMPA, it has sought to negotiate changes with SMMPA that are now making community solar available to all SMMPA member utilities.

communication, are changing the ways individuals can engage with shared governance. As ways of participating are changing, so too are expectations for democratic control. Some munis and co-ops expressed concerns about the pace of these types of changes, but it was less clear what Minnesota utilities will do to be responsive. Some examples do exist, such as "billboard" community solar projects, community engagement events, online customer/member surveys, new online applications for billing and usage data, and volunteer opportunities. As broader demographic and technology shifts continue to disrupt traditional connections between consumer-owned utilities and their communities, new forms of participatory governance are needed. Case K highlights how one municipal utility was able to pursue specific clean energy policy goals, provide opportunities for community members to participate in energy decisions, and advocate for changes that eventually expanded access to community solar for other distribution munis.

CASE L: MOORHEAD PUBLIC SERVICE

Connecting Municipal Services to Community Solar

Moorhead Public Service is a municipal utility in northwestern Minnesota outside of Fargo, North Dakota. Moorhead worked in iterations at community shared solar, working toward seven projects totaling more than 150 kW. Its first 40 kW project has a higher return on investment for participating subscribers compared to nearly all other CSS offers in Minnesota (other than Moorhead's subsequent CSS projects). For example, in its 44.6 kW phase 1 project, 50.3% of the cost of a CSS subscription was paid for by the utility. Moorhead was able to create this program by creatively pairing other locally defined energy programs with their CSS offering.

Because they needed to meet state Conservation Improvement Program spending requirements, Moorhead was able to subsidize the upfront cost of a panel in its CSS program by using general utility funds and its Capture The Energy community funds (Moorhead Public Service, 2015). Moorhead's first project drew 125 subscribers for 144 panels, and following projects sold out to community members, local universities, and a county government (Moorhead Public Service, 2018; Shaw, 2015). Given the focus on providing overall service value to its customers and creative linkage of other programs with community solar, Moorhead demonstrates how local governance and autonomy can be used to facilitate broader participation in DER programs.

4.3. Cross-Subsidization: Fairness Across Scales

One of the most frequently cited issues in our interviews was the potential for cross-subsidization associated with deployment of distributed generation (see also Section 3.3). Cross-subsidization is the incidence of costs (or benefits) on one utility customer/member due to the actions of another customer/member. In practice, regulators balance the objective of fully allocating the cost of service to each customer/member with other policy goals, such as ensuring access for all community members and providing incentives for energy conservation. Concerns about cross-subsidization were most frequently raised in the context of customer-sited DER (particularly solar) and the reimbursement structure required by state law to "net meter" distributed solar. Under the Minnesota net-metering law, enacted in 1983, the amount of generation that exceeds load from customer-sited generation below 40 kW is required to be reimbursed at the retail rate of electricity (North Carolina Clean Energy Technology Center, 2018). The state net-metering law is often described as a cross-subsidy because electricity customers/members that self-supply some electricity pay proportionally less toward the utility's recovery of the sunk costs of generation and transmission. The negotiation over how to appropriately balance the agency of individuals to self-generate electricity with overall system fairness within a distribution utility has played out very publicly in Minnesota munis and co-ops. For a summary, see the Minnesota Public Utilities Commission Staff Briefing Paper filed in November 2017 under docket E999/CI-16-512 (Minnesota Public Utilities Commission, 2017).

Many interviewees repeated concerns about fairness among residential customers/members with and without customer-sited solar. In our interviews, we found that most utility perspectives on fairness reflect a presumption that the status-quo distribution of benefits, costs, and risks is already fair. This presumption leads some utilities to place additional burdens on system changes, requiring interventions to demonstrate neutrality before they can be implemented. Thus, new customer-sited distributed generation, as implemented within current Minnesota net-metering provisions, can be viewed as unfair. For example:

We have an obligation to minimize cost shifting between our members…I'm not maximizing shareholder value, the point is to limit cost redistribution among the membership. —Interviewee

Many munis and co-ops expressed the additional concern that customer-sited solar benefits the wealthy at the expense of more marginalized community members.

In contrast, utilities that don't start with the presumption that the status quo is inherently fair use DERs as an opportunity to address concerns about current and future fairness and actively re-align benefits, burdens, and risks across customers/members. We found munis and co-ops actively redistributing benefits and burden by choosing to explicitly socialize all or part of the benefits and costs of DERs. These utilities justify their decisions based on customer/member interests or as a means of diversifying long-term generation resources. For example:

Any of these community solar programs…really end up kind of creating winners and losers locally...We're really trying to socialize the cost over the entire utility. —Interviewee

Active redistribution through DER programs is occurring through utility-scale solar connected at the distribution level, community-shared solar that is intentionally overbuilt and undersubscribed, community-shared solar that is subsidized or offered at a negligible rate, and rebates or other efforts to encourage customer-sited solar sized to match load. Munis and co-ops that explicitly accept subsidized or socialized design are expanding access by actively redistributing from the population as a whole or from one sub-population to another. Case L highlights how local governance and autonomy can be used to meet locally defined policy goals.

In addition to concerns about cost shifting among subpopulations, distribution utilities are also concerned about cost shifting among member utilities that participate in the same JAA or G&T co-op. The wholesale rate structure is designed around the idea that each distribution utility participating in a JAA or G&T co-op is paying a fair share. Thus, individual distribution utility efforts to install community-shared solar, energy storage, or load management is viewed as potentially unfair. These DERs could potentially result in cost shifting among member utilities depending on the debt position and wholesale market participation of JAAs and G&Ts. For example:

When you moved to [city] and put solar on your roof, right now it's just going to affect [city]. But it could, with these joint action agencies, end up raising the rates of people in [nearby city]. If we went at this truly in an aggregate fashion…we could see distributed energy resources affecting rates of other communities. —Interviewee

Case M highlights how being an early adopter of new technology can result in local utility cost savings, while shifting the burden of sunk investments to other member utilities that receive services from the same JAA or G&T co-op.

At both the individual and member-utility levels, introducing DERs into the existing cost allocation framework raises concerns about an unintended redistribution of costs.

CASE M: EAST RIVER ELECTRIC COOPERATIVE

Take a Load Off

In 1983, East River Electric Power Cooperative, a transmission cooperative with distribution cooperative members in eastern South Dakota and western Minnesota, made a large investment in load management. In a decision decided by one vote, East River decided to invest one-fifth of the utility's total value on its way to deploying over 10,000 load-management receivers within a year on its member utilities' customers' water heaters (Hexom, 2000).

Speed was necessary because East River was in the midst of mass farm foreclosures, high interest rates, poor load factors, and flat sales overall (Holt, 2007). East River's power provider, Basin Electric Power Cooperative, had overbuilt capacity, anticipating high growth. Facing revenue shortfalls, Basin nearly quadrupled its demand charge to East River from $3.95 per kW in 1978 to $15.35 per kW in 1985. As the owner of transmission, East River had no choice but to reduce load, possibly at the expense of others in Basin's nine-state service area who only adopted load management later.

Given that East River avoided more than $30 million in demand charges from 1984 to 1990, burdens of cost recovery fall to other Basin members who couldn't avoid demand charges as easily as East River could. In one interview, a utility manager confirmed that a cost-shift between Basin's member utilities probably occurred during that time. Today, the question of fairness among Basin's member utilities still lingers. For Basin in particular, a recent decision to extend their "demand period waiver" means that certain off-peak demand increases won't be billed if they happen during those waiver time frames (Basin Electric Power Cooperative, 2018). In turn, this affects how much member utilities can control their load. This case illustrates how fairness and cross-subsidization issues are not limited to the residential customer scale but also manifest at the utility level when power providers cover multiple utilities.

5. TAKEAWAYS

The diversity across munis and co-ops as well as the legitimacy of local authority is often cited as a rationale to limit policy or implementation assistance targeting these utilities. Differences in local context, internal capacity, institutional relationships, community preferences, and interpretation of shared values mean that there is no "one size fits all" approach to facilitate the current energy transition among these utilities. Furthermore, DERs are disrupting traditional institutional relationships, rules, and social practices that munis and co-ops have relied on for decades. This is both changing the "solution space" and creating a critical need for policy, cooperation, and assistance.

In designing policy or assistance, the implementation strategies that munis and co-ops are using in response to DERs provide two important insights. First, the strategies draw attention to differences in reliance on—and flexibility of—existing institutional relationships with energy service providers, other utilities, consultants, nonprofits, and local and state agencies. For example, some munis and co-ops are redefining their role and relying less on traditional relationships, whereas others are reinforcing their relationships either to resist or support change. Recognizing the structure of these relationships allows better targeting of organizational actors at the level in the nested system that can enable change (state level, generation/transmission level, distribution level, or customer/member level).

Second, the strategies draw attention to differences in community preference for change. For example, some munis and co-ops are monitoring and planning for how to adapt DERs into existing structures; others are engaging their community and experimenting with system change. Recognizing the diversity of community preference allows for better alignment of policy or assistance with the different practices for engaging customers/members of different types (residential, commercial, and industrial).

In designing policy, engagement, and implementation assistance with munis and co-ops, it is important to target the appropriate actors for engagement, participation, and compliance. Addressing issues at the appropriate scale has implications for both the pace of change and the centralization of sustainable energy alternatives. Below, we identify five overarching takeaways from our empirical review and synthesis in this report. Then, in Table 5.1, we suggest example policies and decisions that actors at the state-level, utility-level, and customer/member and community-level can take to act on these takeaways.

1 While munis and co-ops share a set of common principles, the wide variation in DER "technology configurations" and implementation strategies highlights an important opportunity for ***learning across utilities, experimentation, and more effective collaboration*** building on the muni and co-op tradition of cooperation that bridges, but acknowledges, differences in individual local contexts. This may be particularly important for munis that in some cases lack the strong networks available to distribution co-ops.

2 Distribution munis and co-ops are also constrained in their ability to implement new technologies by long-term contracts or other institutional relationships that obligate resources for community purposes. Policy and implementation assistance could focus attention on ***adapting or re-structuring power supply contracts***.

3 As communication with customers/members shifts to incorporate more electronic and automatic mechanisms, munis and co-ops need new modes of information sharing, new approaches to transparency, and new mechanisms for governance and democratic participation. As ways of participating are changing, so too are expectations for democratic control, highlighting the importance of focusing policy attention on electricity-system governance at the local and state level. Re-structuring requirements and opportunities for ***information sharing, transparent decision making, structures for representation, and modes of participation*** has important implications for local legitimacy and autonomy.

4 DERs bring questions of fairness to the fore for munis and co-ops: fairness among customers/members and fairness among JAA or G&T member utilities. Some munis and co-ops have an explicit or implicit presumption that the status-quo distribution of benefits, costs, and risks is fair. This presumption leads these utilities to place additional burdens on new DERs to maintain the status quo distribution of benefits. In contrast, utilities that don't start with this presumption use DERs as an opportunity to address concerns about current and future fairness and re-align benefits, burdens, and risks across customers/members. This highlights the importance of understanding the tacit assumptions in how utilities conceptualize fairness. Policy reform could proactively consider the ***fairness implications of policy design*** by placing DER in the context of larger energy system goals and recognizing that considering fairness among distribution utilities may require negotiations that extend beyond Minnesota state boundaries.

5 Many munis and co-ops in Minnesota are constrained by their internal capacity. Internal capacity may be limited due to technical factors (e.g. aging hardware) or organizational factors (e.g. limited staff). Distribution utilities that face declining load, high debt burden, or lack expertise or infrastructure for communication and management are often unable or unwilling to take on the uncertainties and risks associated with new DERs. Policy and implementation assistance could focus on new ***financing mechanisms, risk reduction, and joint ownership opportunities*** for DER infrastructure and communication and data management systems.

TABLE 5.1. **Example Policy and Decision-Making Takeaways**

The takeaways of this report can help inform policy and decision making at the state, utility, and customer/member or community levels. This table provides *examples* of actions that could be considered for implementation based on each of the report's takeaways.

	What State-Level Actors Can Do	What Utilities Can Do	What Customers/Members or Communities Can Do
Learning across utilities, experimentation, and more effective collabo-ration	Provide financial and institutional support for learning exchanges across utilities (e.g. seed grants, conferences, workshops, and formal organizations that engage all munis and co-ops).	Strengthen networks (within and across power suppliers and across states) for knowledge exchange; organize workshops on emerging issues; develop best practices and share case studies. Engage those utilities without strong existing networks utilizing expert facilitators. Consider joint technology and program demonstration.	Organize customers/members, utilities, contractors, and other actors within the energy community for information sharing around best distributed energy practices.
Adapting or re-struc-turing power supply contracts	Develop guidance for contract re-negotiation and design that accommodates new technologies. Consider transparency requirements for power supply contracts, energy mixes, and resource planning.	Develop methodologies for assessing alternatives for power supply and other energy services. Provide support for studies of contract re-negotiation and design.	Request information from utilities over the contract design and sources of their power.
Information sharing, transparent decision making, structures for representation, and modes of participations	Consider transparency requirements for utility meetings and minutes.	Leverage technology and other modes of participation to enable democratic customer/member input in decision making. Develop best practices for communication and information technology (considering tradeoffs of in-house, shared, and contracted options).	Organize communities to hold local utilities accountable to local priorities. Engage utilities through existing channels and seek to create new channels.
Fairness implications of policy design	Modify existing and future policies to avoid one-size-fits-all policy design and accommodate local context (e.g. set limits to the size of customer-sited generation based on load; tie net-metering reimburse-ment to DER penetration levels). Allow for experimentation in DER reimbursement (e.g. statewide or power-supplier-wide reimburse-ment funds for DER reimbursement at/above a calculated value-of-DER or other avoided cost rate).	Support studies of the value of DERs that recognize regional differences or that are specific to utilities. Facilitate experimentation with DER reimbursement to balance multiple objectives, at a local and system level.	
Financing mechanisms, risk reduction, and joint ownership opportunities	Provide enabling conditions for finance targeted to munis and co-ops (e.g. tax credits or grants for DERs, and loan loss reserves or other credit enhancements).	Support and develop risk management and risk sharing opportunities (e.g. workshops on best practices, shared ratings of service providers, standardizing service packages, joint-ownership of technology). Enable new financing mechanisms (e.g. on-bill financing).	

6. SUGGESTED FUTURE RESEARCH

We were fortunate in this project to spend so much time with executives in Minnesota's munis and co-ops. While our project was focused on understanding the perspectives of distribution utilities, we also interviewed some G&Ts and JAAs. But missing from our formal discussions were more in-depth conversations and systematic engagement with customers/ members and boaard members of these utilities. Future work in this area should be sure to engage these other groups. In addition, we raise three specific topics that we were not able to fully address left for future work.

Participatory Governance: Munis and co-ops that traditionally relied on face-to-face communication and deep community ties to ensure adherence to cooperative principles and democratic accountability are challenged by changing demographics and new expectations for communication. Future research could focus explicitly on the role of new technologies in both the decline and emergence of new participatory mechanisms and structures of governance. This research could examine the evolving mechanisms of participatory governance and the role different stakeholders have in influencing decision making and increasinglegitimacy. DERs are creating new challenges for all utilities, and as utilities expand their management of DERs, training and educating staff and members/customers is likely to become a greater challenge.

Power Contracts and Markets: Many muni and co-op systems are invested heavily in coal assets. The un-depreciated life of these assets is a common concern among munis and co-ops. However, the burden of these assets and the value of DERs (energy efficiency, demand management, and distributed generation) not only depends on debt, but also on the opportunity to sell surplus generation or reduce purchases from the bilateral or wholesale market. The value for distribution utilities varies depending on the utility's contracts for power and other energy services. Importantly, DERs also can have different value for distribution utilities and for their power providers. Understanding these dynamics is critical for distribution utilities and energy-services providers in making decisions about the value of DERs. Research could help provide a more transparent framework for evaluating the value of DER by examining the variety of energy-services, how they interact with each other, and how they have changed over time.

Effective Network Building: Munis and co-ops have long depended on nested systems and external networks. This organizational structure allows munis and co-ops to retain local autonomy, while taking advantage of economies of scale. DERs are re-structuring these relationships and networks. Some DERs, like distributed generation, are modular and depend less on economies of scale. However, DER implementation often depends on advanced metering infrastructure, communication systems, and data management technologies that continue to exhibit economies of scale. In addition, DER implementation requires integration of many new actors, technologies, and interests. These nested systems include electricians, contractors, car dealers, community organizers, and state or national organizations. These networks shape energy deployment in rural Minnesota: a contractor's suggestion becomes the utility's legacy of electric sales, and energy developers or informed citizens become the backbone of public opinion when major energy supply decisions come to the fore. Research could examine how these networks are being disrupted, how diffusion of new technologies occurs in rural spaces, and how they are reforming with a specific focus on how to effectively strengthen these networks, while allowing sufficient flexibility for energy system transition.

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APPENDIX A. METHODOLOGY

Systematic direct interviews with Minnesota munis and co-ops have been limited (one notable exception is the 2017 report by the Center for Energy and Environment (Sullivan et al., 2017)).

Data for this study came from two sources: secondary descriptive data on utility sales and distributed generation in Minnesota and interviews with muni and co-op utility managers and other related industry actors. Initial interviews were selected through repeated conversations with field experts and purposive sampling to recruit interviewees across the different utility types (Lindlof and Taylor, 2011). Subsequent interviews were identified through referrals from interviewees and included in the study to the extent they achieved our purposive sampling objectives. Our semi-structured interview protocol asked practitioners about how they define DER, how they frame the opportunities and challenges associated with DER, and how the drivers of changes affected their organization (see Appendix F). The protocol was used as a flexible guide to encourage respondents to share their view of how decision making occurs and questions were adjusted or improvised to accommodate the widely varying experience and expertise of the respondents (Lindlof and Taylor, 2011, p. 200).

The data analysis for the interviews used an iterative coding process that began with open coding guided by our research interests and used subsequent cycles of coding to compare and reorganize the primary codes according to similarities or patterns that facilitated the analysis of the connections among codes and the development of themes. To strengthen the validity of this analysis, a member-validation test was performed to see how munis and co-ops managers and industry stakeholders responded to the research findings. We conducted two listening sessions in different parts of Minnesota, a discussion session with organizations that provide technical assistance to munis and co-ops in Minnesota, and a pair of discussion sessions sharing our initial findings with co-op managers.

TABLE A.1. **Overview of Interviews**

Respondents	55
Organizations	21 Munis 17 Co-ops 3 G&Ts 3 JAAs 2 Other
Average Interview Length	63 minutes
Total Interview Length	1,107 minutes
Timeline of Interviews	May 2016 – March 2018

APPENDIX B. KEY FINDINGS FROM YEAR 1 INTERIM REPORT

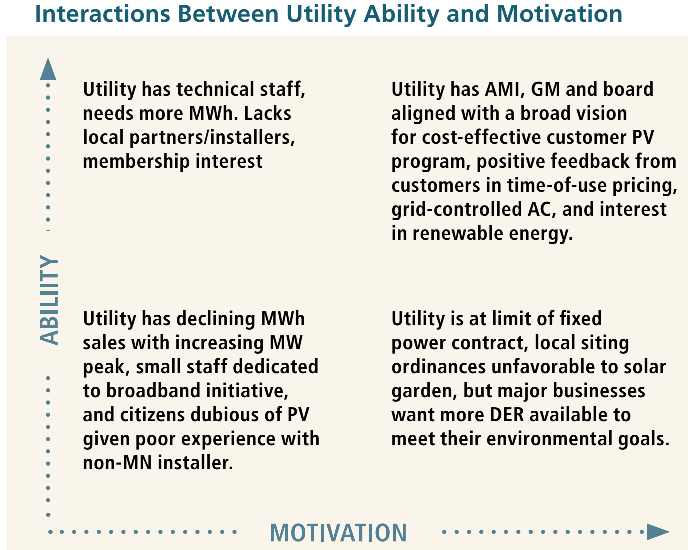
In the first year of the project, our team completed a literature review, descriptive data analysis, and ten interviews with muni, co-op, JAA, and G&T leaders in Minnesota. Based on this preliminary work, we highlight three key findings:

- It is important to distinguish between munis and co-ops when considering Minnesota's not-for-profit electric utilities, as they face different operational and financial barriers.
- Preliminary conversations and descriptive data reveal that the circumstances that define each utility affect their pathway towards a more distributed energy future.
- There is heterogeneity in both ability and motivation for these utilities to deploy DER, illustrated in Figure A.

We concluded in the first year that traditional levers of energy system change—such as state-level regulation and policy—were likely to be less effective in supporting change in Minnesota's munis and co-ops due to their local governance structure and local policy objectives, as well as their highly-valued culture of independence. Instead, our team suggested that alternative engagement approaches should be explored, such as technical support, capacity building, new finance mechanisms, and further research on power contract provisions.

A full copy of the interim year-one report is available upon request.

FIGURE A.1.
Interactions Between Utility Ability and Motivation



APPENDIX C.
UTILITY IMPLEMENTATION STRATEGIES: DETAILED FRAMEWORK

Table A.2 below, shows the four implementation strategies introduced in Section 3.1 horizontally, arranged loosely on a scale from precautionary to progressive. The vertical categories reflect the core cooperative and municipal values discussed in Section 2.3 but arranged on a scale from individuals to external institutional relationships, with two dichotomous interpretations at each level. These dichotomies highlight the varying interpretations of shared values. We developed this framework based on coding over 50 interviews with muni and co-op managers, clustering similar statements heard from multiple utilities regarding their decision-making approaches, and identifying patterns that could be aggregated to the four implementation strategies. The "X" marks in Table A.2 represent the outcomes of clustered responses.

Although it is not reflected in this framework, utilities recognize that these dichotomies are in fact not completely dichotomous. Instead, utilities are continuously working to balance the tensions in these interpretations of values, with the most-forward thinking utilities looking beyond simple tradeoffs for "win-win" opportunities at all levels.

This framework helps explore the reasons why munis and co-ops differ in their implementation strategies toward DERs. By asking questions about a utility's views on the dichotomies listed at each scale—from individual to external institutional—a utility's members/customers, policy makers, and members of the public can gain insight into the type of DER programs or policies appropriate for specific utilities. Table A.3 expands on this framework by offering illustrative examples of one DER technology, solar PV, in different technology configurations that are primarily consistent with each implementation strategy.

TABLE A.2. **Values-Basis of the Four DER Implementation Strategies**

The four implementation strategies for distributed energy resources with their derivations in distinct interpretations of a utility's relationships with individual customers/members, local authority in communities, internal identity, and external institutional relationships.

		Monitoring and Planning	Reinforcing Institutional Relationships	Community Engagement and Learning	Redefining the Distribution Utility
Concern for Individual Consumers / Members	Accepting of limits to individual agency for community benefits	X	X		X
	Responsive to individual agency			X	
Local Authority for Community Benefit	Precautionary approach to protect overall affordability and reliability	X	X		
	Seek stakeholder platforms and opportunities for creating overall value			X	
Internal Institutional Identity	Commitment to regulatory and current service roles		X		
	Actively enabling and providing new energy services and business models			X	X
(Nested) External Institutional Relationships	Adapting and strengthening existing networks		X		
	Active in reshaping external relationships to allow greater flexibility			X	X

TABLE A.3. **Examples of Implementation Strategies & Solar Technology Configurations**

Implementation Strategy	Local Context	Size, Ownership, and Placement	Payment/ Reimbursement Schemes	Solar PV Deployment
Monitoring and Planning	Low community interest in a cleaner grid Other infrastructure needs	Customer-sited	State net metering provisions One-time rebate Financing assistance	Solar PV capacity is a very small share of peak
Reinforcing Traditional Relationships	Relatively high share of residential sales	Utility-scale, controlled by distribution utility or service provider Customer-sited	Shared solar priced to cover installation and maintenance Grid access fees or relatively high fixed fees	Solar PV capacity small to moderate share of peak
Community Engagement and Learning	Community interest in a cleaner grid and in tax advantages	Customer-sited Utility-scale controlled by distribution utility or service provider	Customer-sited size exceeding load Shared solar with discounted subscriptions	Solar PV capacity moderate to high share of peak
Redefining the Distribution Utility Role	Community interest in a cleaner grid Economic growth in some communities	Utility-scale controlled by a distribution utility Customer-sited	Capped rebate or relatively high fixed fees Shared solar priced to cover installation and maintenance Utility-scale cost socialized	Solar PV capacity moderate to high share of peak

APPENDIX D.

MUNICIPAL AND COOPERATIVE AGGREGATED UTILITY ENERGY SAVINGS

TABLE A.4. **Municipal and Cooperative Aggregated Utility Energy Savings**

Energy savings, carbon-dioxide savings, and expenditures by aggregators under the Minnesota Conservation Improvement Program (CIP).
Table replicated from the Minnesota Department of Commerce (2016).

Organization	Incremental Energy Savings (kWh/yr)	Energy Savings %	Incremental CO_2 Savings (tons/yr)	Expenditures	Expenditures
COOPERATIVE CIP AGGREGATORS					
Dairyland Power Co-op	5,518,318	0.9%	3,965	$2,493,067	3.5%
East River Electric Power Co-op	11,599,401	3.5%	8,334	$367,323	1.5%
Great River Energy, All-Requirements Members	193,137,366	2.3%	138,769	$15,575,524	1.7%
Great River Energy, Fixed Members	27,418,152	1.0%	19,700	$4,277,865	1.6%
Minnkota Power Co-op/NMPA, 17 of 18 members	27,446,537	1.6%	19,720	$2,481,152	1.4%
Total—Co-op CIP Aggregators	**265,119,775**	**1.9%**	**190,489**	**$25,194,931**	**1.7%**
MUNICIPAL CIP AGGREGATORS					
CMPAS, 10 of 12 members	3,821,466	1.2%	2,746	$668,391	2.2%
MMPA, 8 of 11 members	9,474,550	1.5%	6,807	$939,095	1.5%
MRES, 23 of 24 members	17,221,376	0.9%	12,314	$3,999,925	2.6%
SMMPA, 15 of 18 members	18,495,262	2.0%	13,289	$2,574,555	2.9%
The Triad (SMMPA members)	40,489,019	2.1%	29,091	$4,346,841	2.3%
Total—Municipal CIP Aggregators	**89,501,674**	**1.6%**	**64,307**	**$12,528,807**	**2.4%**
INDEPENDENT COOPERATIVES					
Minnesota Valley Co-op Light & Power	2,905,341	1.7%	2,087	$333,403	2.4%
Sioux Valley Energy	549,603	0.5%	395	$63,974	0.7%
Total—Independent Cooperatives	**3,454,944**	**1.3%**	**2,482**	**$397,377**	**1.7%**

APPENDIX E. INTERVIEW PROTOCOL

Research Questions

1. What do utilities consider to be 'DER'?
2. What are opportunities and barriers are perceived by rural utilities? Which of these are most important?
3. How are decisions made regarding DER technology/program deployment, and/or why did a particular outcome arise in a particular utility?

Opening Script

Thank you for meeting with me today. I am a Graduate Researcher at the Humphrey School the University of Minnesota, and have been working with Prof. Gabe Chan and an interdisciplinary team studying energy policy, technology deployment, business models and rural economic development. The primary goal of our research is to investigate the unique opportunities and challenges utilities like yours face in deploying distributed energy resources (DER). We are speaking with a wide range of consumer owned utilities and stakeholders across the state. The insights we gain will be synthesized into materials that we plan to share broadly with all stakeholders wanting to gain a better understanding of the unique circumstances facing Munis and Coops.

Our questions are really a conversational guide to help us understand your experience with distributed energy resources.

If it's still ok with you, I would like to turn the recorder on now.

Interview Structure

SECTION GOAL: Gain background information, general DER information

1. Could you briefly describe your experience at UTILITY / involvement with UTILITY?
   a. How long have you been working with ______?
   As I mentioned, our goal is to understand how your utility considers, plans for, and interacts with distributed energy resources.
2. How do you define distributed energy resources?
   a. Are there any other new technologies or programs that your utility has recently deployed or is considering?
3. What has your experience been with these distributed energy technologies or programs?
   a. It sounds like you've had a [positive experience]; can you tell me more about what works well in the process? Is there anything that you would change?
   b. It sounds like you've had a [negative experience]; what were some of the challenges or what would you change in the process?
   c. It sounds like distributed energy resource are not a significant issue for your utility, why do you think that is?
4. Who, within your utility and in the stakeholder community, was involved in the decision making process?
   a. Who took the lead in initiating the project [or opposing the project]?
5. What was the role of your Board in this process?
   a. How do people enter into these or other leadership positions?
6. Have new distributed energy resources [or, NAME SPECIFIC TECHNOLOGIES OR PROGRAMS USED] affected your relationship with your [G&T or JAA/dependent utilities]?
   a. How would you describe the [G&T or JAA/dependent utilities] influence in decision making?
   b. What are some common disagreements?
7. How has being a Muni or Coop influenced your ability to pursue innovations?
   a. Could you tell me about where you learned about these technologies or programs?
   b. What were the major hurdles you faced in this project? How did you attempt to overcome them?

SECTION GOAL: Prompt a discussion of benefits, challenges related to DER based on open-ended questions. Anticipate at least some of the following challenges: rate impact/cross-subsidization, financing/costs, contractual limitations, "lack of membership interest", and will follow-up based on issues raised.

8. What do you see as the key opportunities that distributed energy resources provide, or could provide to your utility operations?
   a. Are there particular technologies or programs that present greater opportunities for your membership than others?
   b. Are there particular technologies or programs that present greater operational opportunities to your system?
   c. What about your system characteristics or utility circumstances lead to the benefits you mention?

9. What challenges has your utility faced in deploying distributed energy technologies or programs?
   a. Are there particular technologies or programs that present a greater challenge to your membership than others?
   b. Are there particular technologies or programs that present a greater operational challenge to your system?
   c. What about your system characteristics or utility circumstances lead to the challenges you mention?

10. Community solar programs have become an option in (some places) Minnesota. What are your perceptions of community solar programs?
   a. How do you think community solar programs compare to other DER resource options?
   b. (If they have a program) Could you share your experience creating a community solar program/project?
   c. (If they have a program) How do community solar programs affect your different customer groups?

SECTION GOAL: Understand the drivers of change, membership engagement/information

11. What issues do your members bring to you?
   a. What are the primary concerns of your members?

12. How have the new distributed energy technologies or programs that you have deployed [OR ARE PLANNING] affected your members?
   a. Are members differently affected by these changes?
   b. Are there differences in this respect between DERs and community solar [if they have one]?

SECTION GOAL: Get an overall sense of attitude, perceptions, etc. for changes in the industry.

13. What do you think your utility will look like in 20 years? Feel free to answer how you'd like it to look, or how it will actually look, or anywhere in between.

14. Are there any state or federal policy changes that you would recommend to open up more opportunities or reduce the challenges you face in integrating DER?

Concluding Questions

15. Is there anything that you think is important that I haven't asked about?

16. If you wanted to communicate one or two pieces of information with the academic or regulatory or legislative world what would that be?

17. Who else should we be speaking with to better understand the benefits and challenges associated with DER?

****

ADDRESS VIA EMAIL—ALONG WITH CONSENT

I sent along some summary information and statistics that I pulled together to characterize UTILITY. These data are helpful to me in understanding your specific, local circumstances. Before we begin, I wanted to confirm that there are no major gaps or errors I need to correct?

NOTES

i. We use the phrase "customer/member" throughout this report to generally refer to electricity users served by a muni or co-op. Munis serve electricity users who reside in their service territories and often also receive other municipal services from the same local government. Co-ops serve electricity users who reside in their service territories and who are members and owners of their co-op (sometimes referred to as "member-owners").

ii. The one exception is Dakota Electric, which is the one distribution co-op in Minnesota that elected to be rate-regulated by the Minnesota Public Utilities Commission.

iii. In recent years, renewable energy and social justice advocates have organized for energy democracy. Energy democracy movements seek to transition the energy system to one that is more environmentally sustainable, fair in terms of economic and environmental impacts across different communities and sub-populations, and able to provide agency and opportunity to the full breadth of people who are stakeholders in the energy system (Burke and Stephens, 2017). Within the energy democracy movement, munis, co-ops, and other community organizations are seen as central actors in a transition to low-carbon energy and social empowerment. Munis and co-ops are owned by their customers/members; they are governed through representative agents and elections, and potentially represent the grassroots, empowering structures toward which energy democracy strives. However, energy democracy can take many forms and realizing the movement's envisioned benefits requires fundamental shifts in relationships among technological configurations, energy consumers, electricity distribution service providers, and electricity generation and transmission providers. The energy democracy movement is discussed more fully in a forthcoming academic paper from this research project and is an area ripe for future research.

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