Business & Technology Report

February 2020

Electric Cooperatives Bring High-Speed Communications to Underserved Areas

Insights from NRECA's 2018 – 2019 Broadband Case Studies

NRECA

America's Electric Cooperatives

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NRECA
America's Electric Cooperatives

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Foreword

This report is an updated and revised edition of NRECA's 2019 report, "**Electric Cooperatives Bring High-Speed Communications to Underserved Areas."** The original report summarized findings from NRECA's 2018 series of twelve case studies of electric cooperatives that have entered the broadband communications business. This new version of the report summarizes the original 2018 case studies, with updated information, plus another eight case studies completed by NRECA in 2019.

In order to provide data and findings that are comparable across both groups of cooperatives, those whose experiences were captured in 2018 and those in 2019, all twenty co-ops were asked to provide data updated through year-end 2019. Ten of the twelve 2018 case study cooperatives provided updated data. All eight of the 2019 case study co-ops responded to the request and all but one provided updated information. Cooperatives featured in the 2018 case study series that did not update their information to reflect 2019 conditions are noted with an asterisk (*) where applicable. The extent of the data revisions varies.

Data tables contained in this updated report are separated according to the year in which the case studies were released. In each section, data tables from the 2018 case studies come first, followed by data tables for the 2019 cases.

How do the 2019 broadband case study cooperatives compare with those featured in 2018? Several differences and similarities are worth noting:

- Electric cooperatives featured in the 2018 series operate in twelve states; half of the 2019 case studies operate in one of those twelve states and the other half operate in four more, bringing the total number of states represented to sixteen.
- The 2019 case study cooperatives, on average, are larger and operate in lower density areas. Together, the twenty co-ops studied serve more than 530,000 electric members directly and another 220,000 indirectly, e.g., a G&T cooperative with distribution cooperative members.
- Broadband investments reported by several of the cooperatives featured in 2019 case studies are very high, making the average level of investment for the 2019 group higher than the 2018 group.
- Cooperatives featured in 2019 typically began offering broadband services at an earlier point in time than the 2018 group, thereby offering more years of experience from which to draw insights. A third of the 2018 case study cooperatives began offering broadband to customers five or more years ago. In contrast, more than half the 2019 group began offering broadband that early.
- A high degree of diversity in broadband business models was seen in the 2019 case study cooperatives, as was the case in 2018. In both year-groups, roughly half of the broadband entities reported that they operate at least partly as a for-profit business. Moreover, in 2019 as was seen in 2018, for-profit operations are often correlated with cooperatives that conduct business activities in non-electric membership areas.

- Some of the 2019 case studies surfaced business directions that were not seen in the 2018 group — one of the 2019 case study cooperatives has more broadband subscribers than electric members. Two more have adopted a wholesale business model that involves selling to business customers and telecommunications carriers rather than retailing to homes and businesses under the more common, fiber-to-the-premises (FTTP) model.

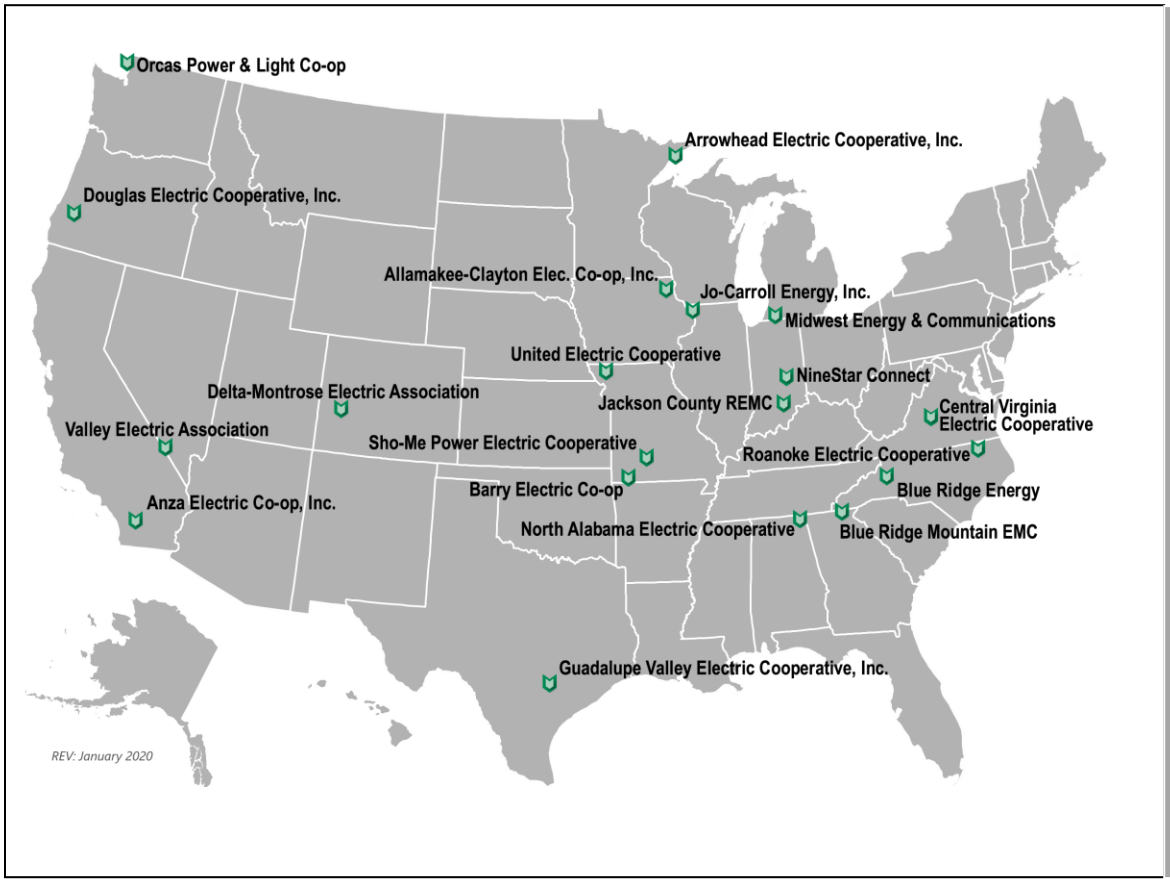
- The vast majority of broadband investments by 2019 case study cooperatives are in building fiber networks, as was the case in the 2018 cases.

Together, the 2018 and 2019 broadband case studies provide a reasonable (but still not statistically representative) cross-section of electric cooperatives that have made a significant shift in their business models. Nothing in the eight additional case studies suggests that this shift is slowing or has produced undesired outcomes.

Introduction

Electric cooperatives of all sizes and in many regions across the United States are building broadband communication networks, a focus seemingly beyond their traditional mandate. These networks enhance electric grid operations and member services, and just as significantly bring much-needed, high-speed Internet access to their communities. For many co-op CEOs, extending true broadband communications into rural areas is the current-day equivalent of rural electrification in the 1930s. The stakes are exceptionally high. Internet access is the great equalizer — enabling a virtual workforce, distance learning, telemedicine, and economic opportunities across the spectrum. However, high-speed communication networks are expensive to build and operate, and entry into a new business as different as broadband services often brings unexpected challenges to an electric utility organization.

What makes this report relevant and timely for electric cooperatives is the upcoming federal funding opportunity for rural broadband. The Federal Communication Commission (FCC) is preparing to conduct its largest auction of rural broadband funds to date, the $20.4 billion Rural Digital Opportunity Fund (RDOF). NRECA's broadband case studies, as summarized in this report, contain a treasure trove of information for cooperatives intent upon competing for these funds.



Electric Cooperatives Featured in NRECA's 2018 and 2019 Broadband Case Study Series.

What the 2018 and 2019 Case Studies Tell Us

Numerous lessons can be learned by carefully examining experiences of electric cooperatives that have entered the broadband business. This report looks at twenty electric cooperatives profiled by NRECA during 2018 and 2019, to learn from their bellwether successes (and challenges) in broadband.[1] What the case studies tell us is remarkable:

Together, these twenty cooperatives have to date invested approximately $700 million in broadband communication networks and have deployed about 26,900 miles of fiber.[2] Forward investments over the next five years by these cooperatives for broadband network build-out are conservatively estimated to exceed $370 million.[3] This would bring total investment in broadband by these twenty co-ops alone to well over $1 billion, an average of $50 million per case study co-op. Just over 100,000 subscribers are currently taking some form of broadband service from these cooperatives, with more being added every month.

Considering that half of the cooperatives featured in the 2018 and 2019 NRECA case studies began deploying broadband networks and offering service within the last five years, these are impressive, if not eye-catching, results. Some of these co-ops may in fact spend as much for their broadband network buildout over a few, short years as they have invested in electric infrastructure over the lifetime of their cooperative. Investment in broadband, for the featured cooperatives and perhaps many more, is a defining moment with lasting consequences. While these twenty case studies do not represent a statistical cross-section of NRECA's membership, they are likely to be indicative of a broadening trend among members. The increasing scale of broadband activities, as seen with these bellwether cooperatives, suggests that broadband investment represents a sea change not likely to abate any time soon.

[1] The case studies can be found at: https://www.cooperative.com/programs-services/bts/Pages/Broadband-Co-op-Case-Studies.aspx.

[2] Note that these investment figures are not directly comparable with those in the original 2019 report. The current investment figure is for actual investment to date, not actual and planned spending as was previously reported. Estimated investment to date (2019) is in the range of $686 million to $723 million due to timing differences inherent in the reported data.

[3] Only about half of the twenty cooperatives provided a response when asked for planned capital investment through 2024. These co-ops alone plan to spend about $370 million.

Purpose of This Summary Report

This report reviews data from the work NRECA undertook in 2018 and 2019 to capture the experiences of electric cooperatives that have launched a retail broadband services business, either through the electric cooperative itself, through a subsidiary entity, or through an affiliate.

In this summary report, NRECA creates additional value for its members by:

- Developing a set of data tables that summarize key aspects of the twenty broadband case studies. These tables enable cooperative planners and decision makers to look across the case studies and identify those experiences that are most directly relevant to their own, specific business situation. The tables also highlight common themes, challenges, and approaches that flow through the cases.
- Providing accompanying discussion points that identify strategic findings, common threads, innovations, and approaches from these bellwether cooperatives' experiences.
- Offering the wider electric co-op community the convenience of a consolidated, all-under-one-cover report containing the case studies themselves, high-level findings, and data tables in a PDF or hard copy for easy reference.

It is not the purpose of this report or the data tables it contains to reach conclusions about NRECA's membership as a whole. The sample count is far too small to reach statistically defensible conclusions for a population of nearly 900 diverse entities.

Cooperative Profiles

Introduction and Overview

The twenty electric cooperatives selected by NRECA in 2018 and 2019 as case studies operate in sixteen states and many different regions of the U.S. and are a reasonable, but not necessarily representative, cross-section of the larger cooperative community. They share one important attribute — each featured cooperative has taken a bold step into the world of broadband communications. The entry cost to build a high-speed communications network is high, and the need for due diligence of any such investment cannot be overstated.[4] The majority of broadband network deployment by our case study cooperatives has taken place in a very short period of time — typically, in the last five years.

Communications services are a competitive business, even in areas where businesses and households have had only limited options from which to choose in the past. Capturing market share is critical for recovering upfront capital investment dollars and covering ongoing, operating costs. However, even competitors who have a small market share and might otherwise appear disinterested can take pre-emptive steps to hamper the success of new market entrants, as is reported in several of the case studies. Some of the featured case study co-ops also note that retail marketing was not previously a competency that their co-op possessed, and that the learning curve should not be underestimated. But, the insights, data tables, and broadband case studies in this report suggest these challenges are, in fact, not insurmountable.

Key Insights from the Case Studies

- **Diverse Group –** The twenty electric cooperatives profiled by NRECA range in size from 3,900 to 85,000 members and operate in sixteen states. While not a statistically representative sample of the overall NRECA member universe, this group is nonetheless highly diverse.
- **Low Density Areas –** The cooperatives profiled serve a weighted average of 7.5 members per mile of electric line. This is close to the average of 8 consumers per mile of line for NRECA members nationwide.
- **A Recent Development –** Just over half of these cooperatives began deployment of their broadband networks within the past five years.
- **Population Served –** Together, the electric co-ops profiled by NRECA serve roughly 537,000 members directly, and another 220,000 indirectly, e.g., a G&T cooperative through its member distribution cooperatives. In spite of the relative newness of these broadband service offerings, 100,000 electric co-op members and non-members currently subscribe to broadband services, a 42 percent average take-rate in areas covered by these co-ops' broadband networks. Co-ops generally report an increase in take-rates over time.
- **Target Markets for Broadband –** The target market for broadband services typically includes the entire electric membership area, with the exception of areas adequately served by other broadband

[4] NRECA's Due Diligence Report can be found at: https://www.cooperative.com/programs-services/bts/documents/reports/broadband-due-diligence.pdf

service providers. However, about half of the twenty co-ops profiled currently serve broadband customers beyond their traditional electric membership areas. Others report that they plan to serve non-member areas in the future. One cooperative reports having more broadband subscribers than electric members.

Tables 1 and 2 on the following pages contain cooperative profile data from the 2018 and 2019 broadband case studies, respectively. This glossary of terms defines the abbreviations used in the data tables throughout this report.

Abbreviations Used in the Data Tables

CAFII:	Connect America Fund Phase II, part of the Federal Communications Commission's (FCC) reform and modernization of its universal service support programs.
CASF:	California Advanced Services Fund, a broadband infrastructure grant program.
CDBG:	Community Development Block Grant, a program of the U.S. Department of Housing and Urban Development, which funds local community development activities and infrastructure development.
CLEC:	Competitive Local Exchange Carrier, a company providing local telephone services that compete with the incumbent local services provider (see ILEC).
EBITDA:	Earnings before interest, tax, depreciation and amortization, a measure of a company's operating performance.
FTTP / FTTH:	Fiber-to-the-Premises / Fiber-to-the-Home.
Gbps:	Gigabits per second, a measure of communication speed.
GPON:	Gigabit Passive Optical Network, a way of providing fiber to the home.
ILEC:	Incumbent Local Exchange Carrier, a company providing local telephone services.
IPTV:	Internet-Protocol-based TV.
LTE:	Long Term Evolution, a 4G wireless mobile communications standard designed to provide up to 10x the speeds of 3G networks.
Mbps:	Megabits per second, a measure of communication speed.
MPLS:	Multiprotocol Label Switching, a routing technique in telecommunications networks that directs data from one node to the next, based on short path labels rather than long network addresses.
OLT:	Optical Line Terminal, the endpoint device in a passive optical network.
ROI:	Return on Investment, a measure of profitability.
SCADA:	Supervisory Control and Data Acquisition system.
VoIP:	Voice over Internet Protocol, an Internet-based telephony approach.

Table 1. Cooperative Profile – Electric Operations (continued to next page)
Updated 2018 Case Studies

Cooperative Name	Broadband Entity Name	Location	2019 Member Size (Electric)	Electric Line Density (Members per Mile)	Electric Membership Area	Physical Terrain
Anza Electric Cooperative	*ConnectAnza*	Southwest of Palm Springs, California	3,900	5.6	550 square miles in Anza Valley, Southwest Riverside County, California	Varying, coastal slopes and mountains ranging from 2,000' elevation to 5,000'
Arrowhead Electric Cooperative	*True North Broadband*	Northeastern tip of Minnesota, bordered by Ontario, national forest and Lake Superior	4,200	7.0	Cook County and part of Lake County, in far northeastern Minnesota	Rough, rocky terrain with tall trees; mountains on one side and Lake Superior on the other. Ground extremely hard with shallow line depths. Includes national forest and wilderness areas.
Barry Electric Cooperative	*goBEC Fiber Network*	Southwestern Missouri	6,700	6.1	Southern part of Barry County, Missouri	Peaks and valleys--running fiber overhead on poles is the "*de facto* choice." Cellular coverage poor due to terrain.
Delta-Montrose Electric Association	*Elevate Fiber*	Western Slope of Colorado	28,137	8.5	Delta and Montrose Counties, and part of Gunnison County, Colorado	Colorado valley lands with rolling hills and mountain foothill terrain. Rocky for a large marjority of the service territory
Douglas Electric Cooperative	*Douglas Fast Net*	Southwest Oregon	10,000	6.0	2,200 square miles in western and northern Douglas County, with small portions in northeast and southeast Coos County and south Lane County.	Mountains and valleys.

* For Barry Electric Cooperative data shown are for 2018.

Table 1. Cooperative Profile – Electric Operations (continued from previous page)
Updated 2018 Case Studies

Cooperative Name	Broadband Entity Name	Location	2019 Member Size (Electric)	Electric Line Density (Members per Mile)	Electric Membership Area	Physical Terrain
Jo-Carroll Energy	*Sand Prairie Broadband*	Northwestern Illinois, near Wisconsin and Iowa borders	16,000	8.4	Four northwestern Illinois counties	River bluffs and ridges used for siting wireless towers connected to fiber backbone to enable FTTH/FTTP.
Midwest Energy & Communications	*[Same name]*	Southwestern and southeastern Michigan	36,000	9.0	Twelve counties in Michigan, plus adjacent areas in Indiana and Ohio	Typical Midwestern terrain
Ninestar Connect (formerly Central Indiana Power)	*Ninestar Connect / GigE Internet*	Central Indiana	14,700	9.5	Four Indiana counties	
North Alabama Electric Cooperative	*NA Fiber*	Northern Alabama	18,200	8.5	Jackson & Marshall Counties, Alabama	Rivers and mountains
Orcas Power and Light Cooperative	*Rock Island Communications*	Twenty islands off northwestern Washington state	11,316	11.0	San Juan County, Washington	Islands off Washington coast; rocky terrain.
Roanoke Electric Cooperative	*Roanoke Connect*	Northeastern North Carolina	14,500	7.3	Parts of seven North Carolina counties.	Coastal plain.
Valley Electric Association (VEA)	*Valley Communications Association (VCA)*	Western Nevada	19,158	8.5	Approximately 6,800 square miles in western Nevada with a sliver in California.	Mountains and valleys.

* For Ninestar Connect data shown are for 2018.

Table 1. Cooperative Profile – Electric Operations
2019 Case Studies

Cooperative Name	Broadband Entity Name	Location	2019 Member Size (Electric)	Electric Line Density (Members per Mile)	Electric Membership Area	Physical Terrain
Allamakee-Clayton Electric Cooperative Postville, IA	*AC Skyways*	Northeast Iowa, bordering on Wisconsin and Minnesota	9,990	4.0	1,475 square miles in parts of eight counties; principally Winneshiek, Allamakee, Fayette and Clayton counties.	Fairly rugged, with hills, valleys and forests.
Blue Ridge Energy Lenoir, NC	*RidgeLink, LLC*	Northwestern North Carolina	76,000	9.2	1,450 square miles; three North Carolina counties and parts of four more.	Mainly rocky, mountainous terrain with elevations as high as 6,600 feet above sea level.
Blue Ridge Mountain Electric Membership Corporation Young Harris, GA	*(to be determined)*	Northeastern Georgia and western North Carolina	44,000	8.3	1,179 square miles; two and a half counties in Georgia and most of two counties in North Carolina.	Southern end of Appalachian mountains; rugged terrain.
Central Virginia Electric Cooperative Arrington, VA	*Central Virginia Services, Inc. dba Firefly Fiber Broadband*	Central Virginia	32,000	8.0	1,943 square miles; portions of fourteen Virginia counties.	Varied terrain including the foothills of the Blue Ridge Mountains, rolling hills and flatlands near James River.
Guadalupe Valley Electric Cooperative Gonzalez, TX	*Guadalupe Valley Electric Cooperative dba GVEC.net*	South central Texas	85,000	8.5	3,500 square miles; 100% of five Texas counties and parts of eight more.	Gulf coastal plains; flat, low-lying lands
Jackson County REMC Brownstown, IN	*Jackson Connect*	Southern Indiana	20,100	6.9	1,252 square miles; parts of ten Indiana counties.	Farmland and rolling hills
Sho-Me Power Electric Cooperative Marshfield, MO	*Sho-Me Power Electric Cooperative dba Sho-Me Technologies*	South central Missouri	9 member distribution cooperatives serving 220,000 member-owners.	N/A	26 counties	A beautiful area of heavily forested hills and low mountains, as well as caves, lakes and rivers.
United Electric Cooperative Maryville, MO / Savannah, MO	*United Services dba United Fiber*	NW Missouri and SW Iowa	7,500	2.6	5,000 square miles; parts of eleven counties, majority of members in Missouri.	Rolling, hilly country with many streams.

Table 2. Cooperative Profile — Broadband Operations and Plans (continued to next page)
Updated 2018 Case Studies

Cooperative Name	Broadband Entity Name	Broadband Service Area (Actual or Planned)	Broadband Deployment Timeline	2019 Active Broadband Subscribers
Anza Electric Cooperative	*ConnectAnza*	Coincident with electric service area	Began deployment in late 2015; full deployment completed.	1,800 active; 700 additionally signed up. Target of 4,000 subscribers.
Arrowhead Electric Cooperative	*True North Broadband*	Cook County membership area plus City of Grand Marais (non-membership).		Approximately 3,000 active subscribers of either Internet or telephone service, or both.
Barry Electric Cooperative	*goBEC Fiber Network*	100% of electric service territory (planned)	Construction began August 2016 and is now 50% complete. Full completion expected in 2020.	Approximately 1,500. Approximately 50% of members have main line fiber access.
Delta-Montrose Electric Association	*Elevate Fiber*	Plan is to extend fiber network to 100% of electric members by 2021. May extend to non-membership areas in the future.	First customer connected in June 2016.	6,800+ active subscribers
Douglas Electric Cooperative	*Douglas Fast Net*	Roseburg and surrounding Douglas County. Currently, one-third of DFN's fiber network lies within DEC's electric service area while two-thirds of the network is in the rest of Douglas County and surrounding areas. Broadband service started initially outside DEC's electric membership area.	DFN was created in 2001 and began operating in Douglas County in 2002. Residential telecommunications services were first offered in 2003, relying on a fixed wireless network. Fixed wireless was discontinued in 2019.	9,600 Internet subscribers and 400 ethernet connections to city halls, police departments, and schools.
Jo-Carroll Energy	*Sand Prairie Broadband*	100% of electric and natural gas membership area. JCE has no definite plans to extend its broadband network beyond its own service territory. Fiber backbone is exclusively for electric and gas operations.	Sand Prairie officially created in late 2008 and began offering wireless broadband services to memb ers in 2009. Fiber-optic network buildout commenced 2016-17 as the ultimate broadband solution.	2,400
Midwest Energy & Communications	*[Same name]*	Primarily MEC service territory; about 3% of current subscribers are non-electric members .	Launched in 2014. Phase 1 completed in 2019. Phase 2 launches in 2020 to be completed in 2021.	11,300 fiber Internet, telephone and TV subscribers

* For Barry Electric Cooperative data shown are for 2018.

Table 2. Cooperative Profile — Broadband Operations and Plans (continued from previous page)
Updated 2018 Case Studies

Cooperative Name	Broadband Entity Name	Broadband Service Area (Actual or Planned)	Broadband Deployment Timeline	2019 Active Broadband Subscribers
Ninestar Connect (formerly Central Indiana Power)	*Ninestar Connect / GigE Internet*	Electric membership area and beyond. Communications business currently operates on a for-profit basis in ten Indiana counties.	Original plan was for every electric member to have a smart meter installed by mid-2015 and fiber-to-the-home (FTTH) within a few years after that, building on the fiber ring that already connected the co-op's substations. 100 percent FTTH coverage was reached by the end of 2018.	5,500
North Alabama Electric Cooperative	*NA Fiber*			4,900 active "fiber members" as of mid-2019
Orcas Power and Light Cooperative	*Rock Island Communications*	100% of electric membership area.	Network buildout began in early 2015.	5,000 fiber-to-the-premises and LTE wireless subscribers
Roanoke Electric Cooperative	*Roanoke Connect*	100% of electric membership area, initially.	January 2018 launch. Full deployment expected in 24-48 months.	Fiber broadband deployment underway.
Valley Electric Association (VEA)	*Valley Communications Association (VCA)*	Wireless broadband currently covers approximately 95% of Pahrump and five other Nevada towns, as well as a small penetration in two towns outside VEA's service area. FTTH is being constructed in the Pahrump area.VCA owns and operates the broadband network and has the capability to provide wireless broadband services beyond VEA's traditional electric service territory, although this aspect of broadband operations is minimal to date.	VCA was launched in 2015. Wireless (WiMAX) tower construction (with fiber backhaul) began at the end of 2015 with subscriber installations beginning in July of 2016. By the end of 2018 approximately 95% of the electric service territory has wireless service available.	10,100

* For Ninestar Connect data shown are for 2018.

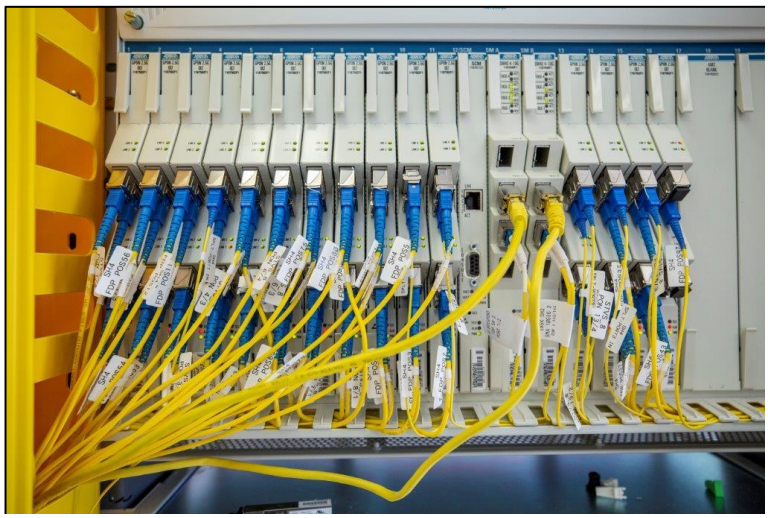
Table 2. Cooperative Profile — Broadband Operations and Plans
2019 Case Studies

Cooperative Name	Broadband Entity Name	Broadband Service Area (Actual or Planned)	Broadband Deployment Timeline	2019 Active Broadband Subscribers
Allamakee-Clayton Electric Cooperative Postville, IA	*AC Skyways*	Coincident with electric service area	Began deployment in january 2014. Continuing deployment of and connection to fiber networks as well as adding wireless repeaters in areas of demonstrated need.	515 hybrid fiber/wireless and 360 continuing satellite subscribers.
Blue Ridge Energy Lenoir, NC	*RidgeLink, LLC*	60% within electric service area and 40% areas outside the service area in northwest NC and NE Tennessee.	Began leasing out excess fiber in 2001; formed RidgeLink in 2009 to respond to growing requests for fiber infrastructure and cellular sites. Currently maintains 450 route-miles of fiber.	~120 contracts with business and institutional customers, including major telecommunications carriers.
Blue Ridge Mountain Electric Membership Corporation Young Harris, GA	*(to be determined)*	Primarily focused on electric service area, with a few exceptions.	Entered communication business in 2002 with dial-up, wireless, DSL and powerline carrier technologies. Fiber broadband deployment bega in 2006. Network expansion continuing with strategic additions in 2019 and 2020.	8,500 broadband subscribers (2019)
Central Virginia Electric Cooperative Arrington, VA	*Central Virginia Services, Inc. dba Firefly Fiber Broadband*	Coincident with service area; however, CVSI will also operate outside CVEC's service area to serve non-members in Census blocks as required by its CAF-II grant.	Began offering service January 2019. Initial buildout targeted for completion within five years. Current estimate is mid-2023.	1,700 subscribers (Dec 2019)
Guadalupe Valley Electric Cooperative Gonzalez, TX	*Guadalupe Valley Electric Cooperative dba GVEC.net*	Primarily focused on electric service area, with a few exceptions, e.g., municipalities outside service area with their own electric systems.	Fiber pilot project 2013-2015; broader deployment began thereafter.	14,000 - 7,700 served by wireless network and 6,300 by fiber-optic network.
Jackson County REMC Brownstown, IN	*Jackson Connect*	Coincident with electric service area	Began phase 1 of a three-phase deployment in November 2017. Expected network completion in 2021.	1,900 broadband subscribers, 710 pending (Nov 2019)
Sho-Me Power Electric Cooperative Marshfield, MO	*Sho-Me Power Electric Cooperative dba Sho-Me Technologies*	Fiber broadband network covers southern two-thirds of the state. Small extensions into Kansas, Illinois and Tennessee.	Fiber deployment began in late 1997 with an initial 500-mile build. Current network encompasses ~8,000 fiber miles. 100% substations connected to fiber. 4% additions annually are typical.	2,000 contracts in place with 300 business customers as of 2019. SMT serves nine distribution co-ops, incumbent telecoms and cellular service providers.
United Electric Cooperative Maryville, MO / Savannah, MO.	*United Services dba United Fiber*	Planning to reach all areas within electric territory that do not already have acceptable broadband; frequently expand into non-member areas, often through partnerships, as requests are made	Construction to connect 14 substations with fiber began in spring of 2011. First broadband customers connected in 2013. Since 2014 have expanded into non-member areas.	11,000 broadband subscribers (December 2019)

Business Decision-Making Factors

Introduction and Overview: No One-Size-Fits-All Approach

The business decision to expand from electricity distribution into broadband communication services is complicated, far-reaching, and strategic. What drives the business decision? What are the underpinnings of the business case justifying the large capital commitment required? And, how must the traditional electric co-op business model change? Detailed data conveying insights into all three of these questions have been provided by the co-ops featured in NRECA's 2018-19 broadband series. The picture that emerges is highly informative. There is no one-size-fits-all approach. Each case study describes an experience that is unique in some ways. As such, these early successes are not necessarily transferrable to other cooperatives looking for the best path to follow. Nonetheless, the case study co-ops' experiences can be highly instructive.



Key Insights from the Case Studies

- **Drivers of Broadband Investment –** The primary driver of cooperatives' broadband investments has been to meet internal business requirements, such as electric grid optimization, external requirements such as regional economic development, or both. In virtually all cases, broadband investment has produced significant benefits both internally and externally.

- **Addressing Underserved Populations –** Population densities served by the cooperatives studied are typical by NRECA standards (7.5 customers per mile of electric line, on average). The high cost associated with serving such low densities has been an impediment to commercial broadband service providers extending their network reach, leaving many rural households and businesses unserved or underserved.

- **Rate of Investment –** Electric cooperatives' rate of investment in broadband communications is rapidly outstripping the historical rate of investment in electrical infrastructure witnessed over the past century. Together, the twenty featured co-ops have invested some $700 million in broadband

communications infrastructure, mainly in fiber-optic networks. Further investments planned by the case study cooperatives to build out their networks total more than $370 million (a very conservative estimate since only about half of the twenty co-ops provided figures for forward investment).

- **Importance of Grant Funding –** More than $150 million in grants have been awarded to the twenty co-ops thus far.[5] These funds help underwrite the broadband investment, and in some cases, have dramatically accelerated the return on investment.

- **High Take-Rates –** Broadband services offered by these electric cooperatives are in high demand. In spite of the fact that some of the featured broadband deployments are not yet complete, more than 100,000 homes and businesses currently subscribe to these cooperatives' broadband service offerings. This corresponds to a weighted-average take-rate of 42 percent in areas covered by the broadband network, member and non-member areas combined. Communities' high level of trust in their local cooperative appear to be a contributing factor.

- **Crowd-Sourcing –** Crowd-sourcing platforms on the Internet have been used by a number of the featured co-ops to reduce financial risk.[6] This enables construction planning to be prioritized according to areas or zones, which in essence, can pay their own way. One co-op has even pioneered an approach that has neighborhoods ("fiberhoods") contributing toward middle-mile, network construction costs.

- **Organizational Decisions –** A wide variety of organizational approaches has been adopted. Some of the new broadband services entities are operating divisions of the cooperative, others are not-for-profit or for-profit subsidiaries with resource sharing agreements, and still others are fully independent, for-profit entities. Some operate both for-profit and not-for-profit broadband businesses. Over time, several co-ops have changed their broadband business structure from profit to not-for-profit, and vice versa.

- **Network Ownership –** Ownership of broadband network assets also varies widely. In some cases, the electric cooperative owns the entire network; in others, ownership of the network assets is split between the electric and broadband entities; and in still others, the broadband entity has financed and built the network and leases bandwidth back to its parent cooperative for electric operations.

- **TV or No TV –** Several of the new broadband co-ops have forgone providing local TV channels and programming content over their networks in anticipation of a full shift to Internet-based TV (IPTV) over time. This has important ramifications for investment planning, as the need for expensive video head-end facilities is eliminated under this approach.

Tables 3 through 5 on the following pages contain business decision factor data from the 2018 and 2019 broadband case studies, respectively.

[5] A small fraction of this total may have come in the form of low-interest loans. Data provided by one or more cooperatives does not allow grant and loan monies to be fully separated.

[6] Crowdsourcing in this context is different from crowd-source funding in general. Electric co-ops are using crowdsourcing platforms to capture subscriber expressions of interest, not to raise all of the capital needed to fund the project.

Table 3. Business Decision Making — Drivers of the Investment (continued to next page)
Updated 2018 Case Studies

		Drivers of the Business Decision	
Cooperative Name	**Broadband Entity Name**	**Internal / Business Requirements**	**External / Community Requirements**
Anza Electric Cooperative	*ConnectAnza*	Significant improvements expected in system operating efficiency and annual operating cost. Eliminartion of leased T-1 lines; internal telephone system was extremely expensive to operate. Grid modernization is also a key driver.	Level of local economic activity is low and a large percentage of the working population commutes out of the area. Median household income lags behind the statewide average. The area has traditionally been underserved by telecommunications service providers.
Arrowhead Electric Cooperative	*True North Broadband*	AEC did not have fiber connectionds to its substations before this project. In process of evaluating SCADA and conservation voltage reduction. AMI mesh network is now using fiber backhaul from data collection points.	A 2006-7 study ranked Cook County last among Minnesota counties for Internet connectivity and rated the county "underserved" insofar as broadband telecommunications is concerned.
Barry Electric Cooperative	*goBEC Fiber Network*	By 2015, BEC had developed a construction work plan to deploy SCADA and Smart Grid applications such as AMI data backhaul, time-of-use metering, voltage control data acquisition, prepaid metering, and remote connect/disconnect. BEC sees revenue stability as a major benefit of entering the broadband services business. "Fiber revenues are predictable."	BEC's B2B broadband service, in partnership with KAMO Power, had existed since 2000. BEC members became aware of broadband services being offered by other Missouri co-ops and began pressuring BEC. BEC's 2015 work plan envisioned FTTP for its electric members.
Delta-Montrose Electric Association	*Elevate Fiber*	Electric operations are significantly enhanced by DMEA's advanced metering infrastructure (AMI)—34,000 advanced meters coupled with high-speed communications. The broadband network enables meter data backhaul. AMI also used for outage monitoring and theft detection.	Regional economic development a key driver--promoting remote workforce;support 'aging in place' for elderly residents (55% of area residents are retirees); connect students; employ former coal miners building fiber network. Telemedicine also seen as a critical community service.
Douglas Electric Cooperative	*Douglas Fast Net*	With DFN's expansion into DEC's service area, DEC capital costs to extend fiber to its substations were only $470,000 for 158 miles of fiber-optic line. The total cost to connect fiber to all the substations was just under $2.4 million. DEC's SCADA system runs off the fiber network as does corporate data storage and IT backups between offices. DFN also installed fiber to 71 cell towers across Douglas County, which enables DEC's line trucks and crews working in the field to communicate via cell towers and back to the co-op's operational hub.	The county's Incumbent Local Exchange Carrier (ILEC) operated an analog telephone switch that had reached capacity; the infrastructure was largely comprised of aging, copper utility plant. Local businesses such as medical imaging facilities were forced to operate a "sneaker net," with couriers running images back and forth between imaging centers, doctors' offices, and hospitals. The situation became dire when ER physicians at the local hospital were unable to call out for a consult.

* For Barry Electric Cooperative data shown are for 2018.

Table 3. Business Decision Making — Drivers of the Investment (continued from previous page)
Updated 2018 Case Studies

		Drivers of the Business Decision	
Cooperative Name	**Broadband Entity Name**	**Internal / Business Requirements**	**External / Community Requirements**
Jo-Carroll Energy	*Sand Prairie Broadband*	The primary driver of JCE's broadband initiative was enhanced utility operations, in particular its implementation of advanced monitoring and control systems on its electric distribution system (SCADA and AMI). 135 miles of JCE's backbone fiber connect the cooperative's main office to one of two outpost offices and to a remote disaster recovery building housing redundant IT equipment to support business continuity.	Members also needed a better communication system. Fast, high quality access to the Internet was severely lacking in JCE's area. Regional economic development initiatives have also been hampered by the lack of an advanced communication infrastructure. As many as 20,000 of the co-op's members lacked robust, high-speed Internet access.
Midwest Energy & Communications	*[Same name]*	MEC was considering revamping its communication system to address legacy copper wire, satellite, powerline carrier and wireless systems it had in place. Plans to upgrade from automated meter reading (AMR) and Supervisory Control and Data Acquisition (SCADA) systems to an advanced metering infrastructure (AMI) demanded broadband communications. Among new capabilities planned are fault location and automated service restoration/downline automation.	MEC members demanded better Internet access. In addition to homeowners and businesses, professors at area universities live in MEC's service territory and needed the same level of broadband access they had on campus. The number of people working from home was unexpectedly high. MEC came to view fiber broadband as a powerful tool for local economic development and jobs retention.
Ninestar Connect (formerly Central Indiana Power)	*Ninestar Connect / GigE Internet*	Automated feeder switching is enabled by the fiber backbone that connects substations. Moreover, data from the co-op's smart meters are backhauled over a combination of wireless and fiber paths to the fiber backbone. The network also enables security cameras at substations and provides the foundation for WiFi coverage serving engineering technicians and line crews working in the field. In addition, SCADA system deployment is planned along with automated reclosers for improved system reliability.	The goal was to bring fiber broadband to unserved areas to create economic, educational, and retail service opportunities for residents. High-speed Internet access in many local homes was so sparse prior to 2011 that schools had to remain open late to meet the community's needs.
North Alabama Electric Cooperative	*NA Fiber*	Because NAEC receives its electricity from TVA, its distribution rates have trended toward being time-differentiated. An advanced metering infrastructure (AMI) was needed to enable time-of-use (TOU) rates and load management programs. 100% of NAEC members now have advanced meters in place. The recently installed fiber network provides the data communication system for NAEC's AMI system. NAEC lacks a SCADA system; however, AMI with fiber backhaul of feeder and substation data gives operations staff vastly improved visibility over what's taking place across the system in near-real-time.	Regional economic development: schools, hospitals and out-of-work residents. Within the two counties served by NAEC, 75% of electric load was industrial as recently as 2002. However, most of the area's industrial base was lost in the last decade. Also, a large part of NAEC territory was previously unserved by broadband ISPs.

* For Ninestar Connect data shown are for 2018.

Table 3. Business Decision Making — Drivers of the Investment (continued from previous page)
Updated 2018 Case Studies

		Drivers of the Business Decision	
Cooperative Name	**Broadband Entity Name**	**Internal / Business Requirements**	**External / Community Requirements**
Orcas Power and Light Cooperative	*Rock Island Communications*	OPALCO's need to better communicate with its crews, electrical substations and submarine terminals was the main driver behind its investment in an expanded broadband telecommunications infrastructure.	Reliability of telecommunications to/from the islands had long been a major issue. A 2013 break in the islands' sole telecom provider's undersea fiber cable interrupted landline, data and cellular telephone communications, including 911 emergency service, for ten days.
Roanoke Electric Cooperative	*Roanoke Connect*	REC recognizes the convergence of telecommunictions into the utility business model and is intent upon building the smart grid infrastructure and deploying the robust, high-speed communication system necessary to operate the utility of the future. The co-op is actively pursuing demand response, system automation, conservation voltage reduction, line-loss reduction, and energy efficiency programs as part of its long-term business strategy of wholesale cost avoidance.	Prior to Roanoke Connect, REC's service territory had very limited broadband access. Considering that all of the counties served by REC are deemed to be "distressed counties" by the state of North Carolina and have low population densities, it is unlikely that expansion of existing telecom services or upgrades to broadband speeds would have been viewed as an attractive business investment by incumbent service providers.
Valley Electric Association (VEA)	*Valley Communications Association (VCA)*	As part of a 230-kilovolt transmission line VEA was building in 2012, a fiber-optic communication system was deployed in the static wire (Optical Ground Wire or OPGW) for the purpose of substation and protection system communications. VEA's fiber network is now being used for SCADA (Supervisory Control and Data Acquisition) system communications and the cooperative is looking at realizing new Smart Grid capabilities..	Demand for quality broadband service was very high in the area. VEA employees initiated the idea of broadband service in response to a lack of competition.

Table 3. Business Decision Making — Drivers of the Investment (continued to next page)
2019 Case Studies

		Drivers of the Business Decision	
Cooperative Name	**Broadband Entity Name**	**Internal / Business Requirements**	**External / Community Requirements**
Allamakee-Clayton Electric Cooperative Postville, IA	*AC Skyways*	Data communications for grid operations currently met by a stand-alone RF system. When fiber broadband is fully deployed the co-op expects 50% of its use to be by the electric side.	The primary impetus for ACEC's investment in its hybrid fiber/wireless broadband network was, and continues to be, to serve members of the community who lack affordable options to access the Internet with a minimum of 10 Megabits per second (Mbps) download speed. Areas of need are demonstrated by clusters of satellite subscribers.
Blue Ridge Energy Lenoir, NC	*RidgeLink, LLC*	BRE's fiber-optic network provides the communications links between headquarters and the district offices, fiber is also used for data backhaul for the co-op's advanced metering infrastructure (AMI) and meter data management (MDM) system and to communicate with automated devices on the distribution system. BRE is currently considering a possible, new RF-based AMI solution for which its fiber-optic backbone would play a central role.	RidgeLink provides business-to-business broadband services, building, operating and maintaining fiber infrastructure projects. Community support is also an active part of the co-op's plan. Expanding the fiber infrastructure helps improve cellular service within the co-op's mountainous territory and improves information exchange and Internet access for health care providers, educational facilities and government agencies.
Blue Ridge Mountain Electric Membership Corporation Young Harris, GA	*(to be determined)*	Automated meter reading currently supported by a dedicated powerline carrier (PLC) technology. Ffiber assets will play a key role in the transition to AMI (advanced metering infrastructure) and implemention of distribution system automation and automated reclosers for outage management. BRMEMC's electrical substations will be an early focus for expanding fiber connectivity.	Area residents' broadband options in 2000 were extremely limited and, where available at all, high cost. And as broadband communications began to expand in cities across the Southeast, residents with second homes in northeast Georgia were becoming accustomed to having high-speed Internet access. BRMEMC's fiber optic network seeks to address these limitations and promote sustainable economic development.

Table 3. Business Decision Making — Drivers of the Investment (continued from previous page)
2019 Case Studies

		Drivers of the Business Decision	
Cooperative Name	**Broadband Entity Name**	**Internal / Business Requirements**	**External / Community Requirements**
Central Virginia Electric Cooperative Arrington, VA	*Central Virginia Services, Inc. dba Firefly Fiber Broadband*	The new fiber network will enable CVEC to better incorporate smart grid technology into its daily operations, improve the integration of distributed energy resources and help lower power costs through interactive energy management programs. Increasing bandwidth for communications within CVEC's system will improve efficiency, increase reliability, and expand security.	CVEC members needed faster, more reliable Internet access and attempts by the co-op to encourage entry by broadband providers had largely failed. By 2017 it became apparent to management and the board that CVEC's existing communications subsidiary (CVSI) might be the only viable option.
Guadalupe Valley Electric Cooperative Gonzalez, TX	*Guadalupe Valley Electric Cooperative dba GVEC.net*	GVEC needs fiber broadband for improved monitoring and control of its transmission system and substations. Communication requirements on the electric side continue to evolve. GVEC's peak demand program—Thermostat Control Program—rolled out in April 2018 has enrolled 1,500 members and saved over $80,000 in transmission costs in 2018. Such programs depend on near real-time data communications with meters and end-use devices.	The increasingly critical need to provide high-speed Internet access to unserved and underserved members was the primary driver behind GVEC's decision to invest in a fiber broadband network and to provide wireless access as an interim solution in some areas.
Jackson County REMC Brownstown, IN	*Jackson Connect*	Electric operations played an important, supporting role in the co-op's decision. In addition to linking up of distribution substations for more reliable data backhaul, the co-op also plans to connect fiber to eighty intelligent control devices on its system, including capacitor bank controls for system power factor improvement and voltage stabilization. They also plan to connect fiber to tie-line switches for enhanced distribution system automation.	Member demand for high-speed services was the primary motivating force behind the co-op's entry into fiber broadband services. With commercial and industrial customers representing only 5% of the membership base, about 1,000 customers in total, expanding existing businesses and attracting new ones was not the immediate driver of the co-op's broadband initiative. However, management recognizes that fiber broadband is an important part of the foundation for future economic activity.

Table 3. Business Decision Making — Drivers of the Investment (continued from previous page)
2019 Case Studies

		Drivers of the Business Decision	
Cooperative Name	**Broadband Entity Name**	**Internal / Business Requirements**	**External / Community Requirements**
Sho-Me Power Electric Cooperative Marshfield, MO	*Sho-Me Power Electric Cooperative dba Sho-Me Technologies*	Fiber-optic network initially deployed internally as the replacement for 2 GHz microwave system, which was threatened by FCC auction for licenses in this frequency band.	SMT has brought high-speed access to hundreds of anchor institutions, including K-12 schools, community colleges, public libraries, health institutions, and various local governments. The fiber backbone has enabled distance learning and telehealth, enhanced public safety applications, and expanded opportunities for economic development across Missouri.
United Electric Cooperative Maryville, MO / Savannah, MO.	*United Services dba United Fiber*	Broadband network provided connectivity to all 23 of the co-op's substations, enabling data backhaul from AMI wireless network, load control and automated reclosers. Volt/VAR control being considered.	Member survey in 2010 indicated 89% of membership area was either unserved or underserved (FCC minimum standard at the time was 4 Mbps/1 Mbps). Management and the board viewed widened broadband access as strategic for its highly positive impacts on the community and the co-op itself.

Table 4. Business Decision Making — the Business Case for Broadband Investment
Updated 2018 Case Studies - (continued to next page)

Cooperative Name	Broadband Entity Name	Invested to Date	Annual OpEx	Take Rates	Annual Revenues	Sources of Funding	Measure of ROI
Anza Electric Cooperative	*ConnectAnza*	$4.4 million Phase 1 cost; Phase 2 buildout expected to cost $3.3 million.	Projected annual operating expenses $900,000	40% projected take-rate appears conservative	Projected annual revenues $1.6 million	$4.4 million grants (two grants) from California Advanced Services Fund (2015 and 2019), and CoBank loans	Positive margins expected by year 5 due on large part to the subsidy effect of the grant
Arrowhead Electric Cooperative	*True North Broadband*	$20.1 million.	~ $2.6 million	36% take rate modeled on projections, currently at almost 60% take rate.	$3 Million projected annual revenues	USDA grants and low-interest loans totaling $16 million (2010); Cook County provided $4 million through its 1% sales tax fund.	Positive margins as of 2017; positive cash flow expected to take a niumber of years.
Barry Electric Cooperative	*goBEC Fiber Network*	$42 million for BEC members; $4.5 million to serve non-members.	~$1.6 million	Expected take-rate was 50% over five years. Initial take-rates 20-26% with 2-4% monthly growth rate.	~$2 million	CAF II auction resulted in award of $6.1 million to BEC in late 2018. Grant to be distributed over ten years.	BEC projecting five years to break-even.
Delta-Montrose Electric Association	*Elevate Fiber*	$70 million, excluding cost of initial fiber ring connecting DMEA electrical substations.	2020 ~ $7.5M forecast year-5 to hit $9M+	Take-rate as indicated by advance signups must be 25% for zone construction to begin; zones in service for more than 1 year exhibit robust take-rates, some as high as 60%.	Projected revenues of $6.4 million (2020) and $7 million (2021).	$6.4 million in grants from Colorado's Broadband Fund; otherwise internally funded.	DMEA expects positive cash (EBITDA basis) by 2021, 4 1/2 years after launch, and positive net income by 2024.

* For Barry Electric Cooperative data shown are for 2018.

Table 4. Business Decision Making — the Business Case for Broadband Investment
Updated 2018 Case Studies
(continued from previous page)

Cooperative Name	Broadband Entity Name	Invested to Date	Annual OpEx	Take Rates	Annual Revenues	Sources of Funding	Measure of ROI
Douglas Electric Cooperative	*Douglas Fast Net*	~$29 M ($25M plant and electronics)	~$11M (2019)	25%	~$13M (2019)	CFC with Coop Guarantee, RBE, CAFII, Stimulus, State Grants.	~8% (2019)
Jo-Carroll Energy	*Sand Prairie Broadband*	Expected to be $85 million when the fiber network is fully built out.	Projected to be $3.5 million when network is completed.	Tied to payback; range from 30% to 80% depending on density and capital expenditure. Average take rates: 45%	Subscriber revenues in 2019 ~$1.4M million (85% wireless and 15% fiber-optic)	Current funding is 100% self-generated from rev enues. JCE expects full build-out to require some grant assistance.	Areas are not built out with fiber until enough signups exist to assure a ten-year discounted payback period on the drops and portion of mainline fiber.
Midwest Energy & Communications	*[Same name]*	Projected cost for initial five-year buildout projected to be $73 million.	Expected to be $14 million when fiber network is fully established.	Approaching 70% in some areas that were built-out early in the five-year deployment period.	Expected to be $18 million when network is established.	Crowdfunding used to assure positive revenue and cash flows before fiber network construction is extended into new areas.	MEC expects positive net income and cash flow by the fifth year with a targeted internal rate of return (IRR) of 10% when the network is fully mature.
Ninestar Connect (formerly Central Indiana Power)	*Ninestar Connect / GigE Internet*	$54 million	(Not available)	(Not available)	(Not available)	(Not available)	The number of years needed to fully recover the fiber broadband infrastructure investment is expected to be lengthy. However, many of the benefits of the fiber network are not easily quantifiable.

* For Ninestar Connect data shown are for 2018.

Table 4. Business Decision Making — the Business Case for Broadband Investment
Updated 2018 Case Studies - (continued from previous page)

Cooperative Name	Broadband Entity Name	Invested to Date	Annual OpEx	Take Rates	Annual Revenues	Sources of Funding	Measure of ROI
North Alabama Electric Cooperative	*NA Fiber*	$24.5 million				ARRA rural broadband grant of $19.6 million received in 2010, covering 80% of $24.5M capital cost of network.	N/A
Orcas Power and Light Cooperative	*Rock Island Communications*	$27.5 million.	Projected to be $3 to 6 milion by 2022.	Conservative target for market penetration is 60% of San Juan County.	Annual revenue was $5.5 million in 2018 and $6 million in 2019; on target to generate $8.2 million by 2022.	Operating revenue from customer subscriptions, loan/line of credit from CoBank and direct investment in middle-mile/last-mile construction build-out by subscribers ($5 million to date).	Positive cash flow acheived in 2018. Net profit&loss on target according to plan.
Roanoke Electric Cooperative	*Roanoke Connect*	Phase 1 Investment cost of the 200-mile, Phase 1 fiber-optic backbone was approximately $4 million. Phase 2 Investment cost for last mile deployment including demand response devices = $27.2 million	2019 - ~$650,000	The 30% projected take-rate may be conservative, given that 70% of the local population have no other broadband options. Update- to date take rates have averaged 40%	2019 Projected = $395k Broadband and $244k Wholesale power Demand Savings (Contra Revenue)	CFC Financing One Community Development Block Grant has so far been obtained and REC is actively exploring other potential funding sources. Applications submitted $4 million State Grant; More will be requested from USDA Re-Connect Grant	REC's business case values its demand response, system automation and broadband backbone investments, using data provided by its power supplier NCEMC. Annual cash flow is positive for the demand response opportunities of smart thermostats and water heater controls, even when lost revenues due to lower kilowatt-hour usage are factored in.
Valley Electric Associatiom	*Valley Communications Association*	$46.5 million.	Expected $6.25 million.	~50% of membership has active broadband service, via wireless or fiber connection.	Annual revenues $6.1 million (2018). VEA management emphasized the Importance of monthly recurring revenue.	Financed through normal co-op financing channels and without the help of grants	Payback on the investment is expected in seven years based on the current and projected growth rates. Financial benefits accruing to VEA from its use of the broadband network for internal, operational requirements have not yet been fully quantified.

Table 4. Business Decision Making — the Business Case for Broadband Investment
2019 Case Studies
(continued to next page)

		Business Justification					
Cooperative Name	**Broadband Entity Name**	**Invested to Date**	**Annual OpEx**	**Take Rates**	**Annual Revenues**	**Sources of Funding**	**Measure of ROI**
Allamakee-Clayton Electric Cooperative Postville, IA	*AC Skyways*	$1.4 million	$836K (2019 budgeted)	Not meaningful for a wireless last-mile system.	$530K (2019 budgeted)	$1.45 million grant received from FCC Connect America Fund (CAF) under Rural Broadband Experiments Program in 2014.	Expected payback period for fiber/wireless broadband investment in 5-7 more years, perhaps longer.
Blue Ridge Energy Lenoir, NC	*RidgeLink, LLC*	Book value of telecom assets currently stands at $16 million..	N/A	N/A	N/A	RidgeLink operates as a cash business, deriving its cash flow from firm contracts and upfront payments. No grant assistance to date.	RidgeLink looks for investments that will produce a return in five years or less.
Blue Ridge Mountain Electric Membership Corporation Young Harris, GA	*(to be determined)*	$33 million	Approximately $5 million (allocation of costs between broadband and electric divisions is subject to TVA oversight as BRMEMC's rate regulator)	34%	$7 million (2019 projected)	Self-funded for the most part; awarded a $3 million USDA Community Connect grant spread over three years (with 15% BRMEMC match)	Management considers payback in 8-10 years to be realistic.
Central Virginia Electric Cooperative Arrington, VA	*Central Virginia Services, Inc. dba Firefly Fiber Broadband*	~ $35 million	$3.5 million (2019); $14 million after full buildout (2024)	Take rates are 50% in areas without cable tv options; 35-40% in areas with cable competition.	$3 million (2019; $18.6 million after full buildout (2024)	$28.6 million CAF-II grant (2018); $66 million Smart Grid loan from USDA RUS; additional grants, tax rebates and donations in-kind totaling about $10 million.	Initial financial model projection indicated 7 years to cash-flow-positive. Current estimate with the external financing sources is 2 years (2020).

Table 4. Business Decision Making — the Business Case for Broadband Investment 2019 Case Studies - (continued from previous page)

		Business Justification					
Cooperative Name	**Broadband Entity Name**	**Invested to Date**	**Annual OpEx**	**Take Rates**	**Annual Revenues**	**Sources of Funding**	**Measure of ROI**
Guadalupe Valley Electric Cooperative Gonzalez, TX	*Guadalupe Valley Electric Cooperative dba GVEC.net*	$42.5 million	Close to revenue levels.	60% in rural areas without high-speed Internet options available. 40% when including a blend of competitive and non-competitive areas.	$12 million in 2019.	Self-funded through revenues generated by Internet products and electric revenues that bring operational savings to the electric grid.	GVEC requires projected paybacks of 3 to 5 years for wireless network expansions and 10 years or less for fiber network expansions.
Jackson County REMC Brownstown, IN	*Jackson Connect*	$26.3 million	$2.3 million in year 5.	Projected to be 50% based on initial feasibility study. Actual rates exceeding forecast for Phase 1 (72% after 18 months).	$7.8 million in year 5.	A $74 million Smart Grid loan from the US Department of Agriculture's Rural Utilities Service is expected to fully cover the cost of the fiber network.	Original estimate of cash flow positive in 17 years improved to 12.5 years based on actual results in phases 1 and 2.
Sho-Me Power Electric Cooperative Marshfield, MO	*Sho-Me Power Electric Cooperative dba Sho-Me Technologies*	$156 million	$30 million	N/A	$34 million from contracts with business customers.	$26.6 million grant under NTIA's BTOP program. Otherwise self-funded through broadband related revenues.	N/A
United Electric Cooperative Maryville, MO / Savannah, MO.	*United Services dba United Fiber*	$63.2 million	$16 million projected for 2020.	55% to date within electric membership area.	$26 million projected for 2020.	$37 million in grants to date-- $17 million ARRA grant in 2010 + $20 million CAF II grant in 2018. CoBank and CFC loans augment grants and broadband revenues.	Business became cash-flow-postive in 2017, four years after first subscribers connected. $7 million EBITDA forecasted in 2020. By 2020, the co-op expects broadband gross revenues to exceed electric revenues.

Table 5. Business Decision Making — the Broadband Business Model
Updated 2018 Case Studies - (continued to next page)

		Business Model			
Cooperative Name	**Broadband Entity Name**	**Organizational Structure**	**Dedicated vs. Shared Staffing**	**For-profit vs. Not-for-profit**	**Broadband Products Offered**
Anza Electric Cooperative	*ConnectAnza*	ConnectAnza is an operating division of the electric cooperative, not a for-profit subsidiary. Broadband communications closely integrated with electric operations.	Five dedicated, technical personnel; shared services such as members services and accounting.	Not-for-profit operating division of the cooperative.	Broadband Internet; optional VOIP; dark fiber for countywide services. Programming content not currently offered.
Arrowhead Electric Cooperative	*True North Broadband*	True North Broadband is an operating division of AEC (not a subsidiary). AEC owns the entire broadband network.	Seven dedicated staff persons work in the broadband division—three handle customer service and billing, another four outside plant personnel perform planning, maintenance, construction and in-home installations. Calls from broadband subscribers are handled jointly with Connsolidated Telecommunications Co. (CTC) of Brainerd, MN.	Not-for profit	Internet access and telephone, faciitated through partnership with CTC. Streaming education supported
Barry Electric Cooperative	*goBEC Fiber Network*	goBEC Fiber Network is a wholly owned, not-for-profit subsidiary of BEC.	All employees of the fiber broadband subsidiary are BEC employees. BEC has seen >50% growth in staffing since 2015 (31 to 47). Dedicated personnel include: 2 indoor techs, 2 outdoor techs, 2 CSRs, 1 marketing person.	Not-for profit	Internet, VoIP-based telephone and IP-based TV/video services. Internet speeds offered are from 250 Mbps to 1 Gbps. TV offer enabled by partnership with Co-Mo Electric Cooperative for video head-end facilities.

* For Barry Electric Cooperative data shown are for 2018.

Table 5. Business Decision Making — the Broadband Business Model
Updated 2018 Case Studies - (continued from previous page)

		Business Model			
Cooperative Name	**Broadband Entity Name**	**Organizational Structure**	**Dedicated vs. Shared Staffing**	**For-profit vs. Not-for-profit**	**Broadband Products Offered**
Delta-Montrose Electric Association	*Elevate Fiber*	Elevate Fiber is a wholly owned, for-profit subsidiary of DMEA.	Elevate Fiber has ~16 dedicated employees including network engineers, installers and outside plant technicians. Back-office functions are treated as shared services.	For-profit.	Current broadband service offerings include Symmetrical Internet access speeds of 100 Mbps or 1 Gbps and VoIP service. Elevate has just become the first broadband service provider in the area to offer an app-based streaming video service using the MOBITV platform which has a look and feel similar to that of traditional cable TV
Douglas Electric Cooperative	*Douglas Fast Net*	The broadband network was built by DFN. DEC purchases reduced rate services; hence the cooperative benefits from the for-profit subsidiary, not vice versa.	DFN employs 56 people (2019), exceeding the number of electric employees at DEC. There is no resource-sharing or joint service delivery between DEC and DFN, resulting in a high degree of operational and financial independence between the electric cooperative and DFN.	For Profit	Internet access (100 Mbps to 1 Gbps) and voice services.
Jo-Carroll Energy	*Sand Prairie Broadband*	Broadband services offered through a regular operating division of JCE, not a subsidiary. Sand Prairie operates as a "fiber cooperative." JCE owns the fiber backbone and drops (last mile); Sand Prairie pays for the retail drops. Both electric/gas operational requirements and external requirements are considered in a ranking/weighting process as the fiber network layout is expanded.	Network operations are a shared responsibility between JCE's three core business units of electric, natural gas and broadband. All three business units are subject to a 'pro-rata' share of administrative services, such as billing and mapping. Only services specific to the business unit, such as Tier I technical call center support, are exclusively part of the respective business units' operating costs.	Not-for-profit	High-speed Internet access only. JCE is providing marketing materials to assist subscribers unfamilair with over-the-top (OTT) products such as streaming video options plus VoIP, IoT (ie.e.security sensors)

Table 5. Business Decision Making — the Broadband Business Model
Updated 2018 Case Studies - (continued from previous page)

		Business Model			
Cooperative Name	**Broadband Entity Name**	**Organizational Structure**	**Dedicated vs. Shared Staffing**	**For-profit vs. Not-for-profit**	**Broadband Products Offered**
Midwest Energy & Communications	*[Same name]*	The fiber business is a new division under the MEC "flagship" brand, not a new subsidiary.	20 staff have been added to date. Dedicated staff include fiber service reps, tech support, and installation/repair. All other personnel are shared resources. Activity-based cost accounting used to meet MPSC requirements and avoid unwanted cross-subsidization.	Selling fiber broadband services to non-members is considered a for-profit service and the associated margins accrue to the cooperative's established margin structure. Non-member subscribers pay the capital cost of network buildout.	High-speed Internet; voice services offered through Alianza. MEC Also offers subscribers ViewLocal (a package of local TV stations) and regularly provides broadband adoption workshops on "cutting the cord" and going "Over-the-top."
Ninestar Connect (formerly Central Indiana Power)	*Ninestar Connect / GigE Internet*	NIneStar Connect, a fully integrated, multiservice cooperative, came into existence in 2011 with the merger of Central Indiana Power and Hancock Telecom. Its communications division operates as a telecommunications cooperative.	A team of 34 works on the technical side to maintain the fiber network, which is used by all the operating functions. Back office functions such as customer support accounting and billing are consolidated for administrative efficiency.	NineStar operates both not-for-profit and for-profit subsidiaries. Communication services outside Ninestar's electric membership area are operated by Central Indiana Communications as Ninestar's CLEC on a for-profit basis.	Services offered include high-speed Internet, telephone, video and security solutions to residential and business customers. Internet access speeds up to 300 Mbps to residential customers with "Triple-Play" bundles of Internet+Phone+TV. Business customers' Internet speeds currently include 600 Mbps and 1 Gbps options. Services offered to business customers include hosted phone service, outsourced IT, and video services.
North Alabama Electric Cooperative	*NA Fiber*	NaFiber is an operating division of NAEC, not a subsidiary or spin-off	11 dedicated employees (as of June 2018) Dedicated installers work on fiber network and member drops; shared back-office functions in finance, accounting, billing and payroll.	Not-for-profit	Fiber Internet access at speeds from 50 Mbps to 1 Gbps, telephone and digital TV services

* For Ninestar Connect data shown are for 2018.

Table 5. Business Decision Making — the Broadband Business Model
Updated 2018 Case Studies - (continued from previous page)

		Business Model			
Cooperative Name	**Broadband Entity Name**	**Organizational Structure**	**Dedicated vs. Shared Staffing**	**For-profit vs. Not-for-profit**	**Broadband Products Offered**
Orcas Power and Light Cooperative	*Rock Island Communications*	Rock Island is a wholly-owned, for-profit subsidiary of OPALCO. OPALCO owns the backbone fiber; Rock Island owns all distribution fiber and LTE sites; OPALCO owns Rock Island.	40 full-time, dedicated employees.	For-profit subsidiary of OPALCO.	Fiber-connected subscribers offered Internet access service up to 1 Gbps and digital telephone service. Rock Island also offers a full suite of IT services--hosting, email, technology classes, etc. and new in 2019 was a full menu of Business Services.
Roanoke Electric Cooperative	*Roanoke Connect*	REC owns and operates the broadband backbone network and provides support related to the co-op's demand response and system automation programs. As such, related capital costs are rate-based as with other investments for system improvement. Roanoke Connect is a wholly owned subsidiary (CLEC).	REC has a total of 62 employees (2018).	Roanoke Connect is a wholly owned, for-profit subsidiary of REC	High-speed Internet only. No telephone service offering.
Valley Electric Association (VEA)	*Valley Communications Association (VCA)*	VCA is a wholly owned broadband communications subsidiary of VEA and co-op members receive patronage capital in VCA revenues.	Intercompany agreements define boundaries between the communications and electrical infrastructures. Some 30 personnel are dedicated to the broadband business while back office resources are shared. VEA's move into broadband services resulted in a 15% increase in overall VEA staffing from 142 to 163. All departments were impacted. Staffing levels have since been reduced to 133 since Jan-2019.		Wireless Internet access at 25 Mbps initially, recently increaed to 40 Mbps. Fiber broadband will offer speeds of 50 Mbps to 1 Gbps. VoIP telephone also offered.

Table 5. Business Decision Making — the Broadband Business Model
2019 Case Studies

(continued to next page)

		Business Model			
Cooperative Name	**Broadband Entity Name**	**Organizational Structure**	**Dedicated vs. Shared Staffing**	**For-profit vs. Not-for-profit**	**Broadband Products Offered**
Allamakee-Clayton Electric Cooperative Postville, IA	*AC Skyways*	Broadband services offered by an operating division of the cooperative, not a subsidiary.	Four full-time equivalents, all of which are shared resources with assignments on the electric or admin services side.	The broadband unit is not currently profitable. When revenues exceed costs, it will support the financial position of the cooperative and contribute to capital credits, as applicable.	Internet access with speeds up to 25 Mbps; VoIP telephone service; and dark fiber leases.
Blue Ridge Energy Lenoir, NC	*RidgeLink, LLC*	RidgeLink is a wholly owned, for-profit subsidiary of Blue Ridge Energy that provides business-to-business fiber broadband services.	RidgeLink has no direct employees. Blue Ridge Energy personnel handle the work of RidgeLink either on a job and task basis (line personnel), charging their time based on hours spent, or on an allocated-time basis (managers and executives). The co-op's Communications and Operations departments supply the personnel.	For-profit.	RidgeLink builds, operates and maintains small and macrocell cellular sites with fiber backhaul and offers col-location services to major carriers. The company also offers dark fiber capacity on its fiber-optic network. RidgeLink does not offer retail broadband services.
Blue Ridge Mountain Electric Membership Corporation Young Harris, GA	*(to be determined)*	BRMEMC's broadband business unit is an operating division of the cooperative, not a subsidiary. Currently, the unit operates simply as BRMEMC, offering fiber optic services. However, the Georgia legislature recently passed a law requiring that GA cooperatives offering broadband services must do so through an affiliate and publish their cost allocations with the Georgia Public Service Commission.	A dozen, dedicated staff run the co-op's broadband services business—six fiber splicers, three admin and billing staffers and three inside installers/troubleshooters. However, these individuals are assignable to electric functions when necessary, such as assisting with power restoration work during storm outages.	The broadband unit is not currently profitable. When revenues exceed costs, it will support the financial position of the cooperative and contribute to capital credits, as applicable.	Internet access speeds range from 30 Mbps upload / download to 100/100 Mbps service. Telephone service also available.
Central Virginia Electric Cooperative Arrington, VA	*Central Virginia Services, Inc. dba Firefly Fiber Broadband*	CVSI, dba Firefly Fiber Broadband, is a wholly owned, for-profit subsidiary of CVEC.	CEO of CVEC also serves as CEO of subsidiary CVSI. CVSI has its own GM, manager of customer service, network engineering manager and customer service reps. Current CVSI staffing is 15, headed toward 24 ultimately. CVEC provides marketing, HR and back-office admin services. Personnel working in electric and broad businesses are subject to "Chinese walls" under VA regulations and cannot share customer information.	For-profit subsidiary.	Internet access from 100Mbps to 1 Gbps download/100Mbps upload; VoIP telephone service bundled or separately. CVSI made a conscious decision not to offer video programming and instead educates subscribers about video streaming / OTT programming options that are available online.

Table 5. Business Decision Making — the Broadband Business Model
2019 Case Studies
(continued from previous page)

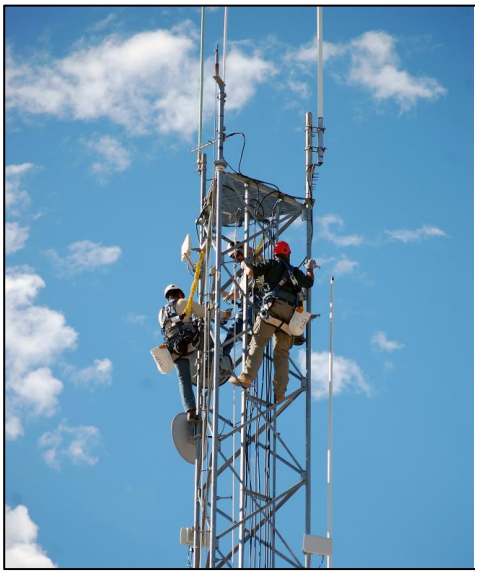
		Business Model			
Cooperative Name	**Broadband Entity Name**	**Organizational Structure**	**Dedicated vs. Shared Staffing**	**For-profit vs. Not-for-profit**	**Broadband Products Offered**
Guadalupe Valley Electric Cooperative Gonzalez, TX	*Guadalupe Valley Electric Cooperative dba GVEC.net*		General manager of GVEC serves as CEO of both electric and Internet operating divisions. Networks are jointly operated by electric and Internet divisions. About 30 personnel in Internet division (out of 300 total co-op employees)	Began as for-profit subsidiary. Merged with electric cooperative in 2018 to become an operating divison alongside electric.	Internet access speeds of 25 Mbps for subscribers on wireless network and 100 Mbps to 1 Gbps on fiber. Voice services being considered. GVEC.net also offers mesh network, in-home networking.
Jackson County REMC Brownstown, IN	*Jackson Connect*	Jackson Connect is an operating not-for-profit division of the cooperative, not a for-profit subsidiary.	Eleven full-time and four part-time fiber broadband personnel today. Some staffers, including customer service reps, handle inquiries and work tasks for both the electric and broadband sides of the business. After-hours calls are handled through a cooperative partner, Ninestar Connect. The co-op expects to need 30 broadband personnel when the fiber network buildout is complete.	Not-for-profit. When cash flow turns positive, net earnings will be channeled into fiber patronage capital. Must be an electric member connected to fiber to receive a fiber allocation. Non-electric members connected to fiber will be considered non-member revenue.	High-speed Internet access at speeds from 100 Mbps to 1 Gbps. The co-op offers periodic training opportunities (Tech Nights) for members to better understand options for VoIP telephone and OTT TV programming / video streaming. Managed in-home Wi-Fi at no additional charge.
Sho-Me Power Electric Cooperative Marshfield, MO	*Sho-Me Power Electric Cooperative dba Sho-Me Technologies*	SMT is a wholly owned, for-profit subsidiary of SMP.	SMT has no actual employees. Of SMP's total employee base of 167, about 39 full-time equivalents perform tasks for SMT. All the individuals performing tasks for the subsidiaries work out of SMP's telecommunications department (comprised of 42 people) and charge their time to the subsidiary.	For-profit.	SMT provides business-to-business connectivity in a wide range of service types including DS1, DS3 (Digital Signal or T-carrier bands-DS1 is the primary digital telephone standard used in the United States and several other countries), OC3, OC12, OC48 (optical carrier bands) and Ethernet scalable from 5 Mbps (megabits per second) to 100 Gbps.
United Electric Cooperative Maryville, MO / Savannah, MO.	*United Services dba United Fiber*	United Services is a for-profit subsidiary of the cooperative.	Management employees are shared between electric and broadband roles. Approximately 30 other personnel are dedicated to the broadband entity. 5 staffers exclusively handle fiber calls. Fiber network construction is mostly outsourced.	For-profit.	High-speed data (up to 10 Gb) with voice services and video packages also offered to subscribers..

Technology Decision-Making Factors

Introduction and Overview

Decisions about what communication technologies to deploy and network architectures to adopt, at least on the scale that many electric cooperatives are now considering, are unprecedented. While virtually all electric utilities have past experience with communications — for substation control, backhaul of metering data, mobile communications with crews in the field and feeder monitoring, to name a few applications — only a handful of the featured co-ops have lengthy experience in retail communications services. And, much of that experience predated current-day, digital broadband technologies, such as fiber-optics. Many of the 2018-19 case studies reflect a common pattern of technology investment — the cooperative first connects its electrical substations and offices with high-speed communications lines, generally fiber-optic. This broadband infrastructure then becomes the foundation, or backbone, for a wider communications network that ultimately enables advanced grid management and automation, and expands Internet access to businesses, institutions, and households in the communities served. Nearly 27,000 miles of fiber have been deployed by the twenty co-ops in the case studies, an astonishing feat for electric utilities of any kind given the short time-frame involved.

One creative approach adopted by several of the featured co-ops is the melding of fixed wireless and fiber-optic networks. In some instances, the fixed wireless is rapidly deployed to provide improved, e.g., 25 Mbps, Internet access and a revenue stream for the new business entity while the fiber network is being built out. In others, last-mile access is wireless and the network backbone/middle mile is fiber-optic. Either way, electric co-ops have demonstrated that they are highly responsive to the communication needs of the communities they serve and creative in the ways they meet those needs.



Key Insights from the Case Studies

- **Minimum Access Speeds –** A wide consensus exists among the cooperatives studied that a minimum Internet access speed of at least 25 Mbps will be required to fully realize the potential of the Internet and take advantage of applications such as video streaming, telemedicine, and distance learning, as well as bandwidth-hungry applications in the future. For low-density, rural areas, high-speed Internet access is what enables full participation in the larger world.

- **Fiber is the Overwhelming Choice –** The vast majority of broadband networks being deployed by the case study co-ops are fiber-optic. Fiber-optic communications is viewed by these co-ops as the most resilient, financially viable and capable, if not "future-proof," network architecture available. Fiber-optic networks are also considered the best fit with the high-speed, low-latency requirements of advanced electric grid operations and near-real-time data backhaul. These networks offer subscribers Internet access speeds up to 1 Gbps and possibly higher.

- **Rapid, Extensive Buildout –** Fiber-optic networks built and planned by the twenty cooperatives encompass approximately 26,900 route-miles. That this level of network deployment has taken place just in the last few years is remarkable.

- **Fixed Wireless as Interim Solution –** Several co-ops have deployed fixed wireless networks as an interim broadband solution while their fiber-optic communication networks are being built out. This has the dual advantage of meeting the immediate needs of communities that are currently unserved or underserved with regard to high-speed Internet access and generating an early revenue stream.

Tables 6 and 7 on the following pages contain technology decision factor data from the 2018 and 2019 broadband case studies, respectively.

Table 6. Technology Decision Making — Scope of the Broadband Network
Updated 2018 Case Studies - (continued to next page)

		Network Scope	
Cooperative Name	**Broadband Entity Name**	**Network Route-miles Deployed to date**	**Overhead/ Underground**
Anza Electric Cooperative	*ConnectAnza*	~600 miles	Almost entirely pole-mounted (10,000 poles)
Arrowhead Electric Cooperative	*True North Broadband*	Approximately 800 miles.	Generally follows electric lines -- 425 miles overhead; 375 miles underground
Barry Electric Cooperative	*goBEC Fiber Network*	1,100 route-miles of fiber (planned).	Most of fiber network going on overhead on poles and in BEC rights-of-way. Fiber is being buried in areas where too many poles would need to be replaced due to inadequate from existing lines.
Delta-Montrose Electric Association	*Elevate Fiber*	Approximately 1,700 miles.	Overhead everywhere. DMEA has pole lines available, buried only where necessary. Following electric co-op easements everywhere possible.
Douglas Electric Cooperative	*Douglas Fast Net*	Nearly 1,300 miles of the fiber network is carried overhead, passing approximately 35,000 homes and business premises.	130 miles placed underground.
Jo-Carroll Energy	*Sand Prairie Broadband*	190 miles of mainlin and drop fiber deployed; ~3,000 mainline fiber miles and ~700 miles of drop fiber miles planned.	Almost equal shares of overhead and underground.
Midwest Energy & Communications	*[Same name]*	2,100 mainline route-miles	80% overhead / 20% underground, following electric system
Ninestar Connect (formerly Central Indiana Power)	*Ninestar Connect / GigE Internet*	1,900 miles of fiber	70% underground/ 30% overhead

* For Barry Electric Cooperative and Ninestar Connect data shown are for 2018.

Table 6. Technology Decision Making — Scope of the Broadband Network
Updated 2018 Case Studies
(continued from previous page)

		Network Scope	
Cooperative Name	**Broadband Entity Name**	**Network Route-miles Deployed to date**	**Overhead/ Underground**
North Alabama Electric Cooperative	*NA Fiber*	1,250 miles of fiber	95% aerial / 5% URD
Orcas Power and Light Cooperative	*Rock Island Communications*	530 miles of fiber	84% underground distribution fiber / 16% overhead distribution fiber.
Roanoke Electric Cooperative	*Roanoke Connect*	200 mile fiber ring currently in place. An additional 150-200 miles is possible, depending on how much additional grant funding becomes available.	Mostly overhead
Valley Electric Association (VEA)	*Valley Communications Association (VCA)*	Ultimate FTTH network will encompass 1,342 route-miles (planned).	

Table 6. Technology Decision Making — Scope of the Broadband Network
2019 Case Studies

		Network Scope	
Cooperative Name	**Broadband Entity Name**	**Miles of Fiber Deployed to Date**	**Overhead/ Underground**
Allamakee-Clayton Electric Cooperative Postville, IA	*AC Skyways*	37 miles.	Currently 100% underground placement of fiber.
Blue Ridge Energy Lenoir, NC	*RidgeLink, LLC*	450 miles.	95% overhead on transmission structures owned by BRE and towers built by RidgeLink / 5% underground.
Blue Ridge Mountain Electric Membership Corporation Young Harris, GA	*(to be determined)*	1,000 miles.	95% overhead / 5% underground.
Central Virginia Electric Cooperative Arrington, VA	*Central Virginia Services, Inc. dba Firefly Fiber Broadband*	4,700 miles of fiber when completed.	Follows existing electric distribution system - 25% underground and 75% overhead
Guadalupe Valley Electric Cooperative Gonzalez, TX	*Guadalupe Valley Electric Cooperative dba GVEC.net*	1.115 miles.	Follows existing electric distribution system - 10% underground and 90% overhead
Jackson County REMC Brownstown, IN	*Jackson Connect*	1,000 miles.	95% overhead / 5% underground.
Sho-Me Power Electric Cooperative Marshfield, MO	*Sho-Me Power Electric Cooperative dba Sho-Me Technologies*	8,093 miles.	20% of fiber is overhead on transmission structrues and owned by SMP; 26% is underground and owned by SMT; 13% is owned by member co-ops; and 42% is leased, dark fiber.
United Electric Cooperative Maryville, MO / Savannah, MO.	*United Services dba United Fiber*	1,900 miles.	Primarily overhead on native UEC system; primarily underground in non-member areas.

Table 7. Technology Decision Making — Broadband Network Architecture
Updated 2018 Case Studies - (continued to next page)

		Network Architecture				
Cooperative Name	**Broadband Entity Name**	**General**	**Regional Transport**	**Network Backbone**	**Middle Mile**	**Last Mile (Retail Drop)**
Anza Electric Cooperative	*ConnectAnza*	100% FTTP GPON network		Fiber	Fiber	100% fiber except microwave or wireless where physical limitations exist.
Arrowhead Electric Cooperative	*True North Broadband*	100% FTTP GPON distributed tap system (for low-cost service in low-density, rural areas.				
Barry Electric Cooperative	*goBEC Fiber Network*	100% fiber network. GPON with Calix electronics. Has capability for direct Ethernet connections. Fiber network backed up by KAMO fiber network connecting substations.	goBEC has two backbone service providers. One is Level3 (CenturyLink) and the other is KAMO Electric Cooperative. Primary provider is Level3. Both are 10Gbps	10 Gbps MPLS fiber ring connects BEC offices with seven remote areas, designed for resiliency in event of tornado strikes.	Fiber	Fiber
Delta-Montrose Electric Association	*Elevate Fiber*	100% FTTP, using GPON architecture with 1:16 splits for residential and 1:8 for commercial.	Limited to only a few options: Fasttrack (a regional transport provider owned by two area electric co-ops), and Forethought (a CO based regional transport provider). Other options in area include CenturyLink and Spectrum, but all carriers are utilizing the same fiber backbone as it is the only one in existence for this area today.	Dual 10Gb fiber rings from diversified carriers for global interconnection. 10Gb ring architecture connecting seven regionalized comm shacks that host OLT connectivity.	Fiber	Fiber
Douglas Electric Cooperative	*Douglas Fast Net*	DFN deploys GPON utilizing centralized splits 1:32. Switched ethernet services are utilized for high priority circuits. DFN is transitioning away from DSL and has decommissioned its fixed wireless network.	Combination of leased and owned transport to regional hubs where DFN access upstream transit providers and peering exchanges.			DFN fiber network.

* For Barry Electric Cooperative data shown are for 2018.

Table 7. Technology Decision Making — Broadband Network Architecture
Updated 2018 Case Studies
(continued from previous page)

		Network Architecture				
Cooperative Name	**Broadband Entity Name**	**General**	**Regional Transport**	**Network Backbone**	**Middle Mile**	**Last Mile (Retail Drop)**
Jo-Carroll Energy	*Sand Prairie Broadband*	Broadband services initially launched via fixed wireless network (2009-2016). FTTP was undertaken in 2015 and the fiber network is in the process of being built out. Fixed wireless provides an interim solution and a needed revenue stream.		In JCE's case the fiber backbone and middle mile are one and the same. Everything except the broadband service drops to homes and businesses are considered to be part of the network backbone.		Currently 95% wireless / 5% fiber, trending to 100% fiber.
Midwest Energy & Communications	*[Same name]*	MEC's broadband network is a bi-directional FTTx open network using Gigabit Passive Optical Network (GPON) electronics.	Everstream 100 gig connection	MEC's FTTP network takes advantage of a 243-mile fiber communications ring that connects its electric substations and facilities to enable smarter grid operations.		
Ninestar Connect (formerly Central Indiana Power)	*Ninestar Connect / GigE Internet*	NineStar's network will ultimately be 100 percent FTTH with GPON with Calix electronics along with Cisco direct fiber drops (Active fiber). Less than 100 legacy DSL customers in CLEC space.	Indiana Fiber Network--4,900 route-miles of fiber-optic cable connecting all of Indiana's major population centers.	Fiber ring connecting electrical substations		Fiber
North Alabama Electric Cooperative	*NA Fiber*	Complete fiber network		160 miles	100% fiber	100% FTTH

* For Ninestar Connect data shown are for 2018.

Table 7. Technology Decision Making — Broadband Network Architecture
Updated 2018 Case Studies
(continued from previous page)

		Network Architecture				
Cooperative Name	**Broadband Entity Name**	**General**	**Regional Transport**	**Network Backbone**	**Middle Mile**	**Last Mile (Retail Drop)**
Orcas Power and Light Cooperative	*Rock Island Communications*	Fiber-based hybrid (fiber to the home and LTE wireless) communications network. Deployment of an LTE fixed wireless system in partnership with T-Mobile delivered immediate cash-flow to the new Rock Island entity while the fiber network is being constructed. (38 LTE wireless towers)	The network relies on OPALCO's Power Grid Control Backbone, the fiber network the co-op uses to manage its electrical system, as its core. 165 miles of backbone / transport fiber in County. Partners with Bonneville Power Administration and Wave Fiber for Backhaul out of County to Seattle, WA.		The transport and distribution network is an active-Ethernet fiber-to-the-premise (FTTP) network supplemented by an LTE fixed wireless network for hard-to-reach locations. As of January 2020, about 36 percent of Rock Island's customers are served by FTTP and 57 percent are served via the LTE wireless, with the remaining 7 percent being served by legacy DSL and other Internet forms.	
Roanoke Electric Cooperative	*Roanoke Connect*	REC's broadband network relies on a hybrid architecture that combines both a fiber-optic backbone with fixed wireless technologies. Grant funds will be used to convert planned wireless backhaul to fiber backhaul	Collaborating with MCNC - NC's statewide fiber broadband network	200 miles of fiber connecting REC's 12 substations to its offices.	Fiber laterals are extended from the backbone into areas containing higher population densities, whereas fixed wireless networking is deployed for the more rural middle-mile connections.	Last-mile connections to member premises is a combination of wired and wireless.
Valley Electric Association	*Valley Communications Association*	VCA's broadband network combines fixed wireless and fiber-optic technologies. The core wireless network is by Nokia with Nokia network gear on towers. Last mile equipment is supplied by Radwin. Use of Radwin's JET PtMP Beamforming solution enabled VCA to roll out its wireless network and connect 6,000 members in one year.	VCA and Churchill County Communications partnered with Las Vegas-based Switch to build a 500-mile, high-speed Internet connection between Reno and Las Vegas.	VEA's fiber backbone connecting substations (completed in 2016).	Fixed wireless network with fiber and microwave backhaul. FTTH in select areas with fiber backhaul.	Mainly wireless until fiber-optic network is built out.

Table 7. Technology Decision Making — Broadband Network Architecture
2019 Case Studies
(continued to next page)

		Network Architecture				
Cooperative Name	**Broadband Entity Name**	**General**	**Regional Transport**	**Network Backbone**	**Middle Mile**	**Last Mile (Retail Drop)**
Allamakee-Clayton Electric Cooperative Postville, IA	*AC Skyways*	Hybridized fiber/wireless broadband network.	ACEC has bandwidth contracts with Hawkeye Telephone and AcenTek.	Fiber loop connecting headquarters and two distribution substations; opportunistic extension of fiber to micro-repeaters sited on vertical properties. Remaining substations to be connected with fiber.	Fiber	Fixed wireless.
Blue Ridge Energy Lenoir, NC	*RidgeLink, LLC*	~15 Macrocell sites include towers able to accommodate multiple carriers using 2G, 3G, and 4G technologies. ~80 Small cell / Outdoor distribution antenna systems (oDAS). Co-location facilities. Network comprised mainly of fiber radials.	RidgeLink operates both short- and long-haul.	Fiber	Fiber	Fiber
Blue Ridge Mountain Electric Membership Corporation Young Harris, GA	*(to be determined)*	100% FTTH. Original network architecture was active Ethernet; migrating to GPON.	North Georgia Network (NGN) provides transport link to Atlanta. NGN was created by BRMEMC and neighboring Habersham EMC in 2009.	Fiber backbone expanding incrementally each year.	Fiber	Fiber
Central Virginia Electric Cooperative Arrington, VA	*Central Virginia Services, Inc. dba Firefly Fiber Broadband*	100% fiber-to-the-home (FTTH) with GPON and Calix platform.	MidAtlantic Broadband Corporation, which was created to build and manage a network in southside VA (financed by tobacco settlement funds), and Lumos Networks.	Fiber loop connecting all 27 of CVEC's substations.	Fiber	Fiber

Table 7. Technology Decision Making — Broadband Network Architecture
2019 Case Studies
(continued from previous page)

		Network Architecture				
Cooperative Name	**Broadband Entity Name**	**General**	**Regional Transport**	**Network Backbone**	**Middle Mile**	**Last Mile (Retail Drop)**
Guadalupe Valley Electric Cooperative Gonzalez, TX	*Guadalupe Valley Electric Cooperative dba GVEC.net*	GPON fiber-to-the-home network with speeds up to 1 Gig. Unlicensed wireless point-to-multipoint network with speeds up to 25 Mbps.	Connected to Telia, Hurricane Electric and Cogent Network, with dual-homed connectivity to Dallas and San Antonio.	Fiber loop to connect all GVEC substations by end of 2020.	Fiber	Fiber or wireless, based on location..
Jackson County REMC Brownstown, IN	*Jackson Connect*	100% FTTH, GPON architecture.	Connected to Metronet. Also interconnected with Orange County REMC.	220-mile fiber loop connecting headquarters with electrical substations.	Fiber	Fiber
Sho-Me Power Electric Cooperative Marshfield, MO	*Sho-Me Power Electric Cooperative dba Sho-Me Technologies*	SMT describes its network architecture as a ring topology with almost 2,000 transport nodes across the state of Missouri. The company operates several GigE rings across Missouri. The bandwidth inside each of these rings is dedicated to Ethernet transport and divided into VLANs (virtual local area networks). Each customer is assigned to a private VLAN, which is carried via fiber optic cable to the customer location. Wavelength services and dark fiber are also available in some areas. These optical waves are available up to 100 Gbps line rates.	Interconnected with 68 different access providers; 27 are electric cooperatives.	Fiber	Fiber	Fiber
United Electric Cooperative Maryville, MO / Savannah, MO	*United Services dba United Fiber*	95% fiber / 5% wireless (as an interim solution and in hard-to- reach-with-fiber areas). Fiber network is mainly GPON with some active Ethernet for business customers.	Connected to Bluebird Networks, NW Fiber Services, and Cogent with dual-homed connectivity to Kansas City and St. Louis	Fiber access connecting 23 substations.	Fiber	Fiber

Summary and Conclusion

Many electric cooperatives nationwide are making, or considering, significant investments in broadband communications. Experiences captured in NRECA's 2018 and 2019 broadband case studies indicate that in every case, expansion of the network to bring reliable, affordable, high-speed Internet access to cooperative members became a key consideration. And in each case, the decision was made to leverage the utility's own broadband network backbone to serve members of the community at large. There is a wide, if not universal consensus among electric cooperatives, that serving the community is what they exist to do.

The case studies make clear that there is no universally applicable technology solution here, or well-tread business path, that everyone can follow. The featured co-ops have made a variety of organizational, financial, and technological choices that reflect their own, specific needs and the needs of their communities. Each case is unique in some way. Many have taken advantage of grant opportunities to improve their investment fundamentals. Others have realized opportunities to serve non-members in nearby locations. Still others have entered into innovative partnerships to deliver broadband services. A few have redefined themselves as integrated utility service providers. The bottom line, however, is unmistakable. Together, these cooperatives offer views through many lenses through which we can look to see the new world rapidly unfolding.

Photo Acknowledgements

Photo credits according to order of appearance in this report: Valley Electric Association, North Alabama Electric Cooperative, Valley Electric Association, Jo-Carroll Energy.

2018-19 Broadband Case Studies

All twenty Broadband Case Studies can be found at:
https://www.cooperative.com/programs-services/bts/Pages/Broadband-Co-op-Case-Studies.aspx

NRECA's Broadband Team

NRECA has a cross-departmental team that works on broadband issues and initiatives:

Front Office Lead:

- Jeffrey Connor, COO

Team Members:

- Paul Breakman – Business and Technology Strategies (Business Models and Solutions)
- Russell Tucker & Joe Goodenbery – Business and Technology Strategies (Economic Analysis)
- Stephen Bell & Tracy Warren – Media & PR (Communications)
- Kelly Wismer– Government Relations (Legislative Affairs)
- Brian O'Hara – Government Relations (Regulatory Affairs)
- Ty Thompson and Jessica Healy – General Counsel's Office (Legal)

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Eric Cody is a consultant who has spent more than twenty years working with NRECA, statewide cooperative associations and individual electric cooperatives on technology planning and management issues. He has four decades of experience with electric utilities and was for a dozen years an officer of several New England Electric System companies, including vice president of IT. Eric holds a bachelor's degree from Amherst College and a master's degree from Harvard University, where he specialized in energy planning and policy analysis.