COMMONWEALTH OF KENTUCKY
BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:

THE ELECTRONIC APPLICATION OF	)
KENERGY CORP. FOR A CERTIFICATE	)
OF PUBLIC CONVENIENCE AND NECESSITY	)
FOR THE CONSTRUCTION OF A HIGH-SPEED	) **Case No. 2021-00365**
FIBER NETWORK AND FOR APPROVAL OF THE	)
LEASING OF THE NETWORK'S EXCESS CAPACITY	)
TO AN AFFILIATE TO BE ENGAGED IN THE	)
PROVISION OF BROADBAND SERVICE TO	)
UNSERVED AND UNDERSERVED HOUSEHOLDS	)
AND BUSINESSES OF THE COMMONWEALTH	)

KENERGY CORP'S RESPONSES TO COMMISSION STAFF'S THIRD REQUEST FOR INFORMATION

KENERGY CORP. responds to **COMMISSION STAFF'S** third request for information as follows:

1. State whether, absent the desire to facilitate the deployment of broadband in Kenergy's territory, Kenergy would have applied for or sought to construct a fiber network to replace its current communication system.

RESPONSE: **Yes. Considering that Kenergy's current communications system only has 2.5 years of its useful life remaining (and was already aging when Kenergy filed its application in Case No. 2020-00215), as well as the fact that half of the radios used in Kenergy's current communications system are no longer supported, Kenergy would have been required to invest in a new communications system even without the additional benefit of being able to assist the vast majority of Kenergy's**

member-owners in gaining access to broadband for the first time.

Based upon current research and studies, a fiber communications system is the best intra-system communications system available to electronic cooperatives. As was concluded in a 2018 study by NRECA and NTC, titled "The Value of a Broadband Backbone for America's Electric Cooperative," "Fiber offers the most secure, most reliable, highest-throughput, and lowest-latency wired communications options for cooperative network connections."[1] Further, as noted in the attached excerpt from the NRECA 2018-19 case study of twenty cooperatives utilizing broadband, "[f]iber communications is viewed by these co-ops as the most resilient, financially viable and capable, if not 'future proof' network architecture available."[2] As was recommended in *The Value of a Broadband Backbone,* "Given the fast pace of technological change and the rapid expansion of data, cooperatives should develop and regularly update 10-year plans to address their communications needs, and account for their expected technological and operational use cases over that time."[3]

Accordingly, Kenergy would have sought to construct a fiber based communications system because it is the best available option that allows for the long-term implementation of developing technologies to best serve Kenergy's

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[1] Exhibit 1 at § 1.3, *available at:* https://www.cooperative.com/topics/telecommunications-broadband/Documents/The%20Value%20of%20a%20Broadband%20Backbone.pdf.
[2] Exhibit 2, "Electric Cooperatives Bring High-Speed Communications to Underserved Areas," Business & Technology Report, February 2020, at 34, *available at:* https://www.cooperative.com/programs-services/bts/documents/reports/report-broadband-case-studies-summary-updated-feb-2020.pdf.
[3] Exhibit 1, at § 1.2.

member-owners.

WITNESS: JEFF HOHN

2. Refer to Kenergy's response to Commission Staff's First Request for Information, Item 13(b) (Staffs First Request) in which Kenergy states it "will treat the fiber the same as if it was an attacher on the pole." Explain whether Kenergy means that it will treat the fiber the same as other attachers under 807 KAR 5:015 as well as Kenergy's pole attachment tariff.

RESPONSE: Kenergy will treat the fiber the same as all attachments on its distribution poles, but because Kenergy will own the fiber there will not be an "attacher" as that term is contemplated in 807 KAR 5:015. However, in its response to Commission Staff's First Request for Information, Item 13(b), Kenergy sought to explain that the Fiber Optic Sublease Agreement was designed so that Conexon's responsibilities for maintenance and repair would closely follow those of an "attacher" under 807 KAR 5:015 and Kenergy's pole attachment tariff.

WITNESS: JEFF HOHN and TRAVIS SIEWERT

3. Refer to Kenergy's response to Staffs First Request, Item 17(a), in which Kenergy states that the proposed project will require the replacement and construction of new poles to accommodate the fiber infrastructure.

a. State whether Conexon will be responsible for the cost of pole replacements and new pole construction pursuant to 807 KAR 5:015.

b. State whether the new poles constructed to accommodate the fiber network will also include Kenergy's distribution facilities.

RESPONSE: (a) Yes, Conexon will be responsible for the cost of pole replacements and new pole construction. The Fiber Optic Sublease Agreement was designed so that the cost of any pole replacements and any new pole construction (typically referred to as make-ready engineering and make-ready constructions) is included in the calculation of Conexon's Base Lease Fee. While neither Kenect nor Conexon are technically an attacher on Kenergy's pole due to Kenergy owning the fiber, the Fiber Optic Sublease Agreement was designed to ensure Conexon bears those costs, similar to an "attacher" under 807 KAR 5:015.

(b) As Kenergy's proposal is to construct its intra-system communications system throughout its distribution territory, it is anticipated that Kenergy's distribution facilities would be included on any new poles that are required. Kenergy does not anticipate new poles being added for fiber only.

WITNESS: JEFF HOHN

4. Refer to Kenergy's response to Staff's First Request, Item 22, in which Kenergy states: "Based on the reliability and capacity factors alone, there are not any reasonable alternatives that Kenergy felt would accomplish what Kenergy was striving to achieve."

a. Explain what Kenergy is "striving to achieve."

b. State whether Kenergy explored any alternatives to upgrade or replace its communication system that supports Kenergy's distribution system.

RESPONSE: (a) Kenergy is striving to provide the safest, most reliable, lowest cost electric service to its member-owners. That includes staying abreast of advancements in technology that will assist Kenergy in being a more efficient provider of low cost affordable power.

With increased microwave frequency traffic from otber microwave users, cybersecurity concerns, and doubt as to whether microwave communications hardware will be supported in the future, fiber is considered to be the best option for electric cooperatives investing in their long-term communication needs. Indeed, "Developing a broadband backbone communications solution will provide the reliability, security, speed, and bandwidth necessary to allow electric cooperatives to adopt emerging use cases and new technologies to optimize grid operations. For most co-ops, that solution will likely include a combination of fiber and point-to-point wireless technologies, which will support the transition to a smarter grid that

is connected and provides real-time situational awareness and control of grid assets." Exhibit 1, at § 1.5.

(b) Yes, Kenergy briefly considered other options, but, based upon Kenergy's review of trade publications and research, Kenergy quickly transitioned to focusing on a fiber optic communications system due to the additional benefits offered by fiber optic cable versus traditional communications systems, such as radio microwave systems. For example, *The Value of a Broadband Backbone* report notes, "To guarantee the performance of all aspects of a network, a fiber backhaul system is typically the best option." Exhibit 1, at § 1.3. "Fiber offers the most secure, most reliable, highest throughput, and lowest-latency communications option for network connections. In addition, fiber provides the opportunity to connect the grid reliably with enough capacity for both current and future cases." *Id.* at § 4.1.2.

WITNESS: JEFF HOHN and ROBERT STUMPH (as to subpart (a))
JEFF HOHN (as to subpart (b))

5. Refer to Kenergy's response to the Attorney General's First Request for Information, Item 3.

a. Provide any studies, data, or other information that supports Kenergy's statement that "[t]he need for the electric regulated business is the long term need to have in place the electric utility communications to meet the future demands of distributed generation resource management and electric vehicles."

b. Provide the anticipated growth of electric vehicles and distributed generation resources in Kenergy's territory for the next ten years.

RESPONSE: (a) Kenergy provides the following information supporting Kenergy's statements:

1. Smartgrid.gov, a website of the United States Department of Energy, states, "[T]he Electric Power Research Institute now considers distribution intelligence to mean a fully controllable and flexible distribution system. . . . When fully deployed, distribution intelligence will enable an electric utility to remotely monitor and coordinate its distribution assets, operating them in an optimal manner using either manual or automatic controls."[4]

2. According to a National Governors Association study, "The Road Ahead: Planning for Electric Vehicles by Managing Grid Interaction,

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[4] Exhibit 3, "Distribution Intelligence," SmartGrid.gov, *available at:* https://www.smartgrid.gov/the_smart_grid/distribution_intelligence.html.

i) "[I]t is important for states to begin preparing for an increasing trend in transportation electrification."[5]

ii) The report further instructed that states needed to prepare for EV implementation through "thoughtful policies and regulations to ensure that the potential advantages of vehicle and electric grid interactions are realized. With careful planning, EV benefits can be captured, leading to cost savings for stakeholders, enhancing grid reliability, and further modernizing both transportation and energy systems."[6]

3. The Value of the Broadband Backbone noted the following:

i) "Rapid changes in technology can allow electric cooperatives to implement innovative solutions that benefit members and their changing consumer preferences. . . . [Distributed energy resources ("DER")] and other edge technologies are changing the grid from a linear, generation-centric system to a flexible two-way grid increasingly dependent on bi-directional communications."[7]

ii) "To successfully add DER to the system, the grid must manage two-way power flows through two-way communications."[8]

iii) "Just as the integration of DER will continue to put pressure on utilities' capital expenditure and operating expenditure models, changes in

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[5] Exhibit 4, Rogotze, M. & Rackley, J. (2020, November). *The Road Ahead: Planning For Electric Vehicles by Managing Grid Interactions*, Washington, D.C. National Governors Association Center for Best Practices, *available at*: https://www.nga.org/wp-content/uploads/2020/12/EV-Grid-Interaction.pdf.
[6] *Id.* at 11.
[7] Exhibit 1, at § 2.
[8] *Id.* at § 5.2.4.

customer behavior – such as rapid adoption of EVs – will impact electricity demand management and pricing models."[9]

iv) "The smart grid can transform the production of distribution of energy from a one-way single source grid into a two-way grid incorporating DER – one that is more resilient and more efficient than previous iterations."[10]

v) "This guide should be considered an input to decision making for cooperatives assessing the value of a broadband backbone for electric operations. A broadband backbone is a foundational technology for other smart grid use cases that will likely become necessary to execute business tasks going forward. Because of changing consumer behavior and the rise of DER, an intelligent grid and the communications network to support it will likely become imperative for safe maintenance of the grid."[11]

(b) The national goal set by the current administration is to have half of all motor vehicle production be electric or plug in hybrid vehicles by 2030. Kenergy serves approximately 48,000 households and businesses in its certified electric service territory. Assuming, conservatively, just under one vehicle per household, there are at least 45,000 vehicles in Kenergy's territory. Without factoring incentive programs to encourage consumers to acquire electric vehicle or

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[9] *Id.*
[10] *Id.* at § 6.1.
[11] *Id.* at § 7.

plug in hybrids, by 2035 (which is 10 years after anticipated completion of Kenergy's proposed smart grid) Kenergy would have 22,500 electric or plug in hybrid vehicles in its territory. Assuming a linear projection, and assuming the existing number of electric vehicles to be 1,000, then 21,500 divided by 10 equals 2,150 new electric vehicles added per year. In 10 years after completion of the Smart Grid, the linear projection is 21,500 electric vehicles in Kenergy's territory. "The growth of EVs offers cooperatives, which have experienced slow load and revenue growth for the last 10 years, the opportunity to achieve almost $1 billion in additional revenue by 2025 at current projections."[12]

Distributed generation is more difficult to predict because, unlike vehicles, it is not necessary for most daily activities. However, Kenergy anticipates growth in this area prompted by continued government incentives for solar projects. Attached hereto as Exhibit 5 is an advertisement in the March 8, 2022, Henderson Gleaner, promoting solar installation.

WITNESS: JEFF HOHN

[12] Exhibit 1, at § 5.2.4 (citing Energy Information Administration (EIA) projections of EV-installed base and average charge cost, spread across all cooperative customers).

6. Refer to Kenergy's response to Kentucky Broadband and Cable Association (KBCA's) First Request for Information, Item 2, in which Kenergy states that "Kenect plans to focus its initial offerings on unserved and underserved areas."

a. State whether Kenect plans to provide subsequent broadband offerings in areas which are not deemed to be unserved or underserved.

b. State what facilities Kenect, if it does provide service to areas that are not deemed underserved or unserved, would use to provide such service.

RESPONSE: (a) Yes, consistent with state and federal law which does not allow the imposition of restraints or conditions on new entrants to the broadband market, Kenect will provide broadband to those Kenergy members in areas that are not unserved or underserved. However, as the confidential maps provided by KBCA show, the vast majority of Kenergy's certified electric service territory is "unserved or underserved" by current broadband providers.

(b) Kenect would use the facilities it leases from Kenergy to provide those services.

WITNESS: JEFF HOHN and ROBERT STUMPH (as to subpart (a))

JEFF HOHN (as to subpart (b))

7. Refer to page 9 of Kenergy's Application, Kenergy states that it plans to enter into "definitive arrangements to lease the excess capacity to an affiliate (Kenect) engaged exclusively in the provision of broadband service to unserved or underserved households and businesses, as well as sublease of the network to Conexon Connect."

a. State whether Conexon will also engage exclusively in the provision of broadband service to unserved or underserved households and businesses.

b. If not, state what customers Conexon plans to serve using the excess fiber optic capacity of the proposed fiber system.

RESPONSE: (a) Consistent with state and federal law which allows for a competitive broadband market free from conditions or restraints, Kenect will be engaged in the provision of broadband service, which will include a sublease to Conexon (among other agreements), to assist in the provision of this service by Kenect. It is anticipated tbat Kenect will likely provide broadband service to all members in Kenergy's certified electric service territory that desire to receive such service. As the confidential maps provided by KBCA show, the vast majority of Kenergy's certified electric service territory is "unserved or underserved" by current broadband providers; tbus, it is anticipated that Kenect's provision of broadband service will primarily be to unserved or underserved households and businesses, as tbe vast majority of Kenergy's certified electric service territory is not served by current broadband providers.

(b) Kenergy anticipates that Conexon will fulfill its contractual obligations to Kenect, which is likely to result in Kenect serving all members in Kenergy's certified electric service territory who elect to receive such broadband service.

WITNESS: JEFF HOHN (as to subpart (a))

ROBERT STUMPH (as to subpart (b))

8. State whether the proposed fiber system will be deployed in areas that arenot deemed unserved or underserved. If the fiber system will deployed in these areas, state whether the fiber will have the same capacity of the fiber serving the unserved andunderserved territories.

RESPONSE: **Kenergy's proposed fiber based intra-system communications system will be deployed along Kenergy's distribution system throughout its entire certified electric service territory. The capacity of the fiber system will be uniform throughout the entire service territory.**

WITNESS: **ROBERT STUMPH**

9. Refer to Kenergy's response to Staff's First Request, Items 1(b) and 6(b). Provide specific information regarding the reliability of Kenergy's existing microwave- based communications and any need, if any, to replace the system based upon reliability or equipment that is no longer manufactured.

RESPONSE: Nearly half of Kenergy's existing microwave system consists of Alcatel MDR 8000 series radios in the frequency range of 6 GHz. These radios have reached end of life and are no longer manufactured or supported by Alcatel. Also, all of these radios are in the frequency band which the FCC has recently reallocated for WIFI and other unlicensed applications.[13] This frequency reallocation increases greatly the possibility for radio signal interference to incumbent users of 6 GHz microwave radios. The Utility Telecom Council, ATT, NRECA, APPA, and other telecommunications organizations lobbied unsuccessfully to overturn the FCC unanimous decision to proceed with the 6 GHz reallocation for WIFI, and after a failed attempt to have the original decision appealed, WIFI companies are proceeding with deployment. This potential radio interference along with the End-of-Life equipment will have major negative impacts on Kenergy's ability to support and maintain their existing microwave radio system.

WITNESS: JEFF HOHN

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[13] *In the Matter of: Unlicensed Use of the 6 GHz Band Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, FCC 20-51 (April 23, 2020), *available at*: https://www.fcc.gov/document/fcc-opens-6-ghz-band-wi-fi-and-other-unlicensed-uses-0; *see also* Statement of Chairman Ajit Pai, Re: *Unlicensed Use of the 6 GHz Band Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, ET Docket No. 18-295 and GN Docket No. 17-183 ("[W]e're making the entire 6 Ghz band . . . available for unlicensed use.").

10. Refer to Kenergy's response to Staff's First Request, Item 3d. Provide in specific detail the intra-system communication needs that Kenergy has identified and specific detail how the proposed fiber network will meet those needs.

RESPONSE: As a starting point, Kenergy's current intra-system microwave communications system only has a 2.5 year remaining useful life and, as is discussed above, half of Kenergy's current radios are no longer supported. Thus, Kenergy has a general need to invest in its intra-system communication network to maintain its reliability, which is one of the primary needs of any communications system.

Indeed, the primary needs for any communications system are reliability and security. As is explained above, due to FCC's decision to allow unlicensed applications in the 6 GHz radio spectrum, which FCC Chairman Pai noted was the opening of a "massive test bed," it is expected that the reliability of Kenergy's current microwave communication system operating in the 6 GHz frequency will be dramatically reduced as 6 GHz applications only continue to increase. This diminishes the value in further investment in a microwave communication system as a microwave communication system is not expected to provide the same reliability it has provided in the past.

The other primary need in an intra-system communication system is security. Based upon currently available research, a fiber optic communication system is also more secure than a traditional microwave communications system. As *The Value of a Broadband Backbone* report detailed, "Fiber offers the most secure, most reliable,

highest-throughput, and lowest-latency communications option for network connections."[14] Accordingly, a fiber intra-communications system best serves Kenergy's need for a safe and reliable communications network.

Moreover, as any investment in an intra-system communications network should be viewed through a long-term lens, Kenergy believes it long-term needs are best served by investment in a fiber based communications network. As is documented in *The Value of a Broadband Backbone*, it is anticipated that the applications available with a fiber enabled smart grid will only "continue to advance and require additional bandwidth in the future."[15] Construction of a fiber based communications system is also expected to meet Kenergy's need to provide its members with the most up to date smart grid applications, leading to optimization, reduced costs, and energy efficiency.

Finally, a fiber optic intra-system communications network also furthers Kenergy's need to provide safe, affordable electric service to its member-owners. By leveraging the opportunities provided by KRS 278.5464, it is anticipated that Conexon Connect's lease payments to Kenect, followed by Kenect's lease payment to Kenergy, will result in the Base Lease Fee fully covering the cost of Kenergy's intra-system communications network. Kenergy is unaware of any third parties that seek to utilize excess capacity of the traditional microwave radio communications'

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[14] Exhibit 1, at § 4.1.2.
[15] Exhibit 1, at § 1.2

spectrum, meaning replacement of the aging microwave communications system with yet another microwave radio communications system would result in higher expected net costs to Kenergy and its members.

As a result, Kenergy believes that construction of a fiber based intra-system communications network best serves its needs because it avoids additional investment in a less reliable, less secure communications system that does not allow for a fully implemented smart grid, the full cost of which would possibly need to be recovered through Kenergy's members (as opposed to the anticipated fully subsidized cost of a fiber based communication system), and which would leave the vast majority of Kenergy's members without broadband access because traditional broadband providers do not find it "economical" to provide rural Kentuckians with access to the economic, educational, and telehealth opportunities provided by broadband access.

WITNESS: JEFF HOHN and ROBERT STUMPH

11. Refer to Kenergy's response to Staff's First Request, Item 6a. Provide specific detail how instantaneous communication between substations and control offices will provide an actual, and not speculative, benefit to Kenergy and its customers, and what needs could be met with instantaneous communication.

RESPONSE: **According to *The Value of a Broadband Backbone*, a cooperative roughly the size of Kenergy (50,000 members) "may see between $10 million and $16.6 million in economic benefit annually" by implementing smart grid technologies described in the study.[16]**

Further, in a Q&A Article explaining the findings of the Report, NRECA's chief economist in the Business & Technology Strategies department, explained the real world needs that can be met with instantaneous communications. First, Tucker explained: "Interest in distributed energy resources (DER) deployment, including behind-the-meter generation and energy storage, is growing among co-op consumer-members. To successfully add these resources, the grid must manage two-way power flows through two-way communications."[17]

The Article also showcased the increased security and asset management that is made available through high-bandwidth applications utilizing fiber. Specifically, streaming video over the fiber backbone can increase security and protect a

[16] Exhibit 1, at § 6.4.2.
[17] Cash, Cathy, *Q&A: The Benefits and Challenges of Building a Broadband Backbone*, Aug. 23, 2018, *available at:* https://www.cooperative.com/news/Pages/q-and-a-benefits-and-challenges-electric-co-op-broadband.aspx.

cooperative's electric distribution assets. "A co-op can monitor loading on transformers to help predict maintenance events. A co-op with a substation near floodplains or in the path of a hurricane can also manage that asset remotely with two-way communications allowed through a broadband backbone. With livestream video, co-op engineers can see water levels rise and switch off the substation's operations to protect it and switch it on after the threat dissipates."[18] Finally, a broadband backbone can allow an electric cooperative to "precisely pinpoint the location and extent of an outage and send repair crews in real-time, which speeds up outage restoration to consumer-members. The technology can further analyze the situation and automatically reroute electricity to minimize service disruption costs for members. For critical loads, DER can be strategically placed to help with this event management and mitigation."[19]

WITNESS: JEFF HOHN and TRAVIS SIEWERT

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[18] *Id.*
[19] *Id.*

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CERTIFICATE OF SERVICE

I hereby certify that the foregoing was served by electronic filing to the Kentucky Public Service Commission, 211 Sower Blvd., Frankfort, KY 40602 with a copy served electronically to the Kentucky Attorney General, Office of Rate Intervention, 700 Capital Avenue, Suite 20, Frankfort, KY 40601-8204, and James W. Gardner and M. Todd Osterloh, Sturgill, Turner, Barker & Maloney, PLLC, 333 W. Vine St., Suite 1500, Lexington, KY 40507, on this 18th day of March, 2022.

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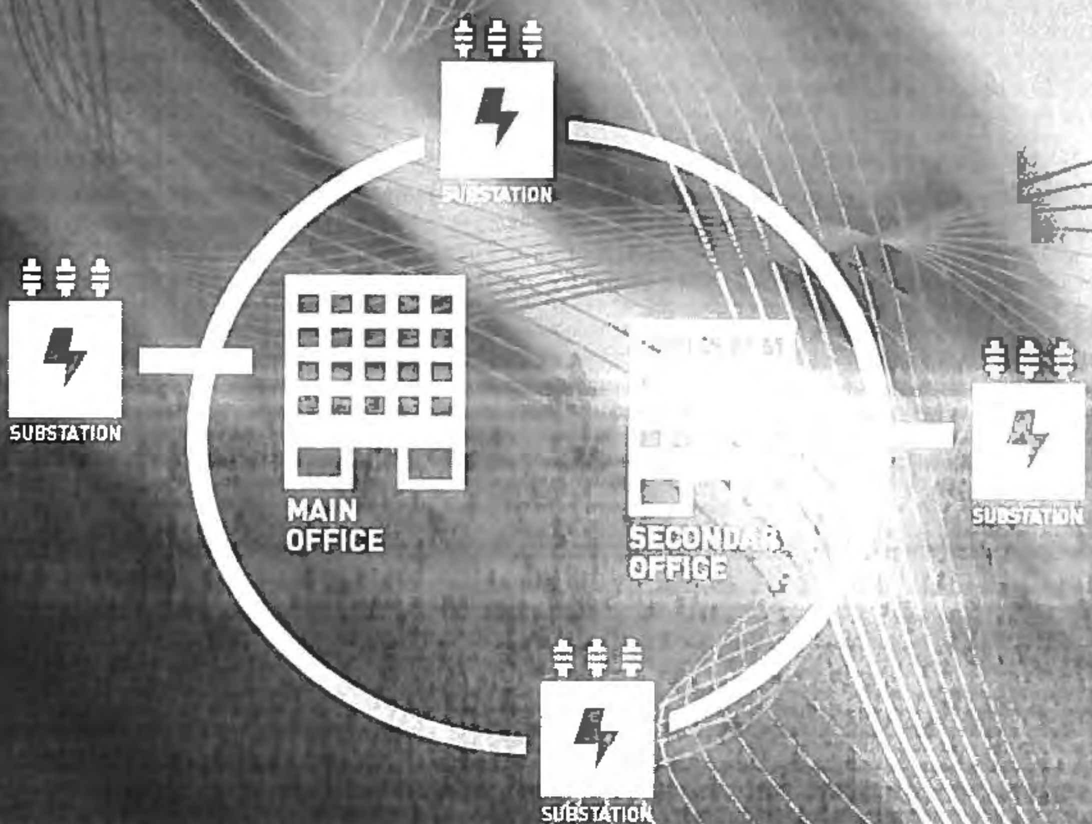
J. Christopher Hopgood

EXHIBIT 1

The Value of a Broadband Backbone

for America's Electric Cooperatives

A Benefit Assessment Study



nrtc
Member driven. Technology focused.

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America's Electric Cooperatives

ERICSSON

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List of Abbreviations

AM	Asset management
AMI	Advanced metering infrastructure
AMR	Automated meter reading
AR	Augmented reality
ARRA	American Reinvestment and Recovery Act
CAGR	Compound annual growth rate
C&I	Commercial and industrial
CAIDI	Customer average interruption index
CBM	Condition-based maintenance
CVR	Conservation voltage reduction
DA	Distribution automation
DCEC	Delaware County Electric Cooperative
DEA	Dakota Electric Association
DER	Distributed energy resources
DG	Distributed generation
DM	Demand management
DOE	U.S. Department of Energy
DR	Demand response
DSM	Demand-side management
EIA	Energy Information Administration
EPB	Electric Power Board
ERCOT	Electric Reliability Council of Texas
EV	Electric vehicle
FLIR	Forward-looking infrared
FLISR	Fault Location, Isolation, and Service Restoration
Gbps	Gigabits per second
IP	Internet Protocol
IP/MPLS	Internet Protocol/Multiprotocol Label Switching
LiDAR	Light detection and ranging
LPWA	Low-power wide-area network
LTE	Long-term evolution
Mbps	Megabytes per second
MDM	Meter data management
MEC	Mobile edge computing
mMTC	Massive machine-type communications
NB-IoT	Narrowband Internet of Things
NRECA	National Rural Electric Cooperative Association
NRTC	National Rural Telecommunications Cooperative
PV	Photovoltaic (solar panels)
SA	Substation automation
SAIDI	System average interruption duration index
SAIFI	System average interruption frequency index
SCADA	Supervisory control and data acquisition
SGIG	Smart Grid Investment and Grant
TBM	Time-based maintenance
TDM	Time-division multiplexing
TOU	Time-of-use
UAV	Unmanned aerial vehicle
VAR	Volt-ampere reactive

1 EXECUTIVE SUMMARY

1.1 Purpose

This paper outlines and quantifies the benefits of a broadband backbone for electric cooperative operations.[1] For the purposes of this paper, a broadband backbone is defined as a high-bandwidth, low-latency data connection, enabled by wired or wireless technology, that connects systemically important infrastructure. Importantly, it provides transport—delivery of data collected by other utility networks—which is critical to managing electric operations. Broadband backbones are necessary to accommodate new data-intensive use cases that optimize operations and adapt to changing consumer behavior.

1.2 Overview

The move to a smarter grid entails more data from more end points on a more frequent basis. Applications such as advanced metering infrastructure (AMI) and distribution automation (DA) enable cooperatives to optimize operations and reduce costs. Meanwhile, as the grid evolves to accommodate more distributed energy resources (DER), system infrastructure must be adapted. At the same time, utilities are moving to take advantage of new technologies, such as drones and video monitoring, to increase grid reliability and security. Many of these use cases can be supported by lower-bandwidth solutions but will continue to advance and require additional bandwidth in the future. Given the fast pace of technological change and the rapid expansion of data, cooperatives should develop and regularly update 10-year plans to address their communication needs, and account for their expected technology and operational use cases over that time.

1.3 Technology Options

A broadband backbone can be comprised of both wired and wireless technologies. To guarantee the performance of all aspects of a network, a fiber backhaul system is typically the best option. Fiber offers the most secure, most reliable, highest-throughput, and lowest-latency wired communications option for cooperative network connections. In addition, fiber provides the opportunity to connect the grid reliably with enough capacity for both current and future use cases. Today, fiber solutions can provide up to 10 Gigabits per second (Gbps) as the wired option. However, fiber has both geographic and cost impediments that limit its use in all situations. In such cases, point-to-point wireless solutions can support the transfer of data with the reliability, bandwidth, latency, and security necessary for cooperative applications. Wireless point-to-point solutions can support all use cases profiled in this white paper. Today, they can provide up to 1 Gbps, with the potential to provide higher speeds in the future. A mix of both wired and wireless solutions will be necessary for most electric cooperatives.

Although it is outside the scope of this paper to analyze the opportunity in depth, cooperatives may be able to leverage this new backbone to provide broadband services to their member-consumers and communitites. The backbone is a major step toward providing those services, either directly or through a third party.

1.4 Use Cases and Quantification

Use cases are technologies that improve the operations or service of a cooperative. The move to a smarter grid is underway, and that smarter grid already has many use cases deployed that collectively require broadband communication. The number of use cases will expand as cooperatives continue to innovate and invest in a smarter grid and the analytics to support it. As described in this study, the value of a broadband backbone depends on the cost avoidance or revenue enhancement associated with use cases on a per-meter basis, collected from publicly accessible data. We evaluated the following use cases: DA, substation automation (SA), AMI, volt/VAR optimization, demand management (DM), outage reduction, asset management (AM), DER, replacement of existing telecommunications carrier costs, and new revenue from leasing dark fiber. This analysis estimates $1.7 million to $2.9 million and $10 million to $16.6 million in economic gain from these cases for a fully implemented 10,000 member and 50,000 member electric cooperative respectively. The value of a broadband backbone is

1 Note that an evaluation of the business case or economic benefits of broadband deployment to member-consumers in electric cooperative territories is beyond the scope of this paper, however, such impacts are "are likely to be substantial." See *The Competitiveness and Innovative Capacity of the United States*, U.S Department of Commerce (January 2012), pp 5–8 to 5–10. As each electric cooperative has unique characteristics, the benefits described in this paper are estimates and will vary from system to system.

demonstrated by its essential contribution to achieving these gains. It is a necessary component to enable these benefits, though it is not sufficient to implement these use cases on its own.

1.5 Proposed Actions

Developing a broadband backbone communications solution will provide the reliability, security, speed, and bandwidth necessary to allow electric cooperatives to adopt emerging use cases and new technologies to optimize grid operations. For most co-ops, that solution will likely include a combination of fiber and point-to-point wireless technologies, which will support the transition to a smarter grid that is connected and provides real-time situational awareness and control of grid assets.

2 INTRODUCTION

Rapid changes in technology can allow electric cooperatives to implement innovative solutions that benefit members and their changing consumer preferences. These changes reinforce the cooperative's member focus and align its goals with the interests of its members. Moreover, DER and other edge technologies are changing the grid from a linear, generation-centric system to a flexible two-way grid increasingly dependent on bi-directional communications.

3 TRANSFORMATION OF COMMUNICATION NETWORKS

Communications networks are long-term assets.[2] Thus, utilities need to account for data and communications needs for at least 10 years in the future, and preferably even further. As we move toward a smart grid—one that is two-way, networked, distributed, and intelligent—communications will provide the enabling technology upon which those applications will be built.[3] The U.S. Department of Energy (DOE) outlines four enabling technologies for the smart grid: (1) the communications network; (2) AMI; (3) meter data management (MDM); and (4) supervisory control and data acquisition (SCADA). Although important on their own, communications networks are also necessary to enable the other three technologies.[4] Upgrading telecommunications infrastructure is imperative to facilitate the improvement and advancement of operations and customer service.

3.1 What Is Driving Backbone Demand?

The proliferation of AMI technology has given utilities unprecedented insights into the performance of their systems. Several factors have impacted the current drive toward broadband networks (Table 1).

Proliferation of Smart Grid	Backhaul communications necessary to support the data
Cyber Security Needs	Older technologies do not have the encryptions and firewalls necessary to protect data in transit over lines
Additional Data Usage	New applications, particularly video-enabled monitoring, require high bandwidths to leverage them to their full potential
Latency Requirements	Technologies with automated response systems require low-latency systems to respond to signals quickly enough to make actionable decisions
Improved Distribution Reliability	Real-time monitoring of critical equipment can identify failures before they occur, allowing for replacement and circumventing a potential outage
Availability of Current Telecommunications Services	Third-party carriers and providers are discontinuing older technologies as they transition to digital networks

Table 1: Reasons for the Move to a Broadband Backbone

2 NRTC, NRUCFC, NRECA, and CoBank, *Due Diligence of High-Speed Broadband Investment and Business Creation by an Electric Cooperative*, 2017, 5, https://www.cooperative.com/programs-services/bts/documents/reports/broadband-due-diligence.pdf.

3 Navigant Research, *Defining the Digital Future of Utilities*, 2017, 1.

4 National Rural Electric Cooperative Association and the U.S. Department of Energy, *Smart Grid Demonstration Project*, "Communications: The Smart Grid's Enabling Technology," 2014, 1, https://www.smartgrid.gov/files/NRECA_DOE_Communications_1.pdf.

These factors create the need for utilities to upgrade systems as they operationalize emerging technologies. The lifecycle of a long-term asset forces them to look beyond current use cases to the expected needs of the future.

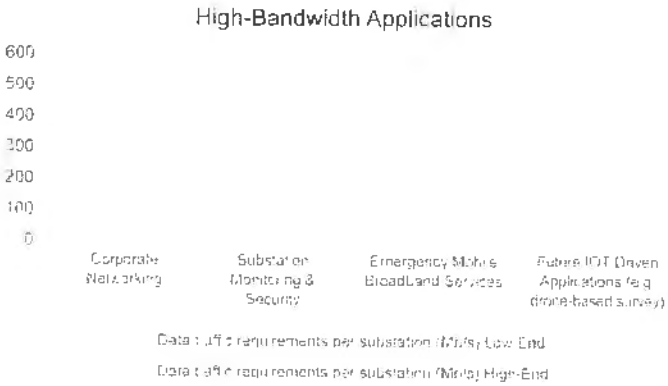


Figure 1: High-Bandwidth Applications *Source: inCode Consulting*

3.1.1 Overview of Changing Customer Behavior

As consumers adjust to new technologies and incentives, their behaviors are changing. More consumers are investing in energy efficiency, distributed generation (DG), electric vehicles (EVs), and storage in the home. Together, these factors are expected to create new "prosumers"—consumers who also produce and/or store energy—for utilities to engage. Consumers also have greater expectations from their utility regarding communication and response. In a 2017 consumer survey, 40% of consumers expressed a desire to have smart grid-enabled solutions for demand response (DR), energy efficiency, or other DER, but only 21% participated. This gap shows that latent demand will likely increase the need to support these solutions more broadly.[5]

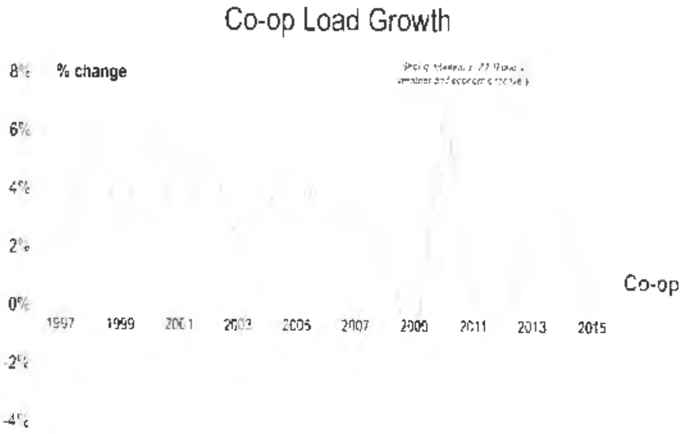


Figure 2: Co-op MWh Sales Growth *Source: U.S. Energy Information Administration*

5 Smart Energy Consumer Collaborative, *Consumer Experience and Expectations Survey*, 2017, https://www.publicpower.org/periodical/article/consumers-becoming-more-aware-smart-grid-issues-offerings-survey

Spotlight: Mid-South Synergy

In addition to sensors, utilities are leveraging new technologies to inspect assets across territories. Some cooperatives are piloting unmanned aerial vehicles (UAV) for jobs that previously required a truck roll or helicopter ride. Mid-South Synergy serves 30,000 members across a six-county territory based in Navasota, Texas. After experiencing many vegetation-related outages from trees outside of its right of way, it started an aggressive vegetation management program. During this program, Mid-South saw the importance of light detection and ranging (LiDAR) and forward looking infrared (FLIR) images from UAVs, and in 2016 implemented UAVs for its program. The new images allowed the cooperative to prioritize vegetation management and save 5% on its work plan for the program by decreasing truck rolls. It also improved customer satisfaction by removing only those trees that posed a threat to their power lines. UAVs offer both cost savings and additional data on remote assets for utilities, giving them potential to grow as part of the asset management profile.

Figure 3: UAV Images *Source: NRECA, TechSurveillance, BTS, Case Studies: Success with Unmanned Aerial Systems, August 2017.*

3.1.2 A Brief Overview of Operational Needs

Utilities nationwide are investing in a wide range of digital technologies as they strive to transform their operations. These digitalization efforts involve smart grid uses, electricity systems software, energy management, and building energy efficiency controls. Utility spending on digitization of the energy infrastructure has grown by a compound annual growth rate (CAGR) of 20% since 2014, reaching $47 billion in 2016.[6] In 2017, 60% of utilities said they expected to increase their digital investments.[7] This spending on communications technologies will facilitate an increase in smart grid spending from $7 billion in 2017 to $12 billion by 2020.[8]

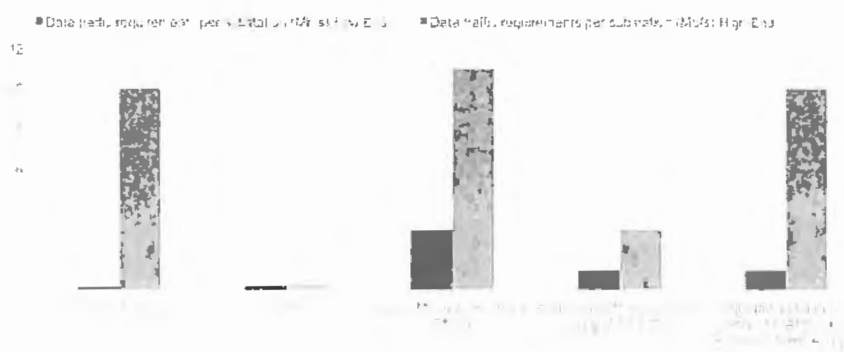


Figure 4: Low-Bandwidth, Low-Latency Applications

The growth of monitoring devices will be particularly apparent in the narrowband-internet of things (NB-IoT) space.[9] Utilities have a large number of assets in the field, often spread over large territories, which drives a need for the growth in connected devices. These solutions often operate on low-power wide-area (LPWA) networks that enable smart devices to be deployed at low cost and can transfer small amounts of data quickly and cheaply. Overall, the market for LPWA is expected to grow at a CAGR of 38%, from a low base of $2.7 million in 2017 to $54.7 million in 2026, as a low-priced network solution.[10] These devices will monitor every part of generation, transmission, distribution, and the consumption of energy, making the grid more responsive and flexible to changing conditions.

Actionable business intelligence, derived from real-time data, is the principal enabler of the smarter grid. The availability of massive amounts of operating data provides the predictive analytics required to transform asset management policies from traditional time-based maintenance (TBM) to measurement-driven condition-based maintenance (CBM) practices that can lower operational costs and defer capital expenditure.

The key to such capabilities is the availability of a future-proof communications network backbone. Having a broadband backbone meets the volume-of-data and low-latency demands of future grid applications that are at the cusp of commercialization, such as real-time video and infrared imagery sent by drones for asset inspections.

3.1.3 A Brief Overview of New Applications[11]

New applications are coming onto the grid, driven by customers and utilities. The growth of roof-top and community solar has newly emphasized the integration of DER and the importance of a two-way grid. For cooperatives in particular, the community solar market has taken off, growing from a handful of projects in 2010 to more than 80 MW by the end of 2017 (Table 2).[12] Solar development creates both opportunities and challenges for cooperatives.

The rise of EVs also presents a mix of opportunities and challenges for cooperatives. EVs offer co-ops a solution to flat loads, with the potential for almost $1 billion annually in additional cooperative revenue by 2026.[13] However, EVs will require a new charging infrastructure to support that growth, including equipment for home charging and charging stations, which must be built, integrated, and managed.

6 International Energy Agency, *Digitalization: A New Era in Energy?* 2017, 25, https://www.iea.org/publications/freepublications/publication/DigitalizationandEnergy3.pdf
7 Global Data, "Technology Trends in Utilities," 2017, 9.
8 Markets and Markets, *Internet of Things in the Utility Market*, 2016
9 NB-IoT: Narrowband internet of things, standard for connecting IoT devices to cellular networks
10 SIGFOX: French LPWA company, LoRa: Semtech standard, RPMA: Random Phase Multiple Access (proprietary to Trilliant), LTE-Cat-M1: cellular-based standards, NB-IoT: narrow-band internet of things. All are LPWA solutions
11 Forecast reproduced with permission
12 NRECA, *Community Solar*, https://www.electric.coop/wp-content/Renewables/community-solar.html
13 $930 million—calculated as a portion of total national EV revenue based on installed cost and average annual cost to charge a vehicle. Data come from DOE: https://www.energy.gov/eere/electricvehicles/saving-fuel-and-vehicle-costs

U.S. Total (Installations)	2018	2019	2020	2021	2022	2023	2024	CAGR (2017–2024)
Distributed Solar PV	4,548	5,777	6,478	7,588	8,888	10,411	12,194	20%
Small & Medium Wind	14	18	22	28	35	43	54	20%
Microturbines	131	157	185	221	245	287	340	19%
Fuel Cells	146	206	279	356	451	558	696	31%
DG	20,801	22,916	24,577	26,714	29,096	31,801	34,872	9%
Distributed Energy Storage	1,694	1,824	1,976	2,197	2,301	2,410	2,527	16%
Microgrids	550	627	746	790	906	1,038	1,190	16%
EV Charging Load	4,557	5,964	7,551	9,179	10,884	12,640	13,950	23%
DR	35,456	40,200	45,291	50,582	57,214	62,877	69,125	12%
Total	**63,058**	**71,532**	**80,141**	**89,462**	**100,401**	**110,766**	**121,664**	**12%**

Table 2: Projection of DER Generation, by Type. *Source: Navigant DER Generation Forecast*

3.2 What Is The Impact Of Communications Network Transformation?

3.2.1 Utilities

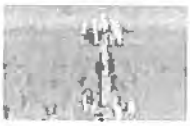
Communications are foundational investments for utilities and, as noted above, have been identified by DOE as one of the four enabling technologies for the smart grid. Cooperatives can see benefits to their operations and increased revenue coming from their communications investments. Operationally, communications investments allow for increased reliability, decreased labor costs, better equipment usage, more efficient voltage control, and other benefits that translate to cost avoidance and higher net revenue. However, broadband backbone communications systems are necessary but not sufficient aspects of many use cases.

Figure 5: Smart Grid-Enabling Technologies *Source: Department of Energy, NRECA*

Utilities have thousands of leased lines and circuits to critical grid infrastructure sites that are at risk of being decommissioned as telecommunications carriers transition from time-division multiplexing (TDM) circuits to Internet protocol/multiprotocol label switching (IP/MPLS) circuits. Carriers are willing to continue supporting utilities' use of these circuits, but at a substantial cost increase—expected to be between 30% and 90% CAGR for 5 years to reach a leveling point.[14] This cost increase has forced utilities to consider their capital expenditures in a way that will create a smooth transition away from TDM circuits over the next couple of years. The transition process and fear of being caught in a similar situation in the future regarding leased infrastructure has created an additional push for utilities considering broadband backbone options.

Leased Line Tension
Carriers are decommissioning pre-existing connections due to new / efficient solutions

Operational Challenges
Complexity and pace of change, hard for utilities to manage



Reliability
Having one connection creates one single point of failure

Figure 6: Reasons for Circuit Transition *Source: InCode Consulting*

3.2.2 Enterprises

When utilities invest in communications infrastructure, the other large enterprises in the community will also benefit from improved operations. Agriculture, manufacturing, oil

14 Proprietary sourcing

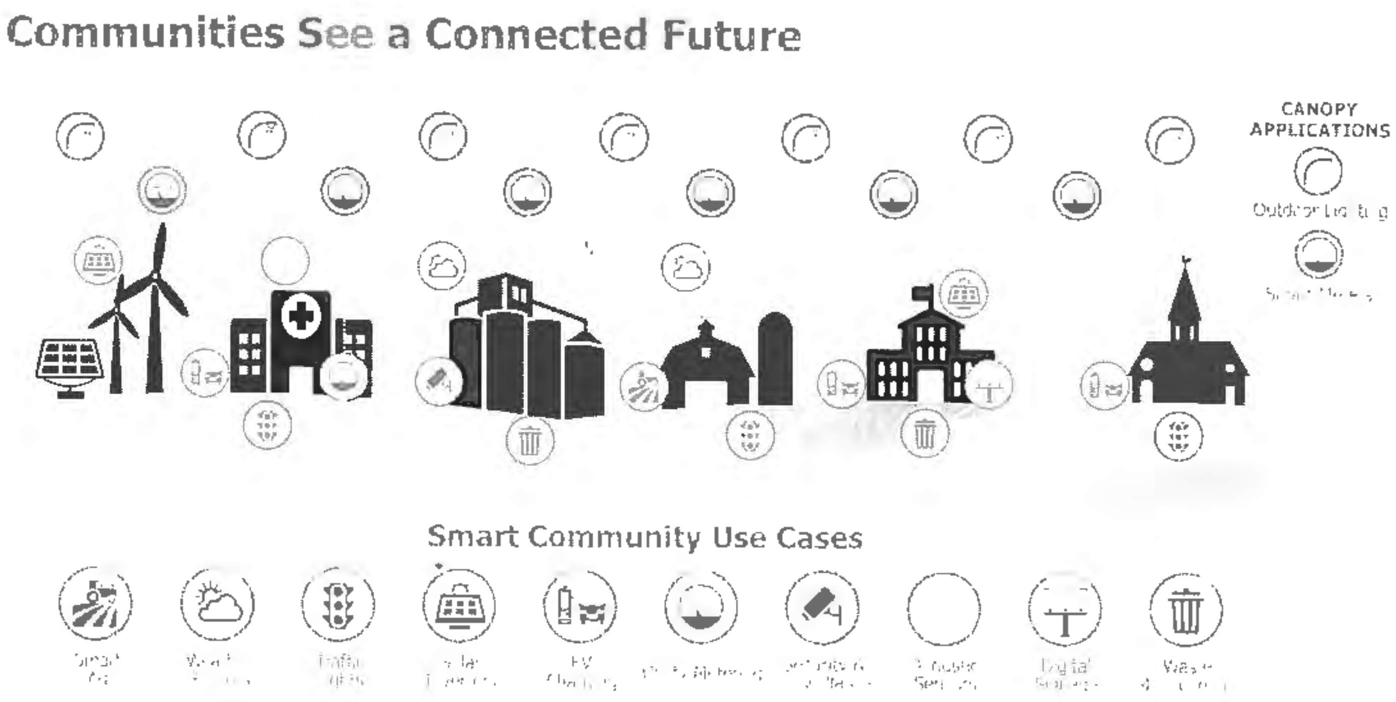


Figure 7: Smart Community Use Cases *Source: NRTC*

and gas, technology, and automotive companies will be positioned to benefit by leveraging excess capacity from networks. These industries can lease fiber bandwidth from utilities to meet their needs for voice/video connections, surveillance, telemetry, asset management, and other applications to improve their efficiency.[15]

3.2.3 Communities

Investments in communications technology by electric utilities can provide benefits to all parts of their communities. Utilities can provide a bridge to smart towns and cities, and new services, such as smart traffic lights, digital infrastructure, and waste management.[16]

Communities may also leverage fiber and other communications to connect citizens in rural areas to broadband Internet. Access to broadband enables advances in health care, education, business and economic growth, and other areas of community interest. Broadband is therefore a vital component in keeping rural communities competitive in the long term.

4 ANALYSIS OF BROADBAND BACKBONE

In the past, cooperatives typically adopted the communications technology that worked best with each grid application. However, once multiple use cases are implemented, this uncoordinated process can lead to a fragmented communications architecture that is difficult to manage. Cooperatives should develop a comprehensive 10-year plan that accounts for communications needs for all anticipated use cases over that period. Without a timeline and use case goals, cooperatives may sub-optimize their networks or be forced to retire assets early.[18]

4.1 Network Backbone: Technology Options

Cooperatives have and likely will continue to have multiple networks to serve all their communications needs. A co-op broadband network could include a hybrid backbone with both fixed wireless and wired solutions, as appropriate. Each network creates additional operational complexity for the cooperative due to the need to support the different systems. Dedicated communications planning allows

15 SNS Telecom and IT, *The Private LTE and 5G Network Ecosystem Opportunities, Challenges Strategies, Industry Verticals, and Forecasts*, 2018.
16 NRTC internal
17 NRECA, *Broadband Case Study Orcas Power and Electric Cooperative & Rock Island Communications*, 2018, 2.
18 NRECA, *Communications Smart Grid's Enabling Technology,* Defining Communications Requirements for Present and Future Applications," 2014, 10

cooperatives to streamline their communications systems and reduce fragmentation. Although it is impossible to suit all geographic areas and use cases with one solution, having fewer networks and technologies creates additional operational efficiency.

4.1.1 Point-to-Point Wireless

Point-to-point provides wireless backhaul service to the grid. Although 80% of current sites have much lower speeds of 25 megabytes per second (Mbps), and even more advanced sites typically have speeds of only up to 150 Mbps, the latest point-to-point technologies offer speeds of up to 1 Gbps and are expected to provide up to 3–5 Gbps by 2025.[19] The development of long-term evolution (LTE) and the rollout of 5G have encouraged microwave point-to-point solutions. Microwave connects dispersed aspects of the grid. It is frequently the most cost-effective option for backhaul, especially if there are existing towers for the cooperative to leverage. Microwave backhaul should be considered in conjunction with the metering infrastructure, right-of-way, and existing infrastructure.[20]

4.1.2 Fiber

Fiber offers the most secure, most reliable, highest-throughput, and lowest-latency communications option for network connections. In addition, fiber provides the opportunity to connect the grid reliably with enough capacity for both current and future use cases. To guarantee the performance of all aspects of a network, a fiber backhaul system is typically the best option. As data needs continue to increase, bringing fiber closer to users and devices improves the performance of the system.[21] Building a fiber solution is time and capital intensive, and requires extensive planning and expectations of future use cases, as it is the longest-lived asset available. Fiber is the backbone of modern community communications, facilitating advances beyond just the cooperative use cases and opening the opportunity for new revenue and business models.

4.1.3 Costs of the Backbone

The cost of a broadband backbone can vary depending on many factors. For fiber backbones, the primary cost driver will be the percentage of aerial deployment using electric poles rather than underground installation. Aerial costs range from $13,000–$17,000 per mile, depending on the amount of "make ready" necessary for the poles and the distances of the runs. Underground costs are significantly higher due to the effort of trenching, ranging from $45,000–$55,000 per mile.[22] These estimates include both equipment and labor (construction, engineering design, and project management). By understanding these cost dynamics, it becomes clear that cooperatives have a potentially substantial cost advantage over other providers due to their ability to leverage electric poles and other assets. Many cooperatives achieve more than 90% of their fiber builds on aerial facilities.

Point-to-point backbones can be significantly more cost-effective than fiber. A direct cost comparison with fiber is difficult, as situations can vary on distance, equipment needs, and other factors. However, point-to-point solutions typically cost substantially less than fiber.

19 Ericsson, *Ericsson Microwave Outlook Trends and Needs in the Microwave Industry*, 2017, 3 and 4, https://www.ericsson.com/en/microwave-outlook/reports/2017
20 NRTC, NRUCFC, NRECA, and CoBank, *Due Diligence of High-Speed Broadband Investment and Business Creation by an Electric Cooperative*, 2017, 5.
21 Ericsson, *Fiber Network Deployment*, 2017, https://www.ericsson.com/ourportfolio/networks-services/fiber-network-deployment?nav=fgb_101_116%7Cfgb_101_0823%7Cfgb_101_0573
22 Pulse Broadband internal estimate

Spotlight. Delaware County Electric Cooperative

Delaware County Electric Cooperative (DCEC) in New York State deployed a fiber backbone to serve its new AMI system by providing IP communication to all substations and remote offices. It chose the technology based on cost and the data rate requirements for both its AMI and SCADA systems, while accounting for its particularly mountainous and large service area. DCEC saw great success with its solution but also saw the system as an opportunity to prepare for the future.

4.2 Consumer Broadband

Participation in the modern economy requires access to broadband. Bringing broadband to underserved communities is an important consideration for many electric cooperatives. Co-ops are well positioned to offer these services because they already have much of the needed infrastructure and have existing relationships with their member-consumers. Moreover, offering Internet or triple-play services for customers potentially opens a large, new revenue stream for cooperatives.[23]

A fiber backbone also offers the potential to extend the network to the middle mile or last mile and eventually provide broadband to the wider member-consumer community. An expanding number of cooperatives are deploying broadband to serve their communities. Deploying all-fiber or stand-alone fixed wireless and hybrid fiber-fixed wireless networks allows the broadband backbone to be leveraged to support both fiber and wireless last-mile options.[24] If the cooperative chooses not to take on the risk of establishing a new retail broadband business, it can still participate by putting in the backbone for its system and allowing a third party to leverage their excess capacity and complete the network.

4.3 Overview Of Benefits Of A Broadband Backbone

4.3.1 Operational Benefits

Advanced communications networks offer the ability to control and operate the grid in new ways, and allow cooperatives to track their assets in the field and operate a two-way grid, integrating new assets.

With more than 1,000 annual fatalities throughout the U.S. electric industry, safety is a primary concern for all utilities. Orcas Power and Light Cooperative in Washington State saw the safety impacts of poor communication after a serious accident to a lineman, when it barely had the communications coverage needed to call for medical assistance.[25] Because of the backhaul provided by a broadband backbone, critical mobility services will also stay functional during outage events.

In addition to safety, communications networks facilitate many other operations that increase both grid resiliency and reliability. Improved communications combined with sensor technology can improve System Average Interruption Duration Index (SAIDI) and Customer Average Interruption Index (CAIDI) scores. The dispersed offices of utilities need improved communications to meet daily business tasks; this need is further impacted by the rise of cloud computing and the growing amount of critical data stored off site.[26]

Figure 8: Cybersecurity Frameworks *Source: NIST, Cybersecurity Framework version 1.1*

The increasing number of sophisticated cyberattacks also necessitates improved in-house communications systems and the need for a private network, rather than third-party carriers, to house and transmit sensitive data. Data security and the ability to control the upgrades necessary to protect the grid will continue to grow in importance.[27] Additionally, private networks are more reliable because cooperatives then are no longer subject to third-party carriers and their network needs and outages.[28]

4.3.2 Economic Benefits

Communications are best considered as an enabling technology for all other use cases that are part of the smart grid. To quantify the benefits of a broadband backbone, one must quantify the individual ways the use cases improve operations and service through reliability, voltage optimization, equipment usage, and labor savings. By optimizing the voltage on the line and delivered to a customer, utilities can minimize line loss and decrease their generation requirements. More sophisticated equipment

23 Triple-play services are home telecommunications packages that bundle Internet, cable, and telephone into one service
24 NRECA, *Communications: Smart Grid's Enabling Technology*, 2014, 7
25 NRECA, *Broadband Case Study: Orcas Light and Power Cooperative & Rock Island Communications*, 2018, 2
26 NRECA, *Communications: Smart Grid's Enabling Technology*, 2014, 11
27 https://www.nist.gov/cyberframework
28 For more information on cooperative cyber security options, please see the *NRECA Guide to Developing a Cyber Security and Risk Mitigation Plan*, https://www.cooperative.com/programs-services/bts/Documents/guide-cybersecurity-mitigation-plan.pdf

monitoring can often lengthen the life of equipment and reduce equipment failure by optimizing operations and maintenance across the entire distribution system, thereby promoting improved reliability. Labor savings come from reduced overtime, less need to hire additional employees, and less time to complete specific tasks. Finally, new revenue can be generated by leasing unused communications capacity, such as dark fiber or other sources, to enterprises.

Figure 9: Operational Benefit Categories *Source. InCode Consulting*

4.4 Industry Case Studies

4.4.1 Cooperatives

Many cooperatives have deployed broadband backbones to support their current needs and prepare for future use cases. Dakota Electric Association (DEA) began looking at options in 2013 to replace its iNet Radio backbone. Dakota's primary goal was to support its planned AMI system with the required backhaul communications, specifically by connecting its substations. It examined multiple technologies and options, including microwave, LTE, and leasing dark fiber from public and private entities. Ultimately, the co-op partnered with Dakota County, Minnesota to deploy fiber to their substations. It built the business case on the cost and security comparison

"The biggest initial driver was security . . . but the number of new ideas we hadn't thought about beforehand has been great."

between fiber and microwave, and developed a strong partnership with the county to serve its future AMI needs. Craig Turner, Director of Engineering Services at DEA, said that "the biggest initial driver was security … but the number of new ideas we hadn't thought about beforehand has been great." The co-op has since enhanced its security by splitting applications onto different wavelengths and fiber strands to make a breach into any one part of the system irrelevant.[29]

4.4.2 Communities

Spotlight: Electric Power Board – Chattanooga

When the Electric Power Board (EPB) determined to invest $300 million to implement AMI and build 6,000 miles of fiber in Chattanooga to deliver advanced city services, it anticipated value for the utility, businesses, households, and the wider community but did not anticipate as much benefit as the project eventually created, especially for the community. A grant from the American Reinvestment and Recovery Act (ARRA) supported upgrades in smart switches, sensors, and controls. The project was expected to bring the utility value through smart grid operations, and in new broadband revenues. By 2015, the project had already generated more than $200 million in value through the smart grid alone, and between $860 million and $1.3 billion in value across the utility, businesses, the community, and individual households. The smart grid provides more than 20% of the benefits, with new investment spurred by the fiber backbone providing the largest impact, comprising 30% of the total benefits.[30]

29 Based on an interview with Craig Turner, Director of Engineering Services at DEA, conducted on April 20, 2018

30 Bento Lobo, *The Realized Value of Fiber Infrastructure in Hamilton County Tennessee*, 2015, 3 See also *"The Competitiveness and Innovative Capacity of the United States,"* U S Department of Commerce (January 2012), http://ftpcontent2 worldnow com/wrcb/pdf/091515EPBFiberStudy pdf

5 BROADBAND BACKBONE USE CASES FOR ELECTRIC COOPERATIVES

Cooperative use cases for broadband backbones are evolving quickly, and each cooperative has unique business processes and service territories to utilize the backbone and its associated technologies. As DOE has stated, "because advanced communication and control is required to operate even one smart meter or automated device, these systems and networks represent a fixed cost for all projects, from small pilots to full-scale deployments. These systems provide a platform for a smarter grid over the next decade or more."[31]

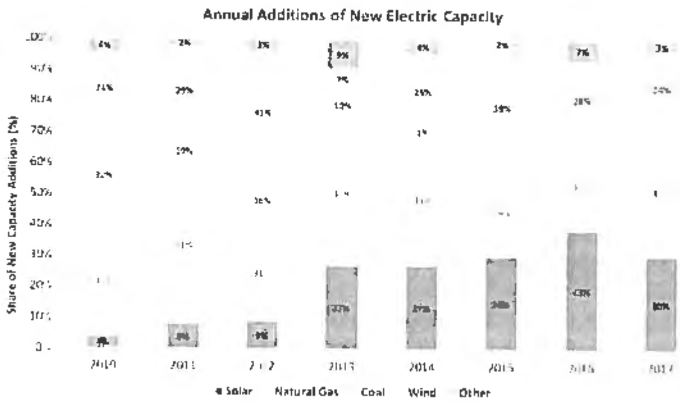


Figure 10: Annual Generation Capacity Additions *Source SEIA*

5.1 Generation Applications

5.1.1 Integration of Renewables

Renewable resources have steadily increased their share of total U.S. load, with solar and wind energy combined accounting for more than 50% of new generation capacity every year since 2014, increasing to 7% of total generation today.[32] New technology can expand electric distribution systems' ability to host these generation assets, monitor power sources, and improve forecasting capabilities to integrate the intermittent nature of their production onto the grid. For example, a smart syncrophaser found a damaging oscillation in wind production in the Electric Reliability Council of Texas (ERCOT) system and was able to constrain the output of the unit while the precipitating malfunction was fixed. Traditional monitoring systems could not have caught this problem.[33] These types of monitoring systems and the communications that enable can be increasingly beneficial as more renewable energy sources are added to the grid.

5.2 Distribution Applications

Distribution applications cover all uses after the transmission and include distribution lines and substations. Due to the large number of cooperatives without transmission or generation facilities, this report focuses only on distribution use cases.

5.2.1 Substation Automation

Substations transform the voltage of power between different levels of the distribution grid. Studies have shown that more than 90% of cooperatives have some substation automation (SA) programs in place.[34] SA can generate savings in a variety of ways, from SCADA systems that monitor and report back on the state of substation equipment to automated switches that control voltage levels and reroute power. These applications are critical to the operation of a cooperative and require constant monitoring. Traditionally, they were controlled manually—either physically switched onsite or from the control house. Significant reliability is required in the communications system to allow these critical aspects of the grid to become automated.[35]

5.2.2 Volt/VAR Optimization

AMI, load tap transformers, automated capacitors, and voltage regulators can be used to improve voltage supply delivery and reactive power compensation. This process optimizes voltage levels and reduces electricity requirements during both peak and off-peak periods, and improves the performance of critical infrastructure. These devices, under coordinated control enabled by the broadband platform, can improve power quality and produce non-intrusive energy savings of 2–4% per year, and reduce reactive power by 10–13% over a year.[36]

31 U.S. Department of Energy, *Smart Grid Investment and Grant Final Report*, 2016, 31, https://www.smartgrid.gov/files/Final_SGIG_Report_20161220.pdf
32 EIA, *Electricity in the United States Is Produced with Diverse Energy Sources and Technologies*, https://www.eia.gov/energyexplained/index.php?page=electricity_in_the_united_states
33 Department of Energy, *Smart Grid Investment and Grant Final Report*, 2016, 32
34 Newton-Evans Research Company, *By the Numbers. A Look at the Substation Automation and Integration Market*, 2007, https://www.elp.com/articles/powergrid_international/print/volume-12/issue-2/features/by-the-numbers-a-look-at-the-substation-automation-and-integration-market.html
35 Navigant, *Networking and Communications for Smart Grids and Smart Cities*, 2016, 11
36 Department of Energy, *Smart Grid Investment and Grant Final Report*, 2016, 10

5.2.3 Distribution Automation and Fault Location, Isolation, and Supply Restoration

Fault Location, Isolation, and Supply Restoration (FLISR) allows utilities to pinpoint the location and extent of an outage to better direct repair crews and resources with precise, real-time information. The FLISR capabilities triangulate the impacted area and relay that information back to cloud-based data systems.[37] Further, FLISR can allow for automated fault detection and feeder switching, which can restore power to customers in seconds. FLISR technologies have been able to reduce the number of customers affected by an outage by up to 55% and reduce the total number of disrupted minutes by 53% using "self-healing" automation. The deployment of these technologies has helped utilities improve their System Average Interruption Frequency Index (SAIFI) scores by as much as 58%.[38]

5.2.4 Distributed Energy Resources Integration

Customers are purchasing DER in multiple forms, through solar photovoltaic panels, energy storage solutions, and other methods. DER can change the shape of their energy loads, and increasingly utilities need to integrate these resources. This is especially true for electric cooperatives in their role as consumer-centric utilities. To successfully add these resources to the system, the grid must manage two-way power flows through two-way communication.[39] In an example of this new trend, Southern California Edison is attempting to integrate 10,000 solar installations onto its system as part of DOE's SunShot program. To successfully complete the task, it is focusing on the software portal, a grid integration and software provisioning process that takes less than 10 days, and a real-time DER control system.[40]

Figure 11: PV Generation Peak Load Shift *Source: SCE*

EVs offer utilities an additional revenue source as they become a larger part of the transportation mix. The growth of EVs offers cooperatives, which have experienced slow load and revenue growth for the last 10 years, the opportunity to achieve almost $1 billion in additional revenue by 2025 at current projections.[41]

Just as the integration of DER will continue to put pressure on utilities' capital expenditure and operating expenditure models, changes in customer behavior—such as rapid adoption of EVs—will impact electricity demand management and pricing models.

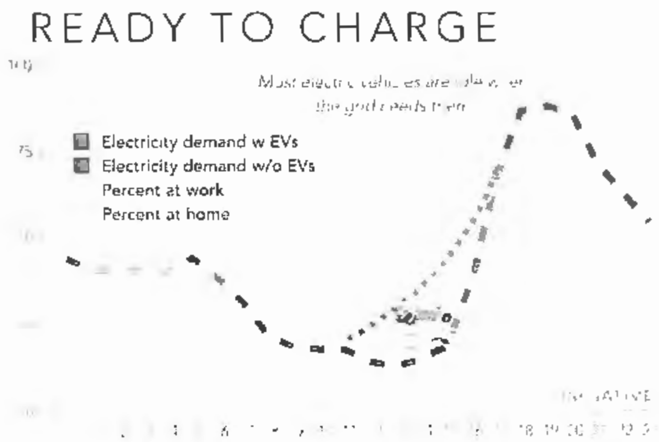


Figure 12: EVs as Potential Storage *Source: Scott Madden*

5.3 Retail Applications

5.3.1 Advanced Metering

AMI, along with communications, is another of the base technologies that supply the information flow to make the grid work effectively. Electric cooperatives are leading the industry in AMI "smart meter" deployment, with AMI deployed at 60% of all co-op meters. Because of the low population density in their service territories, cooperatives were some of the first companies to move

37 Jean-Philippe Moreau, Mario Tremblay, and Troy Martin, DistribuTECH 2018, *Voltage Sag Measurements for Advance Fault Location and Condition-Based Maintenance*, 2018
38 Department of Energy, *Smart Grid Investment and Grant Final Report*, 2016, 9.
39 Department of Energy, *Smart Grid Investment and Grant Final Report*, 2016, 32.
40 Bob Yinger, Le Xu, Pete Maltbaek, Chad Abbey, *DistribuTECH, Southern California's EASE Project*, 2018
41 Calculated from Energy Information Administration (EIA) projections of EV-installed base and average charge cost, spread across all cooperative customers.

to automated meter reading (AMR) meters and this trend has continued with AMI, with many AMR meters being replaced with AMI.[42] Smart meters are integrated with communications systems, allowing them to maintain two-way communications with the cooperative and offering the cooperative the opportunity to send time-of-use (TOU) pricing and other energy information back and forth.

AMI meters can enable decreased operating expenses in several ways, including remote connect/disconnect features, outage monitoring, voltage monitoring, and business loss measurements. AMI also supplies the information necessary to the functioning of DA, SA, DM, VVO, and DER, making it relevant to all other applications discussed in this paper.

5.3.2 Demand Management

DM broadly refers to all programs designed to affect consumer demand for electricity. Energy efficiency programs aim to reduce total energy usage and can potentially defer capital investments in new capacity. DR programs focus on shifting the energy load for customers from certain peak usage times, when energy is more expensive, to off-peak times, when energy is less expensive.[43] Utilities may also lower or increase retail energy prices at certain times to encourage or discourage use (called time-of-use [TOU] pricing), which reduces peak demand by 15% on average.[44] The effectiveness of DM programs varies widely by geographic region, load profile and extent of use, and wholesale power arrangements; cooperatives must assess for themselves which programs might deliver benefits for their systems.[45]

New technology in homes has helped increase the effectiveness of DR. Combined, hot water heaters and HV/AC systems account for two-thirds of residential consumer energy use. Smart thermostats and smart hot water heaters can shift the usage of those systems to lower use times without manual intervention from consumers and without a noticeable change in the effectiveness of their appliances.

6 BENEFIT ANALYSIS OF SELECT USE CASES

6.1 Overview Of Use Cases

The smart grid can transform the production and distribution of energy from a one-way single source grid into a two-way grid incorporating DER—one that is more resilient and more efficient than previous iterations. Many different specific use cases are a part of that transformation; this paper assesses those uses with the most impact at a qualitative level.

6.2 Use Case Selection Qualifiers

To value a broadband backbone, utilities must travel down the value chain to the operational benefits and new revenue that the backbone can enable. These use cases will require up to 100,000 times the amount of data required by today's grid.[46] A robust communications network is necessary to capture these benefits today and will only grow in importance over the life of the asset as new and improved technologies emerge. To quantify the value of the broadband backbone, this paper will not differentiate between the technologies necessary to enable the operational efficiencies and the efficiencies themselves. Communications is only one part of the value chain and should be considered that way. Furthermore, this paper estimates the value of a use case across the country. In reality, these values will vary both regionally and from cooperative to cooperative, based on the load profile and specific grid technologies involved. Also, each cooperative will vary based on its customer profiles, territory size, and geography. These quantifications should be used as a guide and a directional assessment of the value of a broadband backbone and its enabling use cases.

The model is built primarily on a per-meter valuation, which is applied across different-sized cooperatives. Different economies of scale will create different values when cooperatives implement them, but they are estimated to be the same in this case, due to a lack of differentiating data and effective measurement by those utilities that previously implemented the use cases.

42 NRECA, *Technology Advisory*, "Electric Cooperatives Lead Industry in AMI Deployment," 2018, 1 AMI meter penetration data comes from EIA Form 861 (2016)
43 These include annual peak times, generally the hottest and/or coldest days of the year, when demand for space cooling and heating is the highest, as well as daily peak times, such as when customers first wake up in the morning or return from work, and usage increases.
44 TOU programs are also aimed at reducing usage at times when power costs are more expensive and are generally tied to time-based wholesale power costs *Department of Energy, Smart Grid Investment and Grant Final Report*, 2016, 45.
45 NRECA, *Distributed Energy Resources Compensation and Cost Recovery Guide*.
46 National Rural Electric Cooperative Association and U.S Department of Energy, *Smart Grid Demonstration Project*, "Communications The Smart Grid's Enabling Technology," 2014, 1

Benefit of Select Use Cases

Application	Benefit Case	Data Need	Broadband Impact
AR-Based Substation Monitoring	Condition-Based Asset Monitoring	Bandwidth, Latency	High
DA	Reliability, Equipment Usage, Labor Savings	Latency, bandwidth	High
AMI	Reliability, Volt Opt, Equipment Usage, Labor Savings	Bandwidth	High
SA	Reliability, Volt Opt, Equipment Usage, Labor Savings	Latency, Reliability, Security	High
Demand-Side Management (DSM), Volt/VAR, CVR	Volt Opt, Equipment Usage, Labor Savings	Reliability, Security	High
AM	Volt Opt, Equipment Usage, Labor Savings	Reliability, Security	High
Broadband to Home	New Revenue – Triple Play Services	Bandwidth, Reliability	High
Security – Video Surveillance	Threat Reduction	Bandwidth	High
Emergency Load Shedding	Volt Opt, Equipment Usage	Latency, Reliability, Security	High
Broadband Service to Commercial and Industrial (C&I)	New Revenue	Bandwidth, Reliability	High
DR	Volt Opt, Equipment Usage, Labor Savings	Reliability, Security	High
Outage Management	Reliability, Volt Opt, Equipment Usage, Labor Savings	Bandwidth	High
Self-Healing Feeder Automation	Reliability, Volt Opt, Equipment Usage, Labor Savings	Latency, Reliability, Security	Medium
Load Forecasting	Volt Opt, Equipment Usage	mMTC	Medium
EV Management	Volt Opt, Equipment Usage	mMTC	Medium
Relay Protection	Reliability, Volt Opt, Equipment Usage, Labor Savings	Latency, Reliability, Security	Medium
Phasor Measurement Unit	Reliability	Latency	Medium
DER, Renewables	Volt Opt, Equipment Usage	Security	Medium
Teleprotection	Equipment usage, labor savings	Latency, Reliability, Security	Medium
SCADA	Reliability, Volt Opt, Equipment Usage, Labor Savings	Latency, Reliability, Security	Medium
Workforce Mobility	Reliability, Labor Savings	Reliability	Medium
Mission-Critical Apps (PTT)	Reliability, Labor Savings, Equipment Usage	Reliability	Medium
Power Quality	Volt Opt	Latency, Reliability, Security	Medium
Smart Home	Volt Opt, Equipment Usage, Labor Savings	mMTC	Low
Electronic Mapping	Equipment Usage, Labor Savings	Latency, Reliability, Security	Low
Energy Conservation	Volt Opt, Equipment Usage	mMTC	Low
Energy Efficiency	Volt Opt, Equipment Usage	mMTC	Low
Facilities Energy Management	Volt Opt, Equipment Usage	Latency, Reliability, Security	Low
Building Automation	Volt Opt, Equipment Usage	mMTC	Low

Table 3: Application and Benefit Case

6.3 Benefit Quantification Methodology

All use cases were divided into major application areas and valued in those categories. In addition to direct use for the cooperative, an estimated value for the cooperative to lease dark fiber to other enterprises in the area generated additional income for the asset at a valuation of $200 per strand mile annually; note that most leasing agreements have a flat rate for a 20-year contract.[47] See Appendix Section 8.1 for additional details and methodology.

When factoring in slow load and customer growth, a 50,000-member cooperative has the potential for economic benefits of $10 million to $16.6 million today and $15.1 million to $25.2 million by 2027, depending on the utility-specific implementation and regional load profile.[48] This value is driven by the improved resiliency and reliability of the grid, as demonstrated by DA, SA, outage reduction, and AM aspects of the model.[49]

Application	Annual Valuation per Member
DA	$20–$30
SA	$1–$3
AMI	$12–$18
VVO	$14–$29
DM	$88–$140
Outage Reduction	$1–$3
AM	$45–$85
DER	$3–$6
Carrier Cost Replacement	$1–$3

Table 4: Application and Valuation

6.4 Benefits For Different Sizes Of Electric Cooperatives

6.4.1 A 10,000 Member Cooperative

Small cooperatives may see economic value of $1.7 million to $2.9 million per year through their operations. Small cooperatives may realize many of the benefits outlined above but may be too small to create efficiencies in all of them. They may also be impacted by the scale necessary to create the variance in performance that allows for increases in efficiency to take place. For CVR, different value-based solutions, such as aggregation and defined services, may be needed to assist in achieving the long-term benefits required by smaller cooperatives. Similarly, voltage control solutions that behave like traditional DR programs can have large impacts because power supply costs are the largest part of the cooperative cost structure.

2018 Valuation for a 10,000 Member Cooperative

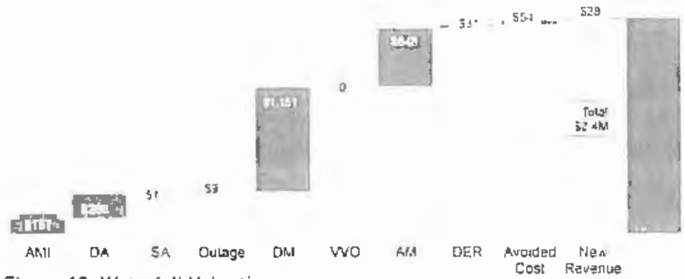


Figure 13: Waterfall Valuation

6.4.2 A 50,000 Member Cooperative

A cooperative of 50,000 members may see between $10 million and $16.6 million in economic benefit annually by implementing the use cases outlined above.[50] DR may play the largest role in determining the success of this operational efficiency through modernization of the grid. Additionally, the revenue could vary, depending largely on how successful the cooperative is in selling its excess fiber capacity to other enterprises.

2018 Valuation for a 50,000 Member Cooperative

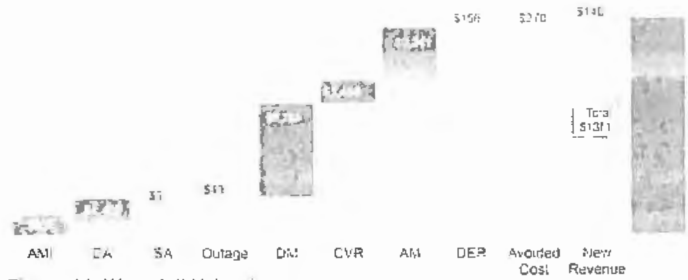


Figure 14: Waterfall Valuation

6.4.3 A 100,000 Member Cooperative

Large cooperatives may see a range of benefits of $20 million to $33.2 million per year. These benefits will follow much the same pattern as those from the smaller-

47 Craig Turner, *Tech Advantage*, "How to Navigate the Backbone," 2015, 17.

48 Assumed 1% load growth.

49 This value is the value generated by all use cases cumulatively but requires additional equipment to operate the use cases. Additionally, it represents the total value, not a net value that would take costs into account.

50 The range of values is driven by utility-specific implementations of the use cases, the benefits of multiple-use cases used in conjunction to create additional value, and regional differences in load profile leading to different opportunities for generating savings.

sized co-ops. Large cooperatives have the scale to allow for more investment in these use cases and may be able to implement more of them because of their larger investment budgets.

7 HOW TO USE THE GUIDE

This guide should be considered an input to decision making for cooperatives assessing the value of a broadband backbone for electric operations. A broadband backbone is a foundational technology for other smart grid use cases that will likely become necessary to execute business tasks going forward. Because of changing consumer behavior and the rise of DER, an intelligent grid and the communications network to support it will likely become imperative for safe maintenance of the grid. A communications network is a long-term investment, which requires its own strategy outside of an ad hoc implementation as part of other use cases. Furthermore, utilities with a broadband backbone can benefit from current use cases as well as positioning themselves to benefit from other use cases not yet commercially viable or even envisioned.

8 APPENDIX

8.1 Model Explanation

We built the model based around a per-meter valuation of different use cases. The use case valuations were sourced from published benefit quantifications, as outlined specifically below. Those benefits were estimated on a per-meter basis, then qualitatively assessed and adjusted to reflect cooperative use cases, data quality, and execution ability. The valuations were then vetted by subject matter experts—including vendors, cooperative employees, and the sponsors of this paper—to examine quantification method, value, feasibility, and scalability. Those initial valuations were then scaled over time to account for growth in customers, loads, and use cases. Although the valuations did not account for specific regional or load profile differences, regional variability informed the ranges of values ultimately selected. All dollar amounts are provided for illustrative purposes only. Each electric cooperative has unique circumstances and should make its own independent business decisions.

The following sections present the different inputs utilized in the benefits case. They provide references to the original data points and supporting sources, as well as the adjustments necessary to account for the per-meter structure of the model and the differences between cooperatives and other utilities.

Size of Cooperative: 50,000 Members

Item			
Revenue			
Business	$140,000	$144,200	$182,668
Revenue - Total	**$140,000**	**$144,200**	**$182,668**
Cost Avoidance			
Distribution Automation	$1,400,000	$1,442,280	$1,829,877
Substation Automation	$5,000	$5,101	$5,985
AMI	$837,000	$862,277	$1,094,005
Outage Management	$42,500	$43,784	$55,550
Demand Management	$5,753,400	$5,927,153	$7,520,011
Volt/VAR Optimization	$1,458,000	$1,502,032	$1,905,686
Asset Management	$3,240,741	$3,338,611	$4,235,827
DER	$155,535	$220,300	$1,738,741
Previous Telecom Costs	$270,000	$329,400	$1,616,599
Cost Avoidance - Total	**$13,162,176**	**$13,670,937**	**$20,002,282**
Total Economic Value	**$13,302,176**	**$13,815,137**	**$20,184,950**
High Estimate	$16,627,720	$17,268,921	$25,231,188
Low Estimate	$9.976,632	$10,361,353	$15,138,713

Figure 15: Valuation Sheet

8.1.1 Advanced Metering Infrastructure

AMI

AMI also provides data to optimize other use cases, including outage management and voltage optimization

Method

Data Point	Customer Count	Annual Expected Savings
$18.74 per meter	50,000	$835,000

Rationale / Source

Sources
1. AMI summary report

- Meter reading
- Tamper detection
- Outage monitoring
- Prevent truck rolls

Further Sources

1. Final SGIG report
2. Distributech
3. Navigant

8.1.2 Distribution Automation

Distribution Automation- FLISR

DA can also generate savings through load balancing

Method

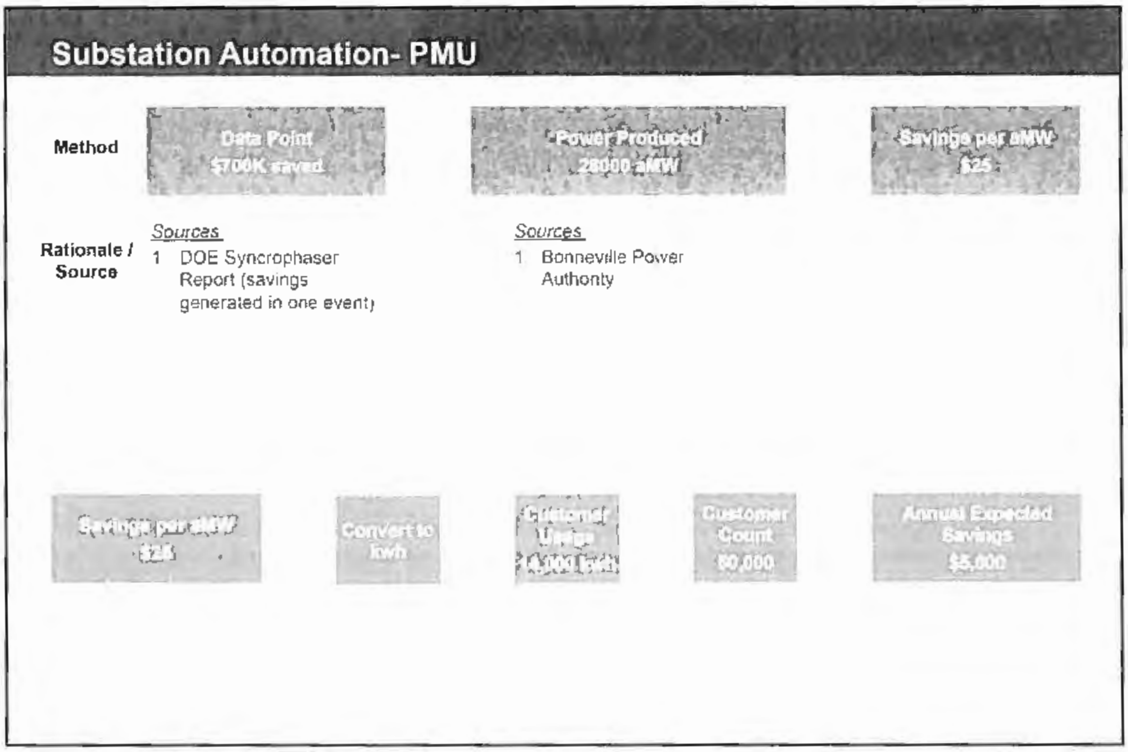
Data Point	Customer [illegible]	Savings per Meter
[illegible]	50,000	[illegible]

Rationale / Source

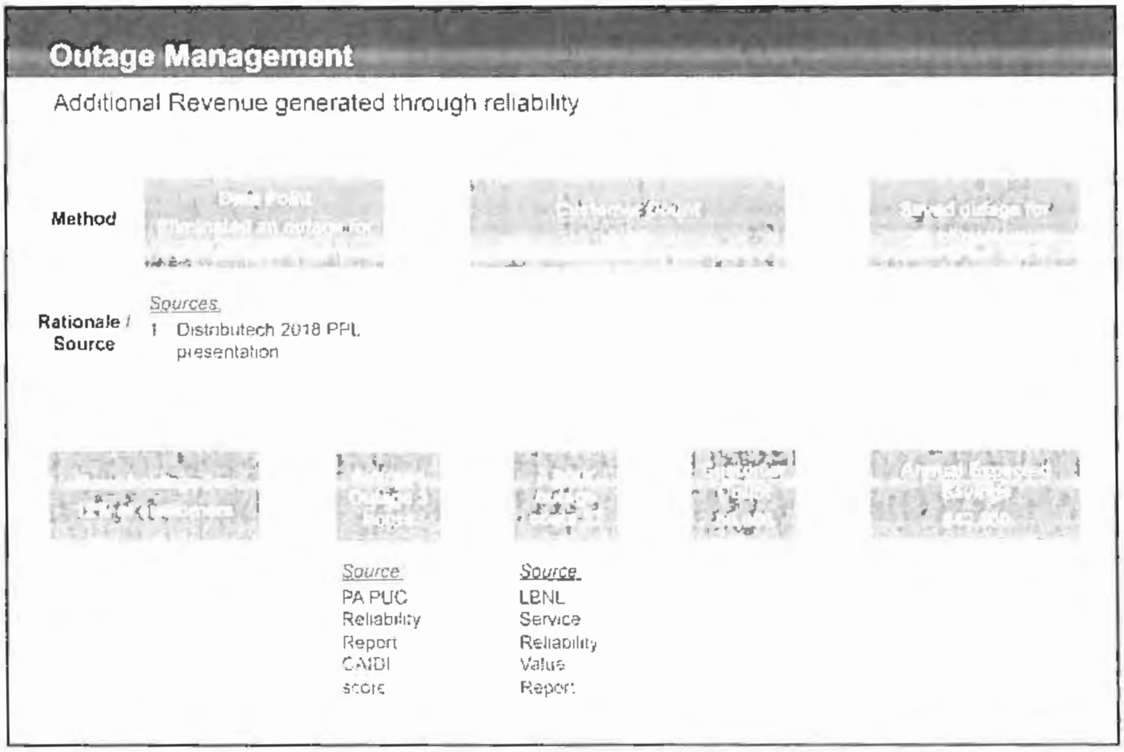
Sources
1. Distributech 2017 White label utility (2 examples)
2. DOE NRECA Smart Feeder Switching Report

Savings per Meter	Customer Count	Annual Expected Savings
$28	50,000	$1,400,000

8.1.3 Substation Automation



8.1.4 Outage Management



8.1.5 Demand Management

Demand Management

Amount saved from DM programs

Method	Data Point $115	Customer Count 50,000	Annual Expected Savings $5,750,000
Rationale / Source	*Sources* 1 OG&E reporting in AMI summary- $191 2 Interviews with SMEs $90-$120	*Number of meters in service area*	

Note. Does not include savings that utilities may pass back to the customer in the form of reduced rates

8.1.6 Volt/VAR Optimization

Volt/VAR Optimization

Method

Rationale/ Source

Sources
1 Interview with SME, Analysis of Naperville, Santee Cooper, Duck River, Glendale Power and Water, Lincoln PUD
2 DA Summary Report, DOE 2%-4% CVR savings

Note 10,000 customers too small to apply solution

8.1.7 Asset Management

Asset Management- Video Security

Security and infrared sensors for predictive maintenance and intruder security

Method

Security Spending
0%-1% value of assets

Substation Asset Value
$20M

Spending per Substation
$100,000

Rationale / Source

Sources
1 Security Directors Report Monthly Members Survey

Sources
1 WECC Capital Cost Report

Spending per Substation
~$100,000

Substation Count
~32.5

50 000 customers

Annual Expected Benefits
$3,240,000

8.1.8 Distributed Energy Resources

DER Integration

Method

Rationale / Source

Sources
1 Electric Drive Transportation Association

Sources
1 US Census

Sources
1 EIA

8.1.9 Avoided Costs

Telecom Replacement Costs

Amount saved from T1 replacement

Method

Data Point
$18k annually for T1

T1 lines per meter
.0003

Annual Expected Savings/ meter
$5.40

Rationale / Source

Sources
1 Estimate from fiber SME

>3 T1 lines for 10k members
<11 T1 line for 50k members

Savings per Meter
$5.40

Customer Count
10,000

Annual Expected Savings
$54,000

8.1.10 New Revenue

New Revenue

Dark Fiber Leasing

Method

Data Point
[illegible]

Miles of fiber per meter
[illegible]

Annual Expected Revenue/ meter
[illegible]

Rationale / Source

Sources
1 Dakota Electric
2 $1k-$4k for 20 year lease per mile

Average of fiber backbone to number of meters for 11 cooperatives

Revenue per Meter
[illegible]

Customer Count
[illegible]

Annual Expected Savings
[illegible]

Note Assumes average of 1 enterprise customer per mile

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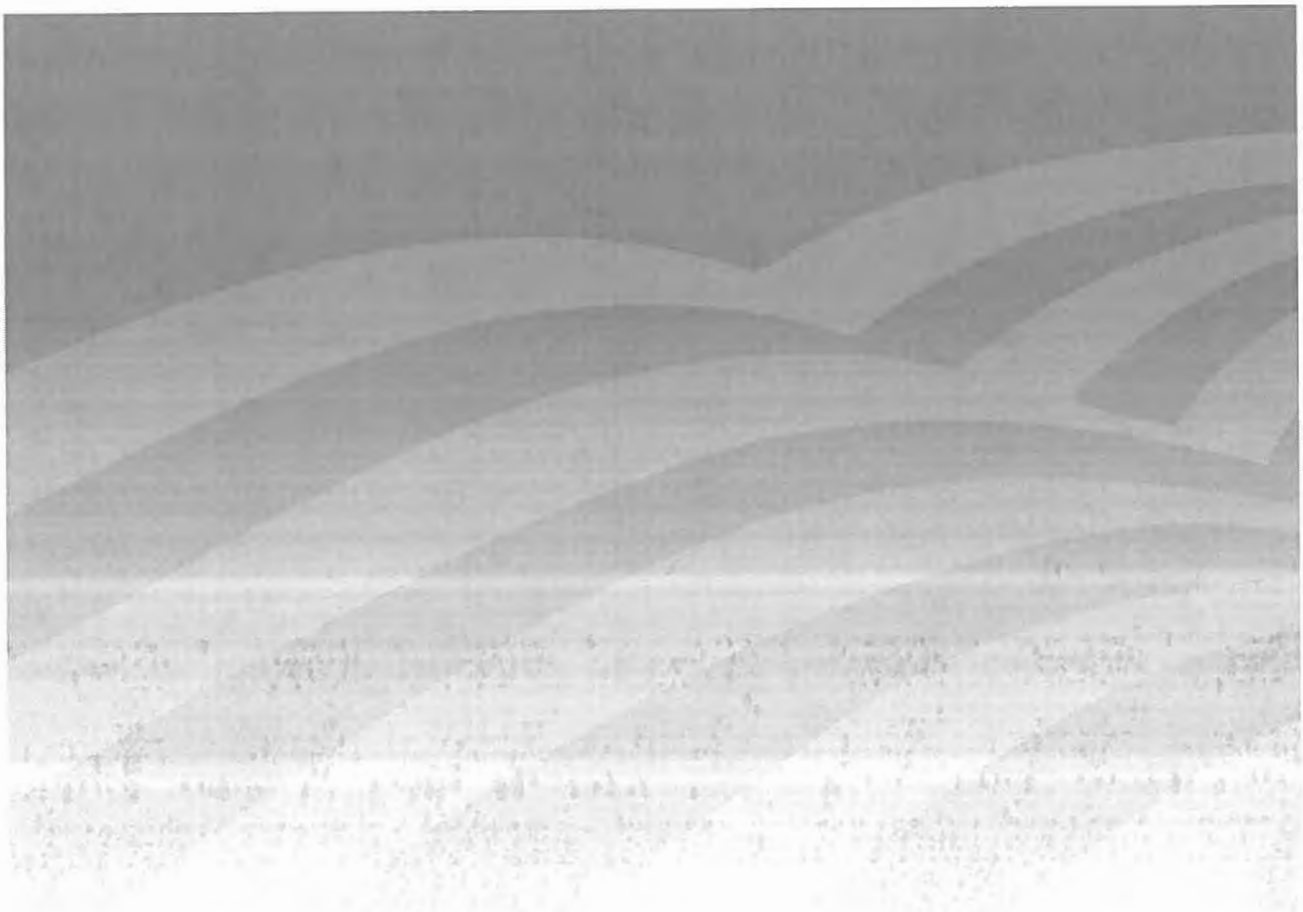
ERICSSON

EXHIBIT 2

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

Business & Technology Report
February 2020

Electric Cooperatives Bring High-Speed Communications to Underserved Areas

Insights from NRECA's 2018 - 2019 Broadband Case Studies

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NRECA
America's Electric Cooperatives

Table of Contents

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.

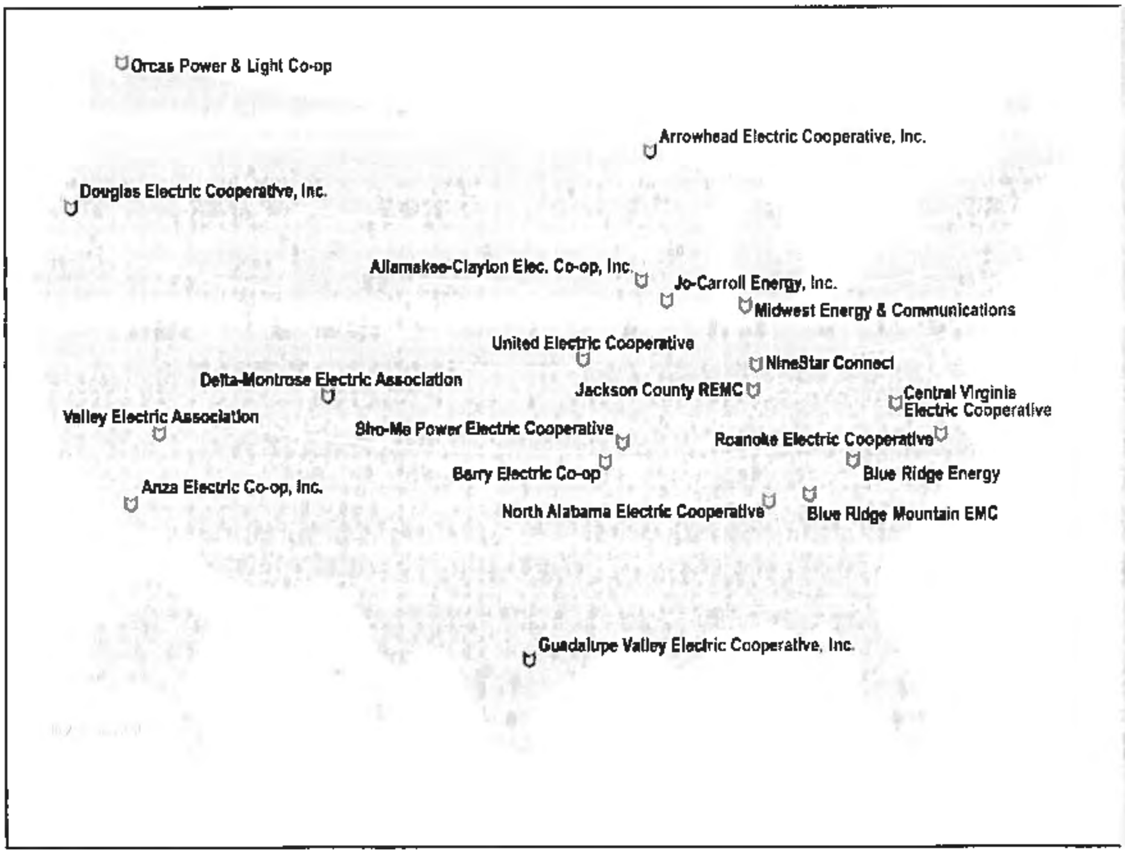
- The vast majority of broadband investments by 2019 case study cooperatives are in building fiber networks, as was the case in the 2018 cases.

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 <u>not</u> 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.

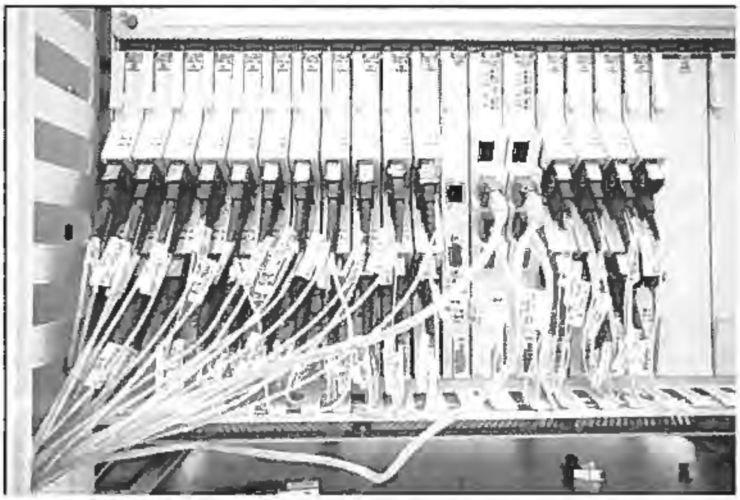
Table 2. Cooperative Profile — Broadband Operations and Plans
2019 Case Studies

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	
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 began in 2006 Network expansion continuing with strategic additions in 2019 and 2020	8 [illegible]00 b[illegible] a subscribers
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 date backhaul, time-of-use metering, voltage control deta 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 advenced 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 plece' 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 capitel 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 thet 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 number 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 Consolidated Telecommunications Co. (CTC) of Brainerd, MN.	Not-for profit	Internet access and telephone, facilitated 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 co-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)

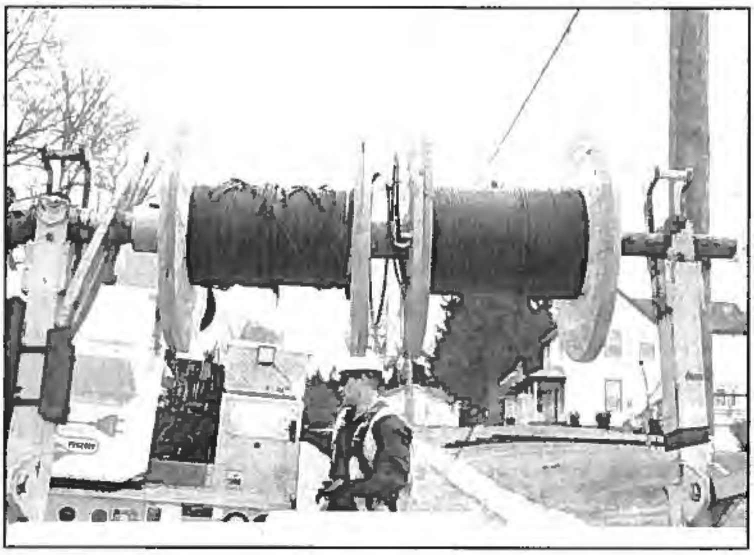
		Business Model			
Cooperative Name	Broadband Entity Name	Organizational Structure	Dedicated vs. Shared Staffing	For-profit vs. Not-for-profit	Broadband Products Offered
Guadalupe Valley Electric Cooperative Gonzalez, TX	*Guadalupe Valley Electric Cooperative dba GVEC.net*		General manager of GVEC serves 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 petronage 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 beckhaul.	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 wireles 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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EXHIBIT 3

SmartGrid.gov

Distribution Intelligence

"Distribution intelligence" refers to the part of the Smart Grid that applies to the utility distribution System, that is, the wires, switches, and transformers that connect the utility substation to you, the customers. The power lines that run through people's back yards are one part of the power distribution System. A key component of distribution intelligence is outage detection and response. Today, many utilities rely on customer phone calls to know which areas of their distribution System are being affected by a power outage. Along with smart meters, distribution intelligence will help to quickly pinpoint the source of a power outage so that repair crews can be immediately dispatched to the problem area. A utility's outage response can also improve. Most utilities count on complex power distribution schemes and manual switching to keep power flowing to most of their customers, even when power lines are damaged and destroyed. However, this approach has its limitations, and in many cases an automated System could respond more quickly and could keep the power flowing to more customers. By having sensors that can indicate when parts of the distribution System have lost power, and by combining automated switching with an Intelligent System that determines how best to respond to an outage, power can be rerouted to most customers in a matter of seconds, or perhaps even milliseconds. It may even be possible to react quickly enough to power disturbances so that only those in the immediate neighborhood are affected, while other customers' power source are rerouted fast enough to avoid any interruption in power. This capability could be the first example of the highly touted "self-healing" aspect of the Smart Grid in action.

The "Self-Healing" Power Distribution System

Outage response is one aspect of distribution intelligence that is commonly referred to as distribution automation (DA). DA may actually be the oldest segment of the Smart Grid, because utilities have been automating their distribution systems since the 1960s. But while DA initially focused just on remote control of switches, the Electric Power Research Institute now considers distribution intelligence to mean a fully controllable and flexible distribution System. Combining DA components with a set of intelligent sensors, processors, and communication technologies will lead to distribution intelligence. When fully deployed, distribution intelligence will enable an electric utility to remotely monitor and coordinate its distribution assets, operating them in an optimal matter using either manual or automatic controls.

Helping the Grid Run More Efficiently and Reliably

Along with outage detection and response, another potential application of distribution intelligence is the ability to optimize the balance between real and reactive power. Devices that store and release energy, such as capacitors, or that use coils of wire to induce magnetic fields, such as electrical motors, have the ability to cause increased electrical currents without consuming real power: this is known as reactive power. A certain amount of reactive power is desirable within a power System, but too much reactive power can lead to large current flows that serve no purpose, causing efficiency delays to allow for momentary flows of high current, which may be caused by industrial equipment powering up, rather than a fault. Protection systems are often a combination of instantaneous breakers with high current settings and time-delayed breakers or relays with lower settings These systems of automated breakers and relays end up being a balancing act: they must allow the System to operate with high currents when needed but protect the System and the people around it from high current flows when a fault exists. Distribution intelligence can provide a more elegant approach to protecting the feeder lines, using sophisticated monitoring and controls to detect and correct for faults while maintaining the highest level of System reliability during non-fault conditions. An intelligent System could even detect and isolate faults in specific pieces of equipment and route power through a backup System instead, maintaining power reliability. Distribution intelligence can also incorporate more sophisticated ground-fault detectors to minimize the possibility that people can be shocked or electrocuted when encountering downed power lines. Most utilities are only starting on the road to true distribution intelligence, but the market is expected to boom in the coming years

EXHIBIT 4

The Road Ahead: Planning for Electric Vehicles by Managing Grid Interactions

NATIONAL GOVERNORS ASSOCIATION

Executive Summary

Transportation electrification is growing across the country and Governors are taking steps to advance electric vehicle (EV) adoption and prepare for the increasing interactions between EVs and the electric grid. Governors in 14 states have set electric vehicle goals and are planning a transition to EVs.[1] Additionally, 15 Governors recently signed a memorandum of understanding (MOU) to commit their states to eliminate medium and heavy-duty vehicle emissions by 2050.[2] A key challenge for states is how to meet EV charging needs and, as charging networks are built out, how to manage impacts to the electricity grid. This issue brief will explore the following topics:

- **Installing Charging Infrastructure.** Locating chargers in strategic locations, often referred to as siting, to provide convenient access to EV drivers can smooth demand impacts on the electric grid.
- **Vehicle Grid Integration (VGI) or Managed Charging**. EVs allow for flexible fueling, enabling them to be more responsive to grid demands and constraints. Appropriate vehicle-grid integration can enable cost savings and ensure a reliable electric grid. VGI strategies include integrating smart charging controls and designing responsive electric utility rate structures.
- **Vehicle-to-Grid (V2G)**. EVs have further capacity to feed electricity back to the grid, allowing for bidirectional energy flow, known as vehicle-to-grid (V2G). This technology is not fully implemented; there are pilot projects underway in parts of the U.S. V2G may provide additional benefits such as cost savings for utilities and customers, while improving grid resilience and reliability.

Impacts to the electric grid remain low as EV adoption remains close to 2 percent of all light-duty vehicles in the country. However, it is important for states to begin preparing for an increasing trend in transportation electrification. Many actions are available to Governors that can help smooth this transition as more EVs are on the road. Some potential steps include establishing an EV working group to plan for this transition; collaboration with other Governors to build out charging networks among interstate corridors; or instructing regulators to consider EV rate pilot programs. States can consider these actions as they move to an electrified transportation system.

Introduction

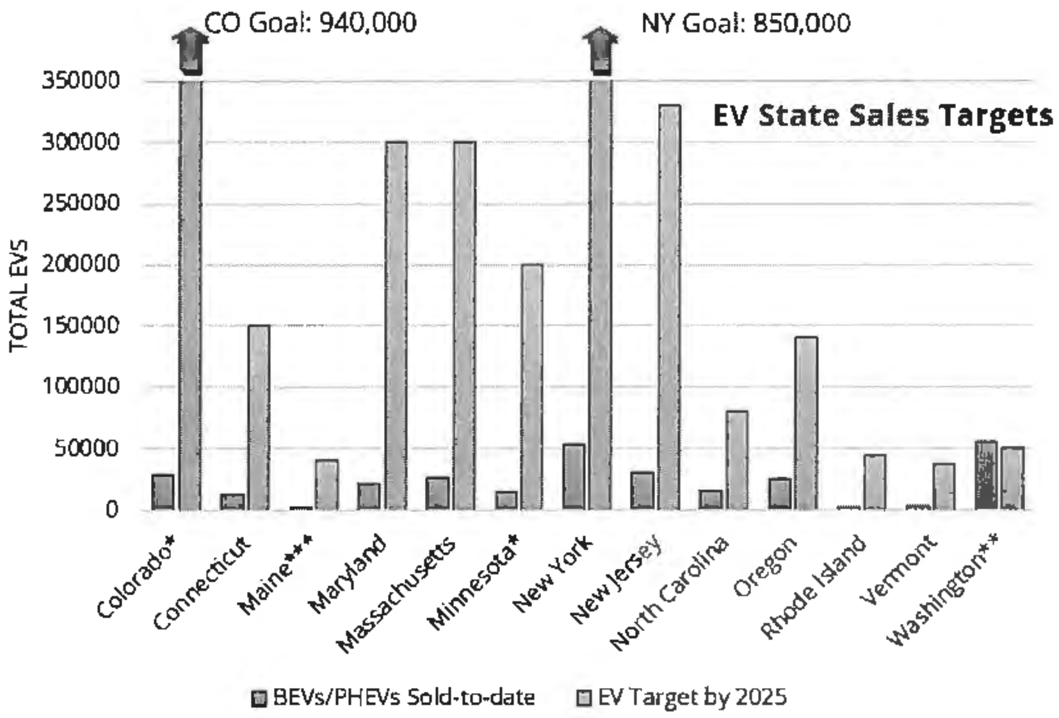
The transportation sector is rapidly evolving as electric vehicles, including both battery-electric vehicles (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs), grow in popularity, costs decline, and EV technology advances. While projections vary, and there may be a temporary slowing in growth due to the economic impacts from COVID-19, EVs are expected to make up 20 percent of annual vehicle sales by 2030 with more than 18.4 million total vehicles sold.[3] Governors have committed to reaching nearly 8.5 million EVs on the road by 2030 (See Figure 1 below). California and New Jersey have recently called for all vehicle sales to be zero emission vehicles by 2035.[4,5] At the beginning of 2020, there were nearly 1.5 million EVs in the U.S.[6] Battery costs have also fallen 87 percent since 2010 to an average market price of $156/kWh, with projections to fall to $100/kWh by 2023. These steady price decreases are edging EVs towards cost parity with internal combustion energy vehicles, which is estimated to be around $100/kWh.[7]

Through new executive actions and legislation, Governors' commitments are expected to further advance EV adoption. However, increasing numbers of EVs may have impacts on the electric grid. Installing charging infrastructure faces potential challenges including:

- Higher costs, particularly for DC fast chargers,
- Consumer awareness of both available chargers and rebate programs, and
- Exacerbated energy peaks by increased electricity demand from EVs

This paper includes recommendations to help Governors meet their EV goals and provides strategies that can improve the interplay between EVs and the electric grid.

Figure 1: Which states have EV targets?[8]



* = Target date is 2030
** = Target date is 2020 *Met Goal* - New goal is 300,000 EVs by 2025, all ZEV by 2050
*** = Vehicle sales goal is an estimate, true goal is 15.4% of vehicle sales in 2025
Due to scaling purposes, California is not included in the above graph. As of June 2020, the state had 726,000 EVs on roads, and a target of 5 million EVs by 2025.[9]

Background: Why are Governors Supporting Grid Integration and Vehicle Electrification?

EVs can provide benefits to the electric grid and can provide environmental benefits if they are charged from electricity generated by renewable or zero-carbon emitting resources. Governors across the country are eager to capture these advantages. A significant electrification attribute is the ability to smooth electricity demand peaks through grid integration – by charging EVs during off-peak times and by using EVs to provide electricity back to the grid during demand peaks. VGI allows for managed charging, where electricity may be turned on or off, scaled up or down, or set to turn on at specific times of most benefit to the grid. One study of five northeast states, found potential electricity savings of $4 to $24 billion per state by 2050 from VGI.[10] These savings would be mostly realized by taking full advantage of off-peak charging, which allows utilities to save money from deferred infrastructure investments.

Colorado Governor Jared Polis

"As we continue to move towards a cleaner electric grid, the public-health and environmental benefits of widespread transportation electrification will only increase."

Strategically located smart chargers coupled with Time of Use (TOU) rates augment grid flexibility. Smart chargers allow for EVs to be plugged into the grid, yet only consume electricity based off energy loads. This allows for vehicles to limit stress on the grid, by charging during periods of low energy demand such as mid-afternoon or the middle of the night. TOU rates incentivize utility customers to use energy during lower demand periods by offering cheaper electricity prices. Combining TOU rates with smart chargers saves energy consumers on their utility bills while mitigating peak loads on stressed electricity feeders.[11] While savings will vary across utility programs, TOU rates can reduce costs by to an EV owner by $400 annually, whereas smart charging can further reduce costs up to $700 annually.[12] Further benefits can be captured by charging when electricity is supplied mainly by renewables. For certain regions, this means charging during periods of high solar capacity during the middle of the day, or in other areas to charge through wind energy generation, which peaks usually between 10 p.m. and 6 a.m.

EV Grid Integration Recommendations for Governors

Governors can lead on advancing EVs in their state and mitigating electric grid impacts. The following section outlines recommendations for Governors to integrate EVs into the grid and is organized into three categories of policy strategies – *i) installing charging infrastructure; ii) VGI and managed charging; and iii) vehicle-to-grid (V2G).* These policy strategies can help ensure that the interactions between EVs and the grid are beneficial.

i. Installing Charging Infrastructure

As Governors and states incentivize EV adoption and the development of charging infrastructure, it is important to avoid potential negative effects from increased electrification. The National Renewable Energy Laboratory (NREL) stresses that charging station installations need to be significantly expanded to meet future EV requirements for both long distance travel (assuming chargers spaced 70 miles apart), and city driving where many plugs are needed to supply daily commuter needs.[13] States are working to build out their charging networks with level 2 or direct current (DC) fast chargers. Level 2 chargers supply electricity faster than traditional household outlets. DC fast chargers are faster still, but much more expensive. (See Figure 2 for charging station characteristics.)

Figure 2: Charging Infrastructure Levels

	Charger	Location	Miles of Range Added per hour Charged[14]	Average Installation Cost[15]
Level 1	120V AC	Home	15 miles	N/A
Level 2	240V AC	Home	30-90 miles	$1,000
Level 2	240V AC	Parking Garage	30-90 miles	$3,500 - $7,500
Level 2	240V AC	Curbside	30-90 miles	$5,000 - $13,000
DC Fast Charge	480V DC	Public Stations	90-200 miles in 30 minutes	$30,000 – $70,000

Electric vehicle supply equipment (EVSE) can increase electricity peaks based on where chargers are installed, particularly if concentrated on specific electric feeders. Coincident vehicle charging could create new peaks in demand that would need to be mitigated, especially if vehicles are responding to price signals. Minimizing these peaks will require management, with modern controls, energy storage, potentially new generation, or a mix of such resources to accommodate increased demand. Effective placement of charging infrastructure, that considers available charging equipment and driving behaviors, will help alleviate many of these challenges.[16]

<u>Recommendation for Governors:</u> Establish working groups and lead collaboration among EV stakeholders to optimize EV charging infrastructure buildout.

As mentioned previously, Governors are setting various EV goals to help meet broader energy or decarbonization strategies. While this is positive, public charging stations remain limited. Siting charging infrastructure involves many key players beyond states to ensure range anxiety is mitigated for drivers. Electrify America and Chargepoint are planning to spend $2 billion and $1 billion, respectively, on EV charging rollout over the next several years.[17,18] Duke Energy is proposing new charging installations in North Carolina to meet Governor Roy Cooper's 2018 Executive Order, which set a state target of 80,000 EVs on the road by 2025.[19] The collaboration of states, private companies and utilities is integral to meeting state EV goals.

Organizing different interest groups to build out charging infrastructure requires strong centralized leadership. Governors can issue comprehensive Executive Orders that establish EV working groups. Maryland Governor Larry Hogan created the *Zero-Emissions Electric Vehicle Infrastructure Council* to develop strategies to both meet the state's aggressive EV targets while planning for charging expansion corridors.[20] Virginia has started a stakeholder group to study EV readiness and develop strategies to meet future needs. Rhode Island and New Jersey have similar working groups to ensure the comprehensive challenges are met. These working groups typically include utilities in discussions and identify critical sites for chargers and what potential challenges may occur. This coordination is essential as policymakers continue to address grid issues as they arise.

<u>Recommendation for Governors:</u> Join regional collaborations to coordinate charging installations and reduce duplicated efforts.

Regional state collaborations have been established to ensure long-distance trips are possible in EVs. These collaborations include the Northeast States for Coordinated Air Use Management, the West Coast Electric Highway and the Regional Electric Vehicle West initiative. The Regional Electric Vehicle West coordinates eight mountain west states by setting Voluntary Minimum Standards. These standards recommend locating charging infrastructure in strategic roadways with sufficient voltage, all while keeping an eye toward the future and considering potential impacts from expansion to direct current fast chargers (DCFC).[21]

Recommendation for Governors: Direct state agencies to plan essential statewide charging networks and can encourage the consideration of charging infrastructure in equitable and accessible locations.

New Jersey is building out an Essential Charging Network to install DCFC along convenient state corridors.[22] The goal is to make fast charging ubiquitous, while acknowledging that low utilization will limit private investment and project return on investments. The network mapped out 100 locations in frequent use roadways, as well as 200 locations in community centers. Florida Governor Ron DeSantis recently signed similar legislation to build electric vehicle charging stations on well-traveled roadways throughout the state.[23] The bill requires the state to plan for increasing charging accessibility and building in emergency contingencies in the case of hurricanes or other disasters.

Further considerations can be made to install charging stations in marginalized communities and ensure equitable access. NGA Chairman New York Governor Andrew Cuomo made equity a key consideration in New York's EV charging plan. The state issued a report directing utilities and regulators to plan make-ready EV infrastructure, which includes all charging equipment except for the plug itself, to enable accelerated charging installations. The plan has a specific call out to place chargers in "environmental justice communities – who have been disproportionately impacted by air pollution – and rural neighborhoods."[24] Focusing on these communities ensures that all populations benefit from transportation electrification.

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ii. Vehicle Grid Integration – Managed Charging

One common charging option that states and utilities are turning to is smart charging combined with TOU rates. Smart charging uses sensors as load control to turn on chargers during periods of low energy demand or when electricity prices are cheaper, potentially due to TOU rates. Load control can occur through the charging device, automaker telematics, or a smart circuit breaker. This allows for charging to cease even while vehicles remain connected.

Demand charges, typically based on the customer's highest 15-minutes of electricity use, can make up 93 percent of monthly electricity bills for EV owners.[25] For direct current fast chargers (DCFC), often known as level 3 chargers, demand charges are difficult to avoid due to their highly concentrated electricity draw. The Rocky Mountain Institute released a study finding that demand charges in DCFC can cost an equivalent of $20 per gallon of gas in extreme situations, largely eliminating the business case for prospective EVSE installers.[26] Innovative rate design such as TOU rates and smart devices can mitigate these charges by shifting EV charging to off-peak periods.

Recommendation for Governors: Instruct regulators to design innovative rate-making frameworks and require utilities to develop transportation electrification programs.

Smart charging combined with TOU rates can greatly increase utility savings for energy customers while smoothing peak demand for utilities. More than half of all investor-owned utilities have adopted time-of-use rates.[27] California required its investor-owned utilities to provide TOU rates by the end of 2019.[28] Pacific Gas and Electric replaced demand charges with fixed subscription rates to simplify customer bills and lock in specific rates. The utility is pairing subscription rates with TOU rates and estimates that it can reduce customer costs 30-50 percent.[29] Subscription rates also allow EV owners to monitor price differences between electricity and gasoline. While these rate-making processes seem promising, most states are in initial phases of identifying the most beneficial TOU rates.

Additionally, states need to explore whether to allow utilities to own and receive cost recovery on charging infrastructure investments. If charging infrastructure is seen as a public benefit, particularly if it is supporting disadvantaged communities, then there may be a case for receiving a rate of return. Virginia regulators are studying vehicle electrification in an open proceeding. Questions to address include allowable rates of return, whether cost recovery can be applied on non-EV owners, vehicle battery storage applications, and charging station ownership models.[30]

States can also offer incentives, but it is more typical for utilities to offer rebates as part of a transportation electrification program. Arizona, Minnesota and Oregon instructed utilities to submit transportation electrification plans, with potential considerations for charging stations rebates and new rate-making.[31] Missouri and Wisconsin are actively considering these questions in regulatory proceedings.[32] Utilities in Colorado and Nevada proposed incentive programs, with a particular focus on low-income customers, to expand charging access.[33] Furthermore, utilities in more than 35 states are offering charging incentives for customers, with many able to apply for a rate of return.[34] Governors can direct regulators to explore these issues further.

***Recommendation for Governors:* Set energy storage goals, and guidance on the locational value of storage, to integrate with current EV charging stations.**

A strategy that Governors may consider is incorporating energy storage at EV charging facilities.[35] Governors in Massachusetts, New Jersey and New York among other states, have set aggressive energy storage goals, which when paired with EVSE can reduce demand charges and provide other grid benefits.[36] Energy storage systems can charge during off-peak periods, perhaps charging from excess renewable generation or renewables co-located with chargers and storage, and then supply electricity for EV charging or excess electricity back to the grid.

Further, demand issues are raised during fleet electrification charging. A fleet of cars charging simultaneously can create a spike in energy consumption as well as demand charges, which may negate the cost advantages of EVs. The spikes can also lead to shifting load curves or reliability concerns as energy feeders may already be congested. Usually fleets require a centralized charging depot, which in turn requires a series of high-powered chargers. Fleet administrators will have to plan for increased demand and collaborate with their electric utilities to lessen any concerns associated with additional fleet electrification. Co-locating energy storage at charging depots can help lessen these demand issues.

Recommendation for Governors: Offer rebates to customers to install charging infrastructure.

Smart charging requires level 2 chargers or DCFC meaning regular household outlet (Level 1) charging is excluded from the technology. Despite limited funding for rebates, one revenue source that states are turning to is the Volkswagen Settlement. States were able to spend up to 15 percent of their total VW allocation on charging stations and 34 states took advantage of this stipulation.[37] Additionally, many states offer their own rebates to install EVSE for individuals or businesses. New York offers rebates up to $4,000 for level 2 chargers, cutting between 30-80 percent of installation costs. The program, known as Charge Ready NY, lists qualified vendors, many of which offer network enabled devices.[38]

EVs provide valuable grid services like other distributed energy resources. This is particularly true when vehicle grid integration includes V2G technology. Traditionally, distributed energy resources are viewed as onsite or nearby generation for a facility and are typically renewable resources or combined heat and power applications. EVs with a 30-kWh battery (which is a typical minimum for most light duty EVs) can store as much energy as an average household consumes daily.[39] ZEV states have pledged more than eight million EVs on the road by 2025 and with this level of energy supply, EVs could greatly alter how electricity is used.[40]

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iii. Vehicle-to-Grid (V2G)

Taking grid integration a step further, V2G technology, which allows for bidirectional energy flow, can enable improved grid flexibility. V2G can allow EVs to charge when electricity is cheap and demand is low, as well as feed electricity back into the grid during times of peak demand. While concerns over battery degradation and vehicle warranty limit technology adoption, the benefits remain compelling. Utilities have filed pilot V2G proposals in California and New York to test the technology on heavy duty vehicles such as school buses. The buses will provide energy storage services to help mitigate demand peaks. Heavy-duty EV fleets are good candidates for V2G pilot programs with centralized charging, predictable schedules, and larger batteries.[41] Light-duty vehicles may be integrated down the road as the technology grows more mainstream. Additionally, EVs may be used as mobile batteries during power outages, improving grid resilience and emergency response services. Further research and pilot programs are required to realize this potential.

Recommendation for Governors: **Direct a study of how EVs can be used for their energy resilience attributes, including assessing how EVs can play a role at critical facilities during grid outages.**

States have been working on using energy storage to fill gaps in electricity supply from intermittent renewable resources. Utilizing electric vehicles as mobile energy storage provides more flexibility to accommodate grid demands. Additionally, EVs could provide rapid relief during power outages, especially if certain vehicles had high voltage power or larger battery packs. While pilots are only beginning to be implemented, the U.S. Army is testing V2G technology at Fort Carson. The project is part of a microgrid project to disconnect the base from the electricity grid and utilize EVs to supplement energy supply.[42] These benefits to resilience and reliability are paramount as EV adoption grows.

Heavy duty vehicles such as school buses may be especially useful to V2G efforts due to their large battery size, lengthy idle periods, and more predictable charge timing and load curves. A single school bus battery is large enough to supply average daily power for 10 homes.[43] Since school buses are not typically used during the summer or weekends they could be utilized more efficiently. For everyday transit purposes, electric buses are expanding swiftly, with commitments to electrify 33 percent of the transit bus fleet by 2045.[44]

Recommendation for Governors: **Encourage utilities and working groups to demonstrate V2G technology and develop pilot programs.**

California, New York, North Carolina and Virginia have experimented with V2G pilot programs, but have yet to be deployed broadly.[45] Utilities in these states including Dominion Energy, Duke Energy and Consolidated Edison have submitted proposals to utilize electric school buses as energy storage during summer months. The Southeastern Pennsylvania Transit Authority (SEPTA) that serves the Philadelphia area utilizes V2G technologies by storing energy as trains brake and then supplies energy back to the grid at opportune times.[46] These projects have shown increased payback periods due to lower maintenance costs and energy bills, while contributing essential grid moderation services.

More research is required to overcome barriers to technology adoption. The grid operator PJM identifies EVs as a potential for frequency regulation that balances short-term variations between load and supply, which is procured through the grid's Regulation Market.[47] Fully realizing this potential would enable states to balance energy loads as greater EV adoption begins to disrupt the grid.

Conclusion

Electric vehicles may not have large impacts to the grid yet, but forecasts indicate this will change in the near-term as EV adoption increases. Governors need to prepare for the build out of VGI-managed charging, V2G and other related infrastructure through thoughtful policies and regulations to ensure that the potential advantages of vehicle and electric grid interactions are realized. With careful planning, EV benefits can be captured, leading to cost savings for stakeholders, enhancing grid reliability, and further modernizing both transportation and energy systems.

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EXHIBIT 5


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