Business & Technology Report

September 2018

Unlocking the Value of Broadband for Electric Cooperative Consumer-Members

NRECA

America's Electric Cooperatives

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Table of Contents

Executive Summary

Millions of Electric Co-op Consumer-Members Lack Adequate Broadband Service

- Approximately 6.3 million electric co-op households, totaling 13.4 million people, lack access to adequate, high-speed broadband service (25/3 Mbps).[1]
- Electric co-op members without broadband service are found widely throughout the United States and there are areas without broadband service in every state served by electric co-ops. This highlights that broadband access is a multi-state issue. Electric cooperatives have an opportunity to partner with other business and government entities to bring the benefits of broadband to rural America.

Market Failure Limits Access and Value for Consumer-Members

- There is a significant gap between private carrier returns and consumer benefits from broadband investment in areas served by electric cooperatives.
- Many areas served by electric cooperatives are characterized by low population density causing broadband deployment costs per cooperative household to be so high that private carrier returns often cannot justify the costs of deployment.
- Over a 20-year period, the estimated loss in consumer-member value due to lack of broadband deployment to electric cooperative areas is more than $68 billion. In contrast, the projected deployment cost of expanding broadband to these areas is approximately $40 billion.
- This is a form of market failure, where private returns do not justify investment even when lost consumer value exceeds deployment costs by 70 percent.

Electric Cooperatives are Part of the Solution

- Today's business forces are driving new and advanced digital communications requirements for rural electric co-ops. This is because high-capacity, low-latency telecommunications are the fundamental enabler of the emerging smart grid and create new areas to generate value across the energy value chain.

[1] The actual number of households without access to 25/3 Mbps service is likely understated due to potential inaccuracies in the FCC's data. According to the National Telecommunications Information Administration, a provider offering service to any homes in a Census block is instructed to report that block as served even though it may not offer broadband services in most of the block. This can lead to overstatements in the level of broadband availability, especially in rural areas where Census blocks are large. Moreover, there is no independent validation or verification process for the self-reported data from providers. *Federal Register*, Vol. 83, No. 104 (Wednesday, May 30, 2018) at 24748.

- A broadband backbone communications system unlocks the benefits of the smart grid. Improved reliability, decreased labor costs, better equipment utilization, more efficient voltage control, and other benefits translate to overall improved grid performance.
- An electric co-op that builds a broadband backbone to support its electric operations may have a cost advantage in deploying broadband to its unserved community.
- Although electric co-ops may have favorable cost characteristics associated with expanding broadband relative to other providers, building-out a retail network may not be financially viable in many cases due to market conditions.

Public Partnership with Electric Co-ops to Overcome Market Failure

- In areas characterized by low household density, private carrier returns often do not justify the investment cost associated with deploying broadband, even though overall consumer benefits would exceed deployment costs.
- Government grants and low-interest loans can overcome market failure by buying down the portion of deployment costs not recoverable through the market, thus making private investment a viable option.
- Grants and low-interest loans, combined with private investment from electric co-ops, hold the potential for unlocking the lost value for electric cooperative consumer-members who do not have access to high speed broadband service.
- The deployment of broadband to electric co-op areas will also enable additional community and network benefits, beyond the $68 billion of value for individual consumer-members.

Section 1: Millions of Electric Co-op Consumer-Members Lack Adequate Broadband Service

Broadband is essential infrastructure for modern life. Unfortunately, broadband access and adoption are not ubiquitous. The digital divide is real and many Americans remain without adequate broadband service. According to the U.S. Federal Communications Commission (FCC), 34 million Americans lack access to service at download speeds of 25 megabits per second and upload speeds of 3 megabits per second (25/3 Mbps),[2] the FCC benchmark for broadband service.[3] Rural areas, in particular, have lagged behind, as 39 percent of rural Americans do not have access to 25/3 Mbps, compared to just 4 percent of urban Americans.

This trend is similar for areas served by electric cooperatives. Although the FCC does not report broadband service levels specifically for electric co-op service areas, NRECA estimates the number of co-op households without high-speed access (25/3 Mbps) using data from the FCC[4] on census blocks with fixed broadband service.[5] Blocks located in areas served by co-ops are identified by merging the FCC's data with 2010 Census data in a geospatial format,[6] and then spatially joining this information with internal NRECA data on co-op boundaries using geographic information system (GIS) software. The results show that approximately 6.3 million co-op and adjacent households,[7] totaling 13.4 million people, are located in census blocks without access to 25/3 Mbps broadband service.[8]

Figure 1 maps the census blocks located in reported electric co-op territories that do not have access to high speed (25/3 Mbps) service. As shown in the map, electric co-op areas without broadband service are found throughout the country, and in all 47 states where electric co-ops operate.[9] This highlights that

[2] Federal Communications Commission, 2016 Broadband Progress Report, GN Docket No. 15-191, January 2016, available at: https://apps.fcc.gov/edocs_public/attachmatch/FCC-16-6A1.pdf.

[3] Federal Communications Commission, 2018 Broadband Deployment Report, GN Docket No. 17-199, February 2018 (hereafter FCC Broadband Deployment Report 2018), available at: https://docs.fcc.gov/public/attachments/FCC-18-10A1.docx.

[4] U.S. Federal Communications Commission, FCC Form 477 Broadband Deployment Data, US – Fixed without Satellite, available at: https://www.fcc.gov/form-477-broadband-deployment-data-june-2016-version-2.

[5] Blocks are the smallest unit that the U.S. Census uses for tabulation, initially named because in urban areas they are typically the size of one city block. However, in less dense areas, blocks can vary greatly in size, population, and housing makeup. Blocks are smaller units of measurement than zip codes and census tracts.

[6] U.S. Census Bureau, TIGER/Line® with Selected Demographic and Economic Data, 2010 Census Population & Housing Unit Counts – Blocks, available at: https://www.census.gov/geo/maps-data/data/tiger-data.html.

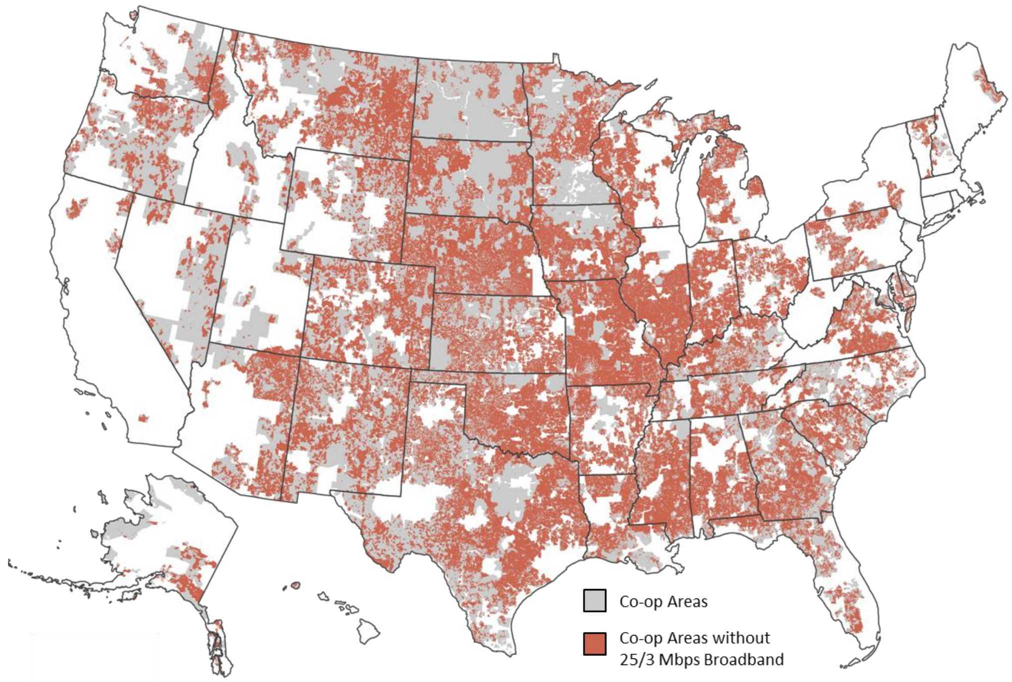
[7] For the purposes of this paper, we define "co-op and adjacent households" as those that are located within reported co-op boundaries, which may include some households that are not served by electric cooperatives. When reporting this data, some co-ops provide broad, less-specific service territory outlines. For example, some boundaries might include a municipal area that is surrounded by co-op territory, but not explicitly carved out in the data, and others include households on both sides of a street, even if only one side is served by the co-op. Unfortunately, data on the exact geographic location of every individual household served by an electric cooperative is not available, making it impossible to determine which of these 6.3 million underserved households are not actually co-op customers.

[8] The actual number of households without access to 25/3 Mbps service is likely understated due to potential inaccuracies in the FCC's data. See Footnote [1] for a detailed explanation.

[9] Depending on state law, electric cooperatives may not have authority to provide retail broadband services.

broadband access is a widespread, multi-state issue. Without adequate, high-speed broadband, co-op communities will be left behind, or worse, will not survive.

Figure 1: Electric Cooperative Areas without Access to 25/3 Mbps Broadband



Section 2: Market Failure Limits Deployment and Value for Consumer-Members

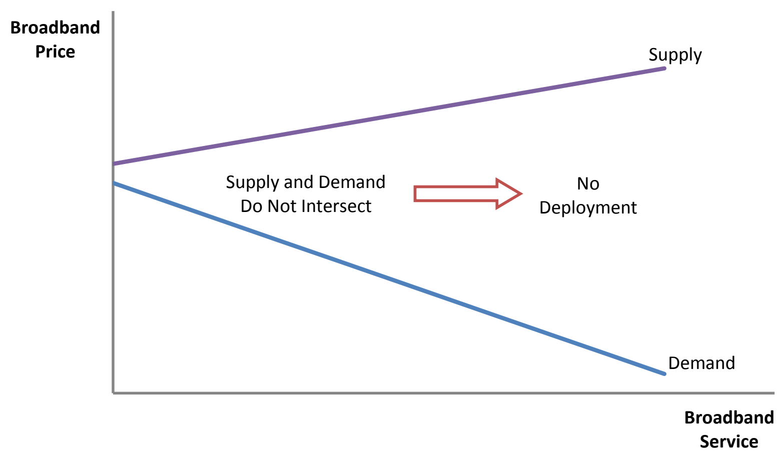
Rural connectivity is essential for many facets of daily life. High-speed broadband can provide substantial value for electric co-op consumer-members and their communities. These benefits include greater availability of information, improved healthcare, online learning opportunities, increased efficiency and productivity for local businesses, the convenience of online communication, increased housing values, and consumer savings through access to more products and competition among sellers online.

Market Failure

When market forces fail to lead to broadband deployment, these benefits are never realized. This is largely due to the significant gap between private carrier returns and consumer benefits from broadband investment. In areas with low population density, the costs of broadband deployment per customer are much higher, and private returns alone may not justify the capital investment required for broadband deployment, even when total consumer benefits might outweigh the costs. This is a form of market failure, which results in lost value.[10]

This situation is illustrated in Figure 2. In this example, consumers' willingness to pay, represented by the demand curve, is lower than the minimum price at which suppliers are willing to offer service on the supply curve. Supply and demand never intersect and therefore no broadband service is offered, as market forces fail to arrive at a socially and economically optimal level of investment.[11]

Figure 2: Market Failure

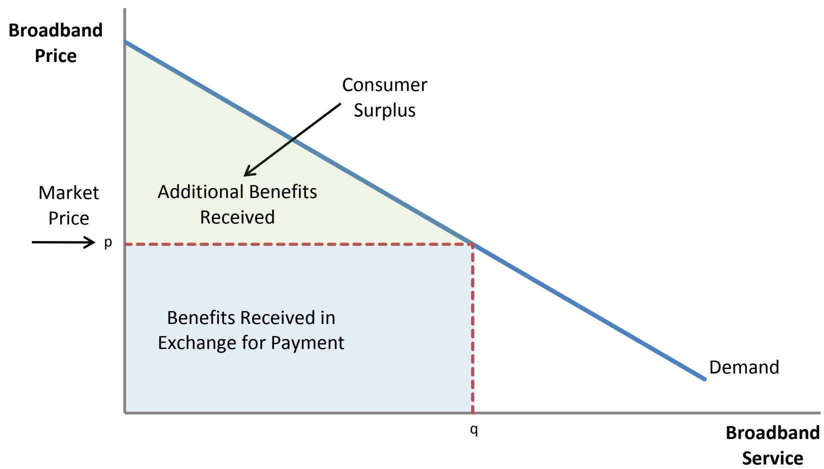


[10] Karl E. Case and Ray C. Fair, Principles of Microeconomics, Upper Saddle River, NJ, Pearson Prentice Hall, Seventh Edition, 2004, p. 245.
[11] The situation presented in Figure 2 is simplified for demonstrative purposes. Although high per-customer costs are the primary barrier to broadband deployment, several other factors, including the regulatory environment, may also influence deployment decisions.

Forgone Value for Consumer-Members

This lack of broadband deployment leads to forgone benefits that would otherwise be enjoyed by electric co-op consumer-members and their communities. The total value of these lost benefits can be quantified by estimating the consumer surplus associated with broadband service, and applying it to the number of households without access to calculate the economic value that would be generated by providing broadband to those who do not already have it.[12] Consumer surplus is defined as the difference between the total amount that consumers are willing and able to pay for a good or service and the total amount that they actually pay. It therefore represents the additional value received over and above the market price, as shown in Figure 3. For example, if a household's monthly bill is $60, but the household would have been willing to pay $110, the additional value received is equal to the household's consumer surplus of $50. This value is lost when broadband is not deployed.

Figure 3: Consumer Surplus



Consumer surplus for broadband is typically measured in one of two ways. The first involves conducting a survey of broadband users to explicitly ask them what they would be willing to pay, and comparing their answers to what they pay for service. One limitation of this method is that responses may not accurately reflect what these consumers would do when facing a different set of choices about price and service options; and furthermore, respondents may be conservative in their answers out of fear that they could be charged more if they reveal their true willingness to pay.[13] The second methodology involves estimating demand curves through variations in prices households paid for broadband service at

[12] Several recent studies have used consumer surplus to measure the potential economic impact of broadband connectivity, including Greenstein, S. and R. McDevitt, *Measuring the Broadband Bonus in Thirty OECD Countries*, OECD Digital Economy Papers, No. 197, OECD Publishing, 2012 (hereafter Greenstein & McDevitt 2012); Mark Rembert, Bo Feng, and Mark Partridge, *Connecting the Dots of Ohio's Broadband Policy*, The Ohio State University Swank Program in Rural-Urban Policy, April 2017 (hereafter Rembert et al. 2017); and Mark Dutz, Jonathan Orszag, and Robert Willig, *The Substantial Consumer Benefits of Broadband Connectivity for U.S. Households*, Commissioned by the Internet Innovation Alliance, July 2009 (hereafter Dutz et al. 2009).

[13] Dutz et al. 2009.

different places and times. From the demand curves, researches can then determine an implicit household willingness to pay and the resulting consumer surplus.[14]

One recent and widely cited study by Nevo et al. (2016) employs the latter method to calculate the consumer surplus associated with the purchase of broadband service at various speeds and service options.[15] Based on these estimates, an average consumer surplus of $1,950 per household is used in this report to calculate the annual economic value of forgone benefits for underserved households in electric cooperative service areas.[16] Multiplying this estimate by the 6.3 million co-op households currently without access to high-speed (25/3 Mbps) broadband service, one arrives at a total forgone consumer value of $12.3 billion per year. Furthermore, because the advantages of broadband are not simply a one-time benefit, but rather occur continuously, the long-term present value of these benefits would total $139.3 billion over 20 years.[17] These benefits represent the potential value of broadband access currently withheld from consumer-members.

It should be noted, however, that these estimates assume a 100 percent adoption rate. That is, even if provided with access to broadband, a percentage of consumers will choose not to purchase high-speed broadband services. While increasing broadband availability is important, without adoption, there is little to no economic benefit for consumers. According to the FCC, the adoption rate for high-speed (25/3 Mbps) broadband service in non-urban areas was nearly 49 percent in 2016.[18] Taking this adoption rate into account, a more realistic estimate of the forgone consumer surplus benefits for co-op and adjacent households that do not have access to 25/3 Mbps broadband service would be $6 billion per year, or $68.2 billion over 20 years. Importantly, this forgone value could be unlocked and captured in absence of the market failure that currently blocks broadband deployment.

It is also worth noting that the broadband adoption rate in non-urban areas has increased steadily over the last several years, from only 11 percent in 2012, to 34 percent in 2014, and most recently to 49 percent in 2016.[19] Given this trend, it is feasible to consider that the adoption rate may be even higher today. To illustrate the significance of broadband adoption, Figure 4 shows how the economic value of providing broadband to underserved areas can vary, based on different adoption rates.

[14] Greenstein & McDevitt 2012; Dutz et al. 2009.
[15] Aviv Nevo, John L. Turner, and Jonathan W. Williams, "Usage-Based Pricing and Demand for Residential Broadband," *Econometrica*, *84*(2), 2016 (hereafter Nevo et al. 2016).
[16] Our assumption of $1,950 per household is based on the average of two consumer surplus values calculated by Nevo et al. (2016) for unlimited broadband service at 10 Mbps and unlimited broadband at service speeds approaching 1 Gbps. This estimate is similar in magnitude to the value of $1,850 per household assumed in Rembert et al. 2017.
[17] Based on a 7 percent discount rate, as employed in Rembert et al. 2017, and a 20-year lifespan.
[18] FCC Broadband Deployment Report 2018.
[19] Ibid.

Figure 4: Forgone Value for Consumer-Members at Different Adoption Rates

Broadband Adoption Rate	Annual Economic Benefits	Discounted Present Value of Benefits over 20 Years
100%	$12.3 Billion	$139.3 Billion
75%	$9.2 Billion	$104.4 Billion
49%	**$6.0 Billion**	**$68.2 Billion**
34%	$4.2 Billion	$47.3 Billion

The wide range of benefits points to the importance of programs that aim to increase adoption and incentivize participation. For example, if an adoption rate of 75 percent could be achieved among currently underserved households in co-op areas, the value of these forgone benefits would exceed $100 billion over 20 years.[20]

Taking the consumer surplus value into account, rather than just private returns, the total benefits of broadband service are likely to exceed the costs of deployment. For example, in a recent report, Ericsson indicated that on average, it would cost approximately $21,000 per mile to deploy fiber in areas served by electric cooperatives.[21] Multiplying this estimate by the 1.9 million road miles[22] in co-op areas that do not have access to 25/3 Mbps broadband implies a cost of approximately $40 billion to provide fiber to underserved co-op areas.[23] Similarly, the FCC Office of Strategic Planning and Policy Analysis estimates that it would cost $40 billion to deploy fiber to the premise to the majority of underserved locations in the U.S. and achieve 98 percent coverage nationwide.[24]

[20] This highlights that programs designed to raise digital literacy are crucial and should therefore be included as part of a larger broadband development plan.
[21] Ericsson, NRTC, and NRECA, *The Value of a Broadband Backbone for America's Electric Cooperatives: A Benefit Assessment Study*, June 2018 (hereafter Ericsson 2018). This calculation relies on internal estimates that it would cost up to $17,000 per mile to deploy fiber along aerial lines and up to $55,000 per mile underground, and is based on the assumption that approximately 90 percent of co-op lines are aerial.
[22] The number of road miles in census blocks located within reported electric co-op boundaries that do not have access to 25/3 Mbps is calculated through the use of GIS mapping software, using FCC Form 477 Data and a detailed national database of streets. In this calculation, total road miles were adjusted to exclude unpopulated areas and non-residential roads. Source: U.S. Census Bureau, 2017 TIGER Geodatabases, Roads National Geodatabase, available at: https://www.census.gov/geo/maps-data/data/tiger-geodatabases.html.
[23] In this calculation, the number of road miles serve as a proxy for fiber route miles.
[24] Paul de Sa, *Improving the Nation's Digital Infrastructure*, U.S. Federal Communications Commission, January 17, 2017, available at: http://transition.fcc.gov/Daily_Releases/Daily_Business/2017/db0119/DOC-343135A1.pdf.

Section 3: Electric Cooperatives are Part of the Solution

Emerging Smart Grid Applications

Today's business forces are driving new and advanced digital communications requirements for rural electric co-ops. This is because high-capacity, low-latency telecommunications are the fundamental enabler of the emerging smart grid.[25] The smart grid consists of digital technologies, including sensors, controls, advanced meters, computers, automation, and communications, working together to optimize utility operations. A broadband backbone communications system connects this critically important grid infrastructure and can accommodate the increasingly data intensive information flows essential to modern-day grid operations.

A central component of the smart grid is advanced metering infrastructure (AMI), which supplies the information flow to make the grid work more efficiently and more effectively. Electric cooperatives are leading the electric industry in "smart meter" adoption, with AMI deployed at 60 percent of all co-op meters.[26] Moreover, distributed energy resources (DER), particularly solar panels and energy storage, are changing the nature of electric operations. The grid was historically designed for one-way energy flow from power supply to end use. With DER, power can be injected into the distribution grid at the point of end use, creating two-way power flows and new challenges to managing the grid. As the gap widens between the emerging grid and traditional grid control tools, the ability of electric co-ops to manage grid reliability will be increasingly challenged. This is because distribution grids suffer from poor observability due to the grid's historical lack of sensing capability. New digital grid sensor technology combined with high bandwidth, low latency data communications make distribution automation and remote monitoring and management of distribution assets a reality. This will enhance the ability to manage the increasing amount of DER added to the system. In this way, broadband infrastructure plays a unique role in the industry-wide shift to distribution system automation, remote monitoring of distribution assets, and the dramatically increased information flows that come with smart grid technologies.

Emerging smart grid applications require significant data communications capability. These technologies provide value by allowing for improved reliability, decreased labor costs, better equipment utilization, more efficient voltage control, and other benefits that translate to overall improved performance. Importantly, a broadband backbone communications system unlocks this value and enables these benefits to be realized.

[25] Eric P. Cody, "Telecommunications: the Linchpin for Smart Grid Success," *TechSurveillance*, NRECA, June 2014.
[26] NRECA, *Technology Advisory*, "Electric Cooperatives lead industry in AMI Deployment," 2018, 1. AMI meter penetration data comes from the U.S. Energy Administration, EIA Form 861 (2016).

Emerging Smart Grid Applications Increasingly
Depend on High Speed Broadband Communications

Demand Management – Broadly refers to all programs designed to affect consumer demand for electricity. Programs aim to reduce total energy usage particularly during peak periods and can potentially defer capital investments in new capacity.

Asset Management – The availability of massive amounts of operating data provides the predictive analytics required to transform asset management policies from traditional time-based maintenance to condition-based maintenance practices that can lower operational costs and defer capital expenditure.

Distribution Automation – Allows utilities to pinpoint the location and extent of an outage to better direct repair crews and resources with precise, real-time information.

Conservation Voltage Reduction – Under coordinated control enabled by the broadband platform, AMI, load tap transformers, automated capacitors and voltage regulators can be used optimizes voltage levels and can improve power quality and improve non-intrusive energy savings.

Advanced Metering Infrastructure (AMI) – Refers to smart meters integrated through a communications system. AMI meters can enable decreased operating expenses through remote connect/disconnect features, outage monitoring, voltage monitoring, and business loss measurements. AMI also supplies the information that is necessary to the functioning of distribution automation, substation automation, demand management, conservation voltage reduction, and DER integration.

Distributed Energy Resources Integration – The integration of solar photovoltaic panels and energy storage solutions and can have significant impacts on the distribution grid. As the prevalence of these resources increases, a two-way communications system is needed to manage the two-way flows of these resources.

Substation Automation – Generates savings from SCADA systems that monitor and report back on the state of substation equipment and from automated switches that control voltage levels and reroute power.

Source: Ericsson, NRTC, and NRECA, *The Value of a Broadband Backbone for America's Electric Cooperatives: A Benefit Assessment Study*, 2018

Extending Broadband to Electric Cooperative Communities

A broadband backbone is defined as a high-bandwidth, low-latency data connection comprised of wired and/or wireless technology that connects systemically important infrastructure.[27] Importantly, it provides backhaul transport – the delivery of data collected by the co-op's communications networks to a central

[27] Ericsson 2018.

location to support analysis and decision making – which is critical to managing electric operations. The backbone is capital intensive and costly to build. It is often made up of high-count fiber cables. It not only enables the co-op's smart grid operations, it also enables connectivity to the broader Internet backbone – comprised of several worldwide networks that interconnect with each other.[28] An electric cooperative that builds a broadband backbone to support its electric operations may have a cost advantage in deploying broadband to its unserved community. This is because the backbone can be leveraged to support the buildout of the retail broadband network to its consumer-members, where permitted by state law.

In the theory of the firm, economies of scope are said to exist if it is cheaper to produce multiple products within a single firm than it is to produce each product in a separate firm.[29] For example, a co-op leveraging and building a retail network off its broadband backbone is less costly than building a retail network independent of the co-op's backbone.[30] The economies stem from the joint use of the backbone to support both electric operations and retail broadband service.[31]

Similarly, electric co-ops own poles, trucks, and other equipment, and employ technicians. Sharing or allocating these resources between electric and broadband operations, when possible, offers additional opportunities to achieve cost reducing economies of scope. These cost sharing dynamics suggest that co-ops can have a vital role in deploying broadband in their communities.

Although electric co-ops may have favorable cost characteristics associated with expanding broadband to their communities compared to outside or third-party providers, building out the retail network may not be financially viable. Constructing broadband service to unserved electric cooperative communities often requires massive capital outlays. The median electric cooperative owns and maintains approximately 2,575 miles of electric distribution line. Assuming an average cost of $21,000 per mile to deploy fiber-to-the-home along the route of the distribution lines implies a deployment cost exceeding $54 million.[32] Moreover, a density of 6.25 consumer-members per mile for the median co-op suggests a challenging, if not impossible, cost-recovery scenario for many low-income areas served by co-ops. Alternatively, deploying a hybrid fiber-fixed wireless network can support the last mile buildout and reduce costs, particularly in difficult to reach areas. In either case, however, without a combination of grants and low-interest loans to buy down the cost of deployment, retail broadband and its commensurate benefits will continue to be out of reach for much of rural America.

[28] CTC Technology & Energy, *Broadband Guide for Electric Utilities*, Version 1, April 2015, available at: http://www.doit.state.nm.us/broadband/reports/NMBBP_FiberGuide_ElectricUtilities.pdf.
[29] W. Kip Viscusi, John M. Bernon, and Joseph E. Harrington, Jr., Economics of Regulation and Antitrust, 2nd Edition, The MIT Press, Cambridge, MA, 1995, p. 356.
[30] Ultimately, it is an empirical question to determine whether the Cost(Backbone, Retail Broadband) < Cost(Backbone,0) + Cost(0, Retail Broadband) based on the co-op's unique operating characteristics and the demographics and topology of its service area.
[31] Alternatively, the co-op may choose to avoid the risk of entering the retail broadband business and lease excess capacity from its backbone to a third party retail broadband entrant. This approach maintains the economies of scope savings.
[32] Ericsson 2018

Section 4: Public Partnership with Electric Co-ops to Overcome Market Failure

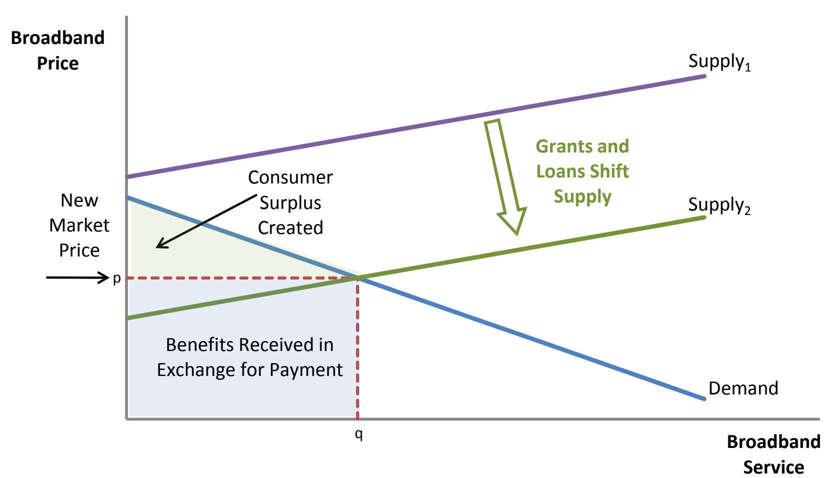
As with most services, the decision to invest in broadband is based on private returns, and does not account for all of the benefits for consumers and their communities. In areas with low population density, where deployment costs per consumer are significantly higher, these private returns often do not justify the investment costs and broadband service is unavailable. As a result, market forces fail to arrive at a socially and economically optimal level of broadband investment.

Solution to Unlocking Broadband Benefits

Traditionally, market failure of this type is addressed through interventions to lower the cost of supply. Investment support through government grants and low-interest loans is a mechanism to lower the cost of supply and create a market solution for the deployment of broadband. When implemented correctly, such funding can provide the foundation for private investment from electric co-ops by covering the portion of deployment costs that would not be recoverable through the private returns from the market.

This situation is illustrated in Figure 5. Consumers' willingness to pay, represented by the demand curve, is lower than the minimum price at which suppliers are able to offer service on the supply curve. As a result, supply and demand never intersect and no broadband service is offered. With the introduction of government grants and low interest loans that lower the cost of deployment, supply increases, shifting the supply curve to the right and creating an equilibrium market price for service. This opens up the substantial value of broadband service for co-op households and potentially unlocks upwards of $68 billion of consumer surplus benefits for consumer-members over a 20-year period that would otherwise be lost.

Figure 5: Impact of Intervention



Broader Community and Network Benefits

In addition to these benefits received directly by co-op households, funding for broadband access and service would provide important social and network benefits for communities and the economy as a whole, which are not monetized in this analysis of lost consumer value.

Network benefits are those that accrue to all broadband users – not just new subscribers in rural America. These benefits are analogous to connectivity values resulting from the use of telephones and fax machines in years past. As more people have broadband access, the more valuable the network itself becomes for everyone, due to increased online participation and the potential for further development of new broadband applications and use cases. In this way, the value of providing broadband to new users includes the positive impact this can have on existing users. Other indirect societal benefits include increased economic output through e-commerce, and increased efficiency and reduced travel congestion from tele-health, distance education, and workforce telecommuting.

In addition, expanding the broadband network to rural America provides substantial direct and indirect economic impacts of broadband on Gross Domestic Product (GDP) in both rural and non-rural areas. The direct effects represent goods and services that providers use in supplying broadband to their customers, comprised primarily of wages paid to linemen, technicians, customer-service representatives, and administrative workers, and capital inputs such as poles, wires, and other network elements, as well as vehicles and general office equipment. Indirect effects capture the ripple effects of the broadband industry, including the impact of those employees spending their wages and the value of economic activity in producing the capital inputs purchased and used by broadband carriers. The Hudson Institute quantifies the direct and indirect economic effects of the rural broadband industry.[33] It estimates that rural providers added $24.1 billion in GDP to the U.S. economy in 2015, with approximately 34 percent of the impact, representing $8.2 billion in annual benefits, accruing to rural areas.[34]

On a broader level, high-speed internet service is becoming more and more necessary in day-to-day life, and this trend is likely to continue. Ensuring broadband access is essential to the economic health and livelihood of rural America.

[33] Hanns Kuttner, *The Economic Impact of Rural Broadband*, Hudson Institute, April 2016, available at: https://s3.amazonaws.com/media.hudson.org/files/publications/20160419KuttnerTheEconomicImpactofRuralBroadband.pdf.

[34] As pointed out in the Hudson Institute paper, a large share of the capital goods used by rural broadband providers are produced in urban areas, and therefore the economic benefits are not confined to the rural communities that are served by these carriers.