

The Impact of Fiber Broadband on Rural and Underserved Communities

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Abstract

This paper delves into the transformative potential of fiber broadband in rural and underserved communities, emphasizing its critical role in fostering economic growth, social inclusion, and technological advancement. By synthesizing recent studies and data, we provide a comprehensive analysis of the multifaceted benefits of fiber broadband. Additionally, we propose innovative strategies to overcome deployment challenges and ensure widespread adoption, thereby bridging the digital divide and promoting equitable access to high-speed internet.[\[1\]](#)

The economic impact of fiber broadband is profound, as it catalyzes business growth, enhances self-employment opportunities, and contributes to significant GDP increases in connected rural areas. Socially, fiber broadband facilitates access to essential services such as telemedicine, online education, and remote work, thereby improving the quality of life and social inclusion for rural residents.[\[2\]](#)

To maximize the benefits of fiber broadband, we explore innovative ideas such as public-private partnerships, community-based models, and technological advancements. These strategies are crucial for overcoming the barriers to broadband deployment and ensuring that the advantages of high-speed internet reach all corners of society.[\[3\]](#)

By adopting these innovative approaches and fostering collaboration among stakeholders, we can harness the full potential of fiber broadband to drive sustainable development and create a more inclusive and connected future for rural and underserved communities.

Keywords: Fiber Broadband, Digital Divide, Underserved Areas, Rural Communities, Economic Growth, Social Inclusion

Introduction

Access to high-speed internet is increasingly recognized as a fundamental driver of economic and social development. However, a significant digital divide persists, particularly in rural and underserved communities. These areas often face challenges such as limited infrastructure, lower population density, and higher deployment costs, which hinder the availability and adoption of broadband services. This digital disparity exacerbates existing inequalities, limiting opportunities for economic growth, education, healthcare, and overall quality of life.[\[4\]](#). Fiber-optic broadband technology has emerged as a promising solution to bridge this digital divide, offering faster speeds, greater reliability, and more equitable access to critical online resources and services. [\[4\]\[2\]](#).

Fiber broadband, with its superior speed, reliability, and capacity compared to other broadband technologies, presents a viable solution to bridge this gap. Unlike traditional copper or DSL connections, fiber-optic cables transmit data using light, allowing for much faster and more reliable internet connections. This technology can support high-bandwidth applications such as video conferencing, telemedicine, online education, and smart agriculture, which are essential for the development of rural and underserved areas.

The introduction of fiber broadband in these communities can lead to transformative changes. Economically, it can stimulate local businesses, attract new investments, and create job opportunities. Socially, it can enhance access to essential services, improve educational outcomes, and foster greater social inclusion. [2] Technologically, it can enable the adoption of advanced applications and innovations, driving further development and modernization.

This paper aims to explore the multifaceted impact of fiber broadband on rural and underserved communities. By examining recent studies and data, we will provide insights into the economic, social, and technological benefits of fiber broadband. Furthermore, we will propose innovative strategies to overcome deployment challenges and ensure widespread adoption, thereby promoting equitable access to high-speed internet and fostering sustainable development.

In the following sections, we will delve into the specific economic and social impacts of fiber broadband, discuss the challenges and barriers to its deployment, and present innovative ideas for growth and expansion. Through this comprehensive analysis, we hope to highlight the critical importance of fiber broadband in bridging the digital divide and creating a more inclusive and connected future for all communities.

This research paper aims to examine the impact of fiber broadband deployment on rural and underserved communities, exploring the potential benefits, challenges, and policy implications surrounding this transformative technology.

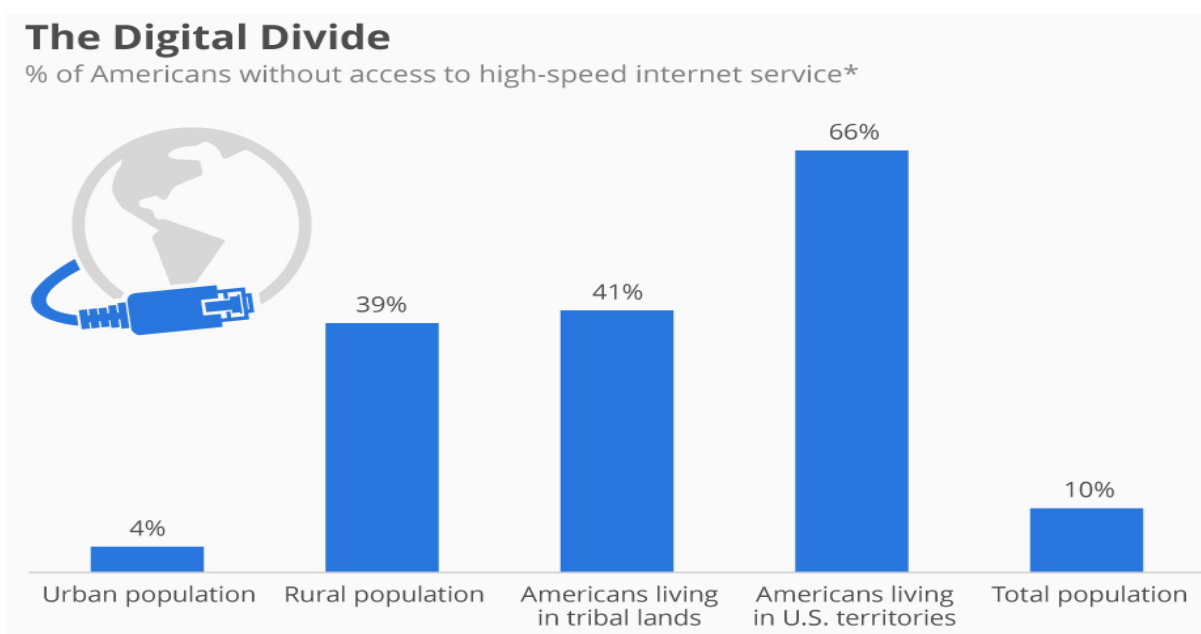


Fig1: Broadband Access in Rural vs Urban [28]/Source: FCC

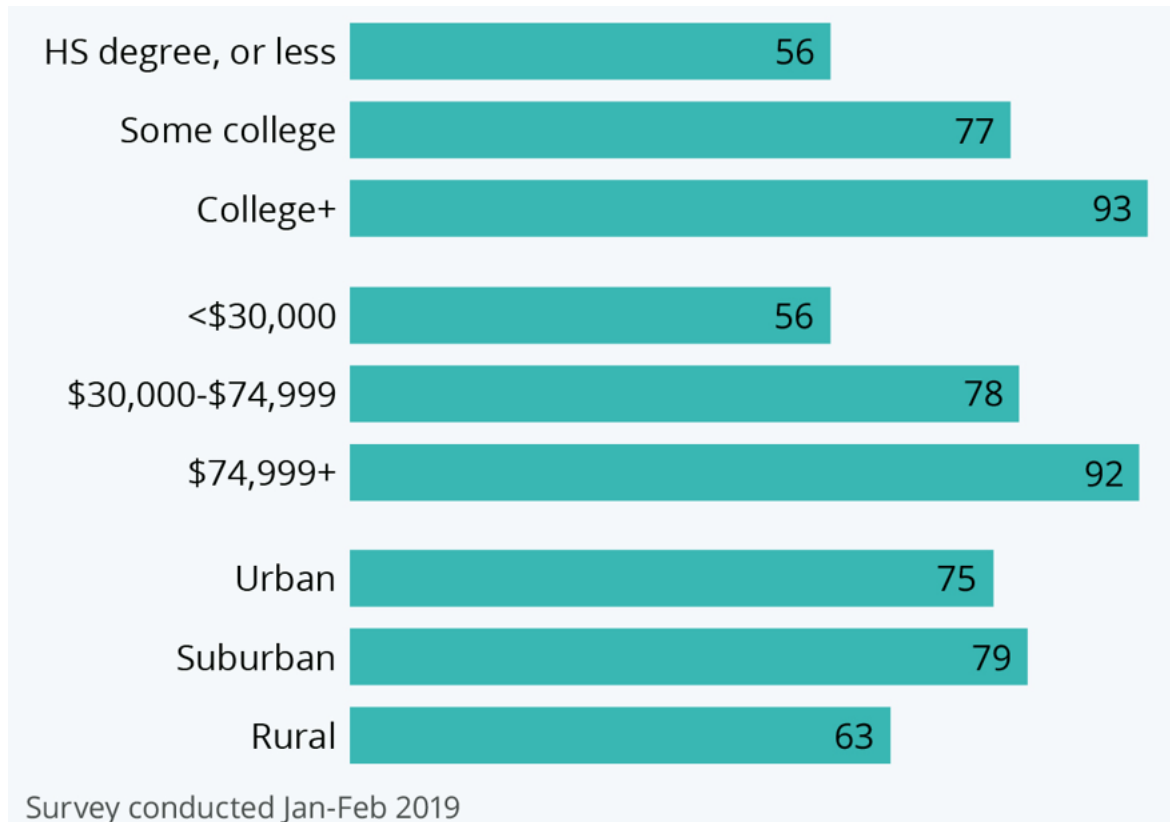


Fig 2: Quarter of American have no internet^[29]/Source: Wall Street Journal, Pew Research Center

Economic Impact of Fiber Broadband

The introduction of fiber broadband in rural and underserved communities has the potential to drive significant economic growth and development. Studies have shown that the availability and adoption of high-speed internet can lead to increased business activity, job creation, and overall GDP expansion in these regions ^{[2][1]}

For instance, a report by the Brookings Institution found that broadband expansion causes economic development, with areas experiencing greater broadband growth also seeing faster growth in employment, output, and income. This is particularly evident in rural communities, where fiber broadband can enable the establishment of new businesses, enhance the productivity and competitiveness of existing enterprises, and create new job opportunities. ^[2]

Furthermore, research has demonstrated that fiber broadband can stimulate self-employment and entrepreneurship in rural areas, as it provides access to a wider range of online resources, tools, and marketplaces. This, in turn, can lead to the emergence of new small businesses and startups, diversifying the local economy and creating additional sources of income for residents.

Beyond the direct economic benefits, fiber broadband can also contribute to the overall GDP growth of rural and underserved communities. Studies have found that a 10% increase in broadband adoption is associated with a 1-2% increase in GDP per capita. This suggests that the widespread deployment and

adoption of fiber broadband can have a significant multiplier effect on the local and regional economy. Some key economic impacts of fiber broadband include:

- **Increased Entrepreneurship:** Broadband access lowers barriers to entry for new businesses. Entrepreneurs in rural areas can leverage high-speed internet to conduct market research, develop business plans, and access online resources and training. This connectivity also facilitates networking with other entrepreneurs and potential investors, fostering a supportive ecosystem for startups.[\[2\]\[5\]](#)
- **Access to Global Markets:** High-speed internet allows rural businesses to reach customers beyond their local communities. E-commerce platforms enable these businesses to sell products and services worldwide, expanding their customer base and increasing revenue. Additionally, digital marketing tools help businesses target specific demographics and optimize their marketing strategies.[\[6\]](#)
- **Digital Tools for Business Operations:** Broadband access provides rural businesses with essential digital tools that enhance efficiency and productivity. Cloud-based services enable businesses to manage their operations remotely, collaborate with team members, and store data securely. Tools such as customer relationship management (CRM) systems, accounting software, and project management platforms streamline business processes and improve decision-making.
- **Remote Work and Collaboration:** High-speed internet supports remote work, allowing rural businesses to hire talent from anywhere in the world. [\[7\]](#) This flexibility reduces the reliance on local labor markets and enables businesses to access a broader pool of skilled workers. Remote collaboration tools, such as video conferencing and online project management platforms, facilitate seamless communication and teamwork
- **Innovation and Competitiveness:** Broadband access fosters an environment conducive to innovation. Rural businesses can stay updated with the latest industry trends, adopt new technologies, and implement innovative solutions to improve their products and services. This adaptability enhances their competitiveness in the global market.
- **Economic Resilience:** High-speed internet contributes to the economic resilience of rural communities[\[8\]](#). During times of crisis, such as extreme weather, businesses with broadband access were better equipped to pivot to online operations, maintain customer engagement, and sustain revenue streams. This resilience helps rural economies recover more quickly and withstand future disruptions.

Social Impact of Fiber Broadband

In addition to the economic implications, the availability of fiber broadband in rural and underserved communities can have a profound social impact, enhancing access to essential services, improving educational outcomes, and fostering greater social inclusion.

For instance, fiber broadband can enable the delivery of high-quality telehealth services, allowing residents in remote areas to access medical consultations, diagnostics, and treatments without the need

for lengthy and costly travel. This can lead to improved health outcomes, reduced healthcare costs, and greater access to specialized medical care.[\[9\]](#)

Furthermore, fiber broadband can revolutionize educational opportunities in these communities. Online learning platforms, virtual classrooms, and distance education programs can provide students with access to a wider range of educational resources and specialized curricula, regardless of their geographic location. [\[10\]](#)This can help bridge the educational gap between urban and rural areas, and create new pathways for lifelong learning and professional development.

Additionally, fiber broadband can foster greater social inclusion by enabling access to a wide range of online resources and services, from e-government platforms to social networks and community forums. This can empower residents to participate more actively in civic and community life, stay connected with their loved ones, and access essential information and support services.

The social impact of fiber broadband on rural and underserved communities is profound, enhancing quality of life and promoting social inclusion in several key areas:

- **Telemedicine:** High-speed internet enables rural residents to access healthcare services remotely, reducing the need for travel and improving health outcomes. [\[11\]](#)Telemedicine allows patients to consult with specialists, receive timely diagnoses, and manage chronic conditions more effectively. This is particularly beneficial for communities with limited access to healthcare facilities. Studies have shown that telemedicine can reduce hospital readmissions and emergency room visits, leading to better health management and cost savings.
- **Education:** Broadband access allows students in rural areas to participate in online learning, access educational resources, and engage in virtual classrooms. This connectivity is crucial for bridging the educational gap between rural and urban areas. [\[12\]](#)Students can attend virtual classes, access online libraries, and participate in interactive learning experiences. Research indicates that students with broadband access perform better academically and have higher graduation rates. Additionally, broadband enables adult learners to pursue higher education and vocational training, enhancing their skills and employability.
- **Remote Work:** The ability to work remotely opens up employment opportunities for rural residents, reducing the need for migration to urban centers. Broadband access supports remote work, enabling residents to connect with employers and clients worldwide. [\[2\]](#)This flexibility allows individuals to maintain their rural lifestyle while accessing diverse job opportunities. Remote work also contributes to work-life balance and reduces commuting-related stress and expenses.
- **Social Inclusion:** Broadband access fosters social inclusion by connecting residents to social networks, community resources, and government services. [\[6\]](#)It enables participation in online communities, access to social services, and engagement in civic activities. This connectivity helps reduce social isolation and promotes a sense of community. For example, seniors can stay connected with family and friends through video calls, and community members can participate in local government meetings and events virtually.

- **Cultural Preservation:** High-speed internet allows rural communities to preserve and share their cultural heritage. Digital platforms enable the documentation and dissemination of local traditions, languages, and histories. This not only strengthens community identity but also promotes cultural exchange and understanding.[\[13\]](#) Online platforms can host virtual museums, cultural festivals, and educational programs that highlight the unique aspects of rural life.
- **Emergency Response and Public Safety:** Broadband access enhances emergency response and public safety in rural areas. High-speed internet enables real-time communication and coordination among emergency responders, improving response times and effectiveness[\[14\]](#). Additionally, broadband supports the deployment of advanced technologies such as remote monitoring, early warning systems, and disaster management tools, which are crucial for protecting lives and property.

Challenges and Barriers to Fiber Broadband Deployment

Deploying fiber broadband in rural and underserved communities presents unique challenges and barriers that can impact project efficiency, cost, and timelines. Understanding these obstacles is crucial for developing effective strategies to overcome them.[\[4\]](#)

1. High Initial Investment Costs

The deployment of fiber broadband requires significant upfront investment. The costs associated with laying fiber-optic cables, purchasing equipment, and building necessary infrastructure can be prohibitively high, especially in sparsely populated rural areas. The return on investment (ROI) is often lower in these regions due to the smaller customer base, making it less attractive for private companies.[\[15\]](#)

2. Lack of Existing Infrastructure

Rural areas typically lack the infrastructure needed to support the deployment of high-speed internet. This includes not only fiber-optic cables but also basic utilities like electricity in some remote locations. Building this infrastructure from scratch is time-consuming and costly, often requiring navigation through difficult terrain that can further escalate costs.[\[16\]](#)

3. Regulatory and Permitting Hurdles

The deployment of broadband infrastructure often involves navigating a complex web of local, state, and federal regulations. Permitting processes can be lengthy and unpredictable, adding uncertainty and delays to deployment projects. Regulatory requirements can vary widely and change frequently, complicating compliance and increasing administrative burdens.

4. Difficult Terrain and Geography

Geographic barriers such as mountains, forests, and lakes interfere with signal transmission in rural areas, preventing reliable connectivity. Additionally, the vast distances between homes and businesses in rural areas mean more infrastructure is required to connect fewer people, diminishing providers' return on investment. Difficult terrain can also pose challenges for construction crews, leading to higher labor costs and extended project timelines.[\[17\]](#)

5. Limited Skilled Workforce

One of the critical hurdles in rural broadband deployment is the scarcity of skilled technicians and engineer's adept in the latest networking technologies. Rural areas often struggle to attract and retain talent due to limited career advancement opportunities and the perceived lower quality of life compared to urban centers. This shortage can lead to delays in project timelines and increases in labor costs as companies may need to bring in experts from outside the area.

6. Low Demand and Population Density

The lower population density in rural areas results in fewer potential customers, which can make it challenging to justify the high costs of fiber broadband deployment. Additionally, there may be lower demand for high-speed internet in these areas due to a lack of awareness or perceived need. This can further reduce the ROI for providers, making it less attractive to invest in these regions.

7. Weather and Environmental Conditions

Environmental factors can significantly impact rural broadband deployment. Seasonal weather conditions, such as heavy snowfall, flooding, or extreme temperatures, can delay construction and pose risks to the integrity of the infrastructure. These conditions can also increase maintenance costs and complicate long-term upkeep[18].

8. Long-Term Maintenance and Upkeep

Maintaining fiber broadband infrastructure in rural areas can be challenging and costly. The dispersed nature of rural populations means that maintenance crews must travel longer distances to address issues, leading to higher operational costs. Additionally, the infrastructure may be more susceptible to damage from environmental factors, requiring more frequent repairs.

9. Connectivity and Communications Challenges

Geographic barriers such as mountains, forests, and lakes interfere with signal transmission in rural areas, preventing reliable connectivity. Additionally, the vast distances between homes and businesses in rural areas mean more infrastructure is required to connect fewer people, diminishing providers' return on investment[19].

10. Economic and Social Barriers

Economic constraints, such as lower income levels and limited access to financing, can hinder the adoption of broadband services in rural areas. Social barriers, including digital literacy and awareness, also play a role. Many rural residents may not fully understand the benefits of high-speed internet or may lack the skills to use it effectively.

Innovative Ideas for Growth

To maximize the impact of fiber broadband in rural and underserved communities, innovative strategies are essential. These strategies can help overcome deployment challenges, ensure widespread adoption, and promote sustainable development. [4]Here are some key ideas:

1. Public-Private Partnerships

Public-private partnerships (PPPs) are a proven model for accelerating broadband deployment. By combining the resources and expertise of both sectors, PPPs can effectively address the financial and logistical challenges of expanding broadband infrastructure.[\[31\]](#)

- **Funding and Investment:** Governments can provide financial incentives, grants, and low-interest loans to encourage private companies to invest in broadband infrastructure. For example, Broadband Initiatives Program (BIP) & Broadband Technology Opportunities Program (BTOP) provide substantial funding to support broadband projects.[\[30\]](#) [\[32\]](#)
- **Shared Infrastructure:** Public entities can collaborate with private companies to share existing infrastructure, such as utility poles and conduits, reducing deployment costs and accelerating project timelines.[\[20\]](#)
- **Regulatory Support:** Governments can streamline regulatory processes, such as permitting and right-of-way access, to facilitate faster and more efficient broadband deployment.

2. Community-Based Models

Community-based models empower local communities to take control of their broadband needs. These models can be tailored to the specific requirements of each community, ensuring that services are accessible, affordable, and sustainable.

- **Broadband Cooperatives:** Local cooperatives can pool resources to build and maintain broadband networks. Members of the cooperative share ownership and decision-making responsibilities, ensuring that the network meets the community's needs.[\[21\]](#)
- **Municipal Networks:** Some municipalities have successfully deployed their own broadband networks, providing high-speed internet to residents and businesses. These networks can be operated by the municipality or in partnership with private companies.
- **Digital Inclusion Programs:** Community organizations can offer digital literacy training, affordable devices, and subsidized internet plans to ensure that all residents can benefit from broadband access.

3. Technological Advancements

Continued investment in fiber technology and complementary innovations can enhance the capabilities of broadband networks and support emerging applications.

- **5G Integration:** Combining fiber broadband with 5G technology can provide ultra-fast, low-latency internet access, even in remote areas. This integration supports applications such as smart agriculture, telehealth, and remote education.[\[22\]](#)
- **Internet of Things (IoT):** IoT devices can leverage high-speed broadband to improve efficiency and productivity in various sectors, including agriculture, healthcare, and manufacturing. For example, smart sensors can monitor crop conditions in real-time, enabling precision farming.[\[23\]](#)

- **Network Virtualization:** Virtualization technologies can create flexible and scalable network configurations, allowing providers to efficiently manage and allocate resources based on demand.

4. Policy and Advocacy

Effective policies and advocacy efforts are crucial for promoting broadband expansion and ensuring equitable access.

- **Universal Service Funds:** Governments can establish or expand universal service funds to subsidize broadband deployment in high-cost areas. These funds can be financed through contributions from telecommunications providers.[\[24\]](#)
- **Broadband Mapping:** Accurate broadband mapping is essential for identifying underserved areas and targeting resources effectively. Governments can invest in comprehensive mapping initiatives to ensure that all communities are accurately represented.
- **Public Awareness Campaigns:** Raising awareness about the benefits of broadband and available programs can drive adoption and usage. Public awareness campaigns can highlight success stories, provide information on subsidies, and promote digital literacy.

Conclusion

The deployment of fiber broadband in rural and underserved communities holds transformative potential, driving significant economic, social, and technological advancements. This research paper has explored the multifaceted impact of fiber broadband, highlighting its critical role in fostering economic growth, enhancing social inclusion, and enabling technological innovation.[\[25\]](#)

Economically, fiber broadband catalyzes business growth, increases self-employment opportunities, and contributes to substantial GDP growth in connected rural areas. By providing access to global markets and essential digital tools, high-speed internet empowers rural businesses to compete on a global scale, fostering entrepreneurship and economic resilience[\[2\]](#).

Socially, fiber broadband enhances quality of life by improving access to essential services such as telemedicine, online education, and remote work. It promotes social inclusion by connecting residents to social networks, community resources, and government services, thereby reducing social isolation and fostering a sense of community. Additionally, broadband access supports cultural preservation and enhances emergency response and public safety.[\[26\]](#)

Despite its numerous benefits, the deployment of fiber broadband in rural and underserved communities faces significant challenges, including high initial investment costs, lack of existing infrastructure, regulatory and permitting hurdles, difficult terrain, and limited skilled workforce. Addressing these barriers requires innovative strategies and collaborative efforts.

Public-private partnerships, community-based models, and technological advancements are key to overcoming these challenges. By leveraging the resources and expertise of both public and private sectors, fostering community involvement, and investing in cutting-edge technologies, we can accelerate broadband deployment and ensure widespread adoption.[\[27\]](#)

Effective policies and advocacy efforts are also crucial for promoting broadband expansion and ensuring equitable access. Universal service funds, accurate broadband mapping, and public awareness campaigns can drive adoption and usage, bridging the digital divide and creating a more inclusive and connected future.

Fiber broadband has the potential to transform rural and underserved communities, driving sustainable development and enhancing quality of life. By adopting innovative approaches and fostering collaboration among stakeholders, we can harness the full potential of high-speed internet, promoting economic growth, social inclusion, and technological advancement for all communities.

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