Wireless 20|20

Closing the Digital Divide in Vermont: A Business Case Study of BEAD

The Wireless 20/20 WiROI™ Fiber Business Case Analysis Tool Was Used to Evaluate the Business Case of BEAD Fund Fiber Projects in Vermont.

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INTRODUCTION

This white paper provides a comprehensive analysis of whether the funding allocated through the Broadband Equity, Access, and Deployment (BEAD) Program[1] will be sufficient to connect all unserved locations in Vermont with fiber. The findings suggest that Vermont may encounter challenges in providing fiber connectivity to all 34,695 unserved locations in the state using the allocated $229 million BEAD funding alone. Though Vermont has made an additional $60 million in funding available to address these challenges, it is imperative that the Vermont Community Broadband Board (VCBB), like other state broadband agencies, adopt a discerning approach based on Geographic Information Systems (GIS) to ensure that a majority of unserved areas receive fiber connectivity. This involves prioritizing the most promising applications while remaining mindful of the financial viability of each project.

State Broadband Agencies must develop their Broadband Plans to optimize available funding resources while prioritizing service provision to areas lacking broadband coverage. This white paper and its accompanying methodology serve as a valuable resource to guide states in formulating their Broadband Plans. It addresses several critical questions that play a pivotal role in this planning process. Including how to determine and communicate Grant Eligible Locations. The importance of Fiber Access Mile analysis to connect all of the eligible locations and in estimating the lifetime cost associated with the deployment of the proposed broadband network. This includes considering various cost components, such as construction expenses, ongoing maintenance, and operational costs.

A detailed GIS analysis is essential for bidders seeking to participate in the BEAD program. Bidders are tasked with evaluating hundreds of clusters, ranking, sorting, and scoring all candidate clusters before making any selections. By concentrating their efforts on locations closest to their existing network footprint, bidders must conduct meticulous financial assessments, consider the financial aspects of competing bidders, and determine the highest subsidy level that qualifies for funding while adhering to their Return on Investment (ROI) criteria. Our observations indicate that bidders should carefully choose clusters in the densest areas nearest to their current network infrastructure, allowing them to create smaller, more economically sustainable clusters. Moreover, requesting subsidies above the average of $6,600 allocated per unserved location by the National Telecommunications and Information Administration (NTIA) for Vermont is a prudent strategy.

It is important to note that while subsidy dollars were allocated based on the number of unserved locations, construction costs are determined primarily by the number of fiber access miles to be built. Therefore, accurate fiber access mile calculations are paramount to enable bidders to conduct proper financial analyses and make informed decisions.

[1]The BEAD Program was authorized by the Infrastructure Investment and Jobs Act of 2021, Division F, Title I, Section 60102, Public Law 117-58, 135 Stat. 429 (November 15, 2021) (codified at 47 U.S.C. § 1702) (Infrastructure Act).

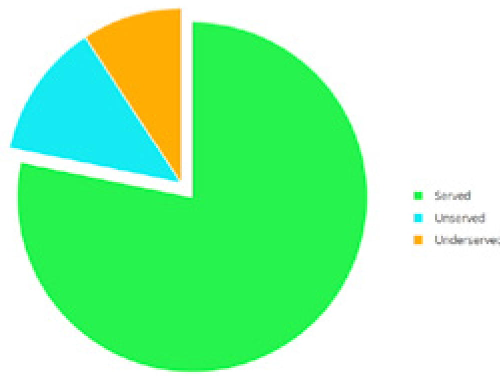
METHODOLGY

Wireless 20/20 follows these steps to analyze BEAD funding in any given area:

1. Determine grant-eligible locations.
2. Determine the minimum fiber access miles necessary to serve all grant eligible locations.
3. Determine a blended cost per mile for fiber deployment.
4. Determine the total deployment cost by multiplying the fiber access miles by the blended cost per mile.
5. Determine financial viability using a total cost of ownership approach

GRANT-ELIGIBLE LOCATIONS

Based on FCC fabric data through December 31, 2022, there are 34,695 unserved locations, 25,563 underserved locations, and 216,195 served locations in Vermont.



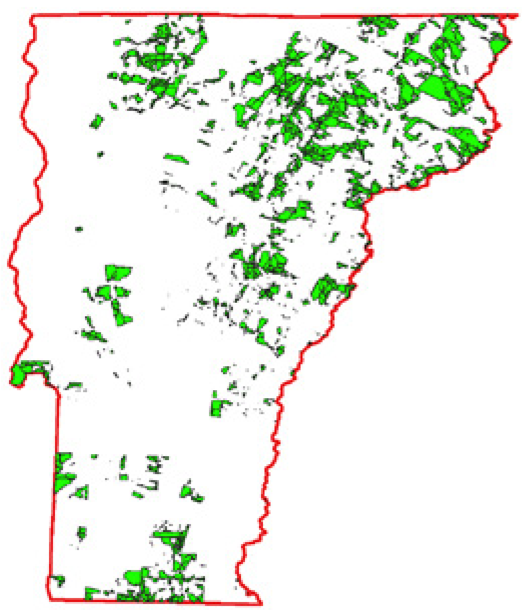
Broadband Serviceable Locations

BEAD Category	Number of Locations
Unserved	34,694
Underserved	25,563
Served	216,195

An unserved location lacks access to reliable broadband service[2] at speeds of at least 25 Mbps for downloads and 3 Mbps for uploads with a latency of less than or equal to 100 milliseconds.[3]

Figure 1

RDOF CB Areas in Vermont



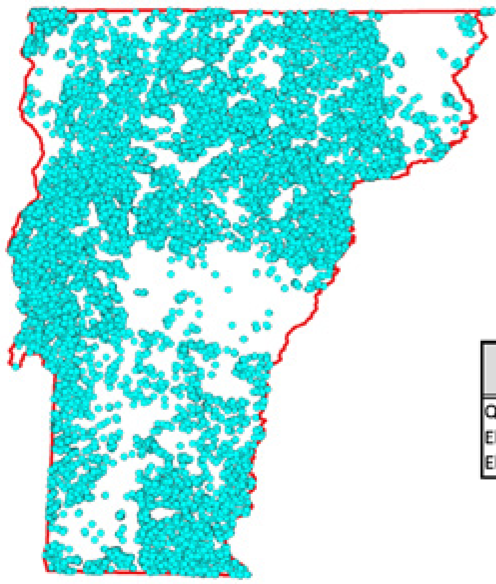
[2] Access provided using satellite technology or entirely unlicensed spectrum is unreliable. Notice of Funding Opportunity, Broadband Equity, Access and Deployment Program, NTIA (May 13, 2022), p. 15.

[3] Id., p. 16.

Not all unserved locations are eligible for BEAD funding. Of the 34,694 unserved locations, 6,837 are subject to a qualifying federal or state grant that render them ineligible for BEAD funding, which leaves 27,858 unserved locations eligible for grant funding.

Figure 2

Grant Eligible Locations in Vermont



Grant-Eligible Locations

Location Status	Number of Locations
Qualifying Grant	6,837
Eligible Locations	27,858
Eligible Units	31,629

Some locations have multiple dwelling units (known as MDUs), with each unit representing a potential subscriber. The total number of eligible unserved units in Vermont is 31,629.

[4] *These locations are subject to FCC RDOF grant commitments to provide service equal to or greater than 120 Mbps download and 20 Mbps upload with low latency. There are no other qualifying NTIA, RUS, Treasury, or FCC grant Commitments in Vermont.*

[5] *In September, VT announced the award of nearly $60M in state grant funding to connect approximately 13,000 locations. We were unable to exclude any of these locations because Vermont did not provide GIS data, addresses, or download/upload speeds for these locations.*

[6] *There are only 137 locations in high-cost areas in Vermont, of which 137 are unserved.*

BROWNFIELD VERSUS GREENFIELD DEPLOYMENT

The number of fiber miles needed to connect a given set of unserved locations varies greatly based on the proximity of the service provider's existing footprint and the availability of middle mile fiber and transit facilities. A greenfield deployment—where there is no existing infrastructure to leverage—requires more fiber miles than a brownfield deployment—where an incumbent service provider can leverage their existing fiber facilities.

If all unserved locations in Vermont were connected by fiber directly in a statewide greenfield deployment, the minimum number of fiber access miles would be 7,203, which would yield 4 units or homes passed per fiber mile.

The minimum number of fiber miles to connect all unserved homes from a termination point on an existing fibered census block or location—an all-brownfield deployment—reduces the number of fiber access miles by 32%, from 7,203 to 4,995. This yields 6 units per fiber mile.

Because this translates to 32% lower deployment costs, brownfield deployments will increase the number of homes receiving access to fiber, all else being equal. This analysis thus assumes all Vermont deployments will be Brownfield.

FIBER ACCESS MILES

This analysis used Wireless 20/20's WiROI db tool to calculate fiber access miles for a Brownfield deployment.

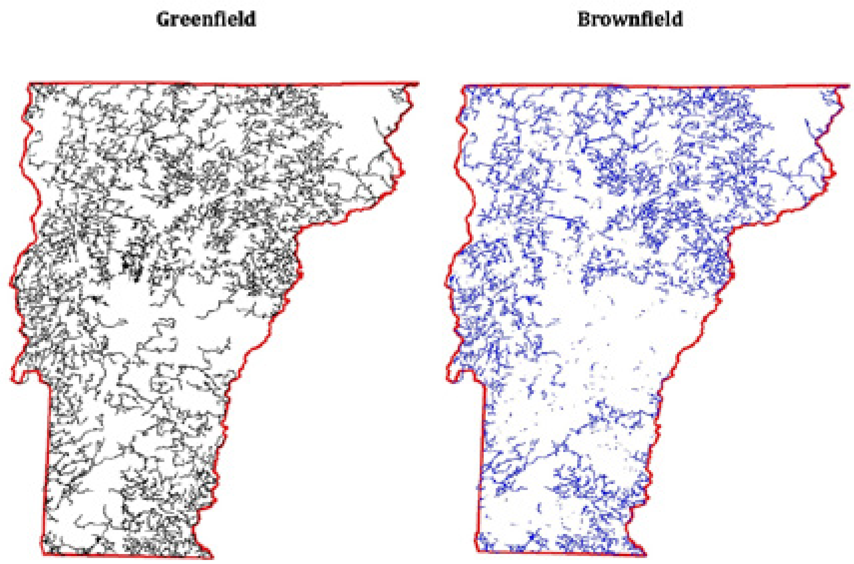


Figure 3

Map of Greenfield and Brownfield Fiber Miles in Vermont

WiROI db uses the V.FAST algorithm from Wireless 20/20, which automatically determines the fiber miles required to connect all eligible locations via the road network. In the fiber map depicted above on the left, all eligible locations are interconnected with one another state-wide. The diagram on the right uses a brownfield deployment strategy whereby clusters of unserved locations are connected to the closest existing fiber deployments[7], thereby reducing the amount of fiber needed to connect all locations by utilizing existing fiber networks in close proximity of each location or cluster.

The practical implication here is that bidders who target clusters located near their existing fiber networks should, in the end, present the most efficient proposals that minimize the length of fiber optic cables required. Consequently, State Broadband Agencies should closely monitor bidders who focus on clusters in close proximity to their pre-existing fiber infrastructure. Similarly, RDOF and other grant winners with obligations to build fiber networks should map their areas to help them identify BEAD eligible locations within close proximity of their proposed fiber networks. Even though a location which qualified for RDOF gigabit funding will not qualify for BEAD funding, often these service providers are able to improve their business models by combining RDOF winnings together with BEAD winnings in geographically proximate areas.

Utility pole ownership can significantly impact the cost-efficiency of deploying new fiber networks in rural America. While utility poles are often widespread along rural roads, access to them may not always be available or free. In some cases, the owners of these utility poles may consider adding fiber to their infrastructure and competing for BEAD grants. These owners may not have an incentive to support competing bidders in securing BEAD grants. Conversely, other utility pole owners may collaborate with Internet Service Providers (ISPs) to facilitate the expansion of fiber connectivity in their communities.

The availability of utility poles and the terms under which bidders can access them can play a pivotal role in optimizing the cost of building fiber networks in rural America. In situations where utility poles are unavailable in certain areas or local regulations mandate underground fiber installations, trenching becomes a necessary step. Trenching typically leads to an increase in the overall cost of building fiber networks. This is because fiber cables must be enclosed

[7] *This analysis used Census Blocks as the basis for existing deployments.*

in conduits and buried underground, incurring expenses not only for excavation and trenching but also for the restoration of driveway cuts and repairs to asphalt and concrete curbs.

It's worth noting that the typical costs associated with underground fiber installations can be two to four times higher than those of aerial fiber installations, especially when existing utility poles are accessible at reasonable connection costs.

In determining the most suitable bidder to build certain clusters, several considerations play a big role in optimizing the cost for fiber network deployments.

6. The locations of pre-existing Fiber Networks
7. The locations of pre-existing RDOF and other grant areas with commitment to build fiber
8. The utility pole ownership landscape

COST PER FIBER MILE

The cost to build one mile of fiber varies depending on several factors, including the cost of labor, availability of contractors, and the cost of materials.

The most significant impact on fiber deployment costs is whether it can be installed on existing utility poles (aerial fiber) or must be buried underground (buried fiber). Buried fiber typically costs $150K to $300K per mile, while aerial fiber typically costs between $40K to $100K per mile. For this analysis, we assume that 90% of the fiber is aerial and 10% is buried (at an assumed average cost of $150K per mile), resulting in an average blended cost of $51K per mile.

At the low end, an assumed average cost of $40K per mile for aerial and $150K per mile for buried results in an average cost of $51K per blended mile. Assuming higher average costs of $90K per mile for aerial and $200K for buried yields an average cost of $92K per blended mile.

FINANCIAL ANALYSIS SCENARIOS

This paper analyzes fiber costs for both the low-end blended average of $51K per mile and the higher end average of $92K per mile.

Low-End Cost

Based on a brownfield deployment at a blended average cost of $51K per mile, the total cost of building fiber to all unserved homes in Vermont would be $ 255M. With minimum match funding of 20%, this would result in $204M of subsidy funding and $51M of match funding, leaving Vermont with $25M in remaining funds for anchor institutions, underserved locations, and administrative costs.

Figure 4

CapEx and Subsidy Calculations for the Low-End Fiber Cost Scenario

Low-End Fiber Costs

BEAD Subsidy Available	$ 228,913,019
Fiber Cost per Mile	$ 51,000
Total Cost	$ 254,762,340
Subsidy % of Total Cost	Match % of Total Cost
80%	20%
Total Subsidy	Total Match
$ 203,809,872	$ 50,952,468
Subsidy per Unit	Match per Unit
$ 6,444	$ 1,611
BEAD Subsidy Remaining	$ 25,103,147

High-End Cost

Assuming a higher blended average cost of $92K per mile raises the total cost of deployment to $460M, an increase of 80%. In this scenario, the grantee match would be 50% and no funding would remain for other uses.

Figure 5

CapEx and Subsidy Calculations for the High-End Fiber Cost Scenario

High-End Fiber Costs

BEAD Subsidy Available	$ 228,913,019
Fiber Cost per Mile	$ 92,000
Total Cost	$ 459,571,280
Subsidy % of Total Cost	Match % of Total Cost
50%	50%
Total Subsidy	Total Match
$ 228,913,019	$ 230,658,261
Subsidy per Unit	Match per Unit
$ 7,237	$ 7,293
BEAD Subsidy Remaining	$ -

[8] These figures include all appurtenant hardware..

FINANCIAL VIABILITY

In this section, we analyze whether it makes financial sense to invest the bidders' matching funds for the deployment of fiber networks in Vermont. We utilize the Wireless 20/20 Fiber ROI financial model to do this analysis. The Fiber ROI model is available in the form of an interactive dashboard for what-if scenario planning and interactive analysis.

The two scenarios analyzed are the Low-End Fiber Cost model of $51K per mile and the High-End Fiber Cost model of $92K per mile for fiber deployment.

In the first case, the total cost to build 4,995 miles of fiber at $51K per mile is $254,762,000 of which BEAD provides 80% ($203,810,000) and the bidders provide matching funds of $50,952,000.

In the second case, the total cost to build 4,995 miles of fiber at $92K per mile is $460,000,000, whereby BEAD provides 50% ($230,000,000) and bidders provide the samea amount in matching funds .

It both scenarios, there is sufficient funds to cover the cost of building the fiber network.

The question is, do either of these scenarios make business sense?

KEY FINANCIAL ASSUMPTIONS

In addition to the crucial factors of fiber miles and cost per fiber mile, there are numerous other significant considerations that impact the business case for fiber deployments. Out of these, we have selected the most influential variables as follows:

Cost per Fiber Mile: While we analyze two scenarios with costs of $51,000 and $90,000 for installing one mile of fiber, the Fiber ROI model provides the flexibility for users to separately adjust the costs of aerial and underground fiber. This variable has a substantial influence on the ROI business case. Cost per fiber mile can vary significantly from one market to another. It will also vary (i.e. increase) over time due to inflation and increases in the cost of labor.

CapEx Maintenance: This represents the recurring annual expenses for maintaining the fiber network. It is expressed as a percentage of the cumulative cost of the fiber network and is initially set at 4%. Users can modify this value within a range of 0% to 8% to conduct sensitivity analysis. This factor also has a substantial influence on financial viability.

Take Rate (Penetration) Assumptions: When building a fiber business case, one of the most challenging tasks is to forecast the number of subscribers that an operator can expect to sign over the life of the network. The take rate, or penetration, is the percentage of potential customers subscribing to the service. The plot of number of subscribers over a 15-year time frame is often called the S curve. This is because the shape of the curve looks like an S with relatively few subscribers in the first couple of years as the operator is deploying the network, expanding coverage, and establishing brand recognition. Once the network is fully deployed, there will be a rapid increase in subscribers until a level of saturation is reached. Determining the S curve for a particular fiber deployment is often the outcome of extensive market research and competitive analysis that includes an assessment of the existing and future broadband, fixed wireless, and satellite alternatives. For rural areas targeted by BEAD funding, it is unlikely that a second fiber service provider will emerge in the future due to the high cost and limited opportunity. Therefore, we set the penetration assumption at 60%, which is the ratio of subscribers to total number of homes passed. Please remember to account for a vacancy rate of a typical 5% when setting this value. The Fiber ROI model includes a slider that allows users to adjust this parameter anywhere between 0% and 100%, enabling exploration of different adoption scenarios.

ARPU (Average Revenue per User): We have set the ARPU at $80 per month for 1-gig fiber service, with an annual price increase of 3%. Users have the flexibility to increase or decrease this value as necessary to reflect market conditions. In addition, the Fiber ROI model allows the user to turn on and off additional value added services such as Video and Voice, which would enhance ARPU. Each of these services have slides to value their monthly fee an the associated take rate.

Number of Years: The Fiber ROI model analyzes both 10-year and 15-year Return on Investment (ROI) models, with a specific focus on the 15-year Internal Rate of Return (IRR) as a key performance metric.

These variables collectively shape the financial outlook and viability of fiber deployment projects, and the Fiber ROI model provides a versatile platform for users to assess and customize these parameters according to their specific project requirements and market conditions.

FINANCIAL ANALYSIS

We leveraged the Wireless 20/20 Fiber ROI dashboard to conduct an in-depth 15-year financial analysis for the proposed fiber network deployment scenarios. This interactive dashboard, known as the Fiber ROI model, empowers users to flexibly adjust specific parameters, facilitating sensitivity analysis and enabling what-if scenario planning. This comprehensive financial model encompasses over 40 critical financial and technical parameters, all seamlessly integrated into an intuitively designed graphical dashboard that can be tailored to suit the unique requirements of each client. This invaluable Fiber ROI dashboard is accessible through Wireless 20/20.

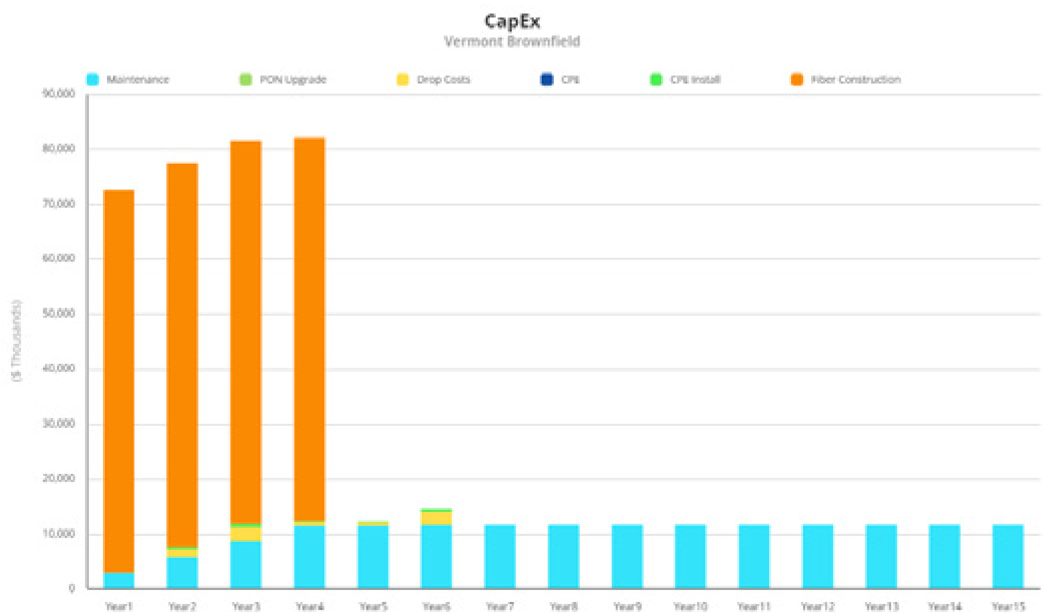
Capital Expenditures

We calculate the Capital Expenditures on an annual basis to establish the cost to build upgrade and maintain the fiber network. In addition to the cost to lay aerial and underground fiber, we consider the cost of electronics such as GPON, splitters, splice closures, cabinetry and power. Drop length installation cost is added to the CapEx calculation for new subscribers each year. CPE and truck roll costs are also added to the CapEx calculations.

The following chart shows the annual CapEx which is dominated by the fiber build during the first four years, followed by the fiber maintenance expenses.

Figure 6

Annual Capital Expenditures



Revenue

Revenue is calculated on an annual basis by multiplying ARPU by the average number of subscribers per year. When installation cost is collected, it is shows as revenue. Any government grant is also considered as revenue for accounting purposes.

Only data revenue is considered in this analysis, but Video and Voice revenue can be added using the Fiber ROI dashboard.

The next chart shows the annual review.

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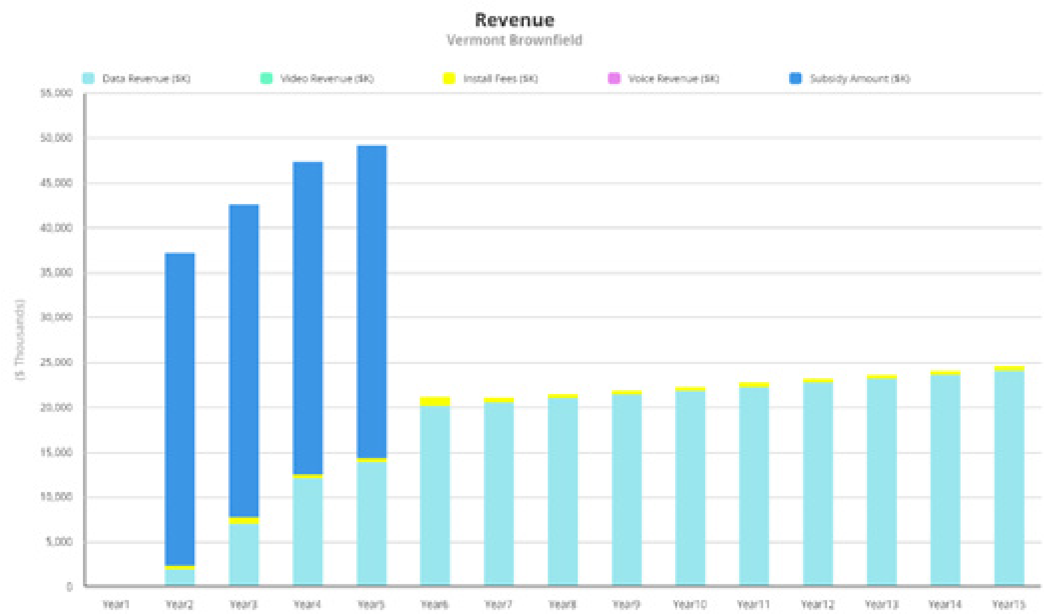
Figure 7

Annual Revenue Projections

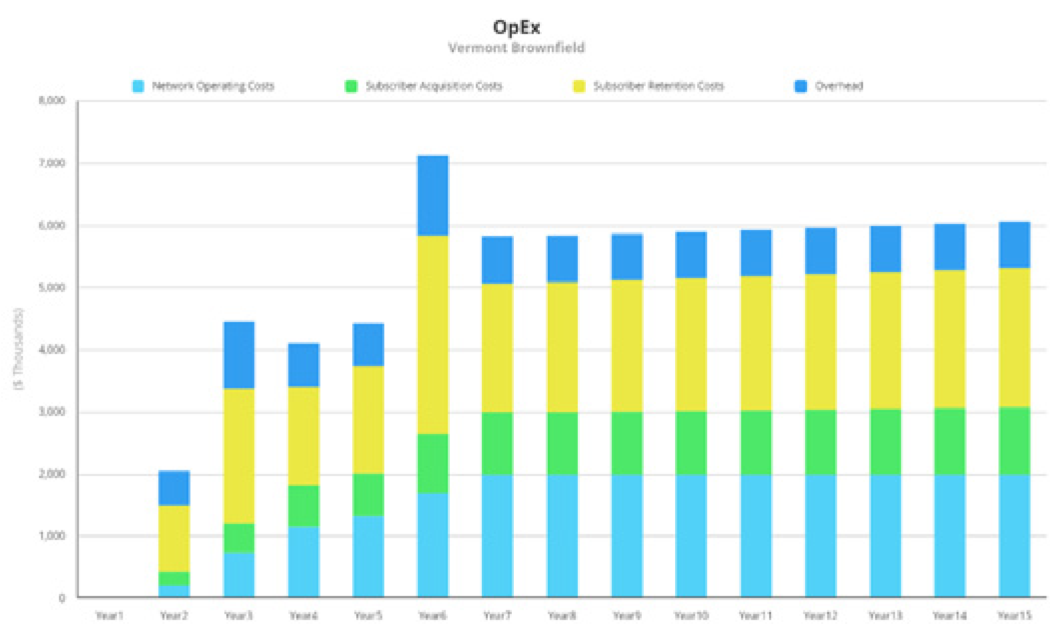


Operating Expenses (OpEx)

Operating Expenses are comprised of subscriber acquisition costs, subscriber retention cost, network operating costs and overhead. These costs include sales and marketing, advertising and promotion, customer service, billing, and overhead expenses.

Figure 8

Operating Expenses including Network OpEx, Subscriber Acquisition, Subscriber Retention and Overhead Expenses



Cumulative OpEx

Operating Expenses (OpEx) in this context are comprised of various components, including connection costs (a combination of pole connection cost and fiber middle-mile connection costs), as well as standard OpEx elements such as billing, fixed marketing, sales, customer service, and overhead. These assumptions can be easily customized within the Fiber ROI model to reflect specific project characteristics and market conditions.

As outlined in the forthcoming sections of the white paper, it will become evident that these OpEx components, while essential, typically represent a smaller portion of the overall expenses compared to the substantial Capital Expenditures (CapEx) associated with fiber infrastructure. This highlights the significance of effectively managing and optimizing CapEx to achieve a favorable financial outcome for the project.

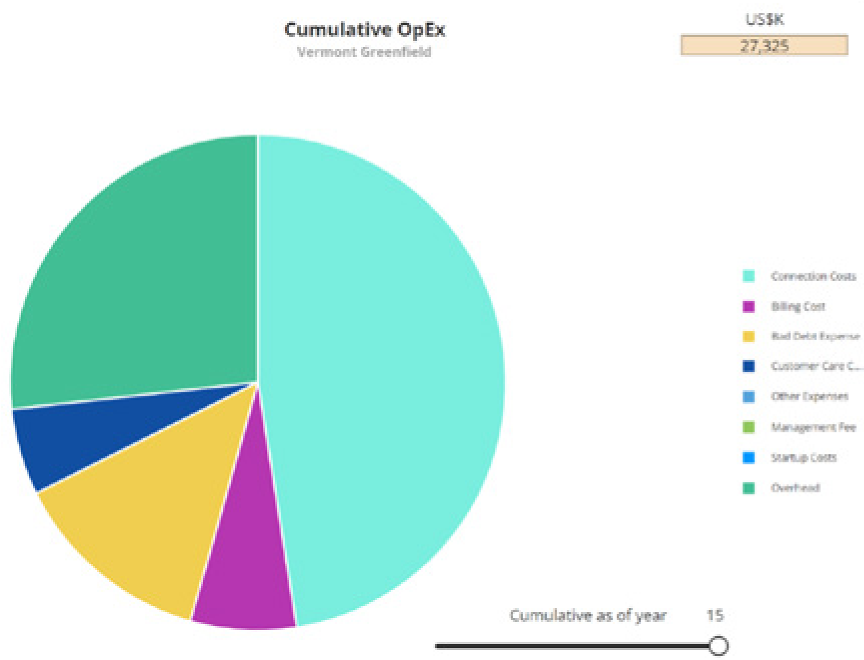


Figure 9

Cumulative Operating Expenses as of Year 15

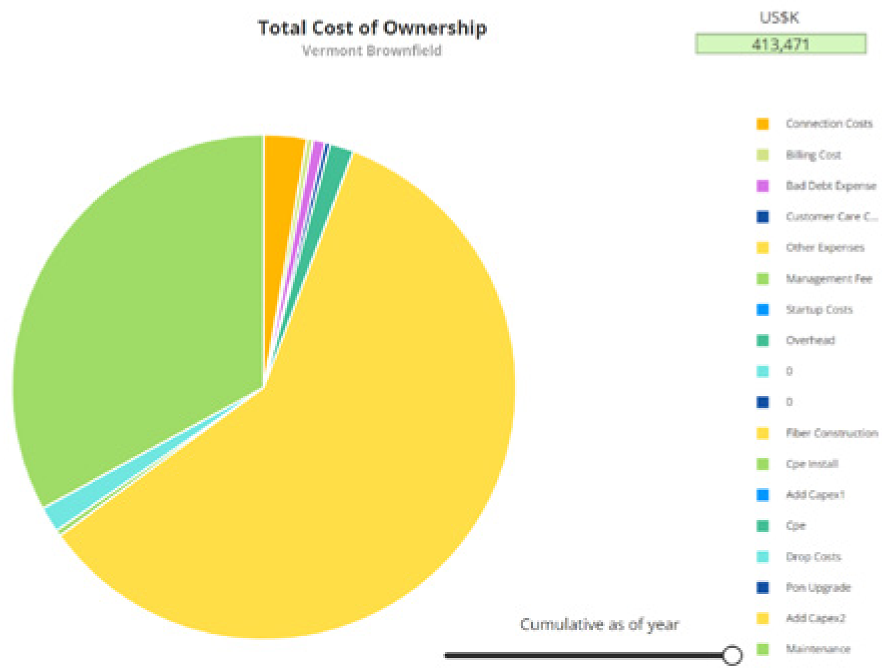
Total Cost of Ownership (TCO)

The concept of Total Cost of Ownership (TCO) encompasses all the expenses incurred by a Fiber ISP in the process of constructing and operating their network. It represents the summation of all Capital Expenditures (CapEx) and Operational Expenditures (OpEx).

As illustrated in the diagram below, the Cumulative TCO is primarily driven by two key components: Fiber construction and maintenance costs. The Cumulative TCO can be evaluated at various points in time using the "Cumulative as of Year" slider, allowing users to assess costs starting from Year 1, including fiber middle-mile connection expenses. Additionally, we account for the standard OpEx elements that contribute to the overall TCO.

Figure 10

Total Cost of Ownership (TCO) is Dominated by Fiber Construction and Fiber Network Maintenance Expenses



Income (Revenue minus OpEx equals EBITDA)

The income chart below shows EBITDA calculated by subtracting annual OpEx from annual Revenue.

Figure 11

Income Showing Revenue, OpEx and EBITDA. Subsidy amounts are counted as Revenue.

Economic Summary (FCF, NPV and IRR)

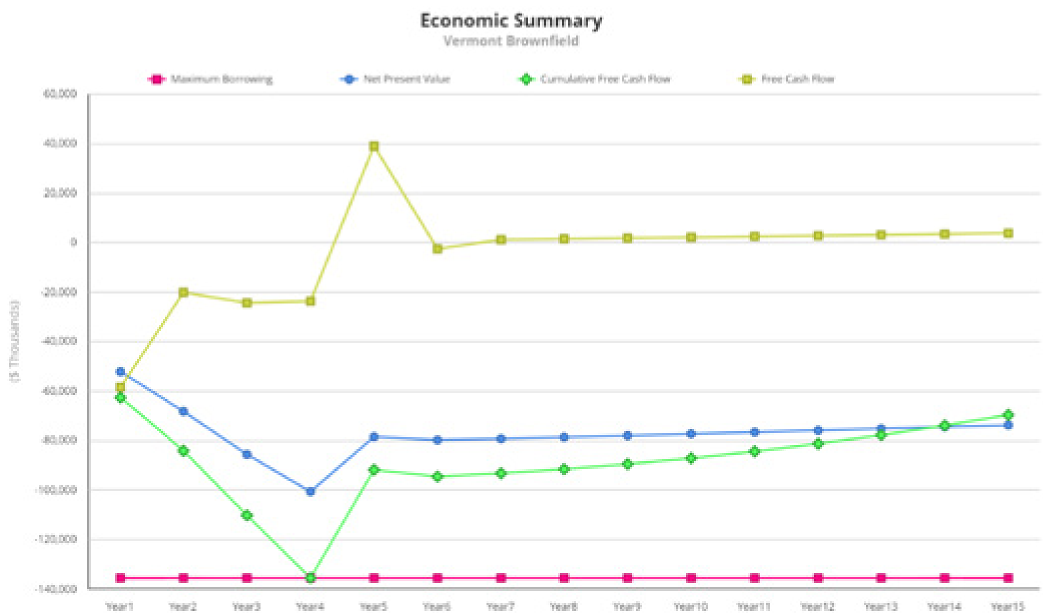
Based on the assumptions provided, including the cumulative negative Free Cash Flow (FCF) and Negative Net Present Value (NPV), it is evident that the financial outlook for statewide fiber in Vermont is challenging. The Internal Rate of Return (IRR) of 4% over a 15-year period, even with the low-cost fiber model at $51,000 per mile, may not be attractive to many investors. These financial metrics may deter potential investors due to the limited profitability and the extended period required to realize returns.

In such cases, it's essential to carefully evaluate the project's viability, explore cost optimization strategies, and consider alternative funding sources or partnerships to improve the financial prospects and make the project more appealing to investors.

With the high cost of construction at $92K per fiber mile, the investment outlook looks much worse.

Figure 12

Economic Summary KPI's incuding Free Cash Flow, Cumulative Free Cash Flow and Net Present Value



Relationship Between Cost Per Fiber Mile, Subsidy and MIRR

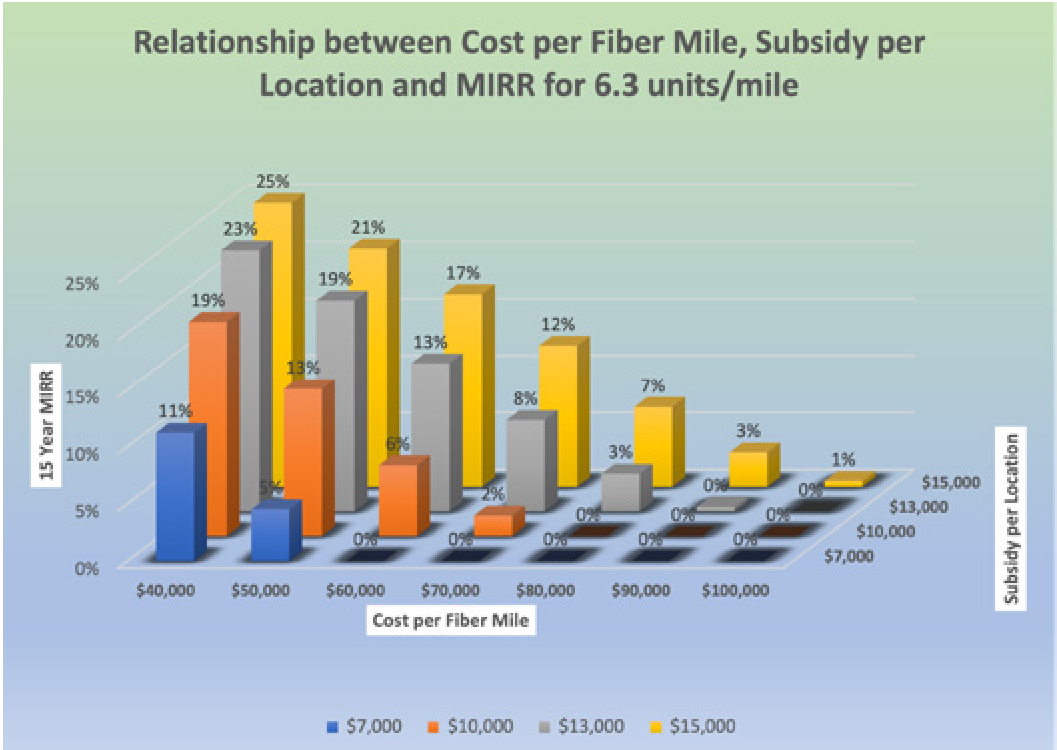
Unit density, expressed in units per mile, plays a significant role in the ROI of rural networks. Vermont's average unit density for BEAD-eligible locations is calculated to be 6.3 units per mile.

This value varies greatly from state to state. Our analysis shows that rural markets targeted by BEAD subsidy typically are low-density markets, where the average varies between 2 and 8 units per fiber mile.

We plot the relationship between cost per fiber mile, BEAD subsidy, and MIRR to demonstrate the impact of these parameters for the Vermont 6.3 homes per fiber mile scenario.

Figure 13

Cost per Fiber Mile, Subsidy per Location and MIRR for Vermont



Typically, private equity funds seek a 12-15% MIRR on fiber deployment projects. Note that to achieve an MIRR of 12% with a unit density of 6.3, the cost per fiber mile has to be at the low end of the spectrum, and the amount of subsidy per location has to be at the high end. In Vermont, the average subsidy per location is set at around $6,500, which indicates that unless all bidders have an extremely low cost of fiber construction, it would be challenging to fiber every unserved location with the current amount allocated for BEAD Funding.

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CONCLUSION

In conclusion, the business case for the Broadband Equity Access and Deployment (BEAD) program in Vermont presents significant challenges for both the state's administration of the grant and Internet Service Providers (ISPs) seeking broadband subsidies. To initiate a financial assessment, it is essential first to establish accurate fiber mile calculations. Without this fundamental data, conducting any meaningful financial analysis becomes impossible.

The cost per fiber mile assumption takes center stage once precise fiber miles are determined through advanced Geographic Information System (GIS) tools. With installation costs ranging from $51,000 to $92,000 per mile, the total expenditure for fiber construction can be bounded within this wide range. Given Vermont's northern location and extended snow season, it's reasonable to expect costs to lean toward the higher end of this spectrum.

However, it is vital to avoid a common pitfall in the analysis: prematurely concluding deployment is financially viable based solely on the equation of grant subsidy equaling a majority of the cost of the initial fiber construction. This type of analysis can be misleading and should not be used in isolation to evaluate the investment opportunity. Instead, a comprehensive Return on Investment (ROI) analysis must be conducted, considering factors such as annual CapEx, Operating Expenses (OpEx), Revenue, and Free Cash Flow (FCF). This detailed assessment is crucial to determine if there is a positive return on investment for each bidder.

Our observation suggests that in Vermont, bidders must exercise careful selection, focusing on the densest areas nearest to their existing network infrastructure to create smaller, financially viable clusters and ask for subsidies substantially above the average allocated per unserved location by the NTIA for the state of Vermont.

Unless the cost per fiber mile falls below $40,000, Vermont may face challenges in fiberizing all of the 28,000 unserved locations with the allocated $228 million in BEAD funding. Fortunately, Vermont has an additional $60 million in funding to help mitigate this situation. Nevertheless, the Vermont State Broadband Agency, like all state broadband agencies, must adopt a selective approach to ensure that a majority of unserved areas receive fiber connectivity. This entails prioritizing the most promising applications while remaining sensitive to the financial viability of each project.

For those interested in exploring the Fiber ROI model in-depth, a fully interactive version can be obtained by contacting Wireless 20/20 at **www.wireless2020.com**.

This White Paper was authored by Fred Campbell, Berge Ayvazian, and Haig Sarkissian,
Principal Consultants at Wireless 20/20.

Wireless 20/20 is a consulting firm focused on fiber and wireless broadband markets. Wireless 20/20 has helped over 180 broadband operators worldwide build business cases, analyze market opportunities, complete technology and vendor selections, and develop network rollout strategies. Wireless 20/20 is the developer of the WiROI™ Business Case Analysis Tools, WiROI™ db Geospatial SaaS Platform, and ChatGIS, the interactive AI-powered US Broadband Discovery platform.

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