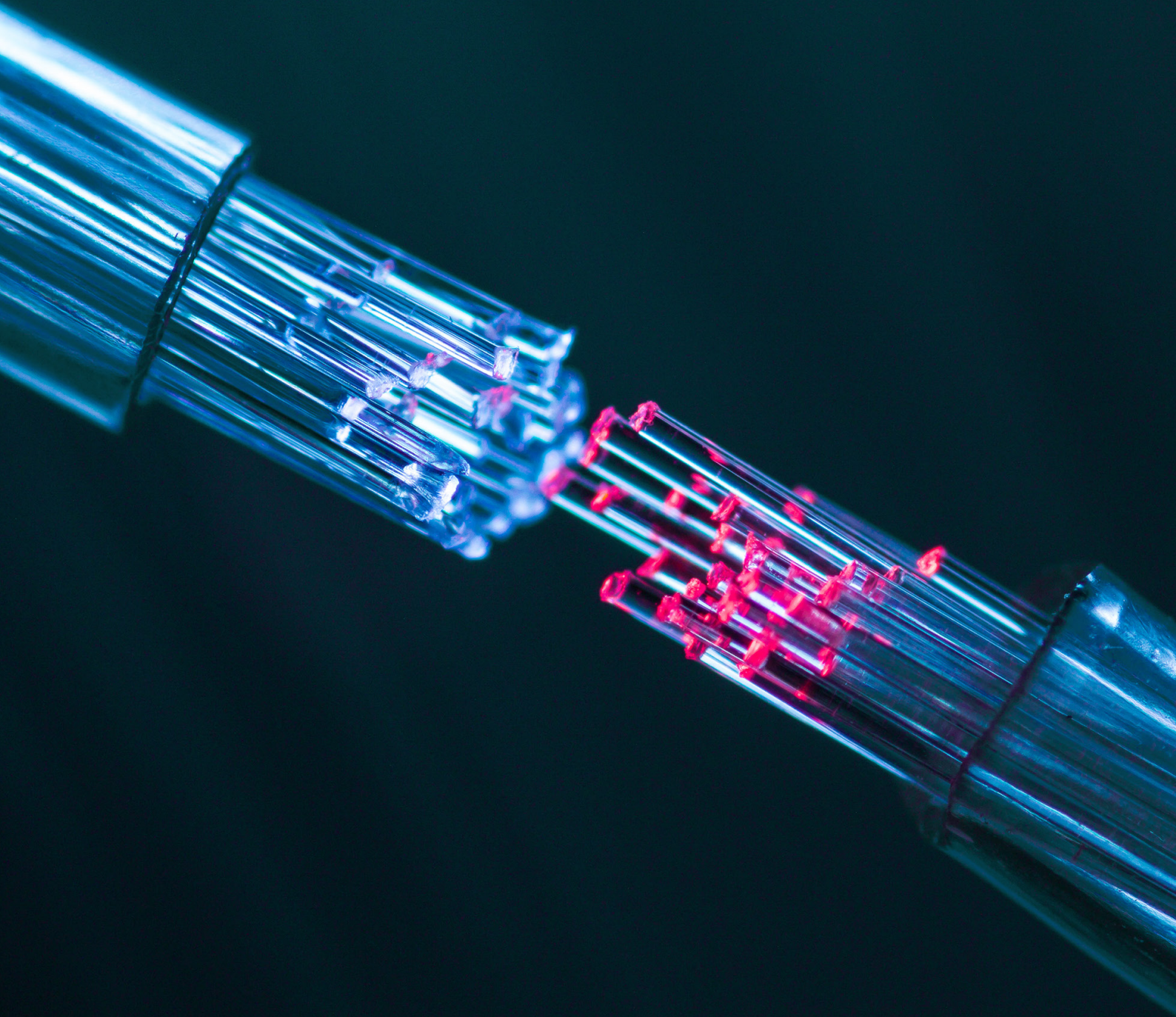


# Beyond the Last Mile

The fiber optic market opportunity



# Executive summary

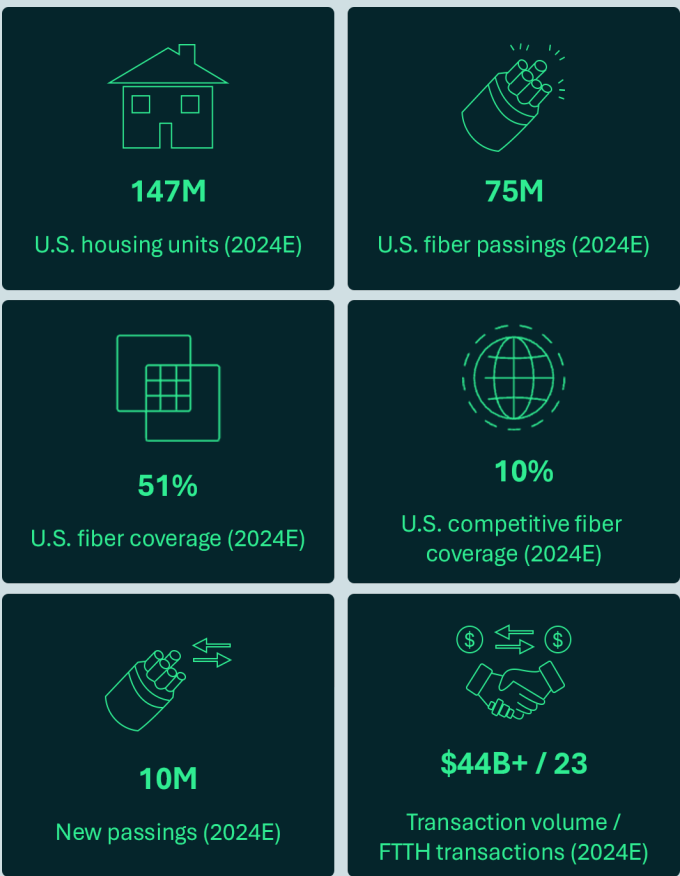
The fiber market is the very backbone of American digital life, and is now at the center of a new era of infrastructure investing

The fiber-to-the-home (FTTH) market in the United States is undergoing a profound transformation, propelled by a convergence of technological necessity, investor enthusiasm, and the growing realization that fiber is not just a communications tool, but a foundational platform for economic growth and societal advancement. What began as a niche, capital-intensive technology reserved for backbone infrastructure has matured into the very backbone of American digital life, and is now at the center of a new era of infrastructure investing.

As a specialist firm focused on industrial decarbonization, Ara Partners sees the FTTH sector—particularly the bulk model—as an attractive intersection of reliable returns, digital infrastructure buildout, and climate impact.

The U.S. fiber market is experiencing unprecedented expansion. Out of approximately 147 million housing units nationwide, 75 million are now passed by fiber, representing 51% national coverage. In 2024 alone, the industry saw 10 million new fiber passings, with \$44 billion in transaction value recorded across 23 FTTH deals.

## 2024E KEY MARKET STATISTICS<sup>1</sup>



<sup>1</sup> Ara Partners, Wall Street estimates

# Executive summary

The FTTH market represents more than an investment in digital infrastructure—it is a lever for industrial decarbonization, energy efficiency, and social progress

Yet despite this rapid growth, the United States still lags behind global peers like Korea, Iceland, and Spain, which boast FTTP coverage rates approaching or exceeding 90%.

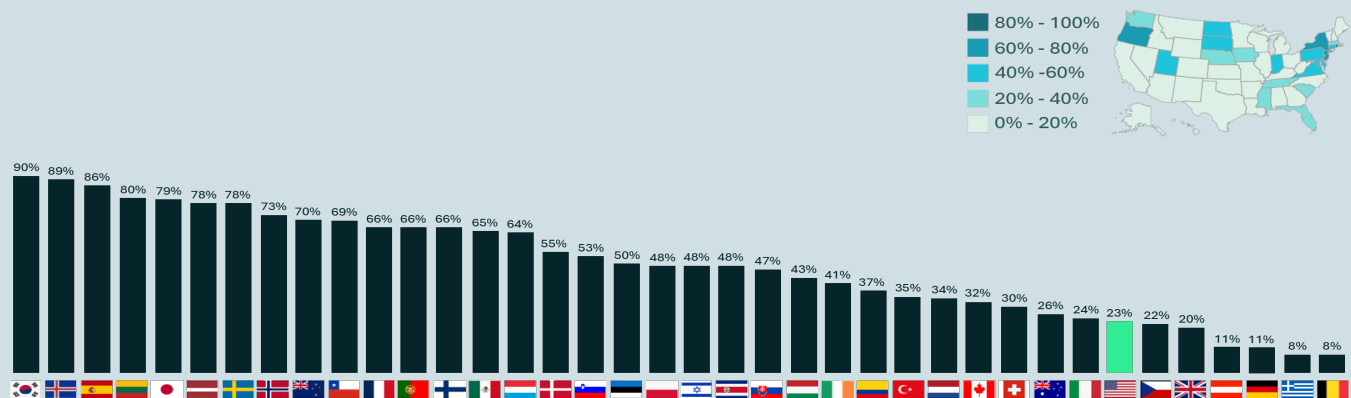
For Ara Partners, the FTTH market represents more than an investment in digital infrastructure—it is a lever for industrial decarbonization, energy efficiency, and social progress. Fiber networks consume up to 95% less energy per petabyte of data transmitted compared to legacy copper networks, are manufactured with up to 60% lower carbon intensity,<sup>2</sup> and enable distributed energy management and remote work applications critical to economy-wide emissions reduction.

The bulk FTTH model—where providers partner directly with developers and homeowners’ associations under long-term, take-or-pay contracts—offers particularly compelling economics: guaranteed penetration rates approaching 100%, predictable cash flows spanning 10 to 30 years,

and attractive risk-adjusted returns. The bulk FTTH model exhibits more infrastructure-like characteristics, such as long-term contracted revenues, lower churn, and utility-essential demand, compared to enterprise fiber and business contracts, which face higher customer concentration risk and competitive dynamics.

This report examines why fiber has become the connective tissue of modern communications infrastructure, the decarbonization benefits fiber offers over legacy networks, and why the bulk FTTH model represents a uniquely attractive opportunity for investors.

% FIXED BROADBAND SUBSCRIBERS WITH FIBER BY COUNTRY<sup>3</sup>



<sup>2</sup> Fiber Broadband Association  
<sup>3</sup> Guggenheim

# Digital infrastructure growth and why fiber is critical

## Fiber carries data at speeds and capacities orders of magnitude higher than any competing technology

Fiber optic networks have emerged as the indispensable foundation of 21st-century digital infrastructure. Unlike legacy copper or coaxial cable systems, fiber uses light pulses transmitted through glass strands to carry data at speeds and capacities orders of magnitude higher than any competing technology. This fundamental physics advantage has positioned fiber as the connective tissue linking every layer of modern communications—from undersea cables spanning continents to cell tower backhaul to last-mile connections bringing gigabit internet into American homes.

The evolution of broadband infrastructure illustrates fiber's inevitable ascendance. While copper telephone lines once powered dial-up and DSL, revolutionary in their time, they were quickly outpaced by demands of an increasingly digital society. Cable broadband delivered a step-change in bandwidth, supporting the streaming revolution. However, as the appetite for data-intensive applications such as 4K video, cloud computing, and smart home devices soars, cable's asymmetric speeds and congestion-prone networks have begun to show their age.

MARKET SHARE BY BROADBAND TECHNOLOGY<sup>4</sup>

### Cable

COVID-related subscriber growth has subsided; net declines despite active builds

### Copper

Continued subscriber attrition due to telco upgrades and new competition

### Fiber

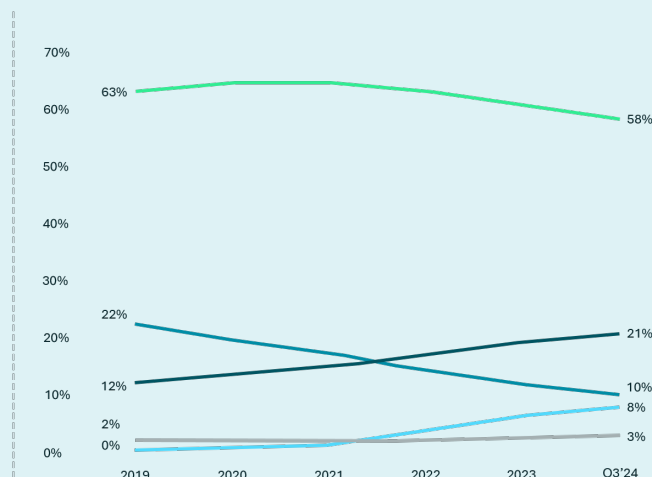
Market share has nearly doubled in the last five years due to telco and greenfield builds

### Fixed wireless access

Rapid growth in fixed wireless subscriptions driven by national wireless carrier success

### Satellite

Starlink driving strong growth but still small from a total market share perspective



<sup>4</sup> Ara Partners, Wall Street estimates

# Digital infrastructure growth and why fiber is critical

## What truly sets fiber apart is its unmatched headroom for future growth

The COVID-19 pandemic dramatically accelerated fiber’s transition from luxury to necessity, exposing legacy network shortcomings as remote work, online learning, and telehealth became daily essentials.

### Future-proof by design: Fiber’s unmatched theoretical capacity

What truly sets fiber apart is its unmatched headroom for future growth. While copper and wireless technologies operate near their theoretical maximum capacities, fiber networks are still in the early stages of what is physically possible.

In November 2023, researchers at Japan’s National Institute of Information and Communications Technology (NICT) achieved a world record by transmitting data at 22.9 petabits per second through a single optical fiber—equivalent to 22,900 terabits per second, or approximately 2,000 two-hour 4K movies transmitted in one second. The researchers accomplished this using standard-diameter fiber with four cores and wavelength-division multiplexing across 750 wavelength channels.

Critically, this demonstrates that fiber’s capacity can scale dramatically without requiring new physical infrastructure—existing fiber strands can be “lit up” with more advanced transmission equipment as demand grows.

| THEORETICAL MAXIMUM SPEEDS BY TECHNOLOGY <sup>5</sup> |                     |                        |                     |
|-------------------------------------------------------|---------------------|------------------------|---------------------|
| Technology                                            | Theoretical maximum | 2025 deployment speeds | Capacity headroom   |
| DSL (copper)                                          | ~0.1 Gbps           | 0.025-0.1 Gbps         | Near maximum        |
| Cable (DOCSIS 3.1)                                    | ~10 Gbps            | 0.5-1 Gbps             | Limited             |
| 5G FWA                                                | ~1-3 Gbps           | 0.1-0.5 Gbps           | Limited             |
| Fiber (commercial)                                    | ~100+ Gbps          | 1-10 Gbps              | Massive             |
| Fiber (lab record)                                    | 22,900,000 Gbps     | N/A                    | Virtually unlimited |

30–50 years

lifespan of fiber deployed today

Fiber deployed today will remain relevant for 30-50 years, readily accommodating applications we cannot yet imagine. Legacy networks face hard physical limits and will require costly replacement as demand climbs steadily. Satellite broadband suffers from high latency, making it unsuitable for real-time applications like videogaming, and faces bandwidth constraints that worsen as more users connect to the satellite beam. While viable for remote areas lacking alternatives, satellite cannot economically scale to serve dense residential markets where FTTH operates.

<sup>5</sup> Japan’s National Institute of Information and Communications Technology

# Digital infrastructure growth and why fiber is critical

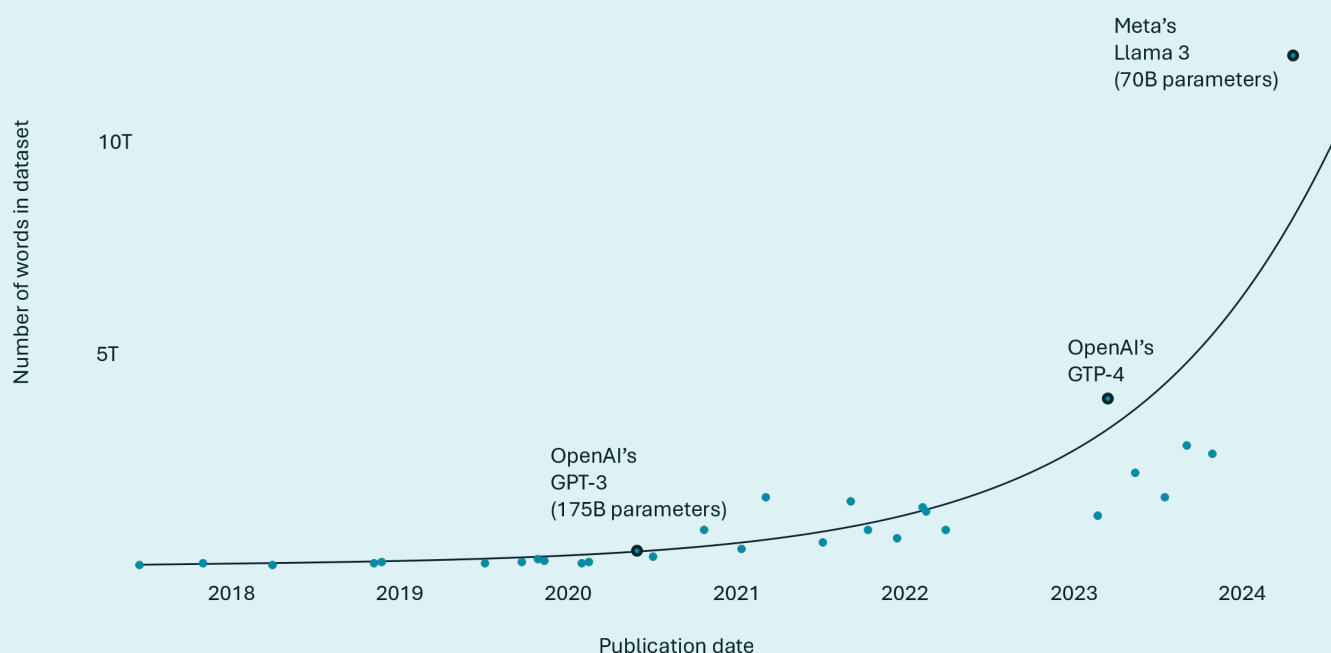
## As demand grows with AI, fiber transitions from a luxury to a competitive necessity

Five powerful trends are driving exponential bandwidth growth, cementing fiber's position as essential infrastructure.

**1) Artificial intelligence and machine learning:** AI's appetite for data transmission can only be met by fiber's bandwidth and reliability. Large language models require terabyte-scale training datasets, while inference generates constant bi-directional traffic. Edge AI applications—real-time video analysis, autonomous vehicles, industrial automation—demand ultra-low latency only fiber provides reliably. According to Epoch AI, training datasets have grown from tens of gigabytes in 2015 to multiple terabytes today, with no plateau in sight.

**2) Remote work and distributed collaboration:** The pandemic permanently altered work patterns. Before COVID, audio calls were common; after COVID, video calls and collaborative platform features became preferred over purely audio. Video conferencing, cloud collaboration tools, virtual desktops, and real-time file sharing demand symmetrical, high-capacity connections where fiber excels. Upload speeds—cable and DSL's Achilles heel—are now as critical as download speeds. As work-from-anywhere becomes permanent, fiber transitions from luxury to competitive necessity.

AI LLM TRAINING DATASETS ARE GROWING EXPONENTIALLY<sup>6</sup>



<sup>6</sup> EIA, Epoch AI

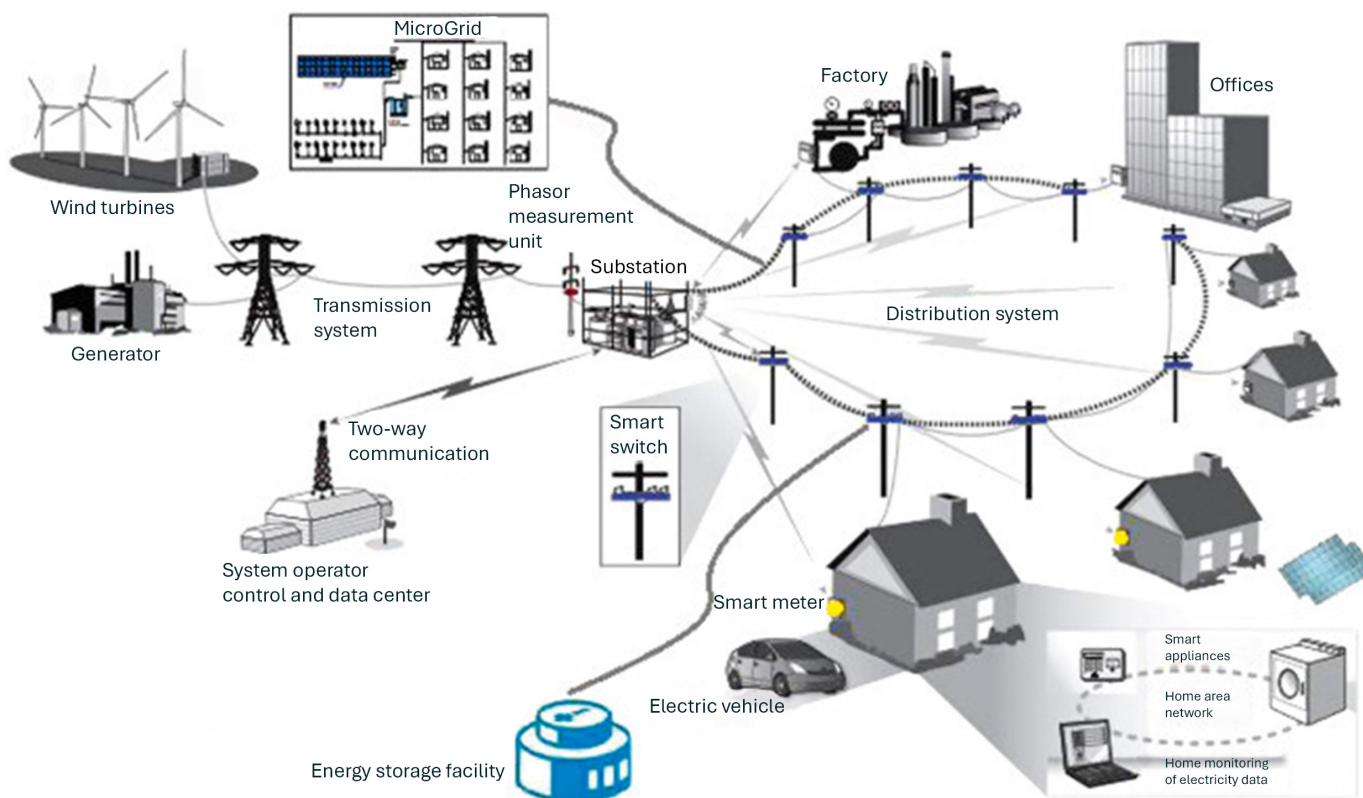
# Digital infrastructure growth and why fiber is critical

Fiber enables smart grids that analyze usage patterns from millions of endpoints to optimize power consumption

**3) Smart grids and distributed energy resources:** The electricity grid is evolving from centralized, one-way power delivery to a distributed, bi-directional network managing an increasing amount of intermittent renewable generation and demand response. Smart grid modernization requires real-time communication with millisecond latency and

bulletproof reliability that only fiber delivers at scale. Fiber enables utilities to monitor operations, analyze sensor data from millions of endpoints, and respond rapidly to fluctuations—lowering bills by 5-22%, reducing peak loads, and enhancing resilience while supporting renewable integration.

## EXPANSIVE DATA NETWORKS ENABLE MODERN SMART GRIDS<sup>7</sup>



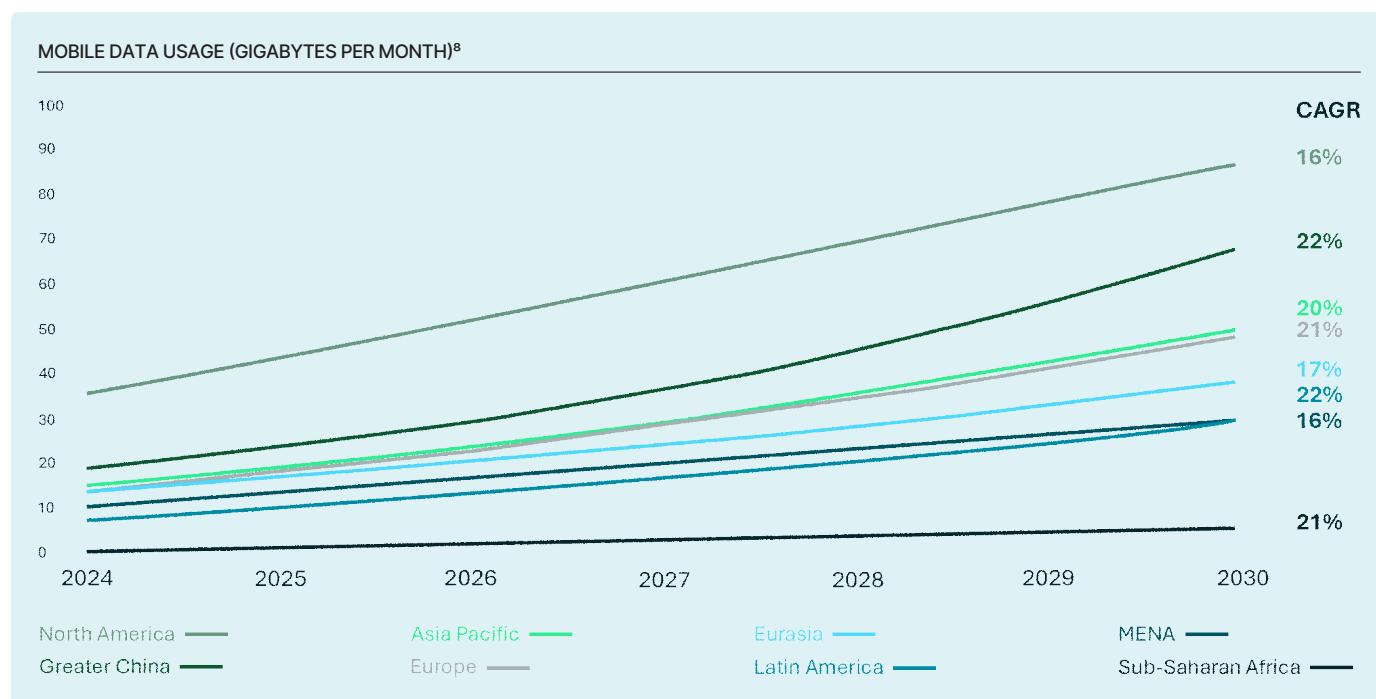
<sup>7</sup> US Government

# Digital infrastructure growth and why fiber is critical

Fiber is particularly important because mobile data usage exploded from 4.1 trillion megabytes in 2014 to over 100 trillion in 2023—a 24x increase

**4) 5G and next-generation wireless:** While wireless captures headlines, it depends entirely on fiber for backhaul. “Backhaul” refers to the portion of the network that connects the local access network (end-users’ homes or buildings) to the core network or the internet backbone (such as a data center, central office, or internet

unbreakable encryption. Fiber is uniquely suited for quantum networking, capable of transmitting entangled photons while coexisting with classical data. Additionally, Distributed Fiber Optic Sensing (DFOS) turns every kilometer of fiber into thousands of sensors for pipeline monitoring, structural health assessment, perimeter



exchange). Each 5G cell site requires fiber to handle data torrents. Mobile data usage exploded from 4.1 trillion megabytes in 2014 to over 100 trillion in 2023—a 24-fold increase. AI-generated content, 8K streaming, and cloud gaming will drive even greater demands.

**5) Quantum networking and distributed sensing:** The future of secure communications will be built on quantum networks using quantum key distribution for theoretically

security, traffic management, and seismic detection—often using existing “dark” fiber.

These multi-use capabilities position fiber not merely as broadband technology, but as foundational infrastructure for the next generation of economic and technological advancement—supporting smart cities, resilient utilities, advanced security, and scientific discovery.

<sup>8</sup> GSMS Intelligence

# Decarbonization benefits of fiber vs. traditional network infrastructure

## Fiber optic cable production is up to 60% more carbon-efficient than manufacturing equivalent-capacity copper cable<sup>9</sup>

Fiber's climate advantages over legacy copper and coaxial cable networks are compelling and often underappreciated.

### Dramatically lower energy consumption

Fiber optic networks are up to 95% more energy-efficient per petabyte of data transmitted compared to traditional copper-based networks.<sup>9</sup> This efficiency stems from fundamental physics: fiber uses light pulses through glass requiring minimal power for signal amplification over long distances, whereas copper networks rely on electrical signals that degrade rapidly and require frequent, energy-intensive boosting.

At a time when telecommunications networks account for approximately 1-2% of global electricity consumption—projected to rise as digitalization accelerates—the energy efficiency of underlying infrastructure becomes critical to meeting climate goals. Moreover, fiber's efficiency compounds over time. As bandwidth demand grows exponentially, legacy networks must add equipment and consume more power. Fiber networks can scale capacity by upgrading terminal equipment while leaving physical infrastructure untouched—delivering massive bandwidth increases with minimal incremental energy consumption.

### Lower carbon intensity of manufacturing

Fiber optic cable production is up to 60% more carbon-efficient than manufacturing equivalent-capacity copper cable.<sup>9</sup> Fiber cables are made primarily from quartz and silica—essentially refined sand—among Earth's most abundant materials requiring relatively low energy to process.

Copper production is carbon-intensive at every stage: mining involves massive earth-moving and diesel equipment; smelting requires high-temperature furnaces generating significant CO<sub>2</sub>. Additionally, only ~5% of copper used in the United States is produced domestically, meaning most copper cable relies on global supply chains with substantial transportation emissions. By replacing copper with fiber, telecommunications dramatically reduces embodied carbon while preserving critical copper supplies for higher-value applications—EV motors, renewable energy systems, and advanced electronics.

### Extended asset life and reduced maintenance

Fiber infrastructure has a significantly longer useful life than copper or coaxial cable—often 30-50 years compared to 15-25 years for legacy systems. This longevity stems from fiber's immunity to corrosion, electromagnetic interference, and physical degradation plaguing metal cables.

Climate implications are substantial: fewer replacement cycles reduce cumulative emissions from manufacturing and installation; lower maintenance activity means fewer truck rolls compared to copper networks prone to water damage and signal degradation; reduced material waste means less cable in landfills requiring energy-intensive recycling.

Fiber optic networks are up to

**95%**

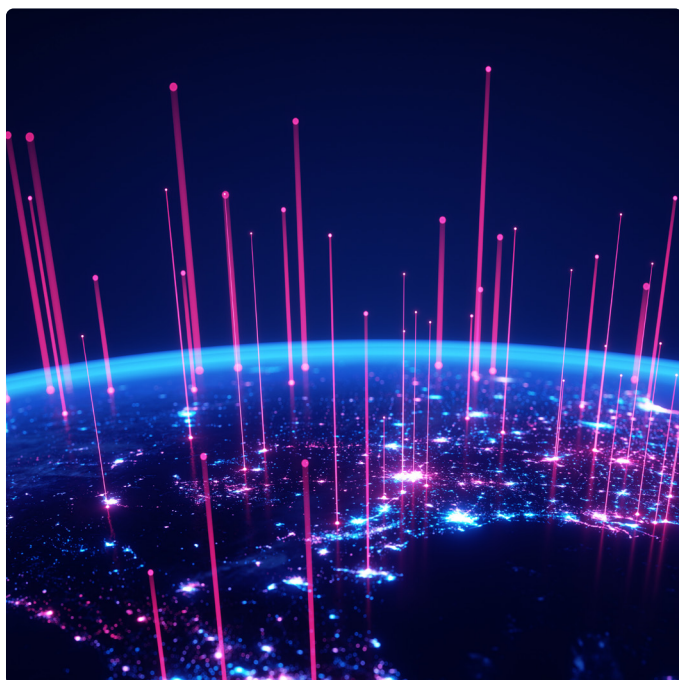
more energy-efficient than copper-based networks<sup>9</sup>

<sup>9</sup> Fiber Broadband Association

# Decarbonization benefits of fiber vs. traditional network infrastructure

---

The alignment of financial, environmental, and social returns makes FTTH bulk format a uniquely attractive area for investors



## Enhanced resilience to climate-related disruptions

Fiber is unaffected by electromagnetic pulses, lightning strikes, and power surges that devastate copper infrastructure. Its smaller physical footprint and lighter weight make fiber less vulnerable to wind damage, ice loading, and physical stress during storms.

## Enabling broader decarbonization through digital applications

Beyond direct footprint advantages, fiber infrastructure enables economy-wide decarbonization:

- > **Remote work** reduces commuting emissions—each remote worker eliminates 2-3 tons of CO<sub>2</sub> annually
- > **Smart home integration** allows fiber-connected thermostats and appliances to optimize consumption, and shift loads to renewable-heavy hours
- > **Telemedicine expansion** reduces patient and provider transportation emissions
- > **Smart grid optimization** enabled by fiber communications integrates distributed renewables, manages storage, and reduces grid losses

The alignment of financial, environmental, and social returns makes FTTH—particularly in the bulk format—a uniquely attractive area for investors seeking strong returns alongside measurable climate and societal benefits.

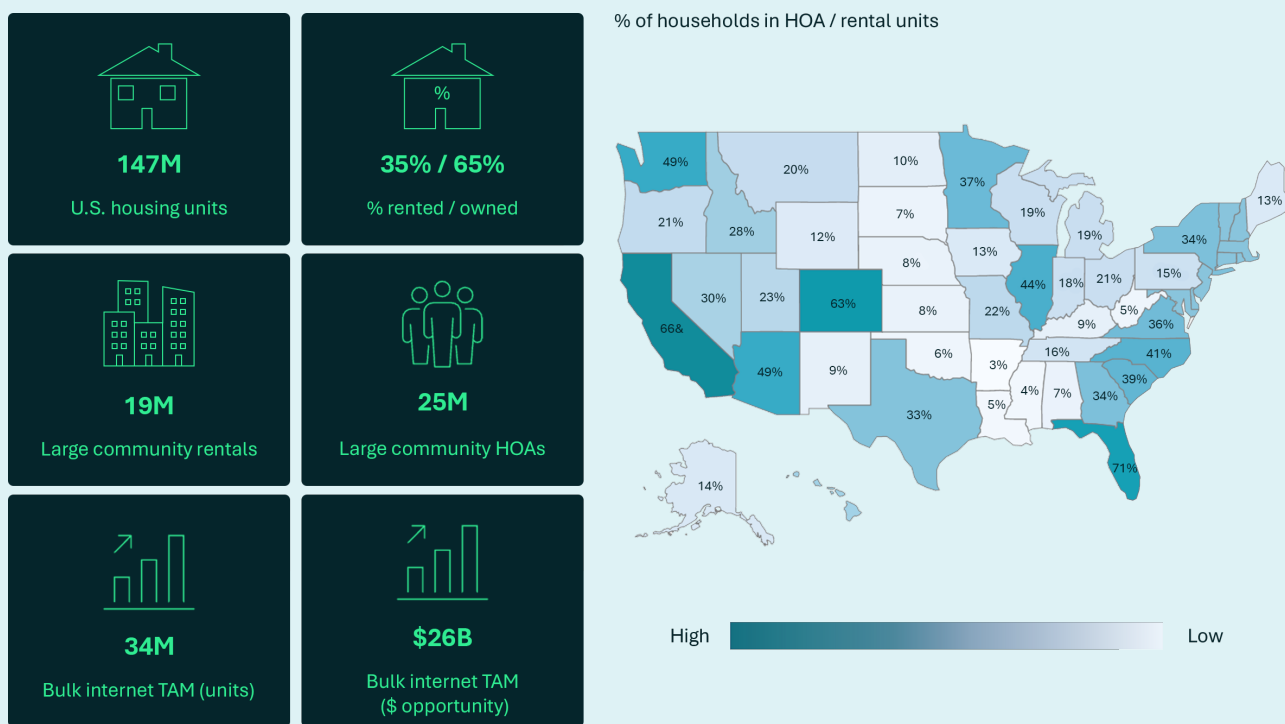
# Why we like bulk fiber to the home

The combination of guaranteed penetration, long contract duration, and built-in escalators produces cash flow profiles for fiber similar to regulated utilities

The bulk FTTH model has emerged as one of the most compelling opportunities in digital infrastructure, combining utility-like economics with substantial growth runway. At the heart of this model's appeal are three defining

characteristics: utility-model economics, long-term take-or-pay contracts, and significant whitespace for future expansion.

BULK CONNECTIVITY DASHBOARD & U.S. MAP % OF HOUSEHOLDS IN HOA/RENTALS<sup>10</sup>



<sup>10</sup> Guggenheim

# Why we like bulk fiber to the home

---

## Long contract duration produces stable cash flow profiles similar to regulated utilities

Unlike traditional overbuilder or retail fiber models that compete for individual subscribers in established markets, bulk FTTH providers partner directly with developers and homeowners' associations (HOAs) to deliver fiber connectivity to entire communities before residents move into new developments. This approach creates a fundamentally different economic profile that closely resembles regulated utilities.

Key advantages include:

- > **Guaranteed penetration:** Bulk contracts typically achieve up to 100% penetration in newly built communities, compared to 30-60% for traditional retail models. Every home is connected, eliminating customer acquisition costs and marketing expenses while maximizing network utilization from day one.
- > **Predictable revenue:** With entire communities under contract, revenue becomes highly predictable and insulated from competitive pressures. Average revenue per user (ARPU) is robust, often exceeding retail models due to bundled services and premium connectivity tiers.
- > **Attractive risk-adjusted returns:** The combination of guaranteed penetration, long contract duration, and built-in escalators produces cash flow profiles similar to regulated utilities—stable, growing, and largely immune to economic cycles.
- > **Minimal churn:** Customer attrition is virtually eliminated by contract structure. Even when individual homeowners move, the community remains under contract, ensuring continuity of service and revenue.

## Long-term take-or-pay contracts

The contractual foundation of bulk FTTH provides exceptional visibility and downside protection. Typical contracts span 10 to 30 years, with built-in annual escalators (often 2-3%) ensuring revenue growth keeps pace with or exceeds inflation.

These take-or-pay structures mean communities commit to paying for connectivity regardless of individual usage levels, transferring demand risk from the operator to the HOA or property owner. For investors accustomed to merchant exposure or competitive churn in other infrastructure sectors, this contractual certainty is transformative.

Moreover, bulk contracts often include exclusive or preferential rights, creating natural barriers to competitive entry even as other fiber providers expand into the same geographic markets. The first-mover advantage in securing developer relationships becomes self-reinforcing as successful deployments build reputation and trust.

**10-30 years**  
average length of bulk FTTH contracts

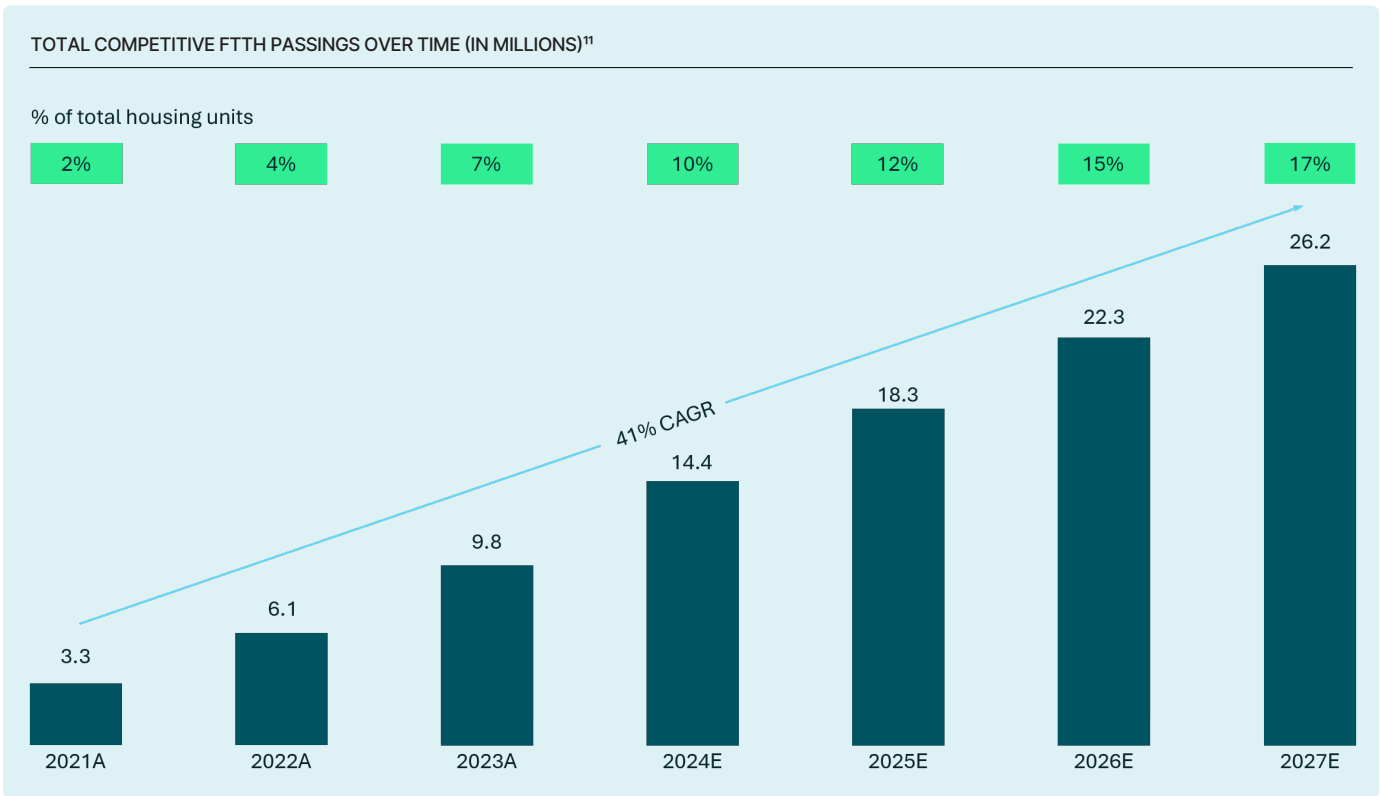
# Why we like bulk fiber to the home

## Fiber connectivity is now as essential as water or electricity

The bulk FTTH market opportunity remains in early innings despite recent momentum. Housing starts in key Sunbelt markets—Texas, Florida, Arizona, Georgia, North Carolina—are projected to grow at 4% annually through 2028, with master-planned communities (MPCs) accounting for nearly 20% of total starts. The demand for bulk FTTH is particularly acute in these new developments, where connectivity is now as essential as water or electricity.

The United States faces a severe housing shortage. The need is particularly acute for single-family homes, as demand from new, smaller, and older households

continues to grow. Increasingly, these homes are being delivered through master-planned communities and HOA-governed developments, especially in high-growth sunbelt states like Texas, Florida, Arizona, and the Carolinas. Master-planned communities in these regions offer developers the opportunity to build at scale while providing essential amenities, infrastructure, and fiber-ready connectivity that modern home buyers demand. As the sunbelt continues to attract new residents through migration and job growth, these structured community developments represent a critical solution to addressing America's housing supply challenge while meeting the connectivity expectations of today's homeowners.



<sup>11</sup> Guggenheim

# Why we like bulk fiber to the home

---

## Uniquely favorable environment for bulk FTTH deployment over the coming decade

The competitive landscape is robust but rational. While a range of players—from national incumbents to regional specialists—compete for deals, market feedback suggests only two to four providers typically vie for any given project. The key to winning is a combination of speed, reliability, and deep relationships with developers—qualities that bulk specialists have honed to a fine edge.

Financial innovation has kept pace with operational advances. Asset-backed securitization (ABS) has emerged as the cheapest and most flexible source of capital for fiber expansion, with nearly \$4 billion in new fiber

securitizations issued in 2023 alone. This has enabled providers to accelerate buildouts while maintaining balance sheet discipline—a critical factor as the market shifts from growth to scale.

The alignment of demographic trends (Sunbelt migration), housing market dynamics (MPC growth), technological imperatives (AI computational intensity), and capital availability (ABS markets) creates a uniquely favorable environment for bulk FTTH deployment over the coming decade.

## Conclusion

---

Fiber networks are emerging as essential 21st-century infrastructure—the foundational platform for smart grids, AI applications, distributed energy systems, and the remote work economy

The U.S. FTTH market stands at a pivotal moment. As digital and low-carbon transitions converge, fiber networks are emerging as essential 21st-century infrastructure—the foundational platform for smart grids, AI applications, distributed energy systems, and the remote work economy defining the next era of American competitiveness.

For Ara Partners, bulk FTTH represents a rare opportunity to deploy capital at the intersection of technological inevitability, industrial decarbonization, and societal advancement. The economics are exceptional: nearly 100% penetration, 10-30 year take-or-pay contracts, and minimal churn. The climate benefits are equally compelling: 95% less energy consumption per petabyte than copper, 60% lower manufacturing carbon intensity, and enablement of economy-wide emissions reduction through remote work and smart grid applications.

The growth runway is substantial. Only 10% of U.S. homes are reached by competitive fiber providers. Sunbelt housing starts are projected to grow 4% annually through 2028, with master-planned communities—bulk FTTH's sweet spot—accounting for nearly 20% of new construction.

Most importantly, fiber is future-proof. With experimental speeds achieving thousands of times current commercial capacity, today's infrastructure will remain relevant for decades, accommodating exponential advances in AI and quantum networking.



As America races to close the fiber gap with global leaders and build digital infrastructure for a low-carbon economy, bulk FTTH offers patient capital a unique proposition: attractive, stable returns while building essential infrastructure that advances innovation, economic resilience, and climate progress.

For Ara Partners, fiber is the connective tissue of the sustainable economy we are building—one community at a time.

## Meet the author

---



Tuan Tran

Senior Managing Director,  
Head of Ara Insights

Tuan Tran is a Senior Managing Director at Ara Partners, where he serves as the firm's Head of Strategic Relations and Head of Research across its Private Equity, Infrastructure, and Energy strategies. He has over 25 years of experience in private equity, investment banking, and equity research.

Founded in 2017, Ara Partners is a global private markets firm focused on decarbonizing the industrial economy. We invest in the middle market across three strategies: Private Equity, Infrastructure, and Energy. We scale commercially demonstrated decarbonization solutions, support the businesses and infrastructure that enable their adoption, and reduce emissions at the source across the conventional energy value chain. Our model combines investing, market and policy expertise, project execution and operational optimization, and rigorous carbon accounting to reduce emissions economically and unlock growth at an industrial scale. Ara operates from Houston, Boston, Dublin and Washington D.C.

