The Value of Blown Fiber Technology in an FTTH Environment

Blown fiber systems offer numerous advantages over traditional fiber systems, including reduced material and installation costs, fewer fiber connection points, simplified repair and maintenance, and a migration path for future applications.

By Beni Blell / *Hexatronic North America*

Civilization is on the cusp of tremendous communications breakthroughs, awakened by radical and disruptive innovation in the arenas of artificial intelligence, blockchain and augmented reality. In anticipation of new and bandwidth-hungry applications, service providers are in intense competition to reach consumers faster and with the ultimate end-state networks – fiber to the everything – FTTx.

What does this mean for the broadband industry? Technology innovation is an important success factor in the growth of information and communications technology. The internet of things (IoT) and the integration of building applications (referred to as "intelligent buildings") are major innovation drivers in broadband. Businesses and homes now require more bandwidth at faster speeds and with lower latency. As a result, system integrators are deploying more fiber systems for the applications of today and tomorrow.

Service providers are on the verge of offering the next generation of network connectivity – 5G – fueled by IoT demands. 4G supplies upward of 150 megabits per second (Mbps), depending on the carrier, but 5G will reach up to 10 gigabits per second (Gbps) or more. That means 5G is 100 times faster than 4G.

8K TV systems require reliable 90 Mbps connectivity. That's up from 25 Mbps for 4K systems. This does not include the three other devices each person in the household has connected to the system at any given point. In addition to offering increased symmetrical bandwidth, 5G promises to significantly reduce latency, which means faster load times and improved responsiveness when doing just about anything on the internet. Specifically, this next network generation promises a maximum latency of 4ms on 5G versus 20ms on 4G LTE today. This lower latency will significantly enhance the virtual reality experience and enable autonomous vehicle technology to finally take off.

Although the focus seems to be around wireless connectivity, we know that wireless cannot happen without a robust fiber optic cabling system from end to end serving as the backbone and supplying horizontal connectivity. Designing a robust network that can accommodate these applications starts with a flexible, high-bandwidth fiber backbone. Designers are quickly realizing that a blown fiber cable system provides the most cost-effective, adaptable, reliable option for scalability and flexibility to meet the initial network needs, and enables adaptation to future network requirements.

WHAT IS A BLOWN FIBER CABLING SYSTEM?

Blown fiber cable is not a new technology, although it is relatively new compared with conventional cabling methods that date back to Alexander Graham Bell.

There are two types of air blown fiber systems depending on the segment of the network. In the first, the feeder (or distribution) portions of the network utilize air blown microcables, typically from 12 to 432 fibers. In the second, for the access (i.e., last mile) fiber-to-the-home (FTTH) segment, air blown fiber “units” are utilized. These are typically one to 12 fiber units. These systems are installed in many environments, including FTTH, hospitality, health care and enterprise campuses.

Here’s how blown fiber technology works. The blown fiber system uses compressed air or nitrogen to literally blow (or “jet”) lightweight optical fiber microcables, or units, through predefined routes at rates up to 300 feet per minute. As shown in Figure 1, microcables (12 to 432 fibers) can be blown for distances of 6,600 feet and beyond. As shown in Figure 2, fiber units (one to 12 fibers) can be blown for typical maximum distances of 3,300 feet.

The microducts through which these fiber units are blown are manufactured using tough, flexible materials and bundled in groupings of up to 24 color-coded microducts, forming a multiduct assembly. These multiducts can be installed above ground aerially, underground or within buildings. Using couplers, installers easily connect individual microducts in duct-branching units to provide pathways through which microcables or fiber units are blown to achieve splice-free, point-to-point, high-speed installation. This reduces total cost and improves overall network performance.

Blown fiber technology is quickly becoming the preferred system of choice in access networks, where cost per home passed, speed of deployment, flexibility and future scalability are of utmost importance.

The cost of a typical brownfield FTTH project usually is divided into 80 percent labor and installation and 20 percent materials. Choosing to install a blown fiber system has an even greater impact on the success and profitability of a project, primarily because installation properties influence the time taken and future maintenance requirements.

Another advantage of blown fiber systems over conventional fiber optic systems is that a blown fiber system allows users to install only the fiber needed to accomplish the tasks at hand. Allowing more room in the ducts or

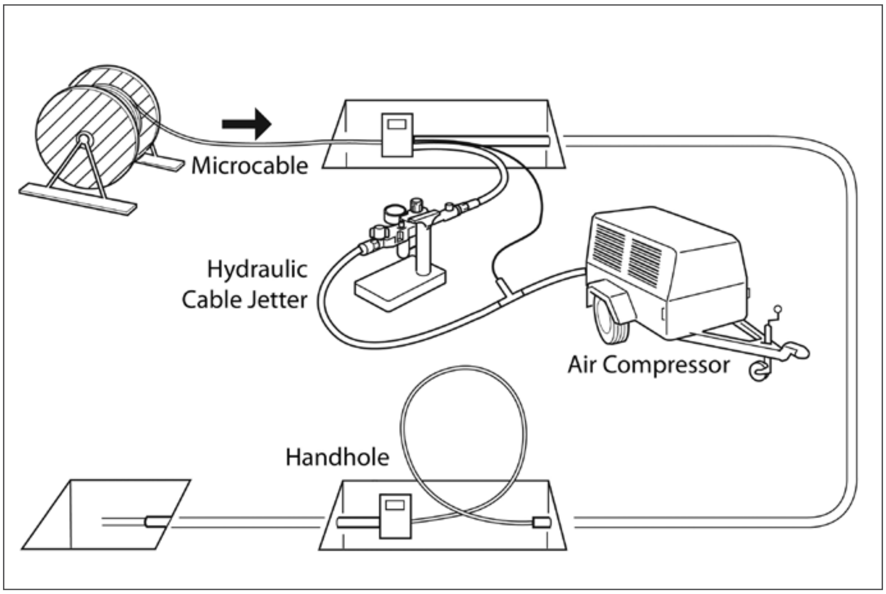

Figure 1: Schematic of blown microcable system components

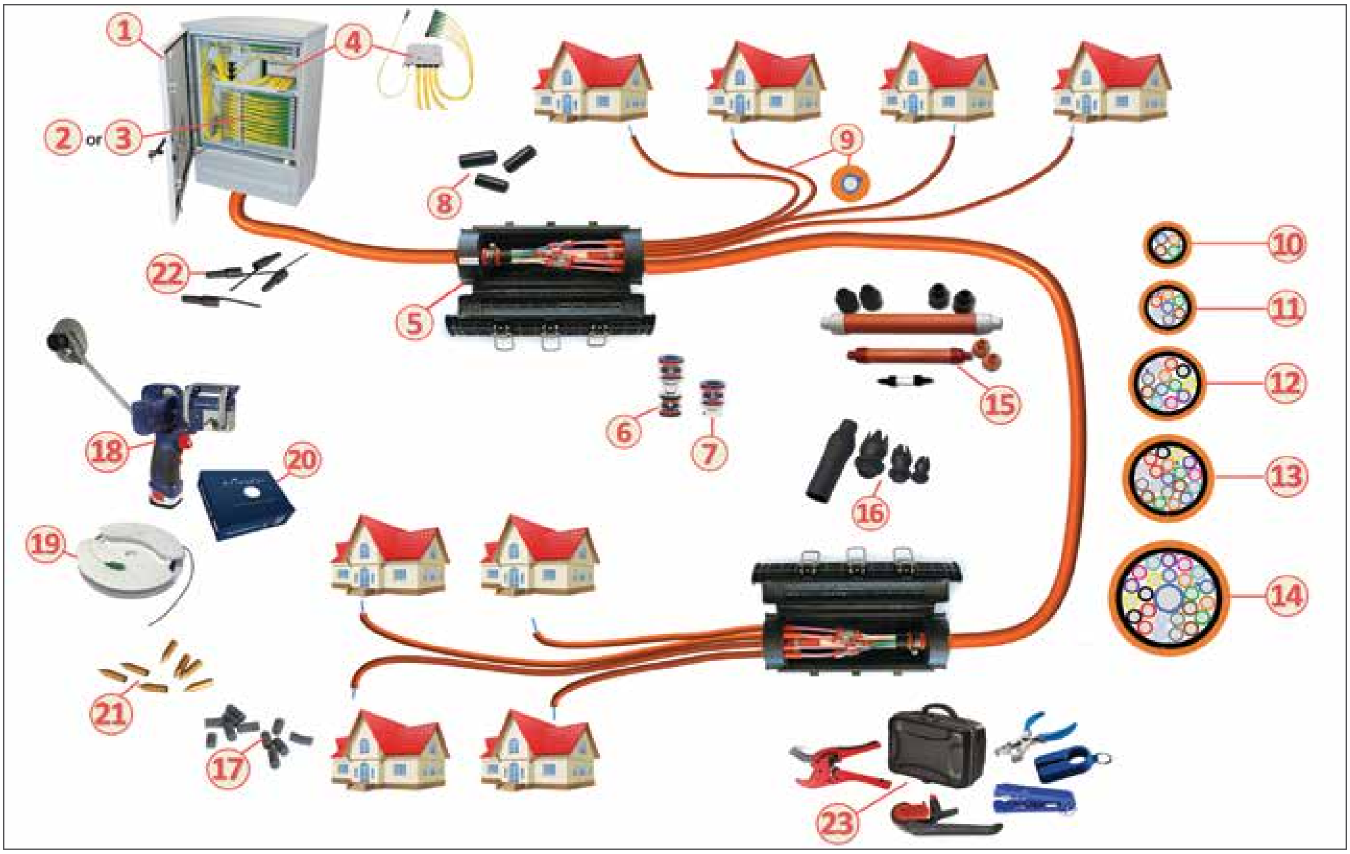

Figure 2: Typical blown fiber system schematic for FTTH

#	Description
1	288 FDH Street Cabinet, 48 or 96 FDH Pedestal
2	Fiber Adapter Tray (Empty)
3	Fiber Adapter Tray with 24XSC/APC Pigtails
4	Splitter, 1:2 to 1:32 splitter, SC/APC
5	Duct Branch Off Closure, 4- or 8-way
6	Connector, 5 or 10 mm
7	Endstop Connector, 5 or 10mm
8	End Caps for Microducts, 10mm (temporarily above ground)
9-14	Direct Buried Microduct, multiple sizes
15	Straight Duct Joint (8 dimensions)
16	End Sleeves, temporarily seal
17	Cleaning Sponges 3.5 and 8mm
18	ABF Blowing Tool
19	ABF 1SC/APC Reel TIA-598 30, 50, 70 … 1000 meter
20	ABF in PAN, 1000, 2000, 4000 and 6000 meter
21	Blowing Beads
22	Strain Reliefs/End Caps for Blown Fiber (use in cabinets, etc.)
23	Installation Tools (Duct Cutters, ABF Stripping Tool, etc.)

installing more ducts at the onset makes moving, adding and changing things easier. Blown fiber streamlines the installation process and optimizes the network's overall quality while lowering the total cost of ownership.

Today, blown FTTH is being adopted as the preferred architecture for access networks – delivering telecommunications service to end-users' premises.

BLOWN FIBER CASE STUDY:

Fiber optic broadband connection of single family units (SFUs) and multiple dwelling units (MDUs) is increasing exponentially. With blown fiber systems, this is achieved at a lower cost.

In the case study, a well-defined topology was used. The study is based on a system design for a pilot project a Tier-1 ISP conducted for 94 suburban lots in the western part of the United States. The design utilizes a Hexatronic end-to-end blown fiber unit system. This approach offers a fair comparison relative to many other studies with arbitrary and subjective estimations.

Figure 5 (p. 82) shows locations for 15 network access points (NAPs) – illustrated by red squares – that traditionally consist of handholes and pedestals, and require fiber splicing. In the blown fiber system, one fiber distribution hub (FDH) – illustrated by the green dot – replaces the NAPs and delivers 96-count fiber. In place of the NAPs, duct-branching equipment is positioned. Fiber units are blown directly point-to-point from the FDH to each SFU through the duct-branching enclosure, eliminating the need for splicing. This reduces total cost significantly.

In addition, optical loss is minimized and system performance enhanced by utilizing the blown fiber system.

DISPELLING BLOWN FIBER CABLE SYSTEMS MYTHS

Blown fiber technology offers great benefits for quick and easy incremental cable installation. Network capacity can quickly be increased by inserting new fibers in spare microducts when needed. The system minimizes a number of fiber splice joints in the network compared with traditional cable solutions. The blown fiber technique guarantees high performance and reliability. But because it is still recognized as an "unconventional" system, there are fallacies and myths to debunk.

Myth #1: Blown fiber systems are only for outside plant – Not true. Blown fiber microcables or units can easily be adapted for any environment – aerial, underground or indoor – and for any application, from large outside plant such as long-haul, WAN, MAN and LAN to small indoor installations. It is now in mass deployment in FTTH. In the case of FTTH, installing only one duct is enough, which is relevant to each area and each property. This means planning this deployment is simplified, with a single type of ducting almost everywhere. Easy branching to individual properties in any location is possible, even at a later date. The fiber microcables and units have extremely good cold and heat resistance and can operate from -45°C to +70°C. The duct systems are available for indoor or outdoor installations.

Myth #2: Blown fibers cannot be pre-terminated because the connectors cannot fit through the microducts – Not true. Sizing larger ducts for outside plant or large enterprise backbones with connectorized high-count fibers may be difficult to plan, but blown fiber units can be pre-terminated in increments of 30m to 1,000m with one to 12 fibers, making this technique ideal for SFU or MDU installations. See Figure 3.

Figure 3: Pre-terminated blown fiber

Myth #3: Installing the ducts and then blowing in the fiber takes more time than pulling traditional cable – Not true. Installations are much simpler and faster. Conventional cable-pulling is time-consuming and normally requires a crew of three or four installers. Blown fiber installations are carried out in a few minutes with normally one or two installers. Using a proper air-compression tool and an electric motor, one person feeds the fiber unit and the other receives it at the far end. Conventional fiber cable requires costly digging of trenches and in-building innerduct. The cost for trenching and installation of conduits has the highest uncertainty and depends on many parameters, such as type of soil (grass, asphalt, stone, etc.), labor cost for different areas and machinery and methods.

Table 1 shows an example of a traditional fiber cable design and a blown fiber cable system with microducts. Traditional fiber cabling requires installing ultra-high counts of fiber strands up front because of labor expenses. In this scenario, the field splicing is drastically increased in the traditional design because of the need to add intermediate fiber enclosures and splicing, which is avoided when using blown fiber technology. Splices impact the network's power loss budget, and fusion splicing is a significant portion of cost and time of deployment. These factors considerably impact the total cost of network ownership both in terms of materials and system engineering costs.

Myth #4: Once fibers are blown in, they can't be reused because they are fragile – Not true. Fibers that are blown in can quickly be removed and reused. A best practice is to install a few spare tubes at the initial installation. These are left empty for future expansion, providing immediate real-time pathways, thereby future proofing the network. This system also eliminates the need for investing in dark fiber, which can become outdated. Because optical fibers can be blown in and out of the network continually with no damage to the optical fiber, there is no end to the fiber and bandwidth life cycle.

Myth #5: Blown fiber systems are best for large enterprise installations only – Not true.

The buildout of FTTH broadband networks and preparing for 5G deployments is driving an increase in fiber deployments in the United States. The example shown in Figure 4 depicts a possible blown fiber cable network solution for a rural network. The starting point is a main duct with microducts, where both microcables and blown fiber units are installed (C, F, G). This branching (J) is to individual properties with a branch duct (microducting and blown fiber C, G). Every duct is sealed. Only a few different components are required for assembly of the duct system and fiber splicing (if needed from feeder to splitters) because the entire area occurs at one single point in a compact splice cabinet (H).

TRADITIONAL FIBER CABLE DESIGN		BLOWN CABLE WITH MICRODUCTS		% DELTA
Innerduct sheath footage	20,070	Microduct sheath footage	23,350	16%
Total fiber in kilofeet	2,200	Total fiber in kilofeet	1,644	(25%)
Central office splicing	432 fibers	Central office splicing	336 fibers	(22%)
Field splicing	1,224 fibers	Field splicing	336 fibers	(73%)

Table 1: Comparison of traditional fiber cable design vs. blown fiber cable system

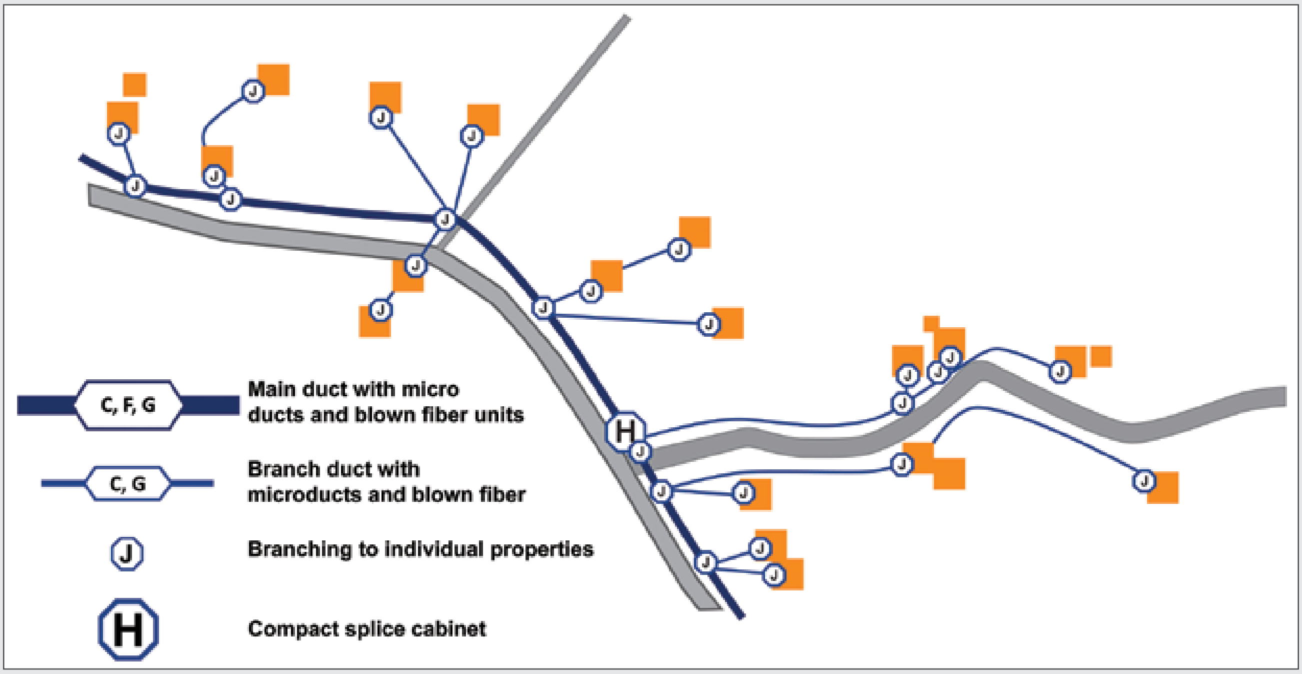

Figure 4: Blown fiber cable network solution for a rural network

Installer or technician skill level and number of people deployed during the installation also are reduced, contributing to the total lower cost of installation. Pathways are easily managed by using the color-coded microducts, thereby simplifying system engineering. Traditional pre-terminated systems design required detailed placement of NAPS, fiber counts and cable lengths as well as conduit placement and splicing management.

The key technologies used in the demonstrated blown fiber system include pre-terminated air blown fiber units, hand-held and easy-to-use installation tools for blowing fiber; high-performance, low-friction ducts

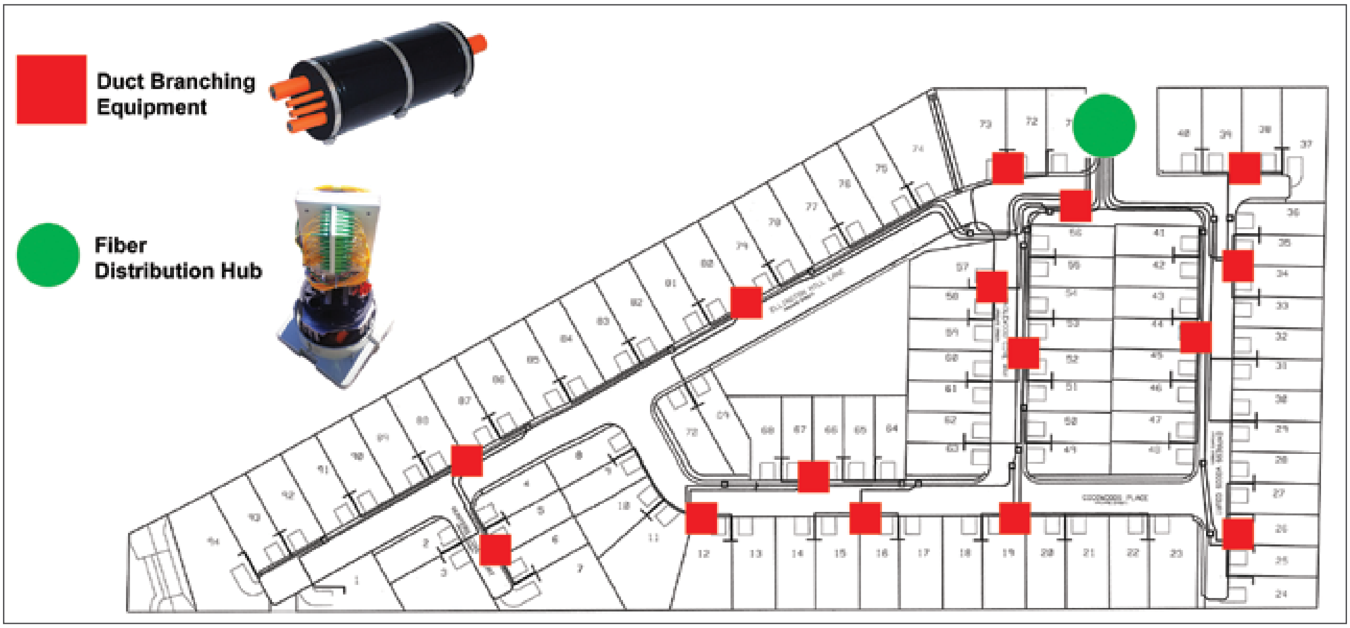

Figure 5: Fiber optic broadband connection of Single Family Units (SFU) in a residential area

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COST COMPONENTS	TRADITIONAL		BLOWN FIBER	
Engineering	$7,640	$81/lot	$6,032	$64/lot
Placement	$24,008	$255/lot	$17,085	$182/lot
Material	$19,552	$208/lot	$15,822	$168/lot
Cost per home passed	$625		$475	
Drops	$9,840	$120/lot	$9,262	$113/lot
Totals	$61,040		$48,201	
All-in cost per lot connected (100% take rate)	$649		$512	

Table 2: Comparison costs for traditional fiber cable design vs. blown fiber system

and duct assemblies; and a complete range of accessories.

The cost of materials and labor for the local convergence point are not included in Table 2 but considered identical for all compared technologies. The cost for the optical network terminal housing at each SFU is not included.

In this study, the cost for trenching is assumed to be without existing conduits for both types of technologies. This case study compares two different fiber optic cabling installation types – traditional (pre-terminated) and the air blown fiber system.

Traditional pre-terminated cable system: A pre-terminated cable system and fiber terminal distribution system use either traditional cables or pre-terminated drop cables. The branches are connectorized with environmentally hardened outdoor connectors. The distribution cable is connected toward several pre-connected NAPs. The 1-fiber drop cable is also pre-connected on both ends and is easily connected to the NAP. The disadvantages of this system are high materials cost and the cost of accurate and time-consuming planning and engineering.

Blown fiber system: The costs of a blown fiber system are demonstrated in this example using pre-terminated, air blown fiber. The main advantages of this system are minimum splice points with lower cost as well as pre-terminated drop fiber bundles that minimize installation cost. A comparison of actual deployments costs is shown in Table 2 above.

The results for this case study show that a blown fiber system is the lowest-cost solution by a considerable margin. At low take rates, the cost delta is as much as 24 percent, and at full take rate, the delta remains high at 21 percent. See Chart 1 below for cost comparison as the take rate increases.

There are also important differences between blown systems in terms of product performance. Although most blown fiber systems have similarities, they may vary in tools and installation methods. Blown cable installations require skilled workers trained and certified in using the blowers, cutting tubes, jetting fiber and, of course, testing. These skills and certifications are critical to system compliance and ultimately a system guarantee.

Cost reduction and other benefits of blown fiber systems over traditional fiber systems are attributed to OSP material reduction, faster installation time, fewer fiber connection points, simplified repair and maintenance, and a migration path for future evolving applications. Overall, blown fiber systems have proven to deliver the lowest total cost of ownership to system operators, both capex and opex. ❖

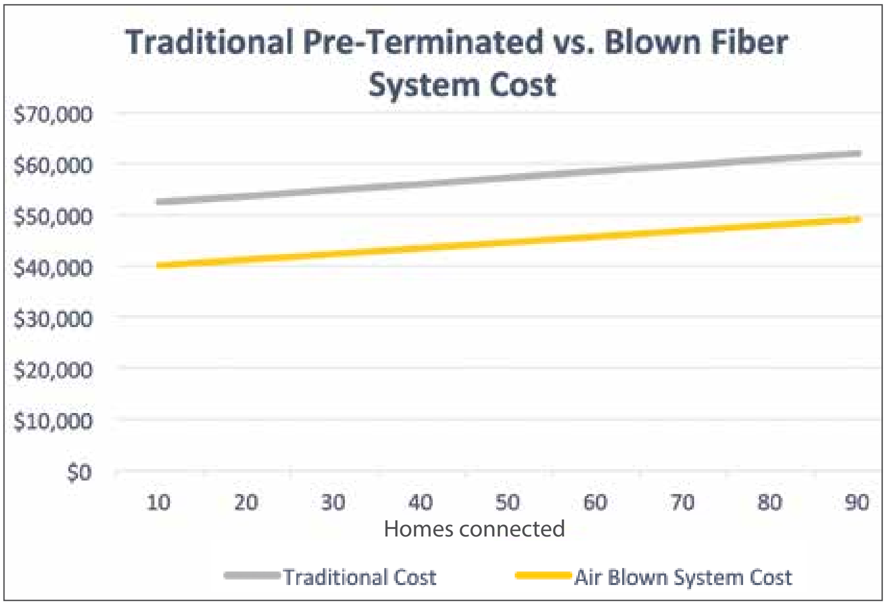

Chart 1. Traditional system cost versus cost of Hexatronic blown fiber system

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