

# **The Economic and Social Value of EPB's Fiber Optic Infrastructure in Hamilton County**

**A report prepared by  
Bento J. Lobo, Ph.D., CFA**

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## EXECUTIVE SUMMARY OF ESTIMATES

	Project	Per county resident
Total Costs	\$396.1 million	\$1,175
Total Benefits	\$1,592.3 million	\$4,722
Net Benefits	\$1,196.2 million + 3,716 jobs	\$3,548

IMPLAN Estimates		
Impact on	Total Impact	Per county resident (Total = 337,175)
County Employment	3,595	NA
County Income	\$571.9 million	\$1,696.0
County Taxes	\$17.9 million	\$53.0
Analytical Estimates		
Source of benefit	Annual Estimate (\$ million)	Per county resident (Total = 337,175)
Environmental & Health Care	56.8	\$168.3
Telecommuting	30.2	\$89.6
Productivity	12.9	\$38.3
Entertainment (e-shopping)	4.2	\$12.6
Smart Grid- TVA	2.4	\$7.1
Smart Grid- EPB	14.0	\$41.5
Smart Grid- Other	2.1	\$6.1
Customer savings	86.7	\$257.1
Total	\$209.3	\$620.6

# 1. Introduction

Over a period of five years beginning in 2008, EPB began investing what would eventually be \$396.1 million in fiber optic infrastructure to introduce fiber-to-the-home (FTTH) broadband service to residential and commercial customers and to install a smart grid for their service footprint.<sup>1</sup>

This study seeks to examine the economic impact and social value of this \$396 million investment in Hamilton County, Tenn. The study will be part of an ongoing effort to analyze the value of the investment to the community.

## Background

In 2005, EPB planned to build out a new fiber optic infrastructure in the community to provide FTTH telephone/internet/TV service to residential and commercial customers. The plan called for a ten-year build-out period (see Lobo *et al*, 2006). In September 2007, Chattanooga's City Council approved EPB's FTTH plan. The build out is currently almost 100 percent complete, about 6 years ahead of schedule. The first customers were connected in the fall of 2009 and as of June 30, 2011 EPB had 28,490 customers subscribed to one or more of their fiber optic services. In September 2010, EPB made available residential symmetrical Fi-Speed Internet connection speeds of up to one gigabit per second - the fastest Internet in the country.

By 2008, the focus of the fiber optic infrastructure project had evolved to encompass modernizing the electric system and offering fiber optic communication facilities to residential and commercial customers in the EPB footprint. The fiber optic infrastructure was viewed as an asset of the electric division of the utility rather than that of the

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<sup>1</sup> EPB was created in 1935 by the Tennessee legislature as a non-profit agency of the City of Chattanooga. Its footprint covers Hamilton County (Tenn.) mostly as well as parts of surrounding counties (Bledsoe, Bradley, Marion, Rhea and Sequatchie) and areas of North Georgia (portions of Catoosa, Dade and Walker). Today, EPB is one of the largest publicly-owned providers of electric power in the country. It serves more than 169,000 residents in a 600 square-mile area.

broadband division. Currently, the broadband division leases the fiber optic infrastructure from the electric division.

In 2008, EPB made a bond offering of \$220 million to fund the construction of a Smart Grid, one of the first and largest in the United States. In November 2009, in the wake of the deep recession of 2007-2008, EPB received a federal stimulus matching grant in the amount of \$111.6 million from the Department of Energy to expedite the build-out and implementation of the Smart Grid.<sup>2</sup>

### **Accolades**

In January 2011, Chattanooga was named one of seven finalists globally vying for the title of “2011 Intelligent Community of the Year” by the Intelligent Community Forum (ICF). ICF seeks to share the best practices of the world’s Intelligent Communities in adapting to the demands of the Broadband Economy, in order to help communities everywhere find sustainable renewal growth. Past winners of the “Top Intelligent Community” honor have included Seoul (South Korea), Stockholm (Sweden), Taipei (Taiwan) and New York City (U.S.).

According to ICF,

*“The Top Seven represent models of economic and social transformation in the 21st Century. They are not the most advanced technology centers, the most wired cities or the fastest growing economies in the world. Instead, each exemplifies best practices in broadband deployment and use, workforce development, innovation, digital inclusion and advocacy that offer lessons to regions, cities, towns and villages around the world. They are charting new paths to lasting prosperity for their citizens, businesses and institutions.”<sup>3</sup>*

Chattanooga was specifically cited for the work it has done with fiber optic network availability. According to Jennifer McCain, Senior Account Director, Alcatel-Lucent<sup>4</sup>:

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<sup>2</sup> <http://www.epb.net/about/our-company-and-history/> This grant was matched \$111.5 million in cash by EPB and the City of Chattanooga, and \$3.57 million by EPB’s private partners, Alcatel-Lucent, Tantalus, and Medium.

<sup>3</sup> <https://www.intelligentcommunity.org/index.php?submenu=Awards&src=gendocs&ref=Top7&category=Events&link=Top7>

<sup>4</sup> <http://www2.alcatel-lucent.com/blogs/corporate/2011/04/epb-chattanooga-alcatel-lucent-intelligent-community/>

*“The launch of the 1-Gigabit network not only helped put Chattanooga on the map and puts them 10 years ahead of and 10 times faster than the FCC’s National Broadband Plan, which calls for 100 Mbps speeds for 100 million households nationwide by 2020 [...] With that come benefits to education, health care, public safety, software development, entertainment, and more – all of which are critical to economic development and helping attract enterprises ranging from large global corporations to small individual startups.*

*And then there are the Smart Grid benefits. All 170,000 homes and businesses within EPB’s nine-county service area are now connected to a 100% fiber optic Smart Grid. This means a 40 percent reduction in customer outage minutes, increased electric power reliability and efficiency, and customer tools to manage energy needs, like an energy portal on your home computer or television.”*

In 2008, RelocateAmerica.com named Chattanooga the third best city to live in. “There was a big emphasis on the quality of life in Tennessee in general, living in Chattanooga and what it affords in terms of recreation, home prices, employment opportunities, the people, music and the arts (and as a) family friendly, mountain area,” said Mr. Nickerson, president and CEO of HomeRoute, a real estate firm in Howell, Mich., that operates RelocateAmerica. The Scenic City is attracting people at a rate about 30 percent faster than the national average, especially baby boomers and members of the millennial generation. A third group of people are those who have been characterized as the young, creative class - the driving force behind new, innovative businesses.<sup>5</sup>

In fact, **Daniel Ryan**, a software programmer in his early 30s who works with high profile companies like Microsoft and Google on the West Coast, has chosen to live in Chattanooga primarily because he can use EPB’s fiber optics to work remotely. When asked why he would choose to stay in Chattanooga over moving to traditionally high tech areas of the country, Ryan responded,

*“I believe that Chattanooga now has the potential to be the next Silicon Valley. I am young, and I want to be here for that transition – our generation especially has so much to gain from this technology.”<sup>6</sup>*

**Stephen Culp**, entrepreneur and founder of [SmartFurniture.com](http://SmartFurniture.com), [Delegator.com](http://Delegator.com), and [Chattanooga3D](http://Chattanooga3D.com), left Palo Alto, CA, to come to Chattanooga to launch his “design-on-

<sup>5</sup> <http://www.timesfreepress.com/news/2008/may/17/chattanooga-ranked-third-best-place-live/>

<sup>6</sup> *Smart Chattanooga: Stories of a Fiber optic Community – Volume 1*

demand” Smart Furniture business. To do this, the company needed cutting edge and fast technology. Smart Furniture now enables consumers and small businesses across the globe to customize everything from bookshelves to ergonomic office chairs, with simple web-based “Smart Designer” tools. After working on the plan, patents and website in Silicon Valley, Culp chose Chattanooga to launch the new business. EPB’s fiber network was a significant factor.

*“Once an unlikely destination for tech minded start ups or larger bandwidth-heavy companies, with that critical bandwidth element covered, Chattanooga can become top of mind for the most innovative companies in the country,” said Culp. “The Gig provides an exponential leap beyond the competition, but more importantly, it gives Chattanooga the ability to attract the next generation of entrepreneurs, innovative companies, and high-tech job growth.”*<sup>7</sup>

Indeed, in 2010 *Business Facilities Magazine* ranked Chattanooga #1 among all American metros for “Economic Growth Potential”.<sup>8</sup> Chattanooga has begun to attract bandwidth-hungry businesses. Recently **HomeServe** hired 140 employees to launch a call center in the city. The company cites Chattanooga’s speedy Internet as “one of the reasons” the company decided to open its data-intensive facility here. According to Felipe Espinosa, director of IT infrastructure, another reason the company chose Chattanooga was the city’s smart grid, which is necessary to provide reliable power for a data center.

*“Chattanooga is also going to be our secondary data center where a copy of all of our systems will be stored, so it will be a hot data center for business continuity and disaster recovery,” Espinosa said.*<sup>9</sup>

### **Previous Estimates**

A 2006 study (Lobo *et al* (2006)) examined for the first time the IMPLAN-generated output/employment/tax impacts of EPB building out a FTTH network with the intention of offering telephone/internet/TV service to the community. The underlying premise of the study was that the entire investment would be made in the telecommunications sector to support a FTTH broadband network with only limited implications for the electric division of the utility. This was a pioneering study in that it was a first attempt at

<sup>7</sup> *Ibid.*

<sup>8</sup> [http://www.businessfacilities.com/Rankings/BFJulAug10\\_METRO\\_RANKINGS.PDF](http://www.businessfacilities.com/Rankings/BFJulAug10_METRO_RANKINGS.PDF)

<sup>9</sup> <http://www.timesfreepress.com/news/2010/oct/04/nations-fastest-internet-sparks-interest/?business>

assessing the direct/indirect/induced effects of such an investment on the regional economy. Moreover, the study provided analytical estimates of the social effects of the project on Hamilton County, Tennessee. A portion of this study was published in the *Journal of Applied Business Research* (Lobo, Ghosh and Novobilski, 2008) and was subsequently cited in a study conducted by the World Bank.<sup>10</sup>

The study was based on capital expenditures of \$195.5 million spread over a ten-year period. Conservative assumptions were used in estimating the indirect social effects in the areas of telemedicine, telecommuting, e-business, e-entertainment and e-government. A major challenge faced in estimating these impacts related to envisioning consumer demand for upstream applications that had not yet been developed. The study pointed out that a successful FTTH deployment would depend critically on educating the public about the nature, scope and utility of upstream applications, and the resultant productivity and cost savings. The incremental economic and social benefits of the project were estimated to be approximately \$438 million, in addition to about 2,600 new jobs. The study concluded that like good roads, schools, and hospitals, cutting-edge broadband infrastructure was crucial to economic development and to the quality of life of the community.

A subsequent study (Lobo *et al*, 2009) examined the economic impact of an investment of \$163.3 million in a Smart Grid project for the EPB footprint. The underlying assumption was that the investment would be an electric division investment in smart grid infrastructure and that some baseline demand-side management (DSM) assumption would be in effect. The study was conducted independently of the 2006 study. Lobo *et al* found that the project could generate over \$266 million in incremental value while creating in excess of 2,100 new jobs in Hamilton County. Much of this value stemmed from customer bill savings from demand-side management, benefits to the Tennessee Valley Authority (TVA) from not having to build costly additional capacity, environmental and health benefits and the provision of more efficient electric utility services. The estimates suggested net benefits in excess of \$1,600 per county resident.

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<sup>10</sup> [http://siteresources.worldbank.org/AFRICAEXT/Resources/258643-1271798012256/YAC\\_chpt\\_19.pdf](http://siteresources.worldbank.org/AFRICAEXT/Resources/258643-1271798012256/YAC_chpt_19.pdf)

**Scope of Study**

In this study we generate fresh estimates of the economic impact of an integrated investment of \$396.1 million to support FTTH and the Smart Grid. The study relies on updated information on expenditures and outlays as provided by EPB. We also reexamine the social/indirect benefits cited in the 2006 and 2009 studies referred to above especially as they pertain to environmental and health benefits, telecommuting, and entertainment, as well as efficiencies associated with electric power distribution due to the smart grid infrastructure. In so doing, we re-estimate the overall value to the community due to EPB's fiber optic build out. This study is intended as an ongoing venture where periodically the estimates will be updated as more data and information about customer experiences become available.

**Methodology**

This study employs two approaches to get to the total value of the investments in FTTH and the Smart Grid. The first uses the IMPLAN methodology (used in *Lobo et al* 2006 and 2009) to derive the direct/indirect/induced effects on employment, output and business taxes in Hamilton County, which makes up over 90 percent of the EPB service area. The second uses analytical methods to delve into the social and indirect effects of the fiber optic broadband and smart grid infrastructure. Here we also use anecdotal evidence from interviews with EPB customers as documented in *Smart Chattanooga: Stories of a Fiber Optic Community – Volume 1*.<sup>11</sup>

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<sup>11</sup> EPB Case Studies: 30 June 2011. Print.

## 2. IMPLAN Estimates

What is the economic impact in Hamilton County of the \$396 million capital expenditure on Smart Grid and FTTH?

To answer this question, we assume that the capital expenditures will be completed over a 5-year period from 2008 through 2012. Included in the \$396 million is a DOE grant for \$111 million. These monies are paid as periodic reimbursements to EPB.

Using the IMPLAN software, we generate estimates based on the expenditure schedule detailed in Table 1:

<b>Table 1. Five year Expenditure Schedule (\$'000)</b>						
	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011E</b>	<b>2012E</b>	<b>TOTAL</b>
Broadband	268	20,443	14,072	19,912	21,030	75,725
Smart Grid	7,094	39,240	83,496	106,032	84,521	320,383
<b>TOTAL</b>	<b>7,362</b>	<b>59,683</b>	<b>97,568</b>	<b>125,944</b>	<b>105,551</b>	<b>396,108</b>
<b>Percentage breakdown by division</b>						
Broadband	4%	34%	14%	6%	20%	19%
Smart Grid	96%	66%	86%	94%	80%	81%

It bears noting that the IMPLAN model is sensitive to the sectors into which investments are made. Based on the expenditures detailed by EPB, we allocated the total investment into the following IMPLAN sectors as listed in Table 2:

<b>Table 2. IMPLAN Sector Allocation</b>		
<b>IMPLAN Sector</b>	<b>Investment (\$ million)</b>	<b>Investment (%)</b>
237 Telephone apparatus manufacturing	65.0	16.0
319 Wholesale trade businesses	21.8	5.5
351 Telecommunications	137.1	35.0
388 Services to buildings and dwellings	118.6	30.0
<b>TOTAL</b>	<b>396.1</b>	<b>100.0</b>

### Direct/Indirect/Induced Effects

The IMPLAN estimates contained in Table 3 suggest that the capital expenditures would generate over \$570 million in income and almost \$18 million in state and local business taxes for the county. This benefit amounts to \$1,749 per county resident.

	<b>Total Impact</b>	<b>Multiplier</b>	<b>Per county resident (N=337,175)</b>
County Employment	3,595	1.59	NA
County Income/Output	\$571.9 million	1.51	\$1,696.0
County Taxes	\$17.9 million	1.96	\$53.0

Moreover, 3,595 new jobs can be conservatively associated with this project. The employment multiplier of 1.59 suggests that for every ten jobs directly associated with this project another 6 jobs will likely be created in the county through indirect and induced effects.

Note that the estimate for jobs created is different from those presented in the Lobo *et al* (2006) and (2009) studies for the following reasons: 1) the IMPLAN sectors used are different from those used in the previous studies, and 2) the underlying structure of and interlinkages between sectors in the regional economy changes (albeit, slightly) with time as reflected in the IMPLAN input-output model.

The five most impacted industries are listed in table 4.

<b>Output/Income</b>	<b>Employment</b>
1. Telecommunications	1. Services to buildings and dwellings
2. Services to buildings and dwellings	2. Telecommunications
3. Telephone apparatus manufacturing	3. Electricity & signal testing instruments manufacturing
4. Electricity & signal testing instruments manufacturing	4. Food services and drinking places
5. Wholesale trade businesses	5. Employment services

### Hamilton County Update

The Chattanooga Area Chamber of Commerce estimates that since 2007, 38 new businesses have moved to the Chattanooga area bringing in a total investment of \$1.2 billion and almost 3,800 new jobs. Moreover, 53 companies have expanded operations to the tune of about \$676 million, creating or saving over 3,300 jobs.

Among the firms investing in Chattanooga is Volkswagen AG (\$1 billion and 2,000 jobs), Alstom Power Inc (\$300 million and 360 jobs), and Amazon (\$91 million and 1,249 jobs). In particular, VW has attracted 15 supplier firms to the city, which have created cumulatively 1,070 new jobs.

How much of this economic activity is due the availability of broadband and the smart grid?

This question is not easy to answer absent direct evidence from the relocating firms. However, evidence from corporate site selection surveys suggests that high-speed internet access and cost-efficient energy availability rank in the top 5 site-selection factors considered.<sup>12,13</sup> This would suggest that the fiber optic investment made by EPB has had a significant impact in attracting companies to the area, consistent with the predictions in Lobo *et al* (2006 and 2009).

The Chamber's 2010 Business Retention and Expansion Visitation (BREV) survey shows that over 49% of existing businesses anticipate increasing internet access speeds. Below, we provide anecdotal evidence pointing to the value of the speedy internet access provided by the fiber optic infrastructure in Hamilton County.

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<sup>12</sup> Availability of high-speed Internet access was not even on the chart in 2003. Today, high-speed Internet access is already considered primary infrastructure by companies that handle a significant amount of electronic data. Such companies could not even consider a community without this feature. Some federal government officials have even equated it to the need for electricity in the 1930s.

<sup>13</sup> <http://msbusiness.com/2006/07/survey-examines-top-site-selection-factors/> and [http://www.utahpulse.com/featured\\_article/survey-site-selection-consultants-say-labor-costs-and-incentives-most-important](http://www.utahpulse.com/featured_article/survey-site-selection-consultants-say-labor-costs-and-incentives-most-important)

### Customer Case Studies

ARS specializes in e-commerce and serves large scale national clients like Sears, Whirlpool, Wal-Mart, and Procter & Gamble from their home base in Chattanooga, TN. ARS traffics one terabyte of data per month.

*"Fiber is absolutely required for what we do," says ARS's Information Technology Officer Jason Brown. "Our business is 95% dependent on the Internet."*

It is not unusual for ARS's 120 employees to transmit 50 GB and receive 110 GB of data in just two days. Using the FCC's current standard for broadband,<sup>14</sup> transmitting 50 GB would take about five days and receiving 110GB would take about three days. Using the upper limit of LTE speeds suggested by Verizon Wireless,<sup>15</sup> 12mbps, downloading the data would take 22 hours. With EPB's 30/30mbps fiber product, the company's slowest service tier, this exchange would take four hours for outbound data and about nine hours for inbound data, a total difference of nearly one week's worth of time from the FCC's current broadband definition. Moreover, in the past three years, ARS has been able to grow its employee base by 30%.<sup>16</sup>

Founded in 2003, **Tricycle**, has been a leader in the sustainability movement taking place in the carpet manufacturing and design industry. They have used the large bandwidth offered by EPB's fiber optic service to fulfill their mission: reduce sample waste.

Traditionally, a significant amount of waste has been a part of the interior design process. Interior designers and architects request numerous carpet and floor samples, items that are made with petroleum, manufactured with traditional sources of energy, and discarded in a landfill. Each carpet sample is equivalent to using one quart of oil.<sup>17</sup> Using broadband enabled technology, Tricycle works to solve this waste issue through creating high resolution 2D and 3D digital simulation images of carpet and hard surfaces that can replace samples. This business is highly dependent on quality bandwidth in both the creation and distribution of its products.

*"Bandwidth is critical to our business," says Tricycle Product Specialist Sujeel Taj. "All of our products and our customers depend on it."*

Tricycle estimates that broadband enabled technology has given them the tools to conserve 69,000 gallons of oil, keep 418,000 pounds out of landfills, and inject \$58M of positive economic effect into the community.<sup>18</sup>

<sup>14</sup> Download speeds of at least 4 Mbps and actual upload speeds of at least 1 Mbps – FCC Sixth Broadband Deployment Report as reported in *Smart Chattanooga. Stories of a Fiber optic Community – Volume I*

<sup>15</sup> *Ibid.*

<sup>16</sup> *Ibid.*

<sup>17</sup> *Ibid.*

<sup>18</sup> *Ibid.*

The first **48 Hour Launch (48HL)** was held in Chattanooga, TN in 2009. The event brought together entrepreneurs who form teams that launch a business in one weekend. EPB provided the 48HL space with a symmetrical 100 Mbps connection. Sheldon Grizzle, a local start-up expert and the event's organizer, said, "We had 100 people throughout the weekend plugged into that connection, hitting remote databases, watching live video feeds, researching online, building programs in 3D – significant usage that only EPB could have supported."

One team started the creation of a virtual model of Chattanooga's downtown core in 3D using Sketch Up and Google Earth, both Google applications. Downtown Chattanooga's Economic Development company, River City Company, absorbed Chattanooga 3D and now uses that platform for their retail recruitment efforts, as well as for enticing economic development. "We were especially excited about this project," says Grizzle. "The implications for business are huge: real time advertising, virtual tourism, e-learning - it's wide open if there is enough bandwidth to build and run the platforms."

48HL also produced LoKewl, a unique mobile application that connects users with special offers and allows for users to share their experiences. LoKewl is more than a new product; it's a mission to champion local businesses and commerce. The event also gave one jewelry maker the online tools she needed to transform her hobby into a viable career. Perhaps most significantly, 48HL served as the catalyst for the creation of the Company Lab, a nonprofit venture dedicated to nurturing local start-ups with expertise and connection to much needed resources.

48HL allowed Richard Hardin to potentially revolutionize the aviation industry. Called the **Cumberland Signal Flight Hub**, CSL's patent-pending offering eliminates traditionally disorganized wiring and bridges the plane's instrumentation through a signal routing matrix. The Flight Hub and its pigtailed are the physical interconnect between the plane's intercom system, radio communications, navigational systems, altimeters and radar; cutting the labor bill by up to 70% and increasing the level of safety associated with the plane's electrical components.

With 48HL volunteers on hand to build the foundation, Hardin's team utilized EPB's bandwidth to build a website, 3D graphics, and informational video. The team used Google Sketch Up for the 3D graphics that illustrated the concept, simplifying a complex product for potential investors.

*"This kind of innovation just would not have been possible without the Gig," said 48HL event organizer Sheldon Grizzle. "Without adequate bandwidth, a device that has the potential to cut costs and increase safety in aviation would have never been able to get off the ground in this time frame. The broadband is really the power behind these promising start-ups."*

### 3. Analytical Estimates

#### 1. Health Care and Environmental Benefits

##### Broadband and Telemedicine

In the field of telemedicine, (which is the provision of health care services, clinical information or medical education using telecommunications technology) bandwidth requirements vary with the service provided. Clinical applications requiring large bandwidth include tele-diagnosis, tele-monitoring, tele-consultation, tele-radiology, the use of remote medical instruments, and behavioral healthcare mediated through telecommunications.<sup>19,20</sup> Analysts appear to agree that telemedicine will facilitate remote doctor visits involving the transfer of data and/or video conferencing, and constant or periodic monitoring of senior, infirm or chronically ill patients. Moreover, President George W. Bush's Technology Agenda envisioned all health care records would be computerized within 10 years and this goal would be facilitated by widespread broadband infrastructure.

In addition to clinical applications, information and communications technology can reduce the administrative costs of health care providers and facilitate continuing education programs. We update the effort in Lobo et al (2006) to quantify a portion of the healthcare cost savings associated with chronic care patients needing tele-monitoring, tele-consulting and other services permissible with FTTH broadband services.

The National Center for Health Statistics points out that total health care expenditures per capita were \$6,411 in 2008. Accordingly, 2010 expenditures would amount to \$7,203 per capita, if the growth continued at the 6% rate that prevailed from 2000 to 2008. Moreover, if as pointed out by Crandall and Jackson (2001), chronic care patients

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<sup>19</sup> At 200 Kbps, transmission of a dozen X-rays would take more than one hour; over an all-optical network, the transmission would take just a few seconds.

<sup>20</sup> Table 2 in Bauer et al (2002) illustrates the different telecommunications needs of selected applications.

account for 25 percent of all health care expenditures, then the expenditures attributable to chronic care could be estimated as follows:

$$\% \text{ of total population with healthcare expenditures}^{21} \times \text{Average health expenditure per capita} \times \% \text{ chronic care patients}$$

$$\text{Hamilton County estimate: } (85\% \times 337,175) \times \$7,203 \times 25\% = \$516 \text{ million}$$

According to Cyber-Care, the manufacturer of Electronic HouseCall, an Internet-based system that allows caregivers to monitor patients in their homes, independent industry studies have shown that remote monitoring of patient's conditions can reduce costs by 35 to 40 percent, while also improving care. Going forward, we will conservatively assume (as in the 2006 study) that only 10% of these broadband-enabled health savings/benefits, or **\$51.6 million**, will accrue to the county.

#### **CASE STUDY: Dr. James Busch, Radiologist**

The effectiveness of emerging telehealth technology is directly tied to broadband speed. Dr. James Busch, radiologist and CEO of Specialty Networks LLC (SN), is utilizing EPB's 1 Gigabit product for both his office and his home to provide a leading-edge telehealth business in the Chattanooga area which seeks to increase the quality of care, decrease Emergency Room wait time, and reduce hospital stays.

Radiology is a data intensive field; each examination averages 250 megabits in size. Using a connection meeting the FCC's basic standard<sup>22</sup>, this data transfer would take over a minute to download and over four minutes to upload. EPB's network transfers the data both upstream and downstream in three seconds. Dr. Busch and his team process about 200,000 exams and millions of images annually, creating the need for the rapid transfer of 50 million Mbits per year in the area. EPB's infrastructure saves SN's radiologists up to 60 hours a year.

Conventional turn-around time for these exams is one to four hours in an Emergency Room and between 10 – 24 hours in a hospital setting. Every day, the whole system allows for a less than 15 minute turn around per STAT exam with the average exam completed in less than an hour. In emergency situations in which every second counts, the quicker turnaround results not merely in cost cutting efficiencies but also in life saving opportunities. Traditionally, patients requiring these tests may have had to stay overnight, waiting for results. This technology makes it possible to reduce the length of hospital stays or even avoid staying in the hospital entirely, reducing payment burdens on patients and taxpayers.

<sup>21</sup> The U.S. Department of Health reports that roughly 85% of the total civilian, non-institutionalized U.S. population had health care expenses.

<sup>22</sup> Download speeds of at least 4 Mbps and actual upload speeds of at least 1 Mbps – FCC Sixth Broadband Deployment Report

### **Smart Grid: Environmental and Health Benefits**

The Smart Grid facilitates the use of automated switching and demand-side management (DSM) programs. These technologies and programs play an important role in mitigating electrical system emergencies, avoiding blackouts and increasing system reliability, and promoting environmental protection and customer value. Thus it provides significant economic, system reliability and environmental benefits. Society benefits when DSM is green. Reduced energy usage can directly translate into less air pollution, less carbon emissions, and a way to lower the potential environmental threats associated with climate change, even though off-peak energy needs are typically met from coal facilities.

#### **A. Reduced emissions of greenhouse gases**

Electricity accounts for 78 percent of commercial CO<sub>2</sub> emissions according to the EIA.<sup>23</sup> Theoretically, a smart grid would create enough efficiencies to reduce carbon emissions by 25 percent.<sup>24</sup> Research has found that DSM programs can have positive and significant impacts on environmental quality.

Johnson (2007) illustrates an example in which a DSM program reduces consumption by 1,000,000 kWh, which is equivalent to 632 metric tons of carbon.<sup>25</sup> She points out that these savings are also equivalent to 71,982 gallons of gasoline saved.

#### **Hamilton County Calculation:**

**DSM Assumption:** 90 event hours during the year at an average of 150 MW = 13,500,000 kWh shifted from peak to off-peak usage.<sup>26</sup>

Thus, 13,500,000 kWh is equivalent to 971,757 gallons of gasoline saved. At an average price of \$3.849/gallon, the benefits of such reduced emissions could amount to **\$3,740,292.69.**

<sup>23</sup> [www.eia.doe.gov/ncic/press/press298.html](http://www.eia.doe.gov/ncic/press/press298.html)

<sup>24</sup> <http://www.riverwired.com/blog/what-smart-grid>

<sup>25</sup> [http://www.marketdevelop.com/docs/white\\_paper\\_program\\_implementation.pdf](http://www.marketdevelop.com/docs/white_paper_program_implementation.pdf)

<sup>26</sup> See "DSM Product Recommendations," EPB December 2007.

## B. Health benefits

The American Lung Association (ALA) reports that the average American breathes 3,400 gallons of air each day, making ambient air pollution a major environmental problem. Children are at greater risk because they are more active outdoors and their lungs are still developing. Numerous research studies show that air pollution can cause cardiovascular and respiratory illness, cancer, birth defects, and even death. It can also damage the environment, dirty buildings and/or eat away stone and cause haze, reducing visibility.<sup>27</sup>

In their 2007 *State of the Air* report, the ALA report gave Hamilton County a failing grade on annual particulate pollution and low grades for high ozone days. In the same report, the ALA provided a county-level breakdown of common respiratory ailments as shown in table 5.

Disease	Estimated # of patients	% of state total
Pediatric Asthma	6,120	4.9
Adult Asthma	18,713	5.3
Chronic Bronchitis	10,106	5.4
Emphysema	4,573	5.6

Using estimates of healthcare costs from various sources, and *assuming a one percent reduction in the number of asthma and chronic bronchitis patients* in the county due to reduced emissions, we can conservatively estimate a benefit in excess of **\$1.4 million** from the assumed DSM model.<sup>28</sup>

<sup>27</sup> <http://www.aaaai.org/patients/advocate/2004/fall/costs.stm>. The 2006 National Health Interview Survey estimated that 9.5 million Americans had a diagnosis of chronic bronchitis and 4.1 million Americans had emphysema. Moreover, approximately 8.5 percent of adults residing in the United States reported having asthma. The direct monetary costs of asthma are enormous. For example, direct costs of asthma total more than \$9.4 billion every year, with inpatient hospital services representing the largest portion of this total at more than \$4 billion.

<sup>28</sup> Future studies will also consider the impact of reduced EPB truck rolls when such data becomes available.

<b>Disease</b>	<b>ALA estimated # of patients</b>	<b>One percent reduction in # of patients</b>	<b>Average annual cost per patient (\$)</b>	<b>Benefit</b>
Pediatric Asthma	6,120	61	\$4,912 <sup>29</sup>	\$1,218,176
Adult Asthma	18,713	187		
Chronic Bronchitis & COPD	10,106	101	\$1,876 <sup>30,31</sup>	\$189,476
<b>TOTAL</b>	<b>34,939</b>	<b>349</b>		<b>\$1,407,652</b>

The total environmental and health benefits due to the smart grid estimated above amount to **\$5,147,944.69**.

Together, the health and the environment benefits of broadband and the smart grid are estimated to sum to **\$56,760,078 million**.

<sup>29</sup> <http://www.revolutionhealth.com/conditions/asthma/treatments/payment/covering-high-cost>

<sup>30</sup> <http://www.chestjournal.org/cgi/content/abstract/123/3/784>

<sup>31</sup> <http://linkinghub.elsevier.com/retrieve/pii/S0954611100909338>

## 2. Telecommuting Benefits

Telecommuting (telework) refers to working from home or satellite offices as opposed to commuting to a physical place of work. Research shows that telecommuting can contribute to time and cost savings as when employees share a reduced office space, use the same facilities on a rotating basis, share large files, access the corporate network from home, and reduced office space rental and parking expenses. Measurable benefits also stem from savings in transportation costs and the reduction in congestion and pollution costs.

RVA (2010) report survey evidence that shows that FTTH users said they work from home an average of two additional days per month because of their FTTH connection.

Telecommuting has also been shown to facilitate group collaborative projects. Additionally, firms could induce well-qualified people to a region, and assist persons with disabilities who are unemployed or underemployed. These and other factors contribute to reduced absenteeism, and improvements in employee retention rates, thereby reducing recruitment and training costs.

### **CASE STUDY: Daniel Ryan, Software programmer**

Daniel Ryan, a software programmer in his early 30s, works with high profile companies like Microsoft and Google on the West Coast, but the programmer enjoys living in Chattanooga and has wrestled with the choice of moving to California to further his career or staying in area he has grown to love.

*“With Fiber optics, it is now realistically feasible for me to work remotely,” says Ryan of his choice to stay in the area.*

Video conferencing with colleagues around the globe is now a feasible alternative to traveling or moving to conduct face to face meetings. “When I subscribed to a cable network, video conferencing wasn’t plausible. Our connection was almost always either dropped or throttled. Using Skype, calls were paused or re-started regularly, making working remotely a challenge,” says Ryan of his previous provider. Ryan spends six to seven hours a week video conferencing with peers across the country in real-time, allowing efficient collaboration. Without Fiber optics, Ryan conducted only one to two meetings per month remotely. Today, he averages 5-times as many remote meetings.

When Ryan does choose to travel, he can work from anywhere in the world utilizing the IP address that EPB Fiber gives its customers. Attaining an IP address from competitors was cost prohibitive for Ryan, but now he can download his files to any computer quickly and reliably.

According to Crandall and Jackson (2001), the quantifiable benefits of telecommuting are the savings in transportation costs – both the time and expense of the worker, and the reduction in congestion and pollution costs imposed on others. Harder to quantify benefits include improvements in worker productivity and the expansion of employment opportunities for people with disabilities.

The U.S. Census 2010 shows that the average commute time to work in Hamilton County is 21.2 minutes (or 0.3533 hours).<sup>32</sup> This would imply a commute distance of 14.13 miles provided folks drive no faster than 40 miles per hour to work. According to census data, 147,673 people or about 85 percent of the workforce commutes to work in Hamilton County. We assume that 30 percent of jobs in Hamilton County will permit telecommuting an average of 20 percent of the time (i.e. 1 day per week or 50 days per year). Moreover, if the average person values his/her leisure at one-half the hourly wage, then we can calculate the potential savings in travel time, cost and congestion to be **\$30,204,966**, as follows:

Savings in travel time

Labor force that currently commutes x 30% possible telecommuters x (0.3533 hours/day x 50 days) x Half median hourly wage rate = (147,673 x 30%) x (17.67 hours/year) x ((\$14.32/2)/hour) = \$5.6 million

Savings in travel costs

Labor force that currently commutes x 30% possible telecommuters x Average commute miles per year<sup>33</sup> x average cost per mile<sup>34</sup> = (147,673 x 30%) x 706.5 x \$0.46 = \$14.4 million

Reduction in congestion costs

30% possible telecommuters x 20% reduction in commuting x peak multiple<sup>35</sup> x Half of total congestion costs per year<sup>36</sup> = 30% x (20% x 2) x (\$85 million) = \$10.2 million

<sup>32</sup> US Census Bureau American Community Survey 2009

<sup>33</sup> 14.13 miles per trip times 50 days per year.

<sup>34</sup> Based on the University of Tennessee at Chattanooga Travel Policy as of March 2011.

<sup>35</sup> From Crandall and Jackson (2001) who use Krugman's approach.

<sup>36</sup> Source: Texas Transportation Institute's 2010 Urban Mobility Report. This is the estimate of average congestion cost for small urban areas (with populations less than 500,000). Available at: <http://mobility.tamu.edu/ums/report/>

### 3. Productivity Benefits

E-business refers to the integration of information and communications technology into every stage of the value chain and includes the use of advanced ICT to attract and retain customers, to streamline firm operations such as supply chain or inventory management, to automate business processes, and to collect, analyze and share business intelligence about customers and company operations with employees, suppliers, and business partners. There is widespread agreement that broadband is a prerequisite for the successful diffusion of e-business services. It is commonly expected that they include facilitating new ways of customer-supplier interaction, reduced transaction costs, and increased operational efficiency.

Besides the benefits that come directly from deploying and using broadband services, communities that have advanced broadband services may have a competitive edge in attracting and retaining businesses. That edge can become a significant competitive factor between businesses, as well as serve as an important aspect of economic development (Pociask, 2005). As previously noted, the evidence from Hamilton County is supportive of this notion.

One of the most touted benefits of advanced technology pertains to gains in productivity (Stiroh, 2001). The U.S. Department of Commerce reported that IT accounted for at least half of the productivity gains in the U.S. economy since 1995.<sup>37</sup> Oliner and Sichel (2000) conclude that IT investment was responsible for two-fifths of the growth in total factor productivity and 68 percent of the accelerated growth in labor productivity. The attendant efficiency gains stemming from enhanced productivity comes from savings in personnel and time, streamlined and automated process flows, less errors, economies of scale and from lower processing costs per unit.

According to surveys conducted by RVA (2010), 77 percent of FTTH users with home-based businesses said their business was more efficient or would not be possible without FTTH.

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<sup>37</sup> <https://www.esa.doc.gov/Reports/DIGITAL.pdf>

The anecdotal evidence of these benefits in Chattanooga is increasing. Consider the examples below.

**ARS:** It is not unusual for e-commerce firm ARS to transmit 50 GB and receive 110 GB of data in just two days. With EPB's 30/30mbps fiber product, the company's slowest service tier, this exchange would take four hours for outbound data and about nine hours for inbound data, a total difference of nearly one week's worth of time from the FCC's current broadband definition.

**Daniel Ryan**, software programmer, believes EPB's 30/30 symmetrical product saves him three days annually. On a cable provider's network, it took Ryan up to 30 seconds to save a file on the West Coast; on EPB's network, the file saves in six seconds. The time that is saved pays for the programmer's monthly subscription fee for fiber optic service. Because he can now work more efficiently, he can take on more work.

To quantify these gains in Hamilton County, we assume a portion of total employee time will be saved each week on account of advanced broadband services. For instance, if we assume that 5 percent of total employee time per firm will be saved each week on account of productivity and efficiency gains stemming from broadband applications, this amounts to 2 hours per week or 104 hours per year per firm.<sup>38</sup> The cost savings from such productivity gains can be computed based on the median wage rate as follows:

Hours saved per firm per year x median wage/hour

$$104 \times \$14.32 = \$1,489.28 \text{ per firm per year}$$

Assuming a conservative commercial take-rate of 40% in Hamilton county, the estimate of productivity gains =  $\$1,489.28 \times (21,678 \text{ firms}^{39} \times 40\%) = \mathbf{\$12,913,845}$ .

<sup>38</sup> The gains are magnified manifold, if we assume instead that 5 percent of time *per employee* is saved each week.

<sup>39</sup> Number of commercial meters used as a proxy for number of businesses (data provided by EPB as of June 2011).

#### 4. Education Benefits

RVA (2005) note that FTTH networks have helped expand communication between teacher/school and students and between teacher/school and parents. In some deployments, early efforts are underway to develop second generation online education which is more interactive and video-based rather than text-based as in first generation online distance learning.

Current asynchronous e-learning uses web-based learning modules but does not support real time interaction between the instructor and the students. Synchronous e-learning consists of on-line real-time lectures, which typically have to be joined by students at the time of their delivery. Additional asynchronous functions typically support the learning environment. Most demanding in terms of bandwidth are forms of collaborative e-learning in which students have to interact continuously to solve problems or engage in other learning activities.<sup>40</sup>

Broadband applications will contribute to the learning process to some extent. However, estimating the benefit of such technology to the community is difficult. Below, we present two cases where broadband is making a difference in the provision of education and the learning of county school children.

##### **CASE STUDY: Brainerd Baptist**

With the one gig service that EPB allows all Hamilton county schools, Brainerd Baptists' K3-5<sup>th</sup> grade students enjoy the benefits of tele-lessons and interactive learning. Teachers are able to focus more on the students because traditionally manual tasks such as attendance and performance tracking are now automated.

*"EPB has changed everything for us," says Information Technology Director Bradley Chambers. "Today, all of our administrative files, emails, and financial records are hosted in the cloud. Those options were available before EPB, but they weren't viable due to speed constraints. The symmetrical 50mbps product has opened our eyes to all the things we can improve."*

In savings related to email, the school estimates that \$40,000 will be saved over 10 years. In addition to the email savings, an upgrade to an expensive \$10,000 server would have

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<sup>40</sup> Bauer et al (2003) illustrate facets of e-learning that require high-end broadband support.

been required without fiber. Instead, \$10,000 bought 50 Mac Books, 15 iPads, 30 iPod touches and 3 Promethean boards.

*“Kids today learn differently from even my age group, so it doesn’t make sense to hand them traditional materials and expect them to work well. A child here can read the Gettysburg address, or they can press a button to hear it or click a link to find more detail. The ability to consume information is limitless with this bandwidth” says Chambers of the new devices.*

The Promethean boards are smart versions of yesterday’s chalkboards that download new lessons and encourage participation through digital response devices that record individual student performance in real time.

In addition the fiber service has also allowed the attached church to develop an improved data recovery plan. Before EPB, the church stored all of its material locally, and eventually all the data was lost. The school had to tediously rebuild their records, starting from scratch. Today, their information can be accessed from anywhere in the county quickly, preventing the likelihood of another large scale data loss.

#### **CASE STUDY: Battle Academy**

Battle Academy, a magnet elementary school located in downtown Chattanooga, educates both affluent and at-risk children. The school relies heavily on technology to teach lessons, streamline administrative tasks, conduct teacher/parent communication and support disadvantaged children with special programs. EPB supplies Battle Academy with 100 Mbps VLAN.

Magnet Technology and Arts Education Facilitator Scott Rosenow estimates that increased bandwidth saves two hours out of each eight-hour day in productivity for Battle’s teachers.

*“That increased productivity not only saves the school anywhere from \$20 - \$40 per teacher per hour but also gives students more time with their instructors” said Rosenow.*

Supported by adequate bandwidth, children can now simultaneously watch live streaming events like the recent NASA shuttle launch on large screens in each classroom, Skype with authors across the country, and connect with other children worldwide. Quality images matter in the classroom, where students engage in virtual science experiments, real-time views from the Hubble Space Station illustrate space lessons, and new species are discovered with vivid, life-like images.

To help its at-risk students, Battle uses Fast ForWord, a web based program, to awaken parts of the brain that may not have been stimulated in early childhood. Before high-quality bandwidth, these students may not have been able to access the program as freely.