VALLEY VISION

Connecting Citizens, Shaping Solutions

Broadband Green Project
Literature Review
Findings Summary

Executive Summary

The use of high-speed internet (broadband), or Information and Communication Technology (ICT), has the potential to reduce greenhouse gas (GHG) emissions and energy consumption. The California Emerging Technology Fund (CETF) Green Committee seeks to highlight the research and data which quantifies the green benefits of broadband such that it encourages rapid deployment of broadband and supports the overarching goal of closing the "Digital Divide" in California.

Valley Vision has been contracted by the CETF to determine if there is sufficient research available to create and certify a protocol and provide an economic valuation for use of broadband-driven applications such that they would be eligible for use as bankable offset credits in an emissions trading system. To meet environmental integrity requirements, the EPA requires that emissions trades demonstrate that the reductions are surplus, permanent, quantifiable, and enforceable. This project seeks to identify the existing literature and research which describes and, if possible, evaluates greenhouse gas emission impacts from broadband-driven applications, and determine if there is sufficient support to develop a "quantification approach" to be used as a CEQA mitigation strategy or as a protocol.

The literature review was supplemented by interviews and consultations with subject area experts. Key findings include:

1. While there are many researched and documented benefits to applications such as e-learning, e-materialization and teleworking, and more prospectively the smart grid, it is challenging to measure the actual greenhouse gases avoided and create enough of a savings to be cost-effective and eligible for trading credits.
2. Much research projects greenhouse gas emission savings at a macro-level, but there are less examples of literature which document actual measurements at an application level which would be applicable to behaviors and trends in California.
3. The application where the research currently demonstrates the most potential to generate sufficient greenhouse gas savings to be quantified for a CEQA mitigation strategy and / or a quantification protocol is the area of **telehealth**.
4. While telehealth is the most promising area, currently sufficient data does not exist to become a CEQA mitigation option. However, opportunities to close this data gap and willing partners have been identified, although it would be a costly and time consuming process.
5. Future opportunities include the potential to integrate greenhouse gas reductions at a regional level due to broadband-driven applications into "Sustainable Community Strategy"(SCS) plans.

This project has generated multiple benefits thus far including:

1. A comprehensive literature review of existing research which evaluates or quantifies at a deeper level the greenhouse gas emission impact from use of broadband-driven applications, resulting in a summary of relevant literature.
2. Through informational interviews and outreach associated with this project, subject-matter experts have been identified as willing partners to engage in closing the gaps to completing research which could provide sufficient data to "bank" emissions savings from broadband-driven applications as credit in a trading system managed by a local air district.
3. An additional tertiary benefit of this project has been raising the awareness with regional influencers and leaders. Identifying how to quantify and capture the greenhouse gas emission reduction and air quality benefits of utilizing broadband-driven applications is now part of regional planning conversations.
4. The green benefits of broadband-driven devices will be incorporated and elevated within the next California Regional Progress Report, prepared for the Strategic Growth Council.

Notwithstanding the merits of developing a protocol, we share CETF's bias for action and fast impact and have determined that pursing the bankable credit path would likely be a lengthy and costly process. Therefore, we recommend the key actionable outcome of this project to be a policy brief highlighting best practices to achieve greenhouse gas emission reductions due to broadband-based applications. Working in conjunction with the CETF Green Committee, we will seek adoption or endorsement of these best practices as promising strategies from Sacramento Metropolitan Air Quality Management District, the Sacramento Area Council of Governments, and the Strategic Growth Council.

Overview:

The literature review sought to answer these questions:

1. What available research quantifies reductions in GHG due to use of broadband-driven applications?[1]
2. In what broadband-driven application could GHG emissions be measured repeatedly and verified in order to be used for credit in an emissions trading system?[2] I.e. In what project activities that reduce GHG emissions through the usage of broadband can the behavior with and without the use of the broadband-driven activity be measured?

Broadband-driven application areas of focus included e-learning, e-materialization, telecommuting/working, telehealth/medicine, aggregated forecasts, and the emerging areas of the Smart Grid, including as an enabling technology for smart buildings, electric vehicles and renewable energies. Other applications include strategies for vehicle demand reduction through use of intelligent transportation systems (ITS) technologies to improve system efficiencies. While the use of these applications has many co-benefits, the focus of this project is the ability to quantify their contributions

---

[1] These could contribute to a CEQA mitigation.

[2] This will help us identify the subject area to focus efforts for protocol development. Also needs to be at a scale that would be cost-effective to put in the processes to measure and verify the emission reductions.

to greenhouse gas reductions for environmental mitigation or bankable credit purposes. However, other potential benefits (co-benefits) such as consumer savings, improved health outcomes, oil security, pollution reduction and creation of new technology applications are referenced.

Through this literature review we identified research which both supports and challenges the theory that the use of broadband-driven applications reduces greenhouse gas emissions. According to the report *Broadband Services: Economic and Environmental Benefits* published by the American Consumer Institute, a review of existing literature shows that the potential impact of changes stemming from the delivery of broadband is estimated to be an incremental reduction of more than 1 billion tons of greenhouse gas emissions over 10 years[3]. The Smart 2020 report estimates that that information and communications technology (ICT) could enable a large portion of solutions to cut annual CO2 emissions in the United States by 13-22 percent by 2020. This would translate to gross energy and fuel savings of $140-240 billion dollars, which could be reinvested in other areas of the economy.[4]

The former study and others acknowledge that additional study of the "rebound effect," where travel or consumption of carbon-generating activities is *generated* due to the use of broadband-driven applications, is necessary to determine how they impact the overall savings broadband can potentially deliver.

Many of the reports describe theoretical or potential benefits at a macro scale but there are often data documentation challenges at a more local level. While there are many researched and documented benefits to applications such as e-learning, smart grid, e-materialization and teleworking, it is challenging to measure the <u>*actual*</u> greenhouse gases avoided (such as through certain types of trip reductions or avoidances) and create enough of a savings to be cost-effective and eligible for trading credits. The application where the research currently demonstrates the most potential to generate sufficient greenhouse gas savings to be quantified for a CEQA mitigation strategy and/or a quantification protocol appears to be the area of <u>**telehealth**</u>.

According to the National Broadband Plan, "Broadband and advanced communications infrastructure will play an important role in achieving national goals of energy independence and efficiency," (Chapter 12, Energy and the Environment, p. 265). Several applications may accelerate rapidly in the coming decade, enabled by the integration of broadband into the Smart Grid, including for smart buildings (residential and commercial to manage energy consumption for lighting, thermostats, electronics, appliances and so forth), more efficient data centers, more efficient road transportation (intelligent transportation systems), and electric vehicles. Development of the Smart Grid is a high priority for California. These applications should be explored further to identify the potential opportunity to quantify reductions in GHG, and the policy and operational barriers to be addressed.

---

[3] Fuhr, J.P. Jr. & Pociask, S.B. (2007). Broadband Services: Economic and Environmental Benefits. *The American Consumer Institute.* Retrieved from http://www.theamericanconsumer.org/2007/10/31/broadband-services-economic-and-environmental-benefits/.

[4] The Climate Group. (2008). Smart 2020: Enabling the low carbon economy in the information age. *United States Report Addendum*. Retrieved from http://www.smart2020.org/_assets/files/Smart2020UnitedStatesReportAddendum.pdf.

Additionally, in response to SB 375, each of California's eighteen metropolitan planning organizations (MPOs) are required to prepare a "sustainable communities strategy (SCS)" that demonstrates how the region will meet its greenhouse gas reduction target through integrated land use, housing and transportation planning.[5] The four largest MPOs (Bay Area, Southern California, San Diego, Sacramento region) cover approximately 85 percent of the State's population. There may be potential to integrate greenhouse gas reduction credits due to broadband-driven applications into **SCS plans**. This is an area that merits further exploration.

While this literature review has focused on the opportunity for quantification for credits, significant impacts additionally may be attained through the promotion of policies, especially at the state level, to develop, integrate and utilize broadband and advanced communications infrastructure for multiple existing and emerging applications as described above.

Summary of Focus Areas:

Telehealth

According to the federal Office for the Advancement of Telehealth, telehealth is the use of electronic information and telecommunications technologies to support long-distance clinical health care, patient and professional health-related education, public health and health administration[6]. Telemedicine, according to the American Telemedicine Association, is the use of medical information exchanged from one site to another via electronic communications to improve patients' health status[7] - typically clinical services from a distance.

Telehealth offers many co-benefits: it can prevent economically-strapped patients from missing work, help reduce the effects of nursing shortages, improve home monitoring of chronic disease, and provide access to distant ICUs and specialists – all acute problems in remote geographic settings.[8] Rural residents have a much farther distance to travel to receive access to healthcare. Seventy-five percent of urban residents live between 1 and 78 miles of a hospital, with an average of 10 miles away from a hospital. Seventy-five percent of rural residents live between 1 and 259 miles of a hospital, with an average of 14 miles away from a hospital**.** Ninety percent of rural residents live between 1 and 283 miles away from a hospital, averaging 25 miles away.[9]

---

[5] California Environmental Protection Agency (2011) *Sustainable Communities.* Retrieved from http://www.arb.ca.gov/cc/sb375/sb375.htm.

[6] Department of Health and Human Serices. (2011) *Telehealth*. Retrieved from http://www.hrsa.gov/ruralhealth/about/telehealth/.

[7] American Telemedicine Association. (2011). *Telemedicine Defined.* Retrieved from http://www.americantelemed.org/i4a/pages/index.cfm?pageid=3333.

[8] Perry, M. (2011). *Telehealth: The Doctor is in…Another City.* Retrieved from http://www.healthycal.org/archives/4466.

[9] Health Services Research. (2004). Updated Variable-Radius Measure of Hospital Competition. *Health Services Research.* Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1361015/.

There are multiple studies which estimate greenhouse gas emission reductions associated with reduced vehicle miles traveled due to the use of telemedicine to replace a face-to-face appointment. For the purposes of this project, we are not including home-monitoring telemedicine which may increase the quality of care with frequent monitoring; rather, we are focusing on apparent *substitution* of travel with telemedicine.

In the paper *Head and neck cancer assessment by flexible endoscopy and telemedicine* the study concluded a total of 42 journeys were avoided due to use of videoconferencing, each journey saving 123 kg CO2 per person. The paper recommended a national telemedicine service in the United Kingdom for the initial assessment of potential malignancy that has the potential to reduce unnecessary transfers to specialist centers, with accompanying reductions in carbon emissions.[10]

The study *The Impact of Telemedicine on Greenhouse Gas Emissions at an Academic Health Science Center in Canada* estimates the reduction in greenhouse gas (GHG) emissions resulting from 840 telemedicine consultations completed in a 6-month time period. Including return travel, the use of telemedicine in this study avoided an estimated 757,234 km resulting in a GHG emissions savings of 185,159 kg (185 metric tons) of carbon dioxide equivalents in vehicle emissions. The GHG emissions produced by energy consumption for videoconference units were estimated to be 42 kg of carbon dioxide equivalents emitted for this sample. The authors recommend development of standardized CO2 elimination algorithms for telehealth programs to both encourage adoption and promote environmental awareness in general.[11]

Results analyzing the environmental impact of using telemedicine (videoconferencing to replace in-person meetings) to improve cancer services was documented in *Use of videoconferencing in Wales to reduce carbon dioxide emissions, travel costs and time.* The study found a total of 18,000 km of car travel, the equivalent of 1,696 kg of CO2 emissions were avoided in October 2006; and 20,800 km of car travel, equivalent to 2,590 kg of CO2 emissions were avoided in October 2007. The authors concluded that telemedicine makes better use of staff time, reduces the time spent traveling, and assists in reducing climate change by limiting the emissions of CO2.[12]

The studies referenced above were conducted in the United Kingdom and Canada based on generally accepted GHG emission calculators in those respective countries. In developing a model to quantify the resulting GHG emission reductions associated with eliminated or reduced vehicle miles traveled in the United States, the calculation of the avoided emissions from transportation and mobile sources should be based on the U.S. Environmental Protection Agency (EPA) document *Emission Facts: Greenhouse Gas*

[10] Dorrian C, Ferguson J, Ah-See K, et al. (2009). Head and neck cancer assessment by flexible endoscopy and telemedicine. *Journal of Telemedicine and Telecare.* 15:118–121.
[11] Masino, C., Rubinstein, E., Lem, L., Purdy, B. & Rossos, P.G. (2010). The Impact of Telemedicine on Greenhouse Gas Emissions at an Academic Health Science Center in Canada. *Telemedicine and e-Health*. 16(9): 973-976. doi:10.1089/tmj.2010.0057. Retrieved from http://www.liebertonline.com/doi/abs/10.1089/tmj.2010.0057.
[12] Lewis, D., Tranter, G., & Axford, A.T. (2009). Use of videoconferencing in Wales to reduce carbon dioxide emissions, travel costs and time. *Journal of Telemedicine and Telecare.* 15, (3):137-138. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/19364897

Emissions from a Typical Passenger Vehicle[13]*.* Additionally, information gathered through informant interviews advised additional study and data collection to model vehicle miles avoided in a U.S. setting are necessary.

In summary, the application of telehealth and telemedicine may have the greatest potential to implement a process to measure and capture vehicle miles avoided, and thus the associated greenhouse gas reductions due to use of broadband.

Teleworking

Telework and telecommuting, as defined by telework.gov, refers to "work done outside of the traditional on-site work environment."[14] There is substantial research available evaluating the greenhouse gas effects of telecommuting and teleworking. The research finds there are many benefits to teleworking including reduction in traffic congestion, increased employee productivity, reduced presenteeism (i.e. allows employees to work from home when sick rather than be present in the office infecting other employees), reduced real estate space requirements and associated costs, and reductions in greenhouse gas emissions.

Published in the Low Carbon Economy Journal, the article *Broadband and Telecommuting: Helping the U.S. Environment and the Economy* finds that telecommuting can reduce greenhouse gas emissions over the next 10 years by approximately 588.2 million tons of which 247.7 million tons is due to less driving, 28.1 million tons is due to reduced office construction, and 312.4 million tons because of less energy usage by businesses. The authors predict that if 10% more of the workforce could telecommute fulltime, emissions of greenhouse gases would reduce by an additional 42.4M tons of CO2.[15]

The Consumer Electronics Association study, conducted by TIAX LLC of Cambridge, Massachusetts, found that just one day of telecommuting saves the equivalent of up to 12 hours of an average household's electricity use, saves 1.4 gallons of gasoline and reduces CO2 emissions by 17 to 23 kilograms per day.[16]

The report *Towards a High-Bandwidth, Low-Carbon Future: Telecommunications-based Opportunities to Reduce Greenhouse Gas Emissions* provides an analysis of the opportunities for Australian society to achieve nationally significant greenhouse gas abatement using telecommunication networks, and

---

[13] United States Environmental Protection Agency (2011) Emission Facts: Greenhouse Gas Emissions from a Typical Passenger Vehicle. Office of Transportation and Air Quality (EPA-420-F-11-041) Retrieved from: http://www.epa.gov/otaq/climate/documents/420f11041.pdf.

[14] Telework.gov. (n.d.) *U.S. Office of Personnel Management and U.S. General Services Administration*. Retrieved from http://www.telework.gov/faq/Employee/What-is-the-definition-of-telework,27.aspx

[15] Fuhr, J.P. Jr. & Pociask, S.B. (2011). Broadband and Telecommuting: Helping the U.S. Environment and the Economy. *Low Carbon Economy Journal.* Retrieved from http://www.scirp.org/journal/PaperInformation.aspx?paperID=4227.

[16] TIAX LLC. (2007). Final Report by TIAX LLC to the Consumer Electronics Association (CEA). *The Energy and Greenhouse Gas Emissions Impact of Telecommuting and e-Commerce*. Retrieved from http://www.ce.org/Energy_and_Greenhouse_Gas_Emissions_Impact_CEA_July_2007.pdf.

estimates energy and travel cost savings to be approximately $6.6 billion per year.[17] The report highlights a Smart Community development which provided high-speed optical fiber cable (Fiber To The Premises - FTTP), for each of the proposed 700 residential buildings. The case study concludes this development is well equipped to provide best practice systems to reduce greenhouse gas emissions through the use of FTTP and consequent high quality teleworking options and other emission reducing applications.

The first analysis of the impacts of center-based telecommuting on individual travel behavior and emissions was completed in 1996 and found the reductions in weekday vehicle miles traveled (VMT) comprised significant reductions in commute-related VMT with insignificant changes in non-commute-related VMT[18]. The significant reduction in VMT translated into a 49% decrease in Oxides of Nitrogen (NOx) emissions and a 53% decrease in Particulate Matter emissions comparing telecommuting days to non-telecommuting days for the small sample. Home-based telecommuting was found to reduce travel and emissions primarily due to the elimination of commute trips, despite an increase in non-commute trips by 9%. However, the report also noted the need to analyze the air quality impacts of center-based telecommuting with a larger sample.[19]

Concern was cited that non-commute travel generation may have a negative impact of telecommuting through a rebound effect. Through an informational interview, we learned that subsequent studies found telecommuting has a net benefit to transportation and associated greenhouse gas emissions. The concerns of non-commute travel generation did not come to fruition to an appreciable degree.

The Smart 2020 report finds that the existing case studies show the impact of working from home varies depending on the amount of time spent at home and the efficiency of the economy in which teleworking is introduced. For example, if a significant number of people worked from home more than three days a week, this could lead to energy savings of 20-50%, even with the increase in energy used at home or non-commuter travel. Home-working allows employers to use or build smaller offices that require less energy to construct and maintain. However, the impact is much lower if take-up is lower than three days a week because it would still be necessary to maintain office space for periodic home-workers.[20] The US Addendum to the Smart 2020 report[21] estimated 50—100MMT of CO2 emissions could be reduced through flexible work in the U.S. in 2020, yielding $15—$30 billion in gross savings in 2020 from lower spending on gasoline. This analysis captured rebound effects.

---

[17] Mallon, K, et. al. (2007) Towards a High-Bandwidth, Low-Carbon Future: Telecommunications-based Opportunities to Reduce Greenhouse Gas Emissions," *Climate Risk Pty Ltd*. (Australia). Retrieved from: http://www.climaterisk.com.au/Climate%20Risk%20Telstra_report.pdf

[18] Henderson, D.K. & Mokhtarian, P.L. (1996). Impacts of Center-Based Telecommuting on Travel and Emissions: Analysis of the Puget Sound Demonstration Project. *Transportation Research.* 1(1): 29-45.

[19] Henderson, D.K., Koenig, B.E., & Mokhtarian, P.L. (1996). The Travel and Emissions Impacts of Telecommuting for the State of California Telecommuting Pilot Project. *UC Davis: Institute of Transportation Studies*. 4(1):13-32.

[20] SMART 2020: Enabling the low carbon economy in the information age. (2008). *The Climate Group, on behalf of the Global eSustainability Initiative (GeSI)*,. Retrieved from: http://www.smart2020.org/_assets/files/03_Smart2020Report_lo_res.pdf

[21] See footnote #4.

Caltrans and the MPOs are conducting a regional and statewide Household Traveler's Survey which may provide better information on the percentage of trips that are due to work commuting versus other types of travel. Earlier research in some regions shows that non-work related trips are a much greater percentage of travel than work trips. For example, non-work trips in the Sacramento region increased as a percent of all travel from 79 percent in 1991 to 85 percent in 2000.[22] The ability to reduce GHG emissions from travel-related sources would need to be addressed by other strategies including better land use and transportation planning (which the Regional Blueprints and Sustainable Communities Strategies are addressing) and transportation demand management strategies that are in part dependent on broadband and advanced communications technologies which are described elsewhere in this document.

Studies have found that teleconferencing could reduce greenhouse emissions by 199.8 million tons, if 10% of airline travel could be replaced by teleconferencing over the next 10 years.[23] While replacement of airline travel saves costs for an organization in addition to reducing greenhouse gas emissions, it is difficult to validate and quantify in a cost-effective way, that certain instances of teleconferencing and videoconferencing is a *substitute* for other forms of meeting and does not generate additional travel.

While there is much research which quantifies the potential greenhouse gas reductions that could be achieved with implementation of teleworking programs, the ability to capture these emission reductions such that they could be traded as carbon credits is another important aspect for the purposes of this project.

The paper *Emissions Trading with Telecommuting Credits: Regulatory Background and Institutional Barriers* provides some context for evaluating whether a trading scheme for vehicle miles traveled reductions through an ecommute program represents a feasible approach to reducing mobile source emissions and promoting telecommuting, and reviews the limited experience with mobile source emission trading programs. This paper identifies two primary challenges facing a telecommuting emission trading program: lack of cost-effective and inability to meet EPA "integrity" requirements.

From the costing perspective, because potential emissions reductions from any individual vehicle are relatively small (and will continue to dwindle as vehicles become more fuel efficient), the costs of monitoring and certifying individual emissions reductions will tend to dwarf the potential value of the credit generated.

To meet environmental integrity requirements, the EPA requires that emissions trades demonstrate that the reductions are surplus, permanent, quantifiable, and enforceable. This paper notes that the emissions reductions from telecommuting will remain speculative when compared with emissions reductions from continually monitored sources like power plants, and the administrative burdens associated with making sure that firms aren't cheating and claiming excess telecommuting are fairly high

---

[22] Valley Vision. (2004). *2004 Sacramento Region Quality of Life report.* (pp. 45). Retrieved from http://www.valleyvision.org/PDFs/QualOfLifeHigh.pdf

[23] See footnote #3

and might make the reductions difficult to enforce. With regards to meeting the surplus requirements, in practice this brings emissions trading of telecommuting credits into conflict with other claims on telecommuting, notably from MPOs seeking reductions in the conformity process and regional transportation plans, and from state environmental agencies seeking compliance in their air quality plans.[24]

In summary, the research identifies many co-benefits to encouraging telecommuting and teleworking, including the potential to reduce greenhouse gas emissions by reducing vehicle miles traveled. However, there is not sufficient research to support creating protocols for an emission trading system for greenhouse gas reductions associated with telecommuting due to the challenges in validating the environmental integrity and the cost-effectiveness of the program.

De/e-materialization:

Many studies have evaluated the potential for dematerialization, the replacement of high carbon products and activities with low carbon alternatives[25], to reduce greenhouse gases. Some studies predicted that by 2010, e-materialization of paper, construction, and other activities could reduce U.S. industrial energy and GHG emissions by more than 1.5%.[26] Additionally, while there are GHG reductions and costs savings associated with replacing paper documents with electronic versions, or downloading music and videos rather than purchasing CDs and DVDs, other studies find that CO2 reductions due to e-materialization negligible[27] (these results do not account for the impact of potential "rebound effects," where consumption of goods and other energy-consuming activities are increased as a result of lower e-commerce prices or free time.)

Greenhouse gas benefits from e-materialization, while valuable for reducing overall costs and carbon footprint, are not easily quantified such that they could be monetized and verified continuously for carbon trading credits.

E-learning:

Through the use of ICT, students can have access to higher education, continuing education, certification courses, and many other learning opportunities. E-learning, sometimes called distance learning, virtual classrooms, web-based or computer-based training, provides educational experiences outside of a traditional classroom environment. A study by Britain's Open University found that on average, producing and providing distance learning courses consumes 90% less energy and produces 85% fewer

---

[24] Nelson,P. (2004). Emissions Trading with Telecommuting Credits: Regulatory Background and Institutional Barriers, *Resources for the Future*, Discussion Paper. Retrieved from: http://ageconsearch.umn.edu/bitstream/10884/1/dp040045.pdf

[25] See Footnote #20.

[26] Romm, J., Rosenfeld, A. & Herrmann, S. (1999). The Internet Economy and Global Warming. *Global Environment & Technology Foundation*. Retrieved from http://www.p2pays.org/ref%5C04%5C03784/0378401.pdf

[27] See footnote #16.

CO2 emissions per student than conventional face-to-face courses.[28] The benefits of e-learning on the environment are the greatest when it replaces or reduces the use of high-carbon transportation and reduces real estate and related energy-generation needs.

While e-learning greatly expands educational *access* opportunities, for the purposes of this project we focus on occasions when e-learning is a ***substitute*** for in-classroom learning. Where it can be clearly documented that a virtual or online learning environment was chosen instead of an in-person travel-heavy option, if these avoided miles traveled can be captured to a scale that is cost-effective, e-learning may be eligible for tradable credits. An applicable scenario could be building off the California Telehealth Network example. If through a CTN membership a rural healthcare facility has sufficient high-speed internet access, they could potentially replace travel for continuing education licensing requirements with distance learning options. Including these vehicle miles avoided within a carbon trading validation process should be considered.

Smart Grid, Smart Buildings, and Smart Transportation Systems:

Several reports on the potential of the Smart Grid and other smart technology applications indicate that broadband and advanced communications infrastructure is vitally important to achieve U.S. prosperity and national security goals of energy independence and efficiency. The Smart 2020 Report identifies four information and communications technology opportunities to cut emissions and generate large scale energy and fuel savings. The underlying premise is that many actors are provided with the information they need to make better decisions about their energy consumption. The areas of opportunity include:

- The Smart Grid
- More efficient road transportation
- Smart buildings that consume less energy (and other resources such as water)
- Travel substitution through virtual meetings and flexible work arrangements (described above)

The Smart Grid is defined as the "two-way flow of electricity and information to create an automated, widely-distributed energy delivery network."[29] The addition of two-way communications, sensors and software to the electrical system, both in the grid and in the home, will be required related to the generation, transmission, distribution and consumption of energy.

The National Broadband Plan recommends the integration of broadband into the Smart Grid, which includes exploring the reliability and resiliency of commercial broadband communications networks.[30] A

---

[28] Roy R.; Potter S.; Yarrow K. and Smith M. (2005). Towards Sustainable Higher Education: Environmental impacts of campus-based and distance higher education systems. *The Design Innovation Group*. Retrieved from http://www3.open.ac.uk/events/3/2005331_47403_o1.pdf.

[29] Broadband.gov. (n.d.) Energy and the Environment. In *National Broadband Plan, Connecting America.* (Chapter 12, p. 267). Retrieved from http://www.broadband.gov/plan/12-energy-and-the-environment/.

[30] See Footnote #29.

report prepared by the U.S. Department of Energy estimating the potential energy and carbon reduction benefits of the Smart Grid assesses nine mechanisms that could reduce the impacts associated with energy generation and delivery. Potential direct and indirect reductions attributable to smart grid technologies in 2030 could reach 12 percent in direct and six percent in indirect reductions. [31] The estimates assume the full deployment of smart grid technologies and the integration of reduction strategies.

The mechanisms include a range of approaches that are based in part on improving the information that allows consumers to monitor and adjust their energy usage. They also include deployment of diagnostics in residential and commercial buildings (smart buildings); increased capacity to support additional electric vehicles and plug-in hybrid electric vehicles; system-wide conservation, voltage reduction and control; and ability to better manage new and expanded sources of renewable energy. These applications depend in part on smart meters in the home and workplace, and will be accelerated through the use of mobile applications. General policy recommendations include the need for all technical mechanisms to be considered in greater analytical depth so as to more rigorously address the quantification of and uncertainties for the estimated reductions, to help set priorities for development of smart grid technologies.

California is a leader in development of the Smart Grid, including through national ARRA investments in the Sacramento region, and investments being made by utilities. However, the literature review and Valley Vision interviews make clear that there are many federal and state regulatory and policy issues, incentives and investments that need to be addressed, as well as local policy issues including siting and installation of smart meters, for the full deployment of necessary infrastructure and smart grid technologies.

Areas for Further Exploration

This literature review and research process uncovered additional areas to explore for achieving the outcomes desired of utilizing broadband-driven applications as an enabler for greenhouse gas reductions. Two key areas are summarized below.

Close gaps to quantify carbon reductions due to telehealth as a bankable credit:

Sufficient data needs to be collected such that a model or algorithm can be developed to confidently determine the average amount of VMT (and associated GHG emissions) avoided per patient utilizing a telemedicine service, and thus applied to a carbon trading system. Through informant interviews, potential partners were identified to support this effort.

The California Telehealth Network (CTN) intends to connect more than 850 rural sites to its broadband network dedicated to healthcare over the coming three years, to provide clinical care to patients from a

---

[31] RG Pratt, et.al. (2010). The Smart Grid: An Estimation of the Energy and CO2 Benefits. *U.S. Department of Energy.* Retrieved Sept 14, 2011 from: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-19112.pdf

distance, using live videoconferencing or digital imagery among other technologies. Through the CTN member reporting requirements there is the opportunity to collect vehicle miles avoided data. In the future, this data can be captured automatically once a centralized scheduling system is in place.[32]

A research study of a test case needs to be designed and conducted evaluating the potential rebound effects associated with access to telehealth. For example, if healthcare is more accessible due to telehealth, will this stimulate additional visits, thus overall raising the net vehicle miles traveled if this application was not introduced? Ideally a study would be conducted which evaluated a population's vehicle miles traveled per year per capita before the implementation of telehealth, and an evaluation of the population after the implementation of telehealth applications. It is estimated that first order effects could be uncovered in 1-3 years. There may be potential to conduct such research in collaboration with the California Telehealth Network as it rolls out the deployment of infrastructure throughout the regions. Additionally, the Center for Connected Health Policy, which has begun to document the economic benefits of telemedicine[33], may be interested in supporting further research on the green benefits of broadband through the use of telemedicine.

Further exploration of implementing a process and undertaking necessary research to capture baseline data on trip reductions and estimated GHG emissions reductions associated with telehealth that could turn into a protocol should be considered.

Inclusion in a Sustainable Communities Strategy:
Research conducted at the Institute of Transportation Studies at the University of California, Davis, indicates that the same technologies and practices implemented by local governments to manage vehicle travel and traffic congestion, such as information and communication technologies, can be used to improve mobility and reduce transport GHG emissions. In the future, more substantial changes are possible by creating new models of travel, such as smart car sharing and smart paratransit.[34] These metrics and strategies can be explored further within the context of Sustainable Communities Strategies and Blueprint planning that the MPOs are conducting.

The Case Connection Zone is a research project with the goal of bringing 1 Gigabit Internet connectivity to the neighborhoods surrounding University Circle and Case Western Reserve University. The current beta block comprises 100 separate residences, each connected by a dedicated fiber to a high-speed switch. They are studying how this ultra high-speed network can be used together with new applications

---

[32] Implementation of a centralized scheduling will occur once a fair and transparent vendor selection process is developed, and funds are available to support this piece of the CTN roll-out.
[33] Newman, M., McMahon, T., The Blue Sky Consulting Group. (2011). Fiscal Impact of AB 415: Potential Cost Savings from Expansion of Telehealth. *Center for Connected Health Policy*. Retrieved from http://www.americanwell.com/pdf/FiscalImpactofAB415PotentialCostSavingsfromExpansionofTelehealth.pdf
[34] Lutsey, N. & Sperling, D. T (2008). Transportation and Greenhouse Gas Mitigation. *UC Davis: Institute of Transportation Studies*. Retrieved from: http://escholarship.org/uc/item/6fz1z05g

and services to improve the quality of life for the residents in health, energy, safety and education.[35] The research from this effort may provide valuable data to be considered with SCS modeling strategies.

Conclusions:

Through this literature review and informational interviews Valley Vision has found there is a new understanding of the connection of broadband to fostering a green economy. The report *Networking the Green Economy: How Broadband and Related Technologies Can Build a Green Economic Future* illustrates this important linkage by highlighting policy recommendations to achieve energy savings and environmental goals in the areas of Smart Grid, Smart technologies / demand-management tools, and broadband-based applications such as telehealth and e-commerce opportunities.[36]

The options with the most potential to meet the goals of the California Emerging Technology Fund's Green Committee are:

1. Pursue additional research and steps necessary to develop usage of telehealth into a measurable, verifiable, bankable credit;
2. Explore integration of greenhouse gas reduction benefits due to use of broadband-driven applications with Sustainable Community Strategies; or
3. Develop a policy brief which highlights key policy barriers and identifies policy action recommendations.

While there is the potential to conduct research and collect sufficient data to ultimately monetize telehealth greenhouse gas savings into a bankable credit, we have determined that the process will be very lengthy in time and costly. Notwithstanding the merits of developing a protocol, we share CETF's bias for action and fast impact. With this frame in mind, we recommend the third option, which is to prepare a policy brief highlighting best practices to achieve greenhouse gas emission reductions due to broadband-based applications. Working in conjunction with the CETF Green Committee, we will seek adoption or endorsement of these best practices as promising strategies from Sacramento Metropolitan Air Quality Management District, the Sacramento Area Council of Governments, and the Strategic Growth Council.

[35] Case Connection Zone. (2011). The nation's first gigabit fiber-to-the-home community. *Case Western Reserve University*. Retrieved from http://caseconnectionzone.org/

[36] Progressive States Network, Communications Workers of America, Sierra Club and the Blue Green Alliance (2010). *Networking the Green Economy: How Broadband & Related Technologies Can Build a Green Economic Future.* Retrieved from http://cwa.3cdn.net/012c8a490dbfa62a20_bem6b8hcx.pdf.