Overview Section: Infrastructure

Essential Services in Need of Attention

By Jeremiah Cox and Anna Johnson

The 2011 Colorado College State of the Rockies Report Card

Key Findings:

-In 1919 it took 62 days for the US Army's Transcontinental Convoy to cross the nation, with Dwight Eisenhower, future President and champion of the Interstate Highway System on board.

-Roads in the Rockies are in better condition than nationwide: only 3 percent are in poor condition vs. 7 percent in the U.S.

-Commuting time in the Rockies is everywhere below the national average of 25.3 minutes.

-Rural America's adults have 50 percent access to broadband vs. 68 percent nationally; 75 Rockies census tracts have no access.

-In 2008 the Rockies consumed nine percent of national electricity with only seven percent of U.S. population.

-Burying major transmission lines costs $6 to $10 million per mile vs. overhead lines costing $0.5 to $1 million.

-Six of eight Rockies states have Renewable Portfolio Standards.

-Rural airport subsidies in 2006 included $255 per passenger from Pueblo to Denver Colorado and $473 from Lewiston Montana with an average of 3 passengers per flight.

-Six of eight Rockies states are net federal tax recipients.

-In 2008 Montana, at $282 per person, and Wyoming, at $212, received more back in Federal Highway Trust Funds than sent to Washington; for the Rockies the surplus received back stood at $45.

About the Authors:
Jeremiah Cox (Colorado College class of '11) is a 2010-11 Student Researcher for the State of the Rockies Project
Anna Johnson (Colorado College class of '11) is a 2010-11 Student Researcher for the State of the Rockies Project

The Rocky Mountains serve as a "spine" for the eight states comprising the Rockies region, the regional focus of The Colorado College State of the Rockies Project. Historically this mountain chain, forming the Continental Divide, has been an immense obstacle to westward expansion and regional development. After the exploration by Lewis and Clark (1804-1806) and other pioneers, waves of settlers swept into the region in search of fortunes (or at least sustenance) in mining, agriculture, and commerce. Along with the settlers came efforts to overcome the region's topographical obstacles: first overland stagecoach routes and the Pony Express, followed quickly by the telegraph and transcontinental railroad, then a growing network of rail, highways, communication technology, and pipelines. At first these projects were created with the intention of linking California and the Pacific coast with the other established population centers in the Midwest and the East. The formidable Rocky Mountains also caused development of infrastructure in the Eastern Front Range and Western Wasatch Front Range on a North-South direction, with relatively few transportation corridors running East-West or North-South through the mountains.

Table 1: Rockies Roads and Bridges

	Road Condition (2008)					Bridges (2009)		
	Very Good	Good	Fair	Mediocre	Poor	Percent Deficient	Average Age of All Bridges (Years)	Average Age of Deficient Bridges (Years)
United States	14%	27%	41%	11%	7%	24%	39	55
Rockies	17%	32%	37%	12%	3%	16%	35	46
Arizona	36%	24%	30%	7%	3%	12%	37	45
Colorado	11%	31%	45%	9%	3%	17%	32	47
Idaho	6%	33%	26%	31%	4%	19%	37	48
Montana	12%	52%	29%	4%	3%	18%	41	51
Nevada	39%	24%	28%	5%	5%	12%	26	40
New Mexico	20%	20%	31%	23%	6%	18%	40	47
Utah	6%	24%	62%	7%	1%	15%	31	44
Wyoming	8%	40%	44%	7%	1%	22%	37	45

Source: Roads: U.S. Department of Transportation, Bridges: U.S. Department of Transportation, Federal Highway Administration

Presently this network of major interstate highways and often parallel railroads and pipelines provides constrained and often congested transportation infrastructure, thus inhibiting the region's internal circulation and linkages to areas outside of the Rockies in all directions. Federal subsidies were infused in a haphazard fashion, often to tackle the most immediate problems rather than to develop a logically designed "grid" girdling the Rockies region. Thus, we were left with patterns of infrastructure poorly designed to stimulate opening the region to settlement, commerce, and the general taming of nature for human benefit.

Today, across the U.S., it is easy to take regional infrastructure for granted. The ease of communication and travel within the country, thanks to the availability of telecommunications, roads, and airports, has played a pivotal role in how the U.S. has developed. However, the interstate highway system, an unprecedented project authorized by Congress in 1956 that once gave the U.S. an advantage, is aging, while the rail system has evolved into primarily slow-moving freight, with passenger services existing chiefly in large coastal urban corridors and around Chicago. The newer high-speed rail infrastructure of Europe and Asia makes the U.S. interstate highway system and rail network appear increasingly outdated and inefficient. These national trends are amplified for the eight-state Rockies region. Antiquated infrastructure is significant because the economic health of the region and its communities is directly related to the strength of available transport and communication. A healthy, modern infrastructure can lead to a community or region's economic success, while a lack of infrastructure can be a weakness that leads to its stagnation and decline.

Presently the transportation infrastructure in the Rockies is in decline, following similar trends nationwide. The average age and percentage of structurally deficient roads and bridges is compiled in **Table 1**. It shows that the Rockies region is doing relatively better than the nation as a whole. The region's bridges are newer and the average age of those that are deficient is younger. The roads in the Rockies are also in much better condition than the nation's roads (only three percent rated poor compared to seven percent for the U.S.), with more in the region ranked very good and good. The data does show that some Rockies states have high proportions of roads ranked mediocre (such as Idaho 31 percent and New Mexico at 23 percent) and without new improvements, more Rockies states are going to have a major decline in the quality of their roads in the near future. In addition to upgrading deteriorating roads and rail, investing in this infrastructure is extremely important because the Rockies region's rapid population growth is expected to continue. In 2000 the U.S. Census predicted a 64 percent increase in population by 2030 for the region compared to 32 percent for the United States as a whole.[1] In more recent years, between the 2000 and the 2008 censuses the Rockies region had 20 percent increase in population compared to 8 percent for the United States as a whole.[2]

The history of the development of the Rocky Mountain Region has been shaped largely by advances in transportation that connected the Eastern and Western United States and allowed settlers to inhabit and travel through the region. Today modern infrastructure plays the same role as it did for the first Europeans that settled the region: connecting people and places by allowing them to communicate with each other and the rest of the world, in the process transcending the obstacles of the Rocky Mountain spine.

Although the transportation-based infrastructure of the Rockies is in decline, the opposite is true of power transmission infrastructure. The Federal government is investing billions of dollars to upgrade our basic level electric transmission grid operation. This technology will make electricity transmission more reliable, secure, and will assist in promoting conservation habits. These funds will incorporate digital technology to make the grid "smart." It will also provide a needed upgrade to a century old system. Privately funded transmission projects to deliver renewable energy and traditional energy are also underway to meet increasing demand in the region and nation as well as to help ensure electricity reliability.

In addition, the federal government is fully committed to providing high speed broadband access to the entire country. They refer to universal broadband access as "the great infrastructure challenge of the early 21st century" and have launched the National Broadband Plan – a highly ambitious project – to achieve this goal.[3] Private funds are facilitating this upgrade of communications capacity: including fiber optic, microwave and satellite facilities.

This infrastructure section of the *2011 Rockies Report Card* will first provide a summary of the history of infrastructure in the region, including transportation and communication. This will begin with the first explorers, the use of wagon roads, mail, and stagecoach routes, moving on to the opening of the transcontinental telegraph lines and railroad, and finally the evolution of the motor car and the building of the Interstate Highway System. The next section will be an evaluation of the current infrastructure and its usage: commuting patterns; rural transportation options; aviation and commercial flight options; the movement of goods and freight; electricity transmission; and telecommunications in the Rockies. We will then consider whether the Rocky Mountain eight-state region has historically and is currently receiving its "fair share" of federal funds compared to the rest of the nation. Throughout this section of the *2011 Report Card* various suggestions for improving the vitality of the region's infrastructure will be discussed.

History of Transportation and Infrastructure in the Rockies

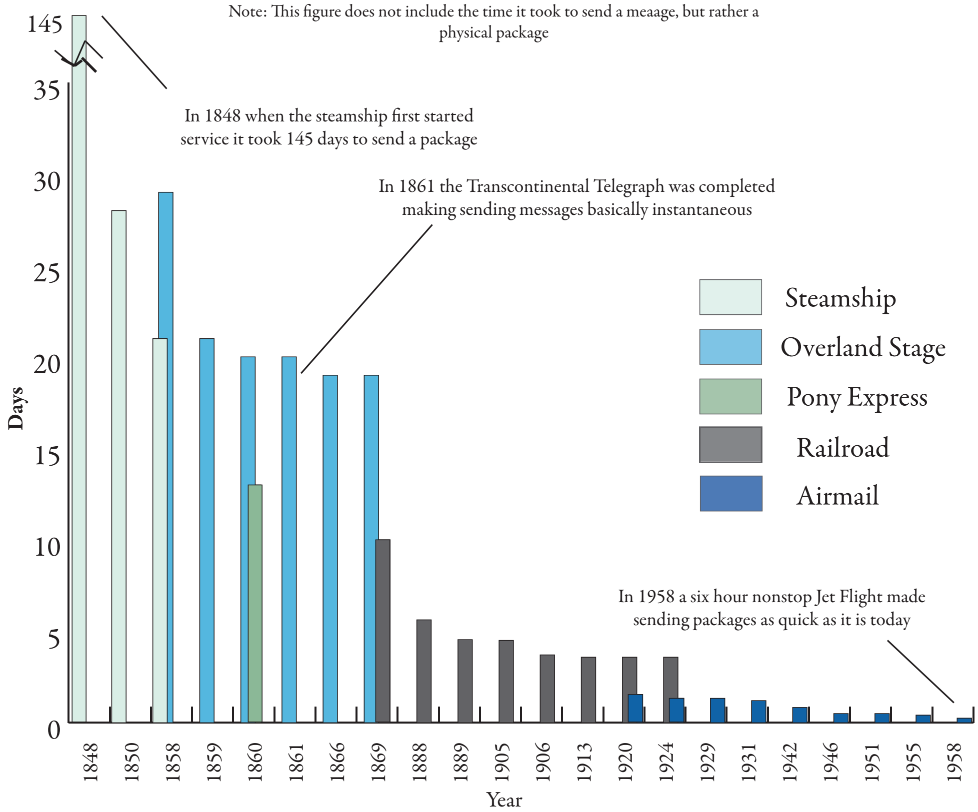
It is hard to determine when the building of infrastructure to connect people and places began in the Rocky Mountain West. Do we begin with the trails built by the prehistoric peoples of the Southwest, simply by following the same path of least resistance over and over again? Or does creating a path require a conscious effort at surveying and clearing out the land to connect regions? This section of the *Report Card* will follow the latter approach to defining infrastructure, although it will also discuss the various pioneer explorers and historic albeit primitive trails taken by them, across the region. For many generations, the Rocky Mountains were considered an intrinsic obstacle to travel and connectivity by persons trying to cross overland from the East Coast to the Pacific Coast. The successive waves of investment in infrastructure gradually helped provide faster transcontinental travel as well as provide the requirements for the region to flourish as a whole.

To highlight just how much faster communication has become through the region (or over the region in the case of air travel), the travel times of sending a package from New York City to San Francisco using the fastest possible means of the time period have been evaluated, along with the primary mode used to send that package across the continent. **Figure 1 s**hows the results of this study. This graph begins with the first westbound mail, a steamship running via the Straights of Magellan at the tip of South America that took 145 days in the winter of 1848-1849. This travel time was eventually reduced to about four weeks during the 1850's by transporting the mail overland via the Isthmus of Panama.[4] In 1858 the first Overland Stage

Figure 1: Sending a Package

This figure represents the time required to send a package between New York City and San Francisco using the fastest means possible

Note: This figure does not include the time it took to send a meaage, but rather a physical package

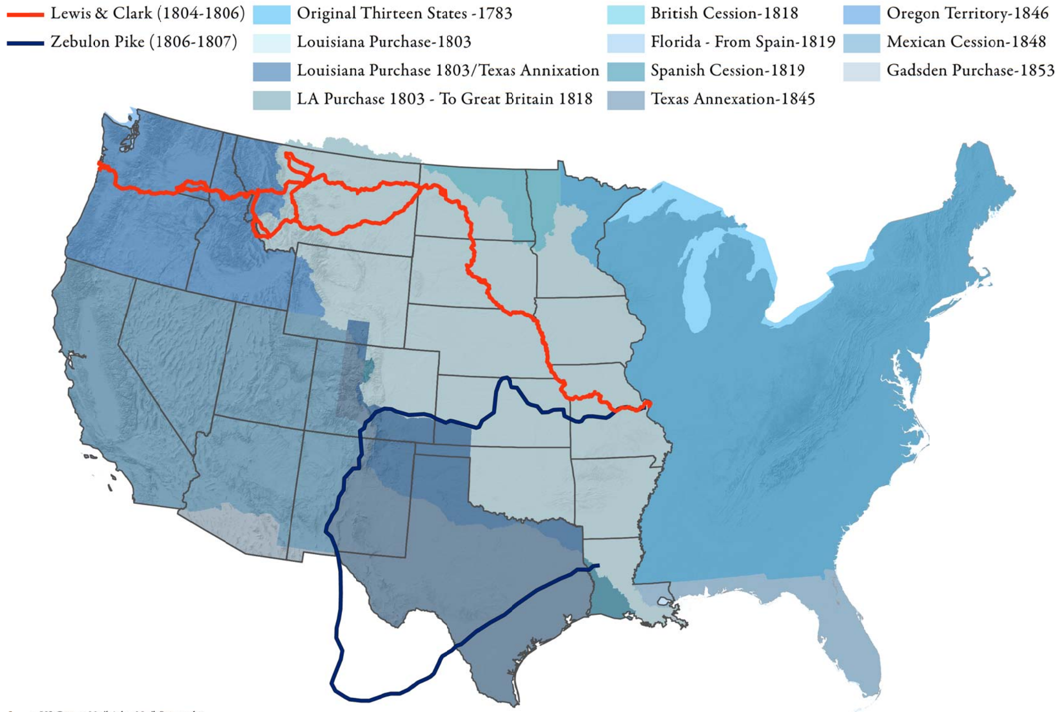


Source: For a full explaination of methods and sources please visit, www.stateoftherockies.com

Coaches were used, and once operations were perfected these became faster than the steamships (at least in summer). On April 3, 1860 the first Pony Expresses commenced, providing the fastest mail service yet. The news of President Lincoln's election left Fort Kearny, Nebraska—then the Western end of the Eastern telegraph network—on November 7, 1860 reaching Fort Churchill, Nevada on November 13 where the news was relayed by telegraph in time for the California papers on November 14, (thus taking just six days, to transmit *information* cross-country). On October 24, 1861 the Pony Express was rendered obsolete by the completion of the transcontinental telegraph line, making the sending of messages virtually instantaneous.[5] The next step was the completion of the Transcontinental Railroad in 1869, and then airmail in 1920 taking 37 hours.[6] Presently, this flying time has decreased down to fewer than seven hours, the time it takes for a non-stop jet to cross the continent.

Before European contact, ancient Indian trading trails covered every corner of the West; most of these were extremely primitive trails,[7] although the Ancient Puebloans built efficient, long, straight, roads in and around Chaco Canyon to connect their Kivas and Great Houses.[8] The first European road built in the region can be attributed to the Spanish that established the City of Santa Fe in roughly 1610.[9] To connect Santa Fe with the rest of their vast Mexican Empire they built the El Camino Real de Tierra Adentro, *The Royal Road to the Interior.* This trail went from Veracruz on the Mexican coast, across to Mexico City before heading North through the interior, reaching Santa Fe, New Mexico in 1603. The road ran a distance of 1,500 miles.[10] For over 200 years it provided the only established connection from Santa Fe; the Santa Fe Trail did not come into use until 1821.[11]

Figure 2: Territorial Expansion of the Lower-48 and the Routes of Lewis and Clark's Courps of Discovery and Zebulon Pike



Source: US Census, Nat'l Atlas, Nat'l Geographic

United States Control: History of Expanding the Frontier and Early Explorers

The beginnings of United States control of the Rockies region came with the Louisiana Purchase from France in 1803. This Western expansion is seen in **Figure 2**. Expansion continued with the Treaty of 1818 that established the Northern border with Canada (then England) along the 49th parallel from Minnesota to the Rocky Mountains, in the treaty called "Stony Mountains."[12] In 1846, the border with English Canada was continued along the 49th parallel all the way into modern-day Washington state, with the passage of the Oregon Treaty. Interestingly, the treaty includes a provision that the Columbia River through the U.S. remain open to navigation by British subjects and the Hudson Bay Corporation.[13]

After the Louisiana Purchase, a pattern of land exploration first helped to open up the Rockies frontier. The early major explorers of importance to the opening of the Rockies, and probably the most well known, are Lewis and Clark and their Corps of Discovery, sent to explore the Louisiana Purchase. The route is shown in **Figure 2**. Their journey took place from 1804 to 1806, going up the Missouri River, reaching the Pacific Ocean, and returning back to St. Louis, Missouri. James Colter left the group and became the first American to experience what is now Yellowstone National Park.[14] The next major exploration expedition came from Zebulon Pike, who on July 15, 1806, started out due West from Saint Louis and followed the Arkansas River into Colorado as far as its source, passing the peak that bears his name on the way. His route is depicted in **Figure 2**. Zebulon Pike's instructions were to find the source of the Red River, but instead he proceeded to cross the Sangre de Cristo Mountains into the San Luis Valley in what is now Colorado but in 1806 was Spanish Territory. Here his group was captured by the Spanish and sent South to Santa Fe, New Mexico and then to Chihuahua, Mexico before being released and deported back to the U.S., arriving back on U.S. soil on June 30, 1807.[15] Other explorers of note included James Bridger, a mountain man who was the first westerner to visit the Great Salt Lake in 1824 and discover Bridger Pass through the Rockies in 1850. This pass became a crucial route across the continental divide for wagon trains, the transcontinental railroad, and eventually Interstate Highway 80. Various explorers went through the region, particularly other mountain men who spent their time gathering, trading, and selling furs and other natural resources when they left the wilderness.

The rest of the Western territory was transferred from Spain. Most of it was acquired through the Mexican-American War from 1846 to 1848, which was ended by the Treaty of Guadalupe in 1848. After this treaty, a previously surveyed Southern Transcontinental Railway Route became unfeasible, since some of the route was located in Mexico. The portion of U.S. controlled land after this treaty was in present day Arizona and New Mexico and was found to be too mountainous and unsatisfactory for the Southern railroad. In 1853, James Gadsden negotiated with President Santa Ana of Mexico for a treaty of sale for the acquisition that bears his name. The Gadsden Treaty was ratified by Congress in 1854. The South though lost its proposed railroad in the 1850's because of the issues of slavery, land grants, disagreements about an Eastern terminus, and a lack of cooperation with Northerners among other reasons.[16] A Southern Railway across the Gadsden Purchase was finally completed in 1883.[17] After this land acquisition, one of the last great explorers of the region was John Wesley Powell who floated down the Colorado River in 1869 and visited one of the few remaining unexplored areas of the Rockies region. In 1890, the U.S. census officially declared the U.S. frontier settled.[18]

Pioneer Roads and Trails:

As soon as the West was acquired for exploration settlers began coming through the region in covered wagons and wagon trains. **Figure 3** shows many of the important trails used by settlers and travelers, although many smaller trails were also used. Most of the trails the settlers followed converged through the center of Wyoming and Bridger Pass, a low elevation pass through the Rockies on their way West.

The first trail to see widespread use was the Santa Fe Trail (various routings are shown in **Figure 3** including the Cimarron Cutoff) which began in 1821 and was primarily a commercial highway; before 1846 it was the main international "highway" between the United States and Mexico. It also became a major military highway during and after the Mexican-American War, as well as during the Civil War when the Confederates tried to take the Western Territories. In 1880 the trail was rendered unnecessary by the arrival of the railroad.[19] Also used by the previous Mexican residents, as shown in **Figure 3** was the Old Spanish Trail whose usage started in 1829 between the Mexican Provinces of New Mexico and California; its use was almost entirely a trade route for the Spanish, and made Santa Fe less isolated by giving it a closer connection to the sea.[20]

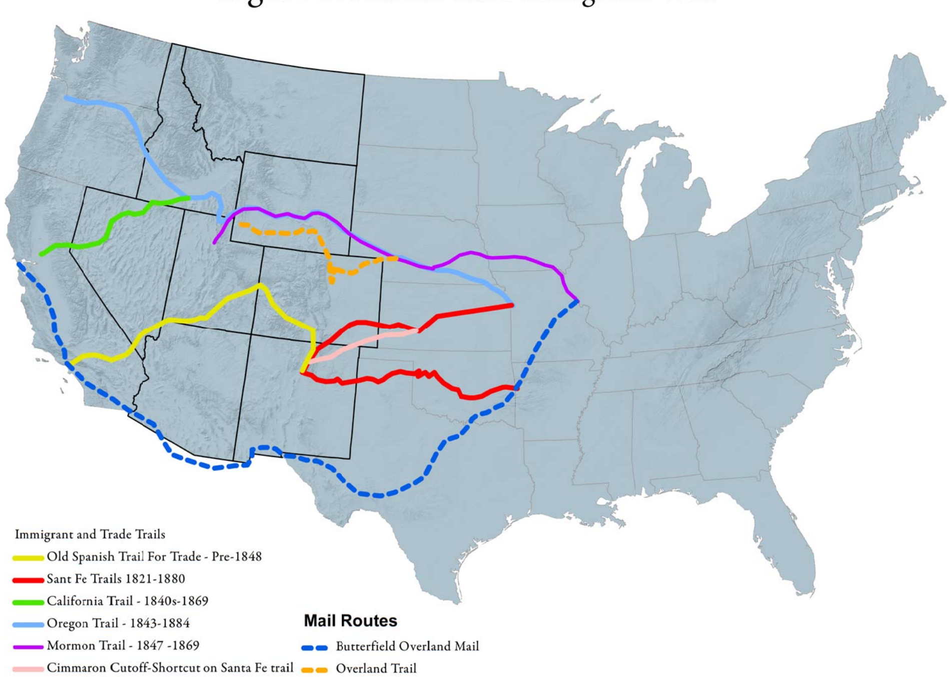
Three of the other trails shown in **Figure 3** were primarily pioneer trails through the West that were used by settlers and prospectors, particularly the California trail used by '49ers when gold was discovered there. The Mormon Trail was first followed in 1847 by Brigham Young to bring his persecuted Mormons from the East to Utah where he initially established their settlement in Salt Lake City. Eventually more than 70,000 Mormons used the trail to reach Salt Lake City until the transcontinental railroad replaced it in 1869.[21] The Oregon Trail opened up Oregon for settlement; Lewis and Clark's original route was seen as too treacherous for families. The first major group of about 1,000 people to use the trail left Independence, Missouri in the spring of 1843 and made their way to Oregon's Willamette Valley. It is estimated that 80,000 people used the trail before usage declined after the opening of the transcontinental railroad in 1869, and in 1884 by a branch rail line to serve Oregon directly.[22,23] The California trail was the most used trail in the region (it followed the Oregon trail until it branched off to the Southwest); it was used by over 250,000 gold seekers and farmers journeying to California, although the depiction in **Figure 3** is a crude approximation because various parties used alternate routes that they believed provided faster and easier passage not only through the Rockies but the equally difficult obstacles of the Sierra Nevada Mountains.[24]

The first mail communication in the West came in 1849 as bi-monthly mail from the East to Salt Lake City after the Mormons had settled there. This route simply consisted of a team of pack animals and was extremely slow. In 1851 a similar mail route was created between California and Salt Lake City. [25] The first stage-coach route in the West that was formally established was the Butterfield Overland Mail Route, shown in **Figure 3**. It was the first transcontinental overland mail route designed for communication with California itself. The route went via El Paso, Texas to the South in order to be snow free and avoid the obstacles of the Rocky Mountains. This was subsidized by the federal government in order to provide California with a faster means of communication after it became a state in 1850.[26]

What constituted a stage route exactly? A prime example is the Butterfield Overland Route, authorized by Congress in 1857. Before it could begin operations a year later, 141 stations were built along the route between 10 and 25 miles apart to provide for changing horses and drivers as well as ticket offices, restaurants, and lodging for passengers.[27] Eventually this stage was replaced by the Central Overland Route to California in 1861, because of the Civil War, it is the latest trail shown in **Figure 3**. [28]

The form of communication in the interior West that was a legend and has the most present day mystique —although it only was in operation for eighteen months and was a business flop—was the Pony Express. The first Pony Express service left San Francisco, California on April 3, 1860. In summer, letters took 13 days between New York and San Francisco and telegraphic dispatches took nine days (messages were relayed via telegraph where lines existed).[28] **Figure 1** shows these times compared to the conventional mail service. The price was $2.50 per half ounce, or approximately $60 in 2009 dollars.[28] The fastest time for communication yet was a special Pony Express run in 1860 that went from Fort Kearney, Nebraska to Fort Churchill, Nevada in 6 days carrying the news of Lincoln's Election.[28] The trip took 13.8 days in winter

Figure 3: Historic Trails through the West



Source: http://www.upa.pdx.edu/IMS/currentprojects/TAHv3/GIS_data/West_Expansion/territorial_acquisitions.zip between the two ends of the telegraph network.[28] Communications finally became instantaneous with the completion of the transcontinental telegraph along the Overland Route to Salt Lake City, and the first message was sent to President Lincoln on October 24th, 1861. This led to the immediate demise of the Pony Express.[28] The stage coach's days along the major routes were equally numbered because of a new form of transportation: the iron-horse.

Railroads:

The next form of technology to dominate transportation and infrastructure in the American West was the railroad. In the 1820's, the first steam powered locomotives were manufactured on the East Coast. In 1845 Asa Whitney made the first proposal to Congress to build a transcontinental railroad.[29] Like most infrastructure projects of this day, the railroad was to connect California with the settled East Coast; there was little or no consideration given to connecting the few communities in the Rocky Mountain West. In 1854 the first Eastern railroad line reached the Mississippi River,[30] but disagreements in Congress over building a Northern or Southern route hampered the railroad's progress. The Civil War and Southern secession settled the matter and the Pacific Railroad Acts passed in 1862 and 1864, which directed the Union Pacific to begin constructing a line West from Council Bluffs, Iowa (across the Missouri River from Omaha, Nebraska) to meet up with the Central Pacific starting from California. In 1864 another act authorized the Northern Pacific Railroad from Duluth, Minnesota to Puget Sound, Washington.[30] Under these acts, through land grants and bonds, the federal government gave the railroads huge financial incentives to build the routes. For example, the Union Pacific and Central Pacific were given ten alternate sections of public land on each side of the railroad right-of-way per straight line of railroad. They also had access to "cheap" capital from low-interest six percent government bonds intended to help fund the lines. Most of the other transcontinental railroads received similar incentives,[31] so that by 1930 the federal government had given the railroads 205,000 square miles of land throughout the country. The railroads thus became a primary landowner and broker of the land along their routes.[31]

Over the next half century, more transcontinental routes were built through the region. The Northern Pacific Route through Southern Montana and the Southern Pacific's "Sunset Route" through the Gadsden Purchase were completed in 1883.[32] In 1887 the Atchison, Topeka and Santa Fe reached Los Angeles, and in 1893 the Great Northern Railroad completed the 'Hi-Line' through Northern Montana. In the first quarter of the 20th century, railroad expansion continued to impact the Rockies. In 1909 the Milwaukee Road opened its transcontinental route from the Northern Plains to Seattle and Tacoma, running through the center of Montana with a route shorter than the two other lines through Montana. To attest to the profitability of the railroads, this route was built without any land grants; the railroad simply purchased the land out right. Major portions of this line were also electrified for more efficient travel through the mountains.[33] Throughout the early 1900's, the railway network continued to expand; in 1916 the number of railway track miles reached their peak in the country at 254,251 miles; subsequently since then, more track has been abandoned than built nationwide.[34] The final major railway achievement in the region was the finishing of the Moffat Tunnel, completed in 1927, which gave Denver, Colorado a viable and direct path through the Colorado Rockies, instead of the more circuitous routes via Cheyenne, Pueblo, or Rollins Pass.[35]

The next major chapter in the history of the railroads in the Rockies came after they experienced huge usage in World War II; this was followed by an increasingly competitive environment with trucks and aviation. Unfortunately, railroads were locked into heavy government regulations under the Interstate Commerce Commission Act (ICC) of 1888 which regulated the railroads as a 19th century monopoly on transportation. These regulations had never been updated because of the increased competition from planes and trucks, leaving in place obsolete requirements for railroads to run unprofitable passenger routes, and most importantly controls on minimum and maximum rates for shipments. These minimum rates were harmful to the railroads because they were generally high enough to make trucking a competitive alternative and did not allow railroads to take advantage of their huge efficiencies in cost.[34] For example, railroads at present are three times as fuel efficient as trucks and in 2008, moved a ton of freight 457 miles on average per gallon of diesel.[36,37] In addition, the ICC made it extremely hard to abandon redundant and poor performing lines because all of its decisions were affected by politics. Even in the railroad "dark ages" of the 1960's, national ton-miles increased from 573 billion to 765 billion; by 1998 this figure had reached 1,365 billion.[38] Unfortunately the low, regulated rates caused the railroads to continue to lose money, and slow speeds from the process of switching railroad cars on and off the tracks (intermodal trains and the use of containers were just beginning) reduced speeds from loading dock to loading dock to a rate of just 20 miles per hour.[38]

The railroads were also unprofitable on their passenger trains in the 1960's, due to the requirements regarding passenger traffic. In 1962 the earliest streamliner operation across the West, the Milwaukee Road's *Olympic Hiawatha* was discontinued. In the next decade, trains became even more unprofitable; in 1967 the U.S. Post Office decided to discontinue its railway post offices and sent mail via planes and trucks.[38] Eventually, as a way to save passenger train service, Amtrak was created and assumed all intercity train operations effective May 1, 1971. This resulted in the discontinuation of more than half of the passenger rail routes in the country, with only 21 percent of the route-miles of a decade earlier surviving.[39] In the Rocky Mountain West, the route map went from six different transcontinental routes at the end of 1970—with North-South service going from Las Vegas, Nevada as far North as Butte, Montana,[40]—to basically how it looks today in **Figure 4.**

From 1970 through 1995 the landscape of the railroads in the Rocky Mountain Region changed drastically through abandonments and consolidations that have resulted in the Union Pacific and Burlington Northern Santa Fe (BNSF) as the only large railroads presently operating. **Figure 5** shows the railroad network in approximately 1970 with all the various historical railways indicated, as well as the year that they were consolidated into BNSF or Union Pacific. Those lines that were abandoned or became minor independent short line railroads are shown in **Figure 4**, the present day network as shown in 2006. In the 1970's the railroads continued to decline, although in 1970, the ICC approved the merger of the Great Northern, Northern Pacific, and Burlington Route, becoming the Burlington Northern Railroad.[41] This merger was approved because of the existence of the declining Milwaukee Road; otherwise it would have been defeated on antitrust grounds. In 1974 the Milwaukee Road discontinued electrification and in 1980 its transcontinental line was abandoned.[42] The passing of the Staggers Act of 1980 allowed railroads to become the profitable businesses they are today. Briefly, this act deregulated railroads, and allowed them to easily abandon lines, as shown on **Figure 4**.[43] With the use of container trains and intermodal operations, the railroads returned to profitability; in 1979 the rate of return for the railroad industry as a whole was one percent, by 1981 it was five percent, and was eight percent in 1990.[43] Today its profitability has even caught the attention of billionaire investor Warren Buffett, who fully purchased BNSF in 2009. The Staggers Act of 1980 also made mergers much easier, harder to protest on anti-trust grounds, and led to consolidation that resulted in the region having just two Class-I main line railroads today. As shown in **Figure 4,** the present day railroad map illustrates an increase in smaller Short Line Railroads, since mainlines that were not abandoned were sold to local interests.[43]

The Motorcar and Road Era:

The beginnings of automobile travel in the Rocky Mountain West can be traced back to the turn of the 20th century. In 1903 Dr. Horatio Nelson Jackson and his mechanic Seawall Croker traveled in a motor-car named *The Vermont*, after Dr. Jackson's home state, and spent 63.5 days driving from San Francisco to New York. They became the first people to drive cross country in a horseless-carriage.[44]

Since 1880 when the League of American Wheelmen was established to champion good roads for bicycling, the general public has not ceased complaining about traffic and poor road conditions.[45] In 1909, for example, Colorado established its State Highway Commission (what has evolved into the Colorado Department of Transportation - CDOT); in 1910 when the commissioners went on a road trip to assess road conditions they were often stuck in the mud on "roads that were never meant for anything but a horse drawn vehicle." These commissioners first realized the potential for economic development from motorcar tourists if the state had improved roads.[46]

Through the early 1900's, road building was mostly a local affair; various auto trails were constructed through the region and these were maintained by private organizations. By far the most prominent organization in the region was formed in 1913 to set the course of the transcontinental Lincoln Highway. This organization still exists and calls itself "Celebrating the First Road Across

Figure 4: Modern Day Railroads in the Rockies

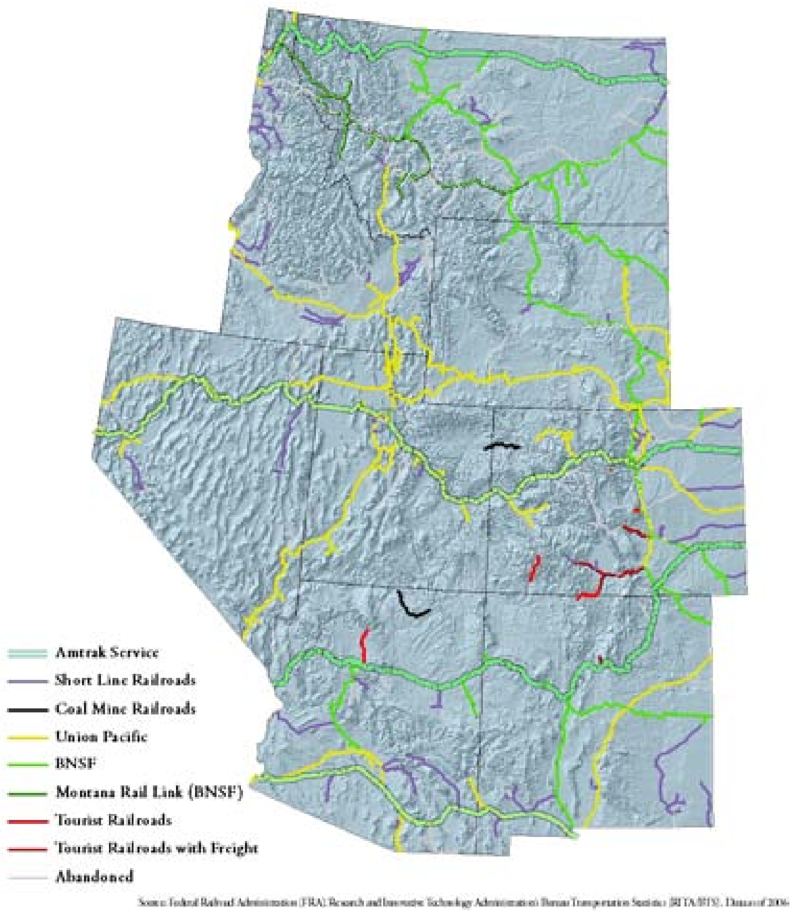
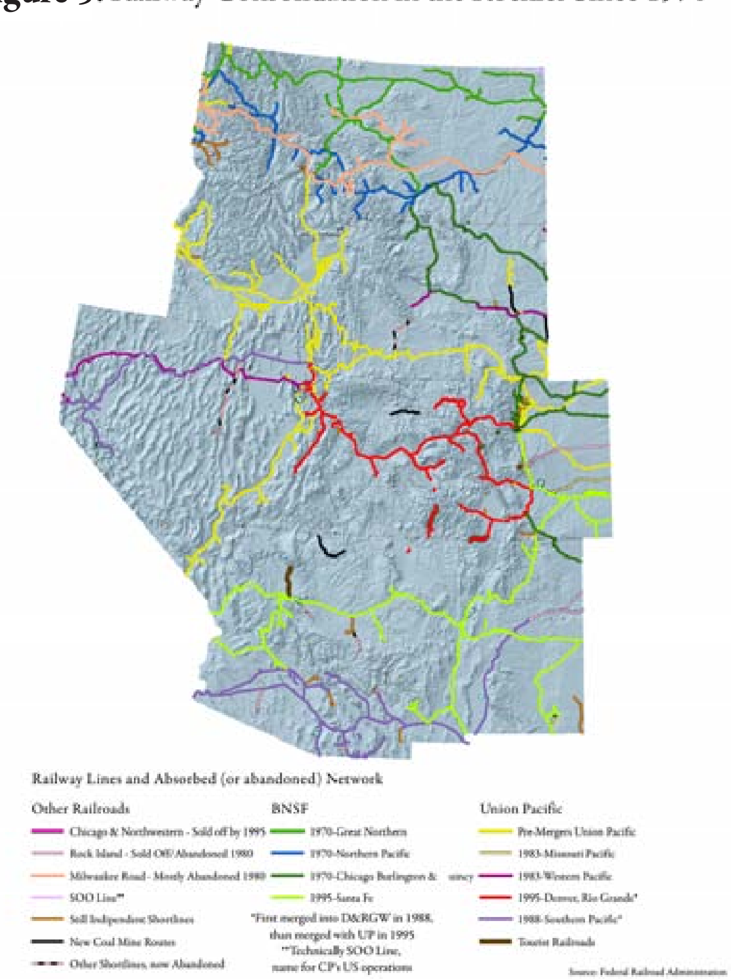


Figure 5: Railway Consolidation in the Rockies Since 1970



America."[47] This road crossed the region through Southern Wyoming, Northern Utah and Nevada with a spur route detour to Denver on its way between New York and San Francisco.[48] There were many other routes too, although it is nearly impossible to know the exact number because of the many different clubs erecting signs on the roads. Barely existing roads were often identified, named, and marked by numerous types of signage. Many roads had multiple signs for overlapping auto trails that were built by competing auto clubs (each supported by different constituency along their route). One road in Southwestern New Mexico carried markers for five different auto trails. The routes could also change from time to time depending upon their backers.[49] In 1919 the US Army sent its first Transcontinental Army Convoy across country, taking 62 days; many roads were nearly impassable. Most important was Dwight Eisenhower's participation on this trip; seeing the road conditions made him realize the importance of good roads and influenced his later role as the founder of the Interstate Highway System.[50]

In 1916 the Federal Government started funding the road system for the first time with the passage of the Federal-Aid Road Act, for highway building in cooperation with the states.[51] This led to every state forming a State Highway Department to use the federal funds and these state organizations joined together to create the American Association of State Highway Officials (AASHTO). These steps then led to the creation (with the help of the Federal Government) of various standards for highways in the country, especially the designation of coordinated route numbers to replace the numerous ad hoc names. The primary reason for disagreements during the 1925 meetings, intended to select names and numbers for our highway system, was what routes to designate – a few transcontinental routes or any route that went between two neighboring states. Eventually the states agreed to have many roads but with the numbering system that exists to this day, even numbered designation for roads going East and West (with the lowest in the East), odd numbered designation for roads going North and South (with the lowest in the North). The interstate highway numbers follow these rules in reverse. There was public uproar throughout the country from locations that felt they had been left out of the new highway system. The network covered over 96,626 miles of federal highways in 1926, but many members of the trails associations complained that simply numbering the roads was too dull. AASHTO adopted the numbering system on November 11, 1926. Slowly, with some federal assistance, the roads of the Rockies were improved from dirt tracks to gravel and paved roadways.[52]

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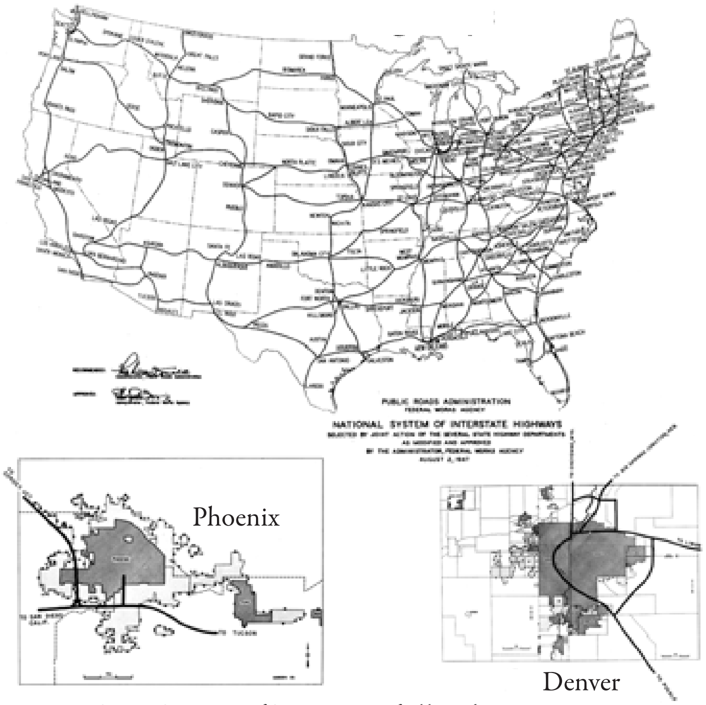
The final major transportation development came in the form of planning and then implementing the National System of Interstate Highways. The first steps consisted of reports in 1939 and 1944 to Congress; these documents all accumulated in one particularly well known document called the "yellow book," partially seen in **Figure 6**. This booklet consists of maps of most metropolitan areas, showing various interstate highway extensions into urban areas and was delivered to every Congressman's desk in 1955.[53] What these plans meant to the relatively small Rockies region, with a total population of just five million people in 1950, can be shown by the fact that only six of the 100 maps of metropolitan areas in the booklet are cities in the Rockies region. **Figure 6** provides some examples. Some interesting observations from the book can be found in the fact that none of the included cities in the Rockies were designated to receive beltways encircling there urban cores, as many Eastern counterparts were receiving. The only city in the region included in this booklet to receive anything comparable was Denver, Colorado with what has become I-225. All the other cities included in the region (Phoenix and Tucson, Arizona; Pocatello, Idaho; and Butte and Great Falls, Montana) simply received one short spur route off the proposed intercity route(s) to connect these urban area to highways that bypassed the cities and their downtown cores.[54] Interestingly enough, cities that were missing insets completely included Clark County, Nevada (Las Vegas), which only had a population of 48,000 in 1950. In addition, Salt Lake City, Utah was missing a page but it did receive its 'Belt Route' of I-215 added in 1957 in some last-minute additions to the system. This addition made Salt Lake City the only city in the region that received a full beltway as part of the interstate highway plan and the full federal funding amounts to build it. Out of the approximately 60 cities in the yellow book given interstate highway bypass routes to avoid downtown cores, only one was in the Rockies region.[54] The small size of Las Vegas, Nevada at the time also explains why there is no interstate route connecting it with Phoenix, Arizona to the Southeast, although there are currently long-range plans to upgrade US-93, the road connecting those two cities to interstate standards. This new Interstate has been named I-11.[55]

A final, even more glaring omission from the early Interstate Highway System planning in the Rockies concerns Colorado's current I-70. The plan adopted for the National System of Interstate Highways in 1947, as seen in **Figure 6**, shows what is now I-70's western terminus in Denver. There was no East-West interstate crossing the Rockies in Colorado; the main reason was the Bureau of Public Roads' fear about the financial resources required to build an interstate through the Rockies. Colorado's Governor at the time, Edwin C. Johnson, of course wanted the road to be built.[56] He offered to have Colorado fund a tunnel (now the Eisenhower-Johnson Memorial Tunnels) beneath the Continental Divide if the Interstate was extended through the mountains and funded with federal dollars. These tunnels had been part of a plan from the 1950's which included a toll tunnel beneath the Continental Divide.[57] Johnson even went so far as to personally lobby President Eisenhower who had complained about the traffic between Denver and the mountains when he came to Colorado on fishing vacations.[56] Eventually, in 1957, the road was added to the Interstate Highway system, although not without further controversy. Utah wanted I-70, after leaving Colorado, to curve North to Spanish Fork and into Salt Lake City. The Defense Department got on board and vetoed that request stating that there was already a connection between those cities (I-25 to I-80 via Wyoming) and that the road would provide a better use for defense purposes by creating a direct link to Southern California, ending in the tiny town of Clove Fork, Utah. In addition, the road West of Green River followed a completely new highway alignment, giving access to an area of Utah that had been previously without roads.[58]

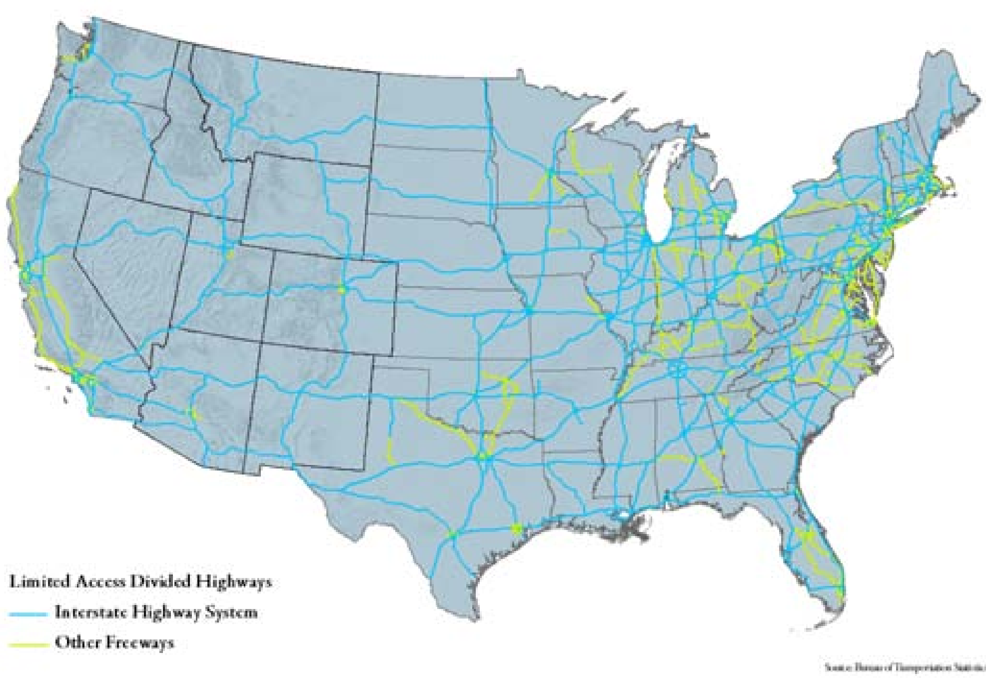
Figure 6: Yellow Book Scans



Source: U.S. Department of Commerce, Bureau of Public Roads

After the interstates were designed—the National Interstate and Defensive Highway Act passed on June 29, 1956—they had to be built, which took quite a bit of persuasion and compromise. **Figure 7** shows a map of the existing interstate highway system with an emphasis on the region, showing fewer routes than in the rest of the country. One possible reason for this was that the Colorado Front Range was the only region that had built any substantial distance of freeways by 1956; it had already built the Denver-Boulder Turnpike (US-36) a limited-access highway which was completed in 1952 and the tolls removed after the bonds for construction were fully paid off in 1967. In addition in 1949, the state began a ten-year project to build the four-lane highway that became I-25 between Denver and Pueblo; it was completed by 1960.[59] For the other Western states this was not the case; none of them had any large-scale experience building limited access highways. In Utah, for example, as is illustrated in the book *Divided Highways*, the state had built practically no limited access divided highways, and residents in its small towns thought that the existing network of roads was adequate and superhighways were only necessary in large cities. Questions were also raised on why seldom-traveled crossroads needed overpasses, what would happen to properties bisected

Figure 7: Current Interstate Highway System and Freeway Infrastructure of the United States



by roads, and why did the right-of-way upon each side have to be so wide? The residents of main streets in small towns did not understand why they and their businesses were being bypassed by limited access highways instead of the state improving the roads that ran through the "main streets" of these small towns. Towns and cities that had the interstates nearby generally prospered economically, while those completely bypassed witnessed population and economic decline, an effect similar to those towns bypassed by the railroads.[60]

After the building of the interstate system in the Rockies, urban populations started to increase and sprawl increased dramatically in many cities. Three cities in the region put together interesting and innovative solutions to building more freeways, particularly beltways and routes connecting their suburbs. The first city was Phoenix, Arizona, whose effort started when a ballot initiative passed in Maricopa County in 1985 for a half-cent sales tax to construct new limited-access highways and freeways; this was extended in 1994 and 2004, and will be in effect for building new freeways until 2025.[61] This sales tax revenue has paid for two three-quarter 'loop freeways' Loop-101 and Loop-202 around different portions of the Valley of the Sun, in addition to other freeway improvements; a third partial Loop, 303 is currently in development. All of these highways are built to Interstate standards, meaning they are eligible to be designated as interstates but Arizona's Department of Transportation (ADOT) has decided to number them independently, not giving them three digit offshoot designates as spur routes of I-10 and I-17. Arizona does not have any auxiliary interstate routes. An example of the breakdown of funding for Highway/Freeway Improvements in Maricopa County from 2006 to 2026 consists of 53 percent from the sales tax, 45 percent from ADOT funds (which includes some state-appropriated federal funds), and just two percent from direct federal funding.[62] This funding breakdown is a far cry from the 90 percent federal funding of the original interstate highway system.

The next metropolitan area in the West that decided to build a beltway was Denver, Colorado. In 1968 it received federal approval to build I-470 as an interstate highway for at least its South-West portion (what is now designated as C-470). In the 1970's attempts to write environmental impact statements for the highway failed and in 1976 the plans were withdrawn. Some federal funds were still available and financed what has become the C-470 portion of the beltway that forms the Southwest quadrant. It opened in stages between 1985 and 1990. In November 1988, voters in the area of the Eastern-half of the Beltway approved a ten dollar per year car registration fee increase and along with bonds guaranteed by toll revenue, the E-470 toll road was constructed and opened in stages between 1991 and 2003. A similar movement was afoot to build a W-470 portion in the Northeastern quadrant, but its referendum was heavily defeated in 1988. Eventually, the northern most portion through Broomfield was built as the 11-mile Northwest Parkway Extension in 2003; it was entirely privately funded, thus not requiring a referendum.[63] This leaves 86 miles of 106 planned miles of Denver's beltway completed according to the Beltway to Tomorrow Coalition run by the Jefferson County Economic Council Business Group. This group proposes finishing the beltway with half as tolled portions and half as an expressway instead of freeway standards.[64]

Las Vegas, Nevada was the last major city in the Rockies to begin building a beltway system with the construction of the Bruce Woodbury Beltway I-215 (with signs Clark County-215 for the sections not up to interstate standards); work slowly continues to this day. The frontage roads of the beltway were completed in 2003. These frontage roads are being upgraded and expanded to freeway standards as funds allow and traffic warrants. Incremental work continues with 2025 being the ultimate completion date for the 53-mile circle roadway around three-quarters of the Las Vegas Valley. The most unusual feature of this project is its funding structure, originating almost entirely from Clark County, making it the first interstate highway in the nation to be funded without federal or state funds.[65] If these three metropolitan areas had had bigger populations in the 1950's when the interstate highway system was being planned, all of these belt freeways would have been designated as interstates and been eligible for the 90 percent federal funding, instead of relying so heavily on local sales taxes or tolls.

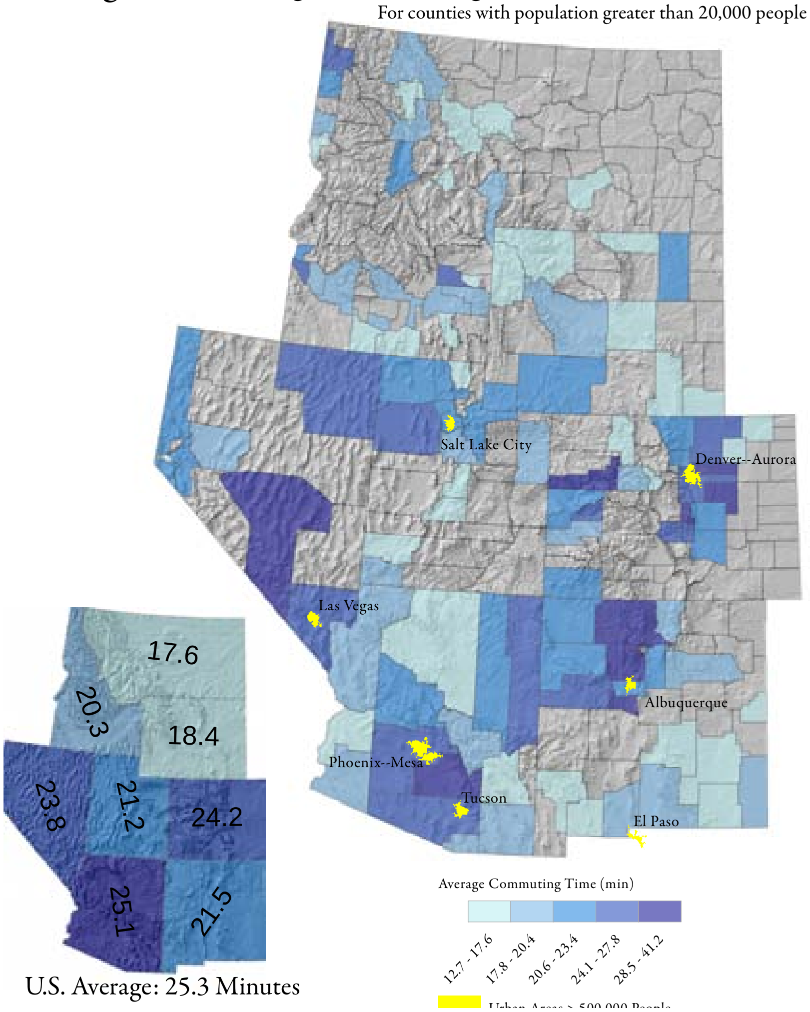
Metropolitan Areas and their Infrastructure:

The Brookings Institute's *Mountain Megas* report classifies five-megapolitan regions in the Rockies: Las Vegas, Northern New Mexico, the Sun Corridor (Phoenix), Wasatch Front (Salt Lake City), and the Front Range (Denver), and highlights some very interesting facts about these urban areas, most importantly the density of the region's population. These regions are included in **Figure 8.** In 2000, for example, 93 percent of the megapolitan population lived in urban areas—containing 1,000 persons per square mile minimum, while 79 percent is the national average. These megapolitan regions had an average urbanized density of over five persons per urban acre. Las Vegas had seven, and Denver and Salt Lake City each had six—the same as urban Chicago, far above the 3.6 persons per acre of urban Boston.[66]

One of the easiest ways to quantify transportation infrastructure usage in regions is by evaluating the commuting trends of the workforce to and from work. This information is collected by the U.S. Census's American Community Survey 2006-2008 three year report. The mode of transit used per percentage of the workforce is shown in **Table 2.** The results show that on average a similar number of people drove alone to work in the region compared to the national average, with more in the region car pooling, taking other means, and working at home. The most staggering trend this data shows is how few people in the Rockies Region take public transit (not including a taxicab) to work; the number is half the national average. With the metropolitan Rockies densities so high, there is room for public transit usage to increase and most of the megapolitans are building new public transit infrastructure. In 2008 alone, the first regional rail lines in the region were completed between Salt Lake City and Provo, Utah, and Albuquerque and Santa Fe, New Mexico. Phoenix also opened its first Light Rail Line in 2008, complementing Salt Lake City and Denver lines that have been open since 1994 and 1999 respectively. Expansion continues: for example, Denver's FasTracks program is scheduled to build 122 new miles of commuter and light rail lines by 2018,[67] and Salt Lake City's Front-

Figure 8: Average Commuting Times In the Rockies

For counties with population greater than 20,000 people



Lines program will build 70 new miles of rail by 2015.[68]

A final way that commuting in the Rockies region is evaluated in the American Community Survey is by measuring the average commute time one-way to work for adults over 16 who did not work at home. These are analyzed for the region on a county by county basis for those counties with a population of over 20,000. **Figure 8** shows these results for the Rockies**.** Every state in the Rockies is below the national average of 25.3 minutes per each direction of their commute, with the more rural Northern Rockies states being much lower; Montana, for instance, has the third-lowest commute time in the nation behind only the Dakotas.[69] In Germany, one researcher has shown that people with longer commute times to and from work are systematically worse off and report a lower life satisfaction and increased stress.[70] This may well mean that short commute times contribute to a higher quality of life in Rockies communities. In the future, if Rockies infrastructure in urban areas becomes too congested, it threatens not just to limit productivity, but also possibly to increase stress and make the Rockies a less appealing region in which to live and visit. Then local, regional, and national action may well be focused on mass-transit solutions.

Broadband Access

In addition to transportation access, it is also important to consider the accessibility of information in the discussion of the state of infrastructure in the Rockies. The current era has been referred to as "the age of information" and "the digital age" thanks to the Internet's ability to disseminate vast amounts of data, facts, and figures and reduce geographic isolation by connecting people from far-reaching corners of the world instantaneously. Internet use worldwide passed the 1.5 billion person mark in 2008 – about 22 percent of the world's population.[71] Businesses and economies are increasingly relying on speedy communication to reach more customers and sell more products and services with increasing efficiency.[72] Reliable high-speed Internet has thus become the prerequisite for economic growth, job creation, and greater quality of life.[73]

Internet access not only makes the U.S. globally competitive, it also has small scale local and regional benefits that go beyond improving businesses and local economies; Internet access enables distance-learning, provides entertainment, enhances healthcare through telemedicine, facilitates civic participation, and improves quality of life.[74]

High speed connection allows businesses to thrive. Broadband enables the use of multimedia uploads and downloads and online applications.[75] The faster the service, the less time it takes to utilize these benefits, and it allows productivity to increase. Broadband also provides online storage and greatly enhances telecommunications; video conferencing is especially beneficial as it allows people to interact face-to-face from miles away. This economic boost that broadband provides for a single company can translate into local and regional economic benefits.

Internet access alone does not translate to providing its full benefits. The transmission speed, or bandwidth at which a person or business is able to upload and download information to and from the Internet, greatly influences its usefulness. The slower the connection, the less beneficial it is.[76] The term "broadband" refers to high speed Internet. The Federal Communications Commission has historically defined broadband as having a minimum of 200 kilobytes per second in one transmission direction; however, the FCC's current definition of high-speed Internet is 20 times faster, at four megabytes per second.[76] Dial-up is the slowest way to connect to the Internet, with a maximum capability of 56 kilobytes per second. **Table 3** outlines the differences between internet options.

Table 2: Workforce Commuting Modes

	Arizona	Colorado	Idaho	Montana	Nevada	New Mexico	Utah	Wyoming	Rockies	United States
Drove alone	75%	74%	76%	73%	77%	77%	75%	75%	75%	76%
Carpooled	14%	11%	12%	11%	12%	13%	13%	13%	12%	11%
Public transit	2%	3%	1%	1%	4%	1%	3%	1%	2%	5%
Walked	2%	3%	3%	5%	2%	2%	3%	4%	3%	3%
Other means	3%	2%	3%	3%	2%	2%	2%	2%	2%	2%
Worked at home	5%	6%	5%	7%	3%	5%	5%	5%	5%	4%

Source: United States Bureau of the Census. American Community Survey. *Means of Transportation to Work by Selected Characteristics 2006-2008* 3 Year Estimates

According to a study done in 2009, 78 percent of American adults use some form of Internet from home. Similarly, 65 percent of American adults use broadband to access the Internet from home.[77] Socioeconomic status and education levels strongly impact whether an adult uses broadband from home. Of those with a college education or higher, 82 percent use broadband at home, versus 46 percent of adults whose highest level of education is a high school degree.[77] Moreover, 52 percent of Americans who earn $50,000 or less annually use broadband at home versus 87 percent of those who earn more than $50,000.[77] Race, age, and disabilities also play a role in broadband adoption. Also noted is that 59 percent of African-Americans and 49 percent of Hispanics use broadband from home. Of Hispanics who opted to take the survey in English, 65 percent use broadband at home, while those who chose to take the survey in Spanish use broadband from home at a rate of 20 percent. Among adults who qualify as having a disability, 42 percent use broadband at home. Senior citizens have the lowest broadband adoption rate of 35 percent.[77] These statistics are displayed in **Table 4**.

Rural Broadband Use

While urban centers like Denver are in the process of upgrading to 4G wireless networks, many rural towns are ignored in terms of Internet upgrades, relying on the crawling pace of dial-up access or lacking any Internet access at all.[78] The Federal Communications Commission calls Internet "the great infrastructure challenge of the early 21st century."[79] Similar to electrification when it was being widely developed and adopted, it is profitable for private companies to develop broadband in urban areas where denser populations mean reaching more customers, with minimal costs per customer to implement the requisite infrastructure. Conversely, in rural centers, "the last mile" of infrastructure is costly, especially if the payoff must be spread over a few customers. Fourteen million Americans throughout the U.S. do not have access to infrastructure that can support broadband, and access to infrastructure that can support high speeds does not necessarily mean Internet service providers will offer Internet at the highest speeds the infrastructure can manage.[79]

According to a 2009 survey by the Federal Communications Commission, rural residents adopt broadband at a much lower rate than their urban and suburban counterparts. In rural areas 50 percent of American adults use broadband at home, versus 68 percent of American adults nationally.[80] This smaller proportion represents the demographics of rural places (older people with less annual income), but also reflects inadequate access to modern infrastructure. Rural dwellers cited reasons for not adopting broadband at rates similar to the national average, except in two categories. Rural residents are less likely to cite cost as a barrier for using broadband at home (31 percent of respondents of rural residents versus 38 percent nationally), while they were more than twice as likely than the national average to say that broadband service was not available where they lived; one in ten respondents from rural areas said they were unable to implement broadband in their homes versus four percent of respondents nationally as shown in **Table 4** and **Table 5.**[80] This reflects the physical difficulty and high cost of building the infrastructure necessary to connect rural areas with high speed Internet

Table 3: Types of High Speed Internet

Type	Speed	Required Infrastructure
Digital Subscriber Line (DSL)	Several hundred kilobytes per second (kbps) to millions of kilobytes per second (mbps), depending on distance from the closest telephone company facility	Existing, traditional copper telephone lines
Cable modem	1.5 mbps or more, comparable to DSL	Cable television lines and a cable modem device that connects to an outlet and a computer
Fiber optic	Tens to hundreds of Mbps, depending on configuration of the service and distance of the fibers from the computer	Fiber optic cables and technology that are capable of converting data-carrying signals to light and transmitting them through glass cables
Wireless	Several hundred Kbps to millions of bytes per second; similar to DSL and cable	A radio link connects a transmitter and receiver (phone or personal computer)
Satellite	Depends on the package purchased, the line of sight to the satellite, and the weather; 500 Kbps is normal	Uses existing satellites
Broadband Over Powerline (BPL)	Several hundred Kbps to Millions kilobytes per second; similar to DSL and cable modem	Uses existing powerlines and outlets. Availability remains very limited because the technology is developing, but has potential to be very useful to rural communities

Source: Federal Communcation Commission, at http://www.broadband.gov/broadband_types.html

The rural dwellers who do use broadband from home use it for shopping and taking online classes at rates comparable to those living in urban and suburban settings. This suggests that people who live in rural areas use broadband as a way to access the benefits that come with living in densely populated areas.[80]

Dial-up Internet requires no additional infrastructure for connection, other than a telephone line, and in many rural areas dial-up remains either the only option or the only affordable option for Internet access. Residents can be stuck with 14 kilobytes per second, which is 1.3 percent the speed of a standard, four megabyte high speed connection; this crawling pace can be used for text e-mails and little else, making most of the Internet inaccessible.[81] This is especially relevant in the Rockies, where population distribution is characterized by megapolitans surrounded by large rural tracts.

Table 4: Broadband Adoption from Home, 2008

	Rural Residents (Percentage)	All others in sample (Percentage)
All	50	68
Ages 18-29	56	78
Ages 30-49	63	76
Ages 50-64	51	67
Ages 65+	29	37

Group	Percentage of group which uses broadband
American Adults	65
African Americans	59
Hispanics	49
>$50,000 annual income	87
<$50,000 annual income	52
Rural Dwellers	50
College Education or higher	82
High School educated or less	46
Disabled	42
Senior Citizens	35

Source: John P. Horrigan. Broadband Adoption and Use in America. Federal Communication Commission, 2009: page 39. Available at http://online.wsj.com/public/resources/documents/FCCSurvey.pdf.

The American Recovery and Reinvestment Act of 2009 designates $7.2 billion in grants, loans, and loan guarantees to the U.S. Department of Agriculture's Rural Utilities Services Department and the Department of Commerce's National Telecommunications Information Administration to help solve this conundrum and give a boost to rural areas across the country.[82] These funds alone however will not achieve the Federal government's goal of universal, affordable broadband access. The Farm Bill of 2008 required the chairman of the Federal Communications Commission along with the secretary of the USDA to produce a comprehensive national strategy to deliver broadband to rural areas. The result is the National Broadband Plan of 2009 to further "promote world-leading mobile and broadband infrastructure and innovation."[83]

Figure 9 highlights increased broadband use around urban centers. Areas around the megapolitans are dark blue, indicating that upwards of 800 households per 1,000 households use high speed Internet.[84] There are some census tracts that reveal much lower usage, with between zero and 200 of every 1,000 households with broadband access.

One of the most striking patterns that emerge from mapping broadband usage on a census tract level is that Native American reservations consistently rank near the bottom in regards to rate of broadband usage. **Figure 9** also highlights this correlation by outlining Bureau of Indian Affairs land; one of the largest concentrations of these areas is around the Northern half of the border between Arizona and New Mexico, which is the site of the Hopi and Navajo Nations. This finding is consistent with historical trends; tribal lands have historically lagged behind the rest of the nation in telecommunications development. The 2000 census found that a mere 69 percent of Native American households on tribal lands in the continental U.S. had telephone service, compared to the national rate of 98 percent.[85] A 2006 report by the Government Accountability Office found that the most commonly cited barriers to telecommunications development were the rugged nature of the terrain of tribal lands and the tribes' limited capital resources.[85] For these reasons, the costs of developing the necessary infrastructure often became too high for companies to recover investment costs.[85] The study also cites the lack of technically trained tribal members and the difficulty to obtain rights of way for projects as barriers to telecommunications development.[85] New Mexico has the lowest average number of high speed Internet connections per 1,000 households in the region, averaging somewhere between 200 and 400. Both the U.S. and the Rockies have an average of somewhere between 400 and 600 out of 1,000 households with broadband access, although the Rockies average is slightly lower. Colorado has the highest average broadband penetration, better than the national

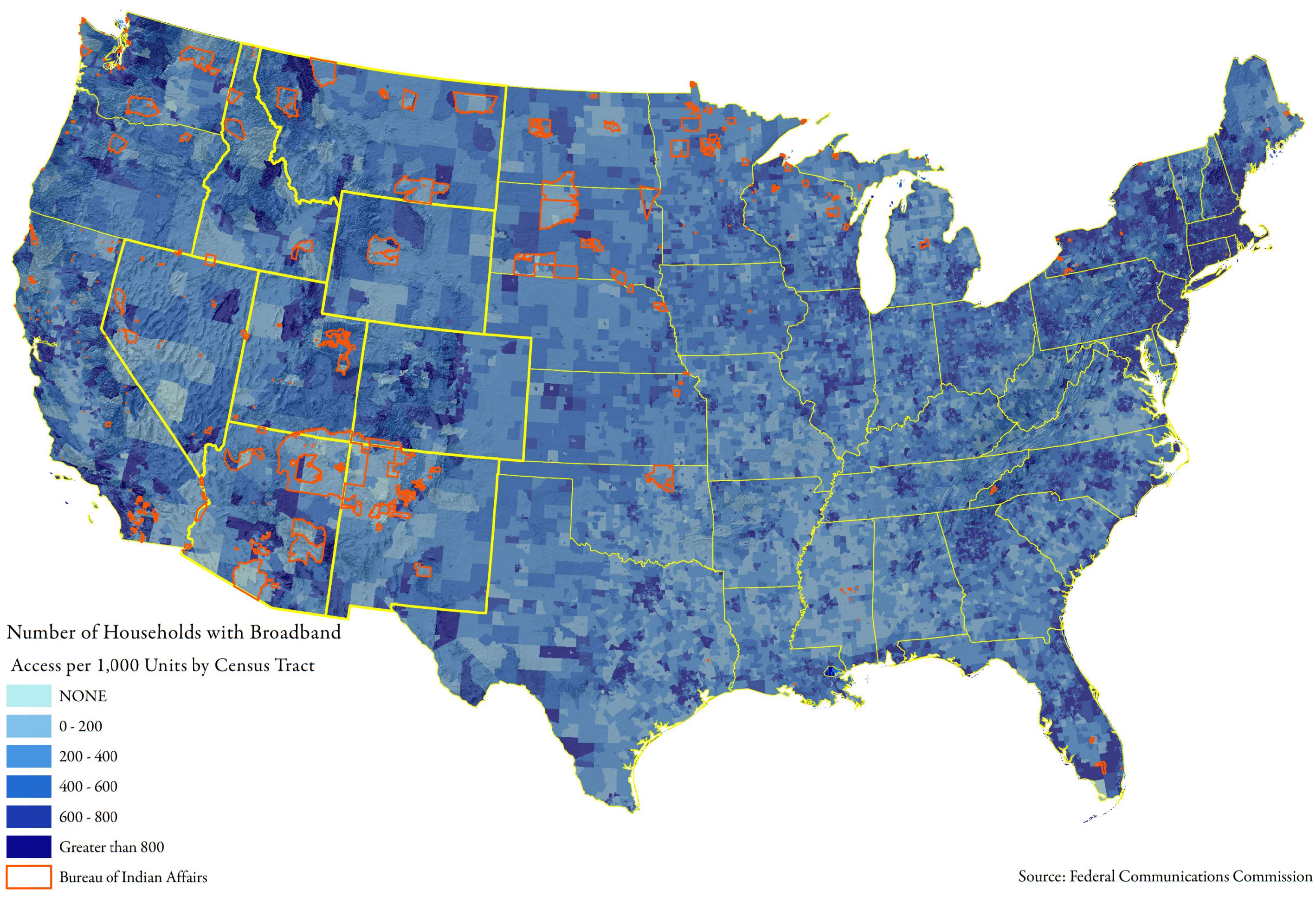
Table 5: Barriers to Broadband Adoption

Main reason cited for not having Internet or broadband (percent of total)

	Rural	National Average
Cost	31%	38%
Digital literacy	23%	21%
Relevance	19%	18%
Service not available	10%	4%
Other	18%	19%

Source: John P. Horrigan. Broadband Adoption and Use in America. Federal Communication Commission, 2009: page 39. Available at http://online.wsj.com/public/resources/documents/FCCSurvey.pdf.

Figure 9: National Broadband Penetration 2008



Source: Federal Communications Commission average.[86]

The Rockies contain 4,298 census tracts, of which 75 contain zero household units with broadband access. Every state has at least one tract that falls into this category. As **Figure 9** shows, the Rockies has a higher proportion of census tracts that fall into the lowest three rates of broadband penetration. The region has a lower proportion of census tracts that fall into the 601 to 800 and greater than 800 categories, the highest rates of broadband penetration.

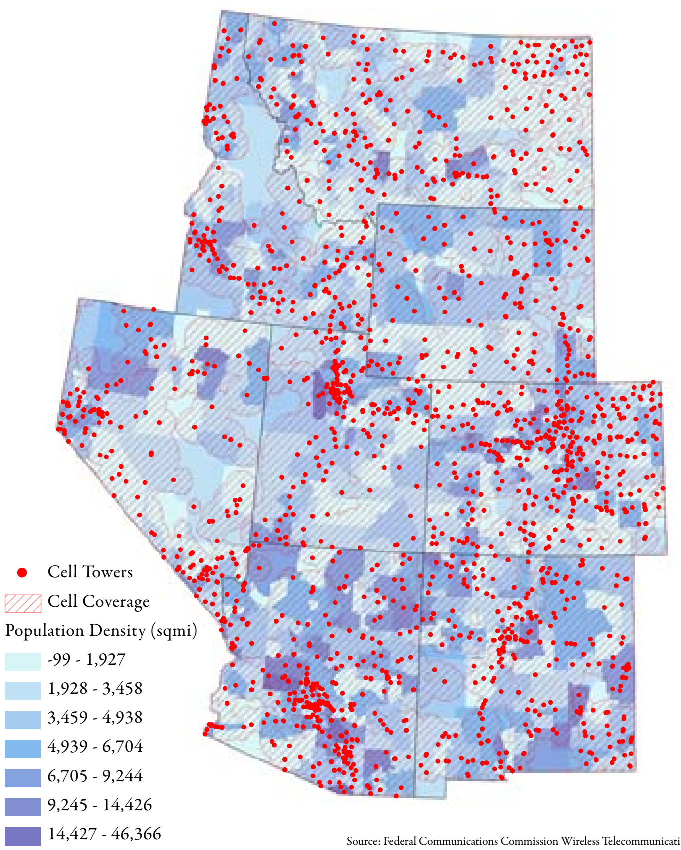
New Mexico has both the largest number of tracts that have between one and 200 households with broadband in the region, as well as the highest proportion that completely lack broadband capabilities; 22 out of 455 tracts (five percent), in the state have zero households with broadband.

Despite the fact that, on average, the Rockies is home to fewer households out of 1,000 with broadband access, the region scores higher than the national average in number of providers for fixed high speed connections, residential fixed high speed connections and mobile high speed connections per census tract. These numbers suggest that areas that do have broadband access have a wider selection of Internet service providers. This could also be attributed the population clusters of the Rockies.

Cell Phone Coverage in the Rocky Mountain West

In our increasingly mobile world, cell phone use continues to play an important role. Like all types of infrastructure covered in this section, wireless phones help connect people and places efficiently. As the use of smart phones grows and wireless broadband technology develops, cell phone coverage becomes even more relevant. An area without cell phone coverage is less likely to attract business and residential development as shown in **Figure 10**. As expected, the areas without cell phone coverage tend to have lower population density.

Figure 10: Cell Towers and Coverage in the Rockies



Source: Federal Communications Commission Wireless Telecommunications Bureau

Electricity in the U.S.

In the U.S., electricity is ubiquitous. Widespread availability allows Americans to take its services for granted, even as it plays an increasingly important role in our everyday lives. We have come to not only rely on its ability to light homes, power refrigerators, air conditioning, and heating systems, but also to power the computers and devices that we now rely upon to stay connected economically and socially and to have access to the "information age" that links people to what is going on in the rest of the world.

Electricity is an unusual commodity. It is generated from many sources: coal, natural gas, uranium, underground heat, water, wind, and the sun. The amount that it costs to produce often depends upon the time of day and year. Electricity must be used the moment it is produced because, as of yet, there is limited ability to store unused power on a large scale. It behaves much like water, flowing through transmission lines instead of pipes, but zipping around much faster. As a nation, we invest 40 percent of the total energy we use into producing electricity.[87]

The century-old electric grid that is woven throughout the U.S. is intricate and vast. It is the biggest interconnected machine on earth, and includes 9,200 electric generating units as well as tens of millions of miles of wire capable of delivering over a million mega watts of power.[88] The National Academy of Engineering declared the American grid the greatest engineering achievement of the twentieth century.[89] However, this system still uses the same technology it did in the 1960's. It was sufficient in the past, but as population and demand increase into the 21st century, an upgraded grid means increased reliability, better management of electricity to reduce consumption, and integration of new renewable energy sources.

The technology that delivers electricity to consumers has remained largely unchanged since it was first installed. In many places, a mechanical meter measures how much electricity a home uses and a meter reader walks around to record those numbers.[90] Most utility companies do not have the ability to see instantaneous changes in demand. That can become a big problem very quickly, because, due to the nature of the system, the amount of electricity produced must match the amount of electricity consumed. If that delicate balance is tipped, it can cause blackouts.[91] As we saw in 2003, when a single wire spurred a blackout in eight states and two Canadian provinces, cutting off power to 50 million people for up to three days, there is plenty of room for improvement. Each year, blackouts cause an estimated $150 billion in losses due to factories that are forced to idle, businesses that are not able to run, and the spoiling of products that rely on electricity, such as refrigeration.[92]

Electricity Demand in Region Grows Twice as Fast as the National Pace

Figure 11 and **Figure 12** illustrate the growing demand for electricity in the U.S. and the even higher growth of demand for electricity in the Rockies. Between 1960 and 2007, the U.S. went from consuming 163 trillion British thermal units (Btu) per state to consuming 804 trillion Btu per state, an increase of 392 percent over the 47 year period. Demand for electricity in the Rockies grew at a rate about twice as fast as the state national average. On average, Rockies states went from consuming about 52 trillion Btu annually in 1960 to consuming 463 trillion Btu in 2008; an increase of about 797 percent.[93] In 1960, the Rocky Mountain West accounted for five percent of total national electricity use compared to just under four percent of the national population; by 2008 the Rockies were responsible for nine percent of total national electricity consumption compared to seven percent of the national population. According to The Brattle Group, a research institution on economics and policy, $1.5 trillion in electricity infrastructure investment will be required between 2010 and 2030 to accommodate growing electricity demand in the U.S.[91] At least $135 billion of electricity infrastructure investment will be required in the Rockies over the same time, calculated as nine percent of the $1.5 trillion.

This accelerated rate in electricity demand in the Rockies is a result of a faster rate of population growth in the region relative to the rest of the country. More people in the region translate to higher demand for resources such as water, natural gas, and electricity. Such growth strains the existing infrastructure and requires new projects to increase capacity to meet growing demand.

The Western Interconnection

There are three major grids in the U.S., each nearly independent from one another: the Eastern, Texas, and Western Interconnections.[94] The electric grid that delivers power to the Rockies states is known as the Western Interconnection. This grid covers the eight-state region, the West Coast states, portions of Texas, South Dakota, and Nebraska, parts of British Columbia and Alberta, Canada, as well as the Northern part of Baja California, Mexico. The webbing of this system traverses 1.8 million miles and delivers electricity to 22 million people.[95] **Figure 13** shows the existing transmission interconnections in the broader U.S. region. The Rockies region is a net electricity exporting area, while California is a net importing area; both are part of the Western Interconnection (WECC). The Pacific Northwest, also part of WECC is a net exporting area in the spring and summer, and is neutral in the fall and winter.[96]

The mountainous geography and the sheer size of the region that have historically presented challenges to settling the Rockies also affect electricity delivery. Electricity requires transmission infrastructure. This infrastructure may take the familiar form of power lines, but also includes underground power lines. The great distances between population centers and the vastness of the region mean that the Western Grid is made up of transmission corridors that are much longer than their Eastern counterparts. The Rocky Mountains also present a physical challenge to connecting electricity sources to consumers, since it is difficult to place transmission lines that cross over mountainous areas.

Figure 11:
Change in Electricity Consumption
Source: Energy Information Administration

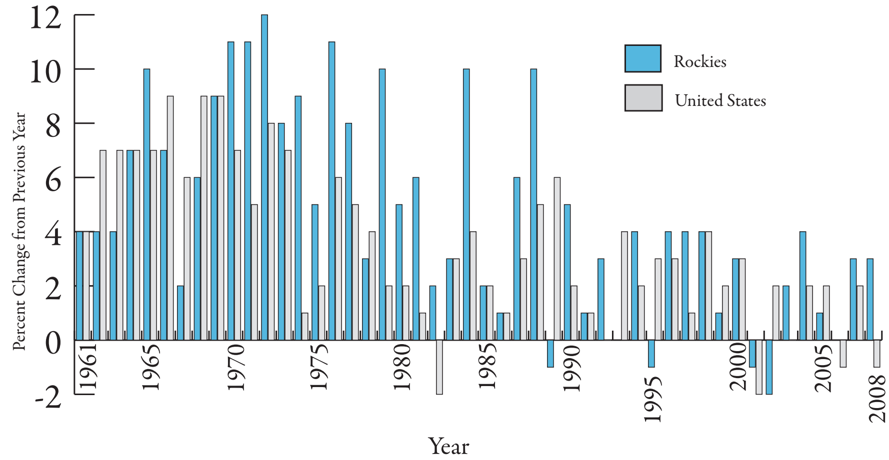
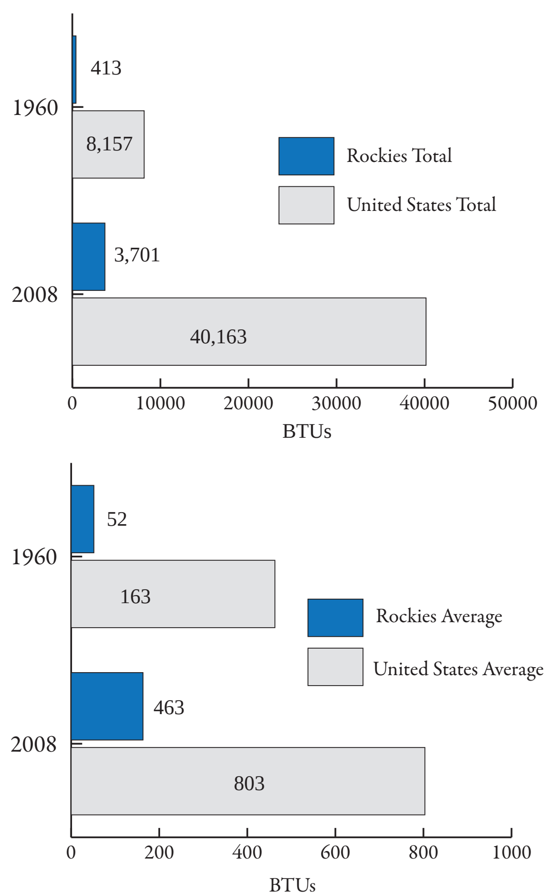


Figure 12:
Electricity Demand Change
Source: Energy Information Administration



Renewable Energy Development in the Western Interconnection

In addition to its physical characteristics, the potential for development of renewable energy also makes the region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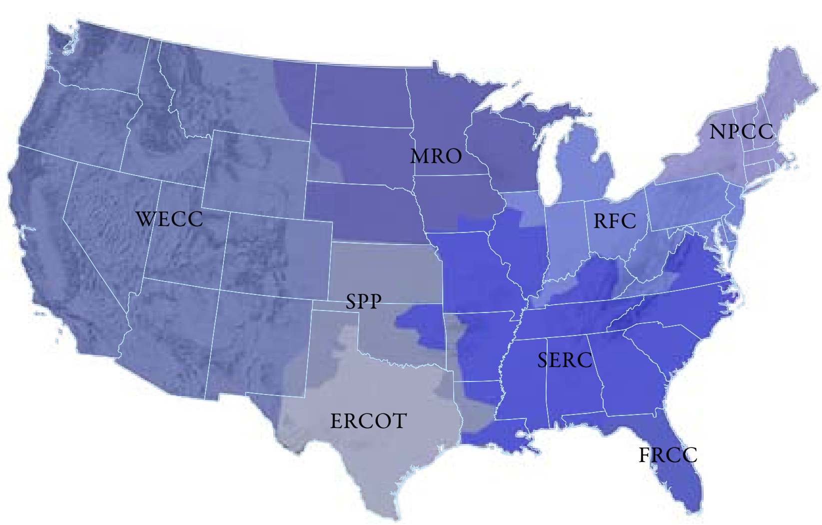
unique. The area served by the Western Interconnection is the most prolific source of undeveloped renewable energy in the country that current technology is able to capture.[97] **Figure 14** displays the renewable energy potential in the Rockies region of the Western Interconnection.

Table 6 lists renewable energy potential in the West. These numbers are based on a report completed by the Western Governors' Association and the U.S. Department of Energy. They reflect high quality renewable energy zones with generating capacity of at least 1,500 megawatts in areas that are within 100 miles of a connection to the grid. Areas where statutes and regulations forbid development, such as on designated wilderness areas and national parks, are excluded. The study also excluded areas whose established purpose does not align with renewable energy development, such as state parks, as well as areas that are not compatible with development, such as urban areas, wetlands, and extremely sloped places.[98] Based on this analysis, there is about 126,000 gigawatt-hours per year of renewable energy potential in the Rockies.[99] For comparison, in 2008, the Rockies consumed 1,085 gigawatt-hours and the U.S. consumed 11,770 gigawatt-hours of electricity.[100] As **Table 6** shows, Wyoming and Montana have the largest amount of high grade wind, while Arizona has the greatest potential for generating solar electricity.

Even though the technology to utilize these potential sources of renewable energy exists, there are multiple reasons why they remain a largely untapped energy resource. Sources of renewable energy tend to be concentrated in remote areas that do not have existing transmission infrastructure, sometimes hundreds of miles from a load center. **Figure 15** on the

Figure 13 : North American Reliability Corporation Interconnection Region



Source: Assessment of Demand Response and Advanced Metering, Federal Energy Regulatory Commission, August 2006

Table 6: Renewable Energy Generation Potential in the Rockies (GWh/yr)

Source	Arizona	Colorado	Idaho	Montana	Nevada	New Mexico	Utah	Wyoming	Rockies Total
Solar	19,780	2,303	0	0	18,582	13,718	7,202	0	61,585
Wind	3,717	15,679	1,603	10,059	431	13,184	1,678	14,854	61,205
Discovered Geo-thermal	0	0	279	0	1,368	0	225	0	1,872
Undiscovered Geothermal	1,043	1,105	1,872	771	4,364	1,484	1,464	174	-
Hydro	0	0	8	0	2	0	0	0	10
Biomass	327	153	358	147	300	223	91	16	1,615
Total	28,824	18,135	2,249	10,206	20,683	27,124	9,196	14,869	126,286

Source:Western Governors' Association and the U.S. Department of Energy, Western Renewable Energy Zones Phase 1

next page shows broadly the areas that contain renewable energy potential but that often lack the necessary infrastructure for their development. This means that new transmission lines must be built to connect the source of electricity to the grid. However, if the source of energy is more than 100 miles from a connection to the grid, the costs of building the requisite infrastructure start to become unreasonably expensive.[101]

In order to build transmission lines, a company must acquire the right-of-way to the land area required to build the lines. This is done by obtaining easement permits and government leases. An easement allows a company to permanently own a corridor across the land required to build and maintain the transmission line. However, this process is not simple. If transmission lines cross state lines, public land, and private land, as is often the case when connecting renewable energy to the grid, the permitting process becomes increasingly complicated. Environmental Impact Statements must be submitted to multiple Federal agencies. On non-federal lands, projects must obtain authorization from state and local governments, as well as environmental, regulatory, and land-use approvals.[102] If transmission projects must involve numerous different agencies, as they usually do in the West, it is more likely that regulatory requirements conflict with each other and that the process becomes increasingly intricate and lengthy.[101]

Electricity providers are also likely to run into local opposition. This may come in the form of conservation groups and citizens that are concerned about how the transmission lines will impact the health of the ecosystem they cut through. For example, transmission projects may threaten landscape species (species that require large tracts of territory to survive) such as the sage grouse; it is unclear how the activity, noise, and disturbance of a wind farm will affect this grasslands bird.[103] There is also concern about the effects that industrial wind farms have on birds and bats, but again, there is very little scientific evidence as to exactly how detrimental wind farms are to wildlife.[104] Wind farms may also pose a different type of threat. The air disturbance from wind farms can create blackout zones in radar systems; this interference can prevent air traffic controllers from being able to locate a plane's position, which may also post a security threat.[105]

Gary Graham, the transmission director for the environmental firm Western Resource Advocates states, "We can't do any energy development without there being some impact, that's just impossible. Denver and the Front Range is a huge market for energy, period. You can't meet that demand and retire dirty sources of electricity without identifying some place to do utility scale generation."[106] Since renewable energy is in the early stages of development in the region, there is little scientific research on how the requisite infrastructure, such as wind turbines, will impact wildlife and habitat, which makes environmentalists wary of new construction.

Utility companies are also likely to face opposition from local residents. Residents may protest because of sentimental ties to the land, or because the unsightly power lines would detract from their view, property values, and quality of life. Residents that live near wind farms sometimes complain that the low-frequency noise causes nausea and dizziness and that the noise of the turbines sometimes exceeds urban noise pollution standards.[107] It is possible to avoid some opposition by placing transmission lines underground, but this procedure costs a great deal more than placing a transmission line over-

Figure 14: Renewable Energy Potential

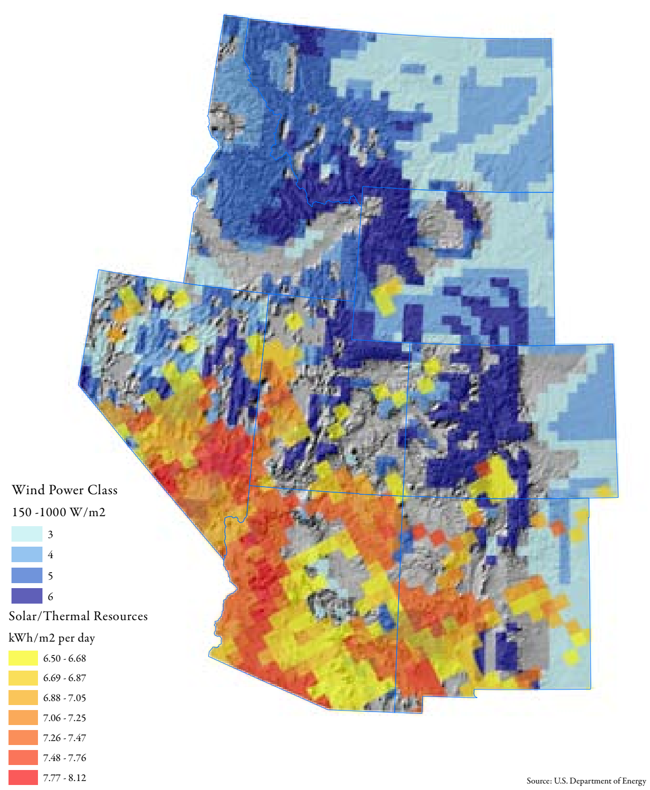
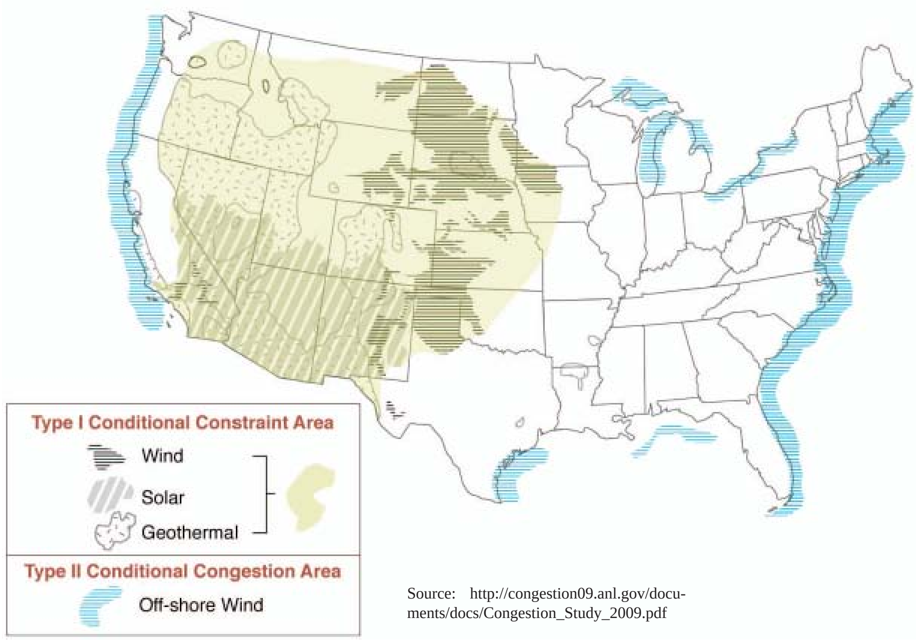


Figure 15: Conditional Constraint Areas



Source: http://congestion09.anl.gov/documents/docs/Congestion_Study_2009.pdf

head. For instance, for Lower Valley Energy, an electricity co-op serving the Jackson Hole, Wyoming area, burying a transmission line costs about $6 million per mile, while placing an overhead line costs about $600,000 per mile.[108] Underground transmission lines translate to rate increases to the consumers to cover the difference – another unpopular strategy. NIMBY-ism ("not in my backyard") continues to be a major issue in the West. In many cases, the local response to renewable energy development is similar to the response that fossil fuel extractors face. As Seth Wittke, the lead geothermal researcher at Wyoming's State Geological Survey, puts it, "They'd like to see the energy produced in a green or renewable manner, but they don't want to see the facility that is producing it across the valley or near their house."[109] Not only is development stalled by opposition falling into the "NIMBY" category, a new acronym is now being used to describe another type of opposition: BANANAism – Build Absolutely Nothing Anywhere Near Anyone.[107] However, not all projects face local opposition. In fact, some communities welcome the economic boost that transmission development can provide. A great example is Fowler, Colorado which is discussed at length in the Rockies Eastern Plains section.

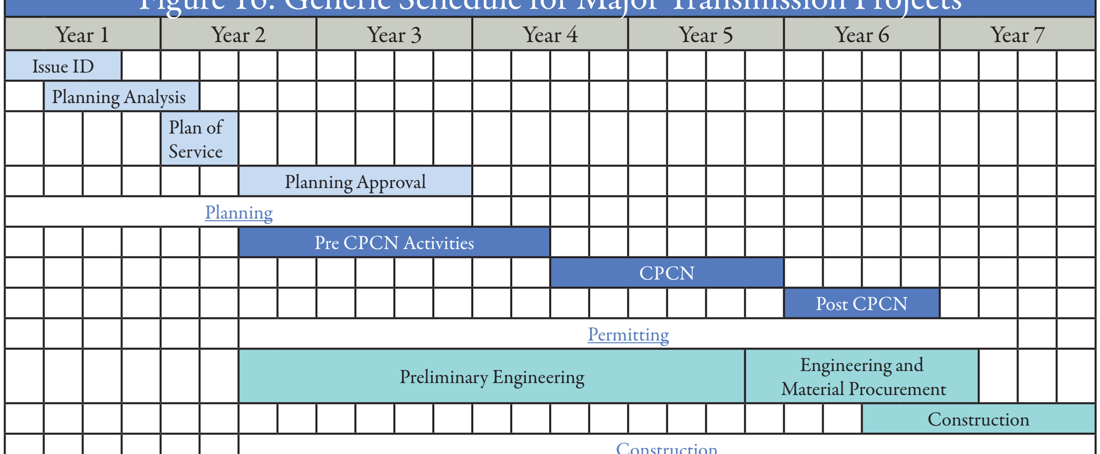
Companies sometimes have the power to condemn private land for the sake of public good using eminent domain. This means that if a company is not able to reach a reasonable settlement with landowners, the company may seize the land as long as they provide just compensation that reflects the current value of the property. Eminent domain has historically been used to obtain land for projects such as the interstate highway system and military bases. Most companies go out of their way to avoid this option in favor of diplomacy. In some cases, the company will even call off a project in the face of strong opposition rather than using eminent domain.

Since renewable energy is frequently located in regions that do not have existing transmission infrastructure and are far from load centers, the projects to utilize the renewable energy must span many miles. The longer the transmission line, the more likely it is that the permitting process becomes long, costly, controversial, and litigious.[110]

Another major obstacle to developing renewable energy is financial capital. It can cost up to $1 million per mile to build a transmission line, and much more to place lines out of sight, or underground.[111] In addition, the time frame within which a transmission project goes from the conceptual stage to being fully operational is seven to ten years.[109] Developing a transmission plan that becomes widely accepted requires technical, engineering, economic, and environmental analyses as well as stakeholder input. With such a costly initial investment of building, citing, and permitting transmission projects, and a seven-to-ten year period before the project begins to generate capital, individual, independent renewable project developers who may be interested in completing these projects often do not have the financial means to do so.

In addition, until recently transmission planning was done on a local scale rather than a regional scale. Therefore there was little analytical evidence to support how opening up broad regions of renewable energy would affect the grid.[112] **Figure 16** gives a typical schedule for developing a major

Figure 16: Generic Schedule for Major Transmission Projects



Source: Western Governors' Association; Renewable Energy Tranmission Roadmap, June 2010, p.6
Notes: This is a general timeline. It can generally be applied to projects 30 to 150 miles long, involving more than three jurisdictions, two to three federal agencies, one to three state agencies, and more that 30 land owners. This timeline assumes a certificate of public convenience and necessity (CPCN) is needed. The Issue ID relates to why the project is needed. Pre-CPCN activities include a) project scope definition, b) project study area definition, c) environmental infromation identification and compilation, d) informational exchange with community leaders, e) consultation with land use and natural resource managment stakeholders, f) preparation of Proponents Environmental Assessment, and g) preparation and filing of permit application. CPCN Process: Actual schedule depends on a) environmental setting and potential impacts, b)project complexity and c) level of public interest. Post CPCN activities include right-of-way acquisitioon and resource agency permits acquisition.

transmission project.

The demand for renewable energy, however, is increasing. According to a 2009 Gallup Poll on the environment, 77 percent of Americans would like to see increased government action to encourage energy production from alternative sources.[113] In addition, many states are setting renewable energy goals and implementing Renewable Portfolio Standards which are displayed in **Table 7**. Six of the eight states in the Rockies region have Renewable Portfolio Standards (Idaho and Wyoming being the exceptions.) These standards require electricity providers to supply a minimum amount of electricity from eligible renewable sources. The goal of a Portfolio Standard is to create market demand for renewable energy and technology so that it will be competitive with nonrenewable sources of electricity.[114] Each state has different specifications of which sources qualify as acceptable based on whether they fit with the goals of the Renewable Portfolio Standard.

Congestion Areas

The Department of Energy's "Electricity Transmission Congestion Study" of 2009 used multiple resources to do a comprehensive analysis of the Western Interconnection. The study identified the most used transmission paths on the western interconnection, as is shown in **Table 8**. The study considers a transmission path congested if it operates at or above 75 percent of its rated capacity.[110] Looking at trends from 1998 to 2007, the study concluded that while congestion has been variable in the past for the region, it has remained relatively stable in the last eight years.[110]

The congestion study also looked at analysis done by the Western Interconnection Regional Advisory Board. The researchers looked at what would be the implications of increasing renewable energy production to 15 percent of regional total production. The report found that the most heavily loaded transmission paths under these conditions would be Path 35 (TOT2C Southwest Utah to Nevada), Path 23 (Four Corners 345/500 kV Transformers), and Path 8 (Montana-Northwest), which are listed in **Table 8**.[110] In addition, more electricity would flow from Colorado, Wyoming, Montana, and Idaho towards Washington and Oregon, and Arizona, New Mexico, and California, increasing congestion.[110] The proposed transmission projects would help alleviate this future source of congestion.[110]

Table 7: Renewable Energy Portfolio Standards in the Western Interconnection

State	Target	Specific Provisions
Arizona	15% by 2025	4.5% by 2012 from distributed energy resources
California	20% by 2010	
Colorado	Investor Owned Utilities 20% by 2020; electric cooperatives and municipal utilities 10% by 2020	Investor Owned Utilities: 0.4% solar by 2020
Montana	15% by 2015	
New Mexico	Investor Owned Utilites: 20% by 2020; rural electric cooperatives 10% by 2020	Wind: 4%; solar: 4%; biomass and geothermal: 2%; distributed renewables: 3% by 2020 (Investor Owned Utilities only)
Nevada	20% by 2015	1% solar by 2015
Oregon	Large utilities (>3% state's total electricity sales) 25% by 2025	Smaller utilities 5-10% by 2025 (depending on size)
Texas	5,880 MW by 2015	At least 500 MW from renewables other than wind
Utah*	20% by 2025	
Washington	15% by 2020	

Source: Environmental Protection Agency, http://www.epa.gov/chp/state-policy/renewable_fs.html
Note:* Indicates Renewable Portfolio Goals, not reguired standards

As part of the same study, the Department of Energy referenced analyses completed by the Transmission Expansion Planning Policy Committee of the Western Electricity Coordinating Council. The study concluded that the lines currently most heavily used would be the source of most of the predicted congestion in 2017.[110] The lines identified as being most congested were Path 20 (Path C Utah-Idaho), Path 31 (TOT2A Colorado-New Mexico), Path 35 (TOT2C Utah-Nevada), Path 23 (the Four Corners 345/500 kV transformers), and Path 8 (Montana-Northwest), in **Table 8**.[110]

In 2005, the Department of Energy funded a study that utilized National Energy Modeling Systems (NEMS), a simulation modeling tool that the Energy Information Administration uses to predict future energy demand, how new transmission projects will affect the grid, and impacts of new legislation.[115] The study applied this model to county-level data. One of their results is a prediction of future electricity demand every five years through the year 2025. Based on this model, electricity demand in the Southwest will increase significantly by the year 2025, with the state of Arizona seeing some of the most dramatic increases.[113] Areas around large cities in the Rockies were the other significant source of increased electric energy demand.[113]

According to Rich Halvey, the Energy Program Director at the Western Governors Association, the current recession will temporarily decrease electricity demand in the region and thereby expand the time frame for keeping up with demand. He predicts that the region has until 2015 or 2016 to build the necessary infrastructure and implement conservation initiatives to meet future demands.[116] **Figure 17** shows proposed major transmission expansion projects in the Western Interconnection

A Smarter Grid

A "Smart Grid" is one that applies digital technology to the existing electric transmission grid. It reconfigures the current grid, which is centralized and supplier-controlled, to one that is decentralized and consumer-interactive.[117] A good description of Smart Grids is in the quote below.

"Smart Grid advancements will apply digital technologies to the grid, and enable real-time coordination of information from generation supply resources, demand resources, and distributed energy resources (DER). This will bring new efficiencies to the electric system through improved communication and coordination between utilities, the grid, and consumers, which will translate into savings in the provision of electric service. Ultimately the smart grid will facilitate consumer transactions and allow consumers to better manage their electric energy costs."[118]

Deploying Smart Grid technology has been compared to the construction of the interstate highway system and the development of the Internet in terms of the extent to which it will change Americans' everyday lives. The expected results

Table 8: Most Used Transmission Lines in the West

#	Path Name
36	TOT 3
20	PATH C
31	TOT 2A
78&79	TOT 2B
35	TOT 2C
23	FOUR CORNERS 345/500Kv
49	EAST OF COLORADO RIVER
46	WEST OF COLORADO RIVER
15	MIDWAY-LOS BANOS
3	NORTHWEST -CANADA
66	COI
65	PACIFIC DC INTERTIE
8	MONTANA-NORTHWEST
1	ALBERTA-BRITISH CO-LUMBIA
14	IDAHO-NORTHWEST
37	TOT 4A

Source: Western Electricity Coordinating Committee Transmission Expansion Report

of applying this technology, according to the Department of Energy, are: superior reliability, similar affordability, global competitiveness, the ability to accommodate traditional, renewable, and distributed energy sources, the reduction of environmental impacts, and the ability to incorporate technology not yet developed.[115] It will be more sensitive and responsive when a system becomes overloaded, and will therefore be more effective at preventing blackouts.[115] For example, if a transmission line becomes congested, a smart grid automatically redirects electricity around it to avoid an outage.[119] It will also be more efficient, limiting the need to build more capacity infrastructure and reducing environmental impact. That translates to a significant environmental impact reduction. For instance, if the grid were five percent more efficient, the energy saved would be the same if the fuel and greenhouse gas emissions from 53 million cars were permanently eliminated.[115] Since it is capable of incorporating distributed power, a smart grid will be more resilient to attacks and natural disasters.[115] Implementation of the Smart Grid will require widely adopted standards to ensure that all parts of a Smart Grid are capable of interoperability, similar to the way that the telecommunications network has adopted industry-wide standards.[120] A smart grid may also allow for distributed electricity storage. Plug-in hybrid vehicles could potentially provide a way to store electricity, and allow the customer to sell it back to the grid when it is needed.[115] The following quote provides a good overview of the importance of a smart grid:

"In the short term, a smarter grid will function more efficiently, enabling it to deliver the level of service we've come to expect more affordably in an era of rising costs, while also offering considerable societal benefits – such as less impact on our environment. Long term, expect the Smart Grid to spur the kind of transformation that the Internet has already brought to the way we live, work, play and learn."[115]

With electricity demand growing at twice the rate of national demand and abundant sources of renewable energy potential, implementation of smart grid technology in the Rockies would be especially beneficial. Smart grid technology can easily accommodate distributed electricity generation, so adding small-scale renewable energy projects would be much easier. Smart grid's ability to manage itself would improve diffusion of renewable energy sources and would be more equipped to handle the sporadic nature of their production. The American Recovery and Reinvestment Act awarded $3.2 billion to 43 states (including the District of Columbia), $2.7 million of which went to six Rockies states, to fund Smart Grid technology deployment and Smart Grid technology demonstration projects.[121]

Demand Side Management

Demand side management refers to energy efficiency programs and demand response programs developed in order to increase electricity reliability, reduce costs, reduce consumption, and manage consumption to decrease the need to add generation units to the grid.[122]

One way the region manages growing demand for electricity is through conservation efforts. New technology and incentives from utility companies help to stabilize electricity demand by lowering per capita demand. As **Figure 18** shows, many Rockies states use slightly less electricity per capita than the rest of the U.S., and conservation efforts are helping to lower per capita consumption further.

Many utility companies across the region and the country are finding creative ways to help households reduce their consumption and in turn reduce their operational costs. Lower Valley Energy, an energy cooperative that services the greater Jackson Hole, Wyoming region, offers a wide variety of incentives to encourage customers to reduce consumption. These incentives include rebates for using Energy Star appliances, rebates for installing geothermal heat pumps and photovoltaic cells, offering to pay for a home energy audit if the owner chooses to implement any of the recommended changes, and lighting evaluation for a reduced cost that includes replacement bulbs that use lower wattage.[123] In addition, many companies are willing to pick up an extra refrigerator or freezer from a home, recycle it, and pay the owner $25 to $50.[124]

Figure 17: Proposed Major Transmission Expansion Projects

Advanced Metering Technology

Advanced metering is an example of enabling technology that is part of a smart grid. These smart meters allow two-way communication between the consumer and the utility provider. The meter records usage per hour for residential customers, and every fifteen minutes for non-residential customers. This information is transmitted via communication networks, such as radio, to inform the customer and the provider about their electricity usage. Advanced meters can be read remotely, so data collection is much more efficient than a person walking house-to-house to record meter activity.[125] Advanced metering technology enables customers to participate in demand-response programs, in which consumers are encouraged to reduce usage during peak demand hours when it is most expensive. The Federal Energy Regulatory Commission defines demand response thusly: "a reduction in the consumption of electric energy by customers from their expected consumption in response to an increase in the price of electric energy or to incentive payments designed to induce lower consumption of electric energy."[126]

Recently there has been some opposition to Smart Metering technology. Some recipients of Smart Meters say that the devices have inaccurately measured their electricity use, driving up their monthly electricity bills. There are now more than two million smart meters in the United States and numerous complaints to go along with them, with some even resulting in lawsuits.[127] Though it is new to the market this new metering system seems to be fairly accurate.

Demand Response Programs

The goal of demand response programs is to reduce peak electricity demand in order to increase electricity reliability, save the utility provider and the customer money, and to prevent the need to build new facilities to generate enough electricity to meet higher levels of peak demand.[128] There are multiple ways of doing this.

Dynamic pricing without enabling technology requires smart meters; energy consumption reduction occurs when the customer chooses to reduce usage when it is most expensive.[126] Dynamic pricing with enabling technology is similar to dynamic pricing without enabling technology, except that with this program, consumers have devices that automatically reduce consumption during peak hours. This may be done by cycling certain appliances, such as air conditioners on and off, or by running appliances, such as water heating systems, during non-peak hours.[126] Direct load control allows utility providers to instantaneously reduce customers' consumption in the event that demand on the grid becomes dangerously high and the risk of failure is great.[126] This type of demand response is widely utilized in order to manage the grid and prevent power outages. Interruptible tariffs provide financial incentives to medium and large scale customers to reduce their consumption when the grid is being strained.[126]

In practice, participating in a dynamic pricing program means that for a small fee per month a household can install an advanced meter that measures the price of electricity per hour. The customer is charged based on the instantaneous cost

Figure 18:
Electricity Consumption Per Capita 2008
Source: Energy Information Administration

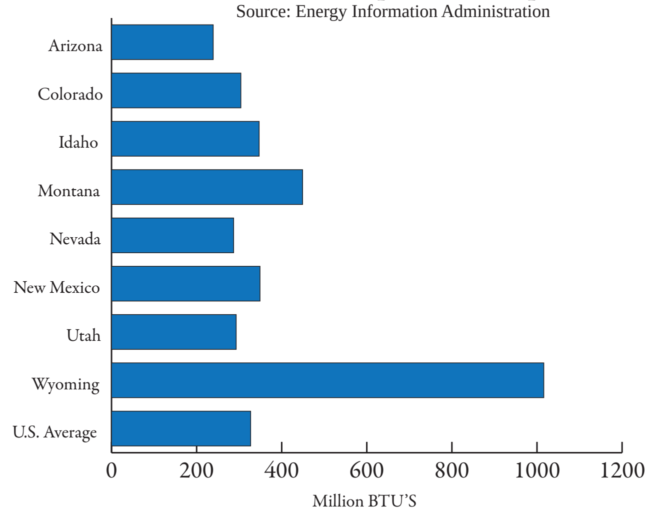
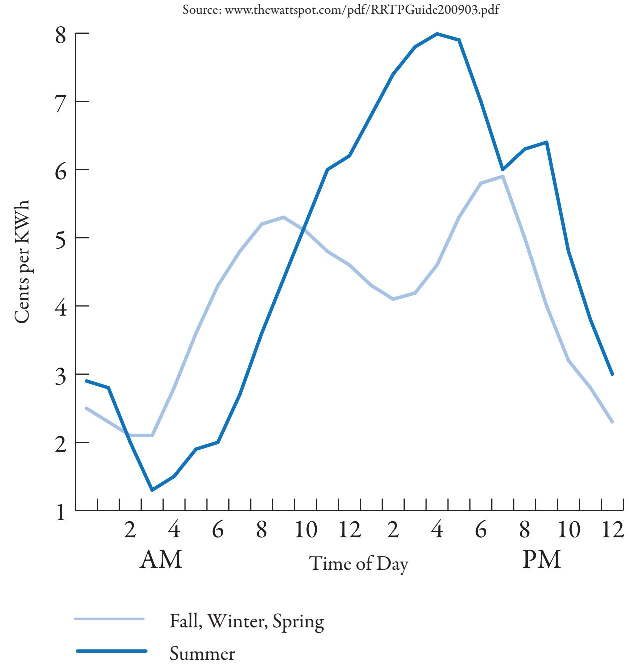
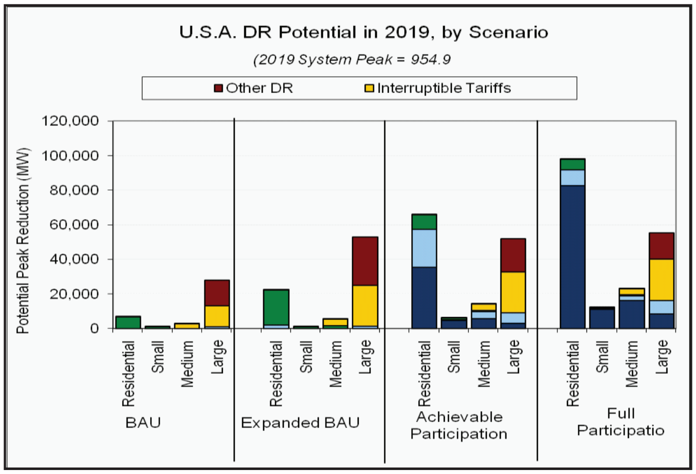


Figure 19: ConEd's Average Real Time Pricing Trends
Source: www.thewattspot.com/pdf/RRTPGuide200903.pdf



of generating electricity, rather than a flat rate per hour. The utility may alert the consumer via e-mail, text, or phone when electricity jumps above a certain rate, inform the customers of predicted price highs for the following day, and provide online analysis tools to help customers manage and adjust their electricity use to increase savings.[129] This technology encourages consumers to reduce electricity usage during peak demand hours (in the evening between 5 pm and 10 pm) when the cost of electricity can spike to three times its lowest price. [130] This fluctuation can be seen in **Figure 19**. By reducing peak demand and making consumers aware of cost fluctuations and their own consumption, this technology often leads to reduced electricity usage and translates to cost savings for the customer and the utility company. Keeping peak demand stable prevents the

Figure 20: Demand Respones Potential by 2019 by Type



Source: FERC National Demad Response Potential Assesment results, http://www.ferd.gov/industrias/electric/inus-act/demand-response/NADR-models.xls

need to build new, costly generation plants to meet increased capacity demands.[131]

Current Reach of Demand Response Technology

According to *A National Assessment of Demand Response Potential*, a report submitted to Congress in 2009 by the Federal Energy Regulatory Commission, current and planned demand response programs have the potential to reduce national peak demand by four percent.[132] The same report also found that current demand response implementation, where it is cost effective, is less than a quarter of what it could be.[129] Therefore, there is a large gap between attainable peak demand reduction and current reduction if demand response programs were properly deployed.[129] **Figure 20** shows how much electricity the nation could save by implementing various demand response scenarios. Definitions of scenarios analyzed in the *National Action Plan on Demand Response* are:

- **Business-as-usual**: existing and planned demand response programs continue[130]
- **Expanded business-as-usual**: in addition to existing and planned demand response programs, current levels of demand response programs are expanded to all states and assume a the highest current rate of participation, advanced metering infrastructure is partially deployed, and five percent of customers choosing to participate in dynamic pricing[130]
- **Achievable participation**: advanced metering infrastructure is universally deployed, everyone participates in a dynamic pricing unless the customer expressly chooses not to (the study assumes a 60 to 75 percent participation rate), and participating in load control opportunities were still available to the customer[130]
- **Full participation**: advanced metering technology is universally deployed, and all customers participate in dynamic pricing where it is cost effective[130]

Regions that have the highest potential to reduce per customer demands by implementing demand response programs are regions that have high central air conditioning saturation.[130] The Rocky Mountain West falls into this category. The Rockies contain a high concentration of central air conditioning units. Therefore demand response programs are a cost-effective strategy for reducing electricity demand. The FERC predicts the universal deployment of advanced metering technology and demand response programs have the potential to reduce peak electricity demand by 20 percent in 2019.

Barriers to Implementing Demand Response

The *National Assessment* of 2009 identified four categories of barriers that prevent expansion of demand response to its full potential: regulatory, economic, technological, and other. Examples of regulatory barriers include financial disincentives for utilities, lack of retail competition, ineffective demand response program design, and lack of real-time information sharing between independent service operators (ISOs) and utilities. Examples of economic barriers include inaccurate price signals and lack of sufficient incentives to induce participation. Technological barriers include lack of advanced metering infrastructure, lack of cost-effective enabling technologies, and concerns about technological obsolescence and cost recovery. Other barriers include fear of customer backlash, lack of customer awareness and education, and perceived temporary benefits of demand response programs.[130]

FERC Recommendations

Broad implementation of demand response practices means great expansion of advanced metering infrastructure, direct load control programs and interruptible tariffs to all states; therefore a means of information sharing among all groups participating and levels of government involved in the development, implementation, and analysis of such programs would help provide effective implementation.[130] The funding or incentives to participate in this type of program could come from national energy policy leaders, the electric industry, consumer organizations, governors, state legislatures, and local and retail regulators.[130] In addition, extensive customer education and awareness is required for demand response programs to be effective, and this information must be disseminated effectively by any or all of the entities listed above.[130]

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Table 9: Rural Residents Within 25 Miles of an Intercity Bus, Rail, or Smaller Airport or Withing 75 Miles od a Major Airport 2005							
Location	Residents Served by At Least One Mode	Intercity Rail Service		Air Service		Intercity Bus Service	
		Access	ONLY Access	Access	ONLY Access	Access	ONLY Access
Arizona	82%	30%	0%	63%	6%	76%	13%
Colorado	91%	28%	0%	76%	7%	83%	10%
Idaho	84%	7%	1%	48%	3%	80%	30%
Montana	77%	17%	3%	50%	3%	66%	21%
Nevada	91%	36%	0%	84%	6%	86%	4%
New Mexico	88%	27%	0%	58%	6%	82%	21%
Utah	82%	38%	0%	71%	7%	78%	9%
Wyoming	77%	0%	0%	52%	7%	70%	26%
Rockies	85%	25%	1%	63%	6%	78%	16%
United States	93%	42%	0%	71%	3%	90%	16%
Source: U.S. Department of Transportation Research and Innovative Technology Administration: Bureau of Transportation Statistics June 2005							

Rural and Intercity Travel Options in the Region

Public Transportation options and their availability for the rural Rockies are important for equity in mobility and preventing isolation of individuals unable to drive a private vehicle. The U.S. Department of Transportation in 2005 analyzed the number of people living in Rural America (outside of urban areas or clusters, these are urban places with a population greater than 2,500)[133] within 25 miles of an intercity bus or rail station or small airport, or within 75 miles of a medium or large airport. **Table 9** shows that for the entire Rockies region the percentage of residents served by at least one mode is eight percent lower than the US total, and in every state it is at least somewhat lower than the national average. Particularly striking is the low number in Montana and Wyoming with only the Great Plains States of the Dakotas and Nebraska having lower numbers (North Dakota has only 59 percent coverage).[131]

Train Coverage consists of only the four Amtrak east-west routes through the region, as previous **Figure 4** on page 62 shows. This service provides very little intercity connectivity within the region since these trains only run East-West but do provide a vital service particularly for rural residents living along the Empire Builder Line in Montana—this line gives Montana it's three percent of residents with only rail access statistic—the highest in the nation.[131] Intercity bus services, such as those provided by Greyhound, have been decreasing consistently over the past decade, particularly to rural communities. Between 2000 and 2005 Greyhound underwent a major restructuring, slimming down operations and cutting service to rural areas in an effort to save costs and provide faster service to its riders.[134 135] A variety of local and regional bus companies have replaced some of this dropped service.

Aviation Travel in the Rockies

"Access to Markets through a Regional Airport is Critical to How Your Performing Economically"

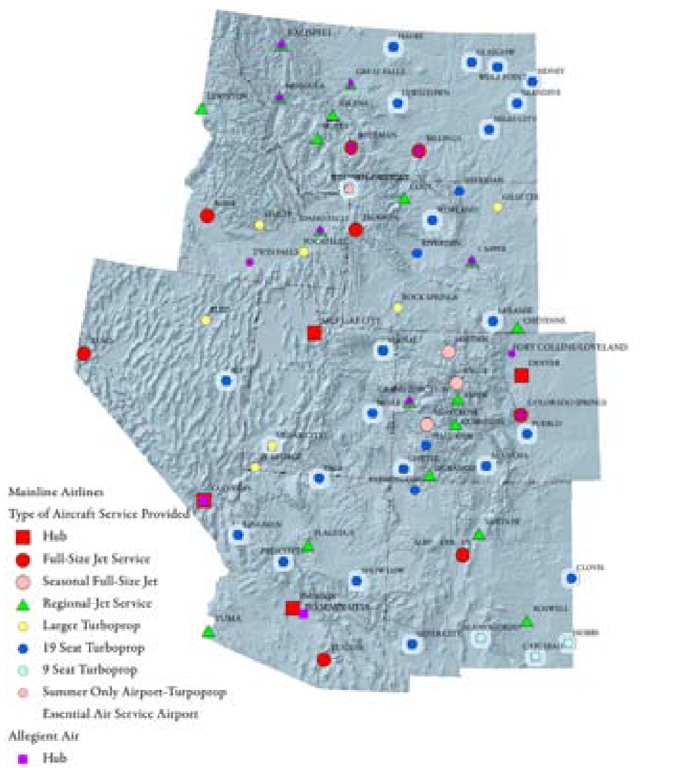
-Mark Haggerty, Headwaters Economics

Presently the main way our region is connected to the world is through aviation and having affordable and easy access to such service. Using existing flight maps of the major airlines **Figure 21** was compiled showing all the airports in the region with regularly scheduled commercial service as well as the largest aircraft-type to serve that airport. The one thing this map does not show is the region's global air connectivity: only Las Vegas has multiple non-stop links to Europe and Asia, with many international airlines serving the airport.[136] Delta's Salt Lake City hub does have limited non-stop service to its hubs in Tokyo and Paris,[137] Phoenix's only transcontinental service is British Airways to London,[138] while Denver has non-stops to London and Frankfort.[139] This map also shows how few airports have any full-size jet service (these are airports that airlines serve with their mainline operations), and with the exception of the hub-cities, the majority of service to even these hubs and other intermediately sized destinations is via regional jets. These are jet aircraft with 75 seats or less branded by the major airlines as American Eagle, Delta Connection, United Express, or US Airways Express. These flights are not operated by the major airlines at all (with the exception of American Eagle, a fully owned subsidiary[140]), but by separate regional airlines operating under contracts from the major airlines. By far the largest of these operators in the Rockies is SkyWest Airlines doing business as Delta Connection from its hub in Salt Lake City, and United Express from Denver using regional jets with between 76 and 50 seats.[141]

The next step down for airline service, shown by the Yellow hexagons in **Figure 21** is via Turboprop planes. Many people have a dislike of these aircraft caused by the increased vibrations, noise, and slow speeds compared to jet aircraft, but their biggest advantage is in fuel efficiency. For example a modern 76 seater Bombardier Q400 turboprop—planes used by Horizon Air (an Alaska Airlines subsidiary) on flights in the region to Idaho—claims to be 30-40 percent more fuel efficient compared to a similar jet aircraft.[142] The rest of the larger turboprops used in the region are 30 seat Brasilia EMB120s.[143] The next size down for aircraft serving the smallest communities in the region are use of 19 seat Beechcraft-900D turboprops by Great Lakes Airlines (Blue Hexagons in **Figure 21**)–although the company also has 30 seat EMB120s that it operates to at least Sheridan and Riverton in the Region[144]— these planes are

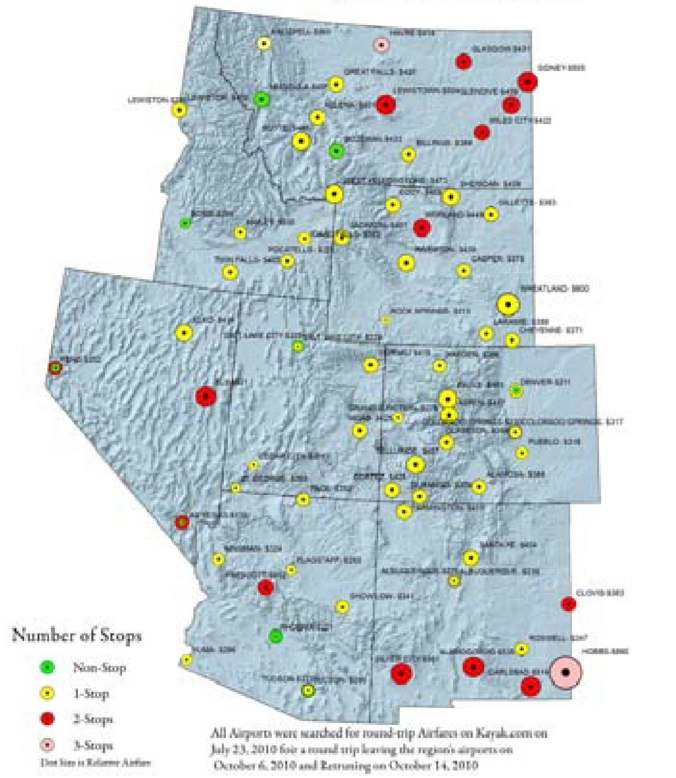
© Jeremiah Cox, Colorado Springs Airport, CO

Figure 21: Rockies Airports with Commercial Service



Source: Federal Aviation Administration.

Figure 22: 2010 Airfares between the Rockies and San Francisco, California



so small that they do not have flight attendants. The smallest planes used in the region are nine-seat airplanes (pink hexagons in **Figure 21**) by New Mexico Airlines connecting Albuquerque with three small cities in southern New Mexico. Many of these smaller destinations are subsidized by the Essential Air Service Program.

The Essential Air Service (EAS) Program gives direct operating subsidies from the Federal Government (through the Federal Aviation Administration) to airlines to serve airports that had air service before deregulation in 1978, and would not be able to support air service on their own. As of May 1, 2010 there were 105 total EAS communities receiving subsidies outside of Alaska with 25 airports in the Rockies. Sidney, Montana receives the highest annual subsidy rate in the region with $2,159,591 (the highest overall is Decatur, Illinois at $3,082,403), with $1,492,109 the national average and $1,362,792 being the Rockies average.[145] This is a program that is often ridiculed by the national media as a 2006 article in *The New York Times* highlights, a single passenger on an EAS flight from Pueblo to Denver, required a $255 per passenger subsidy (Pueblo is only 40 miles from Colorado Springs and 115 from Denver). Another example is a subsidy of $473 per passenger from Lewiston, Montana in 2005, both of these flights averaged 3 passengers. One differing example in the article concerns the subsidies to Rock Springs, Wyoming that in 2005 had 45 passengers per day with subsidies of $14 per person; by 2010 unsubsidized commercial service on this route was realized as viable and now is no longer subsidized.[146] This is the overall goal of EAS: to wean cities off of service subsidies.

The final airline that is also included in **Figure 21** is Allegiant Air. It has its own designation because all of its flights are on mainline MD-83 or MD-87 jets that seat 150 and 130 passengers, but it only serves its destinations from its hub cities (additional destinations served from some of its destinations in the region are Los Angeles and Long Beach, California) with non-daily service (frequencies to cities in the region range from twice to five-days a week) and does not allow passengers to make any connections at its hubs. It considers itself a vacation and leisure airline, by default the airline's website is selected to book a flight and hotel. It does not enter into corporate contracts and is not designed for business travelers with its limited flight schedules. It does provide very low-cost leisure travel from the region to Las Vegas, Phoenix and Los Angeles for people with flexible schedules for its non-daily service.[147]

Another relatively crude analysis was done in an attempt to analyze the region's airfares. For a hypothetical week-long trip from any of the region's airports to San Francisco, California in October 2010, every Rockies city with air service was searched on Kayak.com for the same dates.[148] The results are shown in **Figure 22**. Airlines use yield management to manage their fares, and maximize revenue so airfares are constantly changing. This map does show just how much cheaper it is to fly out of one of the region's major airline hubs compared to the regions smaller cities. But it does not show that travel times are also extremely long from the smaller communities on the map, particularly those in Northeastern Montana and Southern New Mexico that require two stops before reaching a one of the regions four airline hubs that offer frequent flights to San Francisco. For example, the shortest possible travel time from Hobbs, New Mexico is over eight hours (the non-stop from Albuquerque takes two and a half hours, but only operates once a day leaving at 6AM, not providing for any connections). The travel-time would break even by driving the five-hours to Albuquerque.[149]

The extreme travel times from these smaller communities and their infrequent air service are a major impediment to businesses that need to be connected in the global market place, and there are many examples of how these conditions determine where businesses locate. For example, when Ganay Johnson, Development Manager of the American Prairie Foundation was asked why their conservation group is based in Bozeman, Montana and not in Northeastern Montana closer to the prairie they are working to restore, she stated that the biggest reason was the fact their prairie region is four hours from the nearest major airport in Billings, and that she flies at least a couple times a month.[150] The nearest EAS airport is roughly two hours away in Glasgow or Havre.[151] Headwaters Economics, a research group, has taken the closeness of a location to a metropolitan area with frequent air service even further in their study of *The Three Wests: a New County Typology Based on Transportation*.[152] In this study they classified the counties of the West into Metro: those classified by the U.S. government's Office of Management and Budget as metropolitan statistical areas; Connected: "non-metro counties with population centers that are within a one-hour drive of the nearest major airport with daily passenger service;" and Isolated: counties further than a one-hour drive time of the nearest major airport. This study found that there is less income per person the farther the distance from airports, since fewer people are employed in service and professional jobs. This study concluded that the amenities of public lands in the West attract and retain people and business, particularly entrepreneurs that can work basically anywhere courtesy of our telecommunications infrastructure, but they still require some access to markets via transportation infrastructure, especially airports.[153]

Freight Transportation and Infrastructure in the Rocky Mountain West

In addition to moving people, the other crucial component moved by our transportation infrastructure is goods. The U.S. Census measures how commodities are moved through the Commodity Flow Survey; this survey gives good indicators on how goods moving from each state are moved. The freight shipments by their state of origin in the Rockies were charted for travel by rail by the number of tons and the number of carloads in **Table 10**. By far the most striking result in **Table 10** is the amount of railroad tons that originate in Wyoming, courtesy of its coal mines. Over 52 percent of the nation's coal that is shipped via rail originates in Wyoming.[154] The opposite holds true for New Mexico and Arizona which are quite high in the nation for carloads carried, but only in the middle for rail tons.

The ton miles of truck shipments by state were also charted in **Table 11**. Again, New Mexico and Arizona have by far the most shipments. Much of this is also caused by the intermodal freight traffic that passes through these states going between the ports of California and the rest of the country. For example

Table 10: Freight Rail 2008

	Rail Tons Carried		Rail Carloads Carried	
	National Rank	Tons	National Rank	Carloads
Arizona	25	135,492,095	11	6,168,813
Colorado	18	177,255,564	23	2,636,425
Idaho	31	112,043,991	26	2,298,035
Montana	30	112,114,048	29	1,905,176
Nevada	41	41,155,213	41	825,428
New Mexico	23	148,168,555	5	6,347,788
Utah	39	59,819,554	40	1,099,206
Wyoming	1	536,030,087	12	5,506,985
Rockies Average		165,259,888		3,348,482
U.S. Average		160,140,051		3,040,557

Source: Association of American Railroads, US Freight Industry Snapshot: State Rankings 2008, http://www.aar.org/~/media/AAR/InCongress_RailroadsStates/2009rankings.ashx (accessed August 5, 2010),

the ports in Los Angeles and Long Beach, California handle about ten times the amount of containers compared to the Pacific Northwest's Seattle & Tacoma Ports; this is a reason that Idaho and Montana's numbers for both the ton miles of truck travel and shipments by rail are significantly lower compared to Arizona and New Mexico.[155] This data also shows how Wyoming has a significant amount of through truck traffic in the region that is straining the infrastructure of the nation's least populous state. For example, on Interstate 80, 87 percent of the truck traffic on the road is passing through the state and the road currently has $325 million dollars worth of repair needs, with $100 million dollars worth of required maintenance. Currently the state is evaluating a gas tax increase or putting tolls on I-80 to fund these repairs; polls have shown state voters would prefer the tolls on out of state trucks instead of raising Wyoming's gas tax—the lowest in the contiguous U.S..[156] Another important increase in inter-country traffic is caused by goods flowing between Mexico and Canada because of NAFTA. One new major corridor has been developed straight through the region to provide these connections; it is called CANAMEX, the term used by the Federal Government when it was defined as a High Priority Corridor in 1995. The route begins in Nogales, Mexico and follows I-19 for its entire length to Tucson, Arizona then I-10 to Phoenix, US-93 (possible future I-11) to Las Vegas, Nevada and I-15 through Utah, Idaho, and Montana to the Canadian border. This is another possible freight corridor through the region that is still relatively undeveloped, especially the two-lane undivided sections of US-93.[157]

Has the Rockies Received its Fair Share of Federal Funding?

A final topic that needs to be addressed is whether the Rockies region has received its fair share of federal funding for the region's infrastructure. Overall, according to the Tax Foundation, six of the eight states in the region as of 2005 are recipient states, meaning that those states get more in taxes back from the Federal Government than those taxpayers send to the Federal Government. The two donor states are Colorado, receiving 81 cents back per dollar sent, and Nevada, receiving just sixty-nine cents back in 2005. The other six states that are recipient states include New Mexico who receives the top amount in the nation at $2.03 per dollar spent.[158] More impor-

© Emil Dimantchev, Black Thunder Coal Mine, WY

Table 11: Truck Shipments 2009

State	Leaving: Millions of ton miles	Leaving: % of total	Entering: Millions of ton miles	Entering: % of total	Within: Millions of ton miles	Within: % of total	Local: Millions of ton miles	Local: % of total	Through: Millions of ton miles	Through: % of total	Total: Millions of ton miles
Arizona	4,297	10%	6,084	14%	5,798	13%	470	1%	27,495	62%	44,144
Colorado	3,118	12%	5,088	19%	11,234	43%	200	1%	6,471	25%	26,111
Idaho	1,539	10%	2,034	14%	2,933	20%	1,389	9%	6,992	47%	14,887
Montana	1,859	10%	1,741	9%	3,832	21%	36	0%	11,049	60%	18,517
Nevada	1,137	7%	2,210	14%	1,707	11%	57	0%	10,205	67%	15,315
New Mexico	1,710	4%	3,098	8%	5,390	14%	376	1%	27,881	73%	38,455
Utah	4,560	20%	2,247	10%	4,894	21%	62	0%	11,475	49%	23,238
Wyoming	2,522	10%	2,195	9%	2,530	10%	312	1%	16,915	69%	24,474
Rockies Average	2,593	10%	3,087	12%	4,790	19%	363	1%	14,810	58%	25,643
U.S. Average	6,022	15%	6,112	15%	14,914	36%	294	1%	14,112	34%	41,454

Source: Table 3 – 10 Ton Miles of Truck Shipments by State: 2002, "Freight Facts and Figures: 2009", Federal Highway Administration, Freight Management and Operations http://ops.fhwa.dot.gov/freight/freight_analysis/nat_freight_stats/docs/09factsfigures/table3_10.htm

tant, though, is whether or not the infrastructure of the Rockies has gotten its fair share of federal funds. This section will evaluate past and present trends of federal spending on highways and aviation in the region.

To evaluate the federal spending on the region's highways, the differences in payments and appropriations were evaluated. The Federal Highway Trust Fund was created by the Federal Aid Highway Act and Highway Revenue Act of 1956, as an important component of funding the interstate highway system and other federal-aid highways. Its source of revenue is from taxes on gasoline (currently 18.4 cents per gallon), diesel (24.4 cents), and other fuels. In addition there are excise taxes on tires, truck and trailer sales, and heavy vehicle use.[159]

Table 12: Highway Trust Fund Payments and Appropriations

		Arizona	Colorado	Idaho	Montana	Nevada	New Mexico	Utah	Wyoming	Rockies Total	Rockies Average	United States Total	United States Average
2008 Only	Payments (Thousand of $)	662,118	476,782	168,981	141,690	273,745	280,178	288,438	151,489	2,443,421	305,428	31,341,702	614,543
	Per Capita Payments (per $)	102	97	111	146	105	141	105	284	112	---	103	---
	2008-Approrations (Thousands of $)	781,411	583,649	301,181	414,912	373,545	383,330	324,267	264,569	3,426,864	428,358	41,238,918	808,606
	Per Capita Appropriations (per $)	120	118	198	429	144	193	119	497	157	---	136	---
	Differences (a deficit in Tousands of $)	-119,293	-106,867	-132,200	-273,222	-99,800	-103,152	-35,829	-113,080	-983,443	-122,930	-9,897,216	-194,063
	2008 Differences Per Person	-18	-22	-87	-282	-38	-52	-13	-212	-45	---	-33	---
Since 1956	Payments (Tousands of $)	11,529,368	9,081,753	3,495,333	3,155,385	4,364,699	5,689,431	5,286,099	3,070,373	45,672,441	5,709,055	674,403,446	13,223,597
	Appropriations (Thousands of$)	12,156,866	10,497,445	5,754,107	7,626,949	5,539,173	7,250,319	6,925,590	5,290,046	61,040,495	7,630,062	757,429,157	14,851,552
	Differences (Thousands of $)	-627,498	-1,415,692	-2,258,774	-4,471,564	-1,174,474	-1,560,888	-1,639,491	-2,219,673	---	-1,921,007	---	-1,627,955

Source: Federal Highway Administration, 2008
2008 Population values are taken from the U.S. Census Bureau

Table 12 shows the payments into the highway trust fund from gas purchases in each state and the apportions for projects in each state in the Rockies, both for 2008 and all monies since 1956. Per capita amounts are included for the 2008 data. It may seem surprising that the highway trust fund runs a deficit. There are two reasons for this. First is due to interest earned which trust fund makes during the gaps of time between when funds are appropriated into the fund and later allocated to the states for their projects. The second reason is that over the decades of its existence the trust fund has seen infusions of cash from the general fund at various times when it was running a deficit;

the first instance was an infusion for three years right after the Trust Fund was created in 1959 to 1961.[160] The last time was in fiscal years 2008 and 2009, to shore it up against declining revenue.[161] In terms of equity in access to money since the creation of the fund there is a guarantee to all the states of a relative rate of return; in 2008 and 2009, this rate was set at 92 percent, meaning that at least 92 percent of the amount of money contributed to the Federal Highway Trust Fund by a state will be returned for use in that state.[162]

In terms of how the states have fared over the years, the main question that is relevant is how much more each state has received from the Highway Trust Fund compared to payments into it from gas purchases in their state. Since 1956 the average amount the Rockies have received is slightly more than was put into the fund, compared to the average state. In terms of states, the main benefactors have been the three rural Northern Rockies states, receiving a lot more for their many miles of roads compared to their payment of gas taxes and populations. In 2008, the average Montanans and Wyomingites ran a deficit of $282 and $212 per person respectively, while the overall American deficit was $33, and $45 per resident of the Rockies region. Unfortunately three states, Arizona ($18), Colorado ($22), and Utah ($13) received less than their fair share of funds ($33 is the national average). One hypothesis for this phenomenon was fewer federal-aid highway miles per person in those states. That is true for Arizona ($.002) especially, but does not fully explain the phenomenon for Colorado or Utah. It does, however, explain why the statistics for Montana and Wyoming are extraordinarily high.

A one-time infusion of federal funds to the region came through the American Recovery and Reinvestment Act of 2009 that is distributing $787 billion dollars to all fifty states and U.S. territories. This includes $288 billion in tax benefits; $275 billion in contracts, grants, and loans; and $224 billion in entitlements. Based on the state totals in **Figure 23**, it appears as though the Rockies is not receiving its share of this additional federal funding; every state, except for Arizona, is receiving fewer funds than the national average. However, as shown in **Figure 24**, on a per capita basis the Rockies is indeed receiving its fair share. Based on state totals, the Act rewards $858 per person on average, and citizens in the Rockies are receiving $859 per person on average. Using these criteria, Montana and New Mexico are being awarded the most: $1,184 and $1,095 per person. Utah and Arizona bottom out the region with $677 and $658 per person.[163]

A final way the Rockies Region was evaluated for its fair share of federal funds was by the amounts of Federal Aviation Administration's Airport Improvement Program Grants in FY 2009. These amounts are graphed in **Figure 25**. The funding source for these grants is from the Airport and Airway Trust Fund, which receives revenues from aviation-user taxes on airline fares, air freight, and aviation fuel, a similar approach as taken by the Highway Trust Fund.[164] The data shows that every state in the Rockies receives more out of the Aviation Trust Fund than it contributes, at least through Airport Improvement Program Grants, again with Montana and Wyoming so much higher than the national average since they have many airports

Figure 23:
American Recovery and Reinvestment Funds Awarded Per State
As of June 2010
Source: www.Recovery.gov

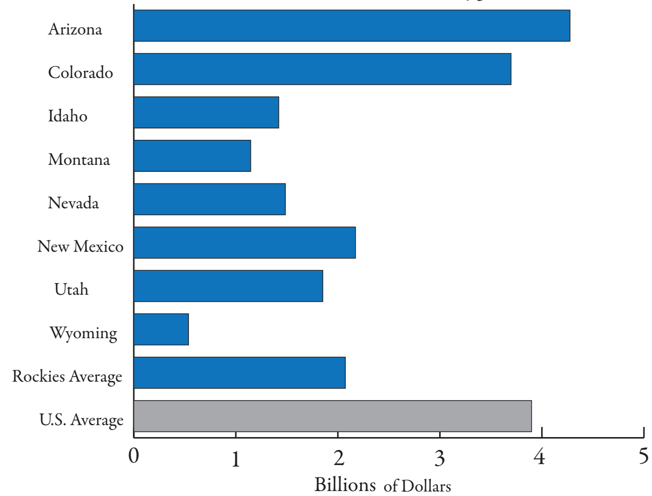


Figure 24:
American Recovery and Reinvestment Funds Awarded Per Capita
As of June 2010
Source: www.Recovery.gov

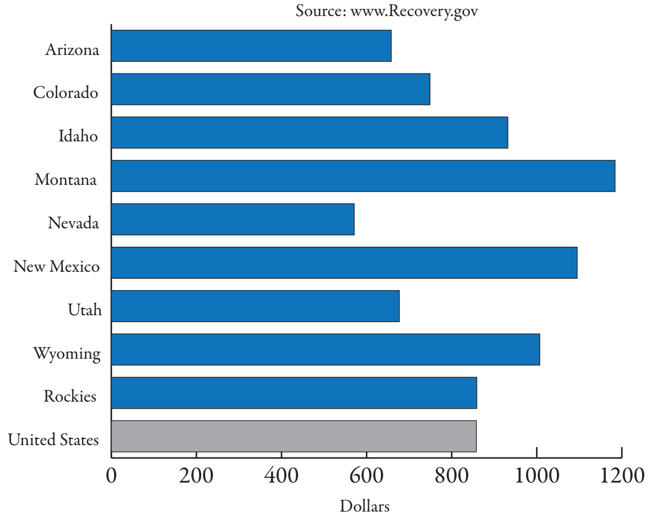
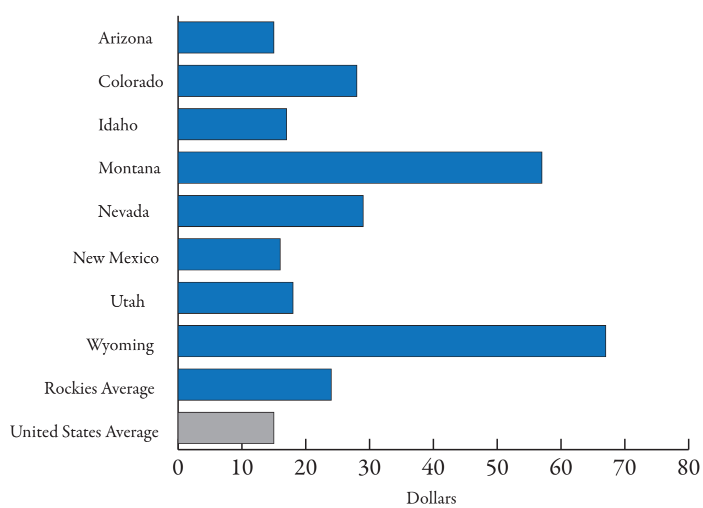


Figure 25:
FAA Improvement Program Grants Per Capita, 2009
Source: Federal Aviation Administration



for their relatively small populations.

Overall, based upon these two small studies, it appears that the Rockies region as a whole is receiving its fair share of federal government infrastructure funds, if not more, of federal dollars from the Highway and Aviation Trust Funds. Some states like Arizona, Colorado and Utah themselves are not receiving their 'fair share' of highway trust and ARRA funds but the huge amounts from both funds being given out to other states, especially in the Northern states, makes this conclusion still applicable to the region as a whole.

Conclusion

The history of the Rockies has been defined by advances in infrastructure, without which the region would be much less hospitable. The condition of the different modes of infrastructure in the region varies significantly. Without continuous and significant investment, the roads and bridges of the Rockies are likely to become critically structurally impaired. The electric grid is outdated and nearing capacity as the population of the region continues to grow faster than the national average. Unlike roads and bridges, the Federal Government is investing in updating the grid to incorporate technology of the 21st century, while private entities are investing in bringing large-scale renewable energy projects onto the grid to meet increasing electricity demand. The Federal Government has declared the universal access to high-speed Internet "the great infrastructure challenge of the twenty-first century," and has launched a plan to see that goal to fruition. Providing access to high-speed Internet and public intercity transportation options to the entire region's residents is a problem that, if solved, would greatly improve social equity – especially as the overall population ages and the Rockies population continues to grow.

Infrastructure is the interconnected mechanism that ties everyone together. As a system, infrastructure physically connects people and goods with roads, railways, and airplanes. Our vast, interwoven electric grid keeps the lights on, the television glowing, and washing machines running, and the computers humming. Telephones and Internet remotely connect individuals and communities with information, entertainment, and other people. Maintaining this infrastructure is crucial to the region's prosperity. A failed infrastructure severs connections to a town or region's support system; without those connections, the flow of goods, people, and information grind to a halt, and may cause the town or region to wither. Conversely, an ideal infrastructure efficiently moves and connects people to each other.

Decades of exploration and development of the Rockies region have been driven, sometimes hindered, by its infrastructure. Whether it was the Pony Express and telegraph of the early days, or rail and highways of today, and wireless communication, as well as optic fiber of the future, the Rockies has presented huge physical challenges to its interconnections and access to the rest of the world. Determination and hard work have built the wonders of roads, bridges, pipelines, and transmission facilities. Sometimes the infusion of outside public and private investment have lead the way; at other times sheer determination and local/regional/state funding have forged ahead. A region's vitality is complex, consisting of the physical terrain, people and their settlement/production patterns, and investments in social needs such as infrastructure. The nation and the Rockies region continue to redefine needed infrastructure and ways to find public and private funds to maintain these essential support systems without which regions and their people languish and fall behind, rather than prosper and advance.

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Case Study:

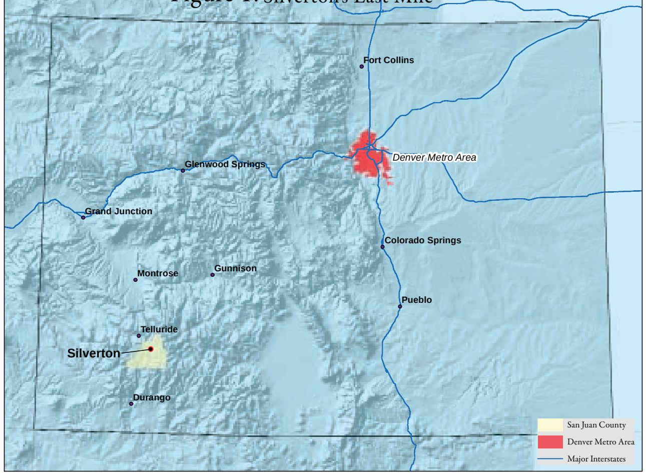
Silverton's Last Mile

By: Anna Johnson

Silverton, Colorado is located in southwestern Colorado near Telluride. Since 1874 It has historically been a Rockies mining town where hardy souls hoping to strike it big battled the harsh conditions and winters. After the Ute Indians were pushed out the residents had to deal with avalanches, poor working conditions and illness that quickly spread through the mining camps. After over a century of mining Silverton has ceased it's historic occupation. Today it is known for its recreational opportunities, specifically skiing. More and more people come to Silverton to enjoy these natural amenities and world-class recreation. Perhaps when mineral prices climb past a certain point mining will again ensue, but until that point Silverton is benefiting from the influx of tourists. Better infrastructure is needed to spur local economic growth and businesses.

Currently the residents are facing the realities of being at the end of "the last mile." Qwest signed a contract with the state of Colorado in 2000 – the $37 million, state funded, Link-Up project – promising to bring high-speed fiber optic Internet to every county seat in the state. Qwest was also given a ten-year contract to construct and maintain the states fiber optic system.[1] Silverton, the county seat of San Juan, claims Qwest has not fulfilled their obligation. The connection was supposed to be finished in 2005.[2] For the past half century only one radio link has connected Silverton's communications to the outside world.[3] In July 2010, the city filed a complaint with the Colorado Public Utilities Commission, petitioning them to issue an order that would require Qwest to extend the fiber optic lines that stop 16 miles short of Silverton in order to deliver the same type of high-speed Internet that the other county seats have access to. Qwest claims that the company had an obligation to deliver a specific level of bandwidth, which they fulfilled. The petition expressed the town's concern that the lack of a fiber optic Internet connection disadvantages the community and prevents it from technologically developing at the same pace as the rest of the state, and that Qwest's failure, "deprives Silverton/San Juan the right to basic service."[4]

Figure 1: Silverton's Last Mile



The longer this debate continues the greater will be the communication gap between Silverton and the rest of the state. Communication infrastructure is lifeblood to an isolated community like Silverton. With such a dated system Silverton's economic growth and residents comfort is at stake making its plea to the state even more timely.

[1] Esper, Mark. "Town, county take on Qwest." *Silverton Standard.* 01 July 2010.
[2] Esper, Mark. "Town, county take on Qwest." *Silverton Standard.* 01 July 2010.
[3] Esper, Mark. "Town, county take on Qwest." *Silverton Standard.* 01 July 2010.
[4] Dolan, Michael. "Qwest short changes Colorado jurisdictions by not bringing fiber, they say." *Communications Daily.* 10 July 2010.

© Jeremiah Cox, Empire Builder Train

Case Study:

The Hi-Line: Vital Artery or Bleeding Vein?

By: Jeremiah Cox

Amtrak's *Empire Builder* trains run east and west daily and are scheduled to take 45 hours eastbound and 46 hours westbound to run between Seattle, Washington or Portland, Oregon (the two different sections meet at Spokane, Washington and join as one train for the rest of the journey) and Chicago, Illinois.[1] By comparison the same journey takes approximately 33 hours when driven straight through, following interstates.[2]

Named for James J. Hill, the *Empire Builder* follows the Hi-Line through the northern reaches of Montana parallel to the U.S. Route 2 Corridor, spending approximately 711 of its 2,205 total route miles passing through the Rockies region. It makes 11 station stops in Montana, including three providing tourism access to Glacier National Park and one at Sandpoint, Idaho. It takes approximately 14 hours eastbound and 15 hours westbound to traverse the Rockies region, proportional to the distance traveled through the Rockies.[3] The train's station stops in Montana are all in small towns stuck in the vastness of the Great Plains that rely on the train for their only public transportation access to the rest of the world. None of the station stops are in Montana's largest cities. **Table 9** on page 78 illustrates that three percent of Montana's rural residents are only covered by Intercity Rail Service**.** Only two station stops along the route in Montana have scheduled intercity bus service, Whitefish and Shelby. Shelby's is provided only twice a week by a county minibus service to Great Falls. Four station stops are in locations with regular scheduled air service, in all of these towns except for Whitefish (served by Kalispell Airport 17 miles south) service is provided by Great Lakes Airlines using Essential Air Service Contracts.[4]

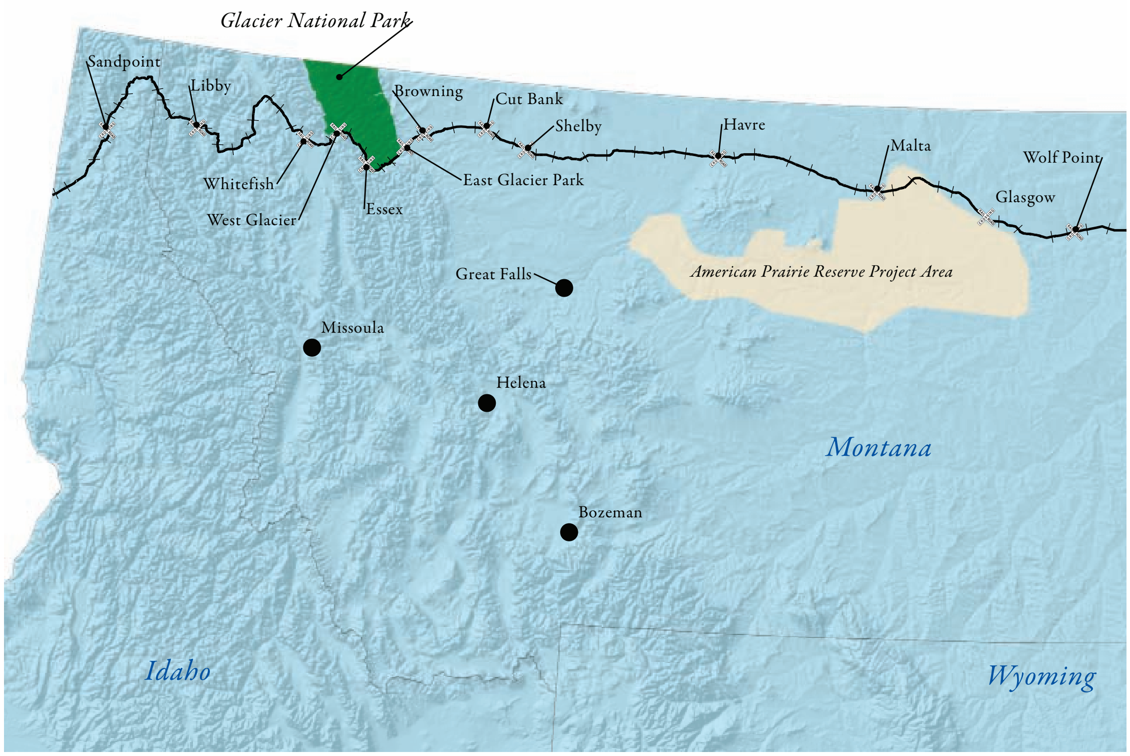
What all of this means is that, the *Empire Builder* provides a transportation and economic lifeline to the small towns it stops in. While one rides the *Empire Builder* and talks to fellow passengers alighting and disembarking at the stations along the Eastern Plains, one of the primary purposes of their trips was to visit family.[5] Trips like this contribute significantly to the train's ridership as well. In fiscal year (FY) 2009 a total of 515,444 passengers rode the train, of these passengers, almost a third, 152,253 boarded or alighted in Montana and Idaho. The number of passengers going to Eastern Plains stations (defined as the seven stops from Browning, Montana and eastward) in Montana is 54,623 passengers. This shows that a large contingent of passengers are accessing the recreation areas around Glacier National Park and ten percent of the train's riders are going to the rural towns on the Montanan Eastern Plains. North Dakota has similar high ridership statistics with 115,938 riders boarding or alighting in the state, but it should be noted that the train serves three out of four of North Dakota's largest cities.[6]

It can appear that the *Empire Builder's* lack of service to major cities would make it an extremely unprofitable route, but the opposite is true. It is Amtrak's most successful ridership of any long-distance route except for the Auto Train (a multi-modal train carrying passengers and their vehicles exclusively between Lorton, Virginia and Sanford, Florida). In FY2008 the *Empire Builder* had a fare box recovery ratio, a statistic used for the amount of costs directly covered by operating revenue, of 66 percent compared to 52 percent for all Amtrak routes system. It made $64,816.255, the most revenue (passenger tickets, food, and beverages) of any Amtrak route. For comparison it cost $98,625,440 to operate. This is an operating subsidy of $61 per passenger.[7] In Montana alone it's estimated it provided $14 million worth of economic benefits.[8] The *Empire Builder's* ridership has increased in the past couple of years. From FY2009 to FY2010 ridership increased three and a half percent, while increasing ticket revenues over eight percent.

Attempting to compare this to Essential Air Service Subsidies in dollar amounts, the four towns along the *Empire Builder* route with airports had contracts for yearly subsidy rates totaling $4,352,974, while only 6,784 passengers used these commercial Airports. This results in a subsidy of $642 per passenger.[9,10] These figures don't include other subsidies for required airport operations such as TSA security screening, it will cost $11 million over five years to provide this service at Montana's small airports. Until 2008 these airports were a security risk for the country as the only ones left that didn't have TSA screeners, passengers were allowed to board planes in these small towns with simply a plane ticket and were not screened until arriving in Billings, Montana to make connecting flights to the rest of the country.[11]

One could argue that it is more cost effective to dedicate funding to the *Empire Builder* to serve these various towns rather than subsidize air service for them if public transit access is in the item in question. The time and associated cost between the two types of public transit are hardly comparable. The different public transit services of rural Montana attract different types of travels, making accessing these remote communities easier for both the business travel and family member. What the *Empire Builder* has done for some of these communities is not build an empire but allow a remote community to subsist in regards to outside access to the outside world. It is a lifeline for a small number of people who would have to find new transportation solutions without its existence.

Figure 1: The Empire Builder




© Jeremiah Cox, Empire Builder stopped in Shelby, MT

[1] Amtrak's Empire Builder Timetable effective November 8, 2010 http://www.amtrak.com/servlet/BlobServer?blobcol=urldata&blobtable=MungoBlobs&blobkey=id&blobwhere=1249213945362&blobheader=application%2Fpdf&blobheadername1=Content-disposition&blobheadervalue1=attachment;filename=Amtrak_P07.pdf (accessed November 3, 2010)

[2] Google Maps Search, Seattle, WA to Chicago, IL. http://maps.google.com/maps?f=d&source=s_d&saddr=Portland,+OR&daddr=Chicago,+IL&hl=en&geocode=FfyhtgIdERyw-CkndKl9CwuVVDGRhdH25rk2HA%3BFWICfwIdGuDG-inty_TQPCwOiDEAwMAJrabgrw&mra=ls&sll=44.840291,-104.941406&sspn=91.956217,65.566406&ie=UTF8&ll=41.640078,-112.148437&spn=94.961287,65.566406&z=3 (accessed November 10, 2010)

[3] Amtrak's Empire Builder Timetable effective November 8, 2010 (mileage to Seattle) http://www.amtrak.com/servlet/BlobServer?blobcol=urldata&blobtable=MungoBlobs&blobkey=id&blobwhere=1249213945362&blobheader=application%2Fpdf&blobheadername1=Content-disposition&blobheadervalue1=attachment;filename=Amtrak_P07.pdf, and analysis on Goggle Maps for exact distances to and from the boarders of the Rocky Region, and scheduled times for Spokane, Washington (approximately twenty miles from Idaho boarder) to Glasgow, Montana (approximately twenty miles before the North Dakota boarder)

[4] Montana Department of Transportation, *Intercity Passenger Transportation in Montana,* 2007 http://www.mdt.mt.gov/publications/docs/maps/intercity_passenger_map.pdf (accessed 3 November, 2010) and Toole County Website: Northern Transit Interlocal schedule http://www.toolecountymt.gov/NTI_Schedule.html and schedule and Information from Great Lakes Airlines, http://flygreatlakes.com (accessed 3 November, 2010)

[5] Personal trip on *Empire Builder* by the Author Jeremiah Cox, from July 12 to July 14, 2006, a full reencounter of the trip is available at http://subwaynut.com/triplogs/amtrakalltheway/empirebuilder (accessed November 10, 2010)

[6] Analysis of Amtrak Fact Sheets FY2009, available online at http://www.amtrak.com/servlet/ContentServer?c=AM_Content_C&pagename=am%2FLayout&cid=1241267288095 (accessed 4 November, 2010)

[7] Amtrak, "Exhibit D: Long Distance Route Fair Box Recovery Table" p. 79 in P.R.I.I.A. *Section 244: Pioneer Route Passenger Rail Study,* Washington, DC: Amtrak. http://www.amtrak.com/servlet/BlobServer?blobcol=urldata&blobtable=MungoBlobs&blobkey=id&blobwhere=1249200496429&blobheader=application%2Fpdf&blobheadername1=Content-disposition&blobheadervalue1=attachment;filename=Amtrak_PioneerServiceStudy.pdf (accessed November 10, 2010)

[8] http://www.mdt.state.mt.us/tranplan/docs/empire_builder.pdf --> site seems to be down for some reason, add footnote later

[9] Federal Aviation Administration, "Primary, Non-primary Commercial Service and General Aviation Airports by State" *CY 2009 Passenger Boarding and All-Cargo Data,* http://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/media/cy09_all_enplanements.pdf (accessed November 10, 2010)

[10] Office of Aviation Analysis Essential Air Service Program, US subsidized EAS Reports: May 1, 2010, http://ostpxweb.dot.gov/aviation/x-50%20role_files/100501nonalaska.xls (accessed November 10, 2010)

[11] Falstand, Jan. "Before March 2008, Travelers Needed Only a Ticket to Board a Plane: Screening at Montana's smallest airports costs millions" *The Billings Gazette*, January 10, 2010, http://billingsgazette.com/news/state-and-regional/montana/article_5caa4d2a-fd8f-11de-b379-001cc4c002e0.html (accessed November 10, 2010)

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Case Study:

I-70: The Interstate *through* the Rockies

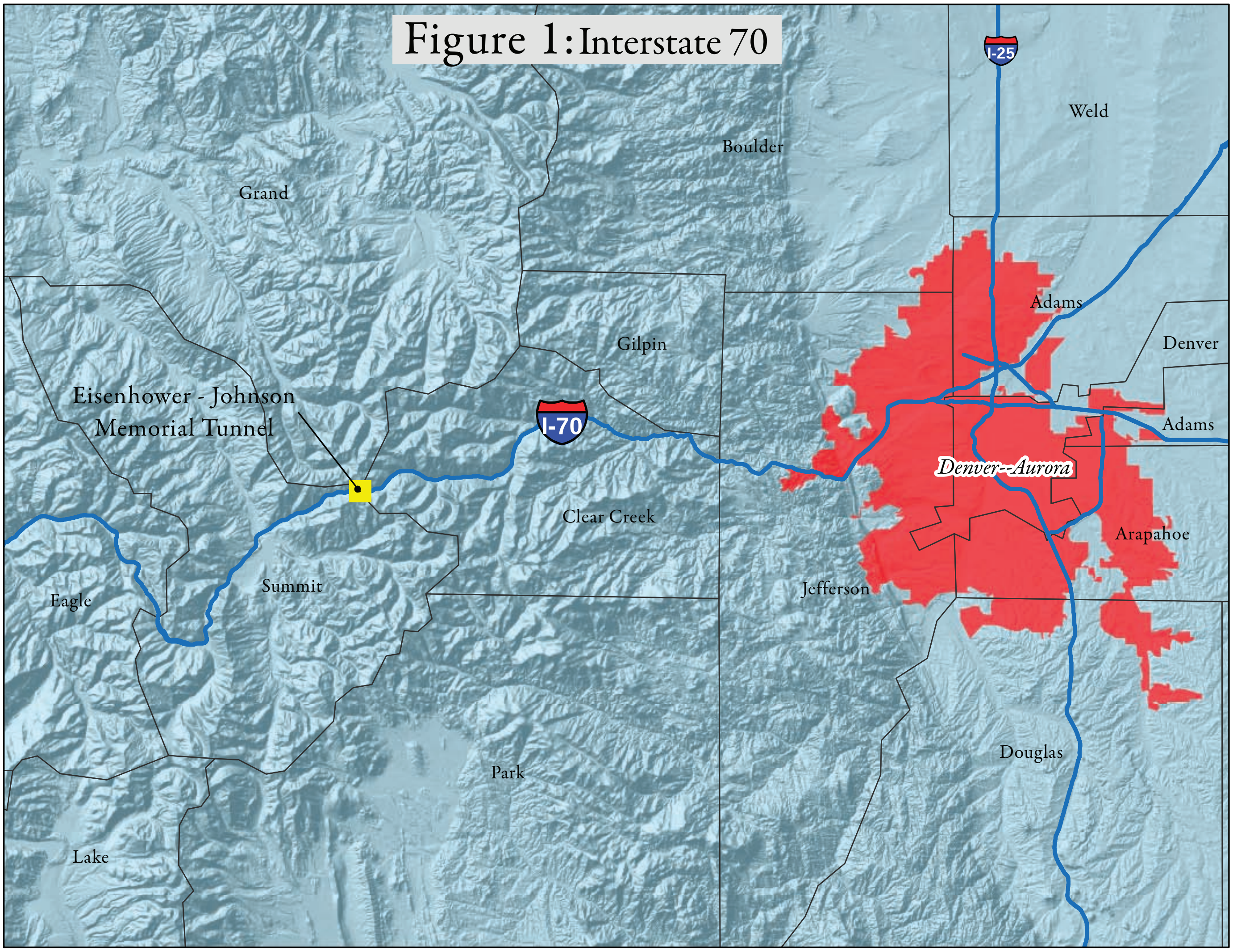
By: Jeremiah Cox

"Colorado without I-70 would be devastating. In some counties like Park it's the lifeblood of the community for goods and services."
-Chuck Attardo, Environmental Manager, Colorado Department of Transportation

Interstate 70 through the Rockies provides a vital link connecting those mountain communities and the Western slope with Denver. Once the Interstate and especially when the Eisenhower Memorial Tunnel was opened on March 8, 1973,[1] it started providing the transportation link that lead to the 'bonanza' of development to various ski-towns such as Vail and Breckenridge.[2] The best example of how important this road is to recreation in the Rockies is the peak traffic times. Most typical highways reach their peak traffic loads during the weekday rush hour periods; the traffic patterns on the I-70 Mountain Corridor are completely different. It reaches its peak traffic congestion Eastbound during the PM of Summer Sundays, in winter there are similar amounts of traffic congestion on weekends, although the amounts of congestion are not quite as high compared to the summer.[3] For example in 2000 there were approximately 60,000 people traveling on a summer Sunday, compared to forty thousand on a summer Weekday through the Eisenhower-Johnson Memorial Tunnel.[4] The fact that congestion on the highway is during many fewer days of the year is because of so many recreation and leisure based trips rather than the standard work related commuting trips. Also responsible is the extremely sensitive area and complex engineering required to build the highway through mountainous terrain, and the fact that many portions of the roadway were not built to the ideal interstate standards such as narrower than standard shoulders to avoid the right-of-way impacts present many challenges to relieving congestion on the interstate.[5] A large portion of this highway, including the entire portion between the Eisenhower-Johnson Memorial Tunnel and C-470 are considered 'problematic areas due to Capacity and Roadway Deficiencies.'[6]

The first step in the process of beginning improvements to corridor was the release of a Preliminary Environmental Impact Statement in 2004 by the Colorado Department of Transportation and Federal Highway Administration. Immediately during the public comment period there was public uproar over the various proposed improvements to the corridor that ranged from widening the many portions of the interstate from four to six lanes to building High Occupancy Vehicle/Toll Lanes, to a fixed-guide way rail, bus or monorail transit system,[7] none of which local communities and interests were interested in. After this the I-70 Mountain Corridor Context Sensitive Solutions (CSS) process group was created. This group consists of 27 members whose affiliations range from CDOT to local government to environmental organizations like trout unlimited to the U.S. Forest Service to work together to recommend a transit solution for the corridor.[8] Their recommendation is for multi-modal solutions, the biggest component of which is to implement an Advanced Guideway System, along with highway improvements.[9] The advanced guide way system would most likely use basically unproven new monorail or magnetic levitation technology to run along the corridor as far west as the Eagle Airport. The Environmental Impact Statement identified the price as $6.15 billion dollars,[10] although a representative of CDOT told the Rockies Project an amount closer to $20

Figure 1: Interstate 70



billion dollars. The reason that a more conventional, proven steel-wheel high speed rail corridor would be less effective in the corridor is because of the extreme grades in the mountain terrain that would cause significantly slow train speeds.[11] Various ways to pay for the project haven't been completely identified but like all road projects it would be a combination of state and federal funds. Possible funding sources include: Federal congressional earmarking, rising gas taxes, or other motor vehicle fees, Tolls on the road either as a congestion pricing technique—making I-70 more expensive to drive on during peak usage times such as Sunday afternoons, or regular tolls along the entire corridor or just at the Eisenhower-Johnson Memorial Tunnels, or increasing local taxes along the corridor.[12]

One improvement to the corridor already implemented by CDOT has been more aggressive measures taken to keep the road clear of tractor-trailer accidents. These measures have included aggressive chain laws, and having tow-trucks on duty to get the road clear of accidents and blockages as soon as possible.[13] The chain laws have included high fines, such as $657 dollars for trucks not chaining up[14] along with the addition of well-lit and safe chaining stations, at strategic locations throughout the corridor. This has resulted in many fewer backups along the roadway caused by accidents. In the 2007-2008 winter season 61 closings of at least one direction of the roadway caused 160 hours of no travel. These aggressive laws have resulted in only 45 hours of no travel in the 2008-2009 winter season. Economic studies have shown that closing I-70 for just one hour results in $800,000 lost from the ski and tourism industry.[15]

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[3] Interview with Chuck Johnson, Environmental Manager, Region 1, Colorado Department Of Transportation on July 29, 2010
[4] Tier 1 Draft PEIS: Executive Summery, December 2004, http://www.coloradodot.info/projects/i-70mountaincorridor/programmaticEIS/00_Executive_Summary.pdf/ Pages ES-4 and ES-5
[5] Interview with Chuck Johnson, Environmental Manager, Region 1, Colorado Department Of Transportation on July 29, 2010
[6] Tier 1 Draft PEIS: Executive Summery, December 2004, http://www.coloradodot.info/projects/i-70mountaincorridor/programmaticEIS/00_Executive_Summary.pdf Page ES-9
[7] Tier 1 Draft PEIS: Executive Summery, December 2004, http://www.coloradodot.info/projects/i-70mountaincorridor/programmaticEIS/00_Executive_Summary.pdf/at_download/file Page ES-10-13
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[10] Tier 1 Draft PEIS: Executive Summery, December, 2004 http://www.coloradodot.info/projects/i-70mountaincorridor/programmaticEIS/00_Executive_Summary.pdf/at_download/file Page ES-11
[11] Interview with Chuck Johnson, Environmental Manager, Region 1, Colorado Department Of Transportation on July 29, 2010
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[14] Colorado Department of Transportation, Chain Tips: Guide to Colorado's chain Law, http://www.coloradodot.info/travel/library/Brochures/ChainTips.pdf (accessed July 30, 2010)
[15] Plunkeet, Chuck, "Chain Law Helps Clear Way on I-70" *Summit Daily News*, (April 1, 2010), http://coloradosenate.org/home/inthenews/chain-law-helps-clear-way-on-i-70 (accessed)