Light-Bulbs to Light-Rails
A Sustainable Solution To Moving the People

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Electric Mass Transit for Spokane/Coeur d'Alene

Rising liquid fuel costs, as well as a need to reduce carbon dioxide emissions are two reasons to examine electrical transportation alternatives. Another reason is that the source of electric generation in the Spokane/Coeur d'Alene region, where a majority of the electricity is generated from hydropower.

In the Spokane area a proposal for a passenger light-rail has some support, although a diesel version was narrowly defeated in 2006. Our white paper examines one aspect of electric transportation, comparing potential conservation savings from a switch to compact fluorescent light bulbs (CFL's) with the costs of operating a light-rail system. We chose to look at an electric light rail system from the Spokane International Airport to Coeur d'Alene, roughly following the I-90 corridor, as well as a segment along the proposed North-South Corridor in Spokane.

Energy consumption figures for the existing and extended Spokane Light-Rail

We started with current energy consumption figures for the Spokane light-rail system, which assumes a 2 car, 10 min headway from Spokane (STA Plaza, 701 W Riverside) to Liberty Lake, totaling 15.5 miles. At full built-out, high capacity, high frequency system, the two rail cars would require 0.113 billion British thermal units (BBtus) per day for operation. In addition, the maintenance yard would require 0.151 BBtus per day. These figures have been taken from the Environmental Impact Statement draft and assume 290 days of operation yearly to account for off-days, holidays, evenings, weekends, etc.

If the rail was extended westward to Spokane International Airport (7.6 miles from the STA Plaza) and eastward to the Coeur D Alene Costco at 355 E Neider Ave, (17.0 miles from Liberty Lake), an additional 24.6 miles and 0.179 BBtus per day would be added to the system. This extension results in a 40.1 mile, 128.47 BBtu per year rail system (including 2 cars and maintenance yard). In terms of megawatt hours, the 40.1 mile light-rail would consume 37,650 megawatt hours (MWh) per year.

Another expansion to consider would follow the North-South Corridor, adding approximately 10 miles to the system. This expansion would require 22.33 BBtus of energy per year for the two car, full built-out light-rail, or 6,540 MWh per year.

The total energy consumption for the expanded 50.1 mile, full built-out, East-West/ North-South light-rail (referred to later as the expanded light-rail) would total 44,190 MWh per year. The

initial system would be a single-car operation on 15-minute headways, operating bi-directionally on a single track. Therefore, the start-up electrical consumption would be about 78%[1] of the built out requirement, or 34,470 MWh/year.

Personal vehicle miles traveled (VMT) for the Spokane area

Daily VMT for the Spokane area include freeway miles and arterial miles (2,030,000 and 4,450,000 miles, respectively) totaling 6,480,000 miles per day or 2.3 billion miles per year.[2] Putting this into perspective, this adds up to over 94,000 trips around the earth at the equator.[3]

Graph 1 shows the history of VMT for freeway, arterial, and their combined total for the Spokane area from 1982 to 2005. This indicates an increase of 116% over the 23-year period (2,995,000 miles in 1982 to 6,480,000 miles in 2005). The rate of increase is 150 miles per year. Graph 2 shows the projection of VMT from 2005 to 2050 with the same rate of increase; this is considered a business as usual (BAU) scenario that does not take into account any changes in peoples behavior due to fluctuating fuel prices or fuel supply. Under the BAU scenario, VMT would reach a combined total of 13,285,000 miles in 2050.

As estimated in the Environmental Impact Statement, the 15.5 mile full built-out light-rail from Spokane to Liberty Lake would reduce VMT throughout the region by 13,200 miles daily.[1] Analyzing the expanded light-rail, VMT would be reduced by approximately 43,000. These figures are very conservative.

After surveying light-rail ridership on the Portland, Salt Lake, and Denver rail system, we found that all three cities have experienced greater than expected ridership.[5] Based on the ridership from these reports and the distance of their tracks (nearly equivalent to our 15.5 mile system) we assumed 30,000 riders per day, corresponding to 15,000 vehicles removed from the road per day. Eliminating 15,000 vehicles corresponds to reducing VMT by 390,000 miles each day, or nearly 113 million miles annually. This is roughly 6% of the current VMT.

This number may also be a conservative approximation due to the potential for increased STA rider participation; cooperative STA bus service could connect light rail stations to other destinations, such as places of business, healthcare facilities, and shopping districts. The light-rail also provides the opportunity for a more sustainable built environment, which would generate more pedestrian friendly streets, increase the number of multi-family housing units, and possibly reduce urban sprawl.

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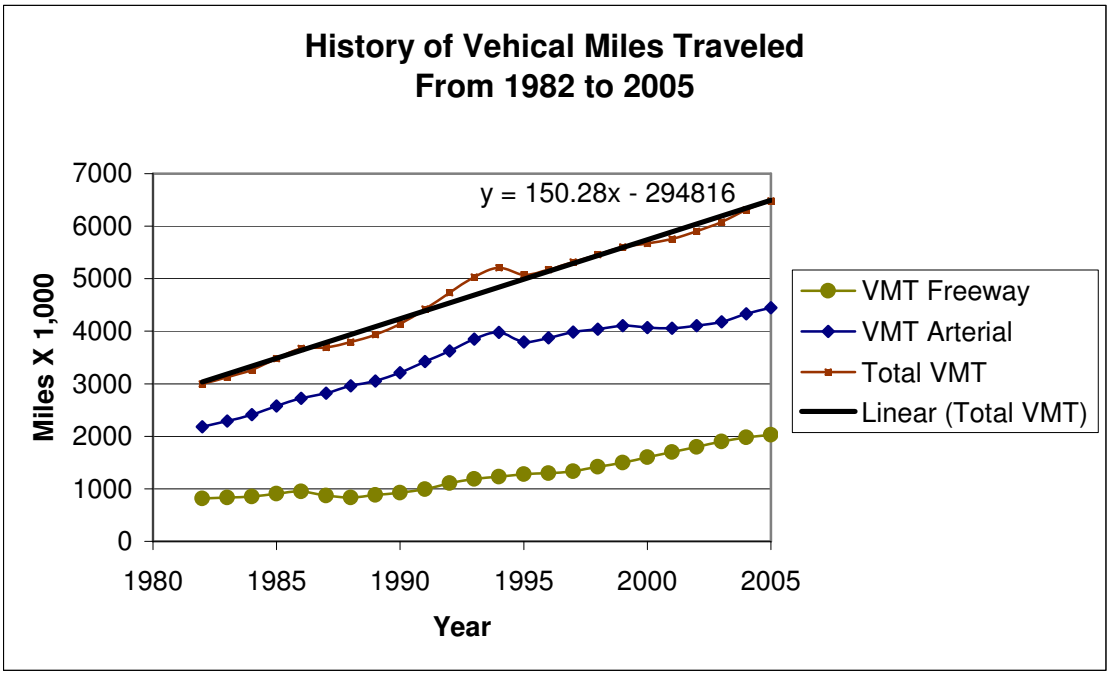
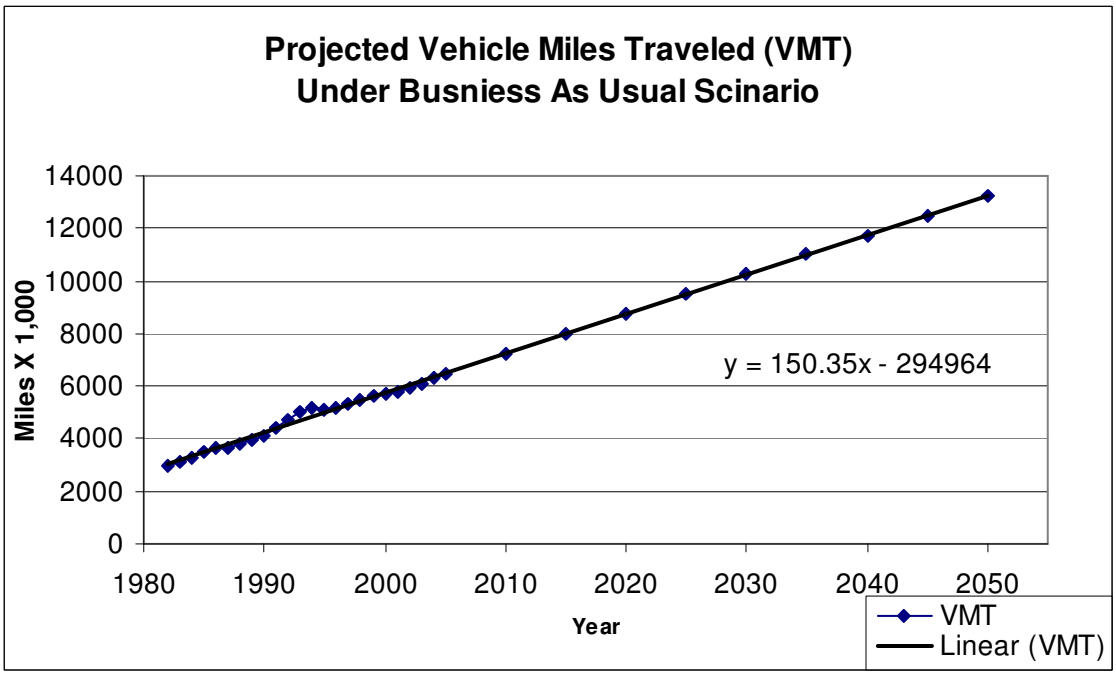
[1] Environmental Impact Report draft
[2] Performance Measure Summary, Texas Transportation Institute, 2005
[3] http://www.geography.about/library/faq/blqzcircumference.html
[4] Salt Lake City: Light-Rail's a Hit; Light-Rail Progress November 2002
Denver: "Blown away" by phenomenal success of light rail; Light-Rail Project Team September 2006
Portland: West-side Max Light-Rail Line Ridership Exceeds 2008 Projection: Light-Rail Project Team September 2005

Graph 1



Source: Performance Measure Summary, Texas Transportation Institute

Graph 2



Fuel consumption associated with personal vehicles

While calculating the total number of gallons consumed by personal motor vehicles in the Spokane area, it is important to consider the consumption of fuel while idling in traffic. It is estimated that each vehicle will consume 5 gallons each year in stalled traffic, adding up to 918,000 gallons per year.[3] Assuming an average of 20 miles per gallon for personal vehicles (including passenger vehicles, pick-up trucks, vans, and SUVs), and taking idling into account, it is estimated that personal vehicles in the Spokane area consumed 328,101 gallons of gasoline each day, or approximately 120,675,000 gallons total in the year 2005.

As the number of VMT continues to increase under business as usual conditions, so will the number of gallons consumed and the number of tons of CO2 emitted. According to the EPA, the combustion of gasoline results in 8.8 kg (19.4 pounds) of CO2 emitted per gallon and 10.1 kg (22.2 pounds) emitted for diesel.[6] Using an average of 9.45 kg CO2/ gallon (20.8 pounds CO2/gallon), personal vehicles accounted for 1.23 million tons of carbon dioxide in 2005.

As mentioned above, the expanded light-rail would reduce VMT by about 43,000 and remove 1,650 vehicles from the road. Assuming each vehicle travels 26 miles a day in a vehicle that receives 20 miles per gallon, removing 1,650 vehicles from the road would reduce CO2 emissions by 6,500 tons each year.

Assuming the more optimistic scenario, removing 15,000 vehicles from the road each day (or 4.35 million vehicles per year) would equate to conserving approximately 59,000 tons of CO2 annually with a constant number of riders. If ridership increases, the CO2 savings may also increase.

Comparative energy consumption to indoor lighting upgrades

A typical household could save approximately 767 kWh of electricity per year by replacing 13 indoor incandescent light bulbs with high efficiency compact fluorescent light bulbs (CFL's)[7]. If 71% of households in Spokane (57,614 out of the 81,512 total households[8]) participated in this conversion, residence would save enough energy annually to operate the expanded light-rail and maintenance yard or the high volume ridership light-rail and maintenance yard with no additional energy consumption.

As previously stated, the high capacity, 15.5 mile light-rail has he potential of eliminating as many as 390,000 vehicles from the road each year. The energy figures were not calculated for this operation but for a general analysis, we assumed this high volume ridership light-rail required as much energy as the expanded light-rail (6,540 MWh per year) to account for a larger number of trains with more frequent stops as compared to the original model.

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[6] Emission Facts: Average Carbon Dioxide Emissions Resulting from Gasoline and Diesel Fuel; http://www.epa.gov Emission Facts

[7] Calculating the Potential Savings of Compact Fluorescent Light Bulbs; Lesley Herrmann

[8] City Data.com Spokane Washington; http://www.city-data.com/city/spokane-washington.html, 2006

The CO2 savings associated with the light-rail can be regarded as *a net reduction in emission.*: Again, if 71% of households participated in switching their indoor light bulbs to low wattage CFL's, residents would be conserving the equivalent energy needed to power the electric light-rail, resulting in a direct energy exchange with essentially zero emissions; the light-rail in return would reduce CO2 emissions by up to 59,000 tons per year.[9]

The cost of fuel

Assuming a current average of $3.22 per gallon, locals will spend a total of approximately 390 million dollars on gasoline over the period of a year. However, this price is volatile and will likely increase over time as seen by the following projection.

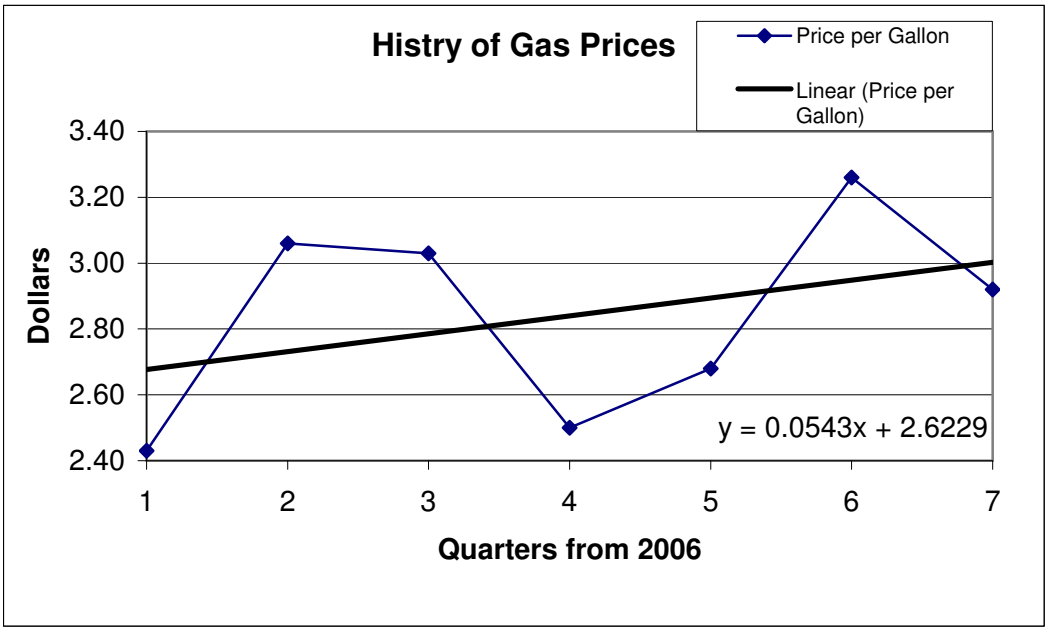
Graph 3 shows the history of gas prices, which includes Washington fuel tax, from the first quarter of 2006 to the end of the third quarter of 2007.[10] This data was published in October of 2007; an updated version will be released in February of 2008. The price had increased 20% during this 21-month period at a rate of $0.05 per quarter. As can be seen from the graph, prices are unstable and are subject to volatility. Graph 4 shows the projection of gas prices through the year 2010, reaching an average price of $3.71. Note that this could easily be lower than the actual local average due to the rising cost of oil and possible tax increases.

An even gloomier figure was stated in an article in the online publication of *The Heritage Foundation* on June 18th 2007 titled, "Senate Energy Bill Would Increase Gas Prices:"

> The Senate is currently debating energy policy legislation that could result in significantly higher prices for gasoline consumers. A review of S. 1419, including the just-completed section on tax changes, reveals that the bill could increase the price of regular unleaded gasoline from $3.14 per gallon (the early May national average) to $6.40 in 2016--a 104 percent increase. – by William W. Beach and Shanea Watkins, Ph.D.

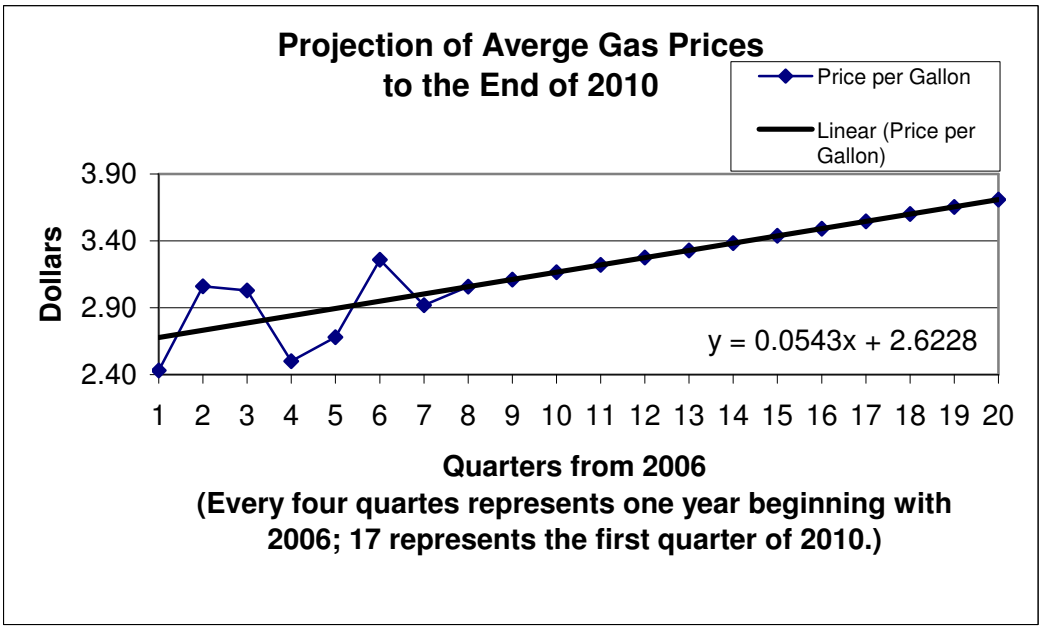
[9] This does not take into account the energy required to build the light-rail system. The pay back period for energy consumption (and emission offsetting time allowance) was not calculated.
[10] Regional Motor Gas Prices and Inventories; Table 4c; http://www.eia.doe.gov/emeu/steo/pub/4ctab.pdf

Graph 3



Source: EIA[11]

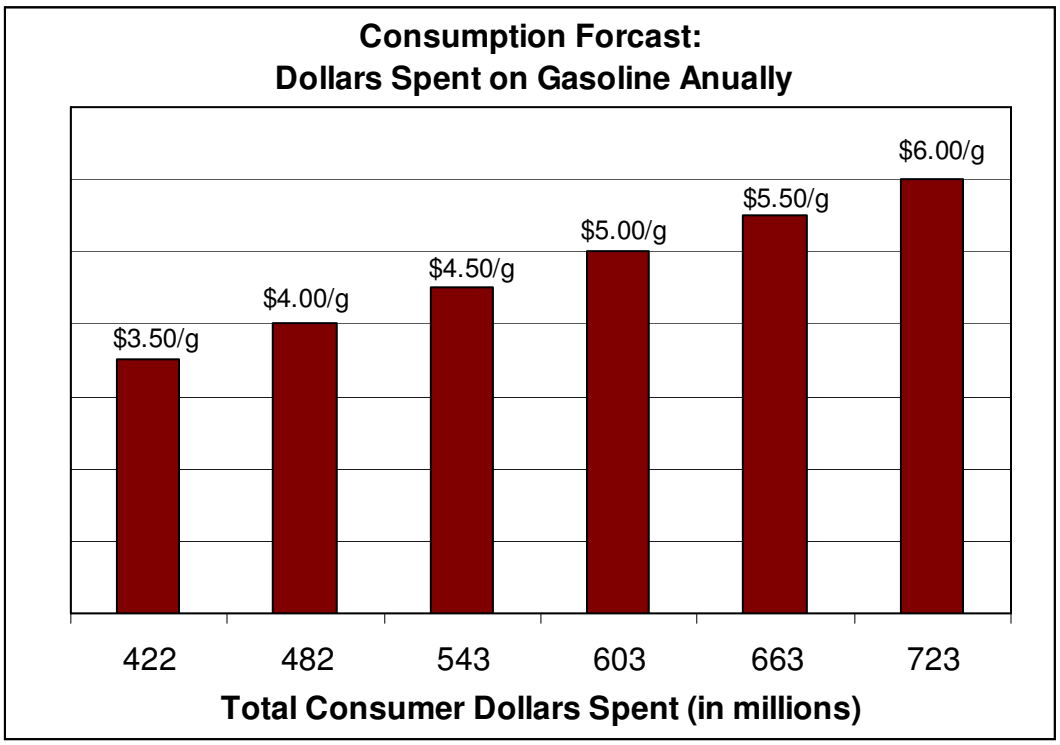
Graph 4

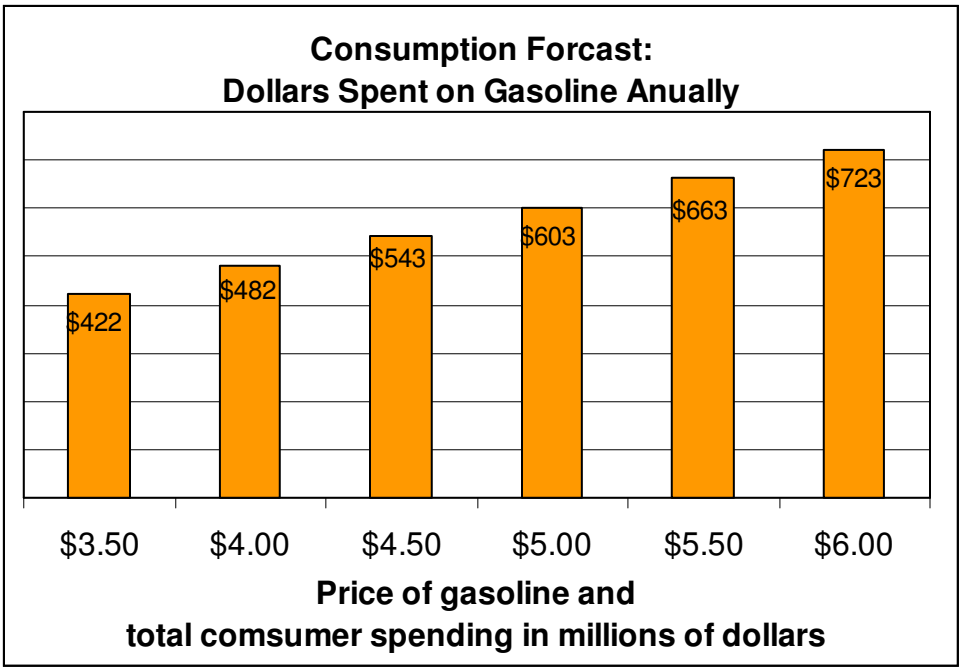


Source: EIA

[11] EIA; http://www.eia.doe.gov/oiaf/aeo/exel/yearbyyear.xls

This figure shows estimated consumer dollars spent on gasoline per year for forecasted gasoline prices, based on the vehicle miles above and an average mpg Prices range from $3.50 to $6.00 per gallon. Consumer spending reached a value of $723,450,000 dollars per year at $6.00/gallon gasoline.




Consumption Forcast:
Dollars Spent on Gasoline Anually
$422
$482
$543
$603
$663
$723
$3.50
$4.00
$4.50
$5.00
$5.50
$6.00
Price of gasoline and
total comsumer spending in millions of dollars