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Vermont Agency of Transportation (VTrans) 2016 State Agency Energy Implementation Plan (SAEIP)

The 2016 VTrans SAEIP was prepared by a VTrans team consisting of:

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- VTrans Solar Consultant, Good Company
- With special thanks to VTrans 2016 summer intern, Steve Yannacone

Executive Summary

The VTrans SAEIP describes how VTrans will meet requirements in state law regarding energy use and efficiency and increases in the use of renewable fuels in order to help the agency achieve cost savings and reductions in greenhouse gas emissions from its operations.

The plan is prepared biannually. For the past 5 years the agency has taken significant steps to better quantify and track energy use and costs across the heating, transportation and electricity sectors and calculate total energy use in BTUs. State law requires that state agencies reduce their total energy consumption, including on the job travel by 5% (measured in BTUs) each year, and increase use of renewables. Data is thus needed in order to address this and other performance measures included in the Vermont Comprehensive Energy Plan and other planning and policy documents

In 2016 the energy data trends were analyzed and the results are described in the plan. Transportation is the largest energy sector, followed by heating, electricity and state reimbursements for on the job travel (see chart on page 11). Transportation and heating have been increasing, electricity use has been flat, and state reimbursements for on the job travel is down. (See graph on page 12)

The plan includes numerous strategies to reduce energy use and increase the use of renewable fuels. They are organized in the plan's various sections described below and include:

1. VTrans energy use data and trends (including BTUs, carbon content and costs) and recommendations based on those trends:
    - Constantly improve data collection and analyses of agency energy trends and utilize the EPA Portfolio Manager to track building energy use
    - Better understand the use of VTrans light duty and passenger fleet in order to maximize the benefits of switching to electric vehicles
    - Increase the use of cleaner and cheaper heating fuels such as wood, natural gas and propane

- Purchase or lease electric passenger cars and fuel efficient trucks and SUVs when available for the various model classes used by the agency and investigate the cost-efficiency and practicality of lower cylinder Ford ½ ton trucks

2. Solar power production, including net metering and other renewable energy sources to serve VTrans' energy demand:
   - Complete the VTrans solar plan and make it available to the public, other agencies and municipalities.
   - Track the final net metering rule and advocate before the PSB to the extent possible that government entities be allowed to participate in the net metering program beyond the proposed 500 KW limit
   - Work with BGS, the PSD and other agencies on alternative power purchase and other solar financing options.

3. Building infrastructure controlled by VTrans – Including improving insulation, heating/cooling equipment, lighting and other efficiency measures and investigating the use of heat pumps for new or expanded facilities

4. Traffic signals and street and outdoor lighting, including an increase in LED parking lot and street lighting where feasible

5. State airports operations, such as continuing building and lighting efficiency projects

6. Non-fleet equipment – Purchasing more efficient and using office equipment such as computers and copiers, as well as other equipment associated with maintenance functions with efficiency in mind

7. VTrans-controlled medium and heavy duty fleet – Including the purchase of vehicles that are efficient in their class and increasing the use of biofuels when available

8. Passenger Fleet – Using the right size, most fuel efficient vehicles from the state's passenger fleet and exploring alternative fuel options including electric vehicles and associated fueling infrastructure. Also minimizing the need to travel by optimizing telecommunications technology and other strategies

9. State employee commuting - a significant energy use associated with state government operations and addressed through the VTrans supported Capitol Commuters Program and Way to Go Week.

Policy and Planning Context:

Reducing Vermont state agencies operations' energy use, increasing the use of renewable forms of energy, and undertaking energy planning and performance monitoring are well established state policies.

3 V.S.A Section 2291 describes the general policy of VT state government regarding energy use in state operations. It asks that state government meet its energy needs and reduce greenhouse gas emissions in a manner that is adequate, reliable, secure, and sustainable, and use energy resources efficiently and in an environmentally sound manner. In addition, state government must evaluate its energy and other needs in accordance with least cost integrated planning (LCIP).

In 2011, the legislature in Act 40, Section 47 specifically asked that each agency *reduce its total energy consumption, including on the job travel by 5% (measured in BTUs) each year and increase it use of renewables*.

3 V.S.A. Section 2291 requires that the Department of Buildings and General Services (BGS) develop a state agency energy plan (SAEP). BGS completed the most recent SAEP in early 2016 and it is included as a chapter in the state of Vermont's 2016 Comprehensive Energy Plan (CEP). There is an expectation in the CEP that the state of Vermont's agencies operations will "lead by example" in efforts to reduce energy use and increase renewables and in doing so reduce greenhouse gas emissions.

The 2016 SAEP includes the following goals for all of state government:

- Reduce total energy consumption by 20% by 2025, and by 25% by 2030.
- Meet 35% of the remaining energy need from renewable sources by 2025, and 45% by 2030.
- 40% reduction of greenhouse gas emissions below current levels by 2030.

The expectation is that each agency will measure individual progress, including the performance of efficiency and other strategies and establish individual agency goals that contribute to achieving the government wide goals described above.

3 V.S.A. Section 2291 asks that, in order to conserve resources, save energy, and reduce pollution, the SAEP shall, in summary, include the following:

- Devise strategies to identify opportunities for conservation of resources through environmentally and economically sound infrastructure development, purchasing, and fleet management, and investments in renewable energy and energy efficiency available to the State which are cost effective on a life-cycle cost basis
- Consider State policies and operations that affect energy use

- Devise a strategy to implement or acquire all prudent opportunities and investments in as prompt and efficient a manner as possible
- Include appropriate provisions for monitoring resource and energy use and evaluating the impact of measures undertaken
- Identify education, management, and other relevant policy changes that are a part of the implementation strategy
- Devise a strategy to reduce greenhouse gas emissions and include steps to encourage more efficient trip planning, reduce the average fuel consumption of the State fleet, encourage alternatives to solo-commuting State employees for commuting and job-related travel, and to incorporate conventional hybrid, plug-in hybrid, and battery electric vehicles into the State fleet if cost-effective on a life-cycle basis
- Provide for the installation of renewable energy systems including solar energy systems

3 V.S.A. Section 2291a asks that all state agencies, including VTrans, engage in a continuous planning process that is coordinated in a manner established by the Commissioner of BGS to assure that programs and actions are consistent with the policy goals described above.

In addition, Section 2291b requires that each state agency adopt an Agency Energy Implementation Plan (AEIP) that is compatible with the SAEP. The AEIP must be reviewed and approved biannually by BGS. ***This document addresses the requirement that VTrans adopt an "Agency Energy Implementation Plan" (AEIP) and is the biannual (2016) update for review by BGS.***

The AEIP is closely linked to the plan prepared by the state of Vermont inter-agency Climate Neutral Working Group (CNWG). The CNWG was placed under the purview of the Climate Cabinet in a 2012 Executive Order. Previous CNWG reports identify steps the state agencies, both individually and collectively, need to take to reduce the greenhouse gas (GHG) emissions of state operations. The strategies of the CNWG are thus reflected in the AEIP.

Discussion

VTrans planning efforts have been in sync with the state mandates described above.

The VTrans strategic plan has made "preserving and operating the transportation system in a cost effective and environmentally responsible manner" an agency goal. Investing in efficiency and renewables helps the agency achieve both the cost effective and environmentally responsible portions of this goal by saving money, and reducing the consumption of fossil fuels and greenhouse gas emissions.

In 2004 VTrans adopted an "Environmental Stewardship Ethic Policy for VTrans" One of the policy's operating principles is to *reduce the use of non-renewable energy resources by promoting building and vehicle energy efficiency in Agency operations*.

There have been challenges, however, associated with meeting the requirements of state law and achieving what the agency has set out to do in its plans.

First, there is a need to have accurate data and analyses of that data that shows energy consumption trends, including costs and GHG emissions, for electricity, heating, and transportation.

For the past 5 years VTrans Finance and Administration (F&A) has taken on this issue by better organizing the many hundreds of energy related accounts, calculating costs and use, and getting the EPA Portfolio Manager up and running for VTrans building accounts. In 2016 an agency intern, Steve Yannacone, worked to present this data in way that is easily understood and conducted trends analyses that are included in the following pages. Steve's methods are being adopted by F&A and will greatly assist future analyses.

The 2016 analyses presented below has some caveats. The 2012-2015 quantity data was calculated by dividing the average total cost data by per unit price data, whereas 2015 marked a step forward in VTrans data collection. Quantities (in addition to total cost) were directly tracked on the invoices. The 2015 method allows VTrans to more accurately capture actual quantities consumed going forward.

There is a large portion of the agency's electricity and heating/cooling use that is not being accounted for. The agency has no data for its leased headquarters at National Life where approximately 400 of the over 1300 VTrans employees are located. BGS is working to get this information through future negotiations with National Life.

Second, the state mandate in Act 40, Section 47 specifically asking that each agency reduce its total energy consumption, including on the job travel by 5% (measured in BTUs) is a herculean task. While the numbers of state employees are remaining stable or even being reduced in some sections there are pressures to increase the needed square footage. For Maintenance and Operations, the maintenance equipment is getting larger and additional space to work on this equipment and keep it under cover is needed. Also energy consuming technology demands are not lessening as the agency works to computerize more of its functions. A more realistic goal is to keep energy consumption flat as demand grows.

Third, Agency investment in efficiency and renewables is subject to the same budget pressures as most preventative measures. Today's budgets discourage costs that won't be gained for many years in the future. Investments in facilities and equipment such as solar or wood fired boilers, while having a demonstrated long term economic benefit, fall victim to competing agency needs being faced today.

Introduction

VTrans is committed to energy efficiency and an increase in the use of renewable sources of power, and is continuously working to better monitor energy use, evaluate trends and assess performance.

Energy conservation as part of VTrans' operations - more efficient energy use and increasing use of renewable energy - makes sense. There are the cost savings associated with reducing energy demand, as well as the air quality benefits of reduced levels of pollutants and greenhouse gas emissions that compromise human health and the global environment. Energy conservation is also a matter of national security as the nation faces dwindling supplies of oil, natural gas and other non-renewable resources.

Responsibilities – *VTrans' energy planning and implementation efforts cut across the agency with all Bureaus and Divisions working together.*

The development and implementation of the VTrans AEIP and coordination with BGS and the SAEP is under the Secretary's leadership and managed by the Policy Planning and Inter-Modal Development Division in close coordination with the agency "Energy Team". The Energy Team consists of the Environmental Policy Manager (plan coordinator), the Director of Operations, the Operations facilities and fleet managers, Finance and Administration Bureau representatives, and others as needed.

Plan Overview

The plan addresses several key areas:

10. *VTrans Energy use data and trends (including BTUs, carbon content and costs) and associated recommendations*
11. *Solar power production, including net metering and other renewable energy sources to serve VTrans' energy demand*
12. *Building infrastructure controlled by VTrans* – Including insulation, heating/cooling equipment, lighting and other efficiency measures.
13. *Traffic signals and street and outdoor lighting*
14. *State airports operations*
15. *Non-fleet equipment* – Purchase and use of office equipment such as computers and copiers, as well as other equipment associated with maintenance functions
16. *VTrans-controlled medium and heavy duty fleet* – Purchase and operation of the VTrans truck fleet including increasing the use of biofuels
17. *Passenger Fleet* – Use of the right size, most fuel efficient vehicles from the state's passenger fleet and exploring alternative fuel options including electric vehicles and associated fueling infrastructure. Also minimizing the need to travel by optimizing telecommunications technology and other strategies

18. *State employee commuting* - a significant energy use associated with state government operations

#1: Where VTrans Stands Today Regarding Energy Use, Costs and GHG Emissions - Overview of the Data and Trends and Recommendations

VTrans Finance and Administration has been collecting energy use data since 2012. This data was intensively analyzed during the summer of 2016[1] by PPAD's climate intern, Steve Yannacone. Steve's full report is available in Appendix A. His work resulted in several recommendations summarized below and further described in this section of the plan.

Heating

- ✓ Increase the use of cleaner and cheaper heating fuels, prioritized in the following order for both cleanliness and cost-effectiveness:
    - Purchased wood: $6.29/MMBtu and very low life cycle emissions
    - Natural gas: $9.69/MMBtu and 53 kg CO2e/MMBtu in combustion
    - Propane: $18.41/MMBtu (and a huge price drop in 2016) and 63 kg CO2e/MMBtu
        - *For comparison: Heating Oil #2 $22.63/MMBtu and 74 kg CO2/MMBtu*

Transportation

- ✓ Purchase or lease electric passenger cars and fuel efficient trucks and SUVs when available, and putting systems in place so that there is consideration of trips that are most suitable for partial electric vehicle and eventually full electric vehicle, use thus increasing the use of the cheap and relatively clean Vermont electric grid instead of more expensive and dirtier gasoline and diesel.

- ✓ Central Garage: Look into the cost-efficiency of lower cylinder Ford ½ ton trucks with EcoBoost technology, as well as the corrosion and maintenance costs as well as the ability to withstand wear and tear of Ford's new aluminum bodies. Central Garage is generally doing very well with getting top-of-the-line fuel economy for their trucks within each tonnage class, but some potential improvements could be made in the ½ ton class. Improvements may be only 1 or 2 mpg, but since they represent a large percentage of the fleet and so many miles are put on them, cost savings can be multiple thousands over the lifetime of the vehicle.

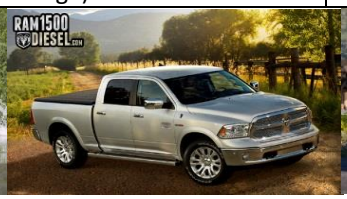
- ✓ BGS Leased Fleet: Although BGS fuel costs only represent 6.6% of the agency's energy consumption, BGS fuel purchases altogether still represent $250,000 annually, much of which is wasted on inefficient vehicles in every class. Suggested models for BGS and Central Garage vehicles include:

Sedans	SUV	½ Ton	¾ Ton	Compact

[1] See the complete report prepared by PPAD intern Steve Yannacone for more information regarding the data and analyses details including climate related control variables and their effects on the various trends.

Sedans	SUV	½ Ton	¾ Ton	Compact
Toyota Prius Eco Chevy Spark EV (1 or 2 only)	Toyota Rav 4	Gas: 4WD Ford F-150 2.7 L with EcoBoost Engine	4WD 14' Chevrolet 2500 (Currently Used at Central Garage)	Chevrolet Colorado (Currently Used at Central Garage)
Honda Accord Hybrid		Diesel: 4WD Ram 1500 FYE		
Chevrolet Volt (PHEV)		Gas: 4WD Chevy 1500 (Currently Used at Central Garage)		






Data Tracking Improvements

- ✓ Increase reporting quantity and quality of bottled gas usage.
- ✓ Install GPS's or at the very least mileage logs in at least 5 sedans and 3 SUVs in order to better understand the VMT distribution of an average trip in a state owned vehicle so that it can be determined how many EVs with specific electric ranges will be appropriate in the coming years.
- ✓ Consider running VTrans test trials on a few vehicles. This may include but is not limited to quantifying relative costs and GHG emissions for
    1) Specializing gear ratios for certain heavy duty diesel fleet vehicles who are much more likely to either drive uphill or on the highway.
    2) Corrosion and repair costs of Ford's new ½ ton aluminum bodies
- ✓ Keep track of the fuel transactions of the BGS vehicles when they are in VTrans possession. Currently the vehicles that BGS leases us at any point during the year gets tracked for the entire year even after they leave our hands. This practice tends to overstates the agency's sedan and SUV use relative to truck use.

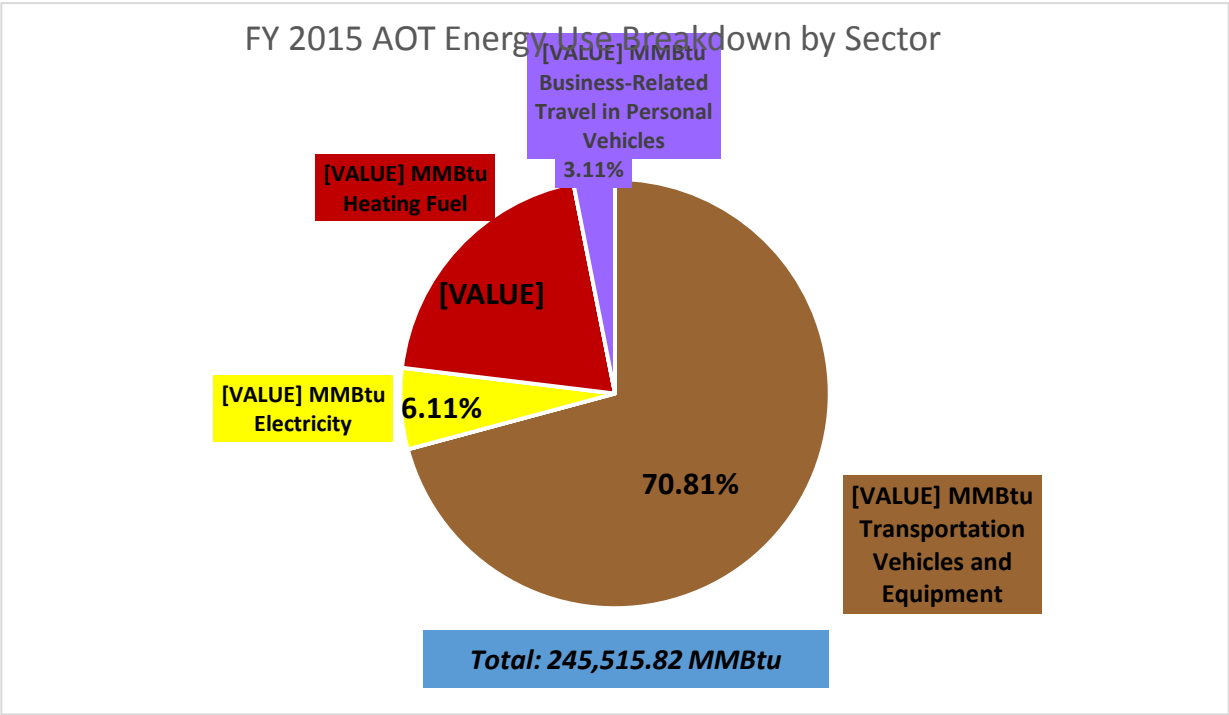
Current State – Total Energy Use

Transportation vehicles and equipment, and the associated use of gasoline and diesel, is the biggest category of agency energy use, representing 70.67% of the agency's 2015 energy consumption. It is also the hardest to address in the short term. Efficiencies in transportation can be achieved primarily through shifting to more efficient vehicle technologies. Major efficiency improvements are possible for sedans and SUVs, and moderate improvements in the agency's ½ ton trucks. However, these vehicles make up a relatively small part of the total fleet which is dominated by heavy duty diesel trucks and equipment. The heavy duty sector is subject to less stringent EPA fuel economy requirements and is beholden to non-diverse fuel options.

Heating fuel is the second biggest category of energy use representing 20.13% of the agency's 2015 consumption. Heating fuel is used in all office buildings and most of garages. Heating is the one sector where the most immediate change is possible. Moving away from kerosene, Heating Oil #2 and diesel and towards natural gas, propane, and wood allows the agency to simultaneously cut heating costs and emissions significantly in the short and medium terms.

Electrical energy consumption is relatively minor, weighing in at only 6.09% of total energy units. 65% of the agency's electricity consumption is used for buildings and other indoor functions, and 35% is used for various highway uses, traffic lights and other signals, weather stations, weigh stations, and street and park & ride lights. The continued replacement of various office and roadway lights with LED bulbs will decrease overall electrical consumption, while the advent of electrical vehicles will simultaneously increase the figure (but decrease our overall costs and GHG emissions). The agency is also committed to increasing use of agency generated solar through net metering and other programs and reaping those economic and other benefits. See Section 2 for more information.

Business-related Travel in Personal Vehicles represents the amount of fuel consumed (nearly entirely gasoline) by VTrans employees on the job using their personal vehicles instead of AOT fleet Central Garage or BGS vehicles. Mileage data was gleaned from mileage reimbursement data, and gasoline consumption data is calculated from that mileage data assuming on-road US average fuel economy figures for 2015 of 21.4 mpg for light duty vehicles.



Current State - Greenhouse Gases (GHG)

Greenhouse gases (GHG) have not decreased over time in line with the CEP goal for state government of a 40% reduction by 2030. Instead, combustion-related GHGs have increased an average of 9% annually over the past 4 years.

Part of this increase is due in part to increased wood consumption for heating, which now represents about a quarter of agency heating needs. While inefficient on a kg CO2/MMBtu basis, emitting about 30% more GHGs per Btu than various traditional heating oils, wood use is nonetheless highly recommended because of its extraordinarily low life cycle emissions. Even if wood combustion is treated as emitting 0 GHGs due to lifecycle emissions, the overall trend for heating is still sharply positive.

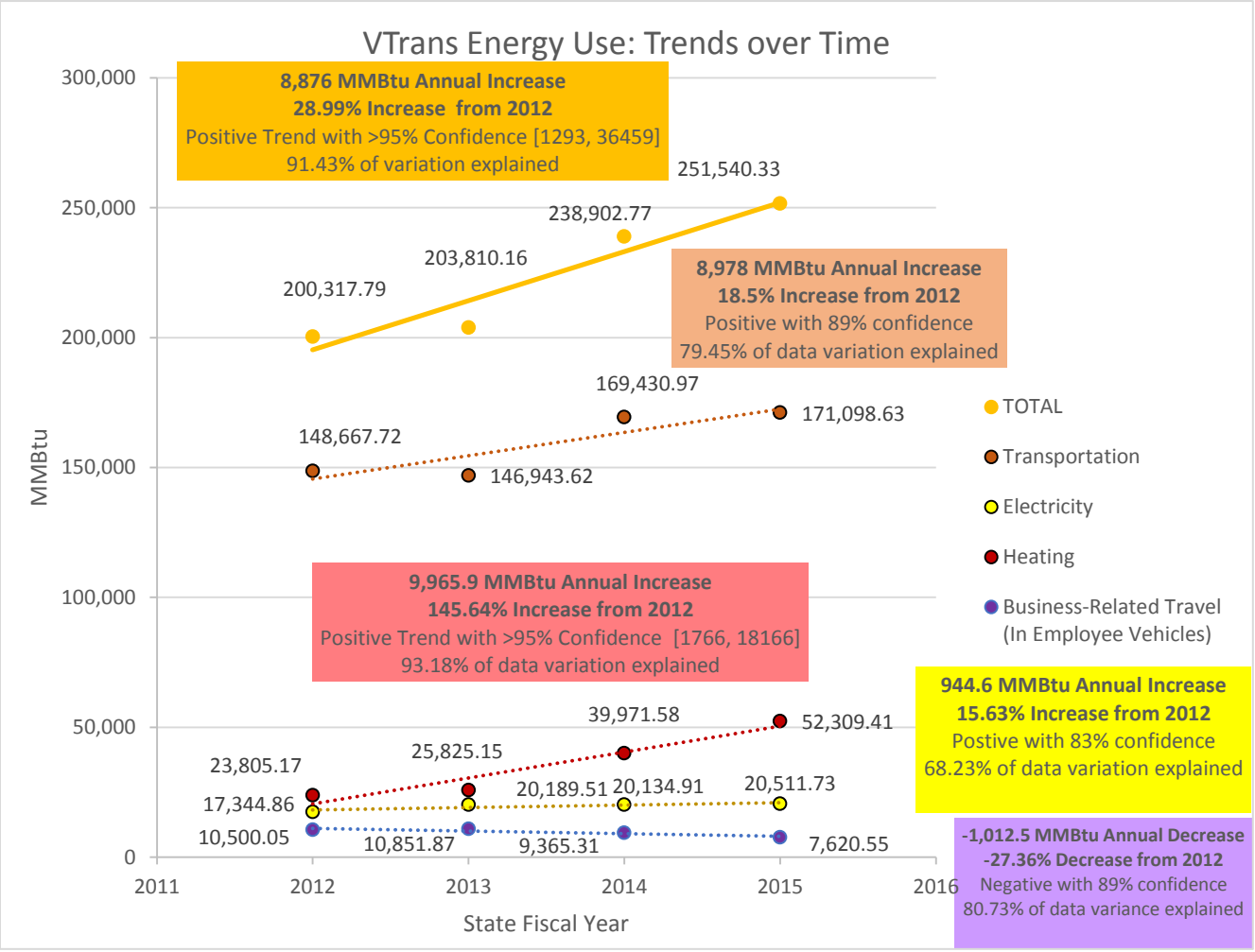
It should be noted that energy and GHG use data, does not necessarily represent a long term trend. The 2016 analysis included controls for some factors that may be affecting the numbers. Using multiple regressions, 2012-2015 values for energy use were considered as if climate factors such as snowfall and freeze thaw events had been the same over these 4 years. This was in order to isolate the true effect of VTrans' energy use and GHG emissions policy and operations over that period.

Recent Trends - Total Energy Use

VTrans energy consumption has increased an average of 8,876 MMBtu over the past 4 years[2], thus indicating that the agency is not on track to meet the legislature's state agencies efficiency goals. The increase instead represents a continuously compounding *5.86% increase in energy consumption, or a 28.98% increase over the 2012 value*.

The most statistically consistent category of increase has been in heating, from which there has been a 9,965.9 MMBtu average annual increase between 2012 and 2015 (145% increase in 2015 from the 2012 value).

The only decreasing sector has been for business-related travel with employee vehicles. The 1012.5 annual MMBtu decrease (total decrease of 27.36% from 2012) is large for that sector, but only represents less than .5% overall agency energy reduction. This decrease is due to the BGS/VTrans passenger car and SUV fuel economies being far superior to the US average of 21.4 mpg.



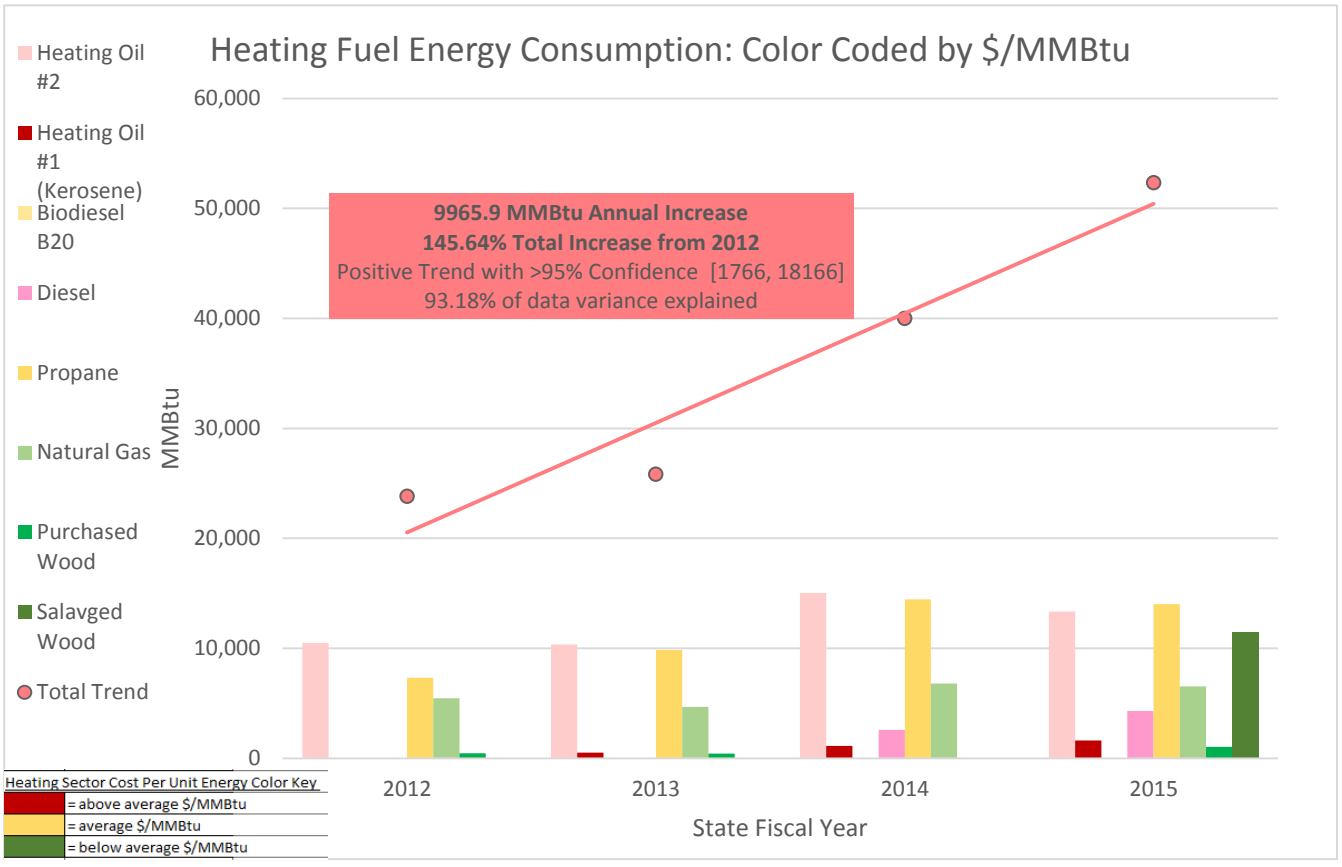
[2] There is a 95% confidence range of estimates. The raw trend stretches from 1,293 MMBtu/year to 36,459 MMBTu/year, and more data over time must be collected in order to achieve a more reliable estimate.

Energy Costs and GHG for the Various Sectors – Heating, Transportation, and Electricity

Heating – Energy Costs

As noted above, total energy used for heating has increased a continuously compounding 9,965.9 MMBtu each year or 145.64% from 2012. This increase represents increases in the amount of relatively dirty major fuel Heating Oil #2, as well as increasing amounts of less-often-used but equally-dirty diesel and kerosene. The agency has, however, made great strides in purchasing and salvaging more wood in 2015, and, across the 2011 to 2015-time frame, have on average, increased natural gas and propane use relative to other fuels. However, there is clearly still much work to be done.

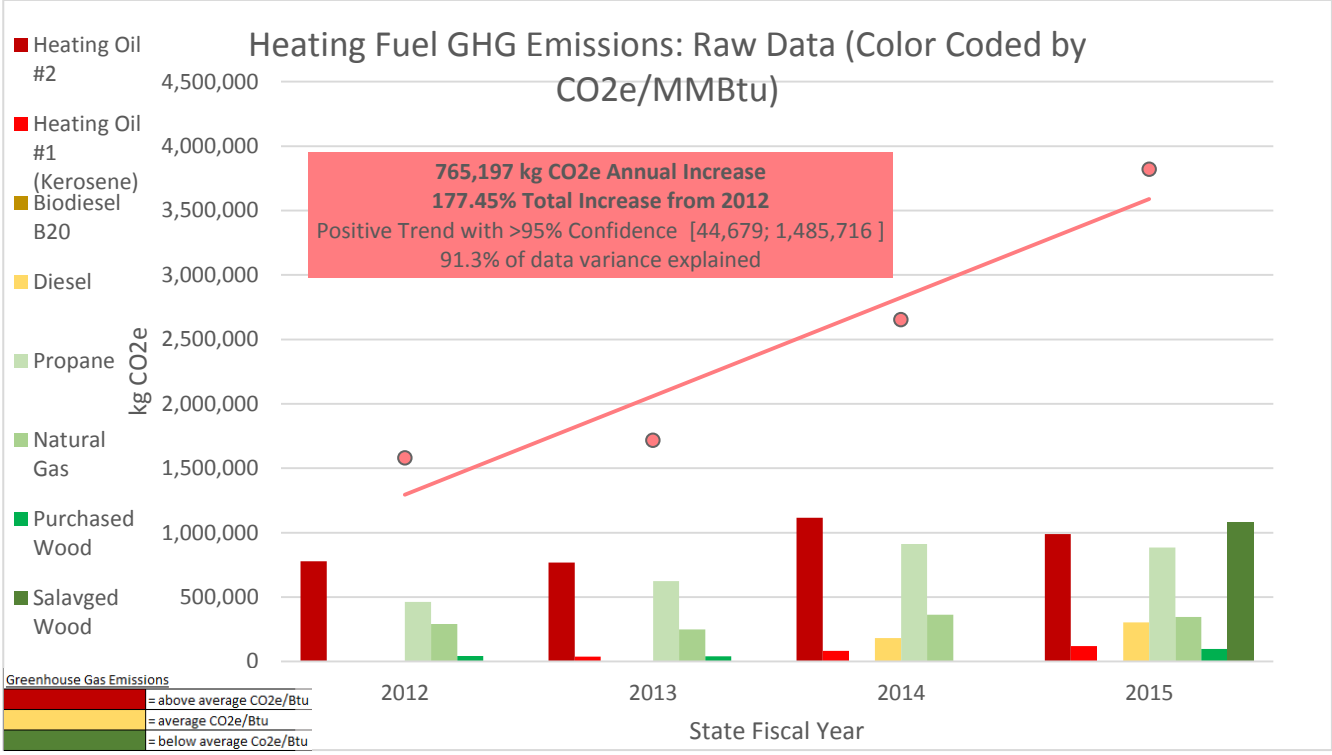
When controls such as temperature are added (see Appendix A for more information), there becomes a 40% chance that the remaining energy relationship over time arose by chance alone or was driven by climate and other critical contextual issues. The agency will need more data, especially from warm winter years in order to make more exact conclusions on the direction of energy and emissions from heating.



Heating - Greenhouse Gas Emissions

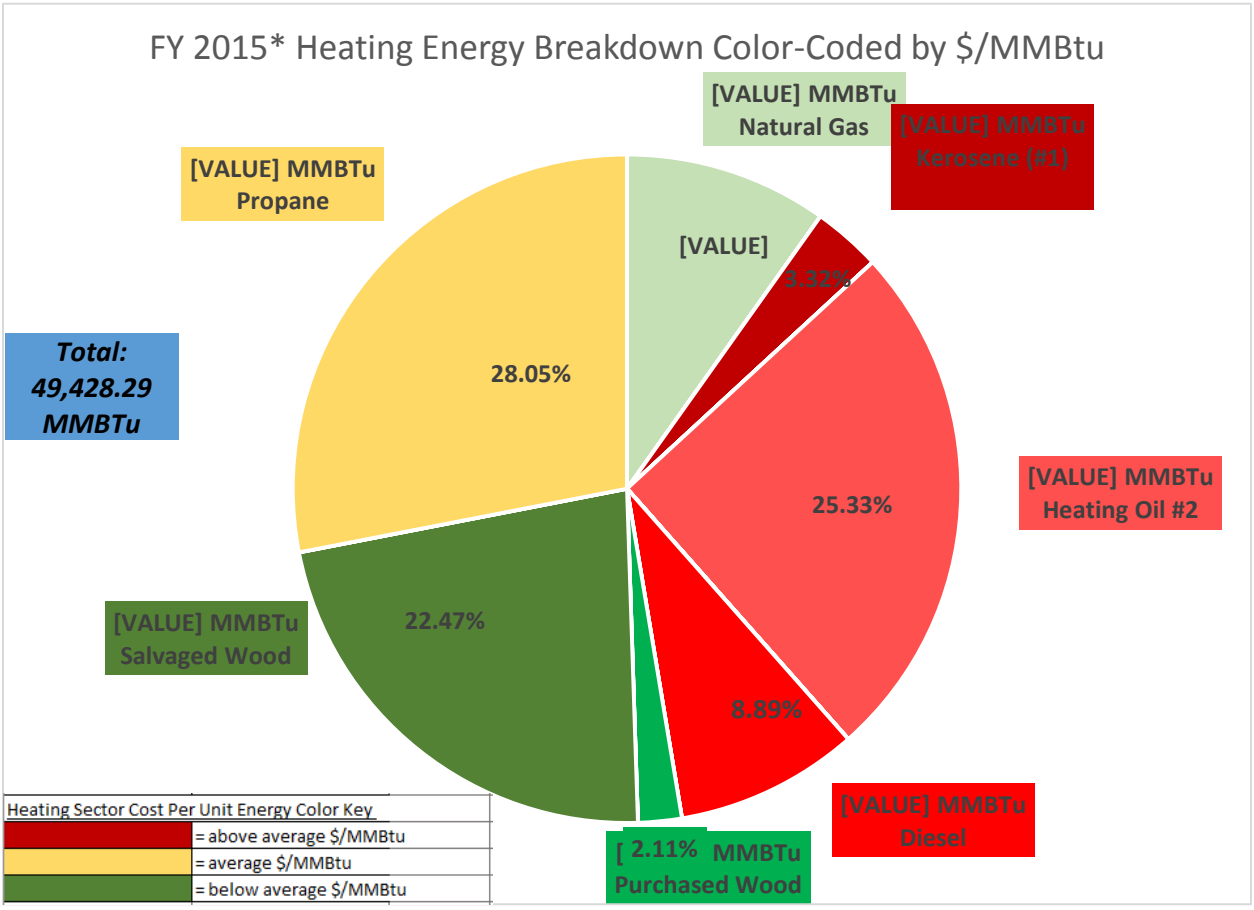
Heating-related GHGs (including wood) increased a significant - 40.5% annually over the 4-year period from 2012 to 2015. Even when considering wood as having emissions of zero (for its extremely low life cycle emissions compared to other fuels), there is still a trend of 429,516 kg CO2 increases every year - an astonishing 23% yearly increase.

A cleaner balance of fuels over time that focuses on cleaner and cheaper wood, natural gas, and propane, as was the case in 2015, rather than in 2012, should show benefits. It will be interesting to see if heating-related energy use and/or emissions drop in SFY 2016 after the warm winter of 2016.

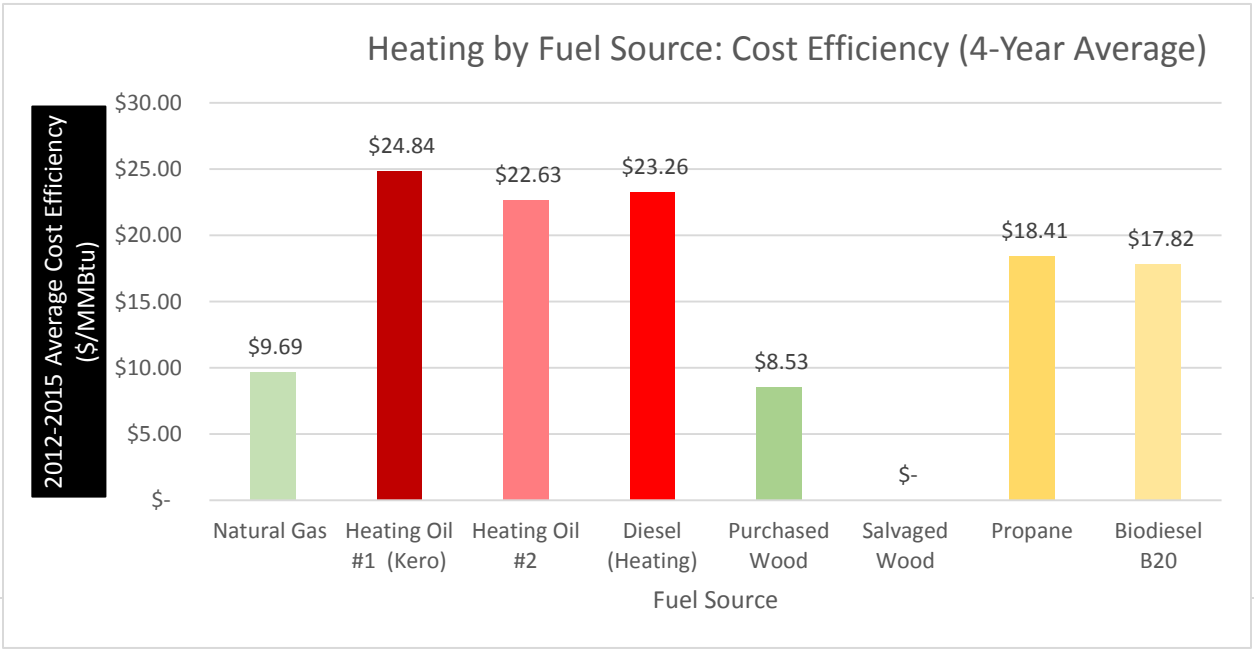


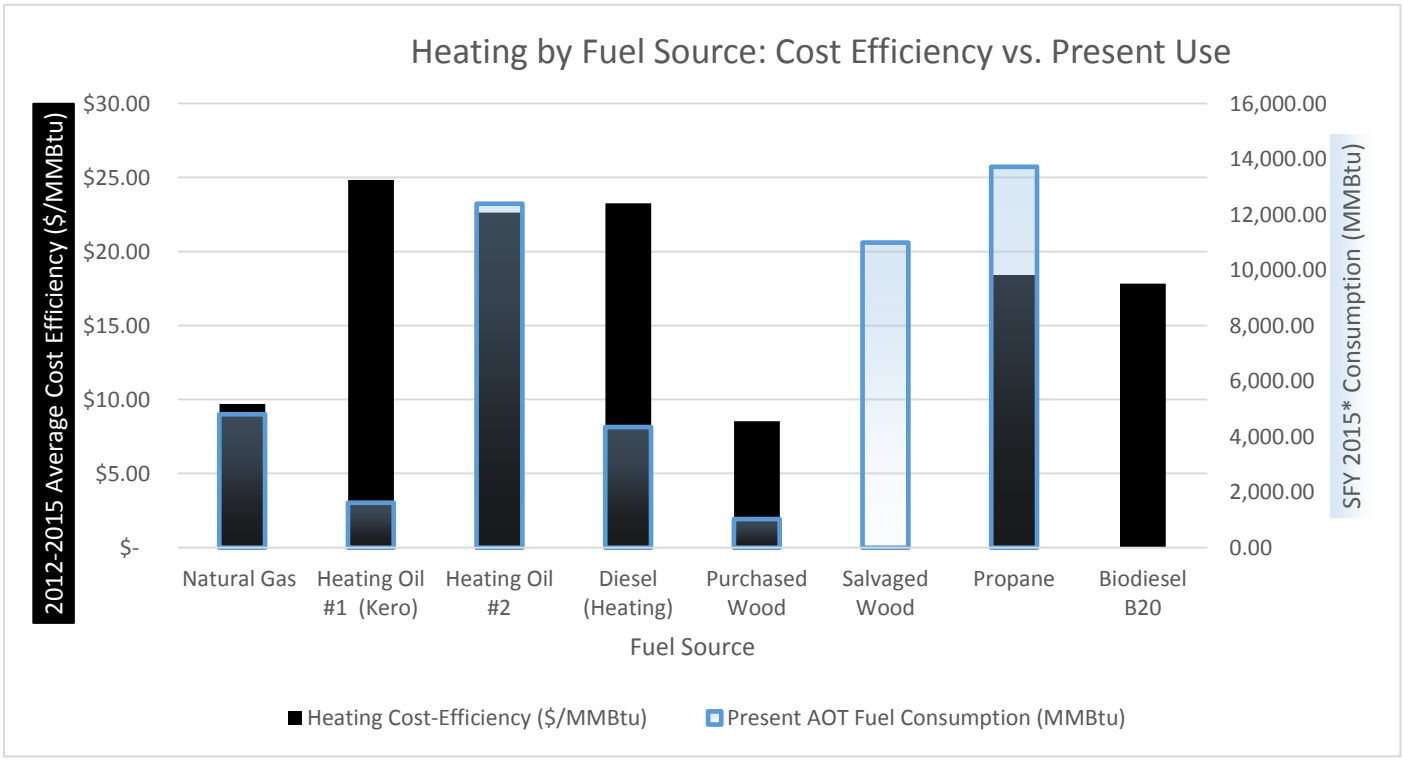
Heating – Cost Efficiency

As noted above, 19.97% of VTrans energy use and 20.45% of its GHG emissions come from heating. The balance has been dominated by 3 fuels: propane, wood, and heating oil #2. Of all fuels, wood is the most efficient per MMBtu with a 4-year average cost for purchased wood at $8.53/MMBtu. Natural gas comes in second at $11.83/MMBtu and then propane at $18.41/MMBtu. Over the 4-year time span, natural gas, wood, and propane have stayed solidly and strongly in their relatively cost-effective positions versus other heating methods.

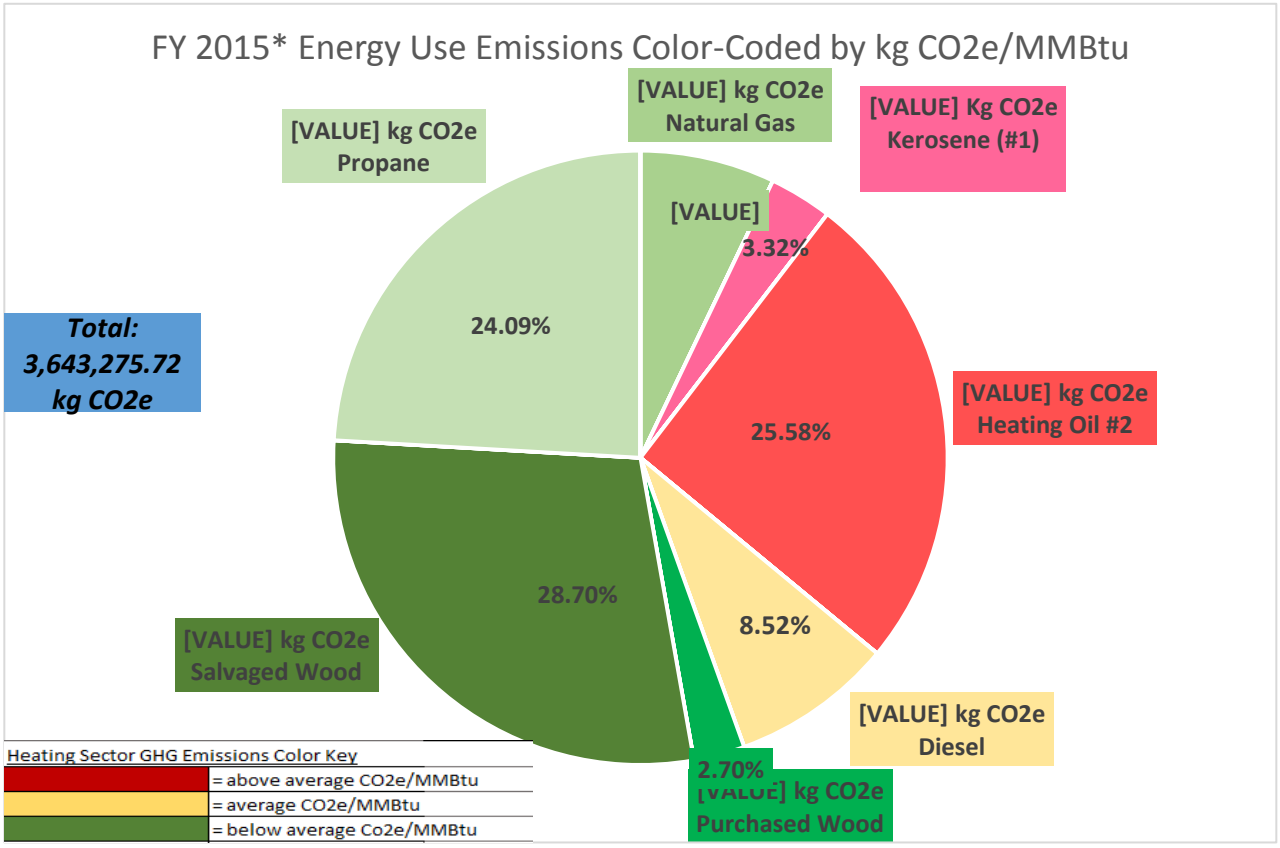


Despite the cost-efficiency benefits of wood and natural gas and the significant benefits of propane, the agency has not been able to fully utilizes them. There have been some increases in propane consumption, but natural gas and wood remain under-utilized and Heating Oil #2 remains a large cost both the agency and the environment.

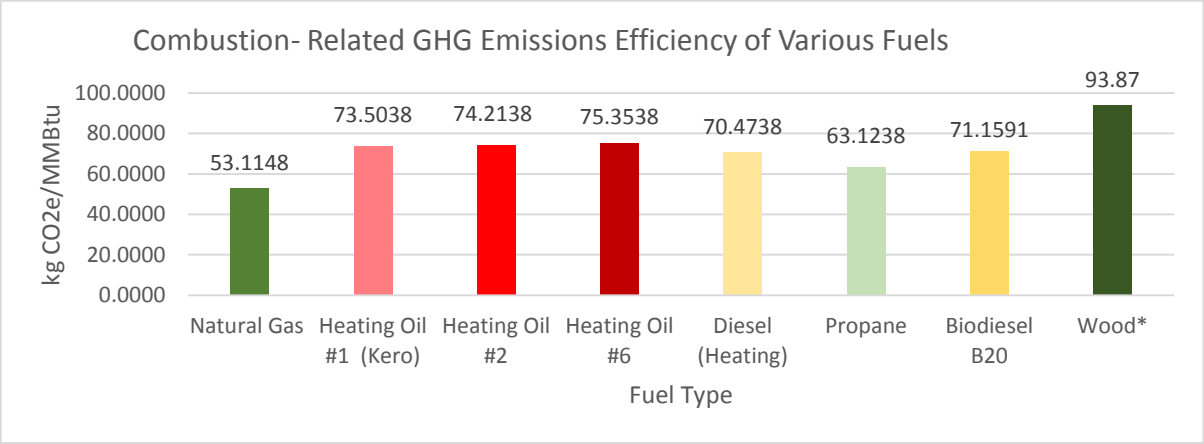




Heating – GHG Reduction Cost Efficiency



Propane is the largest share of the agency's cleaner-than-average heating source and has the co-benefit of lower-than-average costs and lower-than-average GHG emissions. Natural gas, despite being both the second-to-least expensive per unit energy and having the lowest GHG, represents only 7.10% of the agency's total and 9.83% of heating-related energy consumption. See below for a full list of greenhouse gas efficiency numbers represented as Kg CO2/MMBtu.



Heating – Wood and GHG Emissions

Wood is classified as a renewable resource and wood harvesting is more environmentally friendly when compared to extraction and processing other heating fuels. In recent years, wood has been a target fuel for the agency. At the combustion level, wood is one of the least efficient fuel sources and its combustion produces 26% more CO2e/MMBtu than the second dirtiest-at-combustion fuel, Heating Oil #2. However, unlike all other heating fuels, the life-cycle greenhouse gas effect of wood and various other biomass fuel sources is extraordinarily low, more than making up for the combustion disparity and making it the least GHG intensive heating fuel.

Heating - Recommendations

✓ **Propane**:

GHG

Propane combustion releases 14.94% fewer greenhouse gases than VTrans second biggest fuel source, heating oil #2, which makes up 25.08% of the current SFY 2015 heating fuel consumption. Propane is also 10.43% cleaner than diesel, which makes up 8.8% of heating fuel consumption, and 14.12% cleaner than Kerosene, which makes up 3.28% of heating fuel consumption. Fully replacing these three dirtier fuels with propane would cut heating-related GHG by 186,270 kg – 5.11% of heating GHGs and 1.05% of overall VTrans GHGs. The GHG decrease becomes up to 10% better due to the fact that most heating oil furnaces are only 80-90% efficient while propane furnaces are 89-98% efficient.

Cost

Propane has consistently been in the middle of the road for cost per energy unit. Over 2012-2015, it averaged $18.41/MMBtu: 25.89% lower than the kerosene average, 18.65% lower than the heating oil #2 average, and 20.85% lower than the diesel average. These three dirtier and costlier fuels made up 37.16% of our heating energy in 2015 and 48.48% of heating costs (5.6% of total energy costs). Based on current consumption levels and 4-year average prices, fully replacing kerosene, heating oil #2, and diesel with propane in 2015 would have saved approximately $69,115.16, or 10% of our 2015 heating cost and 1.12% of total energy costs.

There are two practical considerations regarding increases in propane use. The first is the availability of furnaces that use propane. The second pertains to the greater quantity of propane tanks needed to get the same heating energy as heating oil. Although propane is more efficient on an MMBtu basis, garages will need to order or haul 30% larger (by volume) shipments and replace tanks 30% more often. Depending on the garage and fuel dealer, this may or may not impose significant additional transaction cost.

keeping these caveats in mind, propane could be a win-win for both the environment and the AOT budget. Garages with furnaces that accept propane and to whom larger shipping volume does not impose significant cost should switch to propane immediately. Garages whose furnaces would need replacement in order to burn propane should weigh the financial impacts on their garage in the medium term.

- ✓ **Natural Gas**

GHG

Natural gas is the second-cleanest heating fuel in the VTrans inventory. Natural gas releases 53.1148 kg CO2e/MMBtu. That makes natural gas 28.43% cleaner than Heating Oil #2, the second-widest used heating fuel, 27.74% cleaner than kerosene, 24.63% cleaner than diesel, and 15.86% cleaner than propane, the most widely used heating fuel and the third-cleanest. A full replacement of kerosene, heating oil #2, diesel (heating only), and propane (everything but wood) with natural gas would cut heating fuel emissions by 507,586 kg CO2e. That's an emissions cut of 13.93% for heating and an overall energy emissions cut of 2.9%.

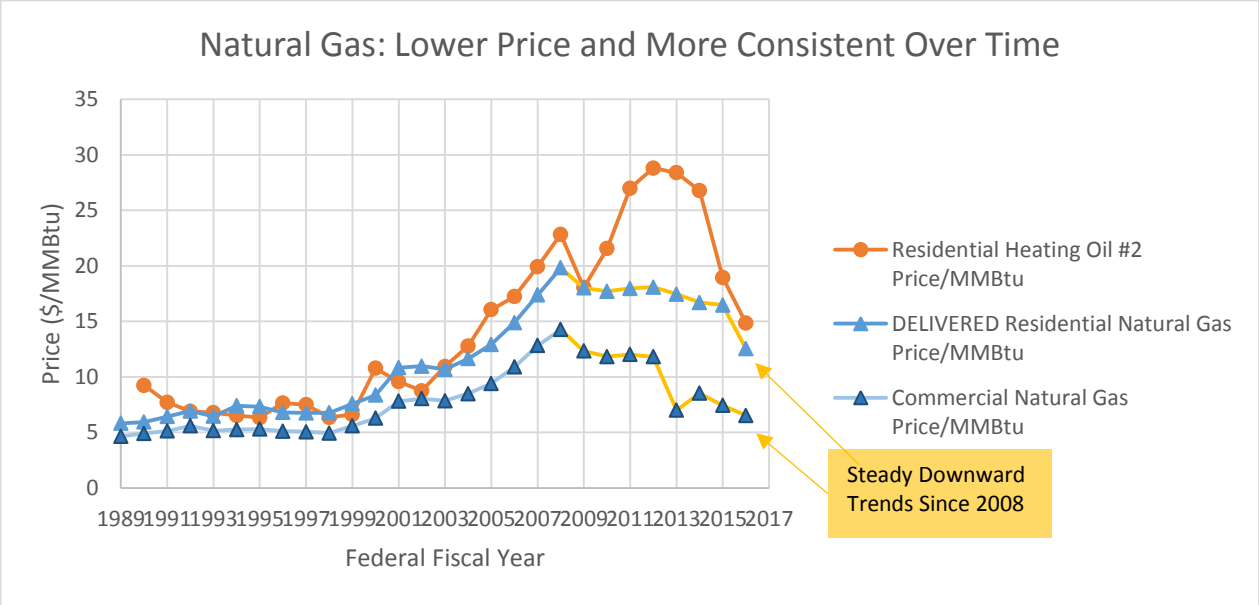
Cost

Except for wood, natural gas is also by far the most cost effective of VTrans current heating fuel inventory. The 4-year average price was $9.69/MMBtu, making it 60.99% more cost effective than kerosene, 57.18% more cost effective than heating oil #2, 58.34% more cost effective than diesel, and even 47.36% more cost effective than propane. Based on current consumption levels and 4-year average prices, a full switch from kerosene, heating oil #2, diesel, and propane to natural gas would save the agency $294,922.54 annually in heating

cost. That's an annual reduction in heating costs of 40.87% and a 4.74% reduction in overall energy costs. Better still, over the past 4 years, the natural gas price has decreased an average of $0.79/MMBtu every year [90% confidence range of $-1.34 to $-0.24], and shows no signs of rising.

Although agency price data is limited, Vermont-wide EIA data shows only signs of decrease going into the future. Prices have been on a steady decline for the past 8 years, even though the background oil market has been volatile, with the price per MMBtu of heating oil peaking at $28.8/MMBtu in 2012. Yet Vermont commercial prices, recorded by the EIA and extending further into history, back up findings for recent price trends. Since 2008, commercial natural gas prices have dropped an average of $.95/MMBtu every year [95% confidence range of $-1.30 to $-$.60].

Even the delivered residential as well as the commercial natural gas prices are lower than the heating oil #2 price. Wherever natural gas is an option and wood is not, garages and office buildings should consider using natural gas.



✓ **Wood**

Environmental Context

As noted previously, wood produces more GHG emissions relative to other heating fuels on an MMbtu basis. While, on a life-cycle level, it is many times cleaner than even natural gas. According to DFPR (Dept. of Forestry, Parks, and Recreation), current harvesting rates are only 50% of the rate of regrowth, meaning that cutting wood for heating in Vermont is a truly sustainable practice.

Costs

Outside of transaction costs and not including the labor associated with moving, stacking, moving/stoking the furnace/boiler, etc. as well as the lost time not spent on the district maintenance workers' core function (maintaining the highway infrastructure) salvaged wood has a cost of $0. But even purchased wood is cost-effective. In fact, at a 4-year average purchasing cost of $6.29/MMBtu, wood is the most cost-effective of all fuel sources. That makes it 65.65% more cheaper than kerosene. 62.29% cheaper than heating oil #2, and 63.31% cheaper than diesel. Compared to other recommended clean and cheap fuels, it is 53.65% cheaper per MMbtu than propane and 11.94% cheaper than natural gas.

If all heating fuel levels remain at 2015 levels, VTrans could save an average of $331,678.74 every year by replacing all non-wood fuels with purchased wood. If salvaging rates increase, so will the savings and if salvaging amounts decline so will the savings decrease. Even if salvaging stopped all together and purchased wood became our standard heating fuel, AOT would still realize a $233,684.39 annual net financial gain.

Individual Facilities and the Annual Fuel Savings That Could Be Achieved by Switching to Wood, Natural Gas, and Propane:

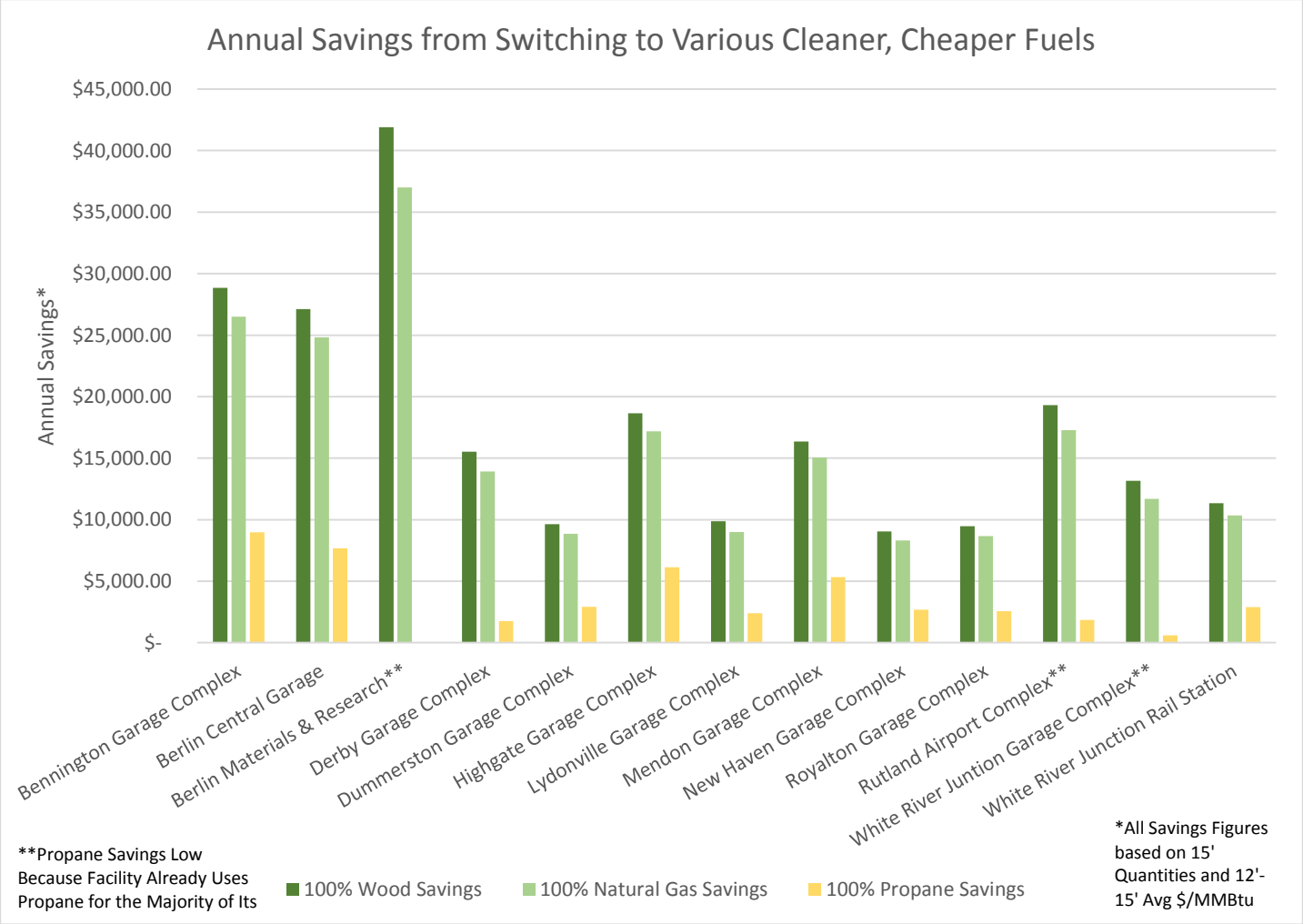
Cost savings should be addressed at the facility level because changing heating sources often involves changing boilers and incurring different maintenance costs and boiler lifespans, some locations will have natural cost advantages over others. Given the upfront cost of switching out a heating oil #2 boiler for a wood boiler that meets the state's particulate matter standards, for instance, larger facilities will tend to have much quicker payback periods than smaller facilities.

Facilities that could save $9,000-$41,000 annually from fuel changes to wood, natural gas, and/or propane (alphabetical order):

1. Bennington Garage Complex: Currently using predominantly kerosene, with a large amount heating oil #2 and a moderate amount of propane
2. Berlin Central Garage: Currently using nearly entirely heating oil #2, with a relatively tiny amount of propane
3. Berlin Materials & Research: Currently using entirely propane
4. Dummerston Garage Complex: Currently using predominantly Heating Oil #2, despite having access to both propane and wood
5. Highgate Garage Complex: Currently using Diesel
6. Lyndonville Garage Complex: Currently using a 4:1 mix of heating oil #2 and propane
7. Mendon Garage Complex: Currently using a 3:2 mix of heating oil #2 and kerosene, despite having access to propane and wood

8. Royalton Garage Complex: Currently using a 4:1 mix of diesel and propane
9. Rutland Airport Complex: Currently using a 3:1 mix of propane and heating oil#2
10. White River Junction Garage Complex: Currently using a 4:1 mix of propane and heating oil #2

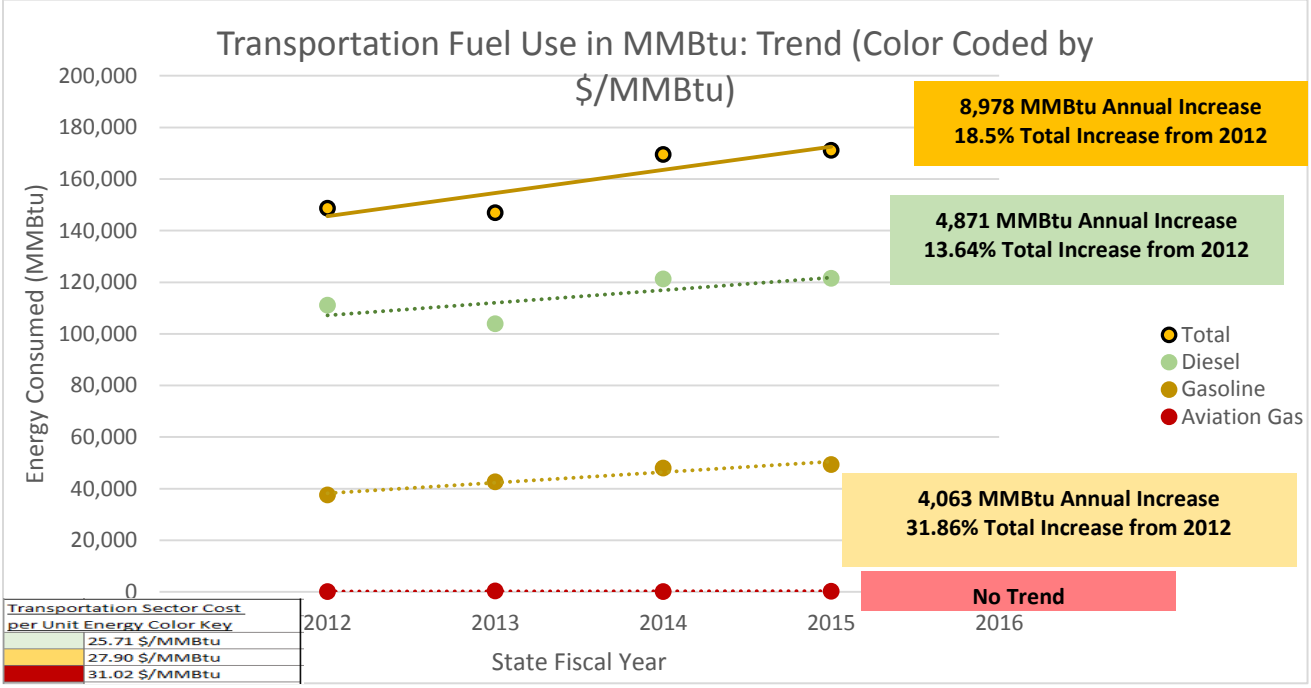
11. White River Junction Rail Station: Currently using a 4:1 mix of heating oil #2 and propane



In addition, several facilities who are already using some wood, natural gas, or propane and have the necessary boilers could realize several thousand more dollars in annual financial gains by using more of these fuels. Further analyses of savings for individual garages are available here.

Transportation - Recent Trends

Overall transportation energy consumption is increasing, with levels being 18.5% higher in 2015 than in 2011. Consumption is not going down. The only trend steadily increasing in a *statistically* significant way is that of gasoline, which increased 31.86% between 2012 and 2015, but all trends are much more likely positive than not.



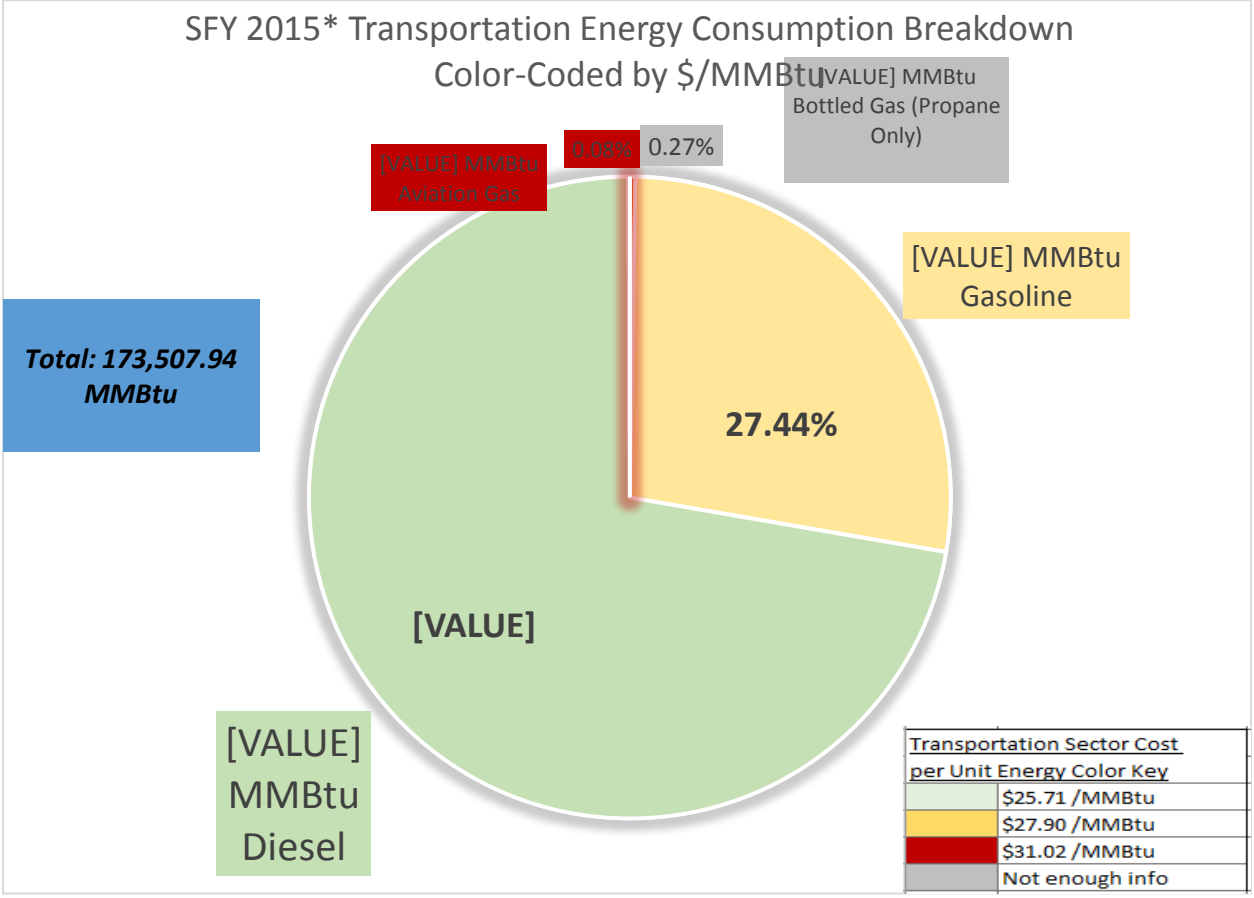
The number of "snow days" control is by far our most explanatory control for the transportation sector. The year, together with the number of snow days, are able to explain 99.7% of the variation (Adjusted R^2) in the energy data, vastly improving the accuracy of the trend. Controlling for the number of snow days, transportation emissions are increasing at a rate of 13,788 MMBtu per year (95% confidence range of 8,166 to 19,410), 53.6% higher than the raw trend would suggest.

Controlling for the number of freeze/thaw days helps explain 97.5% of the variation in the data, suggesting an increase slightly lower than the raw, uncontrolled trend would suggest. Controlling for the number of freeze/thaw days, transportation emissions are increasing at a rate of 8,546 MMBtu per year (statistically insignificant at the 95% confidence level and with a 90% confidence range of 2,759.851 to 14,332.38), 4.8% lower than our raw trend would suggest.

Note that whether there are controls for snow days or freeze/thaw days, the estimates for AOT's energy consumption is still both positive and very large.

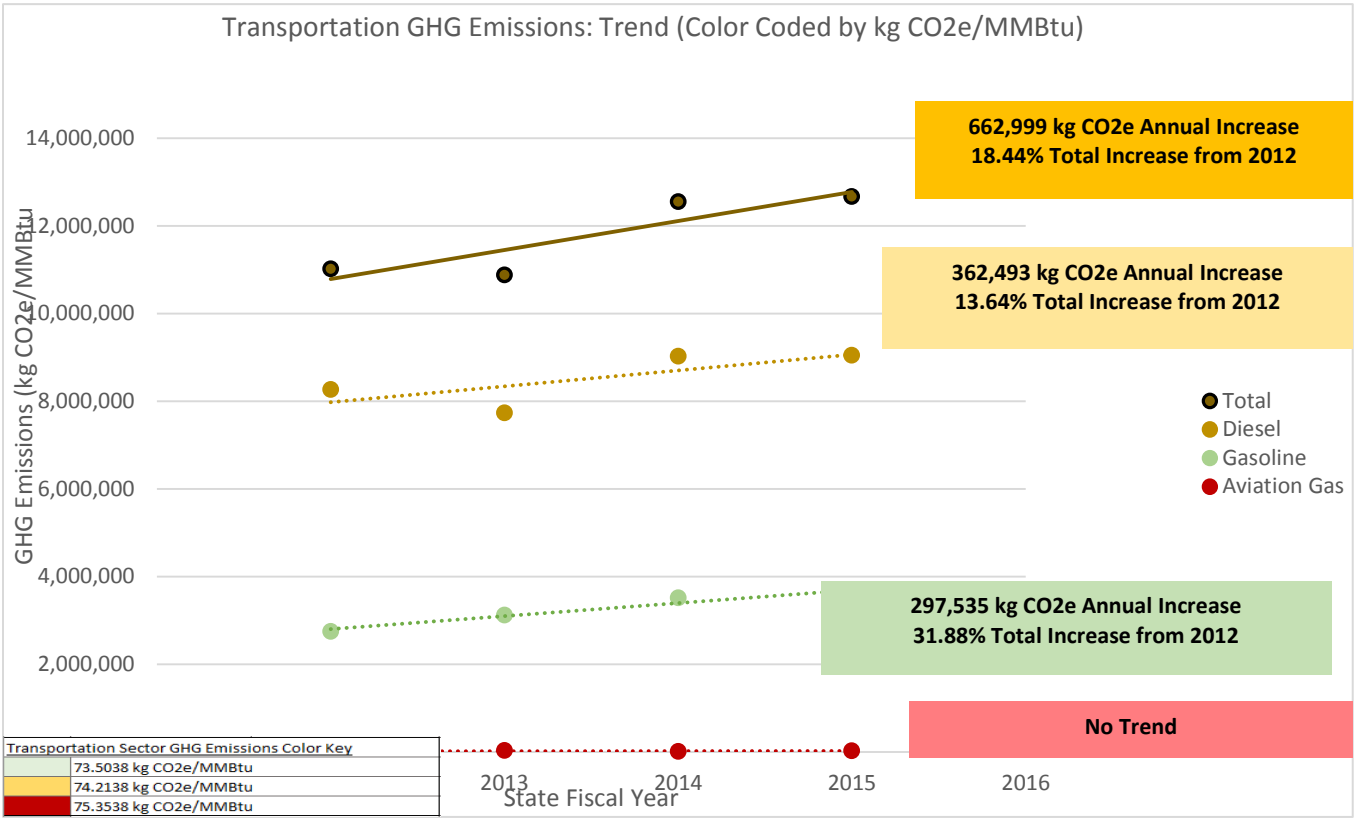
Transportation – Current State

A solid majority of the agency's transportation energy use - 72.21%, and 51.03% of the agency's *overall* energy usage is the diesel fuel used to power Central Garage vehicles. 27.44% is gasoline, which is split 20-80% between BGS-leased sedans, SUVs, vans, and light duty trucks and Central Garage light duty trucks. The remainder goes to aviation fuel for the state's one private plane and for "bottled gas."



Transportation - GHG Emissions

The overall trend is that GHG emissions have been increasing, with 2015 levels being 18.45% higher than 2012 levels. The magnitude of this positive trend is less evident. There is a 12% chance that the variation in the data arose due to other factors. The only trend that is *statistically* significant at the 95% level (and even the 90% level) is for gasoline, which has been responsible for emitting 297,535 kg CO2e more every year for a 31.89% increase from 2012 levels.



72.57% of the agency's transportation GHGs and 52.87% of *overall* GHGs come from diesel, 99.9% of which is used for Central Garage (Garage 5 has 1 diesel BGS-leased vehicle). 27.12% of transportation GHGs and 19.76% of the agency's total emissions come from gasoline.

Although CO2 emissions remain the same across the various vehicle classes, CH4 and N2O emissions vary widely across classes. Agency vehicles are classified based on the EPA categories and are considered "passenger vehicles," basically equivalent to the conventional "sedan" category, "light duty trucks", inclusive of small trucks, vans, and SUVs, "medium/heavy duty trucks," and "construction equipment" inclusive of loaders and other off road equipment.

Although the differences in CH4 and N2O emissions did not make a huge difference because of their small quantities relative to CO2 (even considering the fact that CH4 is 25 times as potent and N2O 298 times as potent as a warming gas over a 100-year time frame), the amount of CH4 and N2O may be important to other air quality concerns.

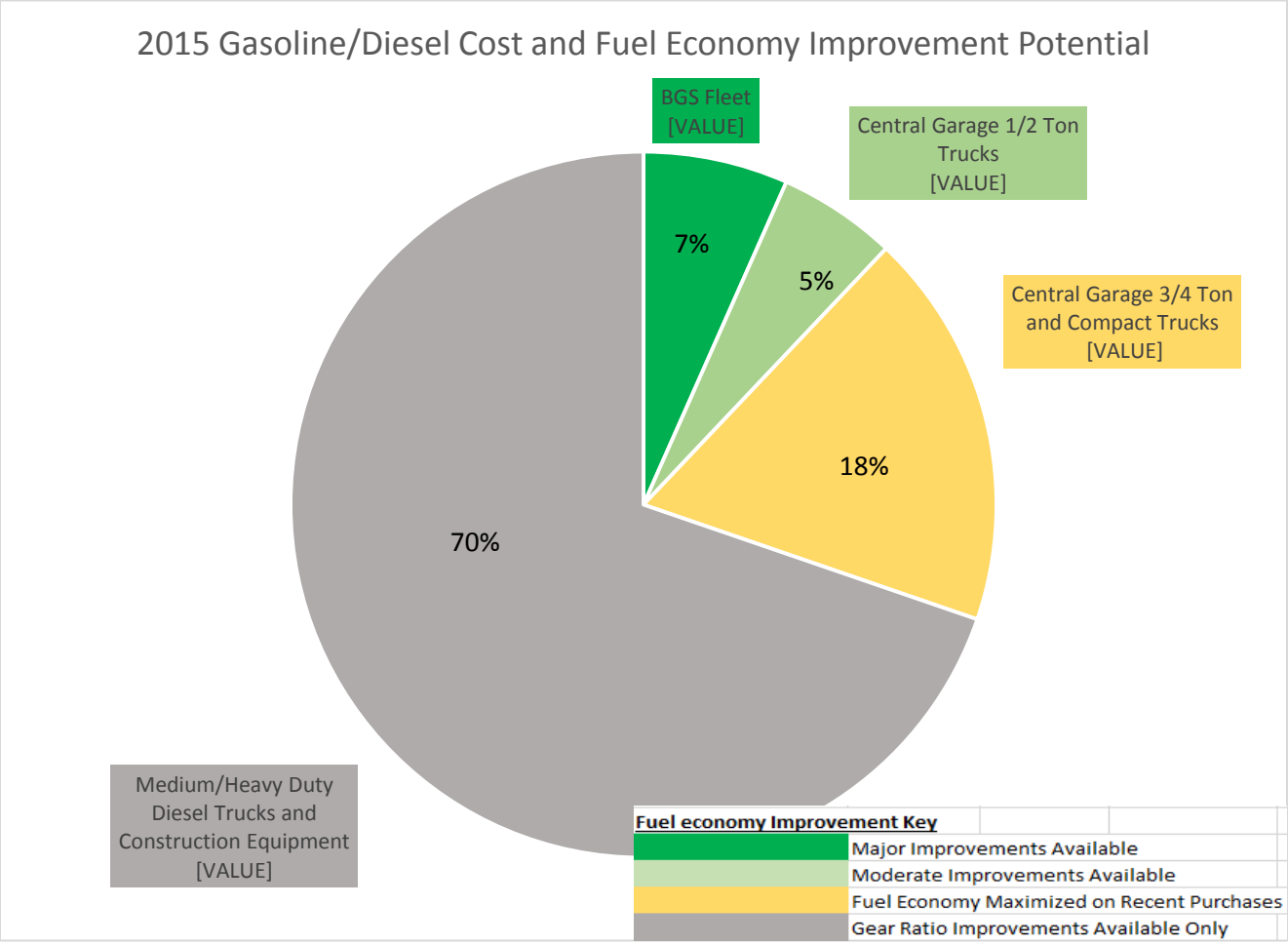
99.9% of diesel fuel goes to the garages, 95.5% of which is used for medium/heavy duty vehicles (mostly dump trucks) with an estimated fuel economy of 5.81 mpg. The remaining 4.5% goes to construction equipment (mostly loaders).

80.76% of gasoline consumption and 21.63% of the overall GHG emissions goes to the garages, all of which is used to power trucks with a long wheel base, averaging about 15 mpg.

Transportation (Business-Related Travel in Personal Vehicles, BGS Fleet Leased by VTrans, Central Garage, Use of Electric Vehicles) – Recommendations

Improve Fleet Fuel Economy Where Possible

The graph below describes the percentage of dollars spent on the various parts of the VTrans fleet and summarizes the potential improvement opportunities described below.

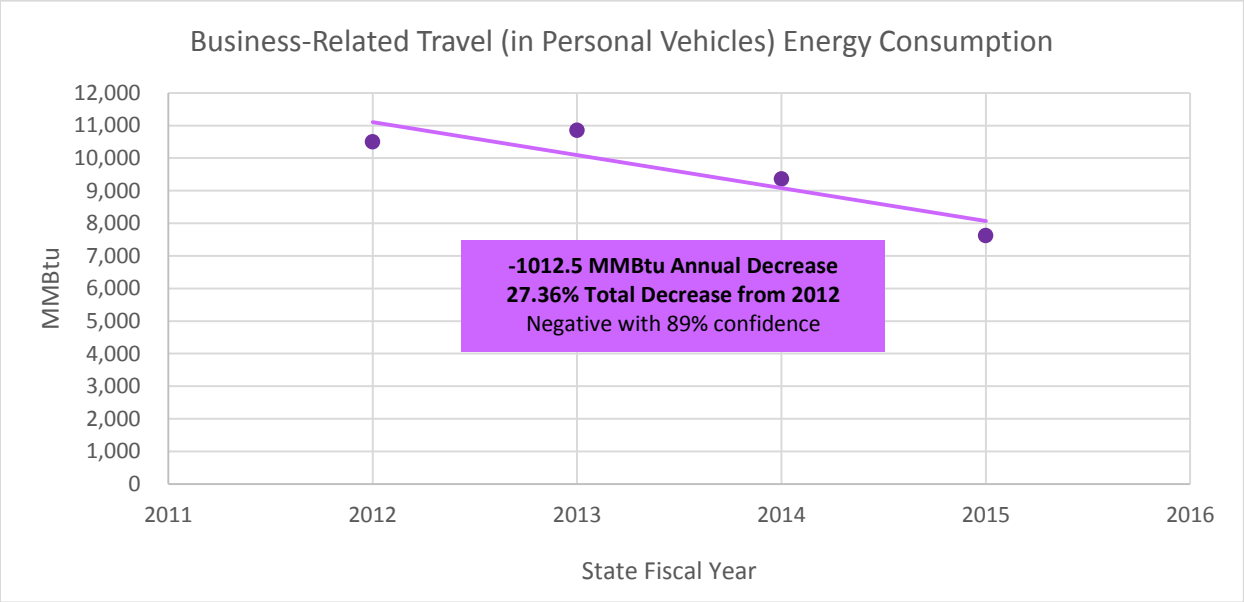


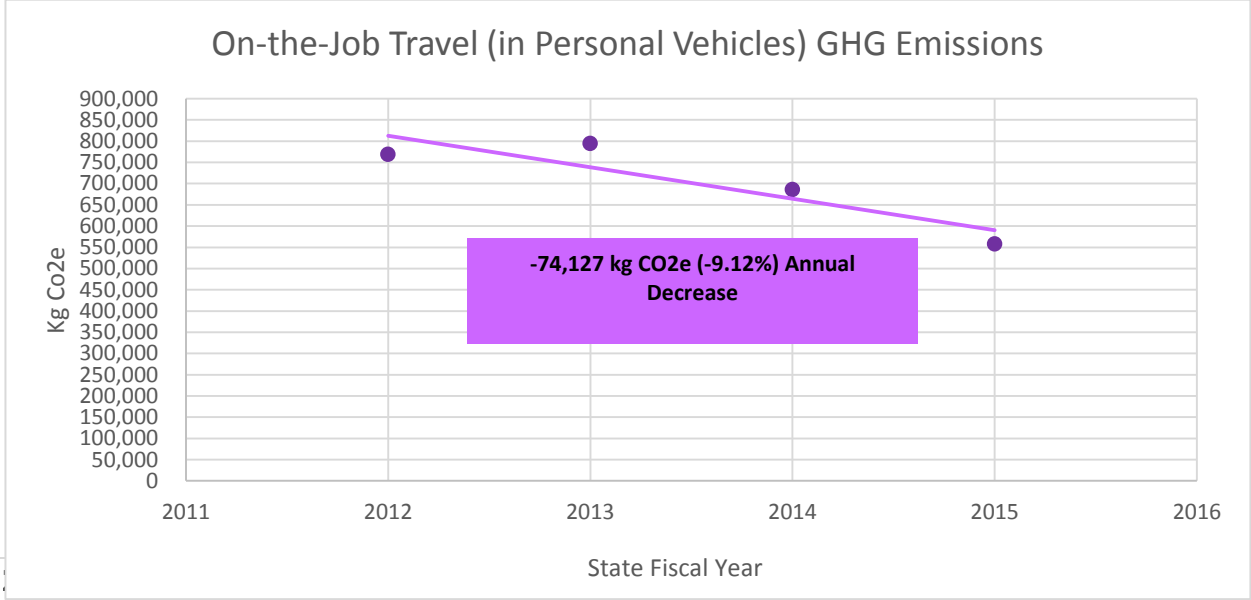
The most immediate improvements can be made to the agency's BGS fleet. In addition, moderate fuel economy improvements are possible for the Central Garage ½ ton truck fleet if the agency is able to use the new Ford F-150s and/or Ram's 1500 EcoDiesel line. Although there are real uncertainties regarding the repair costs of Ford's new aluminum bodies as well as traditionally higher MSRP for diesel engines, the fuel cost savings at the agency's consumption levels is large enough to give the switch some serious consideration.

Business-Related Travel (in Personal Vehicles) – Energy Consumption and GHG Trends

The agency's energy consumption coming from business-related travel in personal vehicles has decreased an average of 1012.5 MMBtu every year from 2012 to 2015, or a 27.36% decrease from 2012 levels. This reflects policies aimed at reducing the use of personal vehicles and replacing this use with fleet vehicles. There is also anecdotal evidence that some managers are using their personal vehicles and not seeking reimbursement.

One such policy was to reduce the standard reimbursement rate for employees who choose to use their own vehicles. This strategy costs VTrans $0 yet reduces CO2 emissions and reimbursement costs because BGS fleet vehicles on average get several miles to the gallon more in fuel economy than their average counterparts as bought or leased by the average VTrans employee.



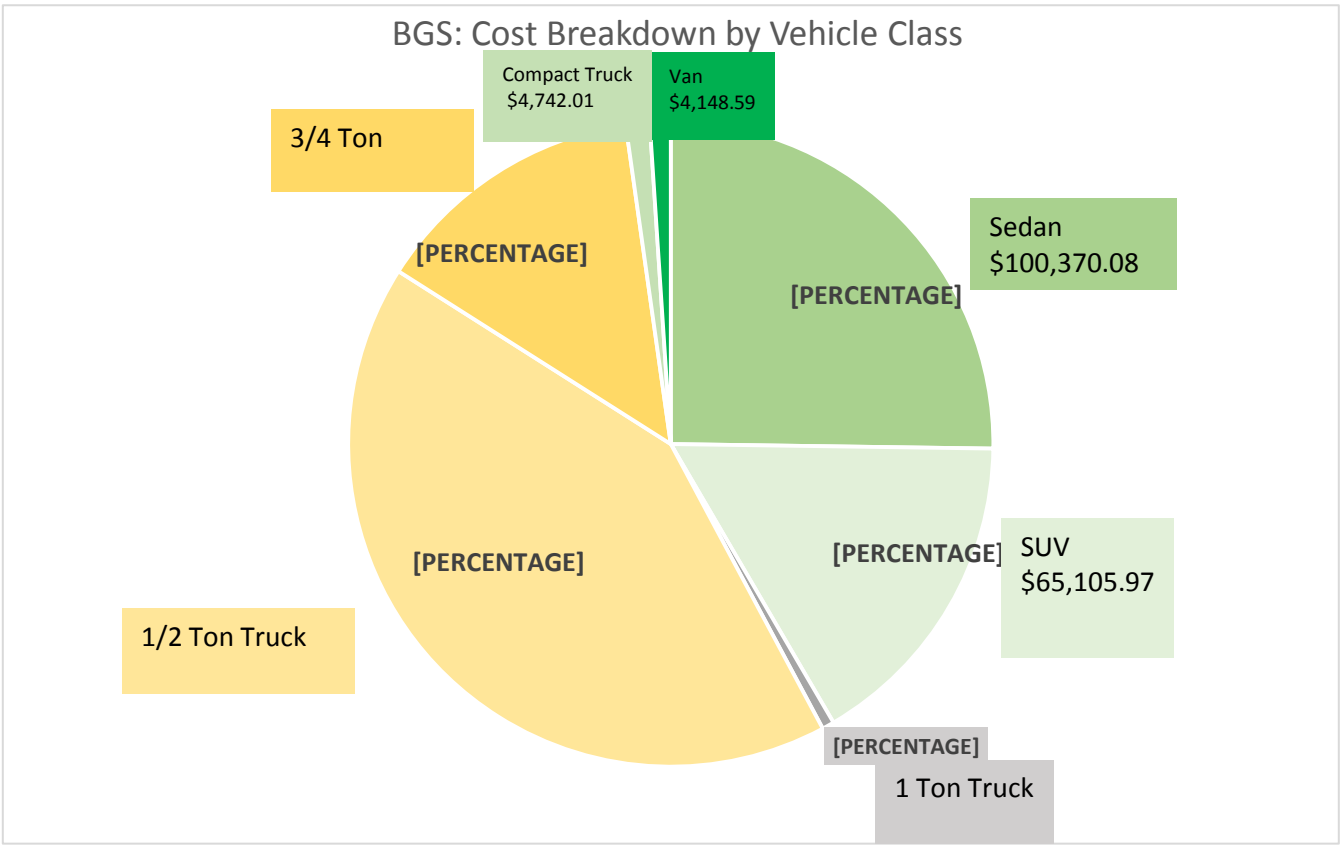


BGS Vehicles Leased by VTrans - Fuel Economy Current State

20.24% of gasoline consumption and 5.49% of the agency's total emissions come from the vehicles lease from BGS. Although this area of energy consumption is not the largest, it is an area where emissions and energy consumption cuts can be made relatively easily.

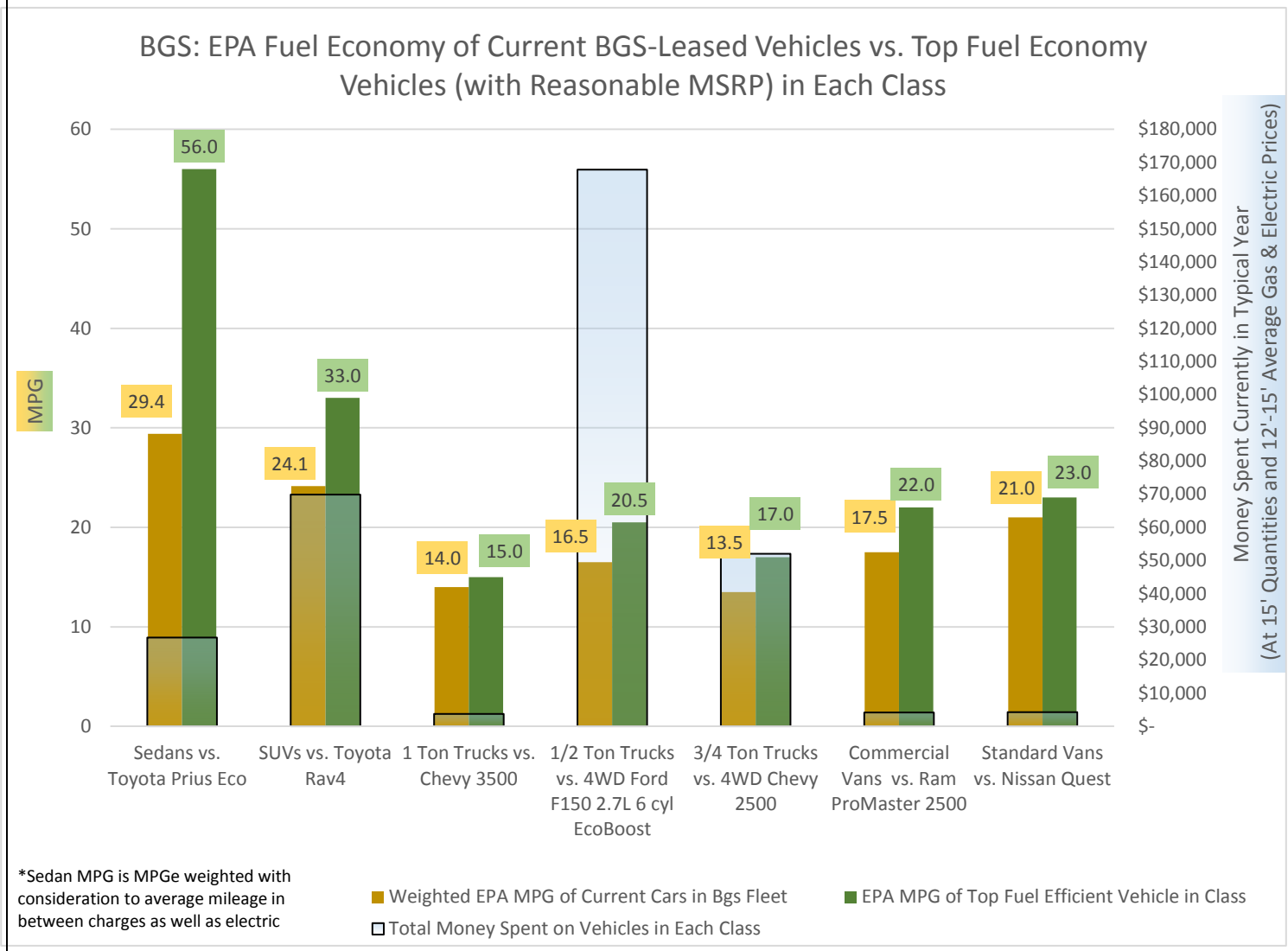
All costs calculated in this section are calculated using SFY 2015 fuel consumption quantities and the SFY 2012-2015 average prices of $3.36/gal gasoline and 14¢/Kwh electricity. Total '15 quantities used were 66% larger than reported due mostly to differences in the timing of financial administration between BGS and VTrans. A minor part of the difference is also due to BGS only keeping track of agency ownership at the start and end of the fiscal year such that, at the individual vehicle level of the analysis, vehicles traded to other agencies during the middle of the year still show as having fuel costs charged to VTrans.

The majority of the energy consumed and the dollars pay for the BGS fleet goes to trucks. Trucks make up 58% of the total fuel consumption and cost. Half tons make up the biggest percentage of the truck category, and also represent the largest chunk of the total pie at 42%, although moderate fuel efficiency gains can also be made in the ¾ ton category as well. Sedans, on which a lot of attention has been focused at the agency, state, and national level, are the agency's second largest category in SFY 2015, representing 25% of total costs. SUVs were also a sizeable factor, composing 16% of VTrans BGS fleet.



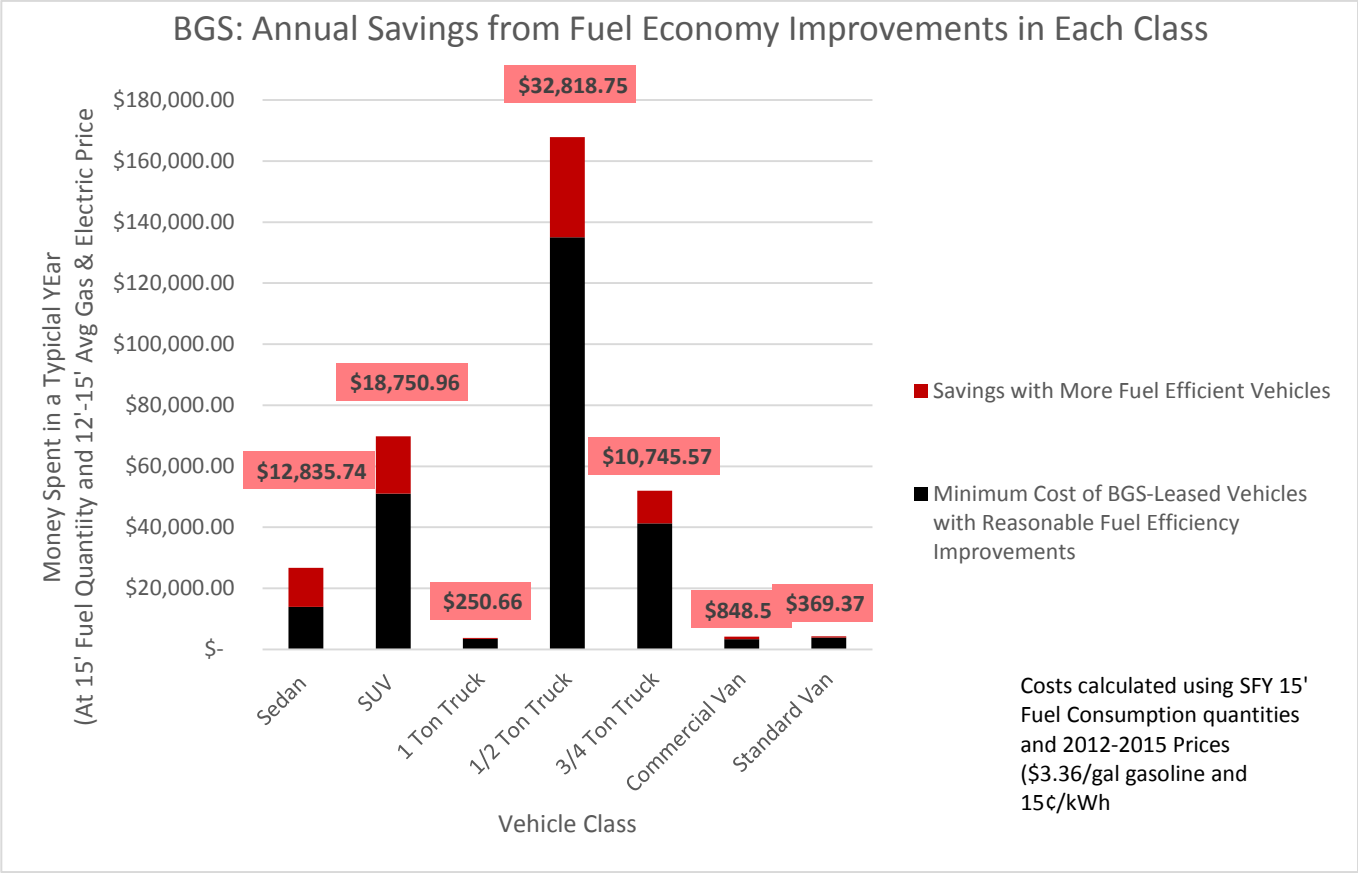
Below are the potential MPG gains for the agency's various vehicle classes. Real Sedan MPGe was calculated for the agency's one Chevrolet Volt PHEV, and is a composite number based on the pure gas EPA MPG and the electric kwH/100 mi fuel economy measure, determined under the assumption that average trip length is 110 miles and that these vehicles are only recharged when they return to the lot.

The fuel efficiency gap between models and the best reasonably priced models is large for the sedan category, as it is also for the SUVs and commercial vans. The potential gains for the ½ ton and ¾ ton trucks, though a little smaller, add up to substantial savings when the large $167,835.94 charge for ½ tons and the $52,003.87 charge for ¾ tons, as well as the heavy mileage put on both vehicle classes, are all considered.



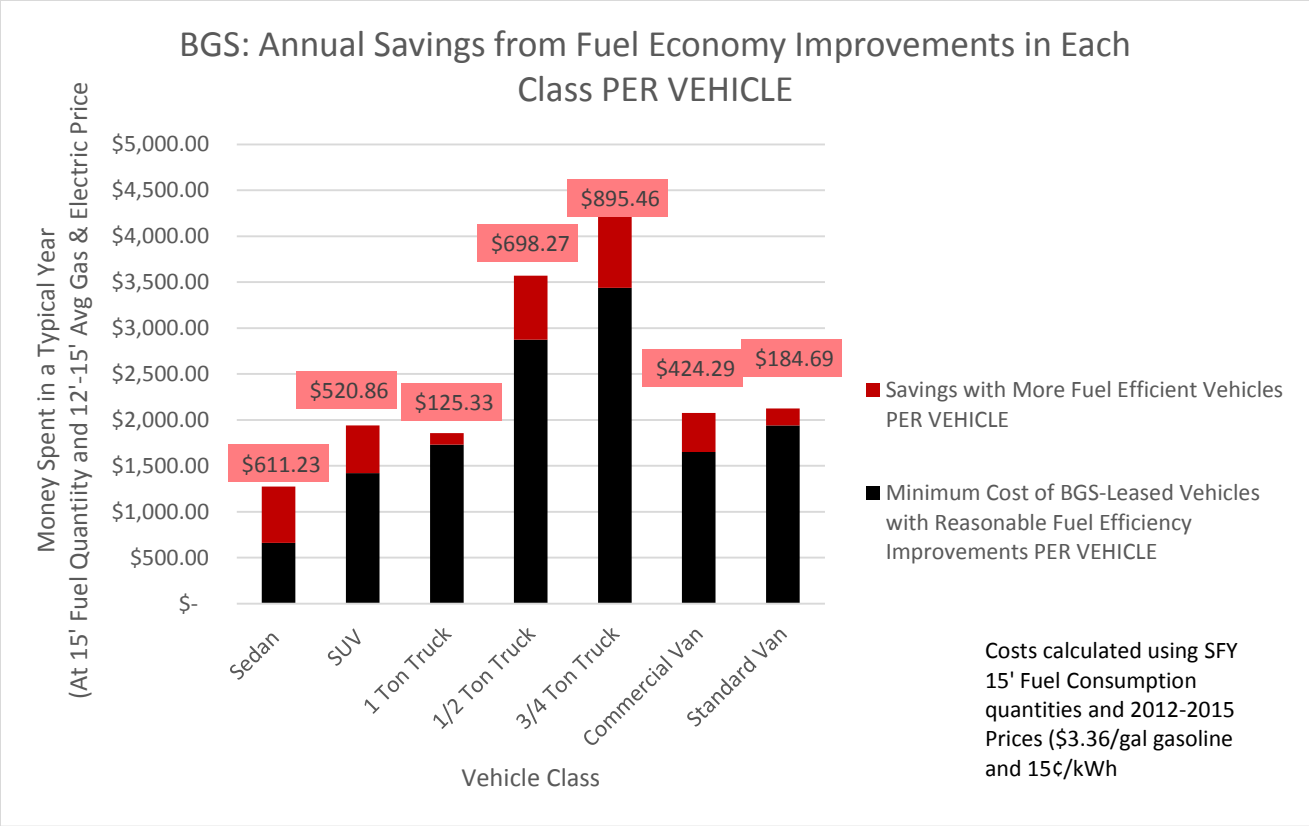
With these fuel economy improvements combined, the agency could achieve an annual average savings of $76,619.63. With fuel economy improvements to the truck fleet alone, a maximum annual average savings of $43,814.98 could be achieved. Despite truck fuel economies being categorically low, the ½ tons are used so much that even a 1 mpg increase across the fleet would result in $8,204.69 of annual average savings for our BGS fleet.

The SUVs can also achieve large annual gains of $18,750.96 and just by standardizing the ¾ ton trucks to the Chevy 2500s, which are already used in some capacity, $10,745.57 in annual average fuel savings could be achieved. Standardizing the1 ton trucks to the Chevy 1500 would save $250.66, switching to more efficient sedans could save $12,835.74, switching commercial vans would save $848.58 and switching standard vans could save $369.37.

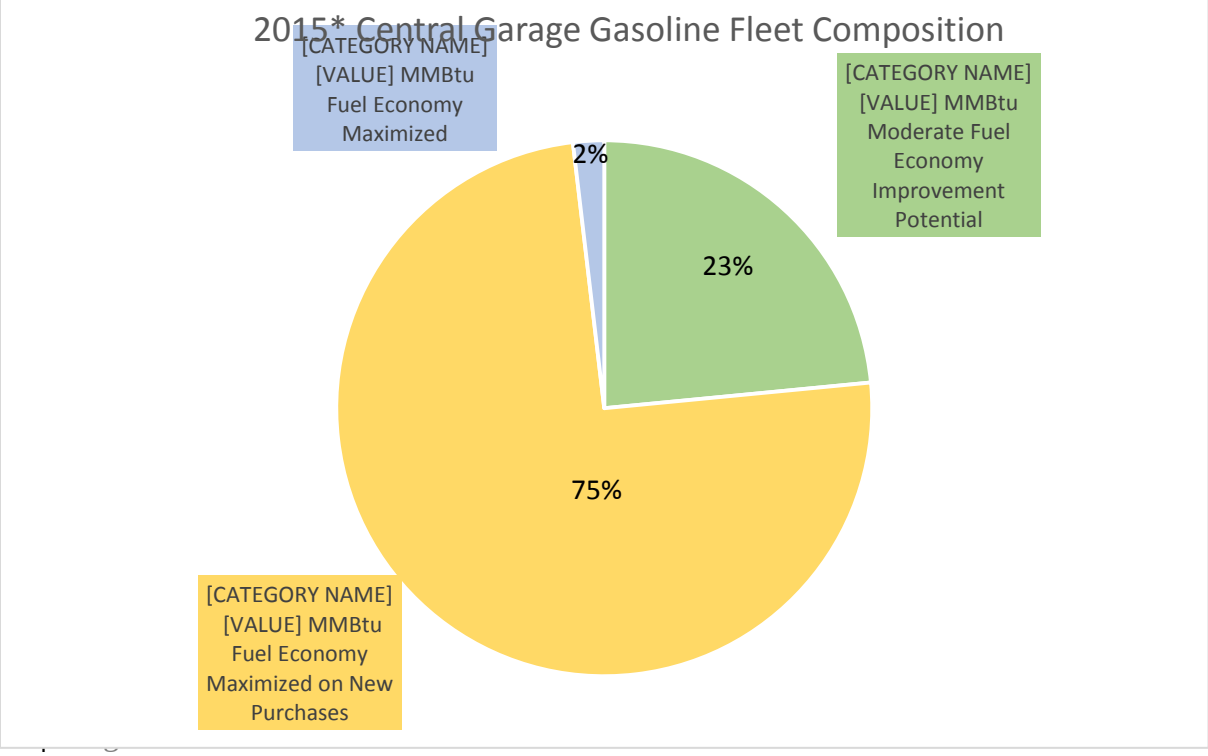


In order to compare the cost savings with annual lease rates, the annual savings per vehicle was determined. Cost savings for every vehicle class range between about $500 and $900 per vehicle. The only exception is the 1-ton category ($125.33 per vehicle), which is maxed out for its class. (There may be some question as to whether they really need to be 1 ton trucks when the Central Garage trucks run as heavy and powerful as the ¾ ton.) Vehicle savings include: $698/vehicle for ½ tons, $895/vehicle for ¾ tons, $521/vehicle savings for SUVs, $611/vehicle

for sedans, and, despite the relatively small savings in the big picture, $424/vehicle for our commercial vans and $185/vehicle for standard vans.



Central Garage Gasoline Fleet Fuel Economy - Current State



In SFY 2016 (2015 data is unavailable), VTrans owned 130 different light duty trucks, all 4WD and powered by gasoline. Out of 17 light duty trucks put into service in SFY 2015, 13 were ¾ ton trucks, 3 were ½ ton trucks, and 1 was a compact tuck.

Half Ton Trucks

VTrans standard ½ ton truck is the 4WD Chevrolet Silverado. It gets a 50-50 combined city/highway EPA mpg of 19 mpg (22/16). Comparable 2WD models get 1-3 mpg more than the agency's current models, but 4WD is necessary in the tough winter Vermont climate. The top 4WD gasoline fuel economy model is the 2.7L 2015 Ford F-150, which gets a combined city/highway mpg of 20.5 mpg (23/18), 1.5 mpg more than our current model. The second-place 4WD truck is the 3.5L 2015 4WD F-150, which gets 20 mpg (23/17), 1 mpg more than our current model.

Chevy trucks are preferred over Ford due to the agency's agreement with Chevy to be reimbursed for warrantee repair costs – an advantage not currently available with Ford. Additionally, there is concern regarding the corrosion and repair costs of Ford's new aluminum bodies. Ford is banking its entire 2015-and-forward F150 ½ ton fleet on aluminum bodies, but the new technology is hotly contested.

Central Garage Opportunities

Unlike the VTrans BGS fleet, the Central Garage fleet is comprised entirely of purchased vehicles, which require replacement about 8 years after purchase. For both the ¾ ton category and the compact truck category, fuel economy is maximized by new purchases. The Chevrolet 2500 gets a best-in-class fuel economy of 14.1 mpg, and the Colorado Compact trucks get a similarly best-in-class (for 3.6L V6 engines) EPA fuel economy of 21 mpg.

That leaves the ½ ton trucks. The superior fuel economy options include the gasoline Ford F-150 with EcoBoost and the diesel Ram 1500 EcoDiesel. Despite the repair and corrosion cost uncertainty regarding the new aluminum bodies in the Ford F-150s and the extra MSRP that comes with a diesel Ram, the fuel economy savings at the agency's regular VMT are potentially large enough to keep these options financially competitive.

Fuelly MPG Data vs EPA Data

Fuelly (on online resource that tracks vehicle fuel economy) numbers were used for the reasons below:

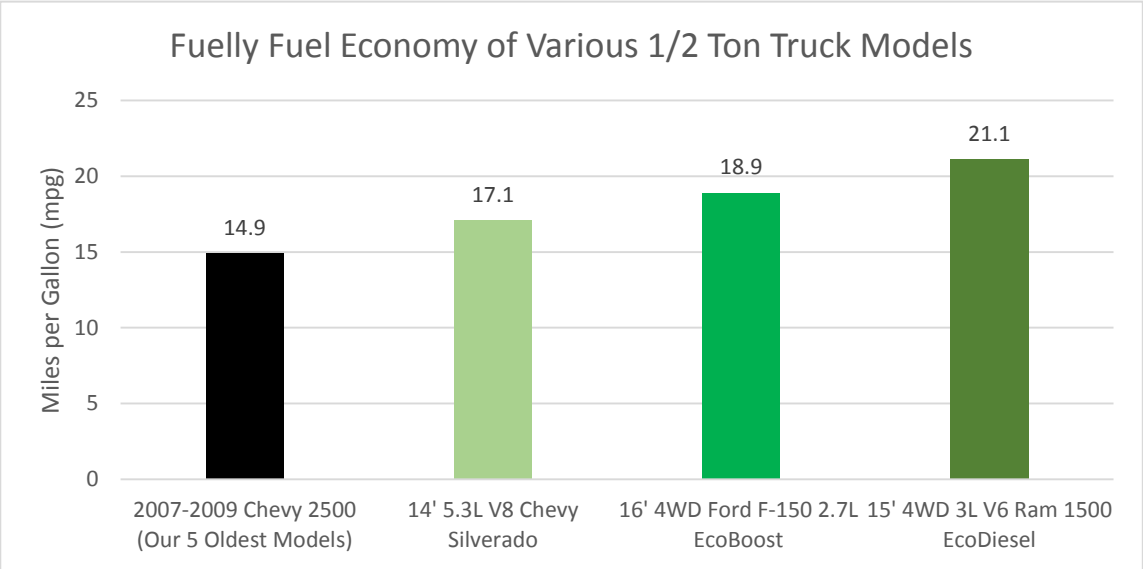
1) 2500 trucks categorically do not report fuel economy data to the EPA, making comparison among truck classes impossible.

2) EPA numbers are otherwise inadequate: fuel economy varies widely depending on the size of the load, the EPA does not test for various cab sizes, loads, inclines, etc., and tested engine types are limited

3) VTrans does not run any of its own trials to indicate mpg of various models. Estimates for the vehicles currently in use is possible, but it is impossible to compare these numbers with other options like the Ford F-150 EcoBoost and the Ram 1500 EcoDiesel.

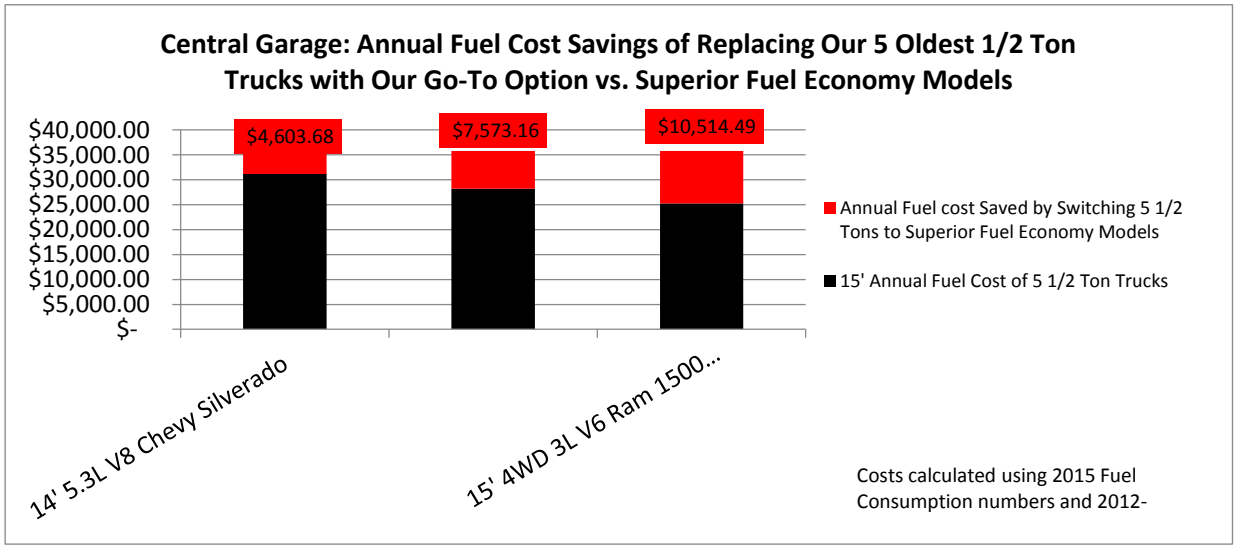
Fuelly fuel economy estimates are not 100% accurate to VTrans applications, since they represent user averages. If the average user pool of each model differs from VTrans uses in a systematic way between vehicles within each class, the estimates could be skewed. For instance, if the average ½ ton Ford user hauls less than the average ½ ton Chevy user, we would tend to overstate the benefits of using Ford. However, for ½ ton and compact trucks, Fuelly estimates were compared with EPA estimates and in all comparisons both the Fuelly and EPA numbers for various models agreed with each other, with Fuelly data being categorically 1-2 mpg lower than its EPA estimated counterpart for each model. Engine type, cab specifications, and other details were used to filter the *Fuelly* mpg estimates wherever doing so did not severely undercut the user sample size.

<u>Fuel Economy Improvement Opportunities for Central Garage Half Ton Trucks</u>

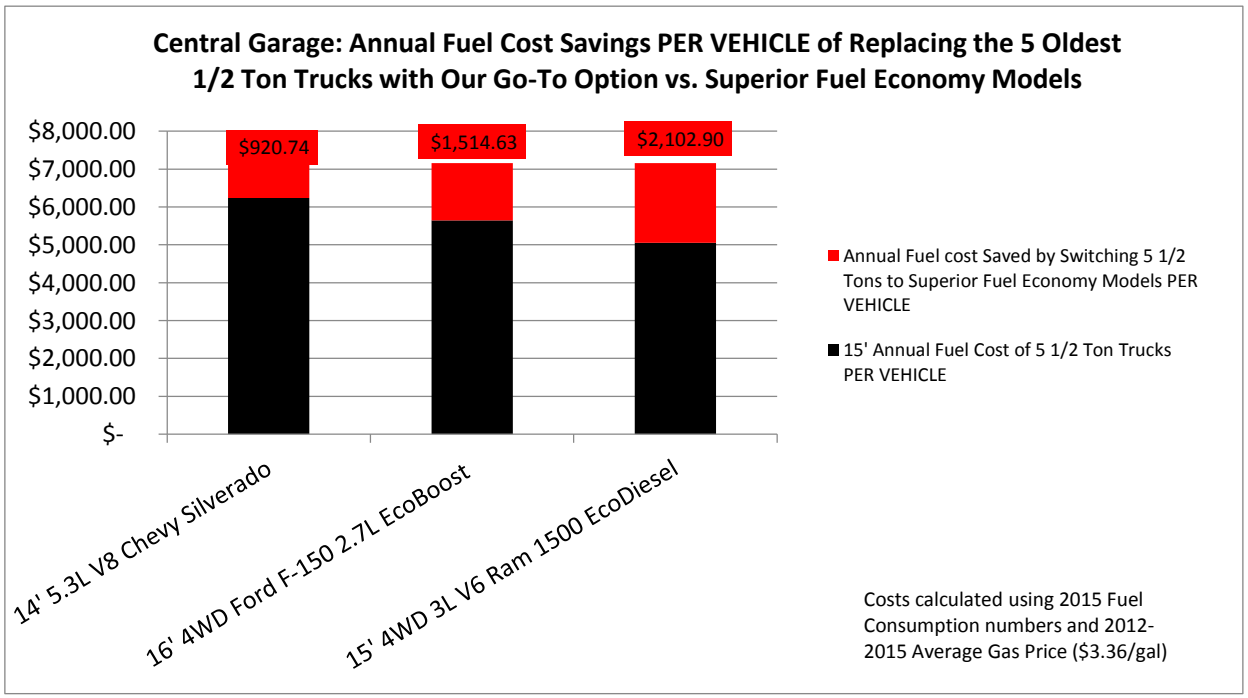


Above are the top fuel economy models on the market for ½ ton trucks. The 14' Chevy Silverado depicted in the second row is a more recent version of what the agency currently purchases, and the Ford F-150 EcoBoost and the Ram 1500 EcoDiesel are what is being measured against. The estimates here, if anything, are conservative, because the 16' Chevy Silverados the agency is buying are getting a slightly lower *Fuelly* fuel economy of 16.8 mpg, not

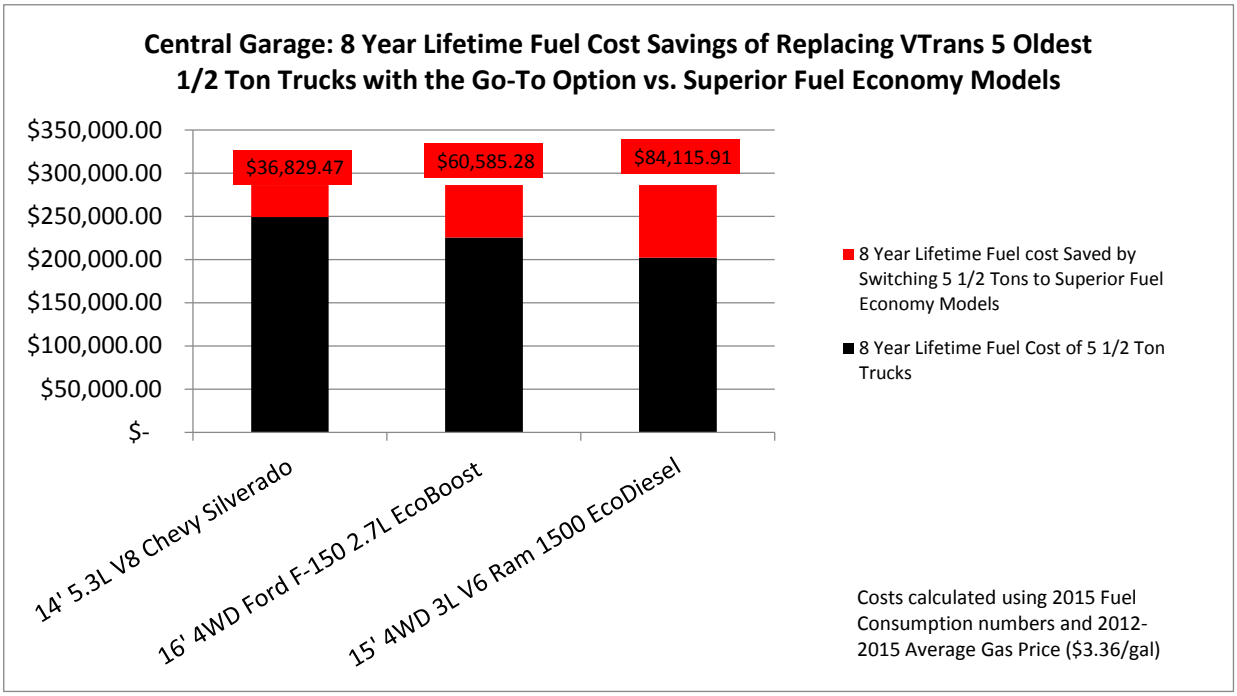
17.1 mpg. Given that our 5 oldest models are 2007-2009 versions and that we have 37 ½ ton trucks, we can expect to replace about 5 on average every year. Below the fuel savings from replacing the agency's 5 oldest models with the agency's go-to Chevy 1500 Silverado as well as two superior fuel economy options are calculated below:

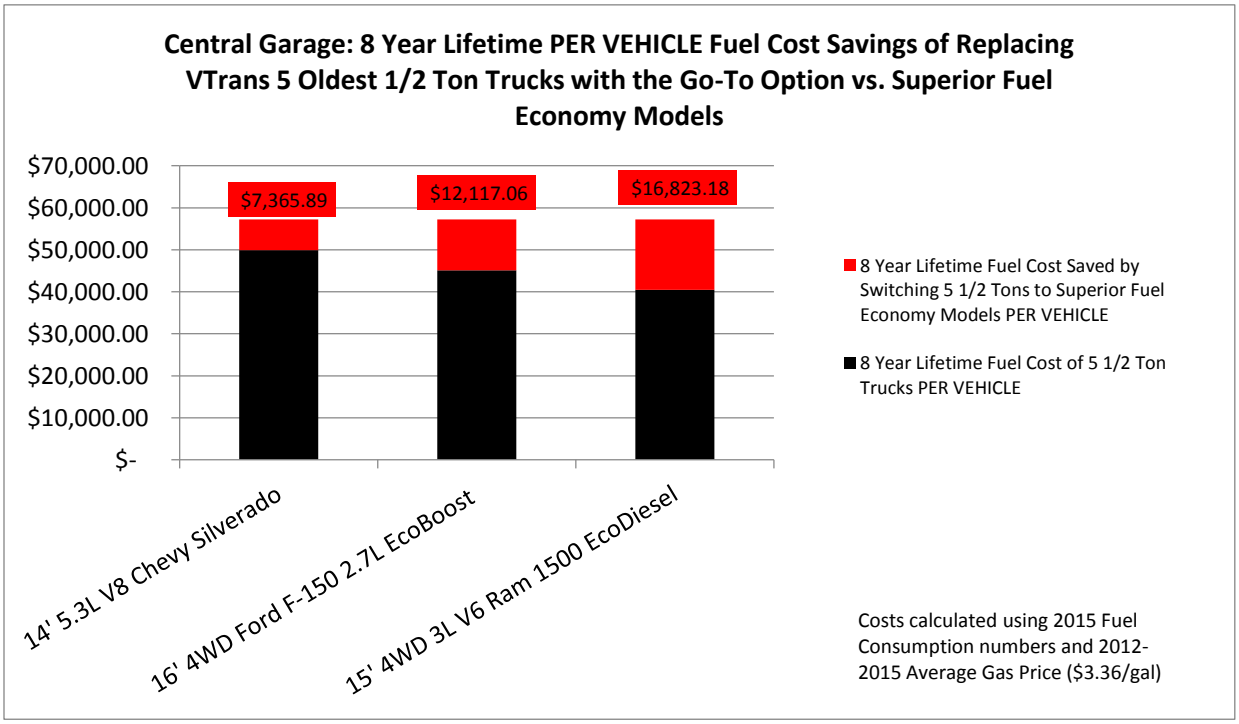


The 4.6K annual savings from just switching to the most fuel efficient version of the Chevy Silverado are large enough on their own, but even larger 7.5K and 10.5K savings from switching to superior more efficient models. What is more relevant to deciding upon the individual purchase of the more fuel efficient vehicles, however, is the annual savings per vehicle described below:



And, unlike the BGS fleet vehicles, VTrans purchases these ½ ton trucks for the long haul. Fuel cost savings over an 8-year lifetime increase 8-fold plus bringing the Lifetime Per Vehicle Savings of switching to more fuel efficient ½ ton truck models to impressive levels.

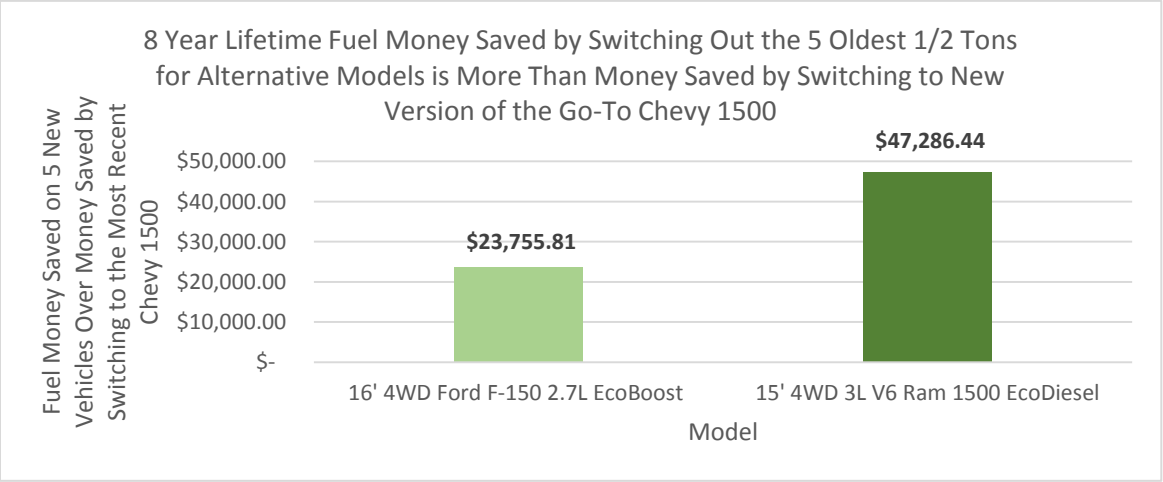




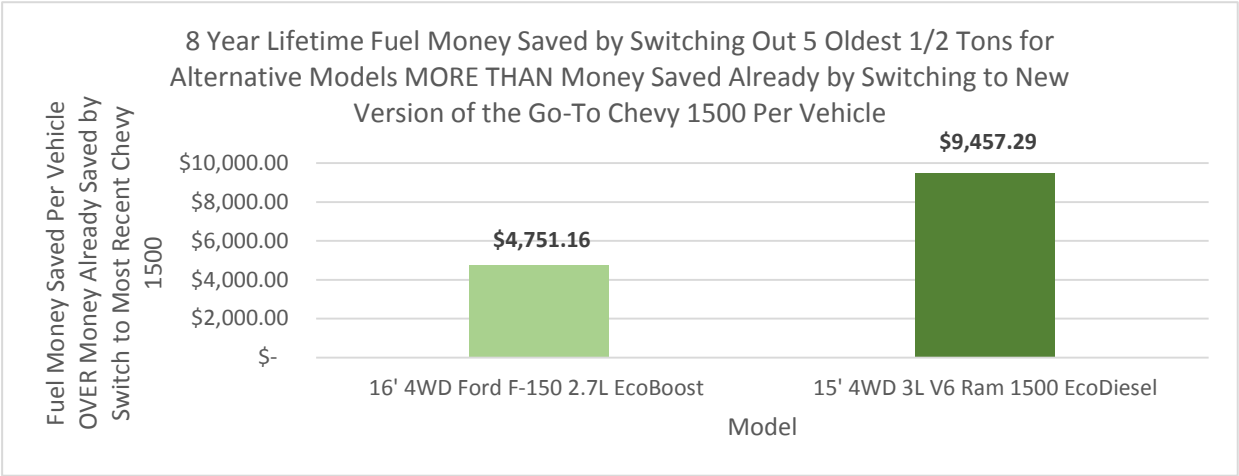
Just by switching out the agency's 5 oldest trucks for newer models, VTrans can expect fuel cost lifetime savings PER VEHICLE of $7.4K, but by switching to the Ford F150 EcoBoost model we

can increase the gap to $12.1K, and by switching to the Ram 1500 EcoDiesel we can achieve $16.8K lifetime fuel savings.

Since eventually the 2007 and 2009 trucks will end their useful life, and we will have to switch them out for newer models, most relevant to the decision is how much more money can be saved by switching to alternative vehicles vs. the top fuel efficient Chevy 1500 Silverado. See below:



Total lifetime fuel savings for switching out these 5 models with vehicles more fuel efficient than the most fuel efficient Chevy 1500 Silverado are still quite large. Switching to the Ford F-150 EcoBoost would save $23.7K MORE than the 14' Chevy Silverado and switching to the Ram 1500 EcoDiesel would save $47.3K MORE than switching to the 14' Chevy Silverado (again, savings against switching to the 16' Silverado would be even greater). The savings per vehicle are equally impressive:

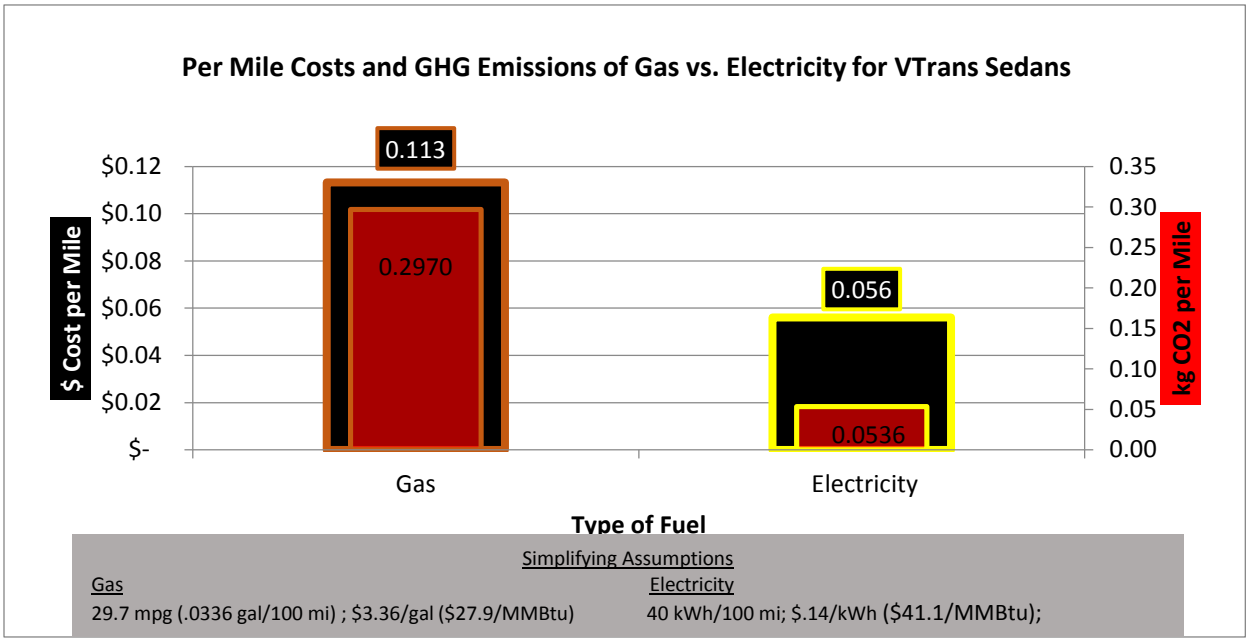


With fuel savings per vehicle of $4.8K more for the F-150 EcoBoost than for the most fuel efficient Silverado and $9.5K MORE for the Ram 1500 EcoDiesel than for the most fuel efficient Silverado, the potential extra maintenance costs of a Ford aluminum body and the extra price tag of a diesel Ram start to seem more reasonable. It will ultimately be the decision of Central

Garage, but the fuel cost savings, and even more so the GHG emissions reduction, both favor this change.

Use of Partial Electric Vehicles (PHEV) and/or Hybrid Vehicles and Full Electric Vehicles (BEV)

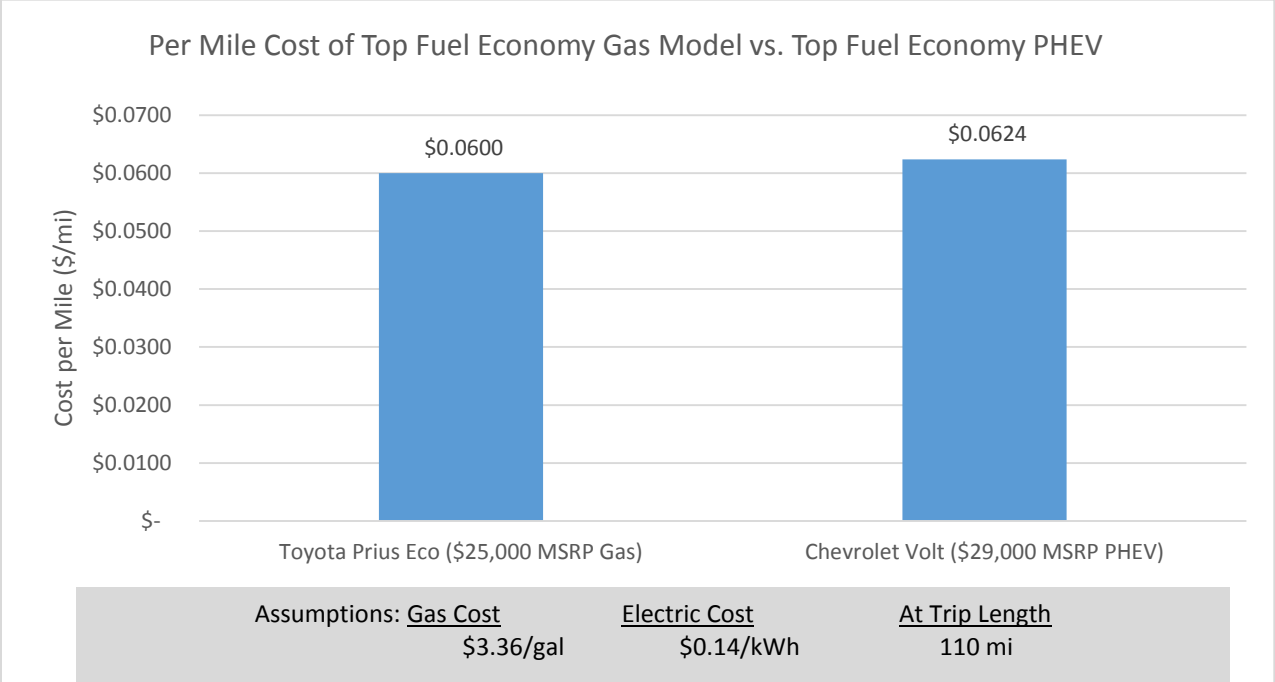
The cost-effectiveness of buying gasoline vs. electricity depends on the relative fuel economy of a given gasoline vehicle and a given electric vehicle as well as the price of gas. In the graphic below, 29.7 mpg was chosen to represent the agency's current sedan fleet average EPA mpg, 40 kWh/100 mi to represent the electric efficiency of a typical PHEV (30-50 kWh/100 mi), and $3.36/gallon, which is the average price of gasoline over the past 4 years. Under these assumptions, electricity costs half as much per mile as gasoline.



The Suitability of Various Ranges of EVs

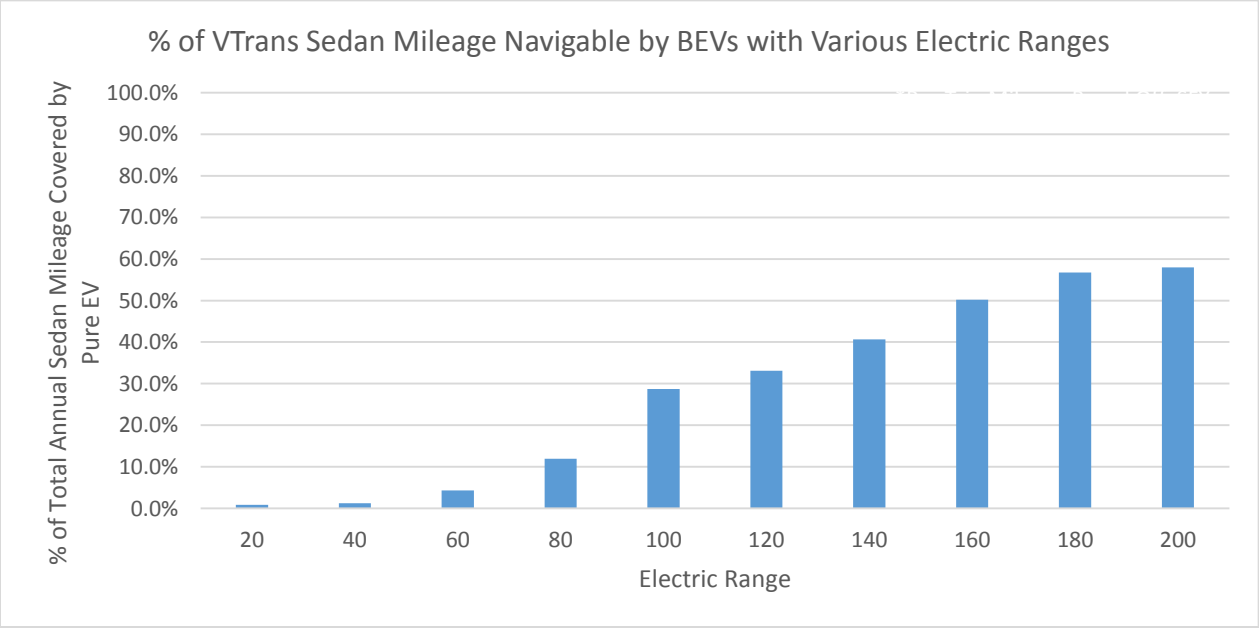
The 2016 Chevrolet Volt gets an electric range of 53 miles with a 108 mpg equivalent fuel economy. It also gets 42 mpg when running just on gas, twice the national average of 25 mpg for new vehicles. In SFY 2015, the agency's only monitored sedan was a Volt, and that was driven 124 times and for 15,471 miles. The average trip was 124.8 miles, meaning that the Volt (2014 model with 38 miles of electric range) got 30% of its power from electricity on average. The 2016 model, with 53 miles of range, would have gotten 42% of its power from electricity on average.

Because of the 53 mile limited range of the Chevrolet Volt, long trips between charges are less cost effective than driving a Toyota Prius Eco. The Prius relies on a comparatively low 42 mpg rather than an electric 29 kWh/100mi efficiency. For VTrans average trip length (based on trip reimbursement data) of 110 miles, the Toyota Prius Eco cost/mi is $.06 -cheaper than the Chevrolet Volt's cost/mi of $.0624. At typical agency travel length and the four-year average prices, a sedan with a fuel economy of 53.8 mpg would break even on cost with the 2016 Chevy Volt.

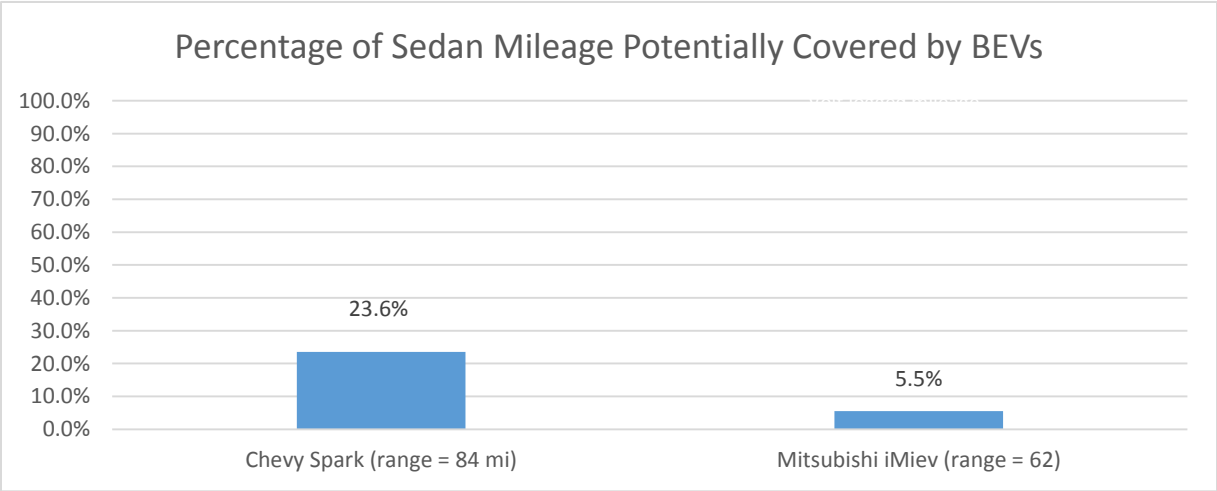


The Chevy Volt would have a solid and secure place in the VTrans fleet for short and medium length trips, as its PURE electric cost is $0.0434/mi, a fair amount less than for the Prius Eco's gasoline electric cost of $.0600/mi, although at reasonable annual mileage the difference is likely not enough to justify the additional $4000 MSRP of the Volt and the resulting raised leasing price on a cost basis alone.

Despite this high average trip distance, there is still a good chunk of the agency's fleet needs that could be met with BEVs. Cars that have an electric range of 100 or more can capture at least 30% of our mileage needs. See table below.

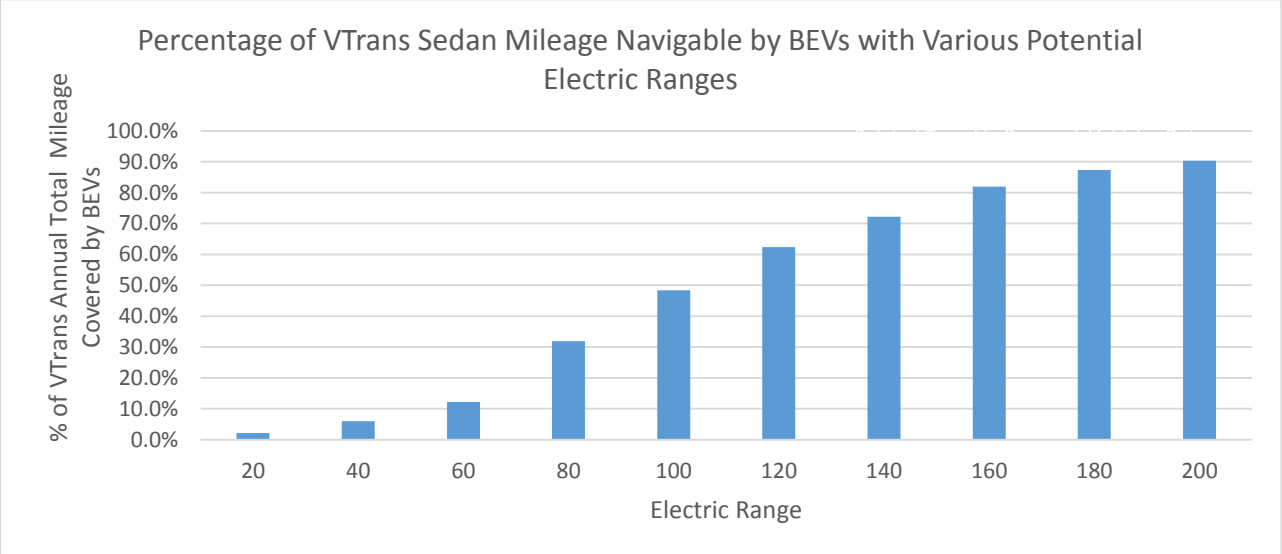


Below is shown the potential of two BEVs with reasonable MSRP and that can meet VTrans mileage needs based on the Volt's use. The Chevy Spark and the Mitsubishi IMeiv, are affordable and will come at less than half the fuel price per mile of our current sedans at 4-year average gas prices.

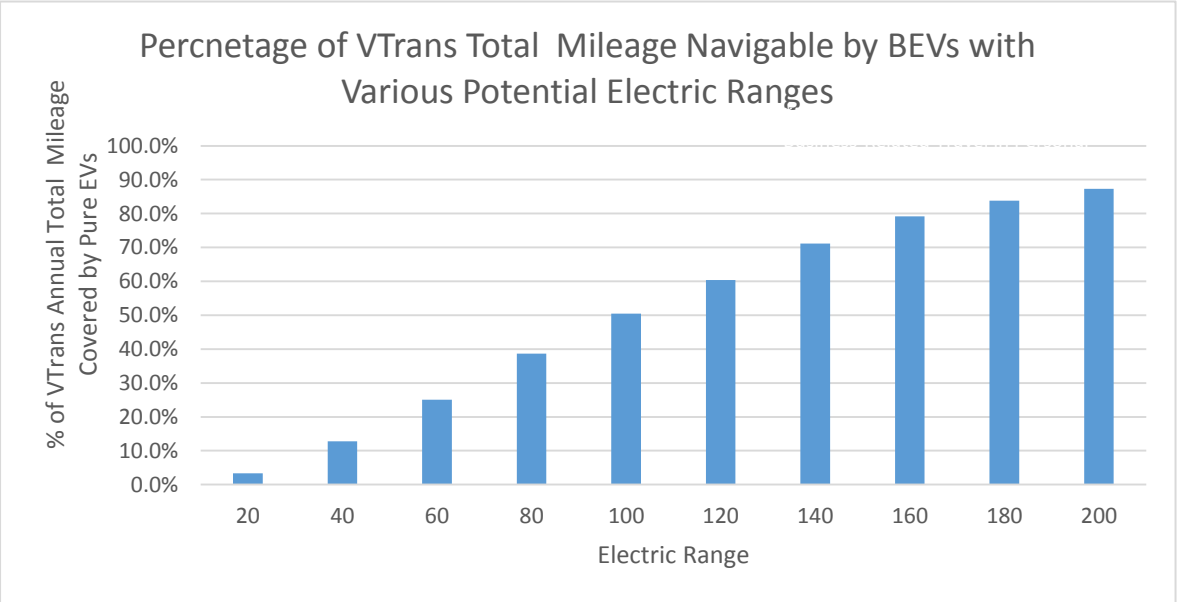


Getting a few Chevy Sparks will allow the agency to cover up to 23.6% of its mileage (based on the Volt data) with full electric power. MSRP begins at $25,120, the range is 84 miles (covering 23.6% of our sedan fuel range needs), and the fuel economy is a virtually unparalleled 28 kWh/100 mi. A few Chevy Sparks would be a great addition to a more expansive sedan fleet of Toyota Prius Eco's and/or Chevy Volts.

Barring installing GPS devices or keeping accurate logs in a sample of vehicles, *Business-Related Travel in Personal Vehicles* data is the best that's available. Mileage estimates are given on a miles-per-trip basis for the purpose of reimbursement. One caveat, the suitability of EVs may be overestimated if employees have a tendency to consider the option of state fleet vehicles only when travel trips are expected to be lengthy.

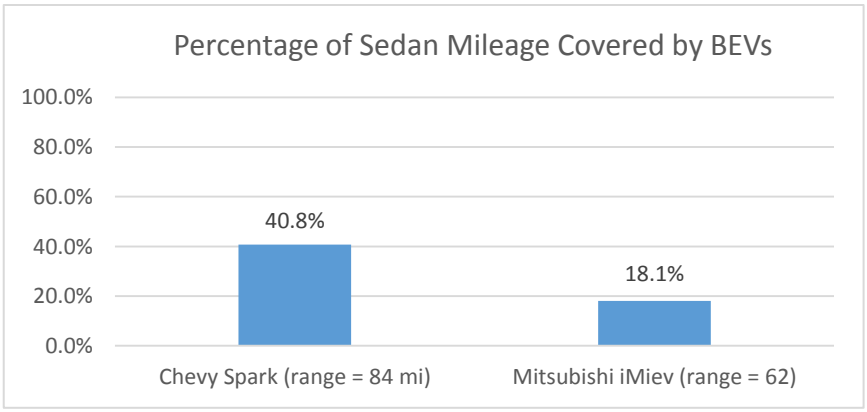


The benefit of a given BEV depends on it range. BEVs below 60 miles of electric range have the least benefit and there are large jumps for each 20 miles of range increase after that. With EV ranges increasing every year, it will only be a year or two before the majority of sedan miles can be covered by BEVs.



Currently, the agency could still get a significant amount of our mileage from the Spark and IMiev, as indicated by business travel reimbursements, and illustrated in the table below.

The agency could use the Chevy Spark (starting MSRP $25,120) for 40.8% of its mileage. Since several trips are dangerously close to the max 84 mpg it's more prudent to say that 30% of agency sedan mileage can be gotten from a small fleet of Chevy Sparks. With savings on fuel, maintenance costs, and leasing costs and a massive decrease in sedan-related GHG emissions, leasing a few Chevy sparks is a win-win.

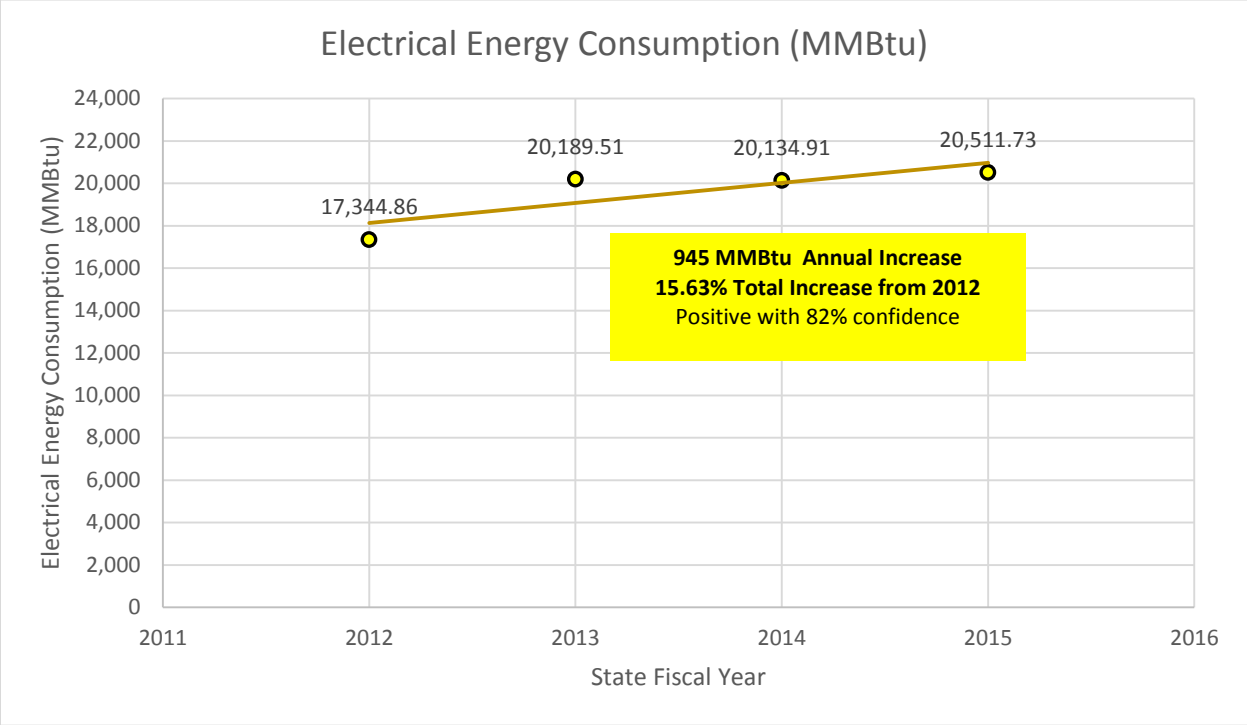


Electric Drive SUVs and Light Duty Trucks and Switching form SUVs to Sedans

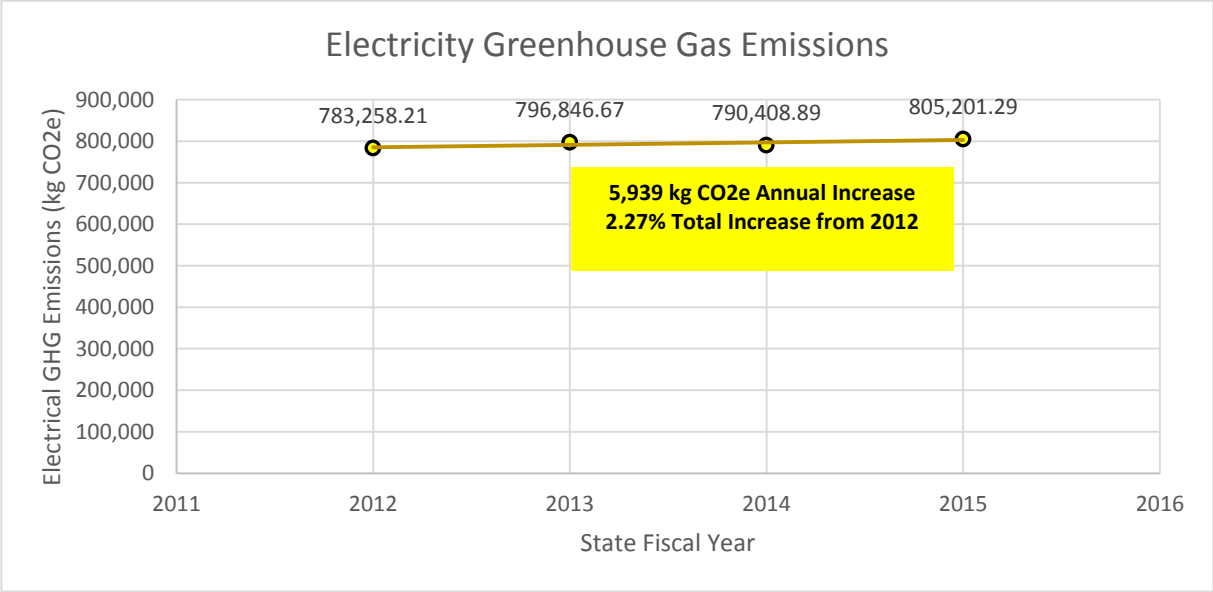
Electric drive SUVs and light duty trucks are not available today but expected to be in the coming years. This will help greatly in saving fuel costs and reducing emissions. While sedans only contribute to 6% of the fuel use of the VTrans BGS fleet, *SUVs contribute to 25% of BGS fuel use*. By switching to using PHEV sedans (PHEV SUVs are not currently available on the market) whenever possible, the agency could save significantly on fuel costs while reducing GHG. This will require Operations and other users of BGS SUVs to consider if an SUV is actually needed for the job or if having a choice of use of a sedan vs SUVs might make sense.

Electricity – Overall Trends

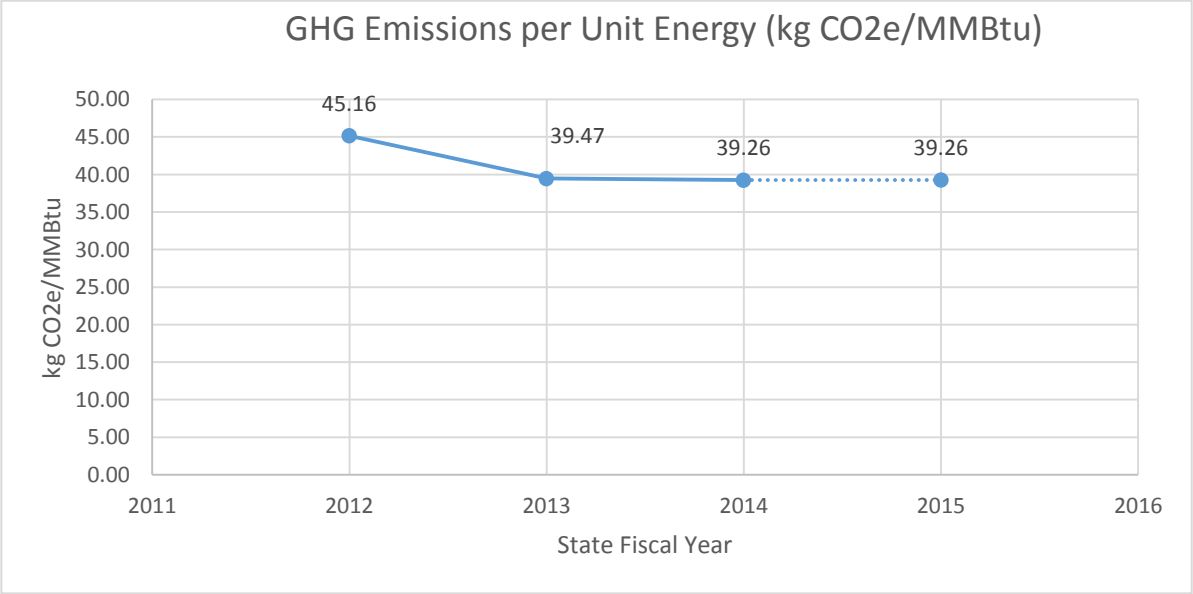
VTrans electric energy consumption has not increased in a statistically significant way. Even the statistically insignificant 945 MMBtu annual increase (15.63% over 2012 levels according to the trend) is miniscule compared to our overall energy consumption, which is dominated by the transportation and heating categories.



Electricity – Green House Gas Emissions

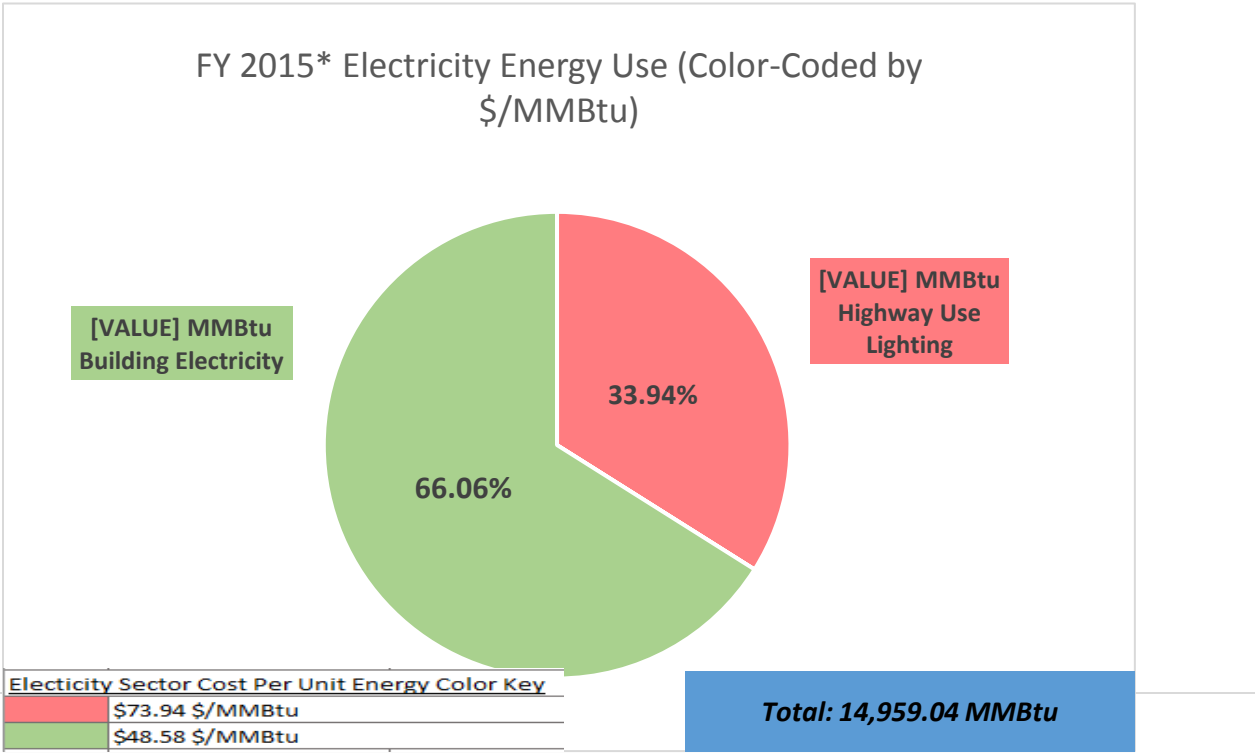


VTrans GHG emissions have not increased in any statistically significant way. Even the statistically insignificant 5,939 kg CO2 annual increase (2.28% over 2012 levels according to the trend) is miniscule compared to the agency's overall trends which are dominated by transportation and heating. Although electrical consumption rose slightly -16.4% between 2012 and 2013 - the kg CO2e emissions per MMBtu simultaneously dropped 12.6% (see below):



<u>Electricity – The Current State</u>

Overall greenhouse gas emissions were 587,226.97 kg CO2e in SFY 2015, with a 66-33% split between building uses and highway lighting uses.



VTrans consumed 14,959.04 MMBtu of energy from the grid in SFY 2015. About 2/3 of this went to buildings, including office buildings, airports, and uses directly outside of building complexes such as lighting for parking and power for security cameras. Note that the actual cost for our building electricity is 21% higher than the $0.14 average Vermont price, and The agency ends up paying 47.1% more for electricity utilized for highway purposes than for building electricity

Electricity – Recommendations

Vermont's energy grid is extraordinarily clean, and electricity is relatively cheap, although electricity represents only 6% of AOT's energy consumption. VTrans intends to continue to grow the number of agency-owned solar facilities through net metering and other means as explained in Section 2.

The agency will also continue to invest in efficiency as described in the building and other sections of the Plan

Increasing agency electricity consumption due to increasing electric vehicles in the VTrans fleet makes sense. Electric vehicles convert 59-62% of electrical grid energy, whereas conventional gasoline vehicles convert only about 17-21% of fuel energy into driving power. As noted previously, the top 6 2016 plug-in hybrid (PHEV) models get between 82 and 117 MPGe. Even running just on gas, the fuel economy exceeds that of BGS conventional passenger cars, which average 27.29 mpg (weighted by fuel use). PHEVs get between 32 mpg and 50 mpg combined city/hwy, and many PHEVs sell at average or below-average MSRP.

 # 2: Solar and Other Renewables

As of the completion of this plan, VTrans is in the process of adopting an agency *Solar Plan* that describes the costs and other benefits of installing solar photovoltaics (PV) systems including tools to evaluate the financial aspects of solar proposals, and a process for locating sites that considers environmental constraints, federal transportation policies, and community concerns. The full report is included in Appendix A.

VTrans electricity consumption is described in the previous pages and is summarized below.

Fiscal Year	Highway Use Lighting (kWh)[3]	Building Electricity (kWh)
2012	1,732,876.94	3,350,609.60
2013	1,866,036.97	4,051,171.00
2014	1,906,868.29	3,994,335.86
2015	2,638,517.22	3,373,127.20
2015 (new method)	1,488,207.00	2,896,038.00
2016 (new method)	1,462,553.00	2,690,751.00

These totals include buildings, signals, and street lighting. It does not include electricity use at VTrans National Life headquarters. Energy use for the National Life campus is not available under the current lease. The Davis Building is LEED certified.

Below is a summary of VTrans' solar facilities installed or planned for completion in 2016. This number represents of the agency's total energy demand.

Project Location	Capacity Rating (kW)	Annual AC Energy Production (kWh)
Airports	60	~65,000[4]
Rutland Airport	60	
Garages	~315	~310,000
Bennington	~15	
Brandon (2016)	~15	
Castleton (2016)	~15	
Dummerston	~15	
Lunnenberg (to be installed)	~10	
Mendon (2016)	~15	

[3] Most street lights are billed under a separate tariff. The agency pays a rate that combines energy, the cost of the equipment and maintenance. Street lights are thus "leased" or "rented" from the utility and the accounts cannot be net metered.

[4] Based on 2016 production number thus far Rutland is on schedule to produce between 90 and 100 kWh

Project Location	Capacity Rating (kW)	Annual AC Energy Production (kWh)
North Montpelier	~20	
Orange	~20	
Readsboro	~15	
Rochester (to be intstalled)	~15	
Royalton (to be installed)	~10	
Tunbridge	~15	
Wilmington	~15	
Right-of-Way	75	~83,000
Fair Haven Welcome Center (2016)	75 kW	
Total	**451 kW**	**460,000 kWh**

The net metering projects that were installed as of 2015 represented a $28,300 savings to the agency. Savings for all of the agency's projects, including those installed this year, have not yet been calculated.

There are significant uncertainties regarding the agency's ability to participate in the state's net metering program in the future. As of early September 2016 The Public Service Board (PSB) issued draft rules that limit an "entity's" net metering projects under any one utility to a total of 500 KW. The Board's intent appears to be an effort to keep any one entity from dominating the net metering program. Also the state's total net metering program has limits due to the financial effect on utilities and rate payers, and the Board's view that solar net metering projects should be smaller, decentralized, and in locations that are most suitable including roof tops and areas of disturbance. VTrans projects described above have all been within GMPs territory. The agency is thus close to meeting the 500 KW limit.

State government, through BGS and the Public Service Department, is expected to ask for clarification from the PSB regarding the intent of the 500 KW limit and what this means for state government. In addition, the Department in consultation with other state agencies through the Climate Cabinet, are expected to explore alternative power purchase agreements with the utilities that will allow for the growth of solar on state property, but that also bring an adequate rate of return for the agencies and thus tax payers.

<u>Strategies</u>

1. Complete the VTrans solar plan and make it available to the public, other agencies and municipalities.
2. Track the final net metering rule and advocate before the PSB to the extent possible that government entities be allowed to participate in the net metering program beyond the proposed 500 KW limit
3. Work with BGS, the PSD and other agencies on alternative power purchase and other solar financing options.

#2 Building Infrastructure Controlled by VTrans (state garages and other facilities)

State statute asks that state agencies adhere to the ambitious goal of reducing state buildings and operations total energy consumption, including transportation, by 5% per year. VTrans will work to adhere to this mandate through the strategies described throughout the AEIP.

VTrans has greatly improved all energy data collection as described in Section 1 of the plan. In addition, beginning in FY 2015 VTrans began using Energy Star Portfolio Manager to track per building energy consumption including electricity, water and non-wood heating consumption by property.

Strategies:

1. Continue to track building fuel and electricity use to better understand use, identify problems, and assess conservation measure performance to inform future investments.

2. Programmable thermostats have been tested and installed in all of the garages in the years ahead.

3. Investigate the use of heat pumps at new or expanded facilities.

#3: Traffic Signals and Street and Outdoor Lighting

Goal Statement: VTrans owns and maintains traffic signals, street lights, and outdoor lighting at park and rides, the state garages and other facilities. The agency has made several important steps in understanding this large energy demand and is implementing conservation measures associated with this demand now and in the future. This has included switching all traffic signals to LED technology and a growing use of LED lighting for exterior buildings, parking areas and roadway lighting.

Strategies:

1. VTrans has installed solar powered flashing yellow beacons to alert drivers of pedestrian crossings in some locations.

2. VTrans has inventoried and assessed the energy demand from outdoor lighting at the state garage facilities. VTrans determined, with assistance from Efficiency VT, that a comprehensive lighting project did not make economic sense at this time. Outdoor lighting will be addressed as efficiency improvements are made at individual facilities such as at the Chimney Corners Maintenance Facility (see below).

3. LED was installed at the Chimney Corners Park and Ride and Maintenance Facility in Colchester in 2014 (saving 40, 675 KW over the life of the project) and new LED lighting was being installed at both Putney and Hartland Park and Rides in 2014 and Bradford and Springfield in 2015 as part of other park and ride improvements at those locations.

4. Increase the use of LED and solar powered street lighting for VTrans' controlled facilities.

   Discussion: VTrans installed LED lighting at the Bennington Bypass interchange with Route 279. The project is a demonstration effort for future uses of LED technology for street lighting in Vermont and the region.

#4: State Airport Operations

The state airports' energy use is primarily related to terminal buildings and equipment, aviation beacons, runway lighting and other outdoor lighting.

Strategies:

1. VTrans manages 38 commercially powered incandescent hazard beacons statewide, all with high maintenance demands. Solar powered LED replacements were designed by VTrans and approved by the FAA for 90% funding and installed in 2011 and 2012. These include: Four LED and solar powered beacons at the Hartness (Springfield airport) area and five under construction in Rutland in 2014.

2. Efficiency Vermont has evaluated all of the state airports' hangar and terminal buildings and a multi-year effort is underway to replace all non-energy efficient lighting and improve heating system efficiency.

3. A 60 KW solar net metering project was completed at the Rutland Airport in 2016. The project has exceeded capacity expectation thus far and is on track to produce 100 KW by the end of this year.

#5: Non-fleet Equipment:

Office Equipment

Much of the equipment that VTrans employees use in performing their jobs uses energy. The energy use associated with items such as telephones, radios, computers, printers, copiers, and lab equipment can be conserved through a variety of strategies. Many of the strategies to better understand the amount of electricity used by the agency's computers and other systems are implemented through the actions of BGS and the Department of Information and Innovation (DII). This also includes researching and analyzing alternatives, calculating lifecycle

cost savings, purchasing or modifying equipment; and identifying and implementing behavior changes.

#6: VTrans Medium and Heavy Duty Fleet

Goal Statement: The Central Garage (CG), part of the Maintenance and Operations Bureau as well as various MOB managers control the agency's medium (primarily gasoline and leased through BGS) and the diesel heavy duty fleet. It is VTrans' goal to utilize that fleet to achieve the agency's mission as efficiently as possible, consuming the least amount of fuel as practical and generating a minimum of emissions. The amount of energy consumed by the diesel fleet is influenced in large part by winter weather and the amount of maintenance activity the conditions dictate.

Strategies:

1. *Vehicle idling reduction through policy requirements, information, education and automated vehicle controls.* Fuel costs are allocated to the users, thus encouraging drivers to reduce idling. A project is underway to install Automated Vehicle Location (AVL) systems in all Agency plow trucks, and some other fleet vehicles. These systems provide easy tracking, reporting, and analysis of idling. Better and more accessible data should allow for better managements and resulting efficiencies.

2. *Use the right size vehicle for the job.* Fuel efficiency is a consideration in vehicle specification and assignment. Fuel costs are allocated to the users thus encouraging them to select the most efficient vehicles. Soon-to-be implemented Federal fuel efficiency requirements for heavy trucks should facilitate comparison among vehicle makes.

3. *Maintain a modern and efficient fleet.* The modernization of the VTrans' fleet continues, thus ensuring more efficient and cleaner burning equipment. New federal requirements will require improvements in heavy vehicle fuel efficiency. In addition, the 2012 and newer heavy duty on-road vehicles have significantly reduced NOx emissions. The majority of VTrans vehicles and equipment are within their cost-effective service. Stable funding remains a challenge.

4. *Consider the recommendations in the 2016 analyses of transportation energy use and described on pages 6-7 of the plan* including:

   For Central Garage looking into the cost-efficiency of lower cylinder Ford ½ ton trucks with EcoBoost technology, as well as the corrosion and maintenance costs as well as the ability to withstand wear and tear of Ford's new aluminum bodies. Central Garage is generally doing very well with getting top-of-the-line fuel economy for their trucks within each tonnage class, but some potential improvements could be made in the ½

ton class. Improvements may be only 1 or 2 mpg, but since they represent a large percentage of the fleet and so many miles are put on them, cost savings can be multiple thousands over the lifetime of the vehicle.

Although BGS leased fleet fuel costs only represent 6.6% of the agency's energy consumption, BGS fuel purchases altogether still represent $250,000 annually, much of which is wasted on relatively inefficient vehicles in every class. Investigate the feasibility of shifting to the models below for both the BGS fleet and Central Garage:

Sedans	SUV	½ Ton	¾ Ton	Compact
Toyota Prius Eco Chevy Spark EV (1 or 2 only)	Toyota Rav 4	Gas: 4WD Ford F-150 2.7 L with EcoBoost Engine	4WD 14' Chevrolet 2500 (Currently Used at Central Garage)	Chevrolet Colorado (Currently Used at Central Garage)
Honda Accord Hybrid		Diesel: 4WD Ram 1500 FYE		
Chevrolet Volt (PHEV)		Gas: 4WD Chevy 1500 (Currently Used at Central Garage)		

5. *Maintain the fleet in good mechanical condition.* With very few exceptions, the agency's fleet operates in good mechanical condition and as efficiently as designed. Training and equipment must be kept current.

6. *Investigate renewable fuels including biodiesel and emerging fuels and technologies for increased efficiency and reduced emissions.* VTrans has reduced its bulk purchase of fuels, including biofuels as bulk tanks reach the end of their serviceable lives. Bulk fuel purchase now represent less than 45% of the agency's transportation diesel use. VTrans will coordinate with BGS in the procurement of biodiesel blends that will not compromise vehicle warranties. Opportunities for retail purchase of biodiesel blends are limited. VTrans will continue to monitor emerging technologies and alternative fuel options including CNG in northwestern Vermont.

#7: VTrans Passenger Fleet

Goal Statement: VTrans, in coordination with BGS, will make plug-in electric hybrid and full electric vehicle technology vehicles available to employees for on the job travel.

Strategies:

1. Increase the number of full and partial electric vehicles in the VTrans' passenger fleet.

Discussion: Late in 2013 VTrans' PPAID Division started leasing a Chevy Volt partial electric hybrid. In 2016 the agency determined that it was more cost effective for PPAD and other Divisions to use the growing number of plug-in EVs available through the BGS fleet. See the 2016 SAEP for more information regarding BGS' Green Fleets Initiative.

2. Track evolving EV technology and evaluate full and partial EV applications for the BGS leased fleet. See recommendations on page 6 including putting systems in place so that there is consideration of trips that are most suitable for partial electric vehicle and eventually full electric vehicle.

3. Determine appropriate fueling technology and locations at VTrans garages, rest areas and other facilities and along key travel corridors and downtown locations through public/private partnerships and other mechanisms, and install infrastructure in the locations deemed most suitable. This work will be in coordination with ANR and BGS and under the auspices of the Climate Cabinet and the Governor's Green EV Corridor Initiative.

   Discussion:

   In 2014-15 level one outlets were installed as part of Park and Ride improvement projects on I-91 at Hartland, Putney, Springfield and Bradford Park and Rides. They were added to light posts and include 12 plugs at Hartland, 12 at Putney, 12 at Springfield, and 14 at Bradford.

   In 2015 Washington Electric Coop (WEC), in coordination with VTrans, installed a 2 port Level 2 charger at the Middlesex Park and Ride (Exit 9 of I-89). Use is being monitored by the agency for three years as part of the agreement with WEC.

   In 2016 VTrans is investigating the placement of EV Fast Charge at the state Welcome Centers. Preliminary results indicate that only the White River S, I-91 south bound lane Welcome Center has adequate 3 phase power service available.

Goal Statement: Agency personnel reduce on the job travel demand when possible and address required travel for field work such as out of state travel, inspections, data collection, and construction and maintenance activities as efficiently as possible.

Strategies:

1. Increase teleconference and video conference use including the creation and upgrading of web based or other types of affordable video conferencing for Agency use

2. Provide employees with headset, speaker phones and other equipment necessary as well as training to facilitate conference calls, webinars and other virtual meetings and information sharing

3. Support ridesharing within sections and between divisions when attending site visits and other meetings

#8: Agency Employee Commuting

Goal Statement: VTrans will coordinate with the inter-agency Climate Neutral Working Group (CNWG) under the Climate Cabinet which is mandated to develop a comprehensive strategy for all of state government to address energy conservation and employee commuting. The average state employee commute is 33 miles round trip representing approximately 266,000 miles traveled daily and 59 million miles annually.

Strategies:

1. Continue support for the Capital Commuters Pilot Program launched by the governor in 2013. The program for state employees includes 50% discounts on transit passes and other incentives. There are approximately employees have registered as of September 2016

2. Continue to support telecommuting as appropriate

Appendices:

1. *VTrans 2016 Solar Plan,* prepared by Good Company
2. *Energy Data and Analyses Report,* prepared by VTrans intern, Steve Yannacone