Estimation and Short Range Forecasting of County Level Vehicle Miles of Travel and Motor Fuel Use for the United States (through 2015)

DRAFT
March 26, 2009

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Managed By UT-Battelle, LLC
for the
U. S. Department Of Energy
Under Contract No. DE-AC05-00OR22725

1. Introduction

This paper describes the development of a set of U.S. county-based vehicle miles of travel and motor fuel use estimates and forecasts. The forecasts are short range, annual forecasts out to year 2015. A range of forecasts can be generated based on different assumptions associated with household travel growth and alternative fuel use scenarios. The principal objective of the work is to produce a set of fuel demand forecasts that can support both the analysis of regional fuel use trends as well as provide information useful to the design of future alternative fuel supply infrastructures, including studies of the best way to sequence the connection of alternative fuel resource sites to emerging consumer-driven fuel markets. The present study is focused on private vehicle (automobile, motorcycle) household travel. The forecasts make use of a variety of econometric modeling steps and integrate data from a number of different government datasets. An important requirement of the forecasts was that they remain consistent with the information contained in these datasets, reflecting the latest government estimates and predictions concerning historical and anticipated household travel activity levels, as well as expected trends in motor vehicle efficiencies (i.e. in average on the road miles per gallon statistics). A range of fuel use forecasts are reported, reflecting the uncertainty in some of the parameters used while also demonstrating the impacts of specific assumptions.

The paper proceeds by describing each of the major computation steps in the fuel forecasting process in the sequence they were developed, and detailing the data sources used in each case. The process is very much a data driven one that tries to make as much use as possible of existing data sources. The available data, while rich in a number of attributes, are limited in their ability to provide statistically robust coverage at the level of spatial disaggregation required for the entire nation. As a result, a number of statistical models are used to create both a base case set of vehicle miles of travel and fuel use estimates as well as project these estimates into the short-term future. A high level flow chart of the entire forecasting process is shown in Figure 1. The figure lists the principal data sources used at each step in what can be viewed as a four step process: 1) estimate annual household VMT at the county level; 2) forecast this VMT into the future; 3) estimate household fuel consumption by fuel type for the latest year for which sufficient data is available (currently selected to be 2006); and 4) using the latest national fuel use forecasts, project this fuel use into the future and distribute it across states and counties using the county VMT forecasts derived from steps 1 and 2.

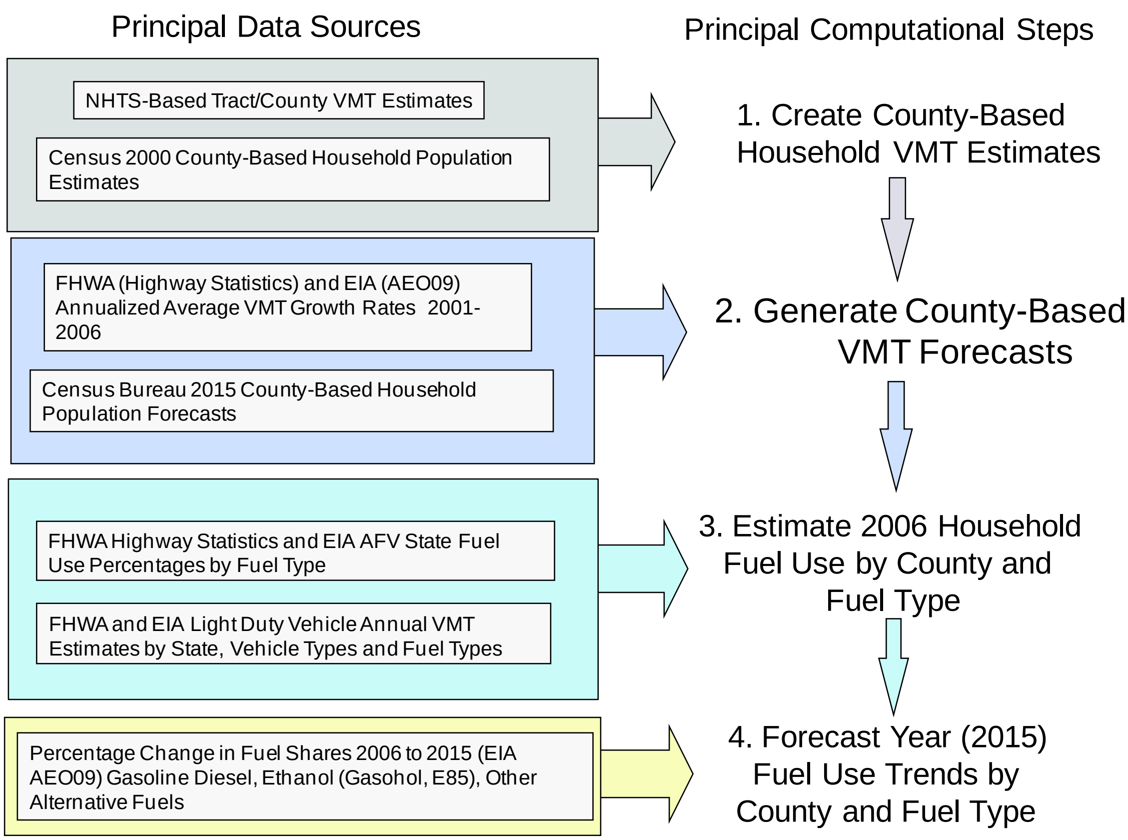

Figure 1. Principal Steps and Data Sources Used to Produce County Level VMT and Fuel Use Forecasts

2. Base Year Household VMT Estimation

Vehicle miles of travel (VMT) measures were generated using the National Household Travel Survey (NHTS) "Transferability" process and its associated Census tract-level database.[1] This process, which is now available online to users, is described in detail by

[1] Accessible for online use at http://nhts-gis.ornl.gov/transferability/

Hu et al (2007). In summary here, a household's major socio-economic and geographic travel determinants are first quantified. A multi-step process involving a combination of cluster analysis and regression analysis is used to assign trip purpose-specific daily trip rates and daily VMT estimates to specific Census tracts based on the number and types of households contained within each Tract. In doing so a wide range of explanatory factors were considered, including household income and buying power, vehicle ownership, stage in household life cycle, metropolitan area size class, population density, cost of living, cost of transportation, region of the country, number of workers who use public transit, and number of bus and train routes within the Census tract. For the 2001 NHTS database the Transferability software translates these results into tract level daily person trips and daily VMT cross-classified by five trip purposes (Home based Work, Home base Shopping, Home Based Social/Recreational, Other Home based and Non-Home based trips), five household size classes (,1,2,3, 4 and 5+ persons per household), and five vehicle ownership classes (0,1,2,3,4 + vehicles per household). County level VMT estimates can then be obtained by summing over the VMT for all tracts within a county. Annual household VMT totals by tract are derived by multiplying the resulting VMT rates per household class by household population expansion factors from the 2000 Census, and by multiplying the resulting number of daily trips by 365. These tract based estimates are then summed into their respective counties. Growth of these county VMT figures to 2006, the base year from which fuel consumption estimates are created, is described below.

3. Household VMT Forecasts

The above described county household VMT estimates for year 2000 are used as a base from which to project household VMT into future years. This is done by combining data on the growth in VMT per household over time with the growth (or decline) in travel due to projected increases (or decreases) in U.S. household populations. Currently, the VMT growth trend is based on nationally averaged VMT growth statistics, while the growth in population is derived at the county level.

National VMT Forecasts: To capture the rapid growth in household VMT over the past 28 years, national level data on passenger travel from the Federal Highway Administration's *Highway Statistics* data series were used (FHWA, 2009).[2][3] This data series reports annual, nationwide travel statistics for passenger cars, buses, motorcycles and other four axle, two tire motor vehicles (principally pickup trucks, sports utility vehicles and van). Since these numbers include a significant number of miles driven for commercial activities, these estimates were first reconciled to household-only NHTS VMT. This process is described in Hu and Reuscher (2009, Section 4). They found that NHTS estimated annual US household VMT was, as expected, significantly lower, than the VMT assigned to "passenger cars, including motorcycles" plus "other two-axle, four tire" motor vehicles by Highway Statistics (HS) in the 2000-2001, as well as in the two prior NHTS (NPTS) surveys from 1990 and 1995.[4] Using simple interpolation, NHTS/HS ratios for 1991-1994 were therefore computed based on 1990 and 1995 NHTS/HS ratios. Similarly, ratios for 1996-2000 were interpolated using 1995 and 2001 NHTS/HS ratios. Since no consistent trend in ratios existed between these two time periods (i.e. ratios went up from 1990-1995 and down from 1995-2001) the 2001 ratio was held constant for dates after 2001 (at 0.88130).[5] Table 1 (based on Table 4.13 in Hu and Reuscher, 2009) shows these ratios, which were also used in the present study.

Table 1: NHTS/HS VMT Ratios

Year	Ratio
1990*	**0.85088**
1991	0.86285
1992	0.87483
1993	0.88680
1994	0.89878
1995*	**0.91075**

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[2] Greater disaggregation of VMT growth factors by individual States is being looked into.
[3] http://www.fhwa.dot.gov/policy/ohpi/hss/hsspubs.cfm
[4] Bus travel was left out of the current forecasts, but can be included in future work. The focus of the current effort has been on private vehicle household travel.
[5] As a reasonableness check on this figure, the amount of travel devoted to household vehicles was also estimated using data from 2006 Highway Statistics, the 2001 NHTS and the 2002 Vehicle Inventory and Use Survey (VIUS). The VIUS (United States, Table 7) puts personal use VMT for light duty trucks at 78.8%. The NHTS (Table 11-A) estimates that 2.9% of automobile VMT is commercial travel. Using these two percentages to weight auto and light truck VMT for 2006from HS Table VM-1 yields a personal .household travel weighting factor of 0.899.

1996	0.90584
1997	0.90093
1998	0.89603
1999	0.89112
2000	0.88621
2001*	**0.88130**
2002	0.88130
2003	0.88130
2004	0.88130
2005	0.88130
2006	0.88130

* Highlighted years were survey years for the National Personal Transportation (NPTS) and its successor the National Household Travel Survey (NHTS).

After this adjustment, simple linear regression, arithmetic moving average (ARIMA), and a weighted average of the regression-ARIMA models were fitted to annual VMT data covering the period 1980 to 2006. The steady rise in annual household VMT over this period (see Figure 2) means that each of these methods fits the historic data closely.

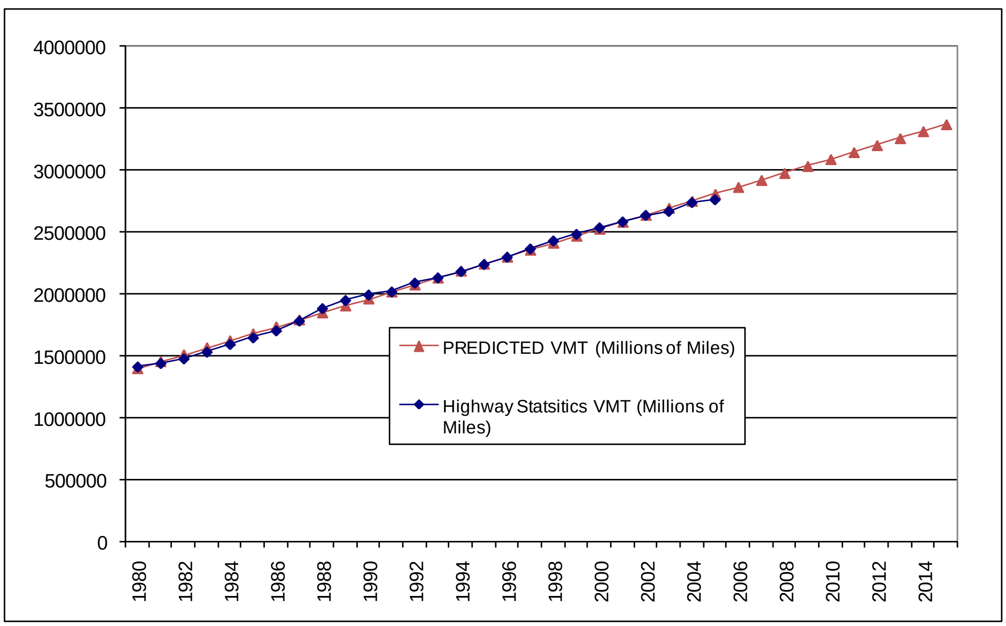


Figure 2. National Passenger VMT Forecast based on Linear Regression.

Of concern, however, is the effect, and potential for sustainability, of the rapid drop in VMT nationwide post-2006[6], and not reflected in the above figure, as well as the recently described decline in the annualized rate of VMT growth since 2004 (see Puentes and Tomer, 2008).

Figure 3 shows this very recent and unprecedented national trend in total (auto plus truck) VMT. With such considerations in mind eight different VMT forecasts based on the FHWA data were produced. These forecasts were then compared with two scenarios based on the latest annual VMT forecasts by the Energy Information Administration (EIA, 2009a, Table 50). This produced the following eight short range VMT projections, termed here VMT scenarios:

Scenario 1: Use EIA growth rates for 2008 starting at 2010
Scenario 2: Pick up Simple Regression (SR) 2006 growth rates at 2010
Scenario 3: Pick up ARIMA 2006 growth rates at 2010
Scenario 4: Pick up a weighted average of SR and ARIMA2006 growth rates at 2010
Scenario 5: Pick up SR 2010 growth rates at 2010
Scenario 6: Pick up ARIMA 2010 growth rates at 2010
Scenario 7: Pick up weighted average of SR and ARIMA 2010 growth rates at 2010
Scenario 8: Pick up EIA 2010 growth rates at 2010

where growth rates refer here to the annual growth in light duty vehicle VMT forecasts contained in the Energy Information Administration's (EIA's) most recent annual Energy Outlook for 2009 (EAI, 2009a). Each of these scenarios represents a 2010 to 2015 growth rate projection preceded by a short term adjustment to the 2007 and 2008 VMT estimates reported by FHWA's *Highway Statistics* series. This is done in order to capture the noticeable downward trend in household VMT observed during 2007 and 2008 and its anticipated continuation for at least some portion of 2009.

[6] See http://www.fhwa.dot.gov/ohim/tvtw/tvtpage.cfm

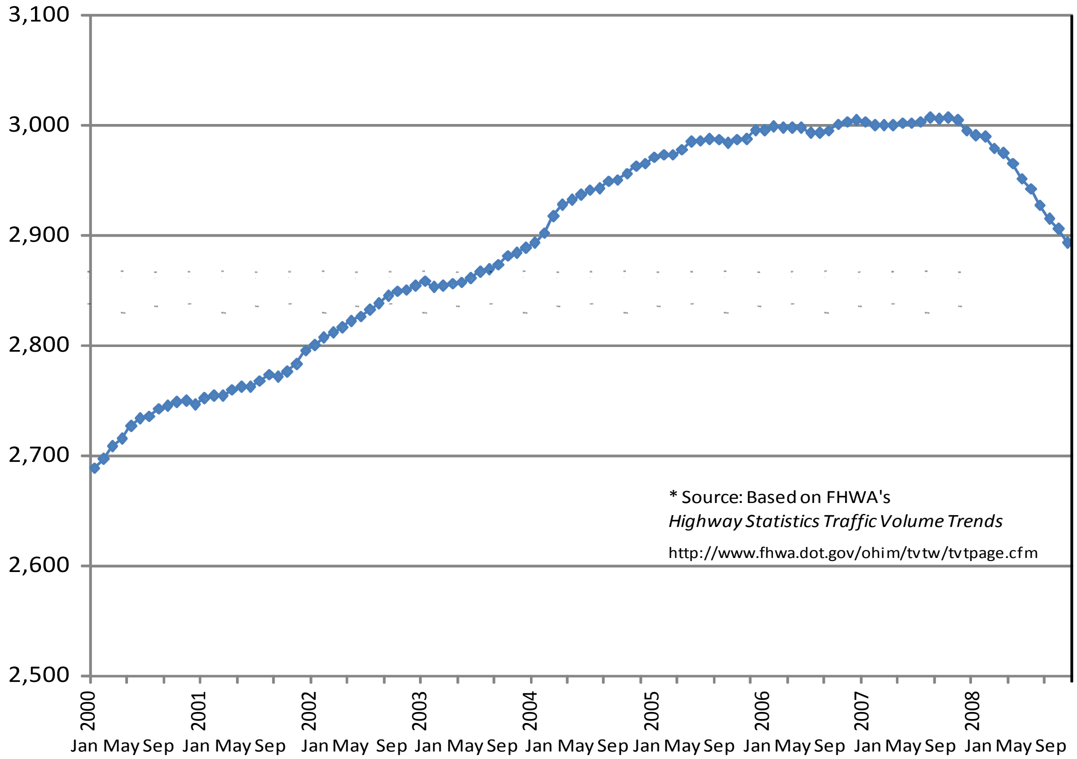


Figure 3. Monthly Trend in Total U.S. Highway VMT Growth: 1/2000 to 9/2008.

Figure 4, with a focus on post-2000 VMT, shows the effect of making these 2007-9 adjustments, effectively re-starting the VMT growth trend produced by the regression and ARIMA models in 2010. The 'default' scenario we have adopted is Scenario 5, which picks up the simple regression model based on the annual growth rate in 2010 once the 'kink' caused by the unusual economic circumstances of 2007-9 have (hopefully) played themselves out. Other options here include the use of a slower post 2009 rate of VMT growth more compatible with the gradual slowing in annual post-2004 growth reported recently by Puentes and Tomer (2008), to rates closer to 1% annual growth as opposed to the 2%+ annual growth rates we have been used to over the past quarter century. As a set the 2015 VMT forecasts produced by these eight scenarios vary by only 1.89% (low = Scenario 1; high = Scenario 3) with our default scenario (used to the fuel use forecasts below) falling in the middle of this range.

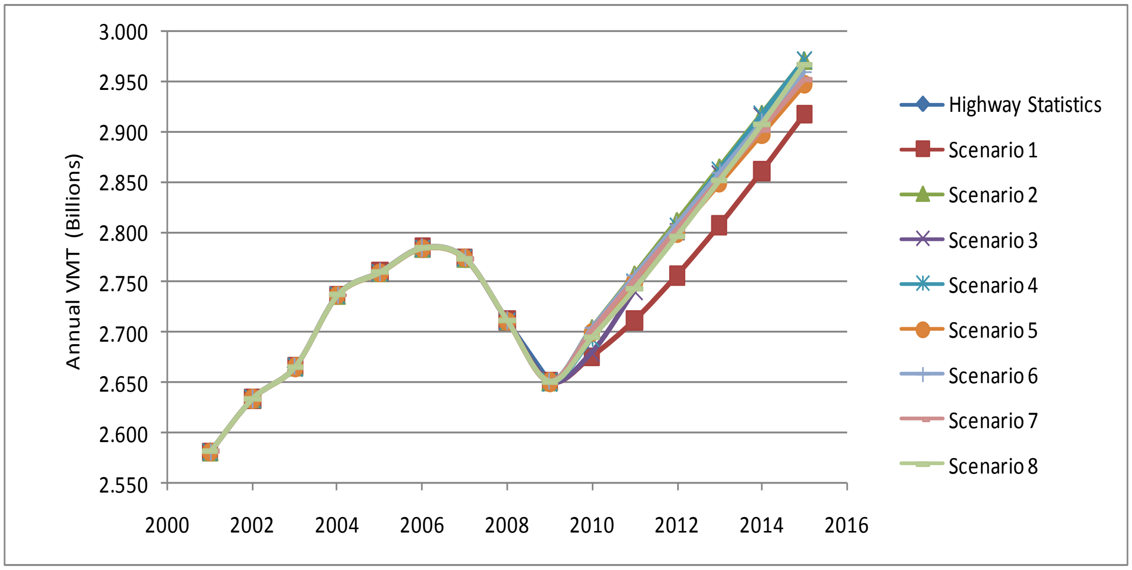


Figure 4. Effect of the Recent Decline in Passenger VMT on Annual Projections

County Population Forecasts: To forecast VMT forward in time by county the above national household VMT estimates were combined with Census Bureau estimates of the future growth in the U.S. household population broken down to the county level. While the most recent Census Bureau projections of the number of future year U.S. households[7] is currently based on data prior to the 2000 Census (and thus is not expected to reflect the population surge from 1990 to 2000), a search yielded population numbers based on the 2000 Census and which Census has projected out to 2030 at the State level[8]. In addition, Census population estimates at the county level were found to be available for the years 2000 to 2007[9]. Both of these datasets were made use of to create a set of annual county based population estimates out to our target year of 2015, as follows:[10]

1. For each county, a compound annual growth rate from 2000 to 2007 was computed. This growth rate was used to extrapolate each county's population out to 2015 (County Estimate 1). A sum of these estimated 2015 population values was then computed for each state (State Estimate 1). The ratio of this newly

[7] http://www.census.gov/population/www/projections/nathh.html
[8] http://www.census.gov/population/projections/SummaryTabA1.xls
[9] http://www.census.gov/popest/counties/files/CO-EST2007-ALLDATA.csv
[10] In the process it was found necessary to make a few changes to the Census data used for estimation. These changes are described in the Appendix to this paper.

computed sum to the Census 2015 total state population estimates was then calculated. This ratio was then multiplied by the estimate of county population created earlier (County Estimate 1) to make the county estimates consistent with the state estimates (County and State Estimates 2).

2. Since the NHTS Transferability data is also based on the 2000 Census data, a bridge must be constructed between the final 2015 county population estimates and 2000 Census estimates. For simplicity's sake, for each county a simple ratio of the 2015 estimate to 2000 Census value was calculated. This ratio was then applied to each Census Tract's household count to grow the 2000 data into 2015 estimates.

Note that in the current estimates we have ignored the difference between population and household counts. Current Population Survey numbers[11] show 2.58 persons per household in 2001. This remained the same until 2003, when the number declined marginally to 2.57. This number stayed the same through 2006, until finally dropping to 2.56 in 2007, the most recent year for which data was available. Given this extremely slow level of decline, combined with the difficulty in determining the changes in the household size distribution, which would be needed in developing population numbers for use with the Transferability data, no change in average household size is assumed through 2015. Given this, the adjustment from 2000 to 2015 households is simply the same adjustment made to the population numbers – 2000 households multiplied by the ratio of 2015 Population Estimates/2000 Census Population numbers. For forecasting further into the future it is then a simple process to introduce any gradual change in the number of persons per household into the forecast.

Combining VMT Estimates and Population Forecasts: The next step in the process combines the above results. First the 2001 NHTS-based household VMT rates for each tract are multiplied by the number of households forecast to be in each county and state, in each future year up to year 2015. Summing over all household groups, trip

[11] http://www.census.gov/population/www/socdemo/hh-fam.html

purposes and tracts within a given county produces an aggregate county-based VMT forecast for each year, based solely on Census determined population growth. These VMT figures are then reconciled with the annual, nationwide VMT estimates and projections derived from the regression and ARIMA modeling of the FHWA and EIA datasets described above. The resulting forecasts are therefore compatible with the most recently available data on:

- the way in which VMT varies across household socio-economic groups and trip purposes, as described in the 2001 NHTS,
- the growth in Census Bureau projected county and state population totals, and
- both longer term and more recent nationwide growth trends, compatible with the latest FHWA or EIA data sources.[12]

4. Year 2006 State and County Fuel Consumption by Fuel Type

VMT forecasts are turned into fuel use forecasts starting with a year 2006 base. This was the latest year for which fuel consumption data by individual states was available. The following two step process was followed, with a number of detailed adjustments to ensure compatibility of data sources being required along the way, as explained below:

1. Use FHWA, EIA and census Bureau data sources to put state- based estimates of gallons of fuel used for highway travel in 2006 into their gasoline-gallon equivalents (GGEs)
2. Distribute this fuel consumption by state and fuel types across the counties within a state on the basis of their share of that state's private vehicle household travel (VMT).

[12] Building on this framework, additional VMT forecasts can also be generated by further disaggregating the VMT growth trends reported in FHWA's Highway Statistics dataset. This can be done by developing separate VMT projections by State or by a broader regional partitioning of the nation as suggested by further statistical analysis, and thereby adding additional geographic information to the step by step proportional fitting process described here..

3. Replace each state's ethanol allocations to E-85 flex-fuel vehicles with an alternative county allocation based on a detailed geographic analysis of the location of existing E-85 refueling stations.

State Fuel Consumption Totals by Fuel Type: Fuel use data was available at the state level from two sources: the annual estimate of gasoline and "special" fuels consumed in each state from FHWA's Highway Statistics series (HS Table MF 21), and the EIA's estimates of alternative fuels (Compressed Natural Gas, Electric, Hydrogen, Liquid Natural Gas, Liquid Petroleum Gas Ethanol E-85, and Other Fuels) consumption (EIA, 2009b).[13] Since the gasoline consumption figures from Highway Statistics included gasohol, a third source of data required was the percentage of ethanol used in this gasoline. The latest readily available data on this at the state level is also reported in Highway Statistics (Table MF33e), but only for as recently as 2004, which became the default set of values for the present study. In combining these various data sources all fuel was converted to its gasoline-gallon equivalent (GGE).

With diesel being used mostly in trucks, a household travel diesel use factor was also needed. This was estimated using the data reported in the Edition 27 of Transportation Energy Data Book (Davis et al, 2008: Table 2.5) in which diesel consumption on highways (in million Btu) is broken down into automobile ("cars"), light duty truck, bus, and heavy duty truck use. After subtracting heavy truck use, this left a proportion of light truck use to be removed. Data from the 2002 Census Bureau's Vehicle Inventory and Use Survey (VIUS: Census Bureau, 2006) was used for this purpose. According to the VIUS some 81.5% of light truck use is for personal travel. Subtracting the remaining 18.5% of the energy used in light duty trucks yielded an estimated 2.1% of total automobile plus light truck energy use for household travel being assigned to diesel in 2006 (= approximately 6.3% of fuel used in 2006 for all automobile and motorcycle on-highway travel being assigned to diesel).

[13] Source: Energy Information Administration, Office of Coal, Nuclear, Electric, and Alternate Fuels. http://www.eia.doe.gov/fuelrenewable.html
http://www.eia.doe.gov/cneaf/alternate/page/atftables/afvtransfuel_II.html#consumption

Finally, since EIA's 2006 alternative fuels data (given in GGEs) does not separate out household from other (i.e. commercial) travel consumption, these figures were reduced by the (NHTS/HS) VMT adjustment ratio of 0.88310 described above for computing household only travel.

The result of these various computations and adjustments is a set of state specific private motor vehicle fuel use totals for 2006 converted to GGEs; one that is consistent with FHWA and EIA reporting of data at the state level.

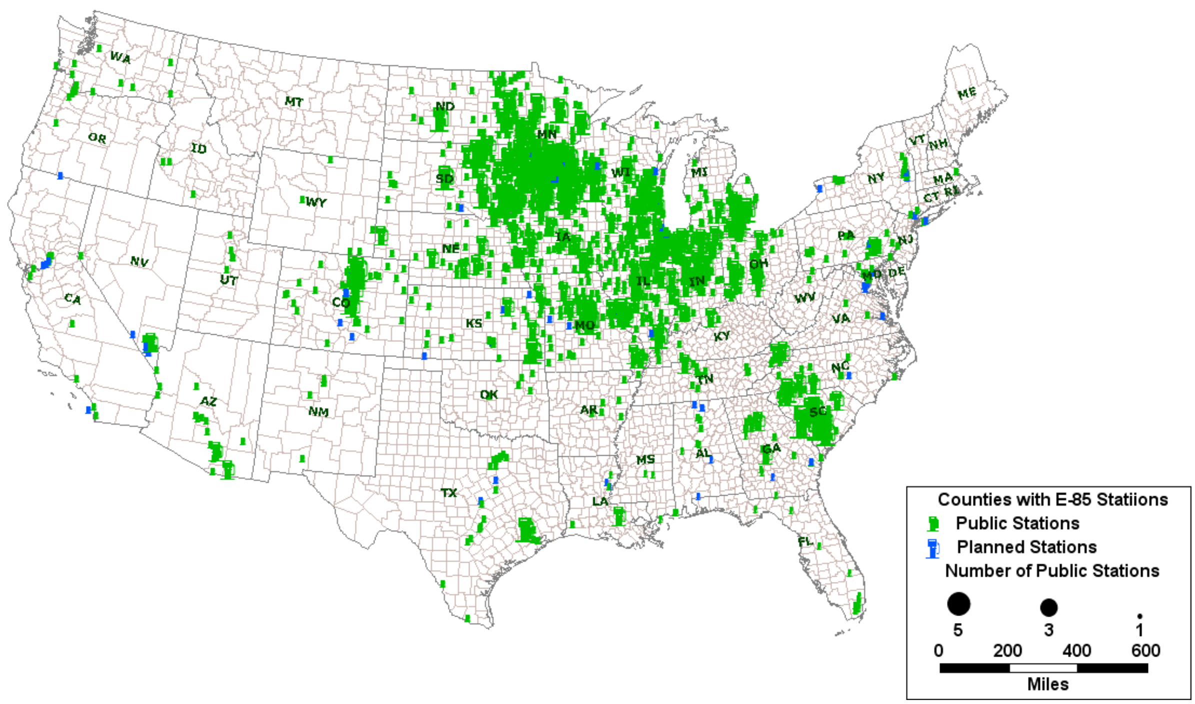
County Fuel Use Estimates for 2006: These state fuel use totals are then distributed across the counties within each state on the basis of that county's share of its state's household estimated household VMT in 2006. Using the mid-range Scenario 5 household VMT numbers (cf. Section 3) produced a 50 state plus Washington DC, VMT weighted average miles per gallon (mpg) estimate of 20.68. This figure is just slightly above the nationwide mpg estimate reported in EIA latest Annual Energy Outlook (EIA, 2009a, Table 69) of 20.37 mpg. State average 2006 mpg's from this exercise range from 15.6 mpg for Louisiana up to 24.8 mpg for Idaho.

E-85 Fuel Use in U.S. Counties in 2006:

Given the growing interest in ethanol fueled vehicles and (see section 5) their anticipated increase in use by 2015 the state specific totals for E-85 consumption in 2006 reported by EIA were assigned to counties on the basis of the number of publicly available E-85 refueling stations in that county. Given the importance of proximity to a refueling station in the selection of this fuel (see Greene, 1998, 2001) this offers a much better method of distributing the fuel demand than a simple county-based VMT weighting. Just how to allocate the amount of ethanol obtained from each refueling station is more problematic. Two options were tested: 1) locate each refueling station according to its 5-digit zip code, and use that zip code area's population to weight its allocation of the state's reported E-85 use in 2006, then assign each zip code areas fuel use to its appropriate county; and 2) allocate the E-85 on the basis of number of stations per county. Option 2 results were used here as the default. The data for this exercise was obtained from the station addresses listed by state on the U.S. Department of Energy's (DOE) Office Energy Efficiency and Renewables Alternative Fuels and Advanced Data center website (EERE,2009). [14]

Figure 5 shows the heavy concentration in the Midwest of publicly available as well a planned E-85 refueling stations, as reported on this website (March 2009).

Figure 5. Counties with Public and/or Planned Ethanol (E-85) Refueling Stations (As of March, 2009)



5. Year 2015 County Fuel Use Forecasts by Fuel Type

The final step in the process illustrated in Figure 1 is to project the 2006 county fuel use forecasts into future years, and specifically out to year 2015. This meant accounting for both household VMT growth (or in some counties, decline) as well as the changes in

[14] http://www.afdc.energy.gov/afdc/stations/advanced.php

vehicle fuel efficiency (average mpg) between the two years. This was done in the following steps:

1. Compute the state VMT estimates for 2015 by summing the forecast VMT over all counties in the state.
2. Compute the estimated average mpg for each state in 2015 by multiplying the 2006 averaged state mpg by the % change in average nationwide mpg by 2015 as reported in EIA's Annual Energy Outlook for 2009 (early release: EIA, 2009a).
3. Compute the 2015 total GGEs per state by dividing the 2015 state VMT by its average mpg from step 2.
4. Project the 2006 fuel consumption shares (in GGEs) onto these 2015 state GGE totals.
5. Adjust these fuel shares to match the shift in each share predicted by the EIA's Annual Energy Outlook (EIA, 2009a, Table 46).[15] In doing so adjust the E-85 fuel shares to reflect the distribution of planned as well as publicly available E-85 refueling stations.[16]
7. Distribute the resulting state fuel totals to counties on the basis of each county's share of its 2015 state VMT.

In this manner it is possible to capture some of the effects of different state geographies on mpg efficiencies and hence on total fuel consumption. The resulting 2006 and 2015 nationwide fuel shares are shown in Table 2.

Table 2: Aggregate Fuel Shares (in % GGEs) 2006 and 2015

	Gasoline	Diesel	Ethanol from Gasohol	Ethanol from E-85	Other Alternative Fuels Total
2006	95.89	2.05	1.79	0.03	0.25
2015	93.51	2.38	1.73	2.14	0.24

[15] Note that the shifts in fuel shares between 2006 and 2015 are used, rather than the 2015 fuels share totals directly. This is done to allow for slightly different base fuel shares caused by computing shares for household private vehicle travel only.
[16] Planned as well as existing public E-85 re-fuelling stations are listed by state on the DOE/EERE website at http://www.afdc.energy.gov/afdc/stations/advanced.php

These shifts reflect EIA's anticipated increase in the use of E-85 flex-fuel ethanol vehicles over the next few years in response to recent federal legislation encouraging this trend. The 2015 VMT weighted average mpg from these calculations comes in at 23.06 mpg for the 50 state plus Washington DC, while individual state average mpg's for 2015 range from 17.6 mpg for Louisiana up to 27.6 mpg for West Virginia. This reflects an 11.3% increase in private vehicle household mpg for the 50 states plus Washington DC dataset. This increased efficiency offsets an estimated 5.87 % increase in overall household VMT for the 50 states plus Washington DC to produce an estimated reduction in motor fuel energy use for private vehicle household travel of 4.9% by 2015.

6. Example Output and GIS Mapping

To allow visual analysis, county based VMT and fuel consumption results have been attached to a set of county latitudes and longitudes. These data are easily exported to a geographic information system (GIS) software. Figure 6 maps the estimated % change in each county's household private vehicle VMT from 2006 to 2015, showing the decline in total VMT in many rural counties and especially in a north-south band of counties running down the center of the nation from North Dakota to Texas.

Figures 7, 8 and 9 map some of the fuel consumption results, for clarity of presentation here showing only those counties estimated to consume at least 50 million total gallons of motor fuel annually in 2015 (i.e. counties with at least some 75,000 in use vehicles). All of these mappings also the default (scenario 5) VMT annual growth scenario discussed above, combined with the estimated change in alternative fuel shares (and notably the growth in ethanol use) from EIA's Annual Energy Outlook 2009 (early release) forecast. Figure 7 maps the U.S. counties with the largest estimated total GGEs consumed in 2006, summed over all fuel types (represented by the height of the grey bars) as well as the projected percentage increase in total GGEs between 2006 and 2015 (represented by the size of the red circles). Figure 8 maps the estimated county GGE totals in 2015, again summed over all fuel types (represented by the height of the grey bars), along with the estimated annual county VMT in 2015 (represented by the size of the red circles). Figure

9 shows the estimated shares of alternative to gasoline fuels (diesel, ethanol from gasohol, ethanol in E-85 vehicles, and “other” fuels), again highlighting U.S. counties with over 50 million total estimated GGEs (including gasoline) in 2015. The size of each pie chart here is proportional to each county’s estimated alternative, non-gasoline, fuel demand in 2015. Significant regional differences in alternative fuel shares are evident from this mapping, which assumes the concentrations of E-85 growth in those counties already supporting this fuel type described above. Other scenarios, under other E-85 penetration and growth assumptions, can now also be simulated using this spreadsheet modeling and mapping software. Longer range forecasts can also be generated using the current scenario-based approach, using EIA and /or other forecasts for alternative fuel penetration rates out to 2030, or by tying the VMT and associated population growth forecasts to more elaborately developed alternative fuel adoption models.

Figure 6. Estimated Percentage Change in Household Private Vehicle VMT by U.S. County from 2006 to 2015

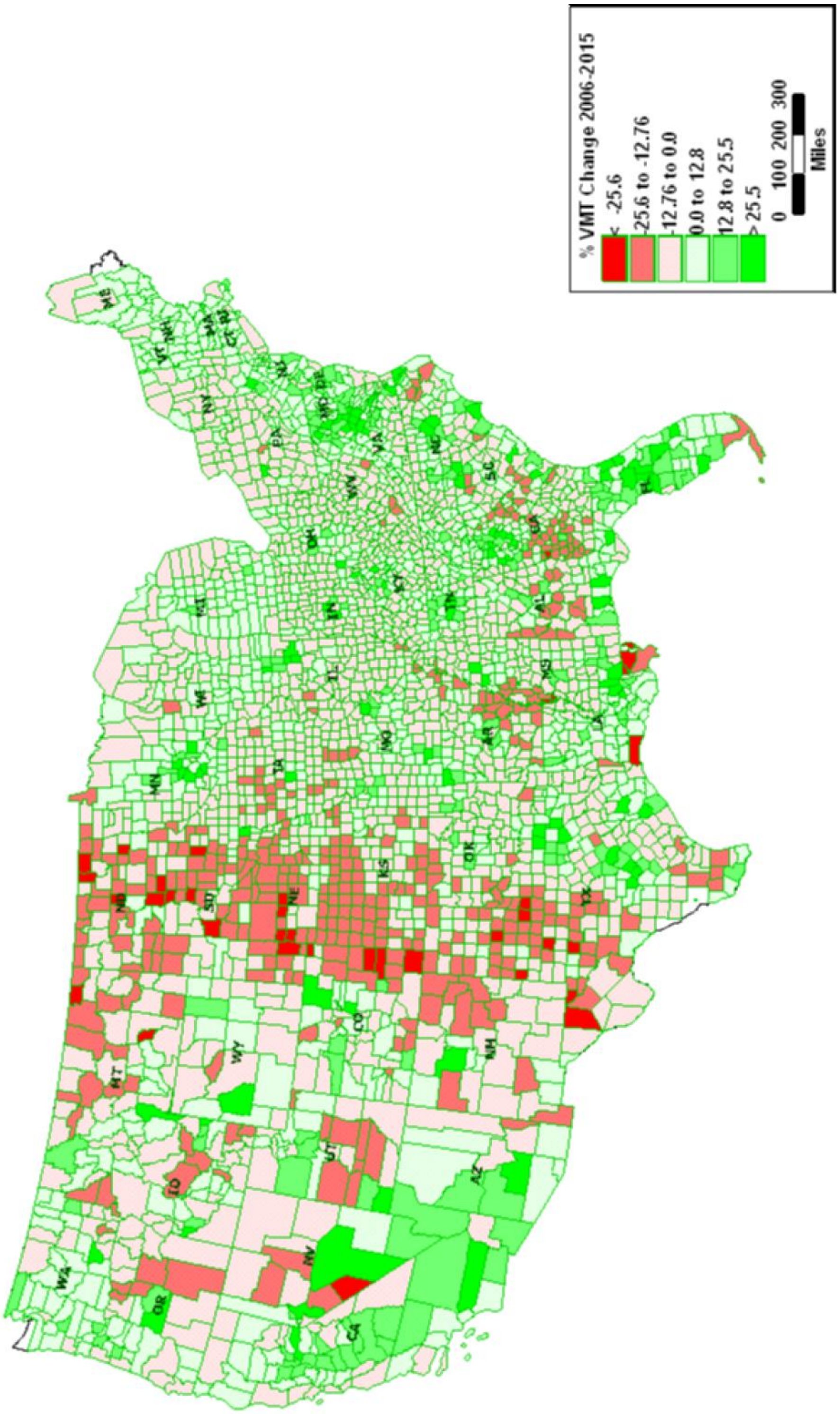


Figure 7. U.S. Counties with the Most GGE's Consumed in 2006

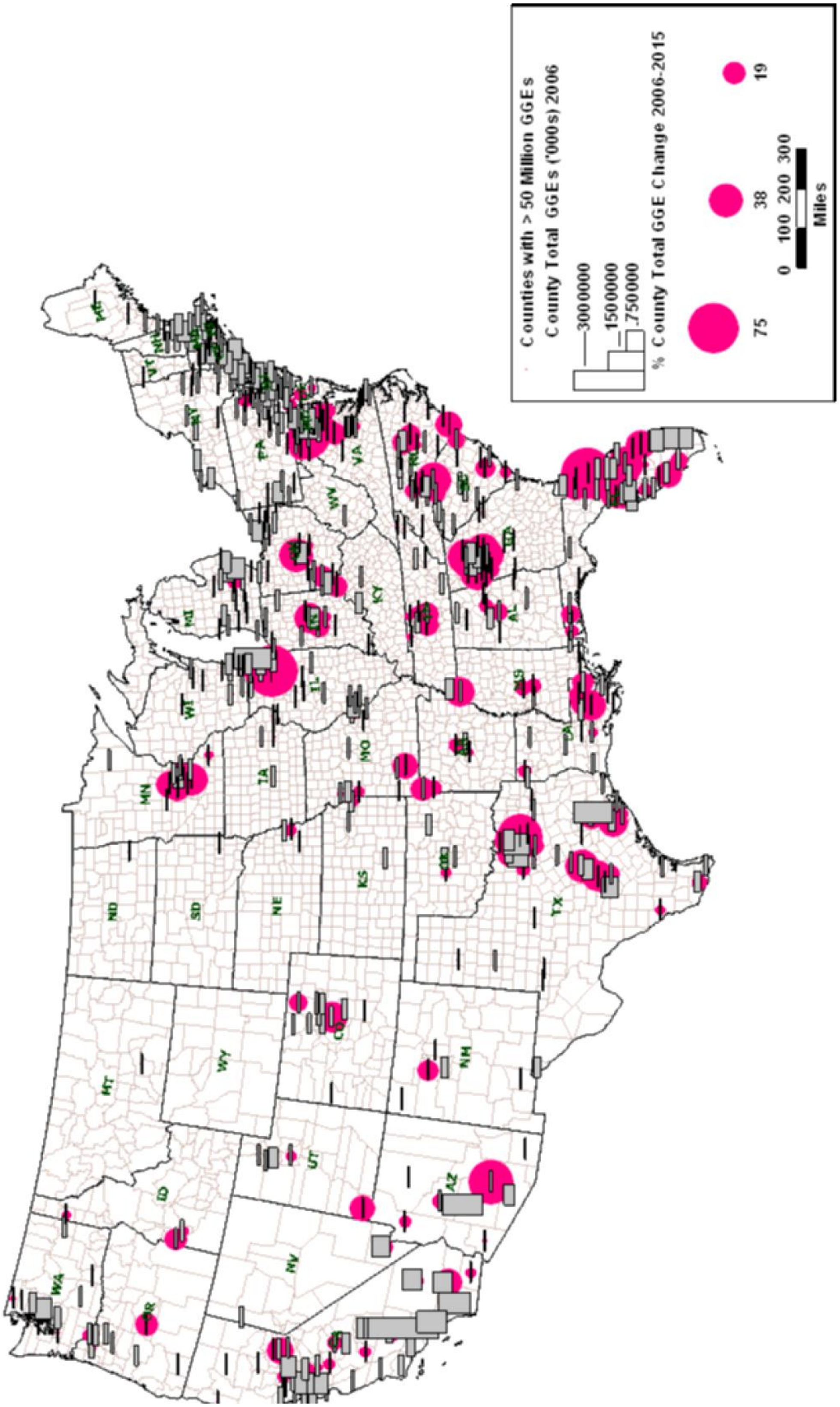


Figure 8. U.S. Counties with Largest Annual Private Household VMT in 2015.

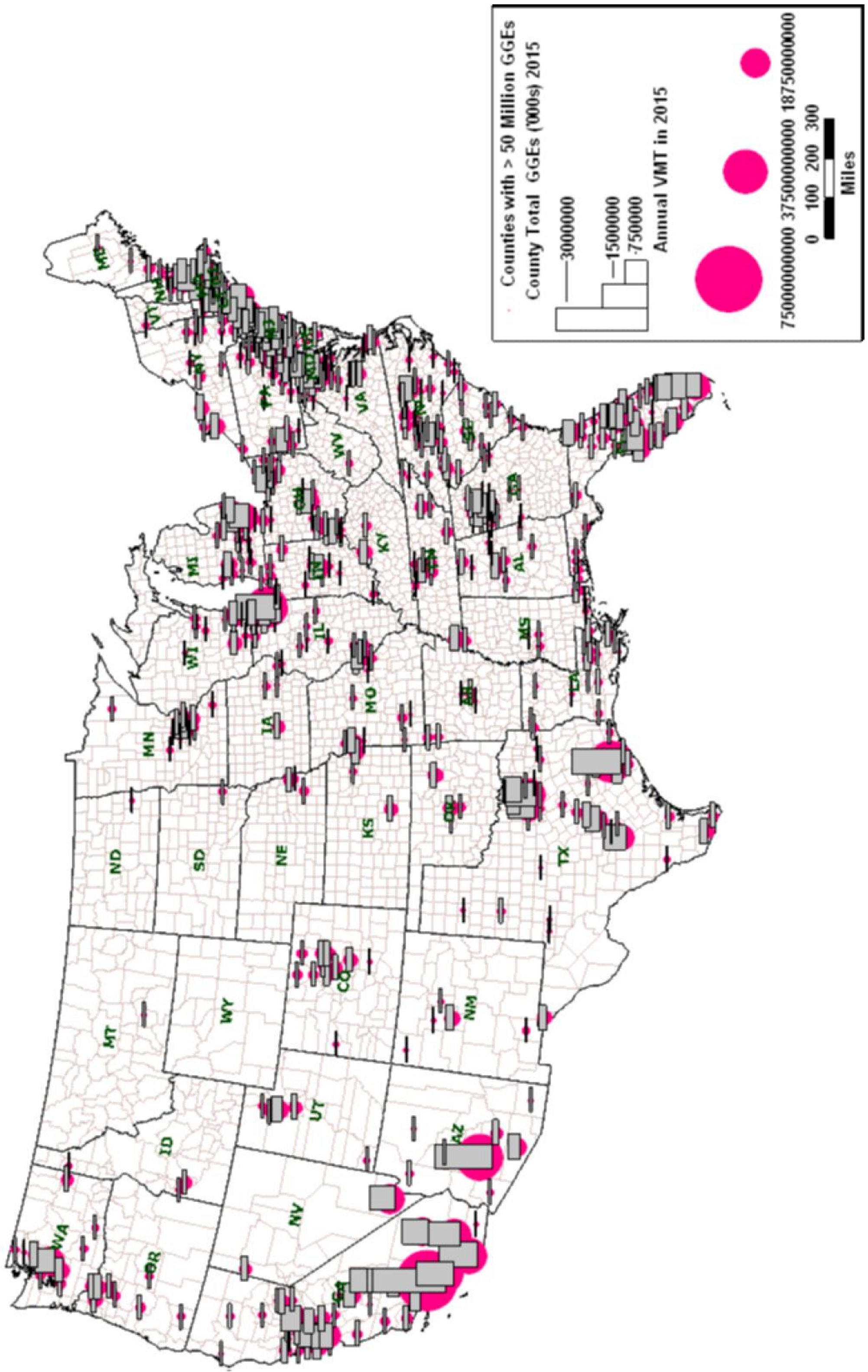
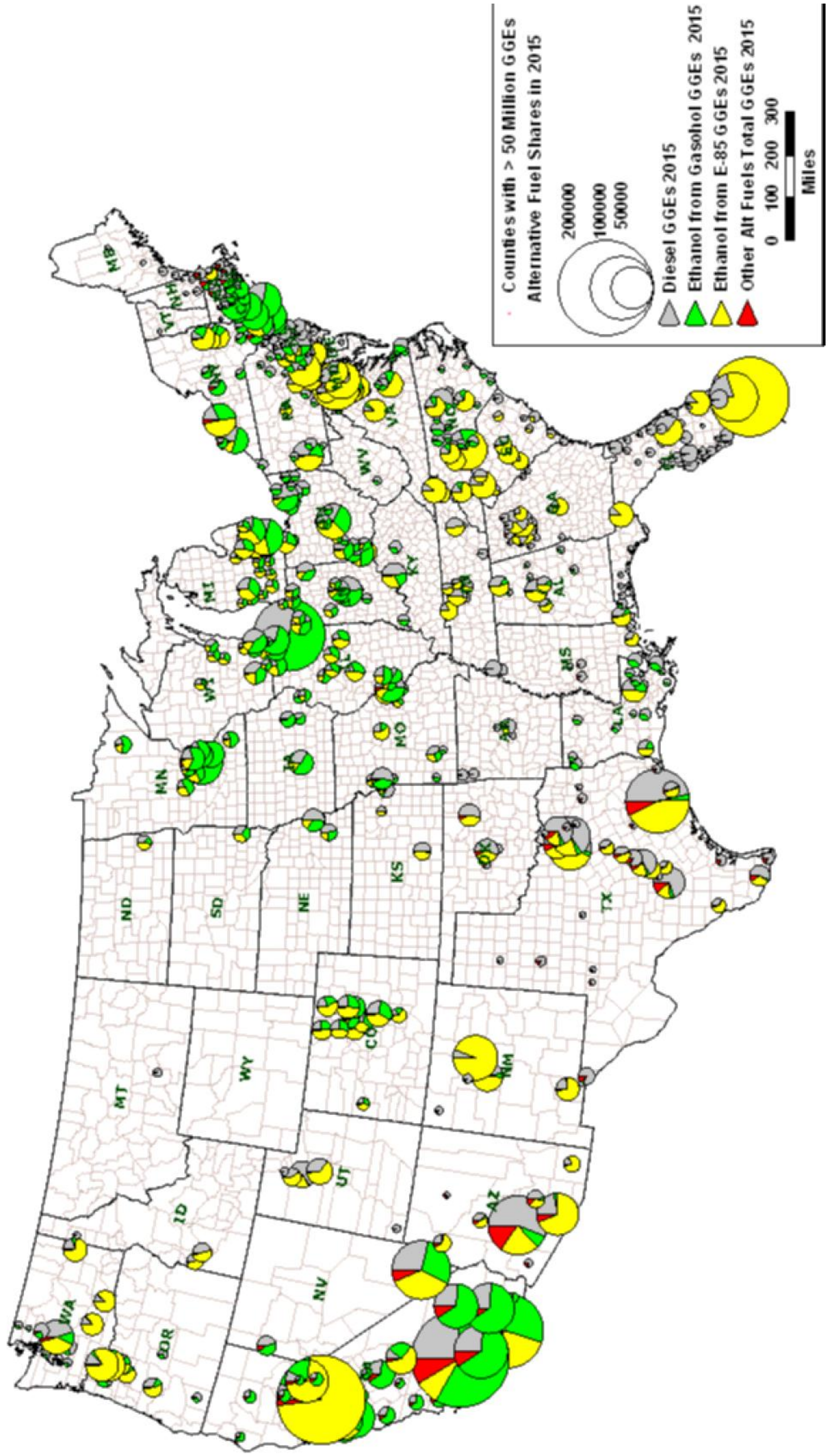


Figure 9. Alternative Fuel Shares in 2015: Counties with Over 5 GGEs



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Appendix

This Appendix describes the changes made to the Census data used for estimating future year VMT, changes that were required due to the nature of the NHTS Transferability data, which was based on the 2000 Census. The Census data is based on the current county breakdown, which has changed slightly since 2000[17]. In particular, in 2001 Broomfield County, CO was created from portions of four other counties. In terms of the data, Broomfield County does not exist in the Transferability data, and the populations of the other four counties are much larger than in the 2015 estimates. In the Census county population estimates file (2000-2007), the CENSUS2000POP (estimates without Broomfield county) and ESTIMATESBASE2000 (estimates with Broomfield county) were compared. The population losses for each of the four counties were totaled and a percent of the total loss was computed for each county, as summarized in Table 1. These percentages were then used to distribute the 2015 projected population of Broomfield county, as summarized in Table 2.

Table 1

COUNTY	CENSUS2000POP	ESTIMATESBASE2000	DIFF	PCT LOSS
Adams County	363,857	347,957	-15,900	40.5%
Boulder County	291,288	269,769	-21,519	54.9%
Jefferson County	527,056	525,330	-1,726	4.4%
Weld County	180,936	180,857	-79	0.2%
TOTAL	1,363,137	1,323,913	-39,224	100.0%

Table 2

COUNTY	2015 ESTIMATE	ADJUSTMENT	NEW 2015 ESTIMATE
Adams County	468,806	27,685	496,492
Boulder County	281,047	37,469	318,516
Broomfield County	68,297	(68,297)	-
Jefferson County	478,188	3,005	481,193
Weld County	303,523	138	303,661

[17] http://www.census.gov/geo/www/tiger/ctychng.html

1,599,862	0	1,599,862

Also in 2001, the independent city of Clifton Forge, VA was added to Alleghany County. This presents the reverse problem to the Broomfield county exercise. Here, the solution is much simpler. The combined Census 2000 population of Clifton Forge and Alleghany County was computed, with percentage shares of for each, 24.91% and 75.09%, respectively, also computed. The 2015 estimate was then simply distributed according to these shares.