Grand Vision Energy Plan

2011 Energy & Emissions Baseline

Final Report

March 6, 2013

Prepared for:
Northwest Michigan Council of Governments
PO Box 506
Traverse City, MI 49685

Prepared by:
SEEDS, Inc.
PO Box 2454
Traverse City, MI 49685

Contents

Figures

Tables

Citation

This baseline analysis was completed by SEEDS' Energy & Environmental Analysis program staff analysts, Barton Kirk and Solomon Townsend. Please cite this report as follows:

Kirk, B.E. and Townsend, S. 2013. Grand Vision Energy Plan – 2011 Energy & Emissions Baseline. SEEDS, Inc. Traverse City, MI.

Disclaimer

This product is the work of SEEDS alone and as a result any errors or omissions in the inventory and analysis methodology are the responsibility of the authors. Much of the source data for this analysis could not be independently verified; therefore SEEDS accepts no liability for errors, omissions, or misrepresentations in the data provided by others. Endorsement of this report or its contents is not implied by the acknowledgment of the organizations and individuals who contributed to its development.

Acknowledgements

This report was prepared to provide the informational foundation for the development of an Energy Action Plan for the Grand Vision to Grand Action regional planning effort. Grand Vision to Grand Action has been funded through a Housing and Urban Development "Sustainable Communities Grant" to the Northwest Michigan Council of Governments.

Other contributors to this report include the Grand Vision Energy Network especially including:

- Ed Bailey, Northwestern Michigan College
- Deb McKeon, NorthSky Nonprofit Network
- Sarna Salzman and Michael Powers, SEEDS, Inc.
- Brian Beauchamp, Michigan Land Use Institute
- Kate Madigan, Northern Michigan Environmental Action Council

Special thanks to Eric Mackres of American Council for an Energy Efficient Economy (ACEEE) for review of the analysis methodology and to the regional data contributors including the following representatives:

- Tony Anderson, General Manager, Cherryland Electric Cooperative
- Bob Gluszewski, Area Manager, Consumers Energy
- Steve Rawlings, Regional Manager, DTE Energy
- Pat Anzell, Vice President, Great Lakes Energy Cooperative
- Jim Cooper, (former) Manager of Communications & Energy Services, Traverse City Light & Power
- Don Howe, HPMS Coordinator, Asset Management Division, Bureau of Transportation Planning, Michigan Department of Transportation

Introduction

About the Grand Vision

The Grand Vision is a citizen-led community engagement process for providing input on the future of land use, transportation, economic development and environmental stewardship across six counties in northwest Lower Michigan. Since its launch in 2008, more than 15,000 citizens and collaborations between government, nonprofits and the private sector have helped shape the Grand Vision. The vision is now being implemented and six specific issue area networks have been formed.

One of the issue areas that came out of this process was the need for regional planning for energy use and development, hence the development of the Grand Vision Energy Network.

This baseline report on the energy consumption patterns of the six-county Grand Vision region is a necessary step toward creating effective strategies for implementing this regional vision.

An Energy Baseline for Strategic Energy Planning

Establishing an energy baseline is a critical step in the development and implementation of a strategic energy action plan (Step 4. of the Strategic Planning Cycle in Figure 1).

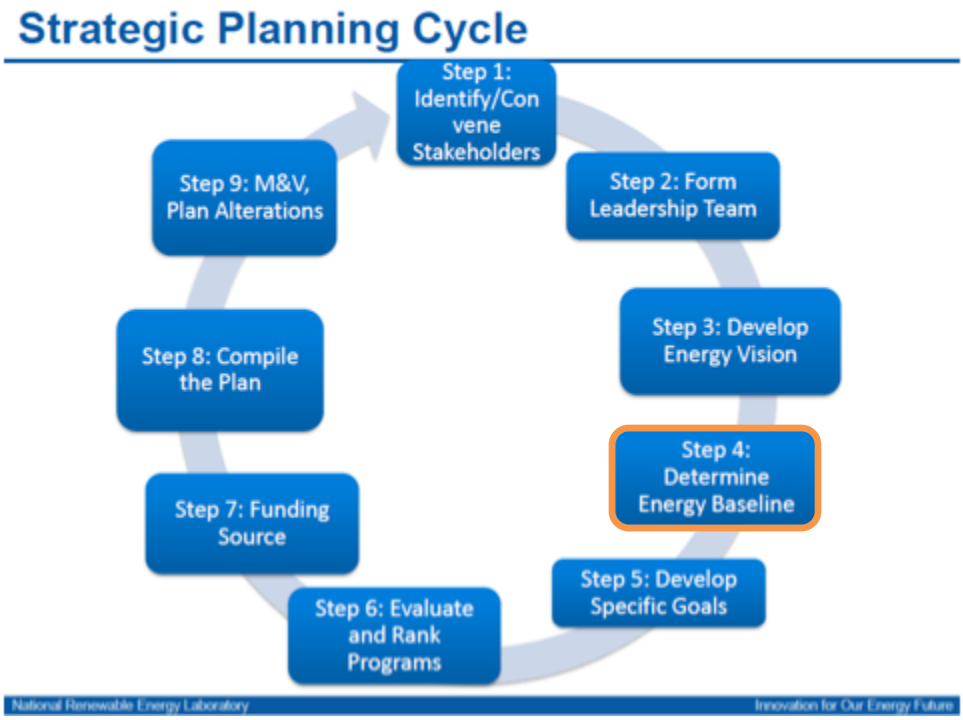


Figure 1: Strategic Energy Planning (Source: DOE EERE 2009. Community Greening: How to Develop a Strategic Energy Plan)

The baseline provides a comprehensive and quantitative assessment of the types and quantities of energy currently consumed by different sectors of the community. The baseline often also includes an analysis of the financial costs and environmental impacts associated with energy consumption. This analysis provides an objective basis for:

- Projecting future energy demand, costs, and impacts;
- Setting reasonable and actionable energy goals;
- Targeting energy liabilities and effective strategies to achieve our stated aims;
- Benchmarking our progress.

Methodology

Summary

The basic process of establishing an energy baseline is to define an area of interest, in this case a six-county region, and sum all energy use for a selected year. Multiple years may be analyzed to reveal historical trends, but typically the baseline is established for the most current year for which complete data is available.

This general process for completing an energy baseline is reflected in several nationally and internationally recognized guides for energy management and greenhouse gas emissions quantification[1,2,3]. These guides have been developed to ensure that each assessment is as complete, accurate, and detailed as practical and reported results may be used for effective decision making, be comparable, and/or added together without double-counting emissions. The most relevant guidance for counties, cities, villages, townships and multi-county regions is the U.S. Community Protocol for Account and Reporting Greenhouse Gas Emissions (Community Protocol)[4].

The Community Protocol has been utilized for this analysis in so far as it relates to energy consumption and generation[5] to ensure consistency and accuracy. As such, whenever possible, records of actual consumption of energy are compiled from energy suppliers. These energy consumption records are broken down into sectors or categories of use so that strategies for energy action can be as targeted as possible. For energy types where consumption records are not available, energy use is modeled or projected from other community census or activity statistics as well as state or national energy use data.

[1] The World Resources Institute - GHG Protocol publishes standards for corporate and community greenhouse gas emissions quantifications. http://www.ghgprotocol.org/standards

[2] The International Organization for Standardization (ISO) publishes standards on a wide variety of topics including ISO 50001 on Energy Management which discusses energy baseline establishment. http://www.iso.org/iso/home/standards/management-standards/iso50001.htm

[3] US EPA – Corporate Climate Leadership program publishes a standard for organizations to voluntarily inventory and report their GHG emissions. http://www.epa.gov/climateleadership/guidance/index.html

[4] Local Governments for Sustainability (ICLEI) publishes standards for local government and community GHG emission inventories. http://www.icleiusa.org/tools/ghg-protocol

[5] Greenhouse gas emission sources or sinks not associated with energy generation or energy consumption (e.g. landfill or agricultural methane emissions, carbon dioxide emissions or sequestration due to land management practices, etc.) have not been assessed for this baseline

Collecting and compiling this data from multiple energy suppliers across six-counties can be a challenging task. Energy suppliers in the State of Michigan are not required to report energy sales by county and so do not have a standard protocol for doing so. And not all energy suppliers use the same means of managing and reporting their sales data. Thus, not all suppliers are always able to provide the same level of detail. For a comprehensive summation of energy consumption, the detail of the analysis is then limited to the level of the least detailed data provider.

Scope

This assessment aims to establish an energy baseline both individually and collectively for the six counties of the Grand Vision: Antrim, Benzie, Grand Traverse, Kalkaska, Leelanau, and Wexford. The year 2011 represents the most current year for which the most complete energy use records are available. The energy types, energy use-related air emissions, and community sectors included and detailed in the study are described below.

Energy Pricing

The costs of commodities such as energy are often presented as either *nominal* cost or *real* cost. Nominal cost reflects the actual price paid in given year or stated period of years, where as real costs are adjusted to remove the effects of inflation to allow for equivalent comparisons to be made between values from different years. All costs reported in this baseline are reported in 2011 nominal US dollars.

Energy Consumption

Energy Types – Electricity, Heating, & Transportation

The forms of energy consumption included in this baseline are grid-supplied electricity; common heating fuels, including natural gas, propane, fuel oil, kerosene, coal, and wood; and common transportation fuels, including motor gasoline and diesel.

Site vs. Source Energy – An Important Distinction

It is important to distinguish that energy consumption can be measured and reported as both *site* energy and as *source* energy. Most often energy consumption is measured as *site* or *end use* energy, i.e. that which is recorded at your electricity or gas meter or at the gas station pump. S*ource* or *primary* energy is a measure of energy that, in addition to site energy, also includes the energy lost or used in extraction, conversion, transmission, and distribution of the energy supply to the end user. Source energy is particularly relevant when measuring electricity energy supplied from a regional grid. Electricity generated from combustion (i.e. coal, natural gas, oil, and biomass) typically loses more than half of its energy as heat at the power plant that is not recovered (See Figure 2).

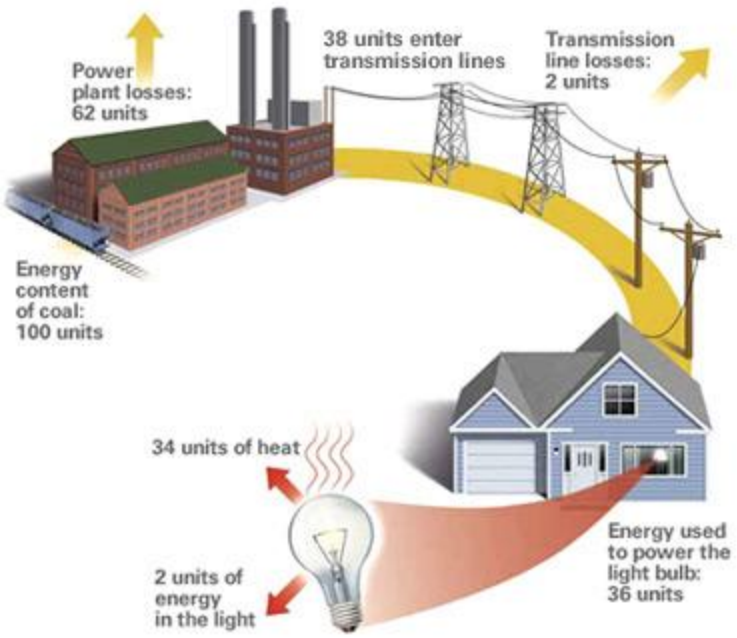


Figure 2: *Source* energy includes *site* energy plus energy lost in conversion, transmission, and distribution to the end user (Source: National Academies Press 2008 What You Need To Know about Energy)

Considering source energy becomes especially important when making comparisons of environmental impact and when comparing the demands of on-site electrical generation versus regional grids.

Energy Emissions

The emissions associated with energy use that are most commonly included in an energy baseline include greenhouse gas emissions[6] and criteria air pollutants[7]. Emissions associated with energy use are typically estimated (as opposed to using direct measurement) by multiplying energy use by a relevant, published emission factor. Emission factors are published and updated by a variety of state and national agencies to reflect current, national, regional, or local conditions where data is available. Reasonably current and complete emission factors were available for greenhouse gas emissions for all energy types; however, due to gaps in criteria air pollutant emission factors for heating fuels, criteria air pollutants were not included in this analysis. See Data Sources below for details on the emission factors selected for each energy type.

Direct (Scope 1) & Indirect (Scope 2 & 3) Emissions

Emissions from energy consumption are often distinguished as direct or indirect. Direct emissions represent emissions directly released by the energy consumer, such as from fuel combustion in a

[6] Greenhouse gases (GHGs) are gasses that trap heat in the earth's atmosphere creating the "greenhouse" effect. Carbon dioxide, methane, and nitrous oxide are GHGs that can be emitted from a variety of natural and human-influenced processes including the production and combustion of fuels to generate heat and power. For more information see http://www.epa.gov/climatechange/ghgemissions/gases.html

[7] Criteria air pollutants (CAPs) include six air pollutants (ozone, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxide, and lead) that are of priority concern because they can result in harm to human and environmental health and property. These CAPs can be emitted from a variety of sources including the production and combustion of fuels to generate heat and power. For more information see http://www.epa.gov/air/urbanair/

furnace or car owned or operated by the consumer. These direct emissions are referred to as Scope 1 emissions. Indirect emissions are those that are emitted as a consequence of energy use, but not under the immediate control of the end user of the energy. Indirect emissions include those associated with purchased steam or grid electricity. These indirect emissions are referred to as Scope 2. Other indirect emissions are associated with the extraction, refinement, and transportation of fuels and the transmission and distribution of electricity; these are classified as Scope 3 emissions. This analysis considers only Scope 1 direct and Scope 2 indirect emissions.

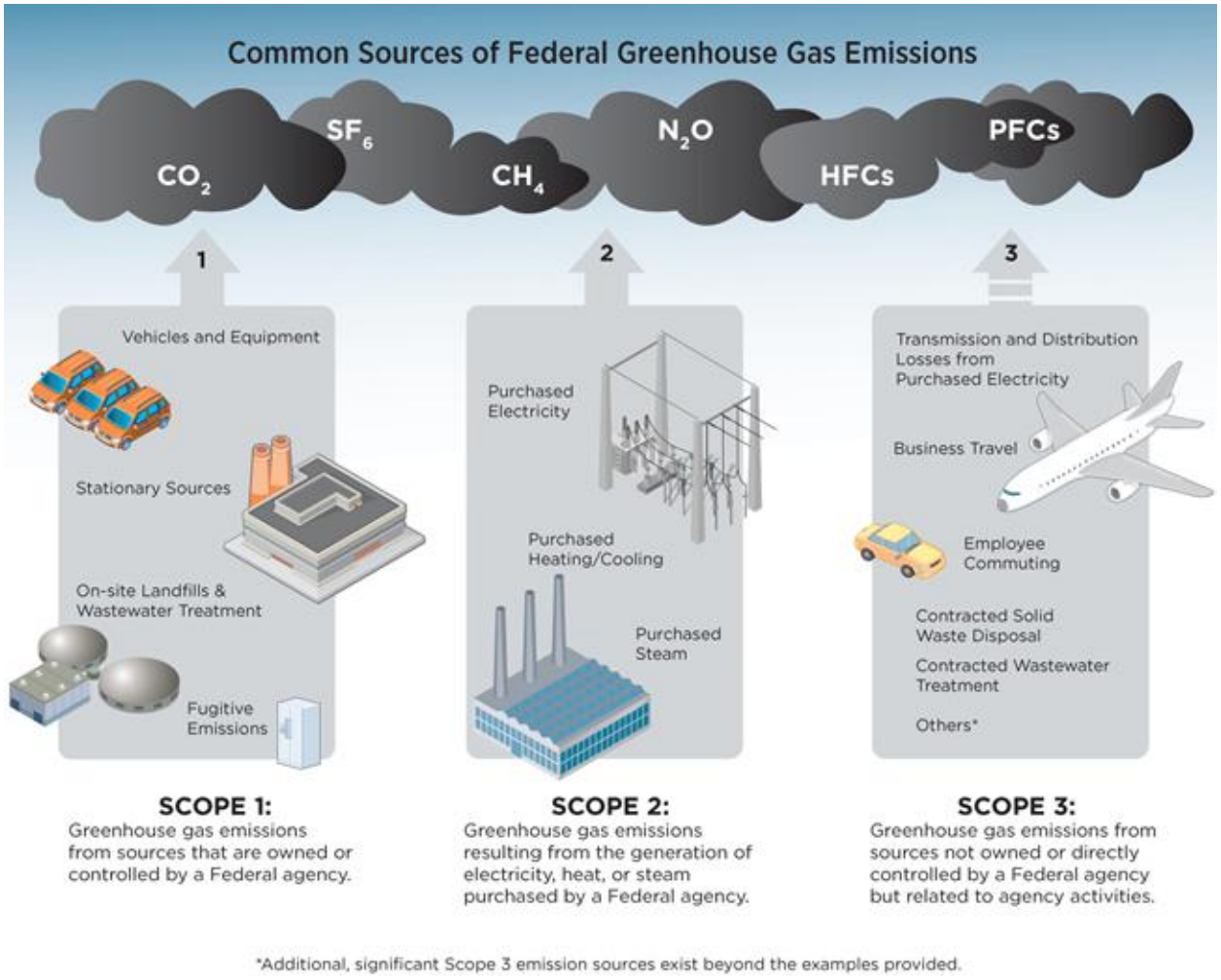


Figure 3: Sources of Scope 1, 2, & 3 Greenhouse Gas Emissions (Source: US DOE EERE Sustainability Performance Office)

Community Sectors

Typical sectors evaluated in a community energy baseline include residential, commercial, industrial, and transportation.

Residential

Includes all owner-occupied and rental housing energy consumption within each county, except for some multi-unit housing classified by utilities as commercial[8].

Commercial & Industrial

Includes all public and private commercial, government, institutional and industrial facility energy consumption within each county. Most utilities provide commercial and industrial data separately, however because not all data was disaggregated, commercial and industrial sectors have been combined for this report.

Transportation

Includes energy associated with vehicular travel within the political boundaries of each county. The travel data provided for this sector was divided into *commercial* and *non-commercial*, where *non-commercial* includes local, through, and visitor travel. No distinction of solely local resident travel was possible with the available data.

Metrics

Several metrics are used throughout this report which are accepted industry standards, but which may deserve some explanation.

Btu (British thermal unit)

The British thermal unit is a standard unit measure of energy or the heat content of a fuel or energy source. All forms of energy and fuels can be expressed in terms of Btus and it is commonly used to compare the energy content of different energy sources. In this context, it is typically reported as mmBtu or million British thermal units.

	Equivalents
1 mmBtu	1 million Btus
	10 therms of natural gas
	1 million cubic feet of natural gas
	11 gallons of propane
	7.2 gallons of gasoline
	80 lbs of coal
	293 kWh of electricity

Table 1: mmBtu Equivalents (Source: EIA Energy Conversion Factors[9])

[8] Households in apartment buildings with individual meters that receive energy utility bills directly from the utility are typically categorized as Residential, while households in apartment buildings with master energy meters for the entire building are categorized as Commercial based on how the data is reported by the utility companies.
[9] http://www.eia.gov/forecasts/aeo/pdf/appg.pdf

CO_2-e (Carbon Dioxide Equivalents)

Carbon dioxide is the most prevalent gas that contributes to the greenhouse effect[10] and is emitted in greatest quantity from fossil fuel combustion. However two other products of fossil fuel combustion, methane and nitrous oxide, are also emitted to the air and are more potent contributors to the greenhouse effect per unit of mass. The greenhouse effect potency of these gases is typically expressed through their potential to cause global warming[11] relative to carbon dioxide. Thus the combined contribution of the combustion gases can be expressed as total carbon dioxide equivalents. In this context, this is typically reported as MT CO_2-e or metric tons of carbon dioxide equivalents.

Greenhouse Gas	Global Warming Potential as CO2-e (100 yr horizon)
Carbon Dioxide (CO_2)	1
Methane (CH_4)	24
Nitrous Oxide (N_2O)	310

Table 2: Global Warming Potentials (Source: US EPA Climate Leaders Emission Factors[12])

Data Sources, Estimates, & Assumptions

A combination of collected data, calculations, conversions, and assumptions are necessary to complete an inventory of energy use. Each is described below.

Energy Sources

Electricity

Annual electricity consumption by sector and by county was provided by the four electricity suppliers serving the six-county region: Cherryland Electric Cooperative, Consumers Energy, Great Lakes Energy Cooperative, and Traverse City Light & Power.

Electricity Generation

Each utility also provided the current profile of electricity generation sources (i.e. percent coal, nuclear, natural gas, renewable etc.) for the energy they supply. Aggregated county and region-wide energy generation profiles were generated by weighting each utility's generation mix based on its portion of electricity distribution to the region.

Natural Gas

Annual natural gas consumption by county was provided by the sole natural gas supplier for the region, DTE. Unfortunately, consumption by both sector and county was not available. In lieu of a break-down by sector, DTE was able to provide data on regional average annual natural gas consumption per

[10] See the US EPA's Causes of Climate Change website for more information http://www.epa.gov/climatechange/science/causes.html#greenhouseeffect

[11] Even though the global effects of greenhouse gas emissions are now commonly referred to as "climate change" it is the warming effect of these gases that serves as the common metric for comparison.

[12] US EPA Climate Leaders Emission Factors for Greenhouse Gas Inventories. http://www.epa.gov/climateleadership/documents/emission-factors.pdf

household relative to annual heating degree days (HDD)[13] and home square footage. Upon assuming an average home floor area of 1800 square feet [14] a linear regression was applied to the DTE data to establish the numerical relationship between heating fuel consumption and heating degree days. With this regression, the residential fraction of each county's known natural gas consumption could be estimated using the known number of households, known percentage of households using natural gas as their primary heating fuel, and the annual number of heating degree days for each county in 2011 This calculation is expressed by Equation 1.

Equation 1

$$NG_{RES} = HH * \%\, NG_{RES} * \ (m * HDD + b)$$

Where:

NG_{RES} = County residential natural gas consumption

HH = Number of occupied households in the county (Table 9)

$\%\, NG_{RES}$ = Percentage of households using natural gas as their primary heating fuel (Table 3)

HDD = County annual heating degree days in 2011 (Table 9)

m = slope of the linear regression of average natural gas consumption for an 1800 ft^2 household relative to HDD

b = y-intercept of the linear regression of average natural gas consumption for an 1800 ft^2 household relative to HDD

This equation was tested against known 2006 residential natural gas consumption data for Grand Traverse County SEEDS had acquired for a separate study in 2008[15]. Equation 1 was able to estimate the residential natural gas consumption to within 2.7% of the actual value.

Once the residential natural gas consumption had been estimated the commercial & industrial sector natural gas consumption was estimated as simply the difference between the known total natural gas consumption and the estimated residential usage.

[13] Heating Degree Day (HDD) is a measure of how cold a location is over a period of time relative to a base temperature, typically 65 degrees Fahrenheit. Heating degree days are summed over a specified period (e.g. a year) to create a heating degree day measure. Annual heating degree days are commonly used in energy analysis as an indicator of space heating requirements. http://www.eia.gov/tools/glossary/index.cfm?id=h

[14] The Midwest east north regional median detached single family or mobile home size is 1800 ft^2 according to the U.S. Census Bureau,2011 American Housing Survey, Table C-11-AO

[15] Residential and commercial & industrial natural gas usage reported in the 2005 GHG emissions inventory was provided by DTE but represents 2006 sales that have been weather normalized. Kirk, B.E., S. Salzman, P. Muñoz, M. Powers. 2008. Grand Traverse County Greenhouse Gas Emissions Analysis Phase I – Final Report pt. III – Grand Traverse County Community Analysis. SEEDS, Inc. November 2008.

Other Heating Fuels

Consumption or sales records of residential, commercial, and industrial heat energy sources other than electricity and natural gas are not comprehensively available at the county level in Northern Michigan. Propane, fuel oil, kerosene, coal, and wood consumption have been estimated based on either surveys of their prevalence locally or state-level inventories of their consumption proportional to natural gas. Natural gas represents the most common source of energy used for heating residential and commercial buildings according to U.S. Census data for the six counties of the Grand Vision and the EIA 2010 Commercial Sector Energy Consumption Estimate (see Table 3 and Table 4).

County residential consumption of each *other heating fuel* is assumed to be proportional to the consumption of natural gas relative to county-level census data on the prevalence[16] of each fuel for residential household heating. County commercial consumption of each *other heating fuel* is assumed to be proportional to the county-level consumption of natural gas relative to ratio of state-level consumption of the *other heating fuel* to natural gas. These estimates are expressed by Equation 2 for residential and Equation 3 for commercial. Each equation also includes an adjustment for the difference in average combustion efficiencies for heating elements using each fuel.

Equation 2

$$OF_{RES} = \frac{\%\ OF_{RES}}{\%\ NG_{RES}} * NG_{RES} * \frac{eff_{OF}}{eff_{NG}}$$

Where:

OF_{RES} = County residential "other fuel" consumption (propane, fuel oil, kerosene, coal, or wood)

NG_{RES} = County residential natural gas consumption (estimated using Equation 1)

$\%\ OF_{RES}$ = % of county households using the "other fuel" as their primary heating fuel (Table 3)

$\%\ NG_{RES}$ = % of households using natural gas as their primary heating fuel (Table 3)

eff_{OF} = Average combustion efficiency of heating device using "other fuel" (Table 5)

eff_{NG} = Average combustion efficiency of heating device using natural gas (Table 5)

[16] The ratio of the prevalence of an *other heating fuel* to natural gas is not necessarily indicative of consumption of that fuel to natural gas. Equation 2 was evaluated based on the state-level census data and compared to known state-level consumption data. The equation estimated the total residential heating fuels to within 0.3% of a percent and the non-natural gas heating fuels to within 6.3%. It was henceforth determined that Equation 2, using heating fuel prevalence from county-level census data as a proxy of consumption, would preferable to the approach used in Equation 3 to estimate commercial *other heating fuels*.

Equation 3

$$OF_{COM,C} = \frac{OF_{COM,S}}{NG_{COM,S}} * NG_{COM,C} * \frac{eff_{OF}}{eff_{NG}}$$

Where:

$OF_{COM,C}$ = County commercial "other fuel" consumption (propane, fuel oil, kerosene, coal, or wood)

$NG_{COM,C}$ = County commercial natural gas consumption (estimated using Equation 1)

$OF_{COM,S}$ = State-wide commercial consumption of "other" non-electric heating fuel (Table 3)

$NG_{COM,S}$ = State-wide commercial consumption of natural gas (Table 3)

eff_{OF} = Average combustion efficiency of heating device using "other fuel" (Table 5)

eff_{OF} = Average combustion efficiency of heating device using natural gas (Table 5)

Home Heating Source	Antrim	Benzie	Grand Traverse	Kalkaska	Leelanau	Wexford
Utility Gas	34.2%	35.6%	71.9%	29.6%	49.0%	51.8%
Bottled, tank, or LP gas	41.4%	39.1%	14.5%	46.0%	25.0%	28.5%
Electricity	7.6%	6.9%	6.8%	6.9%	8.0%	6.0%
Fuel Oil, Kerosene, Etc.	2.7%	5.6%	2.3%	3.5%	8.0%	2.0%
Coal or Coke	0.0%	0.0%	0.0%	0.05	0.0%	0.1%
All Other Fuels[17]	13.9%	12.7%	4.4%	13.8%	10.0%	10.9%
No Fuel Used	0.3%	0.2%	0.1%	0.2%	0.0%	0.7%

Table 3: Distribution of the Primary Home Heating Energy-Type by County (Source: US Census 2010 American Community Survey[18])

Commercial Non-Electric Energy Use	Michigan
Natural Gas	86.3%
LPG	1.5%
Distillate Fuel Oil	3.8%
Coal	2.5%
Wood	5.0%
Other[19]	1.0%

Table 4: Distribution of Non-Electric Commercial Energy Use in Michigan (Source: EIA 2010 Commercial Sector Energy Consumption[20])

[17] All other fuels were assumed to be primarily wood.
[18] Physical Housing Characteristics for Occupied Housing, 2010 ACS 5-Year Estimate. http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml
[19] Includes kerosene, residual fuel oil, motor gasoline and geothermal.

Fuel Type	Average Combustion Efficiency
Natural Gas	82%
LPG / Propane	78%
Fuel Oil	78%
Kerosene	80%
Coal	75%
Wood	72%

Table 5: Heating Fuel Average Combustion Efficiencies (Source: US EIA "Heat Calc" Tool[21])

Transportation

Like *other heating fuels, c*onsumption or sales records of transportation fuels are not comprehensively available at the county level in Northern Michigan. However, the Michigan Department of Transportation (MDOT) models vehicle miles traveled (VMT) annually on state, county, and local roads throughout each county[22]. MDOT provides estimates of both commercial VMT and non-commercial VMT where non-commercial includes local, through, and tourist vehicular travel within each county.

Transportation-related fuel consumption and subsequently fuel costs and emissions may be estimated by making assumptions about the local distribution of vehicle types and vehicle fuel efficiencies in the year of analysis. ICLEI – Local Governments for Sustainability provides its members with a software tool, CACP 2009[23], for inventorying energy and greenhouse gas emissions within communities and local government operations. Transportation-related fuel consumption has been estimated based upon the "Transportation Assistant" tool of CACP 2009 and its default assumptions about vehicle type distribution and vehicle fuel efficiencies for the year 2011.

Source Energy

The electricity and natural gas consumption data provided by the utilities and estimated other heating fuels and transportation fuels represents end-user or *site* energy. As mentioned previously, *source* energy is equal to the *site* energy plus energy lost during extraction, conversion, transmission, and/or distribution. Conversion energy and source energy have been estimated based on the ratios of source energy to site energy published by the National Renewable Energy Laboratory (NREL)[24].

[20] Non-Electric energy use selected from Table C6. Commercial Sector Energy Consumption Estimates, 2010 http://www.eia.gov/beta/state/seds/data.cfm?incfile=/state/seds/sep_sum/html/sum_btu_com.html&sid=MI
[21] Heating Fuel Comparison Tool. US EIA http://www.eia.gov/neic/experts/heatcalc.xls
[22] VMT data provided by the HPMS Coordinator, Asset Management Division, Bureau of Transportation Planning, Michigan Department of Transportation.
[23] ICLEI Clean Air Climate Protection 2009 software. http://www.icleiusa.org/tools/cacp-2009
[24] Source to Site Energy Ratios, See Tables 3 and 5. Deru and Torcelli. 2007. Source Energy and Emission Factors for Energy Use in Buildings. NREL. http://www.nrel.gov/docs/fy07osti/38617.pdf

Energy Source	Source Energy Factor
Electricity (2004 Eastern US Grid)	3.443
Natural Gas	1.092
LPG	1.151
Coal (bituminous)	1.048
Fuel Oil (Distillate)	1.158
Gasoline	1.187

Table 6: Source Energy Factors per Unit of Delivered Energy (Source: NREL 2007. Source Energy and Emission Factors)

Energy Cost

Local, state, or regional fuel prices were available for end user electricity, natural gas, and transportation fuels respectively from the Energy Information Administration (EIA). 2011 prices for *other heating fuel* costs had not yet been published at the time of this report. Other heating fuel prices were instead estimated using the EIA's annual average prices per unit energy for residential and commercial customers as published in the Michigan State Energy Profile for 2010[25] and adjusted by the regional Consumer Price Index[26] for energy to better represent 2011 prices.

Energy Source	Residential	Commercial	Industrial	Transportation
Electricity (regional avg.)[27]	$38.02	$32.47	$24.51	
Natural Gas[28]	$10.21	$8.92		
Propane / LPG	$26.87	$22.96		
Fuel Oil (Distillate)	$27.10	$24.42		
Coal	$5.04	$4.59		
Wood	$11.21	$4.14		
Gasoline[29]				$29.09
Diesel				$27.71

Table 7: 2011 Nominal Price ($ US) per mmBtu (Source: EIA 2011 & 2010)

Energy Related Emissions

Greenhouse gas (GHG) emissions have been estimated by multiplying consumption by an emissions factor representing the average quantity of GHG emissions emitted per unit of energy consumed as described below.

Electricity Emissions

The US Environmental Protection Agency (EPA) develops emission factors per kWh consumed for each power plant, state, regional grid, and the nation based on power and emissions outputs reported by

[25] 2011 Michigan State Energy Profile. http://www.eia.gov/state/state-energy-profiles-data.cfm?sid=MI

[26] The Energy CPI for Midwest Size D communities was 184.9 in 2010 and 215.6 in 2011. Bureau of Labor Statistics http://www.bls.gov/cpi/data.htm

[27] 2011 6-county regional average price / mmBtu based on data reported on US EIA Form 861 utility price data http://www.eia.gov/electricity/sales_revenue_price/

[28] 2011 State average price / mmBtu based on data reported on US EIA Form 176 http://www.eia.gov/dnav/ng/ng_pri_rescom_dcu_smi_a.htm

[29] 2011 Mid-west PA DD2 region average price / mmBtu, Gasoline - All Grades, Diesel – Ultra Low Sulphur. US EIA http://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_r20_a.htm

electricity generators nationally. These emission factors are published via the EPA's eGRID database and the emission factors generally lag behind current conditions by two to three years. The most current data set (eGRID 2012) is based on the emissions and consumption reported for the calendar year 2009[30]. The eGRID greenhouse gas emission factor used in this analysis was the RFC Michigan (RFCM) "Subregion annual CO2 equivalent total output emission rate" which includes three greenhouse gases: carbon dioxide, methane, and nitrous oxide.

It is important to note that the "total output" emission rate is inclusive of both baseload and non-baseload electricity generation sources and is the appropriate emissions factor for reporting *baseline* emissions. When evaluating the impact on emissions of future energy policies it is generally recommended to use the non-baseload emission rate as it represents the sources of electricity generation most likely affected by local reductions in energy demand.

Heating & Transportation Fuels Emissions

The US EPA publishes greenhouse gas emission factors for the combustion of common heating and transportation fuels for GHG emissions quantification and reporting through its Climate Leaders program. These emissions factors include three greenhouse gases: carbon dioxide, methane, and nitrous oxide[31].

Energy Source	kg CO_2-e / mmBtu
Electricity	22.2
Natural Gas	5.31
Propane / LPG	6.32
Fuel Oil (Distillate)	7.42
Coal	9.60
Wood	0.20
Gasoline	7.05
Diesel	7.42

Table 8: GHG Emission Factors per mmBtu (Sources: eGRID 2012 and US EPA Climate Leaders)

[30] eGRID 2012 GHG Emission Factors, RFCM subregion. http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html

[31] Climate Leaders Emission Factors, November 7, 2011 release. http://www.epa.gov/climateleadership/documents/emission-factors.pdf

Weather Normalization

Annual energy use at a community or regional scale can change from year to year due to many factors including changes in population, weather, economic growth or recession, fuel prices, etc. Depending upon the goals of a community strategic energy plan it may be helpful to adjust or normalize annual energy usage relative to changes in weather. There are a variety of methods for weather normalizing energy use most of which involve regression analysis of the relationship between local energy use and local weather variables. To complete an accurate regression, at least 12 months of energy use and weather data are typically required. Unfortunately not all of the electricity and natural gas utilities were able to provide monthly data; therefore weather normalization of the baseline data was not possible for this analysis.

Community Statistics

Evaluating energy use relative to community statistics such as population, number of households, energy customers, heating and cooling degree days, gross domestic product, etc. can be useful for benchmarking against other communities and past or future years. These statistics may also be useful in estimating energy consumption when actual use data is not available (e.g. other heating fuels).

County population and occupied housing statistics were obtained from the U.S. 2010 American Community Survey[32]. Heating degree days were provided through BizEE degree day software[33]. Gross domestic product is not available at the county level so county personal income from the US Bureau of Economic Analysis[34] was used as a measure of economic productivity. Energy customer data by sector and county was not provided by all electricity and natural gas utilities; therefore comprehensive analysis of energy use per customer for each county, sector, and energy type was not possible for this analysis.

County	Population[32]	Occupied Households[32]	Heating Degree Days[33]	Total Personal Income[34]
Antrim	23,316	9,953	7,766	$759,810
Benzie	17,443	7,332	7,314	$542,114
Grand Traverse	88,349	35,101	7,175	$3,259,588
Kalkaska	17,160	7,253	7,873	$465,678
Leelanau	21,703	9,455	7,362	$943,714
Wexford	32,718	12,703	7,874	$905,000

Table 9: 2011 County Population, Households, Heating Degree Days and Personal Income

[32] Physical Housing Characteristics for Occupied Housing, 2010 ACS 5-Year Estimate. http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml

[33] Heating degree days were downloaded from BizEE for each county using the most centrally located regional airport weather station and a base temperature of 65°F http://www.degreedays.net/

[34] US BEA Regional GDP & Personal Income Data. http://www.bea.gov/iTable/iTable.cfm?ReqID=70&step=1

Inventory Results

The results or this analysis are reported as both a six-county regional inventory and comparison of the six counties individually.

Regional Results

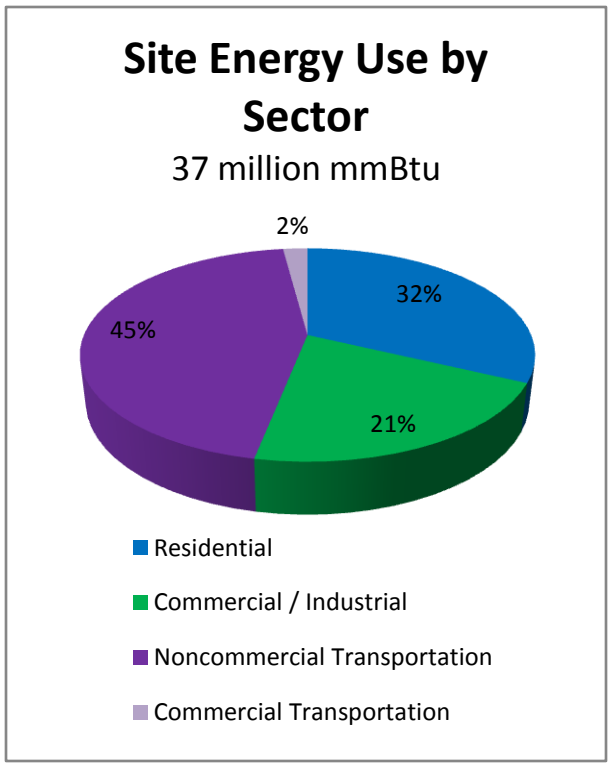
Total site energy consumption in the baseline year of 2011 was 37 million mmBtu, resulting in a total source energy consumption of 58 million mmBtu, the emission of 3.4 million MT CO_2-e of greenhouse gases, and costing regional businesses, governments, households, and travelers $904 million in retail energy expenditures. This cost is equal to 13% of the total personal income of the six-county region in 2011.

Sector	Site Energy (mmBtu)	Source Energy (mmBtu)	GHGs (MT CO_2-e)	Energy Cost ($ 2011 nominal)
Residential	11,946,533	20,049,858	1,114,850	$251,805,984
Commercial / Industrial	7,838,683	17,227,779	1,037,078	$148,278,447
Transportation – Non-Commercial	16,689,113	19,731,154	1,186,231	$481,698,728
Transportation – Commercial	774,592	915,782	55,057	$22,357,089
Total	37,248,921	57,924,573	3,393,215	$904,140,248
Per Capita	186	289	17	$4,505
Per $1000 of Personal Income	5.4	8.4	0.5	$131.50

Table 10: 2011 Regional Energy, Emissions, & Cost by Sector

Energy Type	Site Energy (mmBtu)	Source Energy (mmBtu)	GHGs (MT CO_2-e)	Energy Cost ($ 2011 nominal)
Electricity	6,635,364	22,845,560	1,471,963	$220,964,187
Gasoline	14,619,500	17,353,347	1,030,222	$425,233,254
Diesel	2,844,205	3,293,589	211,066	$78,822,563
Natural Gas	8,804,098	9,614,075	467,251	$85,268,571
Propane / LPG	2,562,597	2,949,549	162,030	$68,289,722
Fuel Oil	1,160,929	1,160,929	2,292	$11,484,809
Wood	506,849	586,931	37,613	$13,275,307
Coal	103,772	106,782	9,961	$475,111
All Other Fuels	11,605	13,810	818	$326,724
Total	37,248,921	57,924,573	3,393,215	$904,140,248

Table 11: 2011 Regional Energy, Emissions, & Cost by Energy Type



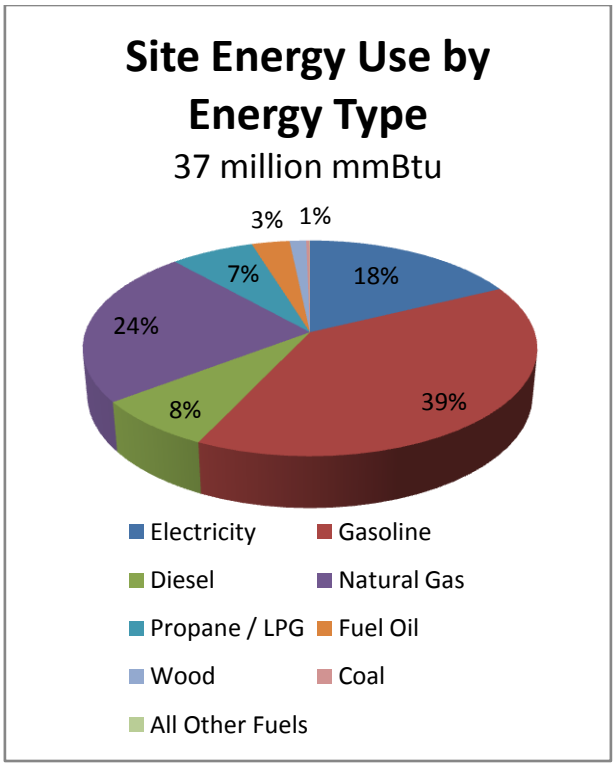
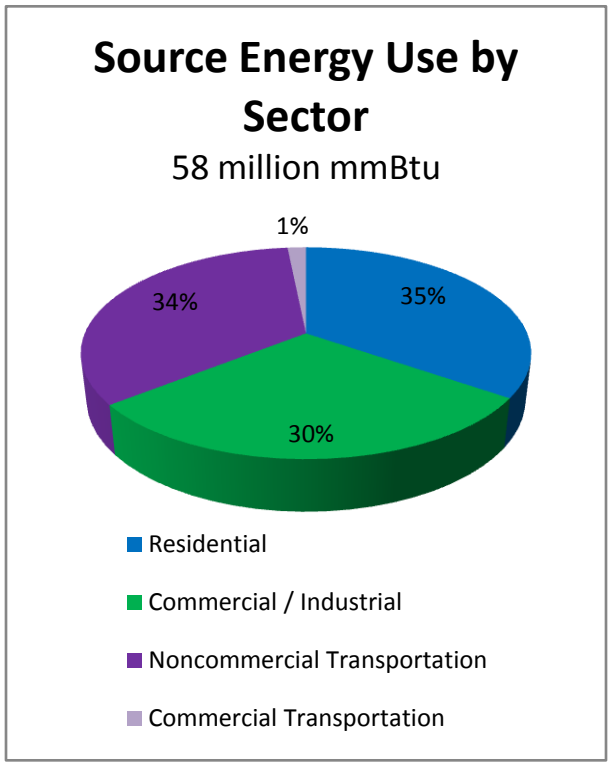


Figure 4: Distributions of Regional Site Energy Use by Sector & Energy Type



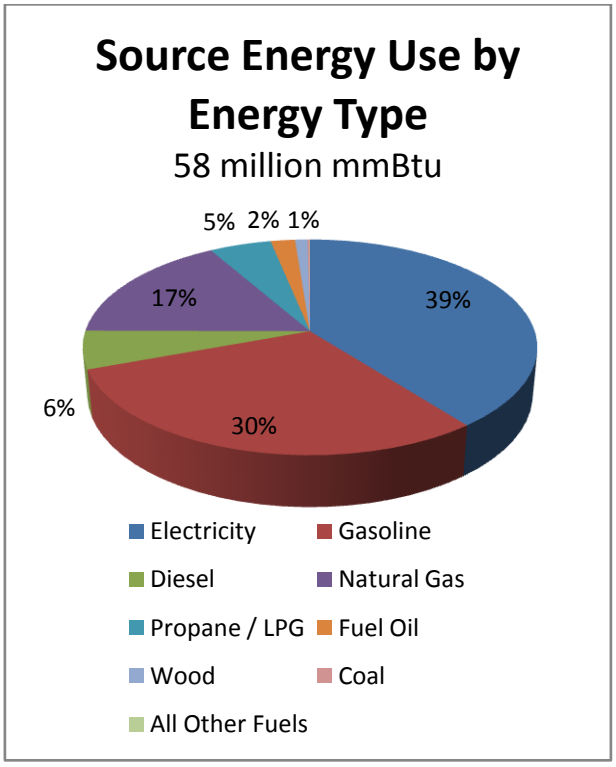
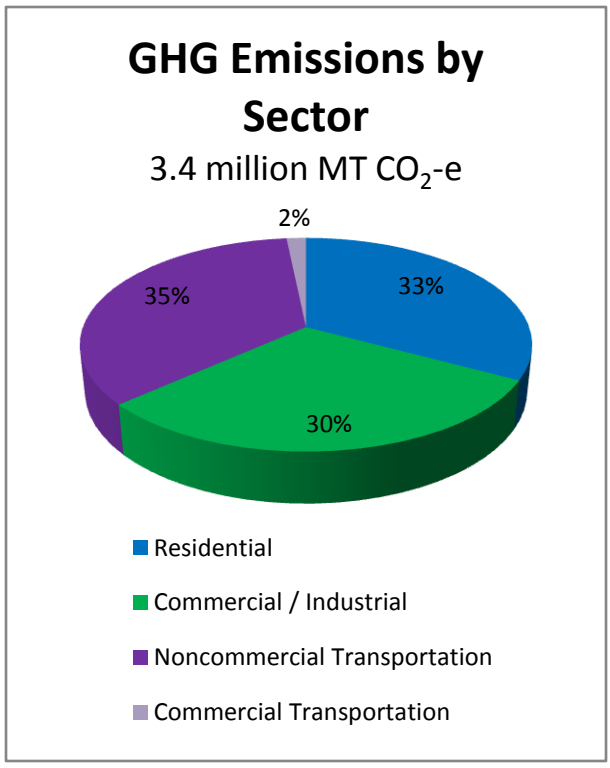


Figure 5: Distributions of Regional Source Energy Use by Sector & Energy Type



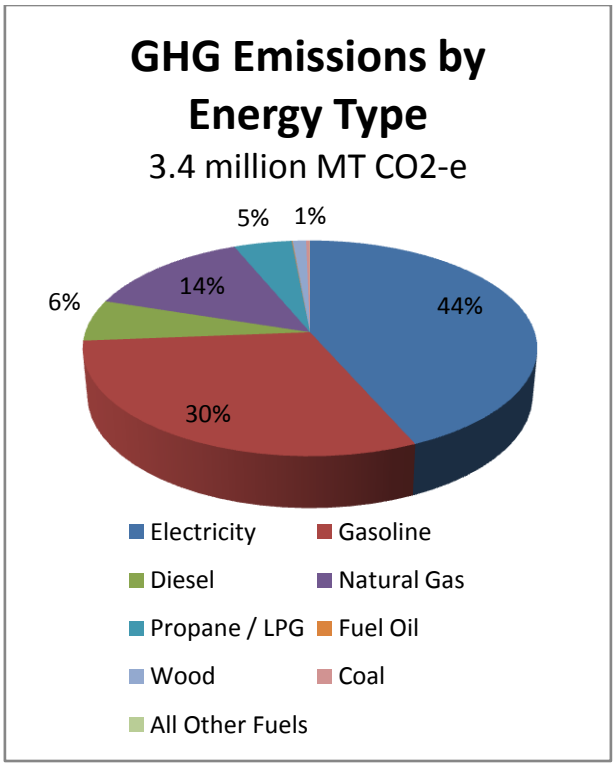
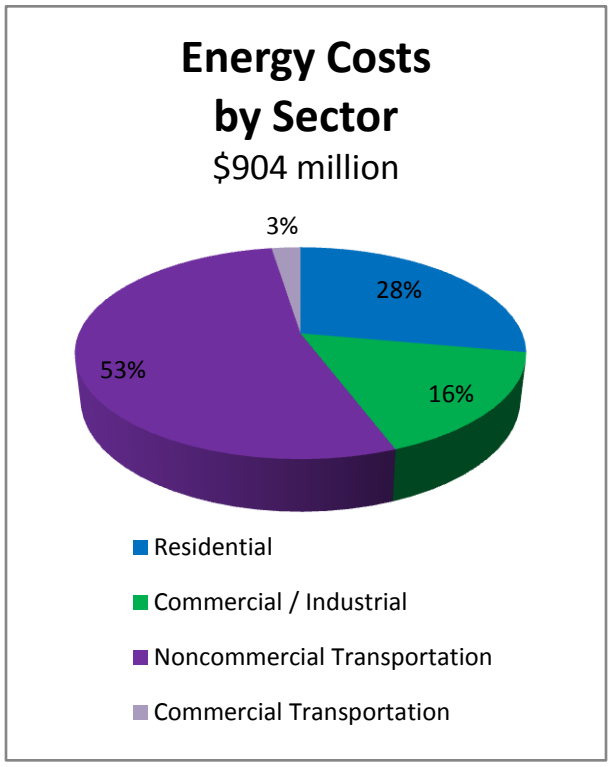


Figure 6: Distributions of Regional GHG Emissions by Sector & Energy Type



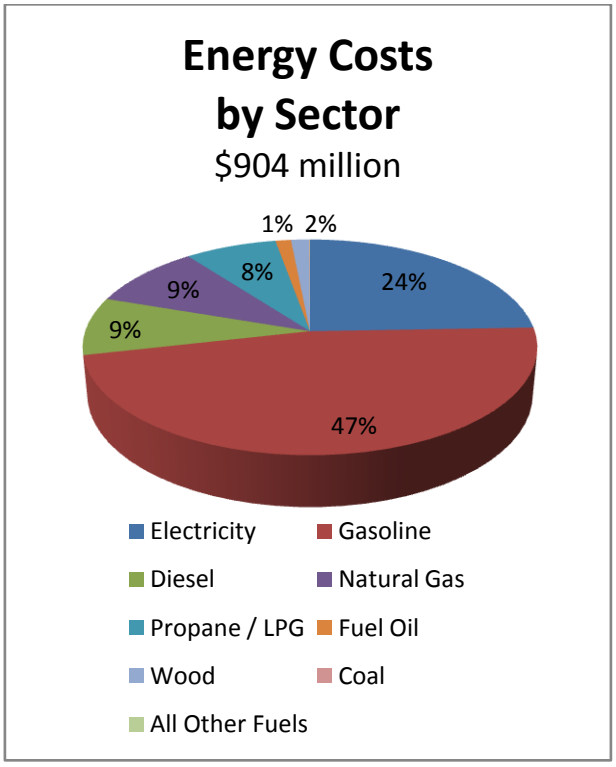


Figure 7: Distributions of Regional Energy Costs by Sector & Energy Type

In total, the Residential, Commercial / Industrial, and Transportation sectors each represent approximately one-third of the region's *source* energy consumption and greenhouse gas emissions, where electricity use is the greatest contributor. However, energy costs and *site* energy consumption are clearly led by gasoline and the non-commercial transportation sector.

The difference between sector distributions of site versus source energy is largely due to the source energy intensity of delivered electricity. This difference is perhaps most apparent in Figure 8, which splits source energy into the site energy and conversion energy (losses due to extraction, generation, transmission, and distribution), illustrating that electricity conversion energy represents 39% of all source energy consumed by the region.

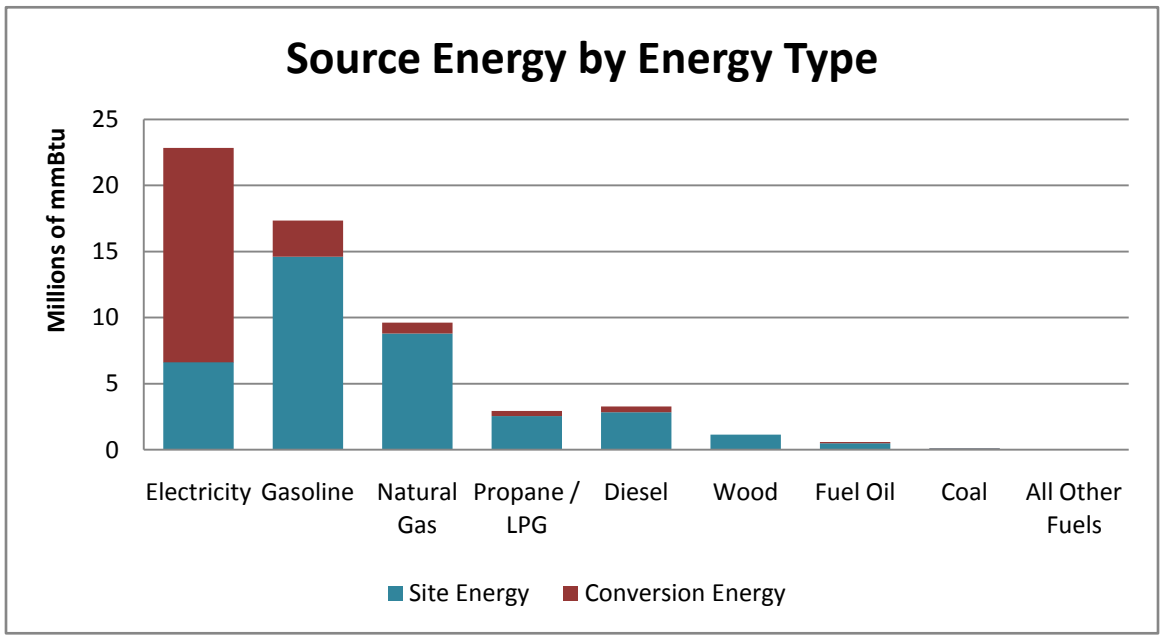


Figure 8: Ratios of Conversion and Site Energy Contributing to Total Regional Source Energy Consumption

Figure 9 compares the 6 county regional average[38] electricity generation mix reported by each electricity utility for 2011 to the 2009 generation mix reported by eGRID 2012 for the RFC-Michigan subregion. The difference in profiles results from both the two year lag in the eGRID data and that the RFCM subregion may represent a somewhat different subset of electricity generators. It is important to note that the GHG emission factors used in this report are taken from eGRID 2012 which is based on emissions and electricity generated the 2009 calendar year[39].

[38] The regional average is weighted by total electricity sold by each utility in the 6-county region
[39] Using the most recent eGRID emission factors is the national standard of practice http://www.icleiusa.org/tools/ghg-protocol. See the methodology section for more details.

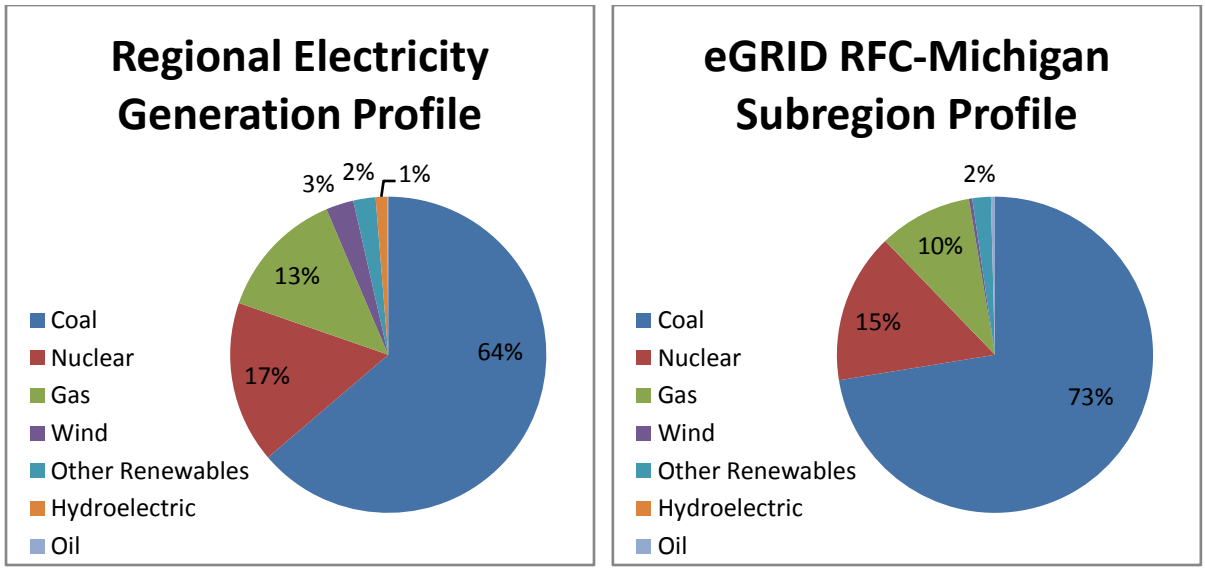


Figure 9: 2011 6 County Regional Generation Profile vs. 2009 eGRID RFC-Michigan Subregion Grid Generation Profile

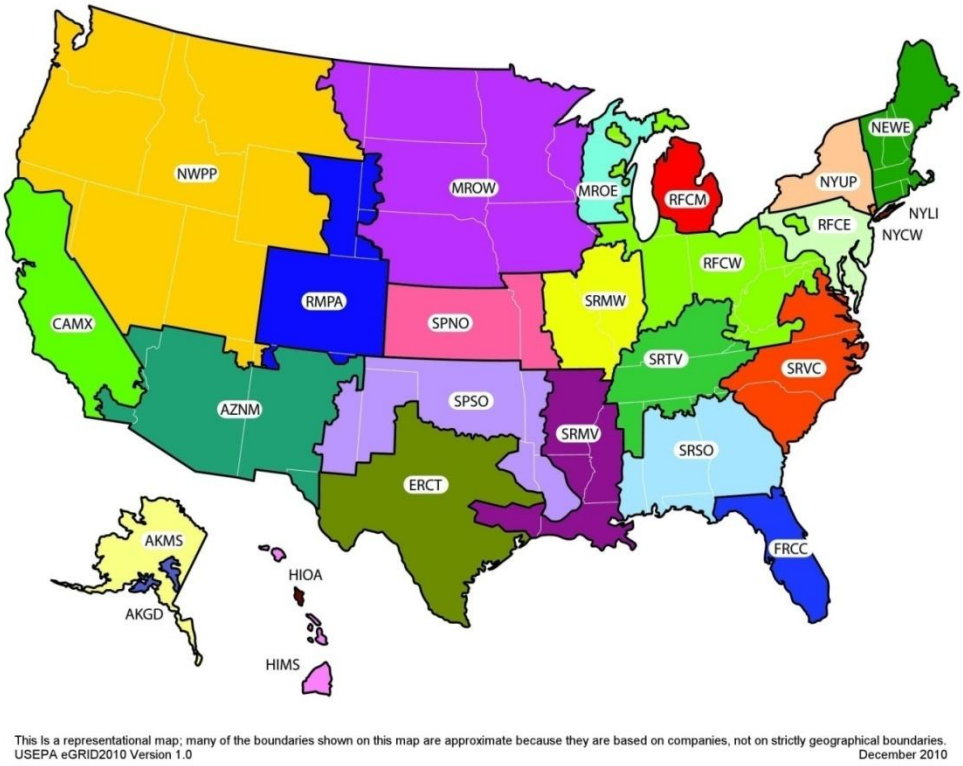


Figure 10: North American Electricity Reliability Corporation (NERC) Subregion Map (Source: USEPA eGRID 2012)

County Comparative Results

Comparison of the individual counties reveals reasonably similar site energy use per capita (range 173 to 203 mmBtu/capita), with much starker contrasts in the counties' total site energy use and the counties' site energy use per $1000 of personal income (range 4.0 to 7.3 mmBtu/$1000). The latter metric

suggests that Wexford may have the most significant energy-based financial liability and Leelanau the least. This may also reflect differences in the energy intensity of the economies in the respective counties.

Sector	Antrim	Benzie	Grand Traverse	Kalkaska	Leelanau	Wexford
Residential	1,549,214	1,078,292	4,898,954	1,122,553	1,427,697	1,869,823
Commercial / Industrial	540,985	687,366	3,987,780	307,755	465,122	1,849,674
Transportation – Non-Commercial	2,514,996	1,576,759	6,460,804	1,593,706	1,796,624	2,746,224
Transportation – Commercial	133,486	52,116	255,706	93,445	69,856	169,983
Total	4,738,681	3,394,533	15,603,244	3,117,459	3,759,299	6,635,705
Per Capita	203	195	177	182	173	203
Per $1000 of Personal Income	6.2	6.3	4.8	6.7	4.0	7.3

Table 12: 2011 County Site Energy by Sector (mmBtu)

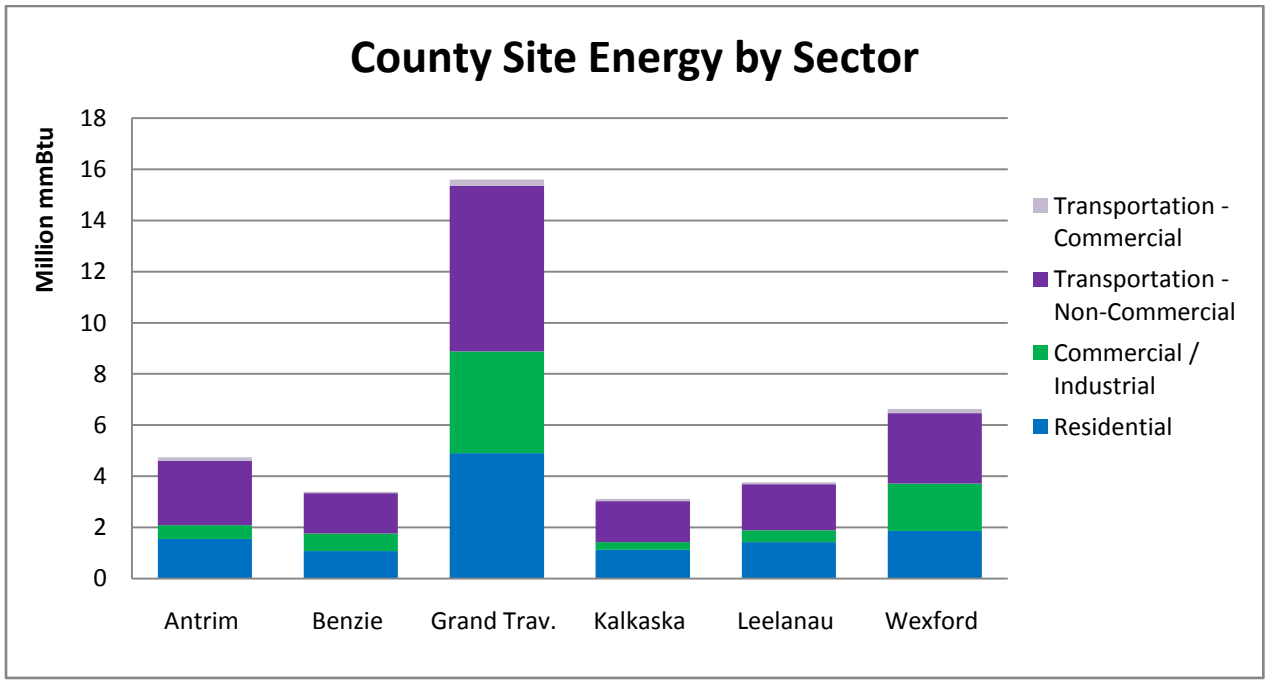


Figure 11: 2011 County Site Energy by Sector

While Non-Commercial Transportation is clearly the most significant sector across all counties, Grand Traverse and Wexford Counties are distinguished by having a much larger share of Commercial & Industrial energy consumption as shown in Figure 11.

Energy Type	Antrim	Benzie	Grand Traverse	Kalkaska	Leelanau	Wexford
Electricity	677,114	510,241	3,090,964	434,038	634,568	1,288,439
Gasoline	2,217,140	1,363,590	5,622,634	1,412,375	1,562,498	2,441,263
Diesel	431,342	265,285	1,093,876	274,776	303,982	474,944
Natural Gas	670,373	701,659	4,644,455	387,896	749,656	1,650,060
Propane / LPG	488,547	330,330	611,073	417,487	271,492	443,668
Fuel Oil	45,644	67,831	181,151	38,681	101,225	72,316
Coal	200,278	142,948	303,347	148,604	129,295	236,457
Wood	7,402	11,359	50,055	3,235	5,911	25,811
All Other Fuels	841	1,291	5,688	368	672	2,746
Total	4,738,681	3,394,533	15,603,244	3,117,459	3,759,299	6,635,705

Table 13: 2011 County Site Energy by Energy Type (mmBtu)

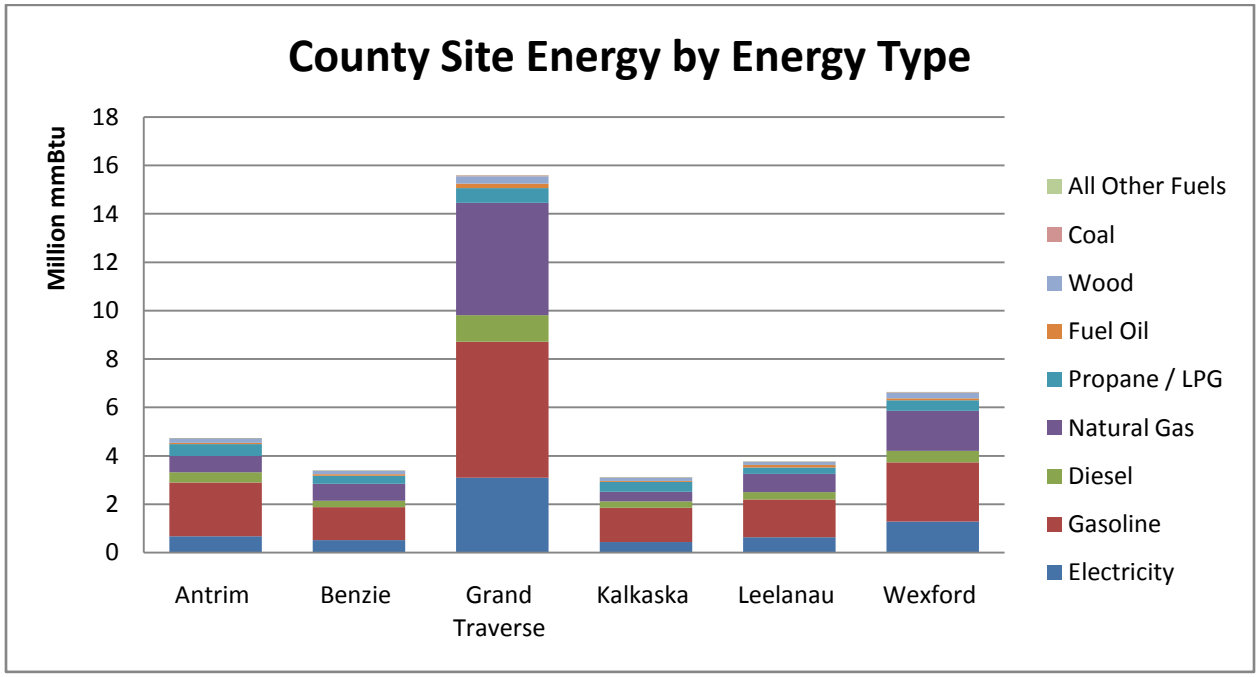


Figure 12: 2011 County Site Energy by Energy Type

Again, gasoline is the predominate site energy used across the counties, however natural gas consumption is also particularly significant in Grand Traverse and Wexford Counties as shown in Figure 12. Individual county consumption of these energy types results in the site energy, source energy, greenhouse gases, and cost totals presented in Table 14.

Sector	Antrim	Benzie	Grand Traverse	Kalkaska	Leelanau	Wexford
Total Site Energy (mmBtu)	4,738,681	3,394,533	15,603,244	3,117,459	3,759,299	6,635,705
Total Source Energy (mmBtu)	7,018,659	5,063,683	24,929,449	4,590,344	5,776,022	10,546,415
Total GHGs (MT CO2e)	409,478	293,589	1,467,460	266,689	338,770	617,230
Total Energy Cost ($1000 2011 Nom.)	$125,645	$83,098	$359,332	$84,116	$95,237	$156,802

Table 14: 2011 County Site & Source Energy, GHG, and Cost Totals

Sector	Antrim	Benzie	Grand Traverse	Kalkaska	Leelanau	Wexford
per Capita Site Energy (mmBtu)	203	195	177	182	173	203
per Capita Source Energy (mmBtu)	301	290	282	268	266	322
per Capita GHGs (MT CO2e)	18	17	17	16	16	19
per Capita Energy Cost ($ 2011 Nominal)	$5,389	$4,764	$4,067	$4,902	$4,388	$4,793

Table 15: 2011 County Site & Source Energy, GHGs, and Cost per Capita

When total energy consumption is divided by county population, it becomes apparent that Wexford County consumes the greatest quantity of source energy per capita and generates the most greenhouse gasses from energy use per capita (Figure 13). However, both Antrim and Kalkaska Counties have higher energy use cost per capita due in part to greater consumption of gasoline per capita and propane for residential heating per capita (Table 16 and Figure 13).

Energy Type	Antrim	Benzie	Grand Traverse	Kalkaska	Leelanau	Wexford
Electricity	100.0	100.7	120.5	87.1	100.7	135.6
Gasoline	112.9	92.8	75.5	97.7	85.5	88.6
Diesel	21.4	17.6	14.3	18.5	16.2	16.8
Natural Gas	31.4	43.9	57.4	24.7	37.7	55.1
Propane / LPG	24.1	21.8	8.0	28.0	14.4	15.6
Fuel Oil	2.3	4.5	2.4	2.6	5.4	2.6
Coal	8.6	8.2	3.4	8.7	6.0	7.2
Wood	0.3	0.7	0.6	0.2	0.3	0.8
All Other Fuels	0.0	0.1	0.1	0.0	0.0	0.1
Total	301.0	290.3	282.2	267.5	266.1	322.3

Table 16: 2011 County Source Energy per Capita by Energy Type (mmBtu)

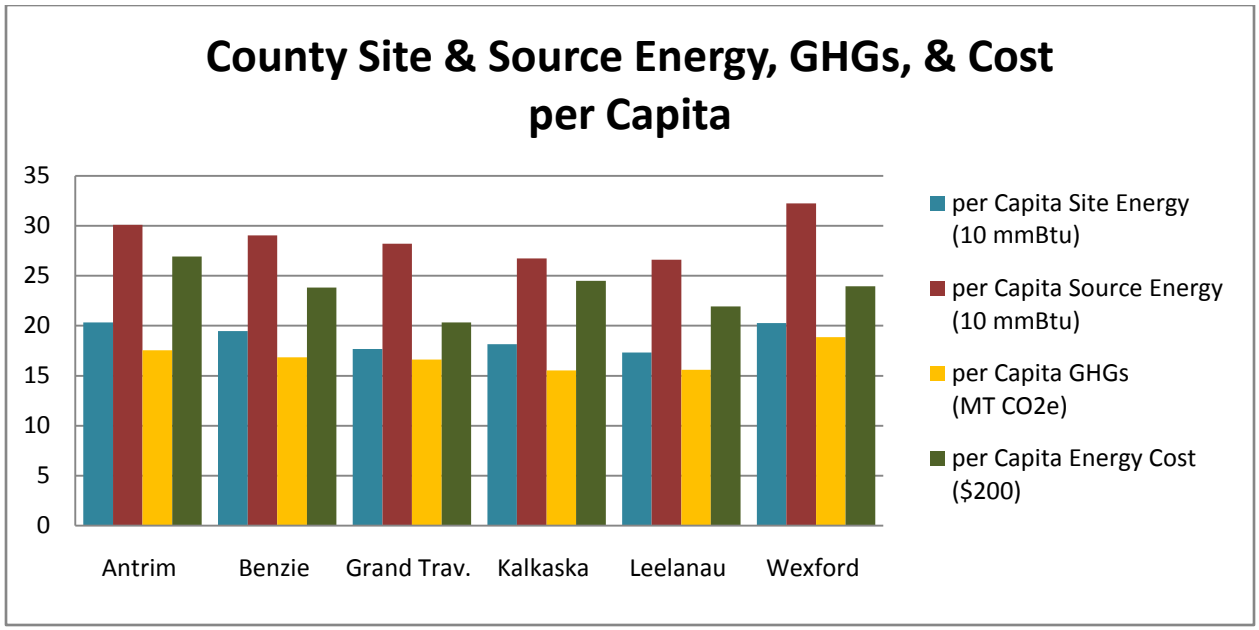


Figure 13: 2011 County Site & Source Energy, GHGs, & Cost per Capita

Lastly, the greatest differences in energy costs per consumer appeared at the household level. Table 17 and focus solely on the residential sector and illustrate that Antrim, Benzie, Kalkaska, and Leelanau Counties have reasonably similar residential energy costs per household. It is noteworthy that the energy costs per household are 45% higher for residents of the county with the highest cost per household, Antrim, than those residents living in the county with the least cost per household, Grand Traverse. This difference is due primarily to Antrim County's greater energy use per household, higher electricity prices, and greater reliance on propane, a more cost intensive heating fuel than natural gas, which is the predominate heating fuel in Grand Traverse County.

Energy Type	Antrim	Benzie	Grand Traverse	Kalkaska	Leelanau	Wexford
Electricity	$1,750	$1,481	$1,174	$1,424	$1,660	$1,296
Natural Gas	$421	$421	$839	$386	$585	$643
Propane / LPG	$1,301	$1,180	$445	$1,532	$758	$904
Fuel Oil	$90	$180	$75	$124	$262	$68
Wood	$208	$182	$64	$218	$138	$164
Coal	$0	$0	$0	$0	$0	$1
Total	$3,769	$3,444	$2,597	$3,685	$3,403	$3,076

Table 17: 2011 County Residential Energy Costs per Household ($ 2011 nominal)

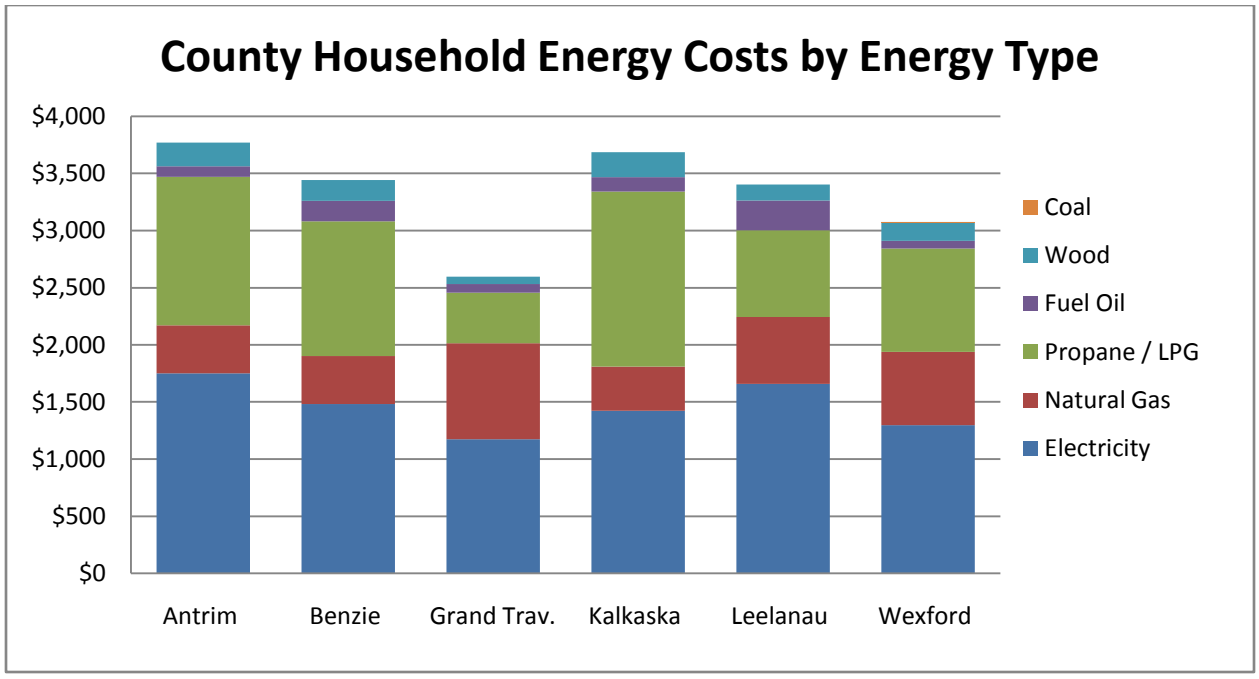


Figure 14: 2011 County Household Energy Costs by Energy Type