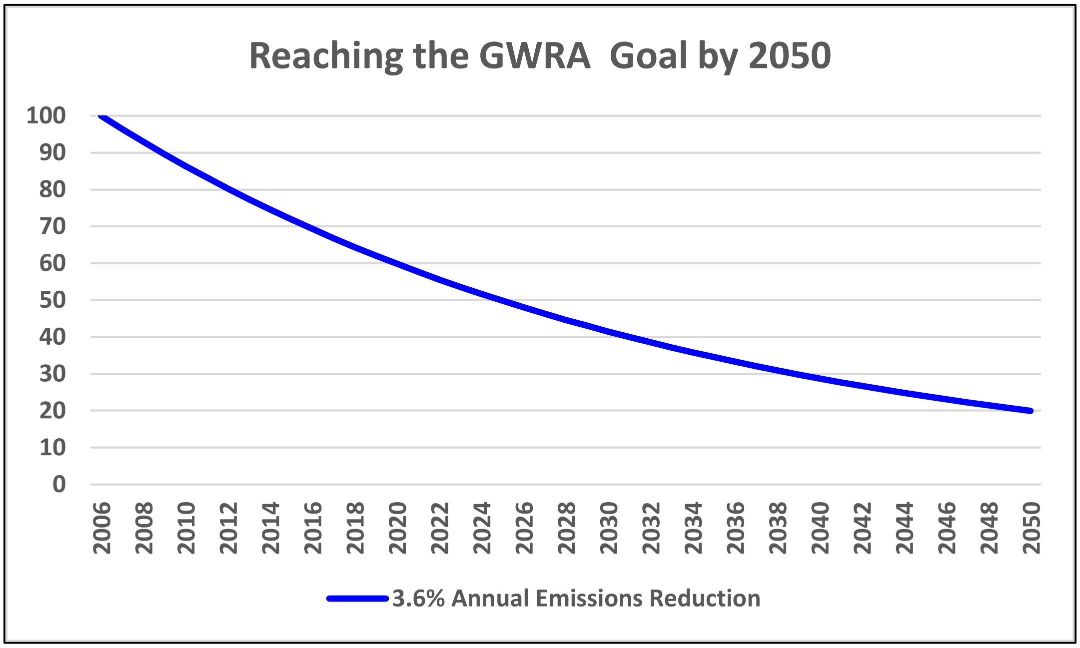
The Gold Star Standard in Energy: Technical Report

1. Introduction: Gold Star Standard and Rationale

This technical document describes the research that underpins the Sustainable Jersey Gold Star Standard in Energy, as presented in the June 2016 publication, *The Sustainable State of the State 2016 Update and the New Gold Star Standard.*

As articulated in the *New Jersey Sustainable State of the State Report* (2016), the primary and overarching sustainability goal in the Energy dimension is: “decrease greenhouse gas emissions in time to avoid catastrophic climate impacts.” The Gold Star standard pins the rate of decreased emissions to New Jersey’s *Global Warming Response Act*. The Act calls for an **80% reduction of GHG emissions from 2006 levels by the year 2050**.

As the following calculation demonstrates, to meet this standard, New Jersey as a whole must reduce greenhouse gas (GHG) emissions at a rate of 3.6% per year.



The Gold Star in Energy is a two-tiered standard.

1) Municipal Facilities and Operations

Because municipalities control energy use and conservation for their own facilities and operations, to achieve the Gold Star in Energy they must reduce the GHG emissions from those operations at or above the **3.6% annual rate** required of all actors in the state.

The scope of the municipal standard encompasses all municipal buildings, street and other exterior lighting, and the municipal fleet. In order to qualify for Gold initially, municipalities must complete and maintain the Sustainable Jersey Municipal Carbon Footprint Action (or equivalent) and either (a) show a 3.6% rate of reduction for a total of three years (10.8%), or (b) show a reduction from a baseline year no earlier than 2006 of .036 x t (where t is 2017-baseline year). The municipality must then maintain a 3.6% on average over the three-year cycle for renewal of their Gold star.

(See Section 3 for validation of the feasibility of the municipal standard. See Section 4 for a discussion of how municipal and community-wide emissions data will be adjusted to account for major factors outside municipal control.)

2) Community-wide GHG Emissions

The scope of the community-wide standard encompasses all use of electricity and natural gas reflected in utility data. This includes all use of purchased energy within municipal boundaries, including emissions associated with power generation outside of the community. These are known as "Scope 2" emissions, with several important exceptions:

- Emissions from mobile sources (the transportation sector) are currently excluded only because the necessary data are not currently available. Sustainable Jersey is working with the Department of Environmental Protection and the Department of Motor Vehicles to obtain these data. When we do, the community-wide standard will be expanded to include this important source of emissions.
- Industrial sources of emissions are excluded on the grounds that municipal governments have very limited influence over their practices. The presence and size of industries also varies widely across the state and in several places would swamp the quantity of emissions from the rest of the locality.
- Emissions from the use of home heating oil is also excluded due to lack of access to the required data. (Note that when residents or business switch from heating with oil to natural gas, this would be reflected in an *increase* in emissions based on the gas utility data that our program measures.)

Municipal governments, however, have influence, but limited control, over community-wide energy use, efficiency and conservation measures and therefore GHG emissions. In order to hold Gold-star applicants accountable only for the change in emissions within their sphere of influence, the required rate of emissions reduction is set well below the statewide target rate (3.6%) at **1% per year**, averaged over six years.

This rate is verified in three ways:

1) by comparison with five years of real NJ municipal emissions data that, by illustrating the range and patterns of emissions over time, give an indication of the feasibility of achieving the Gold standard (see section 2);
2) by summing the potential reductions achieved through the implementation of known municipal strategies to determine the feasible rates of emissions reduction due to municipal action (see section 3);
3) the feasibility of meeting or exceeding the 1% rate of reduction will be tested as Sustainable Jersey staff work closely with the pioneering Gold applicants to track actual emissions based on data that Sustainable Jersey will obtain from the utilities.

In this sense the community-wide rate of reduction is a hypothesis in an ongoing experiment in sustainability. The Gold standard rates and rules may be adapted in response to unforeseen events and consequences as well as future innovation that raises the bar.

2. Establishing the feasibility of the community standard: Historical data

2.1. Introducing the DVRPC dataset

The Delaware Valley Regional Planning Commission (DVRPC) dataset reports energy consumption and GHG emissions in the nine counties of the Greater Philadelphia region. These include four municipalities within New Jersey (Burlington, Camden, Gloucester and Merce), and the 114 townships within their jurisdiction. DVRPC has calculated energy use and the associated GHG emissions in 2005 and 2010 from the following sources:

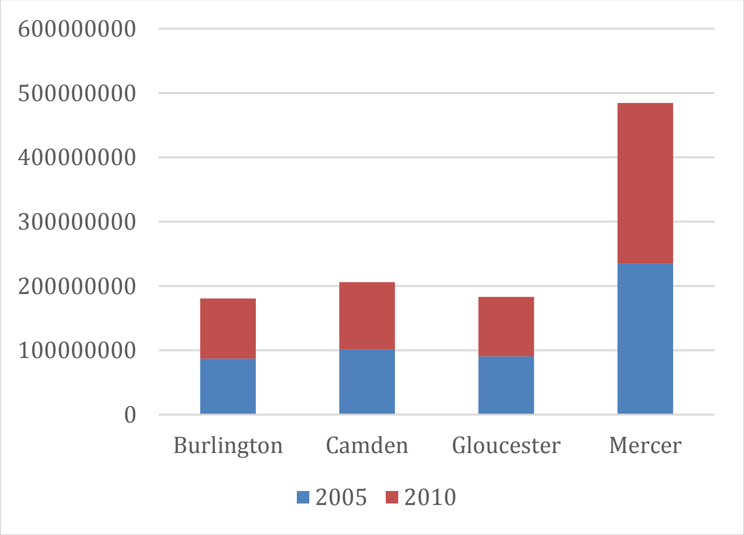
i. Stationary Sources -- including residential, commercial and industrial sectors
ii. Mobile Sources -- including transportation, aviation and passenger and freight rail
iii. Other non-energy related emission and sequestration sources such as waste management, agriculture and land-use.

This inventory provides the information required to track energy-use and emission trends for use in the development of the new Energy Gold standard proposed by Sustainable Jersey. In the following section, we analyze the DVRPC inventory in the years 2005 and 2010 in order to test our methods and assess the feasibility of the proposed standards in light of historical behavior of municipalities in New Jersey.

2.2 Consumption and Emission Trends from 2005 to 2010:

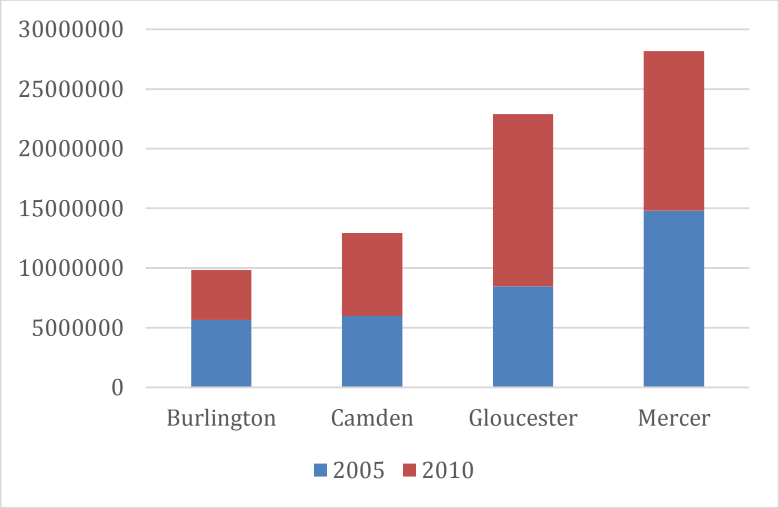
In the case of electricity consumption by residential and commercial users, as shown in Figure 1, we find that for the four counties overall, there is not a significant change in consumption between 2005 and 2010.

Figure 1: Residential + Commercial Electricity Consumption (KWh)



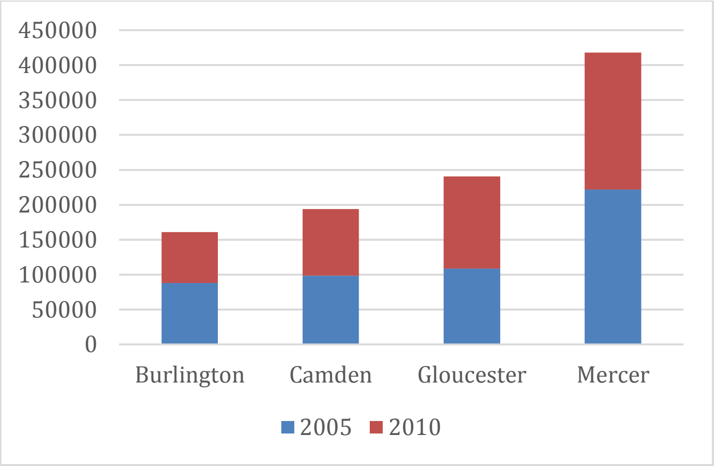
However, natural gas use in these two sectors increased in Camden and Gloucester, and was reduced in Burlington and Mercer counties as indicated in Figure 2.

Figure 2: Residential + Commercial Natural Gas Use (CCF)



How much these consumption trends mean in terms of GHG emissions is given by Figure 3. While Gloucester County shows an increase, the counties of Burlington, Mercer and Camden show a decreasing trend in emissions measured in metric tons CO_2 equivalent.

Figure 3: Residential + Commercial GHG Emissions ($MTCO_{2e}$)



Descriptive Statistics for the Emissions Data

The quantitative analysis of the data begins with summary statistics, which are shown by county in Table 1. Burlington County had the smallest change of 0.28% decrease in emissions between the two years, whereas Mercer County had the largest change of 21.96%. The large standard deviation can be explained by the uncharacteristic difference in the minimum and maximum values of the percent change in emissions. For example, Paulsboro Borough in Gloucester County shows an increase of 326% over five years since 2005. Assessment of the sector-wide emissions in Paulsboro reveals that even though residential emissions decreased from 27,615 MTCO2e to 22,232 MTCO2e, emissions due to commercial activity increased almost five-fold from 125,455 to 63,1102 MTCO2e, which resulted in a overall surge in emissions. This case warrants future investigation.

Table 1: Percentage Change in Residential and Commercial GHG emissions between 2005 and 2010

County	Number of Municipalities	Average	Standard Deviation	Min	Max
Burlington	40	-0.28	54.86	-78.27	175.5
Camden	37	-10.9	36.1	-99.98	104.03
Gloucester	24	17.6	83.13	-69.1	326.82
Mercer	13	21.96	72.66	-50.9	180.78

Frequency Distribution and Outliers

The frequency distribution of the GHG emissions shown in Figure 1 gives a succinct picture of where the 114 counties in the DVRPC dataset stand in terms of change in emissions between 2005 and 2010.

Figure 4: Frequency Distribution: % Change GHG emissions 114 DVRPC municipalities

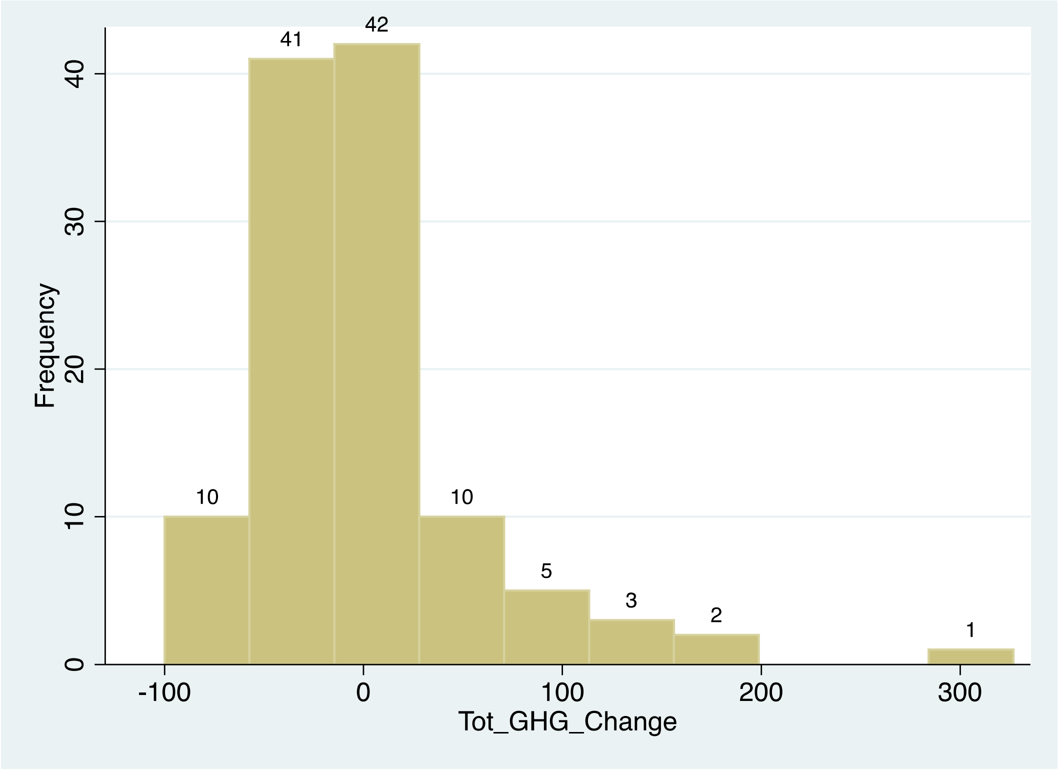


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Figure 4 shows that there is one clear outlier (Paulsboro Township) with an inexplicably high increase in GHG emissions of 326%. With this observation dropped from our analysis, the data descriptives are as follows:

Table 2: Data Summary of 112 Municipalities

	Average	Standard Deviation	Min	Max
GHG emissions change	-1.42	48.62	-99.98	175.51

The above table shows that without the outliers, the average trend of the municipalities is a *reduction of emissions by 1.42% over 5 years or about -0.284% per year*.

2.3 Exclusion of Industrial Sector

The decision to exclude the industrial sector was made on the grounds that it is not under municipal control. Here we look at the actual data for the industrial sector to justify that exclusion.

The DVRPC dataset contains consumption data due to Industrial activity for all 114 counties for the year 2010. However, only 39 counties reported for 2005. Therefore there is insufficient data for measuring change in industrial emissions between 2005 and 2010. Moreover an assessment of industrial emissions in 2010 shows that the average emissions (9,734 MTCO2e) is only 7% of the total stationary emissions as against residential which is 47% (62726 MTCO2e) and commercial which is 45% (60,573MTCO2e). This indicates that industrial emissions comprise a small percentage of the total and gives a further reason that its exclusion from this analysis does not substantially affect total GHG emissions.

2.4. Net activity approach

The Population Effect

The role of human activity in the degradation of natural resources is irrefutable. To that extent, population growth and economic growth contribute significantly to the emission of greenhouse gases by way of consuming energy resources for purposes such as heating, cooling, lighting and transportation, to name a few. Therefore, scaling the emissions data by the number of consumers gives a more appropriate explanation of the emission levels

Moreover, the Gold standard needs to apply equally to larger and smaller municipalities, so the data must be reduced to a common scale with respect to population, namely, emissions *per capita*. This prevents municipalities from being penalized by the movement of people and natural population growth. Indeed, sustainability will require changes in the relative population of New Jersey's municipalities as, over time, more people shift into urban centers and nucleated towns, reducing suburban and exurban sprawl.

The population data provided by the DVRPC is used to derive the per capita emissions, which is defined as:

$$\frac{\text{Emissions}}{\text{Population}}$$

Percent change in emissions per capita between 2005 and 2009 is then:

$$\frac{\text{Emissions per capita in 2010-Emissions per capita in 2005}}{\text{Emissions per capita in 2005}} * 100$$

The frequency distribution of the emissions change per capita is very similar to Figure 4 with Paulsboro Borough being the outlier with 322% increase in emissions per capita between 2005 and 2010. The data summary for the remaining townships is given in Table 3.

Table 3: **Data Summary of GHG emissions change per capita in 112 Municipalities**

	Average	Standard Deviation	Min	Max
GHG emissions change	-1.42	48.62	-99.98	175.51
Population Change	1.56	10.53	-45.45	53.96
Employment Change	2.53	94.56	-100	875.86
% GHG emissions per capita change	2.29	50.04	-99.98	177.7

The data shows that for municipalities that do not show a large increase or reduction in emissions, the *average change per capita is about a 2.29% reduction in emissions or about -0.458% per year.*

The Employment Effect

The data for employment for each municipality is extracted from the Quarterly Census Employment Wages (QCEW) data available with the Bureau of Labor Statistics[1].

The effect of jobs on local emissions can be defined as the percent change in emissions per job between 2005 and 2010 and derived using the following relationship:

$$\frac{\text{Emissions per job in 2010-Emissions per job in 2005}}{\text{Emissions per job in 2005}} * 100$$

The frequency distribution of emissions per job shows three townships: Paulsboro, Tavistock and Chesilhurst, with drastic changes between 2005 and 2010. For example, in the case of Chesilhurst Borough, there was an increase of 735% in emissions per job between 2005 and 2010. These counties warrant a more in-depth investigation into the

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[1] In this dataset, Princeton Borough and Township employment are consolidated into one entity, hence the rest of the variables are also summed up for these two formerly separate municipalities.

determinants that could have led to such large variations. For the purpose of this study, however, we will treat them as outliers and disregard them from our analysis.

The remaining 92 municipalities show an *average increase of 9.36 % per job* as shown in Table 4.

Table 4: **Data Summary of percent change of GHG emissions per job in 110 municipalities**

	Average	Standard Deviation	Min	Max
GHG emissions per job change	9.36	54.73	-98.98	172.46

Scaling with Net Activity

The overall anthropogenic influence on emissions can be evaluated by *net activity,* or the sum of the population and number of jobs in a municipal jurisdiction. Thus, net activity represents two dimensions of energy consumption – residential, which is reflected by the number of people residing in the municipality, and employment, which is the number of people employed and consuming energy for commercial activities.

The frequency distribution of emissions change per net activity shows Paulsboro as the outlier with 327% change. Dropping this observation, *the average change in emissions per net activity is -1.0% or -0.2% per year,* as shown in Table 5.

Table 5: Data Summary of with percent change of GHG emissions per net activity in 112 Counties

	Average	Standard Deviation	Min	Max
GHG emissions change per net activity	-1.0	49.67	-99.97	170.33

Applying the Net Activity Approach

45 Municipalities show a reduction in GHG emissions per net activity between 2005 and 2010. The remaining 48 Municipalities have a net increase in emissions per net activity in that time period.

As seen from Table 6 below, *the average reduction is 24%, which on an average would be -4.8% per year.*

Table 6: Data Summary of 45 counties that show negative change in emissions between 2005 and 2010

	Average	Standard Deviation	Min	Max
GHG emissions change per net activity	-24.14	20.84	-75.04	-1.12

The emissions data scaled by demographic and economic factors is given in Table 7. A comparison of the three indices shows that the sample size (N) is the largest for emissions per net activity. Even though the standard deviation is slightly larger when emissions are scaled by net activity than by population, theory suggests that both demographic as well as economic factors contribute to emissions and therefore we will use this index in our data analysis.

Table 7: Summary Statistics of emissions data scaled by population and employment

Variable (% change)	N=	Mean	Std Dev	Min	Max
Emissions per population		-1.42	48.62	-99.98	175.51
Emissions per job	92	-1.47	30.5	-67.98	73.6
Emissions per Net Activity		-1.0	49.67	-99.97	170.33

(Table 7 represents a summary of Table 3,4,5 combined).

The results of the linear regression of these three variables on emissions in each year are presented in Table 1A in the Appendix. The t-values indicate that population and employment are significant, as is the net activity. This confirms our expectation that population and employment are indeed significant in the determination of the emissions.

2.5 Three Normalization Methods

The GHG emissions reported by municipalities are a direct indicator of the consumption trends in their jurisdictions. For the purposes of the Gold Standard, we would like to know that if a municipality reduces its emissions, it is as a result of the conservation actions that it undertook. Municipalities should not be credited or penalized for emission outcomes for which they are not responsible, but rather occur largely or entirely due to external factors. 'Normalization' in this context means to adjust emissions figures using methods that, in so far as possible, remove these effects, allowing for directly comparable results across municipalities and across time.

Emissions data for the Gold standard will be normalized for the following three factors: the carbon intensity of the grid, weather, and macroeconomic shifts.

1) Improvement in the Grid:

The energy supply that comes from the electric grid for the state has a certain carbon intensity, which is defined as the carbon emissions produced per of megawatt hour of electricity (Source: US Energy Information Administration https://www.epa.gov/energy/egrid). Due to New Jersey's Renewable Portfolio Standard (RPS), the energy supply from the grid has become progressively more efficient in order to meet the objective of 20% of the total supply from renewable energy sources by 2020. In fact, the carbon intensity of the electric grid for NJ was 0.359 tons of $CO2/MWh$ in 2005 and 0.309 tons of $CO2/MWH$ in 2010 indicating that carbon intensity of the electric grid reduced by 14.1% over 5 years.

This increase in the efficiency of the statewide electrical grid occurs external to and almost completely independent of municipal effort (an exception might be municipal production of solar energy, thus far a negligibly small factor.) In order to isolate the GHG reductions that might have been spurred by municipal action, it is therefore necessary to adjust, or 'normalize,' so that the increased efficiency of the grid is removed as a factor.

In order to adjust for the fact that the grid became more efficient over the 2005-2010 period, the following adjustment is made:

a. Taking 2005 as the baseline year, we adjust the GHG emissions due to electricity in 2010 by a factor of 0.359/0.309 = 1.16.
b. Therefore, total emissions due to electricity adjusted for carbon intensity in 2010 are:

$$E\_{CI\_2010} = 1.16 * (\text{Total Electricity Emissions in 2010})$$

2) Variation in Weather

Weather plays an important role influencing energy consumption in a community. A cold winter and a very hot summer are both responsible for increased energy use whether it is for heating or cooling. Weather normalization is a means of adjusting for weather when calculating emissions from a particular source such as residential or commercial buildings. There are three main categories of energy consumption involved:

a. Heating (consumption related to natural gas)
b. Cooling (consumption related to electricity use)

c. Base Load (consumption related to electricity use, but not weather)

The influence of temperature change on energy demand is most commonly expressed as heating or cooling 'degree days'. A "degree day" is the difference between the daily average outdoor temperature and a defined baseline temperature for indoor comfort (in this case, 65°F for the US) (www.epa.gov/climatechange/indicators). For example, if the average temperature on a particular day is 75°F, then that day counts as 10 cooling degree days, as a building's interior would need to be cooled by 10°F to reach 65°F. Conversely, if the average outdoor temperature is 40°F, then that day counts as 25 heating degree days, as a building's interior would need to be warmed by 25°F to reach 65°F.

Methodology for weather normalization:

i. We first calculate the annual total degree days (TDD), which is the sum of heating (HDD) and cooling (CDD) degree days in 2005 and 2010 (source: http://www.weatherdatadepot.com/).

ii. Using 2005 as baseline year, we then calculate the ratio of TDD in 2010 to 2005 for each municipality

iii. Heating and cooling days affect the consumption of both electricity and natural gas.
So the total Electricity and Natural Gas emissions (E_NG) adjusting for the weather are

$$E\_NG_{CIW\_2010} = (E\_NG_{CI\_2010})* TDD_{2010} / TDD_{2005}$$

3) Macroeconomic trends: Scaling for Net Activity

Finally, the level of economic activity drives energy consumption in the municipality. Local economic activity and employment both are significantly determined by macroeconomic trends, such as regional or national recessions. 'Net activity,' the sum of population and number of jobs in a jurisdiction, thus serves as a proxy for residential and commercial consumption levels.

Dividing the grid and weather adjusted emissions by the net activity for each year, we get:

$$GHG_{Adj\_2010} = E\_NG_{CIW\_2010}/Net\text{-}Act\_2010$$
$$GHG_{\_2005} = E\_NG_{2005}/Net\_Act\_2005,$$

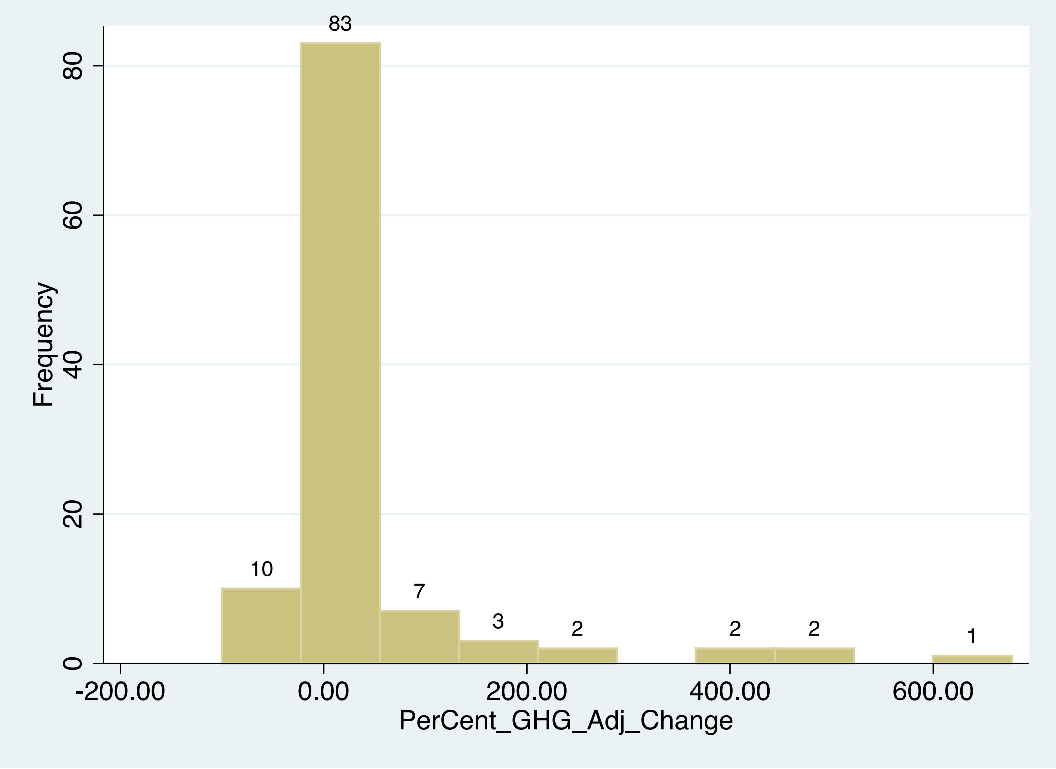
where GHG_{Adj_2010} is the total emissions adjusted for weather and grid and normalized by net activity, and $GHG_{\_2005}$ is the total electricity and natural gas consumption in year 2005 normalized by net activity.

These three forms of normalization applied together constitute the proposed methodology to compensate the total reported energy emissions for each municipality in a given year for the three major factors external to municipal control. These adjustments made with respect to a baseline year ensure that the municipalities are assessed fairly for their actions towards achieving the gold standard.

2.6 Results: Application of Net Activity + Normalization

The following figure shows the frequency distribution of the percentage change in adjusted emissions after normalization. The distribution in Figure 5 reveals that there are five municipalities whose emission change exceeds 300 percent (see Table 2A in Appendix). These five data points are treated as outliers and excluded from further analysis.

Figure 5: Frequency Distribution of the Percentage Change in GHG emissions after normalization in all 114 municipalities in the DVRPC dataset



The following table shows that the average percentage change in GHG emissions in the remaining 109 municipalities is -6.39 or -1.28 per year, whereas after normalization, the adjusted emissions change is +19.28, or +3.85 per year. Thus, after removing the effects of the carbon intensity of the grid and the weather, as well as accounting for the changes in population and employment, there is in fact a small average increase in the emissions between 2005 and 2010 in the four Counties in the DVRPC data.

Table 8: Comparison between Percent Change in Emissions before and after Normalization

Variable (N=105)	Mean	Std Dev	Min	Max
% Change in GHG emissions	**-6.39**	41.3	-99.9	151.5
% Change in Adjusted GHG emissions	**19.28**	54.7	-100	264.96

To achieve the Gold Standard, municipalities much reduce emissions by at least 1%, per year i.e., the annual percentage change in emissions should be -1%. It is not expected that the "average" municipality would achieve this level of improvement. Rather, this will fall to the municipal leaders who make a concerted effort to provide incentives and resources to their communities in a drive to reduce GHG emissions. We find that in the DVRPC region during 2005 and 1010, 27 Municipalities demonstrated an average reduction of emissions of 30%, or 6% per year – well above the Gold Star-mandated rate of reduction of 1% per year.

Table 3A in the Appendix lists all the municipalities that have achieved this level, and Table 9 below displays the summary statistics.

Table 9: Summary Statistics of Municipalities which show reductions in emissions after Normalization

Variable (N=27)	Mean	Std Dev	Min	Max
% Change in GHG emissions after normalization	**-30.17**	28.3	-100	-1.97

Further research is needed to uncover the possible reasons why these 27 southern New Jersey towns were able to achieve this level of improvement. Do they have certain demographic, geographic, economic or other factors in common? Is there any evidence of municipal energy conservation, efficiency or related (e.g., land use and development) policy measures promulgated during that period?

Despite these unanswered questions, this analysis demonstrates the feasibility of municipalities making reductions in GHG emissions commensurate with the Sustainable Jersey Gold Star in Energy. This analysis also demonstrates that the methodology proposed for evaluation Gold Star applications produces convincing results consistent with outcomes within the range of informed and reasonable expectation.

The final conclusion from this analysis had significant repercussions for the structure of the Gold star standard in Energy. It was found that the DVRPC data-set and our normalization methods are not together sufficiently sensitive and comprehensive to register a community-wide 1% reduction in GHG over one year traceable to local interventions. The utility data upon which Sustainable Jersey will rely for making assessments in the future will be substantially the same as supplied the DVRPC data-set. Thus, the decision was taken to evaluate the performance of municipal Gold-Star applicants over five years periods. We will test with real data from participating municipalities our expectation that a 5% decrease in emissions over five years, after adjusting for the exogenous effects of weather, economic trends, and changes in the carbon intensity of the grid, can in practice be documented and tied to municipal efforts.

In the meantime, the community-wide emissions criteria will rely on the accomplishment of critical, prescribed action areas as specified in the Gold Star in Energy rules:

1. Make Your Municipality Alternative Vehicle Friendly
2. Make Your Town Solar Friendly
3. Promote Building Efficiency to Residents
4. Promote Building Efficiency to Businesses

The evidence that undertaking these and other municipal actions will make the necessary impact on emissions to meet the Gold Star standard is presented in the following, and final, section of this report.

3. Verifying feasibility of the standards: Effective Strategies

In order to confirm the feasibility of municipalities reaching and maintaining the Gold star standard in Energy, our research generated well-founded estimates for the impact on total emissions of municipal strategies to reduce GHG emissions from municipal operations and across the community as a whole. Many of these strategies correspond to existing Sustainable Jersey actions and have been proven by participating municipalities to be attainable in practice.

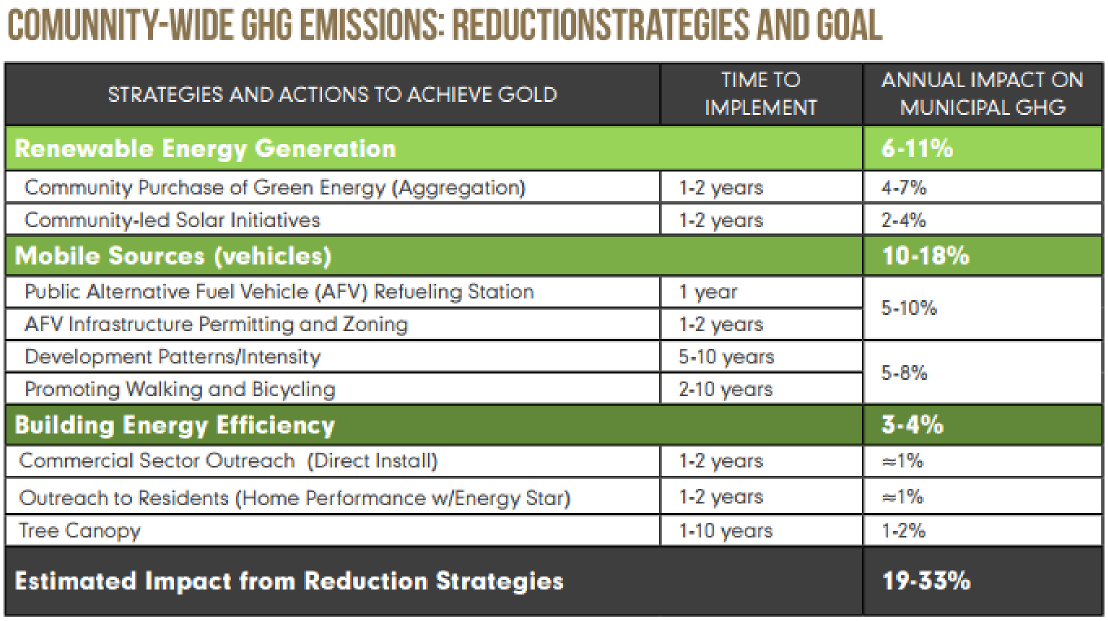
To maintain the rates of reduction in emissions necessary to retain a Gold Star over the coming decades, further innovation and behavior change will be required (see *The Sustainable State of the State 2016 Update and the New Gold Star Standard*). We demonstrate that even with existing best practices, municipalities can meet and exceed the Gold Star standard for the next ten to twenty years if not beyond.

3.1. Effective Strategies to Achieve the *Community-wide* standard

In this section we summarize the research and assumptions underpinning the estimates for each listed strategy, beginning with the community-wide standard.

As shown in Table 10 these attainable strategies yield substantial results, summing to a 19-33% reduction in municipal GHG emissions in the near term. Even the low end of the estimate would cover 19 years of reductions at the 1% target community-wide rate. As time elapses, municipalities will still need to up their game to stay on track with reducing emissions over the longer term. Moreover, in practice, municipalities will not be able to implement all of these activities at once, but will pick and choose among the strategies to implement first those that are suitable to their local circumstances. Sustainable Jersey is committed to working with municipalities to continue to innovate to improve and add to these strategies to achieve higher rates of reduction over time.

Table 10



COMUNNITY-WIDE GHG EMISSIONS: REDUCTIONSTRATEGIES AND GOAL

STRATEGIES AND ACTIONS TO ACHIEVE GOLD	TIME TO IMPLEMENT	ANNUAL IMPACT ON MUNICIPAL GHG
Renewable Energy Generation		**6-11%**
Community Purchase of Green Energy (Aggregation)	1-2 years	4-7%
Community-led Solar Initiatives	1-2 years	2-4%
Mobile Sources (vehicles)		**10-18%**
Public Alternative Fuel Vehicle (AFV) Refueling Station	1 year	5-10%
AFV Infrastructure Permitting and Zoning	1-2 years	
Development Patterns/Intensity	5-10 years	5-8%
Promoting Walking and Bicycling	2-10 years	
Building Energy Efficiency		**3-4%**
Commercial Sector Outreach (Direct Install)	1-2 years	≈1%
Outreach to Residents (Home Performance w/Energy Star)	1-2 years	≈1%
Tree Canopy	1-10 years	1-2%
Estimated Impact from Reduction Strategies		**19-33%**

Renewable Energy Generation

Community Purchase of Green Energy (Aggregation)

In New Jersey, a Government Energy Aggregation (GEA) program is defined by the enabling Statute and the rules promulgated by the Board of Public Utilities.[2] The “R” in Sustainable Jersey’s R-GEA refers to the fact that enhanced renewable content will be part of the electricity product procured by the municipality on behalf of the aggregation entity members.

The simplest way describe a R-GEA is that it is an entity, created by a Municipal Ordinance that is used to procure energy products for its constituent members. By Statue, for residential customers, membership is structured as an “opt out” program

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[2] http://www.state.nj.us/bpu/pdf/energy/NJ_Gov_Energy_Aggregation_Summary.pdf

and as an "opt in" program for commercial customers. For residential customers, unless the customer elects to "opt out" of the program, or is already using a third party supplier, the residential customer is automatically enrolled in the GEA program. A residential customer is able to "opt out" of the program at any time during the term of the contract without penalty.

The estimate for potential savings from instituting this action came from an application of two different standards in the action to data on community energy usage supplied by the Delaware Valley Regional Planning Commission (DVRPC).[3] The lower end range of the standard calls for an R-GEA that sources 20% of its energy from renewable sources. The upper end range of the standard requires that 40% of energy be from a renewable source.[4] The mean GHG reduction from the 114 municipalities in the DVRPC data using the 20% standard is 11.7%. Using the 40% standard on the same data, the mean GHG reduction is 23.3%. Given that 35% of the carbon footprint from a typical New Jersey municipality is from electricity, the final adjusted range of impact for this action is a 4-7% reduction in greenhouse gas emissions.

Community-led Solar Initiatives

Community-led procurement of solar energy is an attractive alternative for those residents who cannot obtain renewable solar energy due to the physical constraints of their property. A NJ Future study estimates that the average usable solar rooftop space in the state is 22%.[5] To arrive at our estimate for GHG impacts, we combined the NJ Future finding with an average 20% participation (close) rate in six Energy Sage pilot programs, as well as a 90% electricity displacement (Northeast average).

This calculation (.22 x .20 x .90) yields a high-end estimate of 4% reduction in GHG emissions for this strategy. The low-end range (2%) is based on the wide range of suitability of solar energy in New Jersey municipalities statewide.

Mobile Sources (vehicles)

Public Alternative Fuel Vehicle (AFV) Refueling Station:
AFV Infrastructure Permitting and Zoning

These two strategies were considered together in estimating their potential impact on GHG emission reductions. Given the current very small percentage of alternative fuel vehicles in NJ (.0064% of all vehicles as of 2015), the potential was estimated using a low-to-high range of growth scenarios. A US Department of Transportation Federal Highway Administration study from 2015 ("Feasibility and Implications of Electric Vehicle (EV) Deployment and Infrastructure Development"[6]) suggests the range of

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[3] http://www.dvrpc.org/EnergyClimate/Inventory/

[4] http://www.sustainablejersey.com/actions-certification/actions/#open/action/517

[5] http://www.njfuture.org/wp-content/uploads/2011/08/Solar-Siting-05-11.pdf

[6] https://www.fhwa.dot.gov/environment/sustainability/energy/publications/ev_deployment/fhwahep15021.pdf

impacts in the coming decade to be a 5-10% reduction in GHG emissions due to the switch to alternative fuel vehicles.

Development Patterns/Intensity

According to a U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy study conducted in March 2013 ("Effects of the Built Environment on Transportation: Energy Use, Greenhouse Gas Emissions, and Other Factors." [7]), changes to the built environment could result in a reduction in U.S. transportation energy and GHG emissions from less than 1% to as high as 10% by 2050, the high end corresponding to a reduction of up to 16%–18% in the urban light-duty vehicle travel subsector.

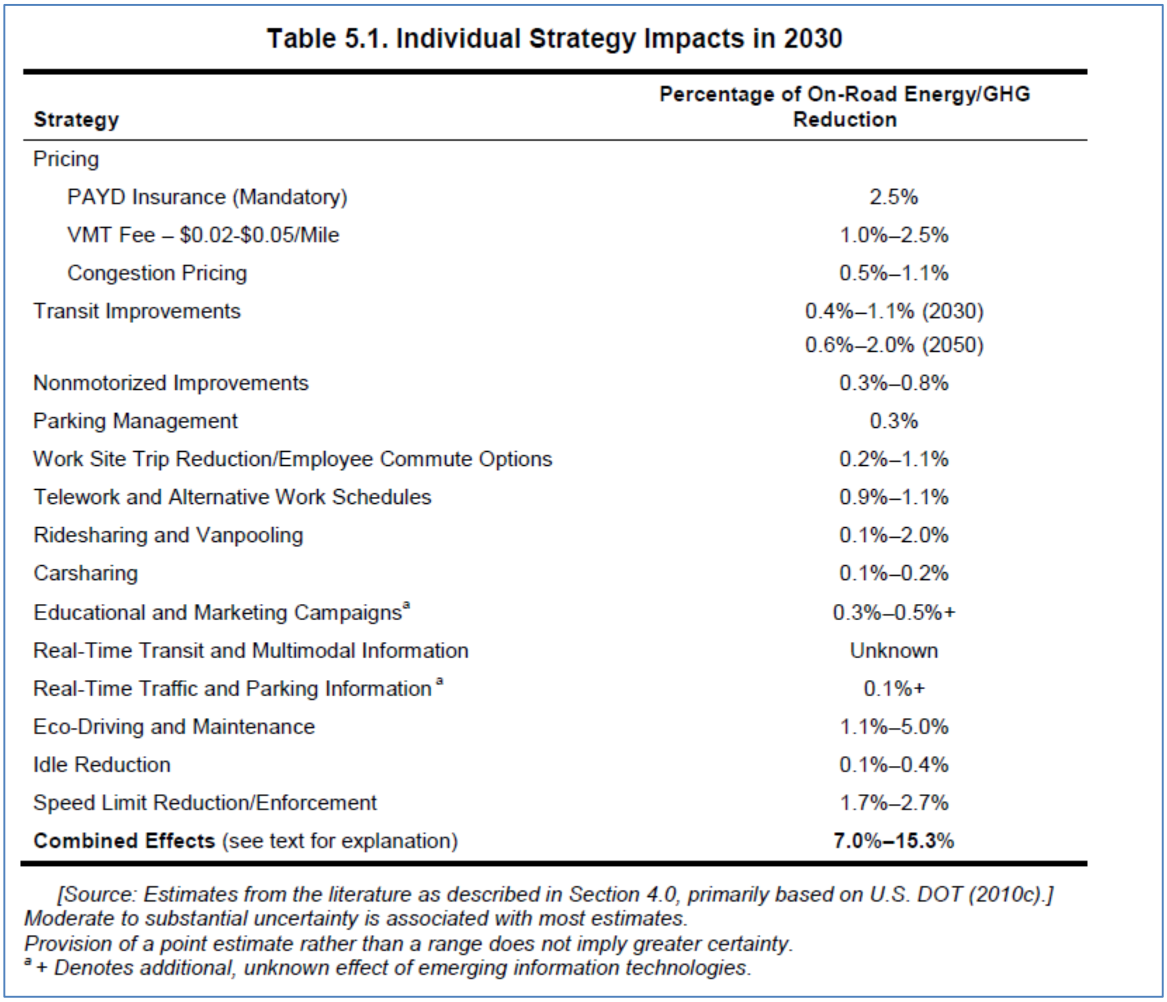

Table 5.1. Individual Strategy Impacts in 2030

Strategy	Percentage of On-Road Energy/GHG Reduction
Pricing	
PAYD Insurance (Mandatory)	2.5%
VMT Fee – \$0.02-\$0.05/Mile	1.0%–2.5%
Congestion Pricing	0.5%–1.1%
Transit Improvements	0.4%–1.1% (2030) 0.6%–2.0% (2050)
Nonmotorized Improvements	0.3%–0.8%
Parking Management	0.3%
Work Site Trip Reduction/Employee Commute Options	0.2%–1.1%
Telework and Alternative Work Schedules	0.9%–1.1%
Ridesharing and Vanpooling	0.1%–2.0%
Carsharing	0.1%–0.2%
Educational and Marketing Campaigns[a]	0.3%–0.5%+
Real-Time Transit and Multimodal Information	Unknown
Real-Time Traffic and Parking Information[a]	0.1%+
Eco-Driving and Maintenance	1.1%–5.0%
Idle Reduction	0.1%–0.4%
Speed Limit Reduction/Enforcement	1.7%–2.7%
Combined Effects (see text for explanation)	**7.0%–15.3%**

[Source: Estimates from the literature as described in Section 4.0, primarily based on U.S. DOT (2010c).]
Moderate to substantial uncertainty is associated with most estimates.
Provision of a point estimate rather than a range does not imply greater certainty.
[a] + Denotes additional, unknown effect of emerging information technologies.

Promoting Walking and Bicycling

A 2015 study from the Institute for Transportation and Development Policy measured the potential of bikes and e-bikes to reduce greenhouse gas emissions.[8] According to the

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[7] http://www.nrel.gov/docs/fy13osti/55634.pdf

[8] http://usa.streetsblog.org/2015/11/18/how-much-can-bicycling-help-fight-climate-change-a-lot-if-cities-try/

study, bicycling could help cut carbon emissions from urban transportation 11%. Similar studies have demonstrated that land use patterns and intensity that encourage walking can reduce GHG emissions by up to 10%.[9]

Building Energy Efficiency

Commercial Sector Outreach (Direct Install)

As part of a US EPA grant-funded study in 2011-2012, the Sustainability Institute conducted a pilot study that encouraged municipalities to leverage their own experiences with the Direct Install program into a targeted outreach to the local business community. The New Jersey Sustainable Energy Efficiency Demonstration Projects (NJ SEED)[10] findings showed an increase of 59% for local business uptake of the Direct Install program based on this approach. As a result, a Sustainable Jersey action was created and these initial efforts have been duplicated by a number of New Jersey municipalities. Given the typical savings, we estimate about a one-half of one percent (.005) reduction in GHG emissions as a result of this action.

Outreach to Residents (Home Performance w/Energy Star)

Also as a part of the NJ SEED study, a pilot program focusing on the residential Home Performance with Energy Star program was conducted. This effort led to a new action in the Sustainable Jersey program. As of 2015, six municipalities have successfully completed the action with an average increase in program participation of 700%. Given the average savings for a typical home, we estimate an annual GHG savings of approximately 1% for municipalities who complete this effort.

Tree Canopy (Shading Effect)

According to a study done by the USDA Forest Service ("Energy-Saving Potential of Trees in Chicago", E. Gregory McPherson[11]), the potential GHG savings associated with an increase in tree canopy due to the shading effect can range from 1-2% of community emissions.

3.2 Effective Strategies to Achieve the *Municipal Operations* Standard

In this section we summarize the research and assumptions underpinning the estimates for each listed strategy, beginning with the community-wide standard.

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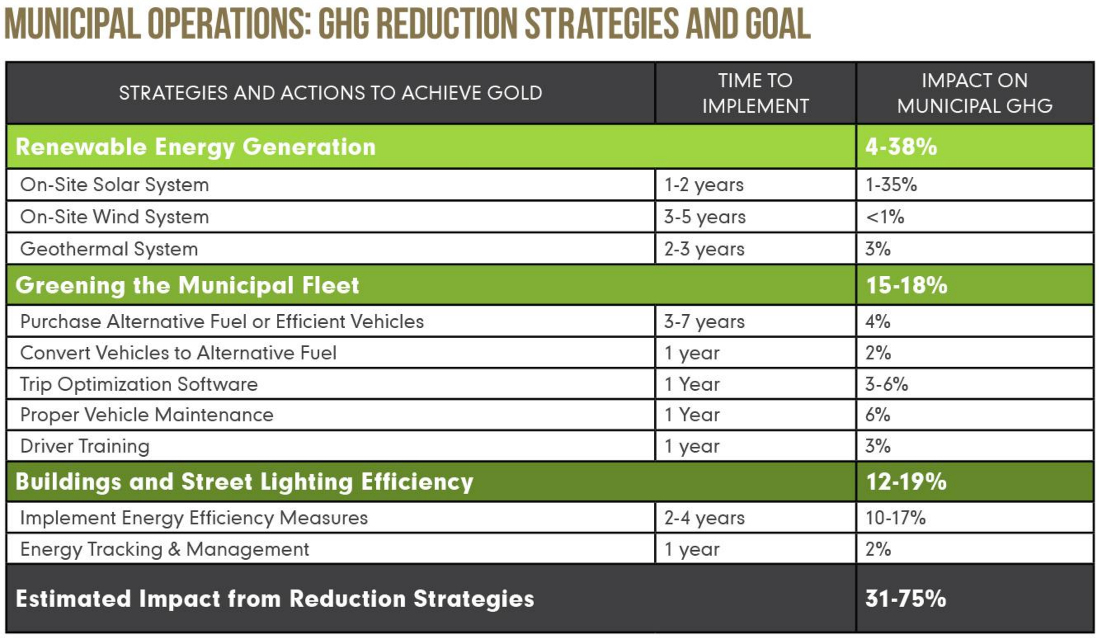
[9] "Carbon emissions from land use and land-cover change." / Houghton, R. A.; House, J. I.; Pongratz, J.; Van Der Werf, G. R.; Defries, R. S.; Hansen, M. C.; Le Quéré, C.; Ramankutty, N. Biogeosciences, Vol. 9, No. 12, 26.12.2012, p. 5125-5142.

[10] http://www.sustainablejersey.com/fileadmin/media/Grants_and_Resources/Publications/Final_NJ_Seed_Technical_Report.pdf

[11] http://wcsu.csu.edu/cerc/documents/EnergySavingPotentialofTreesInChicago.pdf

Figure 8



MUNICIPAL OPERATIONS: GHG REDUCTION STRATEGIES AND GOAL

STRATEGIES AND ACTIONS TO ACHIEVE GOLD	TIME TO IMPLEMENT	IMPACT ON MUNICIPAL GHG
Renewable Energy Generation		**4-38%**
On-Site Solar System	1-2 years	1-35%
On-Site Wind System	3-5 years	<1%
Geothermal System	2-3 years	3%
Greening the Municipal Fleet		**15-18%**
Purchase Alternative Fuel or Efficient Vehicles	3-7 years	4%
Convert Vehicles to Alternative Fuel	1 year	2%
Trip Optimization Software	1 Year	3-6%
Proper Vehicle Maintenance	1 Year	6%
Driver Training	1 year	3%
Buildings and Street Lighting Efficiency		**12-19%**
Implement Energy Efficiency Measures	2-4 years	10-17%
Energy Tracking & Management	1 year	2%
Estimated Impact from Reduction Strategies		**31-75%**

On-Site Wind System

The potential for On-Site Wind systems as a viable energy alternative are limited to offshore development according to a 2004 study conducted by a consultant to the NJ BPU.[12] While limited use of the technology has been used by some school districts, the economics at this point severely limit this as an attractive option. We estimate the potential impact on GHG emissions to be <1% at this time.

Geothermal System

According to industry data, geothermal energy systems can cut natural gas consumption by 50%. Given that a typical municipal carbon footprint for natural gas is 7% of the total emissions, this suggests a potential savings of 3% for a municipality that is suited to this technology.

Greening the Municipal Fleet:

Purchase Alternative Fuel or Efficient Vehicles

To calculate the potential for alternative fuel vehicles, we assumed the replacement of non-essential vehicles only (non-police, non-fire). Based on an analysis of New Jersey municipalities who have submitted a Fleet inventory to Sustainable Jersey[13], these vehicles account for just 15% of the typical fleet carbon footprint. GHG savings for

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[12] http://www.njcleanenergy.com/files/file/FinalNewJersey.pdf

[13] http://www.sustainablejersey.com/actions-certification/actions/#open/action/86

replacing conventional vehicles with hybrid vehicles are around 40% fuel savings. Finally, the typical municipality has a carbon footprint that comprised of 58% of GHG due to fleets.

So, 15% *40%*58% = 3.6% is the estimated GHG reduction for this action.

Convert Vehicles to Alternative Fuel

Fuel efficiency savings for retrofits are typically about 20% (as opposed to replacement with hybrid vehicles above). Assuming the same universe of possible replacements vehicles as above, savings for retrofits are half those of outright vehicle replacements. The potential savings are thus approximately 2% for this strategy.

Greening the Municipal Fleet: Trip Optimization Software

Various sources place the immediate range of reductions for trip optimization software in the 5-10% range. Given the 58% carbon footprint of the average fleet, this works out to a potential GHG reduction of 3-6% for this strategy.

Proper Vehicle Maintenance

According to the US EPA, proper vehicle maintenance can reduce the lifetime GHG emissions of a municipal fleet by 10%.[14] Given the 58% carbon footprint of the average fleet, this works out to a potential GHG reduction of approximately 6% for this strategy.

Driver Training

According the Sustainable Jersey action write up, the US EPA estimates that proper driver training can generate fuel savings of at least 5%. Given the fleet GHG composition, this translates to a potential annual GHG savings for the municipality of 3%.

Implement Energy Efficiency Measures

We have calculated a range for this action based on data from two separate sources. For the low end of the range, we utilized data from the DOE study on NJ Local Government Energy Audit data. This database covers the results of energy audits for 354 local government units in New Jersey through 2014. The recommended energy conservation measures in those audits result in average savings of 23.4% for electricity and 20.6% for natural gas. So, given the carbon profile already referenced for a typical municipality, the potential GHG savings is: 23.4% * 35% + 20.6% * 7% = 10% for the lower range.

For the upper range potential, we have used statistics from the Energy Saving Improvement Programs (ESIPs). Those savings thus far have been considerably higher than savings found in the LGEA program; average savings have been 41% for electric and

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[14] http://reason.org/files/pb84_san_diego_fleet_maintenance.pdf

32% for natural gas, making upper bound calculation of GHG potential for this action 41% * 35.5 + 32% * 7% = 17%.

Energy Tracking and Management

According to one study ("The Effectiveness of Feedback on Energy Consumption", Darby, Environmental Change Institute, 2006)[15], "….In the longer term and on a larger scale, informative billing and annual energy reports can promote investment as well as influencing behavior. Savings have been shown in the region of 5-15% and 0-10% for direct and indirect feedback respectively."

Given the difficulties is teasing out the synergies between tracking itself and building upgrades, we have conservatively chosen 2% as the effective potential on GHG emissions from implementing and energy tracking and management system.

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[15] http://www.usclcorp.com/news/DEFRA-report-with-appendix.pdf

Appendix

Table 1A: Regression: Role of Population, Employment and Net Activity on emissions

Dependent Var **N= 113**	**Independent Var**	**t-val**	**R^2 (%)**
GHG emissions in 2010	Pop_2010	17.88	74.22
	Job_2010	11.66	55
	Net_Activity_2010	15.34	67.95
GHG emissions in 2005	Pop_2005	25.9	85.8
	Job_2005	16.45	70.9
	Net_Activity_2005	24.13	83.99

Table 2A: 5 Municipalities with large % change in GHG emissions after Normalization

Municipality	**% change in emissions**
1. Bordentown City	421.44
2. Medford Lakes Borough	444.13
3. Pemberton Township	677.19
4. Southampton Township	482.93
5. Pennington Borough	387.42

Table 3A: Municipalities meeting Gold star standard rate of community-wide reduction in GHG emissions

	Municipality	Normalized % Change/year
1	Chesterfield Township	-30.24
2	Delanco Township	-39.89
3	Eastampton Township	-44.79
4	Florence Township	-31.46
5	Moorestown Township	-8.45
6	Shamong Township	-11.97
7	Springfield Township	-59.01
8	Tabernacle Township	-8.06
9	Washington Township	-65.62
10	Westhampton Township	-21.65
11	Woodland Township	-53.58
12	Wrightstown Borough	-71.3

13	Audubon Park	-99.95
14	Collingswood Borough	-17.74
15	Hi-Nella Borough	-39.15
16	Laurel Springs Borough	-5.35
17	Tavistock Borough	-100
18	Deptford Township	-6.85
19	E. Greenwich Township	-6.41
20	Elk Township	-3.37
21	Paulsboro Borough	-16.61
22	Wenonah Borough	-7.2
23	Ewing Township	-11.4
24	Hightstown Borough	-13.09
25	Hopewell Township	-23.7
26	Lawrence Township	-15.73
27	Robbinsville Township	-1.97

Table 4A: Municipalities with more than 75% increase or reduction of GHG emissions

	Municipality	County	% GHG emissions change
1	Audubon Park Borough	Camden	-99
2	Tavistock	Camden	-99
3	Pine Valley	Camden	-89
4	Wrightstown	Burlington	-78
5	Washington (Burlington)	Burlington	-76
6	Logan	Gloucester	85
7	Mount Holly	Burlington	103
8	Chesilhurst	Camden	104
9	Medford Lakes	Burlington	109
10	Hopewell Borough	Mercer	113
11	Southampton	Burlington	122
12	Pennington	Mercer	128
13	Glassboro	Gloucester	151
14	Bordentown City	Burlington	175
15	Princeton Borough	Mercer	180
16	Paulsboro	Gloucester	326

Table 5A: Municipalities with more than 75% increase or reduction of GHG emissions per job

	Municipality	County	% change in GHG emissions per job
1	Audubon Park Borough	Camden	-98.9
2	Delanco Township	Burlington	-94
3	Pine Valley Borough	Camden	-89.6
4	Hi-Nella Borough	Camden	-88
5	Wrightstown	Burlington	-78.8
6	Pemberton Township	Burlington	76.7722
7	East Windsor Township	Mercer	83.73282
8	Hopewell Borough	Mercer	93.28733
9	Fieldsboro Borough	Burlington	93.48549
10	Greenwich Township	Gloucester	122.4942
11	Westville Borough	Gloucester	132.0547
12	Stratford Borough	Camden	133.7523
13	Pemberton Borough	Burlington	134.4636
14	Mount Holly Township	Burlington	137.8083
15	Medford Lakes Borough	Burlington	137.9949
16	Southampton Township	Burlington	143.0289
17	Bordentown City	Burlington	153.5433
18	Glassboro Borough	Gloucester	172.4653
19	Paulsboro Borough	Gloucester	335.4859
20	Chesilhurst Borough	Camden	735.278

Table 6A: Municipalities with more than 75% increase or reduction in emissions per net activity

	Municipality	County	% change in GHG emissions per net activity
1	Tavistock Borough	Camden	-99.97
2	Audubon Park Borough	Camden	-99.066
3	Pine Valley Borough	Camden	-85.637
4	Wrightstown Borough	Burlington	-78.79
5	Logan Township	Gloucester	77.32
6	Pennington Borough	Mercer	81.41
7	Hopewell Borough	Mercer	124.74
8	Medford Lakes Borough	Burlington	128.23
9	Chesilhurst Borough	Camden	130.73
10	Mount Holly Township	Burlington	131.80
11	Southampton Township	Burlington	132.93

12	Glassboro Borough	Gloucester	162.39
13	Bordentown City	Burlington	170.33
14	Paulsboro Borough	Gloucester	327.55

Table 7A: Municipalities with reduction in GHG emissions per Net Activity between 2005 and 2010

	Municipality	% Change in Emissions per Net Activity
1	Wrightstown Borough	-75.04
2	Woodland Township	-70.81
3	Woodbury Heights Borough	-65.68
4	West Deptford Township	-61.2
5	Maple Shade Township	-60.31
6	Delanco Township	-51.47
7	South Harrison Township	-51.04
8	Eastampton Township	-48.23
9	Greenwich Township	-43.41
10	Florence Township	-42.2
11	Elk Township	-35.9
12	Westampton Township	-35.26
13	Chesterfield Township	-34.62
14	Hopewell Township	-34.55
15	Hi-Nella Borough	-33.01
16	Robbinsville Township	-29.92
17	Wenonah Borough	-27.06
18	North Hanover Township	-24.08
19	Mantua Township	-22.27
20	Medford Township	-19.09
21	Ewing Township	-18.94
22	Deptford Township	-18.86
23	Moorestown Township	-18.56
24	Lawrence Township	-16.29
25	Collingswood Borough	-15.61
26	Oaklyn Borough	-13.83
27	Lawnside Borough	-11.9
28	Mansfield Township	-11.28
29	Delran Township	-10.99
30	Berlin Township	-8.83
31	Shamong Township	-8.56
32	Bellmawr Borough	-8.39
33	Hamilton Township	-6.59
34	Runnemede Borough	-6.54

35	Cinnaminson Township	-6.42
36	Franklin Township	-6.08
37	Woolwich Township	-5.91
38	Tabernacle Township	-5.31
39	Cherry Hill Township	-5.03
40	Willingboro Township	-3.64
41	Palmyra Borough	-3.46
42	Somerdale Borough	-3.1
43	Camden City	-2.98
44	Clementon Borough	-2.79
45	Burlington Township	-1.12