NJTPA Regional Greenhouse Gas Mitigation Plan

Final Report

prepared for

North Jersey Transportation Planning Authority

prepared by

Cambridge Systematics, Inc.
4800 Hampden Lane, Suite 800
Bethesda, MD 20814

with

Fitzgerald & Halliday, Inc.

date

July, 2013

Table of Contents

List of Tables

List of Figures

Executive Summary

NJTPA is addressing the challenges of climate change through a series of research activities providing the analytic foundation for sound, effective policies to mitigate the transportation sector's role in climate change and prepare the transportation system for potential climate change impacts. The outcomes of these research activities are designed to support the diverse planning, development, and infrastructure needs of NJTPA's member jurisdictions.

In 2006, on-road transportation accounted for 25 percent of all GHG emissions in the NJTPA region. This share is projected to increase relative to other sectors without significant and sustainable improvements in vehicle and fuel efficiency, as well as strategies to reduce growth in vehicle miles traveled and improve the operational efficiency of the transportation system. Recognizing this, NJTPA led an analysis of the effectiveness of transportation strategy options that would reduce on-road GHG emissions. The results of this analysis are presented in this NJTPA Regional Greenhouse Gas Emissions Mitigation Plan (the Plan).

Plan Objectives

The objectives of the Plan are to:

- Evaluate on-road GHG emissions from 2006 to 2050 consistent with implementation of Plan2035 and all final Federal fuel economy standards,
- Address local transportation and planning needs through estimating the effectiveness of a range of strategies for NJTPA predefined place types,
- Communicate all strategy information through enhancements to NJTPAs ViZtools, and
- Link the findings of the Plan to ongoing Regional, State, and Local transportation planning activities including the Regional Plan for Sustainable Development (RPSD) and NJTPAs next long-range transportation plan - Plan2040.

The Regional GHG Emissions Baseline

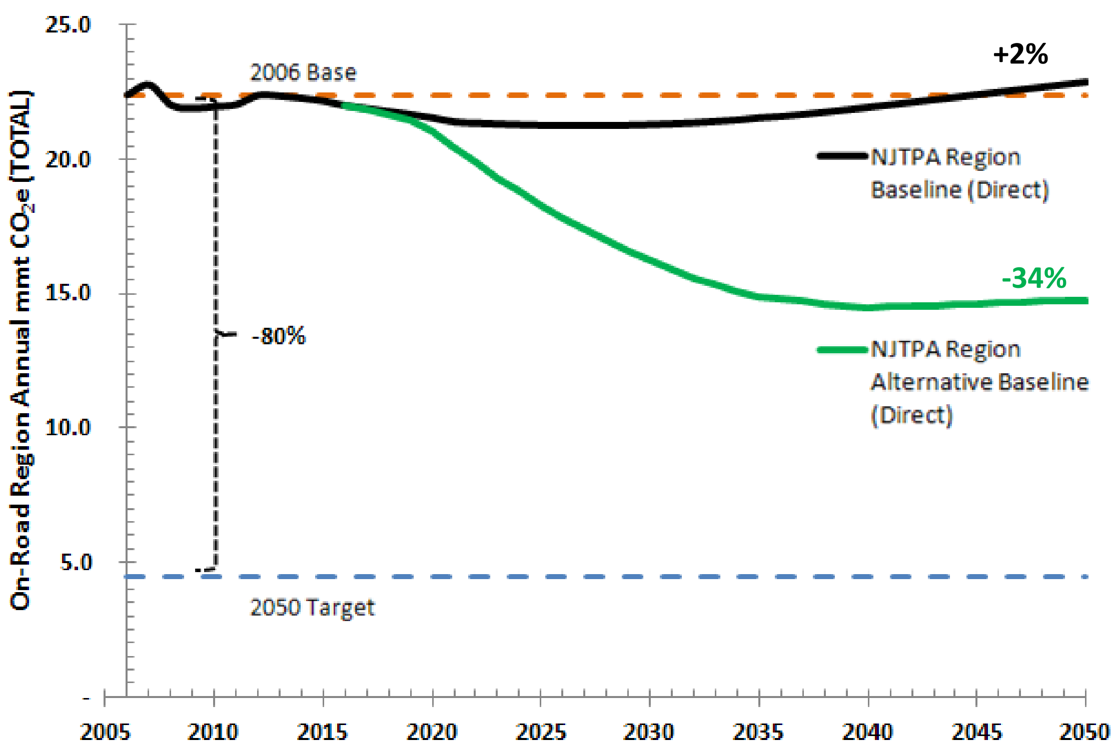
NJTPA reviewed VMT forecasts associated with adoption of Plan2035 and all final Federal vehicle fuel economy standards (including the final MY2017-2025 car and light-duty truck fuel economy standard). From this review, the primary transportation trends that impact regional GHG emissions baseline are:

- **Vehicle & Fuel Technology** – Average passenger vehicle emission rates on a grams of CO_2e per mile basis will decrease with implementation of Federal standards from **397g CO_2e/mi** in 2006, to **177g CO_2e/mi** by 2050;
- **Vehicle Miles Traveled (VMT)** – NJTPA Plan2035 projects a moderate growth in VMT through 2035, overall consistent or slightly exceeding forecast population growth; and

- **Delay** – In congested conditions, with lower travel speeds, idling, and stop and start activity, vehicles operate far less efficiently. Average delay per trip from 2006 to 2035 is forecast to increase **47 percent**, resulting in each trip becoming about **8 – 10 percent** more carbon intensive.

Figure ES.1 presents the regional GHG emission baseline, showing the difference in emissions when accounting only for the Federal 2012-2016 car and light duty truck standards (34.0 mpg by MY 2016 - Baseline) and the 2017-2025 car and light duty truck standards (54.5 mpg by MY 2025 – Alternative Baseline). By 2050 the region achieves a **34 percent** reduction from 2006 emissions as a result of the implementation of Plan2035 and all Federal fuel economy standards. This is a positive trend, however falls well short of the target established by the New Jersey Global Warming Response Act of an 80 percent reduction from 2006 emissions by 2050.

Figure ES.1 2006-2050 Region On-Road Mobile Regional Emissions Inventory



STRATEGIES TO CLOSE THE GAP

NJTPA convened a Technical Advisory Committee (TAC) including state agency, regional, and local partners to develop a list of feasible transportation GHG reduction strategies defined at the local and regional scales. The TAC reached consensus on a universe of 26 strategies arrayed across approaches for reducing VMT, reducing travel congestion, and reducing carbon emissions per mile of travel. The list includes strategies that:

- Enhance smart growth, transit oriented development, and freight oriented development;
- Improve bike and pedestrian accessibility to activity centers and transit stations;
- Increase the availability and convenience of programs aimed at providing incentives for commuters who choose to rideshare, ride transit, telecommute, or change work schedules;
- Continue to invest in improving the operation of regional and local transit systems;
- Support Pay-as-you-drive insurance and develop new sources of revenue through a mileage of emission based fee beyond the current motor vehicle fuels tax;
- Enhance cross-jurisdiction and inter-agency active monitoring and management of the transportation system, including continued expansion of the region's Intelligent Transportation System, incident management, and travel information programs;
- Build partnerships with PANYNJ and private freight carriers to improve truck routing, time-of-day guidance and relieve critical rail network capacity constraints; and,
- Accelerate the deployment of electric vehicle (EV) charging and other alternative fuel vehicle (AFV) infrastructure in the region through multi-region/multi-state system planning, partnerships with the private sector, and expanded incentives for purchasing of EVs, AFVs, and residential and commercial charging stations.

The TAC decided to evolve the analysis of strategies into strategy bundles. The arrangement of strategy bundles is intended to provide additional information on how logical combinations of strategies interact positively to result in more significant GHG emission reductions. The results of the individual strategy analysis and bundle analysis are segmented by four different place types (urban, metropolitan, suburban, and rural) to assist communities in viewing strategies and impacts tailored to the socioeconomic and land use characteristics of their location.

STRATEGY AND BUNDLE OUTCOMES

Utilizing state of the practice analysis methods and local data, NJTPA assessed the potential GHG reduction effectiveness and cost effectiveness of the strategies and bundles (Table ES.1 and ES.2). The combined bundle development process is presented in Figure ES.2.

Table ES.1 Strategy Emission Reduction Results (2040)

Strategy	Potential 2040 GHG Emissions Reduction
Smart Growth	**2 to 3 percent** reduction for municipal land use strategies
Transit Oriented Development	**20 percent** reduction for trips starting or ending within TOD locations only
Freight Oriented Development	**4 percent** reduction regionwide based on regional freight village strategy
Complete Streets	**1 percent** reduction including improved transit access
Travel Demand Management and Parking	**6 percent** to **20 percent** when including parking pricing strategies for commute VMT only

Rail & Bus Service Enhancement	**2 to 6 percent** reduction with greatest potential in metropolitan place types
VMT Fee/Carbon Tax	**1 to 2 percent** reduction for an increase in the motor vehicle fuels tax applied based on miles traveled or emissions
PAYD Insurance	**2 percent** reduction with highest potential in urban and metro place type
Arterial System Management	**6 to 12 percent** reduction by corridor
Limited Access System Management	**3 to 17 percent** reduction by corridor with incident management
Access Management	**28 percent** reduction for full access control, **2 to 6 percent** reduction for retrofits
Commercial Vehicle Efficiency Strategies	- **18 percent** reduction in activity centers for time-of-day or truck routing policies, - **37 percent** reduction by project for intermodal access, - **26 percent** reduction regionwide for freight rail capacity
EV Plan Implementation and Clean Fuels	Up to a **20 percent** reduction regionwide for passenger vehicle travel
Clean Commercial Vehicle Fleet	Up to a **68 percent** reduction regionwide, plus up to a **95 percent** reduction in emissions associated with extended idling

Figure ES.2 Combined Bundle Development

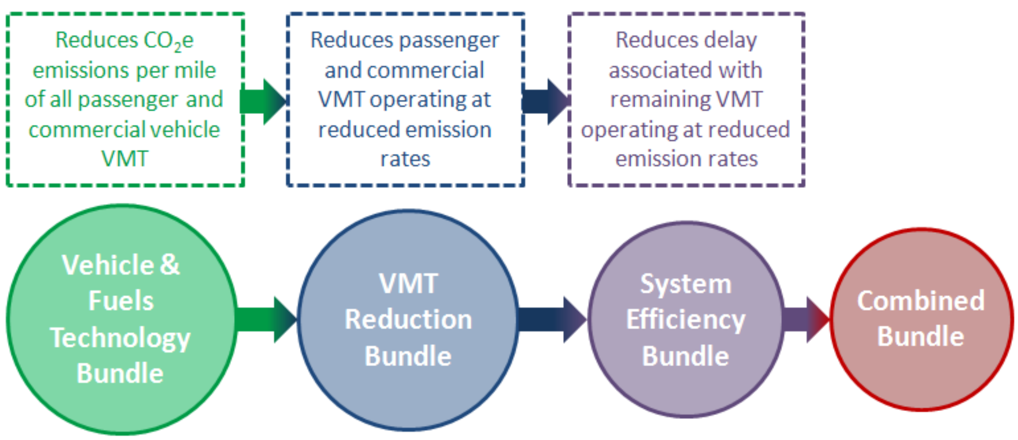


Table ES.2 Combined Bundle GHG Emission Reduction Results

Year/Scenario	Urban	Metro	Suburb	Rural
2025	20%	14%	12%	5%
2040 – Medium	34%	31%	31%	22%
2040 – High	46%	45%	45%	35%

To present cost effectiveness, strategies were arrayed based on an assessment considering the payback period (time it takes for user savings to exceed implementation costs), the level of risk in achieving the anticipated benefits, the implementation barriers, and the level of annual costs.

Short payback period strategies - Predominantly policy or incentive based approaches with low costs that are able to impact a significant proportion of vehicular travel or able to generate significant reductions for a targeted travel market. For example, PAYD Insurance has close to zero public cost, but can benefit all drivers in the region. Employer based commute strategies such as ridersharing, telecommuting, and parking pricing, show comparatively low public sector costs, with the potential for immediate and significant GHG reductions.

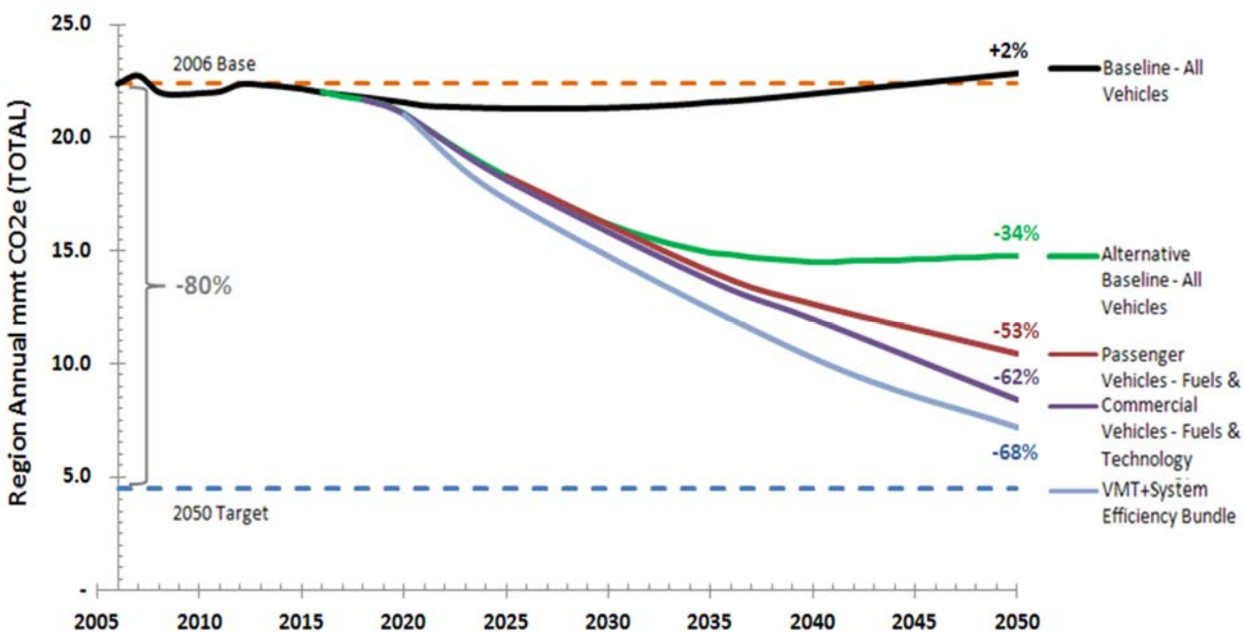
Long payback period strategies - High up-front costs, long implementation timelines or extensive barriers, ongoing maintenance and operations costs, and in some cases uncertain benefits. Most strategies with uncertain benefits were not assessed within the Plan, however cost intensive strategies such as rail transit quality of service fall into this category because, despite the potential for significant benefits, the high capital and ongoing maintenance and operations costs are difficult to completely payback.

REGIONAL "WHAT IF" ANALYSIS

The final step in the development of the Plan linked the results of the bundle analysis to potential regional GHG emission reductions. The overall objective of the regional scenario approach is to conduct a "what if" analysis of how far the region could reasonable expect to move towards a transportation system that attains the New Jersey Global Warming Response Act target of an 80% reduction in 2006 emissions by 2050.

The analysis looks at 2025, 2040, and 2050, deploying feasible strategies consistent with the definitions created by the Technical Advisory Committee, but not considering the cost to implement. The results of this analysis are presented in Figure ES.3.

Figure ES.3 NJTPA Region Scenario "What If" Analysis



This scenario combines the following components to achieve a **68 percent** reduction from 2006 by 2050:

- Improvement in passenger vehicle fuels and technology beyond the final Federal standards takes the region to **53 percent below 2006 by 2050** – based on an EV on-road share of **55-60 percent by 2050,** and remaining on-road vehicles reducing emissions by **25 percent by 2040**;
- Continued improvement in commercial vehicle fuels and technology beyond final Federal standards and other programs takes the region to **62 percent below 2006 by 2050**;
- VMT reduction strategies deployed by place type, at the highest reasonable level of deployment, takes the region to **67 percent below 2006 emissions by 2050 (additional 5 percent reduction)**; and
- System efficiency strategies deployed by place type, addressing VMT on all facilities operating at LOS D+ plus regional strategies that enhance truck operations takes the region to **68 percent below 2006 by 2050 (additional 1 percent reduction)**.

REGIONAL "WHAT IF" ANALYSIS IMPLICATIONS

With an on-road passenger vehicle fleet that is around **74 percent less carbon intensive on a grams/mile basis in 2050 compared to 2006,** reducing enough VMT or inefficient travel to cross the remainder of the "what if" scenario **12 percent target shortfall** is difficult because of the diminishing return on VMT and system efficiency strategies.

If the most aggressive forecast assumption of an **80 percent** passenger electric vehicle market share is considered, emissions fall to within **5-7 percent of the GHG reduction target**. In this case, the challenge is not as significant and the target could reasonably expect to be attained if:

- Regional energy sources supporting EV charging from the grid reduces carbon intensity significantly (consistent with achieving GWRA targets for the power-generation sector). If the power generation sector attains an 80 percent reduction in electricity carbon intensity by 2050, it is plausible that reduction may result in reaching the target.
- Early, continuous, and aggressive deployment of sustainable VMT and delay reduction strategies via smart growth, TDM, pricing, and system management**.**

Challenges remain in drawing the line between what Federal regulation can achieve, and the degree to which state and local programs/incentives can help spur further electric vehicle market penetration. A comprehensive supply and demand approach is required where the public sector can support through regional, state, and local programs and partnerships to expand the availability of charging infrastructure; electric vehicle readiness planning and policy development; and, continued or expanded Federal and state incentives/subsidies for EV purchases and private EVSE installation. Ultimately consumer purchasing decisions will be based on price, vehicle reliability, and potential savings – the actions above help to improve the competition in the short-term.

VMT and system efficiency strategies show a diminishing return in terms of GHG emission reduction beyond 2035. This does not imply that VMT and System Efficiency strategies are not effective contributors to GHG reduction. The societal benefits of these strategies are potentially more significant than vehicle technology or alternative fuels, which so far have uncertain consumer costs and savings. In addition these strategies address value of time, equity, and economic growth – areas that may have more value to the region than GHG emission reductions.

NEXT STEPS

NJTPA is in the process of developing the Regional Plan for Sustainable Development and PLAN2040 (the next Regional Transportation Plan). Both of these efforts will help frame the land use and transportation priorities for NJTPA and its member jurisdictions through 2040. The 13 counties in the NJTPA region, the 384 municipalities, as well as NJTPAs partner state agencies ongoing transportation planning processes are increasingly considering the impacts of transportation and land use planning decisions on GHG emissions. In all of these activities, the findings of this Plan will help guide technical analysis, prioritization of strategies, and identify areas for additional research. Outcomes of the strategy analysis are also included in NJTPAs ViZtools application and GHG emission forecasts by county and municipality are available through the NJTPA GHG Emissions Webtool.

1.0 Introduction

1.1 Background

NJTPA is addressing the challenges of climate change through a series of research activities providing the analytic foundation for sound, effective policies to both mitigate the transportation sector's role in climate change and prepare the transportation system for potential climate change impacts. The outcomes of these research activities are designed to support the diverse planning, development, and infrastructure needs of NJTPA's member counties and municipalities.

The challenges are substantial. The New Jersey Global Warming Response Act (GWRA), enacted in 2007, targets a roll-back of statewide greenhouse gas (GHG) emissions to 1990 levels by 2020, and targets an 80 percent reduction from 2006 emissions by 2050. The northern New Jersey region supports one of the most dynamic and diverse economies in the nation, and this economy relies on a complex transportation system to maintain growth, increase the quality of life, and sustain the efficient movement of people and goods. The region's transportation system is also susceptible to the potential impacts of climate change as recently presented in the Climate Change Vulnerability and Risk Assessment of New Jersey's Transportation Infrastructure study[1].

In 2006, transportation accounted for 28 percent of direct GHG emissions in the NJTPA region[2]. This share is projected to increase relative to other sectors without significant and sustainable improvements in vehicle and fuel efficiency, as well as strategies to reduce growth in vehicle miles traveled and improve the operational efficiency of the transportation system.

Recognizing this, NJTPA has led an analysis of the effectiveness of transportation strategy options that would reduce GHG emissions from on-road mobile sources (which represents greater than 90 percent of all transportation sector GHG emissions in northern New Jersey). The results of this analysis are presented in this NJTPA Regional Greenhouse Gas Emissions Mitigation Plan (the Plan).

1.2 Plan Objectives

The objectives of the Plan are to:

- Update the on-road mobile source GHG emissions inventory and forecast for the NJTPA region, incorporating new federal fuel economy standards for cars, light-trucks, and commercial vehicles,

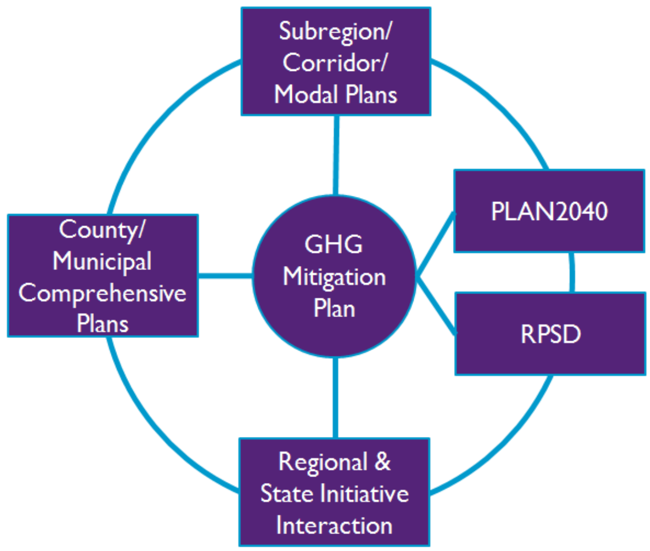
[1] http://www.njtpa.org/plan/Element/Climate/FHWAConceptualModel.aspx

[2] *NJTPA Regional Greenhouse Gas Inventory & Forecast (2010).*

- Develop
- Support local transportation and planning needs by providing effectiveness information and implementation details on transportation sector GHG mitigation strategies,
- Communicate strategy benefits through enhancements to NJTPAs ViZtools interactive webpage, and
- Link the findings of The Plan to ongoing Regional, State, and Local transportation planning activities including the Regional Plan for Sustainable Development (RPSD) and NJTPAs next long-range transportation plan (Plan2040).

There are a multitude of ongoing GHG mitigation planning and implementation activities in the transportation sector in the Northeast/Mid-Atlantic region, New Jersey, and locally which this Plan both builds upon and informs. These include activities led by the:

- Transportation and Climate Initiative (TCI),
- Northeast Vehicle Network[3],
- I-95 Corridor Coalition,
- New Jersey Clean Cities Coalition,
- Northeast States for Clean Air Management (NESCAUM),
- Statewide and local planning efforts led by NJTPA, NJDOT, NJTransit, PANYNJ, NJDEP and local transportation agencies, and
- North Jersey Sustainable Communities Consortium[4].



1.3 Planning Process Methodology

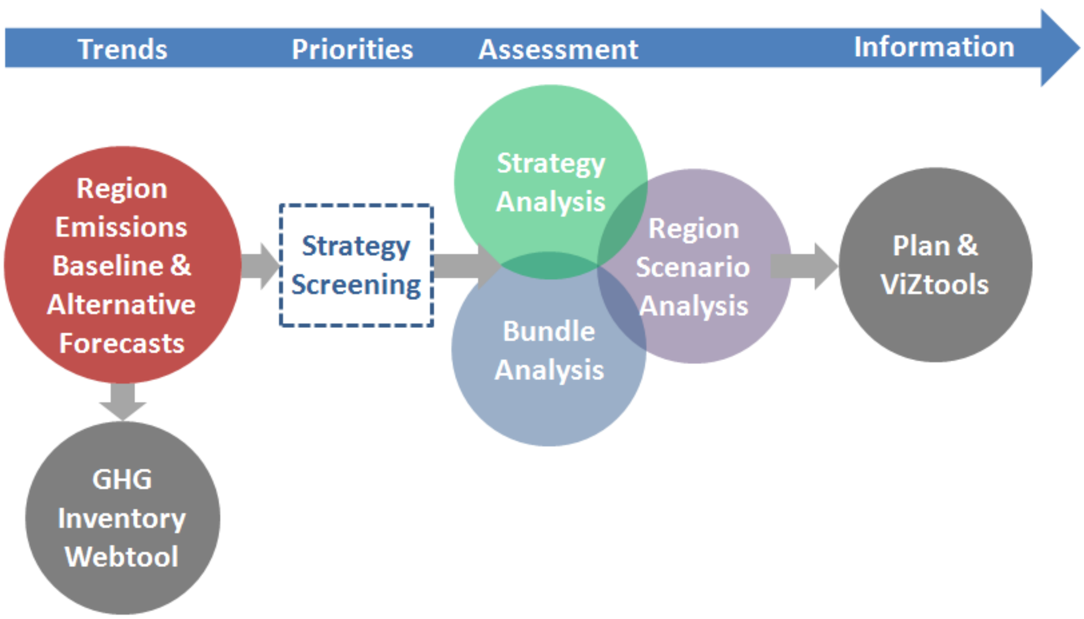
The planning process is presented in Figure 1.1. The overall approach began with a technical assessment of the regional GHG emissions inventory and forecast for both a Baseline and

[3] The Northeast Vehicle Network was formed as part of the Transportation and Climate Initiative (TCI). A recent report funded by U.S. Department of Energy was used extensively in this Plan to guide electric vehicle deployment strategy analysis. http://www.georgetownclimate.org/tci-releases-report-on-the-status-of-electric-vehicles-in-the-northeast

[4] The North Jersey Sustainable Communities Consortium, a project administered by the Edward J. Bloustein School of Planning and Public Policy at Rutgers, The State University of New Jersey, is the recipient of a $5 million U.S. Department of Housing and Urban Development (HUD) Sustainable Communities Regional Planning Grant award.

Alternative Baseline case. During this period, NJTPA convened a technical advisory committee (TAC) to help lead overall direction of the Plan development process as well as provide technical guidance. The TAC met initially to review initial Baseline results and comment on the Plan objectives and schedule. Following completion of the Baseline and Alternative Baseline forecasts, a strategy research and screening process was initiated. The TAC reviewed the outcomes of the screening process and recommended a list of priority strategies for inclusion in the Plan. The strategies and bundles were then defined, reviewed by the TAC, and then the benefits were assessed. The communication of the Plan findings is presented through an updated GHG Inventory Webtool (insert weblink), the Plan document and Appendices (insert weblink) and via NJTPAs ViZtools site (inserts weblink).

Figure 1.1 NJTPA Greenhouse Gas Mitigation Plan Process



2.0 On-Road Transportation GHG Emissions Inventory and Forecast

2.1 PURPOSE AND NEW COMPONENTS

The NJTPA completed the GHG Inventory & Forecast project (I&F) for the 13-county NJTPA region in 2011. The goal of the study was to quantify the amount and kinds of climate change gases that are emitted in the region across all economic sectors, including transportation-related emissions from on-road, non-road, aviation, marine, and rail transportation sectors including freight. The GHG inventory and forecast provides information to assist state, regional, and local policy makers and citizens understand the sources of GHG emissions so that well-informed policy decisions will be made to reduce these emissions.

As a result of updates in emission assessment tools and assumptions including vehicle miles traveled forecasts and vehicle emission rates, NJTPA decided to update the on-road transportation sector emission inventory and forecast at the outset of the development of this Plan. The critical differences between the I&F and this work are:

1. GHG emission rates in the I&F were based upon the U.S. EPA's MOVES2010 emissions model, which does not include the car and light truck greenhouse gas emissions/fuel economy standards affecting model years 2012-2016. Since the I&F work was completed, the EPA has released an update to the model, MOVES2010a, which incorporates the 2012-2016 standards and also updates fuel economy information on model years 2008-2011.
2. Emission estimates now include the effects of the final 2014-2018 medium-heavy duty vehicle standards[5] via an adjustment to emission rates from MOVES 2010a (refer to Appendix A for documentation of this approach).
3. New travel activity data from NJTPA's regional travel model (NJTRM-E) based on travel demand model runs supporting transportation air quality conformity analysis associated with the August 2011 amendment to the Plan2035[6].
4. A new Alternative Baseline assessment that includes modeling of the effects of the final 2017-2025 car and light-duty truck fuel economy standard.[7]

[5] http://www.nhtsa.gov/fuel-economy

[6] http://www.njtpa.org/plan/Element/AQ/conformity.aspx

[7] http://www.nhtsa.gov/About+NHTSA/Press+Releases

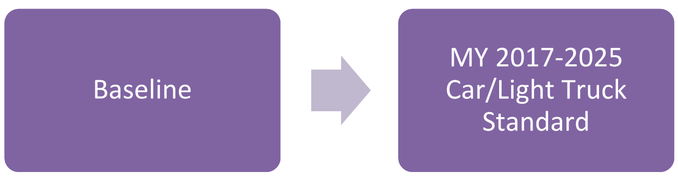
As a result of these extensive differences, particularly the use of an updated emissions modeling tool, direct comparison to the emission results presented in the I&F is cautioned.[8] Comparison of overall regional trends or shares by county are valuable, as long as the four critical differences noted above are kept in mind.

2.2 BASELINE AND ALTERNATIVE BASELINE

Two baseline GHG emission outcomes were modeled for the NJTPA region:

1. **Baseline =**

2. **Alternative Baseline =**



The GHG emission results for both the Baseline and Alternative Baseline are useful because they show the magnitude of the difference in regional on-road GHG emissions when full implementation of the MY 2017-2025 Light-Duty Vehicle Standards is assumed. This difference through 2050 is significant. The Final 2017-2025 Standard, as posted in the Federal register by EPA and NHTSA on October 15th, 2012, establishes the MY 2025 car and light-duty truck standard at 54.5 mpg, compared to 35.5 mpg for MY 2016.

2.3 METHODOLOGY

GHG emission estimates are developed on an annual basis, 2006 to 2050, across the following levels of detail (Appendix A provides additional information on the estimation methodology for each of these components of the regional baseline and alternative baseline emission forecasts):

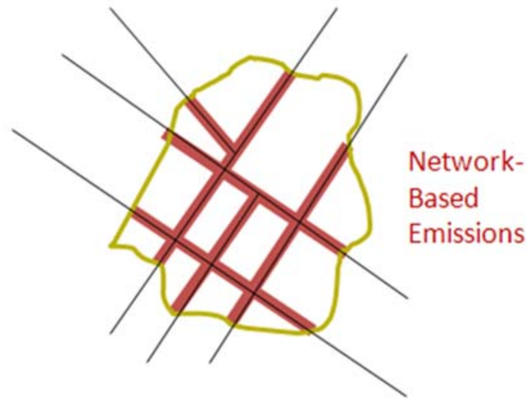
---

[8] http://www.njtpa.org/plan/Element/Climate/RegionalGreenhouseGasInventory.aspx

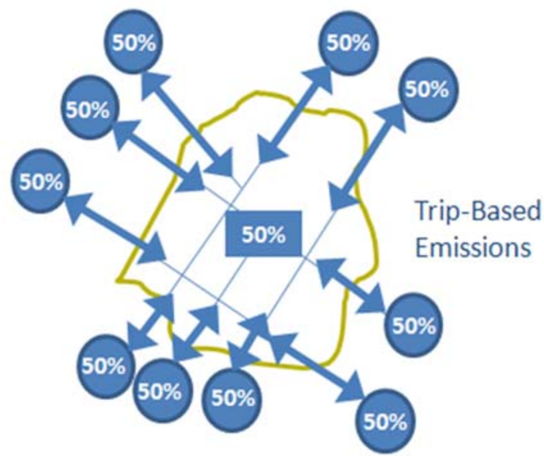
Three emission accounting methods:

1. **Direct** – aggregates total GHG emissions for VMT on each highway link within each jurisdiction including running and non-running emissions[9]. This approach reports the actual emissions from vehicles operating on roadways within each jurisdiction.
2. **Consumption** – aggregates total GHG emissions for 50 percent of emissions associated with all vehicle trips with a trip start or end within each jurisdiction including running and non-running emissions.
3. **Energy Cycle** – building from the consumption accounting method, this adds emissions associated with the production, refining, and transport of fuels.

Direct



Consumption



Two vehicle types:

1. Passenger vehicles – Motorcycles, passenger cars, and light passenger trucks
2. Commercial vehicle – Light trucks, single unit trucks, combination trucks

Three geographies:

1. NJTPA Region
2. NJTPA Counties (13),
3. NJTPA Municipalities (384)

Three greenhouse gases and greenhouse gas equivalents[10]:

1. Carbon dioxide (CO_2), Methane (CH_4), and Nitrogen Oxides (N_2O)

---

[9] Non-running emissions include vehicle starts and extended idle. Emissions from this activity average 6.5 percent of total emissions for passenger vehicles and 5.3 percent of total emissions for commercial vehicles in the NJTPA region.

[10] Greenhouse gas equivalents account for the global warming potential of each gas. The GWPs used in this analysis are consistent with the International Panel on Climate Change (IPCC) estimates used in the I&F.

2.4 Regional and Subregional Results

There are three critical underlying components that impact the Baseline and Alternative Baseline GHG emission results through 2050 at the regional and subregional scale. These are:

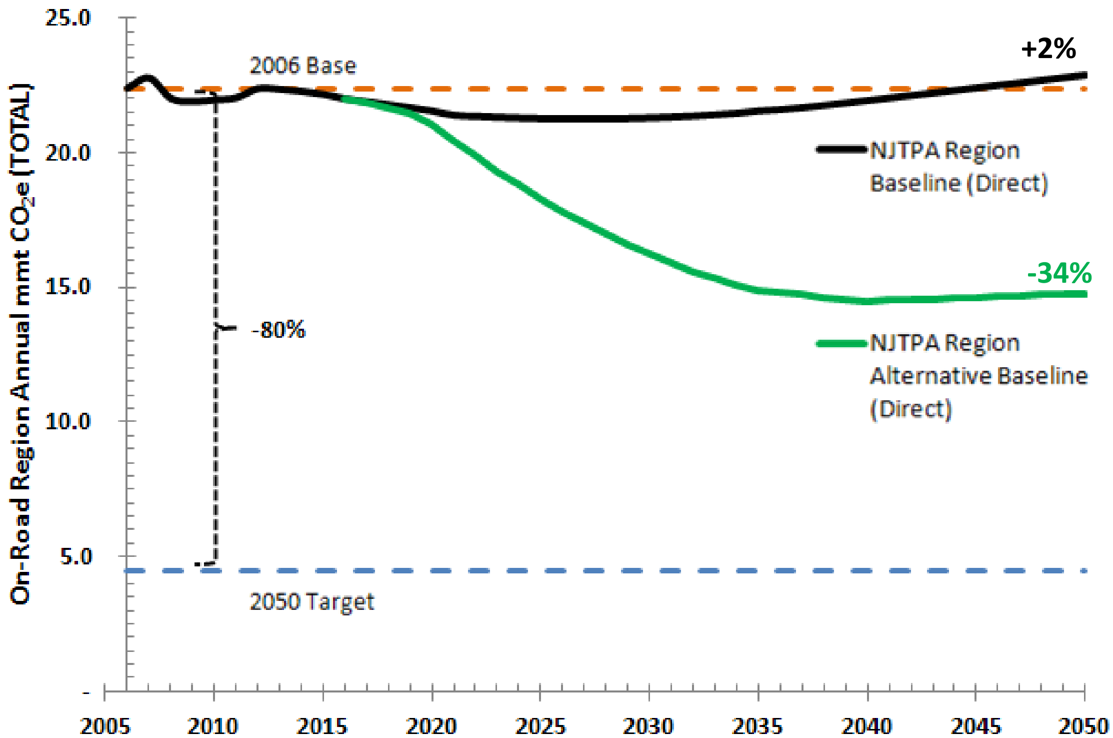
- **Vehicle & Fuel Technology** – Average passenger vehicle emission rates on a grams of CO_2e per mile basis decrease with Federal standards:
  - » 397 g CO_2e/mile (g/mi) in 2006, to
  - » 311g/mi (Baseline) or 177g/mi (Alternative Baseline) by 2050.
- **Vehicle Miles Traveled (VMT)** – NJTPA Plan 2035 projects a moderate growth in VMT through 2035, overall consistent or slightly exceeding forecast population growth:
  - » VMT per household remains constant or slightly increases through 2050, and is highest in exurban counties and areas with a low jobs to housing ratio, and
  - » Interstate VMT, particularly commercial, is a significant component of rural county/municipality total travel and therefore total GHG emissions.
- **Delay** – Vehicles operate most efficiently in a range between 30 and 50mph. In congested conditions, with lower travel speeds, idling, and stop and start activity, vehicles operate far less efficiently:
  - » Average delay per trip from 2006 to 2035 is forecast to increase 47%, resulting in each trip becoming about 8 – 10% more carbon intensive.

The above statistics represent regional trends. Trends in VMT and emissions per household by county show significant differences because of different growth rates in VMT, proportion of travel by passenger vehicles versus commercial vehicles, and the amount of congestion (see Appendix B figures for more details). For example, urban counties such as Hudson are located well below the region average for both VMT and CO_2e emissions per household, while rural counties such as Hunterdon are located above the regional average.

Figure 2.1 presents the Baseline and Alternative GHG emissions inventory and forecast through 2050.

NJTPA Region Baseline – The Baseline curve slightly decreases from 2006 through 2012 as VMT growth has remained stagnant in the region since 2008. As the economy recovers, the growth in emissions from increased travel activity will increasingly be offset by new vehicles entering the fleet that meet federal MY 2012-2016 car and light-duty truck standards and MY 2014-2018 medium- & heavy-duty truck standards. The curve reaches a low point around 2030, where the fleet has essentially completely turned-over, with over 95 percent of on-road vehicles at MY 2016 or newer. After 2030 the curve increases, reflecting essentially no change in fleet fuel efficiency, while VMT continues to grow. Total on-road GHG emissions in 2050 are 2 percent greater than 2006.

Figure 2.1 2006-2050 Region On-Road Mobile Regional Emissions Inventory



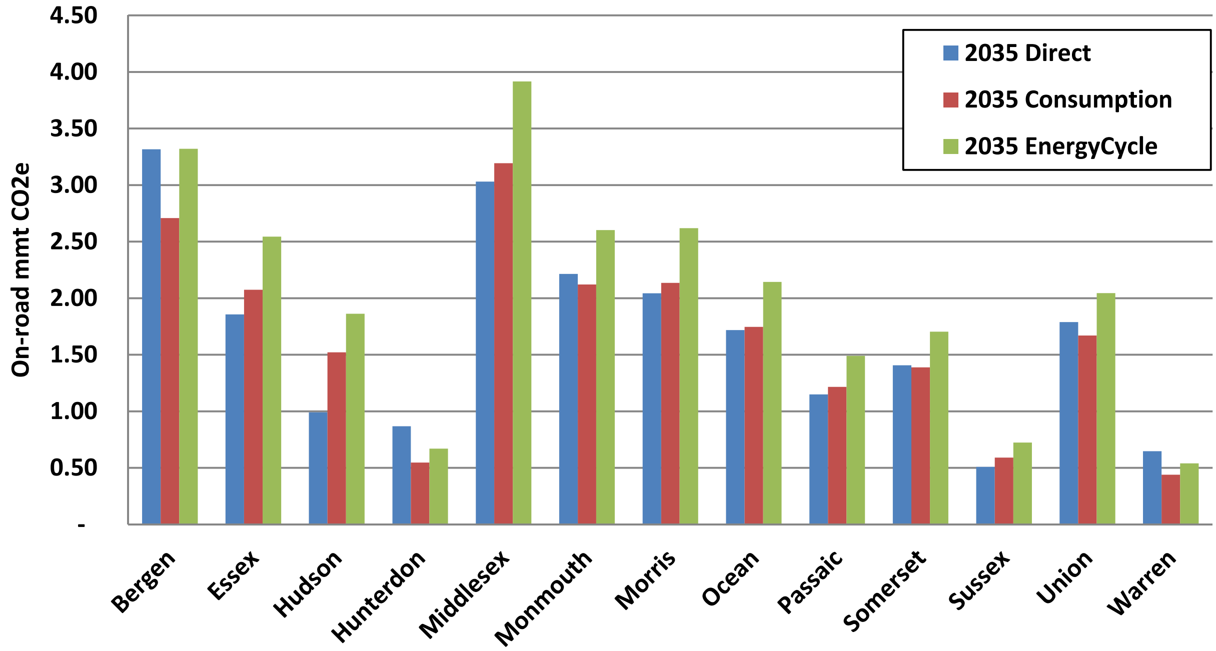
NJTPA Region Alternative Baseline – In 2017 the Alternative Baseline diverges from the Baseline as new MY 2017-2025 vehicles enter the fleet. The curve reaches a low point around 2040, where the fleet has essentially completely turned-over, with over 95 percent of on-road vehicles at MY 2025 or newer. Total on-road GHG emissions in 2050 are 34 percent less than 2006 in the Alternative Baseline.

Figure 2.1 only presents the emission outcomes for the direct emissions accounting approach. At the regional scale, total direct and consumption based emissions are slightly different. The real difference between the two is how through trips (e.g. trips without a start or end in the 13 county region) are accounted for – direct includes them as part of total VMT, consumption excludes them. The following examples explain how this impacts emission estimates:

1. For passenger vehicles, the direct approach shows 7-10 percent lower emissions than the consumption approach.
2. For commercial vehicles, the consumption approach shows 35–37 percent lower emissions than the direct approach.

When looking at direct versus consumption emissions at the county level, locations with significant pass-thru VMT show higher direct emissions (for example rural/exurban counties such as Hunterdon and Warren, while counties that generate and attract significantly more trips than those that pass-thru (Essex and Hudson) show higher consumption emissions (see Figure 2.2).

Figure 2.2 2035 Alternative Baseline CO_2e Emissions (by County and Approach)



Comparison of the direct and consumption based emissions accounting approaches is more valuable at the municipal scale. The reasoning behind a comparison for municipalities is to help identify the emissions that occur on the roadway network within the municipality (some of which are outside the municipality's control), versus emissions generated by trips with an actual origin or destination in the municipality.

Table 2.1 Municipality – Direct v. Consumption Comparison Example

		Total CO_2e (mmt)		
	Municipality	2006	2035	2050
BASELINE - Direct				
1	Newark	0.81	0.75	0.78
2	Woodbridge	0.55	0.53	0.56
8	Jersey City	0.30	0.33	0.36
BASELINE – Consumption				
1	Newark	0.77	0.67	0.69
2	Jersey City	0.56	0.56	0.61
4	Woodbridge	0.41	0.38	0.39

Table 2.1 presents three example municipalities in terms of total on-road GHG emissions in 2006 for the direct and consumption emissions accounting approaches. Newark shows similar direct and consumption based emissions as it has roughly equal balance of thru-trip activity (I-95) and trip origins and destinations (Newark CBD).

Jersey City shows high consumption based emissions as a result of its role as an employment center (e.g. more emissions are generated by all trips to and from Jersey City than all vehicles, including through vehicles on roadways in Jersey City).

Woodbridge shows higher direct based emissions as the result of significant volumes of through traffic on the New Jersey Turnpike and the Garden State Parkway.

The results of the regional Baseline and Alternative Baseline analysis help identify targeted opportunities for reducing GHG emissions. Two of these – a steady increase in VMT per household, and a significant increase in delay per vehicle trip are critical components of on-road GHG emissions. In order to optimize GHG reductions from vehicle technology improvements, a similar focus on reducing VMT and delay is required. The challenge in maintaining the balance between mitigation approaches is the high cost and implementation constraints of addressing the network issues that lead to continued growth in VMT and increases in travel delay. Chapter 3 describes the approach to identifying the preferred strategies for the NJTPA region to further investigate to assist in achieving this balance. Additional data tables and charts are presented in Appendix B.

Note: With the final rulemaking on the 2017-2025 car and light-duty truck fuel economy standard published to the Federal register in October, the analysis of strategies, bundles, and regional scenarios presented in the following chapters are all compared against the Alternative Baseline as presented in this chapter. Similarly, the update to NJTPA's GHG Inventory Webtool includes the emission estimated associated with the Alternative Baseline.

3.0 GHG Mitigation Strategy Development & Analysis

3.1 Guiding Principles

The development of the GHG mitigation strategy list followed a process of first conduction a region specific and then national literature review on best practice strategies and then two Technical Advisory Committee (TAC) meetings to discuss regional priorities and needs first, followed by an in-depth discussion of strategy definitions. The TAC followed some general guidance to more the process of identifying strategies forward, however these were not applied consistently to all decisions:

1. Authority to implement is held by New Jersey, its counties, or its municipalities
2. The strategy is feasible to implement and benefits are well understood
3. The strategy does no economic harm to the region
4. The strategy is consistent with regional and local goals and needs as identified in Plan 2035 and local comprehensive plans.

Overall strategies were picked that met these general criteria and were viewed as approaches with the greatest short- and long-range benefit to the region, not only in terms of GHG emission reduction, but also for other planning factors.

3.2 Strategy Set and Identification Process

Figure 3.1 Strategy Screening Process

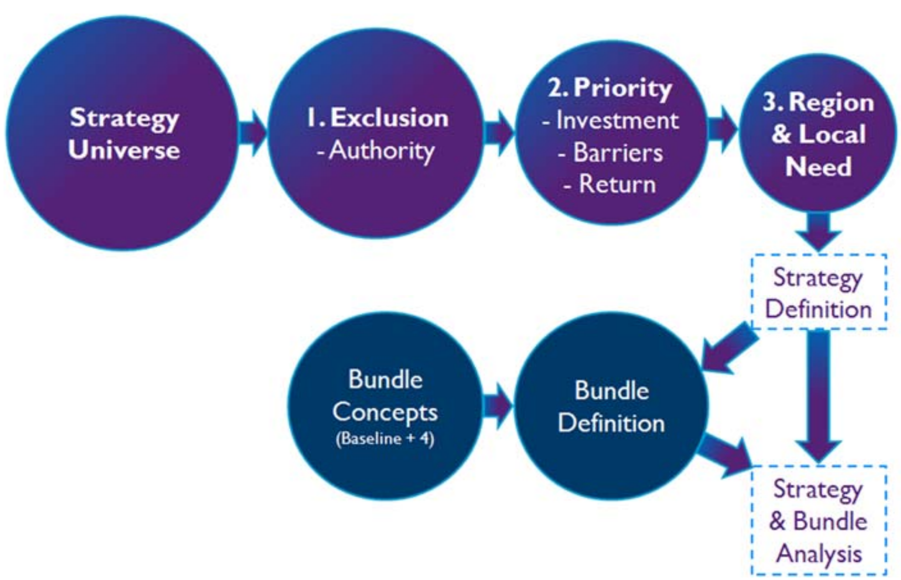


Figure 3.1 presents the strategy screening process for the Plan. A description of the steps followed in the process and the strategy decisions are presented below.

Step 1 – Exclusion

- Strategies were excluded if there is minimal or no local authority to implement:
  - VMT Fee and/or Carbon Pricing (State or Federal)
  - Pay-As-You-Drive Insurance, Insurance Discount for AFVs (State, private insurance companies)
  - Short-Sea-Shipping (Federal and Multi-state)
  - Oversize/Overweight Permits for longer-combination vehicles (Federal)
  - Alternative Fuels Tax Exemption (State)
  - Tax Exemptions for Idle Reduction Equipment and/or Alternative Fuels (State)
  - Renewable Fuel Standards (Federal)

Step 2 – Regional & Local Priority

Build justifications for the most critical strategies to proceed through detailed analysis and inclusion in strategy bundles and regional scenarios.

- **Investment** – Implementation cost (capital, annual operations & maintenance)
- **Barriers** – Degree of technological, engineering, political, regulatory, institutional, private, and public barriers
- **Return** – Cost effectiveness, timing of benefits, and sustainability

  Strategies were then grouped into the following categories:

- **Priority** – Low/medium implementation costs, low barriers, and high return
- **Priority with Barriers** – Medium cost, medium barriers, and high/medium return
- **Priority with Significant Barriers** – High cost, medium barriers, medium return
- **High Cost & Barriers, Low Return** – Uncertain/high cost and barriers
  - GHG Emission Impact Fees
  - Cordon Area Pricing
  - Connected Vehicle Systems
  - Congestion Pricing
  - Freight Rail Bottlenecks and/or Freight Demand Management
  - Biofuel Production Grants/Incentives
  - Low Carbon Fuel Standard
  - ZEV Standards/Heavy Duty Vehicle Standards

The TAC and NJTPA staff followed the above process to narrow an original strategy universe of over 70 strategies (see Appendix C for the full listing), to a list of 26 strategies. These strategies are organized among the three common GHG mitigation strategy options: VMT reduction, system efficiency, and vehicle and fuel technology.

3.3 Strategy Definition

The full description of all GHG reduction strategies is provided in table format in Appendix D. Table 3.1 provides 3 critical components of each strategy definition – implementation timeline, lead time to full effectiveness, and travel market.

Table 3.1 GHG Reduction Strategy Characteristics

Strategy	Implementation Timeline[2]	Lead Time to Full Effectiveness[3]	Travel Market[4]
Smart Growth Incentives	Long	Long	Passenger
Transit Oriented Development	Long	Medium	Passenger
Freight Oriented Development (Freight Villages)	Long	Long	Commercial
Complete Streets (Bike/Transit)	Medium	Short	Passenger
Complete Streets (Pedestrian/Transit)	Medium	Short	Passenger
Carpool/Vanpool Incentive Programs and Ridesharing	Short	Immediate	Passenger Commute
Commuter Outreach/Incentive Programs (TMAs)	Short	Immediate	Passenger Commute
Telecommuting and Compressed Work Week Targets	Short	Immediate	Passenger Commute
TDM Mini Bundle[1]	*Short*	*Immediate*	*Passenger Commute*
Parking Pricing and Supply Management	Medium	Short	Passenger Commute
Bus Transit Quality and Reliability of Service	Medium	Short	Passenger
Rail Transit Quality and Reliability of Service	Long	Medium	Passenger
VMT or Carbon Tax	Long	Immediate	Passenger
PAYD Insurance	Medium	Short	Passenger
Arterial System Management	Medium	Immediate	Arterial All
Limited Access System Management	Medium	Immediate	Limited Access All
Limited Access Incident Management	Medium	Immediate	Limited Access All
System Preservation/Corridor Access Management	Medium - Long	Immediate	Arterial All
Truck Route/Time-of-Day Truck Operation Policies	Short	Immediate	Commercial
Intermodal Freight Centers Access Improvement	Long	Immediate	Commercial
Freight Rail Capacity Constraints	Long	Medium	Long-haul Commercial
PEV Readiness Plan Development and Implementation	Medium	Long	Passenger Vehicle
Clean Fuel Standard (or similar approach)	Medium	Long	Passenger Vehicle
AFV Grants & Fleet/Fueling Equipment Subsidies	Medium	Short	Commercial
PANYNJ SmartWay Trucks & Truck Phase-Out Program	Medium	Short	Drayage trucks
Commercial Vehicle Idle Reduction	Medium	Short	Extended idling

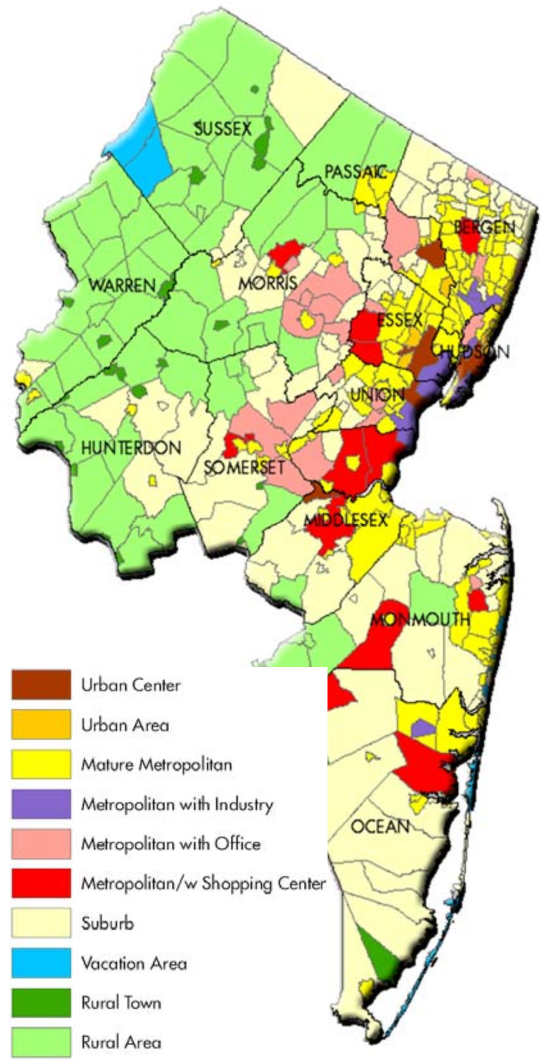
Note: 1) The TDM "Mini-bundle" strategy accounts for overlap between programs that provide incentives for ridesharing and parking cash-out, plus alternative work schedules.

Note: 2) Time required to implement: Short (<= 1 year), Medium (2-5 years), Long (5+ years)

Note: 3) Time required for implemented strategy to reach full potential: Immediate (<3 years), Short (<10 years), Medium (10-20 years), Long (20+ years)

Note: 4) The GHG emission reduction for each strategy is initially estimated based on the effectiveness of the strategy for a specific travel market at the place type scale.

The travel market concept is critical for the definition and evaluation of strategies. Each strategy is defined and assessed at multiple scales. For example some strategies are assessed at the region scale only (VMT fee, PAYD Insurance, Electric Vehicle), while most strategies are defined uniquely and assessed at the place type scale. For purposes of this analysis, the 10 place types presented in the map to the right were grouped into 4 (urban, metropolitan, suburb, and rural). Vacation areas in Sussex County were considered rural, while vacation areas on the Jersey Shore were considered metropolitan.



Source: NJTPA, PLAN2035

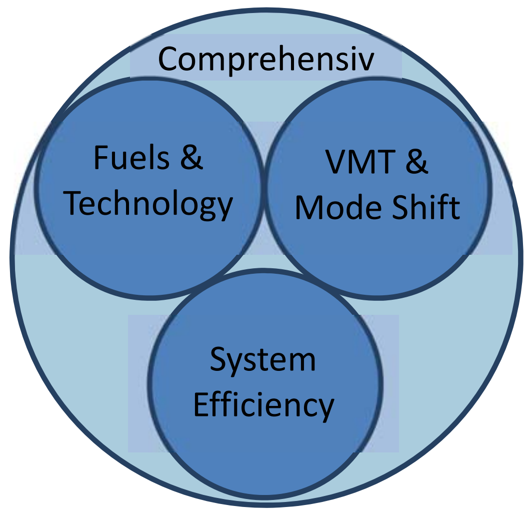
The link between place type and each municipality allows results of the place type based strategy analysis to be viewed at the municipal level. Because the assessment of strategies is completed for an example place type, where the share of travel by trip and vehicle type is unknown, the estimated GHG emission reductions are reported by travel market impacted. For a municipality, the total potential impact of a specific strategy, say for example ridesharing, would depend on the share of total VMT that is commute VMT.

The implementation timeline and lead time to full effectiveness are critical assumptions that impact estimates of GHG emission reduction effectiveness. Strategies with short implementation periods and ramp-up periods for full effectiveness are most critical to address emissions in the short term (many of these are strategies that do not require infrastructure or significant funding). Longer term strategies requiring multi-year implementation periods (such as infrastructure intense strategies or land use), and extended periods to achieve full effectiveness, require ongoing commitment to ensure that benefits are sustained and optimized in the future.

3.4 BUNDLING CONCEPT

The purpose of developing and testing the benefits of place type bundles is to inform the region about the potential combined GHG emission reduction benefits (whole is more than the sum of its parts) that come about when strategies are implemented synergistically (in complement to one another), as opposed to in isolation. Bundle design is intended to be applicable in multiple geographic contexts to ensure that the package of strategies employed will be feasible at multiple scales. Bundle concepts also consider the consistency of the bundle with agency priorities.

Bundle 1: Alternative Baseline + Enhanced Vehicle Technology and Fuels
Considers the combined impact of the proposed 2017-2025 CAFE standards (Alternative Baseline) plus additional emission reductions resulting from the increased penetration of electric vehicles and alternative fuels into the passenger and commercial vehicle fleet.



Bundle 2: Alternative Baseline + Expanded VMT Reduction/Mode Shift Strategies – Considers an enhancement of the Plan2035 RTP that focuses on strategies to reduce the growth of passenger and commercial vehicle travel through a combination of land use, transit, travel demand management, non-motorized, and pricing strategies tailored uniquely to urban/suburban place types, exurban/rural place types, and regional strategies applicable to all place types.

Bundle 3: Alternative Baseline + Improved System Efficiency – Considers a systemwide improvement beyond the Plan2035 RTP that focuses on reducing network delay through the combination of system operations, traveler information, bottleneck relief, pricing, and freight efficiency strategies tailored to urban/suburban place types, exurban/rural place types, and regional strategies applicable to all place types.

Bundle 4: Comprehensive Regional GHG Mitigation Plan – Considers a combination of all elements to overall improve vehicle efficiency, reduce the carbon content of travel, reduce VMT, and improve network efficiency tailored to urban/suburban place types, exurban/rural place types, and regional strategies applicable to all place types. Bundle 4 helps explore the interactive effects of vehicle technology and fuels with VMT and operations strategies. The bundle also provides the ultimate regional GHG reduction potential (tied to real/feasible strategies) and provides a roadmap for attaining sustainable and significant GHG emission reductions.

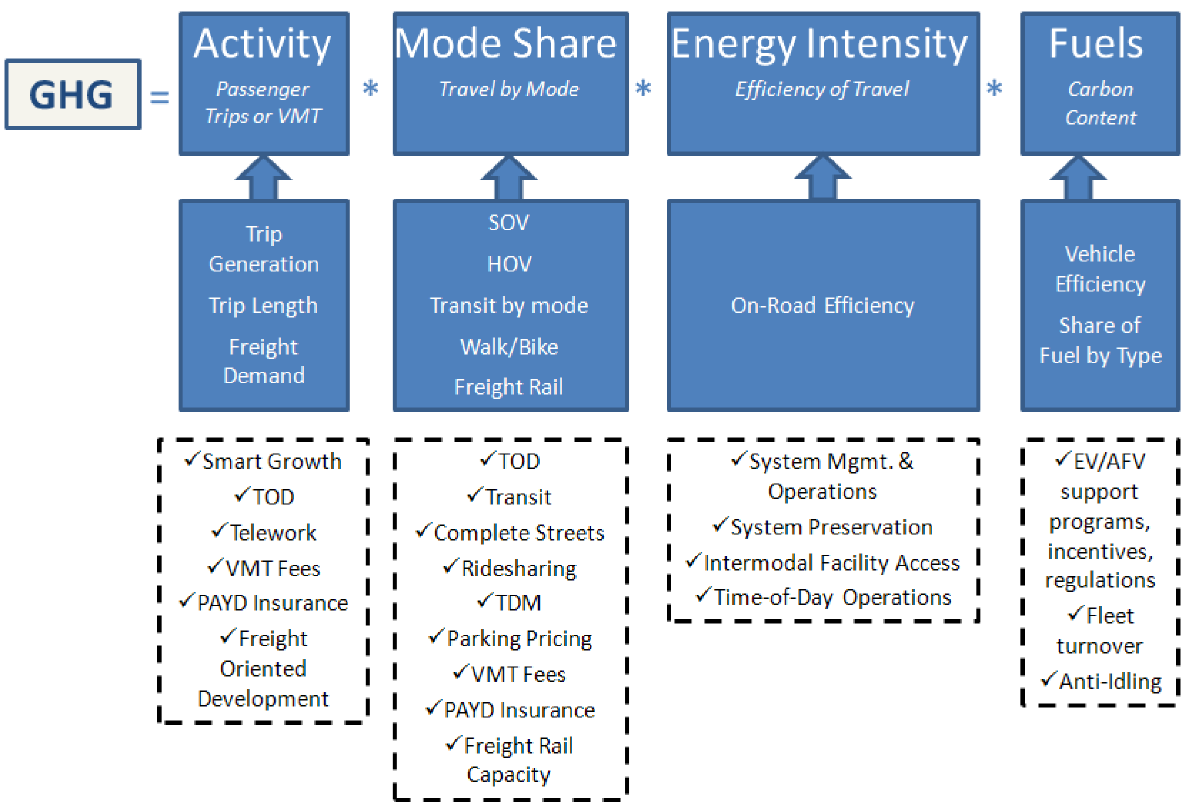
3.5 Strategy and Bundle Assessment Approach

The assessment approach for the strategies and bundles use sketch planning (spreadsheet based analysis methods, not the regional travel demand model) analysis based on regional and subregional land use and transportation data, and effectiveness rates from best practice research and local strategy implementation.

A sketch level approach is ideal for the strategy level assessments in this Plan primarily because the strategy and bundle definitions are only developed at a conceptual scale. Therefore, the sketch level analysis allowed for flexibility in defining inputs and outputs, allowed inserting existing NJTPA analysis processes where available, and represents a timely and resource sensitive approach. The analysis tools and data utilized included existing NJTPA or other agency off-model assessment tools (including for example U.S. EPAs Commuter Model), effectiveness rates from regional/local implementation or planning studies, best practice assessments tailored to NJTPA context from previous/ongoing research, insight provided by ViZtools indicators (current and forecast) by place type and county/municipality, and NJTRME travel forecasts.

Figure 3.2 presents the general approach and the strategies that fit within each aspect of on-road transportation GHG emissions. Recall that the analysis for each strategy is conducted for the targeted travel market segmented by place type. The calculation process and assumptions for each strategy are documented in Appendix E.

Figure 3.2 Overview of GHG Reduction Strategy Assessment Methodology



4.0 Strategy and Bundle GHG Emission Results

4.1 Strategy Results

All analysis results in the Plan are built-up from **Strategies** to **Bundles** to **Region Scenarios.** The starting point is the assessment of 26 strategies, evaluated in 2025 and 2040 for the specific targeted travel market and by 4 grouped place types.

Key notes on the interpretation of the strategy results include:

- GHG emission reductions in 2025 and 2040 are applied **only** to the specific targeted travel market (as noted in Table 3.1),
- System efficiency strategies are deployed in congested corridors (LOS D+ or travel time index > 1.35),
- Fuel and technology strategies are deployed across all place types, applied to specific vehicle fleets, and
- Full potential GHG emission reduction effectiveness accounts for the 2017–2025 car and light-duty truck fuel economy standards which:
  - By 2025, each unit reduction in VMT reduces **25–30 percent** less GHG compared to a 2025 fleet consistent with 2012–2016 car and light-duty truck fuel economy standard
  - By 2040, each unit reduction in VMT reduces **58–62 percent** less GHG compared to a 2040 fleet consistent with 2012–2016 car and light-duty truck fuel economy standard

Strategy Findings – VMT Reduction

Complete strategy findings by place type and individual strategy are included in Appendix F. Bundle results are presented in Appendix G. The below summary highlights the strategy results. The results are also presented in Table 4.1.

Smart Growth/TOD – Average reduction of **2-3 percent** for municipal land use strategies including zoning, development impact fees, and developer incentives across all place types. Up to a **20 percent** reduction at TOD locations with greater potential in Metro/Suburb place types.

Complete Streets – With access to transit in the corridor or activity center, a reduction of **1 percent** is possible for complete street approaches that include a mix of bicycle and pedestrian accommodations.

Travel Demand Management/Parking – Enhancing programs managed by TMAs that encourage or incentivize alternative commuting modes such as ridesharing (carpools and vanpools), transit, biking or walking, and alternative work schedules or teleworking, result in reductions ranging from **6 percent** to as high as **20 percent**. Coordination among programs, providing commuters a complete suite of options, financial incentives, and information is critical in order to optimize the potential benefits. Parking pricing provides an added "stick" to build TDM program demand (only in urban areas), and is included in the high end benefit estimates of this strategy.

Bus and Rail Transit Quality and Reliability of Service – Improving quality of service by enhancing transit frequency during peak periods, deploying new limited stop services, providing traveler information, and where operationally feasible, adding cars to trains during peak periods. The reductions range from **2 to 6 percent** depending on place type. Rail transit can result in VMT reductions across broader travel markets, particularly when combined with park-and-ride lot expansion, and shuttle bus services between stations and employment centers.

VMT/Carbon Tax and Pay-As-You-Drive (PAYD) Insurance – A new user fee structure in New Jersey that replaces the gas tax with a VMT or emissions based tax, and increases over time indexed to the average fleet fuel economy, could result in a regionwide reduction of **1 to 2 percent**. Increased availability and/or incentives supporting expansion of PAYD Insurance for New Jersey vehicle owners could result in a reduction up to **2 percent**, varying by place type (higher urban, lower rural).

Strategy Findings – System Efficiency

Arterial System Management – Strategies that develop and implement traffic signal coordination plans along heavily traveled arterial corridors and expand capabilities and interoperability of traffic management centers (TMCs) can reduce emissions associated with delay from **6 to 12 percent** varying by place type. Potential reductions are greatest when system management strategies are linked across corridors.

Limited Access System Management – Strategies that expand capabilities and interoperability of TMCs and expand coverage of traffic cameras and other sensors to enhance the overall coordinated management on limited access facilities can reduce emissions associated with delay from **3 to 17 percent** with comprehensive incident management included.

Access Management – Implement access management plans on emerging travel corridors or retrofitting developed arterial corridors can generate emission reductions associated with mitigated recurring and non-recurring delay up to **28 percent** with full access control, with retrofitting approaches falling in the **2 to 6 percent** range

Commercial Vehicle Strategies – Commercial vehicle emission reductions of **18 percent** for time-of-day or truck route policies, **37 percent** for intermodal access and bottleneck improvements, and **26 percent** for freight rail capacity enhancement. Time-of-day policies show immediate benefits focused in urban locations. The intermodal access capacity strategy targets delay caused by bottlenecks on facilities accessing intermodal areas. Rail capacity addresses infrastructure constraints such as low clearance bridges, and low railcar weight limits that result in circuitous rail routings, leading to more freight movement by truck.

Strategy Findings – Vehicle and Fuels Technology

PEV Plan Implementation and Clean Fuels – At the regional scale, programs to incentivize electric vehicle purchases, installation of charging stations, preferential parking, and electricity rate reduction could combine to increase the market share of electric vehicles in New Jersey by 2040 by up to 60 percent, resulting in a **20 percent** GHG emissions reduction. These benefits are added to forecasts associated with current vehicle fuel economy standards.

Commercial Vehicle Fleet – The combination of programs to encourage commercial vehicle fleet turnover, purchasing of alternative fueled vehicles or electric vehicles, and installation of alternative fueling locations and charging stations could result in up to **68 percent** reduction in on-road truck emissions through 2040. In addition, more stringent anti-idling programs and infrastructure including truck-stop electrification could reduce up to **95 percent** of emissions associated with extended idling.

Table 4.1 Strategy GHG Emission Reductions

Strategy	Strategy Emission Reduction Results (2025)	Strategy Emission Reduction Results (2040)	Description/Travel Market Impacted
VMT Reduction Strategies			
Smart Growth	1%	2–3%	Reduction for all passenger travel due to municipal land use strategies
Transit Oriented Development	5%	20%	Reduction for trips starting or ending within TOD locations only
Freight Oriented Development	<1%	4%	Regional commercial vehicle VMT reduction based on a strategy where all new freight related commercial and industrial growth occurs adjacent to truck and rail corridors
Complete Streets	<1%	1%	Reduction for all passenger travel includes benefit of enhanced access to transit
Travel Demand Management (TDM) and Parking	6–14%	6–20%	Reduction for all commute based trips including combination of all TDM programs plus parking pricing in urban activity centers
Rail & Bus Service Enhancement	2–3%	2–6%	Reduction for all passenger travel with greatest potential in metropolitan place types
VMT Fee/Carbon Tax	<1%	1–2%	Reduction for all passenger travel for an increase in the state motor vehicle fuels tax applied based on miles traveled or emissions
PAYD Insurance	1%	2%	Reduction for all passenger travel with highest potential in urban and metro place types

System Efficiency Strategies			
Arterial System Management	6–12%	6–12%	Reduction applied to all congested travel by corridor
Limited Access System Management	3–17%	3–17%	Reduction applied to all congested travel by corridor, including the benefits of reduced delay from incident management
Access Management	2–6%, up to 28%	2–6%, up to 28%	2- 6% reduction for corridor retrofits, 28% reduction for full access control (suburban and rural place types only)
Time-of-Day/Truck Routing Policies	16%	18%	Reduction from congested travel in activity centers
Intermodal Access Improvements	24%	37%	Reduction from congested travel by project for intermodal access
Regional Freight Rail Capacity	7%	26%	Reduction in commercial vehicle VMT from mode shift to freight rail
Vehicle and Fuel Technology Strategies			
EV Plan Development and Implementation	1%	20%	Reduction regionwide for all passenger vehicle travel based on 60% market share by 2040
Clean Transportation Fuels	<1%	6%	Reduction regionwide for all passenger vehicle travel based on ICEVs emitting 25% less carbon per mile compared to the Baseline by 2040
Commercial Fleet EV/AFV Grants and Subsidies	5%	67%	Reduction regionwide for all commercial vehicles
PANYNJ SmartWay Trucks and Truck Phase-Out Program	12%	68%	Reduction for PANYNJ drayage only
Commercial Vehicle Idle Reduction	37%	95%	Reduction in emissions from extended idling only

4.2 BUNDLE RESULTS

The bundle results reflect the potential GHG emission reduction beyond what is assumed in Plan 2035 and the Alternative Baseline in a typical municipality within each place type grouping. In 2040, a medium level and high level of strategy deployment is presented, consistent with the low and high-end of emission reduction as presented in the strategy result tables.

These results represent best case emission reduction estimates and will vary depending on the characteristics of an individual municipality. They assume implementation of all strategies within each category consistent with the strategy definition. GHG reductions from the strategies are weighted by travel market VMT by place type to estimate a total place type bundle reduction.

VMT Reduction Bundle Results Summary

Table 4.2 VMT Reduction Bundle Results

Year/Scenario	Urban	Metro	Suburb	Rural
2025	13.1%	10.8%	8.4%	3.6%
2040 – Medium	15.9%	14.2%	14.1%	4.7%
2040 – High	19.2%	20.1%	18.8%	7.6%

The VMT reduction bundle shows the highest potential reductions in urban and metro place types, where existing and projected land use patterns are most supportive of alternative modes.

Through 2025 –

- The largest share of reductions (30 – 40 percent of total) is from the combination of commuter related strategies (ridesharing, commuter incentives, and telework) and public transit.
- Smart growth and TOD strategies show low benefits as a result of a longer timeframe for implementation and actual shifts in travel behavior. Bike and pedestrian strategies show the most promise in urban places and adjacent to transit.
- PAYD insurance unlikely to recognize significant enough market share in short-term to result in notable benefits.

Through 2040 -

- The combination of commuter focused travel demand management strategies and parking pricing is critical for encouraging mode shift in urban employment centers.
- Interactions among strategies are important, particularly over the long-term when comprehensive changes in land use and multimodal accessibility is achievable.

System Efficiency Bundle Results Summary

Table 4.3 System Efficiency Bundle Results

Year/Scenario	Urban	Metro	Suburb	Rural
2025	18.5%	16.4%	18.8%	5.1%
2040 – Medium	15.4%	13.7%	15.7%	4.2%
2040 – High	16.7%	14.9%	25.6%	4.3%

The system efficiency bundle shows the highest potential reductions in suburban place types where severe congestion is expected to increase most significantly over time, and where more options are available for system management and preservation approaches. For example, developing suburban arterial corridors can proactively address access management concerns through zoning or corridor improvements preceding and during development activity leading to reduced growth in congestion in the near term.

Strategies are assumed to impact VMT in locations where the travel time index (ratio of congested travel time to free-flow travel time exceeds 1.35).

Through 2025 –

- Most system management strategies can be implemented in the short-term and recognize immediate benefits, especially when systems are interconnected across jurisdiction boundaries and facility types.
- The corridor access management approach will vary depending on land uses and land use plans. In urban and metro place types, retrofit approaches are the predominant solution, while in suburban locations, more complete access control such as grade separation or parallel service roads are possibilities.
- Commercial vehicle strategies to identify preferred routes and establish time-of-day operation policies are quick to implement and may recognize immediate benefits.

Through 2040 -

- Due to a cleaner fleet, delay reductions in the long term result in less GHG reductions. New system management approaches are unlikely to result in significant additional delay reduction unless they are coupled with VMT reduction strategies.
- Maintaining benefits requires continuing monitoring and management of the system (e.g. system management solutions vary over time as travel conditions change).
- Strategies to improve efficiency of the freight rail system are likely to better address long-term freight movement delays.

Vehicle and Fuels Technology Bundle Results Summary

Table 4.4 Vehicle and Fuels Technology Bundle Results

Year/Scenario	Urban	Metro	Suburb	Rural
2025	0.9%	0.9%	0.9%	0.9%
2040 – Medium	17.5%	17.5%	17.5%	17.5%
2040 – High	29.3%	29.3%	29.3%	29.3%

The results of this bundle are consistent across place types as it is assumed the penetration of electric vehicles and alternative fuel vehicles into both the passenger and commercial vehicle fleet in New Jersey occurs at the same rate across all locations. However, there is evidence based on current electric vehicle (EV) usage, that urban areas will experience quicker growth in EV market penetration as a result of shorter average trip lengths. As battery technology improves and charging locations become more widespread, it is assumed that the issue of "range anxiety" will disappear; therefore barriers to owning an EV in a rural location versus an urban location will be the same (predominantly contingent on purchase cost).

Through 2025 -

- Passenger alternative fuel vehicles (AFVs) and EVs entering the fleet through 2025 are assumed to achieve a market share consistent with projections associated with the Alternative Baseline, therefore no additional benefit assessed.
- Commercial vehicle fleet turnover programs and incentives for purchasing of AFVs/HEVs/EVs remove older (pre-2007) trucks from the fleet.

Through 2040 -

- Medium range deployment assumes a EV on-road fleet share of 55-60% by 2050. This projection is consistent with the middle of the range of market projections.
- Internal combustion engine vehicles reduce carbon intensity per VMT by 25% by 2040 (25% is an extrapolation of the Northeast and Mid-Atlantic region's clean fuel standard goal of 15% in 15 years).

Combined Bundle Results Summary

Table 4.5 Combined Bundle Results

Year/Scenario	Urban	Metro	Suburb	Rural
2025	19.7%	14.1%	11.8%	5.2%
2040 – Medium	34.4%	30.8%	30.8%	21.8%
2040 – High	46.3%	44.8%	44.8%	35.0%

The combination of the three bundles into the combined approach uses a multiplicative approach using the order of analysis presented in Figure 4.2.

Figure 4.1 Combined Bundle Development

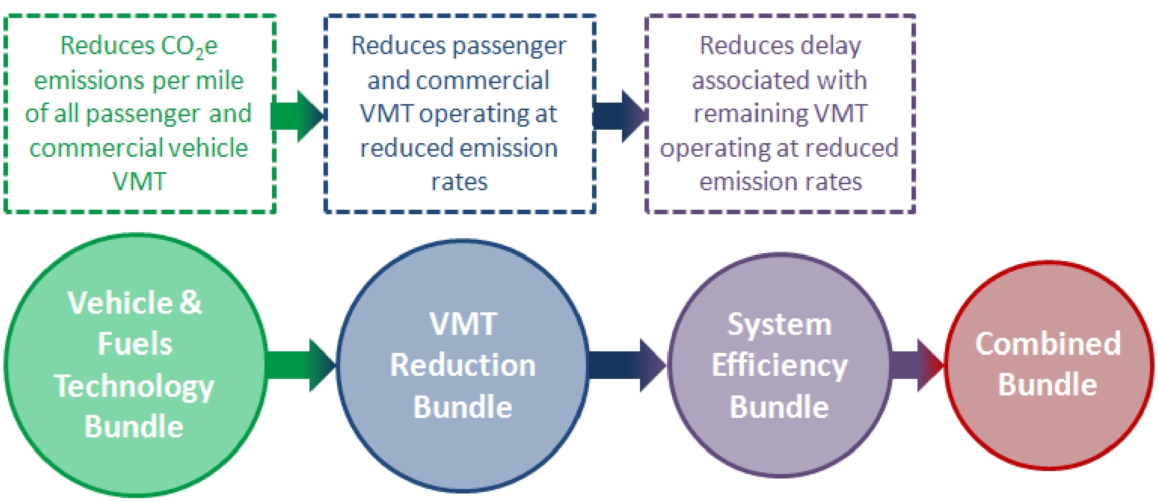
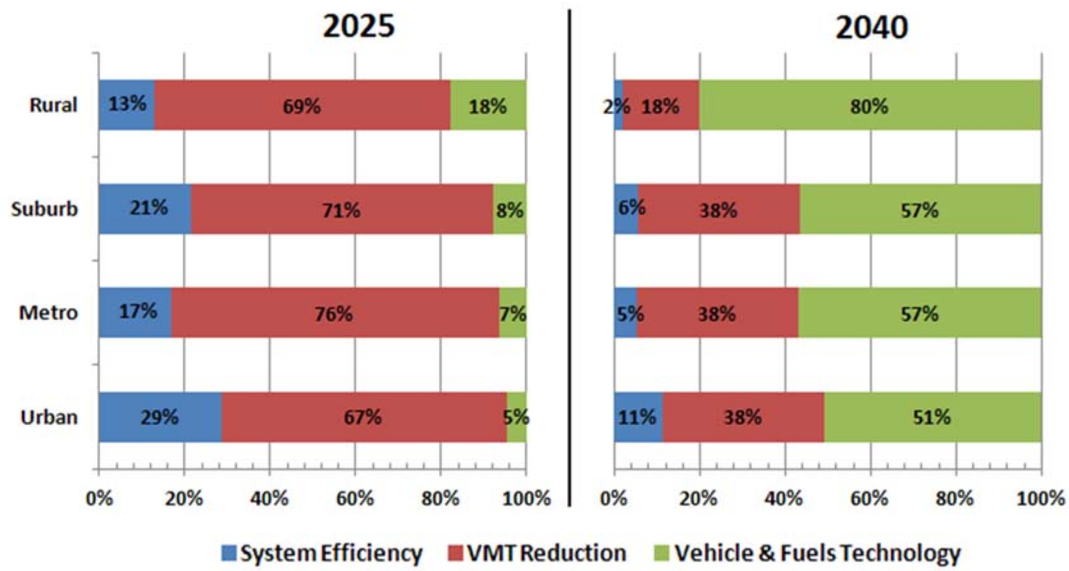


Figure 4.3 presents the share of reductions attributed to system efficiency strategies, VMT strategies, and vehicle and fuel technology strategies within the combined bundle. It is clear that in the near term, there is greater potential for significant reductions from VMT and System Efficiency strategies. There are also differences by place type, for example in rural areas, system efficiency strategies are less critical, as emissions that are a product of delay are not as significant.

Figure 4.2 Contributions to the Combined Bundle GHG Emission Reductions



5.0 Strategy and Bundle Cost Effectiveness and Co-Benefits

5.1 Cost Effectiveness Approach and Results

The cost effectiveness approach for the Plan focused on orienting strategies into different categories of cost effectiveness based on ranges of implementation cost, user cost savings, and GHG emission reductions. In the context of greenhouse gas mitigation, cost-effectiveness is typically measured in terms of dollars per metric ton of greenhouse gases reduced, providing a consistent and comparable metric for GHG reductions anticipated across strategies and deployed at varying intensities and at different geographic scales.

Cost effectiveness refers to all strategy costs and user cost savings at full implementation effectiveness per unit of CO_2e reduced. Table 5.1 presents a summary of the average strategy direct and net cost effectiveness, payback period, and cost effectiveness adjustments by place type.

- Direct: Average strategy implementation cost (capital + operations + administrative) per metric ton of CO_2e reduced
- Net: Regional average implementation cost minus user savings (reduced fuel consumption and vehicle operating costs) per metric ton of CO_2e reduced
- Cost effectiveness adjustments reflect the expected directional change of net cost effectiveness based on place type characteristics
- Payback refers to the breakeven period for a strategy, where the cumulative monetary value of vehicle operating savings and energy savings exceeds the implementation cost

The cost effectiveness adjustments reflect how the location of strategy implementation is inherently linked to strategy cost, benefits, and GHG emission reductions. The reasons why a strategy may show higher or lower cost effectiveness in a specific place type compared to the strategy average is tied to: the strategy level of deployment, place type travel patterns and the opportunity they provide for more significant reductions, existing transportation and land use system framework, and implementation cost.

The cost effectiveness values presented in table 5.1 equate to the following ranges:

Direct: **$** = < $200, **$$** = $200-500, **$$$** = $500-1000, **$$$$** >$1000

Net: **($$)** = <-$200, **($)** = -$200-0, **$** = $0-200, **$$** = $200-500, **$$$** = >500

Table 5.1 Strategy Cost Effectiveness, Payback, and Adjustments

	Cost Effectiveness		Payback	Cost Effectiveness Adjustments			
Strategy	**Direct**	**Net**	**Years**	**Urban**	**Metro**	**Suburb**	**Rural**
Smart Growth Incentives	$$	($)	10-15	□	↑	↑	↓
Transit Oriented Development	$$	($)	5-10	□	↑	↑	↓
Freight Oriented Development	$$	$	15-20	□	↑	↑	↓
Complete Streets (Bike/Transit)	$$	($)	5-10	↑	↑	□	↓
Complete Streets (Pedestrian/Transit)	$$	($)	5-10	↑	↑	□	↓
Carpool/Vanpool Incentive Programs & Ridesharing	$	($$)	< 5	□	□	↑	↓
Commuter Outreach/Incentive Programs (TMAs)	$	($)	5-10	↑	□	↑	↓
Telecommuting and Compressed Work Weeks	$	($$)	< 5	↓	□	↑	↑
TDM Mini Bundle[1]	$	($)	< 5	□	□	↑	□
Parking Pricing and Supply Management	$	($)	< 5	↑	□	↓	↓
Bus Transit Quality and Reliability of Service	$$$	$	15-20	↑	↑	□	↓
Rail Transit Quality and Reliability of Service	$$$$	$$	>20	↑	↑	□	↓
VMT or Carbon Tax	$-$$	$	5-20	□	□	□	□
PAYD Insurance	$	($$)	<5	↑	↑	□	↓
Arterial System Management	$$$	$	5-10	↑	↑	□	↓
Limited Access System Management	$$$	$$	10-15	↑	↑	□	↓
Limited Access Incident Management	$$	$	5-10	↑	↑	□	↓
System Preservation/Corridor Access Management	$$$$	$$	15-20	↓	□	↑	□
Truck Route/Time-of-Day Truck Operation Policies	$	($)	< 5	↑	□	↓	↓
Intermodal Freight Centers Access Improvement	$$$$	$$$	15-20	□	□	↓	↓
Freight Rail Capacity Constraints	$$$$	$$$	>20	□	□	□	□
EV Readiness Planning and Implementation	$	($)	< 5	↑	□	↓	↓
Clean Fuel Standard (or similar approach)	$$	$	10-15	□	□	□	□
AFV Grants & Fleet/Fueling Equipment Subsidies	$$$	$	5-10	□	□	□	□
PANYNJ SmartWay Trucks & Phase-Out Program	$$$	$	< 5	□	□	□	□
Commercial Vehicle Idle Reduction	$	($)	< 5	□	□	□	□

↑ Cost effectiveness expected to increase as a result of lower than average implementation costs, or estimated higher benefits for place type.

□ Strategy implemented at the regional scale, with consistent cost effectiveness expected, or place type cost effectiveness is consistent with regional average.

↓ Cost effectiveness expected to decrease as a result of above average implementation costs, or estimated lower benefits for place type.

Figure 5.1 presents the results of this analysis from 2010 through 2040. Strategies are arrayed on a continuum representing multiple effectiveness elements.

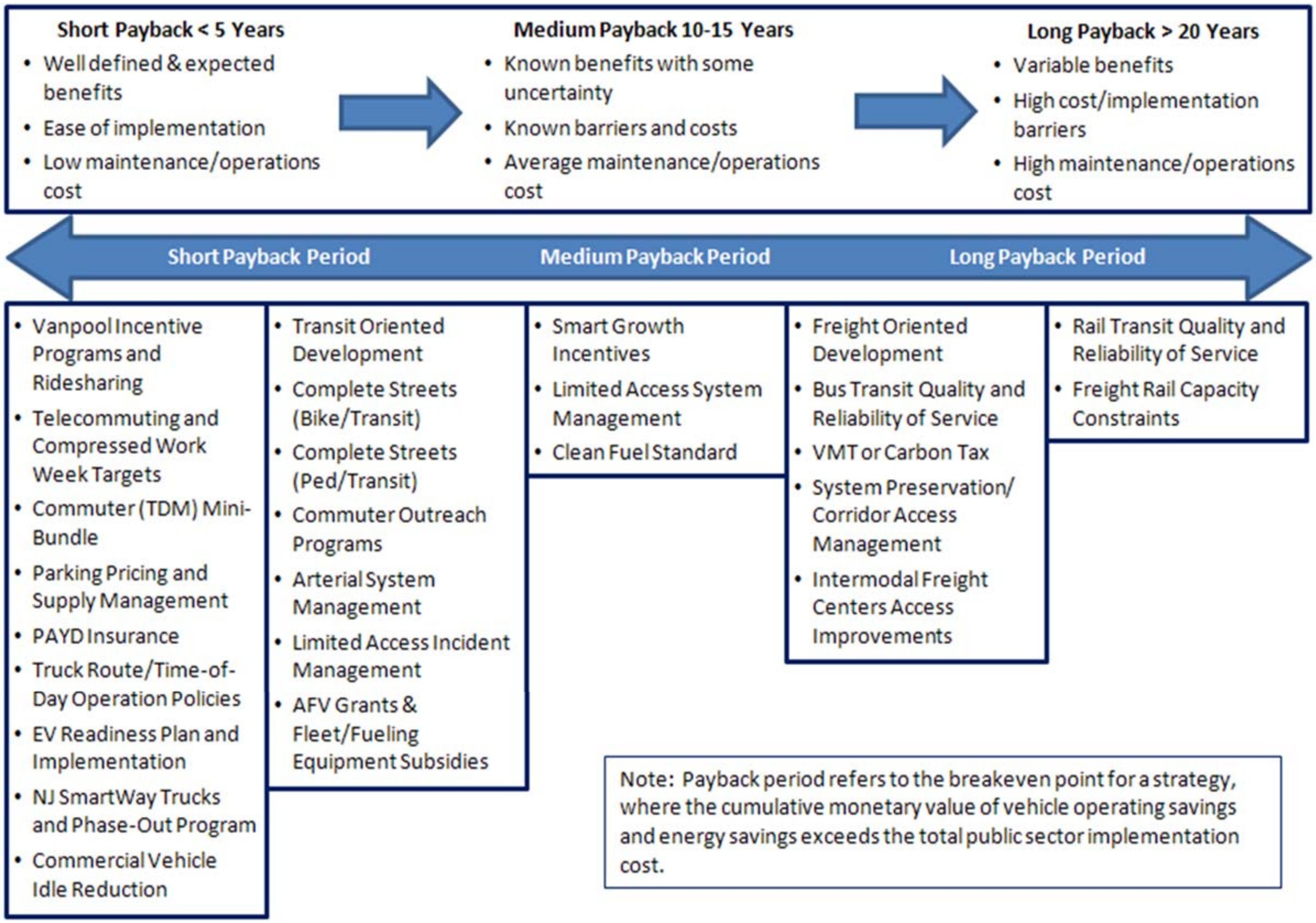
- **Payback Period –** The number of years it takes a strategy or program to "break even" on its up-front capital investment and annual operations costs compared against energy savings.
- **Variability of Benefits –** Strategies to reduce GHG emissions are often impacted by other conditions including external economic factors or land use decisions.
- **Ease of Implementation –** Presents a perspective on the relative requirements, barriers, and technology required to implement a strategy.
- **Level of Annual Maintenance and Operations Costs –** Strategies with ongoing high maintenance and operations cost, such as investment in transit, maintain a high cost per GHG reduction over time.

Figure 5.1 portrays the full range of strategies – strategies with quick payback periods (5 years or less), well understood/expected benefits, low implementation barriers, and low annual costs – and strategies with long payback periods or continuous net costs, variable benefits, and potentially significant implementation barriers. The overall scope of the continuum ranges from a net savings per ton of carbon to costs greater than $1,000 per ton of carbon. The midpoint of the continuum is in the range of $0 to $100 per ton.

Short payback period strategies are predominantly policy or incentive based approaches with low costs that are able to impact a significant proportion of vehicular travel or able to generate significant reductions for a targeted travel market. For example, PAYD Insurance has close to zero public cost, but can benefit all drivers in the region. Employer based commute strategies such as ridersharing, telecommuting, and parking pricing, show comparatively low public sector costs, with the potential for immediate and significant GHG reductions.

Long payback period strategies typically have high up-front costs, long implementation timelines or extensive barriers, ongoing maintenance and operations costs, and in some cases uncertain benefits. Most strategies with uncertain benefits were not assessed within the Plan, however cost intensive strategies such as rail transit quality of service fall into this category because, despite the potential for significant benefits, the high capital and ongoing maintenance and operations costs are difficult to ever payback.

Figure 5.1 Strategy Cost Effectiveness Continuum



5.2 Indirect Costs and Benefits

Indirect benefits and costs can be characterized as those costs to society that are not already paid by motor vehicle drivers including the costs of air pollution and public health impacts.

Air pollution – Costs associated with air pollution from motor vehicles include public health, building and material damage, and environmental resource damage, including lost agricultural and forest productivity and ecosystem health. GHG reduction strategies that overall reduce total travel or improve the efficiency of travel act to reduce total emissions associated with the burning of fossil fuels. Strategies that decrease the share of VMT consuming traditional fossil fuels or that improve the efficiency of internal combustion engines also will reduce emissions.

Because portions of the NJTPA region fail to meet the National Ambient Air Quality Standards, the NJTPA is required to demonstrate conformity on all plans, programs, and projects. This means that the NJTPA must demonstrate that the projects it approves through its Transportation Improvement Program (TIP) and Regional Transportation Plan (RTP) will have a net positive impact on air quality and contribute to the achievement of the air quality goals contained in the New Jersey State Implementation Plan (SIP). All strategies included in the Plan support region efforts to decrease criteria air pollutant emissions[11]

Other environmental resources – Other environmental resource costs include water and soil pollution, and ecosystem/habitat loss and fragmentation. Water and soil pollution have elements that are directly related to vehicle/fuel use (leakage from vehicles, toxic metals in runoff, oil spills), as well as other elements that are not directly related (road salt, stormwater runoff). Costs associated with ecosystem/habitat loss and fragmentation are primarily "fixed" costs, i.e., associated with the amount of roadway infrastructure built or the acres of parking lots, rather than the total distance driven. Some strategies included in the Plan expand the footprint of transportation infrastructure in strategic locations, however the predominant focus is on strategies that either manage travel demand or improve efficiency of the existing system. The Plan does focus on development in town centers and adjacent to transit as opposed to in greenfields, leading to enhanced and sustainable preservation of natural resources in the region.

5.3 Co-Benefits

Co-benefits refer to other outcomes of implementing GHG mitigation strategies that may lead to economic growth, improved transportation system safety and mobility,

[11] Depending on the vehicle type and application, biodiesel has been shown to increase nitrogen oxide (NOx) emissions in some tests up to 3 percent.

improved quality of life and public health, and reductions across all potential air and surface environmental impacts.

All of the strategies will result in lowered consumption of fossil fuels, and as such may have economic benefits to the extent that New Jersey's dependence on importing energy is reduced. In addition improved transportation system operations, rail infrastructure, and more efficient land use will result in reduction in commercial vehicle delay and more efficient locations of distributors and receivers of goods leading towards reduced logistics costs.

Most transportation system efficiency strategies have significant mobility co-benefits, especially travel time savings and resulting economic benefits from reduced congestion (such as improved truck and rail freight movement and better access to employment). Land use and transit strategies also have mobility benefits for those who do not drive because of advanced age, young age, disability, or income. Public health benefits can result from land use, bicycle and pedestrian, and transit strategies that encourage walking and biking. Land use, transit, and bicycle and pedestrian strategies also will reduce household expenditures on fuel and on vehicle operating and ownership costs by reducing demand for carbon-intensive travel. Vehicle efficiency and system efficiency strategies will reduce household expenditures on fuel through more efficient travel. Possible unintended consequences include mobility and equity impacts to lower-income populations from transportation pricing strategies that increase the cost of carbon-intensive travel beyond their willingness or ability to pay.

NJTPA is tracking key indicators as part of the development of Plan2040 and the Regional Plan for Sustainable Development. At the place type level, the GHG reduction strategies presented in this plan present opportunities to move these indicators in desired directions compared to the business as usual case, such as: improving the local balance of jobs and housing, decreasing the number of daily vehicle trips per household, reducing travel time index (a measure of congestion), and increasing household proximity to transit. As part of the communication of the Plan, NJTPA included strategy cards within ViZtools, where individual strategy impacts on these indicators will be mapped.

6.0 Regional GHG Mitigation

6.1 Regional Scenario Development

The final step in the GHG mitigation analysis linked the results of the bundle analysis to potential regional GHG emission reductions. Because the original intent of the Plan was to assess the potential GHG reduction benefit of strategies and strategy bundles at the county and municipal scales to establish estimates of potential regional GHG emission reductions, NJTPA developed an assumption on the share of total travel impacted by place type.

- For 2025, these shares range from 5 percent rural to 40 percent urban.
- For 2040 these shares range from 15 percent rural up to 75 percent urban.
- In the case of the system efficiency bundle these assumptions only apply to total VMT on facilities operating at a travel time index of 1.35 or greater.
- In the case of the VMT reduction and vehicle and fuels technology bundles these assumptions are applied separately to passenger and commercial VMT.

The overall objective of the Regional Scenario approach is to conduct a "what if" analysis of how far the region could move towards a transportation system that attains the New Jersey Global Warming Response Act target of an 80% reduction in 2006 emissions by 2050.

The organization of the regional scenario tests were arrayed across the Baseline and Alternative Baseline, and the three bundles (vehicle and fuels technology was split by the impacts on passenger vehicles and commercial vehicles). Table 1 presents the different combinations that were evaluated. Scenario 1 (not included) is the Baseline.

Table 6.1 Regional Scenario Components

Scenario Components	Regional Scenarios								
	2	3a	3b	3c	4	5	6	7	8
Baseline (Plan2035)	■	■	■	■	■	■	■	■	■
Alternative Baseline (Plan2035)	■	■	■	■	■	■	■	■	■
Vehicle & Fuel Technology (PV)		■		■			■	■	■
Vehicle & Fuel Technology (CV)			■	■			■	■	■
VMT Reduction					■		■		■
System Efficiency						■		■	■

6.2 Regional Scenario Results

The 2025 results represent a reasonable forecast of potential additional GHG emission reductions beyond Plan2035. The 2040 results represent a medium to high-case reduction potential associated with varying assumptions on strategy intensity and extent of travel impacted.

Figure 6.1 presents the incremental reduction by milestone year compared to 2006. Note that Scenario 1 (the Baseline) is not reported in Figure 6.1. As described in Chapter 2, the Baseline shows an aggregate 2 percent increase in GHG emissions by 2050 compared to 2006.

Figure 6.1 Regional Scenario GHG Reduction Results

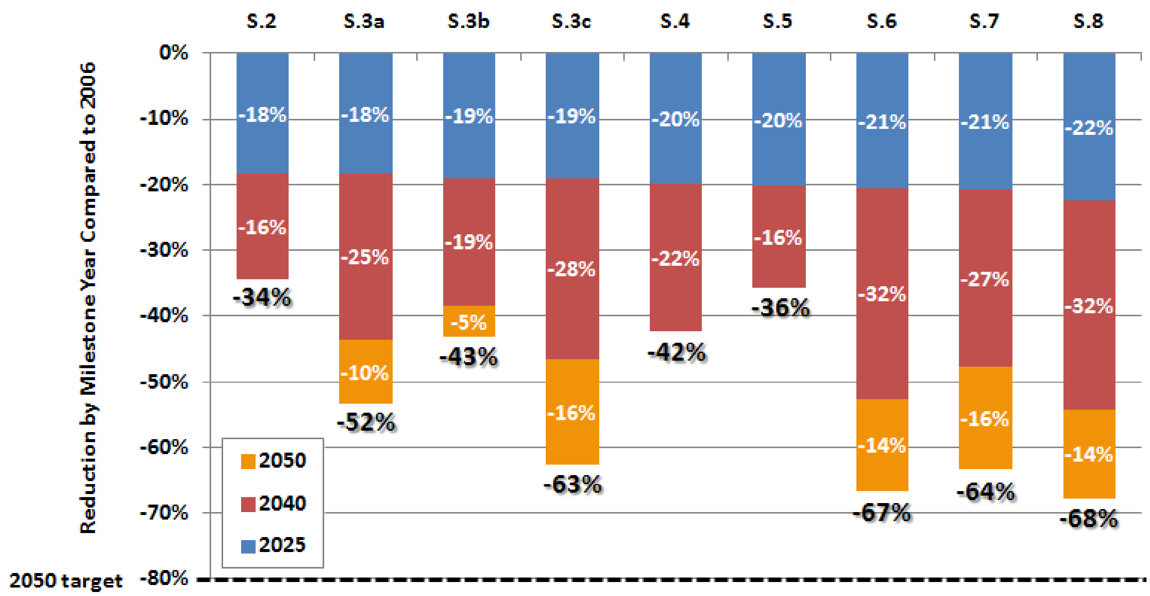


Figure 6.1 presents the following findings:

Scenario 2 - The impact of Plan2035, and current car and light duty truck fuel economy standards through 2025, and the current medium and heavy-duty truck standards through 2018, represent a **34 percent** reduction from 2006.

Scenario 3(a,b,c) – Scenario 3 alternates the inclusion of passenger vehicle and commercial vehicle technology and alternative fuel strategies. Together, as displayed in Scenario 3.c, these strategies contribute an additional **29 percent** reduction by 2050, totaling a **63 percent** reduction. The assumptions for passenger vehicles and commercial vehicles are noted below:

- **PV Fuels & Technology** – Alternative Baseline + electric vehicle penetration rate consistent with long-range market projections (55-60 percent by 2050) + 25 percent reduction in the carbon intensity of fuels by 2040

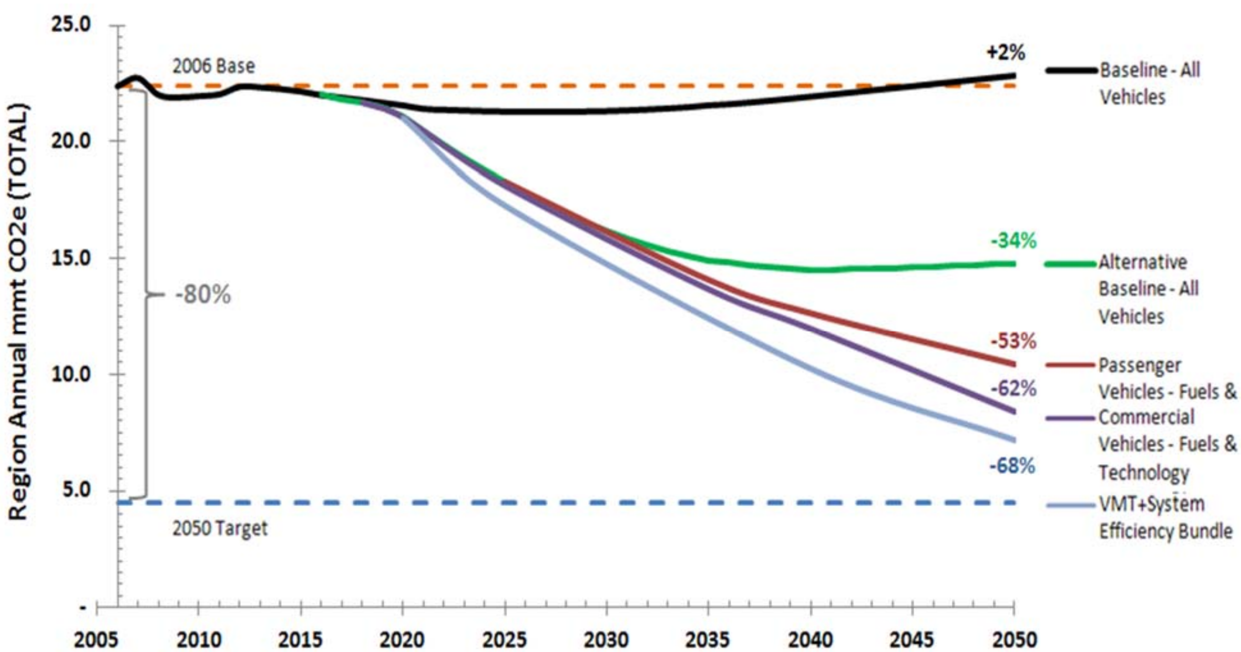
- **CV Fuels & Technology** – Baseline + (30/25/45) EV/natural gas (NGV)/advanced diesel (ADV) medium-duty vehicle share + (10/90) EV/ADV heavy-duty share + 75% reduction in extended idling by 2040

Scenario 4 and 5 – These scenarios present the impact only of the VMT reduction and system efficiency bundles. In total, by 2050 these bundles show the potential to reduce emissions by **42 percent** and **36 percent** from 2006.

Scenarios 6, 7, and 8 – These scenarios present alternative combinations of the vehicle and fuel technology bundles with VMT and system efficiency. Scenario 8 represents the ultimate "what if" scenario analysis, where the region moves in a comprehensively aggressive direction across vehicle technology, alternative fuels, VMT reduction, and system efficiency to reduce GHG emissions. This scenario does not consider the significant cost, regulatory, or implementation feasibility associated with such a regional approach – that's why it is presented as a "what if" analysis.

Figure 6.2 presents the incremental emission reduction curves for each component of Scenario 8.

Figure 6.2 NJTPA Region Scenario "What If" Analysis



This scenario combines the following components to achieve a **68 percent** reduction from 2006 by 2050.

- The Final 17-25 NFES (54.5mpg MY 2025) helps the region reduce GHG emissions to **34 percent below 2006 by 2050**
- The passenger vehicle fuels/technology scenario beyond the 17-25 NFES takes the region to **53 percent below 2006 by 2050**, based on:

  - A PEV on-road fleet share of **55-60 percent by 2050**, overall consistent with the middle of the range of market projections.
  - In addition, the remaining on-road vehicles reduce carbon intensity per VMT by **25 percent by 2040**.
- The commercial vehicle fuels/technology scenario beyond the 14-18 M/HDV standard and other programs takes the region to **62 percent below 2006 by 2050**.
- VMT reduction strategies deployed by place type, at the highest level of deployment, implemented at a regional scale, accounting for interactions impacting up to 64% of regional VMT takes the region to **67 percent below 2006 emissions by 2050 (additional 5 percent reduction).**
- System efficiency strategies deployed by place type, addressing VMT on all facilities operating at LOS D+ plus regional strategies that enhance truck operations takes the region to **68 percent below 2006 by 2050 (additional 1 percent reduction).**

What Does This Mean?

Reaching the 2050 Target:

With an on-road passenger vehicle fleet that is around **74 percent less carbon intensive on a grams/mile basis in 2050 compared to 2006,** reducing enough VMT or inefficient travel to cross the remainder of the "what if" scenario **12 percent target shortfall** is difficult because of the diminishing return on VMT and system efficiency strategies.

If the most aggressive forecast assumption of an 80 percent passenger electric vehicle market share is used, the target shortfall is only **5-7 percent**. In this case, the challenge is not as significant and could be attained if:

- Regional energy sources supporting EV charging from the grid reduces carbon intensity significantly compared to today (consistent with achieving GWRA targets for the power-generation sector). The Plan did not investigate the impact of reducing the carbon intensity of electricity in New Jersey. Current reduction estimates assume that total life cycle carbon emissions on a g/mi basis are 60-70 percent lower for current on-road PHEVs and BEVs than ICEVs. If the power generation sector attains an 80 percent reduction in electricity carbon intensity by 2050, it is plausible that reduction may result in reaching the target.
- Early, continuous, and aggressive deployment of sustainable VMT and delay reduction strategies via smart growth, TDM, pricing, and system management**.**

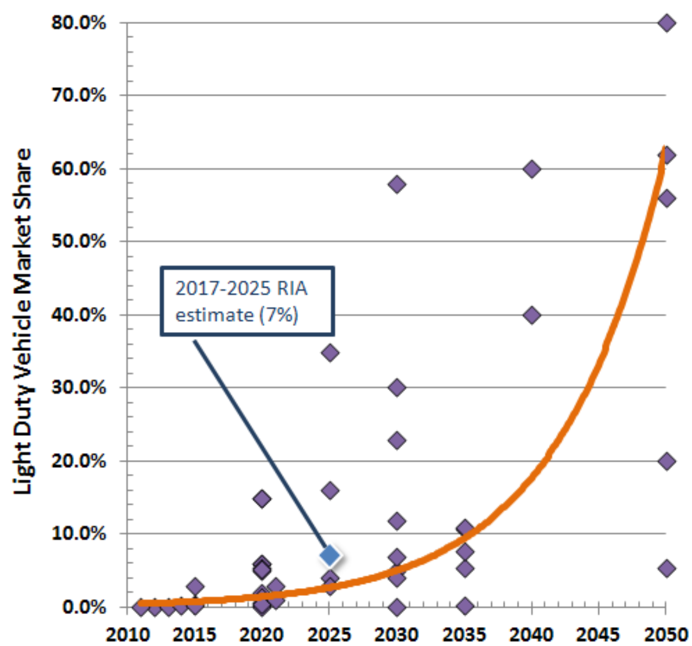
The Role of VMT Reduction and System Efficiency Strategies:

VMT and system efficiency strategies show a diminishing return in terms of GHG emission reduction beyond 2035. This does not mean VMT and System Efficiency strategies are not effective contributors to GHG reduction. The societal benefits of these strategies are potentially more significant than vehicle technology or alternative fuels, which so far have uncertain consumer costs and savings. In addition these strategies address value of time, equity, and economic growth – areas that may have more value to society than GHG emission reductions (or avoided climate change impacts). It is also worth noting that in the near term, VMT and system efficiency strategies show greater potential for GHG reduction – focusing on GHG reductions possible from these strategies in the near-term is critical for maintaining the desired downward trends in emissions in the long-term.

The Role of Vehicle Technology and Alternative Fuel Strategies:

- The 2017-2025 LDV fuel economy standards is the largest contributor to GHG emission reduction from the on-road mobile source sector, accounting for a **34 percent reduction** from 2006 by 2050
- Based on analysis conducted by EPA/ NHTSA as part of the Regulatory Impact Analysis (RIA) of the 2017-2025 LDV fuel economy standard, by 2025 up to **7 percent of the on-road LDV fleet** could be PHEV/BEV
- The remainder of the improvement in efficiency will be made with across the board advancements in internal combustion engine vehicle technology

Figure 6.3 Aggregation of Electric Vehicle Market Share Projections



Challenges exist in drawing the line between what Federal regulation can achieve, and the degree to which state and local programs/incentives can help spur further electric vehicle market penetration. In this Plan, a comprehensive supply and demand approach is assumed which the public sector can support through:

- A mix of regional, state, and local programs and partnerships to expand the availability of charging infrastructure
- Electric vehicle readiness planning and policy development
- Continued or expanded Federal and state incentives/subsidies for EV purchases and private EVSE installation

Ultimately consumer purchasing decisions will be based on price, vehicle reliability, and potential savings.

7.0 Conclusions & Next Steps

7.1 CONCLUSIONS

The diverse transportation, land use, and economic structure of the NJTPA region are both a challenge and an opportunity for mitigating GHG emissions from the transportation sector.

The region presents a challenge because the transportation networks and facilities in the region are essential to the economic and transportation well-being of the 6.6 million residents of the NJTPA region and 20 million in the NY/NJ metropolitan statistical area, along with more than 312,000 regional businesses. Strategies to reduce GHG emissions from the transportation system should act to support the regional economy through improving the efficiency of freight movement, enhancing resident's access to jobs and services, and improving residents and business owner's quality of life. Strategies that seek to reduce travel demand through transportation system pricing, adjust logistic patterns as an approach to reduce delay, or reduce emissions per mile through providing incentives and infrastructure for electric vehicles may result in added costs for consumers in the short term, but lead to longer term benefits. The strategies in this Plan seek to support other regional goals, enhance the ability of the transportation system to support the regional economy, while at the same time supporting efforts to reduce GHG emissions.

The diverse economy of the region also provides significant opportunity for GHG emission reduction. Existing multimodal transportation systems, dense and mixed-use development patterns, and traditional town centers can support multiple alternative modes of transportation. By their very nature, these areas usually show higher than average transit mode shares, and less frequent and shorter vehicle trips. Also, as a result of financial and travel congestion barriers, access to the region's core employment centers including Manhattan is preferential by lower emission modes on a per passenger basis such as buses, all forms of rail, and ferry's.

The strategies evaluated in the Plan focus attention on sustainable options for reducing growth in VMT, decreasing inefficient vehicle operation on the regional roadway system, and reducing the GHG emissions from travel activity through new vehicle technology, including electric vehicles, and alternative fuels. All strategy options are defined and assessed at multiple place types, particularly VMT strategies, where the type of strategy appropriate for implementation and its effectiveness varies significantly from urban to rural areas. The strategy results, cost effectiveness, and implementation considerations will help guide NJTPA and local planners to better incorporate GHG mitigation approaches into ongoing planning processes.

The Plan also evolves strategies into bundles and into potential regional scenarios. One objective of presenting strategies in this way is to help planners better understand the interactive benefits of strategies that complement each other. The other objective is to view optional long-term emissions trends through 2050 based on a "what if" regional scenario analysis. What the assessment tells us is that a mix of vehicle technology, VMT reduction, and system efficiency strategies can move the NJTPAs on-road GHG emissions sector to the forefront of strategies for addressing climate change. In fact, in a best case scenario the region can come very close to attaining a long-range target reduction of 80 percent below 2006 by 2050. This is no small feat, particularly in a region as complex and economically robust as Northern New Jersey.

One high-level conclusion that was reached early in the development of the Plan is the significance of the GHG emissions reduction that results from the implementation of the new MY 2017-2025 car and light-duty truck fuel economy standards. As long as the region's VMT grows at a rate commensurate with population growth (e.g., no net increase in VMT per capita), these standards will result in a 34 percent reduction (compared to 2006) in on-road GHG emissions by 2050. If more aggressive penetration of electric vehicles into the fleet occurs, predominantly as a result of competitive cost and improved battery technology (with some incentive/support programs included), it is likely this reduction could be as high 53 percent from 2006.

7.2 NEXT STEPS

NJTPA is in the process of developing the Regional Plan for Sustainable Development and PLAN2040 (the next Regional Transportation Plan). Both of these efforts will help frame the land use and transportation priorities for NJTPA and its member jurisdictions through 2040. The 13 counties in the NJTPA region, the 384 municipalities, as well as NJTPAs partner state agencies ongoing transportation planning processes are increasingly considering the impacts of transportation and land use planning decisions on GHG emissions. In all of these activities, the findings of this Plan will help guide technical analysis, prioritization of strategies, and identify areas for additional research.

A. On-Road Transportation GHG Emissions Inventory and Forecast Documentation

A.1 Introduction and Overview of Methodology

This memo documents the methodology and assumptions used to calculate the Baseline on-road mobile greenhouse gas inventory and forecast for the 13 county NJTPA region for the years 2006, 2020, 2035, 2040, and 2050. In addition, it documents assumptions used in the Alternative Baseline, which assumes implementation of the proposed light duty vehicle standards for model years 2017-2025.

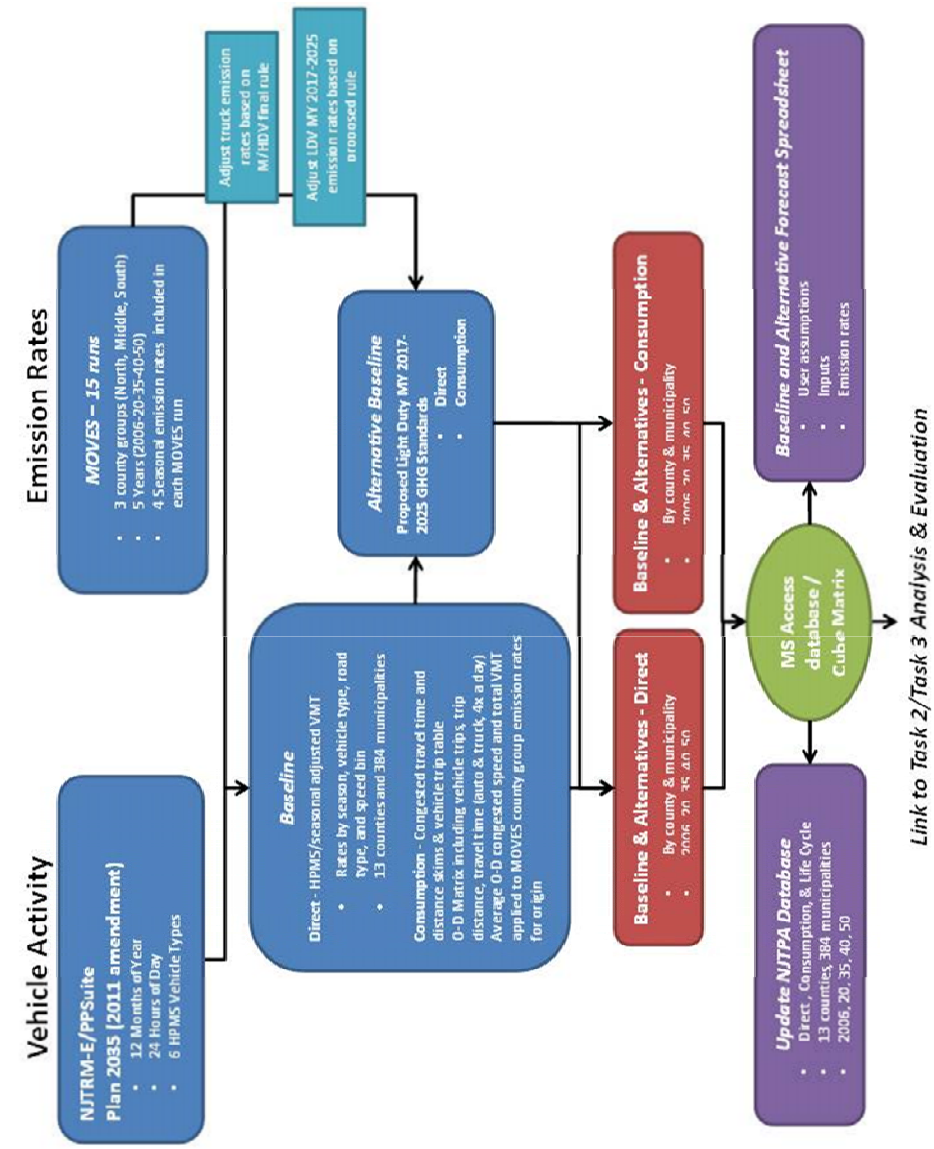
Figure 1 provides an overview of the process, which has two main components: GHG emission rates (grams/mile) and vehicle activity (vehicle miles traveled). Total greenhouse gas emissions can be estimated by multiplying emission rates by vehicle activity. The following bullets briefly describe the boxes in Figure 1:

- MOVES Runs – MOVES 2010a is used to produce the regional specific emission rates. This version of the MOVES model includes adopted GHG standards for model year 2012-2016 light duty vehicles, which were not included in the previous 2011 NJTPA GHG Inventory and Forecast.
- NJTRM-E /PPSuite – Loaded networks from the latest version of NJTRM-E with the August 2011 Amendments to Plan 2035 are fed into the PPSuite post-processing software to get estimates of vehicle activity by county for each month of the year, hour of the day, and six HPMS vehicle types.
- Baseline – Emission rates and activity are combined to create a baseline inventory and forecast based on current activity forecasts and emission rates that include all final GHG emission standards/ fuel economy rules. This requires post-MOVES adjustments to include the final medium/heavy duty truck rule for model years 2014-2018.
- Alternative Baseline – Emission rates and activity are combined to create an Alternative Baseline inventory and forecast that includes all rules included in the Baseline plus the proposed light duty GHG standard for model year 2017-2025 vehicles.
- MS Access Database/CUBE TP+ Matrix – Due to the size of the aggregated regional dataset for both the direct and consumption based emission accounting methods, disaggregated emissions calculations are performed in an Access database (for the

direct method) or through CUBE TP+ matrix processing (for the consumption method) to produce emissions for each of the 13 counties and 384 municipalities.

- MS Excel Spreadsheet Tool – Aggregated emission rates and activity are fed into this spreadsheet from the outputs of the Access database/TP+ matrix processing to create a flexible tool that allows for on-the-fly reporting of emissions and VMT be vehicle type for any year 2006 - 2050. Emissions estimates are created for each of the 13 counties and 384 municipalities.

Figure A.1 Overview of Methodology



A.2 Emission Rate and Vehicle Activity Estimation

MOVES 2010a is the latest EPA emissions model and is the best available model for creating greenhouse gas emission rates since it is able to provide emission rates by speed and vehicle type. This latest "2010a" version of the MOVES model includes significantly updated GHG emission rates, which were not included in MOVES 2010 that was used for the 2011 NJTPA GHG Inventory and Forecast. Specifically, GHG emission rates in MOVES 2010a were updated to include:

- Light Duty MY 2008-2011 CAFE Standards
- Light Duty MY 2012-2016 CAFE/GHG Standards

MOVES 2010a does not include the following GHG standards. Post MOVES adjustments will be made to reflect these.

- Final rule for MY 2014-2018 medium/heavy duty trucks – Post MOVES adjustments are made for inclusion in the baseline.
- Proposed rule for MY 2017-2025 light duty vehicles – Post MOVES adjustments are made for inclusion in the alternative baseline.

Data Acquired and MOVES Run Approach

NJTPA provided MOVES input files from the previous GHG Inventory and Forecast conducted in 2011. These files were set up to run MOVES 624 times, due to inputs that varied for each of items shown in Table 1.

Table A.1 Comparison of MOVES Runs to 2011 Inventory and Forecast

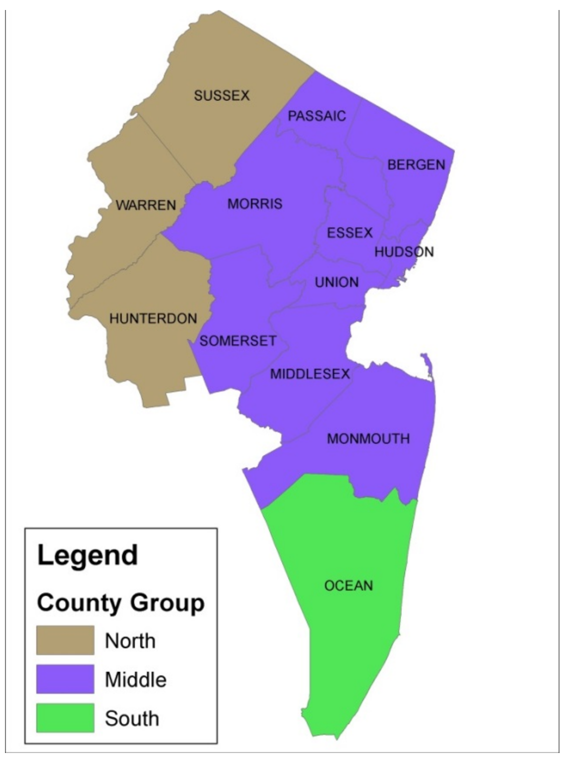
Name	2011 Inventory and Forecast (I&F)	2012 I&F Update for GHG Mitigation Plan
Key Inputs	• 13 Counties • 12 Months • 4 Years (2006, 2020, 2035, 2050)	• 3 County Groups • 4 Seasons • 5 Years (2006, 2020, 2035, 2040, 2050)
Separate MOVES Run by Month?	Yes	No
Resulting number of MOVES Runs	624 MOVES Runs	15 MOVES Runs

While 624 runs may be required if using MOVES in inventory mode, the number of runs can be reduced for running MOVES in emission rate mode (emission rate mode is recommended for this analysis given the need to track emission rates by speed and vehicle class for strategy and bundle analysis in subsequent tasks). This is because only 5 of the 13 inputs are required to have proper values in emission rate mode (the remaining inputs can have dummy values or general values to provide reasonable ratios of vehicle population/activity). The five inputs requiring proper (regional specific) values are:

- Meteorology – NJDEP (via NJTPA) provided these input files in MOVES-ready format. These files included temperature and humidity by hour of day and month of year for each of the 13 counties
- Inspection/Maintenance (I/M) NJDEP (via NJTPA) provided these input files in MOVES-ready format. They include information about the type of testing program for certain vehicle types and model years along with a compliance factor for each of these combinations. In some cases this file was not available for certain calendar years and assumptions were made about the I/M program being similar to the nearest available calendar year with appropriate adjustments being made to the model years covered.
- Fuel Formulation- NJDEP (via NJTPA) provided these input files in MOVES-ready format. They specify the characteristics (such as RVP, sulfur level, and ethanol volume) of fuels used at different times of year for different counties. All of the fuels for the NJTPA region were some variation diesel fuel or E10 gasoline.
- Fuel Supply - NJDEP (via NJTPA) provided these input files in MOVES-ready format. The files include which fuel formulations are used in what mix for different counties, months, and calendar years. This is mainly used to account for gasoline with different RVP values being used during the summer time to address ozone formation. It also shows lower sulfur fuel being used in later calendar years as those regulations are phased in. MOVES assumes that the fuel formulations used in 2012 will be used for every calendar year after that. Therefore, fuel inputs into MOVES should not be expected to impact GHG emission rates.
- Age Distribution – NJDEP (via NJTPA) provided these input files in MOVES-ready format. These files simply provide a distribution based on the number of vehicles that fall in each of 31 age bins (ages 0 to 30 years old) for each MOVES source (vehicle) type.

Upon examination of the NJPTA data for these five inputs it was determined that age distribution and I/M do not vary over the 13 counties. It was further determined that meteorology does vary by county, but counties can be grouped into 3 groups with the same meteorology characteristics. For fuel only one county (Ocean) has different fuel than the remaining counties. Therefore, the MOVES runs are done by the following three county groups, which can also be seen in Figure 2:

Figure 17. Map of County Groups Used for MOVES



- North – Warren (34041), Hunterdon (34019), Sussex (04037)
- South – Ocean (34029)
- Middle – All other NJTPA counties

Meteorology and fuel inputs were provided by NJTPA for each of the 12 months of the year. These are aggregated to average values over the three months that make up each season as shown below:

- Winter – Dec –Feb
- Spring – March – May
- Summer – June – Aug
- Fall – Sept – Nov

MOVES Outputs

MOVES provides outputs of GHG emission rates in two tables: rateperdistance (running emissions measured in g/mile) and ratepervehicle (non-running emissions measured in g/vehicle). Non-running emissions are associated with off-network emissions associated with vehicle start-up and idling.[12]

Running Emissions and Post MOVES Adjustments

Running emissions are those from the tailpipe while the vehicle is in motion. These gram/mile emission rates were analyzed to determine if the level of output detail provided by MOVES (by season, hour of day, vehicle type, road type, and speed bin) should be maintained. An analysis of the greenhouse gas emission rates generated through MOVES found that they vary very little by season and hour of day; therefore, emission rates for January from midnight – 1 AM are used.

Post MOVES adjustments are made to running emission rates to reflect the final medium/heavy duty truck rule for the Baseline and the proposed light duty rule for the Alternative Baseline. The adjustments for the medium/heavy duty truck final rule for MY 2014-2018 are based on percent changes in fuel consumption and greenhouse gas emissions for model year 2018 and later vehicles found in the EPA/NHTSA factsheet[13]. These percent changes are based on vehicle type as shown in Table 2. Linear interpolation between zero and the 2018 values are used to get values for model years 2014-2017.

---

[12] Non-running emissions are not included in the emission results for either the direct or consumption based methods. Appendix A attached to this memo presents a table on estimates for non-running emissions by county for NJTPA reference.

[13] EPA and NHTSA. FACTSHEET: Paving the Way Toward Cleaner, More Efficient Trucks. Available: http://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/Factsheet.08092011.pdf

Table A.2 Adjustments for HD MY 2014-2018 Final Rule (Baseline)

	GHG Rate % Improvement		
Model Year	**Combination Truck**	**HD Pickups & Vans**	**Vocational**
2014	4.00%	3.00%	2.00%
2015	8.00%	6.00%	4.00%
2016	12.00%	9.00%	6.00%
2017	16.00%	12.00%	8.00%
2018 & Later	20.00%	15.00%	10.00%

The rule is assumed to impact all model years 2014 and beyond. Based on vehicle age distribution by MOVES source type (vehicle type), the share of vehicles conforming to the standards for 2020, 2035, 2040, and 2050 can be estimated. The emission rate adjustment factors are summarized in Table 3, and presented in full detail in the "Model Data" tab of the Task 1 GHG emissions spreadsheets. Note, that light trucks have an overall newer age distribution and therefore new rules have a quicker impact.

Table A.3 2014-2018 M/HDV Standard – Emission Rate Adjustment Factor

Vehicle Type	2020	2035	2040	2050
Light Truck	0.995	0.989	0.989	0.989
Buses	0.962	0.904	0.901	0.900
Single Unit Truck	0.971	0.912	0.905	0.900
Combination Truck	0.938	0.819	0.808	0.800

The adjustments for the proposed light duty vehicle rule are based on new fuel economy estimates for each model year from 2017-2025, which is included in the notice of proposed rulemaking (NPRM)[14]. These fuel economy estimates and the corresponding percent improvement in greenhouse gas rates are shown in Table 4. The final rulemaking was published in the federal register on October 15th, 2012.

[14] EPA and NHTSA. Notice of Proposed Rulemaking (NPRM). 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards. Available: http://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/2017-25_CAFE_NPRM.pdf

Table A.4 Adjustments for LD MY 2017-2025 (Alternative Baseline)

Model Year	Fuel Economy (mpg)		GHG Rate % Improvement	
	Passenger Cars	Light Trucks	Passenger Cars	Light Trucks
2016 Base	37.8	28.8		
2017	40	29.4	5.82%	2.08%
2018	41.4	30	9.52%	4.17%
2019	43	30.6	13.76%	6.25%
2020	44.7	31.2	18.25%	8.33%
2021	46.6	33.3	23.28%	15.63%
2022	48.8	34.9	29.10%	21.18%
2023	51	36.6	34.92%	27.08%
2024	53.5	38.5	41.53%	33.68%
2025 & Later	56	40.3	48.15%	39.93%

The rule is assumed to impact all model years 2017 and beyond. Based on vehicle age distribution by MOVES source type (vehicle type), the share of vehicles conforming to the standards for 2020, 2035, 2040, and 2050 can be estimated. The vehicle age distribution by source type is based on NJTPA MOVES input data.

Table A.5 Proposed LDV Standard – Emission Rate Adjustment Factor

Vehicle Type	2020	2035	2040	2050
Passenger Car	0.966	0.585	0.537	0.520
Light Truck	0.978	0.658	0.631	0.620

Non-running Emissions

Non-running emissions include start emissions for all vehicles and extended idle emissions for combination long haul trucks. The non-running grams/vehicle emission rates from MOVES are multiplied by the vehicle population of each county group to calculate total grams of non-running emissions. This is the method outlined in the EPA guidance.[15] In the direct approach, the non-running emissions of each county group are allocated to the counties and municipalities in that group using the VMT of each of these jurisdictions. In the consumption approach, the non-running emissions of each county group are allocated to the counties and municipalities in that group using population.

[15] U.S. Environmental Protection Agency, Office of Transportation and Air Quality. *Using MOVES for Estimating State and Local Inventories of On-Road Greenhouse Gas Emissions and Energy Consumption-Draft*, EPA-420-D-12-001. January 2012;

Vehicle Activity Estimation

Direct Approach

The PPSUITE VMT and speed adjustment module (PPNET) was utilized to account for HPMS and seasonal volume adjustments to ensure overall consistency with NJTPA emissions modeling practices and the 2011 Inventory and Forecast approach. The adjustments were performed on NJTRM-E networks for 2008, 2020, 2035 and 2050. The output from the network adjustments consisted of individual database files of link based VMT and speed by vehicle type and facility type for each county and each month of the year. These files were merged and manipulated using Microsoft Access to enable a lookup function between VMT and speed by vehicle type and facility type to emission rates by vehicle type, facility type, and speed bin. Each link record also has an assigned county or municipality based on a lookup of traffic analysis zones.

Estimating 2006 Vehicle Activity

Travel activity from NJTRM-E for 2008 and emission rates from MOVES for 2006 were run through the process to calculate 2008 direct emissions as detailed above. To create an estimate for 2006, annual VMT by county was adjusted based on VMT data from NJDOT. Table 6 presents 2006 and 2008 VMT data and the percent change. The percent change was applied to the 2008 VMT data and 2006 emissions were calculated for county and municipality using 2006 emission rates from MOVES. Regional VMT decreased approximately 1.8 percent from 2006 to 2008.

Table A.6 2008 to 2006 VMT Adjustment

County	NJDOT 2006 Daily VMT	NJDOT 2008 Daily VMT	VMT Change
Bergen	21,160,651	20,838,702	1.54%
Essex	13,122,387	12,812,795	2.42%
Hudson	6,319,652	6,246,861	1.17%
Hunterdon	5,419,326	4,943,029	9.64%
Middlesex	20,756,172	20,685,807	0.34%
Monmouth	17,215,840	16,979,518	1.39%
Morris	14,858,496	14,592,429	1.82%
Ocean	12,417,366	12,432,482	-0.12%
Passaic	7,846,642	7,925,608	-1.00%
Somerset	8,897,056	8,420,937	5.65%
Sussex	3,557,207	3,146,595	13.05%
Union	12,137,158	12,295,940	-1.29%
Warren	4,056,930	3,818,544	6.24%
TOTAL	**147,764,883**	**145,139,247**	**1.81%**

Estimating 2040 Vehicle Activity

Table 7 presents the annual VMT estimate for 2040. This data represents a linear extrapolation between 2035 and 2050 VMT from NJTRM-E.

Table A.7 2040 VMT Estimate

VehicleType	Annual VMT(1000s)		
	NJTRME 2035	2040 Estimated	NJTRME 2050
Passenger	52,462,778	53,765,954	56,372,308
Commercial	2,841,953	2,898,756	3,012,362

Consumption Approach

Unlike direct emissions, which were computed for individual highway links and allocated to the municipality in which the link was located, consumption based emissions were calculated for each origin-to-destination (OD) trip in the region, then allocated to the origins and destinations which produced and attracted those trips.

The following steps were taken to estimate travel activity for the consumption based approach:

1. Using the NJTRME peak and off-peak trip tables and skim files, a matrix of peak and off-peak VMT and congested speed by vehicle type for all trips with an origin or destination within the 13 county-region was developed. This includes trips with an origin or destination outside the 13 county-region, excluding all external to external trips.
2. Truck trips were split into three truck classes as defined by the NJRTME—commercial, light and heavy. The percentage of total truck trips assigned to each of the truck classes by time of day was determined from factors developed during the trip generation stage of the NJRTME, consistent with the Inventory and Forecast approach.
3. For each origin-destination pair, the most common facility type and area type is reported. For example - to go from zone 1 to zone 10 there may be 10 links of which 4 are facility type 2, 3 links are road type 3 and 3 links are road type 4. In this case the most common link travelled from zone 1 to zone 10 is road type 2. The NJTRM-E network is skimmed based on congested travel time, and the most common facility type and area type is reported. The combination of NJTRME facility type and area type are applied to determine MOVES road type (rural restricted, rural unrestricted, urban restricted, urban unrestricted).
4. From the accumulated data (OD VMT by time of day, peak & off-peak travel time), total VMT and vehicle hours of travel (VHT) for each origin destination pair were determined by road type (MOVES 4 road types) and vehicle class (private vehicles, heavy, light & commercial trucks). This procedure was conducted for the analysis years 2008, 2020, 2035 and 2050, using travel model outputs provided by NJTPA.
5. The same VMT adjustments made for the direct approach were utilized to determine 2006 and 2040 OD data.

6. All OD zones were tracked at the county and municipality level for emissions reporting purposes.

A.3 Calculation of GHG Emissions

MOVES model results were aggregated to provide grams CO_2e/mile emission rates across four unique categories: by 3 county groups, 6 vehicle types (motorcycle, passenger car, light truck, buses, single unit truck, combination truck), 4 road types (rural restricted, rural unrestricted, urban restricted, urban unrestricted), and 16 speed bins (2.5 mph bins starting at zero up to speed > 72.5 mph) for 2006, 2020, 2035, 2040 and 2050. For each year, there are 1,152 unique emission rates across these four categories. While the MOVES runs did generate emission rates by season and hour of the day, after comparing rates by month and hour, it was decided to use a single representative month (January) and single representative hour (midnight – 1AM) to help significant decrease the size of the emission rate database.

Direct Approach

Using a Microsoft Access database query, link characteristics (speed and facility type/area type) are modified using lookup tables to be consistent with MOVES outputs (speed bin and road type). Emission rates outputs from MOVES are also modified using a query to translate from 13 MOVES source types to 6 vehicle types as presented in Table 8 (consistent with MOVES default assumptions). All lookups are provided on the "Model Data" tab in the Task 1 GHG emissions Excel worksheet.

Table A.8 VMT Based Vehicle Weights for Conversion from 13 MOVES Source Types to 6 Vehicle Types

Source Type	Vehicle Type	2006	2020	2035	2040	2050
11	1	1	1	1	1	1
21	2	1	1	1	1	1
31	3	0.750	0.750	0.750	0.750	0.750
32	3	0.250	0.250	0.250	0.250	0.250
41	4	0.408	0.421	0.424	0.424	0.424
42	4	0.126	0.114	0.111	0.111	0.111
43	4	0.466	0.466	0.465	0.465	0.465
51	5	0.022	0.009	0.007	0.007	0.006
52	5	0.829	0.825	0.825	0.825	0.826
53	5	0.102	0.120	0.121	0.121	0.121
54	5	0.047	0.046	0.047	0.047	0.047
61	6	0.431	0.404	0.406	0.406	0.406
62	6	0.569	0.596	0.594	0.594	0.594

VMT by vehicle type for each link is multiplied by the assigned emission factor (based on county group, vehicle type, road type, and speed bin) to estimate annual grams CO_2e emissions. The resulting output is total annual grams of CO2e emissions and VMT by passenger vehicles and commercial vehicles for each network link. Each link is also assigned a county and municipality based on the traffic analysis zone each link is within in order to estimate total annual emissions.

Consumption Approach

Cube matrix function is utilized to lookup emission rates for each OD pair based on county, vehicle type, road type, and speed bin. Total emissions are estimated for each OD pair, and then split 50 percent assigned to the origin, 50 percent assigned to the destination. Total emissions and VMT by passenger and commercial vehicles are aggregated by TAZ to the county and municipal level.

Final Products

Interim Year Approach

In order to estimate annual emissions for all years 2006 to 2050, interim factoring approaches were employed differently between milestone years (06, 20, 35, 40, 50) based on different available data.

2006 – 2020: Table 9 presents the results of the interim year estimation for 2006 to 2020.

Table A.9 Interim Year VMT and Emission Rate Estimation (2006 – 2020)

		Annual VMT (1000s)		Baseline CO_2e g/mile	
Source	Year	Passenger Vehicle	Commercial Vehicle	Passenger Vehicle	Commercial Vehicle
Ratio	2006	43,402,469	2,363,618	396.53	1,535.80
Ratio	2007	44,128,684	2,403,167	396.53	1,535.80
NJTRME/MOVES	2008	42,727,825	2,308,745	396.53	1,535.80
Ratio	2009	42,504,084	2,296,655	396.53	1,535.80
Ratio	2010	42,622,473	2,303,052	396.53	1,535.80
Exp. growth	2011	43,081,878	2,339,887	392.72	1,535.80
Exp. growth	2012	43,546,235	2,377,311	388.94	1,535.80
Exp. growth	2013	44,015,596	2,415,334	383.44	1,535.80
Exp. growth	2014	44,490,017	2,453,964	377.30	1,530.45
Exp. growth	2015	44,969,552	2,493,213	370.35	1,525.11
Exp. growth	2016	45,454,254	2,533,089	362.30	1,519.79
Exp. growth	2017	45,944,182	2,573,604	357.07	1,514.03
Exp. growth	2018	46,439,390	2,614,766	351.85	1,508.26
Exp. growth	2019	46,939,935	2,656,586	346.62	1,502.50
NJTRME/MOVES	2020	47,445,876	2,699,076	341.39	1,496.73

VMT for years 2006, 2007, 2009, and 2010 are derived based on ratio between NJDOT VMT by county from 2006 to 2010 and NJTRME VMT for 2008. An exponential growth rate in VMT is assumed from 2010 to 2020 as the region emerges gradually from the recession.

Emission rates are constant for passenger vehicles for 2006 to 2010 and for commercial vehicles from 2006 to 2013. The 2006 – 2010 assumption for passenger vehicles is based on data from the US Department of Energy and EPA. In 2011 the benefit of 2008 – 2011 CAFE standards, plus a ramp-up of increased overall model year 2011 and 2012 vehicle efficiency to meet the new 2012 – 2016 CAFE standard begins to result in decreased emission rates. The change in emission rate from 2011 through 2020 is overall consistent with an average annual percent decrease in fleet on-road running emission rates of 1.5 percent. This falls in-line with 2012 Annual Energy Outlook Early Release estimates of the impact of the 2012-2016 CAFE/GHG emission standard.

2020 – 2050: Table 10 presents the results of the interim year estimation for 2020 to 2050.

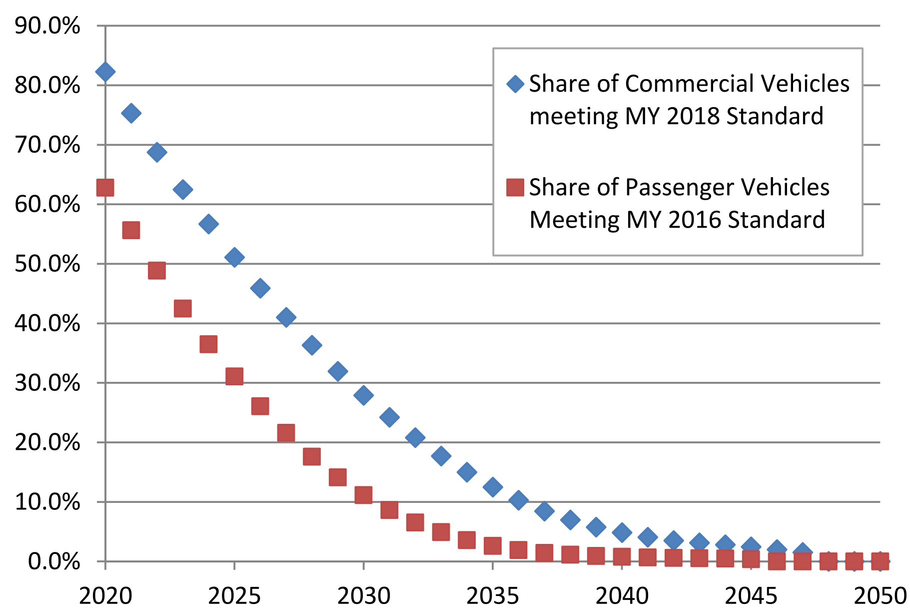
Table A.10 Interim Year VMT and Emission Rate Estimation (2020 – 2050)

		Annual VMT (1000s)		Baseline CO_2e g/mile	
Source	**Year**	**Passenger Vehicle**	**Commercial Vehicle**	**Passenger Vehicle**	**Commercial Vehicle**
NJTRME/MOVES	2020	47,445,876	2,699,076	341.39	1,496.73
Linear VMT	2021	47,780,336	2,708,601	335.88	1,490.22
Linear VMT	2022	48,114,796	2,718,126	332.81	1,483.49
Linear VMT	2023	48,449,256	2,727,651	329.93	1,476.76
Linear VMT	2024	48,783,716	2,737,176	327.25	1,470.03
Linear VMT	2025	49,118,177	2,746,701	324.75	1,463.30
Linear VMT	2026	49,452,637	2,756,226	322.45	1,456.56
Linear VMT	2027	49,787,097	2,765,752	320.33	1,449.83
Linear VMT	2028	50,121,557	2,775,277	318.41	1,443.10
Linear VMT	2029	50,456,017	2,784,802	316.68	1,436.37
Linear VMT	2030	50,790,477	2,794,327	315.14	1,429.63
Linear VMT	2031	51,124,937	2,803,852	313.79	1,422.90
Linear VMT	2032	51,459,397	2,813,377	312.63	1,416.17
Linear VMT	2033	51,793,857	2,822,902	311.67	1,409.44
Linear VMT	2034	52,128,318	2,832,427	310.89	1,402.71
NJTRME/MOVES	2035	52,462,778	2,841,953	310.58	1,388.58
Linear VMT	2036	52,723,413	2,853,313	309.92	1,389.24
Linear VMT	2037	52,984,048	2,864,674	309.72	1,382.51
Linear VMT	2038	53,244,684	2,876,035	309.71	1,375.78
Linear VMT	2039	53,505,319	2,887,395	309.75	1,369.04
Linear VMT/MOVES	2040	53,765,954	2,898,756	309.86	1,356.20
Linear VMT	2041	54,026,590	2,910,117	309.99	1,350.29
Linear VMT	2042	54,287,225	2,921,477	310.13	1,344.38
Linear VMT	2043	54,547,860	2,932,838	310.26	1,338.47
Linear VMT	2044	54,808,496	2,944,198	310.39	1,332.56
Linear VMT	2045	55,069,131	2,955,559	310.52	1,326.65

Linear VMT	2046	55,329,766	2,966,920	310.66	1,320.73
Linear VMT	2047	55,590,402	2,978,280	310.79	1,314.82
Linear VMT	2048	55,851,037	2,989,641	310.92	1,308.91
Linear VMT	2049	56,111,672	3,001,002	311.05	1,303.00
NJTRME/MOVES	2050	56,372,308	3,012,362	311.19	1,297.09

VMT for interim years from 2020 to 2050 is estimated based on a linear growth rate between the milestone years during that time period. Emission rates are associated with the MOVES default vehicle age distribution. Based on the 30 year age distribution in MOVES, in 2045, 100 percent of passenger vehicles meet the 2016 model year standard, and in 2048, 100 percent of commercial trucks meet the 2018 model year standard. Figure 1 presents the passenger and commercial vehicle share by year 2020 to 2050. The change in grams/mile over this period approximately follows these curves between milestone years.

Figure A.3 Share of Vehicle Fleet Not-Meeting Model Year 2018 Standards (2020 – 2050)



Municipality Reporting

The VMT and emission results are reported across 384 unique municipalities. For the direct approach, emissions and VMT are aggregated based on a link – TAZ – municipality lookup. For the consumption approach, emissions and VMT are aggregated based on the same TAZ – municipality lookup. There are a limited number of cases where VMT and emissions for a single TAZ are split among multiple municipalities. These splits are consistent with the same splits NJTPA uses to estimate population, households, and employment by municipality.

Energy Cycle

The same percent increases to consumption based emissions applied in the 2011 Inventory and Forecast by vehicle type are applied in Task 1. Table 11 presents the share of regional VMT by vehicle type and the estimated increase from consumption to energy cycle consistent with the 2011 Inventory and Forecast methodology. Based on the weighted averages by year, for passenger vehicles the factor is consistent from 2006 to 2050 at **22.94 percent**. For commercial vehicles, the factor increases over time due to the increasing share of light commercial truck VMT (light commercial trucks predominantly use gasoline which has a higher factor than diesel). The commercial factor increases from **20.19 percent** in 2006 to **20.30 percent** in 2050.

Table A.11 Consumption to Energy Cycle Conversion Summary

Vehicle Type	Share of Regional VMT				Estimated Factor to Convert Consumption to Energy Cycle
	2008	2020	2035	2050	
Motorcycle	0.4%	0.4%	0.4%	0.4%	23.0%
Passenger Car	71.4%	71.4%	71.4%	71.5%	23.0%
Passenger Truck	28.2%	28.2%	28.2%	28.1%	22.8%
Light Commercial Truck	87.8%	87.9%	88.6%	89.1%	21.2%
Intercity Bus	0.8%	0.8%	0.8%	0.7%	10.8%
Transit Bus	0.3%	0.3%	0.3%	0.3%	10.9%
School Bus	2.5%	2.4%	2.3%	2.2%	12.3%
Refuse Truck	0.0%	0.0%	0.0%	0.0%	11.3%
Single Unit Short-Haul Truck	5.2%	5.2%	4.9%	4.7%	14.8%
Single Unit Long-Haul Truck	0.4%	0.4%	0.4%	0.4%	14.6%
Combination Short-Haul Truck	1.7%	1.6%	1.5%	1.5%	10.8%
Combination Long-Haul Truck	1.3%	1.3%	1.2%	1.2%	10.8%

B. Baseline and Alternative Baseline Supplementary Results

The emission analysis results include annual VMT, emission rates, and annual total CO_2e emissions at the following information layers for 2006 to 2050:

Two baselines:

1. Baseline (2011 amendment to Plan2035 RTP with MOVES2010a plus post-processed adjustment for the MY 2014-2018 Medium/Heavy-Duty Vehicle Standard)
2. Alternative Baseline (Baseline plus post-processed adjustment for the proposed MY 2017-2025 Light-Duty Vehicle Standard)

Three emission accounting methods:

1. Direct – link based method by running and non-running emissions[16]
2. Consumption – trip based method by running and non-running emissions[1]
3. Energy Cycle – emissions associated with production, refining, and transport of fuels

Two vehicle types:

1. Passenger vehicles – Motorcycles, passenger cars, and light passenger trucks
2. Commercial vehicle – Light trucks, single unit trucks, combination trucks

Three geographies:

1. Region: 2. County (13): 3. Municipality (384 unique records)

These results represent a combination of four critical differences from the previous *Inventory and Forecast* analysis for on-road mobile source GHG emissions. These differences are:

1. Transition from MOVES2010 to MOVES2010a. Emission estimates now include the effects of the 2012-2016 Light-Duty Vehicle standard and refinements to the modeling of the 2008-2011 CAFE standards.

[16] Non-running emissions include vehicle starts and extended idle. Emissions from this activity average 6.5 percent of total emissions for passenger vehicles and 5.3 percent of total emissions for commercial vehicles in the NJTPA region.

2. Emission estimates now include the effects of the Final 2014-2018 Medium-Heavy Duty Vehicle standards through a post-processed adjustment to emission rates from MOVES 2010a.
3. New travel activity data from NJTRM-E based on model runs supporting conformity analysis associated with the August 2011 amendment to the Plan2035.
4. New base year (2006) travel activity data based on observed NJDOT VMT change from 2006 to 2008.

There are other less significant differences in the setup of MOVES and the number and detail of the MOVES runs conducted that are discussed in more detail in the Task 1 technical documentation. As a result of these extensive differences, we caution direct comparison to the emission results of the *Inventory and Forecast*. Comparison of overall regional trends or shares by county are valuable, as long as the four critical differences noted above are kept in mind.

Summary Results

The following tables and figures present some key components of the emissions analysis for the Baseline and Alternative Baseline. These results provide an indication of the type of information available and different approaches for presenting it. Elements of this information and other findings from the analysis will be presented to the TAC and the CCWG in advance of May 2012 meetings.

Table 1 on the following page presents the summary of annual regional emissions for the Baseline and Alternative Baseline, by emissions accounting method (direct / consumption / energy cycle), and by vehicle type (passenger vehicles – cars, light trucks) and commercial vehicles (buses, light/medium/heavy duty-trucks).

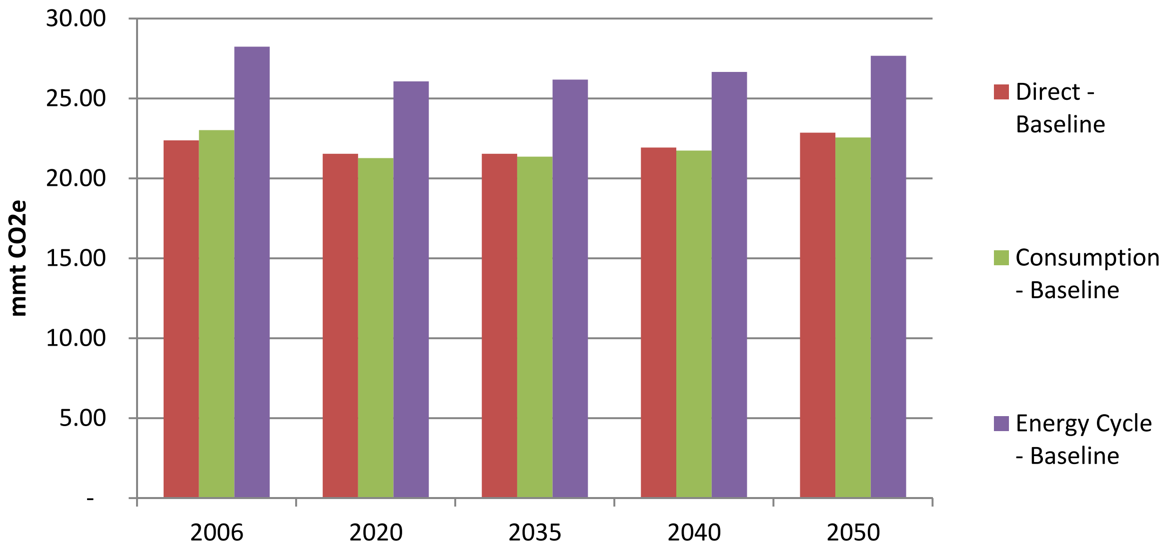
Table B.1 NJTPA Region On-Road Mobile CO2e Emission Inventory Summary

Annual Emissions (mmtCO_2e)	**2006**	**2020**	**2035**	**2040**	**2050**
Direct – Baseline	**22.38**	**21.54**	**21.54**	**21.93**	**22.86**
Passenger Vehicles	18.55	17.29	17.37	17.77	18.72
Commercial Vehicles	3.83	4.25	4.17	4.16	4.14
Direct – Alternative Baseline	**22.38**	**21.08**	**14.94**	**14.51**	**14.76**
Passenger Vehicles	18.55	16.83	10.77	10.36	10.62
Consumption – Baseline	**23.02**	**21.27**	**21.36**	**21.75**	**22.57**
Passenger Vehicles	20.51	18.57	18.72	19.11	19.91
Commercial Vehicles	2.51	2.70	2.64	2.64	2.66
Consumption – Alternative Baseline	**23.02**	**20.78**	**14.24**	**13.75**	**13.95**
Passenger Vehicles	20.51	18.07	11.61	11.11	11.29
Energy Cycle – Baseline	**28.24**	**26.08**	**26.18**	**26.66**	**27.67**
Passenger Vehicles	25.22	22.83	23.02	23.49	24.48
Commercial Vehicles	3.02	3.25	3.17	3.17	3.19
Energy Cycle – Alternative Baseline	**28.24**	**25.47**	**16.35**	**16.83**	**17.08**
Passenger Vehicles	25.22	22.22	14.27	23.49	13.88
Annual VMT (billion miles)[1]	**2006**	**2020**	**2035**	**2040**	**2050**
Direct VMT	**45.77**	**50.14**	**55.30**	**56.66**	**59.38**
Direct Passenger VMT	43.40	47.45	52.46	53.77	56.37
Direct Commercial VMT	2.36	2.70	2.84	2.90	3.01
Consumption VMT	**48.35**	**52.68**	**58.05**	**59.35**	**61.95**
Consumption Passenger VMT	46.90	51.04	56.35	57.61	60.13
Consumption Commercial VMT	1.46	1.64	1.70	1.74	1.82
CO_2e Running Emission Rates (gCO_2e/mile)	**2006**	**2020**	**2035**	**2040**	**2050**
Direct – Baseline	**455**	**404**	**366**	**363**	**361**
Passenger Vehicles	397	341	311	310	311
Commercial Vehicles	1,536	1,497	1,389	1,356	1,297
Direct – Alternative Baseline	**455**	**395**	**254**	**241**	**233**
Passenger Vehicles	397	332	193	181	177
Consumption – Baseline	**444**	**379**	**346**	**344**	**341**
Passenger Vehicles	409	342	313	312	311
Commercial Vehicles	1,587	1,522	1,419	1,386	1,333
Consumption – Alternative Baseline	**444**	**370**	**230**	**217**	**211**
Passenger Vehicles	409	333	194	182	177

Note (1) – Appendix A details the methodology differences between the direct and consumption approach, and how the differences impact VMT.

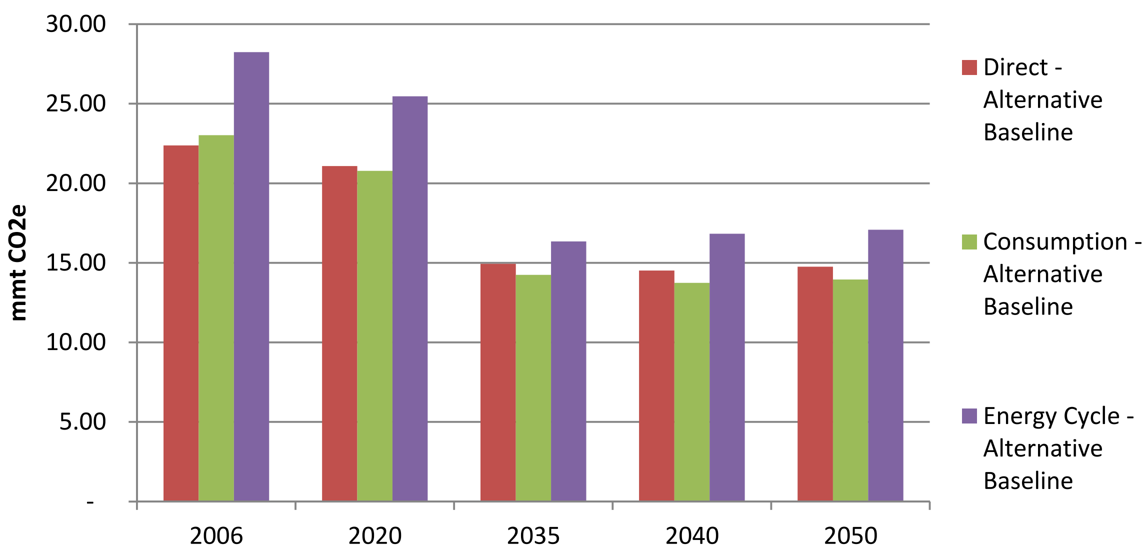
Figure 1 and Figure 2 present total emissions by accounting method for the Baseline and Alternative Baseline. There are a number of differences (refer to Task 1 technical memo) between how travel activity is measured for the direct and consumption based approach that accounts for the variability in results.

Figure B.1 Region Baseline – Annual CO2e Emissions



Note: The Baseline accounts for the effects of the 2008-11 and 2012-16 light-duty vehicle standards and the 2014-18 medium/heavy-duty truck standards.

Figure B.2 Region Alternative Baseline – Annual CO2e Emissions



Note: The Alternative Baseline accounts for the added effects of the proposed 2017-25 light-duty vehicle standards.

Figure 3 presents the comparison of direct and consumption based emissions. The region has higher passenger vehicle consumption-based emissions (7 – 10% higher than direct) and lower commercial vehicle consumption-based emissions (35 – 37% lower than direct). At the regional scale, for passenger travel this is indicative of the region's position as a net importer of workers and for commercial travel this reflects the region's position on the Northeast Corridor with significant interstate thru-truck traffic.

Figure B.3 Direct v. Consumption Emission Comparison

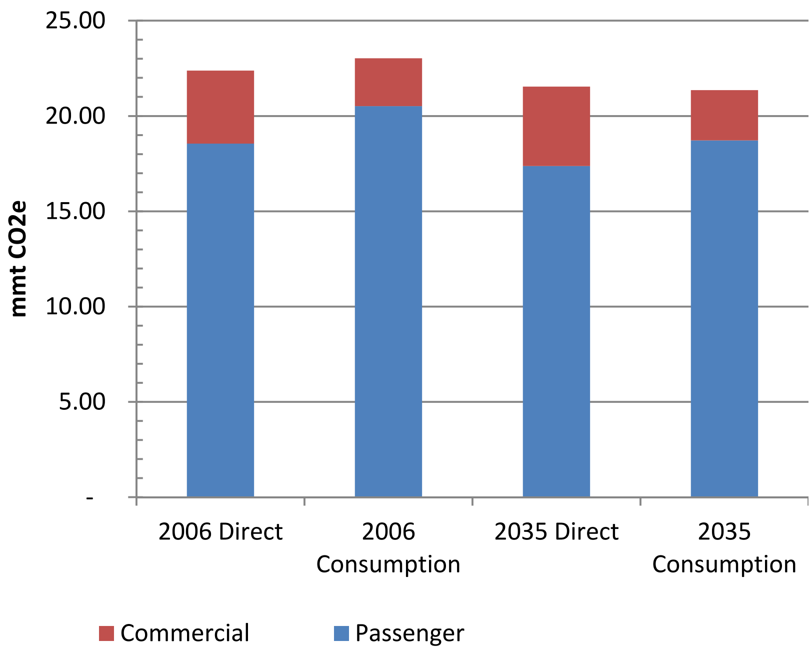
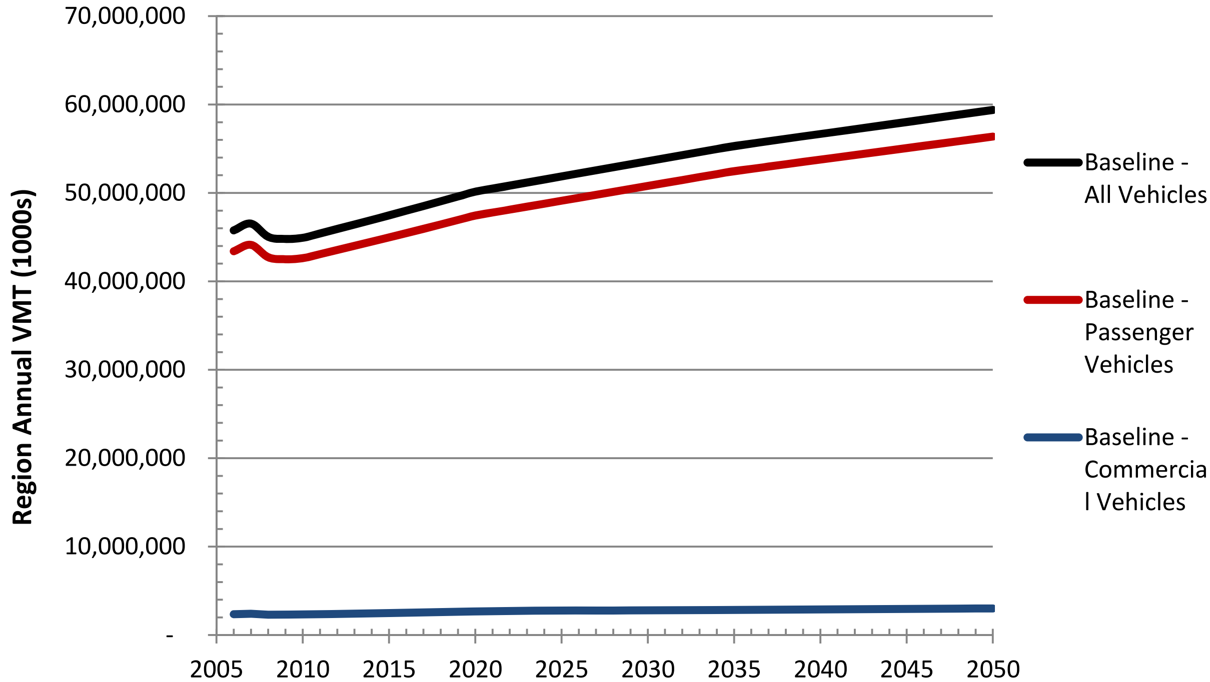


Figure 4 presents annual direct VMT for the NJTPA region by vehicle type and by county. Figure 5 presents annual region direct GHG emissions 2006-2050 for the Baseline and Alternative Baseline by passenger vehicles and commercial vehicles separately. Table 2 presents direct VMT and emission by county. Figure 6 and Figure 7 present the share of annual regional CO_2e emissions for the Baseline and Alternative Baseline by county.

Figure B.4 2006 – 2050 Region On-Road VMT (Direct)



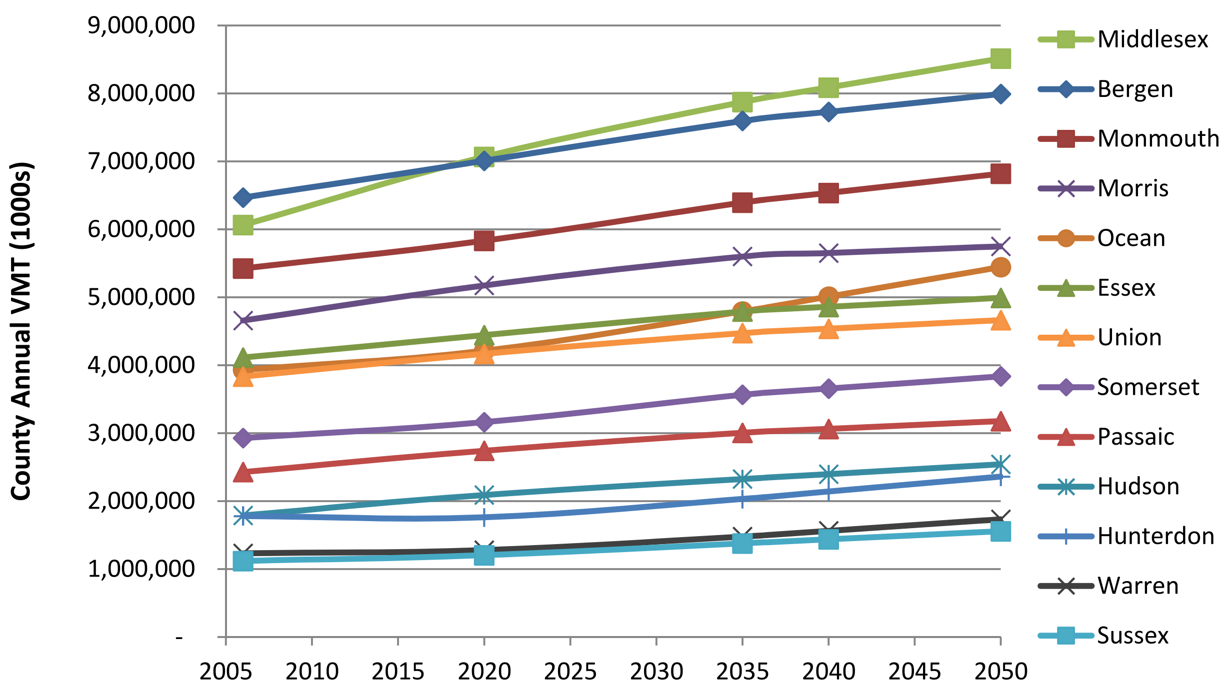


Figure B.5 2006-2050 Region On-Road Mobile Regional Emissions Inventory (Direct)

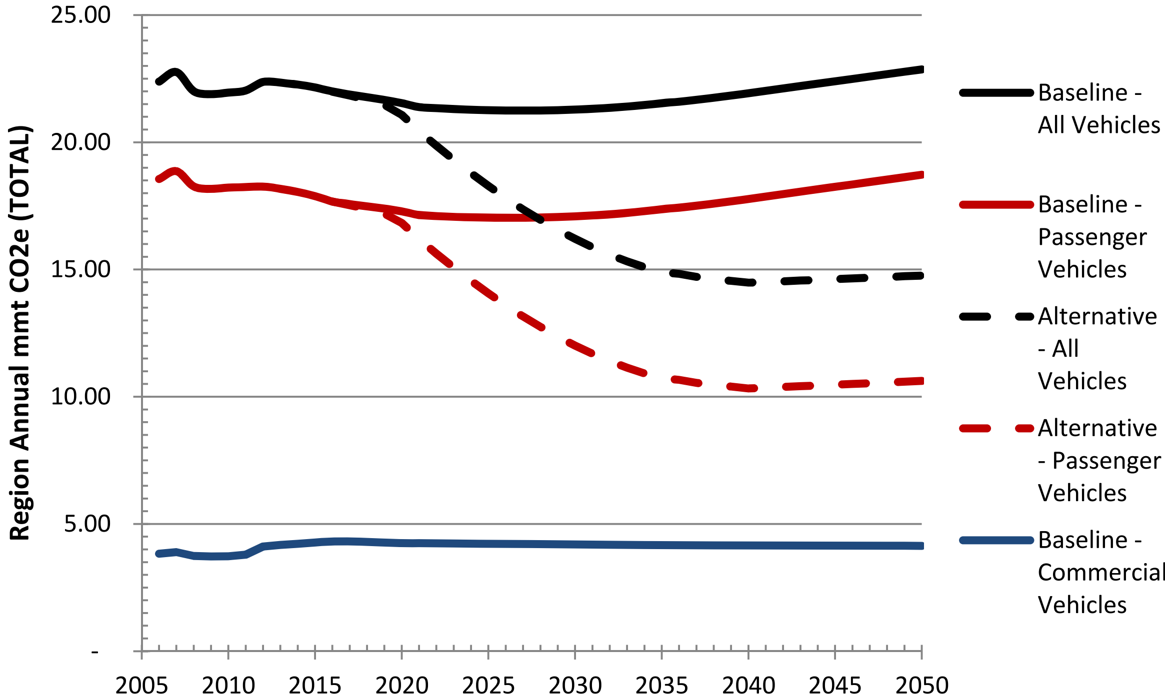


Table B.2 NJTPA Region On-Road Mobile CO_2e Emissions Inventory – Summary by County (Direct)

County	2006		2020		2035		2040		2050	
	VMT (1000s)	CO_2e (mmt)	VMT (1000s)	CO_2e (mmt)	VMT (1000s)	CO_2e (mmt)	VMT (1000s)	CO_2e (mmt)	VMT (1000s)	CO_2e (mmt)
BASELINE										
Bergen	6,467,505	3.57	7,009,111	3.37	7,595,914	3.32	7,728,296	3.36	7,993,061	3.46
Essex	4,112,952	2.01	4,442,703	1.90	4,791,550	1.86	4,858,606	1.87	4,992,719	1.91
Hudson	1,788,185	0.94	2,090,392	0.98	2,324,503	0.99	2,397,084	1.02	2,542,245	1.07
Hunterdon	1,779,134	0.94	1,761,117	0.84	2,032,399	0.87	2,141,991	0.90	2,361,175	0.96
Middlesex	6,063,562	2.90	7,067,955	2.98	7,873,112	3.03	8,087,056	3.10	8,514,946	3.25
Monmouth	5,423,791	2.35	5,832,088	2.21	6,393,387	2.21	6,535,573	2.26	6,819,945	2.37
Morris	4,658,366	2.16	5,175,164	2.09	5,601,573	2.04	5,650,801	2.05	5,749,256	2.06
Ocean	3,931,018	1.79	4,211,918	1.66	4,792,572	1.72	5,009,910	1.79	5,444,588	1.95
Passaic	2,428,032	1.17	2,741,645	1.15	3,005,482	1.15	3,062,793	1.17	3,177,413	1.21
Somerset	2,928,299	1.43	3,161,937	1.38	3,564,960	1.41	3,655,535	1.43	3,836,685	1.49
Sussex	1,119,354	0.53	1,203,949	0.49	1,378,177	0.51	1,437,556	0.53	1,556,315	0.57
Union	3,833,449	1.90	4,168,810	1.83	4,473,292	1.79	4,536,892	1.80	4,664,092	1.84
Warren	1,232,437	0.69	1,278,164	0.64	1,477,810	0.65	1,562,617	0.67	1,732,229	0.72
TOTAL	45,766,087	22.38	50,144,952	21.54	55,304,730	21.54	56,664,710	21.93	59,384,670	22.86
ALTERNATIVE BASELINE										
Bergen	6,467,505	3.57	7,009,111	3.30	7,595,914	2.29	7,728,296	2.21	7,993,061	2.23
Essex	4,112,952	2.01	4,442,703	1.86	4,791,550	1.29	4,858,606	1.24	4,992,719	1.24
Hudson	1,788,185	0.94	2,090,392	0.96	2,324,503	0.70	2,397,084	0.69	2,542,245	0.71
Hunterdon	1,779,134	0.94	1,761,117	0.83	2,032,399	0.65	2,141,991	0.64	2,361,175	0.67
Middlesex	6,063,562	2.90	7,067,955	2.92	7,873,112	2.12	8,087,056	2.07	8,514,946	2.13
Monmouth	5,423,791	2.35	5,832,088	2.16	6,393,387	1.46	6,535,573	1.41	6,819,945	1.45
Morris	4,658,366	2.16	5,175,164	2.05	5,601,573	1.41	5,650,801	1.34	5,749,256	1.32
Ocean	3,931,018	1.79	4,211,918	1.62	4,792,572	1.14	5,009,910	1.13	5,444,588	1.20
Passaic	2,428,032	1.17	2,741,645	1.13	3,005,482	0.78	3,062,793	0.75	3,177,413	0.76

Somerset	2,928,299	1.43	3,161,937	1.35	3,564,960	1.00	3,655,535	0.97	3,836,685	0.98
Sussex	1,119,354	0.57	1,203,949	0.52	1,378,177	0.38	1,437,556	0.37	1,556,315	0.39
Union	3,833,449	1.90	4,168,810	1.80	4,473,292	1.27	4,536,892	1.23	4,664,092	1.23
Warren	1,232,437	0.70	1,278,164	0.64	1,477,810	0.50	1,562,617	0.50	1,732,229	0.52
TOTAL	45,766,087	22.43	50,144,952	21.13	55,304,730	14.99	56,664,710	14.56	59,384,670	14.81

Figure 6 and Figure 7 present the share of annual regional CO_2e emissions for the Baseline and Alternative Baseline by county.

Figure B.6 Baseline Direct CO2e Emissions (by county)

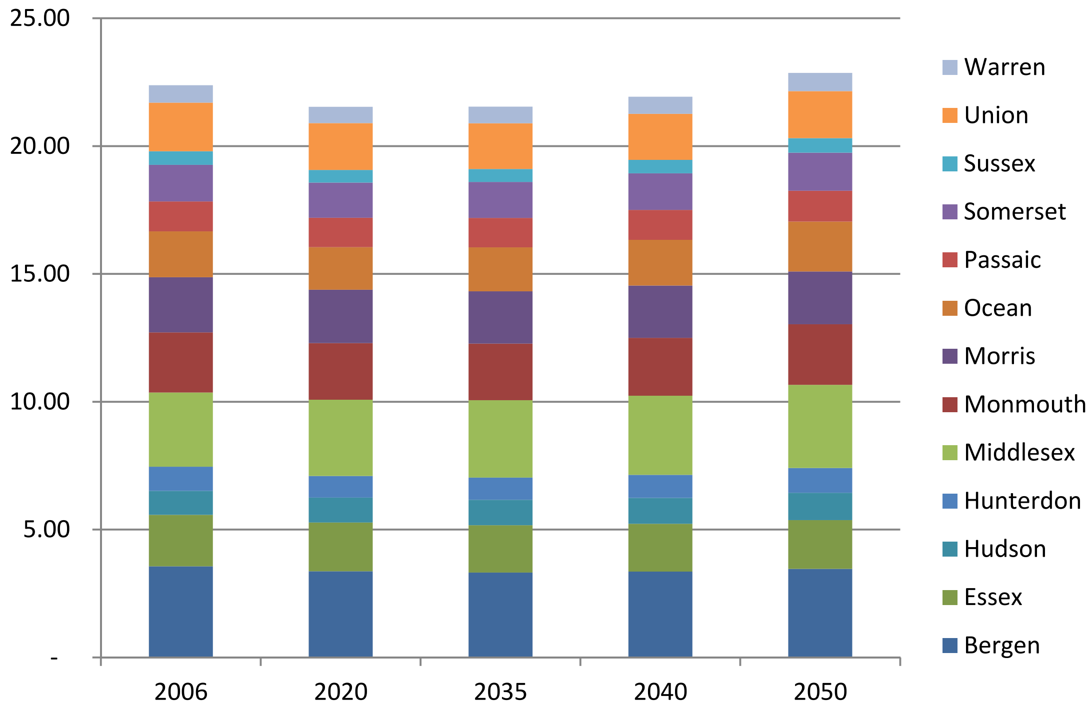


Figure B.7 Alternative Baseline Direct CO2e Emissions (by county)

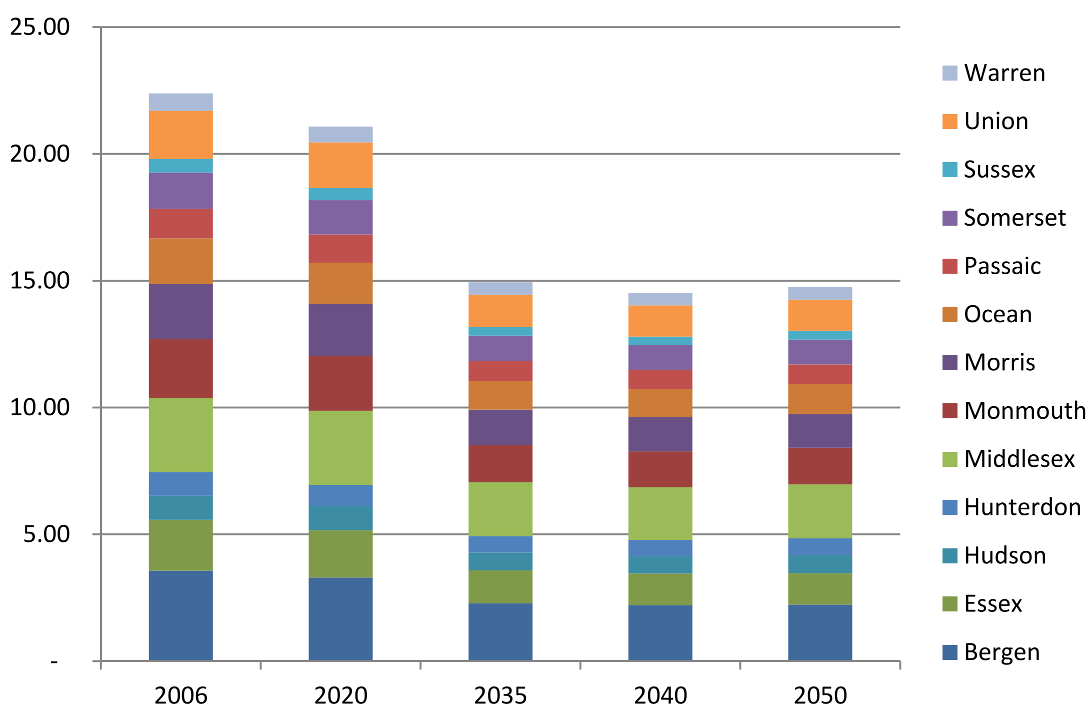


Figure 8 and Figure 9 present a comparison of CO_2e emissions in 2035 for the Baseline and Alternative Baseline by county and by emissions accounting method. The variability in direct and consumption based emission totals is tied to the inherent differences in a link based (direct) versus trip based (consumption) approach. Energy cycle emissions pivot off consumption based emissions by applying a multiplier based on fuel and vehicle type.

Figure B.8 2035 Baseline CO2e Emissions (by county and accounting method)

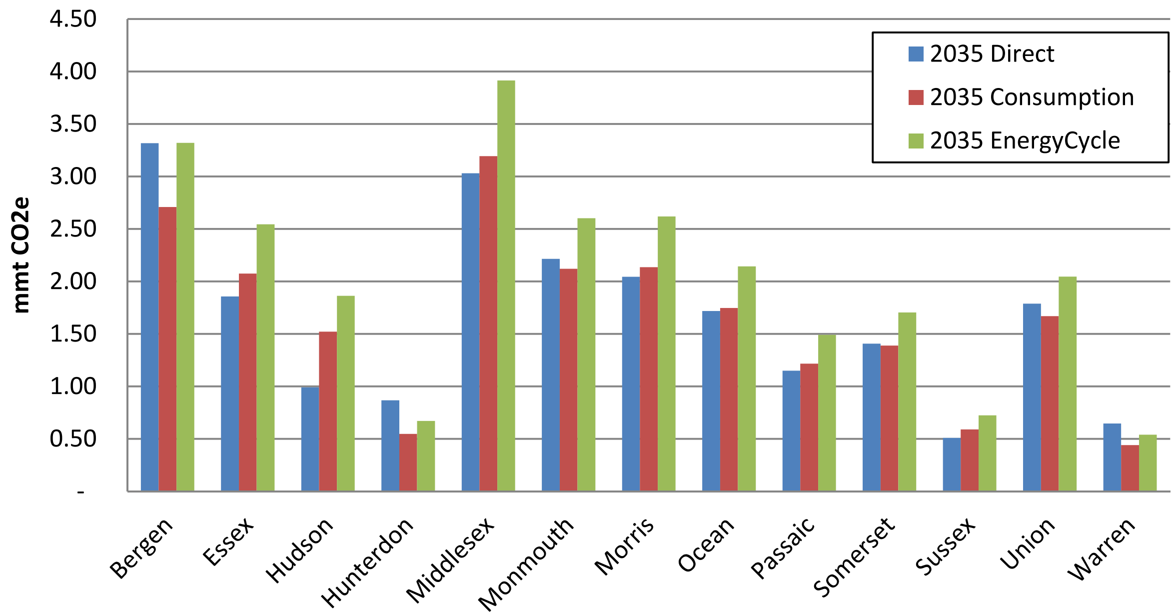


Figure B.9 2035 Alternative Baseline CO2e Emissions (by county and accounting method)

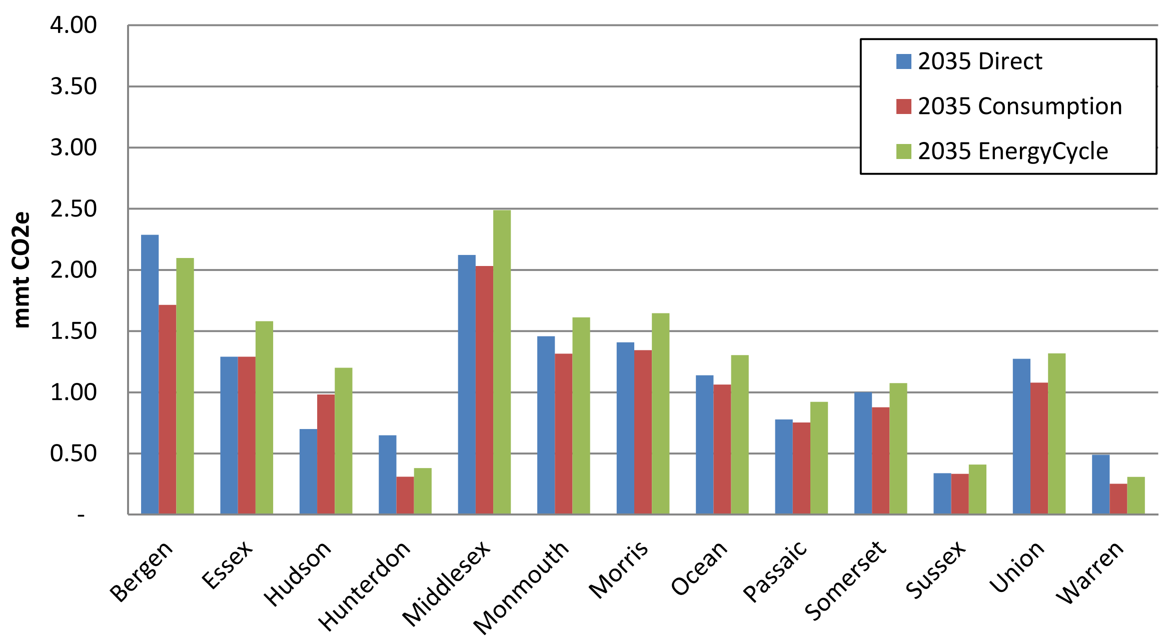


Table B.3 NJTPA Region On-Road Mobile CO2e Emissions Inventory – Top 10 Municipalities VMT and Emissions Baseline Direct and Consumption Comparison – Running Emissions Only

		Total VMT (1000s)					Total CO2e (mmt)				
Municipality		2006	2020	2035	2040	2050	2006	2020	2035	2040	2050
BASELINE - Direct											
1	Newark	1,480,104	1,595,441	1,737,016	1,773,544	1,846,601	0.810	0.768	0.756	0.759	0.785
2	Woodbridge	1,184,202	1,289,072	1,414,189	1,445,289	1,507,489	0.551	0.533	0.531	0.542	0.560
3	Edison	852,190	976,334	1,084,900	1,113,832	1,171,695	0.425	0.425	0.429	0.438	0.456
4	Parsippany-Troy Hills	843,622	956,288	1,024,119	1,035,341	1,057,783	0.387	0.384	0.368	0.368	0.372
5	Paramus	627,653	631,842	676,144	686,519	707,270	0.382	0.324	0.310	0.314	0.322
6	Toms River	810,891	853,508	934,391	956,134	999,620	0.375	0.333	0.330	0.343	0.350
7	Elizabeth	623,564	670,300	735,728	755,692	795,620	0.361	0.351	0.346	0.347	0.360
8	Jersey City	562,590	673,293	743,141	767,059	814,895	0.308	0.330	0.333	0.341	0.363
9	Union	651,135	695,796	743,955	752,516	769,638	0.300	0.280	0.272	0.274	0.279
10	Bridgewater	609,542	642,484	735,646	756,787	799,071	0.279	0.261	0.270	0.274	0.287
BASELINE - Consumption											
1	Newark	1,353,831	1,421,418	1,508,017	1,527,428	1,566,249	0.774	0.695	0.672	0.677	0.694
2	Jersey City	1,041,451	1,222,808	1,349,223	1,396,937	1,492,365	0.565	0.569	0.569	0.582	0.617
3	Edison	1,092,357	1,155,875	1,276,101	1,311,537	1,382,410	0.552	0.495	0.500	0.511	0.534
4	Woodbridge	846,654	917,507	986,944	1,001,892	1,031,789	0.419	0.385	0.380	0.389	0.396
5	Elizabeth	561,699	514,986	560,634	568,618	584,587	0.353	0.293	0.289	0.291	0.299
6	Toms River	658,001	691,161	773,234	806,683	873,582	0.328	0.292	0.302	0.315	0.329
7	Parsippany-Troy Hills	693,899	729,634	744,020	742,134	738,362	0.313	0.268	0.249	0.248	0.244
8	Paterson	519,908	581,217	649,207	664,809	696,011	0.288	0.275	0.280	0.284	0.298
9	Piscataway	568,317	744,770	845,561	873,525	929,451	0.272	0.290	0.299	0.306	0.324
10	Franklin	497,335	686,062	780,875	807,513	860,790	0.250	0.291	0.302	0.309	0.332

Table 2 compares the top 10 municipalities in terms of total 2006 CO_2e emissions for the Baseline direct and consumption accounting methods.

Some of these changes reflect decreases, for example Woodbridge, with consumption emissions that are 20 - 22 percent less than direct. Other's show increases, for example Jersey City, with consumption emissions that are 65-76 percent greater than direct. The direction of the change and its magnitude reflects characteristics about travel activity in each municipality.

In some small municipalities, the differences between direct and consumption based emissions can be significant. In these cases, the results may be more associated with network link or zone detail and not necessarily have anything to do with real differences in travel activity. For example, there are 44 municipalities with 10 or less network links, and 151 municipalities with only 1 traffic analysis zone.

Table B.3 NJTPA Region On-Road Mobile CO2e Emissions Inventory – Consumption Based VMT and CO2e per Capita & per Household (Sorted Based on 2010 VMT per Capita)

	Average Annual VMT/Capita			Average Annual VMT/HH			Average Annual CO_2e (tons)/Capita					Average Annual CO_2e (tons)/HH				
	Baseline			Baseline			Baseline			Alternative		Baseline			Alternative	
County	2010	2020	2035	2010	2020	2035	2010	2020	2035	2020	2035	2010	2020	2035	2020	2035
MORRIS	10,162	11,416	11,779	28,337	31,047	30,790	4.27	3.93	3.70	3.83	2.34	11.92	10.69	9.66	10.41	6.12
HUNTERDON	9,465	9,972	10,631	26,452	27,799	29,534	3.73	3.28	3.15	3.20	2.04	10.42	9.15	8.75	8.91	5.67
WARREN	9,268	9,526	9,873	23,570	24,703	26,296	3.61	3.06	2.86	2.98	1.86	9.17	7.95	7.63	7.73	4.96
SOMERSET	9,268	9,824	10,445	25,737	26,956	28,042	3.93	3.47	3.35	3.37	2.13	10.91	9.51	8.99	9.26	5.71
MIDDLESEX	8,318	8,591	8,743	23,972	23,901	22,835	3.55	3.01	2.82	2.93	1.80	10.22	8.38	7.36	8.16	4.70
SUSSEX	7,463	8,458	8,849	20,239	22,427	22,610	3.07	2.83	2.66	2.76	1.74	8.33	7.51	6.80	7.31	4.44
MONMOUTH	7,065	7,649	7,932	19,637	21,230	21,779	3.07	2.82	2.69	2.74	1.72	8.54	7.83	7.38	7.62	4.72
REGION	**6,817**	**7,135**	**7,231**	**18,708**	**19,281**	**18,982**	**2.98**	**2.60**	**2.40**	**2.53**	**1.54**	**8.18**	**7.01**	**6.31**	**6.83**	**4.05**
BERGEN	6,808	7,016	6,908	18,205	18,539	17,888	2.98	2.54	2.29	2.47	1.47	7.96	6.71	5.92	6.53	3.80
UNION	6,398	6,133	6,144	18,329	17,337	16,973	3.03	2.44	2.25	2.38	1.44	8.67	6.91	6.20	6.73	3.99
OCEAN	5,996	6,151	6,242	14,979	15,149	14,990	2.57	2.23	2.08	2.17	1.33	6.43	5.50	4.98	5.36	3.19
ESSEX	5,427	5,680	5,606	14,909	15,488	15,086	2.57	2.24	2.03	2.18	1.31	7.06	6.12	5.46	5.95	3.52
PASSAIC	5,128	5,142	5,049	15,324	15,105	14,428	2.34	1.94	1.75	1.89	1.13	6.99	5.71	4.99	5.56	3.24
HUDSON	4,306	4,342	4,435	11,233	11,127	10,899	1.98	1.67	1.56	1.63	1.02	5.16	4.29	3.83	4.17	2.50

Table 3 compares annual VMT per capita and per household to annual CO2e emissions per capita and per household by county. The data is sorted based on the 2010 average annual VMT per capita (first column of the table). VMT and emissions from the consumption approach are used to more accurately reflect trip characteristics of the population within each jurisdiction.

This table is supported by a rich set of data that presents a variety of information at the county level (it is also available by municipality) and will assist in developing strategies tailored to each jurisdiction. In combination with estimates of average on-road GHG emission per vehicle mile it presents a complete picture of the amount and efficiency of travel in each jurisdiction.

In Table 3, as expected Hunterdon, Warren, and Sussex counties all appear above the regional mean for VMT per capita and per household from 2010 through 2035. These counties plus Morris, Somerset, and Middlesex all have jobs to household ratios of 50 percent or less of the regional average (jobs housing ratio is one predictor of VMT per household - housing density, land use mix, and availability of alternative modes are others). Hudson, Essex, and Union counties all appear below the regional mean for VMT per capita and per household. These counties all have jobs housing ratio's well above the region average.

Figure B.10 Annual Baseline Direct VMT per Household

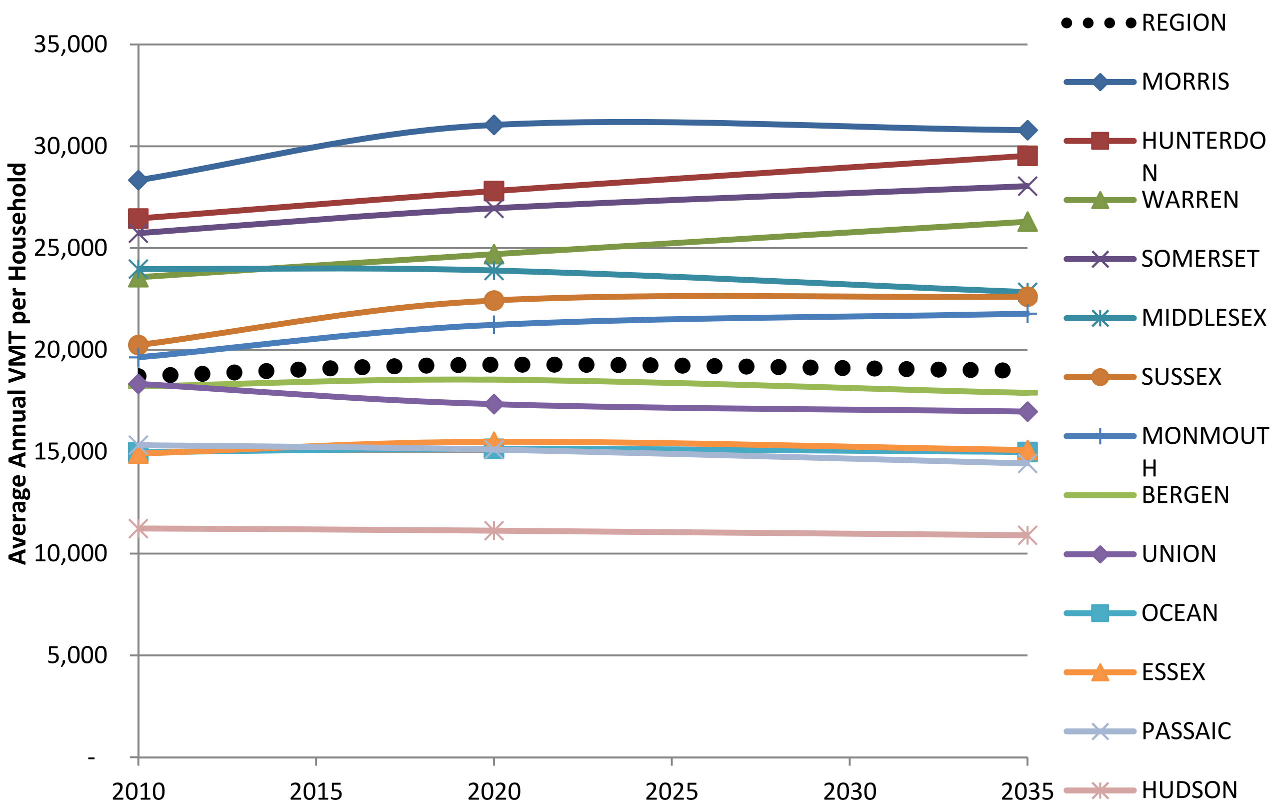


Figure 10 presents the trends in annual direct VMT per household from 2010 to 2035. Recall that VMT is identical for the Baseline and Alternative Baseline, the only change between the two is with regard to implementation of the proposed 2017 – 2025 national fuel economy standards. Note that VMT per household across most all counties increases or remains nearly constant from 2010 to 2035 except in Middlesex, Union, and Hudson which show slight decreases.

Figure B.11 Annual Baseline Direct CO2e (tons) per Household

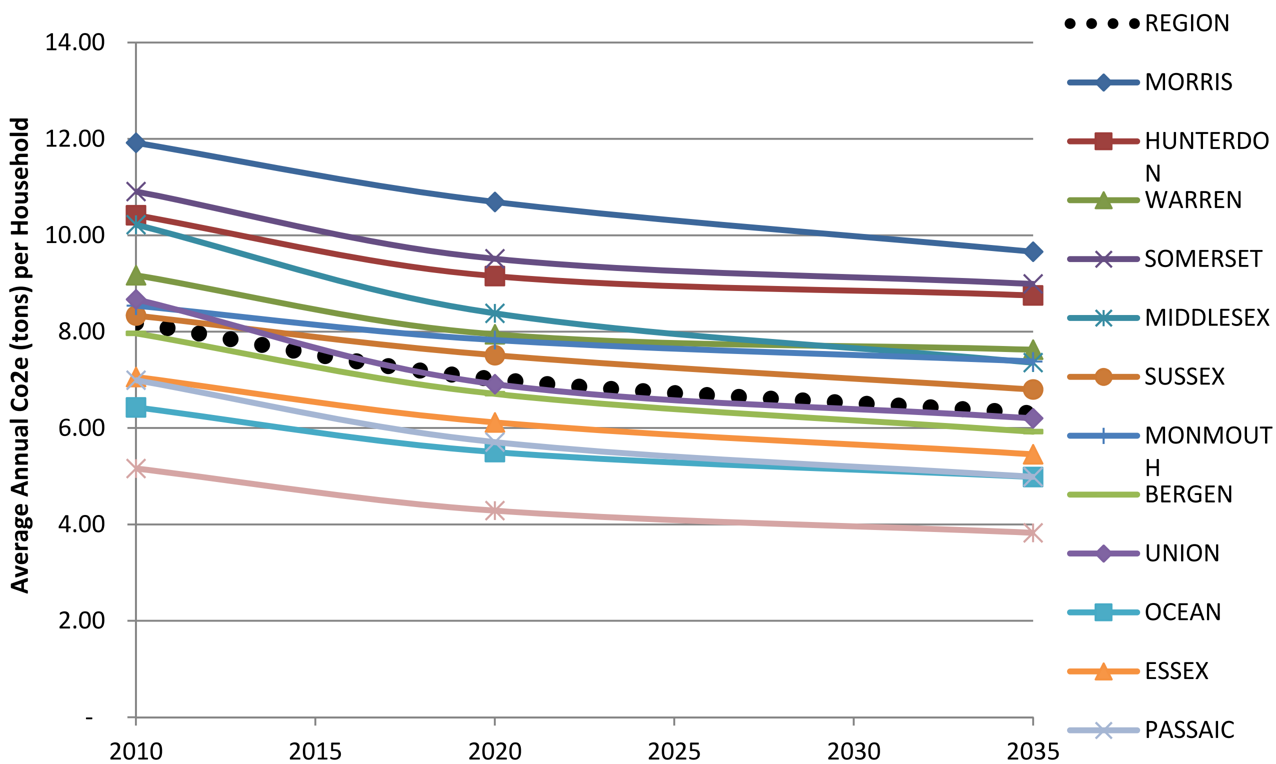


Figure 11 presents the change in annual Baseline direct emissions per household from 2010 to 2035. Notice the trend shows decreases regionwide and across all counties. Middlesex County, which shows a decrease in VMT per household in Figure 10, shows a greater decrease in emissions per household in Figure 10 than other counties. This reflects the multiplicative benefits of VMT per household reduction and emissions per household reduction.

Figure 12 presents the change in annual Alternative Baseline direct emissions per household from 2010 to 2035. As opposed to emissions per household leveling off post-2020, the Alternative Baseline show emissions per household continuing to decrease through 2035.

Figure B.12 Annual Alternative Baseline Direct CO2e (tons) per Household

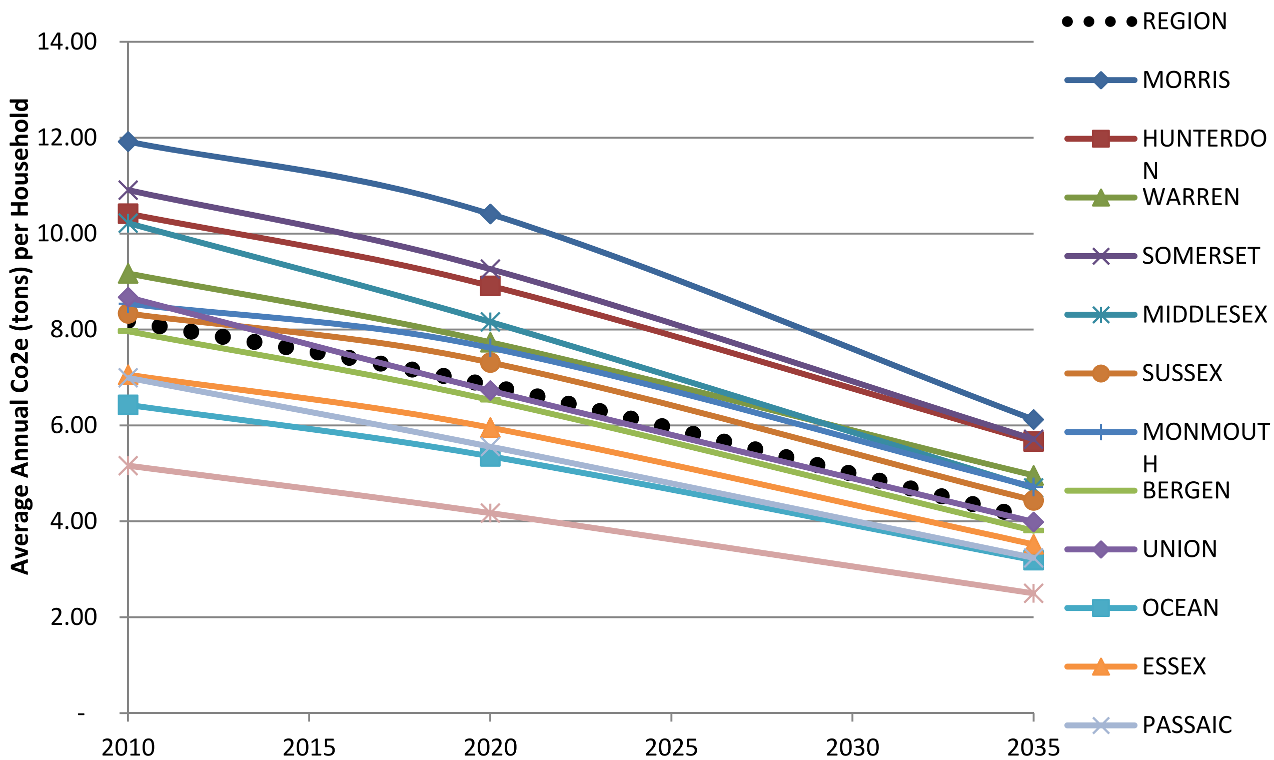


Table B.4 Baseline and Alternative Baseline Summary

	Annual CO2e Emissions (running mmt)					Annual CO2e Emissions (non-running mmt)					Annual CO2e Emissions (TOTAL mmt)				
	Baseline			Alternative		Baseline			Alternative		Baseline			Alternative	
Region	Total	PVs	CVs	Total	PVs	Total	PVs	CVs	Total	PVs	Total	PVs	CVs	Total	PVs
2006	20.84	17.21	3.63	20.84	17.21	1.54	1.34	0.20	1.54	1.34	22.38	18.55	3.83	22.38	18.55
2007	21.19	17.50	3.69	21.19	17.50	1.57	1.37	0.20	1.57	1.37	22.76	18.86	3.89	22.76	18.86
2008	20.49	16.94	3.55	20.49	16.94	1.52	1.32	0.20	1.52	1.32	22.01	18.27	3.74	22.01	18.27
2009	20.38	16.85	3.53	20.38	16.85	1.51	1.32	0.19	1.51	1.32	21.89	18.17	3.72	21.89	18.17
2010	20.44	16.90	3.54	20.44	16.90	1.51	1.32	0.20	1.51	1.32	21.95	18.22	3.73	21.95	18.22
2011	20.51	16.92	3.59	20.51	16.92	1.52	1.32	0.20	1.52	1.32	22.03	18.24	3.79	22.03	18.24
2012	20.84	16.94	3.90	20.84	16.94	1.53	1.32	0.21	1.53	1.32	22.37	18.26	4.11	22.37	18.26
2013	20.84	16.88	3.96	20.84	16.88	1.50	1.29	0.21	1.50	1.29	22.34	18.17	4.17	22.34	18.17
2014	20.80	16.79	4.01	20.80	16.79	1.47	1.26	0.21	1.47	1.26	22.27	18.05	4.22	22.27	18.05
2015	20.72	16.65	4.06	20.72	16.65	1.44	1.23	0.21	1.44	1.23	22.16	17.88	4.27	22.16	17.88
2016	20.58	16.47	4.11	20.58	16.47	1.41	1.20	0.21	1.41	1.20	21.99	17.67	4.32	21.99	17.67
2017	20.50	16.41	4.10	20.46	16.36	1.38	1.17	0.21	1.38	1.17	21.88	17.58	4.31	21.84	17.53
2018	20.42	16.34	4.08	20.33	16.25	1.35	1.14	0.21	1.35	1.14	21.77	17.48	4.29	21.68	17.39
2019	20.33	16.27	4.06	20.15	16.09	1.33	1.12	0.21	1.32	1.11	21.66	17.39	4.27	21.47	17.20
2020	20.24	16.20	4.04	19.81	15.77	1.30	1.09	0.21	1.27	1.06	21.54	17.29	4.25	21.08	16.83
2021	20.08	16.05	4.03	19.20	15.17	1.30	1.09	0.21	1.24	1.03	21.38	17.14	4.24	20.44	16.20
2022	20.04	16.01	4.03	18.66	14.63	1.30	1.09	0.21	1.21	1.00	21.34	17.10	4.24	19.86	15.63
2023	20.01	15.98	4.02	18.14	14.12	1.30	1.09	0.21	1.17	0.96	21.31	17.07	4.23	19.31	15.08
2024	19.98	15.96	4.01	17.64	13.63	1.30	1.09	0.21	1.14	0.93	21.28	17.05	4.23	18.79	14.56
2025	19.96	15.95	4.01	17.18	13.17	1.30	1.09	0.21	1.11	0.90	21.26	17.04	4.22	18.29	14.06
2026	19.95	15.95	4.00	16.73	12.73	1.30	1.09	0.21	1.08	0.87	21.25	17.03	4.22	17.81	13.60
2027	19.94	15.95	4.00	16.31	12.32	1.30	1.09	0.21	1.05	0.84	21.24	17.03	4.21	17.37	13.16
2028	19.95	15.96	3.99	15.92	11.93	1.30	1.08	0.22	1.03	0.81	21.25	17.04	4.20	16.95	12.75
2029	19.96	15.98	3.98	15.56	11.58	1.30	1.08	0.22	1.00	0.79	21.26	17.06	4.20	16.56	12.36
2030	19.98	16.01	3.98	15.23	11.25	1.30	1.08	0.22	0.98	0.76	21.28	17.09	4.19	16.21	12.01
2031	20.01	16.04	3.97	14.92	10.95	1.30	1.08	0.22	0.96	0.74	21.31	17.13	4.19	15.88	11.69
2032	20.05	16.09	3.96	14.65	10.68	1.30	1.08	0.22	0.94	0.72	21.35	17.17	4.18	15.58	11.40

	Annual CO2e Emissions (running mmt)					Annual CO2e Emissions (non-running mmt)					Annual CO2e Emissions (TOTAL mmt)				
	Baseline			Alternative		Baseline			Alternative		Baseline			Alternative	
Region	Total	PVs	CVs	Total	PVs	Total	PVs	CVs	Total	PVs	Total	PVs	CVs	Total	PVs
2033	20.10	16.14	3.96	14.40	10.44	1.30	1.08	0.22	0.92	0.70	21.40	17.22	4.18	15.32	11.14
2034	20.16	16.21	3.95	14.19	10.23	1.30	1.08	0.22	0.90	0.68	21.46	17.29	4.17	15.09	10.92
2035	20.24	16.29	3.95	14.00	10.06	1.30	1.08	0.22	0.89	0.67	21.54	17.37	4.17	14.89	10.72
2036	20.28	16.34	3.94	13.94	10.00	1.31	1.09	0.22	0.89	0.66	21.59	17.43	4.16	14.83	10.66
2037	20.35	16.41	3.94	13.83	9.89	1.31	1.09	0.22	0.88	0.66	21.66	17.50	4.16	14.71	10.55
2038	20.43	16.49	3.94	13.75	9.81	1.32	1.10	0.22	0.88	0.65	21.75	17.59	4.16	14.62	10.46
2039	20.51	16.57	3.93	13.68	9.75	1.33	1.11	0.22	0.87	0.65	21.84	17.68	4.16	14.56	10.40
2040	20.59	16.66	3.93	13.61	9.68	1.34	1.11	0.22	0.87	0.65	21.93	17.77	4.15	14.48	10.33
2041	20.68	16.75	3.93	13.64	9.71	1.34	1.12	0.22	0.87	0.65	22.02	17.87	4.15	14.51	10.36
2042	20.76	16.84	3.93	13.66	9.74	1.35	1.13	0.23	0.88	0.65	22.11	17.96	4.15	14.54	10.39
2043	20.85	16.92	3.92	13.69	9.76	1.36	1.13	0.23	0.88	0.65	22.21	18.06	4.15	14.57	10.42
2044	20.93	17.01	3.92	13.71	9.79	1.37	1.14	0.23	0.88	0.66	22.30	18.15	4.15	14.60	10.45
2045	21.02	17.10	3.92	13.74	9.82	1.37	1.15	0.23	0.89	0.66	22.40	18.25	4.15	14.62	10.48
2046	21.11	17.19	3.92	13.76	9.84	1.38	1.15	0.23	0.89	0.66	22.49	18.34	4.15	14.65	10.51
2047	21.19	17.28	3.92	13.79	9.87	1.39	1.16	0.23	0.89	0.66	22.58	18.44	4.15	14.68	10.54
2048	21.28	17.37	3.91	13.81	9.90	1.40	1.17	0.23	0.90	0.67	22.68	18.53	4.14	14.71	10.56
2049	21.37	17.45	3.91	13.84	9.92	1.41	1.17	0.23	0.90	0.67	22.77	18.63	4.14	14.74	10.59
2050	21.45	17.54	3.91	13.86	9.95	1.41	1.18	0.23	0.90	0.67	22.86	18.72	4.14	14.76	10.62

C. Strategy Screening

Table C.1 Draft NJTPA GHG Reduction Strategies – VMT Reduction

Priority Strategy
Priority Strategy w/ Barriers
Priority Strategy w/ Significant Barriers
High Cost/Risk/Low Return Strategy
Beyond Regional/Local Control

Strategy Description	Scale(s) of Analysis	Place Type	Implementation Authority	Investment - Risk - Return	Barrier Level
Comprehensive Planning - Expand current programs supporting comprehensive planning including visioning and blueprint creation, inter-jurisdictional partnerships for regional land use form and consistency among local zoning codes/provisions, requirements for local comprehensive plans meeting-defined objectives, designation of urban growth/priority funding areas, and interagency plan review.	Regional, Local	All	Local w/ State & Region support	Inter-jurisdictional agreements for complementary zoning across jurisdictions can be politically challenging to implement - Requires regional leadership; designation of priority funding areas needs to be endorsed at state level - As state is often funding source or funding partner impact will be long term and indirect, as it will only occur as policy statements and related zoning upgrades	Low
Zoning and Land Use Regulation - Adopt/expand current municipal zoning and land use regulations to help facilitate increased density in centers, protection of greenspace, concentration of development in areas with infrastructure, improved street connectivity, and reduced parking requirements. Land use regulations other than zoning could include subdivision regulations, site planning requirements, etc..	Regional, Local	All	Local w/ State & Region support	Within the authority of the local jurisdictions making the approach implementable - Jurisdiction may require technical assistance to create the desired zoning language; will require some funding to do so - Impact will be long term and indirect, as it will only occur as new development is incrementally approved	Low
GHG Emission Impact Fees - Develop rules to determine GHG emission impact fees for developments with high auto trip generation rates and streamline review and approvals for location-efficient and compact development projects.	Regional, Local	All	State law	This is not under local jurisdictional control, under current New Jersey Municipal Land use law, impact fees can only be assessed to off-set water, sewer, or streets -State statutes would need to be amended to make this feasible	High

Smart Growth Incentives - Continue and expand local/regional incentives and support programs for communities that adopt zoning regulations that permit smart-growth form.	Regional, Local	All	Local w/ State & Region support	Jurisdictions need to include a Sustainability Element, Open Space Plan and Farmland Preservation Element in comprehensive plan to be eligible for some State incentive planning funds - This strategy would benefit from regional or county government taking the lead and developing an incentives toolkit; many jurisdictions are not knowledgeable about all incentive options they can offer a developer or take advantage of themselves; this strategy should also be supported by State statutory language to broaden authority of local zoning to use incentives in zoning code such as streamlined approval process, reduction in application fees, and relief from some zoning requirements	Low
Transit Oriented Development - Continue to provide and expand priority funding and grants to communities that designate and develop areas as 'transit villages'.	Regional, Local	Urban, Metropolitan, Suburb	Regional/local planning with State support	State endorses or establishes priority funding areas and would be the source of funding as an incentive to establishment of local 'transit-villages' - Local and regional planning can identify locations and secure commitments from developers - Potential significant benefits	Medium
Freight Oriented Development - Provide incentives for private development of freight-intensive land uses, including "freight villages", on parcels with access to multimodal freight transportation options. Implement regional "industrial preservation" zoning and marketing strategies that are aimed at protecting existing industrial clusters from encroachment and possible relocation to outlying greenfields.	State, Regional, Local	All	State/Region/ Local	Within the authority of local jurisdictions - Jurisdictions may require technical assistance to create the desired zoning language and marketing programs, requires commitments from private firms	Medium
Expand On- and Off-Road Bicycle Networks - New interconnected multi-use paths, cycletracks, and trails designed to accommodate both pedestrians and bicyclists and support both short and long distance bike commuting trips as well as recreational trips.	Regional, Local	All	State/Region/ Local	Most jurisdictions would require technical assistance and supportive state or federal funding to create the plans and for subsequent implementation; strategy would also rely on intermunicipal coordination and regional oversight for connectivity among local bicycle and pedestrian networks for a regional system - Pair strategy with educational outreach programs to promote walking and bicycling	Low
Bicycle Parking & Commuting Support - Provide tax incentives and/or include in zoning/development codes for provision of bike parking facilities at government facilities, schools, and commercial and high-density residential uses.	Regional, Local	Urban, Metropolitan, Suburb	State/Region/ Local	Jurisdictions may require technical assistance to create the legal structure for desired incentives and may require some funding - Authorizing tax incentives in the form of reduced tax burden for providing bike facilities may be politically challenging to pass	Low

Bicycle Sharing - Institute a bike sharing program in urban areas of NJTPA region, particularly adjacent to universities, major employment centers, recreational/tourist destinations, and transit stations.	Regional, Local	Urban, Metropolitan, Vacation Area	State/Region Local	Jurisdictions have the authority to create such programs; would require an investment in bicycles and bicycle infrastructure (secure parking); Relatively low-cost program to institute, but would require some ongoing program management by local government staff - May require public private partnership for bike parking locations, with maintenance and security	Low
Bicycle Transit Access - Increase bicycle parking at transit stations, develop bike-stations at major multi-modal transit terminals, and deploy bike racks or priority seating on all transit vehicles.	Regional, Local	Urban, Metropolitan, Suburb	State/Region/ Local	Supported by 2.2 and 2.3, Combine with 2.1	Low
Bicycling Support and Education - Initiate an educational/media campaign emphasizing bicycle and pedestrian benefits and safety.	Regional, Local	All	State/Region/ Local	Requires investment in developing media campaigns and school curriculum, would be a relatively low-cost program to institute, but would require some local government staff training or hiring training program teachers - May employ public private partnership for running the educational program with partnership of schools, employers, youth programs, etc	Medium
Sidewalk Gaps and Grid Completion - Improve sidewalk conditions and street crossing amenities along existing or potential pedestrian corridors, particularly in activity center and residential street grids.	Local	Urban, Metropolitan, Suburb, Rural Town	State/Region/ Local	Requires an investment in pedestrian infrastructure and should be paired with pedestrian network/connectivity planning - Plans precede the construction program and would require some ongoing maintenance by local government staff - Would most likely require state and federal funding support for construction	Low

Pedestrian Access to Destinations - Extend or fill in gaps to the existing sidewalk and shoulder system focusing on connecting residential areas with schools, recreation areas, shopping and other activity centers. Expand Safe Routes to School programs.	Local	Urban, Metropolitan, Suburb, Rural Town	State/Region/ Local	Combine with other bike/pedestrian	Low
Pedestrian Access to Transit - Particularly in transit corridors, improve infrastructure for pedestrian access to stations and stops.	Regional, Local	Urban, Metropolitan, Suburb	State/Region/ Local	Combine with other bike/pedestrian	Low
Complete Streets - Continue the development and adoption of amended/strengthened Complete Streets Policies by all NJ municipalities.	State, Regional, Local	All	State/Region/ Local	Jurisdiction may require technical assistance to create a Complete Streets Design Manual, can be paired with other zoning modifications for livable communities design - Impact will be long term and indirect, as it will only occur as roadway systems are reconstructed or major new development is approved	Low
Parking Management & Policy - Expand and increase the stringency of parking mandates for employers, shopping districts and other destinations including preferential parking for carpool vehicles, decreasing parking availability, eliminating minimum parking requirements in zoning laws, and taxing employer provided free or subsidized parking.	Regional, Local	Urban, Metropolitan	Local	Local jurisdictions do have authority to manage parking supply, increase municipal revenue which could in turn be used to provide more transit and improve parking management, while encouraging park-once behavior - Secure local business support - Pair with a complete streets and connectivity strategy to improve parking, pedestrian and bicyclist connections in urban and suburban places	Medium
Parking Pricing & Incentives - Implement policies and programs to encourage/mandate unbundling the full cost of providing parking, implement residential parking permit fees in dense urban/mixed use residential areas, price on-street parking at a rate consistent with encouraging "park-once" behavior, and mandate parking cash-out for all employers meeting minimum size thresholds.	Regional, Local	Urban, Metropolitan	Local/Private	Developers may find unbundling a disincentive to development if this strategy does not include opportunities to minimize parking required by zoning; banking institutions can make developer financing more difficult if parking is unbundled.	Medium
Carpool & Vanpool Incentive Programs - Expand/continue development of a central regional listing on-line database for carpool and vanpool matching and reinstate/develop new programs to provide incentives for starting carpools and vanpools.	Regional, Local	All	Region/Local	Requires ongoing development and maintenance - No direct revenue to offset start-up costs, opportunity to establish voluntary public-private partnerships	Low
Dynamic Ridesharing - Regional real-time ridesharing service facilitated through Smart Phones.	Regional, Local	All	State/Region/ Local	Requires ongoing development and maintenance and information dissemination, private partnerships/ marketing support possible	Low

Public & Private Commuter Outreach/Incentive Programs - Make implementation of the Employer Trip Reduction Program mandatory for large employers, in cooperation with TMAs, expand financial incentives to encourage the use of transit, institute shuttle services from major employers to nearby transit stations, and broaden the scope of emergency ride home programs.	Regional, Local	Urban, Metropolitan	TMA/Local	Incentive programs may require funding assistance from state agencies (NJDOT, NJ Transit) but could be administered by the TMA's, Other programs such as shuttles, transit incentives, and emergency ride home programs are currently being provided by TMA's throughout the region	Low
Telecommuting & Compressed Work Week - Develop employer goals and offer tax incentives for the adoption of telecommuting and compressed work week targets and provide public funding or subsidies for the private provision of regional telework centers and shared satellite offices.	Regional, Local	All	TMA/Local	TMA's already working with major employers in the region, Needs assistance from the state to place more emphasis on setting regional telework goals and funding opportunities for incentives for companies/agencies that have or begin programs	Low
Carsharing - Coordinate with a car-sharing organization (such as ZipCar) to ensure existing vehicle locations are well distributed and located near public transit and expand carsharing networks to all transit stations, urban centers, and major employers.	Regional, Local	Urban, Metropolitan	TMA/Local	TMA's can implement these programs and/or partner with carshare providers - May require assistance from NJ Transit, universities, and other private businesses, depending on locations of car share stations	Low
Transportation Management Associations - Provide additional funding to TMAs to support expansion of TMA sponsored shuttle bus services (including seasonal services to the Jersey Shore), introduction of new pilot commuter incentive programs, enhanced rideshare matching for carpools and vanpools, and expanded information on public transit and local transportation services.	Regional, Local	Urban, Metropolitan	TMA/Local	Funding assistance comes from NJTPA/NJDOT/US DOT, grants, state funding sources/matches, and private sponsorship.	Low
Freight Transportation Demand Management - Provide incentives for more efficient matching of loads to reduce empty backhaul movements of both short-haul and long-haul trucks and rail cars. Explore opportunities for "freight villages" or urban logistics centers to reduce drayage/empty drayage.	State, Regional	All	Multi-state & Private	Large shippers are already employing this approach to cut costs, incentive or education programs from small shippers needed - Shipper acceptance/benefits unknown	High
Rail Transit Quality and Reliability of Service - Adjust headways and number of cars per train during peak periods to meet demand, provide transit customers with real-time information, and implement system/service operational improvements such as splitting routes, limited-stop services, transfer improvements, and schedule coordination.	Regional, Local	Urban, Metropolitan, Suburb	State with Regional & Local planning	NJTransit/PANYNJ/Amtrak implements and operates all services, Region and locals partner in planning/prioritization process, Medium cost, marginal cost effectiveness - Potential significant short and long-term benefits	Medium

Bus Transit Quality and Reliability of Service - Adjust headways, route alignments (including minimizing dead-head miles), and deploy new limited-stop service during the peak period to accommodate demand, deploy bus-priority lanes or bus-rapid-transit, signal preemption, and other technologies to improve bus travel times. Deploy GIS-based routing systems to improve the efficiency of local "on-demand" transit services.	Regional, Local	Urban, Metropolitan, Suburb	State and Locals, TMAs	Medium-High cost and marginal cost effectiveness - Short term benefits possible	Medium
Park-and-Ride Lots - Evaluate existing park and ride lots and expand those that are at or over capacity to accommodate additional transit riders, and create new park and ride lots in strategic locations along transit corridors.	Regional, Local	All	State and locals	Cost dependent on lot type (surface v. structure) and need to acquire property - Potential high short-term return	Low
Transit Fares and Passes - Continue and expand programs subsidizing fares for students, low-income, and special needs passengers and integrate transit fare media with parking and toll/road pricing payment technologies.	Regional, Local	All	Transit providers, TMAs	Minimal cost - Potential revenue loss - Minor benefits	Low
Transit Station and Stop Access and Amenities - Provide real-time arrival information and enhanced passenger amenities to increase comfort and safety.	Regional, Local	Urban, Metropolitan, Suburb	Transit providers, local, TMAs	Low cost - Short & long term benefits	Low
Transit Capacity Expansion - Invest in new multimodal transit corridors and expand and improve existing systems through improving connections to local and express buses, ferry terminals, intercity passenger rail (Amtrak), and airports.	State, Regional, Local	Urban, Metropolitan, Suburb	State with Regional & Local planning	High cost and long lead time for implementation - Budget overruns/ political barriers - Long term significant benefits	High
Cordon Area Pricing - Institute fees or taxes paid by users entering a restricted area, usually within a city center (CBD), other major employment centers, or concentrations of freight activity.	Regional	Urban	State with Regional & Local planning	Potential high cost - Difficult to secure support, economic development concerns	High
VMT Fee - State administered charge to augment or replace motor vehicle fuel taxes based on how many miles a car is driven.	State	All			State lead
Carbon Pricing - An economy wide or system pricing strategy set either as a fuel tax or as a result of a cap-and-trade system to price carbon emissions resulting from vehicle fuel consumption.	State	All			State lead
PAYD Insurance - Support policy and incentives for insurance providers to charge drivers insurance premium costs based in part on annual vehicle miles travelled.	State	All			State lead

Table C.2 Draft NJTPA GHG Reduction Strategies – System Efficiency

Priority Strategy
Priority Strategy w/ Barriers
Priority Strategy w/ Significant Barriers
High Cost/Risk/Low Return Strategy
Beyond Regional/Local Control

Strategy Description	Scale(s) of Analysis	Place Type	Implementation Authority	Investment - Risk - Return	Barrier Level
Ramp Metering - Expand deployment of ramp metering to help control entry of traffic onto freeways and improve traffic flow and decrease accidents.	Regional, Local	Urban, Metropolitan	DOT/NJ Turnpike/ Region & Local Planning	Relative low cost - Established technology - Some driver acceptance issues, including wait times on ramps	Low
Variable Message Signs/Traveler Information/511 Systems - Increase deployment of signs located along roadways providing drivers with traveler information, such as location and timing of accidents, detours and alternative routes, travel times to specific destinations and weather condition advisories. Expand capabilities of phone/wireless transportation and traffic information systems including real-time traffic and parking information.	Regional, Local	All	DOT/NJ Turnpike/Region & Local Planning	Relative low cost - Short timeframe for implementation - High rate of return within interconnected network	Low
Transportation Management Centers - Expand capabilities and interoperability of TMCs and expand coverage of traffic cameras and other sensors to enhance the overall coordinated transportation management on all transportation facilities.	Regional, Local	Urban, Metropolitan, Suburb	DOT/NJ Turnpike/ Region/Local	High cost for new TMCs, improved network interoperability and communications are lower cost - Established technology - High rate of return within interconnected network	Low
Traffic Signal Coordination/Arterial System Management - Develop and implement traffic signal coordination plans along heavily traveled arterial corridors and in town center grids.	Regional, Local	Urban, Metropolitan, Suburb	DOT/NJ Turnpike/ Region/Local	Low cost - Minimal risk - Significant return, especially high capacity/ directional arterial corridors. Signal design changes and modifications need to have the blessings of NJDOT, since they are the agency in charge of traffic signal designs. Significant emission reductions with relatively low investment.	Low

Active Traffic Management (ATM) - Deploy active traffic management (ATM) strategies (dynamic control of traffic based on real-time roadway conditions) network-wide, including variable speed limits.	Regional, Local	Urban, Metropolitan, Suburb	Variable Speed Limits already adopted on NJ Turnpike, NJDOT	Low-Medium cost - Deployment on arterial facilities less proven - Return tied to existing levels of congestion	Low
Incident Management - Expand services (Safety Service Patrol trucks) and communication and set targets to restore "normal service operation" after roadway incidents (accidents or other actions that interrupt standard operation of roadways).	State, Regional, Local	All	NJDOT service in operation on I-78, I-80, I-280, I-287	Low-Medium cost - No risk - Potential high benefits in reducing non-recurring delay	Low
Road Weather Management - Expand messaging and travel information system strategies applied during inclement weather: Advisory (fog warnings, etc.); Control Strategies (speed limit reductions using Variable Speed Limit signs, etc.); and Treatment strategies (sand, salt, ice).	State, Regional	All	DOT/Turnpike	Combined with system management strategies.	Low
Connected Vehicle Systems - Implement programs/ incentives for development of roadside infrastructure to support widespread use of connected vehicle systems (provide communication links between vehicles and the roadside infrastructure and between vehicles, in order to increase the safety, efficiency, and convenience of the transportation system).	State, Regional	All	Federal/NJDOT/ Turnpike, Regional/Local Planning	VII penetration/adoption needs to be benchmarked and costs to DOT/private partners needs to be considered - State DOT policies on infrastructure penetration not yet developed - Potentially high, dependent on vehicle technology advancement and penetration	Medium
Eco-Driving (passenger vehicles) - Implement programs to educate new drivers on eco-driving behaviors and information materials to all drivers. This includes auto idle education/awareness programs.	State, Regional	All	Idle reduction requirement already in NJ code	Educational programs and State DMV involvement - Difficulty in reaching a broad market, and driver willingness to participate (is there a real financial incentive?) - Benefits shown to decrease over time	Low
Eco-Driving (commercial and other heavy-duty vehicles) - Implement outreach programs and/or implement new regulations regarding truck and bus idling.	State, Regional	All	Idle reduction requirement already in NJ code	Major freight movers doing on their own to mitigate costs - education/incentives for smaller firms - CO2 benefit of eco-driving reduces as fleet becomes more efficient. Idle reduction requirement already in NJ code including orientation programs for medium and small size fleet operators	Low
Bottleneck Relief - Remove freeway and bridge bottlenecks to attain "LOS D" conditions through system management, enhancing alternatives, and capacity expansion in the mix best supported by cost/benefit analysis.	State, Regional, Local	Urban, Metropolitan, Suburb	NJDOT/Turnpike, Regional & Local Planning	Roadway expansion in built-out areas including acquisition of ROW is extremely difficult and expensive - Benefits are not sustainable (local roadway/intersection improvements can act to reduce delay and emissions, although cost effectiveness is not high)	Medium

Access Management - Retrofit arterial corridors through removing driveways and enhancing interparcel connections or in priority corridors grade separate specific intersections when warranted by delay and safety issues.	Regional, Local	Urban, Metropolitan, Suburb	NJDOT/Local Planning	Low-medium cost depending on retrofit v. developing corridors - Risk associated with zoning/business location decisions	Low
Traditional Toll Facilities - Expand use of high-speed tolling/electronic toll lanes, link electronic tolling technology with transit fare and parking payment media and implement more variable tolls with higher prices during peak periods.	State, Regional	All	NJDOT/ Turnpike, Regional & Local Planning	Low-medium cost - Proven technology, user familiarity - High benefits	Low
Alternative Toll Facilities - Implement combination of multiple managed lane approaches throughout the region, first utilizing existing HOV and toll facilities, and second strategically expanding new facilities (options include changing eligibility requirements for HOV lanes, charging SOVs or HOV2 to use managed lanes, charging all vehicles except buses or vanpools to use lanes (express toll lanes), making managed lanes available to trucks in periods of congestion outside peak commute hours, or building new lanes parallel to existing freeway corridors).	State, Regional	Urban, Metropolitan, Suburb	NJDOT/ Turnpike, Regional & Local Planning	Cost dependent on approach, changing eligibility in existing lanes v. new capacity - Public response to changing eligibility or adding new tolls - Impacts to GP lane congestion must be considered in benefits	Medium
Congestion Pricing - Deploy open-road tolling on existing tolled facilities as a dynamic toll responding to congestion levels or on new toll facilities or existing free facilities as a new fee charged during peak periods.	State, Regional	Urban, Metropolitan, Suburb	NJDOT/Turnpike, Regional & Local Planning	High cost - Uncertain technology/public perception - Potential high benefits	High
Freight Rail Bottlenecks - Relieve capacity constraints at critical freight rail bottlenecks, particularly in access corridors to intermodal facilities and in high-volume freight corridors.	State, Regional, Local	Urban, Metropolitan with Industry	Federal/State agencies and ROW owners	High cost of improvements, require agreements with ROW owners and other multi-modal operators/stakeholders	High
Freight Rail Capacity Constraints - Addressing infrastructure constraints such as low clearance bridges, low railcar weight limits, etc… that result in circuitous rail routings.	State, Regional, Local	Urban, Metropolitan with Industry	Federal/State agencies and ROW owners	Medium/High cost of improvements, possible policy options, require agreements with ROW owners and other multi-modal operators/stakeholders - Potential for significant benefits	Medium
Freight Rail Crossings - Implement comprehensive freight rail grade crossing improvements regionwide to improve traffic flow at critical locations along major freight rail lines.	Local	All	NJDOT, Regional & Local Planning	Potential high cost, agreements with ROW owners, private, Amtrak, NJTransit required - Localized benefits	Medium
Short Sea Shipping - Implementation of coastwise transport of international and domestic containers is an alternative and a complement to the existing freight transportation system.	State, Regional	All	Requires multi-state intervention and shipper partnerships		State/ Federal lead

Oversize and Overweight Load Permits for Longer Combination Vehicles (LCVs) - Permit trucks to carry more weight and volume in specific corridors, particularly routes connecting major interregional corridors to intermodal facilities and concentrations of warehouses and distribution centers.	State	All	Predominantly a Federal regulation		Federal lead
Weigh-in-Motion (WIM) and Truck Pre-Screening - Expand deployment of WIM and pre-screening to reduce truck deceleration, acceleration and idling at inspection facilities.	State, Regional	All	Federal/NJDOT/ Turnpike	Low cost - Proven technology - Known benefits	Low
Intermodal Access Improvement - Improve accessibility to intermodal facilities through system operations and capacity enhancements including truck-only lanes.	State, Regional, Local	Urban, Metropolitan with Industry	Federal/NJDOT/ Turnpike/ PANYNJ	Potential high cost - Significant benefits	Medium
Time-of-Day Operation Strategies - Pursue temporal diversion strategies for trucks including off-hours operation of terminals and warehouse/distribution centers, off-hour deliveries to small and large businesses, reservation systems to reduce congestion and queuing at port gates, truck rest/staging areas, and congestion pricing to minimize peak travel.	State, Regional, Local	All	Local decision	No cost, requires enforcement	Low

Table C.3 Draft NJTPA GHG Reduction Strategies – Alternative Fuels & Alternative Fuel Vehicles

Priority Strategy
Priority Strategy w/ Barriers
Priority Strategy w/ Significant Barriers
High Cost/Risk/Low Return Strategy
Beyond Regional/Local Control

Strategy Description	Scale(s) of Analysis	Place Type	Implementation Authority	Investment - Risk - Return	Barrier Level
AFV Pilot Grants and Fleet/Fueling Equipment Subsidies - Offer competitive grants and/or subsidized financing for MDV/HDV fleet owners who wish to pilot AFV and fueling equipment purchases.	State, Regional, Local	All	State	NYSERDA-style solicitations could make incremental progress, but proliferation would be gradual - Return dependent on industry interest	Medium
Truck Phase-Out Program - Develop a program and incentives to phase-out older trucks serving Port Authority marine terminals with MY 2004 or newer vehicles.	Regional	All	PANYNJ	Effective, proven program implemented in Nation's largest port complex - Combine with 9.7	Low
AFV and EVSE Purchase Rebates/Vouchers/Loans/Grants - Provide private vehicle owners with flat rebates or purchase vouchers for AFVs and for household electric vehicle supply equipment (EVSE).	State, Regional, Local	All	State/Private	Likely requires State law - ChargePoint America program already in place in NY Metro area - Uncertain participation rates/benefits	Medium
Car Insurance Discount for AFV - Work with large auto insurers to offer auto insurance discounts for AFVs (see Farmer's Insurance in CA).	State, Regional	All	State	Require insurance industry partnerships and potential State law	State/ Private lead
Tax Exemption for EVSE - Exempt value of EV charging infrastructure from taxed property values or sales tax.	Local	All	State or Local	Requires change in State and/or Local tax code - Benefits uncertain	Medium
HOV Lane Exemption for Alt Fuel Vehicles - Continue to allow certified AFV drivers the right to use high occupancy vehicle lanes, regardless of the number of passengers.	State	Urban, Metropolitan, Suburb	State	Exemption in place on parts of Turnpike, expansion requires change in NJ code - Benefits likely low	Medium
Plug-In EV Parking Incentives - Provide EV dedicated spaces in public (park-and-ride lots, airport parking, and all government facilities) and commercial parking areas.	Local	All	State/Local/Private	Consistent and supportive of objectives of 9.1	Low

AFV Parking Ratio Exemption - Exempt AFV/EV parking from parking ratios mandated by zoning.	Local	Urban, Metropolitan, Suburb	State/Local	Requires zoning changes - Consistent and supportive of objectives of 9.1	Medium
Commercial Vehicle Truck Idle Reduction Facilities - Provide facilities for external heating and cooling of trucks, such as truck stop electrification, at near-Port truck parking areas and rest areas.	Regional	All	State/Private	Requires State investment and private support/willingness to use - Combine with incentive programs in 6.1	Medium
Electricity Rate Reduction for EVSE/ Natural Gas Rate Reduction - Work with BPU/utilities to provide favorable EV charging tariff.	State, Regional, Local	All	State/Private, Local support	Requires Public/Private partnerships - Over time, a more competitive tariff structure could help tip the balance, but effect will be significant only after prerequisites in place	Medium
Value-Added Producer Grants - Provide grants for the increased production of certain biofuels (should be commensurate with targets for fuel mixtures).	State	All		Requires State and manufacturer partnerships and private support - Success tied to change in fleet characteristics	High
Biofuel Volume Rebate Program - Work with biofuel companies to provide discounts and/or rebates for commercial customers purchasing a significant volume of certified biofuel.	State, Regional, Local	All		Requires State and manufacturer partnerships, NJ code already includes a biofuel use requirement for all State agencies, universities, etc… - Success tied to change in fleet characteristics	High
Idle Reduction Equipment Tax Exemption - In concert with HDV idle reduction programs, provide sales tax reductions or exemptions for the purchase and installation of idle reduction equipment.	State	All		Requires State law, existing idle reduction programs - Success tied to change in fleet characteristics	State lead
Alternative Fuels Tax Exemption - Exempt certain alternative fuels from excise taxes.	State	All		Requires State law	State lead
Vehicle Cost Calculator - Based on US DOE AFV calculators, provide an advertised and publically accessible and customized calculator including state, regional, and local incentives/disincentives.	State, Regional, Local	All	State/Region/ Local		Low
Planning & Readiness - Develop regional and/or subregional AFV readiness plans to balance GHG reduction goals with mobility needs.	State, Regional, Local	All	Region/Local	Combine as part of complete EV readiness plan development/ implementation	Low
Regional Alternative Fueling Station Locator Tool - Provide consumers with an online/mobile AFV/EV fueling station finder tool.	State, Regional, Local	All	Region/Local	Combine as part of complete EV readiness plan development/ implementation	Low
Plug-In EV Parking Regulations - Pass statutes that protect EV-dedicated parking spaces from other users.	State, Local	All		Combine with parking incentives and parking ratio exemptions, regional or local programs and incentives - Significant long-term benefits anticipated (although magnitude difficult to determine as these are new programs)	Medium

Low Carbon Fuel Standard - Increase requirements/targets of state or regional low-carbon fuel standard.	State	All	State	Requires State leadership/commitment, Controversial and difficult to pass - Potential high benefits	High
Ethanol/Biodiesel Blend Mandates (RFS) - Mandate more aggressive low carbon fuel blends (link to Value-Added Producer Grants).	State	All	State	Requires State leadership/commitment	High
California ZEV Production Requirements - Follow California ZEV production requirements.	State	All	State	Requires State law	High
SmartWay Based HDV GHG Standards - Mandate that HDVs comply with EPA SmartWay verified technologies including idle reduction, aerodynamic technologies, low rolling resistance tires, and retrofit technologies that improve fuel efficiency.	State, Regional	All	State	Requires State law	High
SmartWay Program for PANYNJ Drayage Trucks - Implement EPA SmartWay program or Port of Los Angeles-style Clean Truck Program for all PANYNJ drayage trucks.	Regional	All	State/Regional	Consolidated into 1.2	Medium
Efficient Fleet Management - Implement tracking programs for fuel consumption and mileage by vehicle and link tracking data to vehicle replacement and emission reduction strategy investments. Implement high efficiency vehicle purchase guidelines or regulations.	Local	All	State/Local	Staff management time, not likely to get much traction from fleet managers/some doing informally already - Low potential benefits	Medium

Table C.4 Strategy Screening Results

VMT/Mode Shift
Priority Strategy
Comprehensive Planning, Zoning and Land Use Regulations
Smart Growth Incentives
Off/On-Road Bicycle Networks and Enhanced Access to Transit
Bicycle Parking and Bicycle Commute/General Travel Support/Education
Bicycle Sharing (Activity Centers, Universities, Tourism Areas)
Sidewalk Grid Completion with Focused Access to Activity Centers and Transit
Complete Streets Policy
Carpool/Vanpool Incentive Programs and Dynamic Ridesharing
Public/Private Commuter Outreach/Incentive Programs (TMAs)
Telecommuting and Compressed Work Week Targets
Carsharing Programs
Park and Ride Lot Expansion
Transit Fare and Discount Pass Programs
Transit Station and Stop Access and Amenities
Priority Strategy with Barriers
Transit Oriented Development
Activity Center Parking Management and Policy
Activity Center Parking Pricing and Incentives
Bus Transit Quality and Reliability of Service
Priority Strategy with Significant Barriers
Freight Oriented Development
Rail Transit Quality and Reliability of Service
Rail Transit Capacity Expansion

System Efficiency
Priority Strategy
Ramp Metering
Variable Message Signs/Traveler Information Systems
Traffic Signal Coordination/Arterial System Management
Active Traffic Management/Variable Speed Limits
Incident Management
System Preservation/Corridor Access Management (Developing Corridors)
Traditional Toll Facilities (High-speed tolling, Variable Tolls)
Weigh-in-Motion & Truck Pre-Screening
Time-of-Day Truck Operation Policies
Priority Strategy with Barriers
Eco-Driving (Passenger and Commercial Vehicle Users)
Freight/Passenger Rail Crossings

Priority Strategy with Significant Barriers
Intermodal Freight Centers Access Improvement
Highway Bottleneck Relief
System Preservation/Corridor Access Management (Retrofit Corridors)
Alternative Toll Facilities (Eligibility Requirement Changes, Managed Lanes)
Freight Rail Capacity Constraints

Alternative Fuels & Alternative Fuel Vehicles
Priority Strategy
Continue HOV Lane Exemption for Alternative Fuel Vehicles
Priority Strategy with Barriers
Electric Vehicle Readiness Plan Development and Implementation
AFV Pilot Grants & Fleet/Fueling Equipment Subsidies
AFV/EVSE Purchase Rebates/Vouchers/Grants
Local PHEV/EV Parking Regulations and Incentives
SmartWay Program for PANYNJ Trucks & Truck Phase-Out Program
Priority Strategy with Significant Barriers
Commercial Vehicle Tuck Idle Reduction Facilities and/or Equipment Incentives
Electricity Rate Reduction for EVSE

Priority Strategy = Low/Medium Implementation Cost, Low Barriers, High/Medium/Low Return

Priority Strategy w/ Barriers = Medium Implementation Cost, Medium Barriers, High/Medium Return

Priority Strategy w/ Significant Barriers = High Implementation Cost, Medium/High Barriers, High/Medium Return

D. Strategy Definitions

Table D.1 NJTPA GHG Mitigation Plan Strategy Definitions

ID	Strategy	Overall Description	Location Deployed	Level of Implementation (2040)
VMT 1.1–1.3	Smart Growth Incentives	Continue and expand local/regional incentives and support programs for communities that adopt zoning regulations that permit smart-growth form.	Region/All place types	The VMT reduction benefits from Plan2040 landuse are increased by a factor associated with a change in effective density by place type and municipality to reflect the impact of additional incentives to support provision of pedestrian and bike networks, additional planning support, and developer incentives supporting increased density or LEED site/neighborhood design, reduced parking, and investment in bike/pedestrian amenities.
	Transit Oriented Development	Continue to provide and expand priority funding, grants, and incentives to communities that designate and develop areas as 'transit villages'.	Urban/Metro /Rural Town	All transit villages meet development and infrastructure goals (# of households, commercial/retail space, improved access to transit station), resulting in transit and bike/pedestrian mode share consistent with best practice mode share in TODs in comparable metropolitan regions/transit systems in the U.S.
	Freight Oriented Development	Provide incentives for private development of freight-intensive land uses, including "freight villages", on parcels with access to multimodal freight transportation options. Implement regional "industrial preservation" zoning and marketing strategies that are aimed at protecting existing industrial clusters from encroachment and possible relocation to outlying greenfields.	Urban/Metro	Starting in 2025, 100% of new freight related development (defined as warehouses / distribution facilities / light-heavy manufacturing) occurs within 1 mile of truck routes and/or intermodal (port) facilities. Freight villages are estimated to reduce VMT by up to 19% (truck only access) to 23% (truck and rail access).
VMT 2.1–2.2	Complete Streets (Bike/Pedestrian/ Transit)	New interconnected on-road bicycling network consisting of bike lanes, paved shoulders, shared-lane markings, and improved signage that supports both short- and long-distance bike commuting trips as well as other transportation trips. Prioritize facilities connecting to transit stations, schools and universities, employment districts, and public facilities. Increase bicycle parking at transit stations, develop bike-stations at major multi-modal transit terminals, and deploy bike racks or priority seating on all transit vehicles.	Region/All place types	Excluding limited access facilities and high-speed, multi-lane arterials (>50mph speed limit), enhance/expand on-road bicycle facilities (bike lanes, paved shoulders, shared lanes) so that 75% of all arterial and collector roads within 1/2 mile of transit stations, schools/ universities, employment centers, shopping districts, and recreational areas include an on-road bicycle facility. Overall, increase bike lane density from current average of 0.2-0.5 mi/sq mi, to 1.0 – 1.2 mi/sq-mi, which would place the region in the top quartile of major US metropolitan regions.

ID	Strategy	Overall Description	Location Deployed	Level of Implementation (2040)
		Improve sidewalk conditions and street crossing amenities along existing or potential pedestrian corridors, particularly in activity center and residential street grids and for access to transit.	Region/All place types	In all transit village zones plus all zones with a transit station, and in areas with a high household density (consistent with urban or metro place types) improve the pedestrian environment to a level consistent with areas in the top 25% of pedestrian compatibility index. Overall this results in an increase in PCI from 2006 to 2040 between 30% (rural place types) up to 57% (metro place types).
VMT 3.1-3.3	Carpool/Vanpool Incentive Programs and Dynamic Ridesharing	Expand/continue development of a central regional listing on-line database for carpool and vanpool matching with dynamic ridesharing capabilities for all program users, and reinstate/develop new programs to provide incentives for starting carpools and vanpools.	Region/All place types	**Ridesharing -** Future participation in ridesharing programs (including carpooling and vanpooling) is tied to the extent of program marketing and information, the level of incentives provided to start-up carpools and vanpools, and continuing incentives or benefits of ridesharing (including preferential parking, use of HOV facilities, parking cash-out). A reasonable target is to double commute to work shared ride mode share and increase the average occupancy of shared rides by 50%. **TMAs –** TMAs coordinate expansion of all current service offerings and the number of workplaces registered as NJ Smart Workplaces increases to 75% of employers in urban center/metropolitan office place types, and 25% of employers in other urban and metropolitan place types. **Telecommuting –** Based on Federal government data (assuming that the Federal government is a reasonable approximation to other industries that might be considered "eligible telework industries"), about 64 percent of workers in eligible industries are eligible workers; about 8 percent of eligible workers become teleworkers; and teleworkers use telecommuting on average about 1.5 times per week (or about 30 percent of the time). This suggests a 1.5 percent baseline estimate for the share of teleworkers on an average daily basis in the NJTPA region. By 2040, assume a target of 10 percent teleworking is achieved. *Overall Participation*: Data from recent national research (EPA, DOE) suggest that approximately 50 - 70 percent of the workforce could participate in commuter programs (based on job requirements) and 50 percent of workers offered the option would take advantage of it. Based on these assumptions, an overall estimate of approximately 25 percent of the region's workforce participating in some type of a commute program represents a mid-range (2025-2030) target. By 2040, assume up to 40 percent of the region's workforce participates in a commute program.
	Public/Private Commuter Outreach/Incentive Programs (TMAs)	Make implementation of the Employer Trip Reduction Program mandatory for large employers. In cooperation with TMAs, expand financial incentives to encourage the use of transit, institute shuttle services from major employers to nearby transit stations, and broaden the scope of emergency ride home programs. Expand TMA sponsored shuttle bus services (including seasonal services to the Jersey Shore), introduce new pilot commuter incentive programs, enhance rideshare matching for carpools and vanpools, and expand information on public transit and local transportation services.	Region/All place types	
	Telecommuting and Compressed Work Week Targets	Develop employer goals and offer tax incentives for the adoption of telecommuting and compressed work week targets and provide public funding or subsidies for the private provision of regional telework centers and shared satellite offices.	Region/All place types	

ID	Strategy	Overall Description	Location Deployed	Level of Implementation (2040)
VMT 4	Parking Pricing and Incentives	Implement policies and programs to encourage/mandate unbundling the full cost of providing parking, implement residential parking permit fees in dense urban/mixed use residential areas, price on-street parking at a rate consistent with encouraging "park-once" behavior, and mandate parking cash-out for all employers meeting minimum size thresholds.	Urban Center/ Metro Office	All large and medium size employers (> 50 employees) who lease parking are required to offer parking cash out. Employers with parking bundled in the building lease are encouraged (along with owners) to unbundle parking, allowing the employer to realize the financial benefit of offering parking cash out.
VMT 5	Bus Transit Quality and Reliability of Service	Adjust headways, route alignments (including minimizing dead-head miles), and deploy new limited-stop service during the peak period to accommodate demand. Deploy bus-priority lanes or bus-rapid-transit, signal preemption, and other technologies to improve bus travel times. Deploy GIS-based routing systems to improve the efficiency of local “on-demand” transit services.	Urban/Metro /Suburb	On all bus transit routes in areas with a transit score above the regional mean (and/or all potential transit enhancement areas), increase level of service up to 15 percent beyond Plan2035 through a combination of reducing headways, increasing reliability and speed, adding express or BRT type services, and providing enhanced traveler information.
VMT 6	Rail Transit Quality and Reliability of Service	Adjust headways and number of cars per train during peak periods to meet demand, provide transit customers with real-time information, and implement system/service operational improvements such as splitting routes, limited-stop services, transfer improvements, and schedule coordination.	Region/All place types	On all rail transit routes serving stations in areas with a transit score above the regional mean, increase level of service up to 15 percent beyond Plan2035 (Metro/Suburb place types), (10% urban, 5% rural) through reducing headways, increasing reliability and speed, extending service hours (including weekend service) and providing enhanced traveler information. Assume an elasticity of transit ridership to level of service of 0.5 (a .5% increase in ridership for every 1% increase in LOS).
VMT 7	VMT or Carbon Tax	Replace motor vehicle fuel tax structure with per mile VMT fee or carbon fee which takes into account both VMT and vehicle efficiency.	State	Starting in 2015 index NJ motor vehicle fuel tax ($0.105/gallon) to rate of increase in average fleet fuel economy. In 2020 replace NJ motor vehicle fuel tax to an equivalent VMT based tax (0.5 cents per mile). Increase per mile rate over time to 1.5 cents per mile by 2025 and 3 cents per mile by 2040.
VMT 8	PAYD Insurance	State to coordinate/develop incentives for insurance providers to market and offer PAYD insurance option to all NJ registered vehicle owners.	State	A conservative assumption for the impact of pilot programs, State legislation, and marketing and/or incentives to support PAYD insurance in NJ plus drivers who would switch for financial reasons alone is 20 percent of all NJ drivers adopting PAYD policies by 2025. Through 2040, assume 3 percent of drivers transfer to PAYD insurance on an annual basis, bringing the NJTPA region participation rate up to a maximum of 65 percent of all drivers.

ID	Strategy	Overall Description	Location Deployed	Level of Implementation (2040)
SE 9	Traffic Signal Coordination/ Arterial System Management	Develop and implement traffic signal coordination plans along heavily traveled arterial corridors and in town center grids. Expand capabilities and interoperability of TMCs and expand coverage of traffic cameras and other sensors to enhance the overall coordinated transportation management on all transportation facilities. Improve overall arterial operation with geometric and capacity improvements at intersections.	Urban/Metro /Suburb	Arterial operational improvements are applied in all congested/high-volume corridors identified in the Plan2035 Strategy Evaluation report. The improvements include the following strategies: • Turning/acceleration/deceleration lanes • Realign intersecting streets • Signalization and channelization • Signal timing/active traffic signal coordination – assume up to a 20% reduction in delay as a result of interconnected signals across a minimum 2 mile corridor length
	Active Traffic Management/ Variable Speed Limits	Deploy active traffic management (ATM) strategies (dynamic control of traffic based on real-time roadway conditions) network-wide, including variable speed limits. Expand capabilities and interoperability of TMCs and expand coverage of traffic cameras and other sensors to enhance the overall coordinated transportation management on all transportation facilities.	Urban/Metro /Suburb	Active traffic management strategies apply to all arterials and limited access facilities in the region. Expand deployment of traffic cameras, variable message signs, and communication systems to cover all congestion management system facilities in the region. Active control of signals to reduce excessive queues in peak hours.
SE 10	Limited Access Facility System Management/ Incident Management	Expand services (Safety Service Patrol trucks) and communication and set targets to restore "normal service operation" after roadway incidents (accidents or other actions that interrupt standard operation of roadways). Expand capabilities and interoperability of TMCs and expand coverage of traffic cameras and other sensors to enhance the overall coordinated transportation management on all limited access facilities.	Urban/Metro /Suburb	Deploy Intelligent Transportation Systems (ITS) and Incident Management systems in all corridors identified in the Plan2035 Strategy Evaluation report and all other limited access corridors (freeway and tollways) including: • Expanded coverage of traffic cameras • Ramp metering in select locations – Up to a 5% reduction in mainline delay per I-81 implementation • Additional variable message signs on key corridors – Provides traveler information and can be used to post variable speed limits, to help reduce high speeds in uncongested periods. • Expanded incident detection/response systems and procedures Assume a 29% reduction in delay per incident as a result of incident management, based on experience of Maryland's CHART program.

ID	Strategy	Overall Description	Location Deployed	Level of Implementation (2040)
SE 11	System Preservation/ Corridor Access Management	Develop and implement access management plans on emerging travel corridors including corridor zoning overlay districts controlling access for new development. Retrofit arterial corridors through removing driveways and enhancing interparcel connections or in priority corridors grade separate specific intersections when warranted by delay and safety issues.	Urban/Metro /Suburb	Arterial access management plans are completed and policies and improvements are implemented to overall improve traffic flow, reduce intersection delay, and improve safety on all congested/high-volume arterial corridors identified in the Plan2035 Strategy Evaluation report. The improvements vary by corridor place type and include the following strategies: • Corridor overlay zoning districts/access control • Consolidating driveways, developing interparcel access – up to a 40% reduction in conflict points • Developing parallel access roads/collector-distributor systems – up to a 60% reduction in conflict points • Grade separating high-volume/high-delay intersections – removes all delay associated with queuing at signalized intersections
SE 12	Truck Route/Time-of-Day Truck Operation Policies	Work with shippers to update truck route system and pursue temporal diversion strategies for trucks including off-hours operation of terminals and warehouse/distribution centers, off-hour deliveries to small and large businesses, reservation systems to reduce congestion and queuing at port gates, truck rest/staging areas, and congestion pricing to minimize peak travel. Increase enforcement of truck route designations, particularly targeting trucks on non-designated truck corridors during peak periods.	Urban/Metro /Suburb	Combination of truck routing, truck route enforcement, and time-of-day truck operation and management policies are deployed regionwide with primary focus areas as follows: • Revision of truck route designation to maximize use of interstate and limited access facilities with better signage/information for truckers • Enforcement on parallel arterials to truck routes and on local streets in commercial areas • For time-flexible deliveries, increased share of night/early morning deliveries to large and small commercial businesses as a result of delivery restrictions or truck parking restrictions Results in a 15-20% diversion of commercial deliveries from peak periods.
SE 13	Intermodal Freight Centers Access Improvement	Improve accessibility to intermodal facilities through system operations and capacity enhancements including truck-only lanes.	Metro with Industry	Identify peak period LOS target for all access/egress roadways to intermodal facilities, particularly all facilities in the Port Strategy Area/Core Freight Facilities Area. Improvements impact 50% of truck VMT operating in congested conditions (speed < 15 mph) on all roadways within 1 mile of intermodal facilities.

ID	Strategy	Overall Description	Location Deployed	Level of Implementation (2040)
SE 14	Freight Rail Capacity Constraints	Address infrastructure constraints such as low clearance bridges, low railcar weight limits, etc… that result in circuitous rail routings.	Region only	All capacity constraints are fully removed from freight rail network. The assessment will also consider the impact of the increase in freight capacity to 315K (in the 2040 timeframe). Key connectors should also be included in the strategy assessment such as the Waverly Loop which connects the P&H with the Greenville Branch. Per 2040 Freight Industry Forecasts, 34% of total truck tonnage could divert to rail based on origins and destinations. Per MAROps study, 25% of long-haul traffic could divert to rail.
VT 15.1-15.4	Electric Vehicle Readiness Plan Development and Implementation	Develop regional and/or subregional AFV readiness plans to balance GHG reduction goals with mobility needs. Provide consumers with an online/mobile AFV/EV fueling station finder tool. Partner with electric utilities, charging station manufacturers, alternative fuel distributors and manufacturers to optimize the location and incentivize the deployment of refueling locations throughout the region. Prioritize locations at public facilities and parking garages and at transit stations/park-and-ride lots.	Region/All place types	Based on an aggregation of New Jersey, California, private industry, and US Department of Energy led evaluations, the high end penetration rate for electric vehicles by 2040 is 60 percent. This is 20 – 25 percent higher than baseline projections which consider full implementation of the 2017-2025 CAFE standards along with continuation of all incentive programs (including tax rebates) on electric vehicle purchases.
	EVSE Purchase Rebates/Vouchers/ Grants	Provide private vehicle owners with additional rebates or purchase vouchers (beyond Federal tax credit) for household electric vehicle supply equipment (EVSE).	Region/All place types	
	Local PHEV/EV Parking Regulations and Incentives	Exempt AFV/EV parking from parking ratios mandated by zoning. Provide EV dedicated spaces in public (park-and-ride lots, airport parking, and all government facilities) and commercial parking areas.	Region/All place types	
	Electricity Rate Reduction for EVSE	Work with BPU/utilities to provide lower EV charging rates for private users.	Region/All place types	

ID	Strategy	Overall Description	Location Deployed	Level of Implementation (2040)
VT 16.1-16.2	Clean Fuel Standard (or similar approach)	A clean fuel standard is designed to spur innovation in fuel and vehicle technologies, some of which are not yet commercially available or new to market. NESCAUM has conducted extensive analysis to date, however no formal recommendations or regulations have been adopted by states who signed the 2009 MOU.	Region/All place types	The high case for NESCAUMs clean fuel standard is a 15% carbon intensity reduction in all transportation fuels over 15 years. Assuming a constant 1% per year reduction, and a commitment by NJ starting in 2015, this would result in an aggregate 25% reduction in carbon intensity of fuels through 2040. Assume that 60% of this reduction is accommodated by electric vehicles, while the remainder is accommodated by natural gas or fuel cell technology. This strategy will only assess the benefit of natural gas or fuel cell vehicles, while EVs are assessed in strategy group VT15.
	AFV Purchase Rebates/Vouchers/ Grants	Provide private vehicle owners with additional rebates or purchase vouchers (beyond Federal tax credit) for AFVs.	Region/All place types	
VT 17.1-17.2	AFV Pilot Grants & Fleet/Fueling Equipment Subsidies	Offer competitive grants and/or subsidized financing for MDV/HDV fleet owners who wish to pilot AFV and alternative fueling equipment purchases.	Region/All place types	The extent to which ZEVs or clean fuel trucks enter private fleets is linked to the cost and the business justification for renewing the fleet. Over the next 28 years, essentially the entire fleet of MDVs/HDVs will be replaced. Assuming that cost issues are overcome either through the broad deployment of new technology or incentive programs, it is possible that by 2040, 50% of the MDV/HDV fleet could be EV/PHEV or alternative fuel technologies, with the remainder being advanced diesel/gasoline technologies.
	Electricity Rate Reduction for EVSE	Work with BPU/utilities to provide lower EV charging rates for private and commercial users.	Region/All place types	
VT 18	SmartWay Program for PANYNJ Trucks & Truck Phase-Out Program	Mandate that HDVs comply with EPA SmartWay verified technologies including idle reduction, aerodynamic technologies, low rolling resistance tires, and retrofit technologies that improve fuel efficiency.	Metro Industry	By 2040, at a minimum all PANYNJ trucks comply with EPA SmartWay verified technologies. In a high technology approach, by 2040 also assess the benefit of achieving a target where 50-75% of these trucks are HEVs or natural gas vehicles.
VT 19	Commercial Vehicle Truck Idle Reduction Facilities and/or Equipment Incentives	Provide facilities for external heating and cooling of trucks, such as truck stop electrification, at near-Port truck parking areas and rest areas. Offer incentives for purchases of equipment such as auxiliary power units to minimize truck engine idling.	Region/All place types	Expand existing NJDEP idling restrictions through establishing a rule that by 2040 idling time associated with over-night parking at rest areas, truck parking areas near ports, and at intermodal facilities are 100% powered through battery or plug-in electric technology. Idling associated with waiting in a queue at an intermodal facility or at the point of delivery is addressed through management and efficiency strategies (See strategy SE 12).
	Electricity Rate Reduction for EVSE	Work with BPU/utilities to provide lower EV charging rates for private and commercial users.	Region/All place types	

E. Strategy and Bundle GHG Reduction Methodology

Table E.1 Strategy GHG Reduction Methodology

Strategy	Location Deployed	GHG Reduction Methodology
Smart Growth Incentives	Region/All place types	Assume that deployment of smart growth incentives act in aggregate to increase the effective population density of a particular location (effective density incorporates the impact of all smart growth components noted in the draft definition, which covers the traditional 4Ds {density, diversity, design, destination}), thus reducing VMT per capita. Utilize population density and VMT per capita data by place type as presented through NJTPA ViZtool indicators. Test strategy by place type to show varying magnitude of VMT change based on adjustments to forecasted Plan2035 density and other factors in different locations. Initial target is to increase the following factors in order to restore each place type to 2006 VMT per capita levels by 2040. To achieve these targets, VMT reductions by place type required are: Urban – 3.8%, Metro – 4.2%, Suburb – 5.5%, Rural – 1% (for the high end of the reductions, a doubling of these reductions by 2040 is assumed). VMT reduction from changes in a combination of household density, retail density, transit access, entropy (or land use mix), and vehicle ownership follow these relationships as documented in the Southern California Association of Governments (SCAG) Sustainability Tool[17]: for each 1% change in: - household density, VMT decreases 0.07% - retail density, VMT decreases 0.01% - transit access, VMT decreases 0.03% - entropy, VMT decreases 0.21% - veh. ownership, VMT decreases 0.04% - Total, VMT decreases 0.35%

[17] http://rtpscs.scag.ca.gov/Pages/Local-Sustainability-Planning-Tool.aspx

Strategy	Location Deployed	GHG Reduction Methodology
Transit Oriented Development	Urban/Metro/Rural Town	TOD generally requires at least 6 residential units per acre in residential areas and 25 employees per acre in commercial centers, and about twice that for premium quality transit, such as rail service.[18] Assume that trip origin VMT per capita from all TAZs within ½ mile of a premium transit station (rail) attain these target densities, plus include improved transit amenities and walkability. For example, increasing residential density near transit stations from 10 to 20 units per gross acre increases transit commute mode split from 20% to 24%, and up to 28% if implemented with pedestrian improvements.[19] A combination of these factors were used to estimate the VMT change associated with extensive deployment of TOD at fixed guideway station locations. Utilizing the same relationships for the Smart Growth Incentives strategy, by 2040 the following average changes are tested: doubling in household and retail density, 50-100% increase in transit access, and 50-100% increase in entropy. This results in 2040 VMT reductions for TAZs within ½ mile of transit stations of 4% in urban areas, 9-16% in metro areas, and up to 35% in suburban areas (in the average suburban TOD a 100% increase in density, access, and entropy is assumed).
Freight Oriented Development (Freight Villages)	Region/All place types	Within a recent study conducted by Rutgers University 5 scenarios of developing freight villages are tested against a baseline.[20] The study estimated that co-location benefits alone of freight villages can reduce truck VMT up to 15 percent. When including access to rail, the truck VMT reduction can be as high as 23 percent. Based on this data, two types of freight oriented development/freight villages are assessed (1 - Access only to interstate highways, 2 - Access to interstate highways and rail). The share of truck VMT by place type affected by development of a single freight village assumes that an average freight village consists of at least 50-100 acres and generates approximately 12 truck trips per day per acre. The NJTPA 2040 freight industry forecasts estimates a 16% increase in commercial vehicle VMT between 2025 and 2040. The low estimate for this strategy assumes 50% of this growth is accommodated through implementation of freight oriented development, while the high estimates assumes 100%. The resulting VMT reductions in 2040 are 1.2 – 3.1%.

[18] http://www.vtpi.org/tdm/tdm45.htm

[19] Robert Cervero, et al (2004), *Transit-Oriented Development in the United States: Experience, Challenges, and Prospects*, TCRP Report 102, Transit Cooperative Research Program, Transportation Research Board (http://gulliver.trb.org/publications/tcrp/tcrp_rpt_102.pdf)

[20] http://ntl.bts.gov/lib/42000/42500/42524/Final_Freight-Villages1.pdf

Strategy	Location Deployed	GHG Reduction Methodology
Complete Streets (Bike/Transit)	Region/All place types	Based on the NHTS, bicycle trips per capita per week ranges from 0.07 for the lowest density range (rural/suburban) to 0.19 for the highest range (urban). To estimate the increase in bicycling that might take place under the strategy definition, a simple model based on data in research by Dill & Carr (2003) examining bicycle commuting and facilities deployment in 42 U.S. cities and followed up in more detail for New York City by J. Pucher (Rutgers University, 2011) is used. This analysis found that "for more typical U.S. cities with at least 250,000 population, each additional mile of Type 2 bike lanes per square mile is associated with a 1 percent increase in bike commuting." Current miles of bike facilities per sq.mi range from 0.1 (suburb/rural to 0.3 urban) in the NJTPA region. A target improvement to 1 mile of facilities per sq.mi in rural and suburban areas, and 1.2 mi/sq.mi in metro/urban areas is tested. VMT per capita decreases are estimated based in a change in utilitarian trip bicycling mode share (for work and non-work separately). In all strategy tests, bike to work mode share increases to 1% or higher for all place types (as high as 2% in urban place types).
Complete Streets (Pedestrian/ Transit)	Region/All place types	The approach will apply an elasticity of VMT with respect to the pedestrian compatibility index (PCI). Elasticity's from a 2001 study by R. Ewing and R. Cervero are applied to example changes in the PCI resulting from pedestrian improvements (eg. as noted in the definition, increasing PCI to a level consistent with the top 25% areas).[21] The elasticity's range from -0.2 to -0.03 for every 1% change in VMT. As a result of applying these elasticity's to increases in PCIs as high as 50% in suburban areas, VMT decreases range from -1.5% in suburban areas (where it is assumed that a greater relative level of pedestrian improvement could be implemented) and -0.5% in urban areas.

[21] Ewing, R. and R. Cervero (2001) Travel and the Built Environment. Transportation Research Record 1780, 87-114.

<table>
<tr><th>Strategy</th><th>Location Deployed</th><th>GHG Reduction Methodology</th></tr>
<tr><td>Carpool/Vanpool Incentive Programs and Dynamic Ridesharing</td><td>Region/All place types</td><td rowspan="3">Ridesharing – Ridesharing includes all programs that provide information, financial incentives, or access to other benefits such as preferential parking or guaranteed ride home to support carpool and vanpool development and sustained use.

Baseline: According to the 2010 ACS 3-year sample, 8.1% of regional commuters carpool (4 persons or less) and 0.5% vanpool (5 or more persons). The vanpool statistics include both public and employer supported vanpools. The average occupancy of shared rides is appx. 2.5 persons per vehicle.
2040 Target: Double rideshare mode share in suburban/rural locations or areas with low transit access (suburban counties average 9%, rural average 8%). In urban locations assume telecommuting, bike/pedestrian, and transit strategies cover most of mode shift from TDM related strategies. By increasing the active number of vanpools in the NJTPA region by 3 to 4x, average occupancy of shared rides will increase.

TMA Outreach/Marketing Strategies – Provision of traveler information, travel choice marketing, guaranteed ride home, shuttle bus services, transit passes, and employer assistance supporting registration as a NJ Smart Workplace can reduce drive alone VMT from 5 to 10 percent depending on level of employer participation and TMA operational resources.[22]

Telecommuting – The 10 percent daily teleworking target in 2040 is equivalent to 50 percent of eligible workers teleworking an average of 2 days per week. Eligible telework industries include most typical office, sales, IT, and web related industries. This expansion of teleworking assumes that technology is not the limiting factor in adoption, rather employer willingness to offer the opportunity and employee knowledge and participation in teleworking as the stumbling block.

EPAs COMMUTER Model was applied with baseline work-trip mode shares and trip distances specific to the NJTPA region along strategy assumptions for the extent of implementation and the employee participation rates in employer based commute programs in 2040.[23] The Model was tested at a medium and high deployment for each strategy separately, and then combined, in order to assess the cumulative benefits of all TDM strategies together. Table 1 provides the inputs tested in the COMMUTER Model.</td></tr>
<tr><td>Public/Private Commuter Outreach/Incentive Programs (TMAs)</td><td>Region/All place types</td></tr>
<tr><td>Telecommuting and Compressed Work Week Targets</td><td>Region/All place types</td></tr>
</table>

[22] 2011 Maryland Department of Transportation – Climate Action Plan. http://www.mdot.maryland.gov/Office%20of%20Planning%20and%20Capital%20Programming/Environmental_Planning.html

[23] The COMMUTER Model analyzes time and cost strategies using a "pivot-point" logit mode choice model, which uses the mode choice coefficients from regional travel models and applies a change in time and/or cost to "pivot" off of a baseline starting mode share to achieve a final mode share. http://www.epa.gov/OTAQ/stateresources/policy/pag_transp.htm#cp

<table>
<tr><th>Strategy</th><th>Location Deployed</th><th>GHG Reduction Methodology</th></tr>
<tr><td></td><td></td><td>Table 1 – COMMUTER Model – Participation Rate Inputs
<table>
<tr><th>Scenario</th><th>Description</th><th>Baseline</th><th>Medium Case</th><th>High Case</th></tr>
<tr><th colspan="5">Assumptions</th></tr>
<tr><td rowspan="3">Employer Support Programs, Percentage of Employers Participating</td><td>Level 1</td><td>1%</td><td>1%</td><td>2%</td></tr>
<tr><td>Level 2</td><td>2%</td><td>2%</td><td>3%</td></tr>
<tr><td>Level 3</td><td>5%</td><td>8%</td><td>10%</td></tr>
<tr><td rowspan="5">Alternative Work Schedules</td><td>Flex Time</td><td>5%</td><td>8%</td><td>10%</td></tr>
<tr><td>Compressed 4/40</td><td>5%</td><td>8%</td><td>10%</td></tr>
<tr><td>Compressed 9/80</td><td>5%</td><td>8%</td><td>10%</td></tr>
<tr><td>Staggered Hours</td><td>5%</td><td>8%</td><td>10%</td></tr>
<tr><td>Telecommute</td><td>5%</td><td>8%</td><td>10%</td></tr>
</table></td></tr>
<tr><td>Parking Pricing and Incentives</td><td>Urban Center/ Metro Office</td><td>A case study of eight large California firms implementing parking cash out (consistent with CA law) showed driving alone dropped 17 percent, carpooling increased by 64 percent, transit use rose by 50 percent, and combined bicycling and walking rose 30 percent.[24] Applying these effectiveness rates focused on the share of employers/employees targeted (depending on size and location) allows for an estimate of overall VMT reduction.</td></tr>
</table>

[24] http://www.bestworkplaces.org/pdf/ParkingCashout_07.pdf

Strategy	Location Deployed	GHG Reduction Methodology
Bus Transit Quality and Reliability of Service	Urban/Metro/ Suburb	The 2040 analysis evaluates the combined benefit of up to a 15% enhancement in quality of service (speed, reliability/priority, traveler information, access) and up to a 15% enhancement in level of service (frequency, route alignment, limited stop or express service). To estimate the potential VMT reduction from these increases by place type, a transit service elasticity is applied to the service increases by place type. For quality of service the elasticity ranges from 0.3 (rural/suburban) to 0.6 (metro/urban) (meaning for each 1 % increase in service, there is a 0.3 to 0.6% increase in ridership). For level of service the elasticity's range from 0.4 (rural/suburban) to 0.8 (metro/urban). These elasticity's are consistent with national research based on a combination of pre/post-implementation studies and state of the practice mode choice model assumptions.[25] The variance in elasticity is tied to differences in transit score by place type, which is representative of density and other socio-economic factors that impact transit ridership. Assumptions by place type grouping: Urban – 15% quality of service increase only (elasticity range of 0.3 – 0.6) Metro – 15% quality of service increase (elasticity range of 0.3 – 0.5), 15% level of service increase (elasticity range of 0.6 – 0.8) Suburb – 10% quality of service increase (elasticity range of 0.3 – 0.4), 15% level of service increase (elasticity range of 0.6 – 0.7) Rural – 10% level of service increase only (elasticity range of 0.6 – 0.7)

[25] TCRP Report 95 provides information on the effects of various types of service improvements on transit ridership. The elasticity of transit use to service expansion (e.g. routes into new parts of a community) is typically in the range of 0.6 to 1.0, meaning that each 1% of additional service (measured in vehicle-miles or vehicle-hours of service) increases ridership by 0.6-1.0%, although much lower and higher response rates are also found (from less than 0.3 to more than 1.0). The elasticity of transit use with respect to transit service frequency (called a headway elasticity) averages 0.5. There is a wide variation in these factors, depending on the type of service, demographic and geographic factors. Higher service elasticities often occur with new express transit service, in university towns, and in suburbs with rail transit stations to feed. It usually takes 1 to 3 years for ridership on new routes to reach its full potential. Completely new bus service in a community that previously had no public transit service typically achieves 3 to 5 annual rides per capita, with 0.8 to 1.2 passengers per bus mile.

Strategy	Location Deployed	GHG Reduction Methodology
Rail Transit Quality and Reliability of Service	Region/All place types	The 2040 analysis evaluates the combined benefit of up to 15% enhancement in quality of service (speed, reliability, traveler information, and access) and up to a 15% enhancement in level of service (frequency, vehicle capacity, limited stop or express service). The level of the enhancement varies by place type – up to 5% urban, 10% metro, 15% suburb, and 5% rural. The logic behind varying enhancement assumptions is based on observed constrained capacity in urban areas, available capacity in metro and suburb areas (particularly for off-peak service), and available capacity in rural areas with limited demand. The elasticity's also vary by place type based on the same logic as bus transit (declining elasticity due to declining transit score): 0.75 urban, 0.5 metro and suburb, 0.25 rural.
VMT or Carbon Tax	State	Per AAA 2012 Your Driving Costs, the cost to operate an average passenger vehicle is \$0.596 per mile, with \$0.147 assigned to fuel costs. Fuel costs and fuel economy are expected to increase through 2035 and average fuel costs per mile will remain constant over time (eg. fuel economy increases proportionally with fuel cost). Based on elasticity research with respect to the cost per mile of driving, the elasticity of VMT with respect to cost per mile is -0.45 – meaning that each 1% increase in the cost of driving results in a 0.45% decrease in VMT.[26] This elasticity is applied to the change in user fees/taxes (options tested include 1 and 2 cent increase per mile) to estimate change in VMT.

[26] To estimate the related GHG reduction of VMT fees, travel cost elasticity's are applied to all private vehicle travel in New Jersey. Automobile travel is generally inelastic, meaning that a price change causes a proportionally smaller change in vehicle mileage. For example, a 10 percent fuel price increase only reduces automobile use by about 1 percent in the short run, and 3 percent over the medium run. A 50 percent fuel price increase, which is significant to consumers, will generally reduce vehicle mileage by about 5 percent in the short run. The effect over time though will increase as consumers take the higher price into account in longer-term decisions, such as vehicle purchases and where to live or work. A combined long and short run elasticity estimate was applied for the VMT fee analysis of a -0.45 percent change in volume for each 1 percent change in trip cost. This elasticity is consistent with the range of estimates made by FHWA in the 2006 Conditions and Performance Report.

Strategy	Location Deployed	GHG Reduction Methodology
PAYD Insurance	State	Utilizes an annual 5 percent VMT reduction per policy switched to PAYD insurance, based on findings from the 2008 NCTCOG study.[27] This is a conservative estimate of the VMT effect. 10 percent is a high-end VMT effect as based on research estimates from a recent Brookings Institution report[28] and Victoria Transportation Policy Institute.[29] Apply these effectiveness rates to the share of drivers and their total VMT that switches to PAYD insurance.
Traffic Signal Coordination/ Arterial System Management	Urban/Metro/ Suburb	Effects of Adaptive control project implementation taken up by NJDOT. Meadowlands Adaptive Signal System for Traffic Reduction reports a 20% reduction in delay and 1.2 million gallons of fuel savings[30] Based on this application and other research, the following assumptions are considered by place type: Urban - Assumption 2 mile stretch, 10 intersections, 10 minutes to travel and a hourly volume of 8,000 vehicles - delay reduction of 20%. Metro - Assumption 2 mile stretch, 6 intersections, 8 minutes to travel and a hourly volume of 4,000 vehicles - delay reduction of 14%. Suburban/Rural - Assumption 2 mile stretch, 4 intersections, 6 minutes to travel and a hourly volume of 1,000 vehicles - delay reduction of 10%.
Active Traffic Management/ Variable Speed Limits	Urban/Metro/ Suburb	Variable speed limits are already enforced on NJ Turnpike and benefits observed there could be attributed to other limited access facilities in the region where there is no data available on deployment, and systems management. An increased throughput of 3-5 percent is identified as a result of variable message signs on NJ Turnpike[31]

[27] *Pay-As-You-Drive Insurance Pilot Program – Phase II Final Project Report*. Progressive County Mutual Insurance Company and North Central Texas Council of Governments, November 2008. http://www.nctcog.org/trans/air/programs/payd/FinalPAYDReport_11-05-2008.pdf

[28] *Pay-As-You-Drive Auto Insurance: A Simple Way to Reduce Driving-Related Harms and Increase Equity*. Bordoff and Noel, The Brookings Institution. July 2008.

[29] http://www.vtpi.org/tdm/tdm79.htm

[30] http://www.its-ct.org/documents/meetings-events/2011Annual/Singh-NJDOT-Swindler-PB.pdf

[31] http://ops.fhwa.dot.gov/freewaymgmt/publications/frwy_mgmt_handbook/chapter8_01.htm

Strategy	Location Deployed	GHG Reduction Methodology
Limited Access Facility System Management	Urban/Metro/ Suburb	*Incident Management* – For the Incident Management System strategy, observed outcomes from CHART (Maryland's statewide IMS and ATMS system) for response times to incidents is used. From this an estimate of the delay reduction based on time saved due to a coordinated response by IMS as opposed to a normal 911 response by highway safety patrol is established. In observed cases there is a 5 minute differential statewide between a coordinated IMS response and a 911 response until the time the traffic is cleared (equivalent to roughly a 29 percent reduction in incident related delay). *Ramp metering* – Reduced vehicle delay due to smooth throughput on the freeway has been studied on the I-80 corridor, resulting in a 3-5 percent reduction in delay.[32]
System Preservation/ Corridor Access Management	Urban/Metro/ Suburb	FHWA's CVE tool (http://teachamerica.com/CVE/cve.html) includes a delay estimation and reduction estimation process. All values are on a per mile basis. The tool is applied to miles of arterials by place type. The number of conflict points reduced per mile due to access management techniques results in reduced delay per vehicle. This is due to consolidation of driveways and other road treatments like reduced signals, openings etc. Delay reduction will pivot from a baseline assumption of number of existing driveways per mile, reduced signals, and openings by lane groups. The total reduction is a sum of total miles by each lane group (conflict points vary by lane groups). For grade separation access management approaches, signal per mile reduction tests include 4 signals to 2 signals per mile, and 6 signals to 4 signals per mile. Driveway per mile reduction tests evaluate a 50% reduction in driveways per mile.
Truck Route/Time-of-Day Truck Operation Policies	Urban/Metro/ Suburb	There are extensive research reports indicating the potential benefits of truck route and time of day operation policies that will help build example rates of effectiveness for this strategy analysis in the NJTPA region. Examples include: Improved travel speeds due to shifting operations to peak hours, Pier Pass Off Peak program at San Pedro Bay (CA) ports[33] Manhattan Off-Hour Delivery Program (OHD) has information on reduced fuel costs and congestion levels due to shifting delivery times in NYC region (Integrative Freight Demand Management In The New York City Metropolitan Area)[34]. Conclusions from these two research reports indicate potential for a 15-20% diversion from peak period deliveries to off-peak. These diversion rates are applied to commercial vehicle VMT and VHD from NJTRM-E loaded highway networks for CBD and urban place types in the AM and PM peak in order to estimate total reduction in delay.

[32] Evaluation of the Potential for Using Ramp Metering in the ATMS of the I-80 Showcase Corridor. http://transportation.njit.edu/nctip/final_report/RampI80.pdf

[33] http://ops.fhwa.dot.gov/publications/fhwahop09014/sect2.htm

[34] http://transp.rpi.edu/~usdotp/OHD_FINAL_REPORT.pdf

Strategy	Location Deployed	GHG Reduction Methodology
Intermodal Freight Centers Access Improvement	Metro with Industry	This strategy represents a combination of both supply and demand strategies that address the first/last mile issue. Research or project specific reports that detail the combined impact of a comprehensive approach was explored in order to develop the assessment of this strategy. Overall the assumed impact is that improvements to bottleneck locations reduce peak period level of service to LOS D conditions or better. LOS D is assumed roughly equivalent to a travel time index of 1.35. Total VHD and VMT for all network links at a 1.35 peak period travel time index of higher within 1 mile of intermodal facilities are totaled. The strategy analysis tests the impact of a 50% reduction of LOS E-F travel conditions to LOS D, up to a 100% reduction. Total percent delay reduction represents the impact to a specific facility of an intermodal centers access improvement that improves peak travel conditions to LOS D or better.
Freight Rail Capacity Constraints	Region only	The 2040 NJTPA Freight Profile indicates that roughly 30 percent of truck trips in the region are long-haul (> 500 miles). This set of trips is viewed as the most likely candidates for switching to the rail mode should significant capacity constraints that hamper freight rail capacity and travel efficiency be removed. According to the MAROps Study, the Mid-Atlantic states are more dependent on long-haul trucking (moves longer than 500 miles) than the nation as a whole.[35] Nationally, 16 percent of total domestic tonnage moves by long-haul truck compared to 18 percent for trips starting or ending in the study area and 35 percent for trips passing through the study area (mostly serving New York and New England). If rail corridor choke points were eliminated, thereby enabling the freight railroads to offer more competitive levels of service and making it possible for the region to lower its reliance on long-haul trucking to the national average, then approximately 25 percent of long-haul traffic could divert to rail intermodal. The 25 percent share is applied to the 30 percent share of long-haul truck trips in 2040 to estimate a VMT reduction in the region.

[35] http://www.i95coalition.org/i95/Projects/ProjectDatabase/tabid/120/agentType/View/PropertyID/178/Default.aspx

Strategy	Location Deployed	GHG Reduction Methodology
Electric Vehicle Readiness Plan Development and Implementation	Region/All place types	Based on the penetration rates identified in the strategy definition by 2040 (60 percent EVs/BEVs/PHEVs), and using average CO2e gram per mile estimates for different technology types, the reduction in total CO2e emissions is estimated through assuming a constant annual VMT per vehicle by vehicle type (consistent with NJTPA regional model forecasts). US EPAs Office of Transportation and Air Quality has developed a calculator (http://www.fueleconomy.gov/feg/Find.do?action=bt2) that estimates both the tailpipe CO2 emissions and total emissions from AFVs/EVs. The relationships from this calculator can be used to estimate the change in emissions from the Baseline for varying future fleet composition scenarios. For current PHEVs (Chevy Volt, Toyota Prius), total tailpipe emissions assume the vehicle runs electric 29% of VMT resulting in an average emission rate of 130 g CO2e/mile. The average equivalent total emissions rate totals 200 g CO2e/mile. This includes tailpipe emissions and the emissions associated with the production and distribution of fuel and emissions associated with the production and transmission of electricity based on regional data from eGrid 2010. For current BEVs (Ford Focus, Mitsubishi i-MiEV), the tailpipe emissions are 0 g/mi, while the total emissions average 160 g CO2e/mile. For standard gasoline vehicles, the total emission rate for a new 2012 vehicle is 500 g CO2e/mile.
EVSE Purchase Rebates/Vouchers/ Grants	Region/All place types	
Local PHEV/EV Parking Regulations and Incentives	Region/All place types	
Electricity Rate Reduction for EVSE	Region/All place types	
Clean Fuel Standard (or similar approach)	Region/All place types	The high case for NESCAUMs clean fuel standard is a 15% carbon intensity reduction in all transportation fuels over 15 years. Assuming a constant 1% per year reduction, and a commitment by NJ starting in 2015, this would result in an aggregate 25% reduction in carbon intensity of fuels through 2040. Assume that 60% of this reduction is accommodated by electric vehicles, while the remainder is accommodated by natural gas, fuel cell technology, or other lower-carbon petroleum based fuels.
AFV Purchase Rebates/Vouchers/ Grants	Region/All place types	
AFV Pilot Grants & Fleet/Fueling Equipment Subsidies	Region/All place types	The GHG reduction will be applied consistently at the regional scale and assess the benefit of increased penetration of low carbon fuels into medium and heavy duty fleets, including buses, commercial vehicles, and other fleet vehicles. Natural gas vehicles (NGVs) are a good choice for high-fuel use fleets—such as buses, garbage trucks, and other fleet vehicles—

Strategy	Location Deployed	GHG Reduction Methodology
Electricity Rate Reduction for EVSE	Region/All place types	that are centrally fueled. A NGV emits approximately 50% less CO2 compared to diesel fuel.[36] 35.0% - Bus+Medium Duty VMT Share (70%) * 100% penetration * Average 50% reduction 6.0% - Heavy Short-Haul VMT Share (16%) * weighted average of reduction and penetration for ADVs and EVs (30% reduction from advanced diesel vehicles, 65% reduction from EVs) 5.0% - Heavy-Long Share (14%) * weighted average of reduction and penetration for ADVs and EVs (30% reduction from advanced diesel vehicles, 65% reduction from EVs) The percent reductions are based on the potential benefits of advanced diesel and alternative fuel technologies, including electric as documented in the U.S. DOT Report to Congress on *Transportation's Role in Reducing U.S. Greenhouse Gas Emissions* (USDOT, 2009).
SmartWay Program for PANYNJ Trucks & Truck Phase-Out Program	Metro Industry	The combination of EPA SmartWay technologies can reduce fuel consumption by 10-15 percent compared to existing conditions and forecasts within AEO 2012 based on data reported in *Transportation's Role in Reducing U.S. Greenhouse Gas Emissions* (US DOT, 2009). Assume all PANYNJ drayage truck VMT in 2040 decreases per mile GHG emissions by 10-15 percent. Early heavy-duty hydraulic hybrid vehicles show a gain of 30–50 percent in fuel efficiency over standard diesel heavy-duty vehicles for short-haul, stop-and-go applications. These vehicles are entering the fleet at a much slower rate and roughly by some 8-10 years later than for LDVs.
Commercial Vehicle Truck Idle Reduction Facilities and/or Equipment Incentives	Region/All place types	Based on data reported in *Transportations Role in Reducing U.S. Greenhouse Gas Emissions* (US DOT, 2009), sleeper cab trucks idle, on average, for about five hours a day while consuming about 1 gallon per hour while idling. In comparison, an APU consumes about 0.3 gallons per hour and a battery the equivalent of 0.05 gallons per hour. The combination of new regulations on extended idling and widespread availability of technologies has the potential of reducing 90 percent or more of extended idling activity. Based on the above relationships, each hour reduced decreases equivalent fuel consumption (or GHG emissions) by 70 to 95 percent.
Electricity Rate Reduction for EVSE	Region/All place types	

[36] http://nj.gov/emp/docs/pdf/20110911_AFV_EMP_Wkg_Group_Final.pdf

Bundle GHG Emission Reduction Methodology

To adjust strategy results to bundle results, the approach to "build-up" strategy results to an example place type requires: (1) a multiplicative approach that eliminates double counting of VMT, delay, or GHG emission reductions, and (2) relationships that translate travel market specific reductions to reductions for all travel activity. The multiplicative approach ensures that each strategy is applied in succession to a declining balance of remaining VMT.

The results of this process for each bundle are included in Appendix G.

VMT Bundle:

The strategy combining approach uses the following order of operations and the travel market impacted:

1. VMT fee & PAYD Insurance – All passenger VMT
2. Smart Growth Incentives & Transit Oriented Development – All passenger VMT for Smart Growth. For TOD, the population of zones within ½ mile of transit station locations is roughly 11 percent of total population in urban and metro place types. The TOD GHG reduction potential is multiplied by 0.11 to reflect that on average, a TOD affects only 11 percent of all travel in an example municipality.
3. Transportation Demand Management & Parking – Commute based VMT represents 49.5 percent of all VMT. The combined GHG reduction potential of TDM and parking management is multiplied by 0.495 to reflect that on average, these strategies affect only 49.5 percent of all travel in an example municipality.
4. Complete Street & Transit - All passenger VMT
5. Freight Villages and Freight Rail Capacity – Commercial vehicles represent 5 percent of regional VMT, and long-haul commercial vehicles represent in the 40-60 percent range of all truck tonnage in the region.

System Efficiency:

The critical approach for system efficiency is to apply the estimated GHG reductions by strategy to the actual share of total delay occurring on arterial facilities versus limited access facilities by place type. After applying these shares, total average impact on all congested corridors (LOS D+) can be estimated. Based on an analysis of Plan2035 networks:

Share of total vehicle delay by place type:

Urban – 15% limited access, 85% arterials and collectors

Metro – 25% limited access, 75% arterials and collectors

Suburban – 30% limited access, 70% arterials and collectors

Rural – 60% limited access, 40% arterials and collectors

Alternative Fuel and Vehicle Technology:

The combination of passenger vehicle and commercial vehicle strategies occur as the last step of the process of aggregating strategy benefits.

Passenger Vehicles (2040):

1. Electric Vehicles – 20% reduction of all passenger vehicle running emissions = 15.1% total emissions reduction
2. Clean Fuels – 2.2% reduction of all remaining passenger vehicle running emissions and all non-running emissions = additional 2.8% total emissions reduction

Commercial Vehicles (2040):

1. Incentives for EVs and ADVs/AFVs = 13.4% reduction of all truck emissions (including drayage trucks)
2. Anti idling – 90% reduction of all remaining non-running emissions

F. Strategy Results

Table F.1 Strategy VMT and Delay Reduction Estimates

Strategy	Geography	Timeline[2]	Lead Time to Full Effectiveness[3]	Travel Market	% VMT Reduction: Urban	% VMT Reduction: Metro	% VMT Reduction: Suburb	% VMT Reduction: Rural	% VMT Reduction: Region	% Delay Reduction: Urban	% Delay Reduction: Metro	% Delay Reduction: Suburb	% Delay Reduction: Rural	% Delay Reduction: Region
Smart Growth Incentives	Place type	Long	Long	Passenger	3.8%	4.2%	5.5%	0.5%	N/A					
Transit Oriented Development	Place type	Long	Medium	Passenger	3.9%	11.9%	34.5%	N/A	N/A					
Freight Oriented Development (Freight Villages)	Region	Long	Long	Commercial	N/A	N/A	N/A	N/A	1.2 - 3.1%					
Complete Streets (Bike/Transit)	Place type	Medium	Short	Passenger	0.7%	0.3%	0.3%	0.2%	N/A					
Complete Streets (Ped/Transit)	Place type	Medium	Short	Passenger	1.1%	1.3%	1.6%	0.8%	N/A					
Carpool/Vanpool Incentive Programs and Ridesharing	Place type	Short	Immediate	Passenger Commute	5.8% - 11%	2.3% - 3.2%	0.9% - 2.6%	N/A	N/A					
Commuter Outreach/Incentive Programs (TMAs)	Place type	Short	Immediate	Passenger Commute	0.3%	0.2%	0.1%	N/A	N/A					
Telecommuting and Compressed Work Week Targets	Place type	Short	Immediate	Passenger Commute	1.7%	1.3%	0.5%	N/A	N/A					
TDM Mini Bundle[1]	*Place type*	*Short*	*Immediate*	*Passenger Commute*	9.4%	5.6%	4.0%	N/A	N/A					
Parking Pricing and Supply Management	Place type	Medium	Short	Passenger Commute	22.5%	14.4%	N/A	N/A	N/A					
Bus Transit Quality and Reliability of Service	Place type	Medium	Short	Passenger	4.1% - 8.2%	3.7% - 10.1%	2.7% - 9.5%	2.5% - 7.3%	N/A					
Rail Transit Quality and Reliability of Service	Place type/Region	Long	Medium	Passenger	3.4%	4.5%	6.8%	1.1%	4.6%					
VMT or Carbon Tax	Region	Long	Immediate	Passenger	0.8% - 2.3%	0.8% - 2.3%	0.8% - 2.3%	0.8% - 2.3%	0.8% - 2.3%					
PAYD Insurance	Region	Medium	Short	Passenger	3.5%	3.5%	3.5%	0.4%	3.2%					

					% VMT Reduction					% Delay Reduction				
Strategy	Geography	Timeline[2]	Lead Time to Full Effectiveness[3]	Travel Market	Urban	Metro	Suburb	Rural	Region	Urban	Metro	Suburb	Rural	Region
Arterial System Management	Place type	Medium	Immediate	Arterial All						20%	14%	10%	10%	N/A
Limited Access System Management	Place type	Medium	Immediate	Limited Access All						6%	5%	4%	-	N/A
Limited Access Incident Management	Place type	Medium	Immediate	Limited Access All (incident delay)						29%	29%	29%	29%	N/A
System Preservation/Corridor Access Management	Place type	Medium - Long	Immediate	Arterial All						5 - 7%	8 - 10%	17 - 58%	-	N/A
Truck Route/Time-of-Day Truck Operation Policies	Place type	Short	Immediate	Commercial (Peak to Off-peak)						20 - 22%	14 - 16%	-	-	N/A
Intermodal Freight Centers Access Improvement	Place type	Long	Immediate	Commercial ("Last Mile")						24 - 36%	20 - 31%	30 - 46%	-	N/A
Freight Rail Capacity Constraints	Region	Long	Medium	Commercial (Inter-region/state)	N/A	N/A	N/A	N/A	22 - 26%					

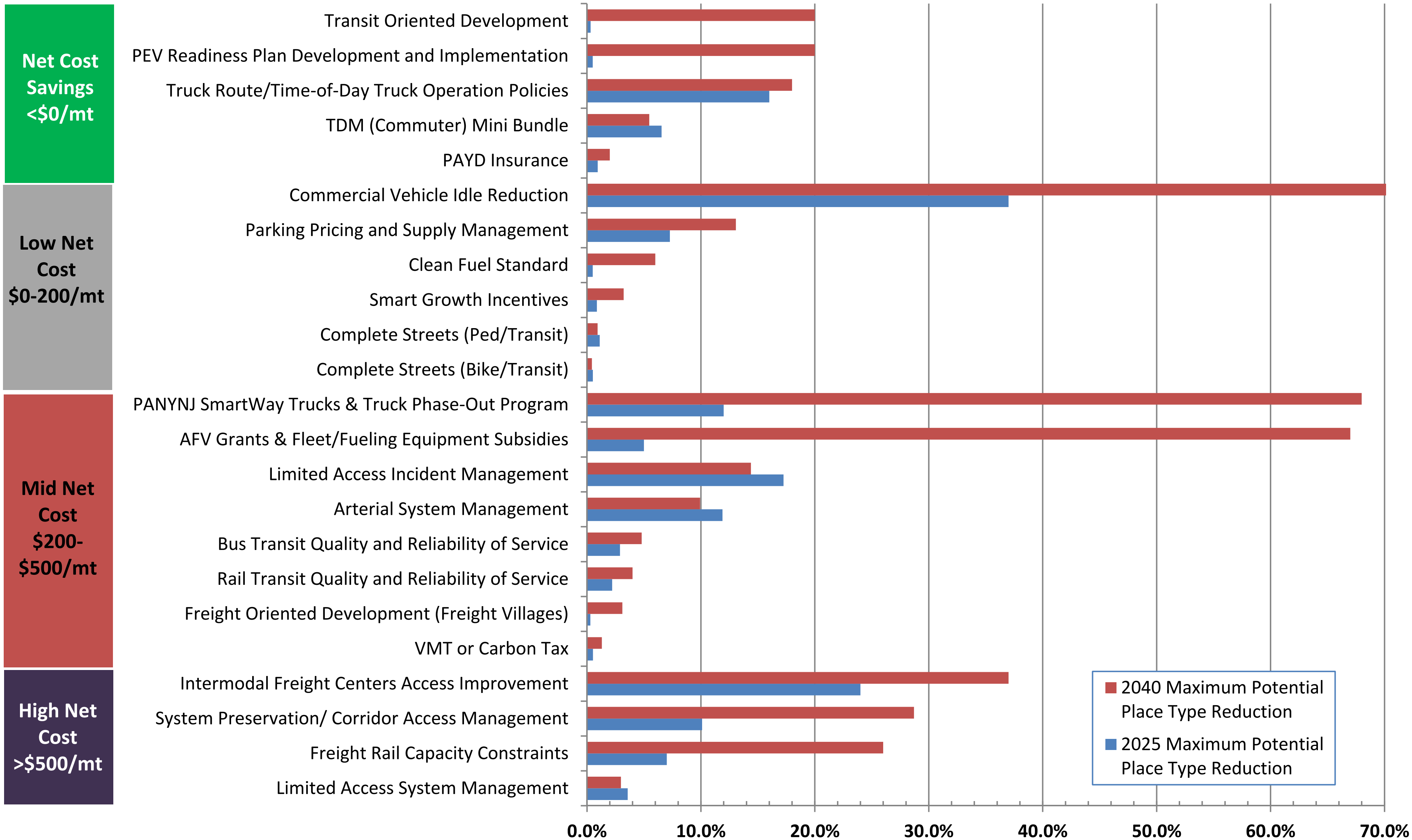
Note: 1) There is overlap between programs that provide incentives for ridesharing and parking cash-out. In most cases, a change in parking subsidies or provision of cash-out also include preferential pricing for ridesharing.
Note: 2) Parking pricing considers the elimination of all parking subsidies, regardless of vehicle occupancy, or the implementation of parking maximums for new developments to constrain total supply.
Note: 3) Time required to implement: Short (<= 1 year), Medium (2-5 years), Long (5+ years)
Note: 4) Time required for implemented strategy to reach full potential: Immediate (<3 years), Short (<10 years), Medium (10-20 years), Long (20+ years)
Note: 5) Full potential CO_2e reduction effectiveness is 25-30% less by 2025, and 58 - 62% less beyond 2035 when full cumulative benefit of the 2017-2025 NFES is included compared to the cumulative benefit of the 2012-2016 NFES.

Table F.2 Strategy GHG Emission Reduction Estimates

Strategy	Geography	Timeline[2]	Lead Time to Full Effectiveness[3]	Travel Market	% CO2e Reduction in 2025 at Full Potential Effectiveness[5]					% CO2e Reduction in 2040 at Full Potential Effectiveness[5]				
					Urban	Metro	Suburb	Rural	Region	Urban	Metro	Suburb	Rural	Region
Smart Growth Incentives	Place type	Long	Long	Passenger	0.9%	0.9%	0.6%	0.1%	N/A	2.2%	2.5%	3.2%	0.3%	N/A
Transit Oriented Development	Place type	Long	Medium	Passenger	0.1%	0.1%	0.3%	N/A	N/A	2.3%	6.9%	9 - 20%	N/A	N/A
Freight Oriented Development (Freight Villages)	Region	Long	Long	Commercial	N/A	N/A	N/A	N/A	0.3%	N/A	N/A	N/A	N/A	1.2 - 3.1%
Complete Streets (Bike/Transit)	Place type	Medium	Short	Passenger	0.5%	0.2%	0.2%	0.2%	N/A	0.4%	0.2%	0.2%	0.1%	N/A
Complete Streets (Ped/Transit)	Place type	Medium	Short	Passenger	0.7%	0.9%	1.1%	0.5%	N/A	0.6%	0.7%	0.9%	0.4%	N/A
Carpool/Vanpool Incentive Programs and Ridesharing	Place type	Short	Immediate	Passenger Commute	1.9 - 3.5%	0.7 - 1.1%	0.4 - 1.0%	N/A	N/A	3.4 - 6.4%	1.3 - 1.8%	0.5 - 1.5%	N/A	N/A
Commuter Outreach/Incentive Programs (TMAs)	Place type	Short	Immediate	Passenger Commute	0.2%	0.1%	0.1%	N/A	N/A	0.2%	0.1%	0.1%	N/A	N/A
Telecommuting and Compressed Work Week Targets	Place type	Short	Immediate	Passenger Commute	1.2%	0.9%	0.3%	N/A	N/A	1.0%	0.8%	0.3%	N/A	N/A
TDM Mini Bundle[1]	*Place type*	*Short*	*Immediate*	*Passenger Commute*	6.5%	3.9%	2.8%	N/A	N/A	5.5%	3.3%	2.3%	N/A	N/A
Parking Pricing and Supply Management	Place type	Medium	Short	Passenger Commute	7.3%	4.7%	N/A	N/A	N/A	13.1%	8.4%	N/A	N/A	N/A
Bus Transit Quality and Reliability of Service	Place type	Medium	Short	Passenger	2.9%	2.6%	1.9%	1.7%	N/A	2.4 - 4.8%	2.1 - 5.8%	1.5 - 5.5%	1.4 - 4.2%	N/A
Rail Transit Quality and Reliability of Service	Place type/Region	Long	Medium	Passenger	1.1%	1.5%	2.2%	0.4%	1.5%	2.0%	2.6%	4.0%	0.7%	2.6%
VMT or Carbon Tax	Region	Long	Immediate	Passenger	0.5%	0.5%	0.5%	0.5%	0.5%	1.3%	1.3%	1.3%	1.3%	1.3%
PAYD Insurance	Region	Medium	Short	Passenger	0.9%	0.9%	0.9%	0.1%	0.9%	2.0%	2.0%	2.0%	0.2%	1.7%

					% CO2e Reduction in 2025 at Full Potential Effectiveness[5]					% CO2e Reduction in 2040 at Full Potential Effectiveness[5]				
Strategy	Geography	Timeline[2]	Lead Time to Full Effectiveness[3]	Travel Market	Urban	Metro	Suburb	Rural	Region	Urban	Metro	Suburb	Rural	Region
Arterial System Management	Place type	Medium	Immediate	Arterial All	11.9%	8.3%	5.9%	5.9%	N/A	9.9%	6.9%	5.0%	5.0%	N/A
Limited Access System Management	Place type	Medium	Immediate	Limited Access All	3.6%	3.0%	2.4%	N/A	N/A	3.0%	2.5%	2.0%	N/A	N/A
Limited Access Incident Management	Place type	Medium	Immediate	Limited Access All (incident delay)	17.2%	17.2%	17.2%	17.2%	N/A	14.4%	14.4%	14.4%	14.4%	N/A
System Preservation/Corridor Access Management	Place type	Medium - Long	Immediate	Arterial All	3.0%	4.8%	10.1%	N/A	N/A	2.5 - 3.5%	4.0 - 4.9%	8.4 - 28.7%	N/A	N/A
Truck Route/Time-of-Day Truck Operation Policies	Place type	Short	Immediate	Commercial (Peak to Off-peak)	16%	11%	N/A	N/A	N/A	18%	13%	N/A	N/A	N/A
Intermodal Freight Centers Access Improvement	Place type	Long	Immediate	Commercial ("Last Mile")	19%	16%	24%	N/A	N/A	29%	25%	37%	N/A	N/A
Freight Rail Capacity Constraints	Region	Long	Medium	Commercial (Inter-region/state)	N/A	N/A	N/A	N/A	5 - 7%	N/A	N/A	N/A	N/A	22 - 26%
PEV Readiness Plan Development and Implementation	Region	Medium	Long	Passenger Vehicle	<1%	<1%	<1%	<1%	<1%	11 - 20%	11 - 20%	11 - 20%	11 - 20%	11 - 20%
Clean Fuel Standard (or similar approach)	Region	Medium	Long	Passenger Vehicle	<1%	<1%	<1%	<1%	<1%	2 - 6%	2 - 6%	2 - 6%	2 - 6%	2 - 6%
AFV Grants & Fleet/Fueling Equipment Subsidies	Region	Medium	Short	Commercial	5%	5%	5%	5%	5%	30 - 67%	30 - 67%	30 - 67%	30 - 67%	30 - 67%
PANYNJ SmartWay Trucks & Phase-Out Program	Place type/Region	Medium	Short	Commercial (Drayage trucks only)	12%	12%	N/A	N/A	N/A	25 - 68%	25 - 68%	N/A	N/A	N/A
Commercial Vehicle Idle Reduction	Region	Medium	Short	Commercial (Extended idling only)	37%	37%	37%	37%	37%	70 - 95%	70 - 95%	70 - 95%	70 - 95%	70 - 95%

Figure F.1 Maximum Potential Place Type GHG Reduction Organized by Cost Effectiveness



G. Bundle Results

Table G.1 Bundle Reduction – VMT, Delay, and GHG Emissions

VMT Reduction Bundle

VMT Reduction[1]

VMT Reduction Strategy Group	Travel Market	2025 - Medium Range Deployment				2040 - Medium Range Deployment				2040 - High Range Deployment			
		Urban	Metro	Suburb	Rural	Urban	Metro	Suburb	Rural	Urban	Metro	Suburb	Rural
VMT/PAYD	Passenger	2.1%	2.1%	2.1%	0.9%	5.8%	5.8%	5.8%	2.7%	5.8%	5.8%	5.8%	2.7%
Smart Growth/TOD	Passenger	1.4%	1.4%	1.3%	0.1%	4.2%	4.9%	7.4%	0.5%	4.2%	5.6%	9.6%	0.5%
TDM/Parking Pricing	Passenger	4.8%	3.0%	0.9%	0.2%	10.3%	6.4%	2.0%	0.5%	14.3%	11.9%	2.5%	0.6%
Complete Streets/Transit[1]	Passenger	7.5%	7.4%	7.8%	4.0%	10.1%	9.8%	11.5%	4.6%	13.4%	16.2%	18.3%	9.4%
Freight (Freight Villages & Rail Capacity)	Commercial	2.2%				8.7%				18.4%			
Total Bundle Reduction (PV VMT)[2]	Both	14.9%	13.3%	11.7%	5.1%	28.8%	25.8%	25.6%	8.6%	34.9%	36.4%	34.1%	13.8%
excluding VMT/PAYD	Both	17.3%	14.3%	12.6%	2.9%	17.3%	14.3%	12.6%	2.9%	24.5%	27.1%	17.3%	5.5%
Total Bundle Reduction (All VMT)[2]	Both	14.2%	12.6%	11.1%	4.9%	27.3%	24.5%	24.3%	8.1%	33.1%	34.5%	32.3%	13.1%
excluding VMT/PAYD	Both	16.4%	13.6%	12.0%	2.8%	16.4%	13.6%	12.0%	2.8%	23.3%	25.7%	16.4%	5.2%

Note 1) - VMT reductions do not include synergistic benefits of smart growth with transit/complete street strategies.

Note 2) - VMT reductions include synergy of smart growth with transit/complete street strategies. Total bundle reduction is based on a strategy multiplication process to eliminate double counting.

System Efficiency Bundle

Delay Reduction[3]

Delay Reduction Strategy Group	Travel Market	2025 - Medium Range Deployment				2040 - Medium Range Deployment				2040 - High Range Deployment			
		Urban	Metro	Suburb	Rural	Urban	Metro	Suburb	Rural	Urban	Metro	Suburb	Rural
Arterials/Collectors	Both	18.8%	16.5%	21.3%	4.0%	18.8%	16.5%	21.3%	4.0%	20.3%	18.0%	37.4%	4.0%
Limited Access	Both	5.4%	5.2%	4.2%	3.4%	5.4%	5.2%	4.2%	3.4%	5.4%	5.2%	4.2%	3.4%
Commercial	Commercial	44.0%	34.0%	30.0%	-	44.0%	34.0%	30.0%	-	58.0%	47.0%	46.0%	-
Total Bundle Reduction (PV Delay)	Both	24.2%	21.7%	25.5%	7.4%	24.2%	21.7%	25.5%	7.4%	25.7%	23.2%	41.6%	7.4%
Total Bundle Reduction (All Delay)	Both	25.3%	22.4%	25.7%	7.0%	25.3%	22.4%	25.7%	7.0%	27.4%	24.5%	41.9%	7.0%

Note 3) - Delay reduction estimates based on potential reduction as applied to facilities operating at LOS D+ conditions.

Technology and Fuels Bundle

GHG Emission Reduction[4]

Emission Reduction Strategy Group	Travel Market	2025 - Medium Range Deployment (Urban / Metro / Suburb / Rural)	2040 - Medium Range Deployment (Urban / Metro / Suburb / Rural)	2040 - High Range Deployment (Urban / Metro / Suburb / Rural)
Passenger Vehicles - PEV Market	Passenger	0.0%	15.1%	27.8%
Passenger Vehicles - Clean Fuels	Passenger	0.0%	2.8%	2.8%
Commercial Vehicles - Incentive Programs	Commercial	2.1%	13.4%	23.0%
Commercial Vehicles - Zero/Clean Idling	Commercial	1.9%	3.2%	3.2%
Total Bundle Reduction (PV GHG Emissions)	Passenger	0.0%	17.8%	30.5%
Total Bundle Reduction (CV GHG Emissions)	Commercial	4.0%	16.6%	26.2%
Total Bundle Reduction (All Emissions)	Both	0.9%	17.5%	29.3%

Note 3) - GHG reduction estimates pivot from Alternative Baseline vehicle technology assumptions and emission rates through 2050

Combined Bundle

GHG Emission Reduction[4]

Bundle	Travel Market	2025 - Medium Range Deployment Urban	Metro	Suburb	Rural	2040 - Medium Range Deployment Urban	Metro	Suburb	Rural	2040 - High Range Deployment Urban	Metro	Suburb	Rural
Technology and Fuels (PV GHG Emissions)	Passenger	0.0%				17.8%				30.5%			
Technology and Fuels (CV GHG Emissions)	Commercial	4.0%				16.6%				26.2%			
VMT Reduction	Both	9.8%	8.8%	7.7%	3.4%	13.0%	11.7%	11.6%	3.9%	13.4%	14.0%	13.1%	5.3%
excluding VMT/PAYD	Both	11.4%	9.5%	8.3%	1.9%	7.8%	6.5%	5.7%	1.3%	9.4%	10.4%	6.6%	2.1%
System Efficiency[5]	Both	5.6%	2.4%	2.5%	0.7%	3.9%	1.6%	1.7%	0.5%	3.6%	1.5%	2.4%	0.4%
Combined	Both	16.4%	12.1%	11.2%	5.0%	34.4%	30.8%	30.8%	21.8%	46.3%	44.8%	44.8%	35.0%
excluding VMT/PAYD	Both	17.9%	12.8%	11.8%	3.5%	29.2%	25.6%	24.9%	19.3%	42.3%	41.3%	38.4%	31.8%

Note 5) - Assumes VMT impacted by place type is equivalent to average daily share of VMT operating at or above TTI = 1.35