     

U.S. Virgin Islands Transportation Petroleum Reduction Plan

Caley Johnson

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Technical Report
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September 2011

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NATIONAL RENEWABLE ENERGY LABORATORY

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This report summarizes the recommendations and work of the EDIN-USVI Transportation working group (TWG). The work, time, insight, and creativity of the TWG members made this report possible, but any errors herein are the author's responsibility. The TWG members come from a diverse set of organizations and backgrounds within the USVI and provided a well-rounded assessment of strategies to improve USVI transportation. Radclyffe Percy of the Virgin Islands Energy Office was a particularly important contributor, through his role as co-chair of the TWG.

Fortunately, the TWG didn't have to start from scratch in the creation of a plan to reduce the USVI's dependence on petroleum-based transportation fuels. Its work builds upon the 2030 USVI Transportation Master Plan, which reflects insight and data achieved after months of research, surveys, and work with community advisory groups. The author would like to thank Marie-Elsie Dowell and Margaret Mund of PB Americas, Inc., for writing the Master Plan and for helping the TWG in its endeavor.

List of Acronyms

BIR	Bureau of Internal Revenue
BMV	Bureau of Motor Vehicles
Btu	British thermal unit
CAFE	Corporate Average Fuel Economy
DOE	U.S. Department of Energy
DP&P	Department of Property and Procurement
DPW	Department of Public Works
EDIN	Energy Development in Island Nations
EIA	U.S. Energy Information Administration
FAST	Future Automotive Systems Tool
HDV	heavy-duty vehicle
HOV	high occupancy vehicle
LDV	light-duty vehicle
mpg	miles per gallon
mph	miles per hour
NREL	National Renewable Energy Laboratory
RFS	Renewable Fuel Standard
TWG	Transportation working group
USVI	U.S. Virgin Islands
UVI	University of the Virgin Islands
VIEO	Virgin Islands Energy Office
VISSIM	Verkehr In Städten – SIMulationsmodell (German for "Traffic in cities simulation model").
VITRAN	Virgin Islands TRANsit
VMT	vehicle miles traveled
WAPA	Water and Power Authority

Executive Summary

The U.S. Virgin Islands (USVI) has set a goal to reduce petroleum use 60% by 2025 compared to the business-as-usual scenario. Ground-based transportation is responsible for 40% of USVI petroleum use, so the USVI and the U.S. Department of Energy (DOE) set up a Transportation working group (TWG) to devise a way to meet the 60% reduction goal in the transportation sector. This report lays out the TWG's plan.

The first step to achieving such a goal was to benchmark current fuel use and transportation characteristics. To do this, we (the TWG) consolidated key statistics from numerous USVI agencies, surveys, and reports. We found that USVI on-road transportation used 47 million gallons of petroleum in 2010 and is on the path to use 75 million gallons per year by 2025. Overall, the USVI transportation system is inefficient, offering much "low-hanging fruit," or relatively easily achievable petroleum use reductions with many co-benefits. On average, USVI residents take an even larger share of their trips in personal vehicles than mainland U.S. residents do, since USVI bus ridership is low and walking or biking is inconvenient or dangerous. The vehicles in the USVI are inefficient, and their fuel economy is further reduced by poor traffic flow.

We broke down the 60% by 2025 goal into smaller, more tangible goals correlating to the six main pathways toward reduced petroleum use. These six pathways are shown in Table A. The pathway-specific goals needed to displace 60% of USVI petroleum use were deemed ambitious but achievable. Progress toward these goals will be tracked by the Transportation working group, Virgin Islands Energy Office (VIEO), and the USVI Department of Public Works (DPW) through a tool set up by the National Renewable Energy Laboratory (NREL).

Table A. Summary of Petroleum Reduction Sub-Goals

Category	2025 Goal	% of total reduction
Miles Reduction	Motorized vehicles will travel 20% less	34%
Fuel Economy Improvements	New light duty vehicle (LDV) labels will average 4 mpg below U.S. fuel economy standards goal for given year	29%
Traffic Flow Improvements	20% of vehicle miles traveled will be converted to highway drive cycle	8%
Electric Vehicles	15% of the vehicles in USVI will be electrically powered	8%
Renewable and Biodiesel	55% of all diesel sold to road vehicles will be renewable diesel or biodiesel	16%
10% Ethanol (E10)	75% of all gasoline sold to road vehicles will be E10	5%

We identified projects that will help the USVI achieve its pathway-specific fuel use reduction goals. We then prioritized the projects using a framework based on project cost, potential petroleum savings, the time frame of the project, and the anticipated popularity of the project with USVI residents. The projects we found to be of highest priority were tracking buses with geotrackers, changing the vehicle specifications the government uses to purchase vehicles, encouraging the purchase of more efficient vehicles by adjusting the registration tax, setting up a road damage identification system, and setting up a ride share website. Next steps will be for the prescribed projects to be implemented in order of priority.

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Introduction

The oil price spike of 2008 alerted the U.S. Virgin Islands (USVI) to the risks of their high level of petroleum dependence. The people took action, and in February 2010, Gov. John P. de Jongh Jr. pledged to reduce petroleum use 60% below projected levels by 2025. To meet this goal, the USVI began working with the National Renewable Energy Laboratory (NREL) through the U.S. Department of Energy's (DOE) Energy Development in Island Nations (EDIN) program. EDIN's initial steps in the USVI were to improve efficiency in the electric and water utility and to increase production and use of renewable electricity. Since ground transportation in the USVI accounts for 40% of the manageable petroleum use in the USVI,[1] transportation was quickly seen as indispensible to meet the overall goal, and the USVI began exploring ways to reduce petroleum use in this sector as well.

Fortunately, the USVI Department of Public Works (DPW) laid the groundwork for major transportation petroleum use reductions in its commissioned report "2030 USVI Transportation Master Plan" (PB Americas, 2009). Petroleum use reduction was directly related to the Master Plan's Goal No. 4 (Environmental Sustainability and Land Use), and tangentially related to its Goals No. 5 (Congestion Management) and No. 6 (Integrated Transportation Network). The Master Plan reflected input gathered through community advisory groups and outlined specific projects that the local communities favored.

This report, funded by DOE and prepared by EDIN's Transportation Working Group (TWG), aims to build on the Master Plan by describing how its recommended projects can be leveraged toward the 60% by 2025 goal. It does so by first establishing a baseline and projected fuel use by USVI ground transportation. The report focuses on ground transportation because air and water transportation fuel is difficult to attribute to the USVI, is beyond the control of USVI authorities, and is lacking the technological options for large-scale fuel use reduction. It then outlines vehicle characteristics and statistics that are needed in order to progress toward the 2025 goal. Next, it charts scenarios for reaching the goal and describes the techniques, technologies, and strategies required to reach the goal. Finally, it describes specific projects (from the Master Plan and from the TWG that can progress the USVI toward the goal, and it introduces a rating system to help prioritize those projects. We envision that the report will double as a template that may be applied to other islands and entities that have transportation fuel use reduction goals.

Baseline Fuel Use and Transportation Statistics

The first step toward meeting a goal is to define it. To do this, the TWG determined how much petroleum was being used by ground transportation in the USVI and project how much it would use in 2025 under a business-as-usual scenario. The Bureau of Internal Revenue (BIR) provided data on the quantity of gasoline and diesel purchased (both taxed and tax exempt) between 2001 and 2010. The TWG assumed that all gasoline labeled as tax-exempt was used in off-road applications because the road tax does not apply to these applications. This assumption was

[1] The USVI manageable petroleum use includes fuel used by the Water and Power Authority (WAPA) and fuel used by ground transportation, as outlined later in this report. The total omits petroleum used for marine, aviation, off-road applications, and private generators that are largely beyond control of USVI agencies.

verified by comparing the quantity of gasoline used with the number of vehicles, and we found the ratio to be realistic. The taxed diesel quantities provided by BIR were far too high to pass such a data check, so we assumed that much of the taxed diesel was used in off-road applications, including boats and generators. The TWG therefore assumed that the volume of on-road diesel was equivalent to 32% of the volume of the on-road gasoline—the same ratio found on the East Coast and Gulf Coast of the mainland United States (Energy Information Agency [EIA] Petroleum Navigator 2011). This assumption then passed a data check by allowing a realistic diesel-fuel to heavy-duty-vehicle ratio.

The on-road gasoline and diesel use quantities discussed above are shown for 2001-2010 in Figure 1 with TWG projections for 2011-2025. This projection reflects the annual average compounded growth rate of 3.2% seen in gasoline use during the 2001-2010 time period and pegs diesel growth to that projected gasoline growth.

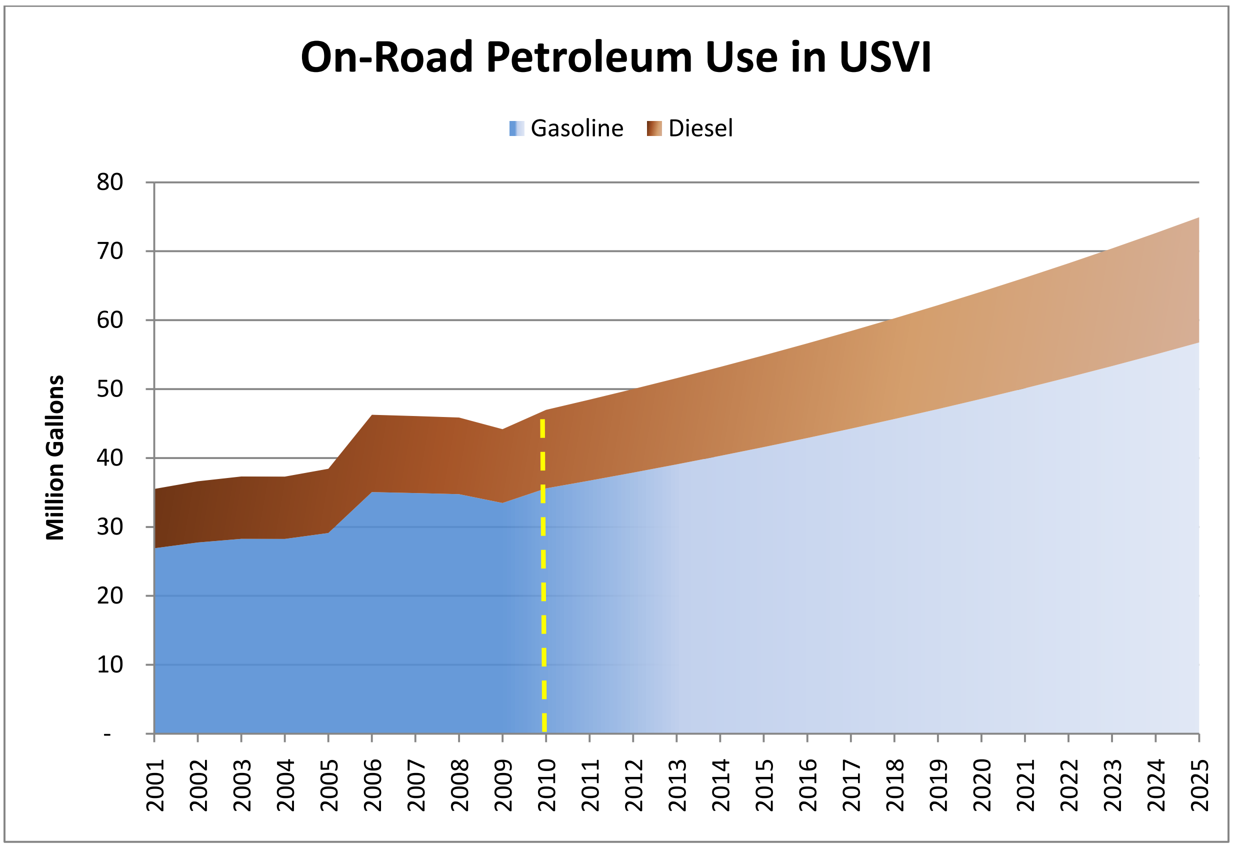

Figure 1. On-road petroleum use in USVI. 2001-2010 reflects data tracked by the BIR. 2011-2025 use is projected by the TWG.

USVI Road Transportation Vital Statistics

In order to chart the way toward the petroleum use reduction goal, the TWG needed to know some key information about the vehicles on USVI roads. These vital statistics, previously dispersed among multiple agencies and reports, are compiled for the first time in this report.

Much vital data is lacking, so the TWG made estimates described in this chapter, and we outline recommendations for future data collection in the next chapter. The vital data, along with the data used for estimates, is listed in Table 1; the description of data sources and estimation methodologies follow.

Table 1. USVI Vital Road Transportation Statistics

Track	Metric	Number	Unit	Source/Verification
A	Walk to work	2.5%	of residents	USVI Household Travel Survey
B	Bus to work	2.6%	of residents	USVI Household Travel Survey
C	Safari taxi to work	2.7%	of residents	USVI Household Travel Survey
D	Personal vehicle to work	78.7%	of residents	USVI Household Travel Survey
E	Carpool passenger to work	8.4%	of residents	USVI Household Travel Survey
F	Average party size of short-term tourists	3	people	USVI Visitor Survey
G	Average vehicle miles traveled (VMT) of light-duty vehicle (LDV) in USVI	7,000	miles/yr	USVI Department of Public Works (Smalls 2010)
H	Average VMT of heavy-duty vehicle (HDV) in USVI	15,463	miles/yr	calculated G*T
I	HDVs in USVI	2,530	vehicles	Calculated V*W
J	Motorcycles in USVI	593	vehicles	USVI BMV 2010
K	Cars in USVI	27,557	vehicles	calculated X*Y
L	Light trucks in USVI	43,834	vehicles	calculated X*Z
M	Annual on-road gasoline use	35,594,525	gallons	USVI Bureau of Internal Revenue 2009, assuming all exempt gasoline is used off-road and all taxed gasoline used by LDVs
N	Annual diesel use	11,390,248	gallons	calculated M*AA
O	LDV fuel economy (assumed to be city drive cycle)	14.0	mpg	calculated (G*X)/M, assuming all gas used in LDVs. U.S. avg is 20.4 mpg
P	HDV fuel economy	3.4	mpg	calculated (H*I)/N, assuming all diesel used in HDVs. U.S. avg is 5.9 mpg
Q	Annual scrappage rate	5.7%	of vehicles	Calculated from AB
R	Average VMT of LDV in U.S.	11,432	miles/yr	Transportation Energy Data Book 29 2010
S	Average VMT of HDV in U.S.	25,253	miles/yr	Transportation Energy Data Book 29 2010
T	Ratio of HDV VMT to LDV VMT in U.S.	2.2		calculated S/R
U	Percent of all traffic that is HDV	7.5%	on road	Traffic Data Collection Technical Report 2009
V	HDVs in USVI	3.4%	of all vehicles	calculated U/T
W	Total vehicles registered in USVI	74,513	vehicles	USVI BMV 2010
X	LDVs in USVI	71,390	vehicles	calculated W-I-J
Y	Cars in U.S.	38.6%	of LDVs	USVI Household Travel Survey
Z	Light trucks in U.S.	61.4%	of LDVs	USVI Household Travel Survey
AA	Diesel to gasoline ratio for U.S. East and Gulf regions	32%	diesel to gasoline	EIA Petroleum Navigator
AB	Average vehicle age	17.5	years	USVI Household Travel Survey and HI Clean Energy Initiative comparison.

Three surveys provided many of the statistics and calculation inputs shown in Table 1. The USVI Household Travel Survey (NuStats 2009a) documents the regional demographics and 24-hour travel behavior of 752 USVI households. The Traffic Data Collection Report (PB Americas, 2010) was conducted to support the Master Plan. To collect this data, PB Americas performed 48-hour traffic counts in 113 locations. The USVI Visitors Survey (NuStats 2009b) tracked the travel patterns of 560 tourists on the three largest USVI islands. A survey of taxi drivers is being conducted by the University of the Virgin Islands (UVI) in conjunction with the TWG that we expect will provide a better picture of the types of taxis, numbers of passengers, and distances driven by taxis in the USVI.

USVI government agencies also provided key data and calculation inputs for Table 1. These include the aforementioned gasoline and diesel quantities collected by the BIR. The annual VMT (statistic G) has been ascertained and adjusted by the DPW through years of fieldwork and a variety of projects. This was cited by DPW Commissioner Darryl Smalls during the June 15, 2011, EDIN meeting. The number of vehicles is tracked by the Bureau of Motor Vehicles (BMV) through its annual registration process. The agency requests information that could enhance the USVI vital statistics (such as annual VMT and specific vehicle type) but it does not aggregate this data into a central database, so it is not available for use.

Many of the vital statistics for the USVI were calculated by applying a known ratio in the United States to a known number in the USVI. The ratio of ultra-low sulfur diesel to gasoline, already mentioned in the previous chapter, allowed us to estimate the on-road diesel consumed in the USVI based on the known consumption of gasoline in the USVI. The ratio of HDVs to LDVs in the United States allowed us to estimate the number of HDVs in the USVI based on the known number of LDVs. The ratio of HDV annual VMT to that of LDVs allowed us to calculate the annual miles a HDV travels.

Fuel economy statistics are particularly important for the remainder of the report. The fuel economy of 14 mpg for LDVs is realistic, since these vehicles are mostly light trucks or SUVs that are primarily driving a city (stop-and-go) drive cycle. It is assumed that USVI roads fit the U.S. Environmental Protection Agency (EPA) city drive cycle because there are no expressways, and speed limits are 40 mph or slower for all roads except a single 8-mile stretch of road in St. Croix. A vehicle with a fuel economy of 14 mpg in the city is expected to have an EPA sticker (combined) fuel economy of 16.3 mpg, based on the way EPA accounts for the city/highway drive cycle differences. USVI fuel economy of light trucks and SUVs is lower than the U.S. fuel economy of those vehicles (18.1mpg), because the USVI vehicles are older (17.5 years versus 13.5 years, on average [Davis, et al. 2010]), because of the hilly terrain of St. Thomas, and because the U.S. Corporate Average Fuel Economy (CAFE) standards do not apply to the USVI until model year 2012.

The average vehicle age (and therefore the annual scrappage rate) is important to determine so that the USVI knows how quickly a new set of vehicles can penetrate the USVI fleet. These figures come from the fact that 50% of the fleet is less than nine years old, according to the USVI Household Transportation Survey. This is the same as in the state of Hawaii, which has the vehicle sales data required to calculate that the average vehicle age there is 17.5 years. This average vehicle age results in a scrappage rate of 5.7% per year.

Improved data collection and consolidation would be of significant help to the USVI's efforts to reduce petroleum consumption. Foremost, the BMV could start collecting and analyzing the VMT and vehicle model information that is already reported to them (including VMT, vehicle type, fuel type, garage ZIP code, and data for HDVs) and maintain it in a database. Secondly, the BIR could improve its differentiation of gasoline and diesel fuel used in on-road and off-road applications. Finally, both the BIR and BMV should report their annual statistics to the Virgin Islands Energy Office (VIEO) as soon as they have them, so that VIEO can use them to inform transportation energy decisions.

USVI Transportation Characteristics

The vital transportation statistics and on-the-ground knowledge combine to provide a narrative of the USVI transportation characteristics. These characteristics are influential to the Petroleum Reduction Plan and help provide a framework of good leverage points and limitations. Some of the key characteristics of transportation in the USVI are as follows.

Space limitations

The USVI (especially St. Thomas and St. John) has limited space for sidewalks, bike paths, high occupancy vehicle (HOV) lanes, rail lines, and other infrastructure that enables low-petroleum-intensity transportation. However, these same space limitations also make it difficult to widen roads and increase parking. This plays into a number of strategies to encourage people to take alternative forms of transportation and down-size their vehicles that will be proposed later in this report.

Large, inefficient vehicles

Despite the space limitations in the USVI, the proportion of trucks and SUVs in the USVI light-duty fleet is much larger than that of the mainland United States. The fleet is also four years older, on average. As a result of these two factors, these vehicles are not as efficient as their counterparts in the United States and much less efficient than their counterparts in other countries. The taxi fleet is particularly noteworthy, as it consists mostly of large vans, even though sedans would suffice for a large portion of their trips.

Drive cycle that slows or stops frequently

The USVI has no expressways, and the majority of roadways are smaller roads with frequent traffic signals, stop signs, speed bumps, and other interruptions. Furthermore, the narrow roads and lack of pull-offs or left-hand turn lanes lead to traffic congestion that forces vehicles to drive in stop-and-go patterns. The relative disrepair of the roads adds many stops and starts to a typical trip.

Shortage of sidewalks and paths

Space limitations notwithstanding, there is a major shortage of sidewalks and paths. Due to the narrow roads and large vehicles, it is difficult to safely walk or bike most places in the USVI.

Low utilization of public transit

There is no rail transportation in the USVI, and only 2.6% of USVI commuters take the bus. This is lower than the U.S. average for commuting trips taken by public transit of 3.7% (Santos, et al., 2011), despite the fact that the USVI has a population density 10 times greater than the U.S. average (U.S. Census Bureau, 2011).

Dollar Rides

The USVI has a unique transit system called Dollar Rides, which 2.5% of people take to work. Dollar Rides are given by privately owned vehicles (called safari taxis on St. Thomas or just taxi vans on St. Croix) that pick up passengers at predetermined locations on the side of the road. These rides circulate on an irregular schedule that is interrupted when a cruise ship comes to port and the taxis cater to cruise passengers. Most safari taxis are built on the chassis of a medium-duty truck and have open-air seating. The advantages of this configuration are that each safari taxi holds up to 25 passengers, and boarding is made easy by two exits for each row of seating. Concerns about passenger safety and vehicle width on narrow roads have led to a moratorium on new safari taxis, so the fleet is aging. There is no formal plan for their replacement, and it is likely that they will be replaced by 15 passenger vans similar to the ones used on St. Croix.

Figure 2. A safari taxi on St. Thomas. Safari taxis are commonly used as Dollar Rides.
Source: Adam Warren, NREL

Water taxis and ferries

There are five ferry companies in the USVI that operate ferries owned by the USVI Public Services Commission. Currently, all routes are between islands, even though numerous intra-island routes could be faster and more efficient than buses or private vehicles.

Interisland differences

St. Thomas and St. John are very hilly with elevation spans from 0 to over 1,500 ft above sea level. Vehicles require more fuel to power up these hills, and the hills limit the space available for roads, parking lots, paths, and other transportation infrastructure. St. Croix is much more flat, but its roads tend to be in greater disrepair than those on St. Thomas. This disrepair hampers traffic flow, forcing people to drive less efficiently, and leads many people to purchase vehicles with a high ground clearance.

Charting Goal Achievement

The goal of reducing petroleum use 60% by 2025 is very ambitious. As with any ambitious goal, this one must be broken down into achievable steps. The TWG did so through a "wedge analysis." The wedge analysis takes the projected fuel use shown in Figure 1 and subtracts fuel use by "wedges," or strategy groups, until the goal is reached. Wedges are shaped as such, because the fuel displacement resulting from each strategy grows as projects progress. This analysis tool allows the user to assess the potential of various scenarios to reach the goal and then formulate a plan of action. The TWG settled on a scenario that is aggressive but achievable on all fronts. The wedge analysis representing this scenario is shown in Figure 3, followed by a description of each wedge. This chapter lays out the general framework for petroleum use reduction that will be translated into specific projects in the following chapter. To avoid overlapping claims, petroleum use reduction is accounted for from the bottom of Figure 3 to the top.

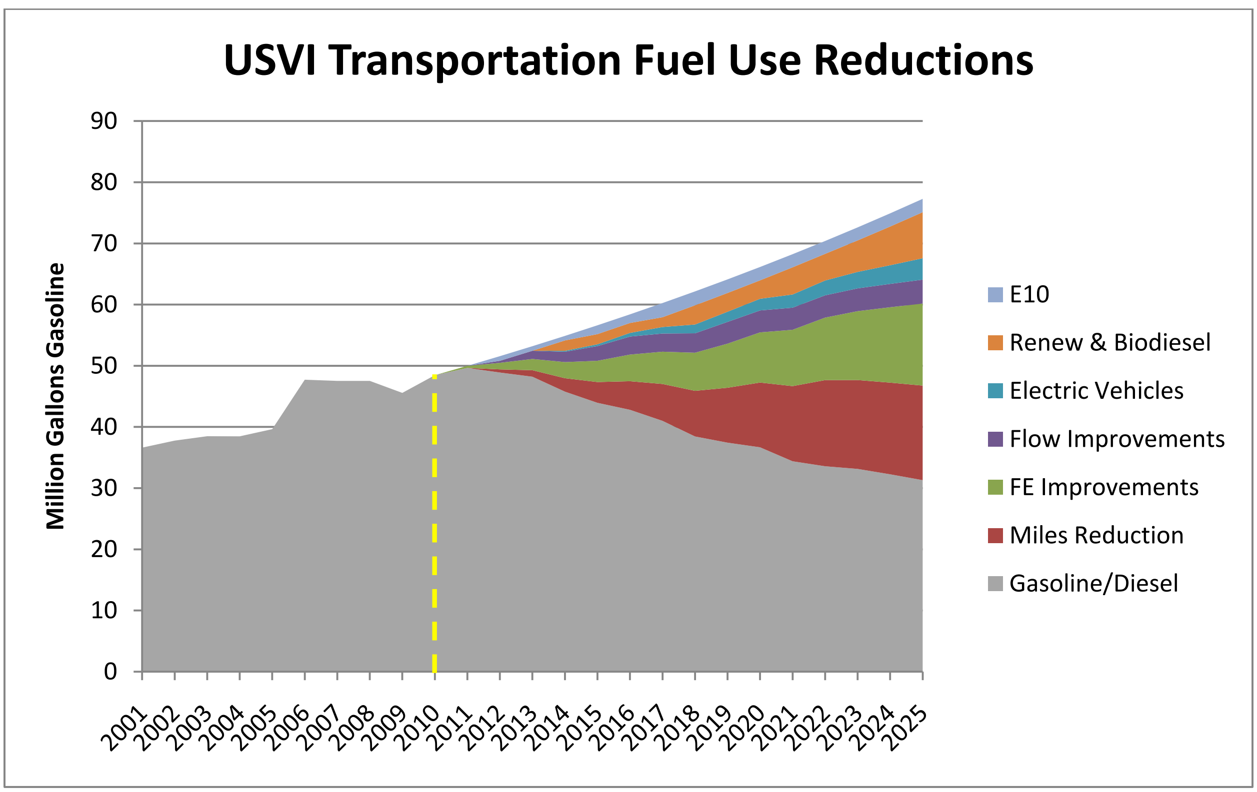

Figure 3. Reduction wedges to meet the 60% petroleum use reduction goal by 2025

Vehicle Miles-Traveled (VMT) Reduction

This wedge represents petroleum use reduced through reductions in the number of miles vehicles drive. Common ways to avoid vehicle miles are by "active transit" (bicycling, walking, or wheelchairs) or telecommuting to work or meetings. Two other forms of vehicle-miles reductions are the use of ride-share and mass transit, because multiple people can be transported by fewer vehicles, leaving more vehicles off the road. Fleets can reduce VMT in HDVs through fleet management systems such as the UPS-developed RoadnetTM. There are many ways the government can promote these VMT reductions, and a few projects will be outlined in the next chapter.

We propose a goal to reduce overall USVI VMT 20% by 2025. This means that one in five trips taken in a motorized vehicle in 2010 would be taken by carpool, bike, foot, or bus, or replaced by telecommuting by 2025. We deem this goal to be feasible for four reasons:

- USVI residents are well positioned to take advantage of the numerous co-benefits that VMT reduction projects offer. These include traveler cost savings, reduced traffic, reduced road maintenance costs, increased safety, and health benefits for active transport. Reducing traffic congestion is a particularly strong incentive for the USVI, where long delays result from too many vehicles crammed onto small roads and inadequate parking lots. Articulating these benefits to USVI residents is critical to progress toward the goal of reducing VMT by 20%.
- As noted above, USVI commuters use public transit at a lower rate than mainland U.S. commuters do (Santos, et al., 2011). In general, locations with mild climate and condensed geography such as the USVI tend to have higher ridership rates. This indicates great potential for increased use of public transit.
- The hospitable weather and condensed geography of the USVI should also encourage more active transit than in the mainland United States. However, the number of people who walk to work is actually less than on the mainland—2.5% as opposed to 3.0% (Santos, et al., 2011). This indicates a large potential increase in active transit once key hurdles are addressed.
- The fact that the USVI consists of four separate islands is an added incentive for teleworking. The first wave of teleworkers, and their employers, will likely see significant financial benefit from fewer interisland flights. This could help accelerate the adoption of teleworking overall.

The VMT reduction wedge is the largest contributor towards the 2025 goal and is expected to provide one-third of the overall petroleum use reduction needed to achieve it.

Fuel Economy Improvements

This wedge represents petroleum use avoided through the use of more efficient vehicles. We propose that the average fuel economy of LDVs purchased in USVI to be no lower than 4 mpg below what U.S. CAFE standards require. This will be a substantial improvement in overall fuel economy, because in 2010, the average EPA fuel economy for LDVs in the USVI was 6.8 mpg below the CAFE requirement for that year. Keep in mind that the EPA fuel economy rating assumes that the vehicle is driven 55% on highways and 45% in cities. USVI driving patterns are assumed to be similar to the U.S. city drive cycle, and adjustments to the fuel economy have been made accordingly in our calculations.

Table 2. LDV CAFE Standards and USVI Target MPG for New Vehicles

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CAFE mpg combined*	23.5	24.1	30.1	31.1	32.2	33.8	35.5	37.6	39.7	41.8	43.9	46.0	48.1	50.2	52.4	54.5
USVI target mpg combined	19.5	20.1	26.1	27.1	28.2	29.8	31.5	33.6	35.7	37.8	39.9	42.0	44.1	46.2	48.4	50.5
USVI Goal mpg city**	16.4	16.9	21.9	22.7	23.6	25.0	26.4	28.2	29.9	31.7	33.5	35.2	37.0	38.7	40.6	42.3

*These estimates assume 55% highway, 45% city drive cycle. They also assume 50/50 breakdown of cars and light trucks.

**The USVI drive cycle is estimated to be close to the EPA city drive cycle, as discussed in the traffic flow section. Therefore, vehicles at the target mpg (in row two) will achieve the fuel economy in row three.

The goal of 4 mpg below CAFE requirements is realistic because the U.S. CAFE requirements will be applicable in the USVI beginning in model year 2012. This will provide manufacturers with the incentive to sell more efficient vehicles there. The reason for this change is that 2012 is the first year that CAFE will be harmonized with the Clean Air Act, which applies to the USVI (EPA and NHTSA, 2010).

Fuel economy improvement projects will provide 22% of the needed petroleum use reduction in order to meet the 2025 goal. Therefore, this category is the second largest contributor to the goal.

Traffic-Flow Improvements

This wedge depicts petroleum saved by reducing the number of times that vehicles need to stop or substantially slow down, then accelerate back up to traveling speed. Acceleration requires much more energy than traveling at a consistent speed. The potential benefit from traffic-flow improvements can be seen by comparing the EPA's city and highway drive cycles. The highway drive cycle has many fewer acceleration events than the city drive cycle (as shown in Figure 4) and has a higher average speed. The average vehicle in the FuelEconomy.gov database, maintained by EPA and DOE, is 35% more efficient when driving the highway drive cycle than in the city drive cycle.

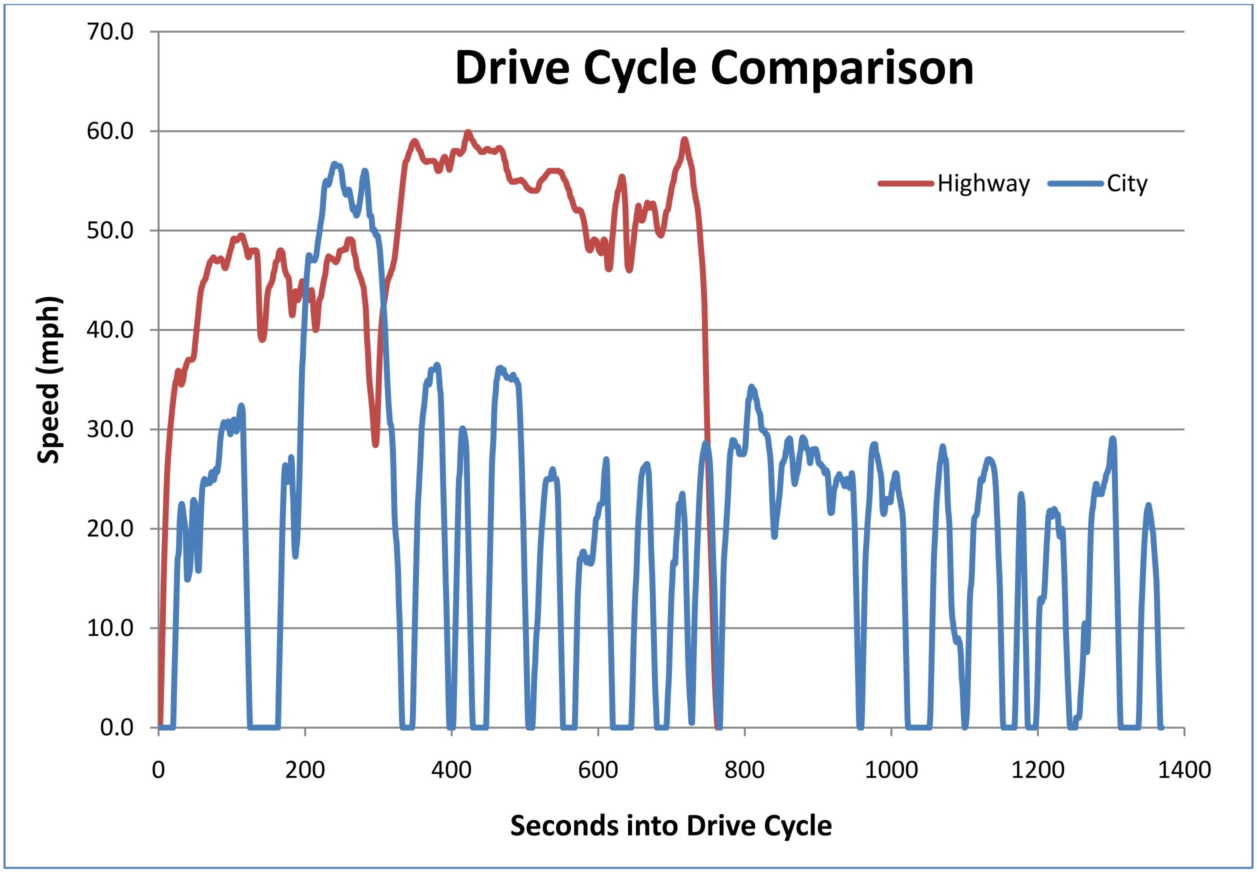

Figure 4. EPA city and highway drive cycles. Source: EPA 2011

The USVI has not derived its own drive cycle yet, but it is assumed to be similar to the U.S. city drive cycle because the USVI has no expressways, and the speed limit is 35 mph for all but two roads. This assumption is in agreement with the fact that the average LDV in the USVI achieves a fuel economy of 14 mpg.

To achieve the fuel use reductions depicted in the Flow Improvements wedge, we set a goal to transform 30% of the city drive cycle miles driven in the USVI to the highway drive cycle. Another way to visualize this goal is to remove enough stops in the city drive cycle in Figure 4 so that it becomes 20% more like the highway drive cycle in terms of number of stops and average speed. Ways of making this goal more tangible and tracking it will be discussed in the project implementation chapter.

Achieving the goal of 30% conversion toward the highway drive cycle is deemed quite achievable, because the current driving conditions in the USVI require so many stops, and there are many ways to reduce these stops at a minimal cost. Some of these easily-avoidable or easily-reduced stops include:

- Stops at right-hand turns. Remember that since the USVI drives on the left side of the road, right-hand turns are the cross-traffic turns. Many intersections in the USVI do not yet have right-hand turn lanes, so numerous vehicles need to stop while the preceding vehicle waits for an opening to make a right-hand turn. These stops are easily avoided by adding left-hand turn lanes.

- Stops at pick-up locations. Most buses, taxis, and Dollar Rides stop in the middle of the road to pick up or drop off passengers, forcing all vehicles behind them to stop. Furthermore, many of the vehicles have right-side exits, despite the fact that they are driving on the left-hand side of the road, which forces people to exit into the road. Adding vehicle pull-offs and passenger-loading spaces could obviate many of the stops these problems cause.
- Stops at traffic accidents. The USVI has not mandated traffic accidents to be cleared from the road. Most accidents cause a long line of vehicles to stop behind them while they wait for police to document the accident scene. The USVI could follow the lead of many states and implement a policy that requires accidents to be removed from the road even before the police arrive.
- Stops at road disrepair. The roads of St. Croix and St. John suffer from many washouts and potholes that cause traffic to slow down or stop. This disrepair can be remedied in two ways: (1) Ensuring that funds collected from the fuel excise tax, which is intended for road maintenance, is not diverted to the USVI General Fund, and (2) DPW development of a system to detect, assess, and repair washouts and potholes. Technology such as SeeClickFix.com can provide the framework for such a system.
- Stops at traffic signals. Many of the traffic signals in the USVI are on simple timers that do not take daily traffic patterns into account. Others use weight-triggered sensors that break easily. Both scenarios lead to many unnecessary stops, and a few of these signals back traffic up for hundreds of yards. The USVI has installed a camera sensor that has solved this problem for the intersection of Routes 69 and 70. Traffic flows would benefit significantly from camera sensors at additional intersections and adoption of a traffic signal coordination system.
- Stop-and-go driving due to congestion. The USVI's overly crowded roads lend themselves to inefficient stop-and-go traffic. Most of the VMT reduction projects will improve traffic flow by reducing congestion and coordinating vehicular and non-vehicular traffic.

Once the USVI meets a goal of converting 30% of its vehicle miles toward a more highway-like drive cycle, it will achieve 8% of the fuel savings toward the overall 2025 goal. These traffic-flow projects are likely to be very popular and will have many co-benefits of reduced traffic time and frustration for residents and visitors. As a caveat, the rebound effect tells us that this reduced traffic time will encourage people to drive more, which will require extra effort in the VMT reduction projects.

Electric Vehicles (EVs)

This wedge consists of petroleum displaced by the use of vehicles that can be plugged into the electrical grid, regardless of whether they also have petroleum-fueled engines (as in the case of the Chevy Volt). To achieve the fuel savings depicted in the wedge, we set a goal for 15% of the vehicles on the road in the USVI in 2025 to be electrically powered.

Electric vehicles can save a substantial amount of petroleum in the USVI, despite the fact that the islands' electricity is produced by oil. This is largely because the electric drive train is three times more efficient than the average internal combustion engine (CARB, 2010). In 2010, the average generation efficiency in the USVI was 24% (meaning 24 Btus of electricity out for every 100 Btus of petroleum in). At this rate, an electric vehicle drives more miles per barrel of oil than does a conventional car that achieves 30 mpg, as shown in Figure 5. It is important to note that the efficiency of electrical power generation varies substantially among the islands. The efficiency in St. Croix is 31%, compared to 21% in St. Thomas. As a result, petroleum savings per EV will be higher in St. Croix than in St. Thomas, and EV deployment efforts should focus initially on St. Croix. Later EV deployment could be focused on either island, since there are plans for substantial electricity-generation efficiency improvements on both (Lantz et. al., 2011).

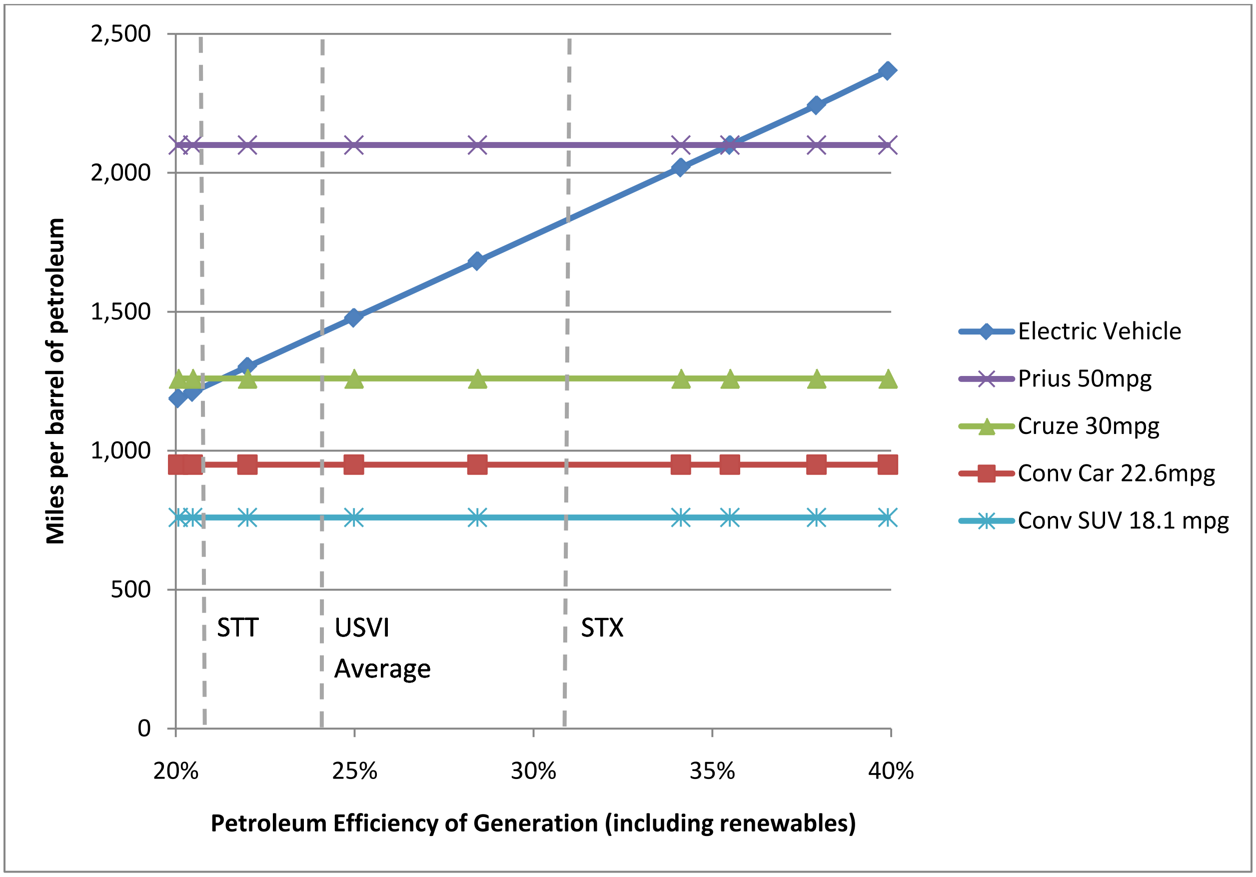

Figure 5. Dependence of EVs on electricity generation efficiency

The goal of 15% penetration of EVs is achievable for the following reasons.

- Production of EVs is now ramping up. Nissan and General Motors are mass-producing the Leaf and Volt (respectively), and their combined production has reached about 1,500 EVs per month. Furthermore, 17 companies are scheduled to manufacture model year

2012 EVs, including minivans and delivery trucks[2]. There are also many companies (including two in the USVI) that convert conventional vehicle platforms to EVs.

- Rising production numbers are bringing about economies of scale that should drop the prices of EVs and their components. For example, battery costs (which are the primary incremental cost of EVs) are already dropping quickly and are predicted to drop 25% by 2015, 36% by 2020, and 43% by 2030 (National Academy of Sciences, 2010). These cost reductions do not consider potential changes from major technology breakthroughs like new battery chemistry.
- Islands are more conducive to EV drive cycles. One of the major hurdles to EV acceptance is "range anxiety"—the fear that a driver will not be able to travel as far on a single charge as he or she wishes. USVI drivers, however, already have their range limited by insular geography. This preempts EV-related range anxiety and puts the USVI at an advantage over other potential EV markets.
- Electric motors are advantageous in hilly environments like St. Thomas and St. John. Regenerative braking can be better used on a hilly environment than a flat one. Conventional vehicles, on the other hand, lose more energy to braking in a hilly environment. Also, the low-end torque of an EV is an advantage in a hilly environment since the EV can start slowly on a steep incline instead of having to rev up to high RPMs to reach a required level of torque.
- The USVI has niche markets that are good potential early EV adopters. These include tourists and second-home owners, whose income levels and ages tend to be higher than average. EVs are expected to appeal to customers with similar demographics as the first purchasers of HEVs, which includes higher income and age (hybridcars.com 2006). Furthermore, many tourists rent vehicles when they come to the USVI. Tourists are likely to be willing to pay a premium to rent a novel cars like EVs, and rental car companies are likely to offer EVs if they are able to charge a premium.
- Neighborhood electric vehicles (NEVs) are another gateway to full-size EVs, and the USVI is an ideal location for NEVs due to its small roads and low speed limits. NEVs are limited to non-highway roads and speeds of 25 mph or less.

Despite the significant advantages the USVI has in pursuing EV penetration, it also has a number of unique challenges to overcome. One of these is higher-than-average electricity prices, which at 35 cents per kWh in 2010, were 3.5 times greater than the U.S. residential average of 10 cents per kWh. However, NREL financial modeling has found that the price of electricity (within a realistic range) is not a major factor on the payback period of an EV (O'Keefe, 2011).

Another disadvantage is that the USVI doesn't have good access to qualified EV mechanics. This discourages people from purchasing EVs, because they fear a mechanical problem could render a vehicle useless. While the USVI EV market is small, groups of fleets and dealers may have to pool their resources to support an on-island EV mechanic.

[2] Compiled from lists at http://www.hybridcars.com/electric-car, http://www.smithelectric.com/, and http://www.brightautomotive.com/

It should be noted that our analysis assumes the same petroleum savings from pure EVs as it does from EVs with range-extending petroleum engines. We make this assumption because the shorter driving distances in the USVI are generally within the all-electric range of vehicles like the Volt.

Renewable Diesel and Biodiesel

This wedge consists of petroleum displaced by the use of biodiesel and renewable diesel, which are described in the following paragraphs.

Biodiesel is a mature technology that is most commonly made from soybeans, rapeseed, palm oil, and waste grease. It can be used in all diesel vehicles at a blend of 5%, in fleet-based HDVs at 20%, and in fleets of slightly-altered HDVs (in the USVI's warm climate) at levels near 100%.

Renewable diesel (also called green diesel) can be made from any type of natural oil or fat. However, the main advantage that renewable diesel has over biodiesel is that it meets the ASTM specifications for conventional diesel, so it can be used in any diesel vehicle at any blend level. Renewable diesel has progressed from the research and development phase and is now considered commercialized. Neste Oil, Dynamic Fuels, and ConocoPhillips now have five plants in operation producing nearly 420 million gallons per year. A fifth plant is under construction and is expected to bring the total to over 660 million gallons per year (Green Car Congress, 2011; Biofuels Journal, 2010; ConocoPhillips 2011). Renewable diesel requires a hydrocracker (equipment used in a refinery) to produce, so the USVI is uniquely equipped to import the renewable oil or feedstock to the Renaissance industrial property, process the feedstock (if needed), hydrocrack the oil into renewable diesel at the HOVENSA refinery, and blend it with the conventional diesel fuel at the same refinery.

The Renewable and Biodiesel wedge calls for 55% of the remaining (after the previously mentioned wedges) diesel fuel use in the USVI to be replaced by renewable diesel or biodiesel. This could be accomplished in the following steps:

1. Blend 5% biodiesel (B5) into all diesel used in the USVI. At this level, the biodiesel essentially performs as a lubricity additive and therefore meets the ASTM standard for conventional diesel and all vehicle manufacturers' warranty requirements. Minnesota and Oregon have mandated that all diesel be B5 and have not reported any issues.
2. Use 20% biodiesel (B20) in all HDVs in government, Water and Power Authority (WAPA), school bus, and corporate partner fleets. B20 doesn't require alterations to HDVs so is suitable for all fleet-based refueling. The reason for not going above B20 is because ASTM doesn't have a standard for blends greater than B20, and therefore, many HDV warranties are void at blends above B20.
3. Blend increasing quantities of renewable diesel into all diesel at the HOVENSA refinery until 55% of all diesel fuel on the islands is renewable diesel or biodiesel. Renewable diesel is currently more expensive than biodiesel and petroleum diesel, but its production costs are dropping as the industry develops (as described in the wedge portion of this report). Therefore, this phase of the plan should be implemented after the biodiesel phases.

This plan of action and overall penetration of 55% is largely dependent upon access to suitable feedstock. Some promising sources of feedstock are as follows:

- The University of Virgin Islands conducted a study suggesting that waste grease is a substantial potential feedstock in the USVI (Phipps, 2010). Tourist hotels and restaurants are a promising source of waste grease, and they currently pay $0.50/gallon to dispose of it. Cruise ships also produce a great deal of waste grease that is often difficult to dispose of properly. St. Thomas is a major port for cruise ships and would be a natural place to offload waste grease.
- The three largest vegetable oil and oilseed exporters in the world (which export more than the rest of the world combined) are relatively close to the USVI (Figure 6). Therefore, shipping from these countries to the USVI should be relatively inexpensive, and USVI biodiesel should be at an advantage over most other countries.
- Algae oil can be turned into either biodiesel or renewable diesel. While the TWG does not expect algae biofuel to be a contributor to the 2025 goal, it is worth tracking the rapid progress of the industry. At some point before 2025, it might become more cost effective to grow algae and harvest its oil than to import vegetable oil from neighboring countries.

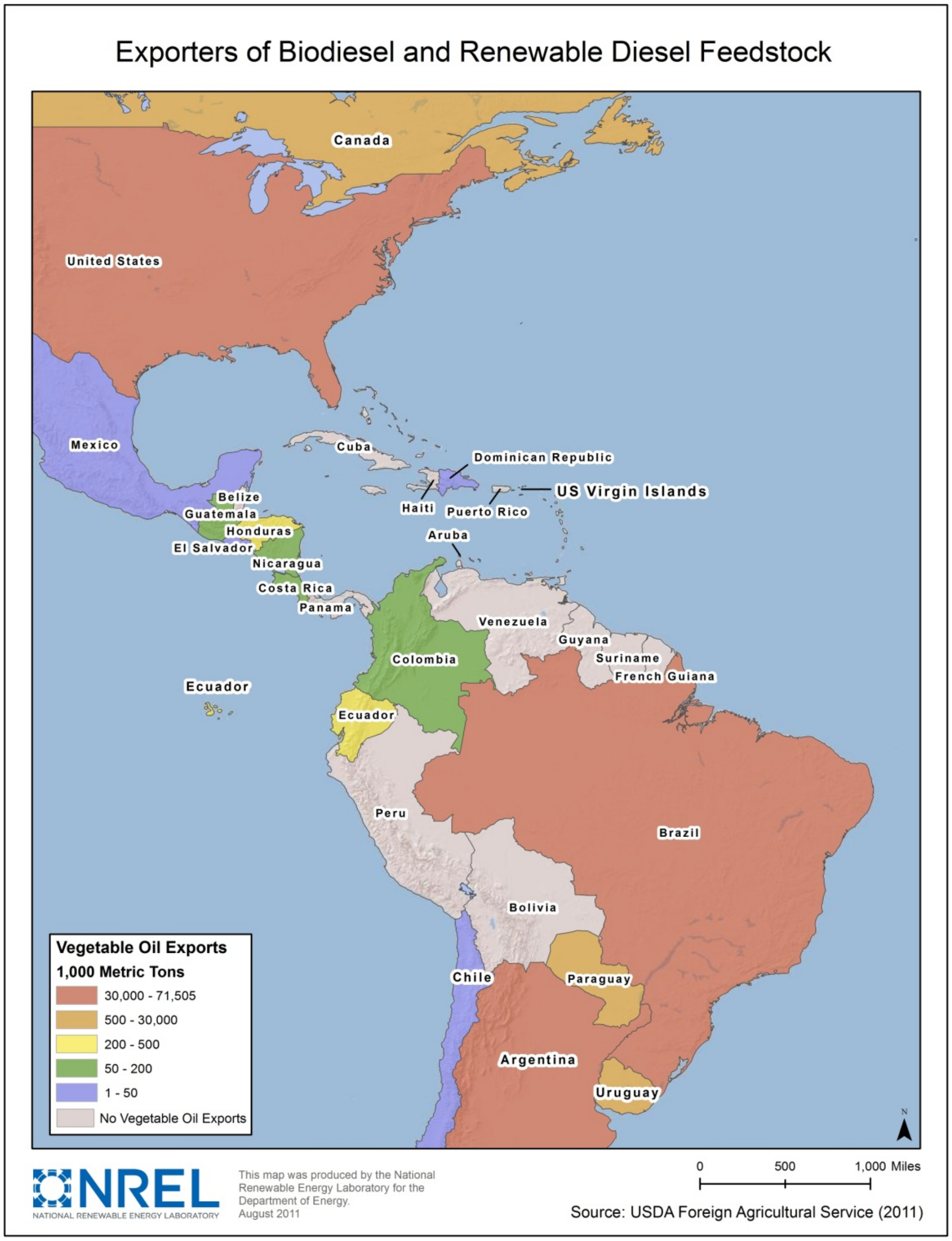

Figure 6. Exporters of biodiesel and renewable diesel feedstock.

10% Ethanol (E10)

This wedge consists of petroleum displaced by blending ethanol into gasoline at a level of 10% by volume. The vast majority of gasoline sold in the United States is E10 (90% gasoline, 10% ethanol), and that is how the United States is meeting its renewable fuel standard (RFS). To fulfill this wedge, 75% of all the taxed gasoline in the USVI in 2025 must be E10.

This goal is achievable for the following reasons:

- All but seven U.S. states have replaced 75% or more of their gasoline with E10 (Renewable Fuels Association, 2010). Furthermore, 34 states have replaced 90% or more of their gasoline with E10. It is highly likely that whatever hurdles these states had to overcome can be overcome by the USVI also. An incentive similar to the U.S. RFS could encourage petroleum marketers to blend and sell E10 in the USVI.
- The USVI has unique access to Brazilian ethanol. Brazil is the largest ethanol exporter in the world (Reuters 2011 and EIA 2010). The United States has a 54 cent per gallon tariff on Brazilian ethanol in order to keep it from undercutting U.S. markets. However, the USVI is exempt from this tariff, as part of the Caribbean Basin Initiative. This should reduce the price of a gallon of E10 by 5.4 cents. The second barrier to Brazilian ethanol is that it contains up to 5% water. Fortunately, St. Croix has an ethanol dehydration facility called GeoNet that is currently mothballed but can be brought back into operation (Baker, 2011). The USVI E10 market, at 4 million gallons per year, is not enough to interest GeoNet in building the additional infrastructure required to store a shipload of hydrous ethanol and pipe ethanol to HOVENSA (which is very close). However, if another entity, such as HOVENSA, could build the infrastructure, GeoNet would be interested in the USVI E10 market. We assume that if the USVI had a renewable fuel standard similar to that of the United States, building such infrastructure would be the most economical way to achieve it.

Despite the factors that make 75% E10 achievable in the USVI, there are hurdles. There have been a number of claims that E10 is ill-suited for boats, and these claims have fostered some resistance from the boating industry (Yamaha, 2009). Most problems stem from the fact that alcohol attracts water, which can ruin the fuel without precautions such as use of a water-separating fuel filter (EPA, 1995). Beyond precautions taken in the boat, it is assumed that gasoline stations at marinas and other areas with high rates of marine customers will use straight gasoline. This is the main reason why the penetration goal for E10 is 75% rather than 100%.

Wedge Summary, Interaction, and Timing

There are numerous tradeoffs and interactions among the petroleum use reduction wedges, and we created Table 3 to clarify these distinctions and avoid double counting.

Table 3. Wedge Summary

Allocation Priority	Wedge	2025 Goal	% of total reduction	Fuel reduced
1	Miles Reduction	Motorized vehicles travel 20% less	34%	Both
2	Fuel Economy Improvements	New LDV labels average 4mpg below CAFE goal for given year	29%	Gasoline
3	Traffic Flow Improvements	20% of VMT will be converted to highway drive cycle	8%	Both
4	Electric Vehicles	15% of the vehicles in the USVI will be electrically powered	8%	Both
5	Renewable and Biodiesel	55% of all diesel sold to road vehicles is renewable or biodiesel	16%	Diesel
5	10% Ethanol	75% of all gasoline sold to road vehicles is E10	5%	Gasoline

Allocation Priority

The Allocation Priority helps to reduce double counting by clarifying the order in which the petroleum reductions are subtracted from the total fuel use. The VMT reductions are taken first, because the resulting number of miles affects the amount of petroleum available to be reduced by any of the other wedges. There are two feedback loops that are not taken into account from VMT reduction projects. One is that VMT reduction reduces congestion and improves traffic flow, so should automatically increase that wedge to some degree. The other is a possible negative feedback from VMT to fuel economy, because the vehicles taken off the road might be smaller ones, and vehicles added to the roads will likely be buses.

Fuel economy improvements are addressed before traffic flow improvements, because the magnitude of the latter is completely dependent on the beginning efficiency of the vehicles traveling in traffic. Fuel economy improvements are accounted for separately from EVs, which is a deviation from how CAFE is calculated. This deviation is deemed worthwhile in order to simplify the two goals, differentiate between them, and make them both more easily accountable. Traffic flow improvements are taken before the three alternative fuels, because they help determine the amount of energy used to drive a given distance on USVI roads. Displacement from EVs is then subtracted from the amount of petroleum used. Finally, the Renewable and Biodiesel wedge is applied to all remaining diesel fuel, and the E10 goal is applied to all remaining gasoline.

To further ensure no double counting, Table 3 tracks the wedges according to the petroleum they displace, whether in the form of gasoline or diesel. We assumed gasoline to be used largely by LDVs, and diesel by HDVs. The Miles Reduction wedge applies to both fuels, because there are VMT reduction programs aimed at both fleet-based HDVs and at individually owned LDVs. However, it does not account for the potential increase in bus use due to increased mass transit, so in reality the non-bus HDVs will probably need to reduce their VMT by more than 20% to accommodate for more buses. The fuel economy goal is assumed to apply only to gasoline-powered LDVs, because there is greater potential for fuel economy improvements in this sector. This is because the fleet-based HDVs already take life-cycle cost into account and therefore have made much progress to maximize their fuel economy while the individuals who purchase LDVs (or any other energy-using device) tend to prioritize upfront cost over lifetime fuel savings (Hausman, 1979) so they have not maximized their fuel economy.

Traffic flow improvements affect both HDVs and LDVs to the same degree. The same percentage of LDVs and HDVs are assumed to be replaced by EVs. This assumption balances the recent growth in LDV mass production with the numerous fleet HDV conversions and the substantial argument that HDV EVs have a sound business case (Ramsay, 2010). Biodiesel and renewable diesel displace only diesel fuel, and E10 displaces only gasoline.

The percent of total reduction reflects the magnitude of petroleum reduction each wedge is responsible for. Their magnitude matches up with their allocation priority for all wedges except for the biodiesel and renewable diesel wedge, which should be in between fuel economy improvements and traffic flow improvements.

Projects are assumed to be phased in on a regular schedule. Some schedules, like EVs and renewable diesel, are delayed because it is deemed best to wait until prices drop. Other schedules, like biodiesel, occur in large steps because it is assumed that production capacity must be developed in phases.

Tracking Progress

Tracking progress toward the fulfillment of these wedges and the overall achievement of the 2025 goal will require new data sources and improved data tracking.

Tracking overall progress is under way. The first step was to centralize all of the data listed in Table 1 under one roof. This data was requested from numerous government departments and contractors through a cumbersome process. Future updates to this information needs to be sent directly to the VIEO so it can maintain a central database, and the TWG can have quick access to the most up-to-date information. The BMV should collect and analyze the VMT and vehicle model information that is already reported to them (including VMT, vehicle type, garage ZIP code, and data for HDVs). The BIR should better differentiate between diesel fuel used on- and off-road. This would greatly improve the TWG's ability to track progress toward the 2025 goal.

The wedge-specific projects can be tracked in the Clean Cities Annual Reporting website (reporting website) that NREL maintains. NREL has already set up an account for the USVI to use. As seen in Figure 7, the reporting website collects all data needed to calculate the petroleum use reduction, has default assumptions for questions the user is likely not to know, and calculates the petroleum savings for any of these projects. The input categories (as shown on the left-hand navigation) closely align with all wedge categories except for traffic flow. There is even a section to report outreach events such as educational campaigns, and marketing-based calculations that convert these outreach activities into petroleum saved. The USVI's reporting website account can be accessed by more than one user, so multiple agencies and organizations can input the data directly.

Figure 7. The USVI account on the Clean Cities Annual Reporting website. This website tracks wedge-based projects and calculates related petroleum use reduction.

To track the miles reduced, Virgin Islands Transit (VITRAN) needs to report its bus passenger count and its count at park-and-rides into the reporting website. It also needs to estimate the distance these passengers travel. VIEO should serve as the depository of ride-share data from the various ride-share websites. TWG needs to work with DPW to estimate the baseline annual VMT in the USVI and repeat the estimate annually.

To track the fuel economy improvements, TWG needs to obtain the vehicle sales records from the Department of Commerce. Average fuel economy of the new fleet can be derived from these estimates and tracked against our fuel economy goal. Specific fuel economy improvement projects can be entered into the reporting website, and petroleum savings will be quantified.

Tracking the improvements in traffic flow will be the most difficult of all the wedges. This is the one wedge that can’t be reported in the reporting website. Traffic signal synchronization packages are able to calculate their fuel savings, but a more holistic system is needed to calculate the savings from other projects. NREL is currently pursuing a novel combination of models that will enable it to calculate fuel savings from traffic flow improvements. One of these models, the Future Automotive Systems Tool (FAST), was developed by NREL to translate drive cycle and vehicle type into fuel use. The other model is a traffic simulation model, Verkehr In Städten - SIMulationsmodell (VISSIM), that translates road configuration and traffic flow into drive cycles. By connecting these two models, NREL hopes to calculate the fuel savings for each traffic flow improvement project. The fidelity of these models will be maximized if DPW can conduct more in-depth traffic counts to understand how many vehicles are traveling over any given section of road in the USVI.

The final three wedges will be relatively simple to track in the alternative fuels and vehicles section of the reporting website. The TWG will likely be involved in the first fleet EV purchases and can record them directly into the reporting website. After that, fleets can continue to report to TWG, and auto dealers can report their EV sales to the TWG. Finally, once the BMV begins logging the full vehicle registration information, it will be easy to track EVs through their database. Quantities of biodiesel, renewable diesel, and E10 will all be tracked by HOVENSA.

Specific Projects

The first step in the fuel use reduction process was to set the general goal of reducing petroleum use 60% by 2025, as done by Governor de Jongh. The next step was to break that goal down into the wedge-based goals listed in Table 3. The third step is to derive specific projects to achieve the wedge-based goals. This was done by the members of the TWG and the committees that developed the Master Plan. The fourth step is to prioritize these projects so that they can be pursued and funded in a systematic manner, as done in this section.

The TWG prioritized specific projects based the four factors listed below. The factors currently carry the label of low, medium, and high, but it is the intention of the TWG to be able to translate these labels into actual numbers, such as project cost, petroleum saved, and years until project fruition. The four factors, in descending order of importance, are as follows.

1. Project cost is deemed the most important factor, because it limits the number of projects that can be taken on. This factor includes up-front cost, not life cycle cost. (The next category, petroleum reduction, is the other main driver in life-cycle cost assessments, so it is already taken into account.) For divisible projects such as pedestrian paths or bus route expansion, Table 4 represents the cost of the less expensive projects rather than the cost of all projects.
2. Petroleum reduction represents the quantity of petroleum that a project displaces by 2025. Ultimately, the TWG will be able to combine the first two categories into a cost–per-gallon-displaced metric for a more straightforward comparison.
3. Time frame considers how quickly the project can begin reducing petroleum use. This rating considers one to two years as short, three to five years as medium, and six to 10 years as long.
4. The popularity rating predicts how much the general population will like the project and whether the project will foster interest in further EDIN work. In general, the popularity rating rises with increased cost savings, time savings, convenience, safety, and healthfulness of transportation. The Master Plan's community advisory groups helped inform the popularity of those projects, and popularity trends were inferred from those projects to the TWG's projects.

The final column in Table 3 is not a prioritization factor, but it outlines the primary hurdles that must be overcome for project implementation. This helps inform the probability of the project being implemented and focuses the project effort to overcome specific hurdles.

Table 4. Proposed Projects by Rank

Project	Rank	Wedge	Cost Reduction	Petroleum Reduction	Time frame	Popularity	Key to progress
Geotrackers to coordinate VITRAN buses, dollar rides, and passengers	1	Miles Reduction	Low	High	Short	High	DPW funding
New government vehicle purchase specifications	2	Fuel Economy	Low	High	Short	Medium	Enactment by DP&P
Purchase-price adjustments to encourage more efficient vehicles	3	Fuel Economy	Low	High	Medium	Medium	Must get Senate to legislate
Road maintenance and repair system	4	Traffic Flow	Low	High	Medium	High	Public participation
Ride sharing website	5	Miles Reduction	Low	Medium	Short	High	Find host organization
Telework	6	Miles Reduction	Low	Medium	Short	Medium	Trusting employees
Expand bus routes	7	Miles Reduction	Low	Medium	Medium	High	Increased ridership
Education campaign for alternative transportation	8	Miles Reduction	Low	Medium	Medium	Medium	Develop catchy, convincing message
Education campaign for fuel economy	9	Fuel Economy	Low	Low	Medium	Medium	Large vehicle culture and rough roads
Waste grease biodiesel in school project	10	Renewable/Biodiesel	Low	Low	Medium	High	Find enthusiastic high school teacher
Intra-island ferries and water taxis	11	Miles Reduction	Medium	High	Medium	High	Getting the taxi association to embrace water taxis
USVI Renewable Fuel Standard	12	E10 and Renewable/Biodiesel	Medium	High	Medium	Low	Convincing Senate to enact
Strategic parking to facilitate carpool, bus, and ferries	13	Miles Reduction	Medium	Medium	Short	High	DPW funding
Traffic signal timing and synchronization	14	Traffic Flow	Medium	Medium	Short	High	Funding for installation and maintenance
Pull-offs for buses/taxis	15	Traffic Flow	Medium	Medium	Short	High	Space for pull-offs
Government vehicle tracking and monitoring	16	Miles Reduction	Medium	Medium	Medium	High	DP&P participation
Maintenance facility for hybrids and EVs	17	Fuel Economy	Medium	Medium	Medium	High	HEV purchase order or shared dealer costs
Right hand turn lanes	18	Traffic Flow	Medium	Medium	Medium	High	DPW funding and space
New sidewalks and paths	19	Miles Reduction	Medium	Low	Medium	High	Space
Pedestrian overpasses at schools	20	Traffic Flow	Medium	Low	Medium	High	DPW funding
Trial fleets of EVs	21	Electric Vehicles	High	Medium	Medium	High	Funding and vehicle availability

Geotrackers

Geotrackers are GIS-based transmitters that track a bus's location to enable coordination with passengers, other buses, and safari taxis. A company called NextBus (www.nextbus.com) sets up a system of geotrackers that feed into a website that enables passengers to see when their bus is coming to their stop. The website can also send text messages to mobile phones to let passengers know exactly when their bus will arrive at a specific stop. An added option is electronic signs at bus stops that announce when a bus will arrive. This system, which is now used by 75 transit agencies throughout the United States and Canada, greatly increases the convenience and sense of control that a passenger has over his or her commute, while greatly reducing wasted time and frustration.

The NextBus system can be set up in the USVI by GeoOrbis, Inc., (www.geoorbis.com) for hardware costs of $1,200 per bus and $6,000 per route. Once it is set up, there is a monthly cost of $100 per bus. This places it in the low cost category. The project is deemed as very important to build consumer acceptance of buses in the USVI to set the stage for increased bus usage and fulfill the largest petroleum reduction wedge. Therefore, it is rated with high petroleum-saving potential. It could be installed quickly, and it is very user friendly, so the time frame is short. It is predicted to be highly popular, because it will make riding the bus much easier and more convenient. The main key to progress on this project will be convincing DPW that it is a sound investment.

The USVI only has 12 fixed-route buses, which makes their coordination much more important. They do not circulate very frequently, and therefore, there is a large risk associated with missing the bus. These 12 buses would be the first to be equipped with geolocators, and the safari taxis would be invited to purchase their own locators. This trackability should be a competitive advantage for any given safari taxi, since this service is notoriously unpredictable and tends to abandon normal routes when cruise ships come into port. Bringing the safari taxis into the system opens up the option for them to run secondary routes to pick passengers up from their houses and take them to the main arteries where they can catch large buses. This would make public transit much more convenient and user friendly.

Government Vehicle Purchase Specifications

The TWG has written new government vehicle purchase specifications and submitted them to VIEO for review. These specs converted all minimum size requirements (such as engine displacement, vehicle weight, and wheel base) into performance requirements (such as acceleration, payload capacity, towing capacity, number of seats, and cargo space). This will enable the Department of Property and Procurement (DP&P) to choose efficient vehicles that still meet performance needs. The new specs now include a minimum mpg for each vehicle category to ensure that government vehicles meet the Act 7075 requirement of purchasing the top one-fifth most fuel efficient vehicles in any category. They also permit alternative fuel vehicles for the first time.

The next step of this project will be for DP&P to formalize these specifications and send them to the vehicle suppliers as the first stage of their bidding process. DP&P should also include criteria that determine when to replace vehicles based on performance measures (including reliability and fuel economy) rather than simply on vehicle age, since not all vehicles age at the same rate. The cost of this overall project is very low—all labor is provided by the TWG and DP&P staff, and additional efforts will be covered by vehicle manufacturers as they prepare their bids. The petroleum savings potential is high, since, according to BMV records, there are approximately 1,200 USVI government vehicles, many of which are currently HDVs. The time frame is short, since the specs have already been written and only need to be reviewed and enacted. Popularity will be medium, with most people feeling relatively unaffected by this project. The clear key to progress will be DP&P's enactment of the new specs.

Purchase-Price Adjustments

Purchase-price adjustments to encourage more efficient vehicles will entail a change to the USVI's vehicle purchase and registration tax. The current tax is more expensive for heavier vehicles, but there are numerous options that would make the tax more effective at incentivizing more-efficient vehicles. Many of these options function well in various countries throughout the world, and the TWG prepared a summary of them at the request of the USVI Senate (see Appendix A).

The cost of this policy would be low, since enforcement of a vehicle tax is already in place. Petroleum use reduction would be high, as this policy would pair with the U.S. CAFE fuel economy standards to achieve a majority of the fuel economy improvement goal. The time frame is considered medium, since it will likely take more than three years for this policy to be written, enacted, and enforced. Its popularity will be medium, since it will likely anger people who want to purchase large, inefficient vehicles. However, it would probably result in a tax reduction or rebate to those who want to purchase a small, efficient vehicle. The key to enacting such a policy is building political will in the USVI Senate.

Road Maintenance and Repair

DPW needs a road maintenance and repair system in order to quickly learn about road problems (such as potholes, washouts, and dysfunctional traffic signals), prioritize them, and repair them. There are a number of software packages that set up such a system, but one stands out because it outsources most of the time and effort to the general public. The site is www.seeclickfix.com, and allows citizens to report road problems via their smartphones. The SeeClickFix application enables citizens to report the exact location of the problem through Google maps, attach a photo of the problem, check to see if the problem has already been reported, rate its severity, and update the status of the problem. Its dashboard option enables DPW to consolidate reports, review road problems, prioritize them, and report their completion through the dashboard.

One of the main groups of projects in the Master Plan is the "operations maintenance and system preservation" projects. SeeClickFix could supersede these individual projects, because it should incorporate these projects and prioritize them based on the number and rating of reports.

The cost of a SeeClickFix account with the dashboard option costs $40 per month, which the TWG considers to be a low cost project. Given the large number of traffic backups, and stop-and-go driving caused by road disrepair, the petroleum use reduction rating for this project is high. Additionally, people would feel more comfortable downsizing to more efficient cars if the roads were in better condition. The time frame is medium, because it would take a while for the public to become effective at reporting. This project will be very popular, because the current condition of the roads is a major source of frustration. It will improve DPW's public relations because it provides a platform to show the repairs that they have made and the work they are accomplishing. Public participation is the main key to this project, which will increase along with the penetration of smart phones. An advertizing campaign of road signs could encourage public participation. A preliminary user group could be the USVI police departments since they know the roads well and could quickly be trained on how to report with SeeClickFix.

Ride-Sharing Websites

Ride-sharing websites enable commuters to find other people with whom to carpool. The websites do so by accepting the user's departure and destination locations as well as the times of travel and flexibility of those times. Ride share websites increase traveler safety through accountability. Most require users to create a profile so they know who they're riding with, and many have reviews, so users can report unsafe driving or other dangerous behaviors. Advanced features can include payment transfers, employee incentives, savings calculators, and free back-up taxi rides.

There are some universal rideshare websites and software packages hosted and sponsored by local governments, nonprofits, and for-profit companies and individuals (National Center for Transit Research, 2011). However, there are advantages to tailoring a website specifically to the USVI or to a specific group, such as USVI government employees.

The cost to use a pre-existing ride share website is very low, but it is not much more expensive to tailor one to a specific subgroup of commuters and then maintain it. The petroleum reduction is rated as medium, because the savings are large for any given user, but the number of users is not likely to be extremely large. The time frame is short, because it is quick and easy to promote the website, and people are likely to try it early or not at all. The key to success is finding an appropriate organization or individual to set up the website and promote it. This organization could be DPW, since it would be the most immediate beneficiary. Alternately, a large employer could do so and then expand to an audience beyond its own employees.

Telework

Telework reduces VMT by enabling employees to work from home instead of commuting every day (telecommute), and by allowing employees to participate in meetings over the phone or Internet (teleconference). It requires programs and capabilities such as videoconferencing, voice over Internet protocol, virtual private networks, and collaborative software. These capabilities usually require a fairly sophisticated information technology staff to keep systems running and secure. Telecommuting requires a level of trust between the employer and employee that is easiest to achieve with pre-existing employees whose jobs are based on deliverables rather than on the amount of time worked. It is important to define the program well and to set policies that outline what is expected of the employees (including training) and the circumstances under which their telecommuting privilege might be revoked. A useful guide for setting policy and choosing the proper technology bundle for telecommuting is the MegaPath whitepaper "How to Implement a Successful Telecommuting Program" (MegaPath, 2006).

Telework has some unique benefits beyond those of other VMT reduction strategies. It saves more of the commuter's time than any other strategy, and it reduces traffic more than any other strategy. It serves as a valuable recruitment tool for companies[3], widens the geographic range of potential employees, and can reduce costs associated with office space. Teleconferences are one of the few ways to reduce the skyrocketing amount of fuel used by the airline industry.

Expansion of Bus Routes

Once bus ridership increases from the geotracker project, the bus routes should be expanded. The Master Plan has done a good job assessing where the routes need to be expanded to and has mapped them (Figures 5-1, 5-2, and 5-3 in the Master Plan). These projects are reiterated in Table 5. Routes can be expanded incrementally, which makes their cost rating low. Their petroleum reduction potential is rated as medium, but is highly dependent on increasing ridership. The time frame is also rated as medium, because it will likely take more than three years to purchase additional buses and increase ridership on the new routes to the point of substantial petroleum savings. Popularity is likely to be high, because new bus routes will increase people's travel options and convenience.

Table 5. Bus Route Expansion Areas Recommended in the Master Plan

Island	Route Expansion
St. John	Gifft Hill Road, between Centerline and Southside Roads
St. John	Southside road, west of Gifft Hill Road
St. Thomas	Shuttle from French Town to Patriot Manor
St. Thomas	Mahogany Run Road from Tutu Park Mall to Magens Road
St. Thomas	Shuttle service to Red Hook Ferry Dock
St. Croix	Further research necessary

Education Campaign for Alternative Transportation

An education campaign for alternative transportation will be needed to teach people about the new bus routes, how to track buses through NextBus.com, and about new options to walk or bike safely. This campaign should consist of advertisements on the sides of buses that not only educate the public about new features, but also market the bus as a safe, convenient, social, and fashionable means of transportation. The TransMilenio bus system in Bogota ran a successful marketing campaign that could be used as a model. The second phase of the education campaign should entail extensive community outreach, whereby representatives from TWG or other appropriate organizations attend various community meetings to deliver short presentations on alternative travel options and sources of transportation information. Finally, the DPW should create and maintain a website to provide easily searchable information about alternative transportation options, complete with maps and schedules.

The cost of this education campaign should be relatively low, since the majority of advertising would be on the side of DPW buses and therefore the only expense would be sign production. Sending speakers to community meetings is very inexpensive, and creating and maintaining a presence in the Internet is not very expensive, relative to other strategies for petroleum use reduction. The petroleum reduction potential of this project is medium, because it is not expected to have a substantial effect on ridership, but the per-rider petroleum reduction will be very

[3] A survey of 1,400 chief financial officers revealed that one-third considered telecommuting to be the best recruiting tool and half considered it to be the second best (Abate, 2008).

significant. The time frame is medium, because it will take time to plan and execute the education campaign to the point of changing people's travel behavior.

Education Campaign for Fuel Economy

An education campaign for improved fuel economy will help raise public awareness of vehicle fuel economy, related cost implications, and options for reducing costs. The campaign will teach people how to track their personal fuel economy, give them resources to compare vehicles, and find efficient vehicles that meet their needs. The campaign will also promote vehicle maintenance and driving tips to enable drivers to maximize the fuel economy of their existing vehicles. The campaign should consist of advertisements and flyers at gas pumps, where fuel expenditures are most salient. The flyers should direct people to classes where experts from VIEO or the BMV can teach about fuel economy.

The cost of the campaign should be relatively low. Gas stations will likely display campaign flyers at a discounted advertising rate, because the flyers will let customers know that station owners are trying to save them money and that fuel retailers are not the source of pain at the pump. Petroleum reduction is expected to be less significant than that from the alternative transportation educational campaign, because each person reached through this campaign will save less fuel than each person reached by the alternative transportation campaign. The time frame and popularity of this campaign are predicted to be medium for the same reasons as the alternative transportation campaign. Some keys to progress are overcoming the engrained large-vehicle culture in the USVI. This will be ameliorated as other projects reduce the need for large cars through better road conditions and reduced risk of collision.

Biodiesel School Project

A waste-grease-to-biodiesel school project is being pursued to introduce biodiesel to the USVI. The conversion from waste grease would be done on a small scale by a high school science class. NREL has worked with a similar project at the Tatnall School in Wilmington, Delaware, and a teacher from that project has agreed to mentor a high school teacher in the USVI. UVI students have already assessed the quantity and accessibility of waste grease in the USVI (Phipps, 2010), and VIEO has discussed waste grease donations with large hotels on St. Thomas. The biodiesel from this project would be used in school buses at blends of 20% or lower, and the health benefits of biodiesel would be conveyed to students and parents. It is envisioned that the students' hands-on experience with biodiesel will translate to comfort with and enthusiasm for the use of biodiesel among students, parents, and relatives. Using waste grease should maximize enthusiasm, because the project has the added benefit of creating a useful product from waste that is often difficult to dispose of properly.

The cost of this project is low—less than $5,000 for a small-scale biodiesel processor. However, the petroleum displacement would also be low. This project is more about generating support for biodiesel in the USVI and paving the way for large-scale projects. The time frame is likely to be medium: The project will not be operational until the school program, teacher, equipment, and vehicles are all in place. Popularity is rated high, based on the high popularity of the project at the Tatnall School. The key to this project's success will be identification of an enthusiastic high school teacher who is willing to take it on. VIEO is currently searching for such a teacher.

Ferries and Water Taxis

Intra-island ferries and water taxis have much potential for growth in the USVI. The 12 public docks on three islands are all used for travel among islands and are just as well equipped for travel among docks on the same island. Figures 3-27, 3-28, and 3-29 in the Master Plan feature maps of the public docks. A water taxi route from the West Indian Company Dock to the Waterfront on St. Thomas would save the most time and fuel. This would enable cruise-ship passengers to travel directly to the shopping district of Charlotte Amalie without paralyzing Charlotte Amalie traffic.

The cost of additional intra-island ferries is deemed medium, because it is likely that the private sector will bear much of the responsibility for investing in boats. The potential for petroleum use reduction is high, because water transportation is much more efficient than ground transportation, and because rerouting cruise-ship passengers from downtown Charlotte Amalie will relieve congestion and enable other drivers to adhere to more efficient drive cycles. The time frame is considered medium, because there are a number of potential routes that will not require a change to dock infrastructure, but it will take time to prove the business plan to business owners who would purchase and operate the boats. Popularity would be high, because this project would greatly reduce the sporadic paralysis of traffic in Charlotte Amalie caused by the cruise passengers. However, some taxi operators and businesses would be bypassed by the water taxis. Buy-in from these two groups (the St. Thomas Taxi Association, in particular) will be critical to this project's success. For the project to gain acceptance, the taxi association must be convinced that owning and operating water taxis is achievable and could be a profitable way to expand its existing business.

Renewable Fuel Standard

A renewable fuel standard (RFS), similar to the one already enacted in the United States, would provide the necessary incentive for petroleum marketers to sell alternative fuels such as ethanol, biodiesel, and renewable diesel. The RFS has proven to be extremely successful in the United States, having led to the use of more than 13 billion gallons of alternative fuel in 2010 (EIA, 2010). Such legislation, if passed in the USVI, would first spur the blending of E10, which is the most profitable way for blenders to use alternative fuels. E10 is so profitable because the ethanol replaces expensive oxygenates, and it can be sold for the same price as pure gasoline.

The RFS would provide incentive for HOVENSA to install infrastructure to use and blend ethanol from GeoNet. GeoNet, in turn, would resume operation of its ethanol dehydration facility if it did not have to pay for the infrastructure costs (Baker, 2010). This facility could easily provide enough ethanol to switch all gasoline in the USVI to E10, but pure gasoline should remain available to boats.

The U.S. RFS has requirements for biodiesel in addition to ethanol. The USVI should do the same in order to meet the biodiesel goal. Likewise, the U.S. RFS has separate requirements that renewable diesel will fulfill. Such requirements could help spur HOVENSA to the forefront of renewable diesel production. The U.S. RFS is frequently reviewed and adjusted so that its requirements do not exceed the capabilities of existing technology for any given year. Therefore, The USVI should tie its requirements to the U.S. RFS, thus eliminating the need for redundant technology reviews and adjustments.

The price of a USVI RFS would be medium, but spread between multiple players. The cost of legislators' and attorneys' time could be minimized by modeling the legislation closely on the U.S. RFS. HOVENSA would face substantial infrastructure costs but would recoup them from the USVI and its export markets over an unknown timeframe. Therefore, it is not clear how much an RSF would raise fuel costs in the USVI. The petroleum reduction would be high, as this rule would enable both the E10 and the biodiesel wedges to be achieved. The time frame is medium, as it would take three to five years to pass legislation through the USVI Senate, build the required blending infrastructure, and reopen the GeoNet facility. The popularity is likely to be low for E10, because some groups complain about its performance. The key to project success is building sufficient Senate support to enact RFS legislation.

Strategic Parking Lots

Strategically placed parking lots are effective ways of facilitating use of ride share, buses, and ferries. The best locations for parking lots are close to intersections of major roads that lead to popular destinations (usually a city). Such intersections are found more often in hilly landscapes, like that of St. Thomas, because roads tend to merge and funnel into common passable routes. This maximizes the number of people traveling between the city and the parking lot, which maximizes the flexibility of ride timing. The effectiveness of parking lots is also increased if there is a toll booth or high-traffic road between them and the city.

DPW commissioned a study of potential strategic parking lots and reported the findings in "USVI Transit Strategies for Energy Conservation" (Lea+Elliott, 2009). The findings of this study and the Master Plan have been combined in Table 6 to show the most promising locations for strategic parking lots in the USVI.

Table 6. Strategic Parking Lots Recommended in the Master Plan and Lea+Elliott, 2009.

Island	Location
St. John	Myrah Keating Clinic on Centerline Road (Rt. 10) at Gifft Hill Road (Rt. 204)
St. Thomas	Intersection of Centerline Road (Rt. 10) and King Hill Road (Rt. 20)
St. Thomas	Red Hook Marine Facility (East end of Red Hook Rd.)
St. Thomas	Cost-U-Less parking lot on Weymounth Rhymer Hwy

The costs associated with strategic parking lots are deemed medium, since their construction is cheap, but the price of land is high in the USVI. They are expected to reduce a medium amount of petroleum, since they will not likely be large enough to hold a substantial number of cars. The time frame is short, because parking lots can be built quickly. Their popularity will be high, since they increase the convenience of and options for people's trips.

Timing and Synchronization of Traffic Signals

Proper timing and synchronization of traffic signals reduces fuel use by minimizing unnecessary stops, idling, and acceleration. This can be done in steps: The first step is to replace one of the numerous broken weight-based vehicle sensors with more resilient camera sensors, and to ensure the signals are programmed properly. This has recently been done at the intersection of Queen Mary Highway and Rt. 69, greatly improving traffic flow on both roads. The second step is to synchronize strings of traffic lights along interconnecting streets to minimize the total number of required vehicle stops. One of the most popular signal synchronization package in the United

States is Synchro 8 by Trafficware. Its associated software has the additional benefit of calculating fuel savings resulting from synchronized lights.

The cost of timing and synchronizing a significant number of signals would be medium. The camera sensors for signals cost about $10,000 apiece, and the package required to synchronize multiple signals costs much more, depending on a wide variety of options. The time frame would be medium, and the popularity would be extremely high, because broken traffic signals are currently a major cause of frustration.

Pull-Offs for Buses and Taxis

Pull-offs for buses and taxis would enable passengers to load and unload without forcing traffic to stop. These are particularly important in the USVI, because vehicles drive on the left-hand side of the road, and most vehicles have exits on the right side. Therefore, vehicles must completely stop to ensure the safety of exiting passengers.

Costs associated with installing a significant number of pull-offs would be medium. Funding would be required to clear vegetation from the pull-offs on an ongoing basis. Fuel savings would be medium, given the limited availability for space to install pull-offs. The time frame would be short, and popularity would be very high among both the vehicle drivers whose stops are reduced and the exiting passengers whose safety is increased.

Tracking Government Vehicles

Tracking and monitoring government vehicles can be done through a wide variety of wireless fleet-management systems. These systems reduce petroleum use by discouraging government employees from using government vehicles for personal trips, improving maintenance scheduling, and planning routes that minimize VMT. Some systems can even provide driver feedback to encourage more efficient driving. DP&P will have to assess its needs, purchase the appropriate system, install hardware on vehicles, and train fleet managers in how to use the system.

The cost of a fleet management system varies widely based on features, but is generally considered to be medium. The petroleum reduction and time frame are also considered to be medium. We predict popularity to be high among citizens who want to see their tax dollars spent as efficiently as possible. DP&P participation is key to the success of this project.

EV Maintenance Facility

A maintenance facility for EVs and hybrid EVs (HEVs) will be necessary to help people feel comfortable purchasing these vehicles. There are currently no mechanics in the USVI who specialize in electric power trains. Consumers are therefore hesitant to purchase these vehicles, because they fear that they won't be able to get them repaired. Car dealerships must be encouraged or helped to bring an EV/HEV mechanic from the mainland. Such a move could be catalyzed by a substantial purchase order from DP&P or WAPA. The National Independent Automobile Dealers Association could organize the hiring and sharing of an EV/HEV mechanic by multiple dealers.

The cost of hiring an EV/HEV mechanic and equipping a garage would be medium. The petroleum reduction would be medium, and we foresee most fuel savings coming from HEVs.

The time frame is medium, because it would probably take awhile for dealers to get organized or incentivized for a new hire. The popularity would be high, because availability of an EV/HEV mechanic would expand the number of vehicles that consumers could comfortably purchase. The key to progress is a sufficient population of EV and HEV owners.

Right-hand Turn Lanes

Right-hand turn lanes allow vehicles waiting to make right-hand turns to get out of the way of traffic so that all the cars behind them don't have to stop. Recall that the USVI drives on the left side of the road, so right-hand turns are the cross-traffic turns. Currently, there are many intersections in the USVI that have no right-hand turn lanes, and traffic that is heavy enough that cars have to stop for relatively long periods of time in order to make right-hand turns.

In regard to traffic congestion mitigation goals, right-hand turn lanes are comparable to the bus and taxi pull-offs (project No. 15), so it is useful to compare the two directly when assessing their ranks. Right-turn lanes are slightly more expensive, because the section of road being widened is at an intersection. They will probably save a bit less fuel than pull-offs, because the stops that they are preventing are shorter. The time frame would be a bit longer because of the lane will be added in locations where it is more difficult to install (in the middle of the road and at intersections). Popularity would probably be slightly lower, because the time savings aren't as great, and the safety improvements aren't nearly as significant. The key to progress will be DPW funding and space for the additional road width.

Sidewalks and Paths

Sidewalks and paths enable VMT reduction through active transit. They are currently in short supply in the USVI, leaving pedestrians and bicyclists along the edges of narrow roads that are traveled by very wide vehicles. The Master Plan calls for the sidewalks listed in Table 7. It specified curb cuts for wheelchairs and bicyclists, which the TWG supports. The Master Plan also called for a few bike routes geared for tourists on pleasure rides, but we have omitted these from this document, because pleasure rides have little potential for displacing petroleum.

Table 7. Sidewalks and Paths Recommended in the Master Plan

Island	Location
St. John	Sidewalk along Rt. 107 in Coral Bay and Johnson Bay
St. Thomas	Sidewalk along Hull Bay Road/Skyline Drive (Rt. 40)
St. Thomas	Near hospital and shopping center on Alton Adams Rd. (Rt. 38) and Centerline Rd. (Rt. 313) from Lovers Lane to Long Bay Rd.
St. Thomas	Sidewalk and bike path from Centerline Road/Wilma Blyden Road (Rt. 313) to Donoe Road (Rt. 39)
St. Thomas	Install sidewalks at Red Hook, Bovoni, Tutu intersection to Nadir, Nadir intersection to Red Hook, and Simith Bay to Tutu.
St. Croix	Bike path along Queen Mary Highway close to Rt. 75

Walking Paths Under Power Lines

In addition to the sidewalks and paths specified in Table 7, the TWG has proposed an assessment of walking paths under power lines on St. Thomas. The idea behind this is threefold: (1) Walking paths are safer if they are away from roads. (2) On St. Thomas, roads often traverse hills and take a longer route to a given location. In contrast, power lines usually follow the most direct route. (3) It is a challenge for WAPA to keep vegetation clear under power lines, so a walking path could actually help in this regard. The largest obstacle to this proposal appears to be the terms of property easements and whether property owners who have granted WAPA the right to string lines over their property would object to people walking on it.

The cost of such a path project is likely to be medium. Petroleum use reduction would be low, since most walkers and bikers are only replacing short vehicle trips. The time frame is medium, because it will take time for people to start using the paths once they are built. Their popularity will be high, because the paths would increase people's transportation options and improve pedestrian safety.

Pedestrian Overpasses at Schools

Pedestrian overpasses at schools can replace crossing guards that back traffic up for hundreds of yards, causing many cars to stop and re-accelerate. Overpass construction is relatively easy, so the cost is medium. Potential for reducing petroleum use is low, because there are only 64 schools in the USVI, and overpasses would not be suitable for all of them. The time frame is medium, and popularity would be high, because overpasses would improve student safety and save time for students and drivers.

EV Trial Fleets

Trial fleets of EVs are needed to introduce EVs to the USVI in a positive light. WAPA would be a good first fleet, since it has the means to keep its EVs well maintained. WAPA vehicles are driven on drive cycles with frequent stops and pauses, where EVs have a particular advantage over conventional vehicles.

Once an EV maintenance facility is set up, the USVI government should purchase the next EV trial fleet. Subsequently, rental car companies could provide the first opportunity for residents and visitors to drive EVs. Rental car fleets are good early adopters, because they derive a marketing benefit from offering cutting-edge and environmentally friendly vehicle options. Both Hertz and Enterprise already own many EVs (ExtremeTech, 2011). They can charge a premium for the novel experience of driving an EV, and they can partner with hotels to provide charging equipment.

EVs still have a higher up-front cost than conventional vehicles, so trial fleets are rated as high cost. However, TWG will do a life-cycle cost assessment of EVs so the trial fleet can base their decision on how much the project will cost when fuel savings are included. This is the only high-cost project included in Table 4, because we deem it strategic for the USVI to gain experience with EVs so that it can be poised to penetrate the market quickly as EV prices drop. Petroleum savings is deemed medium, because their numbers will be small, and they will be operating before the efficiency of the USVI electric grid is improved (as shown in Figure 5). The time frame is medium, because anything beyond five years will no longer be considered a trial fleet. Their popularity among the public will be high because they are cutting-edge and high-profile.

Conclusion

Wedge analysis demonstrates that a 60% reduction in petroleum use in the USVI's transportation sector is indeed achievable by 2025. Current inefficiencies in vehicles, traffic flow, and travel options may be sources of frustration today, but they also translate to significant opportunities for improvement. Furthermore, the many co-benefits of such improvements, including increased convenience, safety, and health, have the potential to generate strong public support for on-the-ground projects that reduce petroleum use.

The wedge analysis proves especially useful in its ability to break down an otherwise daunting overarching goal into manageable subordinate goals, strategies, and tactics, and to chart their growing contributions toward the central goal years into the future. The subordinate goals needed to reduce transportation petroleum use 60% by 2025 appear achievable:

- A more efficient transportation network can perform all necessary services while motorized vehicles travel 20% fewer miles.
- USVI can purchase LDVs whose fuel economy averages 4 mpg less than the U.S. CAFE standard for a given year.
- Traffic flow can be improved to reduce starts and stops, so that 30% of the existing drive cycle is transformed to the highway drive cycle.
- EVs can comprise 15% of the LDV fleet in USVI.
- Renewable diesel or biodiesel can replace 55% of all diesel.
- E10 can replace 75% of all gasoline.

These subordinate goals are achievable, because a substantial number of projects are available to contribute toward them. In an effort to prioritize limited funds, these projects were ranked according to cost, petroleum reduction, time frame, and popularity. In general, the next steps will be for USVI to start implementing projects from the top of Table 4 and work their way down.

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Appendix: Policy Brief: Encouraging High-Efficiency Vehicle Purchases in the U.S. Virgin Islands

Much can be learned from policies in place around the world that encourage citizens to purchase high-efficiency vehicles. The most common of these policies are motor fuel taxes, fuel efficiency standards, and vehicle registration taxes. The latter can be implemented to varying degrees of efficacy through a wide variety of mechanisms. This policy brief assesses countries that have achieved a high level of vehicle fuel efficiency, takes their fuel tax and fuel efficiency standards into account, and analyzes the vehicle tax schemes of a few countries with the most efficient vehicles.

Table 1. $C0_2$ Emissions by EU Country

Country	EU Rank	lbs CO2/mile
Portugal	1	0.45
France	2	0.47
Denmark	3	0.47
Italy	4	0.47
Ireland	5	0.47
Belgium	6	0.48
The Netherlands	7	0.48
Spain	8	0.49
Norway	9	0.50
Greece	10	0.51
Austria	11	0.51
Slovenia	12	0.51
Great Britian	13	0.51
Hungary	14	0.53
Poland	15	0.53
Czech Republic	16	0.53
Slovakia	17	0.53
Finland	18	0.53
Germany	19	0.54
Sweden	20	0.54
Switzerland	21	0.57
United States	na	0.86

Source: JATO 2011

Fuel Economy and Emission Standards

The United Nations (An et al. 2011) recently conducted a review of international fuel economy and greenhouse gas (GHG) emission standards. Its report highlights the fact that these standards are more effective at reducing fuel use when implemented on a broad nationwide or continent-wide basis.

Starting in vehicle model year 2012, the United States' recently harmonized fuel economy and GHG emission standards will apply to the USVI.[4] This will encourage vehicle manufacturers to sell more efficient vehicles in the USVI.

European Union Average CO_2 Emissions

In order to compare vehicle tax schemes while holding efficiency standards constant, it is best to compare countries within the European Union (EU). This is because the fuel efficiency standards are set at the EU level and are therefore the same for each member country. Table 1 does this by showing CO_2 emissions, which are directly tied to fuel consumption rates. Portugal has the most efficient (lowest-emitting) vehicles in the EU, and Switzerland has the least efficient. The United States has been added to the table for reference. Table 1 will be used again in the Vehicle Registration Taxes and Rebates section.

Motor Fuel Tax

Motor fuel taxes are often used to reduce fuel use and fund roads and infrastructure. Figure 1 compares U.S. fuel taxes ($0.18 federal tax plus average state/local tax of $0.34 per gallon) to fuel taxes in Europe.

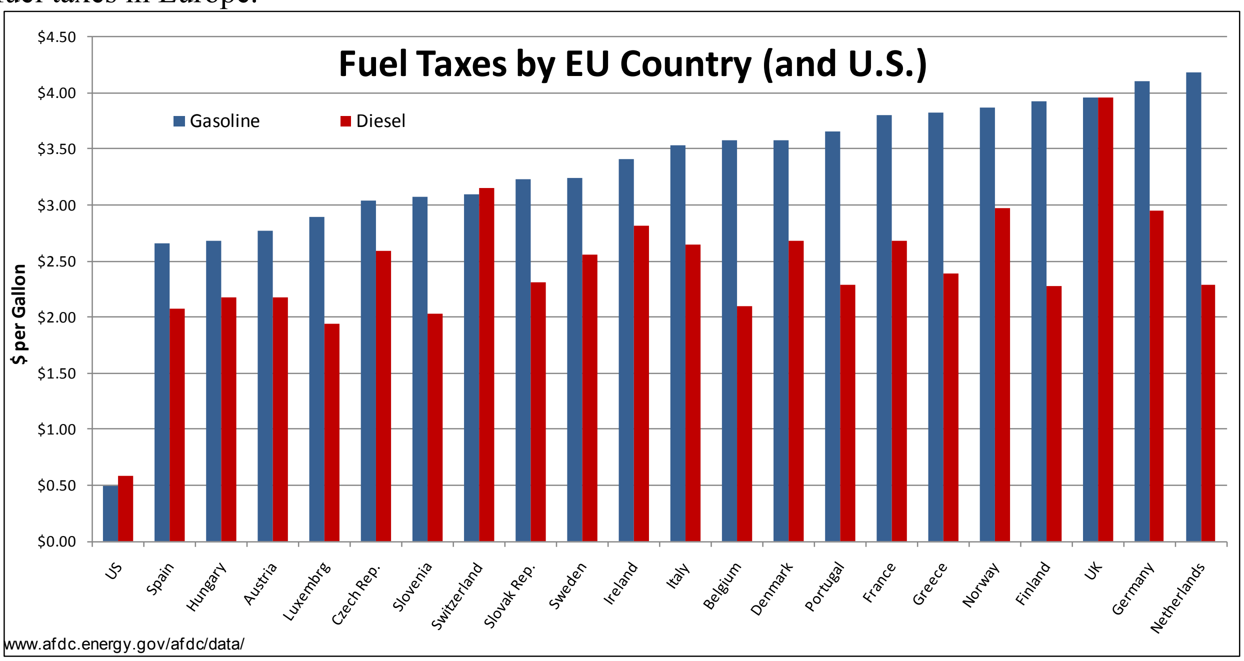

Figure 1. Fuel taxes by EU country. Sources: Organisation for Economic Co-operation and Development (OECD 2010); Alternative Fuel and Advanced Vehicle Data Center (AFDC 2011).

Comparing Figure 1 with Table 1 highlights which countries are likely to have non-fuel-tax policies that are effective at promoting efficient vehicles. Portugal, France, and Denmark have the most efficient vehicle fleets of vehicles despite having lower fuel taxes than six other EU countries. Therefore, it is likely that these countries have policies beyond the fuel tax that are

[4]Although the USVI did not previously fall under the jurisdiction of the Corporate Average Fuel Economy (CAFE) standards, it is under the jurisdiction of the Clean Air Act. The aspects of these two regulatory programs that affect vehicle efficiency and GHG emissions were harmonized by a rule (EPA and NHTSA 2010) that includes a discussion of the geographical jurisdiction in Section III-E-5-g.

effectively promoting vehicle efficiency. Conversely, Finland has relatively inefficient vehicles despite having high fuel taxes.

Vehicle Registration Taxes and Rebates

Vehicle registration taxes and rebates are often structured to encourage the purchase of more efficient vehicles. The taxes that currently do so are directly based upon fuel efficiency or per-mile CO_2 emissions or indirectly based on vehicle weight or engine power/size. These taxes and rebates are implemented in a wide variety of schemes, many of which are quite innovative. Given that Portugal, France, and Denmark have achieved Europe's most efficient fleets while keeping their gasoline taxes relatively low, they are good places to search for effective vehicle tax schemes.

Figure 2 illustrates the monetary impact of the tax schemes of these three countries, Finland (one of the two EU countries that has a disproportionately low fuel economy relative to its high gasoline taxes), and the United States. To facilitate direct comparison between tax schemes, the figure aggregates the up-front and the annual registration tax/rebate and converts the resulting into cost per ton CO_2 emitted over the vehicle's lifetime. The Y-axis is the registration tax (rebate when negative), and the X-axis tracks CO_2 emissions. Low-emitting (efficient) vehicles are on the left, and high-emitting (inefficient) vehicles are on the right.

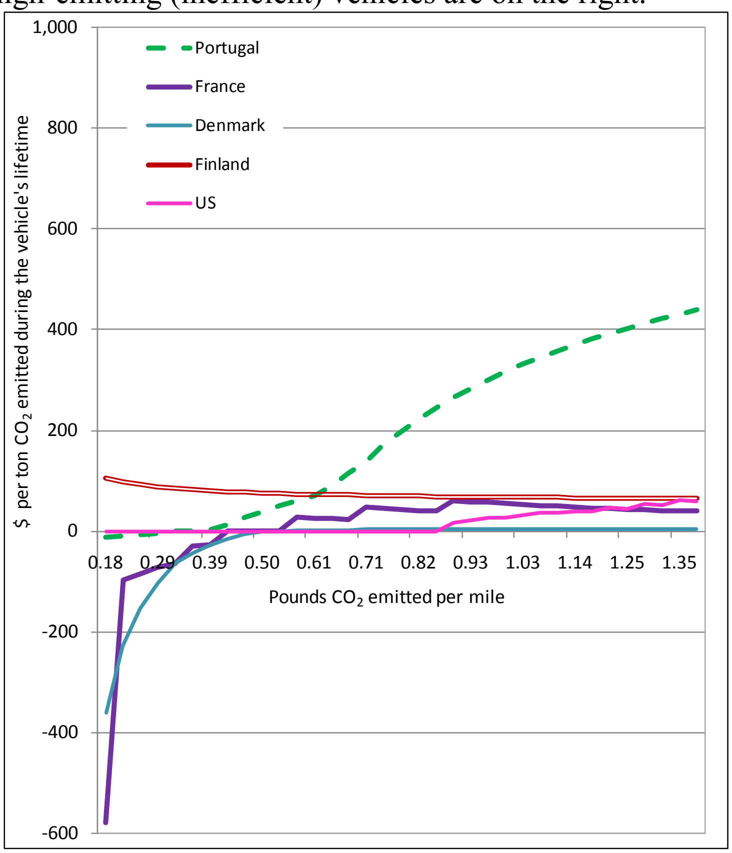

Figure 2. The rebates or taxes on vehicle purchases according to their lifecycle CO_2 emissions.

Source: OECD 2010.

The traits that the three most successful tax schemes exhibit are:

1) Low-efficiency vehicles (on the right) are taxed at a higher rate than high-efficiency vehicles.
2) The increases in cost as vehicle efficiency decreases are relatively consistent and gradual—vehicles aren't lumped into large categories with large increases between them.
3) Highly efficient vehicles are not taxed or, in some cases, qualify for a rebate that is funded by the taxes paid on less efficient vehicles.

Finland is an example of a poorly constructed tax scheme because the cost actually goes down as emissions go up. Likewise, the U.S. tax scheme does not motivate citizens to purchase more efficient vehicles because they pay no efficiency-related taxes for light-duty vehicles and only slightly more for medium- and heavy-duty vehicles.
Having identified the general attributes of vehicle tax policies that are likely to be linked to efficient vehicles, it is useful to consider specific countries and search policies that have these attributes.

Portugal's vehicle registration tax has a component that is based directly on CO_2 emissions, as determined by the European Commission's Certificate of Conformity (section 46.2). This form of tax is the most direct way to minimize CO_2 emissions. Another component of Portugal's registration tax is based on engine displacement: Vehicles with larger, higher-emitting engines are subject to higher registration taxes. Taxing based on engine displacement is a less direct way of encouraging more efficient vehicles because it doesn't take into account the fact that some engines of a similar size are much more efficient than others. A tax discount of 10% to 50% may be applied, depending on a variety of factors such as vehicle weight or use of hybrid technology. A shortfall of Portugal's system is that the tax remains relatively flat for efficient vehicles (from 0.18 to 0.4 pounds CO_2 in Figure 2), which provides very little incentive for people to choose incrementally more efficient vehicles within this range.

In addition to its vehicle registration taxes, Portugal has an annual ownership tax that increases with engine displacement (for passenger cars) and vehicle weight (for commercial vehicles). This annual tax can influence some people who are less influenced by the vehicle purchase tax. The reason some people could be less influenced by the vehicle purchase tax is because this tax comes at a time when purchasers have resigned themselves to a very expensive purchase, so the incremental cost of the tax is less influential. The annual fee comes at a time when the owner can focus entirely on the pain of that fee without its being diluted by the large purchase cost and the emotions associated with buying a new vehicle. Further details on Portugal's taxes can be viewed at www.eu-cars.com/details/newsletter-PT.pdf.

France has implemented a successful policy, called the Bonus-Malus (good-bad), that combines escalating taxes for inefficient vehicles (less than 35 mpg) and large bonuses for efficient vehicles (greater than 43 mpg). This policy is based on the much-publicized "feebate" program that Canada has also implemented (Cohen et al. 2010). The Bonus-Malus had a large impact on France's vehicle fleet, as the market share of economy cars grew from 44% in 2007 to 57% in 2009 (RMI 2010). One shortcoming of the legislation was the stair-steps between vehicle categories that failed to apply consistent pressure toward more efficient vehicles. A second shortcoming of the legislation was that the rebates and fees weren't correctly balanced. It was intended to be revenue neutral but, due to its unexpected success at attracting purchasers to efficient vehicles that were eligible for rebates, ended up costing the government a substantial amount.

Denmark's vehicle tax/rebate scheme applies a strong and consistent incentive to purchase a more efficient vehicle if one is considering a smaller vehicle (that emits less than 0.5 lbs CO_2 per mile). This is because the baseline tax (105% of vehicle value) is reduced $340 every mpg it achieves over 36.7 mpg and is increased $85 every mpg under 36.7 mpg (Skatteministeriet 2011). This reduction does not apply to vehicles larger than 2.5 tons, leaving them no incentive for improved fuel economy.

Finland has inefficient cars given its fuel taxes, which suggests it has a vehicle tax scheme that does not encourage efficiency. Indeed, Figure 2 shows that vehicle taxes in Finland actually increase as efficiency improves, which discourages efficiency. This system has recently been changed, so Finland's average vehicle fuel consumption is likely to start dropping.

Conclusions

There are a number of lessons to be learned from the vehicle taxation policies of other countries. These include:

1. Motor fuel taxes are the most economically direct way to reduce the amount of motor fuel used. This incentivizes all petroleum-reduction options, including efficient vehicles, carpooling, and riding the bus. The average gasoline tax in the EU is $3.50, whereas in the United States it is $0.49.
2. Fuel economy standards and GHG emission standards are effective at improving fuel economy but are designed for nation- and continent-wide application. The United States' fuel economy and GHG emission standards will apply to the USVI market starting in vehicle model year 2012.
3. France has one of the most successful vehicle fee/rebate "feebate" schemes in the world. It taxes the purchase of inefficient vehicles and rebates some of the purchase of efficient vehicles. The rate of increase for both the fee and the rebate as well as the inflection point (in mpg) between the fee and rebate need to be set specifically for each location trying to implement a feebate because the driving economics and fuel use are very different for each location. An assessment performed for the state of California (Bunch et al. 2011) has many lessons to offer in this regard.
4. Portugal's example illustrates that it is very effective to implement an annual incentive in addition to the up-front incentive encouraging greater fuel economy. This is likely due to the fact that the annual ownership tax comes at a time when it is not hidden or made less significant by the much larger cost of purchasing a car.

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