SECTION 4: RECOMMENDATIONS FOR THE GROUND TRANSPORTATION SECTOR

In making the recommendations for the ground transportation sector, the SENTECH Hawai`i Team did its utmost to follow *The Natural Step Principles of Sustainability*, namely that in a sustainable society:

- Nature is not subject to systematically increasing:
  - Concentrations of substances extracted from the Earth's crust,
  - Concentrations of substances produced by society, or
  - Degradation by physical means and, in that society.
- People are not subject to conditions that systematically undermine their capacity to meet their needs.[1]

The Team also adhered to the following guiding principles based on its stakeholder and public meetings, objective energy analysis, and follow-on community input:

- Community priorities and acceptance
- Sound scientific principles and analysis
- Available energy resources
- Commercial, least-cost technologies
- Reduce demand, increase supply of local and sustainable energy/fuels.

As the SENTECH Hawai`i Team worked with stakeholders and the public in developing these recommendations, the following highlights became apparent:

- Greater impact from ***demand reduction*** (bus, efficient vehicles, etc.) will be achieved in this sector
- ***Increased supply*** trickier due to land costs and availability
- Lowered level of *Fossil Fuel Tax* will translate to a lower energy sustainability goal
- At some point, refineries may switch to 100% "drop-in" biofuels, which could become a tipping point for Kaua`i to become completely reliant on biofuels such as locally produced ethanol, biodiesel, and Straight Vegetable Oil (SVO).

Recommendations 4.1-4.7 follow. Each recommendation is broken down into:

1. **Rationale**—to explain why the recommendation was made.
2. **Impact**—to give some idea of the recommendation's impact on Kaua`i commuters, the County, KIUC, developers, landowners, refineries, etc.
3. **Relevant Policies**—to show what other policies could leverage, interfere with, or otherwise effect the recommendation.
4. **Implementation**—including recommended actions, costs, responsible parties, and timeline.
5. **Funding Source**—to show how the costs of each recommendation would be paid for.

[1] Natural Step (n.d.). *The Four System Conditions*. Retrieved on 7/27/10 from http://www.naturalstep.org/the-system-conditions.

RECOMMENDATION 4.1: To Reduce Consumption of Fossil Fuels, Pass *2% Fossil Fuel Tax*

1. Rationale

Taxing a Commodity to Change Consumption Patterns

Petroleum products cost roughly the same to make regardless of the location that they are produced in, according to John Felmy, chief economist for the American Petroleum Institute.[2] However, at-the-pump gasoline prices vary significantly across regions because some governments subsidize petroleum products, while others tax them heavily.

Taxes and overall prices can influence consumption patterns. European countries typically have higher gasoline prices than the U.S., primarily due to fuel taxes, and are generally known to have smaller, more fuel-efficient transportation options than the U.S. Specific case studies of how higher tax rates and overall costs influence consumption in Europe include:

- In 1973, Denmark imported all its oil from the Middle East, but today it does not import any oil from anywhere. When the country was hit hard by the 1973 Arab oil embargo, Denmark imposed on itself a roughly $5/gallon gasoline tax in the form of an ecotax, made massive investments in energy efficiency, invested in systems that generate energy from waste, and made a fortuitous discovery of North Sea oil (which supplies about 40% of the country's needs).[3]
- In early 2008, the average cost of gasoline in France was $8/gallon—more than double the price of gasoline in the U.S. Oil use in France has dropped 17% from 1970 to 2008, according to figures from the Energy Information Administration. Revenues from these higher gas taxes are used to fund a variety of programs, including better public transportation.[4]

In early 2008, American oil prices started climbing toward all-time highs for the West Texas Intermediate (WTI), with oil futures of more than $145 per barrel in July 2008. Eventually, gasoline cost more than $4.00/gallon across America, with spot prices of $5.00/gallon in certain areas, including Hawaii. During this time of increased gasoline prices, US gasoline consumption fell 1.1% from 2007, causing the largest drop in consumption in 16 years. The rising price of gasoline also pushed some consumers into fuel-efficient vehicles: in January 2008, large car sales fell 26.5% from a year earlier, according to Autodata Corp.[5]

Changing from a Flat to a Percentage-Based Fossil Fuel Tax

The SENTECH Hawai`i Team originally recommended a 50¢/gallon flat (or "real") tax on gasoline and diesel, which met significant resistance. The community and members of the County Council were primarily concerned that:

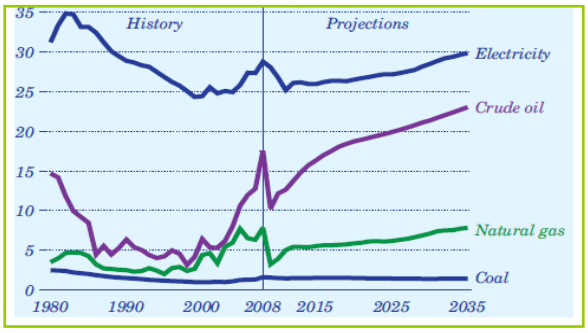
- The suggested fuel tax was too high and would overburden the working class, and

[2] Hargreaves, Steve (July 15, 2008). *U.S. gas: So cheap it hurts.* CNN Money. Retrieved on 7/27/10 from http://money.cnn.com/2008/05/01/news/international/usgas_price/.
[3] Friedman, Thomas (September 19, 2009). *Real Men Tax Gas.* The New York Times. Retrieved on 7/27/10 from http://www.nytimes.com/2009/09/20/opinion/20friedman.html?_r=3&hp.
[4] Hargreaves, Steve (July 15, 2008). *U.S. gas: So cheap it hurts.* CNN Money. Retrieved on 7/27/10 from http://money.cnn.com/2008/05/01/news/international/usgas_price/.
[5] The Raw Story (March 3, 2008). *US gasoline consumption falls hardest in 16 years, excepting Katrina.* Retrieved on 7/27/10 from http://rawstory.com/news/2008/US_gasoline_consumption_falls_hardest_in_0303.html.

- Biofuels such as ethanol and biodiesel would be taxed.

The SENTECH Hawai`i Team has since made it clear that biofuels were never meant to be taxed; only gasoline and diesel derived from imported oil would be taxed by a county fuel tax.

Figure 4-1: Energy prices, 1980-2035 (2008 dollars per million Btu)



The Team is now recommending a *2%* (or "nominal") *Fossil Fuel Tax* to phase in elements of the KESP and also minimize impact on Kaua`i citizens, especially the working class. The tax would be tied to varying crude oil commodity prices, with prices projected to double from 2010 to 2030, as illustrated in Figure 4-1 according to the U.S. Department of Energy's *2010 Annual Energy Outlook.*[6] Since the tax and its revenues are tied to an internationally-traded commodity that DOE predicts will double in price from 2010 to 2030, it is uncertain exactly how much money would be raised, but a reasonable estimate is that a *2% Fossil Fuel Tax* would build a $42.6M *Alternative Ground Transportation Modes & Fuel Fund*.

The *2% Fossil Fuel Tax* will disincentivize fossil fuel consumption, while also creating an *Alternative Ground Transportation Modes & Fuels Fund* that will fund initiatives that reduce energy demand and increase the local sustainable energy supply. Initiatives will include:

- An improved public bus system.
- Incentives for efficient Hybrid Electric Vehicles (HEVs) that would cost Kaua`i citizens 40% less to operate than conventional internal combustion vehicles.
- A rental vehicle program for the visitor industry which would take rented vehicles off the road while improving the Aloha Spirit shared with visitors.
- Inexpensive conversion kits that would turn conventional gasoline engines into Flex Fuel engines capable of using either gasoline or ethanol—to support local ethanol production.
- Purchase of five vegetable oil presses which would allow local small farmers to produce Straight Vegetable Oil (SVO) for off-road vehicles, and potentially public buses.
- Incentives for efficient Plug-in Hybrid Electric Vehicles (PHEVs)—in a few years when KIUC has sufficient night-time renewable energy to charge PHEVs at night—which would cost Kaua`i citizens 50% less to operate than conventional internal combustion engines. These incentives would also be for residential chargers, and KIUC Smart Grid enhancements to enable night-time charging of the vehicles with a 220-Volt charger at people's homes.

The Team realizes that this *2% Fossil Fuel Tax* may be considered politically risky, but if the community supports sustainable energy, it must also support innovative policies and forward-looking elected leaders to help the community meet their sustainable energy goals. The Team also acknowledges that a *2% Fossil Fuel Tax* may represent economic hardship on lower income residents of Kaua`i. However, the Team believes that any tax should be applied across the board to avoid perceptions of inequity or "social engineering," and also stresses that affordable public transportation, incentives to buy efficient vehicles, new jobs creation, and other benefits of the KESP recommendations will offset short-term hardships.

[6] U.S. Energy Information Administration (December 14, 2009). *Annual Energy Outlook Early Release Overview*. Department of Energy. Retrieved on 7/27/10 from http://www.eia.doe.gov/oiaf/aeo/overview.html.

In addition, the Team urges Kauaians to recall that they paid nearly $5/gallon for gasoline in 2008. By investing in local fuel and energy production for ground transportation, Kauaians would be hedging their energy dollars and within a few years should be saving money.

Modeling Inputs and Outputs

With a 2% Fossil Fuel Tax, the fund will grow at a slower rate and result in a lower total than originally proposed, which means energy sustainability goals in the ground transportation sector will also need to be adjusted downward. The SENTECH Hawai`i Team has developed an *Alternative Ground Transportation Modes & Fuel Model* (see Figure 4-2 below*)* to help the County decide for itself what level of Fossil Fuel Tax should be levied, if the suggested 2% level is deemed inappropriate. The Model will also allow the County to decide if/how to spend *Alternative Ground Transportation Modes & Fuel Fund* allocations on alternatives to conventional transportation.

Figure 4-2: Screen Shot of the *Alternative Ground Transportation Modes & Fuel Model*

Basic Assumptions:

2007 baseline Gas Consumption	35,700,000	gallons
Initial Price of Gas	$3.40	
Proposed Tax	$0.34	
New Gas Price	$3.74	
Price elasticity Ratio	(40%)	
Net Increase / (Decrease) in Consumptio	(3.6%)	
Population Growth of Cars on Road	1.1%	
Inflation	1.0%	
Commodity Price Increase	3.0%	

	Average/Year	10 Years - Tot.	20 Years - Tot.
Vehicles Replaced Due to Incentive	12,112	29,966	96,898
Gallons Consumed Pre-Tax	41,012,991	387,718,272	820,259,813
Gallons Consumed Post-Tax	24,708,863	322,236,127	494,177,251
Gals Avoided Post-Tax	16,304,128	65,482,145	326,082,562
Gals Avoided w/ Tax Proceeds to Fund HEVs	5,149	12,738	41,190
Potl Effic'y Gain w Incent. Vs CAFÉ Stds		1%	46%
Total Efficiency Gains - incl. Incents	39.7%	16.9%	39.8%
Yrs of Consumption Displaced	7.95	1.7	8.0

CAFÉ Standards		Gal/Yr
Avg Distance/Yr	10,000	
MPG - Pass Veh	26	385
MPG - Lt Trucks	24	417

Pricing Coefficient: Standard vs PHEV vs After-market Conversion

Cost	Car	Truck/SUV	Car	Truck
Standard	25,000	30,000	**Percent Difference in Price**	
Hybrid	30,000	35,000	20%	17%
Conversion Kit	35,000	40,000	40%	33%
PHEV	40,000	48,000	60%	60%

Assumed Quals (%, Best/Worst): 30% 70%

Federal Incentives	HEV Best Case	HEV Worst Case	Conversion Kit Best Case	Conversion Kit Worst Case	PHEV Best Case	PHEV Worst Case
Average PHEV Credit	$ 3,000	$ 1,000	$ 4,500	$ 2,000	$ 5,500	$ 3,500
Freebate (Annual Cost Offset)	$ -	$ -	$ 500	$ 500	$ 6,300	$ 2,000
Federal Battery Warranty*	$ -	$ -	$ 2,550	$ 1,000	$ 5,100	$ 5,100
Total	$ 3,000	$ 1,000	$ 5,638	$ 3,500	$ 12,438	$ 6,138

* Can only be used to fund battery replacement. Assumed use 1x/vehicle lifetime: 8

*PHEV conversions come w 5 yr battery warranty Or an annualized amount of: $ 638

Allocation of Gas Tax Proceeds	*Allocation %*	1 2010	2 2011	3 2012	4 2013	5 2014	6 2015	7 2016	8 2017	9 2018	10 2019	11 2020	12 2021
Fund Management	*3.0%*	$ 380,236	$ 385,351	$ 390,230	$ 395,057	$ 399,098	$ 399,176	$ 399,345	$ 397,018	$ 390,648	$ 381,559	$ 371,018	$ 359,393
Demand Reduction		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Efficient Vehicle Incentive	*66.0%*	$ 8,365,197	$ 8,477,727	$ 8,585,055	$ 8,691,262	$ 8,780,147	$ 8,781,872	$ 8,785,594	$ 8,734,389	$ 8,594,257	$ 8,394,297	$ 8,162,397	$ 7,906,648
County Visitor Shuttle Service	*0.5%*	$ 63,373	$ 64,225	$ 65,038	$ 65,843	$ 66,516	$ 66,529	$ 66,558	$ 66,170	$ 65,108	$ 63,593	$ 61,836	$ 59,899
Add'l Deisel-Hybrid Public Buses	*1.0%*	$ 126,745	$ 128,450	$ 130,077	$ 131,686	$ 133,033	$ 133,059	$ 133,115	$ 132,339	$ 130,216	$ 127,186	$ 123,673	$ 119,798
Pilot Deisel-Hybrid School Buses	*1.0%*	$ 126,745	$ 128,450	$ 130,077	$ 131,686	$ 133,033	$ 133,059	$ 133,115	$ 132,339	$ 130,216	$ 127,186	$ 123,673	$ 119,798
Biodeisel Cars and Trucks Incentive	*6.0%*	$ 760,472	$ 770,702	$ 780,460	$ 790,115	$ 798,195	$ 798,352	$ 798,690	$ 794,035	$ 781,296	$ 763,118	$ 742,036	$ 718,786
Ethanol/FF Conversion Kit Incentive	*12.5%*	$ 1,584,318	$ 1,605,630	$ 1,625,957	$ 1,646,072	$ 1,662,907	$ 1,663,233	$ 1,663,938	$ 1,654,240	$ 1,627,700	$ 1,589,829	$ 1,545,909	$ 1,497,471
Sustainable Energy Supply		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Smart Grid Upgrades for PHEV Chargi	*5.0%*	$ 633,727	$ 642,252	$ 650,383	$ 658,428	$ 665,163	$ 665,293	$ 665,575	$ 661,696	$ 651,080	$ 635,932	$ 618,963	$ 598,988
Outreach and Education Fund	*1.0%*	$ 126,745	$ 128,450	$ 130,077	$ 131,686	$ 133,033	$ 133,059	$ 133,115	$ 132,339	$ 130,216	$ 127,186	$ 123,673	$ 119,798
Contingency Fund	*4.0%*	$ 506,982	$ 513,802	$ 520,306	$ 526,743	$ 532,130	$ 532,235	$ 532,460	$ 529,357	$ 520,864	$ 508,745	$ 494,691	$ 479,191
	100.0%	$ 12,674,541	$ 12,845,041	$ 13,007,659	$ 13,168,578	$ 13,303,252	$ 13,305,867	$ 13,311,506	$ 13,233,923	$ 13,021,602	$ 12,718,633	$ 12,367,269	$ 11,979,769

Effect of Tax on Gas Consumption	Type Tax Rate Preference:	1 2010	2 2011	3 2012	4 2013	5 2014	6 2015	7 2016	8 2017	9 2018	10 2019	11 2020	12 2021
Use **Real** or **Nominal** Tax Rate?	Nominal												
Real Effect of Price Elasticity		(3.64%)	(3.64%)	(3.64%)	(3.64%)	(3.64%)	(3.64%)	(3.64%)	(3.64%)	(3.64%)	(3.64%)	(3.64%)	(3.64%)
Effect of Inflation on Nominal Prices		100.00%	99.01%	98.03%	97.06%	96.10%	95.15%	94.20%	93.27%	92.35%	91.43%	90.53%	89.63%

2. Impact

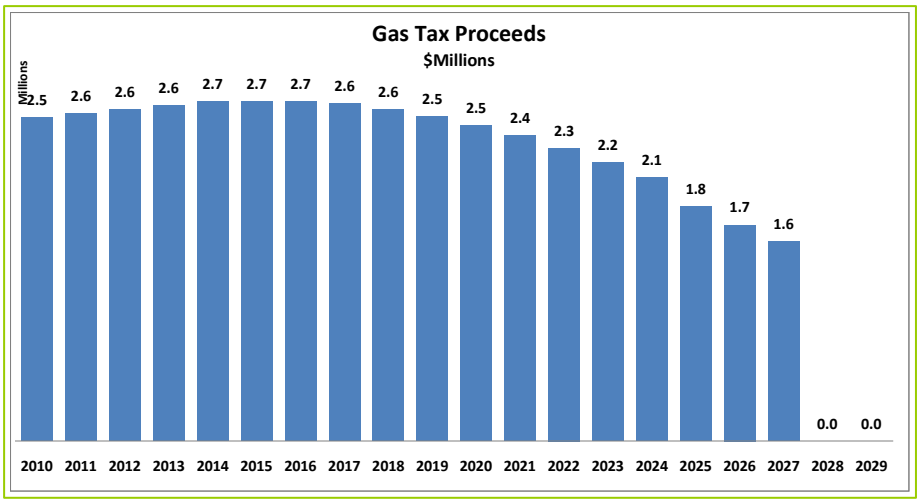
The residents of Kaua`i currently pay 13¢/gallon as a County Fuel Tax, according to the Tax Foundation of Hawaii.[7] Assuming the *2% Fossil Fuel Tax* on gasoline and diesel is legislated, and if gasoline was around $3.40/gallon, 2% of that price = 7¢/gallon added to the price of gasoline and diesel from imported oil. So, the total county tax on fossil fuels would be 20¢/gallon.

The SENTECH Hawai`i Team estimates that the resulting $42.6M *Alternative Ground Transportation Modes & Fuel Fund* would be developed in the pattern illustrated in Figure 4-3. Notably, the funds would drop off as demand is reduced over time. Kaua`i may also want to limit fund raising to 17-18 years —to allow the remaining funds to be allocated.

[7] Tax Foundation of Hawai`i (n.d.). *Taxes in Hawaii*. Retrieved on 7/27/10 from http://www.tfhawaii.org/taxes/fuel.html.

The SENTECH Hawai1i Team also estimates that imported oil demand would be reduced by a few percentage points over the 20-year time period of the 2% Fossil Fuel Tax, with the primary impact seen in the first 5 years.

Figure 4-3: Gas Tax Funds



In terms of meeting energy sustainability goals, since the fuel tax has been drastically reduced, energy sustainability goals in the ground transportation sector will also need to be adjusted downward. Yet it is important to begin the transition by taking first steps such as making the public bus system more attractive for riders to use, supporting local ethanol production, encouraging more efficient vehicles, and looking forward to a time when renewable electricity from the grid can charge up electric vehicles.

Several non-energy social and national security benefits would accrue to Kaua`i. *New York Times* columnist Thomas Friedman discusses some of the potential benefits from an oil or fuel tax:

> *Such a tax would make our economy healthier by reducing the deficit, by stimulating the renewable energy industry, by strengthening the dollar through shrinking oil imports and by helping to shift the burden of health care away from business to government so our companies can compete better globally. Such a tax would make our population healthier by expanding healthcare and reducing emissions. Such a tax would make our national-security healthier by shrinking our dependence on oil….*[8]

3. Relevant Policies

The Kaua`i County Fuel Tax is 13¢/gallon at present. The entire spectrum of other fossil fuel tax policies should be taken into account so the total tax burden on the community is not too burdensome as the *2% Fossil Fuel Tax* is being considered:

- A State Barrel Tax is being considered in the Hawai`i Legislature.
- The nominal Federal Gas Tax at 18.4 ¢/gallon has not been raised since 1993. Adjusted for inflation, the value of the Federal Gas Tax has declined in real terms by nearly 40% since 1993 and is half of what it was in the 1960s.[9]

Several other policies are in place that obviated the need to explore them under KESP as a way to reduce fossil fuel consumption. For example:

[8] Friedman, Thomas (September 19, 2009). *Real Men Tax Gas.* The New York Times. Retrieved on 7/27/10 from http://www.nytimes.com/2009/09/20/opinion/20friedman.html?_r=3&hp.

[9] Progressive States Network (June 9, 2008). *State Policies for a $4/Gallon World*. Retrieved on 7/27/10 from http://www.progressivestates.org/node/21924.

- The $4.2 billion, six-year State's *Highways Modernization Plan* (HMP) was unveiled in January of 2009, by Governor Linda Lingle, together with Senate Transportation Chair Kalani English, House Transportation Chair Joe Souki and State Transportation Director Brennon Morioka. The statewide plan would implement critical highway projects and programs aimed at reducing traffic congestion, improving highway safety, maintaining roads, and saving motorists time and money. The HMP includes 22 projects on Kaua`i with a total cost of $263 million. About $115 million of this cost is for projects aimed to address congestion issues. Implementation of the HMP is pending the Hawai`i State Legislature's approval, which was not achieved in the 2009 legislative session.[10]
- In 2009 the State Legislature approved a *Complete Streets* bill. "Act 54 (SB 718) requires state and county transportation departments to accommodate access and mobility for all users of public highways, including pedestrians, bicyclists, and persons of all abilities. The Complete Streets law is being hailed as a touchstone for transportation planning and design that takes into account Hawai`i's aging population."[11]
- According to the State Department of Transportation, it is currently executing contracts to implement high priority projects identified in *Bike Plan Hawai`i*. Kimura International is developing an implementation plan, which will include bike accommodations in highway widening road improvements, i.e., the Kuhio/Kaumuali`i Highways widening project. [12]
- The County of Kaua`i has also been constructing a 16-mile coastal bike and pedestrian trail running from Nawiliwili to Anahola since 1994. Construction on the bike/pedestrian trail began in 1999 and is being completed in six phases, expected to be completed within 10 years.[13] Each phase requires its own environmental assessment report process and design/build process. The total cost of the entire trail system is anticipated to be in the range of $30 million.[14]

Kaua`i can further reduce its ground transportation demand in the future by creating a long-term and comprehensive *Integrated Ground Transportation Demand Management Plan,* which has proven successful around the world. International cities like Copenhagen, Zurich, and Curitiba, Brazil, and American cities such as Boulder, Portland and Boston are demonstrating that a carefully fashioned and integrated package of demand management strategies can significantly reduce auto-dependency and petroleum-based fuel use, while building livable, efficiently functioning and prosperous communities.

Two long-term ground transportation plan processes are forthcoming:[15]

- The State has secured consultants for an update of the Long Range Land Transportation Plan for Hawaii, which will include a Kaua`i component. The existing plan, adopted in 1997, calls for a 6-lane road between Wailua-Kapa`a and Lihu`e, a 4-lane road from Lihu`e to Koloa, and a 4-lane road between Waimea and `Ele`ele.
- Additionally, the County will soon initiate a multi-modal land transportation plan, with focus on

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[10] State of Hawai`i Department of Transportation (2009). *Highway Modernization Plan*. Retrieved on 7/20/10 from http://hawaii.gov/dot/highways/modernization

[11] AARP Hawai`i (March 23, 2010). *Complete Streets Law Will Help Plan for Needs of Older Drivers and Pedestrians*. Retrieved on 7/27/10 from http://www.aarp.org/home-garden/livable-communities/info-03-2010/complete-streets-law-will-help-plan.html.

[12] Presentation given to Kaua`i Energy Sustainability Plan Transportation Stakeholder group by Hawai`i Deputy Director State Department of Transportation (April 28, 2009).

[13] Personal communication, Doug Haigh, County of Kaua`i, July 2009.

[14] MacDougall and Associates (June 2005). *Bike Path Overview, Nawiliwili to Anahola Bike/Pedestrian Path*. Retrieved on 7/20/10 from http://www.kauai.gov/Government/Departments/PublicWorks/BuildingDivision/BuildingDivisionProjects/AhukiniLydgateBikePathProject/tabid/335/Default.aspx

[15] JoAnn Yukimura. Personal communication with: Doug Hinrichs (SENTECH Hawai`i Team). July 2009.

the Kaua`i Bus as the public transit option. This plan will provide a timely opportunity to envision and plan for an efficient high quality public transit system that will benefit Kaua`i for years to come. It will also be an opportunity to integrate the ongoing work of Kimura International in developing an implementation component for *BikePlan Hawai`i*. The County's multi-modal plan will do well also to incorporate the work of CH2MHill on the State wide pedestrian plan and the *Complete Streets* work that the County must do as well as coordinate with the Long Range Ground Transportation Plan Update.

Measures of a Long Range Ground Transportation Plan may include:

- Holding per capita vehicle miles traveled (VMT) to reasonable levels.
- Increasing total resident transit mode share.
- Establishing a data gathering and performance monitoring and reporting system to build and maintain public credibility and to guide adjustments to programs and measures over time.[16]

4. Implementation

The following table lays out recommended actions, costs, responsible parties, and timeline to implement the recommendation.

Implementation of Recommendation 4.1: To Reduce Consumption of Fossil Fuels, Pass 2% Fossil Fuel Tax

Recommended Action	Costs	Responsible Parties	Timeline
Levy 2% tax on gasoline and diesel from imported oil to build *Alternative Ground Transportation Modes & Fuels Fund.*	NA	• Kaua`i County Council • Kaua`i Tax Department	2010-2011
Administer *Alternative Ground Transportation Modes & Fuels Fund*, funded by 5% fee which would also allow community outreach and education activities by the Sustainable Energy Team.	$2,130,000	• Sustainable Energy Team	2011-2028

5. Funding Source

2% Fossil Fuel Tax.

[16] Ibid.

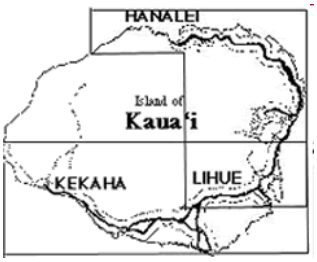
RECOMMENDATION 4.2: To Reduce Consumption of Fossil Fuels, Improve *Kaua`i Bus* System

1. Rationale

Public Transportation

Bus ridership is a much more fuel-efficient form of ground transportation than individual vehicle commuting, and the SENTECH Hawai`i Team recommends that the County bus system extend its geographic service (current service area is pictured in Figure 4-4[17]), increase route frequency, and extend evening and weekend hours to accommodate community interests. Certain infrastructure improvements and amenities—such as more Park-and-Rides, bus shelters, and surf board racks—might also entice more people to ride the bus and give up individual vehicle commuting. The Team saw a great deal of support in improving the Kaua`i Bus system during its latest visit in 2010.

Figure 4-4: The Kaua`i Bus Service Routes: Kekaha to Hanalei



The Team now recommends that the bus system be improved to:

- Extend geographic service to underserved neighborhoods.
- Increase route frequency to increase convenience.
- Extend evening and weekend hours.
- Add surfboard racks to the buses to encourage visitors to use the bus.
- Add wireless Internet capability to 20 of the system's fleet to encourage younger people (and tech-savvy folks of all ages) to use the bus.
- Add Park'n'Rides and bus stop shelters, with neighborhood competition for shelters.
- Replace buses with diesel-hybrid buses—which get 68% better fuel economy than traditional diesel buses, at no additional cost once incentives are utilized.

The following table lays out improvements, details and costs in these areas:

Recommended Kaua`i Bus Improvements

Improvement	Details	Capital Costs	Labor Costs
Increased Frequency During Peak Commuter Times (every ¼ hour for 2 hours in AM and 2 hours in PM during commute times, M-F)	Routes: • Kekaha to Līhu'e • Hanalei to Līhu'e • Līhu'e to Kekaha • Līhu'e to Hanalei	10 vehicles, $918,099	NA
Later Routes (every hour until 11:00 PM, M-F)	Routes: • Līhu'e to Kekaha • Līhu'e to Hanalei • Paratransit-comparable times	4 vehicles, for $524,628	NA

[17] County of Kaua`i Website (2010). Retrieved on 7/27/10 from http://www.kauai.gov/Government/Departments/TransportationAgency/BusSchedules/tabid/208/Default.aspx.

Sunday Service (similar to current Saturday/holiday reduced schedule)	Routes: Similar to Saturday/holiday reduced schedule	NA (current fleet can be used)	$230,152
Additional Weekend Service (similar to current M-F schedule)	Similar to current M-F schedule (less commuter frequency / paratransit contracted routes)	NA (current fleet can be used)	$429,520
10 Bus Shelters	County would hold a competition for community groups to design, build and decorate the shelters built to professional standards.	$50,000 in materials for 10 bus shelters	$50,000 for professional architect/design services
5 Park and Ride Sites	Average of $200,000 per site to acquire land, grade, and construct parking substructure	$100,000 x 5 sites = $500,000	$100,000 x 5 sites = $500,000
20 Surf Racks	To entice inhabitants and visitors to ride bus to/from beaches	$1,000 x 20 = $20,000	NA (County could install)

2. Impact

Recent improvements to the bus system yielded a 24% increase in ridership over two years. Hopefully, similar ridership increases could be achieved with this recommendation.

Funds from the *Alternative Ground Transportation Modes & Fuels Fund* should available for this recommendation in years 2011-2012.

3. Relevant Policies

N/A

4. Implementation

The following table lays out recommended actions, costs, responsible parties, and timeline to implement the recommendation:

Implementation of Recommendation 4.2: To Reduce Consumption of Fossil Fuels, Improve Kaua`i Bus System

Recommended Action	Costs	Responsible Parties	Timeline
Extend service and range, add surfboard racks, add wireless Internet to 20 buses for 5 years, build 5 Park-and-Rides, and build 10 shelters.	$3,300,000	• Kaua`i County Council • Kaua`i Tax Department • Kaua`i Office of Economic Development	2010-2012

5. Funding Source

2% Fossil Fuel Tax.

RECOMMENDATION 4.3: To Reduce Consumption of Fossil Fuels, Offer Hybrid Electric Vehicle Incentives

1. Rationale

Corporate Average Fuel Economy (CAFE) Standards Already Addressed

CAFE fuel efficiency standards for vehicles are tightening up on the federal and state level, so the SENTECH Hawai`i Team felt it unnecessary to target efficiency standards for vehicles for the KESP.

In May 2009, the Obama Administration announced new CAFE regulations that reconciled both federal and state standards. The plan combined California's strict emission rules with the federal rule, raising the national fleet mileage to around 42 mpg for cars and approximately 26 mpg for light trucks by 2016 – an increase over the current standards of 27.5 mpg for cars and 24 mpg for trucks. According to the *New York Times*, the auto industry isn't expected to challenge the new rules as they finally set both a definitive time table and a national standard.[18]

Rather than making the regulatory "stick" larger with even more strict CAFE standards or other regulatory approaches to increasing more efficient fuel use, the SENTECH Hawai`i Team recommends that Kaua`i take the complementary "carrot" approach by offering incentives for the purchase of more efficient vehicles which can essentially double the fuel efficiency, measured in miles per gallon (mpg) that a vehicle owner can attain. Part of the transportation solution for Kaua`i may include not only replacing fossil fuels with renewable fuels like ethanol and biodiesel, but also shifting the end-use from liquid-fueled vehicles to hybrid electric vehicles (HEVs).

Making Efficient HEVs Affordable

Figure 4-5: Toyota and Honda HEV Examples

HEVs operate on a combination of batteries and liquid fuels, and are already commercially available from a variety of auto manufacturers. The batteries in these vehicles are recharged directly from the engine through combustion of liquid fuels for greatly increased fuel efficiency.

HEV products are currently available for passenger cars, transit buses, and commercial vehicles. There are well known electric/gasoline passenger HEVs, e.g. from Toyota[19] and Honda[20], as pictured in Figure 4-5.

HEVs cost more than standard vehicles, but consumers will pay less to operate HEVs over time; vehicles that use electricity more than liquid fuels cost about half as much to own/operate as fueled vehicles, according to transportation expert Terry Penney from the National Renewable Energy Laboratory.[21] Incentives would make HEVs cost the same as conventional internal combustion vehicles and allow drivers to realize significant cost savings since HEVs use an

[18] Motavalli, Jim (May 19, 2009). *Obama to Raise Fuel-Economy Standards*. New York Times. Retrieved on 7/27/10 from http://wheels.blogs.nytimes.com/2009/05/19/obama-to-raise-fuel-economy-standards/.
[19] Toyota Prius Website (2010). Retrieved on 7/27/10 from http://www.toyota.com/prius-hybrid/photo-gallery.html.
[20] Honda Civic Hybrid Website (2010). Retrieved on 7/27/10 from http://automobiles.honda.com/civic-hybrid/exterior-photos.aspx.

estimated 40% less gasoline than conventional internal combustion vehicles, depending on the car type, make, and model.[22]

2. Impact

It is unclear when funds from the *Alternative Ground Transportation Modes & Fuels Fund* would become available for this recommendation, and it is impossible to predict how the community will react to HEV incentives, so it is difficult to measure impact in terms of fuel demand reductions.

HEVs use an estimated 40% less fuel than internal combustion engines.[23] In the future, the Kaua`i Office of Economic Development (OED) could estimate the impact of HEVs by multiplying the number of HEVs purchased by fuel savings.

3. Relevant Policies

Federal and State incentives exist for HEVs, which have been taken into account in the HEV incentive calculations.

4. Implementation

The following table lays out recommended actions, costs, responsible parties, and timeline to implement the recommendation.

Implementation of Recommendation 4.3: To Reduce Consumption of Fossil Fuels, Offer Hybrid Electric Vehicle Incentives

Recommended Action	Costs	Responsible Parties	Timeline
Support $2,500 HEV incentive program for 5,000 cars. Incentives offered through and administered by auto dealers.	$12,500,000	• Kaua`i County Council • Kaua`i Tax Department • Auto dealers	2012-2017

5. Funding Source

2% Fossil Fuel Tax.

[21] Penny, Terry (National Renewable Energy Laboratory). Personal Communication with: Doug Hinrichs (SENTECH Hawai`i Team) at the Hawai`i Clean Energy Initiative Transportation Working Group meetings. 10/20/2009.
[22] Honda News Release (February 6, 2002). *2003 Honda Civic Hybrid*. Retrieved on 7/27/10 from http://www.honda.com/newsandviews/article.aspx?id=2003112038499.
[23] Ibid.

RECOMMENDATION 4.4: To Reduce Consumption of Fossil Fuels, Support "As Needed" Visitor Vehicle Rentals

1. Rationale

Kaua`i is home to 679 visitor properties and 9,203 units, as detailed in Figure 4-6.[24]

Figure 4-6: Visitor Properties in Kauai, 2008

2008 Island of Kauai Inventory of Visitor Accommodations by Property Type		
Property Type	**Number of Properties**	**Number of Units**
Apartment/Hotel	3	8
Bed and Breakfast	30	110
Condominium Hotel	37	2,556
Hostel	1	40
Hotel	13	2,575
Individual Vacation Unit	567	1,621
Timeshare	19	2,276
Other	9	17
Total	679	9,203

On the electricity side, many green hotels are thriving and are defined as environmentally-friendly properties whose managers are eager to institute programs that save water, save energy and reduce solid waste-while saving money. There is even a *Green Hotels Association* which hotels on Kaua`i may join to learn how other hotels supports the greening of the lodging industry.[25]

Being green goes directly to a higher long-term value of hotel property[26]:

- When energy-saving measures are introduced—such as energy management systems, fluorescent bulbs, ceiling fans, linen cards, lights out cards, motion sensors for public restrooms, meeting rooms, exercise rooms, etc.—energy bills are reduced.
- When water-saving equipment and techniques are introduced, such as low-flow showerheads, 1.5 gallons per minute (gpm) aerators, serving water on request only in restaurants, 1.6 gpm dishwashing valves, low-flow toilets, waterless urinals, toilet tank fill diverters in older toilets and linen cards, water bills are reduced dramatically.
- Waste hauling is a huge expense for a hotel which can be lowered drastically through recycling and avoiding wastefully-packaged products. Hoteliers can ask vendors to deliver products in minimal wrapping. Vendors can be asked to deliver products one day, and pick up the packaging materials the next day. For example, a *Chicago Hyatt* reduced their waste hauling by 80%.
- Sooner or later all properties will be sold, and any green property will demand a higher price because its value is much enhanced by lower utility bills per square foot, its healthier aspects and owner care.

On the ground transportation side, there is less progress. Some hotel industry experts estimate that there are about 6,000 - 8,000 rental cars on the island, a much different scenario from the visitor industry transportation situation just a few years ago when tour buses dominated the landscape. Kaua`i is small enough where you can travel from one end to the other in a day and see quite a bit on your own time/schedule and not have to follow that of a tour. Many of these large tour companies with big buses have gone out of business and Kaua`i now has several companies with smaller vans.

Many of Kaua`i's visitors are repeat visitors—they know where they want to go and they like the convenience of being able to get in their cars to go to their favorite beach, hiking trail, restaurant, etc. Relying on overnight rentals, insurance, amenity costs, hidden fees and surcharges, traditional rentals can

[24] DBEDT (2008). *Visitor Plant Inventory 2008.* Retrieved on 7/27/10 from http://hawaii.gov/dbedt/info/visitor-stats/visitor-plant/vpi2008.pdf.
[25] Green Hotels Association Website (2010). *Why Should Hotels Be Green?* Retrieved on 7/27/10 from http://greenhotels.com/index.php.
[26] Ibid.

be very expensive and encourage excess driving. In addition, the majority of vehicles available are not fuel-efficient and most companies do not offer hybrid vehicles–if they are available, it's through limited availability for a considerable premium. Most car rental companies are not in locations adjoining or readily accessible from hospitality locations, requiring customers to walk, take a cab, shuttle, or a bus to pick up the rental car.

As is, rented visitor vehicles sit unused for hours; most Kaua`i visitors use their rental cars during only 30-40% of their stay, according to Grand Hyatt officials.[27] Providing hourly sharing of alternative energy vehicles only when visitors need the vehicles will reduce traffic congestion and reduce vehicular emissions while enhancing visitors' experience through a more convenient and cost-effective mode of personal-vehicle transportation.

Figure 4-7: Green Car Hawaii

One Hawai`i-based start-up business, pictured in Figure 4-7, will provide visitors more convenient, cost-effective and efficient modes of transportation to better explore and enjoy the island. [28] The company will initially form partnerships with hotel and timeshare operators to offer car-sharing of hybrid and electric vehicles exclusively to their guests for an all-inclusive hourly fee.[29]

The enabling technology to coordinate hourly rentals of these vehicles is comprised of a customized software and hardware interface that will allow for direct vehicle access from valet services and automatic reservation check-in and out. By using this system, the company will be able to track and monitor car usage, location and availability with a limited staff and employee infrastructure. Upon any scheduled reservation (whether by phone, internet, mobile device, concierge, or kiosk), guests receive a confirmation number for their specific reservation and use this number to receive a voucher from the in-lobby kiosk. Each voucher is electronically bar-coded allowing for electronic (keyless) access to their reserved vehicle and confirmation of usage. Upon receipt of their voucher, the guest will present it at Valet Services and their vehicle will be brought directly to them to use for the duration of the reservation. The guest will return the car to the valet at the end of their reservation and will be automatically checked out--no waiting, no documents to sign, and no hassle.

Figure 4-8: Grand Hyatt Kaua`i

The start-up will launch its pilot operation on Kaua`i through a Hospitality Partnership with *The Grand Hyatt Kaua`i* in Poipu, as pictured in Figure 4-8.[30]

To launch a progressive initiative such as this, it will take literally millions of dollar. If Kaua`i wants to support the greening of the visitor transportation sector, it will need to commit monetary support to the initiative to reduce costs and risks to entrepreneurs.

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[27] Nelson, Shane (July 19, 2010). *Car rental company pilots a green alternative*. Travel Weekly. Retrieved on 7/27/10 from http://www.library.cornell.edu/resrch/citmanage/apa.
[28] Green Car Hawai`i Website (2010). Retrieved on 7/27/10 from http://www.greencarhawaii.com/.
[29] Ibid.
[30] Nelson, Shane (July 19, 2010). *Car rental company pilots a green alternative*. Travel Weekly. Retrieved on 7/27/10 from http://www.library.cornell.edu/resrch/citmanage/apa.

2. Impact

It is unclear when funds from the *Alternative Ground Transportation Modes & Fuels Fund* would become available for this recommendation, and it is impossible to predict the efficacy of a new venture such as described above, so it is difficult to measure impact in terms of fuel demand reductions. If results on Kaua`i mirror results from the Zipcar experience on some college campuses, Kaua`i can expect to see fewer visitor vehicles on the road and parked in destination parking lots, and to see more alternative fuel/mode vehicles on the roads.

- The University of Florida Zipcar car sharing fleet is increasing the total number of cars to rent on campus as it aims to reduce demand for parking and associated congestion while offering students a convenient, economical and environmentally friendly alternative to owning a car. Vehicles in the fleet are available for use 24 hours a day, seven days a week. The cars are now located in four self-service reserved locations and are available to all staff and students aged 18 and over. Gas, maintenance, insurance, reserved parking and roadside assistance are included within reasonable hourly and daily rates. For universities, Zipcar offers a practical and proven solution to managing demand for parking, reducing congestion and emissions and adding a lifestyle-oriented service to campus. Studies have shown the cost of a single parking spot ranges from $4,000 to $120,000 per spot, depending on whether it's an outdoor surface lot or underground garage. Since each Zipcar replaces 15 to 20 personally owned vehicles, a university could reduce the need for 30 to 40 parking spots costing up to $1.1 million by just putting two Zipcars on campus.[31]

If preference is given to ethanol, biodiesel, or other alternative transportation fuels for a car-sharing program on Kaua`i, this recommendation could help the State reach its biofuels goals.

Certain non-energy benefits have been described in Figure 4-9 from *Green Car Hawaii:*[32]

Figure 4-9: Non-Energy Benefits of a Car Share Program

	GUEST MEMBER BENEFITS	HOSPITALITY PARTNER BENEFITS	GreenCar Hawaii BENEFITS
COST	Guests only pay for a car as needed on an hourly basis; the cost-conscience visitor does not have to pay for gas or insurance (it is a cost saving and inclusive service). Additional savings are realized when guests can avoid paying hotel overnight parking fees.	Hospitality Partners have an opportunity to capture greater percentage of the tourist budget (GCH shares their revenue with the hotel).	Produces a meaningful return to investors, reduces carbon emissions and enhances our position for tax incentives.
CONVENIENCE	The guest experience is significantly enhanced as the car rental portion of a visit typically provides unnecessary stress (lines, fees, complicated forms, terms, insurance choices). Having instant access to vehicles that are waiting at the hotel valet is a convenience that improves the entire travel experience.	HP's enhance their service offerings for guests enabling better customer satisfaction and greater guest re-capture upon return visits.	Delivers an immediate benefit to Hawaii: vitalize hospitality revenue, introduce & promote "green" technology, reducing traffic and carbon emissions.
EXPERIENCE	Guests have access to a new fleet of Hybrid vehicles to explore Hawaii and experience the latest alternative energy "green" automotive technology. It allows tourists to feel good about being a responsible visitor and appreciate the natural beauty of Hawaii.	HP's provide a "green" alternative to the standard guest-transportation model taking advantage of the growing interest in Eco-tourism. Additionally, hotels can make a positive impact on Hawaii's environment.	Builds upon success to expand "Green Umbrella" initiatives for Hawaii. Incrementally delivering alternative energy models and creating good jobs for the local Hawaiian economy.

[31] Zipcar (September 3, 2009). *Florida revs up Zipcar campus car-share program*. Retrieved on 7/27/10 from http://zipcar.mediaroom.com/index.php?s=43&item=148.
[32] Green Car Hawai`i Website (2010). Retrieved on 7/27/10 from http://www.greencarhawaii.com/.

3. Relevant Policies

In 2006 and 2007, several significant legislative measures related to biofuels and ethanol were implemented in the Hawai`i legislature:

- Act 240 (SLH 2006) created an alternate fuel standard (AFS) for the State, with a goal to provide 10% of highway fuel demand from alternate fuels by 2010; 15% by 2015; and 20% by 2020.
- Act 159 (SLH 2007) established an energy feedstock program within the State Department of Agriculture.
- Act 162 (SLH 2006) strengthened and clarified Hawaii's Renewable Portfolio Standard (RPS), including biofuels as a renewable energy source.

In April 2006, Hawai`i's 10% ethanol content requirement for gasoline established by Act 199 (SLH 1994) took effect. The State also provides an investment tax credit for ethanol equal to 30% of nameplate capacity per year for the first 40 million gallons, and a reduction in State and local fuel taxes.[33] The mandate increases to 20% by 2020.

4. Implementation

The following table lays out recommended actions, costs, responsible parties, and timeline to implement the recommendation.

Implementation of Recommendation 4.4: To Reduce Consumption of Fossil Fuels, Support "As Needed" Visitor Vehicle Rentals

Recommended Action	Costs	Responsible Parties	Timeline
Develop and release competitive solicitation to develop hourly visitor vehicle rental program with preferences given to efficient vehicles such as EVs, HEVs, and those using locally grown biofuels such as ethanol and biodiesel.	$2,000,000	• Kaua`i County Council	2018-2019

5. Funding Source

2% Fossil Fuel Tax.

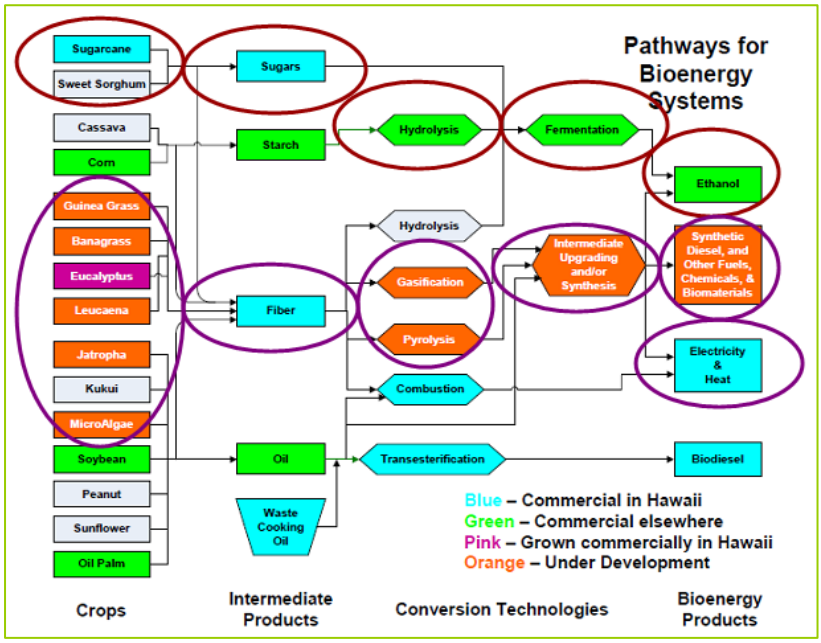
[33] Hawai`i Natural Energy Institute (2009). *Hawai`i Bioenergy Master Plan Project*. Retrieved on 7/20/10 from http://www.hnei.hawaii.edu/bmpp/stakeholders.asp.

RECOMMENDATION 4.5: To Increase Renewable Fuel Production/Use, Purchase 5 Vegetable Oil Presses to Allow Small Farmers to Produce *Straight Vegetable Oil*

1. Rationale

Figure 4-10, from the *Hawai`i Bioenergy Master Plan* (circled regions done by the SENTECH Hawai`i Team), shows a diverse and perhaps confusing array of bioenergy pathways.[34]

Figure 4-10: Bioenergy Pathways



The biomass-to-ethanol pathway (red circles in Figure 4-10) should be based on sugar cane and sweet sorghum feedstock for Kaua`i—as the Pac West project will do—due to proven feedstock, competitive yields, and a well understood sugars/hydrolysis/fermentation conversion pathway.

Several different Biomass-to-Liquids technologies are currently either under development or being implemented for other outputs such as synthetic diesel, or biodiesel. They differ as to the way the biomass is treated and gasified and in the synthesis process. After mechanical preparation, the biomass is either treated thermally or subjected to direct gasification. The synthetic gas extracted in entrained-flow gasification or fluidized bed gasification is purified, conditioned and finally synthesized to fuel. The best-known methods for this are the Fischer-Tropsch process, which is already under use throughout the world in coal-to-liquid and gas-to-liquid plants, and processes which produce methanol at an intermediate stage.

The SENTECH Hawai`i Team recommends that Kaua`i choose Biomass-to-Liquids gasification conversion pathway (shown in Figure 4-10 as purple circles indicating a variety of biomass crops/fiber/gasification pathway) as the only biofuels pathway for several reasons:

- Due to Kaua`i's small energy economy, it is important to maintain any economies of scale from one conversion pathway, rather than two or more pathways which would in essence compete with each other.
- Gasification converts any carbon-containing material into a synthesis gas ("syngas") that can be converted to biodiesel or a variety of other outputs. This variety of inputs will allow developers to utilize many crops, including bagasse, trees, even algae remnants if an algae-to-fuels industry is commercialized on the island. Potential inputs into a gasification system include:
    - Banagrass is a high-yielding grass well suited for Kaua`i that could be integrated into a biomass-to-liquids pathway.
    - The leucaena tree that has good potential to be a biomass feedstock for biodiesel. In the early years of its planting, leucaenas were often called "miracle trees" for their success as fast-growing, multipurpose, nitrogen fixing trees in the tropics. Several leucaena species

[34] Ibid.

are characterized by rapid growth, are highly palatable to animals, and produce dense firewood. Over 50 species hybrids are now under study in Hawai`i for growth, form, psyllid resistance, cold tolerance and fodder quality. Many hybrids have high commercial potential notably in cooler climates and on certain acid soils where LEUC is an economic failure. New varieties are increasingly available from breeding programs in Hawaii, Australia, Taiwan and Indonesia. Leucaenas require inoculation with specific *Rhizobium* in order to nodulate and grow well. Under suitable conditions, leucaenas have produced wood yields similar to the best of tropical trees.[35]

- Oil crops do not appear to be economically feasible at this time, for a variety of reasons. Palm oils, for example, have high yields/acre, yet require significant amounts of low-paying manual labor to make them cost-effective—and there is little low-paying labor force on Kaua`i. Jatropha (pictured in Figure 4-11[36]) can grow on marginal lands and avoid the food/fuel debate perhaps, but yields from this plant will not allow large-scale production at any economy of scale.

Figure 4-11: Jatropha

- Emerging yet commercial Biomass-to-Liquid gasification technologies from companies such as TRI will turn a variety of crops and even Municipal Solid Waste (MSW) into biodiesel—or ethanol or power—depending on what pencils out the best at any particular time period. TRI gasification technology provides wide biomass feedstock flexibility coming in, with a broad range of potential end products going out—including ethanol, biodiesel, and/or energy. By producing multiple products, a biorefinery can take advantage of the differences in biomass components and intermediates and maximize the value derived from the biomass feedstock.

- The SENTECH Hawai`i Team believes that the algae-to-liquid fuels pathway will become more economically feasible in the not-too-distant future and could supply enough biodiesel to provide for the Island's ground transportation and electricity generation needs. Algae-to-liquid fuel yields have not yet been accurately determined, but DOE is reported as saying that algae yield 30 times more energy per acre than land crops such as soybeans.[37] DOD is supporting research to achieve yields of 3,000-5,000 gallons/acre.[38] The advantages of algae are that it can be grown on non-arable land such as deserts or in marine environments, and the potential oil yields are much higher than from plants.[39] Algae-to-Liquids could revolutionize biodiesel production and would bring "high tech farming" jobs to Kaua`i.

Until Biomass-to-Liquid and/or Algae-to-Liquid pathways become commercial, small farmers on Kaua`i can grow jatropha or other vegetable crops on marginal lands to produce Straight Vegetable Oil (SVO), on a small scale, to meet niche markets. Consumers of the biodiesel range from individuals using neat (100%) biodiesel in farm equipment to off-roaders using biodiesel or blends for recreation purposes to the County of Kaua`i Public Works Department that uses a B5 blend in all its vehicles and equipment. In

[35] Nitrogen Fixing Tree Association (May 1990). *Leucaena: An Important Multipurpose Tree.* Retrieved on 7/20/10 from http://www.winrock.org/fnrm/factnet/factpub/FACTSH/Leucaena_sp.html.
[36] Raintree (1996). *Jatropha Pictures*. Retrieved on 7/20/10 from http://www.rain-tree.com/Plant-Images/jatropha-pic.htm.
[37] The Washington Post (January 6, 2008). *A Promising Oil Alternative: Algae Energy.* Retrieved on 7/20/10 from http://www.washingtonpost.com/wp-dyn/content/article/2008/01/03/AR2008010303907.html.
[38] Federal Energy Management Program, Pacific Command (October, 2009). Presentation at: HCEI Working Group Plenary Session attended by Doug Hinrichs (SENTECH Hawai`i Team).
[39] Briggs, Michael (August 2004). *Widescale Biodiesel Production from Algae*. UNH Biodiesel Group (University of New Hampshire).

discussions with Kaua`i Bus, older buses without engine warranty concerns could be used to test SVO in buses. In doing so, Kaua`i will be supporting small farmers and diversifying potential biodiesel/SVO supply for the Kaua`i Bus system.

Figure 4-12: Multi-Crop Press

To facilitate SVO production on-island, the SENTECH Hawai`i Team recommends that the County purchase 5 multi-crop presses that could be shared by small farmers on a neighborhood basis. Agricultural condos that are required to produce agricultural products, Kauaian Institute, Kaua`i Farm Fuels, and the Farm Bureau could play the role of coordination.

Locally produced SVO could potentially be mixed with collected oils to increase economies of scale. Used cooking oil from Kaua`i's residences, hotels, and restaurants would seem to be the most cost-effective, waste-reducing and sustainable energy sources available. The County of Kaua`i is working to establish residential used cooking oil collection points at the Lihu`e and Hanapepe Transfer Stations. Kaua`i Grease Traps has been contracted to haul the used oil for processing to Kaua`i Farm Fuels, which has been producing biodiesel in Hanapepe since 2007.[40] The anticipated start date of oil collection and processing is August of 2009.[41] Kaua`i can utilize the residential used cooking oil from these collection points, as well as its hotel and restaurant industries, as a cost-effective biodiesel resource using a successful mode from Maui.

Pacific Biodiesel, Inc. was conceived in 1995 in response to serious environmental and health concerns surrounding unmanageable quantities of used cooking oil at the Central Maui Landfill. Robert King, then owner of King Diesel that maintains the landfill's generators, proposed converting the restaurant waste into biodiesel that would fuel the generators. Within a year, his proposal was a reality. The original small-scale plant was one of the first commercially viable biodiesel plants in the U.S.[42] A significantly smaller environmental footprint can be obtained by reducing the need for long distance shipping of feedstock to, and product from, a biodiesel refinery. The economic advantages to the community are maximized through local investment and ownership and the creation of jobs, all of which keep profits in the community.

2. Impact

With this recommendation, Kaua`i will be supporting small farmers, and diversifying potential biodiesel/SVO supply for the Kaua`i Bus system.

If County of Kaua`i Public Works Department buses are tested for SVO compatibility, this recommendation will also be adding to the body of data surrounding unprocessed SVO in commercial diesel applications.

[40] The Garden Island (March 18, 2008). *County to explore using biodiesel for its vehicles.*
[41] Fraley, Allison (Solid Waste Program Coordinator, County of Kaua`i). Personal communication with: Doug Hinrichs (SENTECH Hawai`i Team). July 2009.
[42] Pacific Biodiesel Website (2009). Retrieved on 7/27/10 from http://www.biodiesel.com/index.php/company/about_pacific_biodiesel_inc.

3. Relevant Policies

County of Kaua`i Public Works Department that uses a B5 blend in all its vehicles and equipment.

In 2006 and 2007, several significant legislative measures related to biofuels were implemented in the Hawai`i legislature:

- Act 240 (SLH 2006) created an alternate fuel standard (AFS) for the State, with a goal to provide 10% of highway fuel demand from alternate fuels by 2010; 15% by 2015; and 20% by 2020.
- Act 159 (SLH 2007) established an energy feedstock program within the State Department of Agriculture.
- Act 162 (SLH 2006) strengthened and clarified Hawai`i's Renewable Portfolio Standard (RPS), including biofuels as a renewable energy source.

4. Implementation

The following table lays out recommended actions, costs, responsible parties, and timeline to implement the recommendation.

Implementation of Recommendation 4.5: To Increase Renewable Fuel Production/Use, Purchase 5 Vegetable Oil Presses to Allow Small Farmers to Produce Straight Vegetable Oil

Recommended Action	Costs	Responsible Parties	Timeline
Purchase 5 multi-oil crop presses @ $2,000 apiece that can be shared across 5 neighborhoods to allow small farmers and agricultural condos to produce a small amount of Straight Vegetable Oil for niche markets.	$10,000	• Kaua`i County Council	2015-2020 (depends on when crops are grown)

5. Funding Source

2% Fossil Fuel Tax.

RECOMMENDATION 4.6: To Increase Renewable Fuel Production/Use, Offer Incentives to Convert Gasoline Vehicles to Gasoline/Ethanol Flex Fuel Vehicles

1. Rationale

Despite a storied history in growing sugarcane, Kaua`i land owners and developers have been hesitant to commit land and resources to sugar-to-ethanol after the global sugar market collapsed because of market uncertainties, competing land uses, etc. Land owners, sugar farmers, ethanol developers, and biorefinery financiers rightfully felt the need to reduce their risk, to ensure that their Internal Rate of Return will be sufficient to commit land for 10-20 years, to assess exit strategies if ethanol demand drops precipitously, and to guarantee that once the ethanol is produced, that it will have a market to buy it.

On October 14, 2009, KIUC signed a landscape-changing agreement with Pacific West Energy, LLC (PacWest) for a 15M gallons of ethanol/year project to come online by April 2012 in a consortium called Ag-Energy. The project to be operated by PacWest, will provide renewable sourced energy for approximately 30% of Kaua`i's annual electrical use. Cane juice processed from the island's sugarcane will provide feedstock for the ethanol plant; bagasse, the sugarcane fiber remaining after water and sugar is eliminated in the mill, will provide fuel for a 20 MW power plant.[43]

PacWest is negotiating with the state Department of Land and Natural Resources (DLNR) and state Department of Hawaiian Home Lands (DHHL) and private entities for acreage in addition to what is available from Gay and Robinson (G&R). Of G&R's roughly 7,000 acres from Hanapepe to Waimea, 3,400 have been leased to Dow Agronomics for corn, with Pacific West anticipating to lease 4,250 acres to resume growing of sugar.[44] The company is also seeking to lease around 4,000 acres of state land in Kekaha and mauka of Kekaha for sugar, tree crops and other biomass plantings, and eventually seeks to lease around 15,000 acres of Westside land for the project.[45]

Phase one of the multi-faceted project involves investment of $100 million, at least a portion of which he hopes to secure through a low-interest loan or loans from the U.S. Department of Agriculture's Rural Utilities Service. Phase one projects include investing in efficiency improvements in agriculture and mill operations for improved feedstock preparation and sugar and energy yields; expanding sugar-cane cultivation to idle former sugar lands; developing biomass (trees for wood chips, etc.) on non-sugarcane suitable lands; modifying the existing G&R boiler and installing a new boiler; and installing new steam turbine generators.[46]

To grow the market for locally produced ethanol, the SENTECH Hawai`i Team recommends that Kaua`i purchase inexpensive conversion kits which would let regular gasoline engine cars use ethanol in a Flex Fuel configuration. The State's ethanol blending mandate could also be met with locally produced ethanol.

<u>Modeling Success from Brazil</u>

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[43] Pacific West Energy, LLC (2009). *Kaua`i Project*. Retrieved on 7/27/10 from http://pacificwestenergy.com/KauaiProject.aspx.
[44] Curtis, Paul (December 12, 2009). *G&R to lease assets for sugar-to-energy*. Retrieved on 7/27/10 from http://thegardenisland.com/news/local/article_36b9be7f-eb92-5540-8b70-c847f0834613.html.
[45] Ibid.
[46] Sustainability in Hawai`i. *Carbon cloud lifts over Kaua`i ethanol plant: No coal.* Retrieved on 7/27/10 from http://kauaian.net/blog/?p=916.

SECTION 4: RECOMMENDATIONS FOR THE GROUND TRANSPORTATION SECTOR

To make the most of ethanol produced on-island, Kaua`i can learn from Brazil's success story with efficient ethanol, gasoline, and hybrid vehicles. Brazil is emerging as the leader in developing new fuel injection technology for vehicles to run on 100% ethanol (also called E100), such as the Honda Civic Flex. To make their new fleet of flex-fuel cars adaptable to varying ethanol/gasoline content, in 2000 Brazilian engineers created complex sensor software systems which can precisely calibrate the engine performance according to the fuel mix.[47]

Future Developments to Track

A 2004 Massachusetts Institute of Technology (MIT) study identified a method of using ethanol to achieve fuel efficiency at a more cost-effective rate compared to current HEVs. [48] The method consists of using direct-injection of ethanol (or methanol, another alcohol that could substitute ethanol in this case) and gasoline, in any ratio up to 100% of either, in a turbocharged, high compression-ratio, small-displacement engine having performance similar to an engine having twice the displacement. Each fuel is carried separately, with a much smaller tank for the ethanol/ methanol. The high-compression (which increases efficiency) engine will run on ordinary gasoline under low-power cruise conditions. Alcohol is directly injected into the cylinders (and the gasoline injection simultaneously reduced) only when necessary to suppress a "knock" that occurs during changes in the engine, such as when significantly accelerating. Direct cylinder injection raises the already high octane rating of ethanol up to an effective 130. The engines are calculated to use as much as 30% less gasoline than an ordinary engine while still proving high performance. The cost of such engine modifications is estimated at $1,000, plus the cost of adding a couple of gallons of ethanol every few months. The consumer cost payback time shows a 4:1 improvement over turbo-diesel and a 5:1 improvement over hybrid vehicle technolgy.[49]

A separate area of research and development activity that could be beneficial for Kaua`i to track is in the area of cellulosic ethanol production, where the cellulose part of a plant is broken down to sugars and subsequently converted to ethanol. Cellulosic ethanol can be produced from any plant material, potentially doubling yields, in an effort to minimize conflict between food needs vs. fuel needs. Instead of utilizing only the starch by-products from grinding wheat and other crops, cellulosic ethanol production maximizes the use of all plant materials, including gluten.[50]

And finally, a third area for Kaua`i to track is the alternative process to produce bio-ethanol from algae that is being developed by several companies. Rather than grow algae and then harvest and ferment it, the algae grow in sunlight and produce ethanol directly, which is removed without killing the algae. It is claimed the process can produce 6,000 gallons per acre per year compared with 400 gallons for corn production.[51] Among algal fuels' attractive characteristics: they may be produced without a large impact

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[47] Adams, David (October 17, 2005). *Ethanol: Is it the answer?* St. Petersburg Times. Retrieved on 7/27/10 from http://www.sptimes.com/2005/10/17/Worldandnation/Ethanol__Is_it_the_an.shtml .

[48] Cohn, D.R., Bromberg, L., Heywood, J.B. (April 20, 2005). *Direct Injection Ethanol Boosted Gasoline Engines: Biofuel Leveraging for Cost Effective Reduction of Oil Dependence and CO2 Emissions.* Massachusetts Institute of Technology. Retrieved on 7/27/10 from http://www.psfc.mit.edu/library1/catalog/reports/2000/06ja/06ja016/06ja016_full.pdf.

[49] Stauffer, Nancy (October 25, 2006). *MIT's pint-sized car engine promises high efficiency, low cost*. Laboratory for Energy and the Environment. Retrieved on 7/27/10 from http://web.mit.edu/newsoffice/2006/engine.html.

[50] Inderwildi, O.R., King, D.A. (2009). *Quo Vadis Biofuels*. Energy & Environmental Science 2: 343. doi:10.1039/b822951c.

[51] LaMonica, Martin (June 12, 2008). *Algae farm in Mexico to produce ethanol in '09*. Green Tech. Retrieved on 7/27/10 from http://news.cnet.com/8301-11128_3-9966867-54.html.

on fresh water resources, can be put on marginal land,[52] and can be produced using ocean[53] and wastewater[54],.

If cellulosic and/or algae-to-ethanol processes prove to be technically and economically feasible on Kaua`i, developers could build on the successes of PacWest and other ethanol pioneers.

2. Impact

It is unclear when funds from the *Alternative Ground Transportation Modes & Fuels Fund* would become available for this recommendation, the PacWest project has not commenced, and it is impossible to predict how the community will buy into ethanol/gasoline Flex Fuel vehicles, so it is difficult to measure impact of this recommendation in terms of fuel demand reductions.

Under ideal conditions, future ethanol blend requirements and gasoline demand can probably be met with ethanol from sugarcane by 2030, especially if significant numbers of HEVs, EVs and PHEVs are purchased on-island which would reduce gasoline/ethanol demand.

If cellulosic and algae processes become commercially viable, Kaua`i could become a net exporter of ethanol, creating jobs and economic development.

3. Relevant Policies

In 2006 and 2007, several significant legislative measures related to ethanol were implemented in the Hawai`i legislature:

- Act 240 (SLH 2006) created an alternate fuel standard (AFS) for the State, with a goal to provide 10% of highway fuel demand from alternate fuels by 2010; 15% by 2015; and 20% by 2020.
- Act 159 (SLH 2007) established an energy feedstock program within the State Department of Agriculture.
- Act 162 (SLH 2006) strengthened and clarified Hawaii's Renewable Portfolio Standard (RPS), including biofuels as a renewable energy source.

In April 2006, Hawaii's 10% ethanol content requirement for gasoline established by Act 199 (SLH 1994) took effect. The State also provides an investment tax credit for ethanol equal to 30% of nameplate capacity per year for the first 40 million gallons, and a reduction in State and local fuel taxes.[55] The mandate increases to 20% by 2020.

4. Implementation

The following table lays out recommended actions, costs, responsible parties, and timeline to implement the recommendation:

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[52] Sandia National Laboratories (October 7, 2009). *Turning algae into energy*. Retrieved on 7/27/10 from https://share.sandia.gov/news/resources/news_releases/turning-algae-into-energy/.
[53] ScienceDaily (June 28, 2008). *Algae from the ocean may offer a sustainable energy source of the future*. Retrieved on 7/27/10 from http://www.sciencedaily.com/releases/2008/06/080626145543.htm.
[54] ScienceDaily (August 19, 2008). *Algae: Biofuel of the future?* Retrieved on 7/27/10 from http://www.sciencedaily.com/releases/2008/08/080818184434.htm.
[55] Hawai`i Natural Energy Institute (2009). *Hawai`i Bioenergy Master Plan Project*. Retrieved on 7/20/10 from http://www.hnei.hawaii.edu/bmpp/stakeholders.asp.

Implementation of Recommendation 4.6: To Increase Renewable Fuel Production/Use, Offer Incentives to Convert Gasoline Vehicles to Gasoline/Ethanol Flex Fuel Vehicles

Recommended Action	Costs	Responsible Parties	Timeline
Offer $2,000 incentives for 5,000 vehicles, once funds are available. Auto dealers would work with the County to administer the incentives.	$10,000,000	• Kaua`i Office of Economic Development • Vehicle dealers	2015-2030 (depending on availability of ethanol)

5. Funding Source

2% Fossil Fuel Tax.

RECOMMENDATION 4.7: To Increase Renewable Energy Use for Ground Transportation, Offer PHEV Incentives and Support Night-Time Charging Infrastructure

1. Rationale

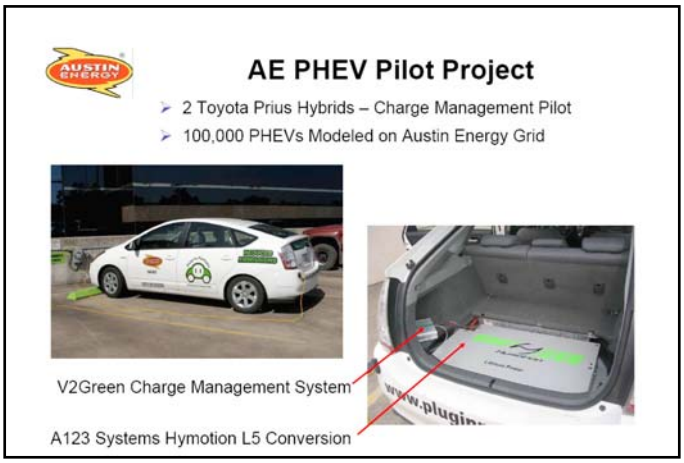
Shifting Demand from Fuels to Electricity

Shifting transportation fuel demand from liquid fuels to electricity has the potential to increase total grid efficiency, or its utilization factor. Implementing a smart grid with smart vehicle chargers would allow communication of price signals to the vehicle charger, and would help to mitigate reliability concerns. In the long-term, it is envisioned that PHEVs could utilize smart chargers with a smart grid to provide high-value energy storage for the grid. Vehicle batteries could not only be used to supply the grid on a real-time, as-needed basis, but could also provide backup power to homes during emergencies or grid blackouts. Some energy experts envision using PHEVs as a way to provide energy storage to the grid or to islanded microgrids. Having these types of functionality, as illustrated in Figure 4-13[56], would require implementation of a smart grid.

Figure 4-13: Smart Grid Illustration

PHEVs differ from HEVs in that PHEVs typically have much larger battery packs (and therefore greater electric range), and must have their battery packs charged by the electric grid. PHEVs can provide 50 to 90% of EV fuel displacement.[57] The most sustainable approach to charge PHEVs is to utilize the output of off-peak energy by plugging them in at night. PHEVs are gaining in popularity because of their ability to travel nominal distances using little to no petroleum-based fuel in their all-electric range. According to the Electric Power Research Institute (EPRI), half of the cars in the U.S. are driven just 25 miles a day or less.[58] Kaua`i would seem to be an ideal venue for PHEVs because of relatively short commuting

Figure 4-14: Austin Energy PHEV Study: Presentation Slide



[56] Department of Energy (n.d.). *Smart Grid.* Retrieved on 7/27/10 from http://www.oe.energy.gov/smartgrid.htm.
[57] Gremban, Ronald (June 2007). *PHEVs: The Technical Side*. California Cars Initiative. Retrieved on 7/27/10 from http://www.calcars.org/downloads.html.
[58] Sanna, Lucy (2005). *Driving the Solution: The Plug-In Hybrid Vehicle*. EPRI Journal. Retrieved on 7/27/10 from http://mydocs.epri.com/docs/CorporateDocuments/EPRI_Journal/2005-Fall/1012885_PHEV.pdf.

distances, which therefore does not require a long-range battery between charges.

PHEVs can be less expensive to operate than conventional vehicles because using grid electricity to recharge the vehicle is cheaper than petroleum fuels. Austin Energy (AE), a municipally owned utility in Texas, assessed PHEVs charged by renewable energy at night (See Figure 4-14). For the assessment, PHEVs were defined as cars outfitted with a battery pack sufficient to power the vehicle for 35 miles or more on battery power alone. AE determined that a PHEV could get up to 100 miles per gallon of gasoline and that the cost of an "electric" gallon of gas was estimated to be less than $1.00.[59]

Product Availability

Major automotive companies are actively working to get PHEVs to the marketplace:

- General Motors (GM) recently released information about the Chevy Volt that will be released in 2011. GM claims that the Volt will travel 40 miles on battery power alone, and that it can achieve 230 MPG on highways, or over 100 MPG for a combined city/highway average. GM estimates the Volt's total driving range to be 640 miles, which is about double that of most conventional hybrids. The Volt will include an "intelligent" control module that allows plugging in to either 120 or 240 volt household circuits. GM estimates the Volt's battery can be charged in less than three hours via a 240 volt outlet, or in about eight hours with a 120 volt outlet.[60]
- Toyota has also indicated that they will add plug-in capability to the Prius as early as 2011.[61] With the number of HEV options increasing, buyers will be able to weigh all the "green car" options with regard to initial cost versus payback time, and even potentially consider net environmental impacts.

The April 2010 rollout of the all-electric Nissan Leaf (pictured in Figure 4-15[62]) electric vehicle may pave the pathway for PHEVs. The Leaf has been met with critical acclaim and has the following attractive features[63]:

- 0-60 in 10 seconds
- 100 mile range
- 8-hour battery charge with a 220-volt outlet (the standard 110-volt outlet will take 14-hours for the battery to charge)
- Battery weighs same as a standard internal combustion engine, drive train, and gas tank
- Cost ~$25,000 (after incentives)

Figure 4-15: Nissan Leaf

Making PHEVs Affordable

[59] Austin Energy Website (2009). *Plug-In Austin*. Retrieved on 7/27/10 from http://www.austinenergy.com/about%20us/environmental%20initiatives/plug-in%20hybrid%20vehicles/index.htm
[60] Poole, Chris (March 2009). *2011 Chevrolet Volt Review and Prices.* Consumer Guide Automotive. Retrieved on 7/27/10 from http://consumerguideauto.howstuffworks.com/2011-chevrolet-volt.htm.
[61] Schefter, Kellen (October 1, 2007). *Toyota Prius Plug-In Hybrid*. Green Car. Retrieved on 7/27/10 from http://www.greencar.com/articles/toyota-prius-plug-hybrid.php.
[62] Cars Globe (July 29, 2010). *Nissan Leaf New Wheels*. Retrieved on 7/27/10 from http://cars-globe.blogspot.com/2010/07/nissan-leaf-new-wheels.html.
[63] Nissan Website (n.d.). Retrieved on 7/27/10 from http://www.nissanusa.com/leaf-electric-car/index?dcp=ppn.39666654.&dcc=0.216878497#/leaf-electric-car/index.

SECTION 4: RECOMMENDATIONS FOR THE GROUND TRANSPORTATION SECTOR

While the federal government already offers a variety of incentives and tax credits to encourage the purchase of more efficient vehicles, these incentives are rarely sufficient to off-set some of the initial costs for most consumers. Typically, a HEV costs about 20% more than a similar conventional vehicle, a conversion kit and installation are another $5,000 on top of that, and a PHEV is a further $5,000 or more. Though, over the life of the vehicle, investments in efficiency, whether through the purchase of a HEV, conversion kit, or PHEV undoubtedly return their value—particularly in a county like Kaua`i, that not only pays high prices to import gas and diesel, but is also small enough to use PHEV technology to its full advantage. Nevertheless, given the upfront financing costs, these federal incentives are not enough to enact the kind of change that Kaua'i is capable of undertaking, and that will save consumers millions of dollars and gallons of fuel.

The SENTECH Hawai`i Team proposes that the *Alternative Ground Transportation Modes and Fuels Fund* be used to offer incentives to purchase PHEVs that are charged up with night-time renewable electricity from hydropower and biomass/biodiesel as these resources become more available (e.g. 2020). Incentives would also be offered for residential PHEV chargers with controls to ensure night-time charging only; and to upgrade Smart Grid control capabilities.

Conversion kits such as the ones used in the Austin Energy PHEV pilot project, shown at right, are commercially available already and typically cost around $5,000, of which Federal incentives cover nearly the full cost. Moreover, they can effectively double the mpg-based efficiency of already twice as efficient (versus conventional) hybrid vehicles, offering a combined 75% reduction in current gas or diesel consumption levels at virtually no additional cost to the consumer.

How Many PHEVs?

To calculate how many PHEVs could be charged at night with excess renewable energy, KIUC recommended considering hydropower and biomass, which if not used at night would be dumped.

If KESP Target **hydropower** goals are met (see Section 6), there would be, by 2030:

- 22 MW = 22,000 kW of capacity
- 55% capacity factor of 8766 hours = 106,068,600 annual kWh
- Charging would take place at night, or 8/24 hours = 35,356,200 annual night-time kWh
- Divide by 365 days/year = 96,866 daily night-time kWh
- Divide by 20 kWh/PHEV[64] = 4,843 PHEVs

Applying the same methodology for **biomass**, there would be, by 2030:

- 30 MW = 30,000 kW of capacity
- 86% capacity factor of 8766 hours = 226,162,800 annual kWh
- Charging would take place at night, or 8/24 hours = 75,387,600 annual night-time kWh
- Divide by 365 days/year = 206,541 daily night-time kWh
- Divide by 20 kWh/PHEV[65] = 10,327 PHEVs

By this method, about 15,000 PHEVs can be charged with night-time renewable energy and be strategically integrated into the Island's new vehicle fleet over time. Because of budget constraints, to ensure that KIUC has plenty of capacity to keep Kaua`i powered at night, and to be conservative on how many people would take advantage of the incentives, the Team recommends that Kaua`i offer $5,000 incentives for up to 5,000 PHEVs.

[64] SENTECH (n.d.). Unpublished report on PHEVs, using Chevy Volt as test case.
[65] Ibid.

PHEV Conversion Kits cost about $5,000 and would have a payback in fewer than 6 years through reduced gas use. If 5,000 vehicles are being targeted for PHEVs conversion from HEVs, the total is $25,000,000.

2. Impact

The Leaf could impact the visitor industry on Kaua`i. Nissan has developed a joint venture with Hertz, the world's largest general market rental brand, to bring car rental to the US and Europe in 2011.

It is unclear when funds from the *Alternative Ground Transportation Modes & Fuels Fund* would become available for this recommendation, and it is impossible to predict how the community will buy into PHEVs, so it is difficult to measure impact of this recommendation in terms of fuel demand reductions. Generally, PHEVs can effectively double the mpg-based efficiency of already twice as efficient (versus conventional) hybrid vehicles, offering a combined 75% reduction in current gas or diesel consumption levels at virtually no additional cost to the consumer.

3. Relevant Policies

American Recovery and Reinvestment Act (ARRA) funds are being used to upgrade KIUC Advanced Metering Infrastructure—one part of a Smart Grid. Perhaps other ARRA funds would be available for follow-on activities that include PHEV charging.

4. Implementation

The following table lays out recommended actions, costs, responsible parties, and timeline to implement the recommendation.

Implementation of Recommendation 4.7: To Increase Renewable Energy Use for Ground Transportation, Offer PHEV Incentives and Support Night-Time Charging Infrastructure

Recommended Action	Costs	Responsible Parties	Timeline
$5,000 PHEV incentive program for 2,000 PHEVs and residential chargers programmed to only charge at night	$10,000,000	• Kaua`i Office of Economic Development • Vehicle dealers	2015-2030
Support Smart Grid charging infrastructure	$2,500,000	• KIUC	2015-2030

5. Funding Source

2% Fossil Fuel Tax.