King County

1200 King County Courthouse
516 Third Avenue
Seattle, WA 98104

KING COUNTY

Signature Report

July 15, 2014

Motion 14184

Proposed No. 2014-0150.1 **Sponsors** Dembowski and Phillips

A MOTION accepting a report by the fleet administration division on strategies and actions to increase drivers' use and understanding of alternative fuel technology vehicles as required in Motion 13982 and Ordinance 17671.

WHEREAS, in accordance with K.C.C. 2.16.140.D, the fleet administration division is responsible for acquiring, maintaining and managing the motor pool and equipment revolving fund for fleet vehicles and equipment including, but not limited to, vehicles for the department of natural resources and parks, facilities management division, and transportation nonrevenue vehicles, and

WHEREAS, the fleet administration division provides fleet support services to most county agencies, and

WHEREAS, efficient and effective management of a fleet of diverse vehicles and equipment is the core business of the fleet administration division, and

WHEREAS, the fleet administration division uses data-driven decision making and fleet management best practices to provide cost effective and environmentally responsible vehicles for its client agencies, and

WHEREAS, the county has shown leadership in the acquisition and use of alternative fueled and advanced technology vehicles, and

WHEREAS, the use of alternative fueled and advanced technology vehicles represents an important contribution to reduce greenhouse gas emissions generated by the operation of county vehicles, consistent with the King County Strategic Plan and the county's Strategic Climate Action Plan, and

WHEREAS, the introduction of new alternative fueled and advanced technology vehicles requires special considerations, such as range of vehicle, currently available or needed fueling or charging infrastructure, time required to refuel or charge the vehicle and expected maintenance and repair requirements and intervals, and

WHEREAS, acceptance of new alternative fueled and advanced technology vehicles requires a plan for introduction and integration into the fleet, and

WHEREAS, Motion 13983, providing for review of the county's light duty vehicle utilization policy with regards to electric vehicles in the county fleet and passed by the council in October 2013, requests that the executive transmit by March 31, 2014, for acknowledgement of receipt by motion, strategies and actions to increase drivers' understanding of alternative fuel technology vehicles, and an update to the 2009 Light Duty Vehicle Utilization Policy, including an evaluation period for categories of vehicles with alternative fuel technologies, and

WHEREAS, Section 1.A.3.c of Ordinance 17671, adopted in October, 2013, directed fleet managers to transmit to the council by March 31, 2014, for acknowledgement of receipt by motion, an alternative fuel technology vehicle integration plan describing necessary and appropriate steps towards the successful integration of alternative fuel vehicles into the county fleets, and;

NOW, THEREFORE, BE IT MOVED by the Council of King County:

The Alternative Fuel Technology Vehicle Report and Integration Plan, included as Attachment A to this motion, summarizing the analysis and recommendations for the integration of alternative fueled and advanced technology vehicles into the county's fleet

and the proposed changes to the county's light duty vehicle utilization policy, is hereby accepted.

Motion 14184 was introduced on 4/7/2014 and passed by the Metropolitan King County Council on 7/14/2014, by the following vote:

Yes: 8 - Mr. Phillips, Mr. von Reichbauer, Mr. Gossett, Ms. Lambert, Mr. Dunn, Mr. McDermott, Mr. Dembowski and Mr. Upthegrove
No: 0
Excused: 1 - Ms. Hague

KING COUNTY COUNCIL
KING COUNTY, WASHINGTON

Larry Phillips, Chair

ATTEST:

Anne Noris, Clerk of the Council

Attachments: A. Alternative Fuel Technology Vehicle Report and Integration Plan

Alternative Fuel Technology Vehicle Report and Integration Plan

Prepared for:

King County Executive

King County Council

Prepared by:

Fleet Administration Division

March 2014

King County

Fleet Administration Division

Department of Transportation

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Alternative Fuel Technology Vehicle Report and Integration Plan

INTRODUCTION

This report is being transmitted to the King County Council in response to Council Motion 13982 and Ordinance 17671 directing the Executive to transmit a report responding to Council on the strategies and actions implemented to increase utilization and acceptance of alternative fuel technology vehicles. This report also provides an alternative fuel technology vehicle integration plan focusing on the alternative vehicles in the King County fleet, including the six electric vehicles (EVs), and 19 liquid petroleum gas (LPGs) vehicles.

This report also chronicles King County's long engagement with alternative fuels and advanced technology vehicles, efforts to reduce operational impact on the environment, and leadership on climate impact issues. In the process we look at the rapidly changing field of choices available for obtaining the most sustainable transportation options. As mandated by Motion 13982 and Ordinance 17671, the report offers a template for evaluating new technologies, adopting and integrating the most suitable ones into the County's fleets in order to achieve the County's Strategic Climate Action Plan (SCAP) Goals as well as the SCAP: Goal S.1, which requires the County to "provide and encourage the use of sustainable transportation choices," and Objective S.1.2 which speaks to the increased use of "alternative transportation vehicles and technologies." It also furthers the goals of Environmental Sustainability in the King County Strategic Plan. Strategy ES-4.c requires that the county, "invest in alternative fuel transit and fleet vehicles to reduce emissions, fuel use, and fuel costs." By strategically integrating alternative fueled and advanced technology vehicles into the fleet, the County will reduce energy consumption and greenhouse gas emissions while continuing to reduce the County's operational costs.

Today, the alternative technology vehicles available to fleets are well engineered, high performance vehicles that provide attractive, cost effective options to reduce dependency on fossil fuels. This allows agencies such as King County to reduce their carbon footprint and harmful tailpipe emissions. Some of the new alternative vehicle and fuel technologies currently being tested by the County include electric vehicles (EV), liquid petroleum gas (LPG, autogas, or propane) and hybrid vehicles.

Between 2011 and 2013, King County purchased 31 electric sedans (EVs). Six of these vehicles were acquired by Fleet Administration Division to replace existing County fleet vehicles. The other 25 were placed in the County's Metro Transit MetroPool program where they became the largest electric rideshare program in the country. In 2013, the fleet of 25 MetroPool vehicles reported greenhouse gas (GHG) emission reductions of over 230 metric tons.

The other alternative fuel vehicle technology recently introduced into the County fleet was liquid petroleum gas (LPG). After gasoline, LPG is one of the most extensively used automotive fuels in the world. It is a byproduct of natural gas and petroleum refining processes. LPG releases 12 percent less carbon dioxide (CO_2) and 25 percent less GHG than gasoline into the environment when used as an automobile fuel (http://www.roushcleantech.com/content/emissions). Through a grant funded by the American Recovery and Reinvestment Act (ARRA), the County was able to purchased 18 LPG pickups and vans. The first two vehicles were placed in service in 2010 and over the next three years the additional 16 were gradually integrated into the fleet. Since then, the vehicles have been closely monitored for performance, return on investment and driver acceptance. So far, our monitoring has revealed that the

vehicles cost less to operate and the drivers experience no loss of power, require no special training to operate the vehicles. However, the vehicles have to be refueled more frequently and some drivers have expressed a concern with this shortcoming.

In addition to electric and LPG powered vehicles, Fleet Administration purchases the newest generation of hybrid technology as replacement vehicles whenever possible. Hybrid vehicles are now available in most vehicle classes, can integrate well into all areas of county operations including medium and heavy-duty applications, and do not require specialized infrastructure.

HISTORY OF ALTERNATIVE VEHICLES IN KING COUNTY FLEET

King County has long been a leader in the adoption of alternative fuels and advanced technology vehicles. Between 1991, when 25 Sheriff's vehicles were first converted to compressed natural gas (CNG), and 1995, a total of 271 dual fueled CNG vehicles were introduced into the County's police fleet. The conversion of those first vehicles to CNG marked the beginning of King County's movement toward the use of alternative fueled and advanced technology vehicles. The County quickly became the largest CNG fleet of its kind in North America. To support the fleet of CNG vehicles, the County built three slow fill CNG fueling facilities.

In 2001, the County made the strategic decision to integrate hybrid vehicles into the fleet. Hybrid vehicles are defined as vehicles that draw propulsion energy from on-board sources of stored energy, usually both an internal combustion engine and a rechargeable energy storage system.

King County maintained its leadership in the clean vehicle arena with the formation of the Northwest Hybrid Heavy-duty Truck Consortium in 2005. This regional consortium consisted of 14 cities and counties within the Puget Sound region. As lead agency for the Consortium (See Appendix A for a list of the Consortium members), the King County Fleet Administration Division secured $400,000 in grants from the Environmental Protection Agency and Federal Highway Administration's Congestion and Mitigation Air Quality Program (CMAQ) to help offset the incremental cost of purchasing 10 pre-production hybrid trucks. The initiative was designed to help accelerate the market for hybrid truck technology by demonstrating a demand for the product and documenting the real-world performance of the units. Not all the members of the consortium opted to participate in the grant option and purchase hybrid trucks. However, through the leadership of King County, three other governmental agencies in the region did partner with the County to purchase heavy-duty hybrid trucks.

Overall, the trucks consume 30 to 35 percent less fuel than their non-hybrid counterparts and the technology is well suited for specific applications: where units use their engines to power tools and equipment while the vehicles are stationary. The King County hybrid truck fleet is made up of the following vehicles:

- 3 aerial lift trucks
- 1 field service truck (lube truck)
- 1 rollback trouble truck

Consistent with the County's commitment to advanced clean vehicle technology, the County participated in Austin Energy's 2006 National Plug-in Partners' campaign by pledging to purchase plug-in hybrid electric vehicles (PHEVs) when the technology became available and it was financially feasible to do so. With the emergence of PHEV technology, the County began introducing PHEVs into the fleet and took delivery of its first converted vehicle in September 2007.

In 2008, the County Executive sought to partner with Idaho National Laboratory (INL), the Department of Energy's (DOE) Office of Vehicle Technologies, and three other regional agencies – the City of Seattle, Port of Seattle, and Puget Sound Clean Air Agency in a PHEV research project intended for the Seattle area. The program involved 13 vehicles from partner agencies and was part of a larger nationwide study. As part of this project, the County converted four of the Toyota Priuses in its fleet to PHEVs at a cost of just over $13,000 each. The conversions were financed with matching funds from INL.

The PHEV project was designed to assess the performance of PHEVs under real world conditions and evaluate the impacts of vehicle electrification on the electricity grid. The initiative came to an end after two years. Three of the vehicles are still operating in the fleet.

King County played a leadership role as one of the 22 governmental entities that collaborated with the Puget Sound Clean Air Agency and the Clean Cities Coalition to establish the Evergreen Fleets Certification program in 2009. The program is designed to coordinate efforts by fleet managers to reduce fuel consumption and greenhouse gas emissions. The collaboration began with a resolution at the 2007 Clean Vehicles Now Conference convened by King County and culminated with the certification of the four inaugural fleets in October 2009.

This voluntary certification program recognizes fleets for making smart, environmentally responsible choices that save fuel, improve operational efficiencies, and reduce tailpipe emissions. This program was the first certification program of its kind in the nation. The County's involvement in the establishment of the program and its certification as one of the first four fleets—certification that was gained for our aggressive right-sizing policy, anti-idling policy, use of alternative fuels, and the improved efficiency of an overall reduction of 110 tons of GHGs in one year is further testament of our commitment reducing harmful vehicle emissions in the Puget Sound region.

Lessons Learned

With the introduction of a variety of alternative fueled and advanced technology vehicles into the County's fleet over a span of 18 years, a lot of experience has been accumulated with a variety of fuels and technologies. However, most have been generalizable across fuels and technologies. These can be used to inform the implementation of an effective alternative fuels and advanced vehicles integration plan and utilization policy for the King County fleet.

- Assess the viability of the technology before committing to the purchase
- Ensure that there are provisions for an adequate fueling infrastructure in place
- Assess fuel supply (including emergency scenarios)
- Conduct a life-cycle analysis to assure a reasonable return on investment
- Test the technology under operating conditions to ensure that the unit will be capable of handling the work load and to assure a seamless user experience for potential customers
- Engage potential users to gain user perspective and ensure buy-in
- Have a well-planned communication and roll out program to promote new technology/alternative fueled vehicles
- Design a user education program to introduce potential users to the new technology/fuel
- Identify duties for the vehicle that is a good match for the capabilities of the unit, the technology and/or the fuel
- Ensure that there is good technical support from the vehicle manufacturer, the dealership, or the company doing the conversion
- Ensure that fleet technicians receive appropriate training on new technologies to support in-house maintenance
- Ensure that appropriate vehicle warranties are maintained if conversions are carried out on vehicles
- Keep good records on the service, maintenance, fueling and mileage of each vehicle in order to be able to assess the performance of the technology and the return on investment for each unit and for the fleet of vehicles purchased
- Keep good records on the performance of the fueling infrastructure that supports the alternative technology vehicle

CURRENT PILOT PROGRAMS

Liquid Petroleum Gas (LPG, Propane or Autogas) Vehicles

Over a period of three years, starting in 2010, the County purchased 18 LPG pickups and vans which were partly funded by a Clean Cities/DOE ARRA grant. Compared to gasoline and other fuels, LPG reduces operational costs and lowers emissions.

Prior to introducing LPG vehicles into the County's fleet, the follow factors were taken into consideration:

- LPG fueling facilities were widely distributed throughout the region
- LPG fuel is stored under very low pressure (300 psi compared to CNG at 3,600 psi)
- LPG infrastructure could be easily and inexpensively installed
- LPG conversions were original equipment manufacturer (OEM) authorized and maintain their factory warranty
- There would be no loss of vehicle bed/storage space with the conversions
- LPG vehicles required less maintenance

The attributes of LPG have made it an alternative fuel of choice for powering motor vehicles not only here in the US but across the world. According to the US Department of Energy, it is a significantly cleaner burning fuel.

> *Compared with gasoline vehicles, propane vehicles produce significantly lower carbon monoxide, nitrogen oxide, hydrocarbon, particulate matter, and greenhouse gas emissions. In addition, propane is not a greenhouse gas when released directly into the atmosphere.*
> http://www.afdc.energy.gov/pdfs/46996.pdf

LPG is one of the more widely available alternative fuels and one of the less expensive fueling infrastructures to install. Clean Cities reports that as of October 2013, there were 2,700 stations throughout the United States. Installing LPG fueling tanks costs less than other alternative fuels because it does not have to be stored underground and does not have to be stored under high pressure.

All the research indicates that propane vehicles have a lower maintenance cost and, in some cases, an engine life of up to two times that of gasoline engines. For owners and operators, propane vehicles are seamless to operate. There is no loss of power, and stop/start and acceleration are the same as in gas vehicles. Fueling a propane vehicle is similar to fueling a conventional vehicle and takes about the same amount of time. In addition, spillage and ground contamination are not concerns with propane because any fuel that might escape dissipates into the air quickly (http://www.afdc.energy.gov/pdfs/46996.pdf).

Vehicle Utilization Data for LPGs

Table 1

Total Fuel and Mileage Data for LPG Vehicles

Vehicle Name	Vehicle Number	In-service Date	Cumulative Fuel Consumption	Cumulative Miles
Ford F250 PICKUP	EPU170	12/27/2010	3,862.50	32,787.00
Ford F250 PICKUP	EPP206	12/2/2010	4480.00	30,960.00
Ford F250 PICKUP	EPP209	3/29/2011	1,201.20	11,098.00
Ford F250 PICKUP	EPP210	2/3/2011	3,211.40	23,229.00
Ford F350 PICKUP	EPU172	4/19/2011	4480.00	30960.00
Ford F250 PICKUP	EPU174	2/28/2011	6,031.80	45,510.00
Ford F250 PICKUP	EPU175	1/2/2011	6,021.10	43,458.00
Ford F250 PICKUP	EPU176	7/11/2011	2,673.90	24,513.00
Ford F350 PICKUP	EPU196	9/18/2012	2,229.00	15,098.00
Ford F350 PICKUP	EPU197	7/30/2012	1,212.30	7,499.00
Ford F350 PICKUP	EPU198	4/30/2012	3,443.40	21,099.00
Ford F350 PICKUP	EPU199	9/11/12	1,872.00	12,993.00
Ford F350 PICKUP	EPU200	4/24/2012	3,395.70	19,883.00
Ford E250 VAN	E0P166	5/20/2011	9,962.00	54,567.00
Ford E350 VAN	EP0P56	6/20/2012	1507.70	12669.00
Ford E350 VAN	E0P167	7/23/2012	1,954.50	19,855.00
Ford E250 VAN	E0P168	3/16/2012	2,257.00	18,438.00
Ford E450 VAN	EWV292	1/30/2013	153.90	880.00

The 16 LPG pickups and vans deployed in the fleet from 2011 to 2013 replaced specific working vehicles and assumed duty cycles in various divisions and departments of the County (See Table 1 above). Ten pickups were placed in Road Services Division with duty cycles that included servicing traffic signals and performing road-maintenance. Four vans assigned to Roads were placed in the Survey and Maintenance units.

In deploying these vans and pickups, Fleet Administration personnel worked with unit supervisors to ensure the best fits for the units and the vehicles were appropriately upfitted to carry out the tasks for which they were intended. The first nine vehicles were acquired in 2010 and deployed over the course of several months as they were upfitted to meet customer specifications (see Table 1 for in-service dates).

Electric Vehicles

The first electric vehicles (EVs) were built in the early to mid-1800s but their popularity was short-lived. With the invention of the electric ignition, the internal combustion engine gained ascendency in the

mid-1920s. That is until recent years, with the impact of fossil fuel on the environment and the search for cleaner alternatives to the internal combustion engine. The turning point came in 2011 with the introduction of the first commercially available all-electric, highway capable sedan manufactured by Nissan, and the subsequent introduction of other EVs by several other vehicle manufacturers. Clean Cities lists seven commercially available models in their 2014 Vehicle Buyer's guide (http://www.afdc.energy.gov/uploads/publication/60448.pdf).

Electricity provides a viable solution addressing the need for cleaner, more sustainable energy from indigenous sources. Electrical power can be generated from clean, renewable sources such as water, and wind. This attractiveness of electricity as a transportation fuel has spurred a significant increase in research and development in the field. It has also highlighted the need for electric utility companies to assess their capacity to support the widespread adoption of electric vehicles and the need to have adequate charging infrastructure.

With the introduction of the EVs into the daily rental motor pool, frequent users and division and department heads were sent invitations to EV orientation sessions at the Goat Hill and King Street Center garages. The orientation sessions were designed to demonstrate the use of EVs and EV charging stations to potential users before making the vehicles available on the Fleet's on-line reservation system, INVERS. In addition, Nissan Leaf quick start user guides were sent out via email and these same quick start guides were laminated and placed in the consoles of each motor pool EV. The demonstration sessions were sparsely attended.

Fleet Administration acquired five EVs in 2011 and one in 2012. The first five vehicles were placed in service between November and December of 2011. The sixth went into service in August 2012. All together, the six units have accumulated just over 24,000 miles since their acquisition. Usage data is being tracked by mileage for vehicles assigned to agencies and by frequency of checkout for vehicles in the motor pool. These data indicate that the vehicles assigned to agencies have shown varied usage over the period, ranging from just over 145 miles per month, in the first quarter of 2013, to a high of approximately 370 miles per month in the fourth quarter of 2013.

Limited data is available for the checkouts in the motor pool. The usage pattern in the motor pool shows a ramp up from an average of four check-outs during the first month the vehicles were available (March), peaking at an average of 13 check-outs in September and tapering off to an average of seven in December (See Table 2 below).

Table 2
Electric Vehicle Usage Patterns in Motor Pool

EQP. NO.	E01228	E01229	E02201
MAR	1	5	5
APR	10	10	8
MAY	12	7	10
JUN	9	8	11
JUL	8	8	8
AUG	12	11	11
SEP	11	14	14
OCT	12	4	10
NOV	0	6	11
DEC	3	9	9

CURRENT LANDSCAPE

By most estimates, EVs cost less to operate than many internal combustion engine vehicles (fueleconomy.gov). Although the total cost of ownership is roughly equal to similar sized sedans in the fleet, the challenge was the significantly higher initial purchase price of these vehicles.

After Fleet Administration purchased the first Nissan Leafs, they were made available to potential customers for test drives to increase familiarity with the technology. This helped potential customers to determine the extent to which these EVs were suitable for their work units. Through this effort, three EVs were placed with General Fund agencies.

A two-month loaner program was implemented at the end of 2013 placing one of the motor pool EVs with an agency for two months free of cost. The objective was to allow agencies to which the vehicles are well suited to become sufficiently acquainted with the unit and overcome any reservations they might have about ownership.

A new instructional video is now being produced which will be widely available to motor pool users. It will be used in training sessions and sent to potential EV users. This production builds on an earlier video produced by KCTV that introduced the EV to potential clients and was designed to demystify the EV driving experience. The link to that first KCTV video is available here: http://www.youtube.com/watch?v=qhEQtbH2de4.

ALTERNATIVE FUEL VEHICLE INTEGRATION PLAN

All the alternative fueled technology vehicles now available present unique challenges. In the case of EVs, there is the higher up-front cost of vehicle acquisition, the specific challenge of limited range, and the time required to recharge a depleted battery. Even with a widely distributed energy supply system, other challenges to the widespread adoption of EVs remain. Developing adequate on-board energy storage, overcoming the range limitation and range anxiety of many potential EV users are all obstacles that demand urgent attention from planners and fleet professionals. The need to improve the range of EVs is juxtaposed against the challenge of decreasing battery recharging time. Inherent in this challenge is the fact that larger batteries with greater storage capacities will likely increase the time required to recharge these vehicles. This will invariably create some tension between the demand for EVs with a greater range and the need to recharge batteries quickly.

When making purchasing decisions about alternative fuel or advanced technology vehicles, the diversity of County services and the wide service area must be taken into consideration. There is no one-size-fits-all alternative fueled or advanced technology vehicle that works for all County agencies.

The various departments within King County have different vehicle requirements and different mileage usage patterns. For example, while driving is an integral part of providing policing services and patrol cars accumulate significant mileage, nurses use vehicles as a means of getting to specific destinations in remote communities where the vehicles are parked for long periods of time (sometimes all day) while the nurses are at work. As the Vehicle Utilization Policy was updated to incorporate alternative fueled vehicles, acknowledging these significant differences led to lower vehicle mileage standards than those set by other municipalities identified in our research.

Opportunities and Challenges for Integrating Alternative Fuel Technology

As alternative vehicle technology research has advanced, and the quality of the alternative fuels has improved, so have the opportunities for introducing these options into the County's fleet. Within the last four to five years, highway-capable EVs have become available from vehicle manufacturers. Several models of LPG and CNG pickups, vans, and trucks have come on the market and many other vehicle manufacturers continually add to the list of available options of clean vehicles.

Meeting Diverse Needs

Opportunities for integrating alternative fuel and alternative technology vehicles into the fleet vary based on some primary considerations—the vehicle type, duty cycle, and the terrain within the County that the vehicle will need to cover. Secondarily, but just as important, is the access to, and the affordability of fueling infrastructure. The availability of fuel is a major determinant in the decision-making process. The one type of alternative technology vehicle that has so far shown to have overall applicability to all aspects of County operations in all vehicle categories is the hybrid vehicle.

In most instances, alternative technology vehicles have been introduced into the fleet in collaboration with customers and have replaced vehicles that have gone out of service at the end of their natural life-cycle. In all cases, these replacement vehicles have been chosen and upfitted to meet the duty cycle of the vehicles going out of service with the jobs and the customers in mind. Understanding the customer's vehicle needs and working collaboratively to address those needs is the most critical step in removing barriers to implementation that invariably accompany any operational change.

Cost Effective Maintenance

Fleet Administration Division operates two Blue Seal certified maintenance shops that are certified to perform warranty repairs for Chrysler, Ford and General Motors. Whenever these corporations release new models, the technicians receive special training in their repair and maintenance. This provides a tremendous advantage in providing service for many of the advanced technology vehicles acquired by the County. Down-time for servicing is minimized when vehicles are serviced in-house and turn-around time is less for the customers.

The level of training varies depending on the agreement reached with the vehicle manufacturer or retrofitter. In the case of the LPG units from Roush Technologies, Fleet Administration Technicians were trained and certified to carry out the installations and service the LPG vehicles. This training was done free of charge. In the case of the EVs, all the servicing for the Nissan Leafs is done by the dealership. Although servicing requirements are minimal, the conditions laid out by the manufacturer for maintaining warranty make specific demands which are outlined in the owner's manual. However, despite the fact that all servicing of the Leaf is carried out by the dealership, a technician has been designated as the point person for EVs and has been receiving specialized training on EV technology and specifically on the Nissan Leaf.

Funding Challenges

Existing agency budgets for vehicle replacement assume in-kind replacement. As the County introduces these new vehicles into its fleets, funding models must be adjusted and agencies incur additional up-front costs associated with higher sticker prices for these vehicles. The Executive is developing a funding plan that would smooth the total cost of ownership curve by allowing agencies to access financing for the up-front costs of alternative fuel vehicles with repayment coming from operating and maintenance savings generated over the life of the vehicle. However, absent outside funding sources such as grants to cover the incremental purchase cost, agencies with budgetary constraints are reluctant to take advantage of this option.

Fueling Cost

Liquid Petroleum Gas

Prices of alternative fuels have been pegged to the price of gasoline and, in every case, they have been shown to cost less. It is also significant to note that LPG and electricity are two of the most inexpensive fuels available.

In 2013, we analyzed the cost of fueling the LPG vehicles compared to what it would have cost if the vehicles were using diesel or unleaded gasoline. The savings for LPG were significant since the cost of fueling was then $0.77 per gallon for LPG after a $0.50 per gallon tax credit from the federal government (part of the American Taxpayer Relief Act of 2012 which expired on December 31, 2013 http://www.irs.gov/pub/irs-irbs/irb13-18.pdf), compared to $3.23 for diesel and $3.01 for unleaded. Even taking into consideration the approximate $14,000 cost of converting vehicles to LPG, the fuel savings more than make up this difference over the life of the vehicles – and pollution levels are significantly reduced with LPG (See Table 3 below).

Table 3
Comparative Cost of Fueling with Propane

Scenario 1

Propane cost assumes some fueling at external sites				
		Fuel	$	
		Diesel	$	3.23
		Propane	$	1.27
		Unleaded	$	3.01
Per 100,000 miles				
Gallons of Fuel	GHG: Metric Tons	Fuel Cost	Fuel Type	Fuel Cost after $0.50/gallon Federal propane incentive
E 250 Vehicles				
11,347	65.1	$ 14,411	Propane	$ 8,737
10,881	95.9	$ 32,751	Unleaded	$ 32,751
E 350 Vehicles				
11,705	67.2	$ 14,866	Propane	$ 9,013
8,594	75.7	$ 25,869	Unleaded	$ 25,869
F 250 Vehicles				
8,895	90.3	$ 28,730	Diesel	$ 28,730
12,099	69.5	$ 15,366	Propane	$ 9,317
10,258	90.4	$ 30,878	Unleaded	$ 30,878
F 350 Vehicles				
15,329	155.6	$ 49,513	Diesel	$ 49,513
15,885	91.2	$ 20,174	Propane	$ 12,232
11,631	102.5	$ 35,008	Unleaded	$ 35,008

Scenario 2

Propane cost assumes some fueling at external sites				
		Fuel	$	
		Diesel	$	3.23
		Propane	$	1.50
		Unleaded	$	3.01
Per 100,000 miles				
Gallons of Fuel	GHG: Metric Tons	Fuel Cost	Fuel Type	Fuel Cost after $0.50/gallon Federal propane incentive
E 250 Vehicles				
11,347	65.1	$ 17,021	Propane	$ 11,347
10,881	95.9	$ 32,751	Unleaded	$ 32,751
E 350 Vehicles				
11,705	67.2	$ 17,558	Propane	$ 11,705
8,594	75.7	$ 25,869	Unleaded	$ 25,869
F 250 Vehicles				
8,895	90.3	$ 28,730	Diesel	$ 28,730
12,099	69.5	$ 18,149	Propane	$ 12,099
10,258	90.4	$ 30,878	Unleaded	$ 30,878
F 350 Vehicles				
15,329	155.6	$ 49,513	Diesel	$ 49,513
15,885	91.2	$ 23,828	Propane	$ 15,885
11,631	102.5	$ 35,008	Unleaded	$ 35,008

Electric Vehicles

Electric vehicle service equipment (EVSE) or charging stations, come in three types (or levels):

- Level 1, regular 110 or 120 volt, 8 to 12 amps, household current
- Level 2, 240 volts, 15 to 100 amps that draws about as much household power as a clothes dryer and requires special installation
- Level 3 are DC fast chargers with 480 to 600 volts, 80 to 120 amps that draw as much as 5 to 10 central air conditioning units.

The County installed six Level 2 charging stations at the Goat Hill garage and eight at King Street Center. Additionally, Level 2 charging stations are available at the King County International Airport and the Renton Road Maintenance Shop.

The EVs currently in our motor pool—the Nissan Leafs—have an EPA rating of 100 gasoline gallon equivalent (GGE) miles to the gallon. According to the US Department of Energy's Alternative Fuels Data Center (http://www.afdc.energy.gov/fuels/prices.html), the average GGE of electricity was $1.22 in October 2013. This is well below the cost of gasoline which hovered just around $3.50 for most of 2013.

Other Cost Drivers

Other costs associated with introducing alternative fuels and alternative technology vehicles into the fleet and operating these vehicles (in addition to the cost of purchasing), include upfitting, training technicians, servicing vehicles, training users, promoting the use of the vehicles, and where applicable, investing in infrastructure. In some cases, there may be need for special safety equipment and safety training. This may be necessary for high voltage or fuel that has to be stored under high pressure. In the case of infrastructure, there may be special certification requirements for underground storage of fuels such as ethanol or compressed natural gas.

Fleet Standards

The vehicle life of any alternative technology vehicle will depend on the technology, the warranty offered by the manufacturer and the track record of the vehicles once they have been successfully integrated into the fleet. Data and information provided by the manufacturer and independent sources (if available) are used to do lifecycle analyses during the research phase of the decision-making process, but ultimately monitoring the performance of the vehicles in the fleet will determine how long the vehicle can economically be retained in the fleet. For example, in 2010, Fleet Administration extended the vehicle life of 2007 model year and newer general purpose automobiles from 85,000 miles to 100,000 miles or 12 years, because starting with that model year, vehicle manufacturers of internal combustion engine (ICE) vehicles had begun offering longer standard warranties. It is with such safeguards in place that it becomes financially viable to extend the vehicle life of vehicles within an entire fleet.

In the case of alternative fueled and advanced technology vehicles, assessing whether and how long to extend the vehicle life becomes somewhat of a circular discussion. We do not extend the life without solid experiential or documented data, but the vehicles must be in service long enough to obtain such data. For example, the Nissan Leaf has limited data available and the information obtained from the Battery Study Committee that will monitor the charge capacity of the battery over time becomes critical in assessing a possible extended vehicle life. As new technologies are introduced into the fleets an

evaluation plan will be designed to monitor the vehicle lifecycle updates and presented to the King County Council with the annual transmittal of the fleet standards.

While the vehicle is under warranty, the fleets maintain it in accordance with the manufacturer's guidelines. However, we also use the pilot period to assess performance trends. In the case of the LPG vehicles, Fleet Administration has been doing oil studies to determine if it will be possible to extend the maintenance intervals within the manufacturer's guidelines and without doing damage to the engine.

Table 4

2013 Nissan Leaf Warranty Coverage Summary

Item	Coverage
Basic Coverage	36 months / 36,000 miles
Corrosion Coverage (Perforation)	60 months / unlimited mileage
Powertrain Coverage	60 months / 60,000 miles
EV System Coverage	60 months / 60,000 miles
Lithium-ion Battery Coverage	96 months / 100,000 miles
Lithium-ion Battery Capacity Coverage	60 months / 60,000 miles

It is a well-documented fact that with fewer moving parts and components than internal combustion engines, the EV requires less servicing and is likely to last much longer than a traditional vehicle. The servicing requirements outlined in the owner's manual of the Nissan Leaf confirm this fact.

Apart from the 100,000 mile/96 months warranty, there are several factors that may affect the life of the lithium-ion battery pack. The specific configuration of the pack will directly influence its performance. This has become quite evident as stories about battery fires on Boeing 787 Dreamliners and Tesla EVs have made the news over the past year. In the case of Nissan Leafs, there have been incidents of early battery degradation because of exposure to excessive heat in places such as Arizona and Dubai.

Trend-watchers expect the price of the battery to decline sharply in the next few years. With the decline of battery prices, the electric car will become much more affordable in the foreseeable future. In fact, the real decline seems to be in the price of the battery cell and not the battery pack. According to top executives at LG Chem and Johnson Controls, leading manufacturers of lithium-ion battery cells, the cost of lithium-ion cells used in electric and hybrid vehicles are likely to be about half of current prices by 2020, but overall costs of battery packs are not likely to fall by as much (Energy Storage Publishing). This, according to the online publication Energy Storage Publishing and the Wall Street Journal reporting on the conversation with the executives, was attributable to the fact that there was a lack of standardization in battery construction among vehicle manufacturers.

In a contending view published in October 2013, analysts at Navigant Research point to several other factors impacting the reduction of lithium-ion battery prices. Chief among them, they assert, are the sudden increase in the scale of manufacturing, the sharp increase in the efficiency of manufacturing, and the radical improvement in access to raw materials due to the concomitant maturation of the supply chain (battery power online).

Electric Vehicle Battery Study Committee

While there are far fewer moving parts in an electric vehicle compared to an internal combustion engine vehicle, the service and performance history information available about electric vehicle is very limited. Electric vehicles have only become available to commercial fleets since 2011. The lack of data over time is compounded by the limited amount of vehicles that have been sold during this period. As a way of compensating for the limited data, Fleet Administration Division has taken several steps:

- Review the material published by Nissan
- Establish a battery monitoring team
- Looked at research data from government laboratories
- Searched for case studies of other government fleets with similar EVs
- Conducted research to find Leaf users with high mileage

The plan is to collate the data collected by our own vehicle monitoring team over time and use that information to augment industry data and inform our decisions. This information will better reflect the unique operating environment and needs of the County. Because the battery is the most expensive component of the vehicle, the major focus of the monitoring committee will be battery performance. The Battery Monitoring Committee is made up of the City of Seattle, King County Metro Pool, and King County Fleet Administration Division, with Fleet Administration as the lead.

Table 5

Electric Vehicle Battery Study Committee Members

Agency	Electric Vehicle Count
King County Fleet Admin Division	6
King County MetroPool Division	25
City of Seattle	43
Total	**74**

Vehicle Integration Plan – Recommendations

Based on the observations of several years of introducing alternative fueled and advanced technology vehicles into the King County fleet, and based on best practices recommended by the literature, the following recommendations should form the core of any alternative fuel or advanced technology integration program:

- Ensure that technicians and other fleet personnel receive appropriate training
- When vehicles are due for replacement, work with customers to assess what alternative fueled and advanced technology vehicles may be appropriate for that use
- Choose units based on suitability of technology/fuel for the duty cycle
- Actively seek to have fueling infrastructure that supports placement of vehicles
- Engage customers (supervisors, users) in the purchasing decision
- Have a roll-out program to announce the arrival of the first units
- Provide an active hands-on customer education program that involves education about the vehicle and the fueling of the unit—if alternative fuel is involved
- Have specially trained persons assigned to respond to customer concerns or liaise with the company to troubleshoot issues so as to minimize what might be otherwise difficult technical glitches.

REVISING LIGHT-DUTY VEHICLE UTILIZATION POLICY

In 2009, the King County Executive signed the Light Duty Vehicle Utilization Policy FES 12-6 (AEP). The policy established minimum use standards for vehicles owned by County departments. A development committee reviewed best practices of other government agencies and determined the best fit for King County. The resulting policy sets the mileage standard at 7,200 miles per year minimum, 5,000 miles for specially equipped vehicles (vehicles that have special equipment mounted on or in them) or utilization 70% of the days a year. This resulted in a reduction of 173 light-duty vehicles between 2009 and 2011 and an estimated savings of $346,000. Light-duty vehicles are defined as those having a capacity of one ton or less, or a gross vehicle weight less than 8,600 pounds.

The vehicle utilization policy was designed to save money by removing excess, underutilized vehicles from the County's fleet, it also helped to accomplish environmental and energy saving goals articulated in several policies and plans promulgated in other executive policies. The program right-sized the fleet while maintaining the same level of fleet services to all departments, ensuring a more efficiently run and better maintained fleet.

The vehicle utilization policy is being revised to establish a transitional period of two years for alternative fueled and advanced technology vehicles. During this period the new vehicles will be rolled out and the performance and user acceptance will be evaluated. Each vehicle technology has its own unique challenges. With that in mind, it has been determined that at the end of an initial two-year period, there will be a performance review and the results will be used to determine appropriate utilization standards

The performance review at the end of the two-year period will focus primarily on frequency of use, the specific technology and the limitations imposed by that technology (see Table 6). At that time, usage trends over the two-year period will also be taken into account and evaluated against the duty cycle of the vehicle or vehicles.

The table below (Table 6), outlines the utilization policy guidelines, items in bold relate to the new proposals with alternative fueled and advanced vehicle technology. It lists categories of vehicles and the minimum utilization standards and exceptions for each category.

Table 6
Utilization Guidelines for
Alternative Fuel Technology Vehicles

Vehicle Category	Description	Mileage Standard
General Purpose	Sedans, station wagons, minivans, SUVs and pickup trucks (1/4, ½, ¾, 1 ton)	7,200 miles per year or used on 70% of working days
Base or Facility Vehicle	Vehicle primarily operates on a base or a facility such as a wastewater treatment plant	70% of working days
Special Equipment	Marked Sheriff's vehicles Medical service vans Cargo vans Inmate transportation vans Inmate transportation autos, etc.	5,000 miles or 70% of working days
Required by another Agency	Contract city vehicles	Exempt from this policy
Heavy Special Purpose	Trucks heavier than 1 ton (8,600GVW) Semi-trucks Flatbed trucks Transit buses Inmate transportation buses Mobile health clinics Mobile command centers	Exempt from this policy
Introductory Alternative fuel or Advanced Technology Vehicles	**All Electric** **Plug-in Electric** **Propane** **Natural Gas** **Hydrogen** **Biodiesel** **Ethanol Flex-Fuel** **Sedans, station wagons, minivans, SUVs and pickup trucks (1/4, ½, ¾, and 1 ton)**	**No mileage standard during two year transitional period; usage data to be tracked and reported**

EVs take hours to recharge and this imposes limitations on turnaround time of each vehicle. EVs also require a specialized recharging infrastructure. Furthermore, users will need orientation and (in some cases) incentives to adopt EVs. The vehicle utilization policy has some built-in flexibility to address specific business needs but will call for additional tailoring to address EVs in particular, and more generally, other alternative fuel technology vehicles.

CONCLUSION

The decision to acquire any kind of new technology vehicle or alternative fuel requires extensive research and planning. There must be assurance that the technology is sufficiently advanced and is sturdy enough to be able to withstand the real-world rigors of fleet applications. It must have the backing of the producer or manufacturer and there must be technical support and training available for the service and maintenance of the vehicle or technology.

For many advanced technology and alternative fueled vehicles, a fueling infrastructure is required for any successful integration of the fleet. Funding considerations for such vehicles, therefore, must take into account not only the cost of the vehicles themselves, but also the acquisition, installation, and attendant costs of establishing and servicing the necessary fueling infrastructure.

Planning must also take place to prepare potential users for the new technology. Users may have to change the way they interact with the new vehicles. The fueling experience or the range of the vehicle may be different. In some cases, this may impact the way users do their work. Having demonstration vehicles available for potential customers to use for extended periods or try out before they commit to purchasing them and having educational materials available well in advance of introducing new technology vehicles into the fleet can make a difference in the level of acceptance or resistance encountered.

Some technologies may have specific limitations that require extended introductory periods during which time the usual vehicle utilization policies may have to be suspended. The EV is one such technology.

The discussion and strategies that have been laid out in the report have focused mainly around LPG and electric vehicles. However, it is important to note that while these vehicles have been used as the specific point of reference, the recommendations are generalizable to other types of alternative fuel or advanced technology vehicles.

APPENDIX A

Northwest Hybrid Consortium Members

The Northwest Hybrid truck Consortium, led by King County, was formed in November 2005 for the purpose of accessing incremental funding for hybrid trucks. In exchange, with the support of WestStart-CALSTART, a California-based non-governmental agency, Consortium members planned to provide on-road data on the performance of these early production hybrid trucks to the Environmental Protection Agency. The members were:

City of Bellevue
City of Bremerton
City of Everett
City of Kent
King County
Pierce County
City of Renton
City of Richland
City of Renton
City of Seattle
Seattle Public Utilities
Snohomish County
City of Tacoma
Thurston County
Washington State Department of Ecology

The original projection was to acquire nine (9) hybrid class 5 to 7 utility trucks in 2007. Each of the participating consortium members submitted letters of commitment to International Truck and Engine Corporation at the end of 2006 and subsequently ordered the trucks. The orders were as follows:

City of Renton	2 trucks
City of Seattle	4 trucks
King County	2 trucks
Snohomish County	1 truck

Additionally, the city of Tacoma committed to ordering one (1) hybrid refuse truck in 2007/2008 but this truck did not become available during the period of the grant.

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