Fuel Forward Fleet Study
Prepared for
The City of Auburn Hills, Michigan

clean energy coalition

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Introduction

The City of Auburn Hills is interested in improving its practices and policies relating to its fleet of vehicles in order to realize costs savings and reduce environmental impacts. Data and information provided by the City of Auburn Hills' staff revealed several target areas for the city to consider. Following a thorough analysis of the data the following areas are recommended by CEC for further consideration by the city:

- Idle reduction for the city's police fleet
- Compressed Natural Gas (CNG) for city pickup trucks
- Liquefied petroleum gas (LPG) for city police vehicles
- Alternatively fueled lawn equipment
- A resolution by the city to support the advancement of alternative fuel vehicles (AFVs) and alternative fueling infrastructure

Each of these areas was explored in detail and scenarios are provided to guide the City of Auburn Hills in their decision making and planning process for a cleaner, fuel-efficient fleet. Where appropriate, recommendations are made mindful of the City's continued focus on economic development by supporting its robust automotive manufacturing industry.

In addition to the scenarios included in this report, an electronic copy of the calculator used to create the scenarios will be provided to the city. It is CEC's hope that the city can use the calculator for future scenarios that may not be currently addressed in this report.

Fleet Profile

Baseline Values

From January 1, 2011 through January 1, 2012, Auburn Hills' fleet of 99 vehicles traveled more than 818,000 miles and consumed more than 92,000 gallons of fuel, priced at more than $285,000. Overall, these vehicles required 2,207 barrels of petroleum (oil) to operate, which produced 1,206 tons of greenhouse gas emissions (Figure 1).

Vehicle counts, miles traveled, fuel consumption, and fuel and maintenance costs data are recorded by the city's fleet manager. Factors used to calculate the petroleum consumption and greenhouse gas emissions were based on Argonne National Laboratory's GREET Fleet Footprint Calculator 1.1a and include a "well-to-wheel" fuel life-cycle, which accounts for all the energy inputs and associated emissions from the point of origination of the fuel to its combustion within the vehicle.

As noted in Table 1, pickup trucks accounted for the most miles driven with 236,200 (28%) and police pursuit vehicles were responsible for the most greenhouse gas emissions with 388 tons, or 32% of the entire fleet's footprint (Table 3). Overall, pickup trucks and police vehicles were the cause of over 50% of the entire fleet's carbon footprint.

Figure 1: City of Auburn Hills Fleet Baseline

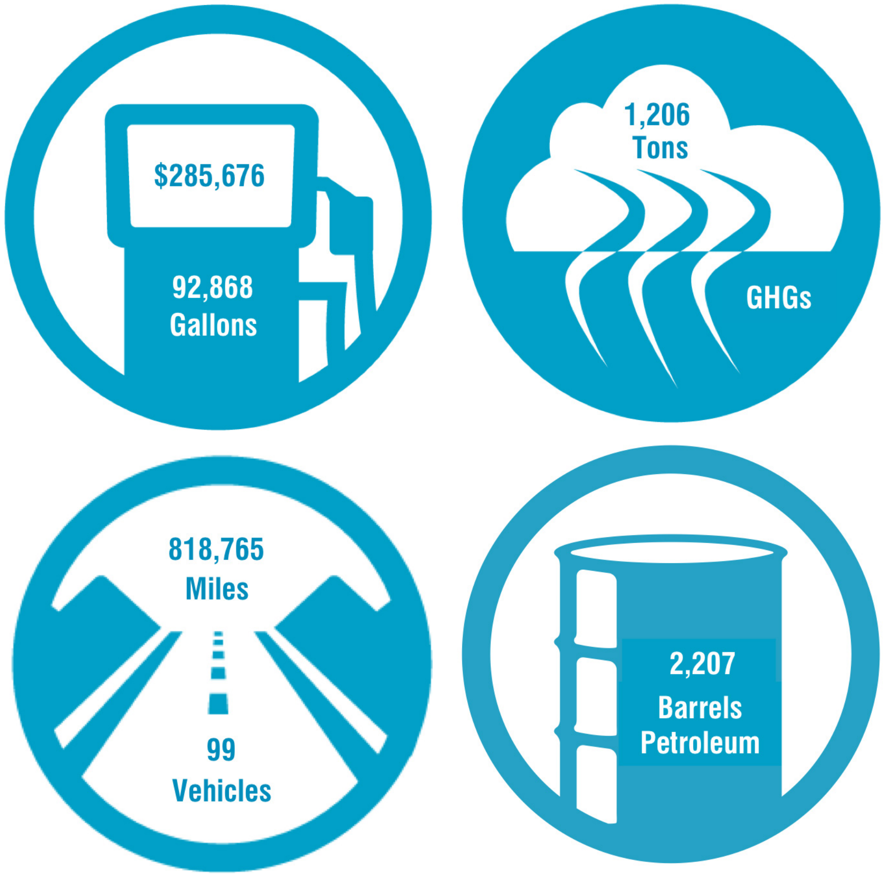


Table 1: Annual Mileage by Vehicle Type and Department

Vehicle Type	# of Vehicles	Average Miles per Vehicle	Sum of Miles Driven 2011
Aerial Truck	2	5,514	11,027
Ambulance	4	5,311	21,243
Crane truck	1	9,785	9,785
Crane truck - Water	1	12,157	12,157
Dump	15	4,821	72,313
Fire Engine	6	5,966	35,795
Flatbed Truck	2	5,057	10,114
Lift Bucket Truck	1	3,709	3,709
Pickup	22	10,741	236,300
Police Pursuit	19	9,760	185,442
Recovery Truck	1	10,413	10,413
Sedan	8	6,044	48,348
Special Response	1	1,429	1,429
SUV	8	9,160	73,281
Sweeper	1	3,869	3,869
Vactor	1	18,140	18,140
Van	6	10,900	65,400
Grand Total	99	8,270	818,765

Low High

Table 2: Annual Fuel Expenditure by Vehicle Type and Department

Vehicle Type	City Manager	Community Development	DPS	Fire	Police	Pool	Grand Total
Aerial Truck			$ 5,343				$ 5,343
Ambulance				$ 7,730			$ 7,730
Crane truck			$ 2,454				$ 2,454
Crane truck - Water			$ 2,948				$ 2,948
Dump			$ 34,097				$ 34,097
Fire Engine				$ 18,368			$ 18,368
Flatbed Truck			$ 4,009				$ 4,009
Lift Bucket Truck			$ 1,609				$ 1,609
Pickup		$ 3,478	$ 41,142	$ 5,054	$ 1,518		$ 51,191
Police Pursuit					$ 94,216		$ 94,216
Recovery Truck			$ 3,056				$ 3,056
Sedan	$ 1,689				$ 6,825	$ 3,532	$ 12,047
Special Response				$ 662			$ 662
SUV		$ 1,149		$ 8,965	$ 8,152		$ 18,266
Sweeper			$ 2,597				$ 2,597
Vactor			$ 10,187				$ 10,187
Van			$ 16,147		$ 750		$ 16,897
Grand Total	$ 1,689	$ 4,627	$ 123,588	$ 40,779	$ 111,461	$ 3,532	$ 285,676

Low High

Table 3: Annual GHG Emissions (in tons) by Vehicle Type and Department

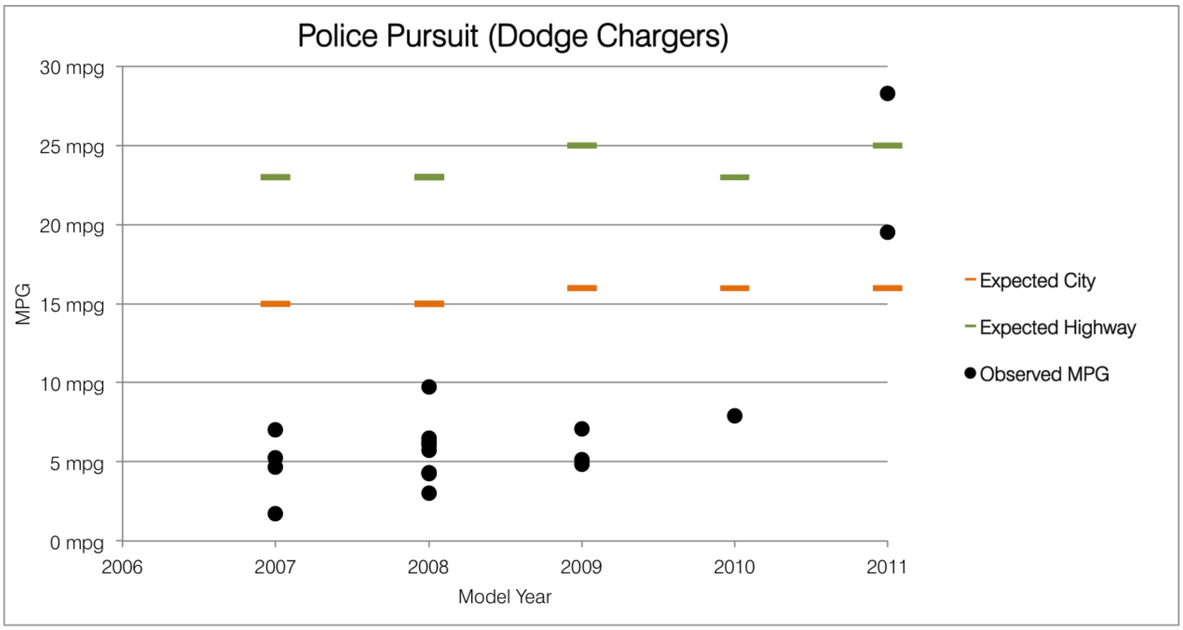
Vehicle Type	City Manager	Community Development	DPS	Fire	Police	Pool	Grand Total
Aerial Truck			23				23
Ambulance				34			34
Crane truck			11				11
Crane truck - Water			13				13
Dump			150				150
Fire Engine				81			81
Flatbed Truck			17				17
Lift Bucket Truck			7				7
Pickup		14	175	21	6		217
Police Pursuit					388		388
Recovery Truck			13				13
Sedan	7				28	15	50
Special Response				3			3
SUV		5		37	34		75
Sweeper			11				11
Vactor			45				45
Van			67		3		70
Grand Total	7	19	531	175	459	15	1,206

Low High

Idle Reduction

The city's law enforcement vehicles (Police Pursuit) spend significantly more on fuel than any other vehicle type. Furthermore, the city's law enforcement vehicles use a much higher amount of fuel than would typically be observed given the amount of miles driven and the vehicle makes/model. For instance, in a sample of 18 Auburn Hills police pursuit vehicles (Dodge Chargers only), the vehicles traveled a total of 175,143 miles in 2011 and used 29,324 gallons of gasoline (31.5% of the entire city fleet). This equates to an average of 6.0 mpg for the vehicles (Chart 1) – far from the 17.4 mpg for which the vehicles are rated (assuming 75% city and 25% highway.) If the vehicles had achieved their rated mpg, they would have consumed approximately 10,039 gallons of fuel. This is a difference of 19,284 gallons of gasoline from the observed fuel use, or $57,000 assuming $2.99/gallon.

Chart 1: Observed MPG in Police Vehicles



The decrease in mpg for the city's police vehicles is likely due to excessive idling of the engine while the vehicle is parked. An idling engine consumes approximately half a gallon of fuel per hour and greatly increases wear and tear on the engine, thereby increasing maintenance costs. It is often necessary for police vehicles to idle in order to power electrical devices and the vehicle's climate control system while stationary. However, idling the engine is an expensive, and unnecessary, way to deliver these services to the police officer.

Fortunately, there are anti-idling devices available that will allow the vehicles' electrical components and/or climate control system to function without the vehicle's engine operating. The next section discusses two of these available technologies in detail.

Available Idle Reduction Technology

Havis IdleRight2

IdleRight2 monitors the battery's voltage while the police vehicle is turned off and the lights or electronics equipment are still on. If the voltage of the battery drops below the low voltage sense level IdleRight2 triggers the vehicle's Remote Starter to idle the vehicle. The system runs the engine until the battery is charged, Remote Starter turns the vehicle off, and the process begins again. The IdleRight2 component is small (Figure 2), easy to install, and costs about $150 per vehicle. IdleRight2 is intended to be used with small electrical loads on the

Figure 2: Havis IdleRight2 (green box) combined with a Havis Chargeguard (yellow box) and Hub (white box)

vehicle. A good example would be traffic or construction details where the vehicle's warning lights are needed for safety but the officer is not required to stay with the vehicle. The vehicle's climate control system is not intended to be used with the IdleRight system.

If the Havis IdleRight2 is going to be implemented, Auburn Hills police pursuit vehicles would first have to be outfitted with remote start systems, as their police vehicles do not currently have remote starters.

According to a recent article in *Law and Order Magazine,* the Glastonbury Police Department in Glastonbury, Connecticut tested the original IdleRight system. During the test, a vehicle ran for four hours with all its emergency lights activated. The vehicle would have used 2.8 gallons of fuel during this time, but with IdleRight installed the vehicle's idle time dropped to 40 minutes and consumed only 0.46 gallons of fuel.*

The City of Troy is in the process of installing the IdleRight2 technology in its police vehicles and may be a resource if Auburn Hills chooses to pursue this technology. In addition to IdleRight2, City of Troy police vehicles are equipped with LED light bars that draw only one-third of the energy of conventional lights, and therefore reduces the number of times the engine must turn on to recharge the vehicles battery.

EnergyXtreme

EnergyXtreme is an auxiliary battery system that is stored in the trunk of the police vehicle. The system self charges via the vehicle's alternator when the car is in motion. When the vehicle is turned off, the car's electrical system draws on the EnergyXtreme's battery power.

As with the IdleRight2, the EnergyXtreme system will run the vehicle's electronics but not the climate control system. Though, EnergyXtreme does offer an optional "polar package" from Espar Heater Systems, which allows vehicle

Figure 3: EnergyXtreme system installed in the trunk of a Dodge Charger owned by the Dallas, TX police department.

* *(Law and Order Magazine, August 2012) http://lawandordermag.epubxp.com/i/77063/29*

heaters to operate without the use of the vehicle's engine. EnergyXtreme will offer an AC system but it hasn't yet been released.

EnergyXtreme offers two small auxiliary battery systems in their Law Enforcement Series Independence Package (IP), the IP1 with a capacity of 1,000 whrs and the IP2 with a capacity of 2,000 whrs. Both products take up 2 cubic feet of trunk space and weigh 80 and 100 lbs respectively. (Figure 3)

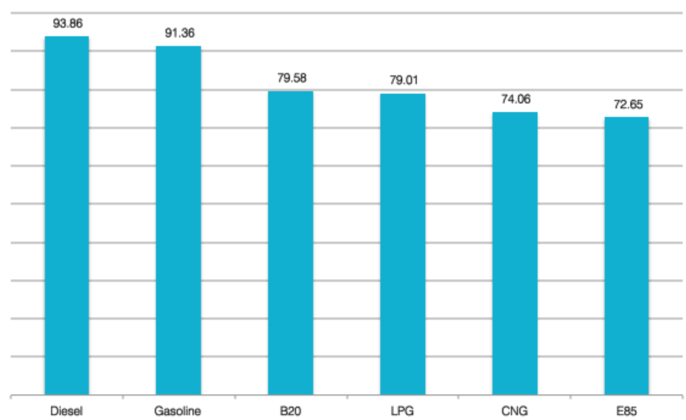
The cost of the EnergyXtreme is high compared to the IdleRight2. The IP1 is $2,995 and the IP2 is $3,995. The Dallas Police Department has reported savings of $252.00-$479.00 per month per vehicle at gas prices between $2.00-$3.80. More detail on the Auburn Hills police fleet's actual idling habits would be required in order for an accurate cost-benefit analysis to be completed.

Purchasing Alternative Fuel Vehicles

Alternative Fuels Overview

By using alternative fuels, fleets can significantly lower greenhouse gas emissions (Chart 2), reduce dependence on petroleum, lower maintenance costs, and, in some cases, save money on fuel. For further details about alternative fuels, see the U.S. Department of Energy's Alternative Fuels Data Center, a Clean Cities program resource (http://www.afdc.energy.gov/). Clean Cities Guides to Alternative Fuels and Advanced Vehicles are included with the supplemental materials for this report.

Chart 2: Well-to-wheel GHG Intensity by Fuel (gram CO2e/MJ)



When considering the addition of alternative fuels or advanced vehicle technologies, four major variables should be considered.

1. Fuel price spread
2. MPG of the alternative fuel vehicle verse the conventional vehicle
3. Incremental cost
4. Miles driven per year

Attention should also be given to the complexities that new technologies can bring to maintenance and repair facilities. While some fleets will choose to include multiple fuels or technologies, they must also consider the cost of training and tools required to service new systems. See the section *Further Considerations for Compressed Natural Gas Vehicles* and *Further Considerations for Propane Vehicles* for more details.

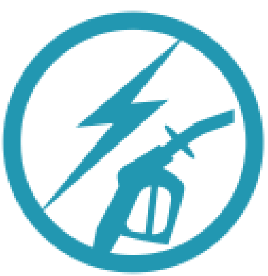
The following section is intended to give a background on the most common types of alternative fuels used by fleets:

Compressed natural gas (CNG) is a widely available, domestically produced fuel. CNG is sold in gasoline gallon equivalent units (GGE), which are equal to about 5.6 pounds of natural gas. One GGE has the same energy as one gallon of unleaded gasoline so if a vehicle travels 15 miles per gallon of gas, it will travel about 15 miles per gasoline gallon equivalent. Vehicles can be converted to run exclusively on CNG (dedicated), or on either gasoline or CNG (bi-fuel). CNG is compressed to 3,000-3,600 psi and dispensed into high-pressure tanks on the vehicle. Although the fuel is typically about half the price of gasoline, fueling infrastructure can be cost-prohibitive due to the compression equipment required. The fuel is clean burning and can prolong vehicle life and increase some maintenance intervals.

Liquid petroleum gas (LPG), also known as propane or autogas, is a widely available by-product of natural gas and oil refining processes. Fueling infrastructure is relatively inexpensive compared to CNG. Propane is compressed to between 100 and 200 psi, at which point it becomes a liquid fuel that is dispensed into tanks on the vehicle. It has a higher octane rating but 27% less energy density per gallon than gasoline. Like CNG, LPG is clean burning and can prolong vehicle life and increase some maintenance intervals.

Biodiesel is renewable fuel produced from vegetable oils or animal fats. It is blended with diesel fuel and results in a cleaner burning fuel with lower greenhouse gas emissions. Newer diesel engines can burn blends up to 20% biodiesel (B20) without any conversions or modifications. There are no noticeable impacts on vehicle performance and most manufacturers approve blends up to B20 under warranty conditions. To avoid cold-start issues, users may choose to lower the blend to 5% (B5) or blend B20 with cold-weather diesel fuel, which includes additives that improve fuel flow.

Ethanol is a renewable fuel made from fibrous plant material. Any Flex Fuel vehicle can use E-85, which is a blend of 85% ethanol and 15% gasoline. The fuel is cleaner burning and has lower greenhouse gas emissions but has 30% less energy density per gallon than gasoline. A Flex Fuel option with a new vehicle purchase typically costs about $100.



Hybrid electric vehicles (HEV) use battery power to supplement a gasoline engine. HEVs do not need to be plugged in since the battery charges while the vehicle is in operation. While the battery alone can only power the vehicle for a few miles without gasoline, the power assistance significantly improves the gas mileage. The batteries of HEVs are not capable of being charged from an external source and therefore do not require external charging infrastructure.

Plug-In hybrid electric vehicles (PHEV) and battery electric vehicles (BEV) must be plugged in to charge the battery. EVs do not produce any tailpipe emissions (although there are emissions associated with producing the electricity) and have a typical range of up to 100 miles. Electric-only range for a PHEV is around 40 miles. However, after the battery power is depleted PHEVs run on gasoline, which can extend the vehicle's overall range to over 350 miles.

Scenario Results: CNG Pickup Trucks

The average number of miles traveled for the City of Auburn Hills' 22 pickup trucks in the fleet was 10,740. The minimum miles traveled for a pickup truck was 4,235 (17 miles/day) and the maximum was 27,460 (112 miles/day). Overall, the 22 vehicles averaged 14.5 miles per gallon. The annual miles traveled by pickup trucks within the City of Auburn Hills fleet varied widely.

Given the City of Auburn Hills preference to purchase Chrysler vehicles, this scenario uses the model specifications from the new Chrysler's Ram 2500 CNG pickup truck. The Ram 2500 CNG is considered a bi-fuel vehicle, meaning the engine will operate primarily on CNG but will automatically switch to gasoline operation if the CNG tank pressure falls below a set limit. Note the duel 9.1 gallon GGE CNG tanks in the bed of the vehicle, thereby decreasing the truck's payload capacity.

Photo from Chrysler Group LLC

The Ram 2500 CNG pickup is expected to achieve 14 mpg and have a range of 255 miles on the CNG tank with an additional 112 miles on the vehicle's gasoline backup tank. If longer vehicle range is desired, the vehicle can be outfitted with an optional 35 gallon gasoline tank, extending the overall vehicle range to over 700 miles.

RAM 2500 CNG Pickup Truck

- 14 miles per gallon
- Dual 9.1 gallon CNG tanks located in the truck bed
- Backup 8 gallon gasoline tank

The base model is expected to retail at $47,500, compared to $35,500 for a non-CNG Ram. An incremental cost of $12,000 for CNG and non-CNG light duty truck models is in-line with the incremental costs of comparable CNG vehicles it. Nevertheless, the extra cost greatly diminishes the vehicle's potential for a positive payback.

Table 4: Key Assumptions for Scenario

Assumptions	
Fuel Prices	$/unit
Gasoline	$3.00
CNG (GGE)	$2.00
Baseline Information	
Number of Vehicles	1
Annual Miles Traveled/Vehicle	12,000
# of days vehicle is driven per year	245
Daily Miles Traveled/Vehicle	48
MPG Gasoline	14
Maintenance cost/mile	$0.08
Vehicle Life (Miles)	200,000
Payback Goal (Years)	8
Bi-Fuel	
Maintenance Savings	7%
Percentage of CNG miles	95%

A summary of the assumptions for this scenario are listed in Table 4. The scenario was run for replacing one pickup truck that travels approximately 12,000 per year. The price of gasoline is assumed to be $3.00 (approximate price City of Auburn Hills paid in 2010-2011) and the price for CNG is assumed to be $2.00. It should be noted that the current, as of January 2013, advertised price for CNG at DTE owned fueling stations is $2.64 per GGE, however price contracts for CNG are frequently available for less than $2.00 GGE.

Table 5: Gasoline vs Bi-Fuel CNG vehicle results

Gasoline and Alternative		
	Gasoline	Bi-Fuel CNG
Fuel Cost	$3.00	$2 CNG
MPG	14	14
Daily Fuel Cost (based on 48 miles)	$10.29	$7.03
Annual Fuel Costs	$2,571	$1,757
Annual Fuel Savings (Expense)		$814
Maintenance cost/mile	$0.080	$0.075
Annual maintenance costs	$960	$897
Annual Maintenance savings (Expense)		$63
Total Annual Costs	$3,531	$2,654
Total Annual Savings (Expense)		$877
Incremental Costs/Vehicle		$12,000
Infrastructure Costs (Total)		$0
Grants, Incentives, Other Revenue (Total)		$0
Simple Payback (Years)		13.68
Simple Payback (Miles)		164,147
Petroleum Footprint (Barrels)	19.4	1.1
Percent reduction		94%
GHG Emissions Footprint (Tons CO2e)	10.6	8.7
Percent reduction		18%

Table 6: Fuel Spread Payback Matrix

Simple Payback (years)

CNG Price	Gasoline Price: $2.71	$2.85	$3.00	$3.30	$3.63	$3.99
$1.81	15.04	13.13	11.58	9.37	7.75	6.51
$1.90	16.65	14.34	12.52	9.98	8.15	6.79
$2.00	18.78	15.89	13.68	10.70	8.63	7.12
$2.20	25.20	20.26	16.80	12.52	9.78	7.88
$2.42	40.39	29.05	22.42	15.39	11.45	8.93
$2.66	119.97	55.54	35.48	20.60	14.10	10.46

Table 7: Fuel Spread Annual Savings Matrix

Total Annual Savings (Expense)

CNG Price	Gasoline Price: $2.71	$2.85	$3.00	$3.30	$3.63	$3.99
$1.81	$798	$914	$1,036	$1,280	$1,549	$1,845
$1.90	$721	$837	$959	$1,203	$1,472	$1,767
$2.00	$639	$755	$877	$1,122	$1,390	$1,686
$2.20	$476	$592	$714	$959	$1,227	$1,523
$2.42	$297	$413	$535	$780	$1,048	$1,344
$2.66	$100	$216	$338	$582	$851	$1,147

A Bi-Fuel CNG vehicle will have an approximate 7% maintenance savings over its gasoline counterpart. This is due to an increase in the time between oil changes and the cleaner burn from combusting natural gas.

In this scenario, the Bi-Fuel CNG vehicle is assumed to operate 95% of the time on CNG and 5% of the time on gasoline.

Given these assumptions, a Bi-Fuel CNG vehicle will save a total of **$877** ($814 fuel and $63 maintenance) per year over a traditional gasoline vehicle. The CNG vehicle will achieve a payback in **13.68** years, or after **164,147** miles (Table 5).

The payback numbers rely heavily on the fuel spread between CNG and gasoline (Table 6). In this scenario a payback is desired in less than 8 years. The desired scenario is highlighted in green and the undesired scenario is highlighted in red. The matrix shows that if the fuel spread between CNG and gasoline is greater than $1.57 per gallon (e.g. CNG GGE under $1.81/gallon and gasoline above $3.63/gallon) then CNG becomes a financially viable option.

The financial payback of CNG vehicles is not the only consideration when considering converting. Using the same assumptions, if the scenario was run for all of Auburn Hills' 22 pickup trucks converting to Bi-Fuel CNG, the city would reduce its barrels of petroleum consumed annually by 403 barrels (18% of the entire fleet's petroleum use) and its GHG emissions by 41 tons (3% of the entire fleet's emissions.)

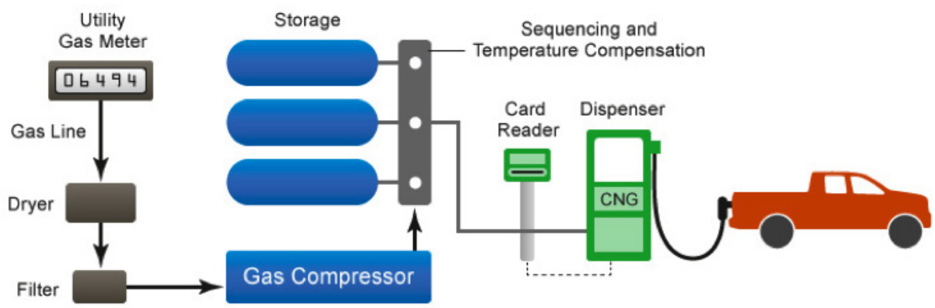
Further Considerations for Compressed Natural Gas Vehicles

Using compressed natural gas (CNG) as a fuel requires making decisions regarding fueling infrastructure and maintenance facility safety retrofits.

On-Site Infrastructure Options

Fast-fill stations are often used in retail applications or in private facilities where many vehicles must be able to fill up quickly. In general, on-site fast-fill infrastructure costs of $1-2 million can be prohibitive for fleets unless they are converting a large number of vehicles so that the capital costs can be spread out over a number of vehicles.

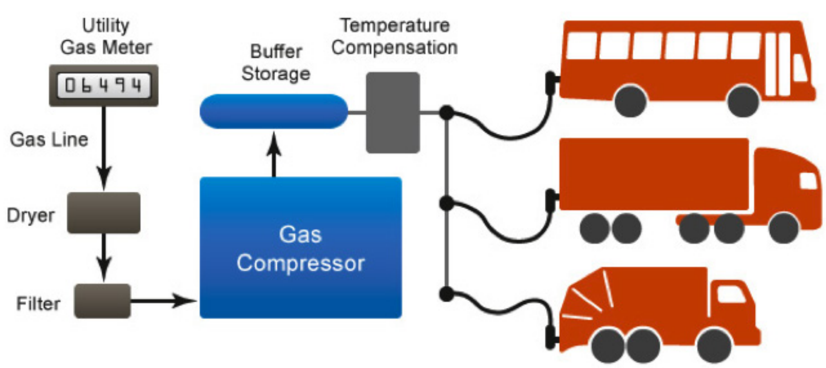
Fast-Fill Station



(Source: Clean Cities)

Time-fill stations are customized for fleets that have predictable schedules that allow vehicles to be parked at the pumps for extended periods of time. The cost to build time-fill infrastructure is between $500,000 and $1 million, depending on the fleet size. Time-fill systems are less expensive because they do not include storage tanks for compressed gas. Time-fill station compressors may also be less expensive to run compared to fast-fill stations by taking advantage off-peak electricity rates.

Time-Fill Station



Fueling appliances are small-scale options that are suitable for home use or small fleets. There are also several small-scale fueling options in development right now, such as the CNG In A Box concept from GE. The FuelMaker and Phill systems from BRC are the most widely used products for this kind of application. The FuelMaker costs approximately $7,000. Though this system will only fill a vehicle at about 1 GGE per hour and would not be a viable long-term option for the city's fleet.

To explore the cost of infrastructure further, refer to the Clean Cities Alternative Fuel and Advanced Vehicles resources found here: www.afdc.energy.gov/fuels/natural_gas.html

Facility safety

Natural gas is lighter than air and quickly dissipates when released. Because of the gaseous state of CNG, hazards can exist in repair facilities if it is accidentally released. Maintenance facilities must ensure they are safe for CNG vehicles before work on these vehicles can occur. Upgrades may include, but are not limited to, the following:

- Ventilation
- Sources of ignition (i.e. restrictions on facility heating equipment)
- Lighting
- Gas Detection

Auburn Hills should involve the local fire marshal early on in project planning in order to understand what changes will be needed. The national codes that cover vehicle maintenance facilities are:

- The International Code Council's International Fire Code (IFC 2012)
- International Mechanical Code (IMC 2012)
- International Building Code (IBC 2012)
- National Fire Protection Association's NFPA 30A (2012) Code for Motor Fuel, Dispensing Facilities and Repair Garages,
- NFPA 52 (2010) Vehicular Gaseous Fuel Systems Code
- NFPA 88A (2007) Standards for Parking Structures.

Requirements for NFPA 30A will depend on the duties of the Auburn Hills facility and whether it is considered a "major repair" or "minor repair" facility.

Further reading: *Guideline for Determining the Modifications Required for Adding Compressed Natural Gas and Liquefied Natural Gas Vehicles To Existing Maintenance Facilities,* Clean Vehicle Education Foundation

Training Employees for proper maintenance

Clean Energy Coalition, through its *Michigan Fuel Forward* program (a recent grant award through the U.S. Department of Energy's Clean Cities program), will be providing training opportunities for mechanics and service technicians. This training will promote the correct repair, maintenance, and installation of alternative fuel vehicles and infrastructure. Training will utilize National Alternative Fuels Training Consortium (NAFTC) curriculum or similar and will be offered in partnership with Macomb Community College.

Scenario Results: Hybrid or PHEV

Scenario 1: Replace Community Development SUV (#901) with a PHEV or new efficient vehicle

The Community Development SUV (#901) is a Jeep Liberty Sport with an MSRP of $25,395. In 2011 this vehicle traveled about 6,600 miles and had a fuel economy of 17 MPG. In this scenario a 2013 Ford C-MAX Hybrid and 2013 Ford C-MAX Energi (PHEV) are compared to a Jeep Liberty Sport.

The Ford C-MAX Hybrid's MSRP is $25,245 ($150 less than the Jeep) and the Ford C-MAX Energi's MSRP is $33,745 ($8,350 more than the Jeep), the PHEV price does not include the federal tax rebate which Auburn Hills would not be eligible for. Given that the Hybrid retails for less than the Jeep, and has a rating of 47 MPG, it will have an immediate payback to the city. The PHEV on the other hand, has a payback of 8.7 years or 57,442 miles.

Vehicle #901's daily miles driven (26 miles) is close to all-electric range of the C-MAX Energy (21 miles), therefore minimal gasoline should be needed. Based on current use patterns, it is unlikely that the city will drive the vehicle enough miles each year to achieve the payback in less than 8 years unless the utilization increases.

Both the HEV and PHEV have significant petroleum and GHG emissions reductions over the current vehicle assigned to Community Development. Both vehicles can reduce the GHG emissions footprint by approximately 3 tons.

Assumptions	
Fuel Prices	$/unit
Gasoline	$3.00
Premium Gasoline	$3.00
Ethanol E85	$2.50
CNG (GGE)	$2.00
LPG	$1.50
Electricity ($/kWh)	$0.09
Baseline Information	
Number of Vehicles	1
Annual Miles Traveled/Vehicle	6,600
# of days vehicle is driven per year	245
Daily Miles Traveled/Vehicle	26
MPG Gasoline	17
Maintenance cost/mile	$0.08
Vehicle Life (Miles)	200,000
Payback Goal (Years)	8
Hybrid Electric Vehicle (HEV)	
Maintenance Savings	5%
MPG	47
Plug-in Hybrid Electric Vehicle (PHEV)	
Maintenance Savings	11.5%
MPGe	93
All-electric range	21
kWh per 100 miles	29
kWh/mile	0.29
Gasoline MPG (PHEV only)	50

Gasoline and Alternative			
	Gasoline	HEV	PHEV
Fuel Cost	$3.00	$3.00	$0.09
MPG	17.0	47	
Daily Fuel Cost (based on 26 miles)	$4.59	$1.66	$0.85
Annual Fuel Costs	$1,165	$421	$208
Annual Fuel Savings (Expense)		$743	$957
Maintenance cost/mile	$0.080	$0.076	$0.071
Annual maintenance costs	$528	$502	$467
Annual Maintenance savings (Expense)		$26	$61
Total Annual Costs	$1,693	$923	$675.06
Total Annual Savings (Expense)		$770	$1,018
Incremental Costs/Vehicle		-$150	$8,350
Infrastructure Costs (Total)		$0	$0
Grants, Incentives, Other Revenue (Total)		$0	$0
Simple Payback (Years)		0.00	8.21
Simple Payback (Miles)		0	54,155
Petroleum Footprint (Barrels)	8.8	3.2	0.6
Percent reduction		64%	93%
GHG Emissions Footprint (Tons CO2e)	4.8	1.7	1.9
Percent reduction		64%	60%

PHEV Lease Option

Given the City of Auburn Hills' tax status as a public institution, it is not eligible to take advantage of the federal rebates offered on plug-in hybrid electric vehicles ($3,750 for a C-MAX compared to $7,500 for a Volt). However, if the city were to lease a PHEV, the leasing company would be able to capture the savings from the federal rebate and pass the savings onto the city. This is one potential method to increase the payback period of a PHEV but a leasing study is beyond the scope of this Fuel Forward report.

Scenario Results: Propane Police Pursuit Vehicles

The average police vehicle in the fleet travels approximately 10,000 miles per year. The police vehicles in the scenarios below are anticipated to achieve 17.4 mpg. This number assumes that anti-idling technology will be used on police vehicles in the future.

The price for LPG differs drastically depending on the source but purchase contracts for LPG are frequently available for less than $1.50 per gallon. Typically, the cost to convert a light-duty vehicle from gasoline to propane ranges from $4,000 to $12,000.

Propane Scenario 1 looks at using a ICOM North America propane conversion on a 2009 Dodge Charger. The cost of this system is approximately $6,250. ICOM North America is a Michigan company, with its headquarters and assembly plant is in New Hudson, MI. LPG powered Dodge Chargers are currently only available as retrofits and only available on the 2009 model year Dodge Charger. This scenario could be a first step for the city to test the use of propane police vehicles by converting one or more of the 2009 vehicles to operate on propane.

The table below shows the Dodge Charger conversion will have a payback less than 8 years as long as the price of LPG is at or below $1.50 and the price of gasoline is at or above $3.30. At the current fuel spread, the conversion would have a payback in 9.37 years.

Assumptions	
Fuel Prices	$/unit
Gasoline	$3.00
LPG	$1.50
Baseline Information	
Number of Vehicles	1
Annual Miles Traveled/Vehicle	10,000
# of days vehicle is driven per year	245
Daily Miles Traveled/Vehicle	40
MPG Gasoline	17.4
Maintenance cost/mile	$0.08
Vehicle Life (Miles)	200,000
Payback Goal (Years)	8
LPG	
Fuel Economy loss	20.0%
Bi-Fuel	
Maintenance Savings	7%
Percentage of LPG miles	95%

Gasoline and Alternative	Gasoline	Bi-Fuel LPG
Fuel Cost	$3.00	
MPG	17.4	
Daily Fuel Cost (based on 40 miles)	$6.90	$4.44
Annual Fuel Costs	$1,724	$1,110
Annual Fuel Savings (Expense)		$614
Maintenance cost/mile	$0.080	$0.075
Annual maintenance costs	$800	$748
Annual Maintenance savings (Expense)		$52
Total Annual Costs	$2,524	$1,857
Total Annual Savings (Expense)		$667
Incremental Costs/Vehicle		$6,250
Infrastructure Costs (Total)		$0
Grants, Incentives, Other Revenue (Total)		$0
Simple Payback (Years)		9.37
Simple Payback (Miles)		93,745
Petroleum Footprint (Barrels)	13.0	5.8
Percent reduction		56%
GHG Emissions Footprint (Tons CO2e)	7.1	6.2
Percent reduction		13%

Simple Payback (years)

LPG Price	Gasoline Price: $2.71	$2.85	$3.00	$3.30	$3.63	$3.99
$1.35	10.30	9.13	8.15	6.72	5.63	4.78
$1.43	11.20	9.83	8.71	7.09	5.89	4.96
$1.50	12.33	10.69	9.37	7.53	6.18	5.17
$1.65	15.45	12.96	11.08	8.58	6.88	5.65
$1.82	21.40	16.90	13.84	10.15	7.85	6.29
$2.00	37.17	25.41	19.06	12.71	9.30	7.18

Propane Scenario 2 looks at the payback, petroleum, and emissions results from converting the entire fleet of 22 police vehicles to Bi-fuel LPG. Since there is no Chrysler product available, a generic propane vehicle with similar specifications to a Dodge Charger was used. A new LPG light-duty vehicle will cost approximately $9,000 over the price of a gasoline vehicle.

In this scenario, a payback of less than 8 years will only be achieved if the fuel spread is $2.50. Because of the added incremental cost of the vehicle, gasoline would need to be at or above $3.99 with propane at or below $1.50.

Converting the city's police vehicles to propane would have a strong impact on the entire fleet's petroleum use by reducing the overall amount by 159 barrels of petroleum (7% of the fleet's petroleum use). LPG police vehicles would also reduce overall fleet GHG emissions by 20 tons (1.5% of the overall fleet's GHG emissions.)

Assumptions	
Fuel Prices	$/unit
Gasoline	$3.00
LPG	$1.50
Baseline Information	
Number of Vehicles	22
Annual Miles Traveled/Vehicle	10,000
# of days vehicle is driven per year	245
Daily Miles Traveled/Vehicle	40
MPG Gasoline	17.4
Maintenance cost/mile	$0.08
Vehicle Life (Miles)	200,000
Payback Goal (Years)	8
Bi-Fuel	
Maintenance Savings	7%
Percentage of LPG miles	95%

Gasoline and Alternative	Gasoline	Bi-Fuel LPG
Fuel Cost	$3.00	
MPG	17.4	
Daily Fuel Cost (based on 40 miles)	$151.72	$97.67
Annual Fuel Costs	$37,931	$24,418
Annual Fuel Savings (Expense)		$13,513
Maintenance cost/mile	$0.080	$0.075
Annual maintenance costs	$17,600	$16,445
Annual Maintenance savings (Expense)		$1,155
Total Annual Costs	$55,531	$40,864
Total Annual Savings (Expense)		$14,667
Incremental Costs/Vehicle		$9,000
Infrastructure Costs (Total)		$0
Grants, Incentives, Other Revenue (Total)		$0
Simple Payback (Years)		13.50
Simple Payback (Miles)		134,992
Petroleum Footprint (Barrels)	286.2	127.2
Percent reduction		56%
GHG Emissions Footprint (Tons CO2e)	155.9	135.9
Percent reduction		13%

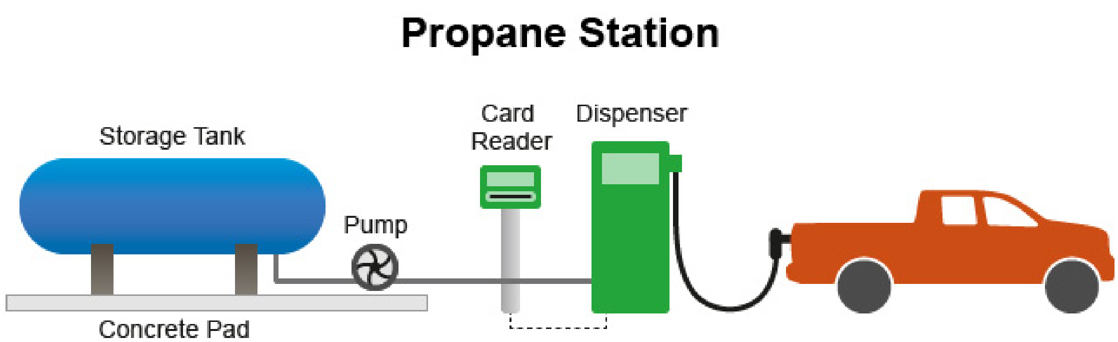
Simple Payback (years)

LPG Price \ Gasoline Price	$2.71	$2.85	$3.00	$3.30	$3.63	$3.99
$1.35	14.83	13.15	11.74	9.67	8.10	6.88
$1.43	16.12	14.15	12.54	10.21	8.48	7.14
$1.50	17.75	15.39	13.50	10.84	8.90	7.45
$1.65	22.24	18.66	15.95	12.36	9.91	8.13
$1.82	30.82	24.34	19.92	14.62	11.31	9.06
$2.00	53.52	36.59	27.45	18.31	13.40	10.34

Further Considerations for Propane Vehicles

On-Site Infrastructure Options

Refueling a propane vehicle is very similar to fueling a conventional gasoline vehicle. The cost of purchasing and installing a propane filling station for dispensing propane for vehicles or cylinder use typically costs between $37,000 and $175,000, depending on the size of the tank and the location of the station. However, fuel suppliers often offer the propane station for free, or at a reduced leased price, in exchange for a fuel contract. Typically, the fleet is still responsible for the station's supporting infrastructure (i.e. concrete pad, electrical wiring, etc.) This makes the up-front costs of propane much more affordable, especially when compared to CNG.



(Source: Clean Cities)

Safety

Propane vehicles and tanks have excellent safety records given the many integrated safety features. Normal operating pressure of a propane tank is less than 300 psi, though the tanks themselves are rated to 1000 psi. The tanks are constructed with carbon steel under a code developed by the American Society of Mechanical Engineers (ASME). In addition, a propane tank is 20 times more puncture resistant than a typical gasoline tank. (NAFTC)

It should be noted that pressurized propane systems should only be serviced by a certified technician and if the City of Auburn Hills is interested in installing a propane station it is highly recommended that their staff take part in Dispensing Propane Safely training program from the Propane Education & Research Council. (More information at http://propanesafety.com/)

Alternative Fuel Lawn Equipment

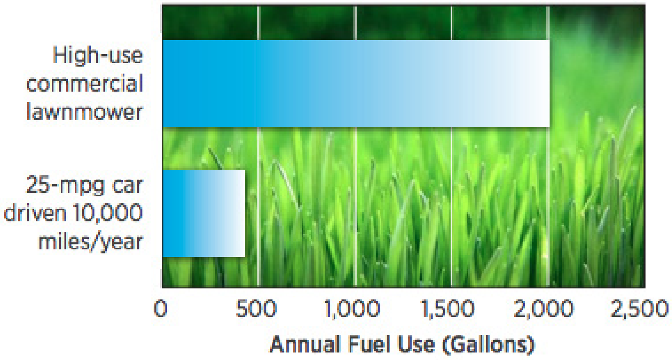


Figure 4: Commercial lawn care fuel use (Source: Clean Cities)

Lawn care can represent significant fuel use for city operations (Figure 4). The City's inventory shows 8 riding mowers and, although detailed data was not available on specific fuel amounts used for the city's lawn care equipment, it is still worth discussing alternative fueling options for the city as it considers gasoline reduction options. CEC will be able to calculate the savings for the city when the lawn care fuel data is available.

Electric

Commercial electrically powered mowers are available though, these mowers typically do not provide more than 75-80 minutes of continuous mowing time. This is not a recommended option for the City of Auburn Hills, due to electric mowers inability to operate for long periods of time.

Electrically powered landscaping equipment should be considered for tasks that do not run for long periods of time and can reach an outlet. An electric leaf blower would be a good replacement option given that electricity does not have any emissions and would be healthier for the operator as well as quieter.

CNG

The first CNG mower was manufactured by Dixie Chopper. The Dixie Chopper Eco-Eagle retails at $20,599, more than $6,000 over its propane counterpart. It is not advisable that the city pursue CNG for its lawn care equipment unless a fast fill CNG station were to be installed on the city's campus to provide a constant fuel source for the mower.

Propane

Propane mowers are the most popular alternatively fueled lawn equipment and would likely be the best alternative fuel lawn care choice for the City of Auburn Hills. LPG fueled mowers typically cost 20% more than traditional mowers. Propane cylinders are available for exchange or they can be refueled by a trained city staff member if the city installs a propane station. Propane conversions for existing mowers are available for certain models through EnviroGard.

Funding

Propane Education & Research Council (PERC) through its Propane Mower Incentive Program, offers $1,000 per qualifying new mower purchase or $500 per qualifying mower. Organizations that take advantage of the incentive program agree to provide feedback and performance data for one mowing season following the incentive.

Further Reading

Clean Cities Guide to Alternative Fuel Commercial Lawn Equipment,
www.afdc.energy.gov/pdfs/52423.pdf

City Support for Alternative Fuel Vehicles

The adoption of alternative fuels in the City of Auburn Hills' fleet vehicles represents a both a strategic and forward thinking move. Implementing the recommendations in this report not only provides the city with long-term cost savings and reduced emissions; it serves as a statement that Auburn Hills is willing to stand as a leader in fiscal responsibility, environmental stewardship, and energy independence. To help commit to this statement and help ensure that the recommendations of the report are moved forward, we are offering a sample Resolution of Support (page 18) to be considered for adoption by City of Auburn Hills' Council. The language included in this sample resolution is meant to serve as a draft that can be modified to suit the city's specific needs.

CITY OF AUBURN HILLS
RESOLUTION

AUTHORIZING EFFORTS THAT ADVANCE ALTERNATIVE FUEL ADOPTION WITHIN THE CITY'S FLEETS AND THAT HELP TO SUPPORT THE DEVELOPMENT OF ALTERNATIVE FUELING INFRASTRUCTURE WITHIN THE CITY

WHEREAS, Michigan's automotive manufactures are moving forward with new lines of alternative fuel vehicles (AFVs) to help meet market demands and needs; and

WHEREAS, Equipment manufacturers in Michigan are developing new technologies to make charging and fueling safe, easy, convenient, and affordable for customers; and

WHEREAS, The City of Auburn Hills is home to key automotive and equipment manufacturers, therefore the City wishes to take leadership on this issue and views supporting advancements in alternative fuel technology an essential contributor to the region's economic prosperity and quality of life; and

WHEREAS, A recent analysis of the City's fleet vehicles shows that the adoption of AFVs can offer savings over time in fuel and maintenance costs.

WHEREAS, The United States imports an increasing amount of oil, primarily for transportation; alternative vehicles powered from domestic sources can help our country reduce its dependence on oil from unstable foreign sources; and

WHEREAS, AFVs release fewer emissions, which have been linked to long-term health and environmental hazards; and

WHEREAS, Advancing the adoption of AFVs supports the values set for the in the Tri-Cities' Sustainability Plan;

NOW, THEREFORE, BE IT RESOLVED THAT the City of Auburn Hills supports adopting driver behavior, fuel saving equipment, AFVs as part of their fleet composition, and the advancement of infrastructure and policies necessary for the robust deployment AFVs; and

BE IT FURTHER RESOLVED THAT the City of Auburn Hills will work with industry leaders to keep current on alternative fuel solutions and track the cost savings of driver based behavior modifications and adoption of AFVs; and

BE IT FURTHER RESOLVED THAT the City of Auburn Hills will work with other private, nonprofit, and government entities, as appropriate, to develop policy recommendations to maximize the potential for and accelerate the deployment of AFVs; and

BE IT FURTHER RESOLVED THAT the City of Auburn Hills pledges to be a leader and partner with industry leaders on this issue by coordinating and sharing information on ways to advance alternative fuel adoption.

About Clean Energy Coalition

Founded in 2005, Clean Energy Coalition is incorporated as a nonprofit in the State of Michigan. The organization received its 501(c)3 designation from the IRS in January 2006. Clean Energy Coalition was created with start-up funding from the U.S. Department of Energy, the Michigan Energy Office, and the City of Ann Arbor.

The mission of the Clean Energy Coalition is to promote clean energy technologies as a way to create healthier, energy independent communities. To date, the organization has managed over 30 federal, state, local, and foundation grants for innovative energy projects valued at over $55M. Clean Energy Coalition operates a diverse array of programs and services to municipal, residential, and commercial clients.

Clean Energy Coalition is an outgrowth of the Ann Arbor Area Clean Cities (AACC) program. AACC has been operating in Washtenaw County since 1999. In 2005, the stakeholders of AACC voted to create a new nonprofit entity to house this program. Their decision was to expand the scope of this new entity, beyond the parameters of Clean Cities and the Ann Arbor Area, to include the advancement of "clean energy" throughout the State of Michigan. Clean energy includes: technologies associated with improved sources of energy, more efficient use of energy, and better management of energy waste.

As an organization, Clean Energy Coalition has since gone on to manage three of the four Clean Cities programs operating in Michigan. Early in 2010, Clean Energy Coalition assumed management of the Detroit Area Clean Cities Coalition from NextEnergy. Later in 2010, through a support grant provided by the Michigan Energy Office, Clean Energy Coalition assumed management of the West Michigan Clean Cities Coalition (currently seeking designation from the U.S. Department of Energy) from the West Michigan Strategic Alliance.

Through Clean Energy Coalition management of these Clean Cities programs, in addition to the organization's statewide reach, Clean Energy Coalition reaches the majority of Michigan's population centers and currently operates in more than 40 communities from Detroit in southeast Michigan to Marquette in Michigan's Upper Peninsula, nearly 500 miles away.

Disclaimer

This Assessment Report has been developed based on information and data collected during CEC's engagement and as supplied by the City of Auburn Hills. Cost data and value propositions are based on dynamic pricing formulas that are subject to change. Therefore, this Report is intended to be used only as a reference for fleet managers, not as a substitute for strategic decision-making that may incorporate many other administrative and operational factors in the City of Auburn Hills' business.