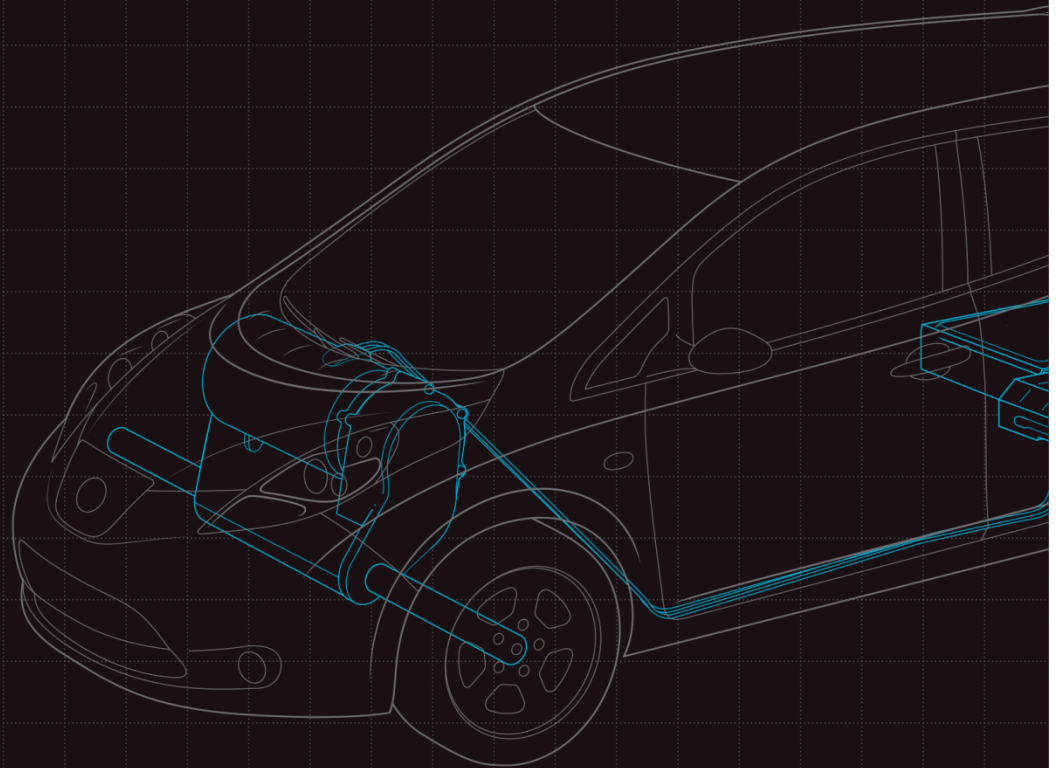


EV CASE STUDY

The City of Houston

Forward Thinking on Electrification

*The City of Houston on Integrating
Electric Vehicles into Fleet Operations*



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Introduction

To most people in the energy space, Houston is known as the oil and natural gas capital of the United States. A stroll around the city's downtown will lead you past the corporate headquarters of many of the world's conventional energy giants. But the city is increasingly gaining a reputation for something unexpected—its ambitious deployment of electric cars.

Why does the City of Houston care about electric vehicles? As one of the fastest growing cities in the country, Houston expects a population increase of 600,000 by 2030. This growth has already led to air quality issues that have become increasingly difficult to mitigate. As a result, the city is employing a comprehensive strategy to promote sustainable transportation options for residents and visitors, as well as for its own fleet of 9,277 cars, vans, and trucks.

With the third largest municipal hybrid fleet in the country, the City of Houston has already made tremendous progress in improving the efficiency of its overall fleet. However, Houston is pushing for even greater gains in efficiency and fuel savings through electrification. In 2010, the city converted 15 Toyota Prius hybrids to plug-in hybrid electric vehicles (PHEVs). Most recently, the city purchased 27 Nissan LEAF battery electric vehicles (BEVs) and has plans to steadily increase that number over the coming years.

Houston has also successfully integrated PHEVs and BEVs into its fleets by rethinking how fleets are managed. By reorganizing its operations into a centrally managed vehicle pool, the city has improved operational efficiency, increased vehicle utilization rates, and built a strong financial case for vehicle electrification. In addition, the city has simplified the transition to electric vehicles by deploying a robust network of charging stations and an advanced reservation system. The ultimate goal is to create a seamless experience for city staff to utilize electric vehicles for their day-to-day needs.

Houston is leading the way forward in municipal fleet electrification through creative problem solving and a focus on cost savings.

HIGHLIGHTS

- > The City of Houston began its efforts to incorporate alternative fuel vehicles (AFVs) into its fleet in 2002 with an initial purchase of hybrid electric vehicles (HEVs), mainly the Toyota Prius and Ford Escape hybrid.
- > Hybrids now constitute more than fifty percent of the city's light-duty fleet.
- > The city's move to electrification began with its conversion of 15 Toyota Prius hybrids to plug-in hybrid electric vehicles (PHEVs) and later its procurement of 27 Nissan LEAF electric vehicles (BEVs).
- > The city's fleet of PHEVs and BEVs now numbers roughly 40 units and accounts for 25 percent of its passenger fleet.
- > Each of these vehicles are estimated to save the city \$7,000 in fuel and maintenance over a three-year period.
- > By consolidating its fleet management services, the city has made its operations more efficient and has improved its procurement processes. By better understanding route dynamics and total cost of ownership, the fleet management team is better able to identify how to best utilize and deploy BEVs.
- > Twenty-five of the city's BEVs are used in "Fleet-share," a pool of vehicles made available to employees for meetings and personal use. The remaining two BEVs are reserved for the Director of Fleet Management and other team members.
- > FleetShare vehicles are reserved based on the requirements of the employee's trip. Gasoline-powered vehicles are provided for trips more than 70 miles and BEVs are provided for shorter trips.
- > The city has installed ample charging infrastructure for its fleet of BEVs, but it still faces challenges in ensuring that the vehicles are fully charged when reserved.
- > To improve user experience, the city is exploring technologies that will integrate vehicle reservations with state-of-charge information.
- > The city estimates that its fleet of 27 Nissan LEAFs will accrue \$110,000 in annual savings compared to internal combustion engine vehicles.

FIGURE 1. OVERALL FLEET SIZE

Passenger Car	SUV/Crossover	Van	Class 1-2 Truck	Class 3-5 Truck	Class 6-8 Truck
3,685	3,685	1,043	1,802	1,402	1,100

NOTE: Figures provided by City of Houston.

FIGURE 2. FLEET VOCATIONS

VOCATION TYPE	Psg. Car	Pick-Up	Class 3-6 Truck	Class 7-8 Truck
Assigned	161	198	115	674
Emergency Responder	2,468	172	10	201
Pool	629	426	214	977
Day Use - Service	153	58	155	684
Take home	304	189	12	171

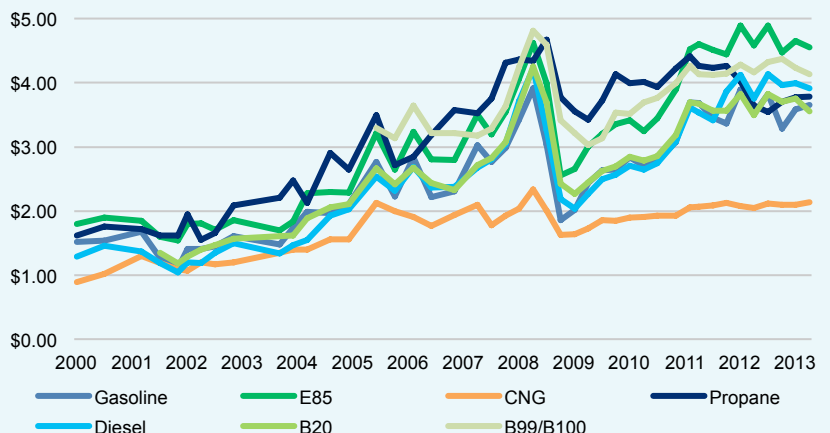
NOTE: Figures provided by City of Houston.

FIGURE 3. 2014 PROJECTED AFV PROCUREMENTS

TECHNOLOGY TYPE	Psg. Car	Pick-Up	Class 3-6 Truck	Class 7-8 Truck
Compressed Natural Gas	10	-	-	-
Hybrid Electric	6	-	-	-
Plug-in Hybrid Electric	-	-	-	-
Worksite Idle Management	10	-	-	-

NOTE: Figures provided by City of Houston.

FIGURE 4. U.S. AVERAGE RETAIL FUEL PRICES (2000-2013)



Source: Clean Cities

STRATEGIC CONSIDERATIONS

The City of Houston is one of the fastest growing cities in the country, with a population that is projected to increase by 600,000 by 2030. The entire Houston region is expected to grow by 2 million over the same period. For Houston, air quality issues have posed an ongoing challenge for several years. The city is currently an EPA non-attainment zone for ground-level ozone, a designation given to an area with an increased frequency of respiratory issues like asthma. Volatile organic compounds (VOCs) are key contributors to ground-level ozone, and a 2005 inventory of metro-area emissions found that vehicles are responsible for more than two-thirds of Houston’s VOC emissions.

For a city that is expected to continue to grow in population density in the coming years, air quality is a challenge that must be addressed. The city’s leaders are also taking advantage of a shifting mentality among Houston’s citizens—a clear majority of respondents in the 2012 Houston Area Survey believed that more taxpayer dollars should be spent on improving rail and bus access instead of expanding highways—to offer a more holistic approach to transportation, including supporting greater access to pooled mobility solutions like carsharing. As part of its strategy, Houston has focused on supporting the deployment of alternative fuel vehicles (AFVs) such as compressed natural gas vehicles and, to a greater extent, electric vehicles.

The city also views electric vehicles as a means to attract highly skilled, young workers because their presence signals support for new technologies, innovation and common-sense solutions. The city therefore hopes that its support for cleaner, more ‘sustainable transportation’ resonates strongly with both current and prospective residents as well as those that visit Houston for business or leisure.

Electric vehicles also have the advantage of giving fleet operators an opportunity to disconnect operating expenditures from volatile gasoline prices. Although HEVs are much more efficient on a miles-per-gallon basis than conventional vehicles, they remain reliant on oil as their primary source of fuel. The city was an early mover into the electric vehicle space, having converted 15 of its Toyota Prius HEVs to PHEVs in 2010. The city has subsequently added all-electric Nissan LEAFs to its fleet. Together, the 27 LEAFs have been estimated to save approximately \$110,000 annually in fuel and maintenance costs in comparison to comparable gasoline-powered vehicles.

CRITICAL DECISION FACTORS

A number of factors were taken into consideration as the City of Houston explored the possibility of adding PEVs to its fleet. The vehicles carry a great deal of promise for a number

of political, economic, and environmental reasons. City of Houston officials offered insight into their decision-making process by ranking various factors and discussing their rationale behind each decision in detail.

Total Cost of Ownership: Though not the initial motivator for the city, the low-cost operational benefit of electric vehicles is significant and will play an important role in Houston’s fleet management strategy going forward. Of the city’s 27 BEVs, 25 were purchased with the help of ARRA funding. However, the two newest Nissan LEAFs were paid for through the city’s budget because the city was able to make a strong fiscal case for investing in the technology.

In many cities, total cost of ownership plays a surprisingly small role in purchasing decisions. Often times, those responsible for the procurement budget are not responsible for paying for operations and maintenance. This creates disconnect within many organizations and fleets that leads to vehicles with low up-front costs being prioritized even though these vehicles may ultimately be less advantageous from an operations and maintenance standpoint. One of Houston’s big successes has been solving this problem.

In 2012, Houston began restructuring the management of its vehicles, many of which are spread out in hundreds of locations around the city. Previously, each city department managed its own small fleet of vehicles. By consolidating the

FIGURE 5. PURCHASE RATIONALE

Scale is 0 to 5, with 5 indicating a factor weighed heavily in the decision process and 0 indicating that it did not factor at all.

Positive Factors		Negative Factors	
Fuel Savings	5	Vehicle Upfront Cost	5
Social Responsibility	5	Total Cost of Ownership	4
Long-term Commitment to the Technology	4	Concerns about Battery/Vehicle Residual Value	3
Operational Benefit (e.g. on site power generation)	3	Operational Sacrifices	3
Vehicle Maintenance and Support Savings	3	Concerns about On-Site Infrastructure (Cost, Complexity, Ability to Manage)	1
Research and Development	1	Concerns about Safety	0

NOTE: Based on interview with City of Houston officials.

FIGURE 6. EV PERFORMANCE SATISFACTION

EXPECTATION VS. REALITY	Much Worse	Worse	As Expected	Better	Much Better
Fuel Savings					✓
Maintenance Savings				✓	
Vehicle Reliability			✓		
Vehicle Performance			✓		
Vehicle Range			✓		
Driver Satisfaction (initially)			✓		
Impact on Brand/Image				✓	
On-site Charging Infrastructure				✓	
Access to Public Charging		✓			

NOTE: Based on interviews with City of Houston officials.

management of these vehicles into one citywide fleet department, Houston was able to make smarter purchasing decisions and shrink operating expenses. As a result, total cost of ownership is more properly valued in vehicle procurement, which has opened the door for increased electric vehicle adoption.

Because the PEVs have only logged, on average, a little over 3,000 miles each, the City of Houston has yet to develop a comprehensive cost comparison with comparable HEVs. However, given experiences to date, the city estimates potential savings of \$110,000 dollars per year. This is largely dependent on high utilization rates, which the city is facilitating through new efforts to pool its vehicles.

Pooling Vehicles to Maximize Utilization Rates:

The formation of the City of Houston’s new motor pool is an important step toward enabling electric vehicle adoption. The city’s Fleet Management department worked with ZipCar to create FleetShare, a pilot carsharing program for government employees, at its main downtown office. The city equipped 50 vehicles—25 LEAFs, 21 HEVs, and 4 Prius PHEV conversions—with Zipcar’s FastFleet wireless technology, enabling employees to reserve available vehicles in the fleet pool. An employee is able to pick a vehicle from his or her desk and access it with keyless entry technology. On the fleet management side, FastFleet offers a number of monitoring and analytical capabilities. Fleet managers are able to better monitor usage, driving patterns, and other information critical to understanding how the vehicles are being used, and better identify additional applications.

In many ways, electric vehicles fit ideally into such a carsharing fleet. By right-sizing the pool of vehicles according

to increases in membership, the city can maximize utilization rates and vehicle miles traveled (VMT). Because electric vehicles make up for their higher upfront premium with operating costs much lower than those of gasoline-powered vehicles, a fleet manager will see a better return on investment with greater utilization. As those rates increase, the argument for electrification strengthens.

The service currently has 400 members and is growing in popularity. As BEV utilization rates reach fifty percent per vehicle, the city will procure more vehicles. The vehicles are currently being reserved at a 47 percent utilization rate.

Electric Vehicle Charging Infrastructure: Charging infrastructure is a key piece of Houston’s electric vehicle FleetShare strategy. Although a robust charging infrastructure is publicly available in Houston, city employees rarely use the stations because the city has installed a hub of stations in their vehicle pool garage.

The build-out of the infrastructure for the FleetShare program was accomplished with relative ease and at low cost. All of the stations were provided for free by ChargePoint, GridBot, and other charging station manufacturers using funding provided through ARRA. To date, the city has installed 66 level two (220v) and 32 level one (110v) charging stations in the central fleet garage.

The installation process proved to be straightforward and cost effective. The installations required no new transformers and only a small upgrade to the circuit breaker panel. Each BEV requires 7 kilowatts of power for a full charge, but for a facility with a 160 megawatts power capacity, this small amount of usage is so minimal that the facilities manager does not even bill the fleet management department.

The city intentionally installed more stations than vehicles in anticipation of future BEV purchases and to streamline the process of moving cars throughout the FleetShare parking lot (the vehicles are frequently parked in different areas).

As a solution, the city is exploring alternative methods to managing reservations and charging. All Nissan LEAFs are equipped with the CarWings app, which shows real time states-of-charge. The fleet managers are able to log into this app and remove vehicles with low states-of-charge from the FastFleet reservation system. While not an elegant solution, it is helping improve processes. Long-term, the city hopes to find a single, comprehensive solution to managing the reservation system more effectively. And as these solutions are improved, the city will continue to pull other vehicles from its larger fleet into FleetShare.

PEV Fleet Profile

FIGURE 7. DEPLOYMENT PROFILE

FACILITY PROFILE			
Depot/Plant Location	Houston, TX		
Type of Facility	Municipal Government		
Total Number of Vehicles at this Location	12,465		
Vehicle Type	Service, Utility, Repair, Other		
Refueling Mechanism	Retail Station for ICE Vehicles, Depot for PEVs		
Route Type	Regular Route from Depot, Multiple Sites / Fixed Route / Random		
Total Number of Employees at the Location	21,722		
CHARGER PROFILE			
	Level 1	Level 2	DC Fast Charge
Number of Chargers Installed for this Phase	32	66	-
Vehicle-to-Charger Ratio	2:1	2:1	-
Charger Manufacturer	ChargePoint and GRIDbot	Blink and GRIDbot	-
VEHICLE PROFILE			
PEV Deployment Details	Class 1 Autos		
Total Number of PEVs Purchased	25		
Battery Electric Vehicles (EVs)	27		
Plug-in Hybrid Electric Vehicles (PHEVs)	15 (Prius Conversions)		
Vehicle Manufacturer	Nissan		
Vehicle Model	LEAF S		

Ben Holland, Director of Deployment Strategy for the Electrification Coalition, discussed Houston's fleet strategy with Jedediah Greenfield, Public Information Officer for City of Houston, Fleet Management Department. What follows are highlights from the discussion.

Q: How have rising fuel costs informed your purchase decisions?

Greenfield: The first 25 battery electric cars we bought were purchased with the last remaining ARRA funding available to the city. We justified purchasing them for our sustainability initiatives and got approval from the federal government. That happened right around the same time that we formed our fleet department. Prior to then, the fleet services were all handled by the individual departments.

Our new fleet department was put together to consolidate all of those services and to eliminate duplications, since we had these big departments with different facilities. By merging them together, we could eliminate overlapping services.

At the same time the department was starting, these 25 vehicles arrived. When our Director came in, we put the electric vehicles into a program that the city could use for business. Once we were able to track the vehicles, we could see the potential to reduce fuel costs.

We've purchased 2 additional LEAFs since then, which were purchased with city funds. We've seen the rising costs associated with fuel, and these cars are a great answer to that while also getting city employees to meetings and other things they need to do. So that was our drive—cost. And the maintenance costs have also been a lot less. For example, we do not need to perform oil changes.

Q. What observations have you made about operating costs since the program began?

Greenfield: The cars are just over a year old, so we haven't had any maintenance costs yet. We know we'll have a few things to do when they reach the 22,000-mile mark and we have to take them in for service. But so far, we've done some back-of-the-envelope estimates.

We compared the Nissan LEAF to a Ford Focus and calculated how much we save in fuel costs by using electricity. We're expecting annual savings of \$110,000 with the full fleet of 27 LEAFs and a two year payback. Since our vehicles have a 10-year lifespan, we'll have 8 years of significant fuel savings.

Q. What challenges have you encountered with infrastructure?

Greenfield: It is critical that there is a dedicated charging station for each electric vehicle in the fleet. We have a high volume of users taking them out, so we educate them on the

importance of properly charging the vehicles when they sign up for the program. When we have new drivers, we have to make sure that they activate the charging station before leaving the car. We cover that in an initial kickoff and then watch the program closely. But we don't see this as a major issue.

The biggest issue is that, since these are in a motor pool program, a vehicle might be used multiple times a day and run up high mileage totals. When I go down to the car, there might only be 10 miles of range left. We're trying to catch these issues earlier.

Nissan has a CarWings app that lets us see the state of a car's charge and we're trying to figure out how to use that to improve our reservation system. We don't want to tell our drivers that the cars can't go out multiple times, so we're looking at how we can integrate this intelligence so that our staff can see when a LEAF has a low battery and move the employee to a different vehicle.

Q. What is the long-term plan for increasing the adoption of these vehicles?

Greenfield: As we're increasing the fleet share program, we'll obviously need to add vehicles. As the technology matures and improves, the range will increase and we can start paring back our need for the gasoline vehicles. Right now, we need those other vehicles when employees are going over 75 miles on a single trip. We expect our vehicle mix to move more toward electric in the future, because we can realize the cost savings.

The vehicle miles traveled are increasing quickly. We're adding more Fleet Share drivers so the utilization rates of the vehicles are getting better. Once we approach 50 percent utilization of the electric vehicles, we will begin to add more. We have close to 480 drivers in our program and our utilization of electric vehicles is now up to about 47 percent, so we're now in the process of planning to purchase more.

LEARN MORE

Visit [ElectrificationCoalition.org](https://www.electrificationcoalition.org) to learn about electric vehicles for fleet applications, to download case studies, and more.

Visit [FleetAnswers.com](https://www.fleetanswers.com) to access a wide variety of fleet tools, read future case studies, and learn more about electrification.