

# GREENING THE FLEET

A FISCALLY RESPONSIBLE APPROACH TO  
ELECTRIC/HYBRID VEHICLE TECHNOLOGY



# A BRIEF HISTORY OF ELECTRIC VEHICLES

- Battery operated electric vehicles (EV's) have their origins in the mid to late 19<sup>th</sup> century in both Europe and the United States
- The first successful electric car made its debut in 1890 and was built by William Morrison, in Des Moines, Iowa
- His six passenger car was capable of a top speed of 14 miles per hour
- Over the next decade electric cars increased in popularity
- The City of New York had 60 electric taxis in 1900
- Thomas Edison and Henry Ford partnered to explore options for low cost electric cars in 1914
- However, electric was only available in the more populous cities
- At the turn of the 20<sup>th</sup> century oil exploration and refinement made gasoline powered engines a cheaper alternative to electric
- By 1912 a gasoline powered car cost \$650 while an electric car cost \$1,750
- By the 1920's better roads and the building of filling stations increased the demand for gasoline engine cars

# A BRIEF HISTORY OF ELECTRIC VEHICLES

- BY 1935 electric cars had all but disappeared from the U.S.
- Through the 30's up and into the early 70's gas was abundant and cheap
- In the early 70's crude oil prices skyrocketed causing soaring prices and fuel shortages
- This peaked with the 1973 Arab oil embargo which created a growing interest in the U.S to lower our dependence on foreign oil and finding home grown sources of fuel
- Interest in electric vehicles again was piqued; however, interest began to fade once the oil shortages and soaring fuel prices eased
- BY the 1990's interest in electric cars was increasing again but for environmental reasons
- IN 1990 the Federal Government passed the Clean Air Act and in 1992 the Energy Policy Act regulating fuel emissions in motorized vehicles

# A BRIEF HISTORY OF ELECTRIC VEHICLES

- This forced manufacturers to improve their internal combustion engines while also researching potential alternative fuel vehicles
- In 1997 Toyota introduced the first practical Hybrid/Electric vehicle; the Prius
- The success of the Prius and the Honda Insight raised public awareness about alternative fuel vehicles
- The other major event that helped reshape electric vehicles was the creation of Tesla Motors in 2006
- Tesla's aggressive entry into the automobile industry forced other automakers to accelerate their own research into electric vehicle development
- In 2010 the Chevy Volt and Nissan Leaf were introduced into the U. S. Market
- As of 2014 3% of new vehicle sales in the U.S. are hybrid, plugin, or all electric
- It is estimated that the annual percentage of electric car sales could grow to as much as 7% by the year 2020

# TYPES OF ELECTRIC VEHICLES SUITABLE FOR USE BY THE CITY OF MELBOURNE

## PLUSES AND MINUSES

- Full electric plug-in vehicles
  - Higher initial cost to purchase (-)
  - Federal rebates on new purchases (+)
  - Limited mileage range (-)
  - Very low cost for fuel (+)
  - Low maintenance costs (+)
- Hybrid electric vehicles
  - Lower/same initial cost to purchase (+)
  - Better fuel economy than conventional gasoline units (+)
  - Lower fuel economy than a full plug-in electric (-)
  - Unlimited mileage range (+)
  - No incentives for purchase (-)

## How the City Evaluates Potential Electric/Hybrid Purchases

- During the annual acquisition process the Fleet Manager identifies what new or replacement units, if any, require an analysis to determine if an electric or hybrid vehicle will work as a replacement
- The Fleet Manager utilizes a Vehicle Utilization Analysis Form to identify potential units
- Items such as vehicle use, load requirements, number of staff transported, and towing requirements are identified to determine if an electric/hybrid vehicle could be used
- If the analysis shows that there is a potential use, a Lifetime Cost Analysis is performed to determine if it is economically sound to purchase an electric vehicle
- The next few slides show examples of these analyses

## TYPES OF FULL ELECTRIC VEHICLES SUITABLE FOR USE BY THE CITY OF MELBOURNE

- Full electric plug-ins such as the Chevy Bolt, Ford Focus, Nissan Leaf



- Uses include transportation for staff and materials for local on-road driving only
- These cars have a charge range of between 85-120 miles

Shown: Nissan Leaf

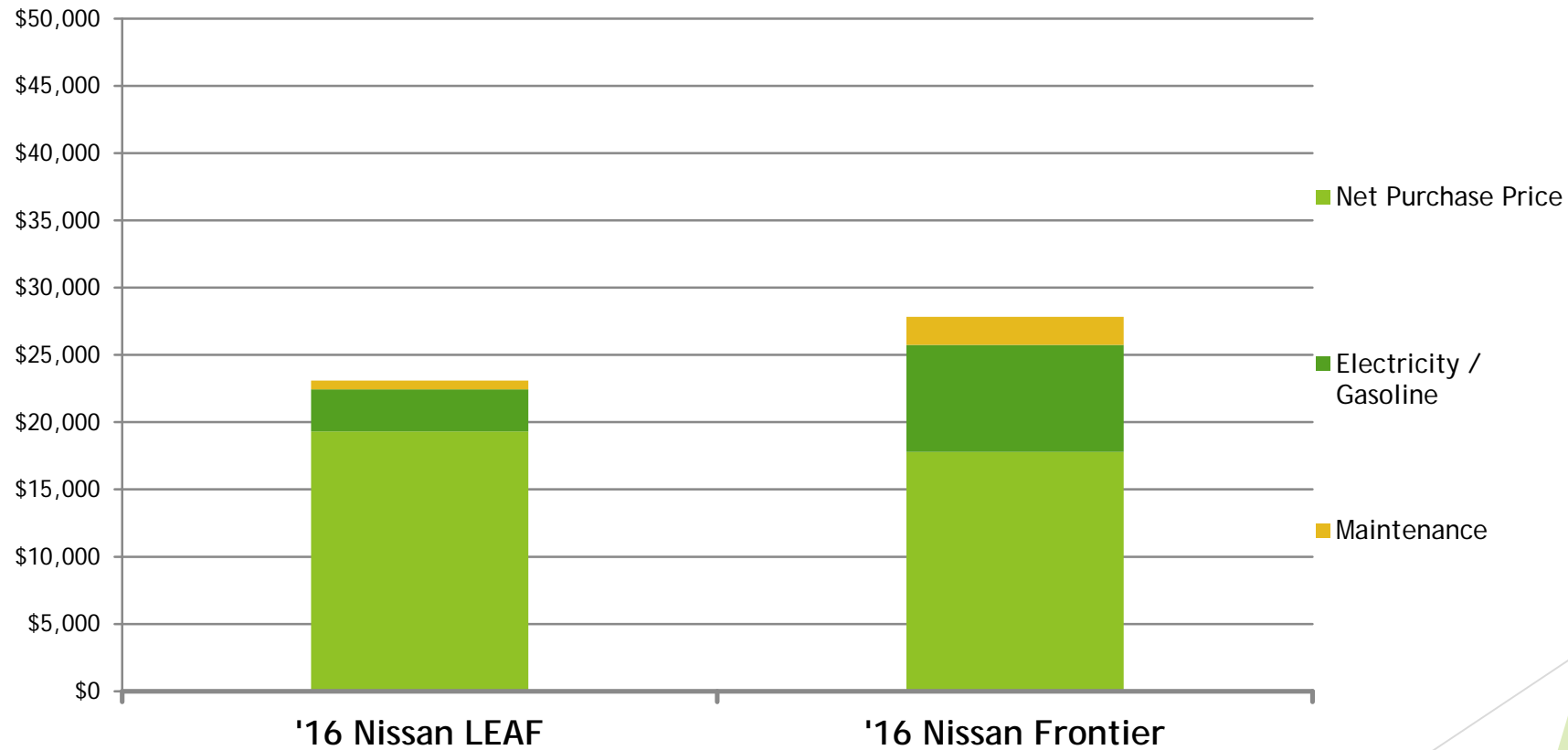
# LIFETIME COST ANALYSIS ESTIMATE FOR NISSAN LEAF PURCHASED IN 2016

Total Cost of Ownership and Payback Period for Light-Duty Vehicles					
	Comparison Vehicle	Baseline Vehicle			
Enter Vehicle Type	'16 Nissan LEAF	'16 Nissan Frontier			
Select type of vehicle from Drop Down menu	Plug-in hybrid electric vehicle	Petroleum vehicle	Results	'16 Nissan LEAF	'16 Nissan Frontier
Vehicle purchase price incl. all taxes and fees	\$27,793	\$17,787			
Purchase incentives	\$8,473	\$0	Payback period (yrs.)		2.12
Useful life of vehicle(s) or depreciation period (yrs.)		8	(does not incl. resale)		
Cost of gasoline(\$/gal)	\$1.85	\$1.85			
Gasoline cost escalation rate (%/yr.)	3.50%	3.50%	List Purchase Price	\$27,793	\$17,787
Cost of electricity (\$/kWhr)	\$0.091		Electricity / Gasoline	\$3,111	\$7,949
Electricity cost escalation rate (%/yr.)	2.00%		Maintenance	\$657	\$2,102
Maintenance cost (\$/mile)	\$0.010	\$0.032	Insurance	\$0	\$0
Annual insurance cost	\$0	\$0	License and Registration	\$0	\$0
Annual license and registration cost	\$0	\$0	Incentives	-\$8,473	\$0
License and registration escalation rate (%/yr.)	0.00%	0.00%	Total lifetime costs	\$23,088	\$27,839
PEV all-electric range (miles)	107		Calculated resale value (present value)	\$6,442	\$4,123
Number of full charges per driving day	0.29		Optional resale value (recalculates results)	\$0	\$0
Annual vehicle mileage (miles/yr.)	7,879	7,879			
Ave. annual number of days driven (days/yr.)	251	251			
Petroleum fuel economy (miles/gal)	1.0	16.0			
PHEV electricity consumption rate (kWhr/100 miles)	28.0				
Charging efficiency losses (%)			High mileage penalty calculator		
			Enter % resale penalty	30%	30%
			High mileage resale value (enter above)	\$4,509	\$2,886
Annual inflation rate	2.20%	2.20%			
Annual discount rate	0.79%	0.79%			



# LIFETIME COST OF OWNERSHIP

## 8 Year - Lifetime Cost of Ownership\*



## TYPES OF HYBRID ELECTRIC VEHICLES SUITABLE FOR USE BY THE CITY OF MELBOURNE

- Hybrid electric vehicles such as the Chevy Volt, Ford CMAX, Toyota Prius



- Uses include transportation for staff and materials for any on-road driving
- These cars have an unlimited mileage range due to combined gas/electric fuel technology

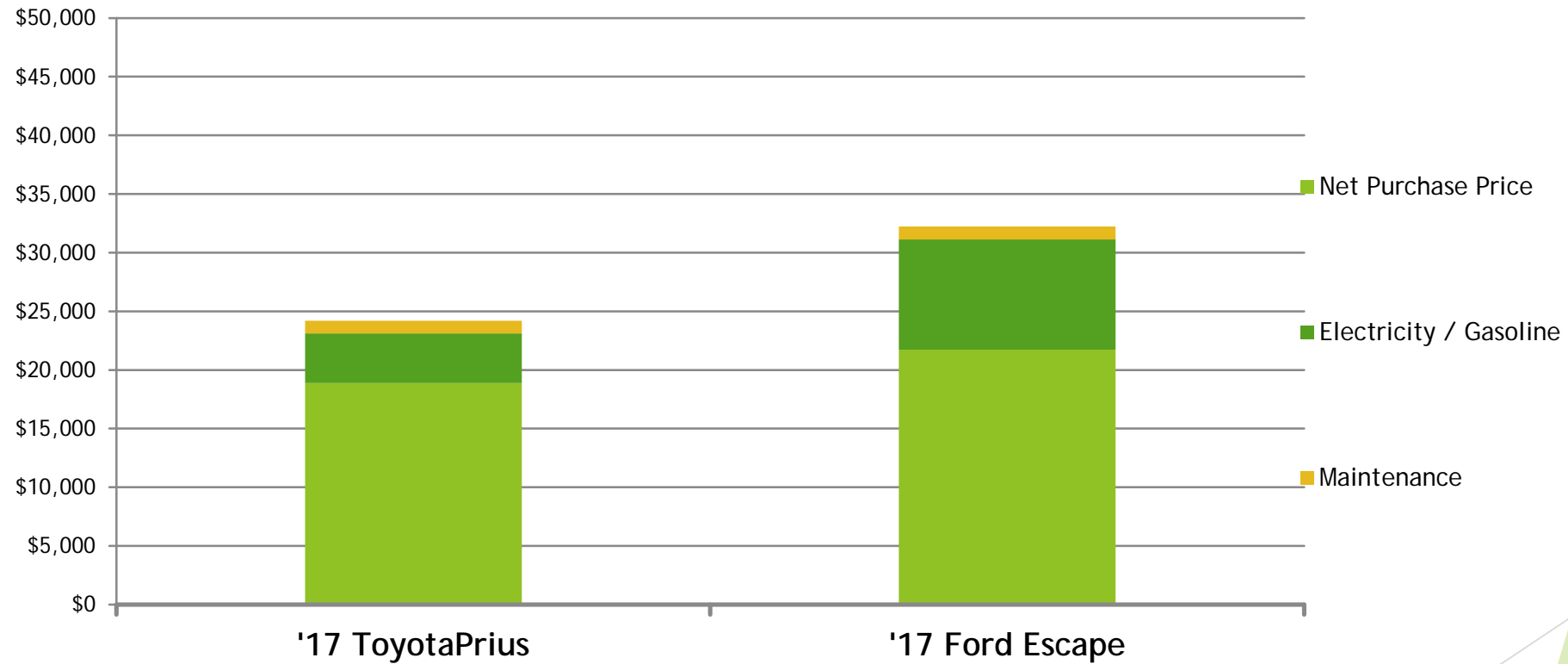
Shown: 2017 Toyota Prius

# LIFETIME COST ANALYSIS ESTIMATE FOR TOYOTA PRIUS PURCHASED IN 2016

Total Cost of Ownership and Payback Period for Light-Duty Vehicles					
	Comparison Vehicle	Baseline Vehicle			
Enter Vehicle Type	'17 Toyota Prius	'17 Ford Escape			
Select type of vehicle from Drop Down menu	Plug-in hybrid electric vehicle	Petroleum vehicle	Results	'17 ToyotaPrius	'17 Ford Escape
Vehicle purchase price incl. all taxes and fees	\$18,887	\$21,730			
Purchase incentives	\$0	\$0	Payback period (yrs.)		0.00
Useful life of vehicle(s) or depreciation period (yrs.)		8			
			(does not incl. resale)	immediate cost savings	
Cost of gasoline(\$/gal)	\$1.94	\$1.94			
Gasloine cost escalation rate (%/yr.)	3.50%	3.50%	List Purchase Price	\$18,887	\$21,730
Cost of electricity (\$/kWhr)			Electricity / Gasoline	\$4,078	\$7,093
Electricity cost escalation rate (%/yr.)			Maintenance	\$2,775	\$2,775
Maintenance cost (\$/mile)	\$0.035	\$0.035	Insurance	\$0	\$0
Annual insurance cost	\$0	\$0	License and Registration	\$0	\$0
Annual license and registration cost	\$0	\$0	Incentives	\$0	\$0
License and registration escalation rate (%/yr.)	0.00%	0.00%	Total lifetime costs	\$25,741	\$31,597
PEV all-electric range (miles)			Calculated resale value (present value)	\$4,378	\$5,037
Number of full charges per driving day			Optional resale value (recalculates results)	\$0	\$0
Annual vehicle mileage (miles/yr.)	7,500	7,500			
Ave. annual number of days driven (days/yr.)	251	251	High mileage penalty calculator		
Petroleum fuel economy (miles/gal)	40.0	23	Enter % resale penalty	30%	30%
PHEV electricity consumption rate (kWhr/100 miles)			High mileage resale value (enter above)	\$3,065	\$3,526
Charging efficiency losses (%)					
Annual inflation rate	2.20%	2.20%			
Annual discount rate	0.79%	0.79%			

# LIFETIME COST OF OWNERSHIP

## 8 Year - Lifetime Cost of Ownership\*



# LOOKING TO THE FUTURE, WHAT ELECTRIC/ HYBRID TECHNOLOGY HAS COMING

- Lower battery prices
- Increased mileage ranges
- More charging stations
- The automotive industry is embracing EV's
- Stronger pollution standards
- Share of automotive market is expected to be @35% by 2040
- Crude Oil displacement is projected to be 2 million barrels per day by 2023
- Displacement is projected to be 13 million barrels a day by 2040

# WHAT DOES THIS MEAN FOR THE CITY OF MELBOURNE

- ▶ As technology improves a wider variety of vehicles will have electric and hybrid technology
- ▶ Technology is advancing into the police and public safety sector
- ▶ Hybrid technology continues to expand into the mini-van and SUV fleets
- ▶ Ford plans to have a ½ ton (F-150) hybrid pickup available by 2020
- ▶ As prices continue to become more competitive on hybrid vehicles and the variety of vehicles increases the City will be able to take advantage of electric/hybrid technology because of the overall cost savings
- ▶ The City continues to evaluate the electric/hybrid technology annually and utilizes it when an EV meets the requirements of the job and is economically feasible to purchase

# What IS CNG TECHNOLOGY?

- ▶ Compressed Natural Gas (CNG) and its sister Liquid Natural Gas (LNG) are by-products of the crude oil industry
- ▶ CNG is pumped from independent wells or off of oil wells and is abundantly available in the U.S.
- ▶ There are @ 250,000 CNG powered vehicles currently in use in the U.S.
- ▶ CNG is primarily methane
- ▶ When used as a fuel it burns cleaner than fossil fuels and emits lower amount of carbon monoxide and nitrogen oxides
- ▶ CNG is cheaper than fossil fuels but is only about 60% as efficient as the same measured quantity of diesel fuel
- ▶ CNG must be delivered under pressure (more than 3,000 psi.) in order to be a usable motor fuel

# CNG TECHNOLOGY & THE CITY OF MELBOURNE

- Currently the City has not used any Compressed Natural Gas (CNG) technology in the vehicle and equipment fleet
- Utilizing CNG technology would require installation of fueling station
- Estimates from the U.S. Department of Energy place the cost of building a CNG fueling station to be between 1-4 million depending on the specific needs of the site
- Maintaining CNG vehicles requires the maintenance facility to be 100% explosion proof. Special tools are required that won't spark and all electrical outlets must be explosion proof
- Certain chemicals that have a high explosive rate such as brake cleaners and others cannot be used in this shop environment. All chemicals must be non-flammable





# CNG TECHNOLOGY & THE CITY OF MELBOURNE

- CNG offers two types of fill stations, Fast-Fill and Time-Fill
  - Fast-fill stations are best suited for retail stations where vehicles arrive randomly and fill up quickly
  - Time-fill stations are best used by fleets and with vehicles that have large tanks that are filled slowly overnight, or after normal work hours
  - Depending on the size of the compressors, tank size, and number of vehicles being filled a time-fill site may take from a few minutes to a few hours to fill a tank
  - In order to make a CNG station cost effective there needs to be a high volume of fuel sold in order to cover the capital costs of constructing a site.
  - Time-fill operations work best for a fleet that has a consistent fleet of vehicles much like UPS or a Soda distributorship where all of the vehicles can be fitted with CNG technology and filled after normal work hours
  - The City of Melbourne does not have a fixed fleet. There are over 50 different manufacturers and types of equipment the City utilizes on a daily basis

# CNG TECHNOLOGY & THE CITY OF MELBOURNE

- Most of the City Public Works and Parks vehicles and equipment are housed overnight at the Harper Road Complex
- Fire Apparatus is housed at the different Fire Stations
- Police units are taken home by each officer at the end of their shift
- All units that are housed at Harper Road use the City's fuel station located on site
- The Fire Stations each have a small fuel tank that is used to fuel their diesel apparatus
- The Police Dept. and Fire Admin units utilize local retail stations to purchase their fuel using a fuel purchasing card program
- Logistically it would be impractical for the City to explore the use of CNG technology for the City vehicles and equipment

# OTHER FLEET GREENING INITIATIVES

- In 2016 Fleet Management converted to full synthetic blend oils for all uses
- Synthetic blends allow Fleet to extend the service intervals on the vehicle and equipment fleet, reducing out of service downtime, costs, and oil consumption
- A typical Public Works type vehicle's service interval was increased from every 4,000 miles/4 months, to 10,000 miles/annually which reduced the oil consumption on these vehicles types by 66%
- Police patrol unit service interval's were increased from 3,000 miles/3 months to 4,000 miles/4 months which reduced oil usage by 25% on these vehicles
- Aligned automatic transmission services with manufacturer recommendations which reduced consumption of transmission fluids by over 50%
- All of the used oils created by the City are recycled

# CONCLUSIONS

- With the ever expanding and reduced cost of electric/hybrid technology it can be assumed that the City will increase their number of EV units over the next decade
- CNG is not currently a practical application for the City to invest in for their fleet
- The City has and will continue to balance the greening of the fleet with fiscally responsible decisions regarding the purchase of electric/hybrid vehicles
- Fully committing to any technology at this time is not prudent because the technology continues to change rapidly
- Blending the fleet with a combination of fuel types over time will ensure the City utilizes technology to its advantage without being forced to keep a technology that is no longer efficient or cost effective

# QUESTIONS?

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*"The day science begins to study non-physical phenomena, it will make more progress in one decade than in all the previous centuries of existence"*

*-Nickola Tesla-*