



# The Future of Public Transport – In Pursuit of Zero Emissions

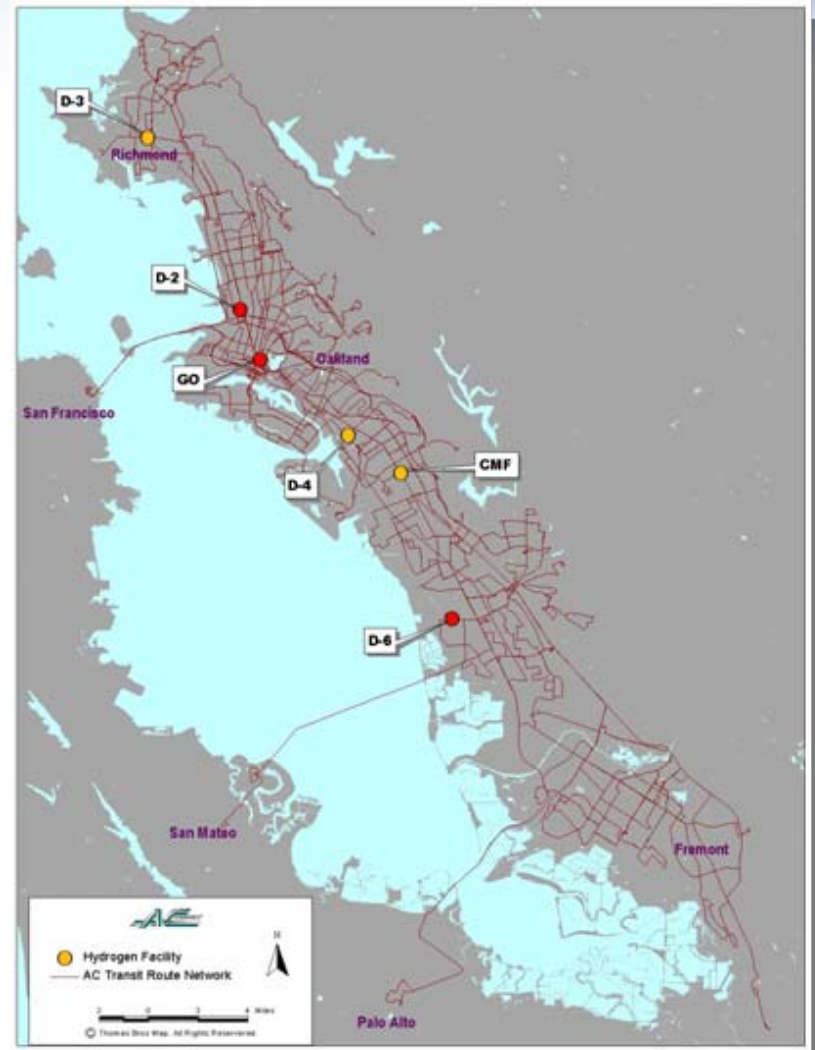
Jaimie Levin





## AC Transit

- **Serving 1.5 million people in 13 cities**
- **61 million passengers**
- **600 buses**
- 2,000 employees
- \$325 million budget
- 105 lines (26 transbay)





# AC Transit Regional Role

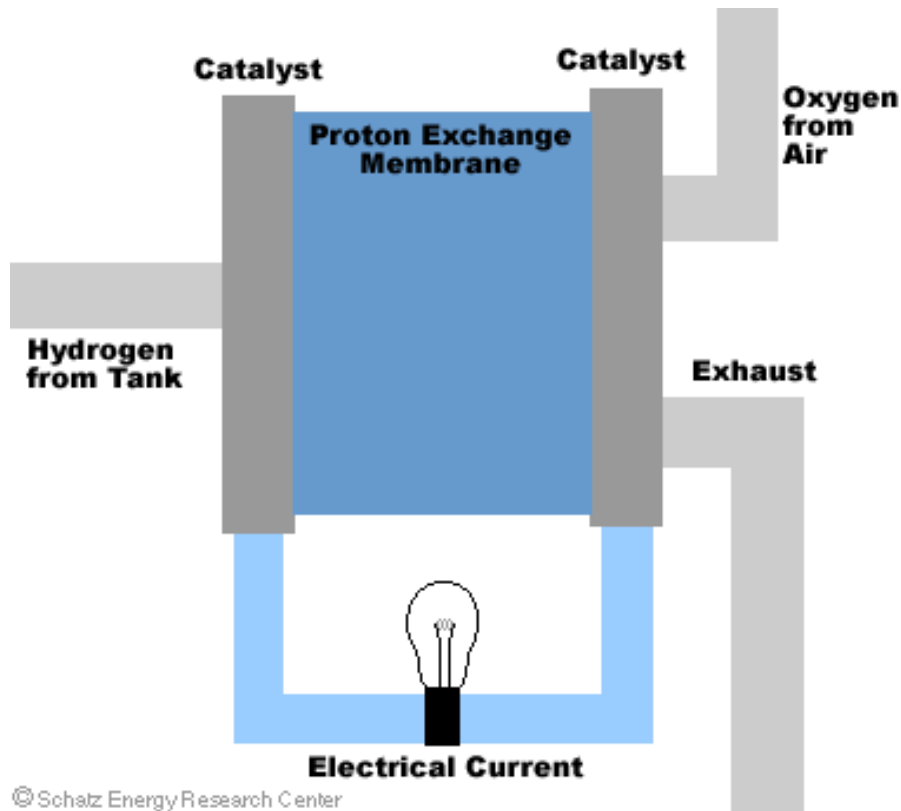
## One of 27 Transit Operators

- San Francisco MUNI
- BART (Capitol Corridor)
- **AC Transit**
- VTA
- Samtrans
- Caltrain
- Golden Gate
- County Connection
- ACE
- Wheels, Tri Delta, Vallejo, WestCAT
- 14 Smaller Operators





# What's A Fuel Cell?



© Schatz Energy Research Center

- An electrical generator
- **NOT** a battery
- A chemical reaction between hydrogen and oxygen
- Emits only water vapor and heat
- 120 kW to 200 kW of output



# Phase 1 – 26 Partners – \$21 Million







## 1<sup>st</sup> Generation Bus

- >267,000 Miles (as of OCT 2010)
- >700,000 Passengers
- 60% Better Fuel Economy
- 43% GHG Reductions  
(Reforming Natural Gas;  
100% reduction with solar or wind hydrogen)





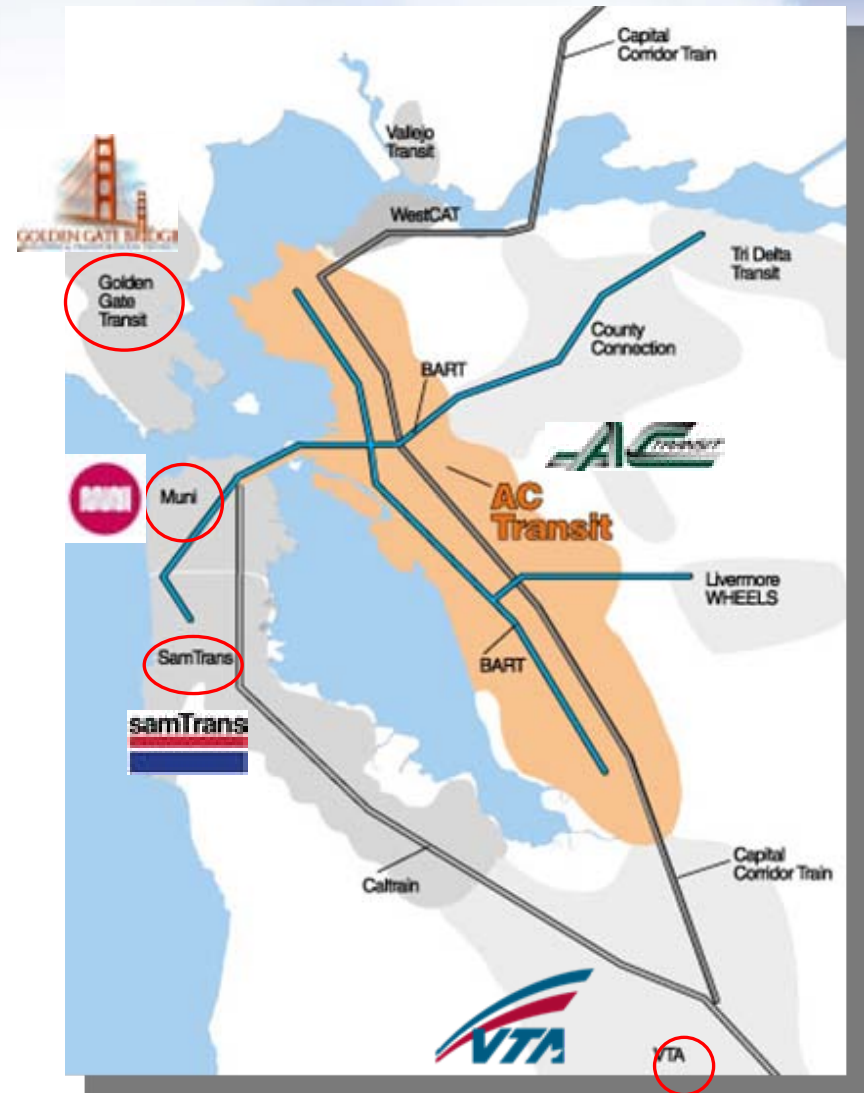
## Passenger Survey – 493 Passengers

- Funded by Federal Transit Administration
- **ACT's Fuel Cell Program – 84% Positive**
- Program's Effect on Opinion of Local Government – **70% Improved**
- Importance of Considering Alternative Fuels – **90% Yes**
- Support **Expanded Fuel Cell Bus Program** at AC Transit – **81% Yes**



# Phase 2 – Bay Area Demo

- \$60 Million
- 12 New Buses in 2010
- 5 Transit Agencies (>2,500 vehicles)
- Shared Service
- Shared Training







# 1<sup>st</sup> Generation Design





# 2<sup>nd</sup> Generation Design







# 3<sup>rd</sup> Generation Design – 28,000 Mi



**“Disneyland in The Real World.”**

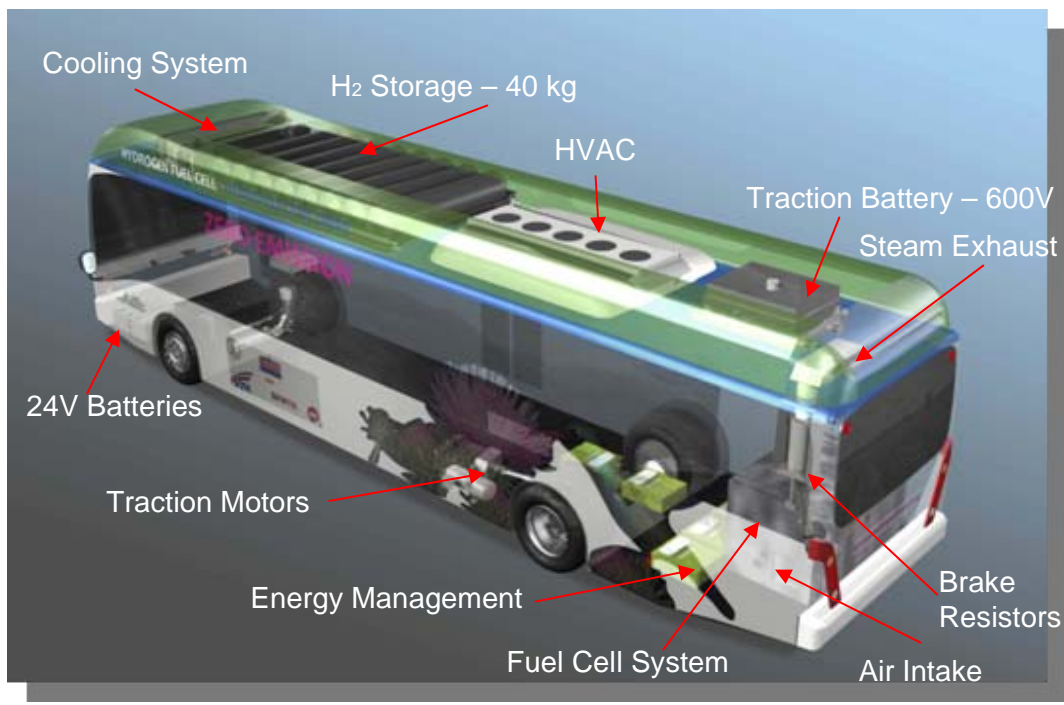






# Next-Generation Enhancements

- 5,000 Pounds Lighter/Lower Profile
- OEM Integration/EnerDel Li-ion Batteries
- Hybrid-drive Components
- FC Cooling
- H<sub>2</sub> Storage
- Performance
- FC Durability
- Reliability





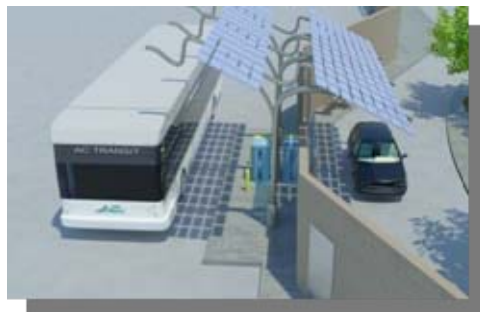
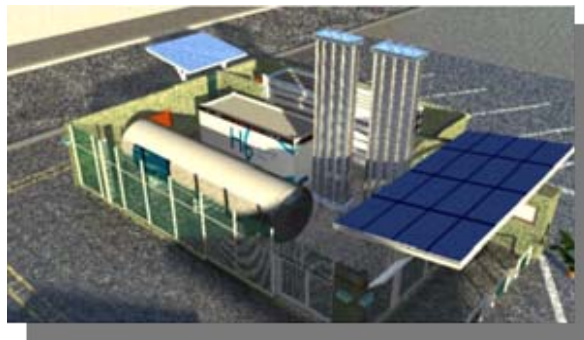
# Oakland Temporary Fueling







# New Emeryville Energy Station



- **Solar Electrolysis and H<sub>2</sub> Delivery**
- **6 to 12 buses daily**
- **Fast Fueling 5-6 kg/minute**
- **20 cars per day**
- **Toyota, Daimler, Hyundai**
- **Startup – April 2011**







# Seminary Station – 180/360 kg/Day







# ACT Solar Power – 1.3 Megawatts

AC Transit solar system will provide renewable power to Emeryville station

**\$6.4 Million FTA  
TIGGER I Grant for  
new solar system**



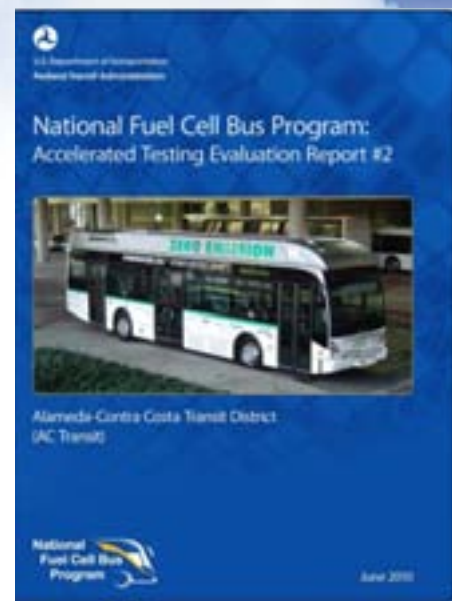
Existing solar at AC Transit Oakland Division





## Evaluation

- In Partnership with NREL, FTA, and DoE
- **DoE has approved continued data collection and analysis of 12 buses and new stations through 2011.**
- Monthly and Semi-annual Performance Reports







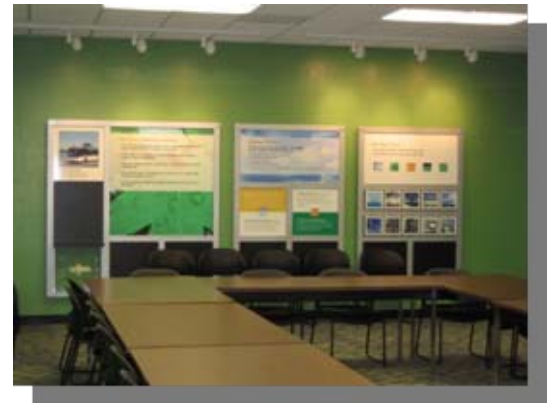
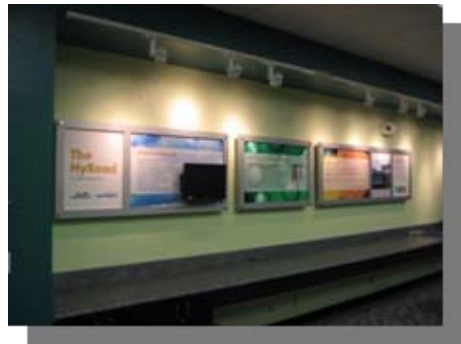
# Education – \$1.1 million

**HyTEC**  
**Hydrogen Technology & Energy Curriculum**  
Integrating Hydrogen and Fuel Cells into a Standard High School Chemistry Curriculum

**PROGRAM PARTNERS**  
LHS, Lawrence Hall of Science, ACTransit, and a green circular logo.

**PROGRAM ADVISORS**  
National Hydrogen Association (NHA), Chobot Space & Science Center, California schools and teachers.

- In Partnership with **Lawrence Hall of Science at UC Berkeley**
- Curriculum Development for Middle- and Secondary Schools





# Proof of Concept: Performance

Next Steps	Evaluation Criteria
12 Next-Generation Buses in Service by November 2010	<ol style="list-style-type: none"> <li>1. Performance by different operators</li> <li>2. Fuel economy</li> <li>3. <b>RELIABILITY</b></li> <li>4. <b>HYDROGEN SUPPLY</b></li> </ol>
Four or Five Regional Centers of Excellence : Demo 25 to 50 Buses	<ol style="list-style-type: none"> <li>1. Reliability</li> <li>2. <b>DURABILITY</b></li> <li>3. <b>HYDROGEN SUPPLY</b></li> </ol>

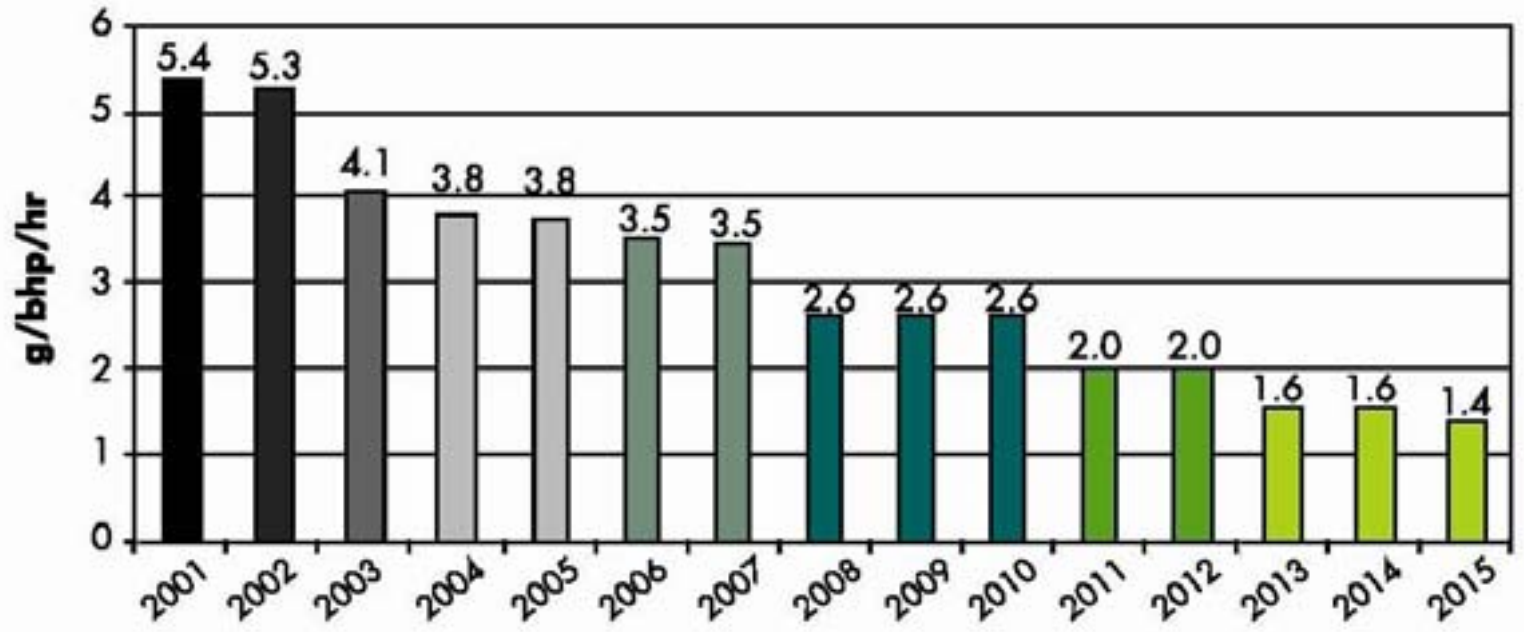






# NO<sub>x</sub> Emissions

### NO<sub>x</sub> Fleet Average over 15-year Period AC Transit Urban Bus Fleet

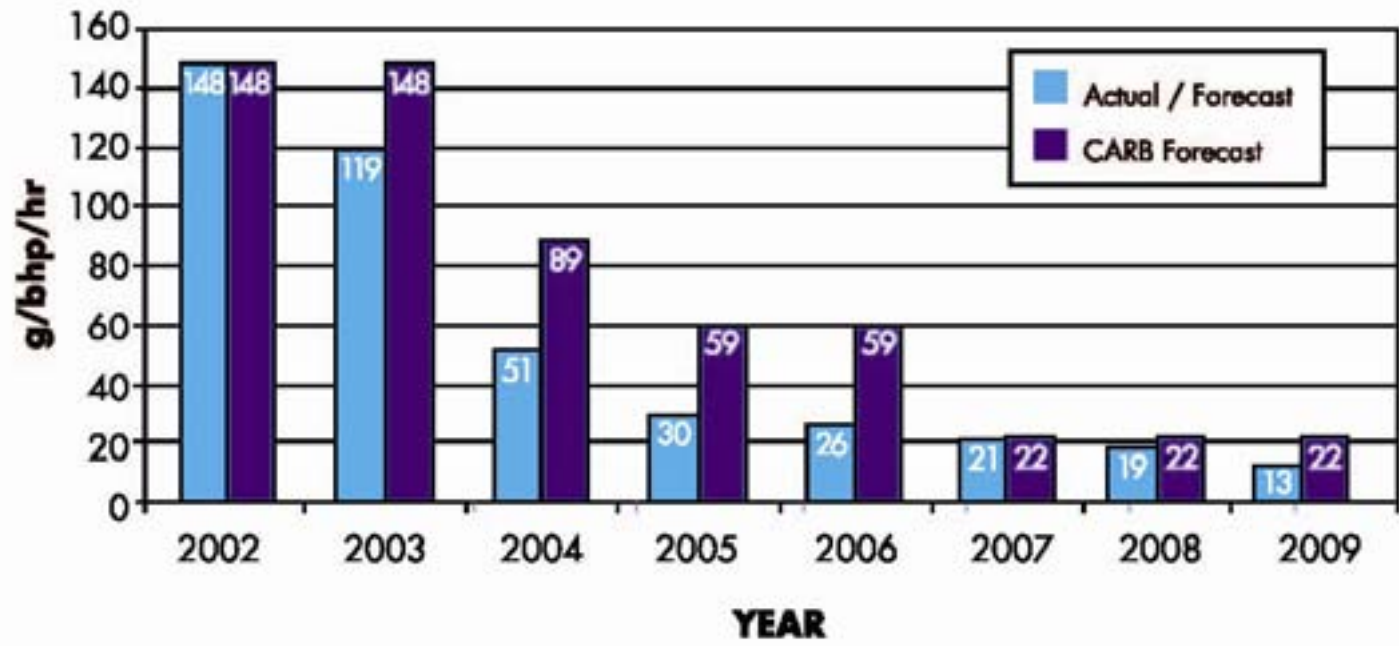






# PM Emissions

### Total PM Emissions AC Transit Urban Bus Fleet





# CO<sub>2</sub> Emissions

## AC Transit CO<sub>2</sub> Emissions (metric tons)

Source	2004	2005	2006	2007
Imported Natural Gas	2,047	1,830	1,965	2,131
Purchased Electricity	2,565	2,415	2,438	2,289
Fleet Diesel Consumption	62,384	62,631	63,108	66,015
Fleet Gasoline Consumption	1,299	1,372	1,138	1,322
Clean Fuel Test Program	—	—	—	356*
De minimis sources	NA	NA	152	62
<b>Total CO<sub>2</sub></b>	<b>68,295</b>	<b>68,248</b>	<b>68,801</b>	<b>72,175*</b>

*\*Does not include 2007 biodiesel emissions (25 metric tons) as they are considered biogenic.*

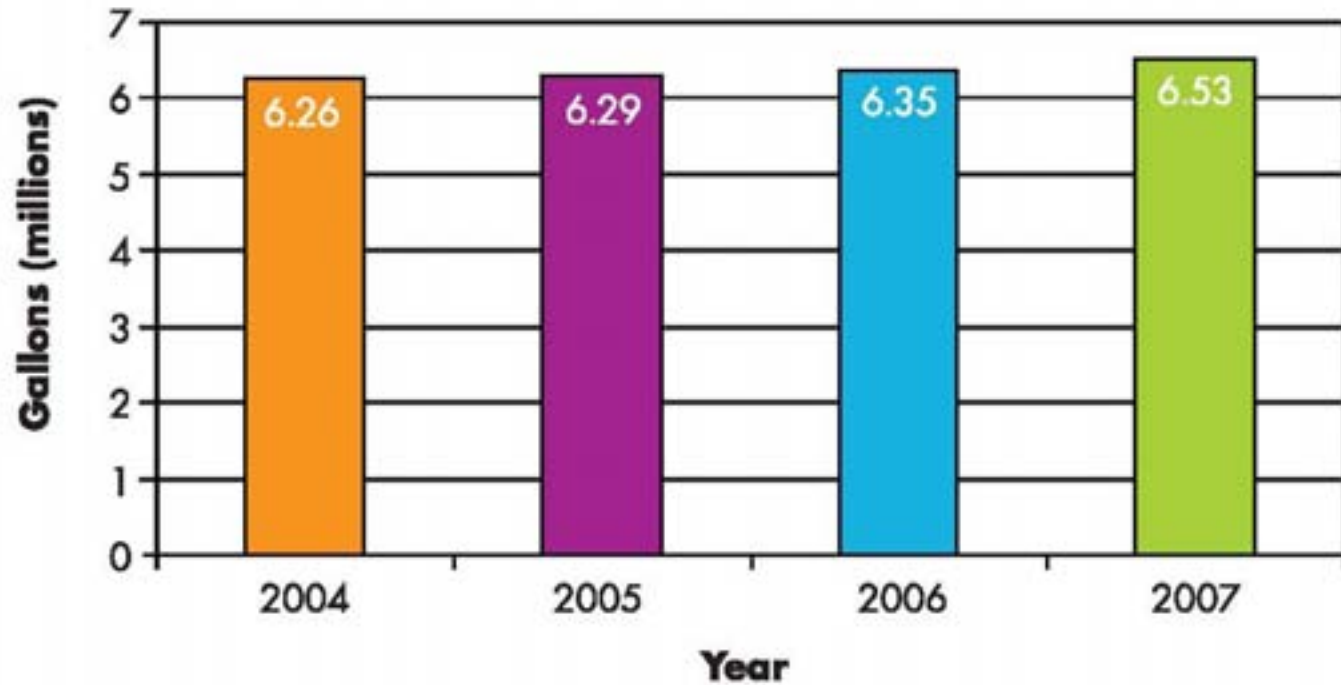






# Diesel Consumption

**Total Annual Diesel Consumption**





# Hybrids – 30% Fuel Reduction

