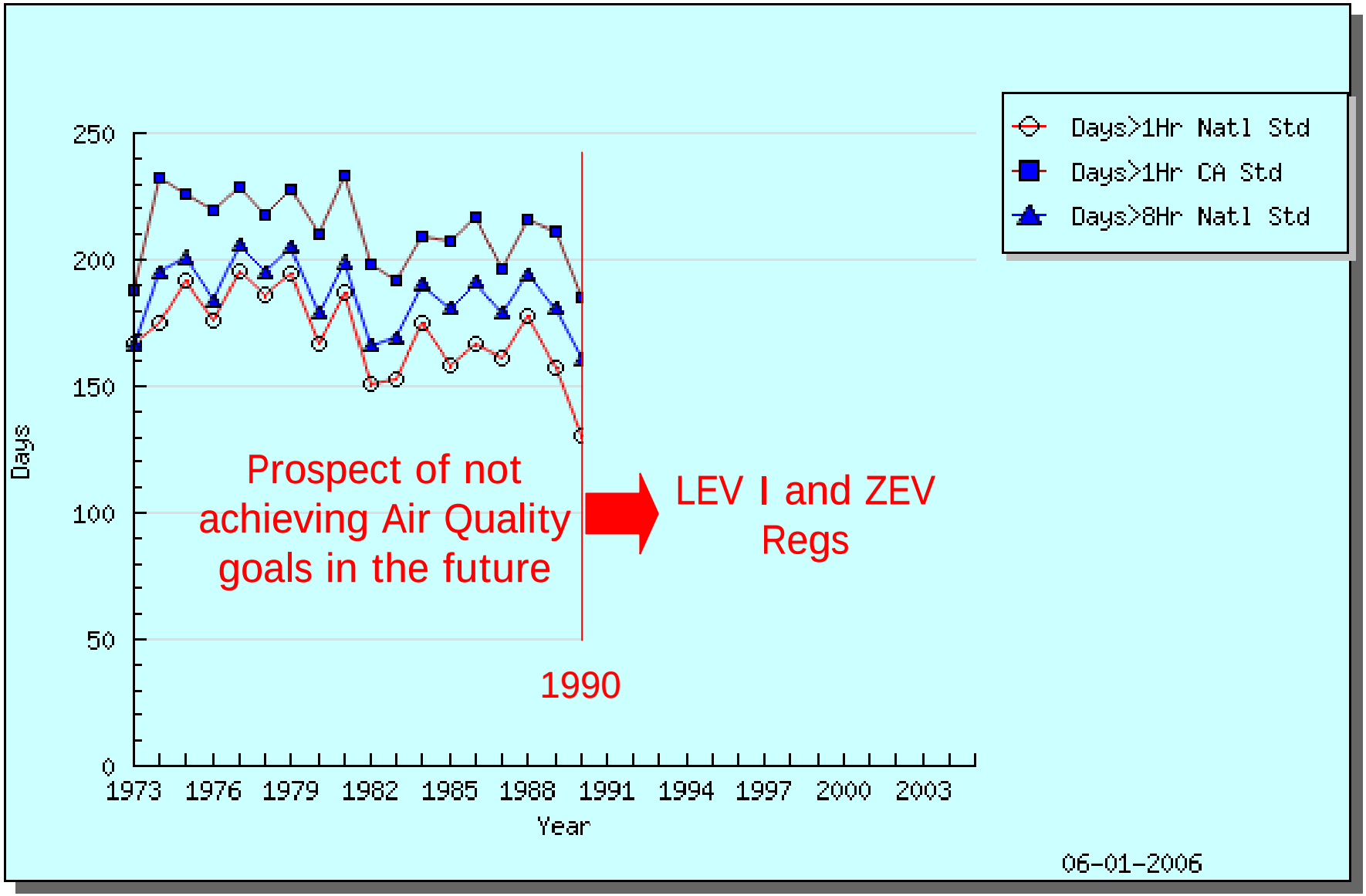
Honda's ZEV Program & Related Activities

ZEV Technology Symposium
September, 2006

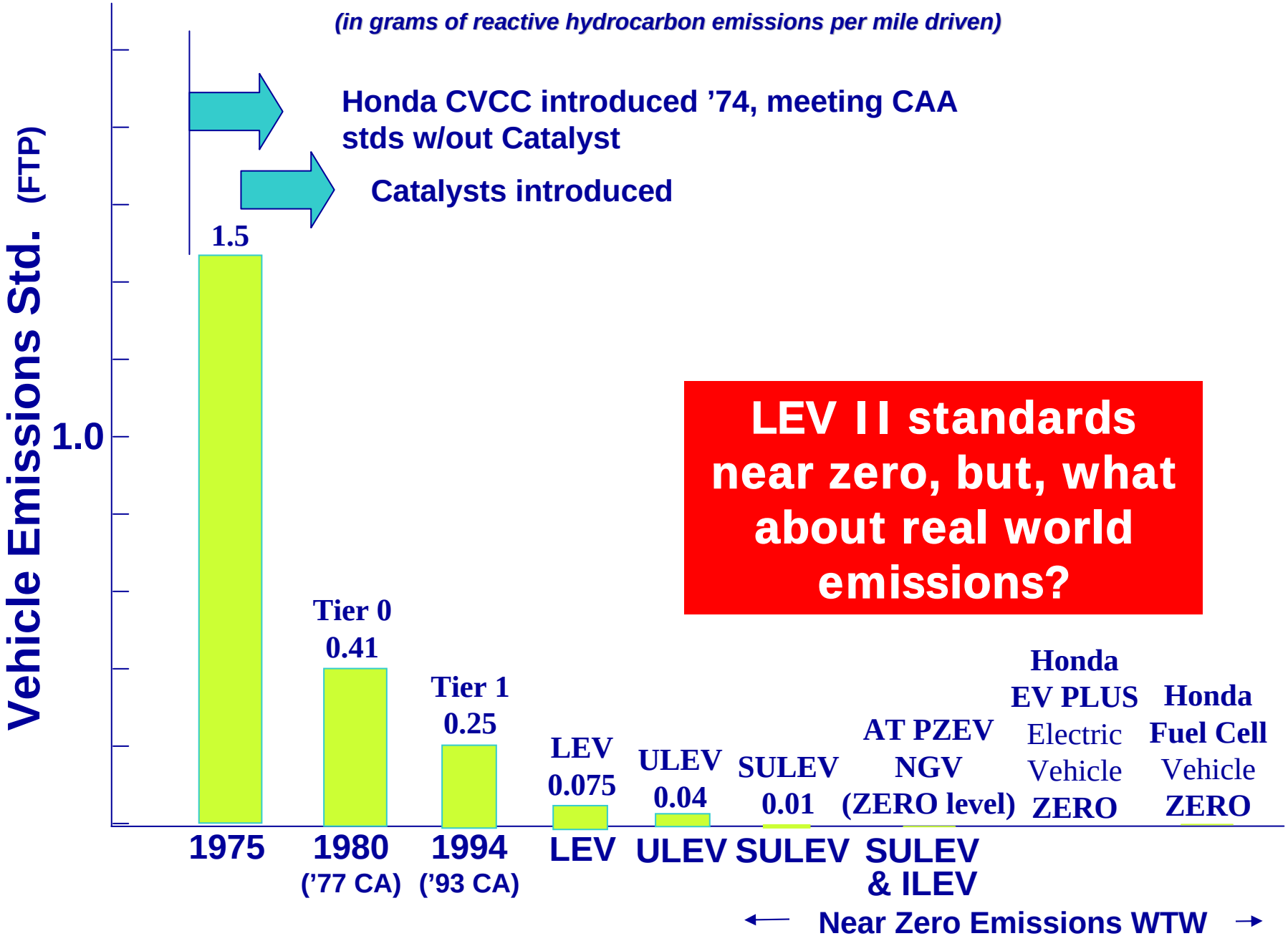
Ozone Trend Summary

South Coast Air Basin



U.S. Emission Stds

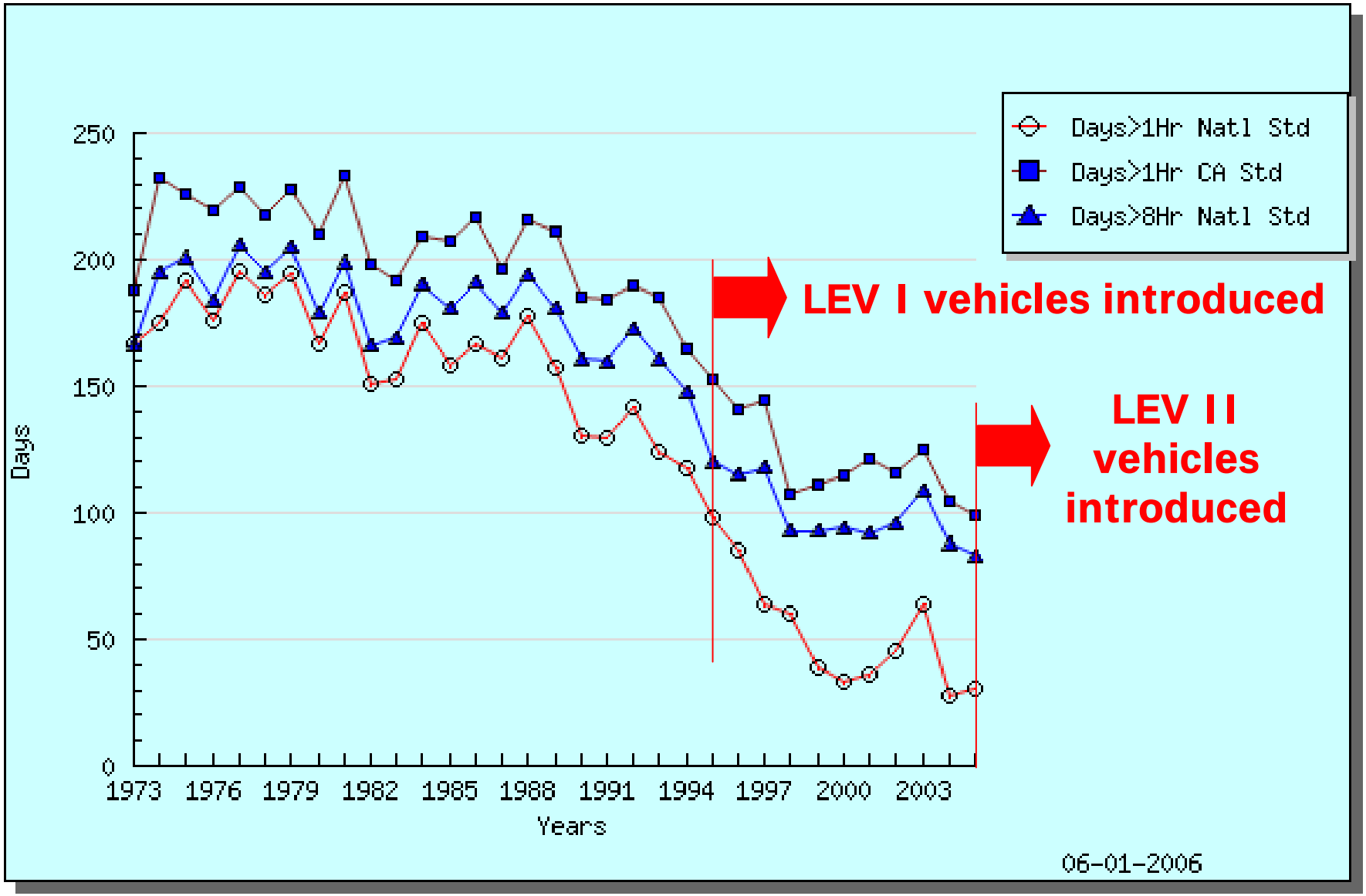
(in grams of reactive hydrocarbon emissions per mile driven)



LEV II standards near zero, but, what about real world emissions?

Ozone Trend Summary

South Coast Air Basin

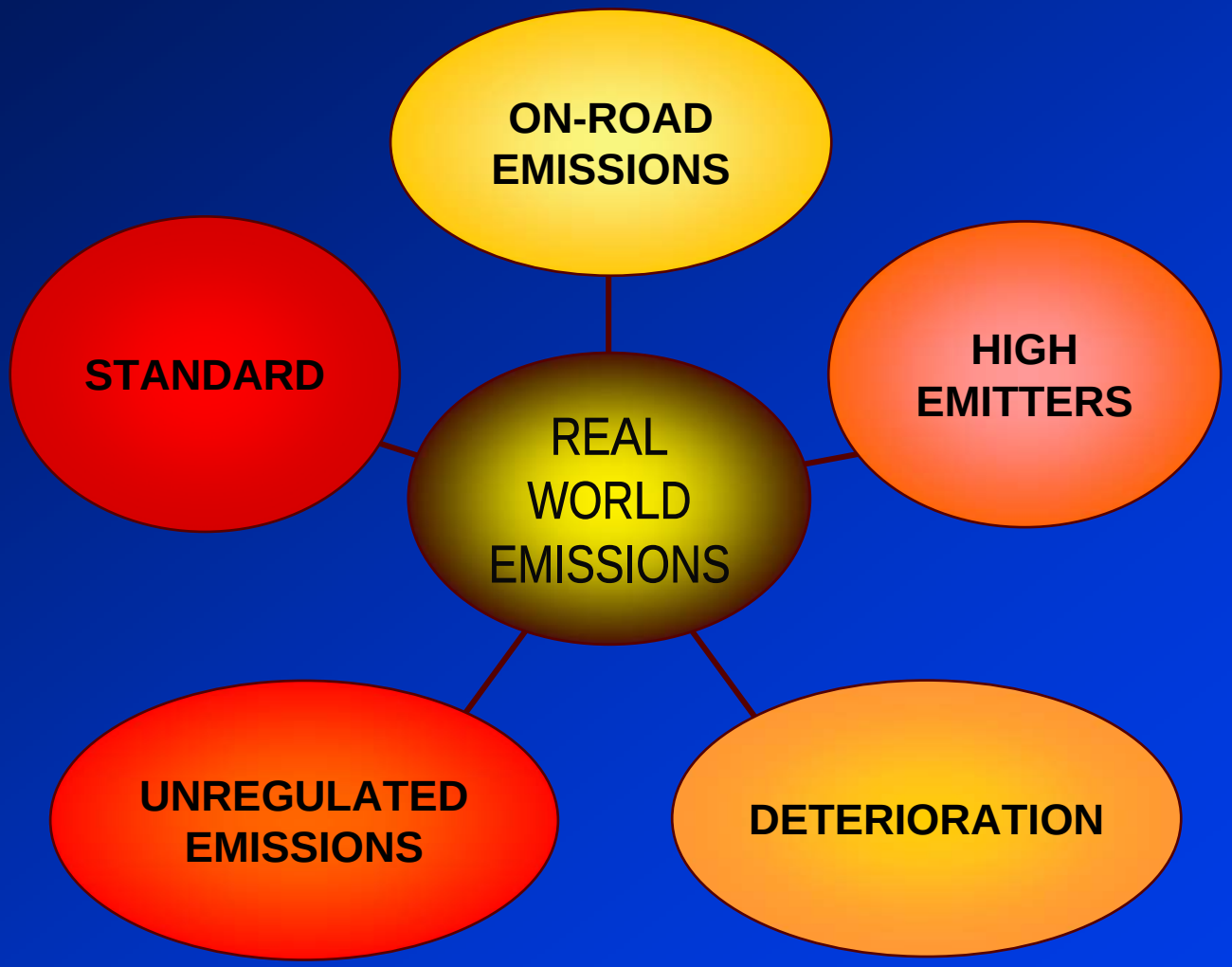


The SELEV Program
(Study of Extremely Low Emission Vehicles)

- CARB, US EPA, Honda, and Chevron Products Company initiated the SELEV Center at the University of California, Riverside.

- The purpose for establishing this center was to establish an independent, credible entity with the ability to objectively measure and assess the effect of ELEV technology upon air quality.

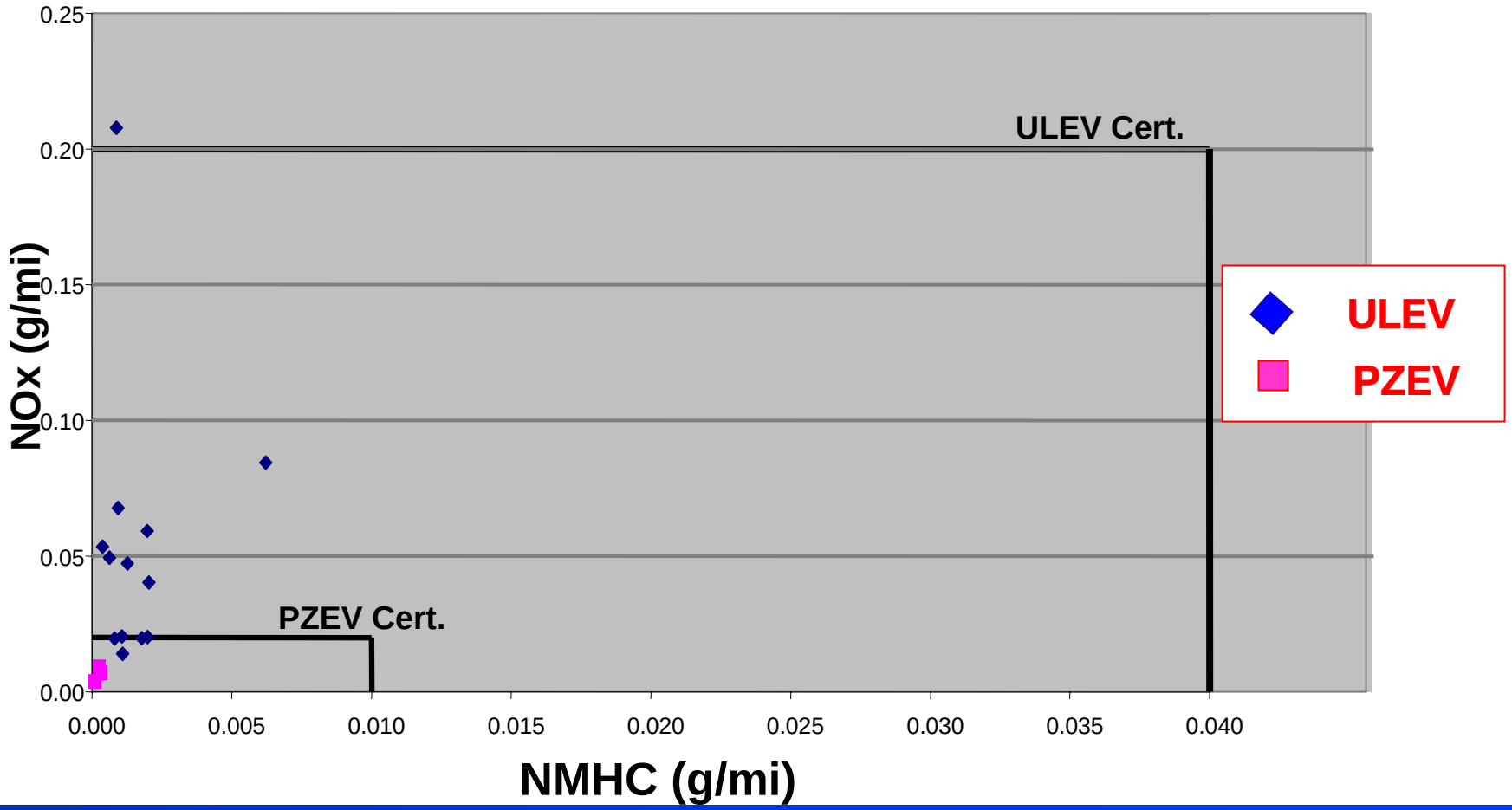
What needs to be quantified?



Nicole Davis
Center for Environmental Research and Technology

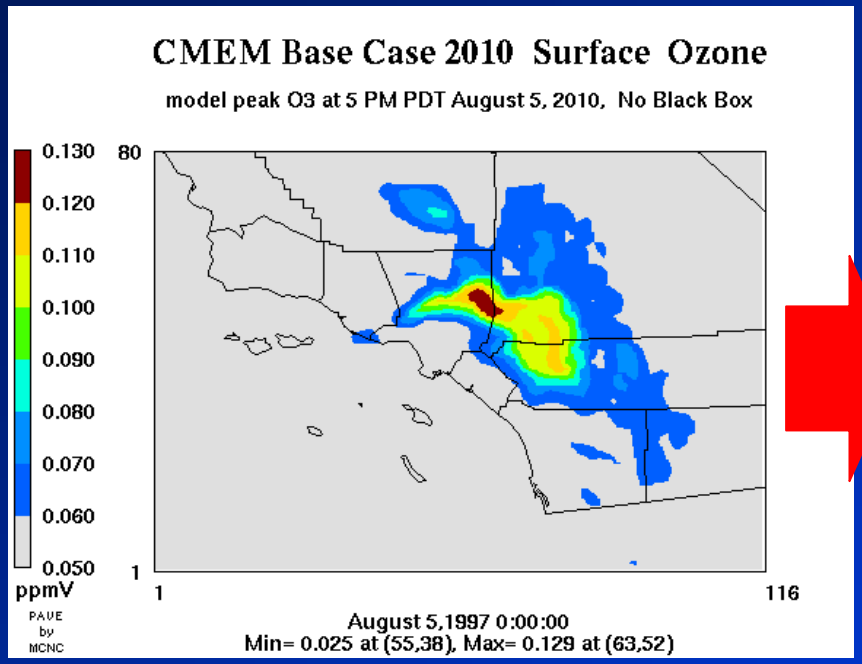
Real World Emissions

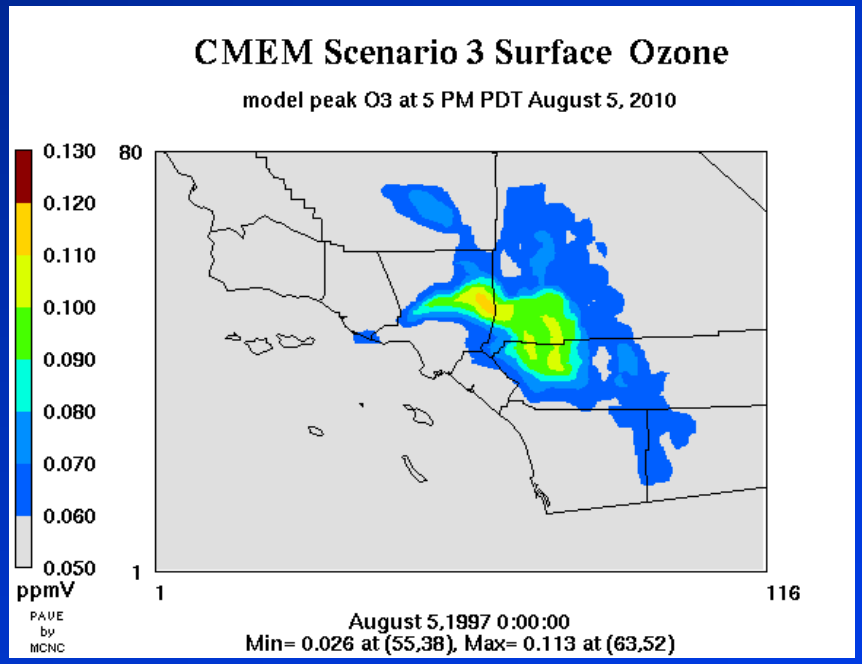
On-Road Hot Running NMHC & NOx



Nicole Davis
Center for Environmental Research and Technology

Air Quality Modeling Results





Nicole Davis
Center for Environmental Research and Technology

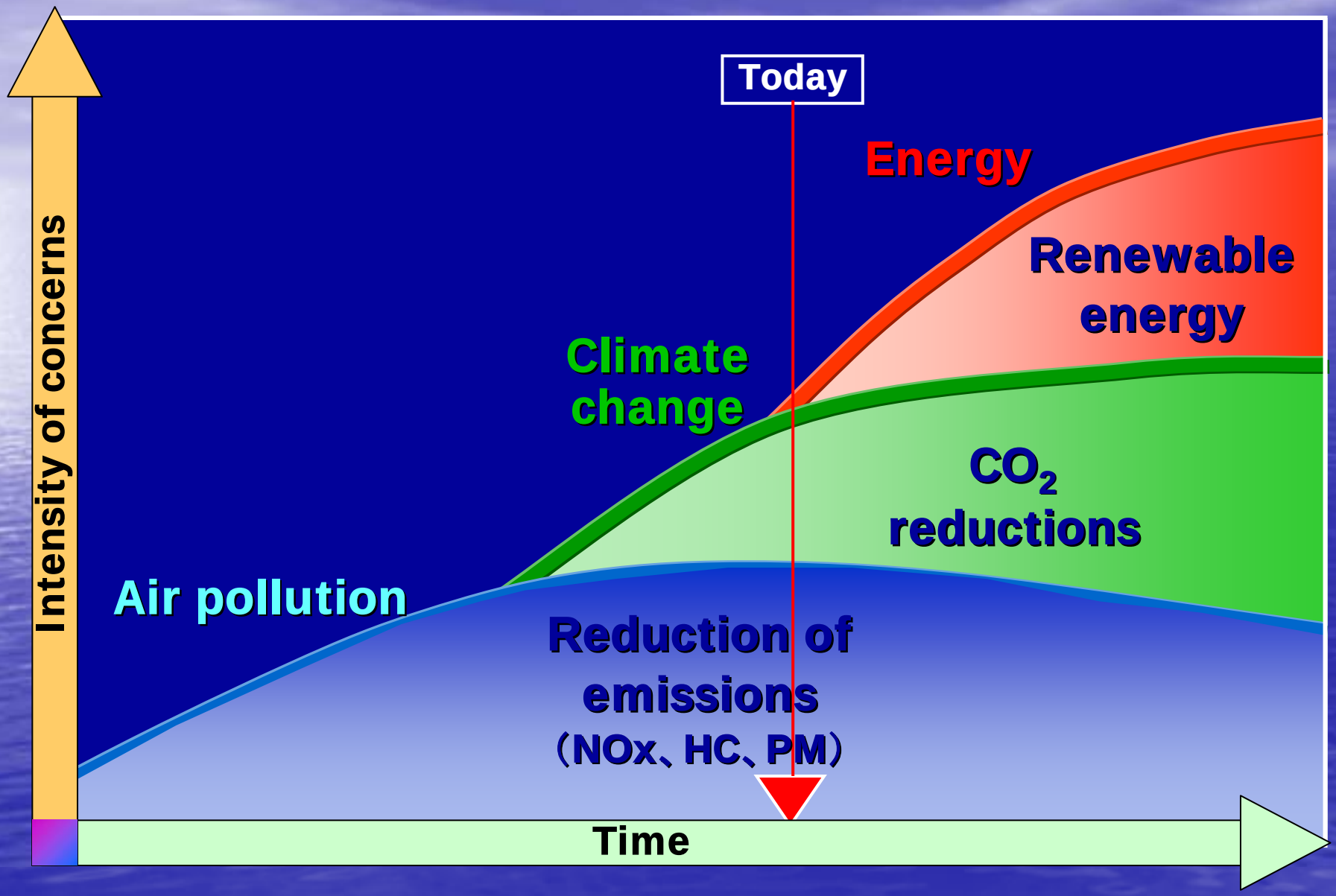
Key Findings To Date

- The SELEV project has shown that ELEV emissions are very low:
  - Well below certification levels
  - Consistently perform with low emissions on the road under various conditions

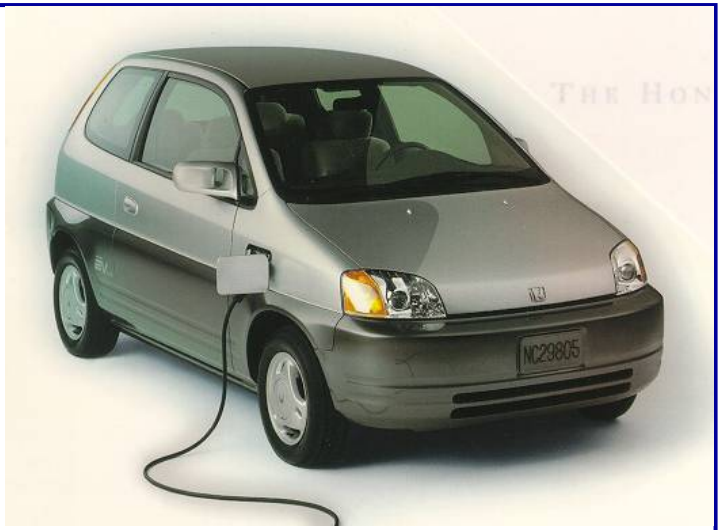
- Implications: As ELEVs replace current vehicles in larger numbers, the LDV fleet will become a very small portion of the inventory.

Transition of Environmental Issues

HONDA
The Power of Dreams



Honda's Battery EV Program



- **EXCELLENT VEHICLE**
  - All new vehicle design
  - Advanced technology battery
  - Enjoyable for intra-city use
- **CONSUMER PLACEMENTS**
  - Excellent value; protects customers from risk
  - 'Real world' trials, dealer supported
  - Valuable feedback on market acceptance issues
- **HONDA'S STUDY POINTS**
  - Vehicle and infrastructure utility in customer use
  - Battery technology issues
  - Customer acceptance issues

EV PLUS Customers' Perception

EV PLUS customers generally satisfied, but they recognize RANGE and CHARGING concerns for broader application:

Positives

- **Generally, customers appreciate EV qualities**

  -unique features and attributes:
  - **Performance, handling**
  - **Smooth, quiet ride**
  - **Cutting edge technology**
  - **Unique aspects : lower fuel cost, no need to go to gas stations**
  - **Helping the environment: reducing smog, saving oil**

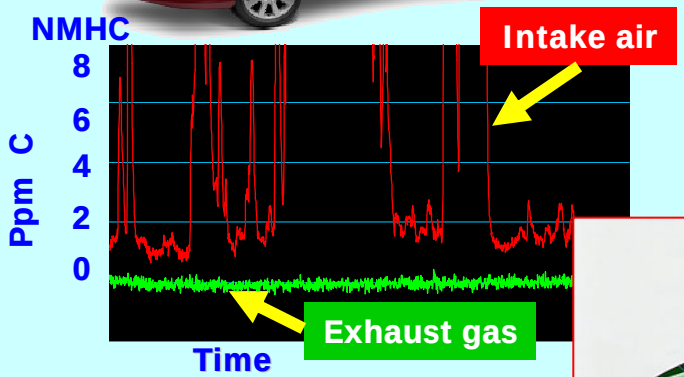
Negatives

- **The EV-unique inconvenience factors:**

  - **RANGE**
  - **CHARGING TIME**
  - **OUT-OF-TOWN "REFUELING"**

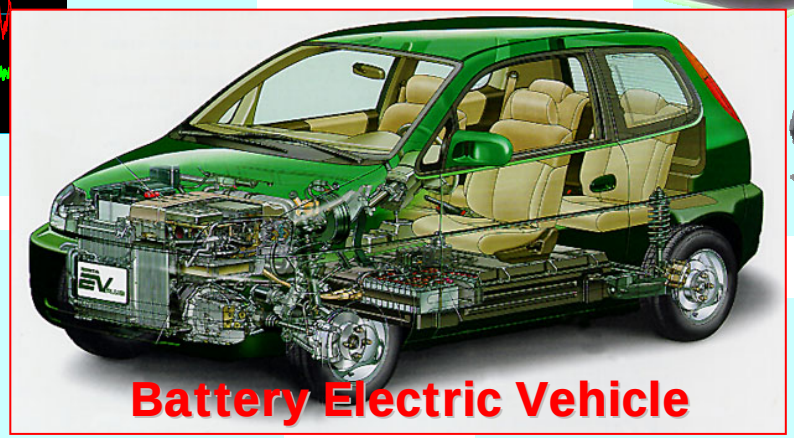
HONDA
The Power of Dreams

Near Zero Emission ICEs (Gasoline and Natural Gas)



SAE Papers # 2000-01-1140 and 2000-01-1140

Hybrid Electric Vehicle Applications



Battery Electric Vehicle

Home Refueled Natural Gas Vehicle

Advancement of Fuel Cell Electric Vehicle development

HONDA
The Power of Dreams

Honda Fuel Cell Vehicle Placements

California & Nevada

San Francisco

Las Vegas

AHM

LA

AQMD

Spallino Family

Chula Vista

New York

Albany

New York

New York City

:03M FCX

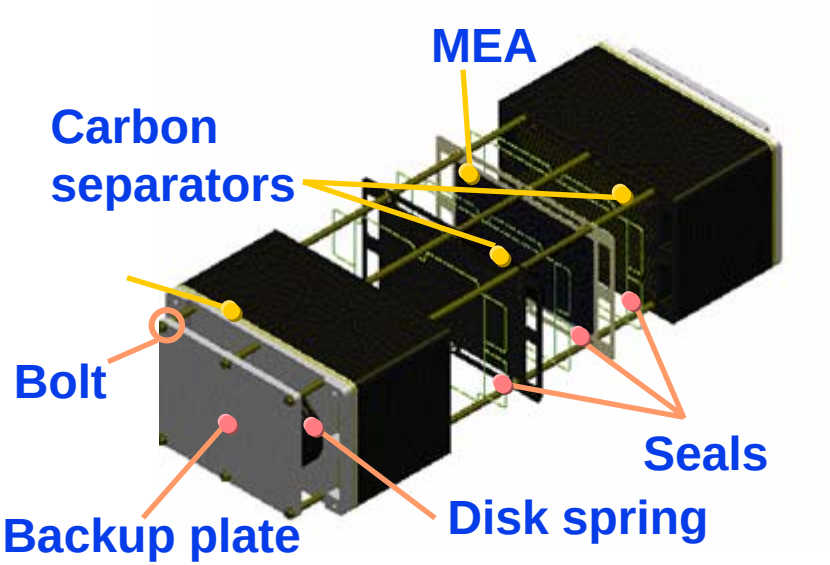
:04M FCX

:05M FCX

©2004 Yahoo! Inc
©2004 NAVTEQ
©2003 Navigation Technolo

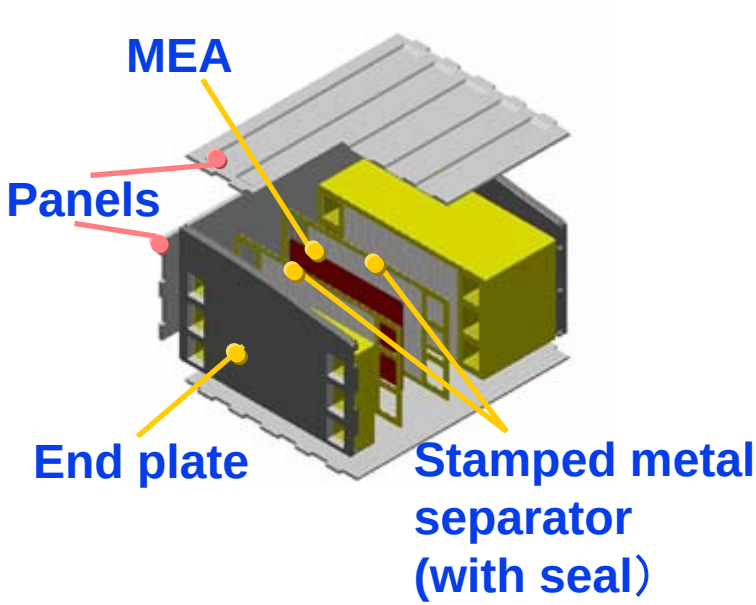
Fuel Cell Stack Engineering

Conventional Fuel Cell :



- *Carbon & Resin plates*
- *Tensioning bolts and springs*
- *Separate seal parts*

2005/6 Honda Fuel Cell:

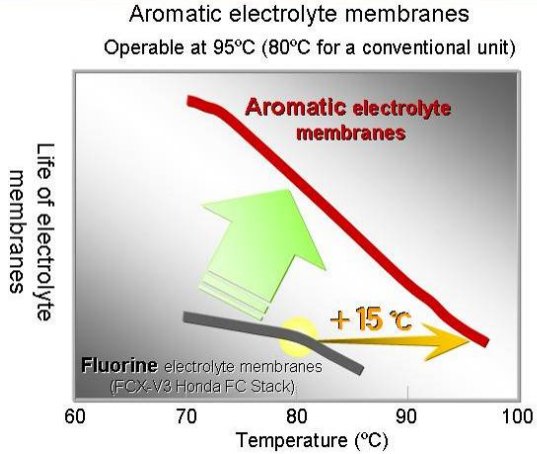


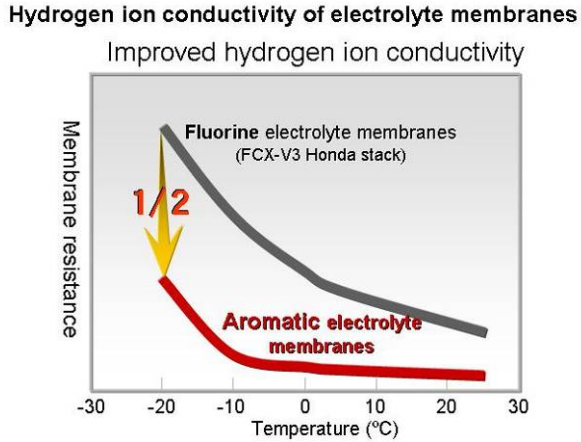
- *Stamped metal plates*
- *No tensioning bolts*
- *Aromatic Membrane*
- *No separate seals*

Half the parts

New Aromatic Electrolytic Membrane Materials

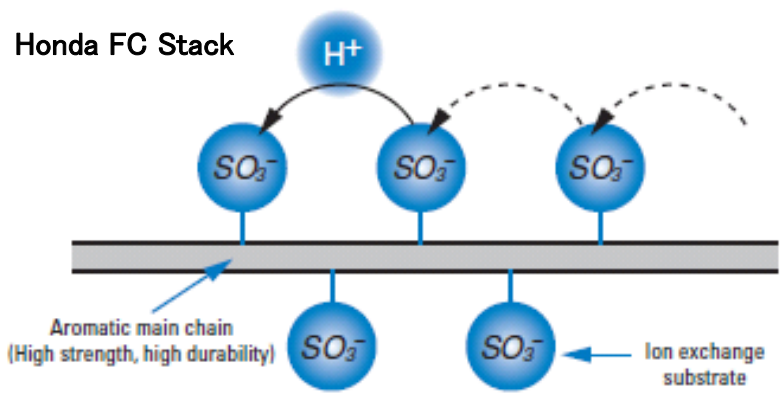
Innovations in Fuel Cell Materials

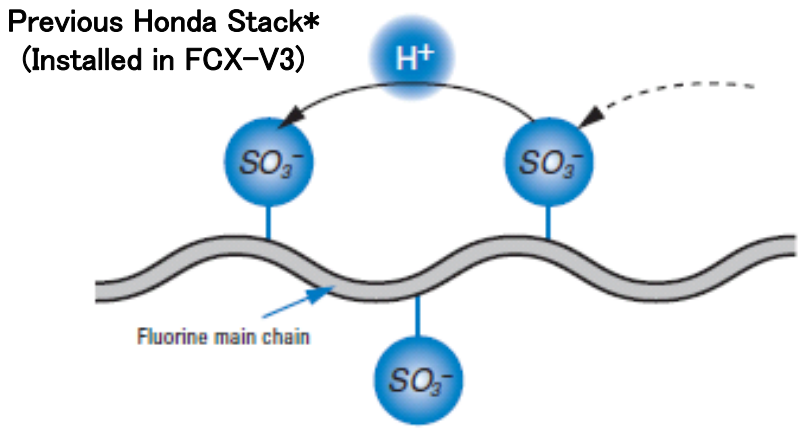




- **Improved high temperature durability and sub-zero start-up capability compared to conventional Fluorine membranes**
- **It has future cost reduction potential**

Comparison of electrolytic membrane



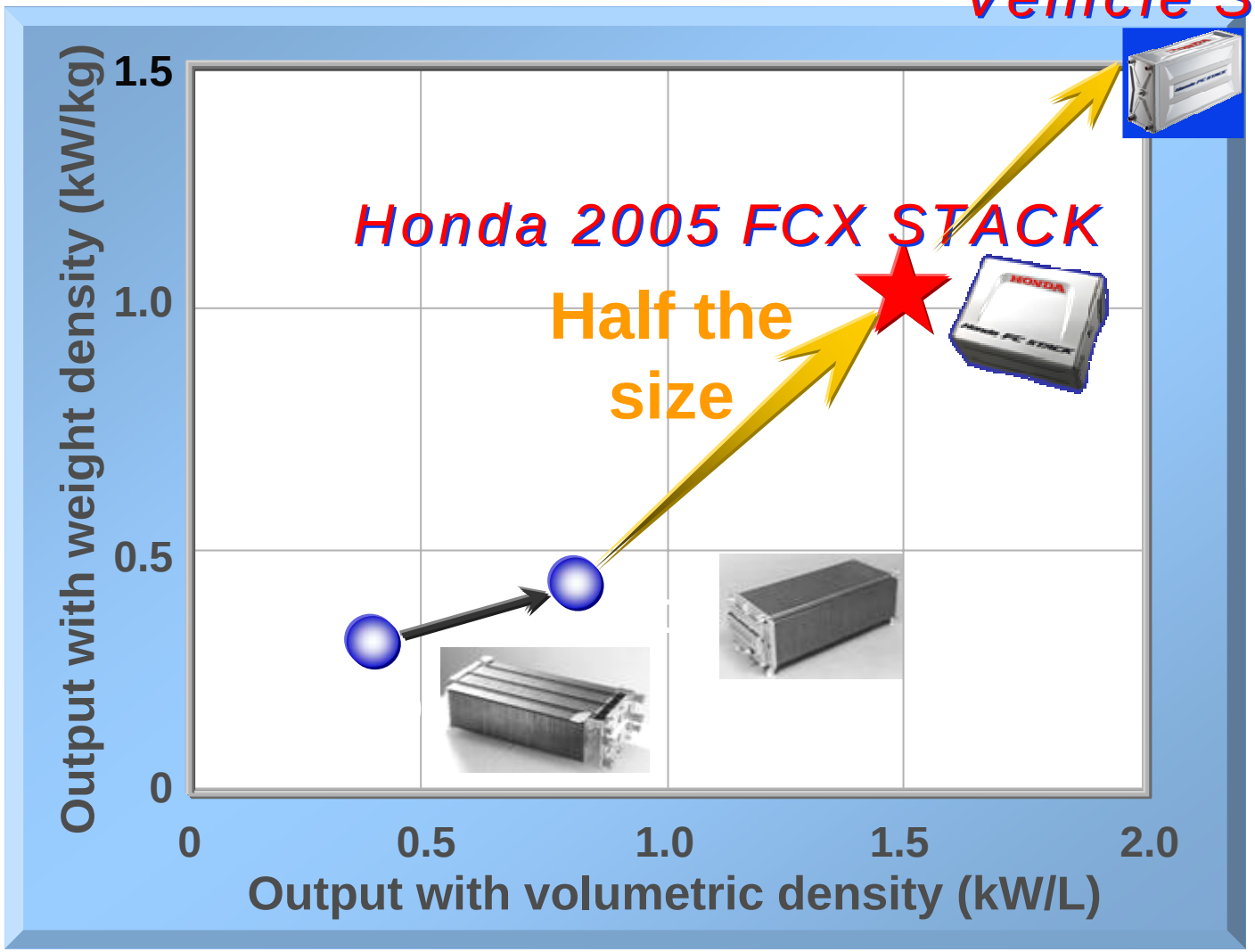


The aromatic electrolytic membrane contains more of the ion exchange substrate than the fluorine electrolytic membrane, resulting in lower membrane resistance over a broad temperature range.

HONDA
The Power of Dreams

Fuel Cell Performance

Rapid Reductions in Size and Weight

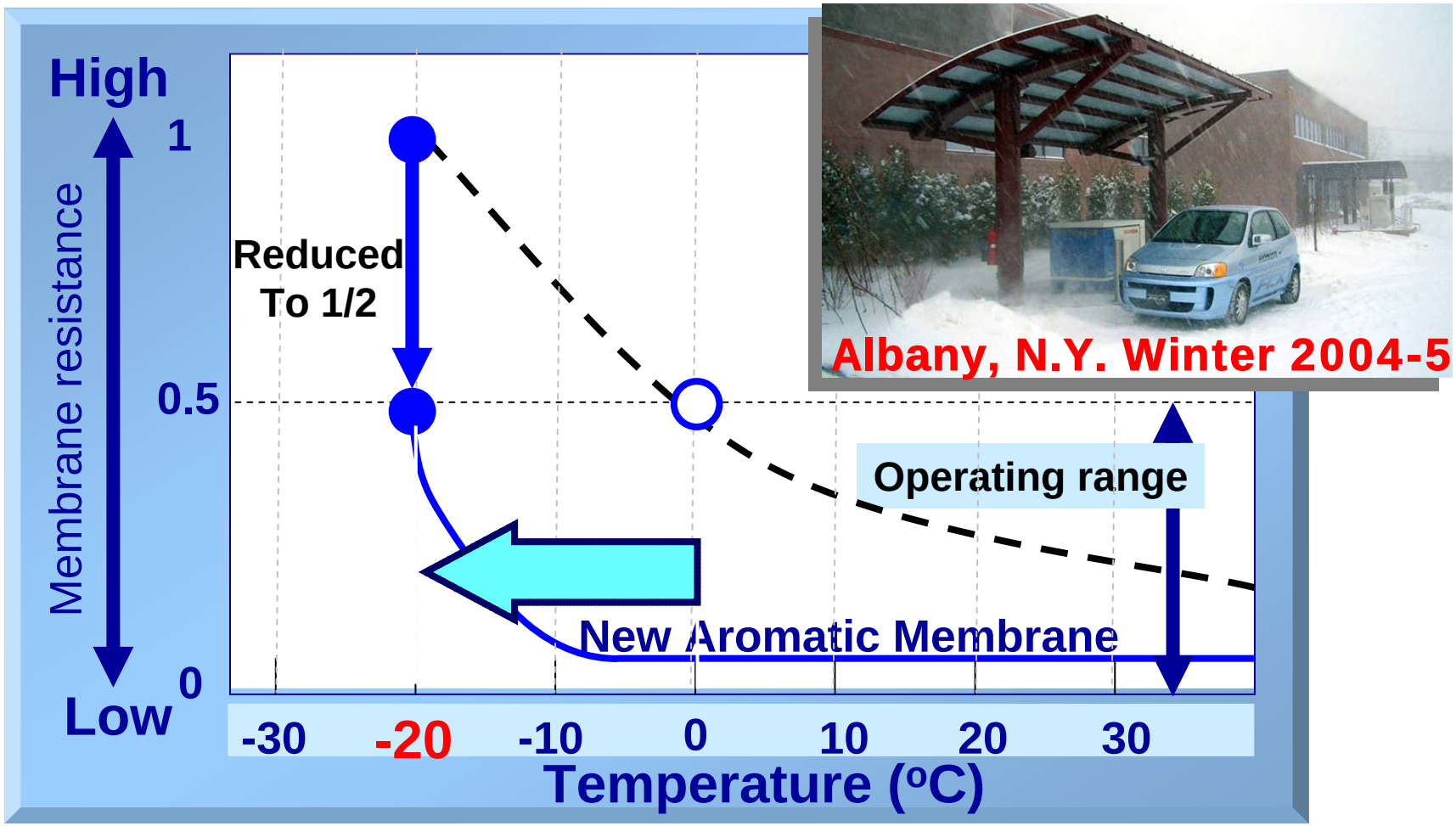


HONDA
The Power of Dreams

Fuel Cell Performance at Sub-Zero Temperatures

Previously, a technology barrier for Fuel Cell Vehicles

Hydrogen ion conductivity of fuel cell membrane in freezing conditions



HONDA
The Power of Dreams

FCX Driving Range

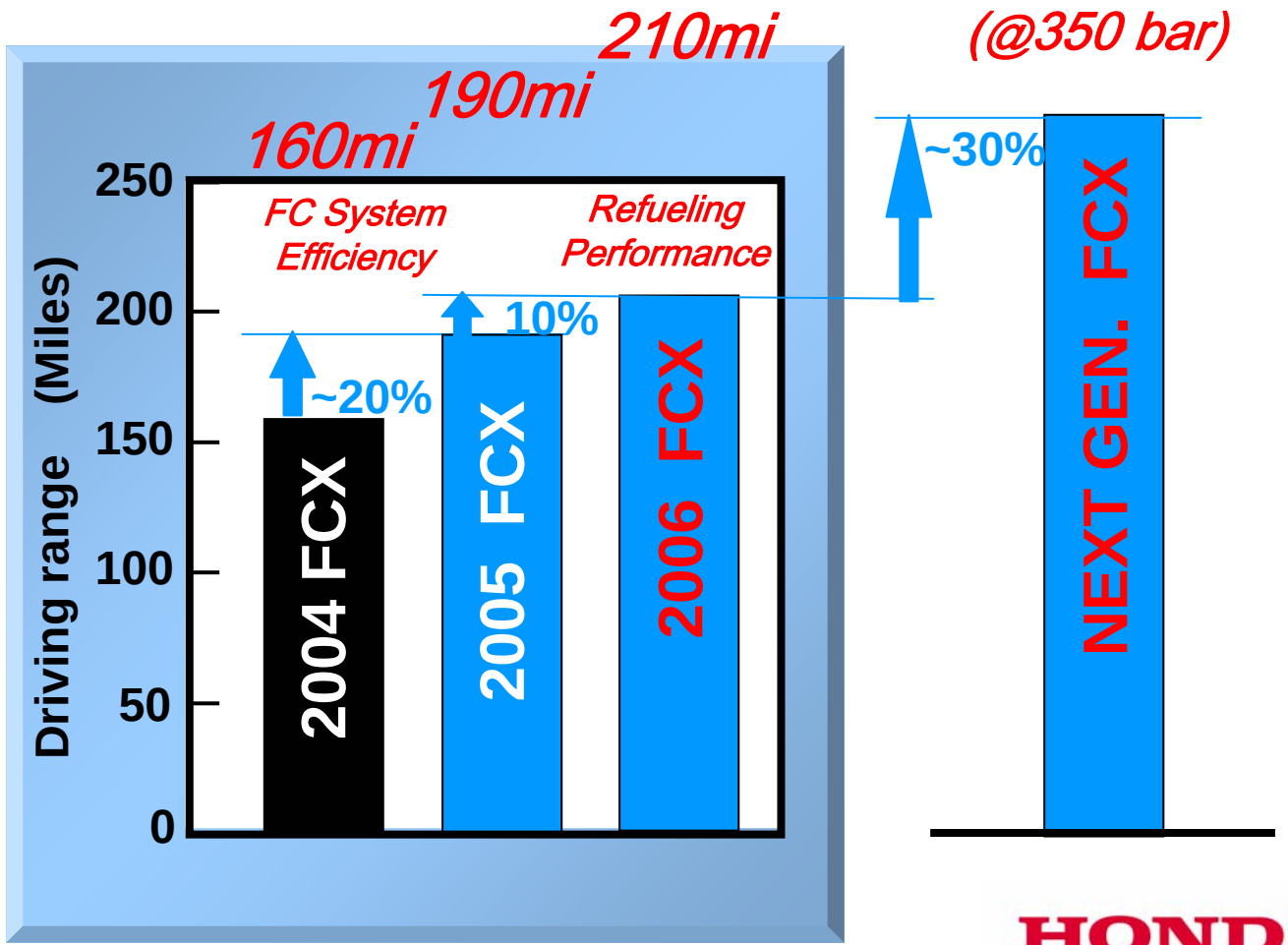
EPA-Officially Rated Range

Next Gen.: EPA-rated range anticipated, without increasing tank pressure

~270 miles

(@350 bar)

2006: EPA-rated range is now 210 miles without increasing tank size



EPA officially rated range

HONDA
The Power of Dreams

Advancing Fuel Cell Vehicle Technology

Honda's Next Generation Fuel Cell Electric Vehicle advancement (under development)

- **Anticipated advances in:**
  - **Range**
  - **Freezing Temp perf.**
  - **Weight**
  - **Dynamic Performance**
  - **Packaging**
  - **Efficiency**
  - **Etc.**

Air Quality – Zero Emission Vehicle

Greenhouse gas reductions, use of diverse energy sources, use of renewable energy

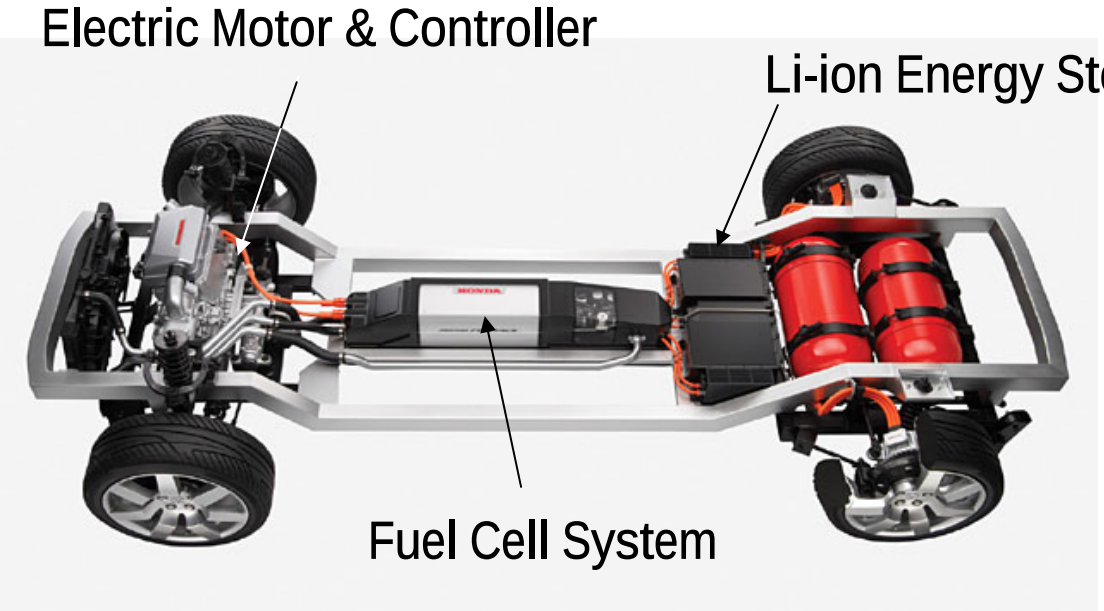
HONDA
The Power of Dreams

FCX CONCEPT

HONDA
The Power of Dreams

All new layout

Possible for Fuel Cell Vehicle, due to compact, distributed components



Vertical Gas Flow fuel cell stack

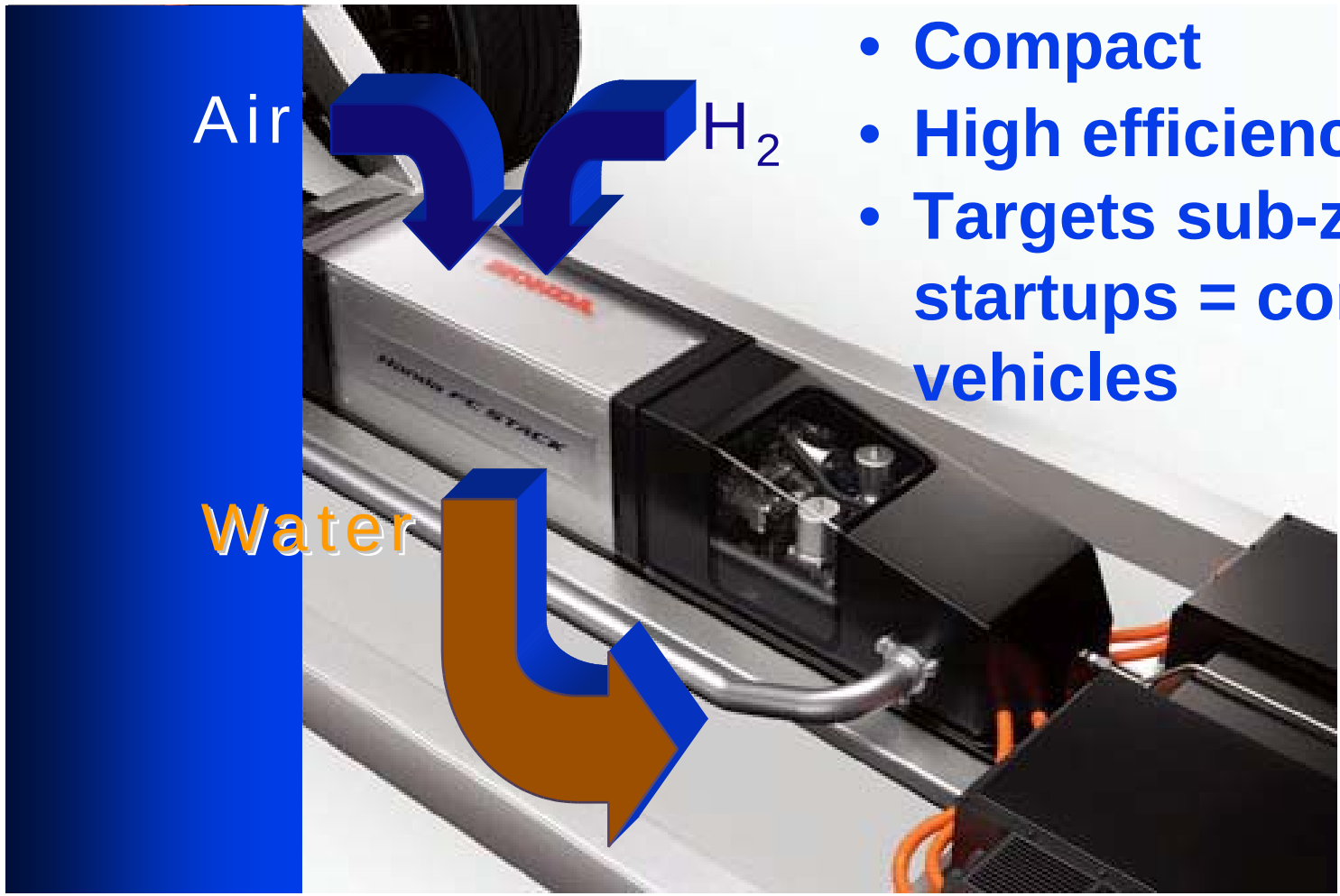
- New architecture for FC and FCV (V-flow):
  - Compact, high output Fuel Cell System to fit in center tunnel
  - Human-fitting cabin: low floor height, spacious, safety engineered
  - New Vertical Gas Flow fuel cell stack takes full advantage of gravity to efficiently drain water formed during electricity generation.

Vertical gas flow
Vertebral layout
Volume-efficient

VFlow

HONDA
The Power of Dreams

New Fuel Cell architecture: vertical gas and water flow:



- **Compact**
- **High efficiency**
- **Targets sub-zero startups = conv. vehicles**

Honda Research on Hydrogen Stations

Renewable Energy Hydrogen Station

Los Angeles, CA

Solar Energy Input

Home Energy Station

Los Angeles, CA

Natural Gas Input

Honda's research into hydrogen production and supply systems for a hydrogen-based society of the future

HONDA
The Power of Dreams

Study of P-HEV

Honda Goals

- Energy Sustainability
- Stable Climate (GHG)
- Healthy Air Quality

Honda ZEV Program

HONDA

The Power of Dreams