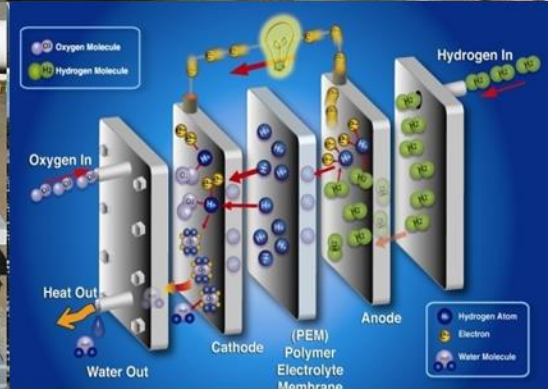


# Natural Gas and Hydrogen Workshop: Goals, Objectives and Desired Outcomes



*Exploring the Intersection of Hydrogen Fuel Cell and Natural Gas Vehicles Workshop*

American Gas Association, Washington, D.C.  
September 9, 2014

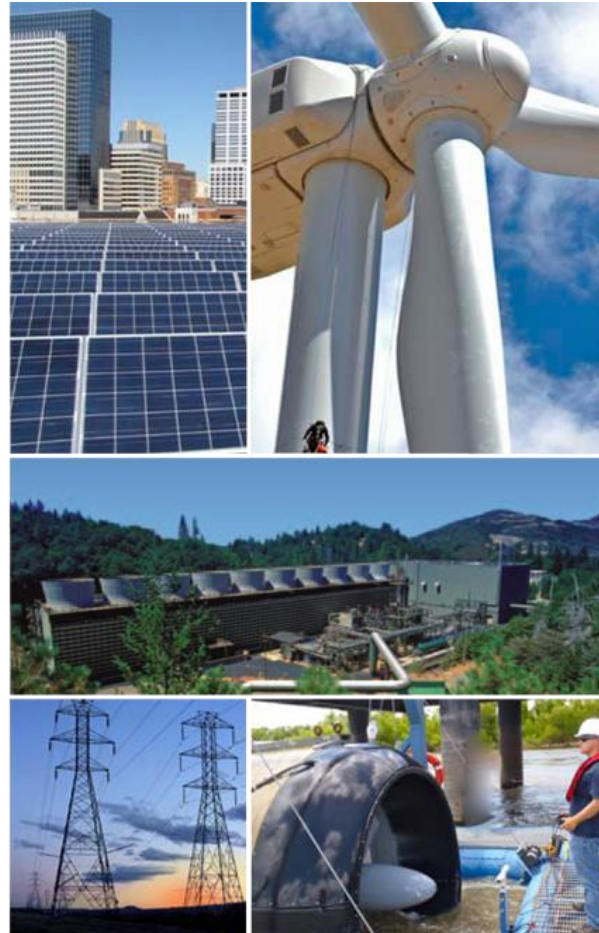
**Reuben Sarkar**  
U.S. Department of Energy  
Deputy Assistant Secretary  
Sustainable Transportation

# EERE Areas of Focus

## Sustainable TRANSPORTATION



## Renewable ELECTRICITY GENERATION



## Energy Saving HOMES, BUILDINGS, & MANUFACTURING



# “All of the Above” for Sustainable Transportation

## Sustainable TRANSPORTATION



### Hydrogen and Fuel Cells



### Vehicles



### Bioenergy

- Efficiency Improvement
- Fuel Diversification
- Domestic & Renewable Sources
- Reduced GHG

#### National Energy Goals & Climate Action Plan

Reduce oil imports by 50% by 2020, compared to 2008

Reduce GHG emissions 17% below 2005 levels by 2020

# Natural Gas Use in Transportation Sector is Projected to Grow Exponentially

Transportation is projected as **fastest growing** sector for gas consumption

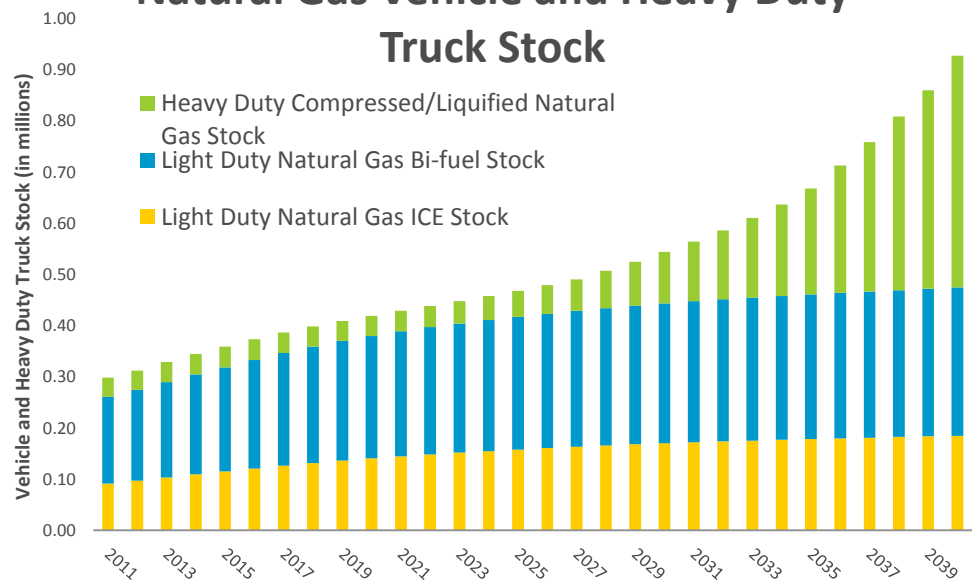
**~12%** projected annual growth from 2012 to 2040

**Heavy duty trucks - fastest growing** segment in transportation for NG consumption

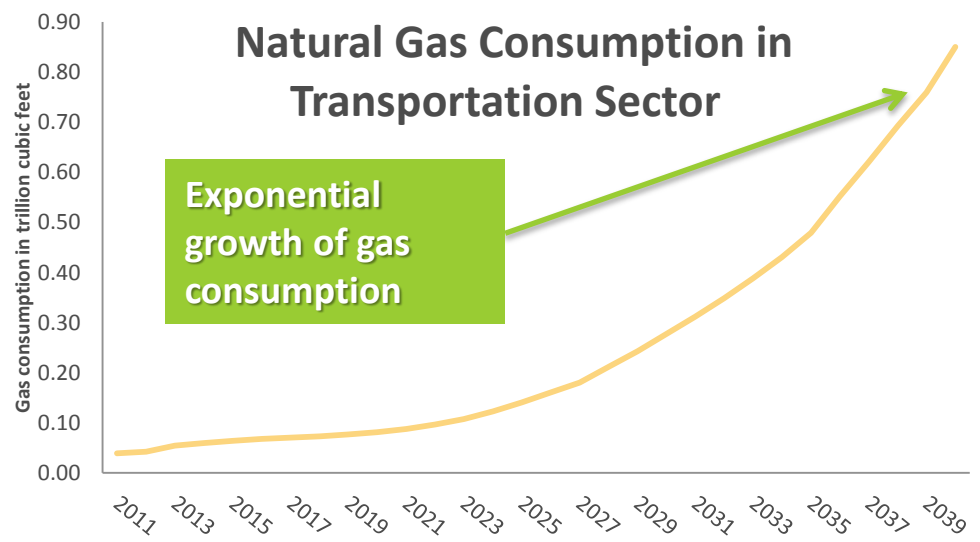
**>900K** stock of vehicles and heavy duty trucks running partially or fully on natural gas by 2040

**>100K** vehicles running fully on NG

### Natural Gas Vehicle and Heavy Duty Truck Stock



### Natural Gas Consumption in Transportation Sector

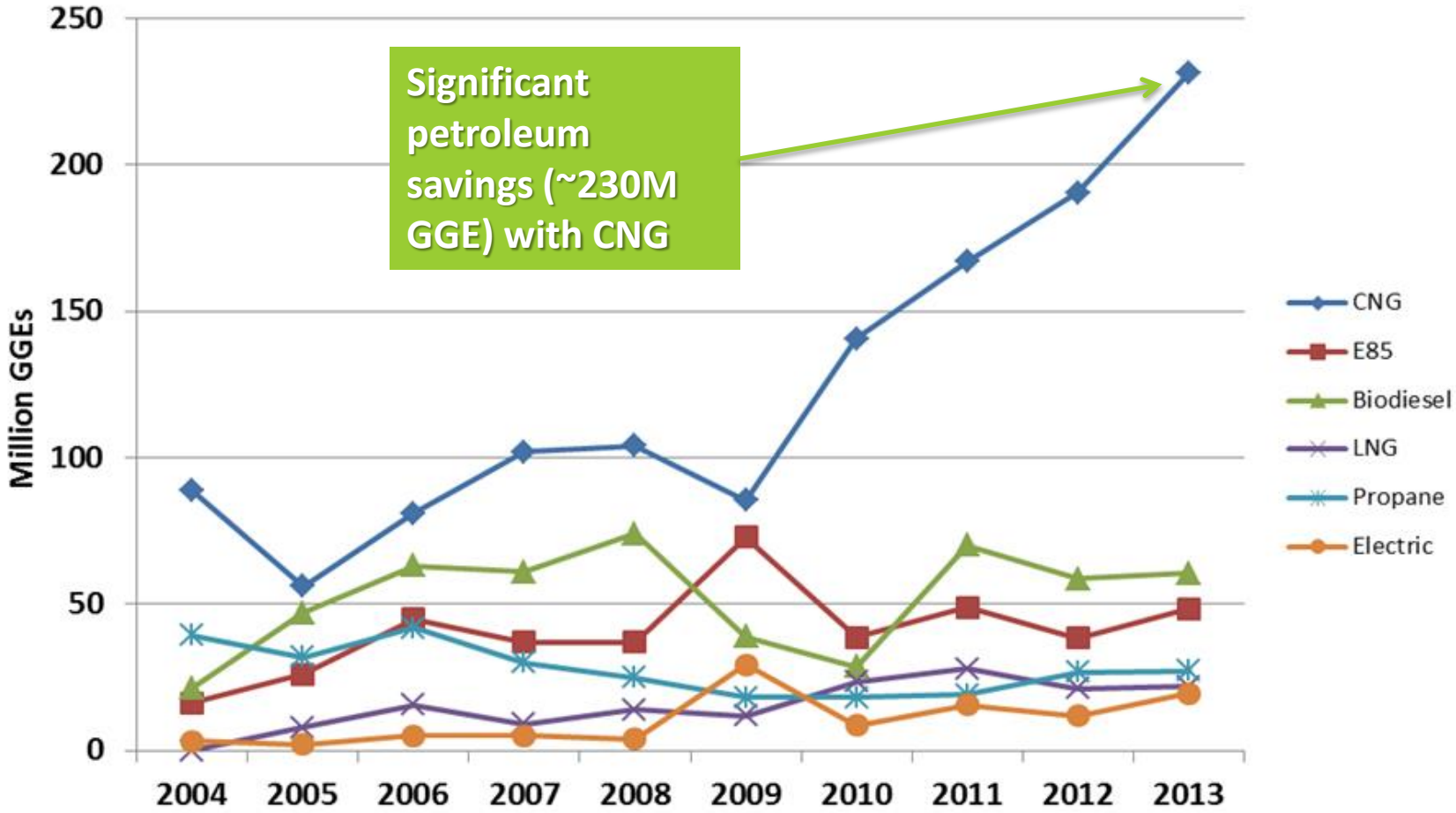


# Largest AFV petroleum reductions come from CNG



U.S. Department of Energy

## Clean Cities Petroleum Savings by AFV Type



[www.afdc.energy.gov/data/](http://www.afdc.energy.gov/data/)

# NG price stability has an advantage over gasoline and diesel fuels

## Average Retail Fuel Prices in the U.S. From 2000 to 2013



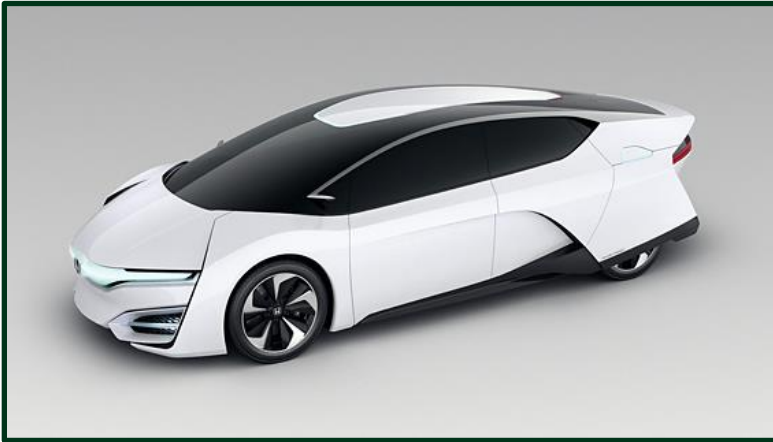
CNG **low** and **stable** price serve as a powerful market motivator

Domestic **truck/bus** OEMs now have LNG and CNG models serving important niche markets



# Hydrogen Preview: Fuel Cell Cars are Here

FCEVs on display at North American auto shows.



Honda Fuel Cell Electric Vehicle



Toyota Fuel Cell Electric Vehicle



Hyundai's first mass-produced  
Tucson Fuel Cell SUVs arrive in  
Southern California  
May 20, 2014

Lease includes **H<sub>2</sub>** and **maintenance**.

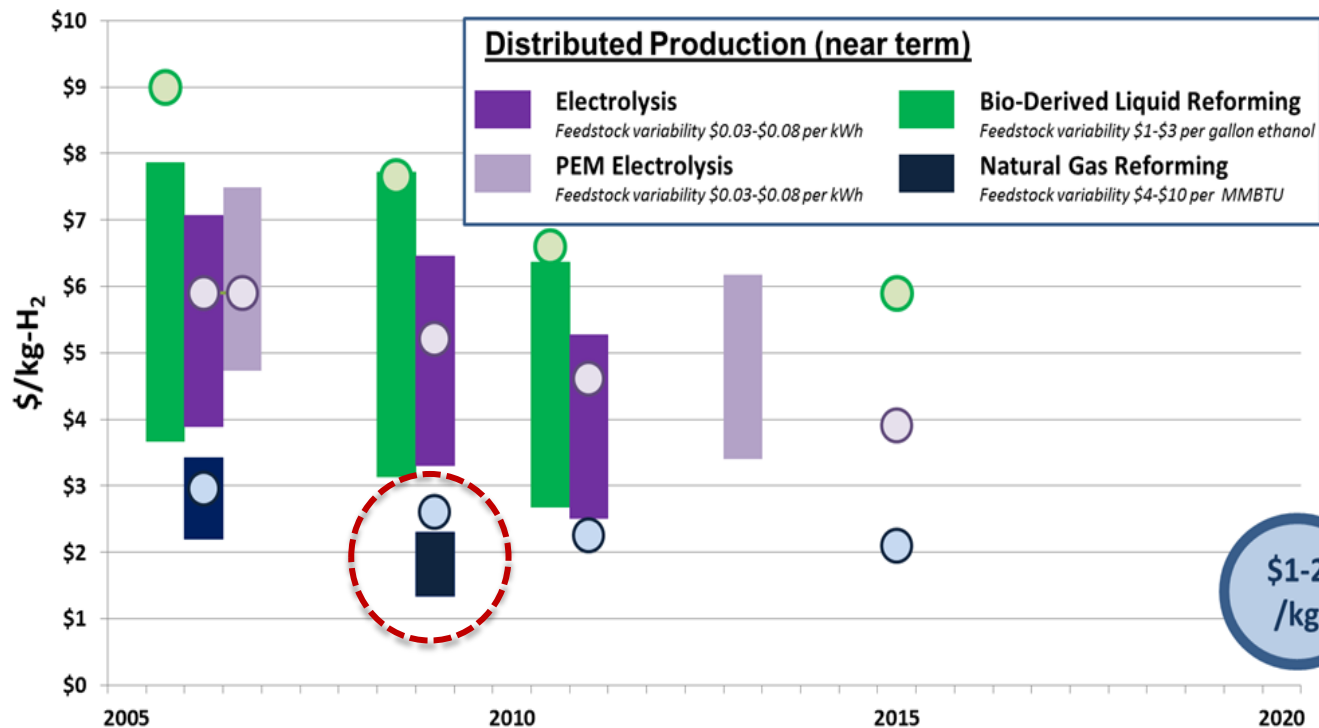
# Cost reductions of H<sub>2</sub> produced from natural gas

## Program Success in Distributed NG Reforming:

- Completed R&D phase

- Showed H<sub>2</sub> from NG can be competitive with gasoline at high volumes

- Goal < \$4/gge by 2020\*



Source: Program Record #10001, [www.hydrogen.energy.gov/program\\_records.html](http://www.hydrogen.energy.gov/program_records.html).

\*Including delivery and dispensing at the pump



# Co-Launched Public-Private Partnership

## H<sub>2</sub> USA

**Mission:** To promote the commercial introduction and widespread adoption of FCEVs across America through creation of a public-private partnership to overcome the hurdle of establishing hydrogen infrastructure.

Current partners include (additional in process):



U.S. DEPARTMENT OF  
**ENERGY**

DAIMLER

HYDROGENICS  
Advanced Hydrogen Solutions



**HONDA**  
The Power of Dreams



Mercedes-Benz



American Gas Association



DRIVING FOR THE FUTURE



THE LEADER IN ON SITE GAS GENERATION.

Pacific Northwest  
NATIONAL LABORATORY



NUVERA

Making hydrogen make sense.



U.S. DEPARTMENT OF  
**ENERGY** | NATIONAL LABORATORY  
Energy Efficiency &  
Renewable Energy

# Examples of Challenges for CNG and H<sub>2</sub>

## Technical Challenges

- Storage (on-board vehicles and at stations)
- Delivery
- Compression
- Dispensing
- Cost and Reliability

## Market Challenges

- Infrastructure (station siting, lead times)
- Insufficient part inventories
- Lack of standardization of parts (meters, valves, hoses, nozzles)
- Financing: ROI during early years can be negative, and future demand is difficult to predict

**Are there any synergies between CNG and H<sub>2</sub> that can address these challenges?**

**\$1M (DOE funded) project + cost share of \$250k**

**Two projects focusing on NG being directly injected and the gasoline being port injected to result in a more efficient way of using NG/gasoline dual fuel.**

## Clean Air Power

Performance = the base diesel engine

Average duty-cycle diesel substitution factor of **60%**.

## ANL

Enable **>50%** petroleum displacement, **improved** efficiency relative to gasoline base engine and **improved** power density over comparable CNG port fuel injection technology.

# Workshop Objectives, Goals, Desired Outcomes

## Overall Objective:

- Accelerate the use of both natural gas and hydrogen for on road transportation

## Goals:

- Identify synergies between natural gas and hydrogen fuels
- Identify key technical and non technical challenges which prevent or delay the widespread deployment of natural gas and hydrogen technologies

## Desired Outcomes:

- Identify and prioritize opportunities to address key challenges and synergies between natural gas and hydrogen
- Determine roles and opportunities to partner across both government and industry stakeholders

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# Thank you