CALIFORNIA ENERGY COMMISSION

Moderator Introduction:
Natural Gas Transportation Issues

Integrated Energy Policy Report Workshop on Electricity and Natural Gas as Transportation Fuels

Sacramento, California

June 23, 2014

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California Transportation: Nation-State Statistics

- Population: 37.8 million
- GDP: $2.0 trillion - 8th largest global economy
- GHG Emissions: 448 MMT (2011)
  - Transportation accounts for 40 % of all GHG emissions
  - On Road Transportation totals 168 MMT
- Vehicles: 26.5 million cars + 0.92 million trucks
- Annual Fuel Consumption: 17.8 billion gallons
  - 14.5 billion gallons gasoline
    - Includes about 1.4 billion ethanol as E10 blendstock
  - 3.3 billion gallons diesel

Research Division: Current Portfolio Highlights Major Initiatives

Name of Initiative	Description	Status
Develop and Demonstrate an Ultra Low Emissions, High Performance Spark Ignited Natural Gas Engine **$1 million**	GTI is partnering with Cummins Westport, Inc. (CWI) to develop and validate an Alpha engine design for a new, high-performance, spark-ignited, dedicated natural gas 6.7 liter engine.	In progress. Alpha version of engine expected to be completed in 2015.
Near-Zero Emission Technology Research for Heavy-Duty Natural Gas Vehicles **$2 million**	Reduce NOx levels by 90% through advanced engine technologies. Objective is to obtain near-zero NOx levels while continuing to meet or exceed other emission standards without incurring a fuel economy penalty.	In progress. Expected project completion in 2016. *AB118 funding Demonstration* Previously developed and demonstrated optimized 12L, 13L, and 15L natural gas engines. Active solicitation for optimized 6 to 8 liter engine.
Natural Gas Vehicle On-Board Storage **$1.2 million**	Develop and demonstrate advanced natural gas tank technologies providing a safe, low-pressure, high-density, conformable storage system that enables cost-effective home refilling of NG vehicles.	Work authorization to determine research gaps; existing research is being conducted to improve storage.

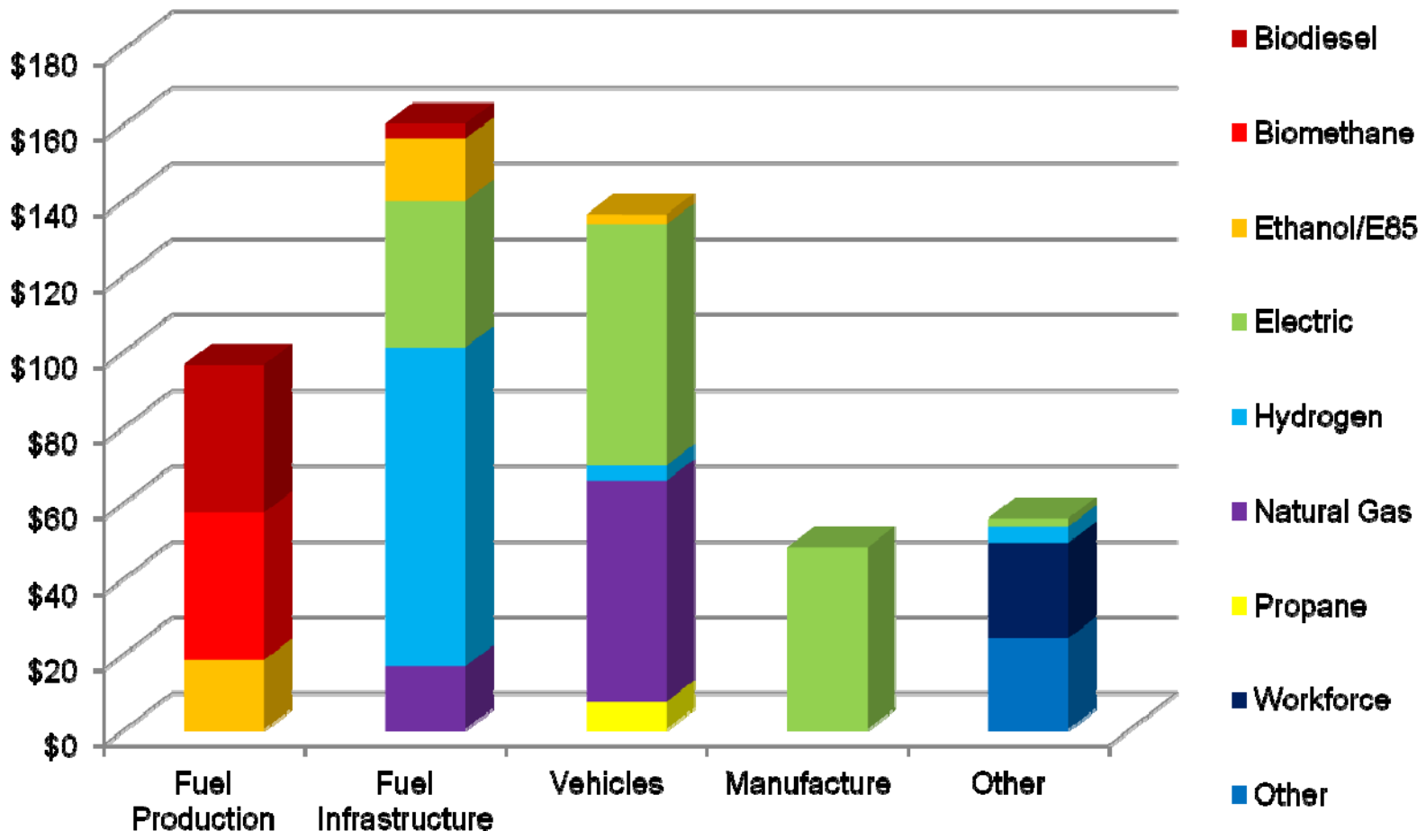
Research Division: Current Portfolio Highlights Major Initiatives

Name of Initiative	Description	Status
Natural Gas Vehicle Hybridization **$2.7 million**	Develop and demonstrate hybridization designs that use battery power to minimize emissions, idle, and low-load engine operation.	Solicitation released early 2014. Three projects awarded in June 2014.
Natural Gas Fueling Infrastructure Improvements **$800,000**	Develop technologies and processes to reduce natural gas venting and fugitive emissions, improve equipment efficiency, and improve economics.	Solicitation to be released mid-2014.
Advanced Ignition Engine Research **$2.25 million**	Develop advanced ignition methods to improve efficiency while reducing emissions.	Solicitation to be released mid-2014
RD&D for Advanced Renewable Natural Gas Production Technologies **$2.4 million**	Develop efficient processes and technologies for RNG production from waste-based feedstocks.	Four projects awarded in 2013 to develop and demonstrate RNG production technologies and methods.

ARFVTP Funding Summary: 2009-2014

Investment Areas	Funding Amount (millions)	Percent of Total (%)	Number of Awards
Biofuels	$119.5	24	45
Electric Drive	$152.7	31	120
Natural Gas/Propane	$82.3	16	55
Hydrogen	$92.6	19	26
Workforce Development	$25.2	5	30
Market and Program Development	$24.1	5	36
Total	**$496.4**	**100**	**312**

Existing Agreements



ARFVTP Truck Sector-Related Funding

About 30 Percent of Total Program Funding

Technology	Funding ($ Millions)	No. of Vehicles, Fueling Stations or Projects
Commercial Natural Gas Trucks	48.5	2,339 Trucks
Natural Gas Infrastructure	17.5	62 Stations
Commercial Propane Trucks	7.3	600 Trucks
Commercial ZEV Trucks (Class 6 package delivery)	4	160 Trucks
Advanced Technology Truck Demonstration or Manufacturing	70.4	36 Projects
Total Funding	**147.7**	

Biofuels Funding

Category	Funding ($ millions)	No. of Projects
Fuel Production		
Biogas	38.9	12
Biodiesel / Renewable Diesel	34.1	13
Ethanol	18.4	8
Total Fuel Production	**91.4**	**33**
Fueling Infrastructure		
Biodiesel Tankage	4.0	4
E85 Retail Stations	16.5	205
Total Infrastructure	**20.5**	**209**

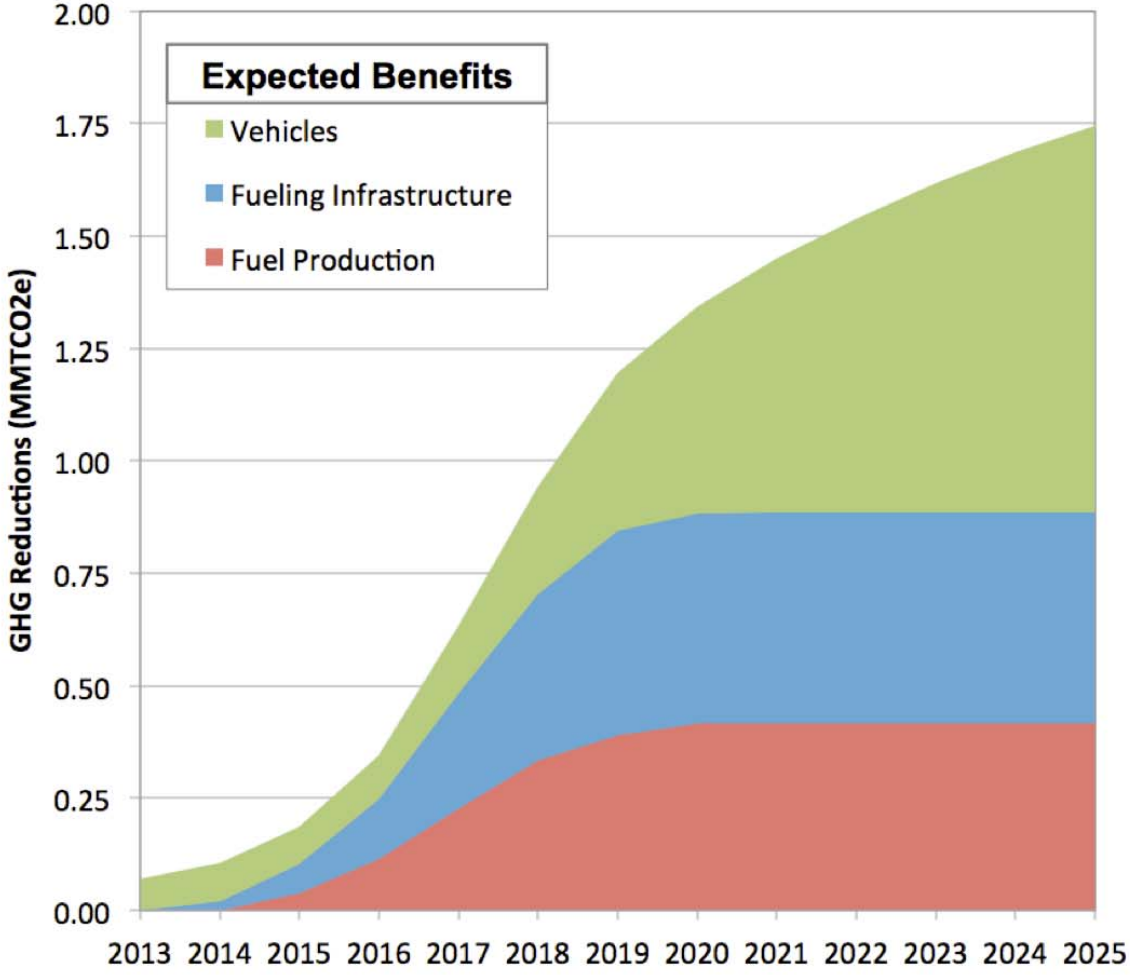
Projected Carbon Reduction Benefits from ARFVTP Investments

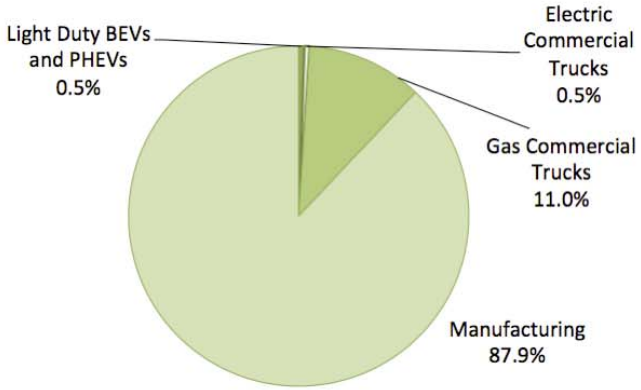
Results from NREL's 2014 Analysis of Expected and Market Transformation Benefits

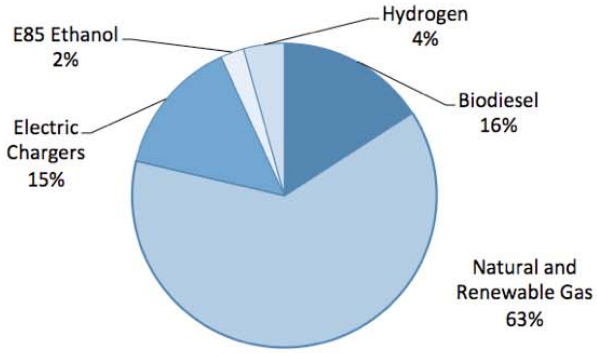
http://www.energy.ca.gov/2014_energypolicy/documents/#06122014

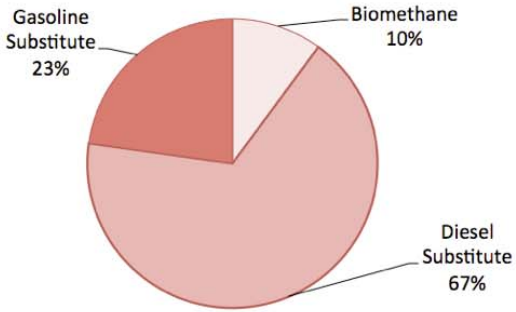
- **Dr. Marc Melaina, Principal Investigator**
  - **Analyzed 207 projects totaling $426.1 million**

Expected Benefits: GHG Reductions Through 2025









Expected Benefits: GHG Reductions Through 2025

Benefit Category	Project Class	GHG Reductions (thousand tonnes CO2e)		
		2015	2020	2025
Refueling Infrastructure	Biodiesel	5.0	70.5	70.5
	Natural and Renewable Gas	**29.7**	**304.3**	**304.4**
	Electric Chargers	25.4	58.1	62.7
	E85 Ethanol	2.3	11.1	11.1
	Hydrogen	1.2	20.9	20.9
Vehicle	Light Duty BEVs and PHEVs	0.1	3.0	2.0
	Electric Commercial Trucks	0.0	3.0	1.4
	Gas Commercial Trucks	**82.0**	**33.3**	**4.8**
	Manufacturing	2.0	422.4	851.2
Fuel Production	**Biomethane**	**1.6**	**42.7**	**42.7**
	Diesel Substitute	37.5	277.5	277.5
	Gasoline Substitute	0.0	96.5	96.5
Total		**186.8**	**1,343.1**	**1,745.7**

Panel Questions

1. What are the market opportunities for Natural Gas as a transportation fuel?
2. Should natural gas be considered as:
    1. A near-term, low cost bridging fuel with moderate environmental benefits? Or,
    2. As a potential ZEV-caliber truck fueling option with the potential to meet the environmental performance standards associated with electricity and hydrogen?

Panel Questions

3. How should policy makers and regulators consider the long-term potential for natural gas as a transportation fuel given the risk and uncertainties associated with methane leakage and potentially higher carbon intensity values?
4. What are the opportunities and constraints for using biogas / renewable natural gas at a commercial fueling scale in California?

Panel Questions

5. What changes in natural gas engine design and sizing options are needed to make natural gas trucks competitive in California and the West? When can we expect sizeable numbers of vehicle products?
6. What do fleet operators need from OEMs and government policy makers and regulators to make natural gas trucks a competitive alternative to diesel-fueled trucks?