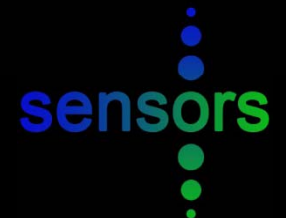


# On-road Emissions Testing Equipment

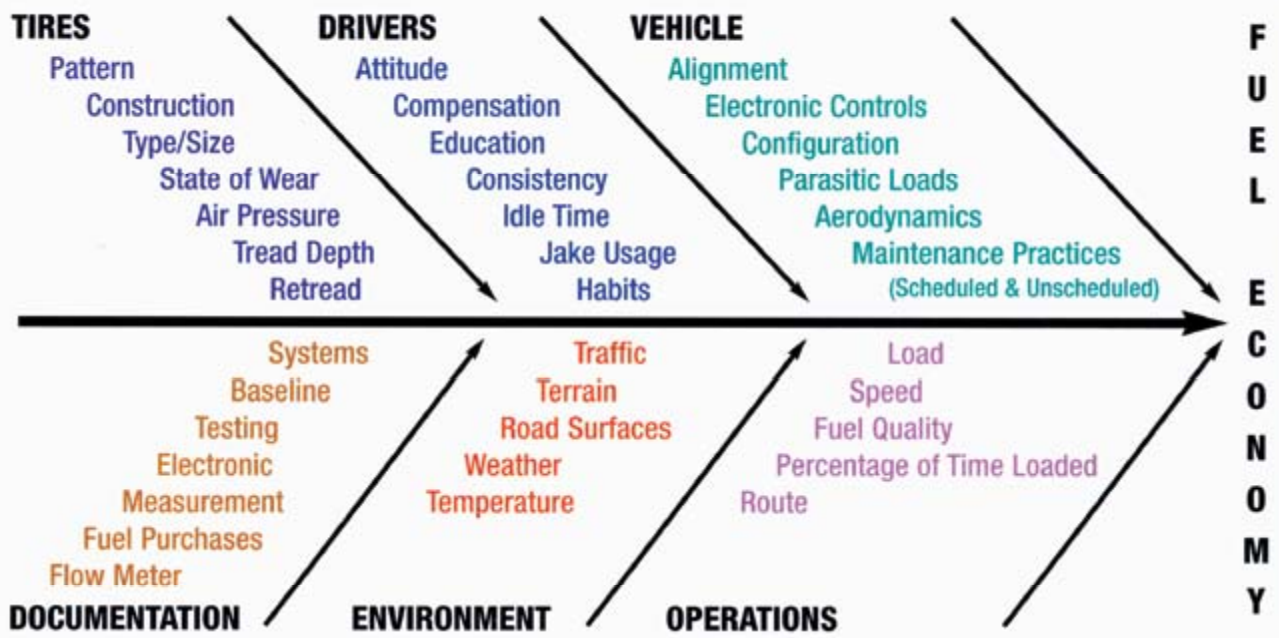
Dave Kalen, Semtech Account Executive, Sensors, Inc.

# PROGRESSIVE AUTOMOTIVE XPRIZE



PIAXP  
11/2/2009

## FACTORS AFFECTING FUEL ECONOMY IN THE REAL WORLD





# Introduction to Sensors, Inc.

- Founded 1969
- Nearly 40 years in emissions analysis
- Multiple international patents on emissions measurement technology
- Over 260,000 OEM Inspection and Maintenance gas/smoke analyzers installed world-wide
- World leader for Portable Emissions Measurement Systems (SEMTECH); Approximately 170 systems delivered to date
- 90 employees; 4 offices world-wide

# PEMS

- Portable Emissions Measurement System
  - Evolved from EPA ROVER Conceptual idea
  - Need for a laboratory grade analyzer capable of measuring emissions on the road
    - Non-road engines and difficult applications
    - Eliminate the need to remove and replace engine
    - Improve inventory accuracy
    - Less expensive method of performing PLT and certification testing for manufacturer's of record

# REAL WORLD RESULTS

- **Laboratory**

- Temperature Controlled
- Humidity Controlled
- Dynamometer controlled
- Special Fuel
- Certified Driver
- FTP Test cycle
- Dilution tunnel
- Expensive to implement
- Expensive to run
- Expensive to maintain
- Subject to scheduling possible long waits
- Stationary testing limits capabilities

- **PEMS**

- Real world conditions:
- Wind/ Rain/Terrain
- Rugged construction
- Portable and flexible
- Total Vehicle test
- Less expensive to purchase and install
- Less expensive to maintain and staff
- Allows portability from cell to cell
- Multiple tests per day possible
- Data available quickly
- Post processing of data allows for “what if’s”
- Real world fuel properties
- Ship to various locations world-wide
- Alternate fuels and Hybrid testing

# Fuel Economy Testing

**EPA Smartway Transportation Tests**

**ChallengeX DOE academic competition**

**EcoCAR DOE academic competition**

**HTUF drive cycle development Partner**

**Motorweek fuel economy study**

**Alternate fuels evaluation studies:**

**Argonne National Laboratory**

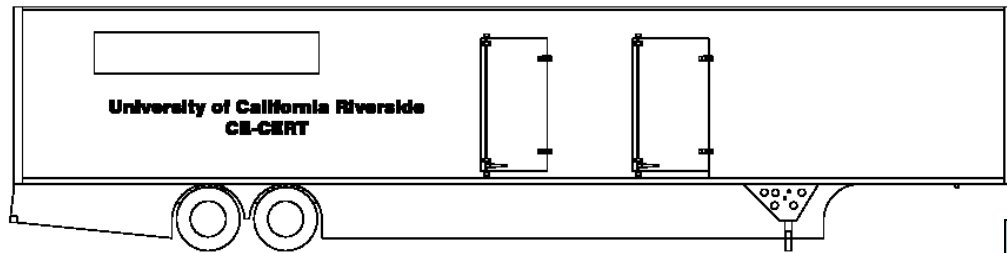
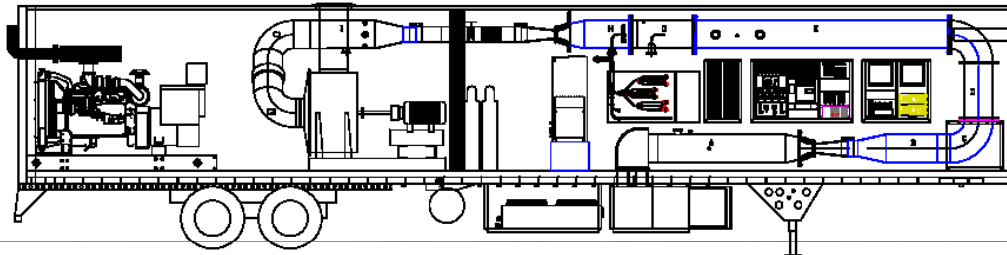
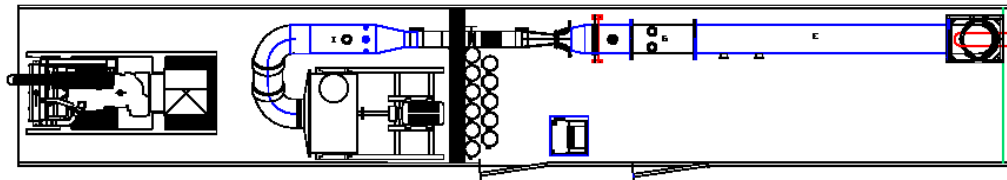
**National Renewable Energy Laboratory**

**Michigan Technological University**

University of California, Riverside

Mobile Emissions Laboratory

Bourns College of Engineering  
Center for Environmental Research & Technology (CE-CERT)



# Installations



# On-Road Diesel Applications



# Buses









# SEMTECH Measurement Technologies

- Heated Flame Ionization Detector (FID) and Sample System for THC
- Non-dispersive Infra-red (NDIR) spectroscopy for CO and CO<sub>2</sub>
- Non-dispersive Ultra-violet (NDUV) spectroscopy for NO and NO<sub>2</sub> (simultaneous)
- Electrochemical O<sub>2</sub>
- **All Technologies are approved for Certification by EPA and comply with CFR40 Part 1065**

# Typical SEMTECH Test Display

SENSOR Tech-D Version 6.52 10.10.1.72 L02-SD03 1.024\_JG6 1024

**SENSOR  
Tech-D**

- Home
- System Setup
- Status
- Test
- Data Analysis
- Activity Logs
- Tech Support

---

- Test Setup
- Log Files
- Data Table
- Graph
- Emissions
- Bench Display
- Road Test
- Drive Cycle

### Test

Exhaust Gas Concentrations			Ambient Conditions	
CO2 (%)	CO (%)	THC (ppm)	Temp (deg C)	Press (mbar)
<b>0.08</b>	<b>0.001</b>	<b>3.0</b>	<b>19</b>	<b>981</b>
NO (ppm)	NO2 (ppm)	O2 (%)	RH (%)	
<b>41.4</b>	<b>3.2</b>	<b>0.1</b>	<b>13</b>	

Vehicle Interface			Auxilliary Vehicle Data	
Eng Spd (rpm)	Veh Spd (mph)	Throttle (%)	Ex Temp ( )	RPM Probe (rpm)
<b>1181</b>	<b>65</b>	<b>15</b>		<b>1180</b>
Fuel Rate (gal/s)	Eng Load (%)	Oil Temp (deg F)	Ex Flow ( )	
	<b>18</b>	<b>190</b>		

System Monitor				GPS Data
Sample (mbar)	Aux Temp (deg C)	Htd Filter (deg C)	Htd FID (deg C)	Speed ( )
<b>897</b>	<b>20</b>	<b>198</b>	<b>190</b>	
Htd Line (deg C)	FID Fuel (psi)	Chiller (deg C)	Power Sup (volts)	Altitude ( )
<b>191</b>	<b>2498</b>	<b>4</b>	<b>12.4</b>	

Record:  Filename: TEST3.XML Status:

READY

FID LIT

SYSTEM OK

ZERO IDLE

NOT RECORDING

Ambient Air

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PIAXP  
11/2/2009

# SEMTECH EFM Exhaust Mass Flow Meter



- Volumetric flow meter based on the multi-point averaging Pitot-tube principle
- Four  $\Delta P$  sensors operating in parallel ranging from 0.1" H<sub>2</sub>O to 50 "H<sub>2</sub>O full scale
- Automated Zeroing of sensors at fixed intervals
- Backpurge capability to clean pressure ports/lines
- Flow tube all Stainless steel construction capable of measuring over 700 C

# SEMTECH Performance

- Laboratory measurement accuracy under real-world conditions
- Capable of testing both gasoline and diesel engines
- Proven over wide environmental operating range: temperature, pressure, shock & vibration
- The only participant in the EMA/EPA/CARB PEMS Measurement Allowance Program

# Conclusions

- SEMTECH-Ds is fully compliant with CFR 1065, Subpart J for Portable Emissions Measurement Systems
- On-road testing by customers proved highly beneficial for engine development and validation
- On-road testing is equally beneficial for development and validation of after-treatment devices
- Exhaust flowmeter is required to ensure compliance to regulatory emissions standards