

Context for Hybrids: HTUF & Industry Actions



*Advanced Transportation
Technologies*

*Clean Transportation
Solutions* SM



**Bill Van Amburg
Senior Vice President**

**SCAQMD Hydraulic Hybrid
Vehicle Tech Forum
November 15, 2007**



MISSION STATEMENT

WestStart-CALSTART is dedicated to the growth of an advanced transportation technologies industry and markets that will:

- **Create high-quality jobs;**
- **Clean the air;**
- **Reduce dependence on foreign oil; and**
- **Prevent global warming**



WestStart: A Strategic Broker for Advanced Transportation

2007

145+ Worldwide Participant Network

4 Offices in US

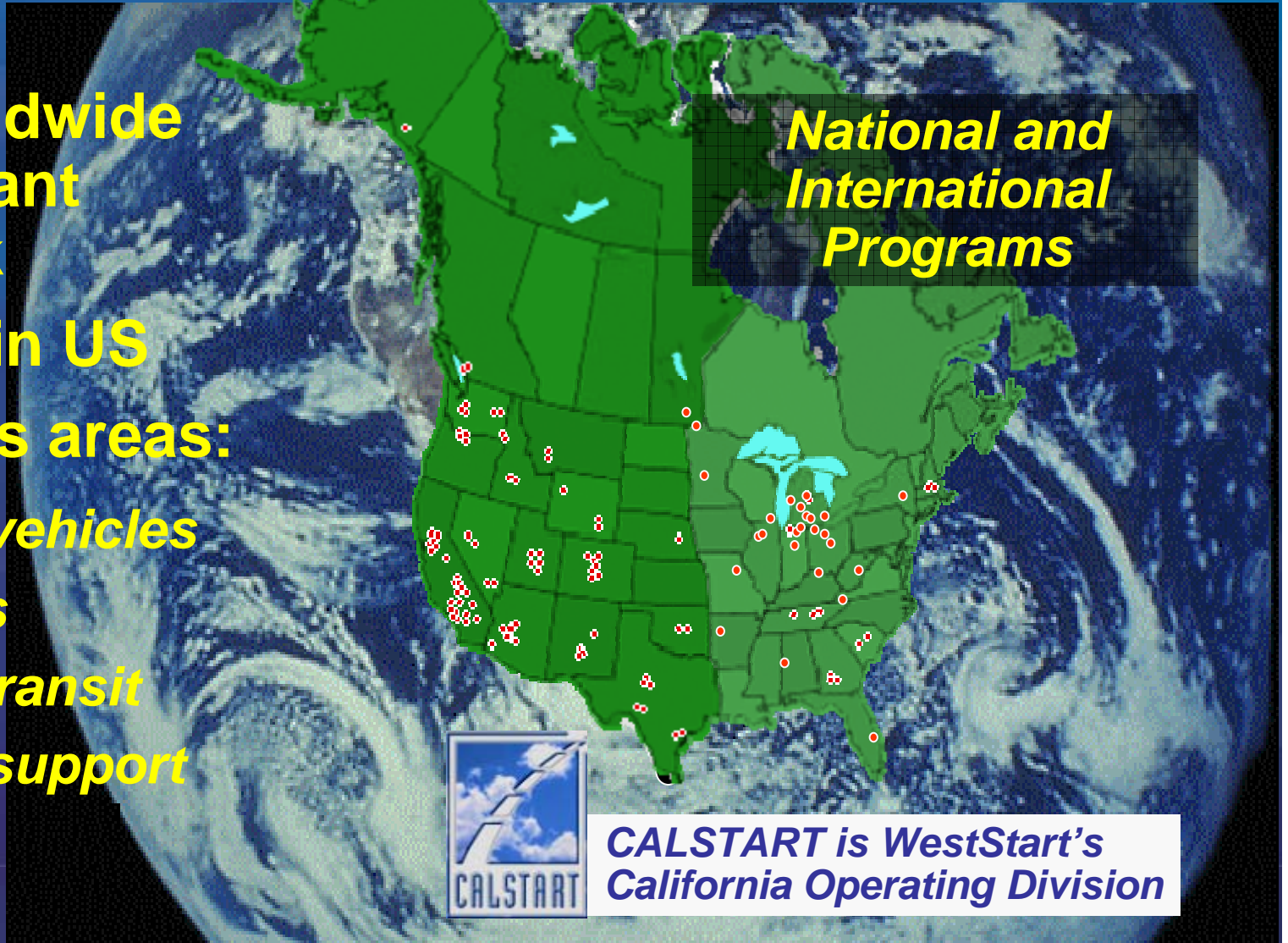
Four focus areas:

Efficient vehicles

New fuels

Mobility/transit

Industry support



National and International Programs

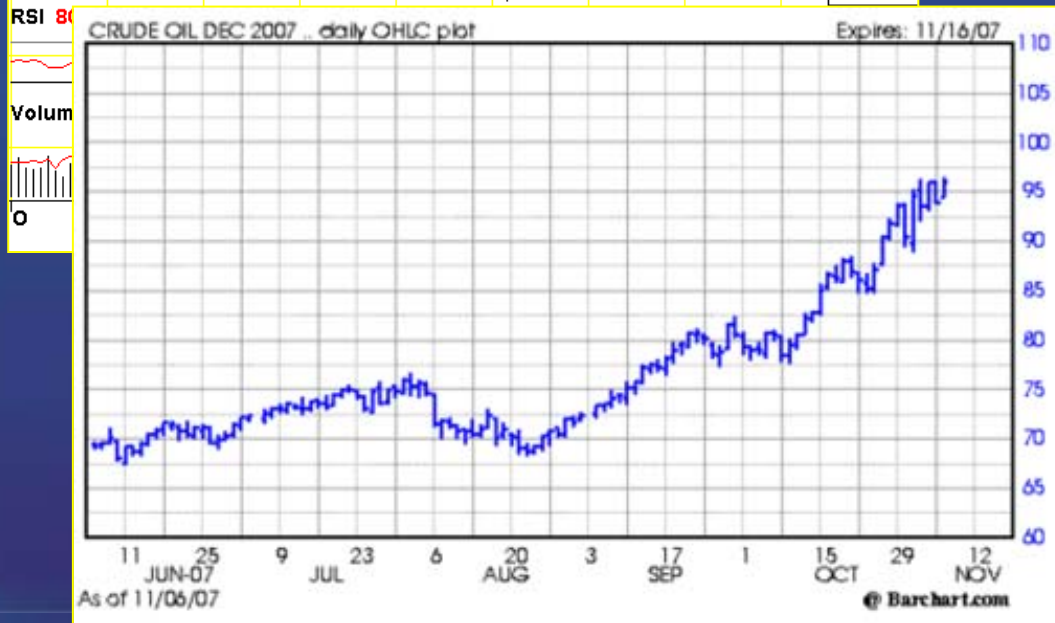
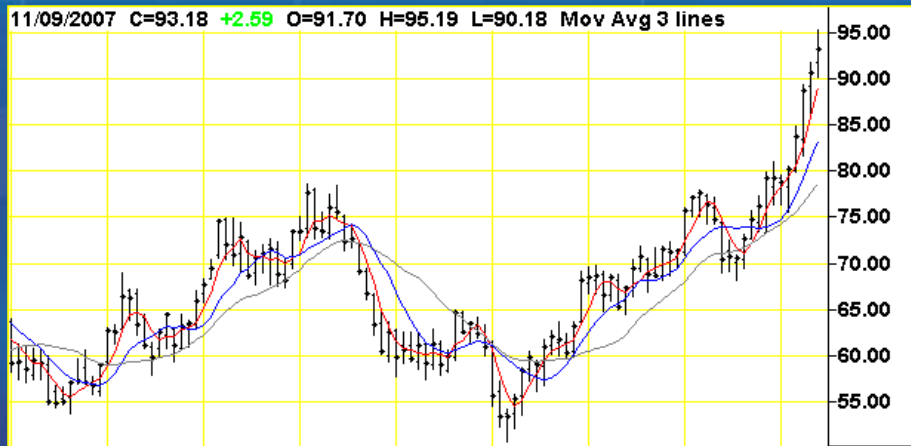


CALSTART is WestStart's California Operating Division



High Energy Costs Here to Stay

- \$100 bbl oil?
- \$4 gal gasoline?
- US EIA forecasts heavy demand will keep imported oil prices on rise until 2014; new supplies after then may ease supply crunch, cause decline in crude costs

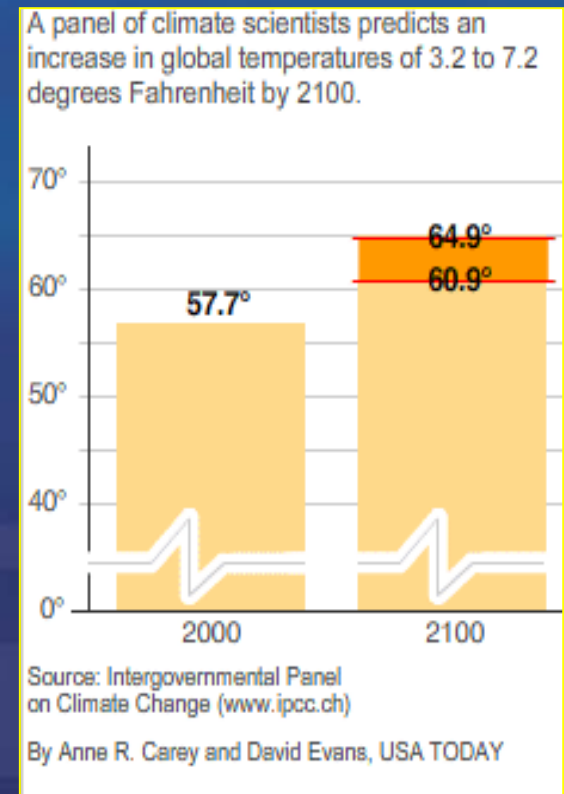




Major Global Warming Report

Intergovernmental Panel on Climate Change (IPCC) findings:

- Human activity “highly likely” (90% certainty) responsible for recent global warming
- CO2 emissions already affecting climate and earth’s ecosystems; serious economic, social, political consequences
- Long term outlook dim; temperatures to rise 3-5 degrees F
- Shifting climate patterns will benefit some, hurt others, primarily poor nations; adaptation essential
- IPCC Report showing potential solutions released May 4, 2007





Fighting Global Warming

IPCC Climate Change Mitigation Report (May 4):

Summary for Policymakers

IPCC Fourth Assessment Report, Working Group III

Table SPM 3: Key mitigation technologies and practices by sector. Sectors and technologies are listed in no particular order. Non-technological practices, such as lifestyle changes, which are cross-cutting, are not included in this table (but are addressed in paragraph 7 in this SPM).

Sector	Key mitigation technologies and practices currently commercially available.	Key mitigation technologies and practices projected to be commercialized before 2030.
Energy Supply [4.3, 4.4]	Improved supply and distribution efficiency; fuel switching from coal to gas; nuclear power; renewable heat and power (hydropower, solar,	Carbon Capture and Storage (CCS) for gas, biomass and coal-fired electricity generating facilities; advanced nuclear power; advanced

Transport
[5.4]

More fuel efficient vehicles; hybrid vehicles; cleaner diesel vehicles; biofuels; modal shifts from road transport to rail and public transport systems; non-motorised transport (cycling, walking); land-use and transport planning

Second generation biofuels; higher efficiency aircraft; advanced electric and hybrid vehicles with more powerful and reliable batteries

- More fuel efficient vehicles
- Hybrid vehicles
- Cleaner diesel vehicles
- Biofuels
- Modal shifts to rail and public transport
- Non-motorized vehicles
- Land use and transit planning



The New "Strike Zone" in Transportation

Air Quality

Balances all three competing needs

Integrated Solutions Needed

Energy Security

Climate Change



Why Hybrids Are Gaining Traction with Fleets

- **Rising fuel costs:** Optimizing urban truck drivelines is becoming critical for fuel efficiency, emissions
- **Major engine changes** – and increased cost/complexity – coming in 2007-2010 to comply with EPA emissions requirements
- **Idle Management** is a growing issue nationwide
- **Productivity/performance** complaints from cleaner engines
- **“Green Footprint”** – pressures from management to reduce carbon and overall environmental impacts
- **Trend toward integrated engine/drivelines** in trucks
- **Increasing electrical power needs** in heavy vehicles and equipment



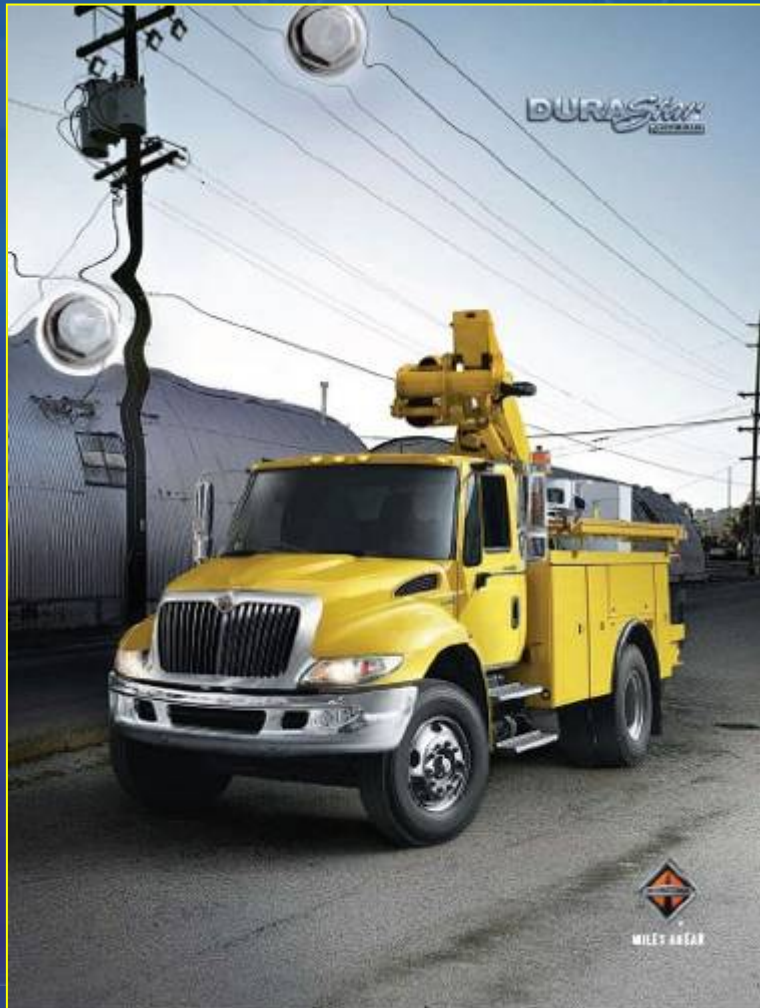
Recent Heavy Hybrid News

- Freightliner to produce 1500 M2 hybrid trucks in next 3 years
- Peterbilt/Eaton to enter production hydraulic refuse truck 2008
- Azure plans production of hybrid shuttles in 2008
- Kenworth and Peterbilt announce production plans for medium hybrid trucks in 2008
- International launches first hybrid production: Fall 2007
- Eaton moves into production of hybrid drive system
- Kenworth announces pre-production delivery hybrid truck
- FedEx/Azure announce partnership on gas-electric hybrids
- Peterbilt testing Class 8 hybrid with Eaton system
- ArvinMeritor signs Wal-Mart agreement for Class 8 hybrids
- Oshkosh unveils hybrid refuse truck at HTUF meeting
- Peterbilt introduces Class 7 hybrid truck for customer trials
- International builds first production-line hybrids in Nov 06
- Freightliner unveils Class 7 utility hybrid on M2 chassis
- IC/Enova roll out hybrid electric shuttle bus
- Azure/StarTrans agreement on producing hybrid shuttles
- UPS testing advanced series hydraulic hybrid prototype
- Bosch-Rexroth buys Dana hydraulic hybrid drive unit
- Mitsubishi-Fuso Unveil Hybrid work truck (CI 4-5 delivery)
- ISE builds 50 advanced hybrid buses for Las Vegas
- Volvo announces hybrid heavy trucks for 2009 production





First US Hybrid Truck Production



International: will launch first production hybrid trucks – “DuraStar Hybrid” – Sept 2007

Can build up to 1000 units per year to start

100 “Production-Intent” hybrid trucks built in 2006 and delivered to customers

- Incremental cost remains high and purchase assistance needed
- Roughly half are “utility” type trucks, half other applications (regional delivery/cargo, flatbed, reefer, etc.)



Production-Intent – Peterbilt/Eaton Hydraulic Refuse Truck

- Peterbilt in field pilot testing of hydraulic hybrid refuse truck (63,000 pound GVWR)
- Pre-production in 2006/2007 – Production in 2008
- Eaton to use same pump/accumulator design for hydraulic shuttle bus
- Fuel savings in 10-30% range – carbon reductions track fuel reductions closely



Peterbilt Hybrid Refuse Chassis



Recent Introductions



Peterbilt Class 7 hybrid utility truck

Oshkosh hybrid refuse truck



Freightliner Class 6/7 hybrid utility truck



IC/Enova hybrid shuttle bus



Kenworth Class 7 hybrid truck

ISE hybrid cutaway shuttle bus





Timeline to Commercialization: Hybrid Tech Just Starting in Trucks

*Trucks are not Priuses!
Tech introduction 10 years behind cars
BUT: big fuel impact per truck*



Development

Test prototypes and systems

Pre-Production

Field pilot assessments (10-50 vehicles)

Production Intent

Assembly line builds up to 100+

Early Production

Initial commercial volumes – still high incremental cost

TOOLS:

R&D Support

Purchase Incentives

Pre-Production Deployment Support (HTUF)

Hybrid Truck Users Forum (HTUF)



- Goal: Speed the development and introduction of commercially viable medium- and heavy-duty hybrid trucks in the U.S.
- User driven process involving more than 80 fleets with > 1 million trucks
- Joint WestStart-U.S. Army program



HTUF National Meeting 2007

Hybrid Truck Users Forum - 7th Meeting



- Two and a half day forum at Qwest Field, Seattle
- More than 430 attendees, one quarter fleet users – *a new record*
- 19 med. and heavy-duty hybrids in ride and drive – *a new industry record*
- All major trucks makers and suppliers involved in process





Key Findings at HTUF 2007



- HTUF process has taken 1-2 years off the development cycle of med and heavy-duty hybrids – *Paul Skalny, Director, Army's National Automotive Center*
- Hybrid trucks now at cusp of first production
 - International launching first production of medium duty hybrids Fall 2007
 - Peterbilt and Kenworth start production of medium duty hybrids in 2008
 - Peterbilt begins production of refuse truck hybrid in 2008, and Class 8 big-rig hybrid in 2009
 - Mack/Volvo to start hybrid truck production in 2009
- Class 8 hybrids are a key new capability emerging in more-efficient trucks – could impact biggest fuel users on road
- Better purchase incentives are needed to help fleets adopt technology sooner
- Need to speed pre-production trucks and equipment in additional applications (including small bus and Class 8)
- **Technology improvement needed: energy storage; electrified and efficient components; light-weight materials; power generation; optimized engines; systems control**





HTUF Working Groups

- **6 Core Working Groups of fleet truck users now operating, plus:**
 - *1 WG partnership with NTEA (light truck)*
 - *1 new Forum forming (construction equip.)*
 - *1 Task Force: Plug-in HE Trucks (PHET)*
- **Main Working Groups:**
 - *Utility/Specialty trucks – George Survant, Florida Power & Light, lead*
 - *Parcel Delivery trucks – Sid Gooch, Fed Ex Express; Bob Dengler, FedEx Ground; Robert Hall, UPS – user leads*
 - *Refuse Truck Working Group – Matt Stewart, City of Chicago Sanitation, lead*
 - *Bus Working Group – launched with support of Federal Transit Administration*
 - *Class 8 Working Group – underway*
 - *Incentives Working Group – underway*





HTUF Moving Rapidly



• Working Group Activities (continued)

– Refuse Vehicle

- Making final decisions on RFP for hybrids
- Targeting 10+ pre-production trucks
- Likely electric and hydraulic variants



– Hydraulic Hybrid Parcel Delivery

- Reviewing proposals for hydraulic parcel demo
- Hydraulic tech not as developed in this size



– Shuttle Bus

- Spec info being gathered from fleets



– Plug-in Hybrid Truck (PHET)

- Successful workshop at CHDV conference in Feb.
- Next steps
 - Develop a PHET business case
 - Define best target vehicles and applications
 - Select fleets and regions that can be “first-movers”



Utility Hybrid Class 6/7 Deployment Data to Date



- All 24 trucks delivered – 12 months of service on first trucks
- 391 total truck months of service through Aug 07; 409,352 miles
- Availability of trucks high: 99+% overall daily availability of hybrid systems
- Strong user acceptance and trucks meeting mission needs



Fuel economy varies by fleet and use

- 54% fuel economy gain for highest fleet
- 14% fuel economy gain for lowest fleet
- Biggest variables: mileage driven versus work site “boom” time (more work site time equals better mpg)



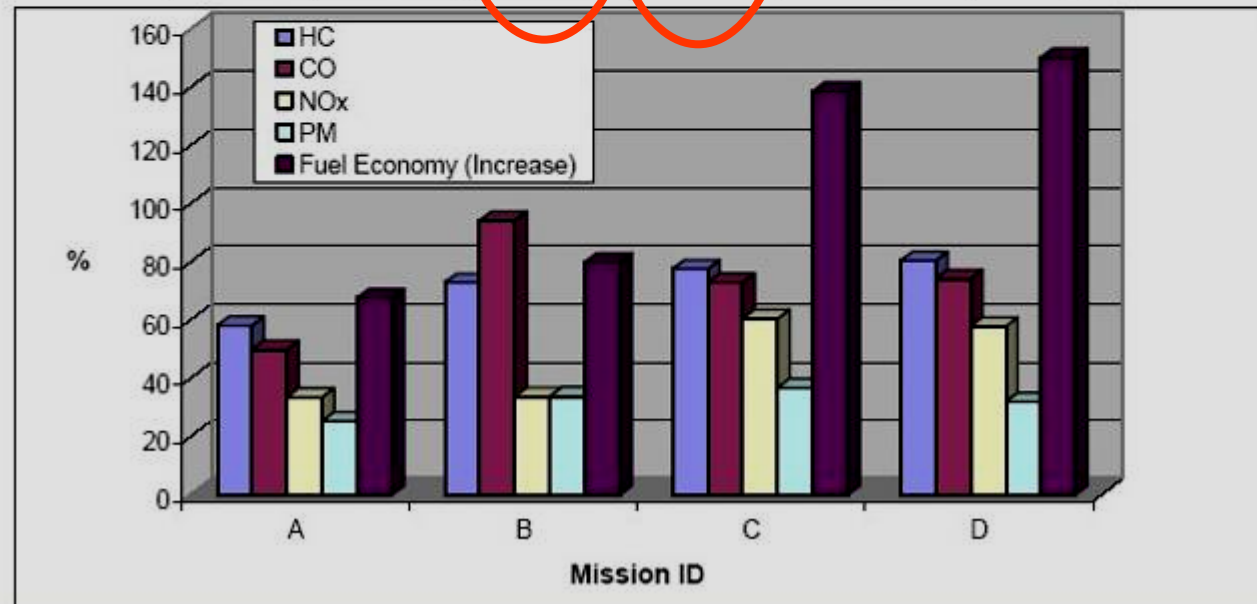
Emissions Reductions by Mission

Reductions just from hybrid system, no additional after treatment

CO2 reductions closely tracked fuel reduction percentages

TABLE 10 AND FIGURE 9. PERCENT DECREASE IN RATE OF EMISSIONS (g/hr) AND PERCENT INCREASE IN FUEL ECONOMY (mpg) OBTAINED BY USING THE HEV TRUCK COMPARED TO THE BASELINE USING FOUR EATON-SPECIFIED MISSION CYCLES

Mission Cycle ID (given in Table 8)	HC (g/mi) %	CO (g/mi) %	NOx (g/mi) %	PM (g/mi) %	Fuel (mpg) % (increase)	Miles Driven	Hours of Operation (hydraulic + electric)
A	58	50	34	25	68	70	1.5
B	73	94	34	34	80	70	4.5
C	78	73	61	37	139	48	3
D	80	74	58	32	150	38	3





Hydraulic Hybrid Vehicles

- *Extremely promising technology*
- *Benefits: possible lower cost than electric technology; excellent at high power, demanding duty cycles; robust component base*
- *Weight, system integration and control are key issues; farther behind in development curve*
- *Most focus is on medium and heavy-duty vehicles*
- *Major US manufacturers are leaders in this technology*



Eaton Hydraulic Hybrid

- Eaton receives \$2.15 million from DoD to accelerate commercial development of its energy-saving Hydraulic Launch Assist™ (HLA®) system technology
- Working under a program with the US Army National Automotive Center and Impact Engineering
- Eaton will focus on designing third generation HLA system and optimizing for specific vehicle applications
- Eaton's HLA regenerative braking system has demonstrated significant fuel economy, reduction in emissions, brake wear in stop and go driving applications



Prototype Series Hydraulic Hybrid in Testing

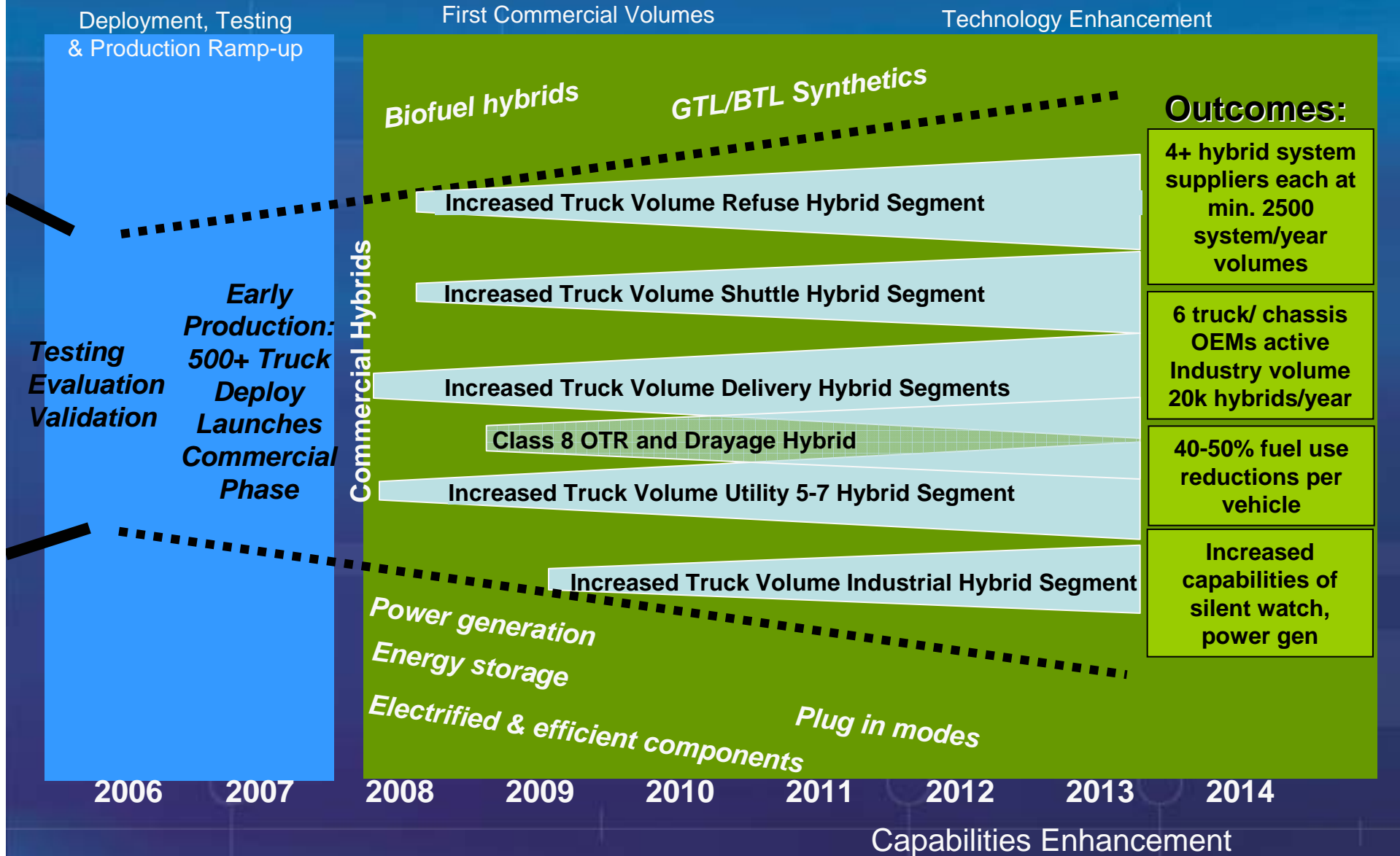


- Test project of EPA, Army/NAC, Eaton, International and UPS
- Series hydraulic design eliminates transmission and driveshaft, operates engine in narrow range
- Early testing has shown up to a 70% increase in fuel economy over conventional truck
- Still several years from commercialization



UPS will field test prototype truck for several months in delivery operation

HTUF: "Expanding the Funnel" From Hybrids to More Efficient Trucks





What's Target for Volumes, Price?

**Increase Volumes in Markets
With Similar Drivelines to Lower Costs**





Conclusion: Status of Hybrid Trucks

- **Not Yet at “Tipping Point” for hybrid commercialization – but making strong progress**
 - Have sped commercialization process by 1-2 years
 - One truck maker in production
 - Three truck makers entering production-intent manufacturing process, one in pre-production
 - Still behind automotive curve – but business case is driver
 - Need assistance to cross cost gap to first production
 - Must increase early volumes
- **Hybrids are one of several critical “wedge” strategies to boost fuel economy, reduce GHG**
 - First targets urban vocational trucks
 - Will likely also have Class 8 impacts
 - Enabling technology for many future advancements
 - Expect yearly volumes to exceed 1-2-thousand in next 3 years
- **Need targeted incentives: Federal and State**
 - Partnership of fleets, manufacturers and government
 - Structured to work in commercial, not consumer, market
 - Also need regional incentives and “aligned” incentives across regions

Clean Transportation Solutions SM

Advanced Transportation Technologies SM

www.weststart.org



For info contact:

**Bill Van Amburg
(626) 744-5600**

bvanamburg@weststart.org

www.htuf.org