

Pilot Hybrid Utility Trucks Assessment



*Advanced Transportation
Technologies*

*Clean Transportation
Solutions* SM



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Hybrid Electric Utility Truck



International-Eaton

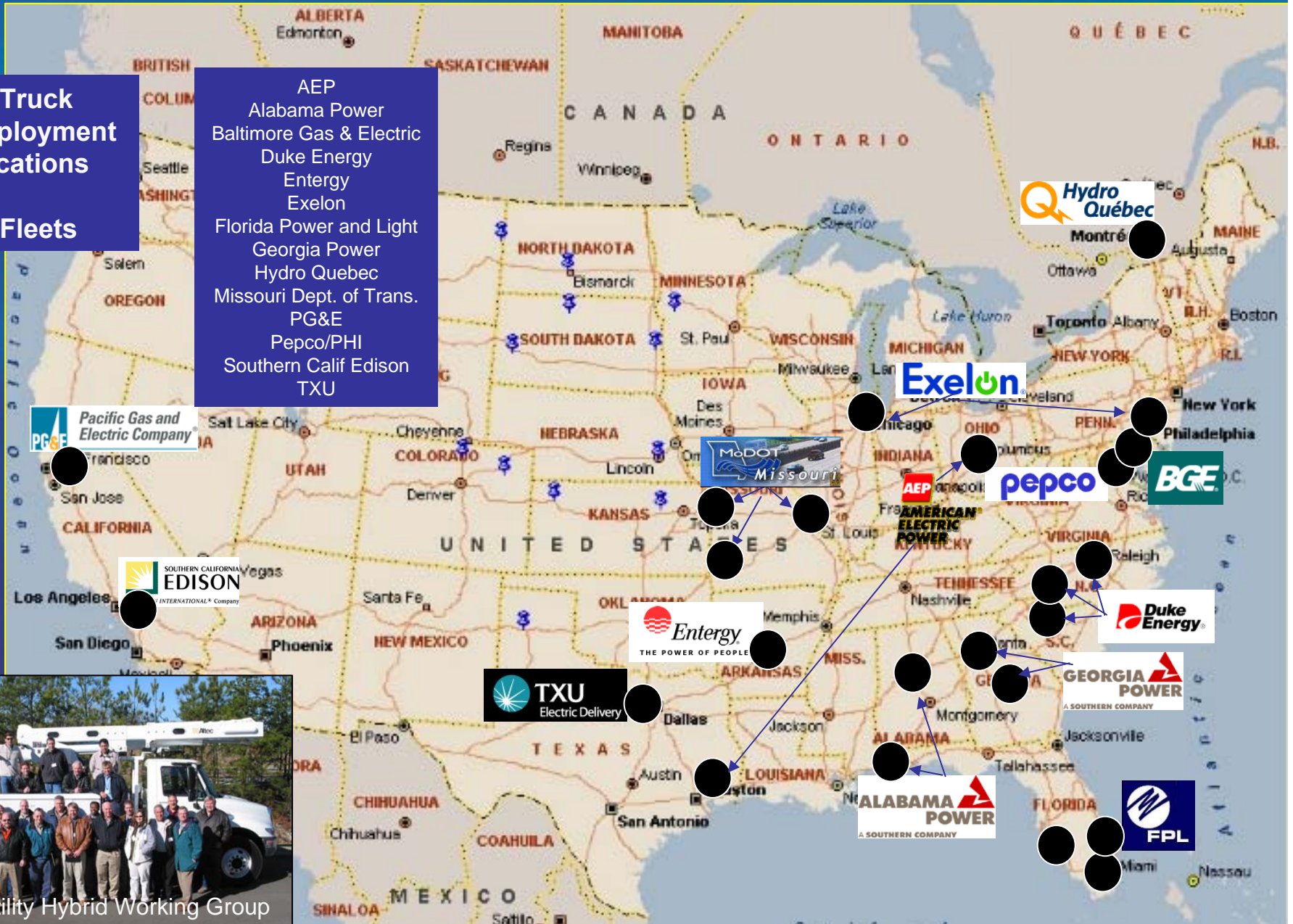
- Class 6-7
- 24,000-33,000 GVW
- Engine DT466, 225 hp
- Automated Manual Transmission
- Battery-electric, 44 kW electric motor
- Engine-off PTO operations
- 25 kW / 5 kW export power

North American Deployment & Assessment

24 Truck
Deployment
Locations

14 Fleets

- AEP
- Alabama Power
- Baltimore Gas & Electric
- Duke Energy
- Entergy
- Exelon
- Florida Power and Light
- Georgia Power
- Hydro Quebec
- Missouri Dept. of Trans.
- PG&E
- Pepco/PHI
- Southern Calif Edison
- TXU



HTUF Utility Hybrid Working Group



Field Deployment Status



First Truck Deliveries
Winter/
Spring
2006



Training &
In-service
Winter/
Spring
2006



Start Field
Deployments
Summer
2006



- All 24 trucks delivered to fleets
- 23 in field; 1 truck in fleet controlled testing
- Staggered deployment but 12 trucks have been in use over 1 year
- Standard comparison units in same locations
- 25 kW APG – installed in field; some units with 5 kW APG



Field Testing – Key Findings

Key Findings

- Reliability greatly improving
- Availability very high (99%)
- Users finding truck meets needs
- Fuel consumption improvements measured up to 54%
- Reduced noise
- Duty cycle is very important
- Best place in urban setting with high PTO use



- Reliability/Availability
- User acceptance
- Performance data
- Maintenance data
- 24 HEV
- 20 Baseline Trucks
- 12+ Months
- 14 Fleets



Utility Truck Operations

Daily Average Operation Parameters

	HEV	Base
Operation Hrs	7 h	7 h
Boom, Hrs	0.5 h	1.8 h
Mileage	70 mi	80 mi



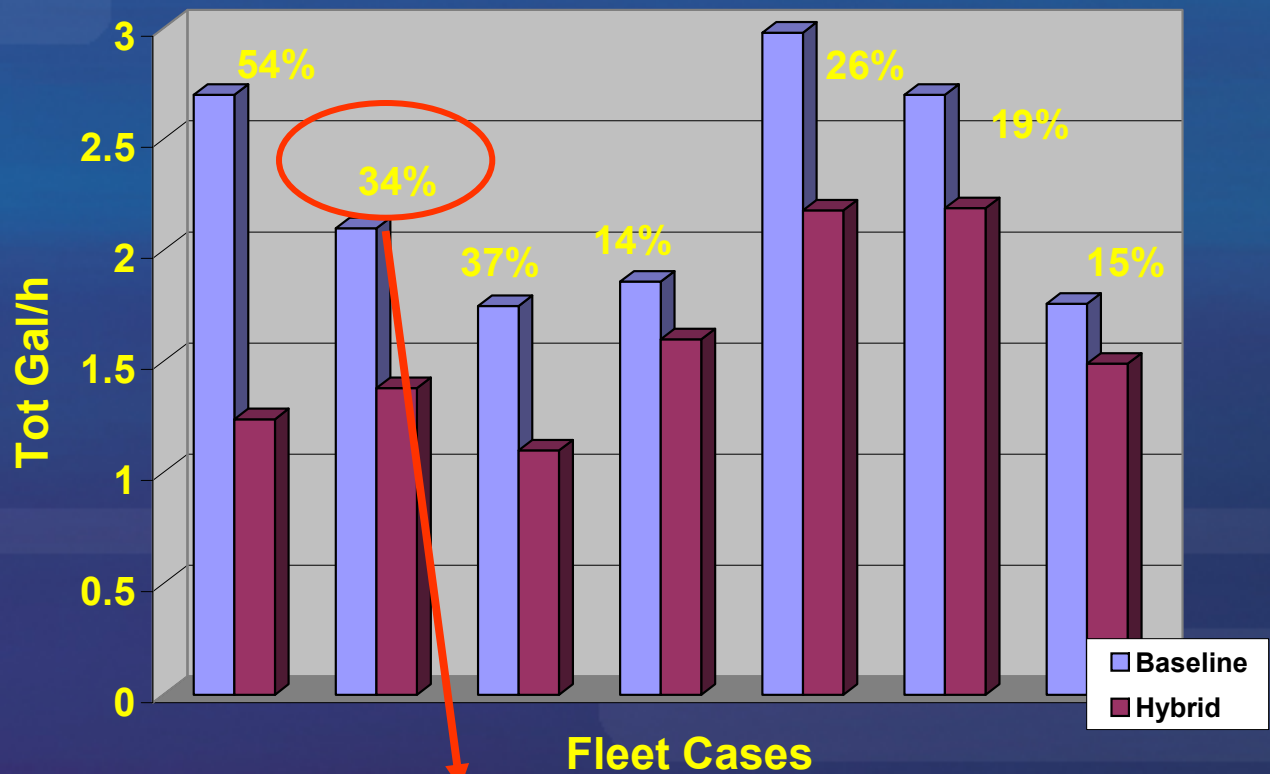
Application has lower boom hours than expected
Observing lots of idle time (measurement needs to be improved)



Overall Fuel Consumption Improvements

Improvements Total Gal/h

- Overall savings as high as 54%
- Total Gallons over Total Operation hours, capturing engine ON and OFF operation
- Dependant on duty cycle!



Decrease 2.1 to 1.4 gal/h totals fuel saving from 14.7 - 9.8 gallons, or 34%
Lab Testing savings from 12.5 - 7.5 gallons, or 40%



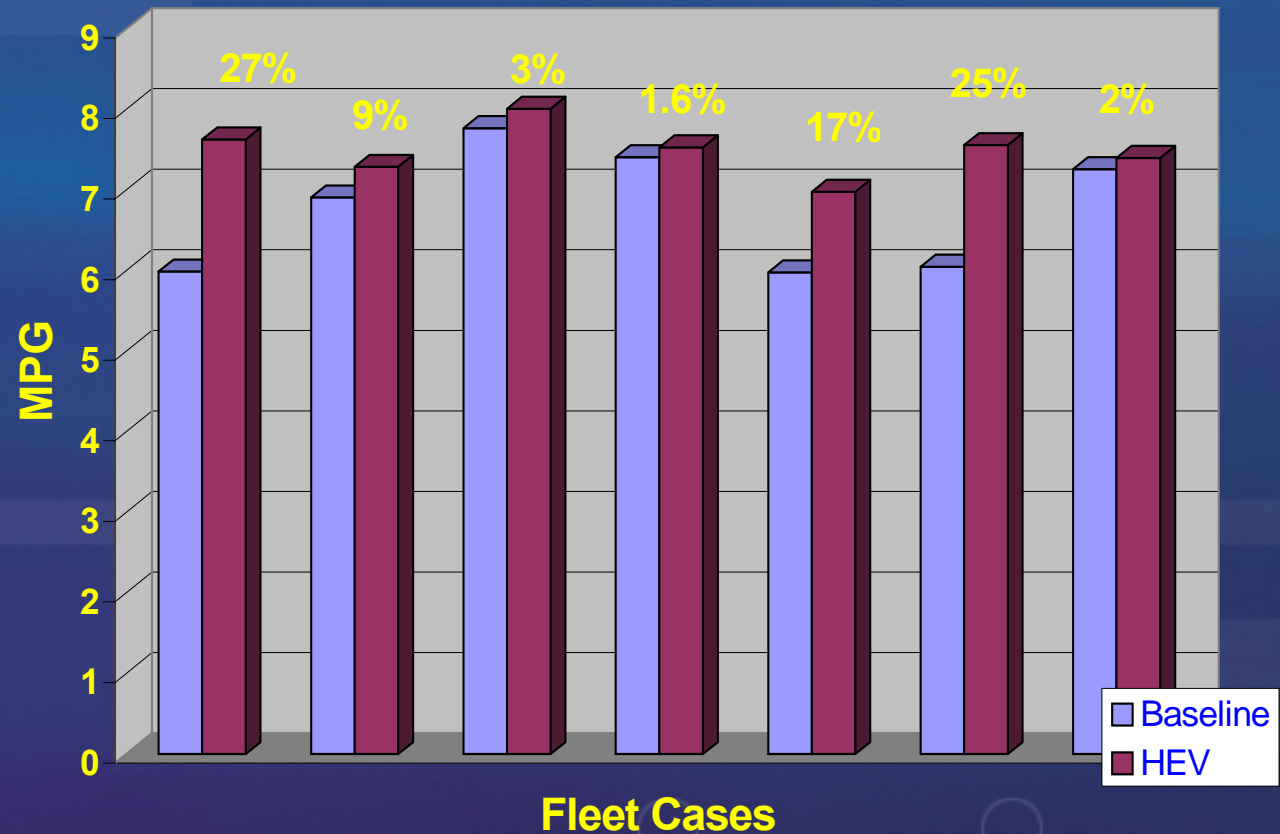
Driving MPG Improvements

1 -27% driving
MPG
improvement of
HEV

Testing data
26%

The trucks drive
daily ~70 miles
and use 80% of
fuel for driving.

Driving MPG Improvements





Truck Availability

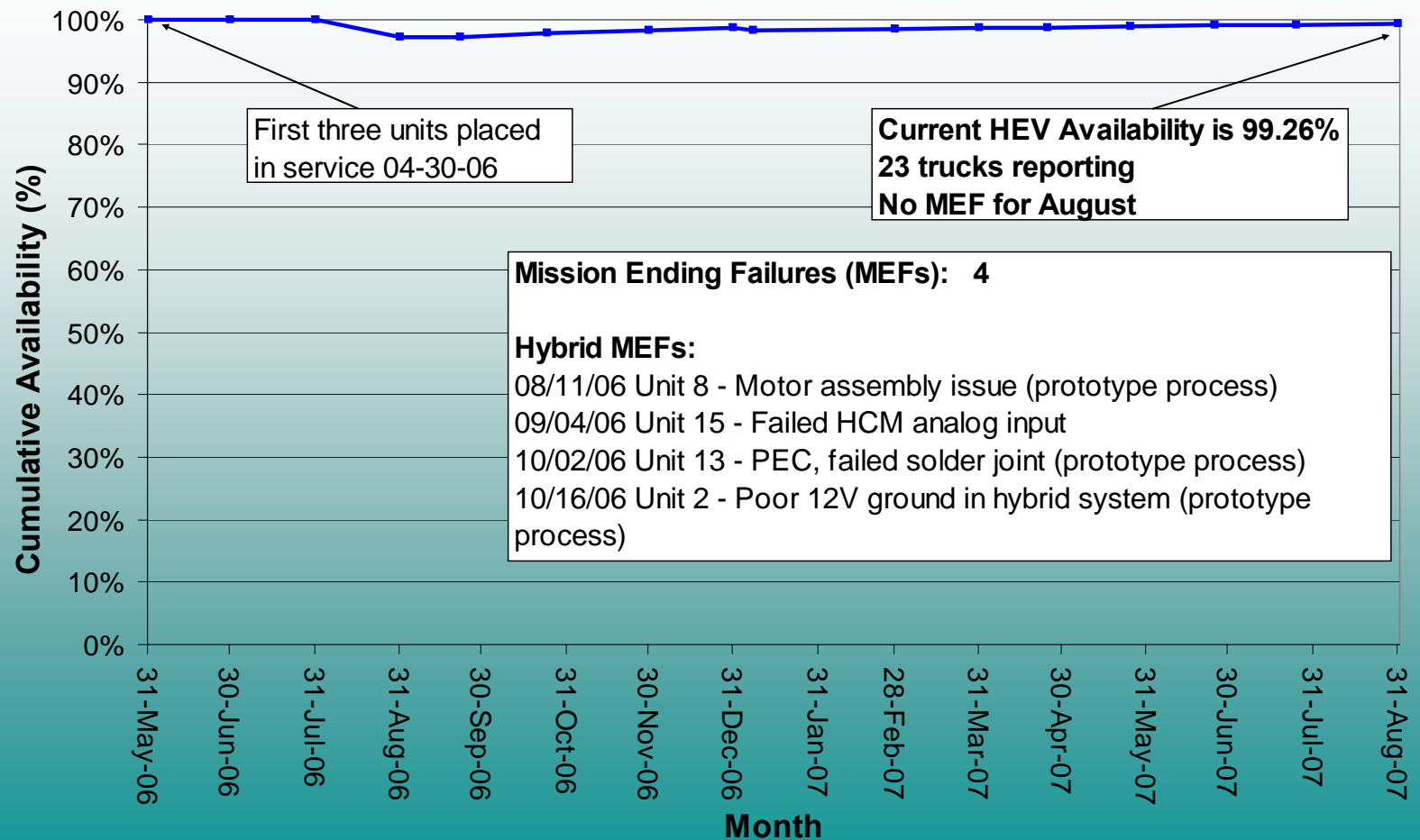
- What is **Availability**?
 - Industry measure of vehicle being available for revenue service
 - HEV Availability = Time vehicle is available for service. Hybrid system not preventing truck from being used.
- HEV Availability through August '07: 99.26 %
- 23 of 24 units eligible for reporting – in full service for more than 1 month (1 in fleet controlled testing)
- 391 Truck Months (Aug '07)
- 409,352 Miles Driven to date (Aug '07)



Availability of HEV System All Units

HTUF Field Trial: 391 Truck Months (as of 8/31/2007)

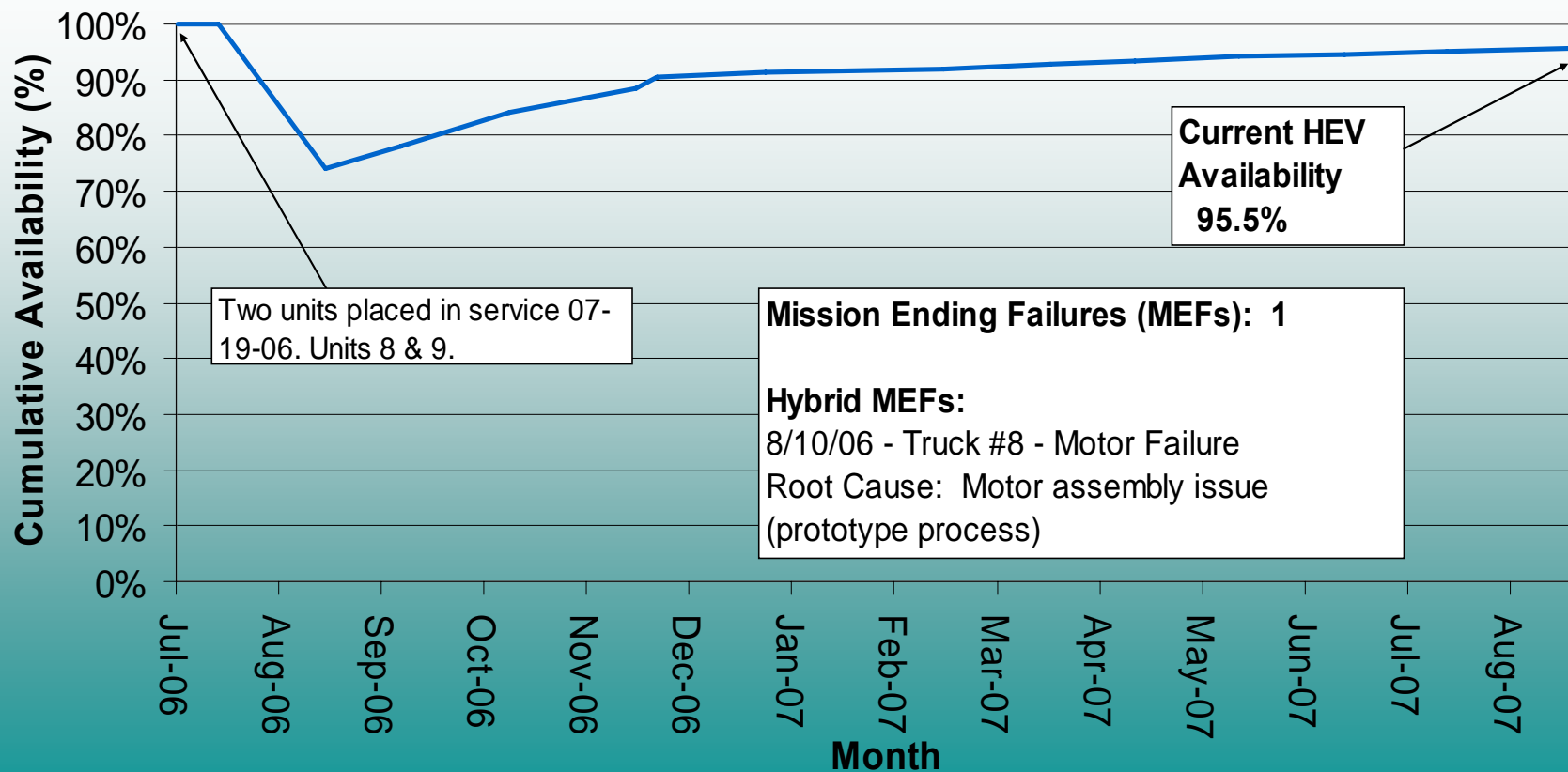
Majority of trucks show high availability!





Availability HEV- Case A

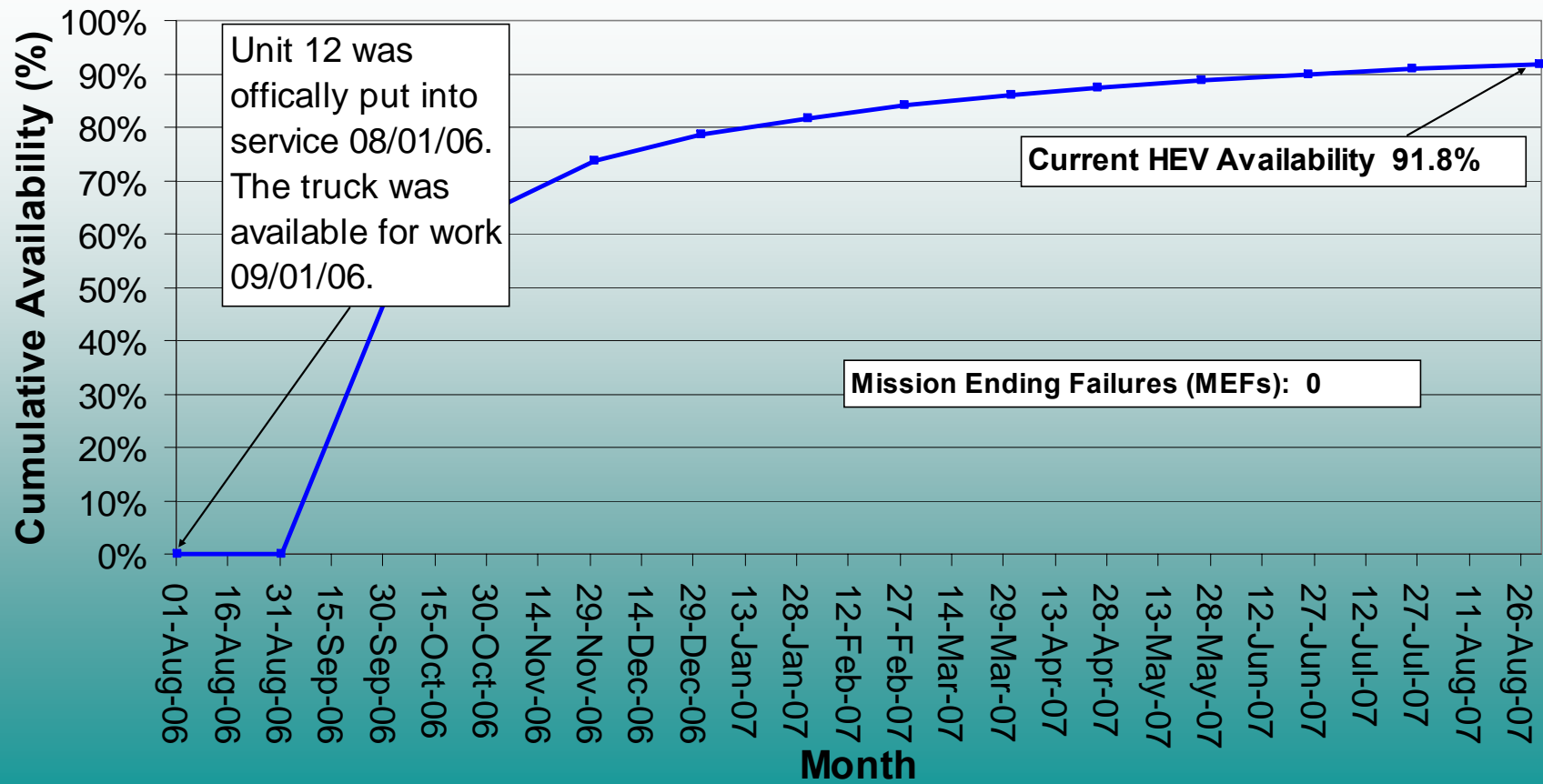
HTUF Field Trial: 23 Truck Months (as of 8/31/07)





Availability HEV- Case B

HTUF Field Trial: 12 Truck Months (as of 8/31/07)





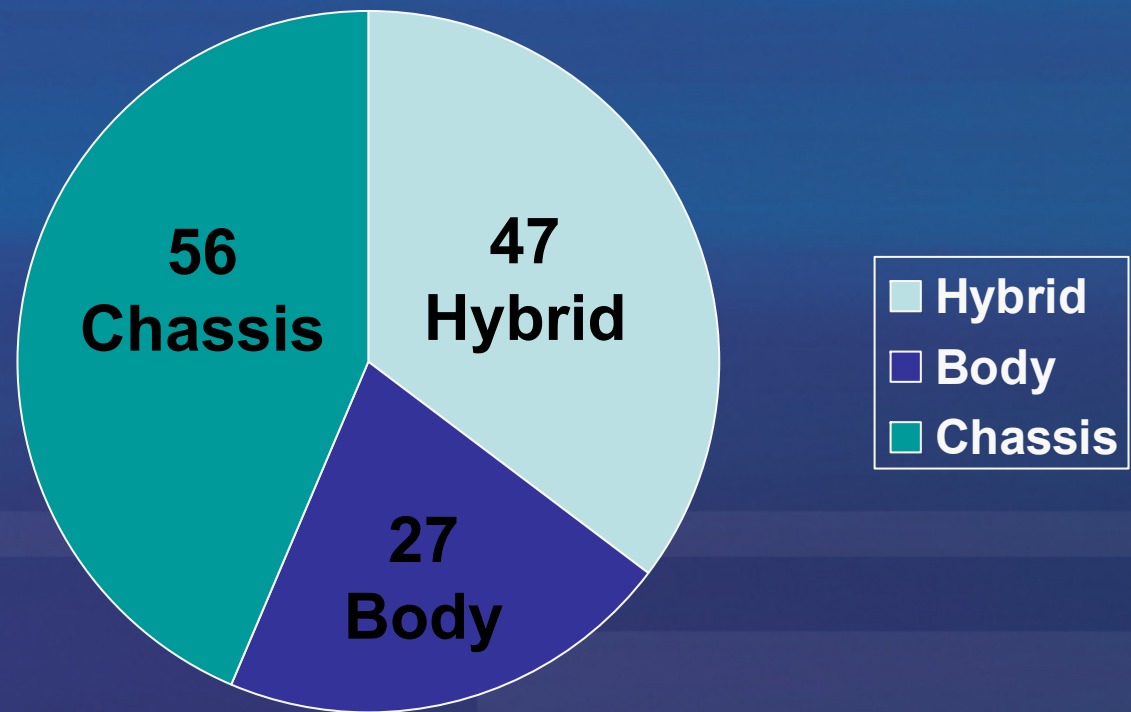
Reliability – Service Issues

- *What is Reliability?*
 - Component / System Reliability
 - Failures result in reduced reliability
 - Loss of Functionality results in reduced reliability
 - Tracked for production



Service Issues by Type

130 Total Field Issues
Logged
(May '06 - August '07)



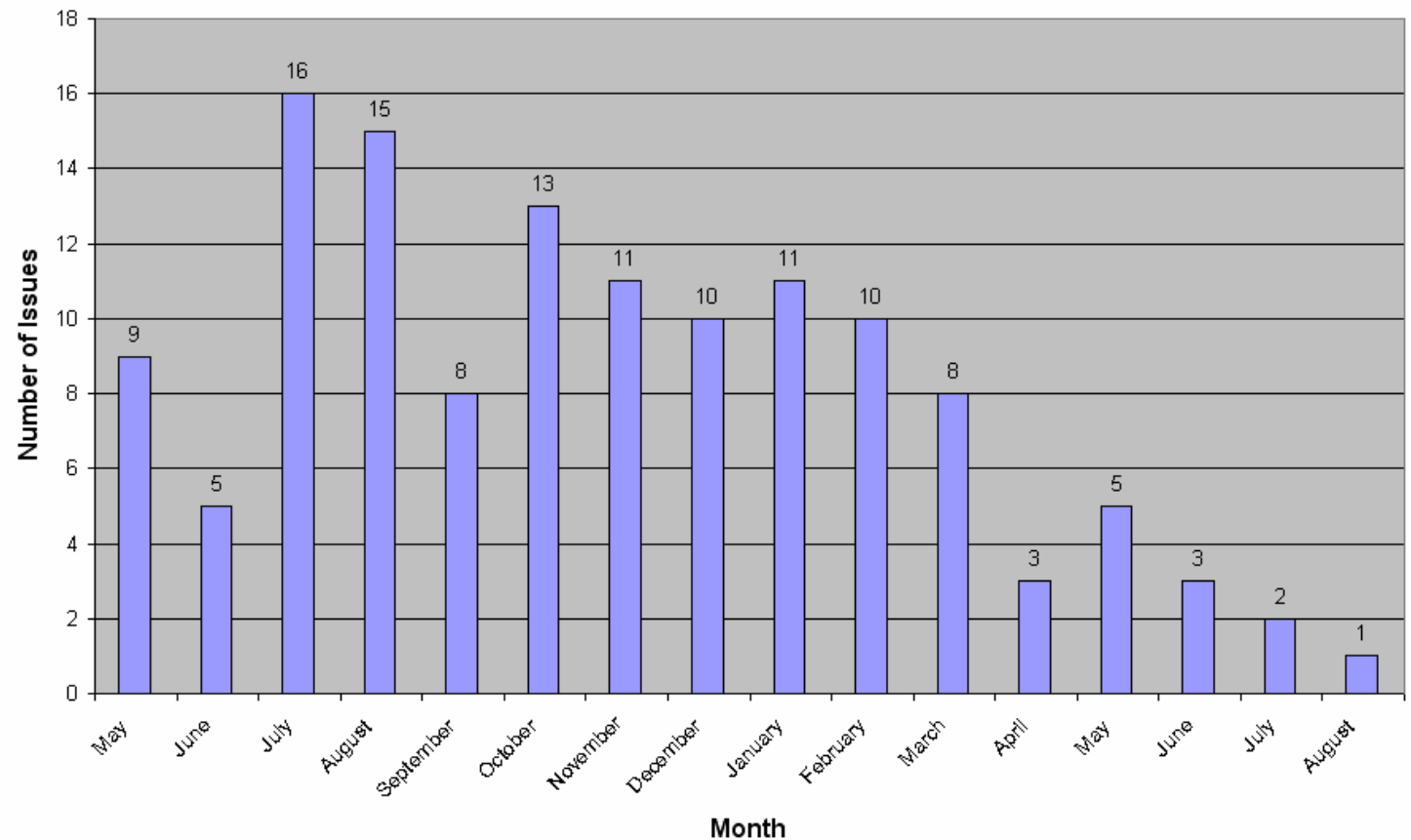
Courtesy Eaton & International



Issues Steadily Decreasing

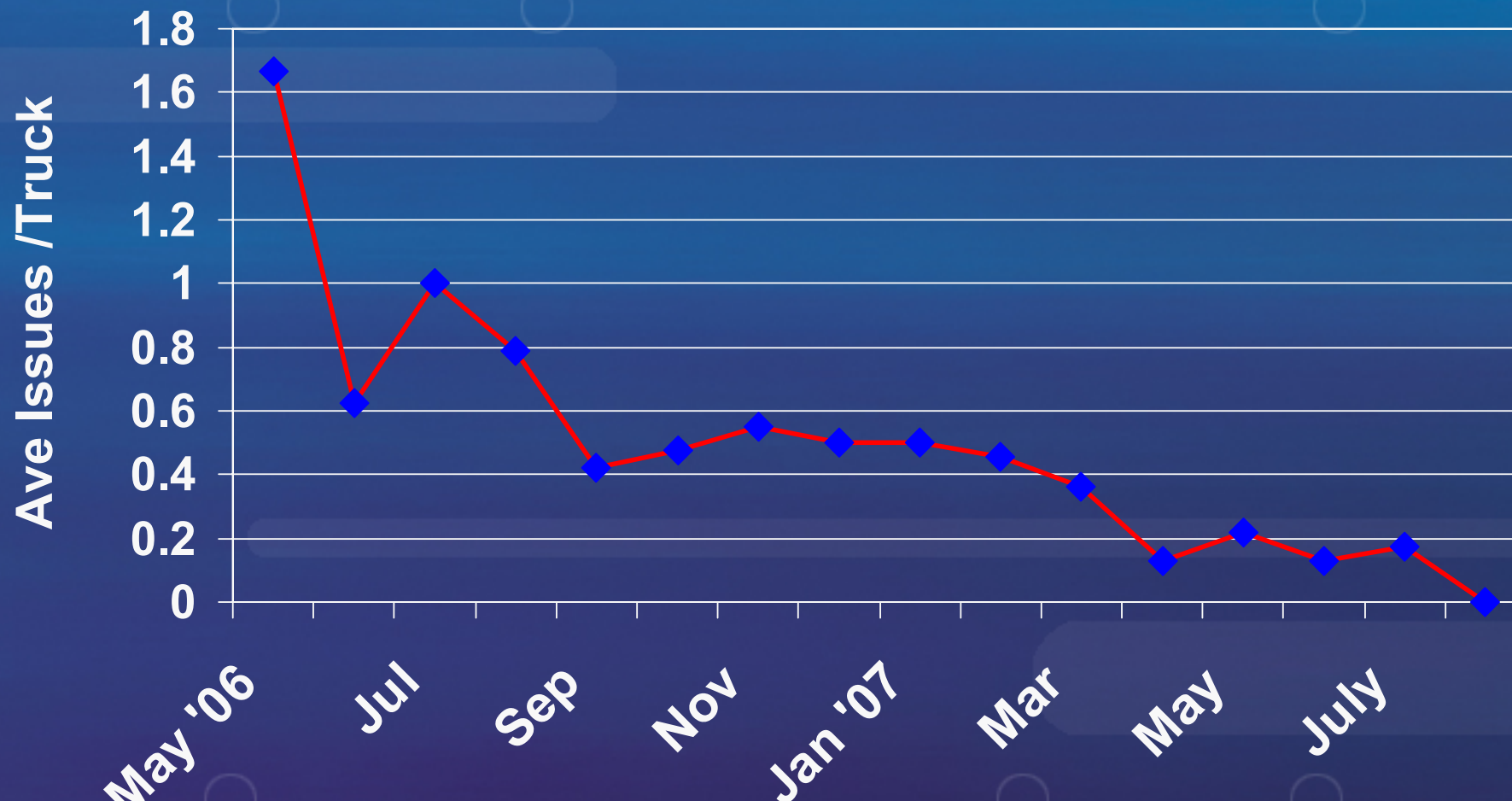
- Pilot issues folded into learnings
- Improvements incorporated into production release

Hybrid Vehicle Service Issues





Vehicle Issues Per Truck



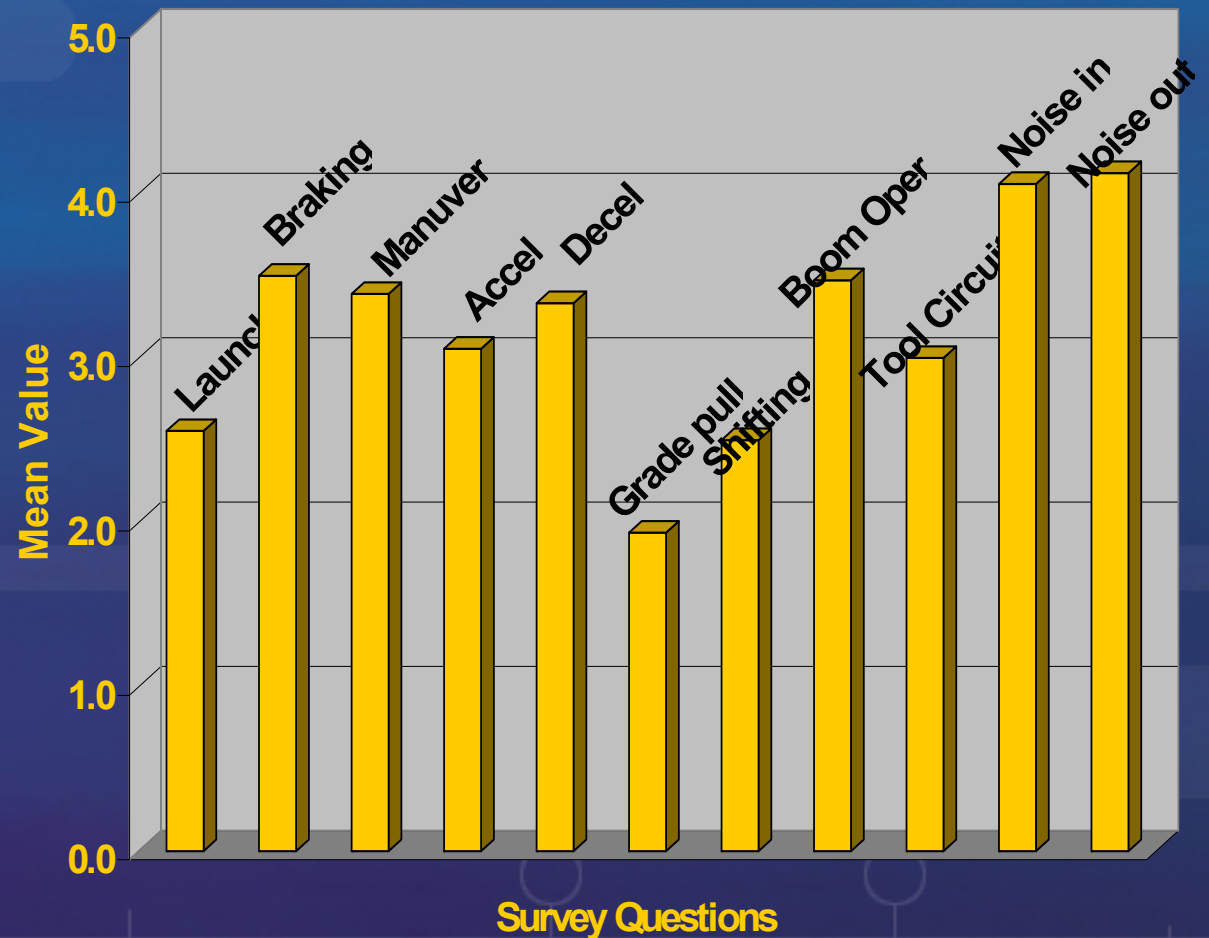
One issue per field test truck every two years!



Initial User Surveys ('06)

- 5 - much better
- 4 - somewhat better
- 3 - same
- 2 - somewhat worse
- 1 - much worse

- Comparative survey HEV to baselines
- 18 surveys collected
- Some baselines units have higher hp
- Most ratings better than baseline
- Goal was equal to or better than baseline

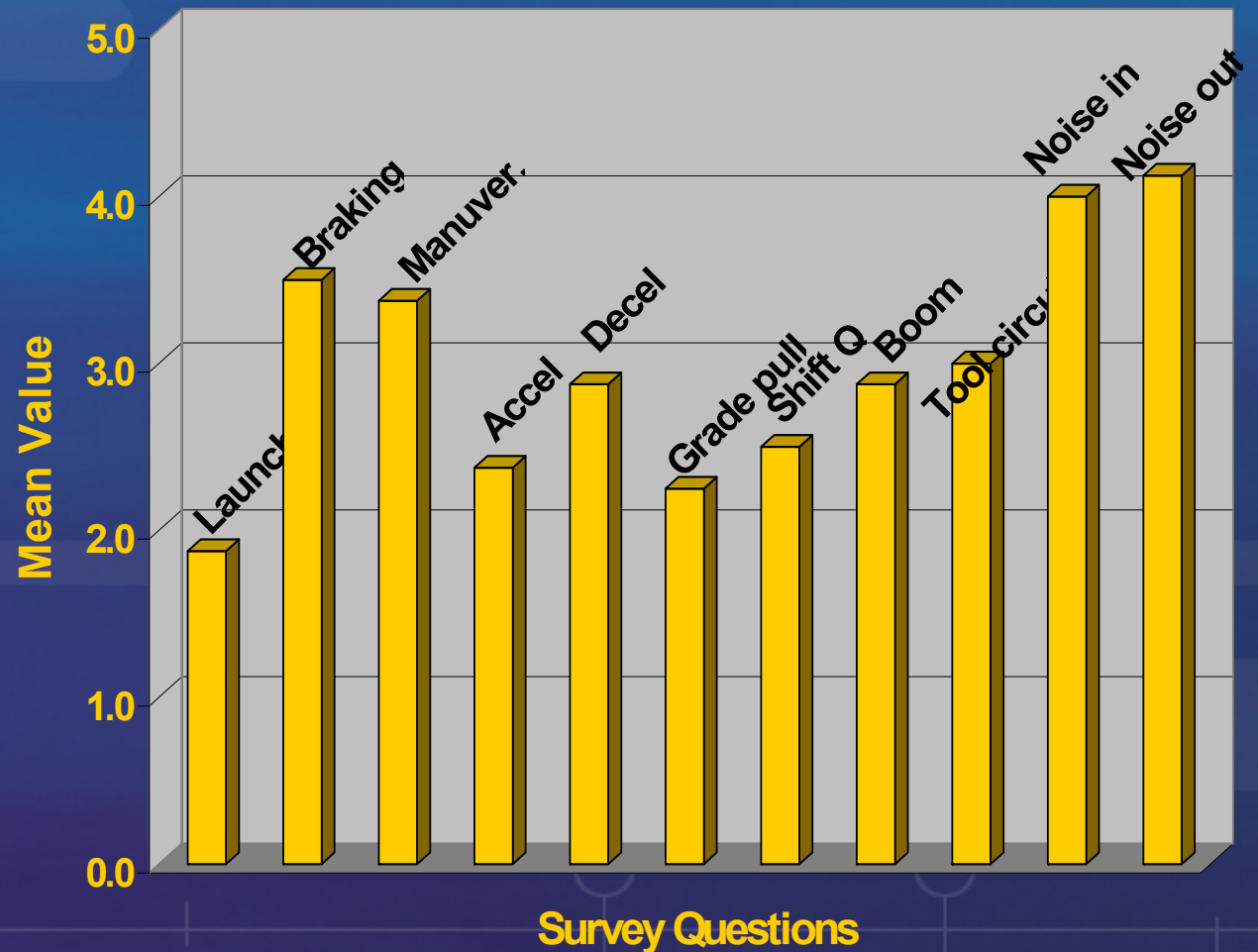




Surveys – Year Later ('07)

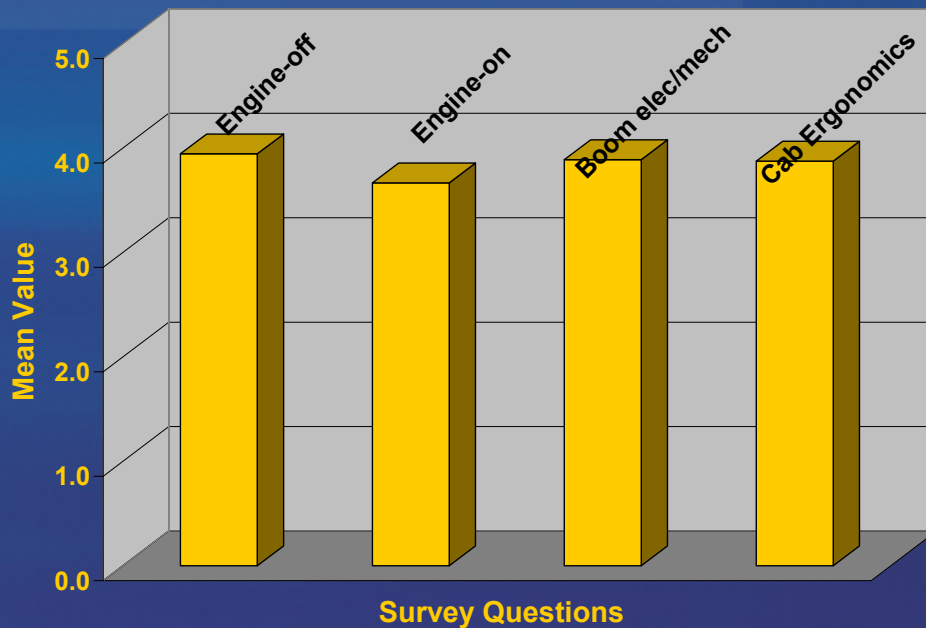
- 5 - much better
- 4 - somewhat better
- 3 - same
- 2 - somewhat worse
- 1 - much worse

- Results from 8 operator surveys
- Operators not always same

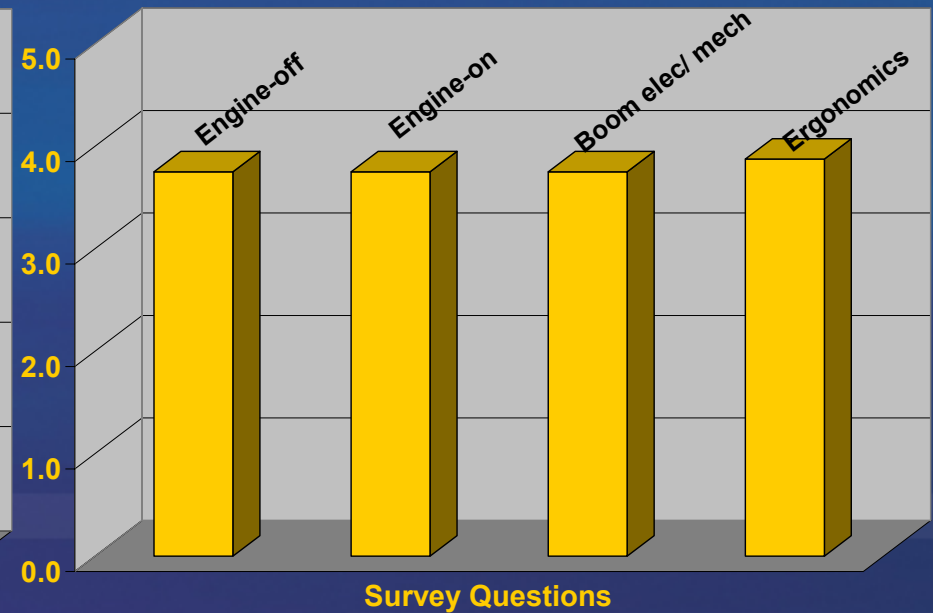




New Hybrid Features Rated “Very Good”



Initial Survey '06



Year Later '07

- 1 – 5 score
- New hybrid features rated “Very Good”



Conclusions

- **Number of issues decreased over time – great learning experience!**
- **HEV availability very high – 99%**
- **Truck are in applications which have lower than expected boom and PTO hours**
- **Majority of fuel used for driving ~80%**
- **HEV's showed fuel savings up to 54%**
- **Benefits in MPG for driving only range from 1-27% likely varying with driving duty cycle (speed, terrain, etc)**
- **Noise reduction benefits rated high**



Future Plans

- Continue data collection and validation
- Fleets considering placing trucks in service with higher boom and PTO hours & urban settings with lower mileage
- Duty cycle is very important – greater benefits when truck is in appropriate application
- Continue closer investigation of idle reduction opportunities



Team Effort!

Eaton:

Jeff Bosscher, Scott Davis, Eric Smith, Kevin Snow

International:

Ben Beverly, Jay Bissontz, Robert Dannenberg, Amy Farler, Michael Filler, Francisco Gutierrez, Randy Oetting, John Randal, VK Sharma, Scott Sine, Jim Williams

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