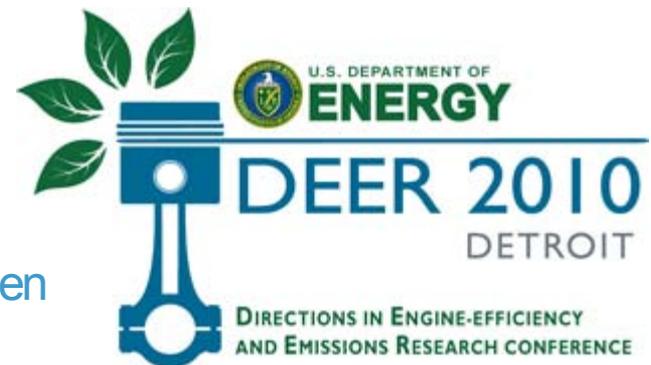# DAIMLER

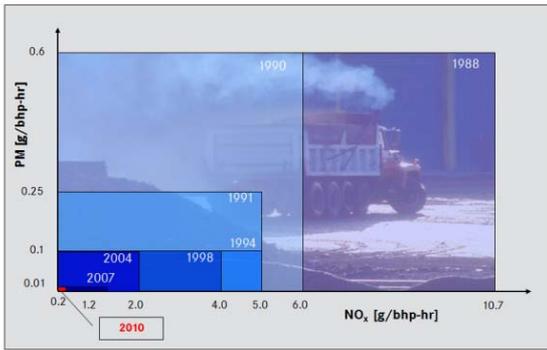# High-Efficiency Engine Technologies Session Introduction

Detroit, Sept. 29th 2010

Derek Rotz, Rakesh Aneja, Mark Groeneweg,
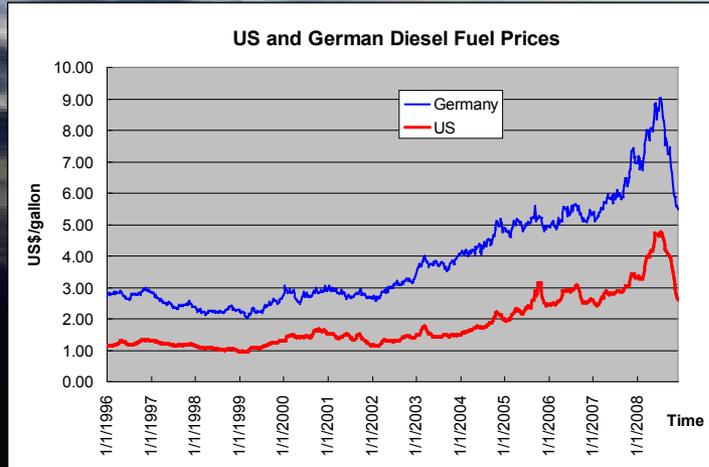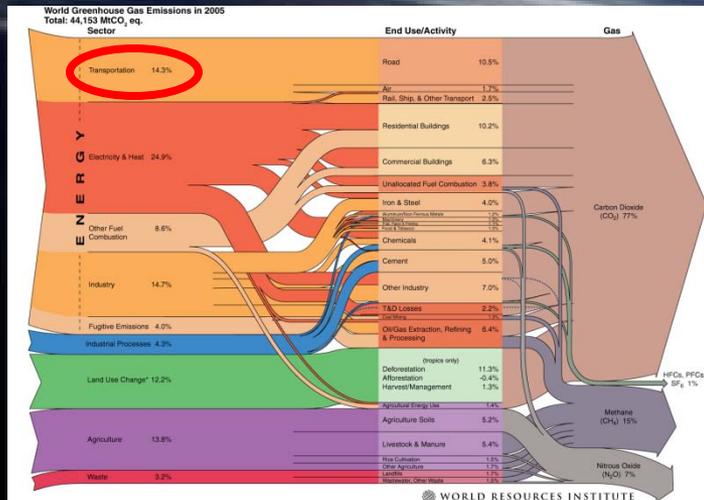David Kayes, Alan Pearson, Sandeep Singh, Kevin Sisken

U.S. DEPARTMENT OF ENERGY

DEER 2010 DETROIT

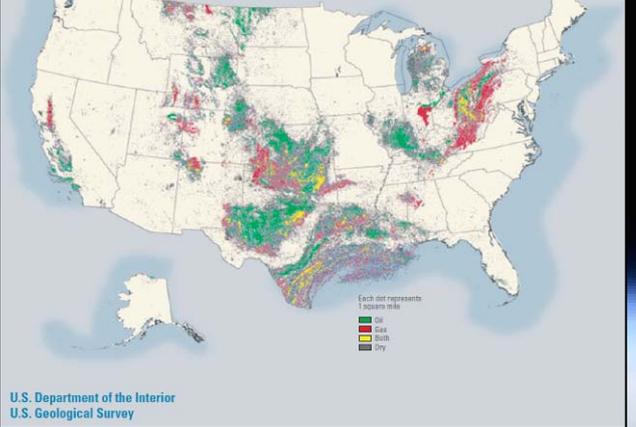**DIRECTIONS IN ENGINE-EFFICIENCY AND EMISSIONS RESEARCH CONFERENCE**

SuperTruck Team

DAIMLER

Changed priorities - Transition from emission regulations to CO_2 footprint & fuel economy


EPA Emission standards 1988 to 2010

2007: DPF, ULSD
2010: SCR
2002: EGR

Oil and Gas Exploration in the United States (1998)

U.S. Department of the Interior
U.S. Geological Survey

World Greenhouse Gas Emissions in 2005

US and German Diesel Fuel Prices
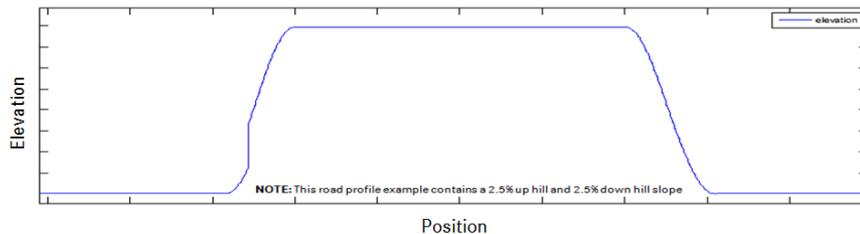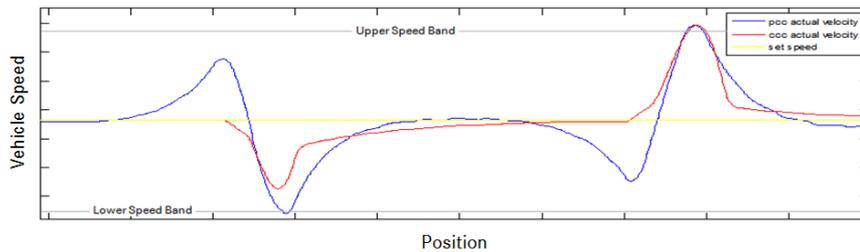
Predictive Technologies

- Enables the truck to "<u>see</u>" the road that lies ahead

  - Uses on-board GPS and 3D digital maps

  - 'S*ees*' upcoming hills in advance

- Enables vehicle systems to be optimized for fuel economy

- Where can Predictive Technologies be used?

Predictive Technologies Roadmap
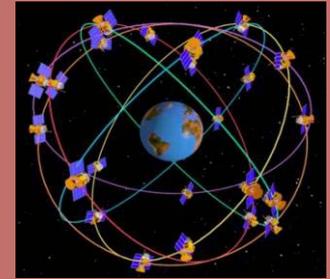
Predictive Technologies Roadmap

- Evaluates 2 kilometers of up-coming road grade
- Optimizes desired cruise speed to save fuel
- Maximum of 6% deviation from set speed
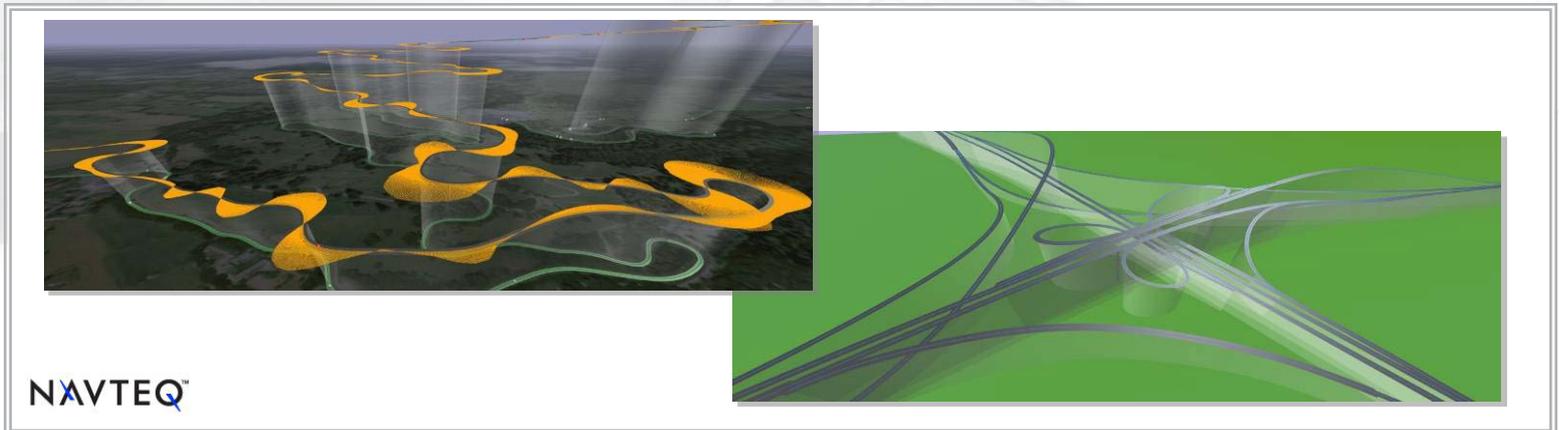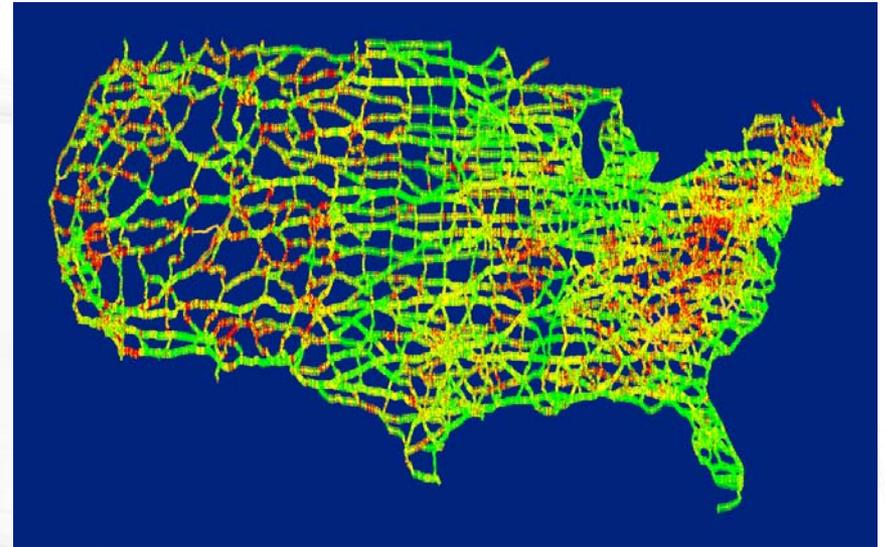

Predictive Engine Controls

Predictive Trans. Controls

Predictive Hill Detection

Predictive Curve Detection

3D Digital Map Database

- High precision positioning and terrain data

  - Longitude, Latitude

  - Heading, Slope

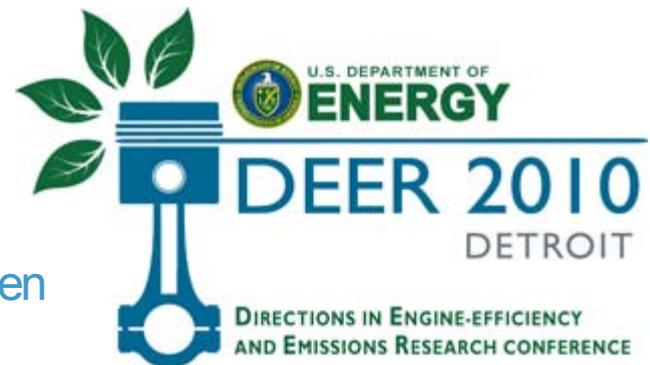- Covers over 200,000 highway miles in the continental 48 US states

NAVTEQ

DAIMLER

Scoping Plans for 50% Improvement in Class 8 Freight Efficiency

Detroit, Sept. 29th 2010
Derek Rotz, Rakesh Aneja, Mark Groeneweg,
David Kayes, Alan Pearson, Sandeep Singh, Kevin Sisken

U.S. DEPARTMENT OF
ENERGY
DEER 2010
DETROIT
DIRECTIONS IN ENGINE-EFFICIENCY
AND EMISSIONS RESEARCH CONFERENCE

SuperTruck Team

# Department of Energy Super Truck Project Overview

Project objectives

Develop and demonstrate vehicle and advanced engine technology for Heavy-Duty Class 8 Trucks as follows:

- Demonstrate 50% improvement in Freight Efficiency (65,000 lbs CVW)

  - Including 50% Engine Brake Thermal Efficiency
  - Modeling and analysis for pathway to 55%

Funding

- Federal awards: $39.6M (+ $40M Daimler matching) over 5 years
- Pairing with partners or subcontractors encouraged
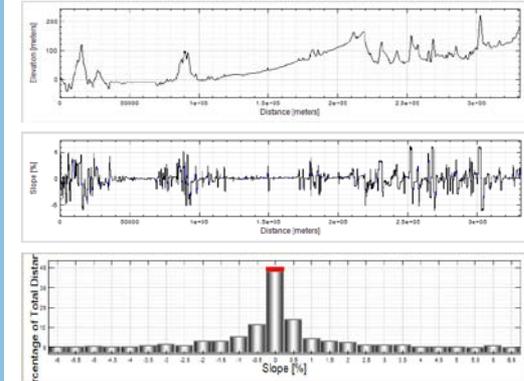
Determinants of Freight Efficiency
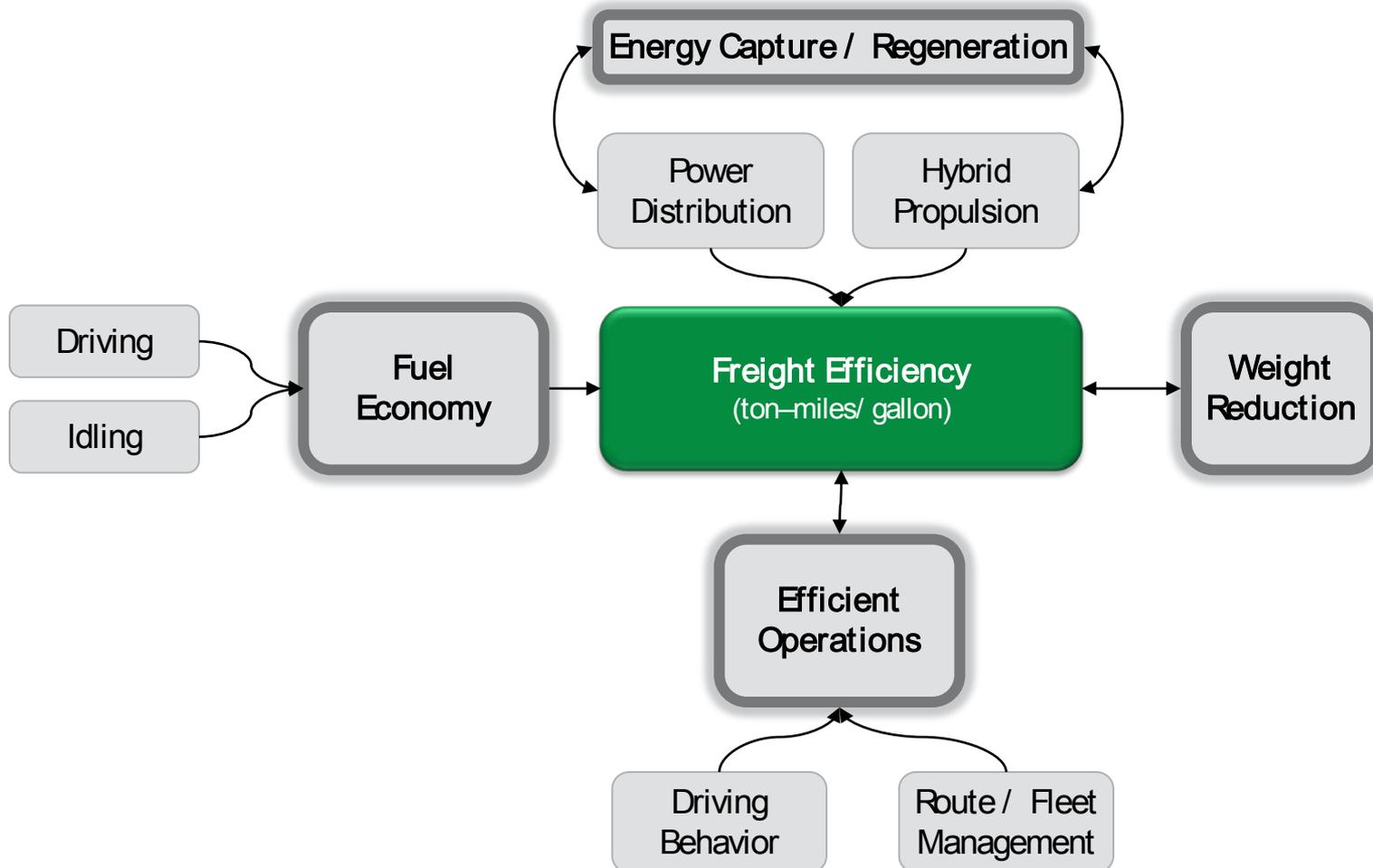
Criteria to Guide Test Cycle Definition

Traffic Density

Tons (Millions)
1 - 3.75
3.75 - 7.5
7.5 - 15
15 - 30
30 - 60
60 - 315

Terrain

-5 .. -3	-3 …-1	-1 …+1	+1 …+3	+3 …+5
3%	11%	68%	10%	3%

SuperTruck Requirements

- ≥ 75% Highway / Freeway Cycle
- ≤ 25% City Cycle
- Idling : 5/ 12 total test cycle duration

Hours of Service

Property-Carrying CMV Drivers

11-Hour Driving Limit
May drive a maximum of 11 hours after 10 consecutive hours off duty.

14-Hour Limit
May not drive beyond the 14th consecutive hour after coming on duty, following 10 consecutive hours off duty. Off-duty time does not extend the 14-hour period.

60/70-Hour On-Duty Limit
May not drive after 60/70 hours on duty in 7/8 consecutive days. A driver may restart a 7/8 consecutive day period after taking 34 or more consecutive hours off duty.

Sleeper Berth Provision
Drivers using the sleeper berth provision must take at least 8 consecutive hours in the sleeper berth, plus a separate 2 consecutive hours either in the sleeper berth, off duty, or any combination of the two.
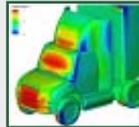
Speed Limits

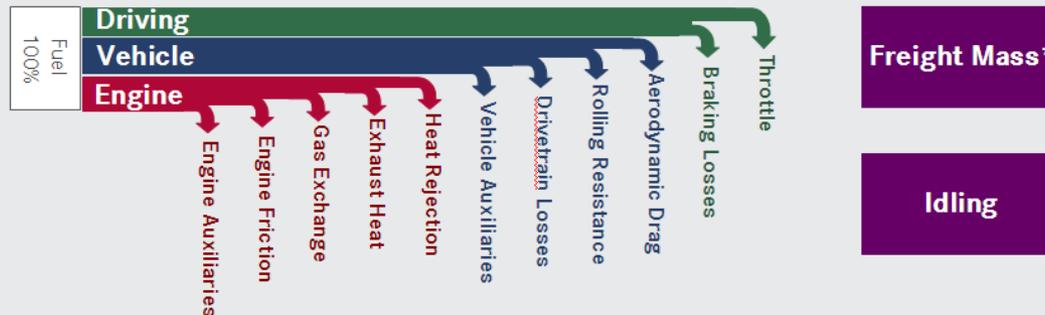Maximum Truck Speed Limit (mph)
55 60 65 70 75
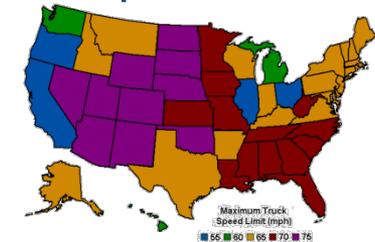
Source: FHWA, Freight Facts and Figures 2008

Target Setting Process
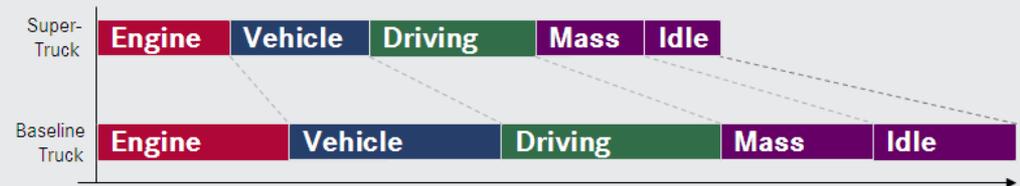

Component, System & Vehicle Measurements

Energy Balance Framework (simulation)
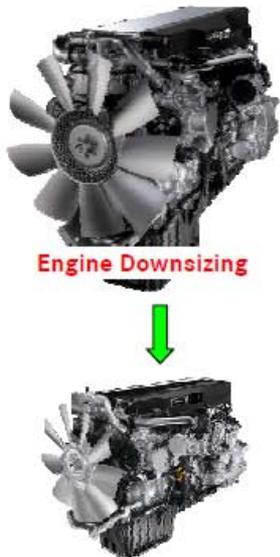
Fuel 100%

Driving
Vehicle
Engine

Engine Auxiliaries
Engine Friction
Gas Exchange
Exhaust Heat
Heat Rejection
Vehicle Auxiliaries
Drivetrain Losses
Rolling Resistance
Aerodynamic Drag
Braking Losses
Throttle

Freight Mass*

Idling

SuperTruck Targets

	Engine	Vehicle	Driving	Mass	Idle
Super-Truck	Engine	Vehicle	Driving	Mass	Idle
Baseline Truck	Engine	Vehicle	Driving	Mass	Idle

Technology Assessment

Freight Efficiency

Economics

Reliability/ Durability

Vehicle Integration

SuperTruck

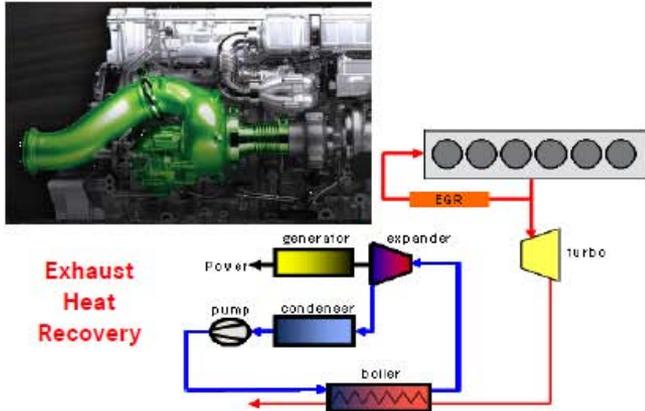Market

Boundary Conditions

Safety / Regulatory

Manufacturability / Serviceability

Maturity

8 Cross-Functional SuperTruck Workstreams

Predictive Technologies

Engine Downsizing & Hybrid

Powertrain Integration

Engine

Energy Management

Packaging, drivability, weight distribution

Waste heat Recovery

Parasitic Losses

Aerodynamics

Weight Reduction

Engine Technology & Integration

Exhaust Heat Recovery

Optimized Combustion

APCRS

Engine Downsizing
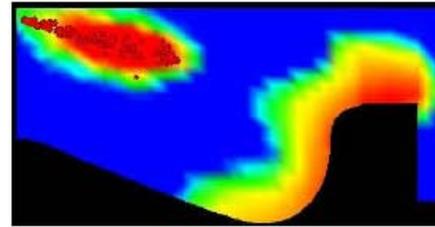
Optimized Aftertreatment

Next Generation Controller
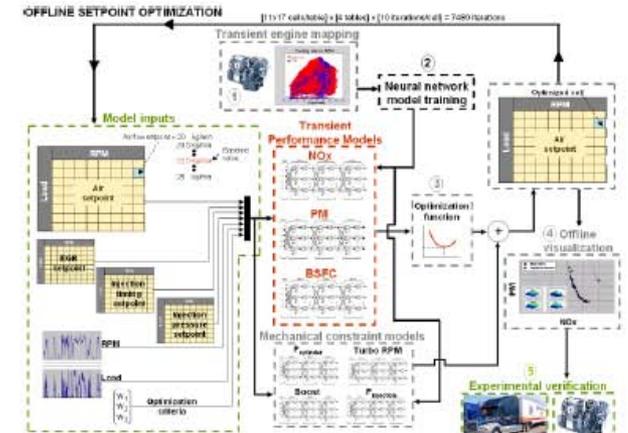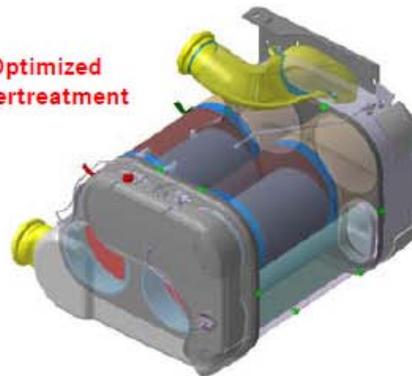
Tractor & Trailer Aerodynamics

Full Scale
Wind Tunnel

Scale Wind
Tunnel

Aerodynamics
Competencies

Computational
Fluid Dynamics

Fuel Economy
Testing
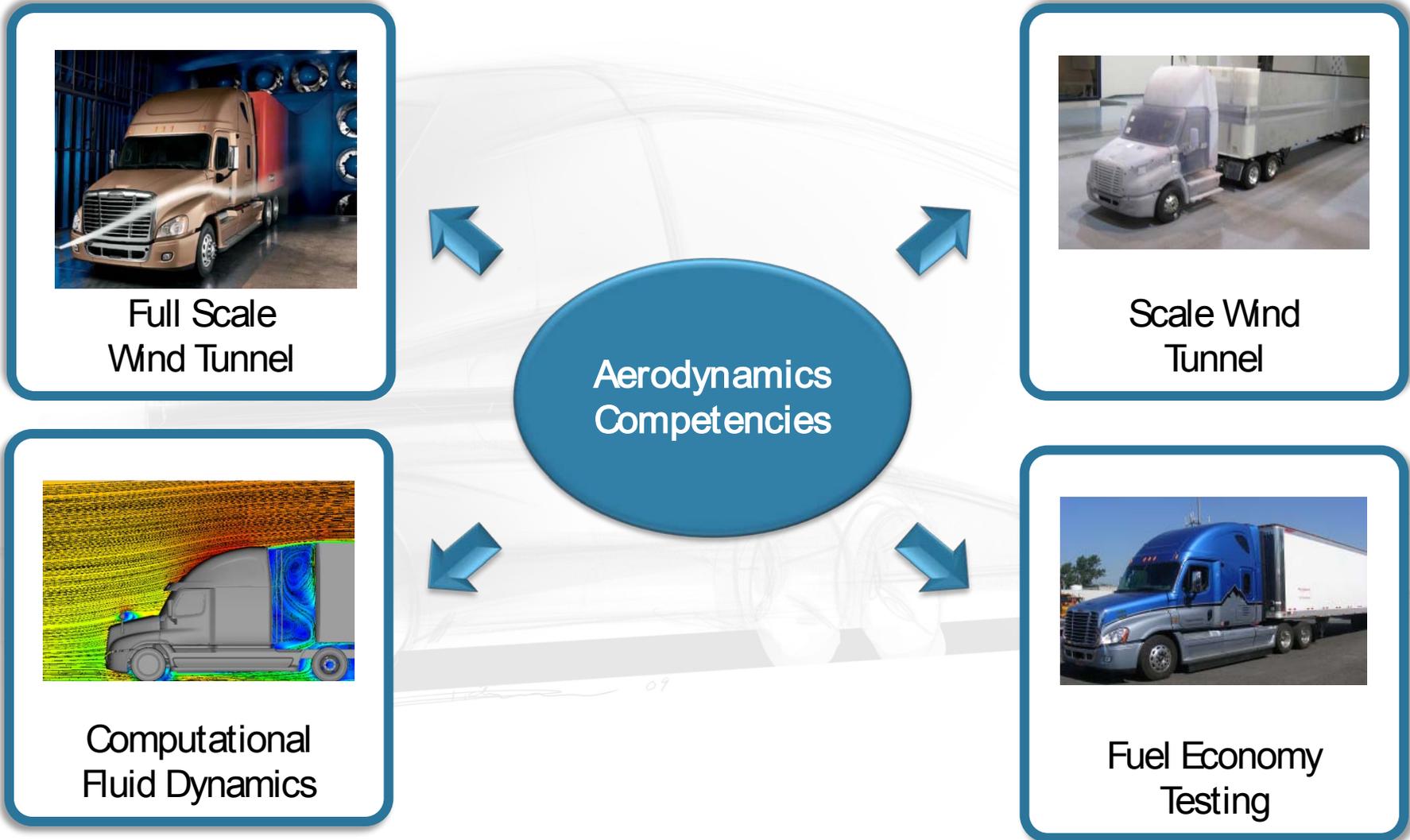
Tractor-Trailer drag development: significant trailer contribution
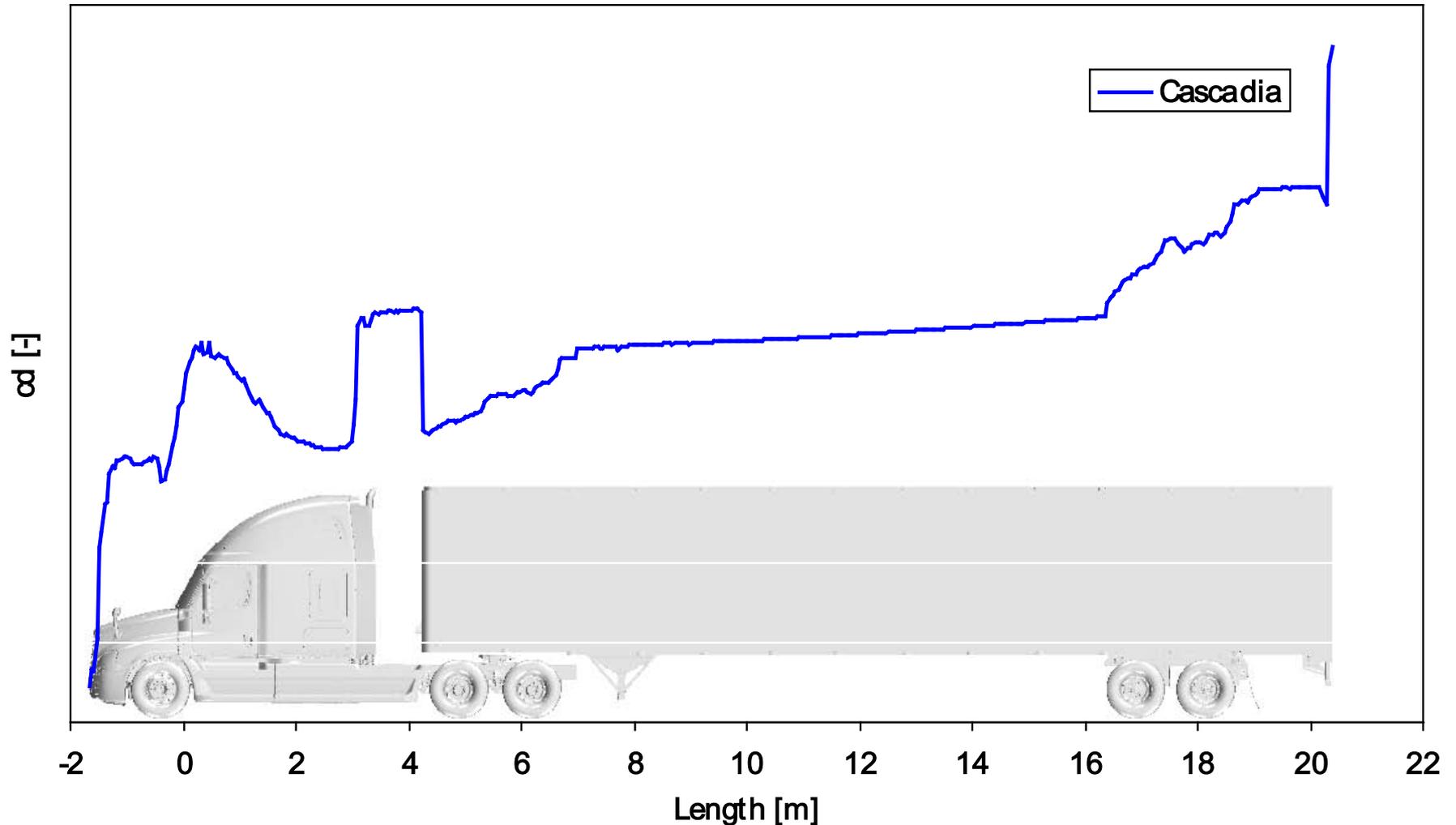
Hybrid Electric Technology

E-Machine on
Engine Output

E-Machine on
Transmission Input

E-Machine on
Transmission Output

E-Machine on
separate axle or PTO

Drive Cycle Profile / Application

Hybrid System / Vehicle Specification
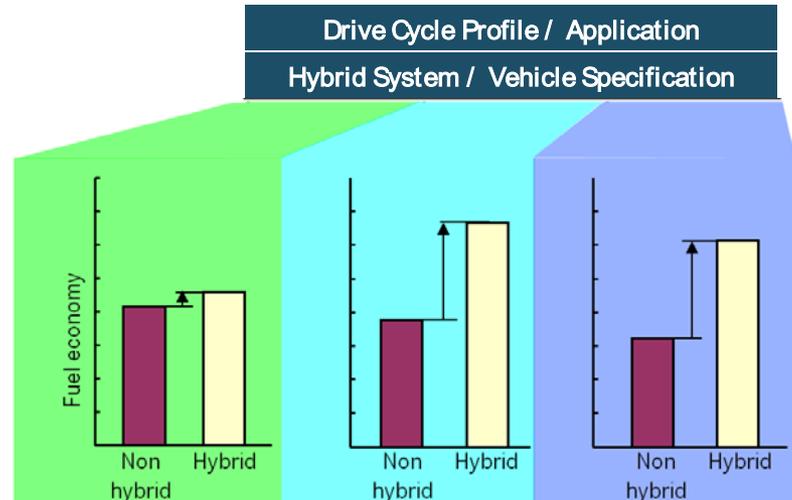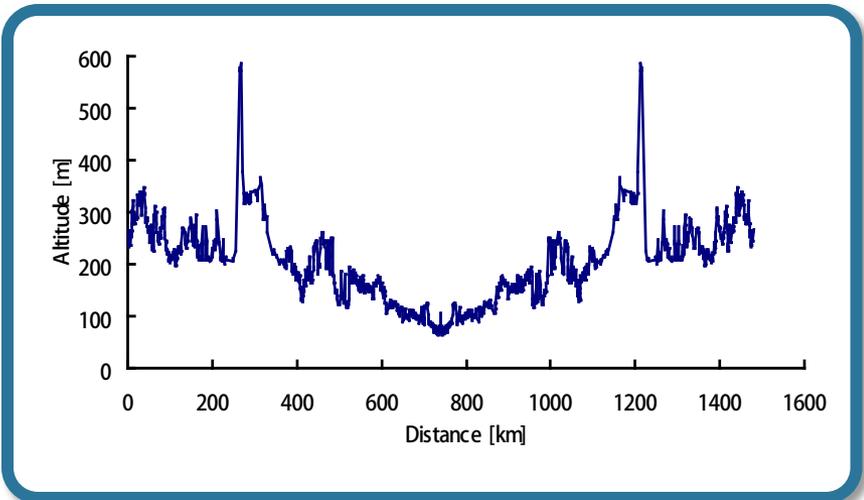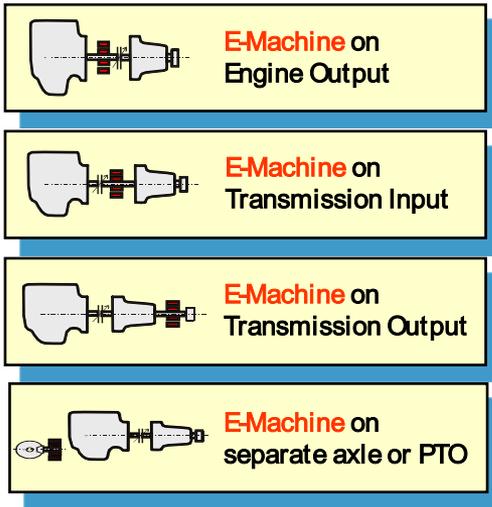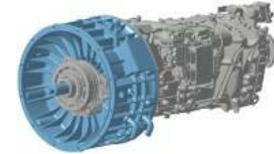
Determinants Class 8 Hybrid Performance:

- Hybrid layout dependant
- Varies by drive cycle, terrain
- Maximized by broad feature set (regen., start/ stop, WHR)
- …

Acknowledgements

- Department of Energy Headquarters
  - Gurpreet Singh
  - Roland Gravel

- National Energy Technology Laboratory
  - Carl Maronde
  - Jeffrey Kooser