



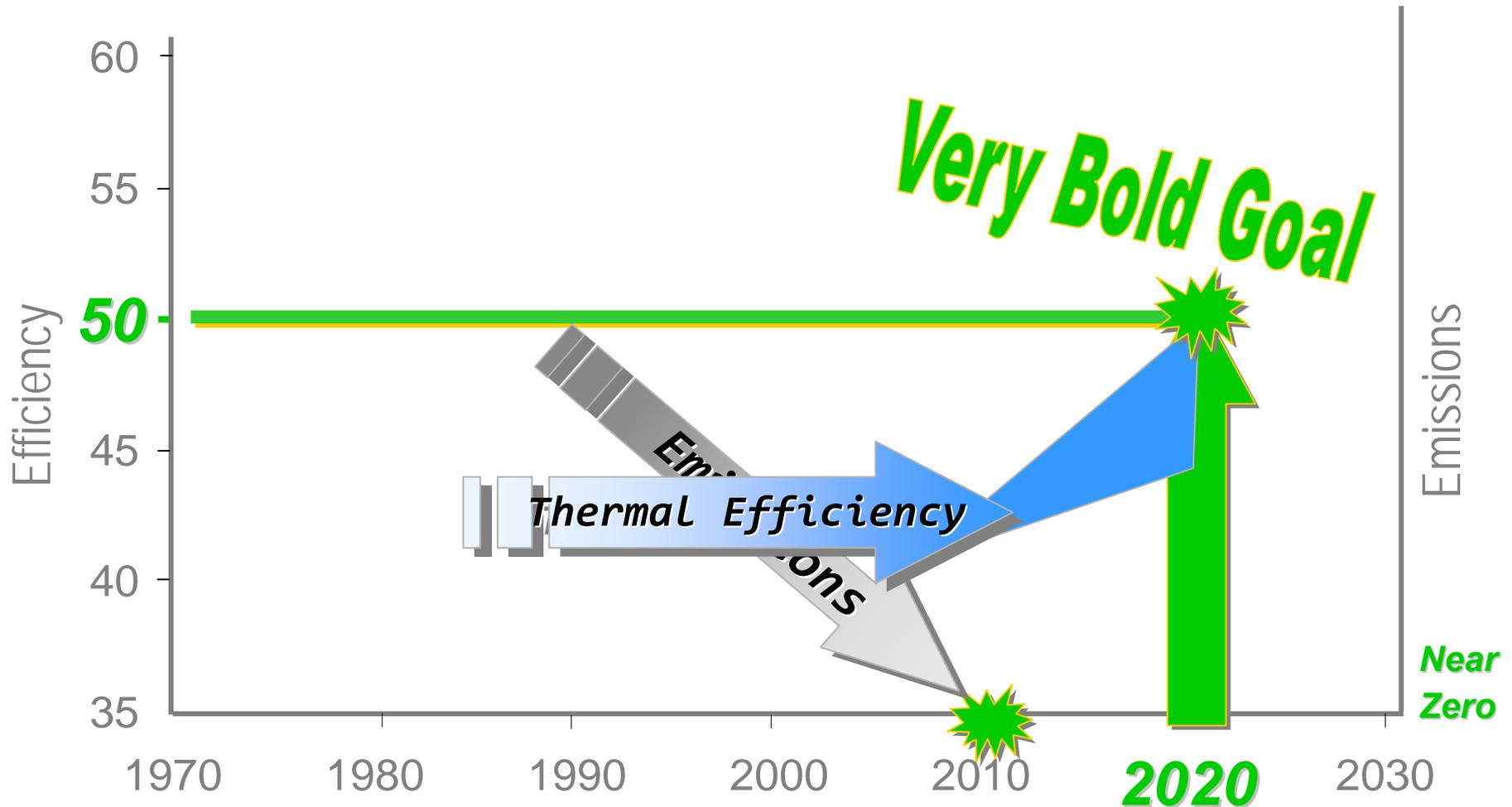
Efficiency Improvement Pathway

Terry Goff
Director Emission Regulations &
Conformance
Caterpillar Inc.



DEER Conference
Dearborn, MI
August 3, 2009

Efficiency and Emissions Progress- Diesel Engines



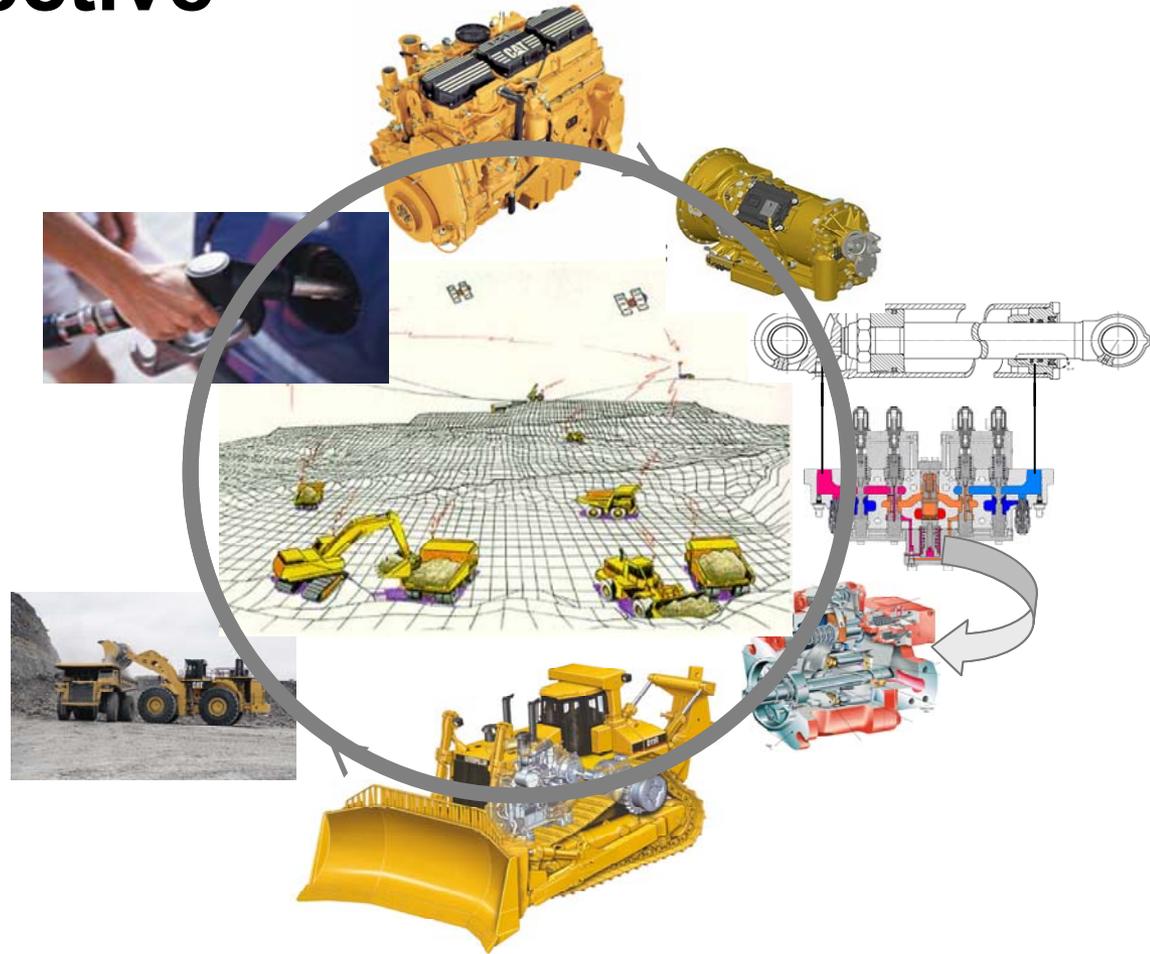
Core Caterpillar GHG Reduction Positions

- **Purpose-designed legislation needed at economy-wide & national levels**
- **International alignment necessary**
- **National Climate and Energy Policies must align**
- **Economic action at the highest practical level drives innovation & optimal solutions**

Core Caterpillar GHG Reduction Positions

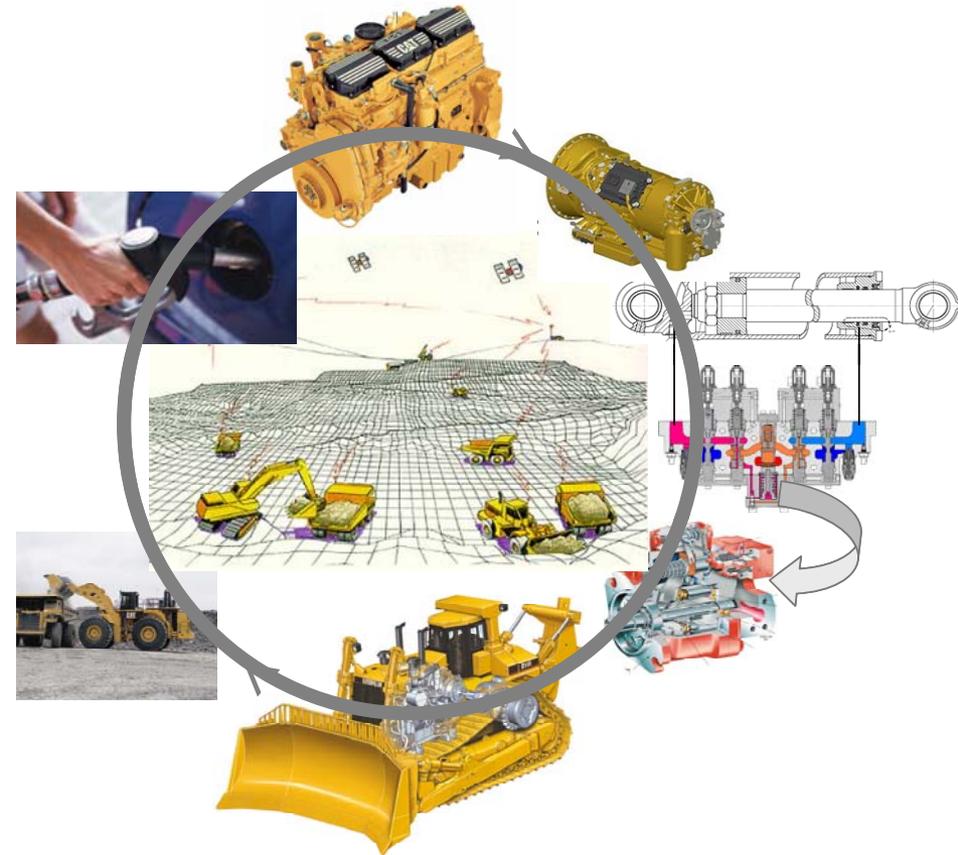
- **Sound science, consistency, transparency, robust stakeholder input, lead-time and stability**
- **Clear government agency boundaries to avoid duplication & conflicting regulations**
- **The “Pareto” principle (the 80/20 rule) should drive prioritization & investment**

Systems Perspective



Systems Perspective ...Why?

- Enormous diversity and complexity in the world of non-road machines
- Machines need to perform many different functions
- Efficiency and productivity usually measured on a “work performed” basis at the job- site level



Caterpillar Energy & Sustainability

Four Areas of CO2 Opportunity

Energy Sources
Up to 100%



Zero Net Carbon Fuels

Job Site

+10-30% Efficiency



Move the Dirt Once

Machine

+10-20% Efficiency



System Optimization

Engine

+5-10% Efficiency



New Combustion Technologies

D7E

First of its Kind with Electric Drive

Machine Efficiency

50% less
operator noise

50% better
steering performance

10% lower
lifetime operating costs

Easier to operate

No shifting
Low-effort controls

Less fluids used

35% more
visibility

35%–70% lower
owning & operating costs with
SystemOne™ undercarriage

10% more
material moved per hour

Up to 20% less
fuel consumed per hour

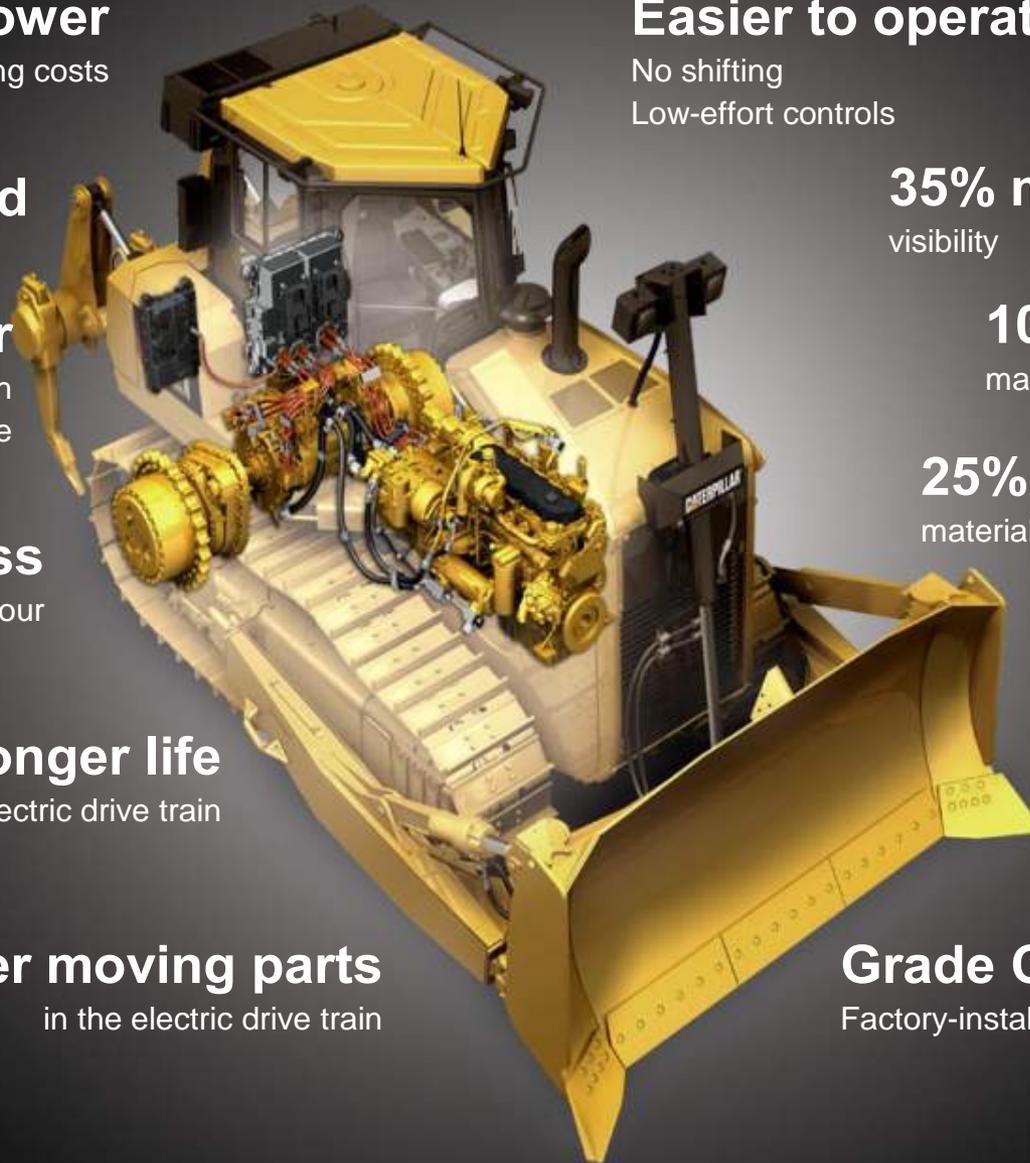
25% more
material moved per gallon of fuel

Up to 50% longer life
for the electric drive train

Less down time
No engine belts

60% fewer moving parts
in the electric drive train

Grade Control Ready
Factory-installed AccuGrade® ARO



Job Site Efficiency

✓ **D10 Utilizing Computer Aided Earthmoving System (CAES)**



✓ **Caterpillar's AccuGrade® GPS System for Road Construction**



✓ **Caterpillar's MineStar® Fleet Commander**



Focus on Fuel

✓ **Zero Net Carbon Diesel Fuel supported by robust Life Cycle Analysis**

✓ **Price for carbon drives innovation in Fuels, Machines, & Total Integrated Systems**

✓ **Technology Neutral**

✓ **Globally Consistent Standards**



Critical Non-Road Technical Approaches

- **Efficient Power Trains and Energy Conversion Systems - including "tank to tracks" approaches, heat recovery, & energy storage**
- **Adaptive and System Controls - including Autonomy, behavioral, operator assist, machine to machine and site level logic**
- **Alternative Low (or zero) Carbon Power sources - including alternative fuels, power sources and mobile sequestering**

The Path Forward

- **No simple solutions ... only intelligent choices**
- **Regulation alone will not create optimized Solutions**
- **Technological solutions hindered by current economic reality & competing needs**

The Path Forward

- **Government / Academic / Business Collaborative efforts must be expanded**
- **Commercially viable transformational innovation must be the goal**
- **Caterpillar supports expansion of the DOE Vehicle Technology Program to include an explicit non-road component**

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