

Technologies and Policies for Improving Truck Fuel Efficiency & Reducing CO2

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AB Volvo Business Areas

Mack Trucks



Renault Trucks



Volvo Trucks



Nissan Diesel



Buses



Construction Equipment



Volvo Penta



Volvo Aero

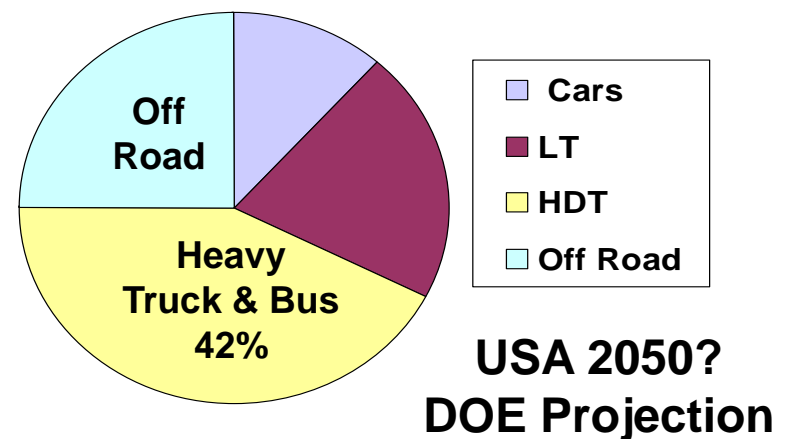
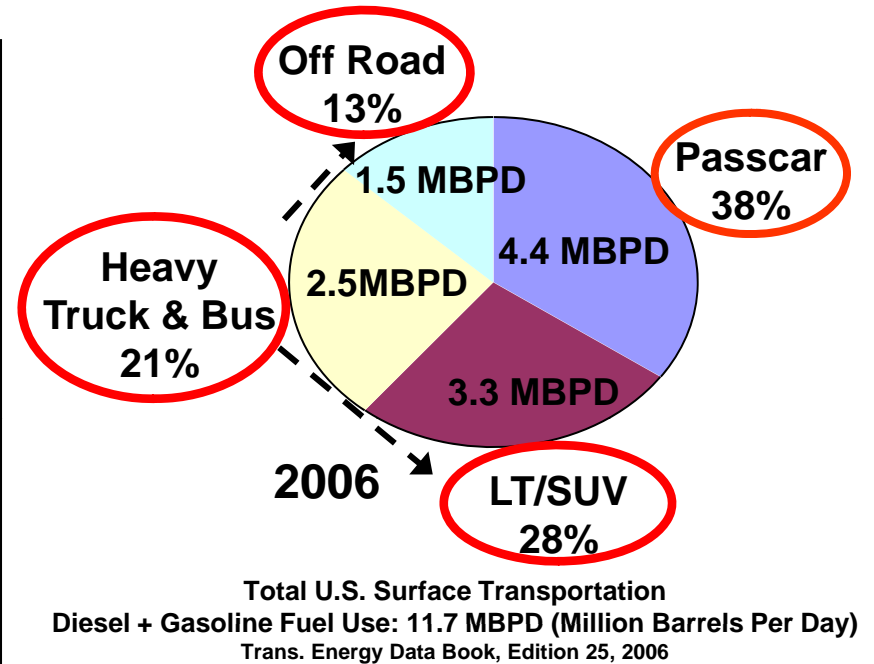


Financial Services



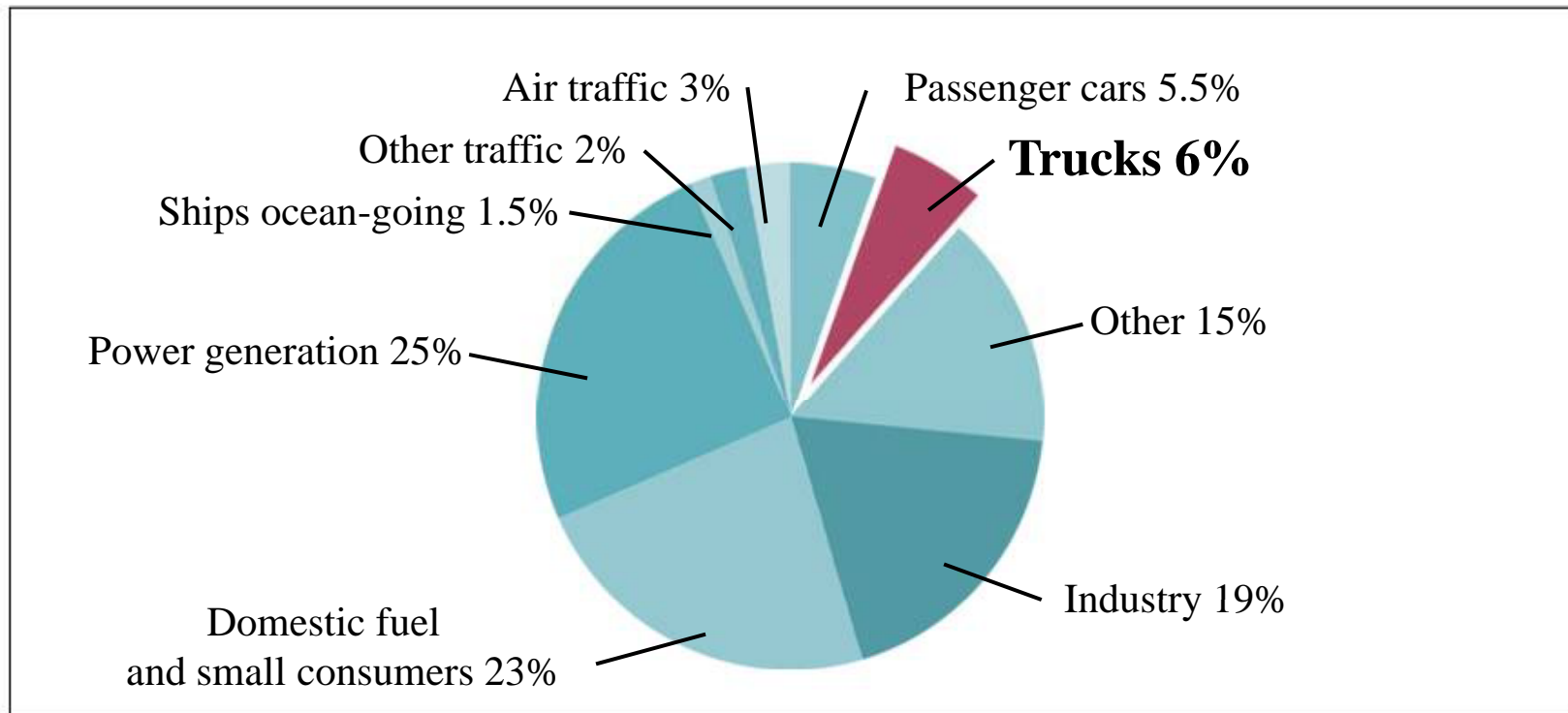
US Significant Freight Statistics

- EIA's America's Energy Outlook 2009 projects annual truck VMT to grow by 2.5%, reflecting both increased freight and somewhat longer average hauls.
- If the efficiency improvement rate and freight growth hold to these historical rates, truck CO₂ will continue to grow.
- US DOE has proposed that if light duty meets targets and heavy duty continues on these trends, HD fuel use will exceed LD by 2040. Currently HD is about 1/4 of LD usage.



Globally - trucks and cars have near equal CO₂ contribution

Global anthropogenic CO₂ emissions



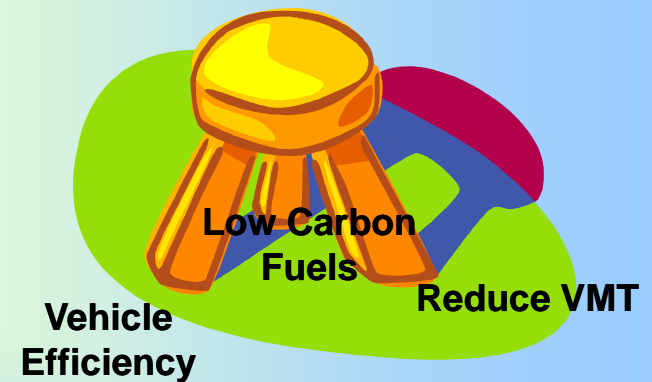
Source: UNEP 2002

Trucking Role in US Economy

- More than 80% of all communities in the United States are supplied exclusively by trucks
- Trucks hauled 10.7 billion tons of freight in 2005
 - 69% of all freight carried in the U.S. in terms of weight.
 - Virtually every item a person comes in contact with traveled on a truck at some point.
- Typical domestically-manufactured product moves by truck an average of six times before reaching its end customer
- Average imported product moves four times by truck once reaching a domestic port.
- Trucking represents roughly 5% of the U.S. gross domestic product
- Over 80% of all freight transportation revenues for all modes (truck, air, water, rail and pipeline)

How to Meet the Challenge?

- **Light Duty** often refers to a 3 legged stool approach to reduced use of fossil energy.
- **Heavy Duty Long-Haul** - 1/2 legged stool???
 - Improving the front (tractor) half of the combination truck through vigorous competition but not much focus on trailers.
 - Minimal plans for low carbon alternate fuels to replace diesel
 - Little attention to VMT
- **We need all three legs.**
 - **Fuel Efficiency**
 - Engines
 - Vehicle
 - Truck and tractor
 - Implement trailer improvements
 - Integrate tractor and trailers for breakthrough aerodynamics.
 - Policies to promote reduced VMT while still moving the freight that supports our economy.
 - Serious policies to develop and implement new low carbon fuels for HD application.



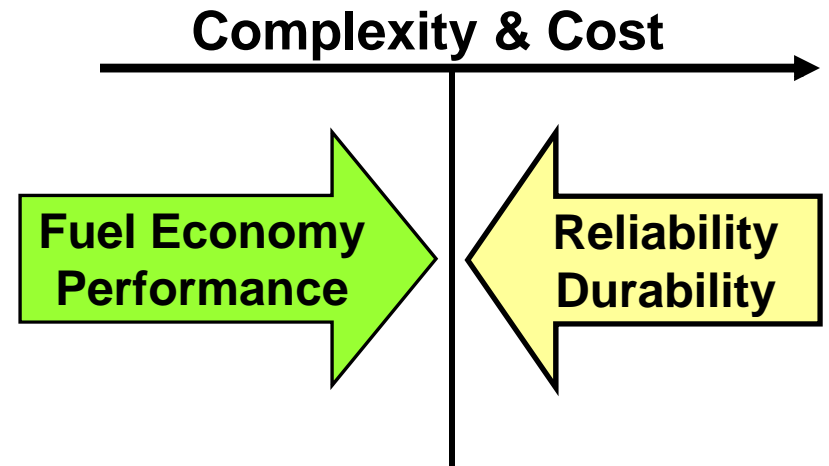
Heavy Truck Fuel Efficiency

Progress and Opportunities

Fuel economy has always been a critical factor in diesel engine and truck marketing!

TECHNOLOGY DEVELOPMENT CRITERIA

- Primary selection criteria
 - ✓ Meet emissions limits
 - ✓ Reliability is most important for customers
 - ✓ Lowest operating cost
 - **Fuel economy**, maintenance, initial cost, etc.
 - ✓ Durability
 - ✓ Performance



Fuel is typically around 30% of truck fleet operating cost.

Where are we?



1950?



1980



2007

Big change in tractors. Trailer changes??

- Used as rolling warehouse
- Three trailers per tractor
- Often owned by shipper
- Least cost is main consideration

Long Haul Tractors Progressing Well Incorporating Aero Features



Volvo Powertrain

VOLVO

Key Technology Areas to Improve Long Haul Truck Freight Efficiency

Engines

- **Diesel Combustion Efficiency**
- **Waste Heat Recovery**
- **NO_x aftertreatment improvements**
- **Engine friction reduction**
- **Engine Auxiliaries (water/oil pump)**
- **Other New Technology Developments**

Truck Technology

- **Transmission & Driveline Efficiency**
- **Powertrain integration (includes engine)**
- **Cooling optimization**
- **Vehicle Auxiliaries (Air comp, PS pump, Air Cond, Fan, Alternator)**
- **Aerodynamics (tractor)**
- **Weight**
- **All Tractor Tires**
- **Trailer Gap or vortex stabilizer**
- **Smart Navigation**
- **Mild hybrid (long-haul)**
- **Full Hybrid (vocational)**

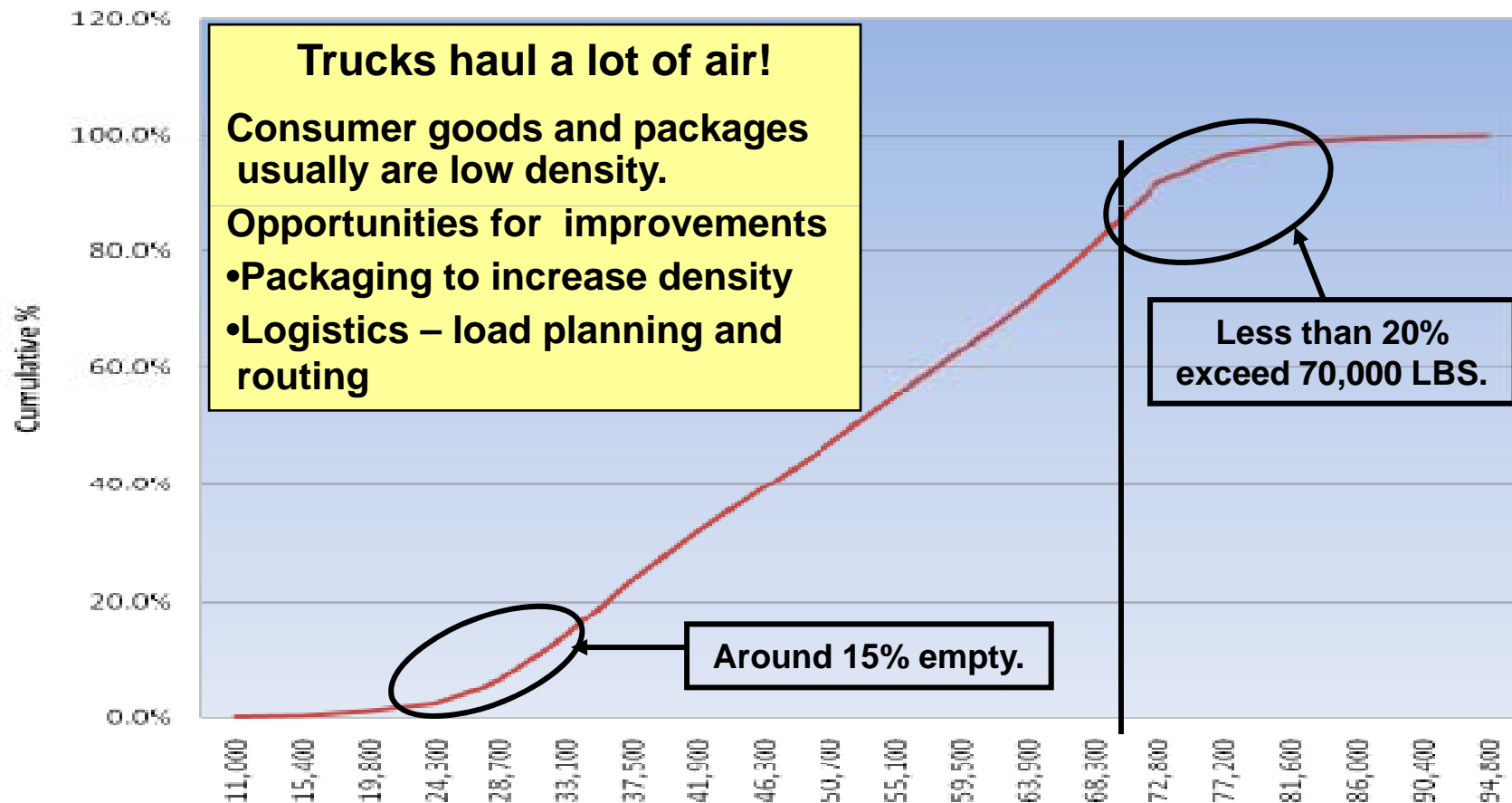
Fleet Operations

- **Logistics**
 - **Load planning**
 - **Route Planning**
 - **Backhauls**
- **Trailers -Tires, Aero, Weight**
- **Longer Combinations & increased weight (assuming consistent state regulations)**
- **Intermodal (rail)**
- **Driver Training**
- **Trailer gap control**
- **Idle Elimination**
- **Road speed reduce 7 MPH**

Technologies can only contribute to the extent they are integrated into the complete vehicle and system in real applications and are supported by public policy.

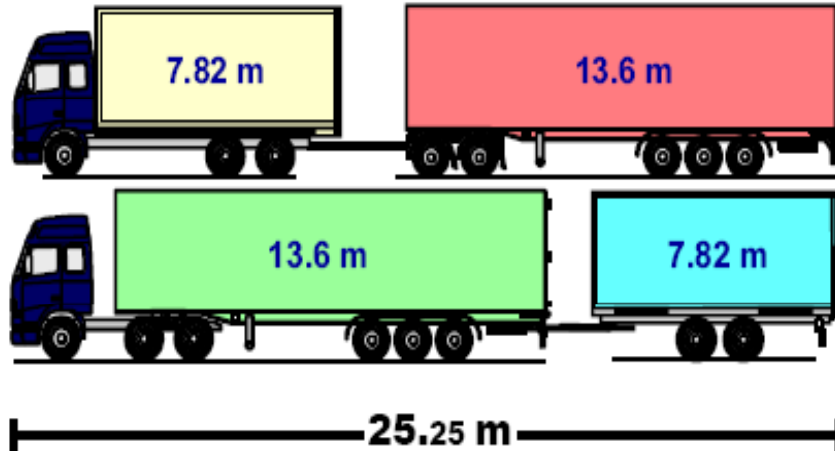
Heavy Truck VMT

Cumulative Percentage of 5-Axle Tractor Trailer Combination Vehicles by Gross Vehicle Weight as Reported by VTRIS for Fifteen States (CA, CT, FL, GA, HI, IA, MN, MO, MT, NC, MN, OR, PA, SD, TX, & WA) in 2008



Longer Combination Trucks

Single Biggest Potential Efficiency Gain via Lower VMT



Sweden and Finland allowing rigs up to 25.25 m
vs 18.75 m in rest of EU (14-20% less fuel)

Quote – Ontario, Canada Ministry of Transport
LCVs are a win-win-win. They are good for the economy, good for the environment and improve highway safety. They can move goods at a lower cost and with fewer greenhouse gas emissions than single-trailer trucks and, under carefully controlled conditions, more safely.

Fuel saving for longer US combinations (with volume limited freight- per ATRI study)

6-axle Tractor-Semitrailer



Rocky Mountain Double (RMD)

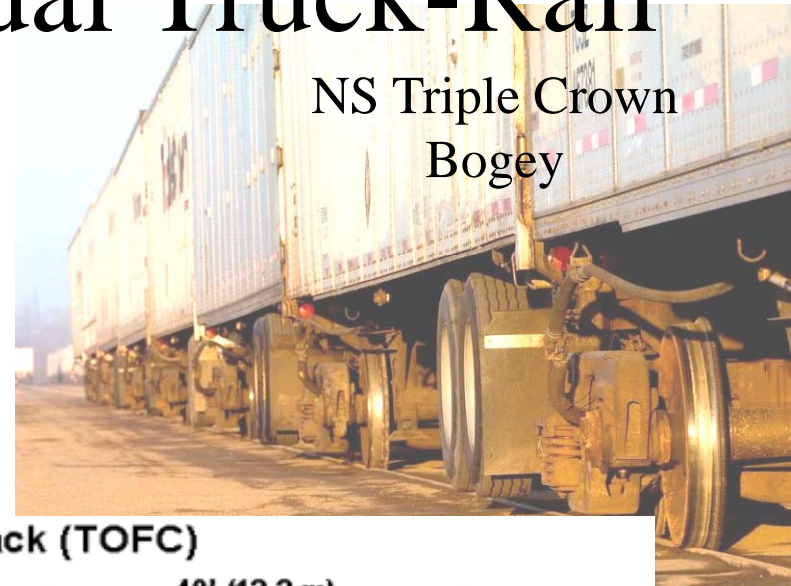


Triple Trailer Combination (TRPL)



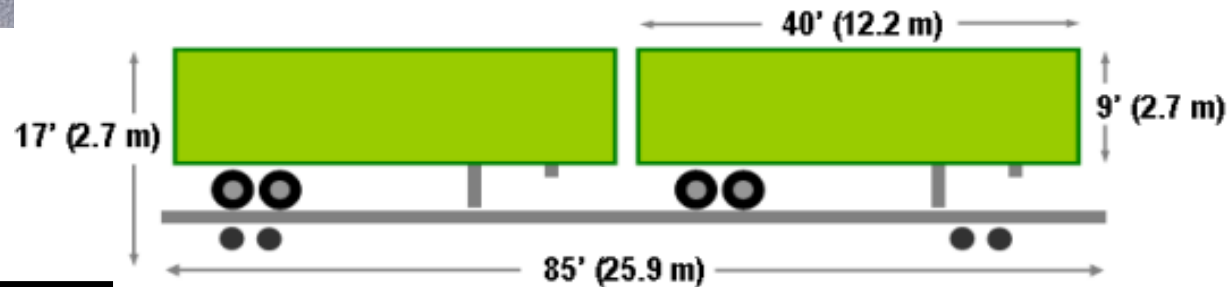
Turnpike Double (TPD)

Increase Intermodal Truck-Rail

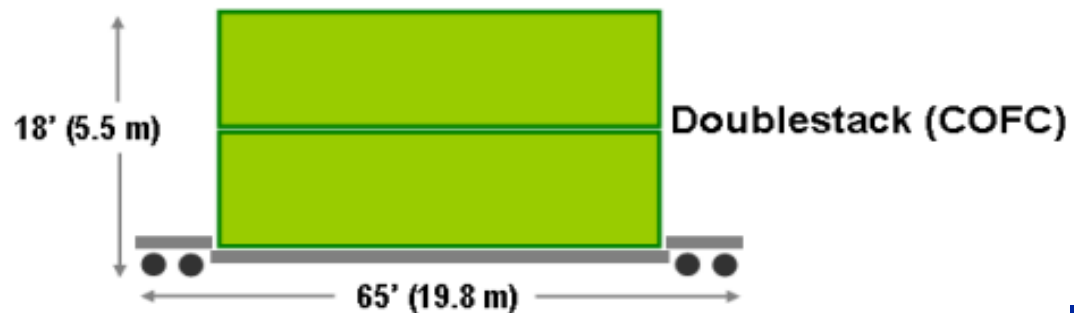


NS Triple Crown
Bogey

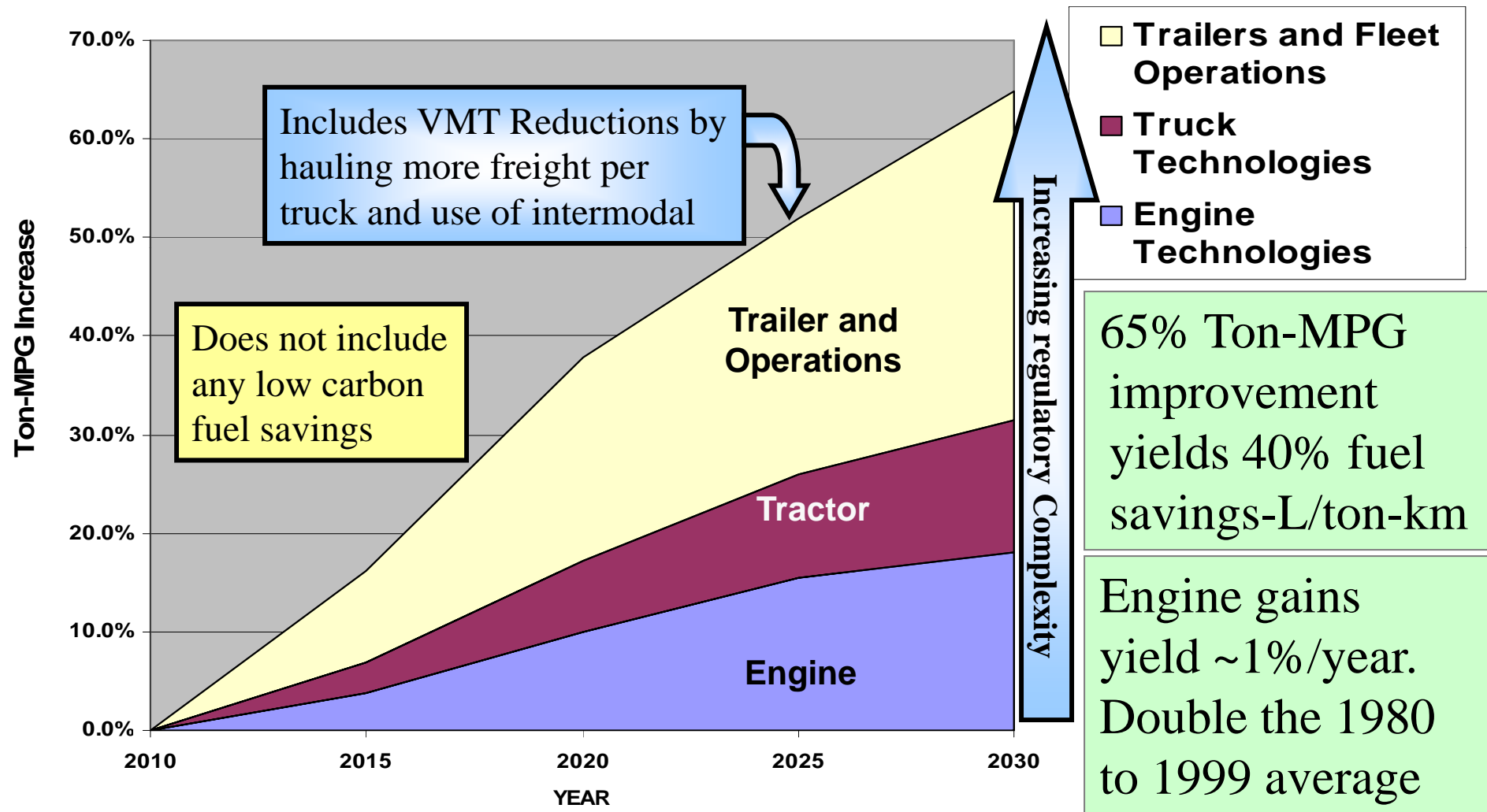
Piggyback (TOFC)



Estimated Fuel
savings of around
50% but need
better study.



Class 8 Ton-MPG - A Prospective Scenario Via Vehicle Efficiency Gains and VMT Reductions



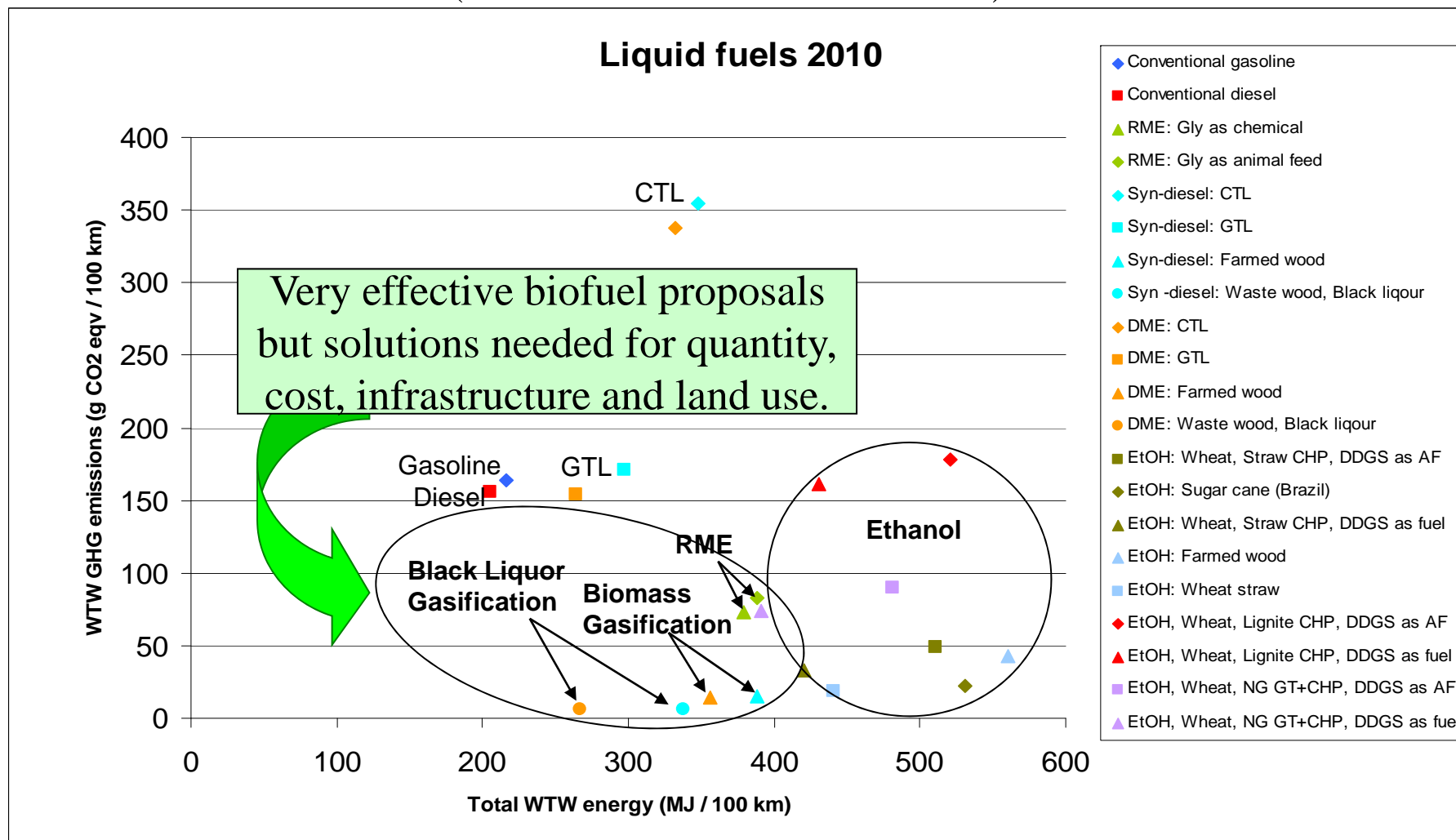
CO2 Reduction through Bio-fuels

Seven trucks running on renewable fuels



Well-to-Wheel GHG versus total energy use

(from Eucar/Concawe/JRC 2006)



Issues & Opportunities

- **Trailer economics do not easily support efficiency improvements**
 - 3-4 trailers per tractor drives up cost vs fuel savings
 - Difficult to manage proper trailer match to tractors
 - Very long trailer life – slow turnover
- **Shipper's area of influence**
 - Manufacturing and distribution systems are based on low cost freight transportation. (Just-in-Time)
 - Packaging impact on freight density and volume
 - Warehousing and distribution patterns
- **Infrastructure**
 - Highway infrastructure
 - Truck stops (Availability and Electrification)
 - Congestion mitigation
 - Intermodal facilities
- **Lack of Long-Term Vision**

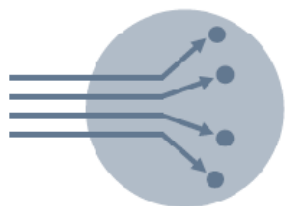
Long-Term Vision Needed

- Long Haul

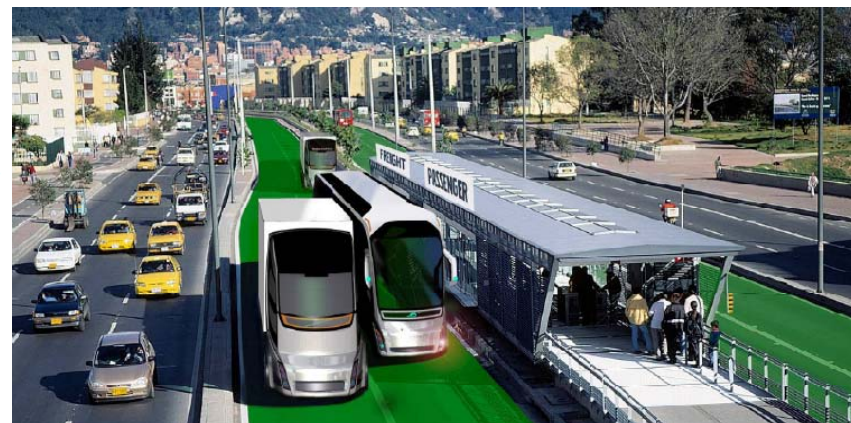
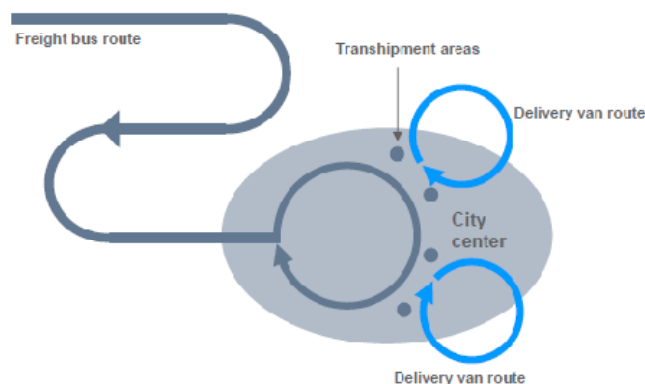
Truck only lanes
Autonomous operation
Lower speeds
Warehousing and Distribution
Road trains Packaging
Intermodal

- Urban

Today



Tomorrow - The logistic hub



Collaborative transport ...already a reality in some places



Public Policies to Promote Road Freight Efficiency

- **Establish fuel or carbon tax policy to increase overall cost of fossil fuel or set a long-term escalating floor price for fossil fuel.**
 - Establishes a target value for alternate fuel development.
 - Establishes market value for fuel efficient vehicle technology development.
 - Incentivizes freight efficiency by carriers and shippers.
- **Establish uniform vehicle size and weight limits at the highest possible levels with supporting highway infrastructure.**
- **Replace new vehicle taxes (12% excise) with increased fuel tax to promote fleet roll-over to lower emissions vehicles.**
 - 24% shift in value of technology
- **Support technology development of efficient trucks, alternate fuels, and fuel infrastructure.**
- **Set mandatory hard-programmed road speed limits as is already done in Europe and most countries.**

Public Policies to Promote Road Freight Efficiency

- **Develop infrastructure for efficient rail and intermodal shipment between rail and truck.**
- **Develop Highway Infrastructure and Intelligent Vehicle Management**
 - Mitigation of congestion
 - Ample truck stops to avoid idling (electrification)
 - Truck lanes in congested areas to support longer combinations and avoid conflict with higher speed cars.
 - Intelligent systems to manage vehicle flow
- **Revise vehicle regulations that inhibit efficiency**
 - Allow cameras to replace mirrors
 - Allow extra length for aerodynamic features (trailer boat-tail)
 - Allow extra weight for emissions and fuel efficiency technologies to avoid displacing freight.
- **Create trailer standards to integrate with tractors and support full vehicle aerodynamic optimization.**

Public Policies to Promote Road Freight Efficiency

- **Truck Efficiency Regulation?**

- Variation in truck size, work performed, and duty cycle makes such regulation very difficult.
- Impossible to regulate all significant impacts on freight efficiency

Vehicles

Trailers

Combinations

Freight logistics

Driver management

Route planning

Smart Vehicle Management

Warehousing and distribution

Mode shifting

Packaging

- **Still Good Reasons to Consider Regulation**

- Establish firm dates for technology introduction
- Remove market barriers to new technology
- Set targets and lead time

But also need to drive demand and efficiency in all areas via market mechanisms through carbon tax or cap & trade.

Heavy Duty Vehicle Fuel Efficiency is a Complex Issue

Many types of vehicles with different functions

How to Define
& Measure
Efficiency?





Volvo Powertrain

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Possible Regulatory Options

- Start with focus on long-haul and regional tractors.
- Use vehicle modeling to simulate specification variants to deal with diversity
- Establish target efficiency levels based on available or expected technologies.
- Metric based on truck freight capacity – volume and weight
- Very difficult to account for vehicle and driver management technologies.
- Not Clear how to drive trailer efficiencies and proper tractor trailer matching
 - Not controlled by truck manufacturers
 - Could have trailer regulations or incentives to operators
- Still need to address VMT growth.
 - Logistics, Packaging, Routing

Six Possible Vehicle Classes

- Sleeper
 - Box Van



- Tanker



- Flatbed



- Day Cab
 - Box Van



- Tanker



- Flatbed



Standard for each class to include:

- Composite US duty cycle
 - Typical US routes including speeds and grades
 - Average load for the class.
- Standard truck set up with 80K GCW capability and adequate for safe and efficient operation (traction and gradeability) on US major roads.

These classes cover about 80% of tractor sales and 60-70% of total fuel used in commercial trucks

Conclusion:

On the way to climate neutral transportation

- **Significant gains in freight efficiency are possible, but efforts by governments, vehicle manufacturers, trailer manufacturers, carriers, and shippers is required.**

