International Vehicle Productivity Performance Benchmarking

Workshop
OECD-ITF International Study on Truck Safety, Productivity, and Sustainability

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Purpose of Benchmarking Study

- To compare the most common trucks “workhorses” from participating countries as well as various high and very capacity vehicles in terms of:
  - Road wear performance
  - Impact on road structures
  - Safety performance (with a focus on vehicle design)
  - Productivity (in terms of mass and volume)
  - Environmental impacts (emissions, energy consumption)

Increasing truck volumes vs productivity

Essential Aspects of Truck Transport

- Large trucks exist to do work and to do it efficiently. Their worth and function are tied directly to work performance in exchange for money – there is a large incentive to be efficient.
- Freight tasks vary, as do the weight, shape and density of cargo transported, therefore vehicle efficiency varies for a given cargo and vehicle design.

Essential Aspects of Truck Transport

- The nature of freight transport can be volume limited or mass limited. Transport efficiency for volume limited freight task is evaluated differently than mass limited freight task.
- A specific vehicle with a low fuel consumption does not necessarily have good fuel efficiency. In the context of this study:
  - Fuel consumption references fuel used to move a vehicle.
  - Fuel efficiency refers to the fuel used to accomplish a specific freight or work task.

Regulatory Factors influencing Efficiency

- Basic aspects of truck design such as the length, wheelbase, width, height, axle loads, axle spacing and GVW, are influenced and limited by size and weight regulations
- Since many of these factors directly influence fuel efficiency it can be concluded that fuel efficiency is directly related to size and weight regulation.
- Size and weight regulation has a significant influence on national fuel use and emissions output

Vehicle Classification

- 40 heavy vehicles representing 10 participating countries were examined
- The study focused on Class 8 highway transport vehicles

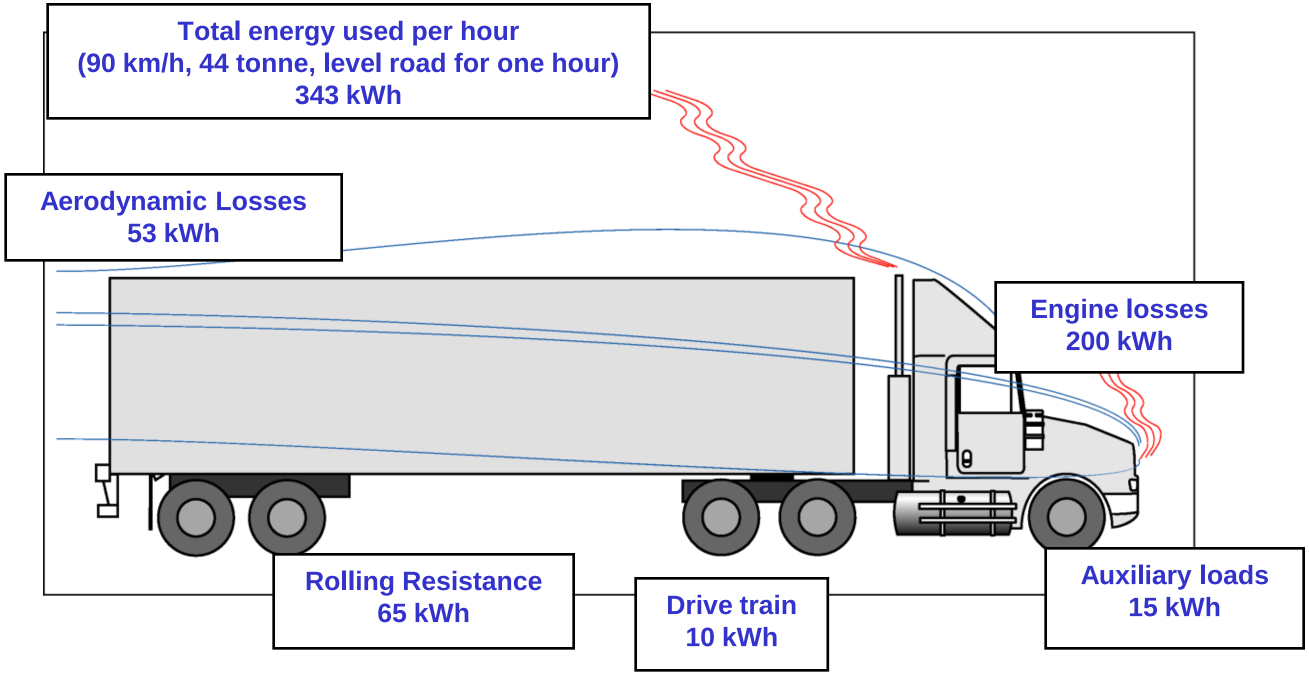
  Note: In the U.S. class 8 vehicles consume 59% of all fuel used by commercial vehicles

Vehicle Classification

- Workhorse – common "go anywhere" vehicle
- High capacity – up to 57 tons
- Very high capacity – up to 77 tons greater than 98 ft

Productivity and Environmental Performance

Steady State Energy Balance



Calculating Energy Consumption

The power required to overcome aerodynamic drag and tire rolling resistance at constant cruising speed on a level road with no wind can be expressed as follows:

$$P = (F_R + F_A) * v = \left(C_R * m * g + \frac{1}{2} * \rho * C_D * A * v_x^2 \right) * v$$

P is the power required to overcome the resistive forces – (expressed as Watts)

F_R is the tire rolling resistive resistive force

F_A is the aerodynamic resistive force

C_R is the tire rolling resistance coefficient

C_D is the aerodynamic drag coefficient

A is the frontal area of the vehicle

v is the velocity of the vehicle

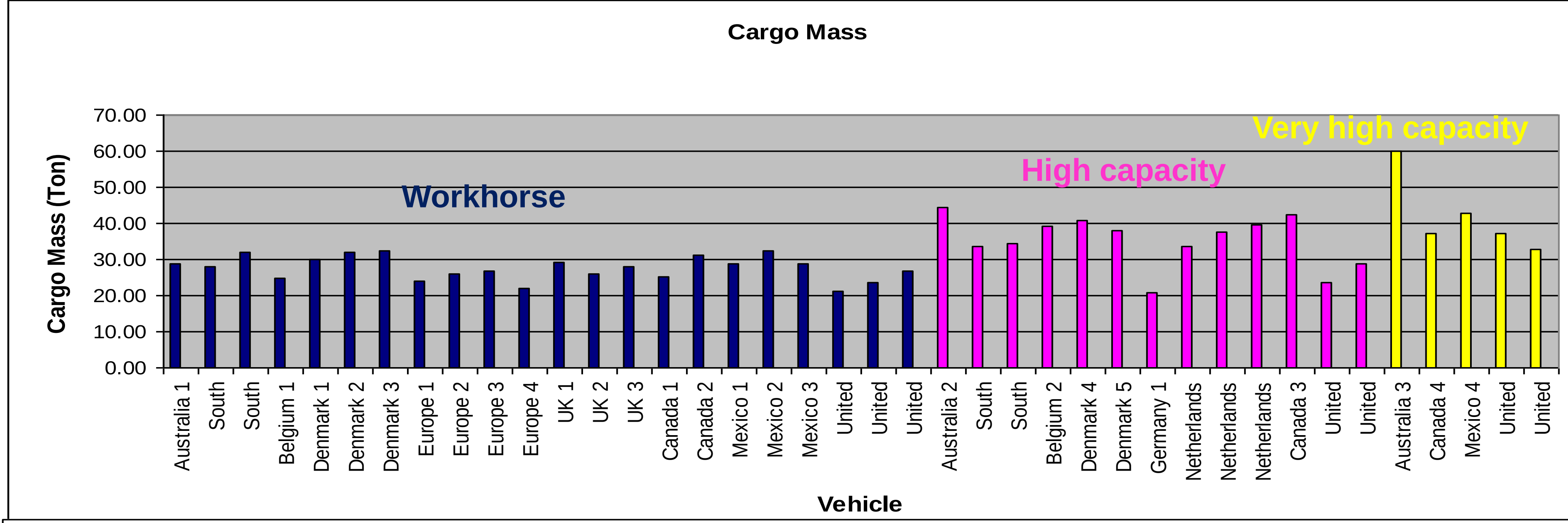
ρ is the air density

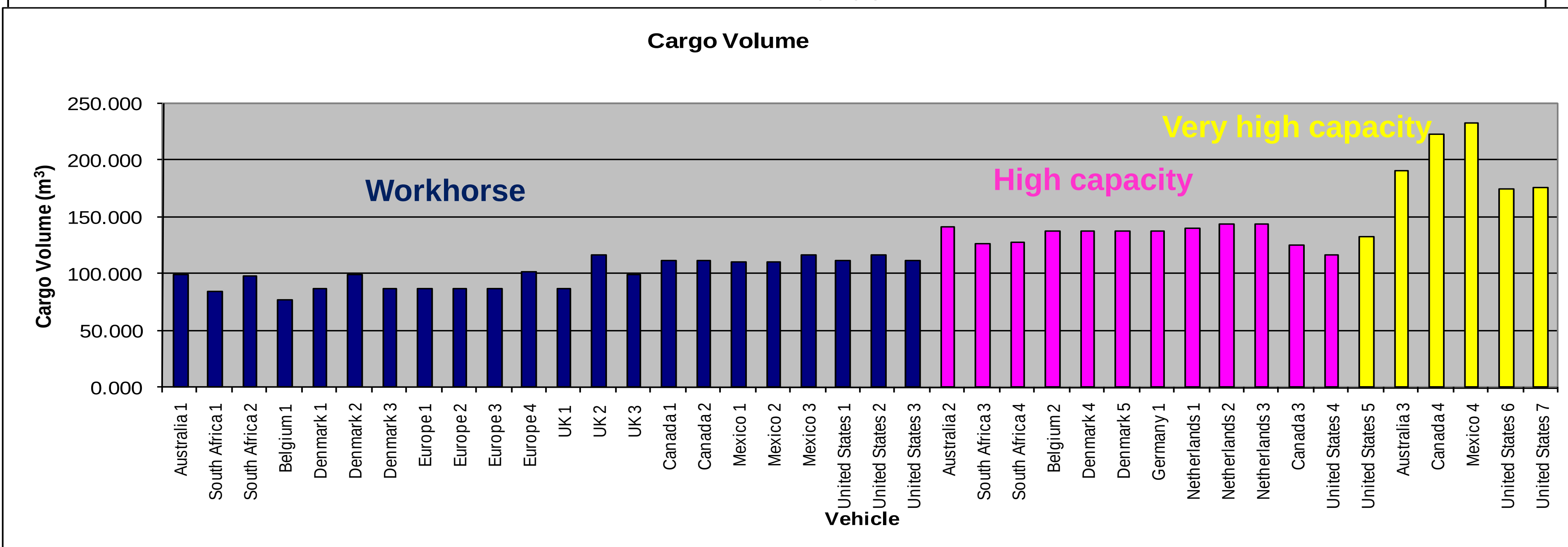
internal losses + 225 kWh applied equally to all vehicles in this analysis.

Estimating CO_2 Emissions

- Diesel fuel consumed for truck applications is approximately 200 grams/ kWh (assuming 50% engine efficiency)
- Mass of diesel fuel is approximately 850 grams/litre
- Amount of CO_2 emissions produced is ~2.67 kg/litre
- Therefore the amount of CO_2 produced per kWh is 0.63 kg

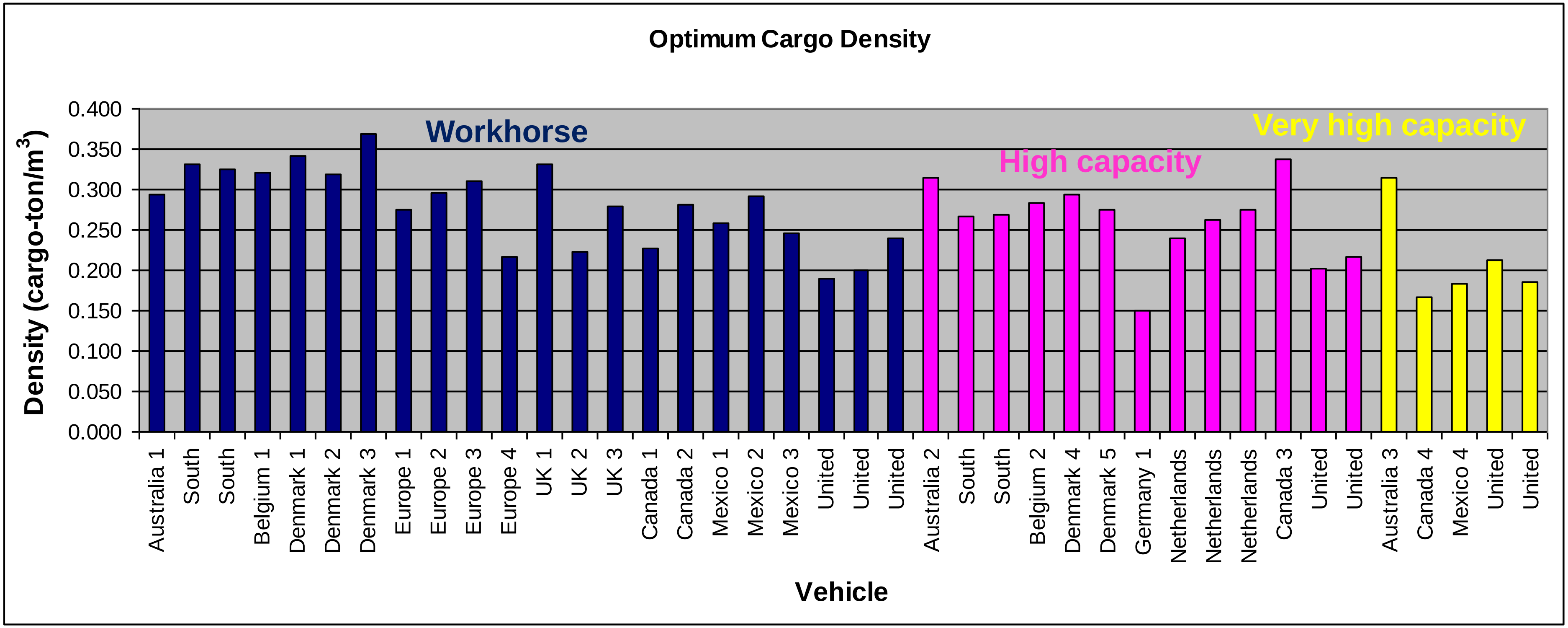
Results


Cargo Mass
Cargo Mass (Ton)
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Workhorse
High capacity
Very high capacity
Australia 1
South
South
Belgium 1
Denmark 1
Denmark 2
Denmark 3
Europe 1
Europe 2
Europe 3
Europe 4
UK 1
UK 2
UK 3
Canada 1
Canada 2
Mexico 1
Mexico 2
Mexico 3
United
United
United
Australia 2
South
South
Belgium 2
Denmark 4
Denmark 5
Germany 1
Netherlands
Netherlands
Netherlands
Canada 3
United
United
Australia 3
Canada 4
Mexico 4
United
United
Vehicle


Cargo Volume
Cargo Volume (m³)
250.000
200.000
150.000
100.000
50.000
0.000
Workhorse
High capacity
Very high capacity
Australia 1
South Africa 1
South Africa 2
Belgium 1
Denmark 1
Denmark 2
Denmark 3
Europe 1
Europe 2
Europe 3
Europe 4
UK 1
UK 2
UK 3
Canada 1
Canada 2
Mexico 1
Mexico 2
Mexico 3
United States 1
United States 2
United States 3
Australia 2
South Africa 3
South Africa 4
Belgium 2
Denmark 4
Denmark 5
Germany 1
Netherlands 1
Netherlands 2
Netherlands 3
Canada 3
United States 4
United States 5
Australia 3
Canada 4
Mexico 4
United States 6
United States 7
Vehicle

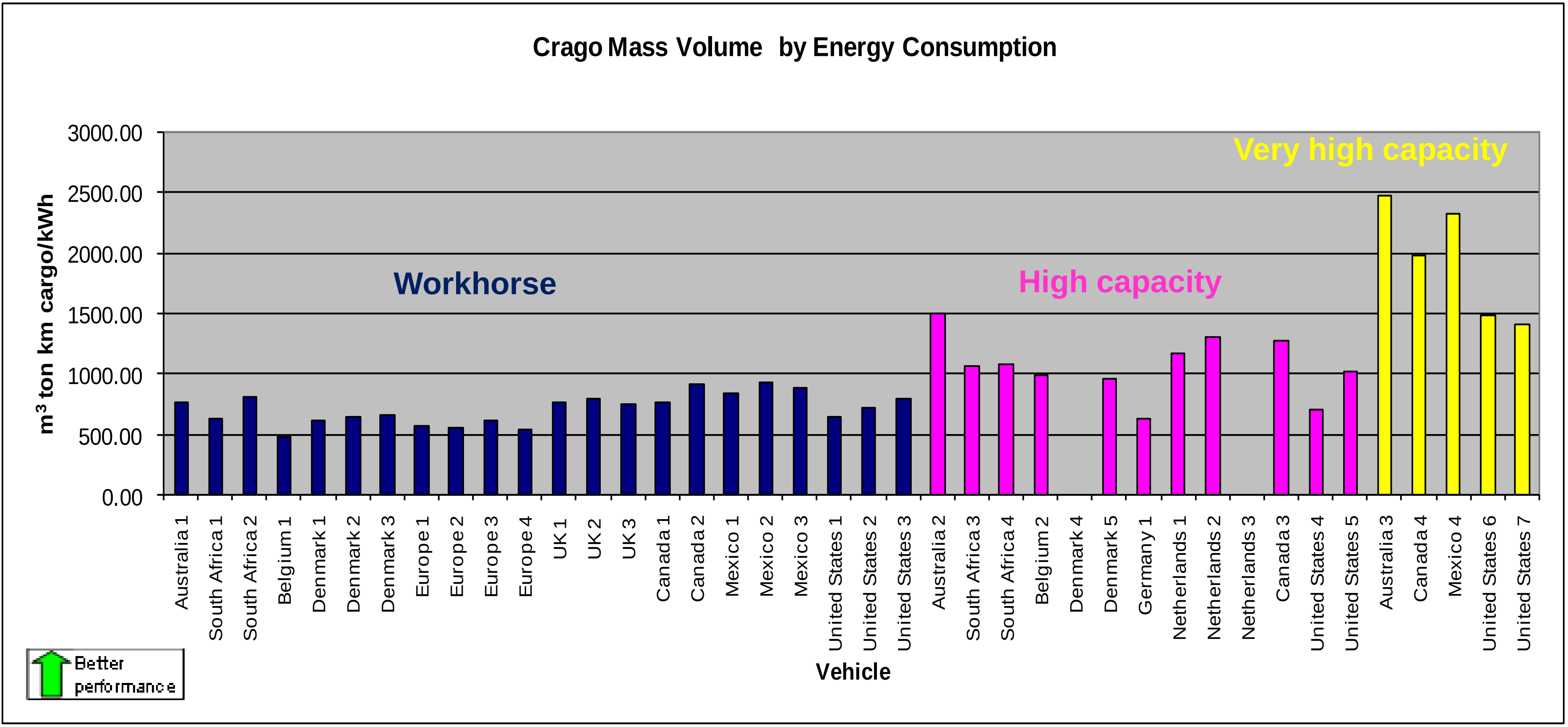
Optimum cargo density

(cargo mass / cargo volume)



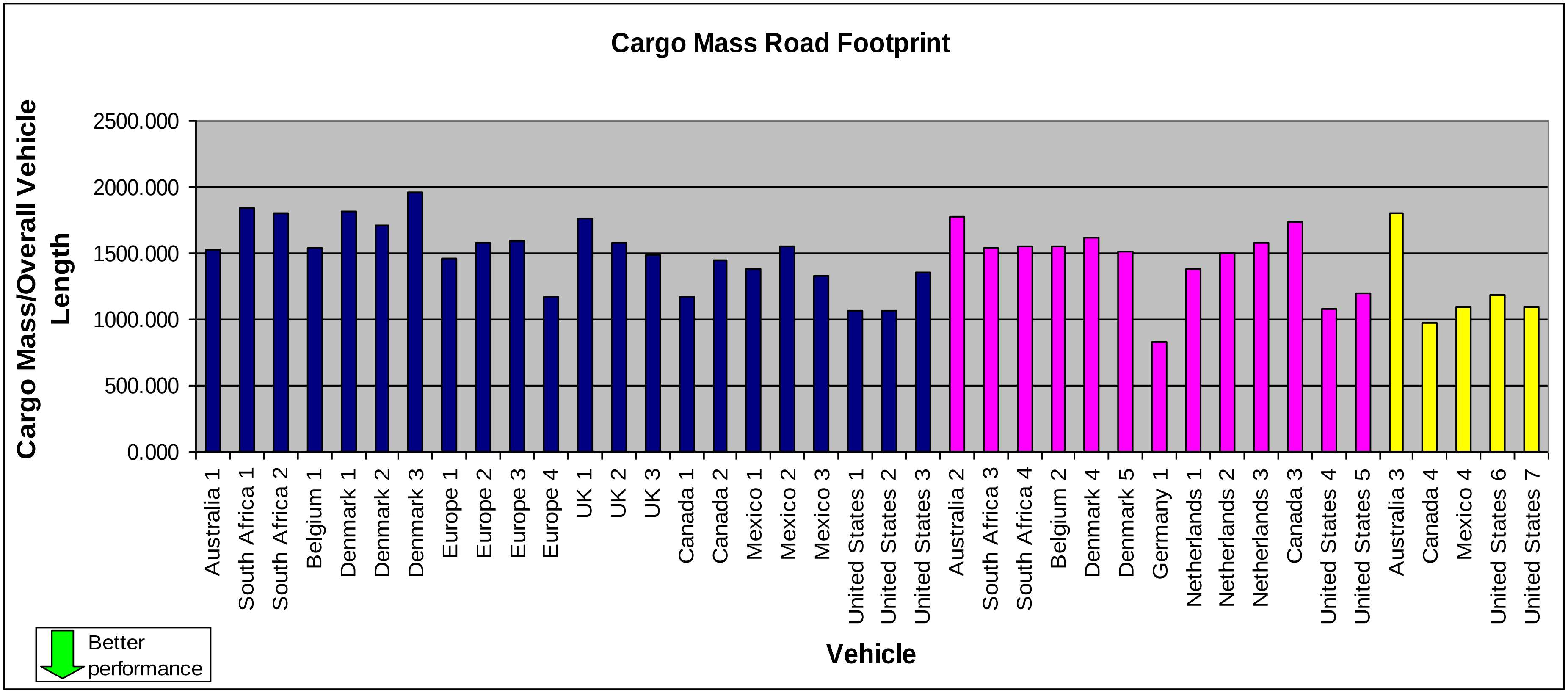
Energy efficiency: cargo mass volume

(Cargo mass x cargo volume x distance / energy consumed)



Cargo mass footprint (Road occupancy)

(Available Cargo Mass / Overall Vehicle Length)



Workhorse vehicles by country

5-axle tractor semitrailers

Denmark	96,800 lbs
Mexico	96,800 lbs
South Africa	95,700 lbs
Europe	88,000 lbs
Canada	86,900 lbs
US	80,000 lbs

6-axle tractor semitrailers

South Africa	108,460 lbs
Mexico	106,700 lbs
Denmark	105,600 lbs
Canada	102,300 lbs
Australia	100,100 lbs
US (a)	97,000 lbs
UK	96,800 lbs
US (b)	92,000 lbs

Conclusions

- Truck size and weight regulations directly influence transport efficiency, fuel use and emissions output
- Such regulations represent a tool that can not only protect the infrastructure but also encourage vehicles that provide significant societal benefits
- From the vehicles examined in this study, it is apparent that the higher capacity vehicles in use around the world are delivering improved productivity and efficiency with greater increases in cargo volume than cargo mass
- Higher capacity vehicles need to be managed to ensure compatibility with the infrastructure and to realise maximum safety potential

Thank you