

Carbon/Fuel Indicators for Light Duty Vehicles in Regulatory Space and Real-World

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New Energy Indicators for Transport: The Way Forward

IEA Headquarters

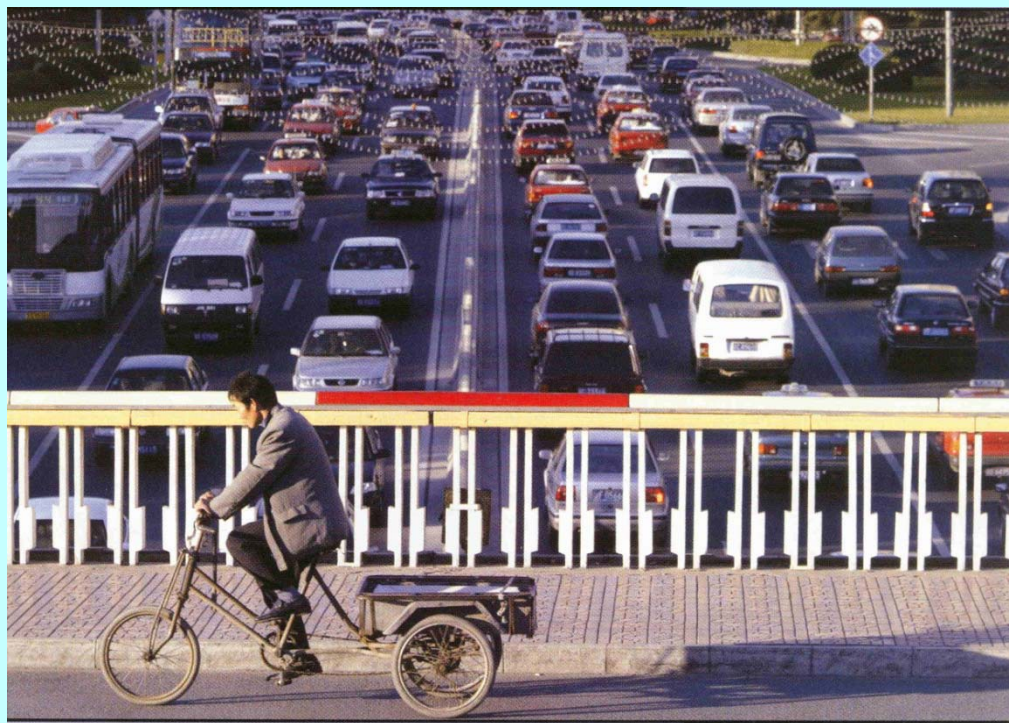
9 Rue de la Fédération, 75015 Paris

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The Innovation Center for Energy and Transportation (iCET) is a non-profit, non-governmental organization registered in Beijing, China. We are dedicated to promoting clean, sustainable, low carbon policies and technologies for vehicles and fuels in China.



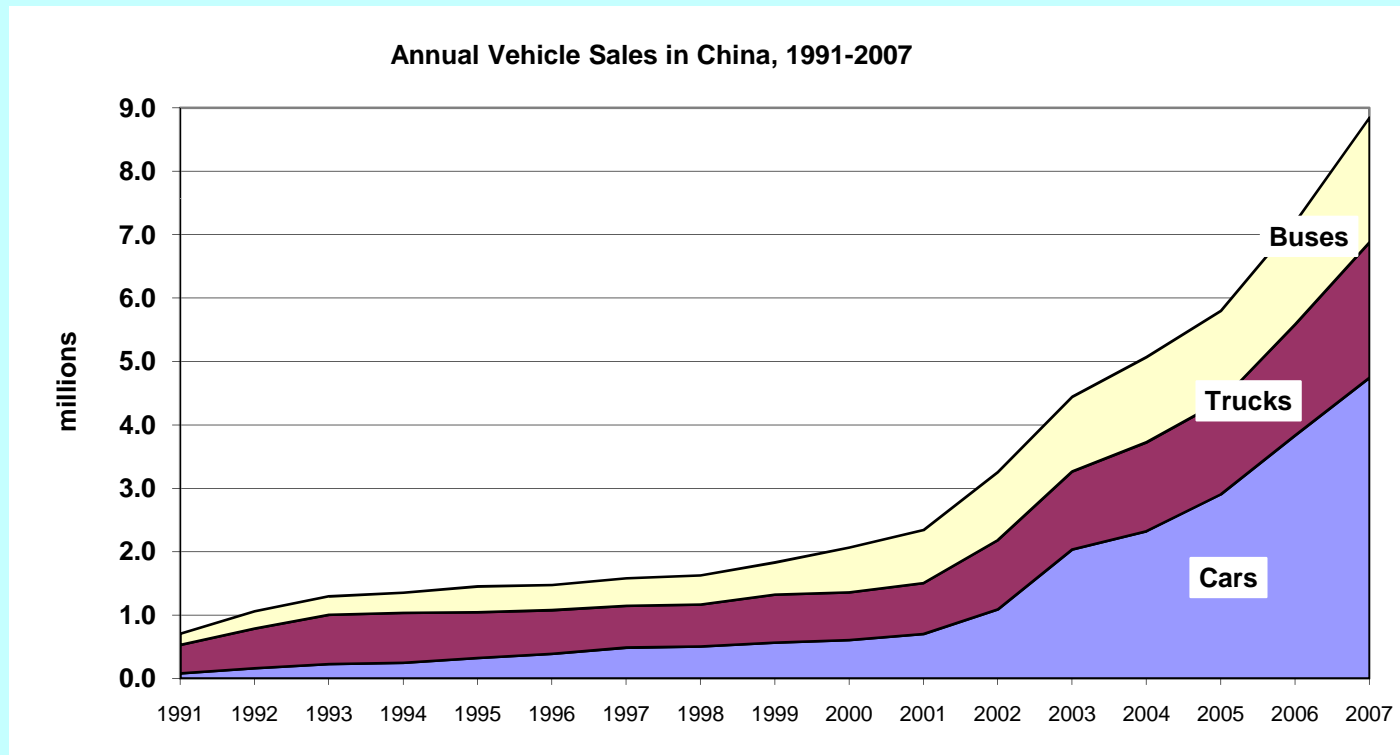
Outline



- Background
- Snapshot on China
- Updates on World-Wide FE Standards in regulatory space
- Carbon intensity indicator in Real-world
- Conclusions

China has become the second largest vehicle market since last year, with total new sales 8.8 million units last year. Car market exploded in the past several years. New car sales about 4.7 millions in 2007.

Annual growth in new car sales averaged about 30% since 92, trucks 11%, buses 17%



Estimated China on-road vehicle stock in 2006

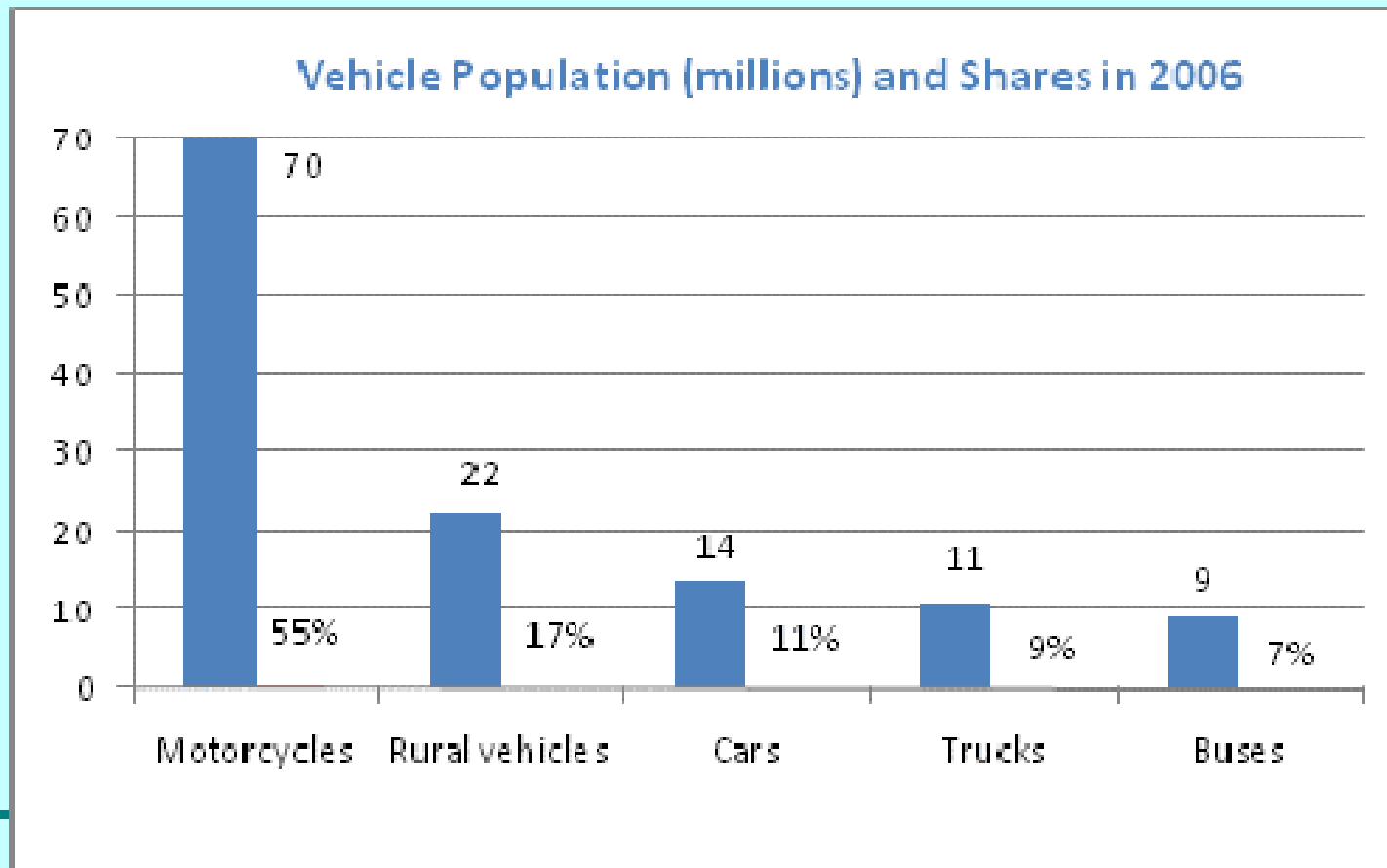
Total stock ~130 millions (10% ownership ratio)

Motorcycles - 70 millions (5% ownership)

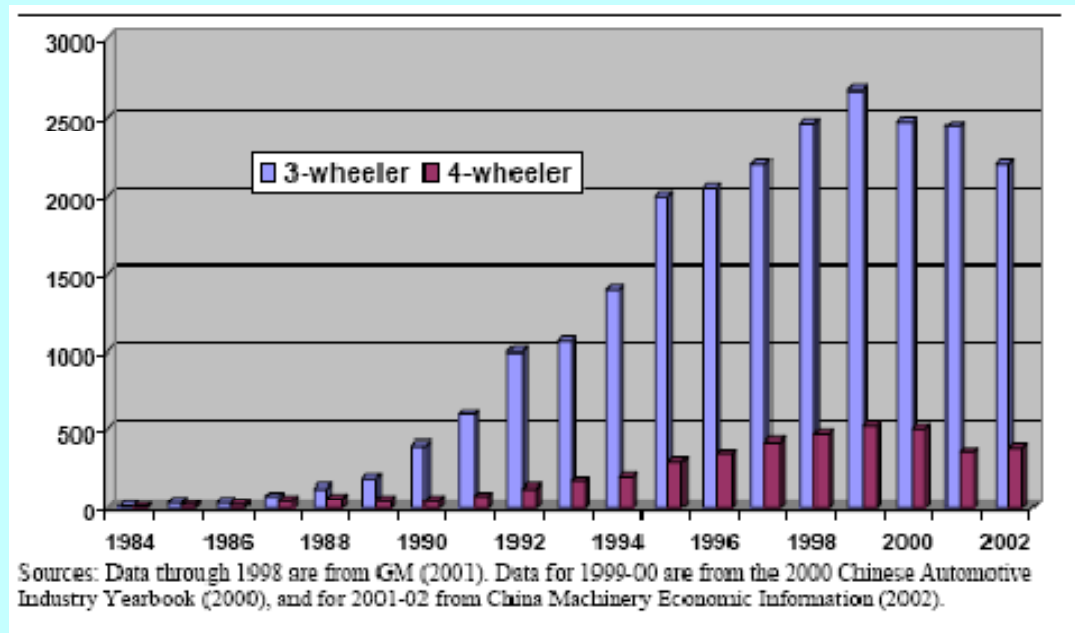
Rural vehicles - 22 millions

Cars - 14 millions (1% ownership)

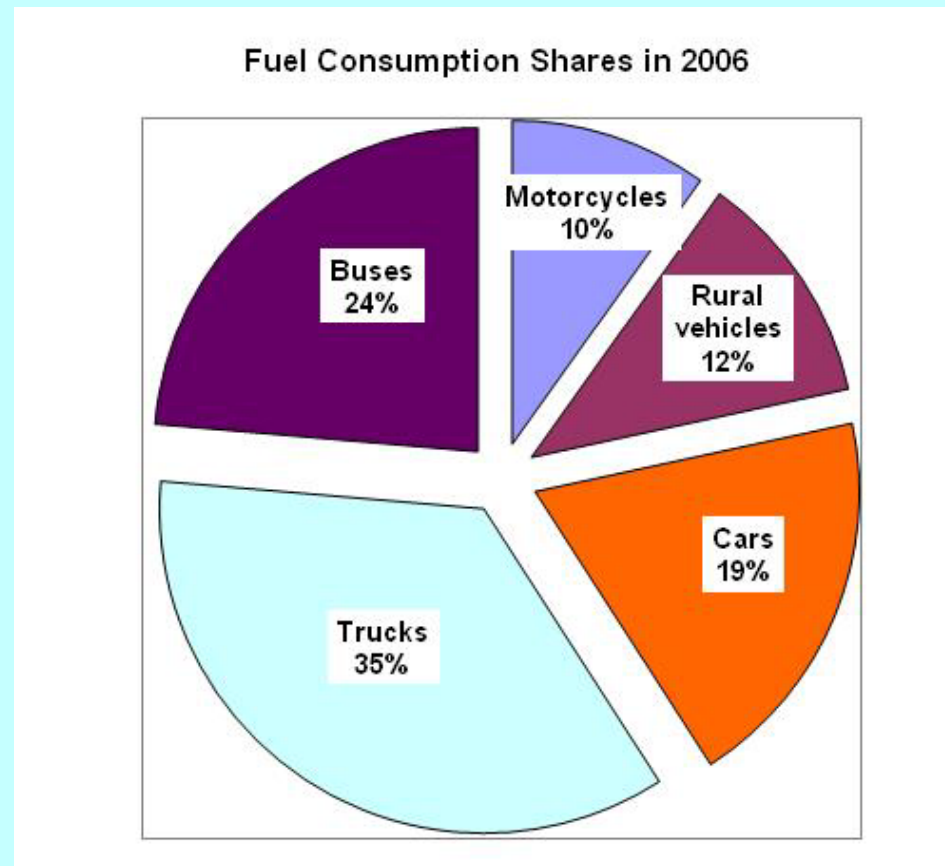
Trucks & Buses - 20 millions



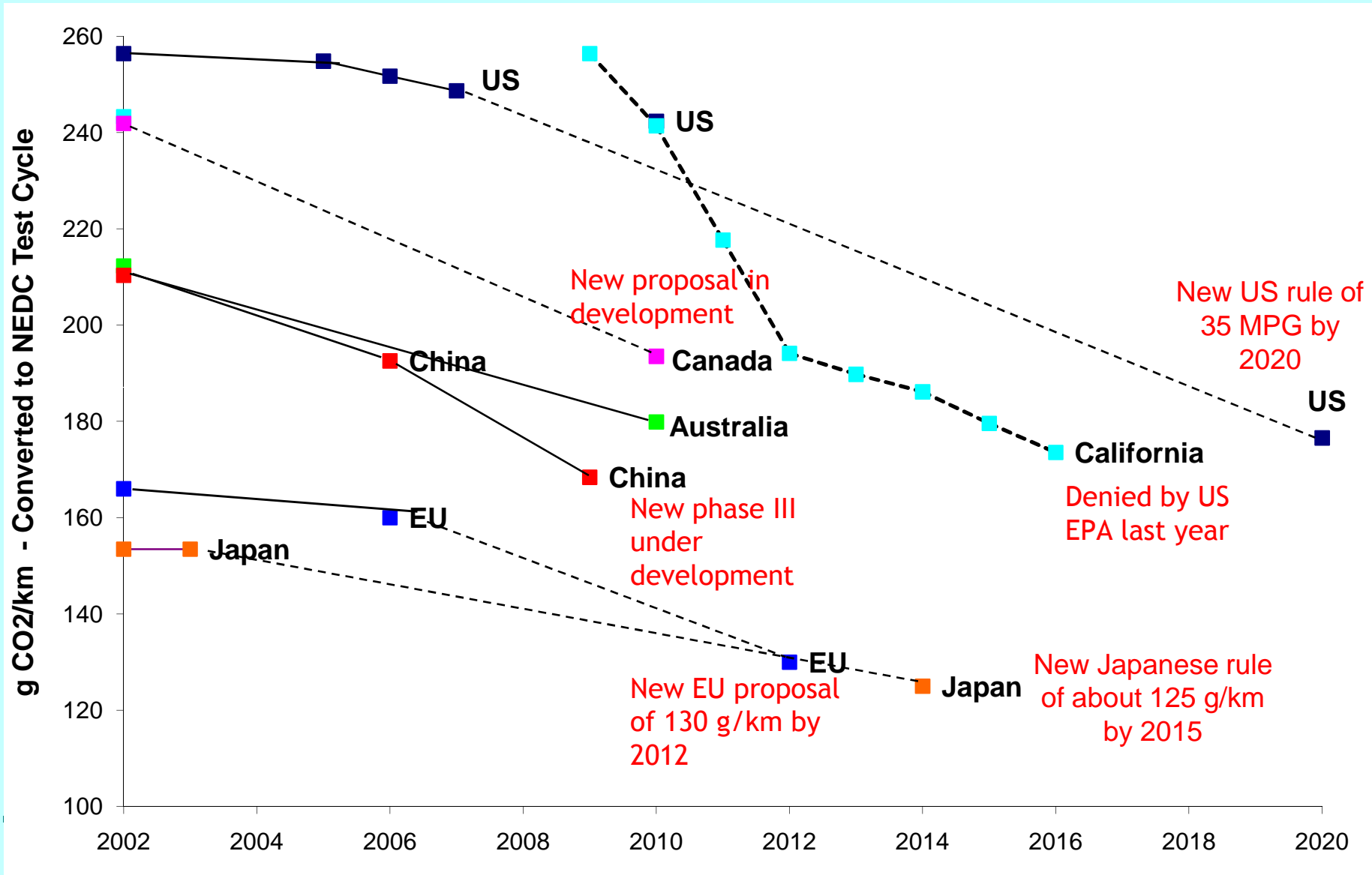
China's Dark Secret: Rural/Farmer Vehicles



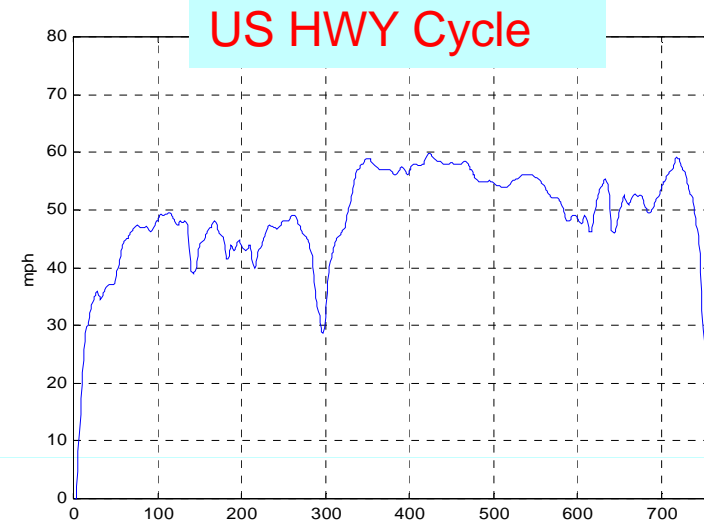
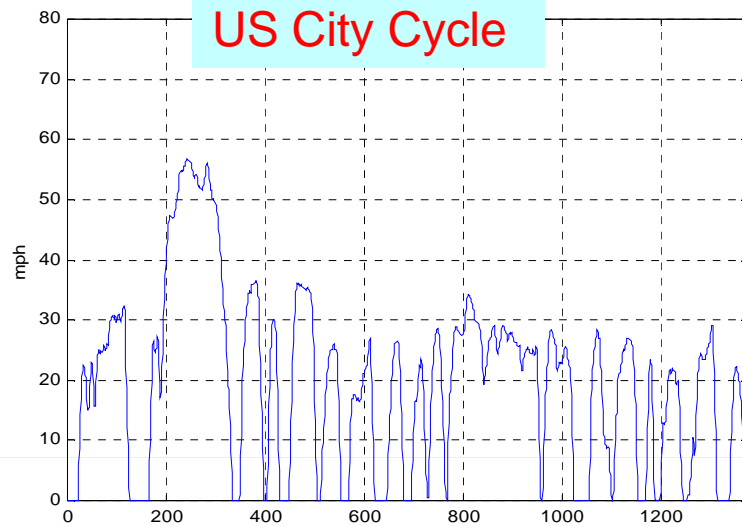
Fuel consumption share dominated by trucks (35%) and buses (24%), followed by cars (19%), rural vehicles (12%), and motorcycles (10%)



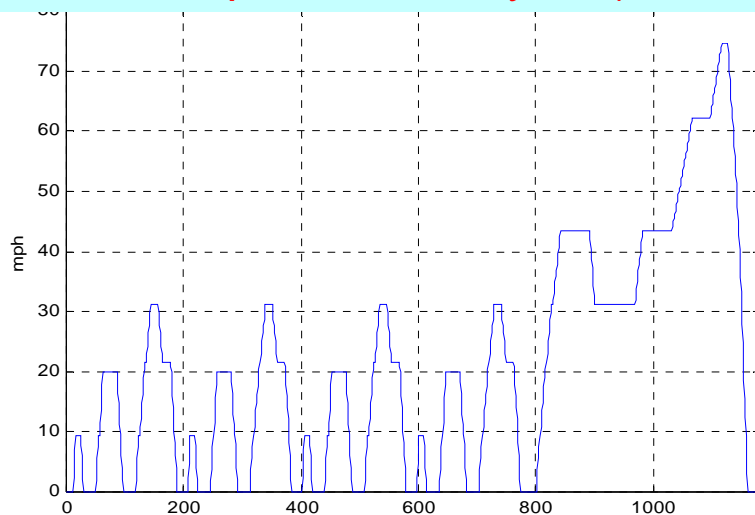
Updates on Fuel Economy/GHG Regulations Worldwide



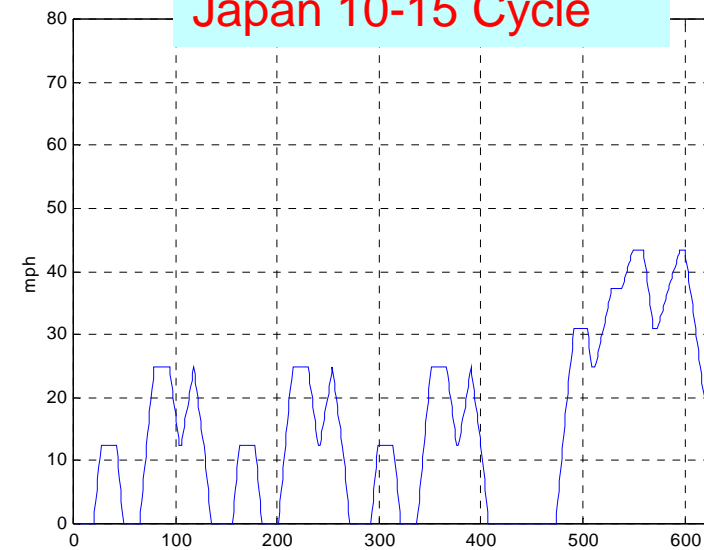
Differences in driving cycles are crucial for regulatory purpose – however, are they representative of real-world driving?



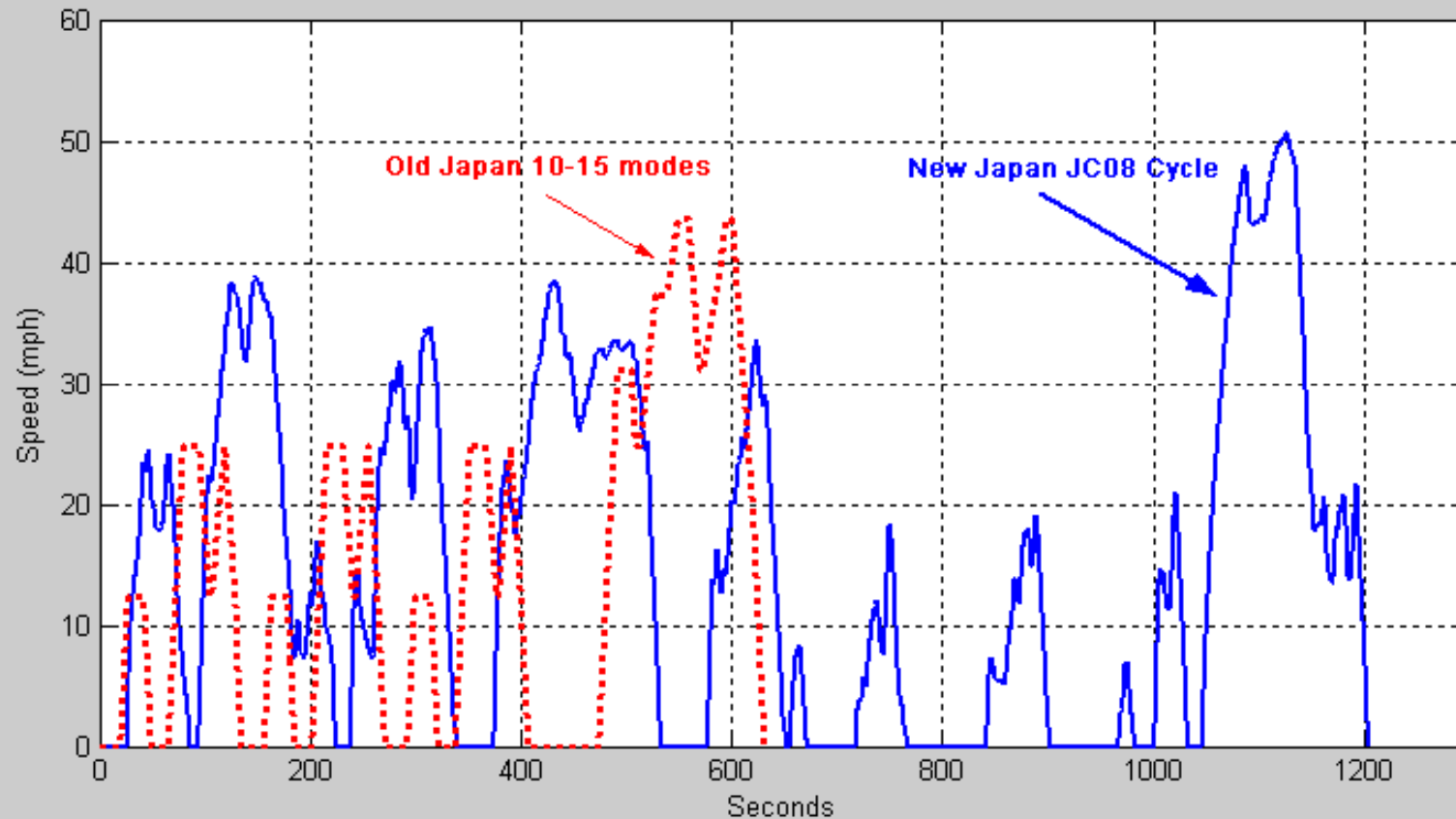
New European Drive Cycle (NEDC)



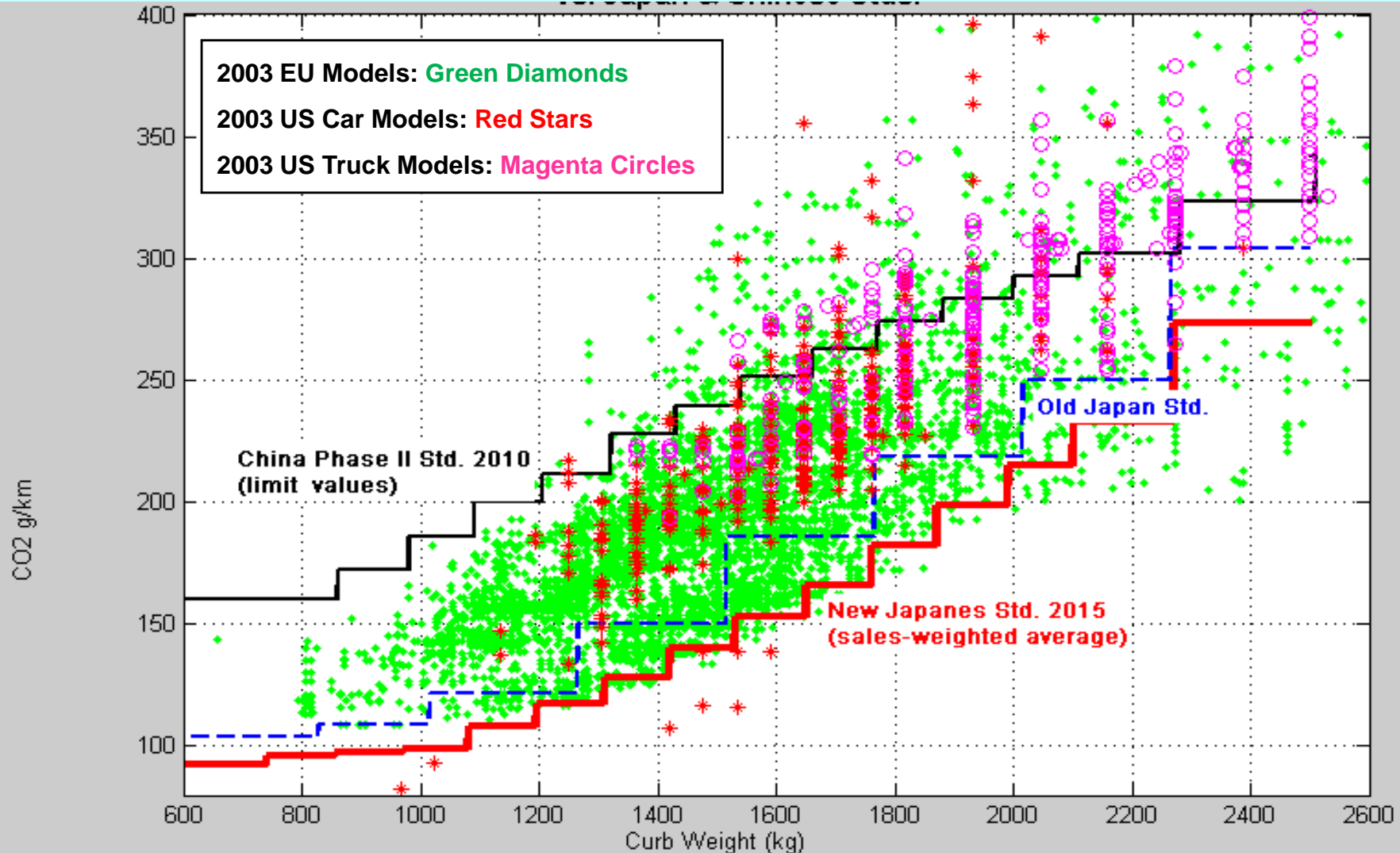
Japan 10-15 Cycle



Japan just updated its regulatory drive cycle to close the “reality gap”



US and EU Vehicle Models in Regulatory Space, Plotted Against Japanese and Chinese Standards



Fundamentals in Demining in-use Carbon Intensity & Inventory for Vehicles

Regulatory Space (which regulations intend to control):

- Standardized Drive Cycle (SDC)
- Lab test FE/Carbon emission results based on SDC for new sales
- Annual VKT for new vehicles
- Unites of new vehicle sales

In Reality, On-road (largely out of regulatory control):

- Real-world, on-road driving patterns/conditions
- Gaps/deficiencies between test vs. on-road in-use FE/Carbon emissions
- Vehicle stock/population, older vehicles
- Survival Rate (or retirement rates for older vehicles)
- VKT Decay Rate for older vehicles

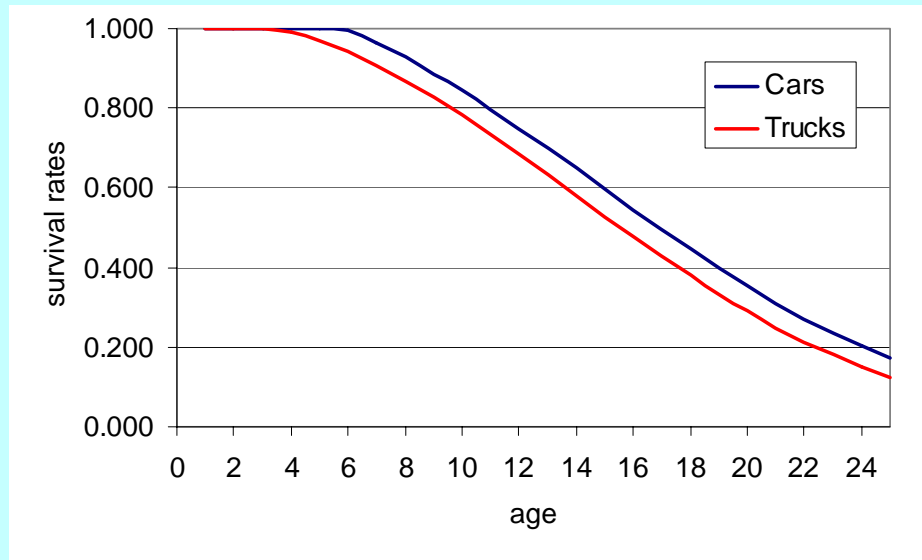
Fundamentals of Vehicle Stock Model

$$F_y = \sum_{i=0}^N (V_{y-i} s_i a_i \frac{1}{(1-g)m_{y-i}}) \cdot D_y$$

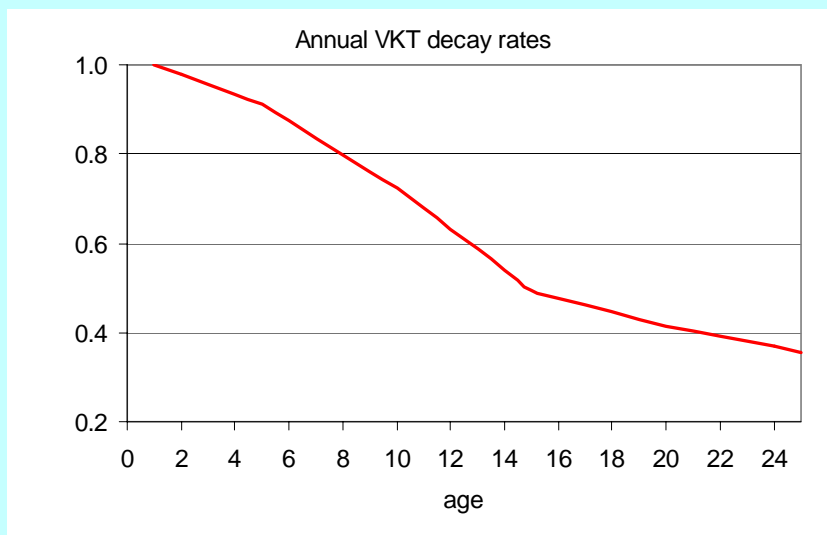
Total Fuel Consumption → F_y
sales → V_{y-i}
survival → s_i
decay → a_i
fuel intensity → $\frac{1}{(1-g)m_{y-i}}$
VKT → D_y
FE Gap → g
Reg. Fuel Economy → m_{y-i}

- y = year
- i = vehicle age, $i = 0, 1, \dots, N$ ($N = 25$ is used here)
- m_y = fleet average fuel economy in year y ,
- g = on- road adjustment (gap or short-fall)
- s_i = survival rate (probability of surviving to age i)
- a_i = annual vehicle travel decay rate (to age i)
- D_y = new vehicle first year travel in year y
- V_y = new vehicle sale in year y
- P_y = vehicle population in year y
- VMT_y = aggregate VMT of vehicle population in year y
- F_y = total fuel consumption in year y
- $\langle m \rangle_y$ = stock average fuel economy

Survival rate and VKT decay rate

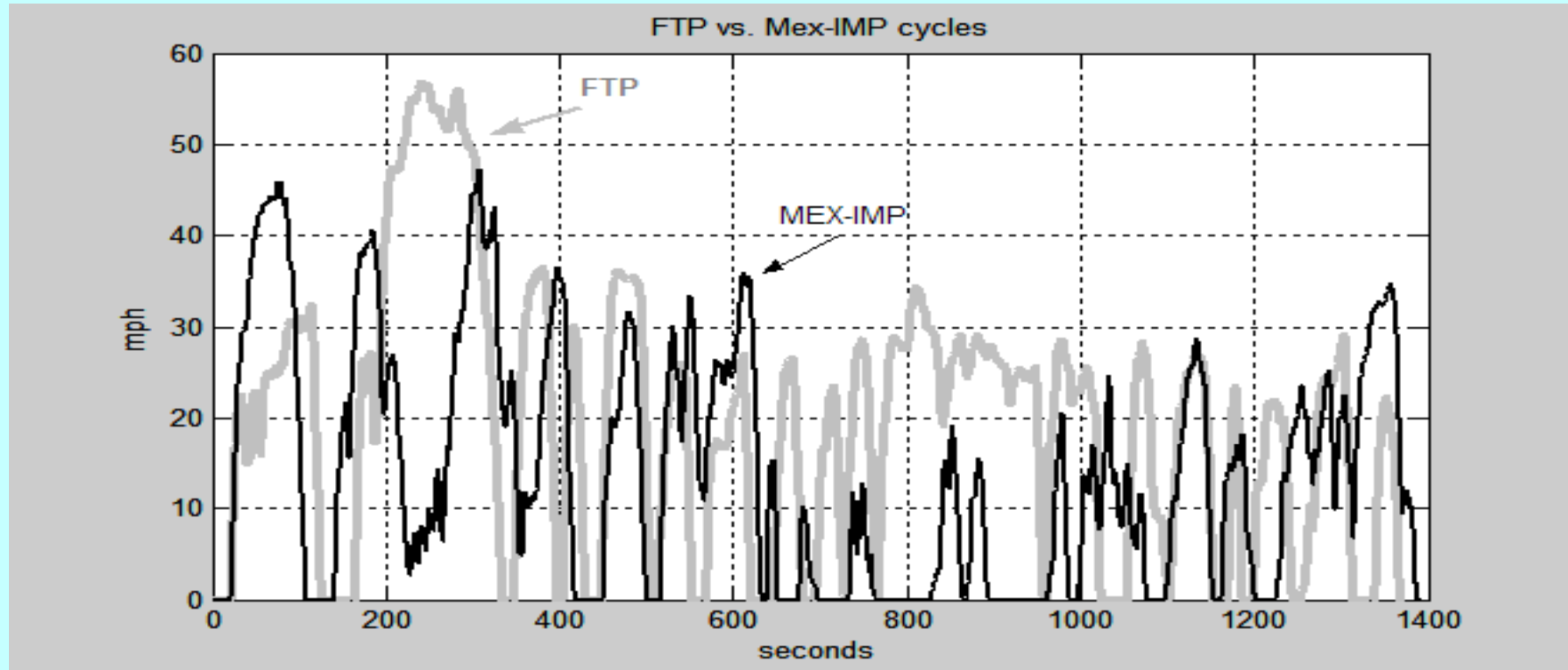


Source: the survival rate is adopted from Oak Ridge National Laboratory (ORNL) Transportation Energy Data Book (Davis 2003).



Source: Derived Mexican vehicle travel decay rate based on John Rogers's (2000) report

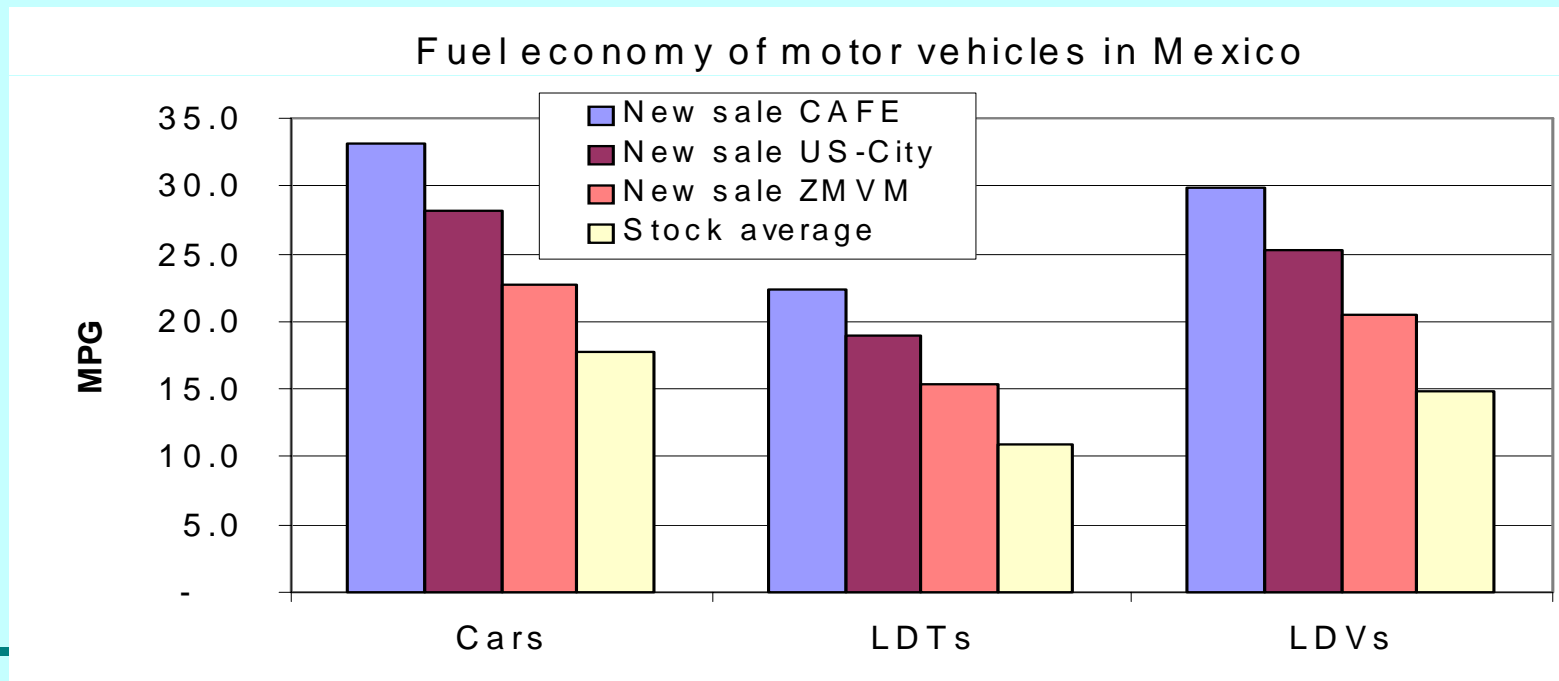
A Mexican Example - Driving cycle and fuel economy “gaps” - “Mex-IMP” cycle



Cycle	Distance (miles)	Average Speed (mph)	Max. Speed (mph)	Max. Acceleration (mph/s)	Share of Idling	Ford Focus MPG	Over-prediction	Conversion factor
Mex-IMP	8.9	22.9	76.0	7.6	26%	8.8	0%	1.00
US City	11.9	31.4	91.2	5.3	19%	10.9	24%	0.81
US CAFE	14.0	52.1	96.4	5.3	11%	12.7	43%	0.70

New Vehicle vs. Stock-wide Average Fuel Economy - a 40% Shortfall

MPG	Cars		Light-duty trucks		LDVs		Short-fall
	mpg	km/L	mpg	km/L	mpg	km/L	
New sale CAFE	33.2	14.1	22.3	9.5	29.9	12.7	18%
New sale US-City	28.1	12.0	18.9	8.0	25.3	10.8	
New sale MCMA	22.8	9.7	15.3	6.5	20.5	8.7	-19%
Stock average	17.7	7.5	10.9	4.6	14.8	6.3	-42%



Conclusions

- Chinese vehicle sales will continue to grow at double digit rates in the foreseeable future
- Oil consumption continue to grow world-wide
- World-wide drive for fuel-efficiency/GHG programs in regulatory space has been intensified
- However, current actions insufficient to make fundamental changes
- More aggressive, but practical comprehensive short-, medium- and long-term targets and strategies are urgently needed
- Carbon emission inventories from cars & trucks are needed
- Understanding real-world, on-road, in-use vehicle fuel efficiency/carbon indicators are challenging tasks
- Sectoral cap vs. intensity target