



Baseline Setting for Vehicle Fuel Efficiency Improvement and CO2 Emission

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Outline

- Background
- Policy review
- Objective
- Collect vehicle registration data
- Cleaning data
- Structuring data
- Estimate baseline fuel economy
- Policy Measure for Fuel Efficient Vehicles



Background

- It is estimated that the vehicle population in Ethiopia has exceeded 450,000 and growing with above 8% annually. Among this about 300,000 are light duty vehicles which emit about 2.3 million ton of CO₂ per annum.
- Most of the light duty vehicles are older than 10 years and beyond their useful service life. As a result, high fuel consumption, emission of pollutants and road accident prevail.
- Hence, Ethiopia is working with United Nations Environment Program (UNEP) to increase vehicle fuel efficiency by identifying and implementing relevant policy packages and this study is part of that.



Objective

- The main objective for this study, setting a baseline and developing a national vehicle database,
 - indicate the trend in fuel economy
 - determine the trend in Carbon dioxide emission level.



Review of Policy and Legislation

- Ethiopia's taxation system of imported vehicles is progressive with cylinder volume.
- There is no regulation that limits the age of import of second hand vehicles
- There is no regulation that encourages cleaner and fuel efficient vehicles such as Hybrid and electric vehicles
- There is no regulation that limits emission of pollutants from vehicles such as Euro standards for catalytic converter and diesel particle filters

Collection of Vehicle Data

- Records of LDVs at ERCA are the main sources of data for the study of pilot GFEI project in Ethiopia
- LDVs data are also collected from new brand vehicle importer and assembler
 - LDVs incorporate those which are
 - Newly registered in the year 2005, 2008 and 2010
 - With gross weight less than 3500kg
 - Whose seat capacity ranges b/n 2 and 15
 - Brand new as well as the used one

Classification of Light Duty Vehicles

- Based on body type LDVs classified as
 - Compact car
 - Saloon
 - SUV
 - Minivan and Van
 - Pick-up

LDVs Registered by Year from ERCA and Assembler s

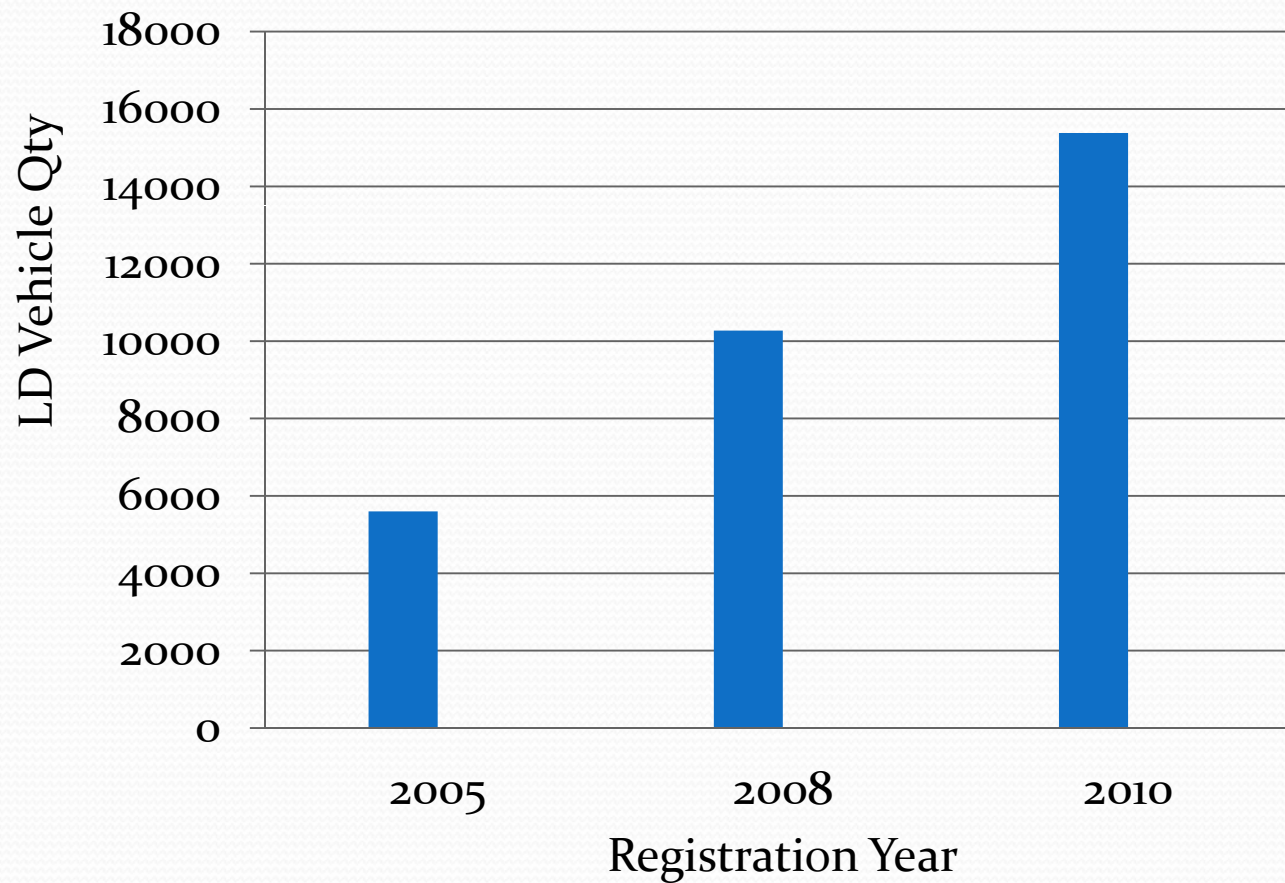
ERCA data

Import Years	2005	2008	2010
Vehicles Quantity	5598	10254	14931

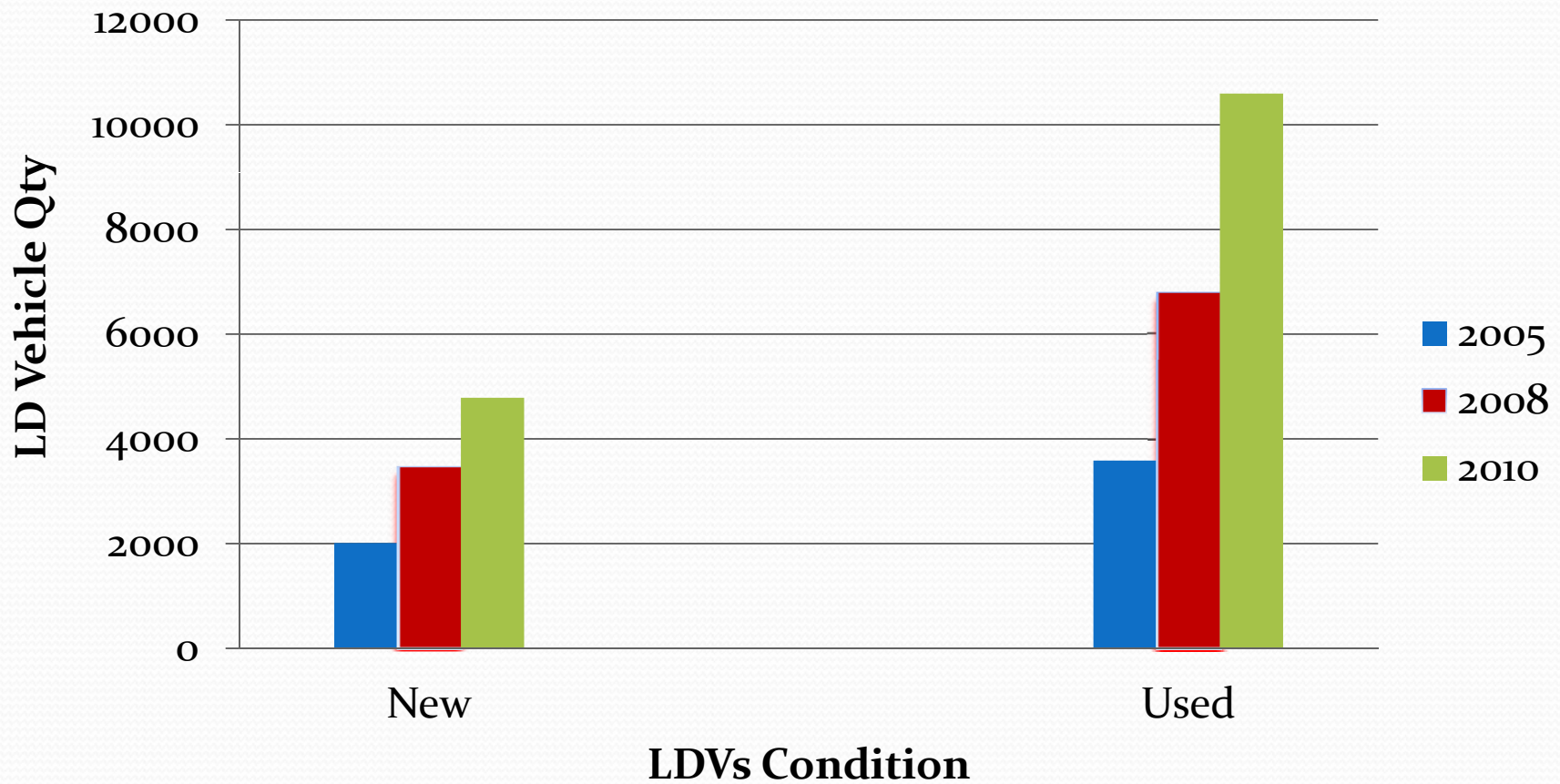
Local Assembler

Assembled Years	2005	2008	2010
Vehicles Quantity	0	257	450

Total LDVs versus Registration Year



Total Registered LDVs by Condition



Major Data Attributes for the Baseline Setting

- Vehicle make and model,
- Model production year
- Year of first registration, if different from model year
- Fuel type
- Engine size
- Domestically produced or imported
- New or second hand import
- Rated Fuel Economy per model and test cycle basis.
- Number of sales by model

Nature of Raw Data from ERCA

Data collected from custom authority has severe irregularities and unregistered information

Raw Vehicle Data

TOYOTA COROLLA (CH#JT1EOEE9000447281,M/Y1992 MODEL-EE90L-AEMDEW,ENG-2E-2451657)

ENGINE 3L-5475634, MODEL LN166L-PRMDS,M/Y2004 (TOYOTA HILUX DOUBLE CABINE PICKUP CH.NO. JTFDE626X00128020)
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NISSAN X-TRAIL MOD.TVHNLAYT30URAY062Z (CH.NO. JN1TENT30Z0005735 EN.NO. YD22146725)
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1*2ND HAND CAR TOYOTA COROLLA,M.Y 1992 (CH#.JT1LOEE9007143710, CC 1295 MOD#.EE90L-ALMDEW,ENG#.2E-2441128)
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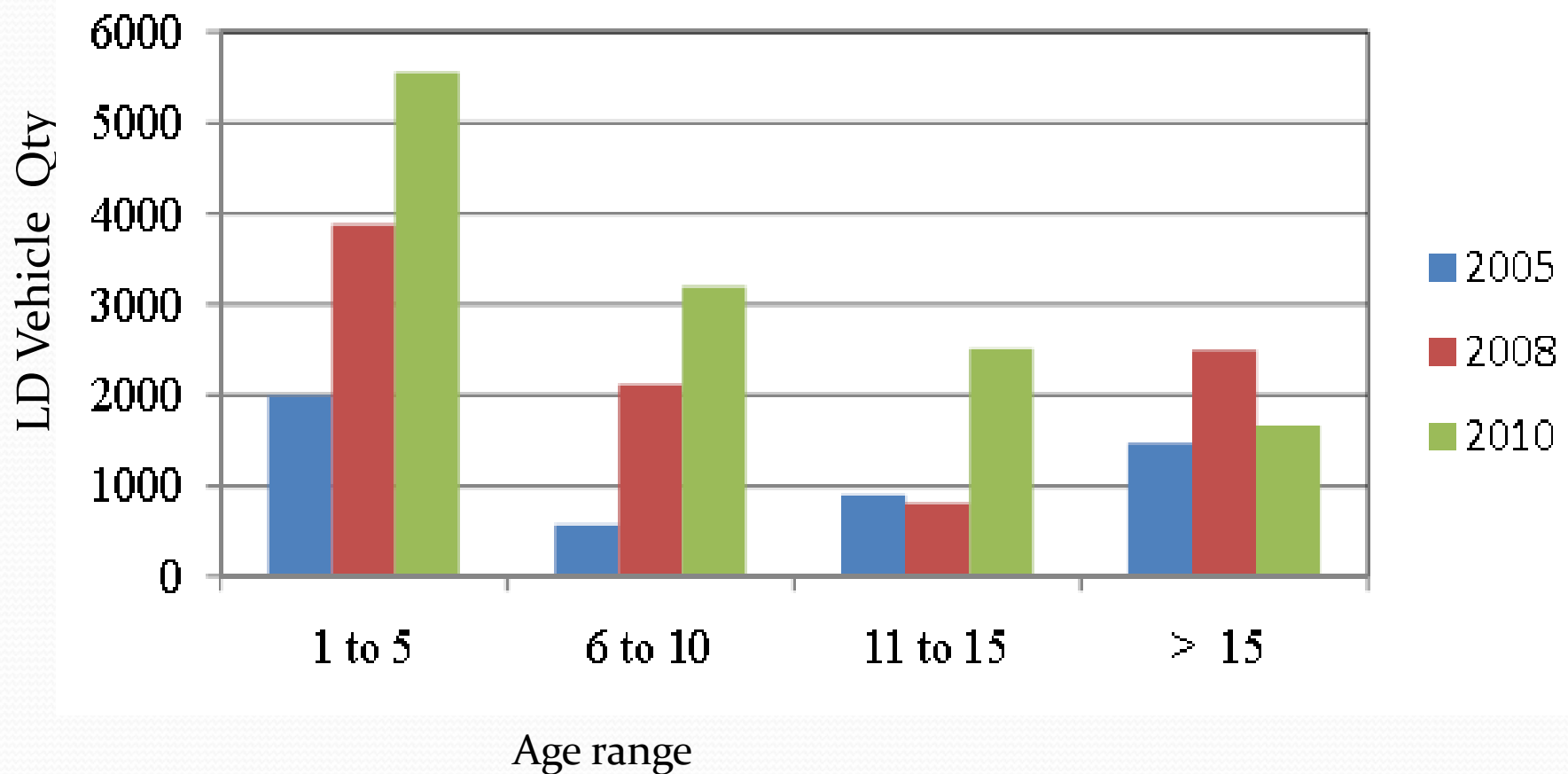
TOYOTA CORLLA, CH.NO. JTFDE626X00128021

Make	Model	Condi.	Body Type	Engine Disp. Vol. CC	Net Weight	Fuel Type	Qty	Prod.ion year	Regist Year	Fuel economy l/100 Km	GHG Emission gCO2/km
TOYOTA	Corolla	USED	Saloon	1300	950	Petrol	1	1986	2005	8.2	192.9
TOYOTA	Corolla	USED	Saloon	1300	1000	Petrol	1	2003	2008	6.5	153.8
FORD	Fiesta	NEW	Compact	1250	3441	Petrol	3	2010	2010	7.6	178.3
HYUNDA	Getz	NEW	Compact	1086	961	Petrol	1	2010	2010	5.6	133.0
NISSAN	Hardbody	NEW	Pick Up	3153	3836	Diesel	2	2010	2010	8.8	236.6
TOYOTA	Hilux	USED	Pick Up	2779	3000	Diesel	1	2002	2008	11.1	296.0
TOYOTA	Land cruiser	NEW	S.Wagon	4164	2060	Diesel	1	2004	2005	13.3	355.2

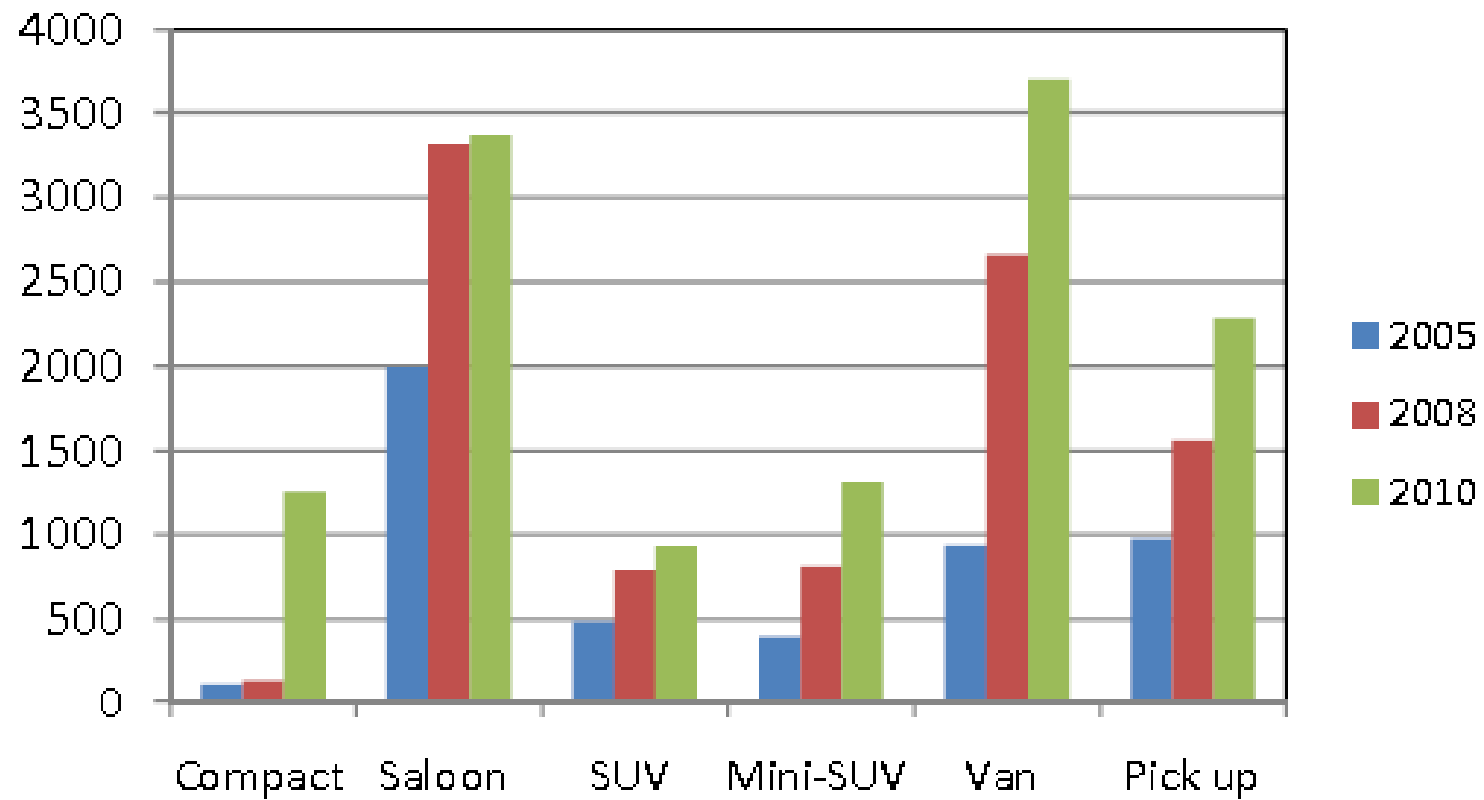
Volume Classification by Engine

Volume	2005		2008		2010	
(cc)	<i>PETROL</i>	<i>DIESEL</i>	<i>PETROL</i>	<i>DIESEL</i>	<i>PETROL</i>	<i>DIESEL</i>
≤ 1000	204	0	142	0	1190	0
1001-1300	1834	8	3378	5	3361	333
1301-1800	309	8	417	29	390	54
1801-2000	260	2	122	21	123	16
2001-2500	72	146	68	1181	186	2763
≥ 2500	115	1953	192	3841	1590	4250

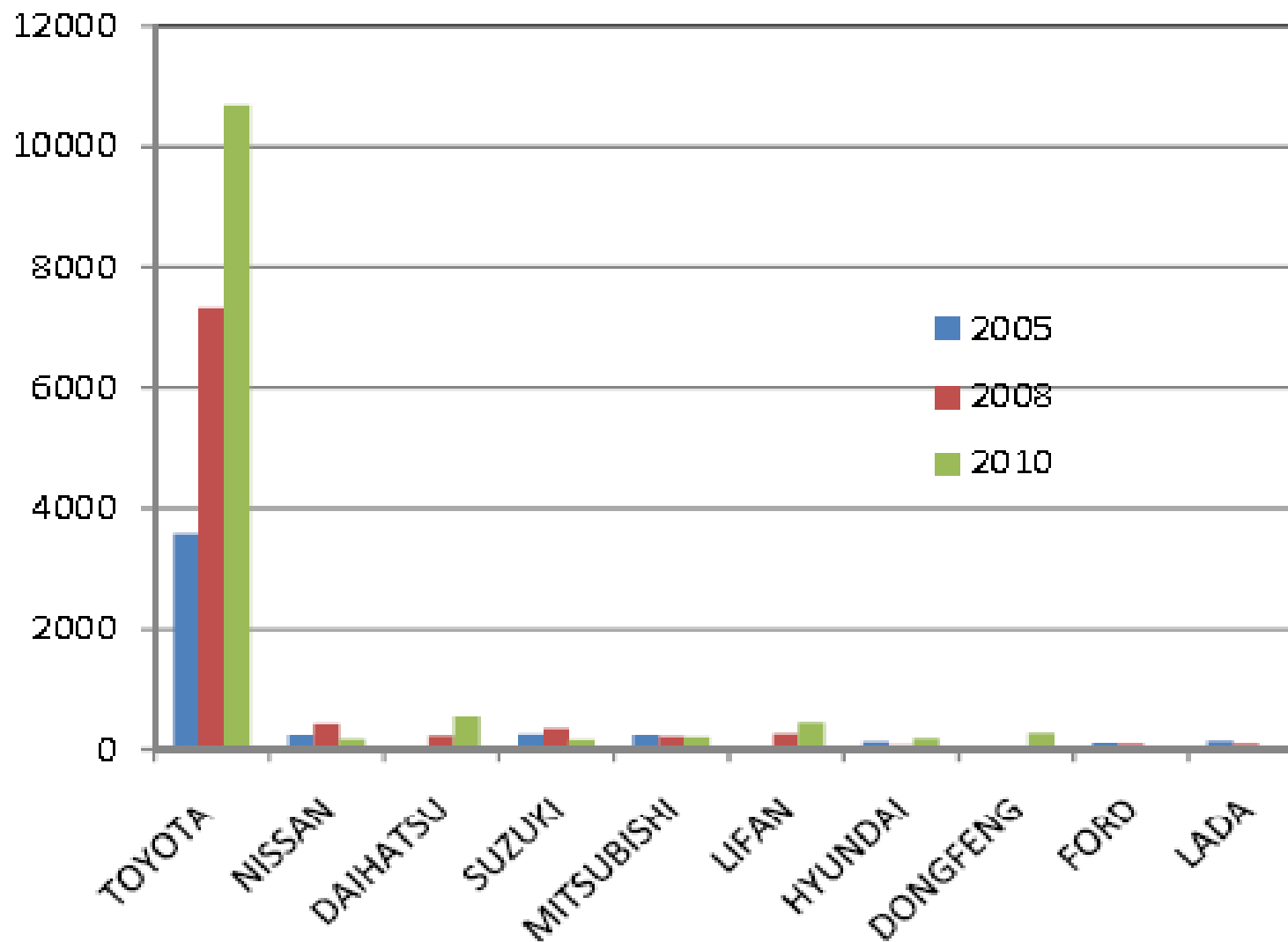
Registered LD Vehicles by Age Group



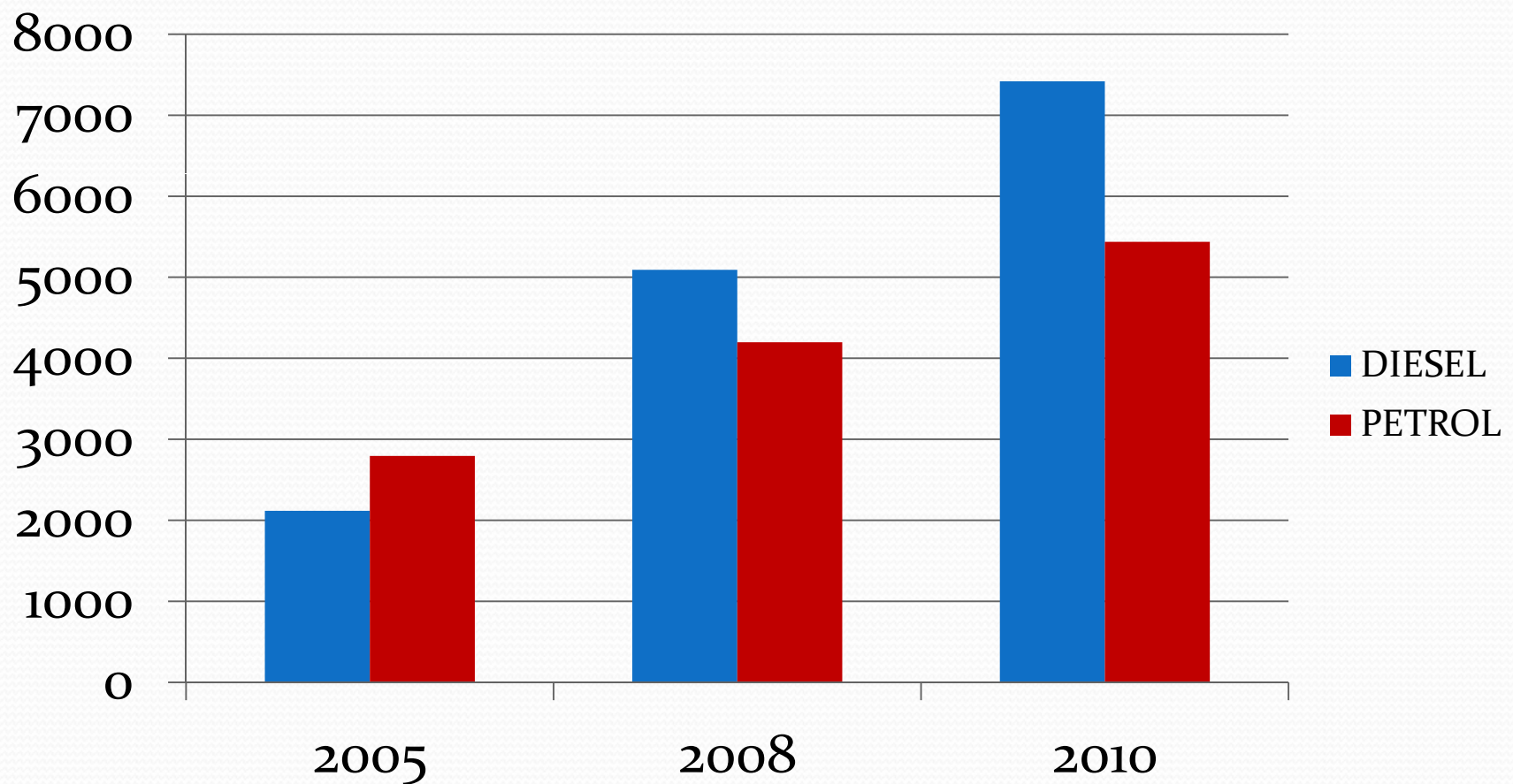
Classification of Regist. Vehicles by Body Type



Quantity of Imported Vehicles by Brand



Classification by Fuel Type



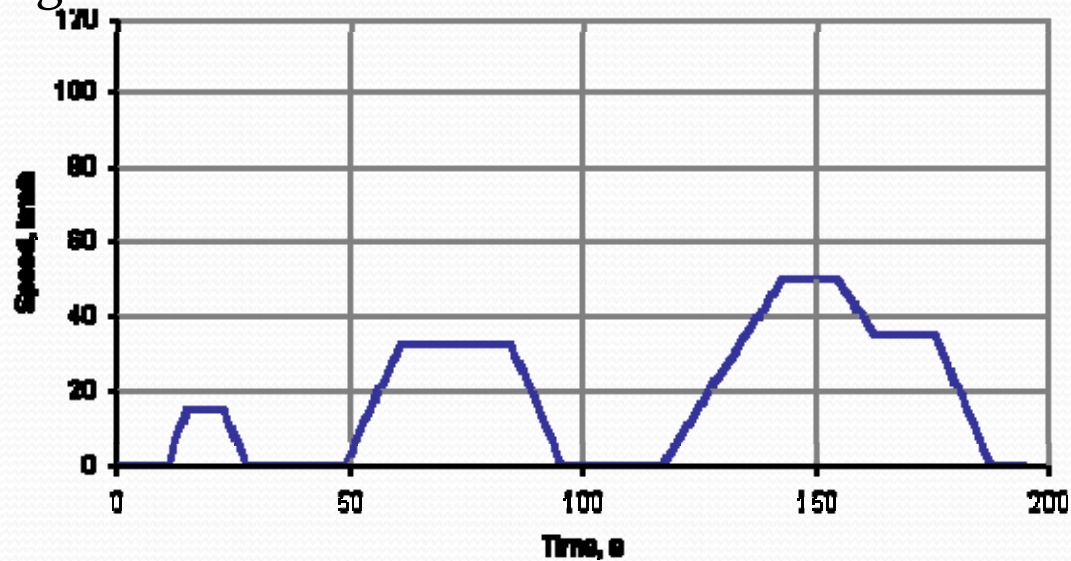
Average Fuel Economy and Emission

$$\text{Harmonic average annual fuel economy} = \frac{\text{Total sales in the year}}{\sum_i^n \frac{\text{sales model } i}{\text{fuel economy model } i}}$$

$$\text{Average annual CO}_2 \text{ emission} = \frac{\sum_i^n \text{sales model } i * \text{emission model } i}{\text{Total sales in the year}}$$

Fuel Economy

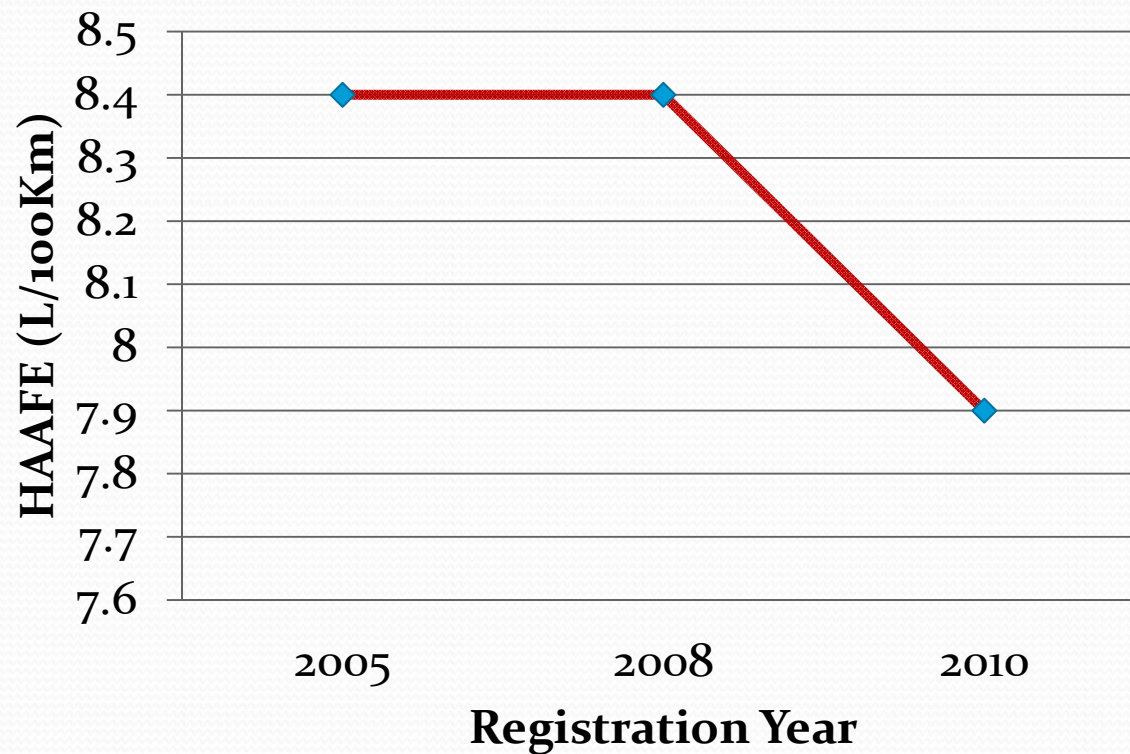
- All auto fuel economy records included in this database are in compliance with European Driving cycle
- The urban driving cycle known as ECE which is devised to represent city driving conditions.



- The extra urban driving cycle represents high way driving condition.

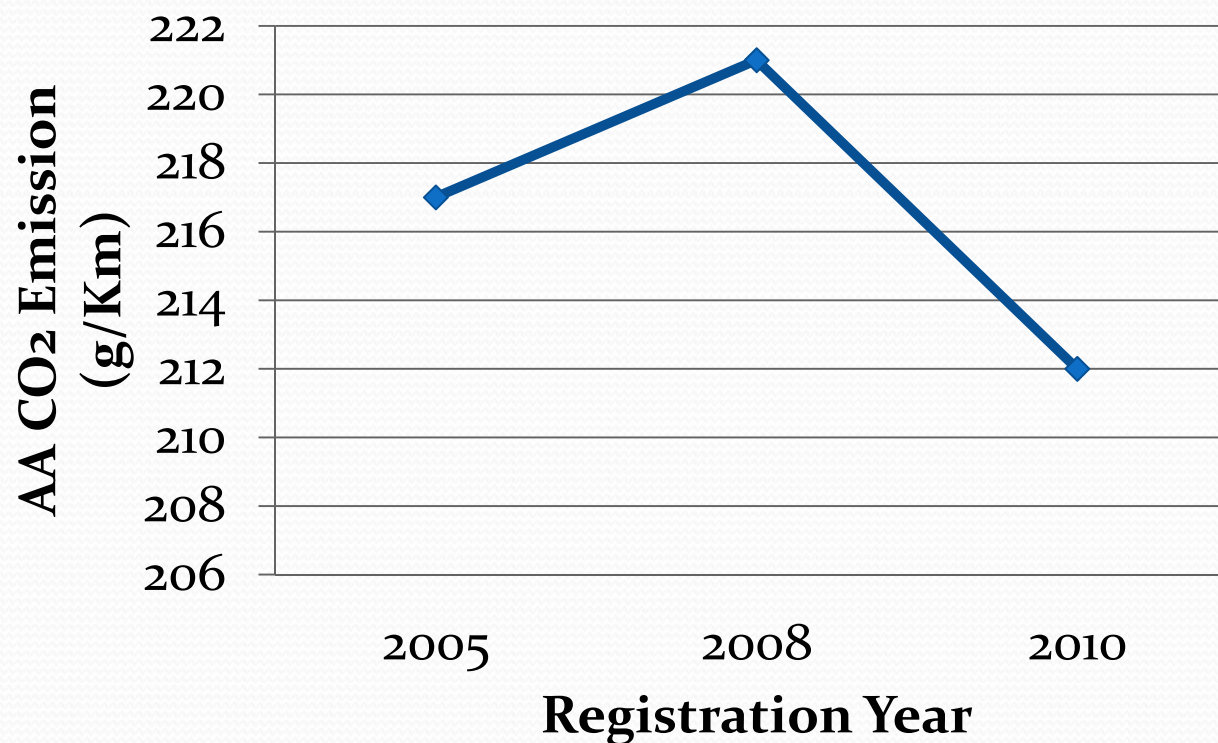
HAAFE Vs Registration Year for all LDVs

Registration Year	2005	2008	2010
Harmonic Average Annual Fuel Economy (L/100Km)	8.4	8.4	7.9



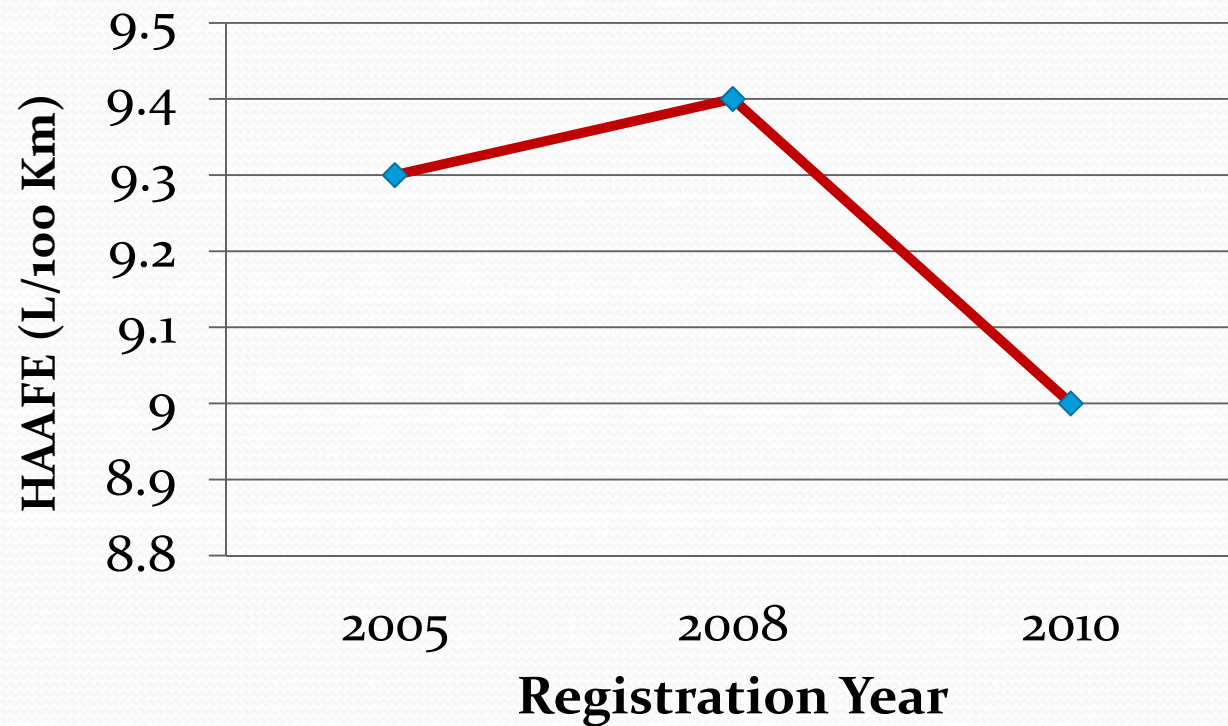
AA CO₂ Vs Registration Year for all LDVs

Registration Year	2005	2008	2010
Average Annual CO ₂ Emission (g/Km)	217	221	212



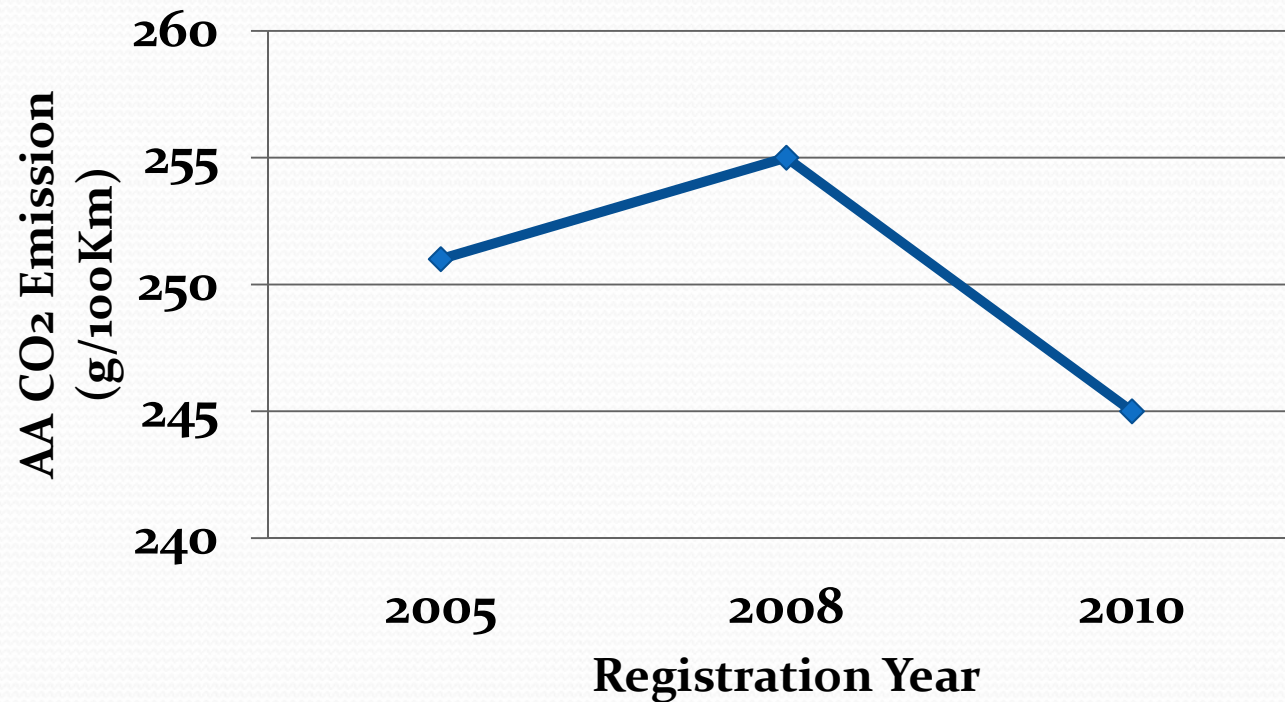
Average Fuel Economy Vs Registration Year for Diesel LDVs

Registration Year	2005	2008	2010
Harmonic Average Annual Fuel Economy (Km/L)	9.3	9.4	9



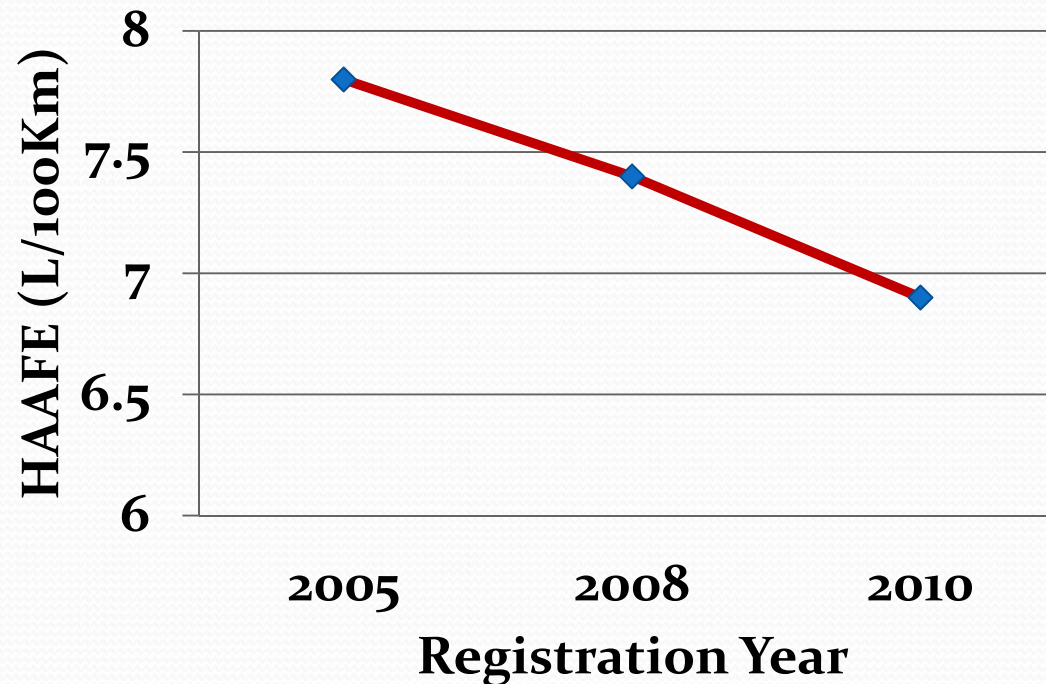
AA CO₂ Vs Registration Year for Diesel LDVs

Registration Year	2005	2008	2010
Average Annual CO ₂ Emission (g/Km)	251	255	245



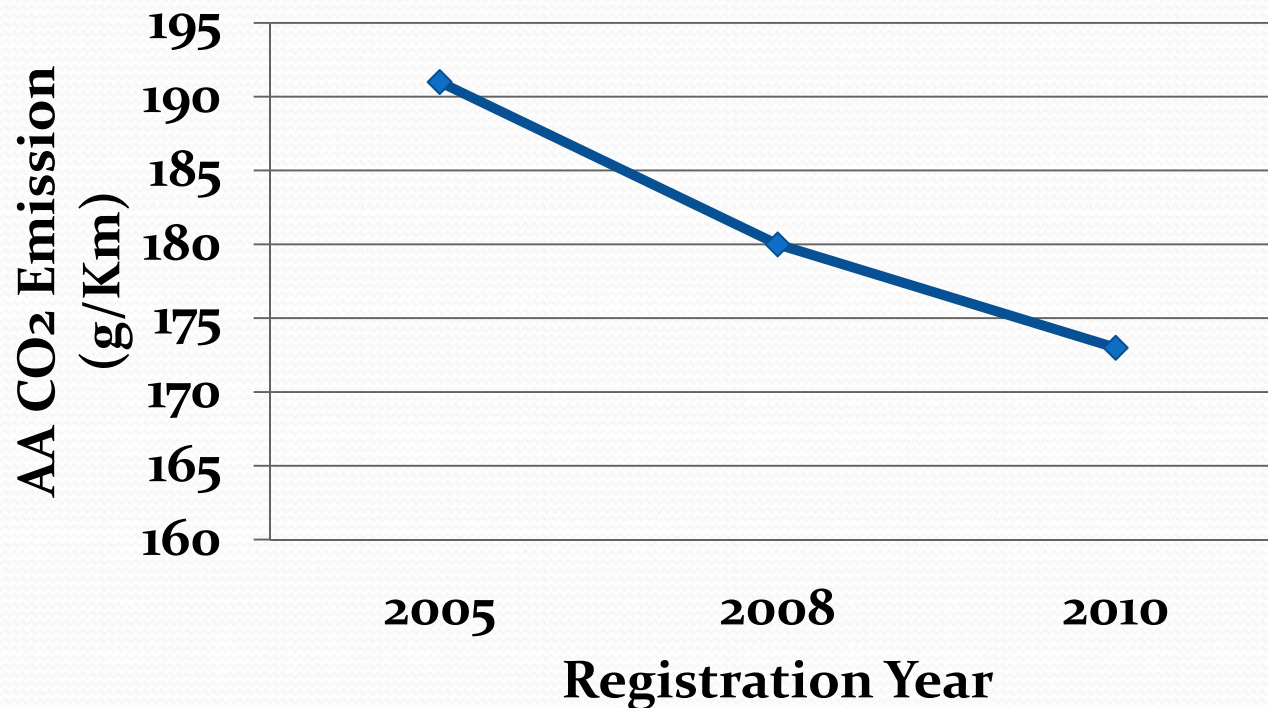
HAAFE Vs Registration Year for Petrol LDVs

Registration Year	2005	2008	2010
Harmonic Average Annual Fuel Economy (Km/L)	7.8	7.4	6.9

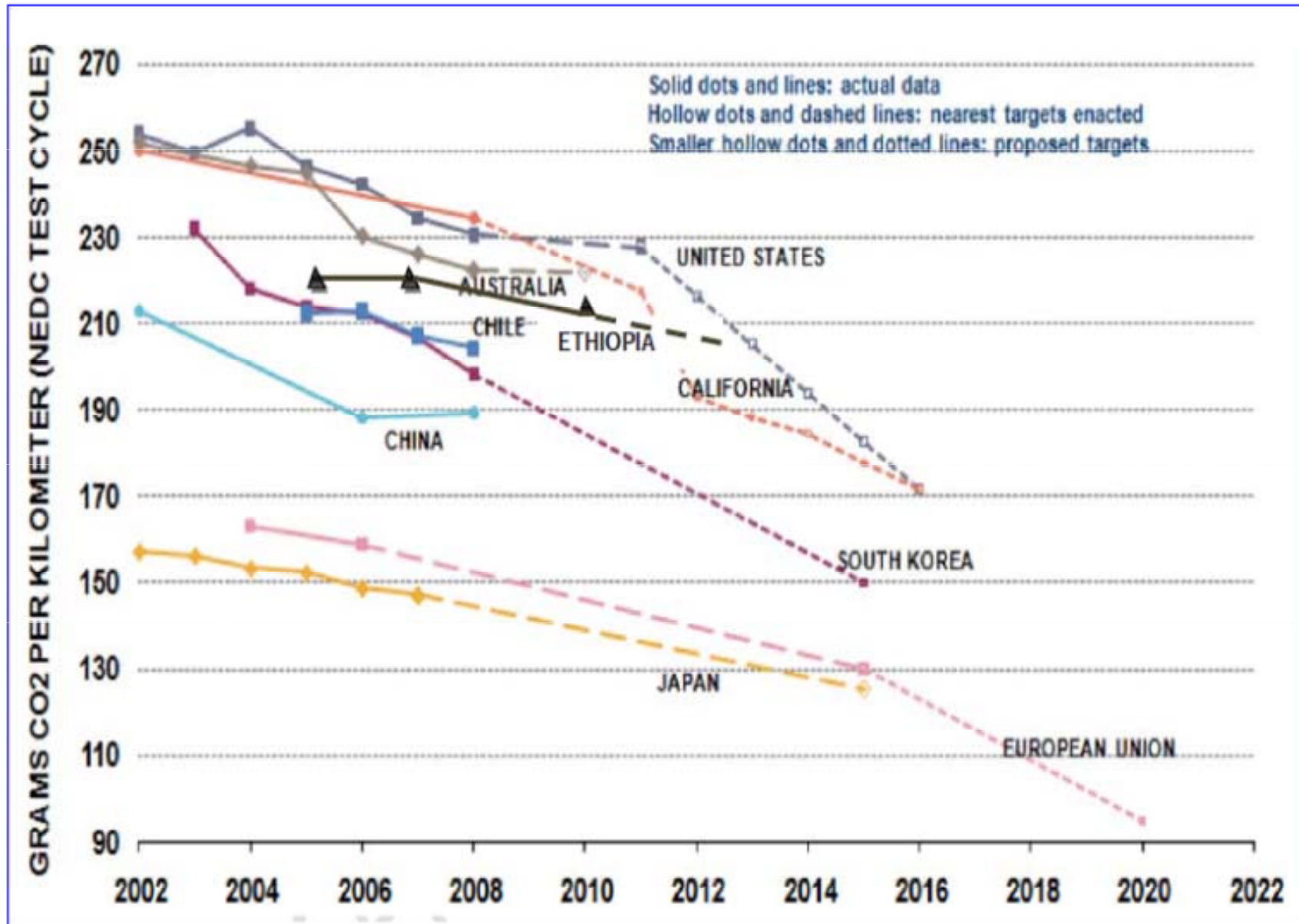


AA CO₂ Vs Registration Year for Petrol LDVs

Registration Year	2005	2008	2010
Average Annual CO ₂ Emission (g/Km)	191	180	173



Comparison of Average Vehicle CO2 Emission data with the International Trend.

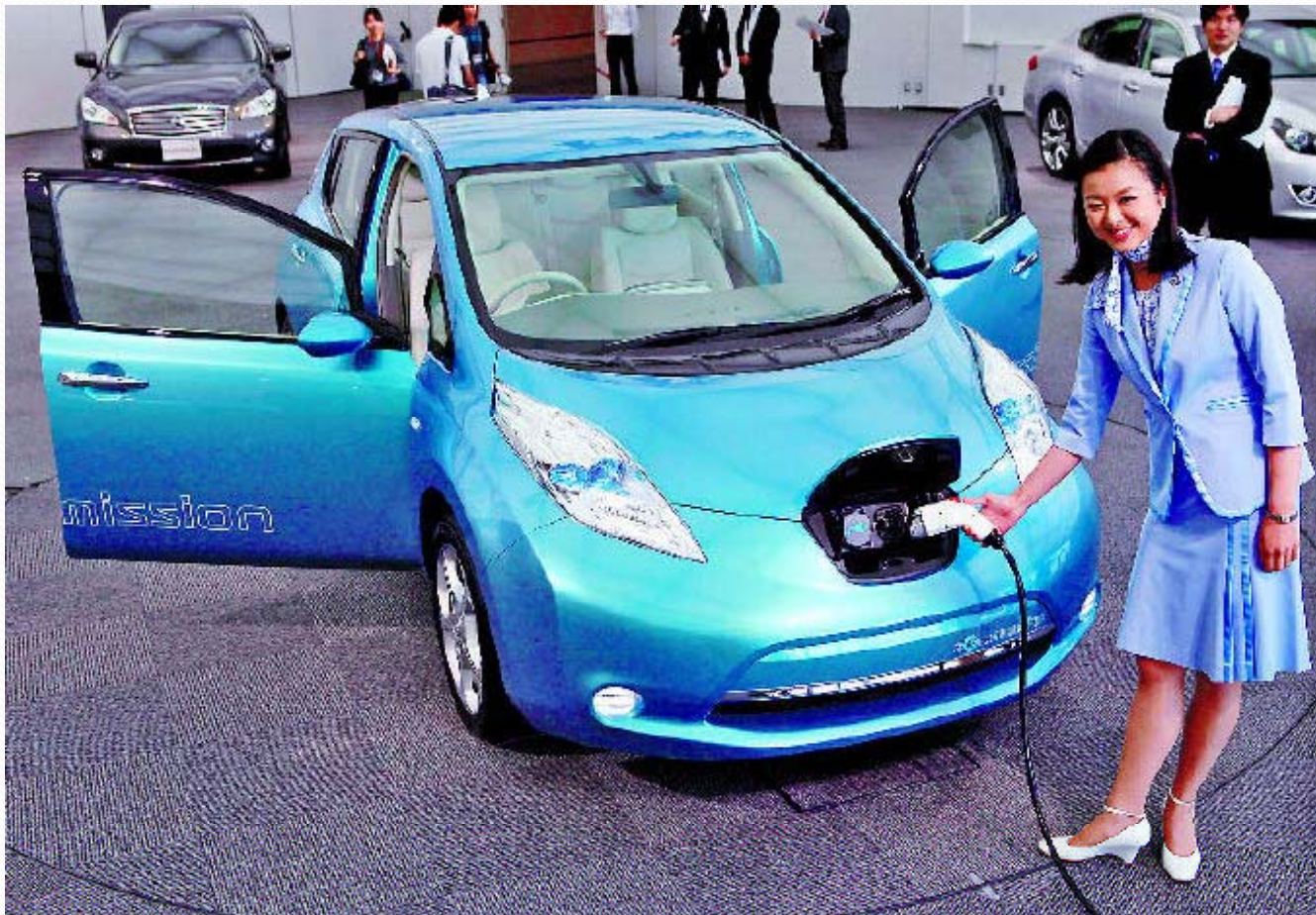




Policy Measures: Vehicle Efficiency Improvement

- Mandatory requirement of fuel efficiency and emission certificate for vehicles to be imported or assembled in the country.
- Banning of import of old second hand vehicles
- Introduction of hybrid and electric vehicle by offering tax incentives (Excise and Sur Tax)
- Improvement of maintenance infrastructure of vehicles and
- Increasing awareness on Eco driving

Technology Options: Electric vehicle



Policy Measures: Imported Vehicles Age Limit

- Algeria - must be less than 3 years old.
- Brazil Imports of used vehicles are not allowed
- South Africa does not allow
- Sudan new (except migrants)
- Jordan, less than 5 years old.
- Kenya 8 years
- Lesotho 8 years
- Gabon 5 years
- Mozambique cars – 5 Vans -9
- Niger 5 years (Diesel=360 ppm sulfur petrol=160 sulfur)



Policy Measures: Awareness for ECO Driving

- Start slowly, avoiding rapid acceleration.
- Gear-up, use the highest gear possible, and lower the engine speed.
- Maintain a constant speed
- Anticipate traffic conditions, and accelerate and decelerate smoothly – it is safer, uses less fuel, and reduces brake wear.
- Drive at posted speed limits.
- Avoid idling for any stop of more than 60 seconds reduces fuel consumption and carbondioxide emissions.
- Avoid excessive weight - on roof of car or boot causes additional fuel consumption.
- Check the tire pressure monthly with cold tires.
- Replace air filters regularly - saving up to 10% fuel consumption.

Policy Measures: *Promoting Use of Cleaner Fuels*

- Amending the Ethiopian standard for limiting sulfur to 50 ppm maximum in diesel fuel by 2015 so that modern vehicles with diesel engines with lower particulate emissions can effectively use particulate filter for cleaning exhaust.
- Preparation of incentive package to promote biodiesel production such as VAT exemption

Policy Measures: Cleaner Vehicles

- Legislation Emission Standards by 2016 or _by adopting Euro IV standard taking a transition with Euro III.
- Emission certificate shall be presented as per European Driving Cycle.
- The Standard shall not be applicable Three wheel vehicles which will be used outside Addis Ababa
- Three wheel vehicles shall have 4 stroke engines.
- Tail pipe CO emission test shall be conducted to check functionality of Catalytic converters.



Conclusions

- This study indicates that the average fuel economy for LDVs in Ethiopia in 2005 and 2008 were 8.4 L/100Km with corresponding CO₂ emission of 217 and 221 gCO₂/km
- The same study shows that in 2010 the fuel economy slightly decreased to 7.9 L/100Km with a corresponding CO₂ emission of 212 gCO₂/km.
- Diesel fueled LDVs were found to travel less kilometer per liter of fuel as compared to petrol engine vehicles and emit more CO₂ than petrol fueled vehicles.
- This results are in lower regime when compared to that of reported in the literature [ICT,2012], which is caused by importation of second hand vehicles and relatively larger share of Vans, SUVs and Pick-ups in the total import of LD Vehicles.