ENVIRONMENTAL MONITORING OF THE CHILEAN AUTOMOTIVE MARKET

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Executive Summary

The main purpose of this study is to present a set of indicators which allow making a monitoring of the automotive market from the environmental point of view. One of the main challenges of sustainability is the impact mitigation associated to the growth of vehicle fleets, either from the point of view of greenhouse gases emissions, as well as the increase in the contribution to local pollution problems, for instance, the case of Santiago City. Proposed indicators, developed from the demands of emission averages and performance applied to large automotive manufacturers in developed countries is a valuable tool for monitoring automobile annual sale impacts and for the definition of more efficient regulation instruments.

The national automotive market has shown growing rates of a 27% and 30% between 2005, 2006 and 2007; except in 2008 when there was a stagnancy as a consequence of the international financial crisis and sales decreased a 8%. The segment of greater size vehicles, like double cab trucks and SUV[1], have broken through in a very notorious way, growing in 212% in the period of 2005 to 2008 representing almost a third of automobile sales which has an effect on a bigger size and average cylinder capacity of the market. This is a phenomenon previously observed in other economies. For example, at the end of the nineties in the United States which caused an increase in the emissions of local and global polluting agents as well as a deterioration of the energetic efficiency having these vehicles a minor performance. The national legal framework has also an effect on this phenomenon with distortions like the tax discount when purchasing pickup trucks and four-wheel drive vehicles.

In Chile, models homologated under EURO standards have displaced those homologated under EPA standards, and diesel technology has progressively gained a greater market participation representing the 22% of all sales in 2008. This has produced two effects: a reduction of the average of CO2 emissions and a substancial increase of Nitrogen Oxides emissions. The NOx emission average of all EURO gasoline light-duty automobiles commercialized in 2008 was 0.022 grams per kilometer, while in the case of EURO diesel light-duty corresponds to 0.19 grams per kilometer, that is to say, 9 times bigger. In the case of commercial vehicles, the emission is 21 times bigger.

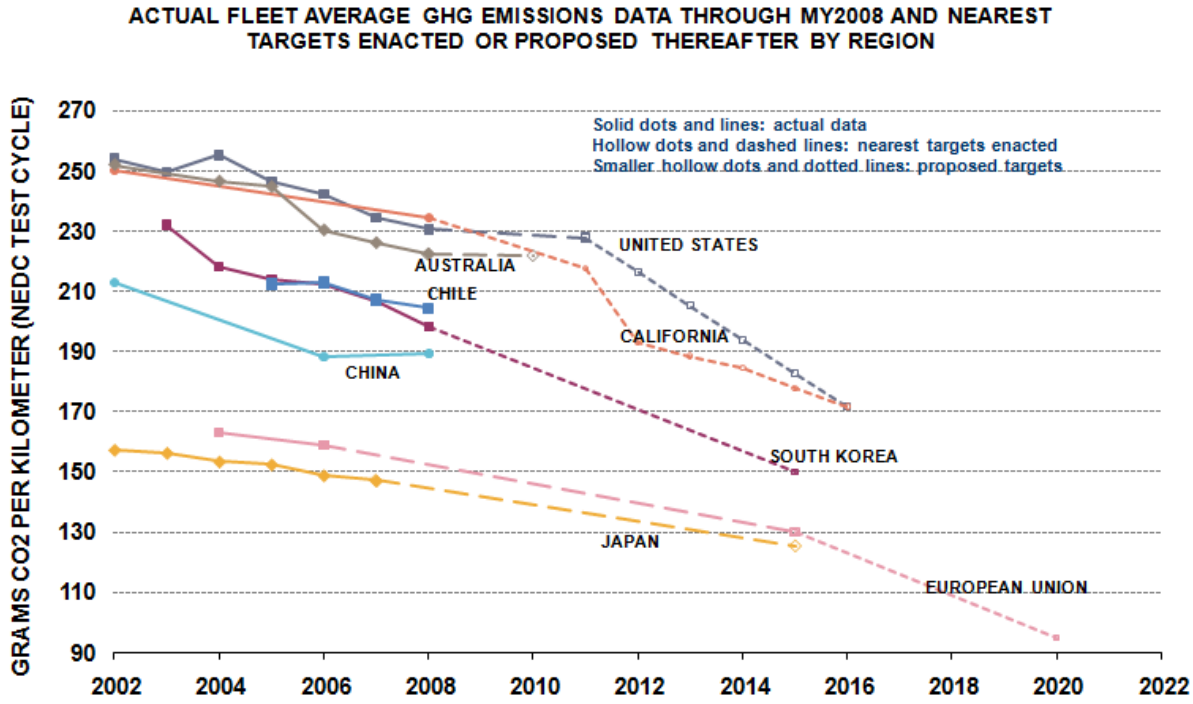
Sales average emissions from 2005 through 2008 have been stable, except in the case of models homologated under EURO standards, which present a reduction from 2005 to 2006. This was the result of an increase in the offer in the national market, since this regulation was adopted at the end of 2004 in the Metropolitan Region. Besides that, diesel commercial vehicles segment presents an importan increase in its emissions during 2007 and 2008, maybe due to the increase in pickup trucks offer and SUV EURO III from Asia, since this regulation is still accepted in the country in spite of being 10 years old.

The national market presents CO2 average emissions similar to those observed in South Korea and close to the average of Australia and U.S.A. In order to understand this phenomenon, it is necessary to know that the national market composition is very particular because they share

[1] Sport Utility Vehicle; corresponds to an automobile category produced as from a commercial vehicle chassis adapted as station wagon or similar for familiar use, often four - wheel drive equiped. According to its commercial category, environmental demands are less than those for an automobile, for this reason the overcrowding problem has been internationally faced by means of an optimization of polluting agents emission regulations.

very important sales in pickup trucks and SUV segment, very typical of the United States with a great quantity of units sold in city cars segment (Class A Automobiles) inexistent in the North country. It's necessary to consider that the countries above mentioned, unlike Chile, have in force fuel efficiency regulations , for which the difference of emissions is also minor.

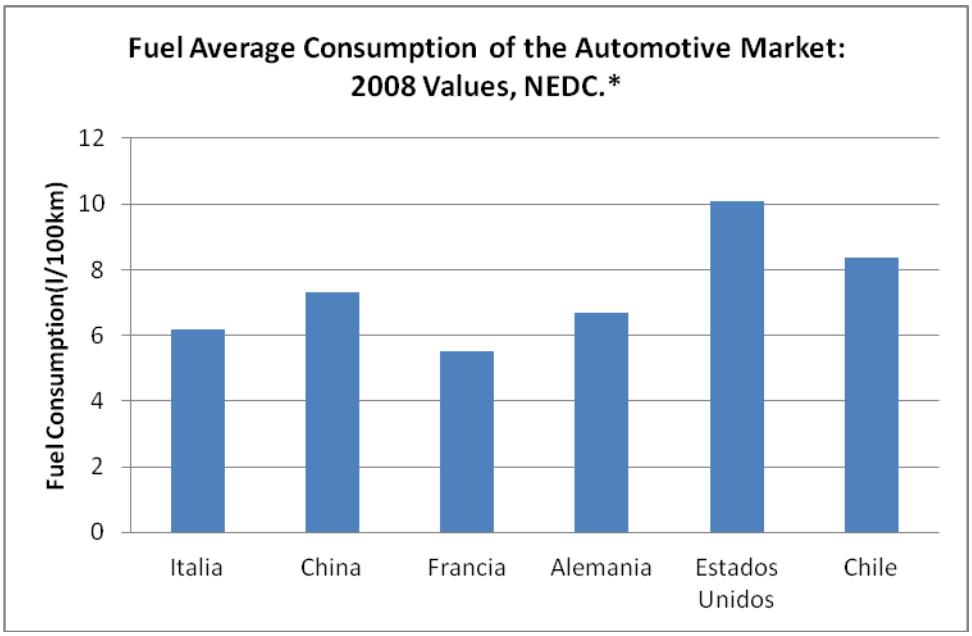
With respect to the markets of the EU and Japan, our country shows an important delay, with emissions 30% higher. The reason is that these countries show less SUV and pickup trucks participation and have either programmed or current strong efficiency and CO2 emission regulations.



In the period studied, a reduction in the CO2 average emissions is observed due to the growing participation of diesel[2] automobiles in the market. The problem is that this CO2 partial reduction through dieselization has meant a trade off with the increase of local polluting agents' emissions such as NOx and particulate matter since these diesel vehicles have been acquired to the detriment of gasoline vehicles which present less emissions of these pollutans.

Relating to the growing international concern, due to the problem of climate change, we find the need to reduce the dependence of fossil fuels, an aspect in which Chile is extremely sensitive. This was demostrated in the last crisis of 2008 where the State had to complement in a billion dollar the Oil Price Stabilization Fund along with an important loss in fund collection due to the transitory reduction of gasoline taxes. In an international comparison we can see that the national automotive market average consumption is high, which has important implications in future oil demand.

[2] In general terms a diesel automobile is more efficient than a gasoline automobile.



*International data taken from ICF International

The automotive fleet growth is one of the biggest environmental challenges for the country in the next decades. From an environmental perspective, NOx emission, particulate matter and volatile organic compounds goals are required for the automotive market integrated in a coherent strategy with CO2 reduction. It is required as well, to complete this effort with a promotion to use automobile in a more reasonable way, public transport and non motorized means.

Finally, there is no doubt that an amendment to adquisition taxes and the use of vehicles is required, as well as fuel taxes to align them with the environmental goals of the automotive sector.

National market description of light-duty and commercial vehicles

The automotive market has experienced a high growing during last years, with rates above 20%, except in 2008 where a decrease was observed as a consequence of the world economic crisis. In order to describe this market, two vehicles categories have been used: light-duty and commercial. The first one corresponds to sedans, coupe, sport and station wagons[3]; the second one considers pickup trucks, van and SUV[4].

Figure 1 shows annual sales from 2005 through 2008, pointing out the percentage corresponding to light- duty and commercial vehicles.

[3] Light: considers models classifyied as ligh plus commercial class 1 according to EURO standards plus models classifyied as light, commercial light and commercial type 1 according to EPA standards. For more details see annex 1.

[4] Commercial: Considers models classifyied as commercial type 2 and 3, plus medium class 3 according to EURO standards, plus models classifyied as commercial type 2 and medium type 1 and 2 according to EPA standards.

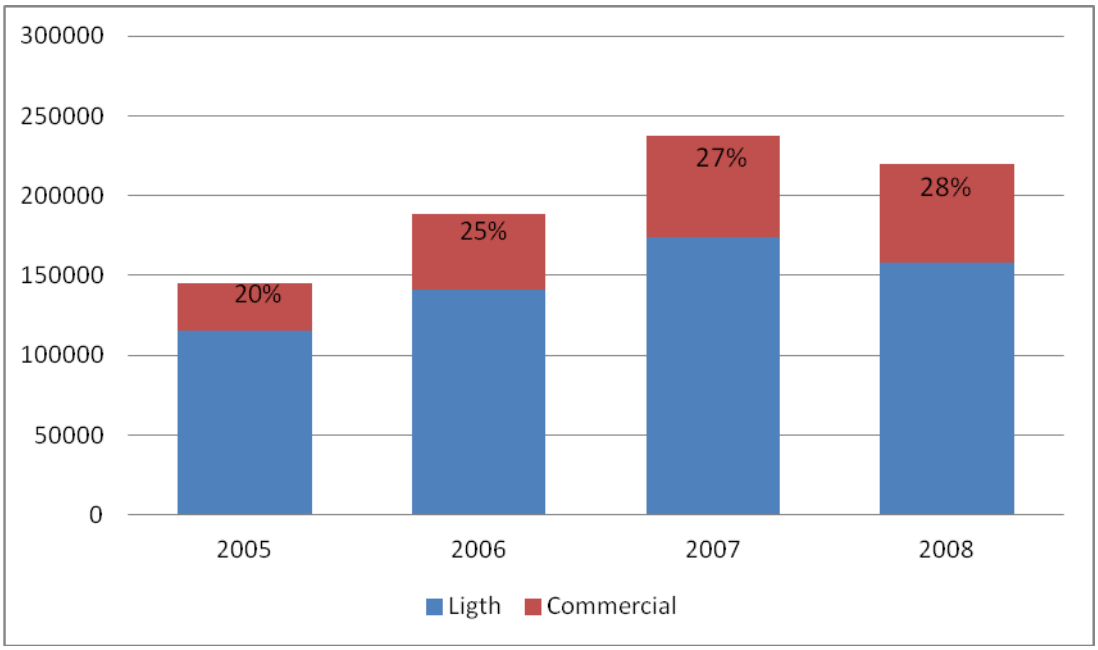


Figure 1: Sales of new vehicles during 2005 to 2008

It is noted that commercial vehicles category is growing at a very high rate, even in the period of economic crisis, showing an increase of 212% for the studied period.

This behaviour has been previously noted in developed countries such as the United States of America due to the interest of the market in bigger size and four - wheel drive vehicles. It is probable that in our country this trend be strengthened by the tax incentive to purchase work vehicles, which is used to purchase personal use vehicles through the companies.

It is important to highlight that commercial vehicles have less emission requirements than light vehicles. This may be the reason why most of diesel commercial vehicles sales of the period 2005 - 2008 is concentrated in the range of 2710 and 2750 kg. same as shown in Figure 2, just over the value dividing light and medium categories (2.700 kg). Total sales between vehicles in this range correspond to a 24% of total sales of diesel commercial vehicles.

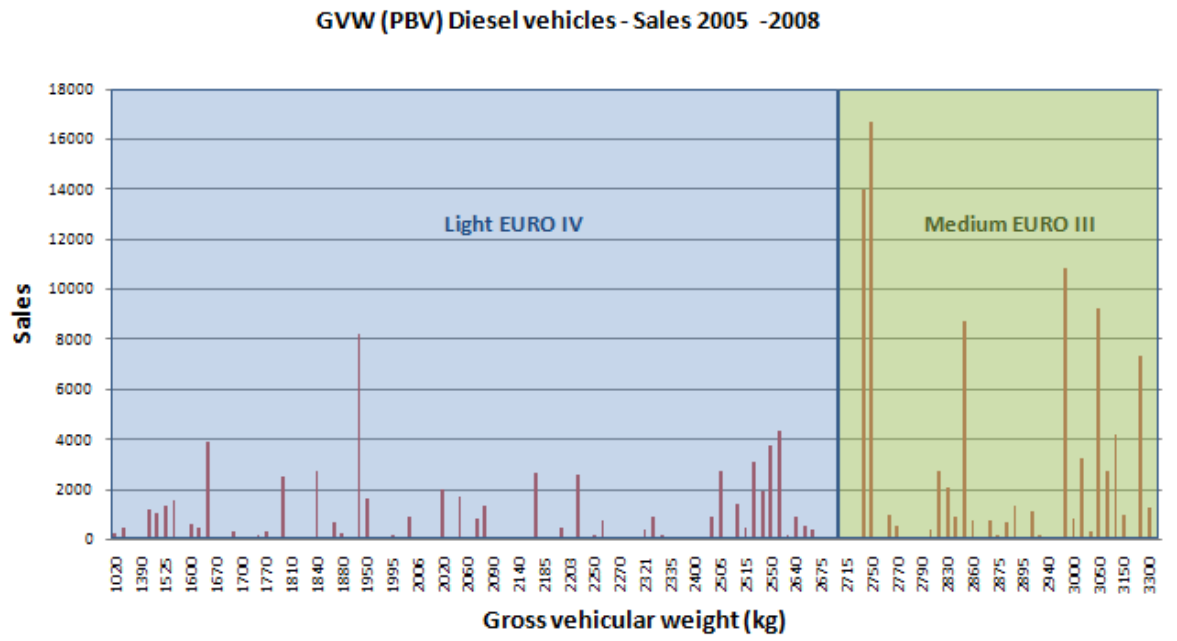


Figure 2: GVW (PBV) Diesel Commercial Vehicles sold during 2005-2008 (Light Euro IV and Medium Euro III)

Figure 3 shows the participation in sales of different vehicle size categories. It is noticed that the bigger part of the market belongs to light-duty vehicles with Otto cycle (gasoline), although there is a progressive penetration of diesel vehicles in the commercial area as well as in the automobiles area. Otto commercial vehicles category is the only one that presents a growth in 2008, probably due to a combined effect between: firstly, corresponding to a bigger price vehicle segment with less vulnerable customers to the difficulty to obtain financing in a year of crisis, and secondly, a part of the buyers who did not decide for diesel commercial vehicles as a reaction to the transitory end between the difference in the price of diesel and gasoline.

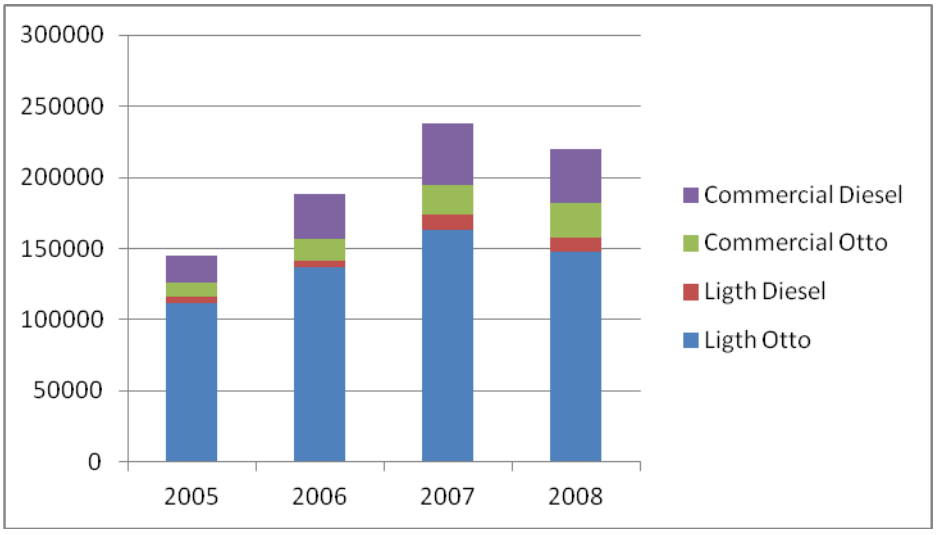


Figure 3: Sales of vehicles as per category and fuel type

Best-selling brands and models

Chart 1 shows best-selling light-duty vehicles models during 2007 and 2008; these represent the 35% of sales. Toyota Yaris Sedan takes sales first place and we can notice a very important participation of Asiatic manufacturers mainly from Korea and Japan. Latin America also appears in this listing with products from Mexico and Brazil.

Chart 1: Best selling light-duty vehicles, 2007 and 2008

Marca	Modelo
Toyota	Yaris 1.5 l DOHC Sedan 4D. T/M Motor Otto
Chevrolet	Corsa 1.6 l, Station Wagon 5D. T/M, Motor Otto
Chevrolet	Spark LT 1 l SOHC Hatch Back 5D. T/M Motor Otto
Toyota	Yaris Sport 1.3 l DOHC Hatch Back 5D. T/M Motor Otto
Kia	Morning 1.1 l SOHC Hatch Back 5D. T/M Motor Otto
Chevrolet	Aveo LT NB AC 1,4 DOHC Sedan 4D. T/M Motor Otto
Kia	Rio JB 1.4 l DOHC Sedan 4P. T/M Motor Otto
Suzuki	Alto 800 0.8l SOHC Hatch Back 5D. T/M Motor Otto
Chevrolet	Corsa Plus (Sail) 1.6 l SOHC Sedan 4D. T/M Motor Otto
Nissan	Sentra V-16, series B-13, Sedan 4P, 1.6 l, T/M, Motor GA16DNE Otto (MARUBENI)

Chart 2 shows a listing of the 10 best-selling commercial vehicles during 2007 and 2008 which represent the 43% of sales.

Chart 2: Best selling commercial vehicles during 2007 and 2008

Marca	Modelo
Chevrolet	Luv D-Max 3.0 l, TDI SOHC Crew Cab 4P Pick Up 4WD, Motor Diesel
Mitsubishi	L200 Dakar CRS 2.5 l CRDI 16v DOHC Pick Up D/C 4P. 4x4 T/M Motor Diesel
Nissan	Terrano D22 2.5 l Turbo DOHC Double Cab Pick Up 4P. 4x2 T/M Motor Diesel
Hyundai	HR 2.5 l SOHC High Deck Long Wheel Base Std.Cab.Truck 2P. T/M Motor Diesel
Toyota	Hilux 2.5 l DOHC TDI Regular Cab Truck 2P. 4x4 T/M Motor Diesel
Nissan	Terrano D22 2.5 l Look 4x4 Turbo DOHC Double Cab 4P. T/M Motor Diesel
Hyundai	H1 2.5 l., Long Body 12 Seater SOHC Minibus 4P T/M, Motor Diesel
Kia	Frontier 2.5 l, SOHC Double Cab Truck 4P T/M, Motor Diesel
Hyundai	H1 (TQ) 2.5 l SOHC 5P 12 Seats T/M Motor Diesel
Suzuki	JB420 Grand Nomade 2.0 l DOHC 4WD Station Wagon 5P. T/M Motor Otto

Commercial vehicles category is the one that has increased the most its participation in the market during 2005 through 2008. Following, some Figures showing sales by brands of this vehicle category.

Figure 4 shows sales by brands of diesel cycle commercial vehicles where we can see that sales of models corresponding to this category of vehicles are doubled between 2005 and 2007. Most of the sales correspond to Korean and Japanese origin vehicles. (Chevrolet imports from Asia)

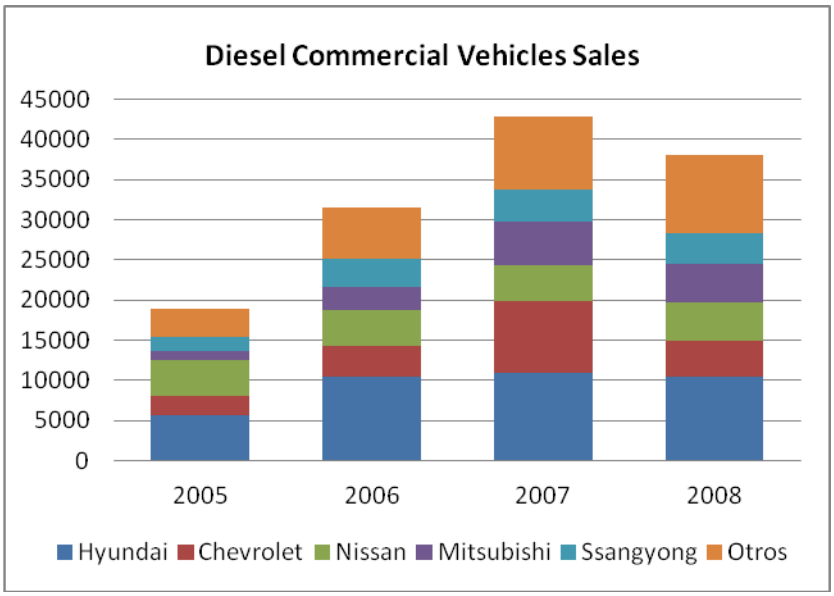


Figure 4: Sales by brand of Diesel cycle commercial vehicles

Sales of commercial vehicle models with Otto cycle certified under EURO standards have grown almost a 700% during the period corresponding to 2005 - 2008. Figure 5 shows a breakdown by brands. Even though its number in sales is smaller than diesel, it's the segment that it is growing the most.

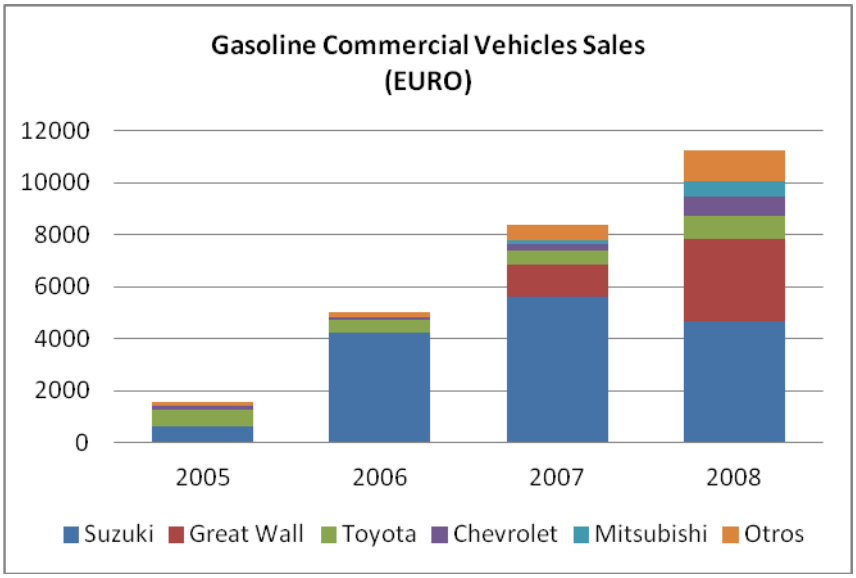


Figure 5: Sales by brand of Otto cycle commercial vehicles under EPA certification.

This category shows a strong penetration of Chinese vehicles, with Great Wall which has displaced Toyota from the second sales place, behind Suzuki.

The growth of this category it is probably because there are Asiatic manufacturers with SUV at very competitive prices, to whom EURO standards have opened their doors to the national market.

Commercial vehicles sales with Otto cycle certified under EPA standard[5] (Figure 6) have not grown equaly as those certified under EURO, because in an important part they correspond to products of north american origin of higher cost than those commercialized under EURO standards . Coinciding with this approach, Ford and Chevrolet are the best-selling brands in this vehicle's category.

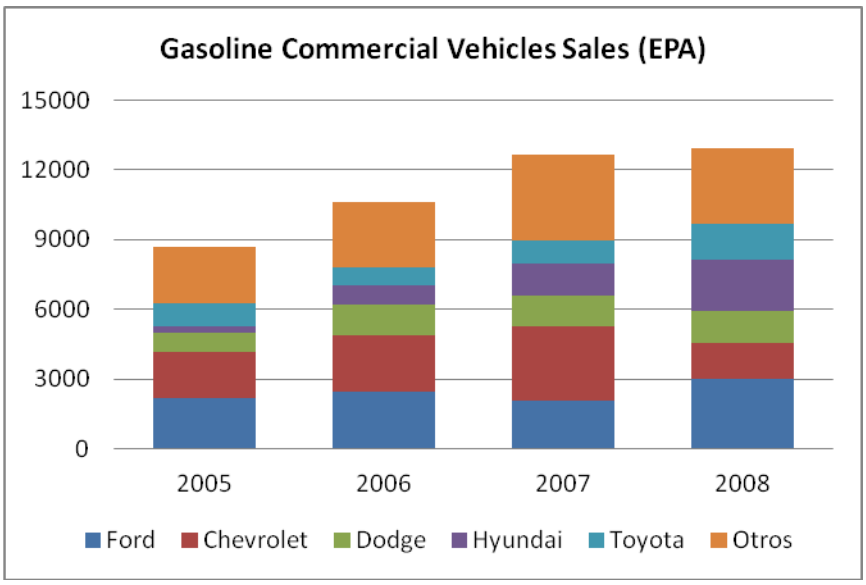


Figure 6: Sales by brand of Otto cycle commercial vehicles under EPA certification.

Sales by fuel type

Regarding the use of fuel, diesel automobiles sales have increased due to the incentive that means the lower price of this fuel with regard to gasoline price (Figure 7), which involves differences of the order of 25% with regard to the 93 octanes gasoline liter. During 2008, prices of both fuels matched since the government temporarily decreased gasoline taxes, as a result of the oil barrel international price increase. This could explain that the market participation of diesel vehicles continued in the same level than previous year.

[5] Abbreviation in English for **Environment Protection Agency** of the United States of America

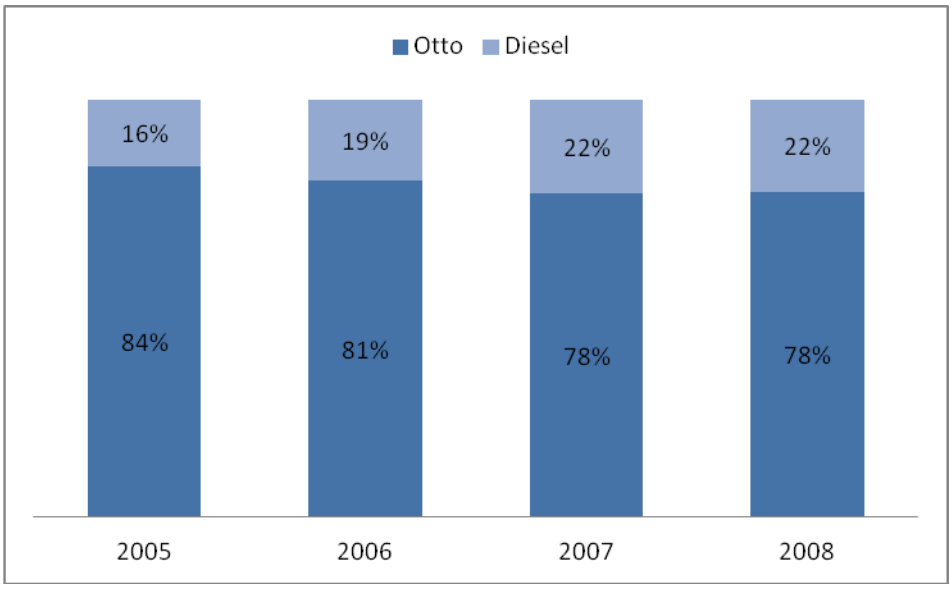


Figure 7: Sales distributed by type of fuel

Figure 8 shows the evolution of diesel and gasoline price per liter for the period 2005 – 2008.

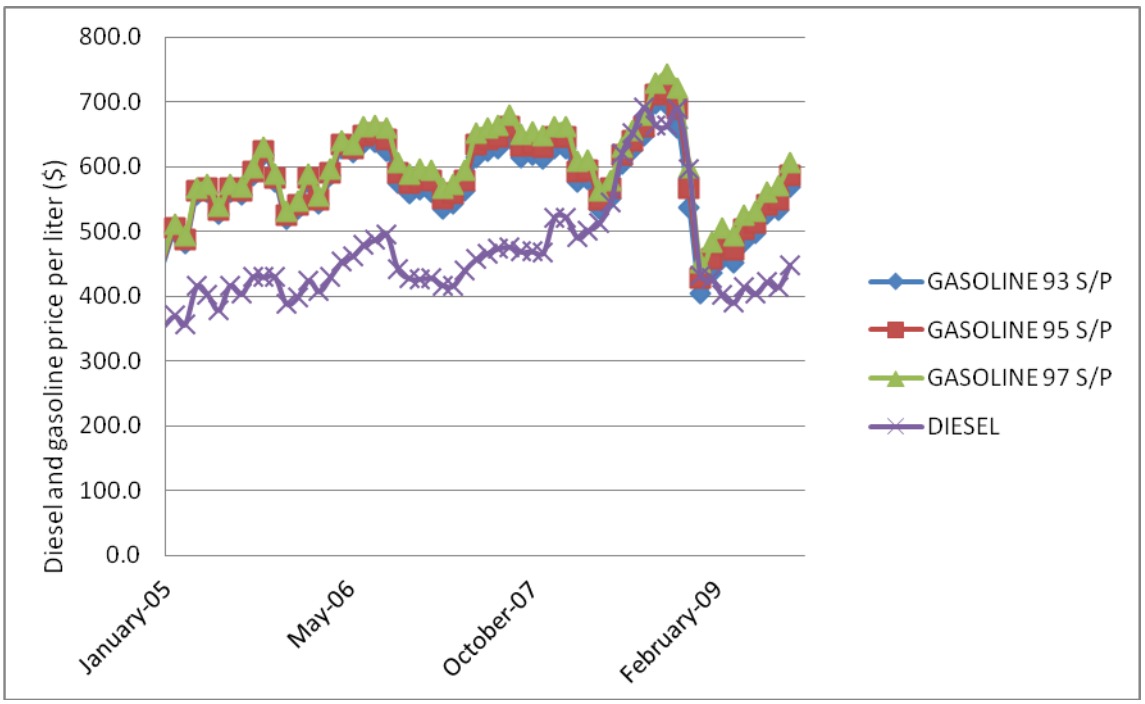


Figure 8: Gasoline and Diesel price variation

Sales according to the emission regulation system

Since September 1992, when in the Metropolitan Region the first emission regulation was effective for new vehicle models until January 2005, the only certification system accepted was

EPA. As from this last date, the Plan for Prevention and Decontamination of the Atmosphere included also the EURO standard which was later extended at national level, encouraged as well by an agreement between Chile and the European Union.

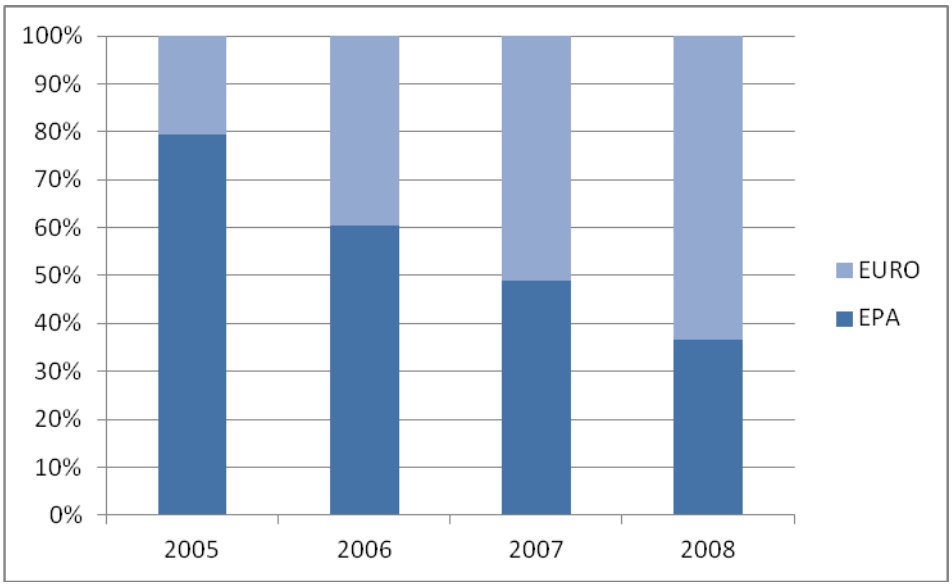


Figure 9: Participation in the market of vehicle models under EPA and EURO standards

The adoption of this regulation favoured the positioning of Asiatic, European and Latin American manufacturers that count on similar regulations in their origin countries. This has meant that EURO models completely rule diesel vehicles segment and have gradually displaced EPA models in gasoline segment.

The biggest participation of EURO vehicles is shown in Figure 10, where it is clearly seen that Euro Otto Light Duty vehicles and Euro Otto Commercial vehicles have been the categories that have increased sales the most during last years.

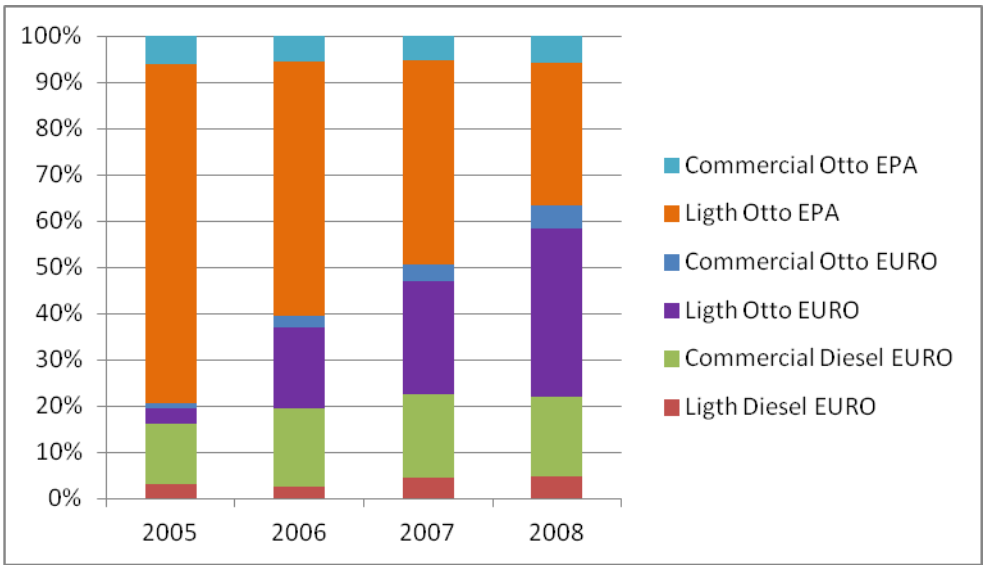


Figure 10: Participation in the market of vehicles categories under EPA and EURO standards.

In the case of Commercial vehicles with Otto cycle there is no great differences between sales associated to EPA or EURO models, unlike diesel commercial, where all the sales are EURO due to the great diesel vehicles' offer range existing for the European and Asiatic market.

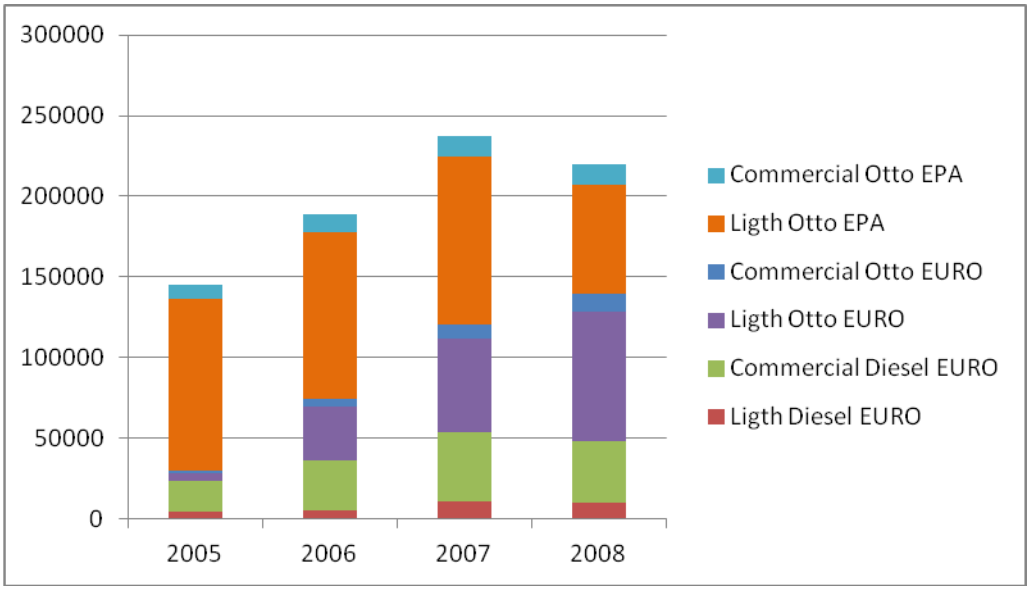


Figure 11: Sales of vehicles by category, fuel type and homologation standards.

Emission trends of local polluting agents of the automotive market

Following we submit Nitrogen Oxide (NOX) emissions and average particulate matter (PM) of the automotive market during 2005 through 2008 according to the fuel used and the type of standard (EURO or EPA). This last distinction must be done since applied homolagation procedures differ between both regulation systems, so their results are not comparable. Chart 3 shows emission regulations of current polluting agents for the studied period.

Chart 3: Polluting agents emission regulations for new vehicles.

	Otto Light duty	Diesel Light duty	Medium(Otto and Diesel)
Metropolitan Region	EPA Tier 1/ Euro III	EPA Tier 1 Califronia / Euro IV	EPA Tier 1/ Euro III
	January 2005	March 2006[6] / March 2007[7]	January 2005
Other Regions	EPA Tier 1/ Euro III	EPA Tier 1/ Euro III	EPA Tier 1/ Euro III
	May 2006	September 2006	September 2006

Results submitted in this chaper correspond to national market averages obtained from each model emission and weighted as per annual sales. For more details, see annex II.

Diesel Light-Duty Vehicles

In the national market almost the total of diesel vehicles sales correspond to models homologated under EURO standards. Therefore, in this subchaper, it is only considered the information of trends under this regulation system.

Figures 12, 14 and 15, display NOx and PM emissions of Diesel light-duty vehicles, pointing out with a horizonzal line the limits of current emissions regulations or of international reference. This category represents the XX% of total sales in 2008.

[6] Date of effectiveness of light-duty vehicles regulation
[7] Date of effectiveness of diesel commercial light-duty vehicles regulation

NOx emission showed a strong reduction in 2006 with respect to the previous year which is coinciding with the date of effectiveness of Euro IV standards at the beginning of 2006 at the Metropolitan Region and with the beginning of the consolidation of vehicles offer homologated under EURO standards in the national market. Nevertheless, in spite of the reduction, the average of NOx emission is near the limit of Euro IV standard since in the rest of the country (Regions) the sales of Euro III vehicles remain.

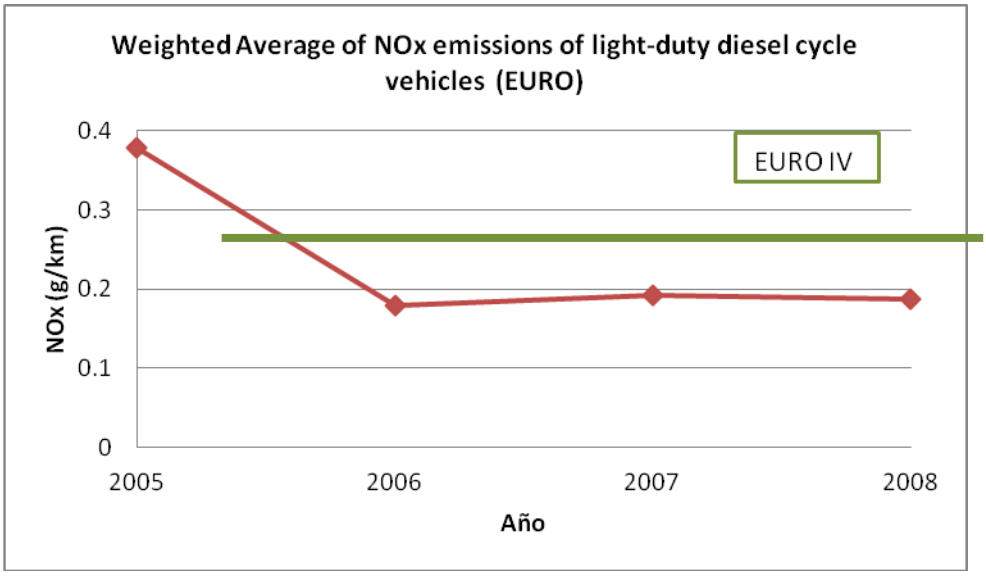


Figure 12: Weighted Average of NOx emissions considering all sales of light-duty Diesel cycle vehicles certified under EURO Standards.

Similarly, PM emissions have experienced a reduction during the same period, noticing nationally a slightly lower average to the one defined by EURO IV Standards.

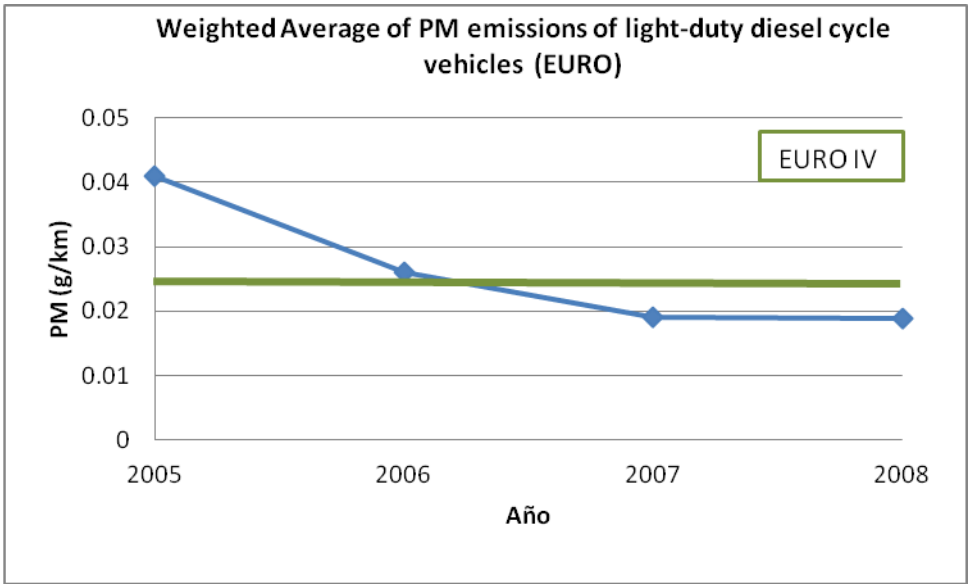


Figure 13: Weighted Average of PM emissions considering all sales of light-duty diesel cycle vehicles certified under EURO standards.

When analyzing car behavior according to the brand we can notice that as a general rule they have reduced the PM emission annual average from their diesel light-duty vehicles sales as a response to the implementation of more demanding regulations. Till 2008 all brands except Volkswagen had emission averages below EURO IV limits. It is remarkable that Kia, BMW, Chevrolet and Alfa Romero had PM emission averages below the limit fixed by EURO V standards considering that this regulation is a demand in Europe as from 2009 and in the Metropolitan Region of Chile will be effective in 2011.

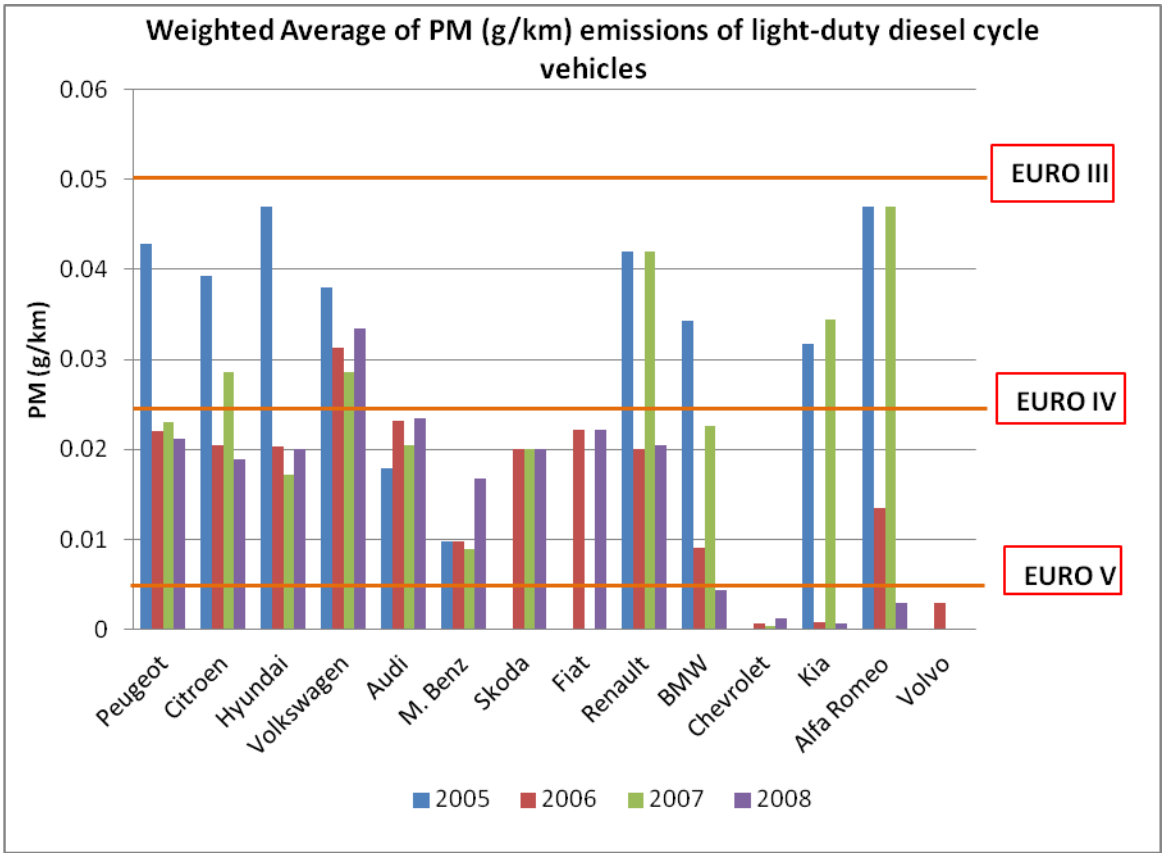


Figure 14: Weighted Average of PM (g/km) emissions considering sales by brand and year.

Diesel Commercial Vehicles

This category represents the 17% of sales during 2008. Light-duty and medium commercial vehicles which have different emission standards are considered: EURO IV for light-duty commercial vehicles and EURO III for medium vehicles.

Emission regulation for medium diesel vehicles has a five-year delay with respect to light-duty ones since EURO IV standard will be in force in the Metropolitan Region as from January 2011.

Commercial vehicles theoretically corresponding to work vehicles have internationally less demanding emission limits than cars, stations wagons, sports and coupés cars. This fact along with the delay of regulations for medium vehicles is the reason why NOx and PM average emission levels for diesel commercial vehicles have doubled the levels of the diesel light-duty segment.

As mentioned in the previous chapter, sales of this category have noticeably increased mainly because of market interest in bigger vehicles such as 4WD vehicles, SUV and double cab pick-up trucks. The interest for purchasing these kinds of vehicles for personal use turns into larger emission levels than those in the optional case of a light-duty car. This interest is aggravated by lower diesel tax rates with respect to gasoline and tax discount for the acquisition of pick-up trucks and 4WD vehicles.

As seen on Figures 15 and 16 there is not a significant reduction of NOx and PM average emissions of this market segment where we can find emissions averages within EURO IV and EURO III[8].

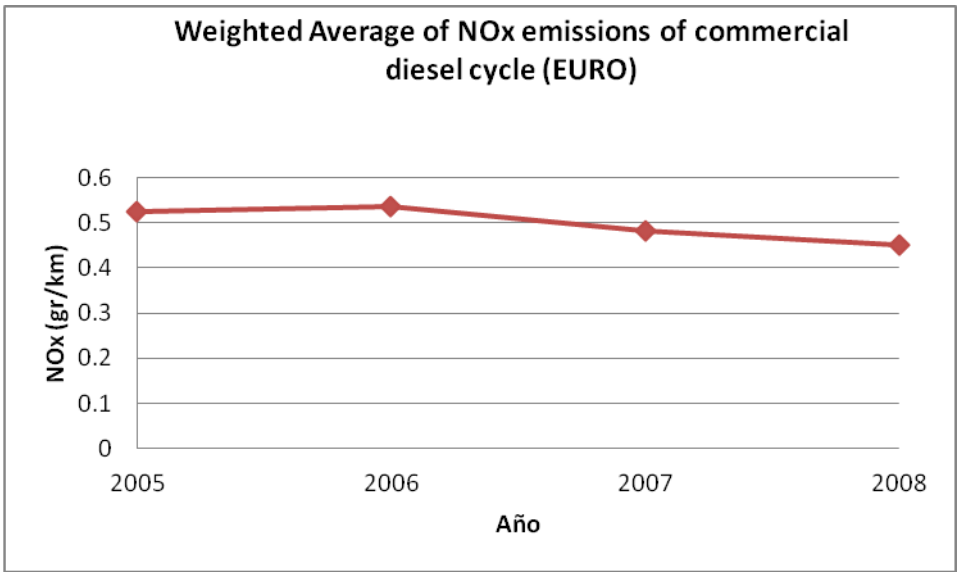


Figure 15: Weighted Average of NOx emissions considering annual sales of commercial diesel cycle vehicles certified under EURO Standards.

[8] It is important to recall that five different emission limits are applied to this category. Thus, mentioned regulations are only referential.

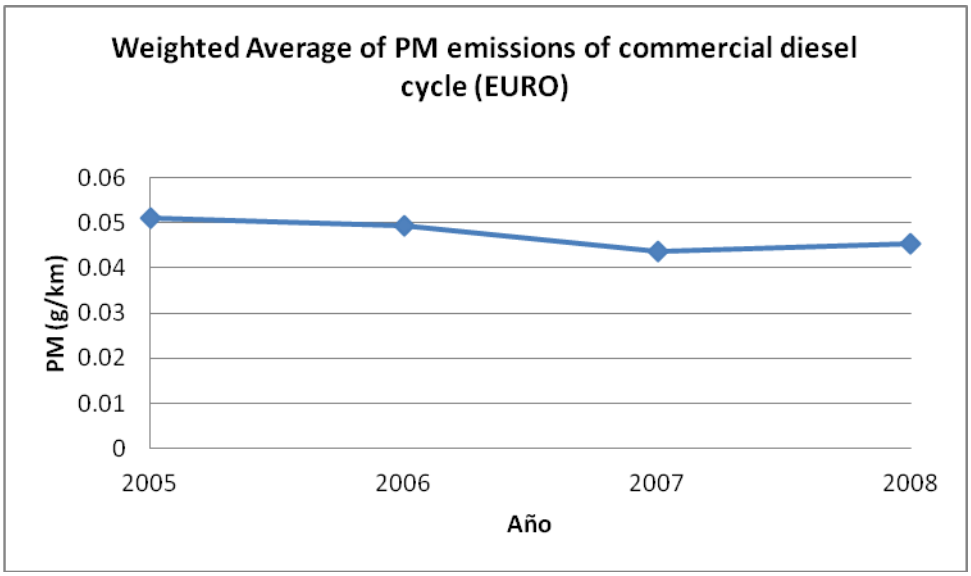


Figure 16: Weighted Average of PM Emissions considering annual sales of commercial diesel cycle vehicles certified under EURO Standards.

Sales of Chevrolet and some European brands such as Mercedes Benz, BMW, Peugeot and Citroën show a reduction in PM emissions to EURO IV levels or even lower.

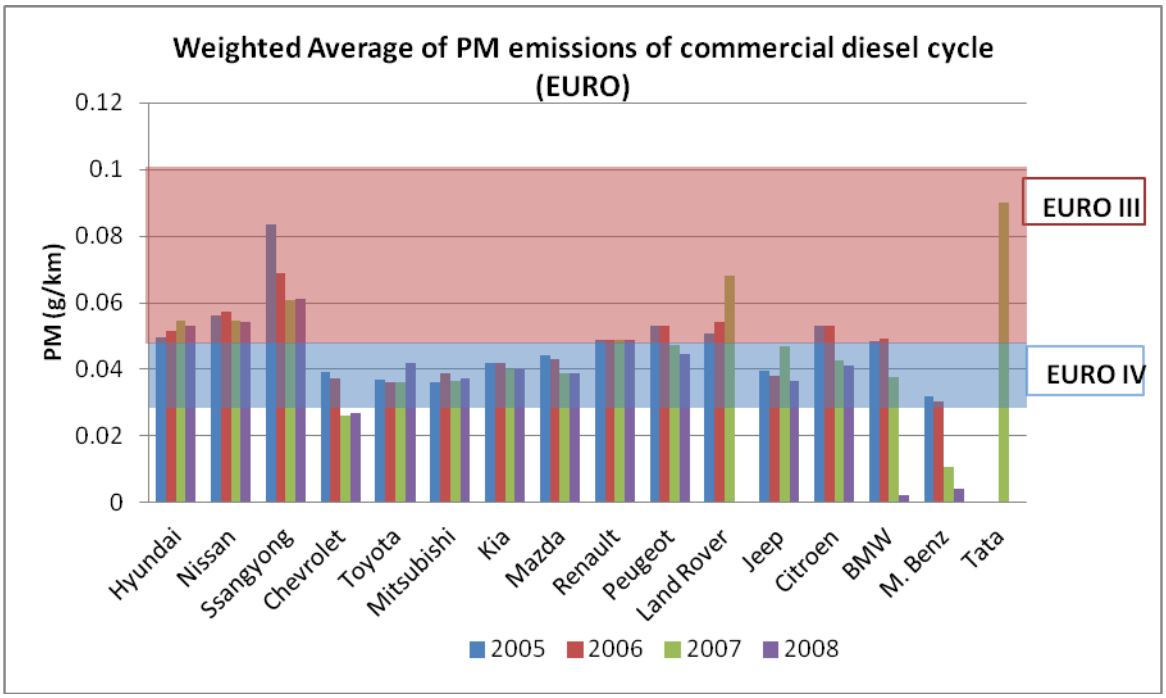


Figure 17: Weighted Average of PM Emissions considering sales of commercial diesel cycle vehicles certified under EURO standards as per car brand.

Gasoline light-duty Vehicles

As mentioned in the previous chapter unlike diesel vehicles, gasoline vehicles market has homologated models under EURO and EPA standards.

With EURO offer diversification NOx average emissions of this market segment decreased to become steady the last three years of the studied period at a rate of 20% of the limit defined by EURO III Standards for this polluting agent (NOx 0.15 grams per Km)

It is evident that gasoline vehicle models currently in the market comply with regulations better than diesel ones. Later on, it shall be necessary to corroborate this by means of a study of the total average emissions of hydrocarbon which is a polluting agent playing and important role in the formation of Ozone and organic sprays.

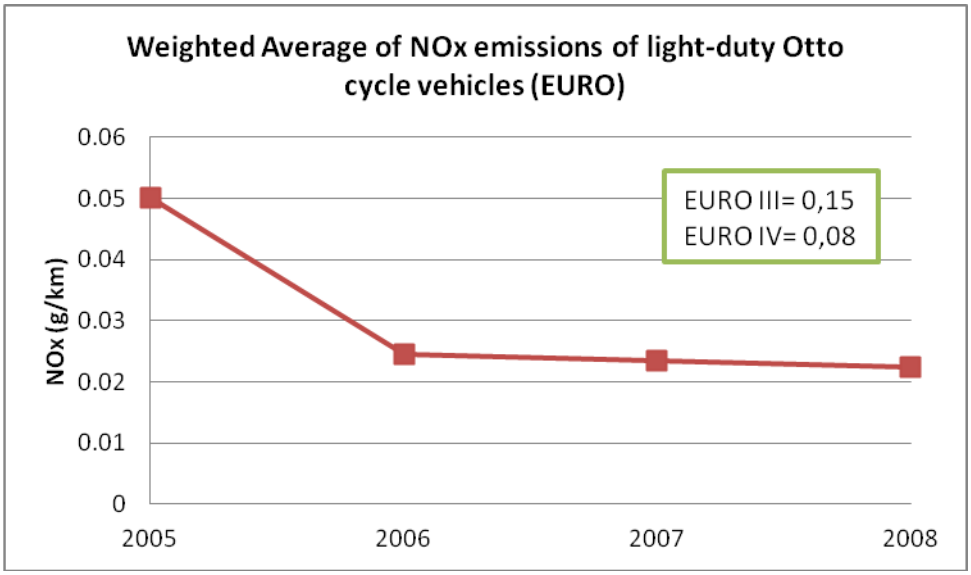


Figure 18: Weighted Average of NOx emissions considering annual sales of light-duty Otto cycle vehicles certified under EURO Standards.

Even though as from January 2005 the Atmospheric Prevention and Decontamination Plan for the Metropolitan Region updated EPA demands to Tier 1 Level already effective at a Federal Level in the United States since 1994, there is not an impact in NOx emissions trend shown in Figure 19.- This might be because the models previously commercialized already comply with these demands which is no wonder considering the 10 years time lag of this regulation in respect of its origin country .

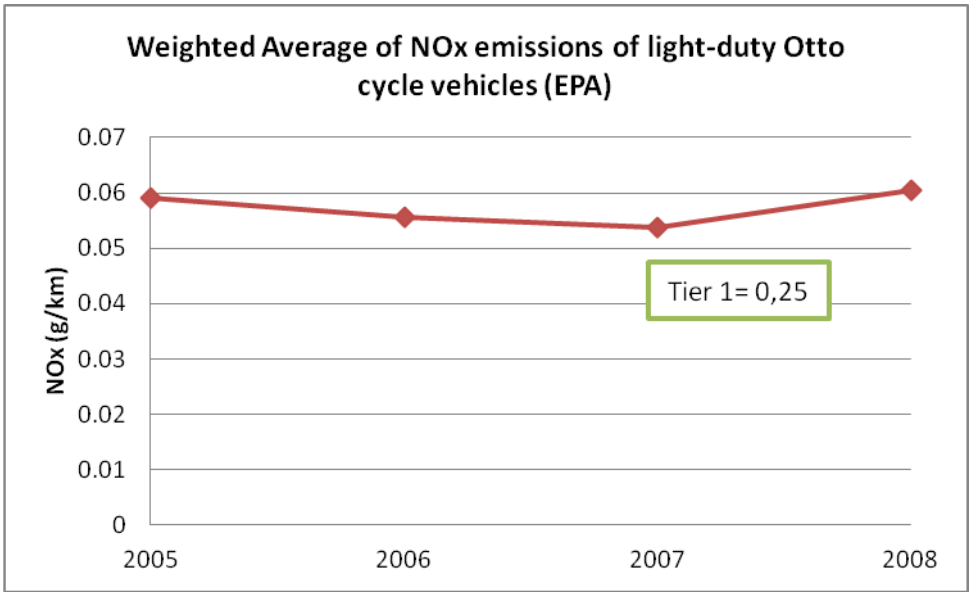


Figure 19 Weighted Average of NOx emissions considering annual sales of light-duty Otto cycle vehicles certified under EPA Standards.

Gasoline Commercial Vehicles

NOx average emissions in EURO gasoline commercial vehicles market are increasing significantly (Figure 20). This is the fastest growing segment in all the automotive market due to the great interest aroused for bigger size vehicles already mentioned before. This has diversified the offer adding more new Asiatic models which probably have older technology. It is important to recall that for this segment the EURO III standard is still effective; which is more than 10 years old.

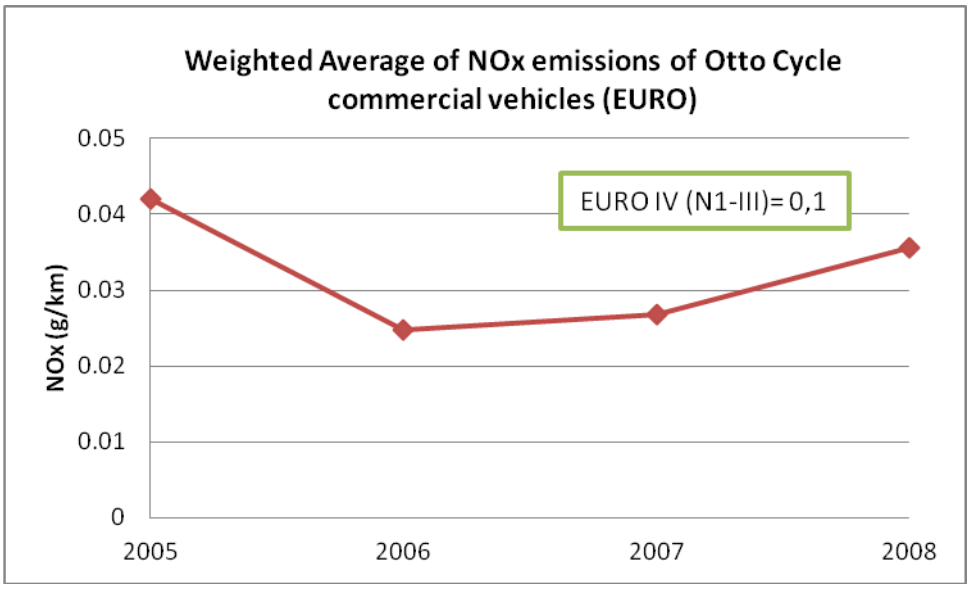


Figure 20: Weighted Average of NOx emissions considering annual sales of Otto Cycle commercial vehicles certified under EURO standards.

In the case of gasoline commercial vehicles homologated under EPA standard a clearer trend is seen towards lower emission levels because a great part of the commercialized models are coming from the United States; a country where more severe emission levels rule since 2007.

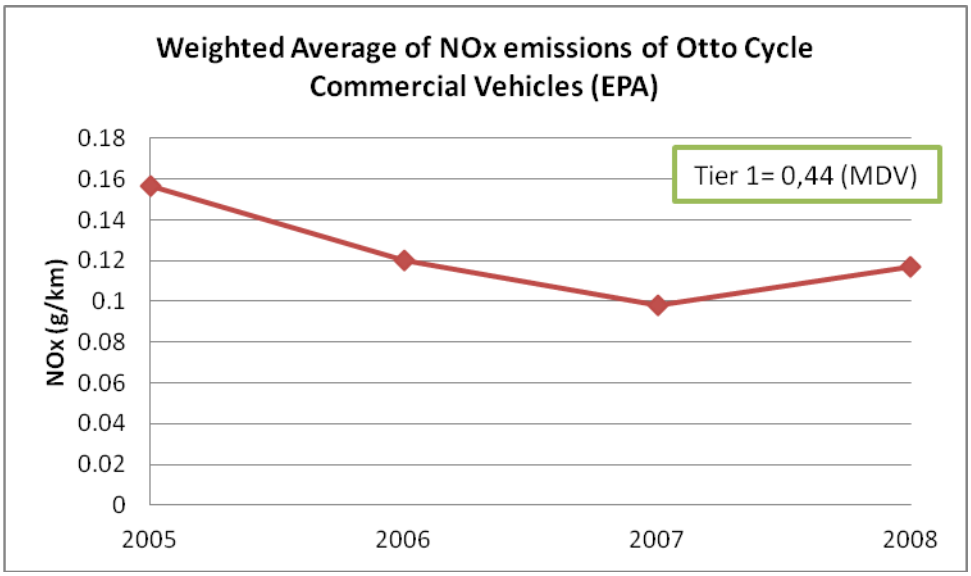


Figure 21: Weighted Average of NOx emissions considering annual sales of Otto Cycle Commercial Vehicles certified under EPA Standards.

CO2 Emission Trends and Energetic Efficiency

There is an important international effort to face two different problems but directly related to one another; the reduction of greenhouse effect gases and the need to reduce Oil dependence. The European Union, The United States, Canada, Japan, China and Australia among others, are already using different instruments: such as, emission regulations, energetic efficiency regulations and tax incentives to move forward in the solution of both problems. CO2 emissions correspond to the carbon included in the fuel used up by vehicles. Therefore, regulation strategies taken by the countries contribute with benefits to the solution of both problems.

Chile does not count on a strategy in this matter but the capacities developed for the enactment of local polluting emission regulations and mainly for the fulfillment of them by The Ministry of Transports and Telecommunications make up a good platform to move forward in this aspect.

At present emissions coming from the transportation sector represent a third of the country's total contribution to climate change. If we don't take actions as soon as possible, the growth in the automotive fleet will result in an aggravation of the national responsibility of this global problem and in a greater risk when facing oil supply eventualities. It is important to recall that during the supply crisis of 2008 a contribution of more than one thousand million dollars from the Oil Price Stabilization Fund was required; besides a lower collection due to the gasoline tax transitory reduction.

The ICCT has been devoted to face these problems globally and has issued a series of publications. During 2007 the study "Passenger Vehicle Greenhouse Gas and Fuel Economy Standards: A Global Update" was launched; where the efforts of different countries on this matter are described and for the first time it is made a comparison of average CO2 emission levels of developed countries' automotive market. A comparison of the average energetic efficiency is also included.

As from methodologies developed by the ICCT and with the support of the professional team in charge of the publication already mentioned, CO2 emissions and the Chilean automotive fleet average energetic efficiency was estimated between 2005 and 2008. These methodologies are described in Annex III.

Figure 22 shows the comparison of average CO2 emissions in the national market[9] with values fixed by ICCT for six countries plus the State of California. In order to make this information equivalent with the different regulation systems, results are shown in CO2 grams per kilometer according to NEDC driving cycle used by EURO Standards

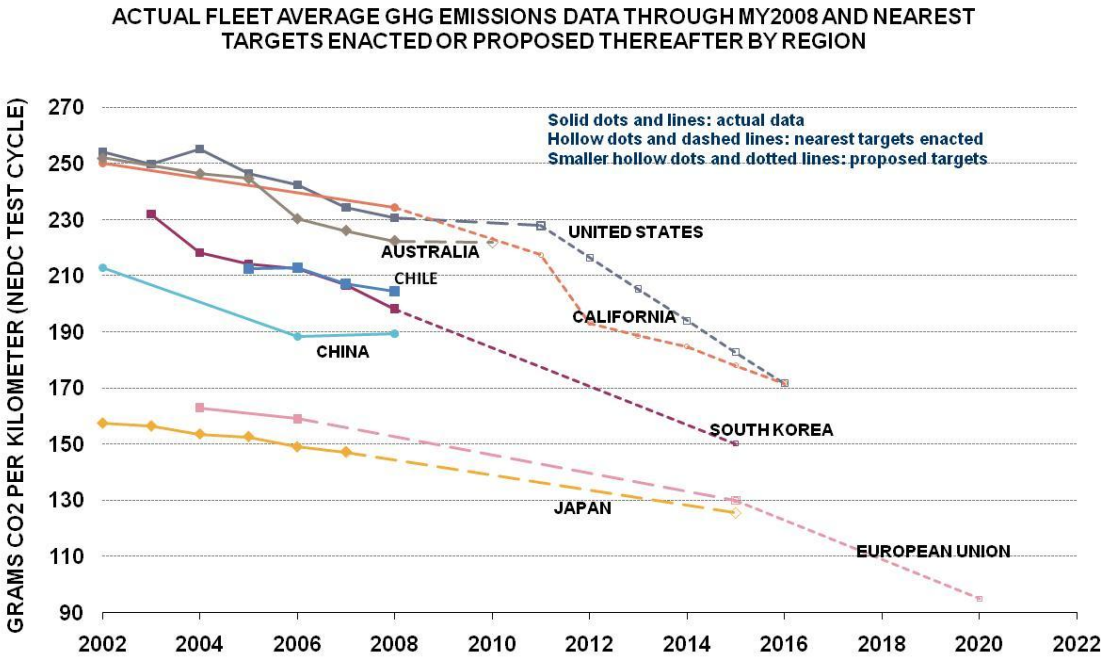


Figure 22: CO2 Emissions of vehicle fleets in different Regions of the World.

National automotive market has relatively high emission levels; higher than those in Japan, China and Europe; origin countries of the most common models in Chile. Average levels higher than 200 grams per kilometer are closer to the ones exhibited by countries where models of greater cubic capacity prevail, such as Australia and The United States.

The national situation is showing a lack of an energetic efficiency strategy and mitigation of CO2 emissions, since as it is a market of small and medium size cars, emission levels are closer to big car markets which have regulations on energetic efficiency as in the case of The United States. This country which has the world's largest automotive market with 17 million vehicles sold annually counts on a system of energetic efficiency regulations called CAFE[10] implemented as from the oil crisis at the beginning of the seventies. According to the National Academy of Science this regulations system allowed a reduction in gasoline consumption to one third in the United States between 1975 and 2000.

National average emission levels are 50% higher compared to a market of similar size vehicle models but regulated, as it is in the case of Japan. Japan which has the third world's largest

[9] Average shown is the result from considering both categories; commercial and light-duty vehicles.
[10] Corporative Average Fuel Economy (CAFE)

automotive market with 5.5 million units sold annually has a system of energetic efficiency standards and tax incentives.

According to the Japan Automobile Manufacturers Association (JAMA) an owner of a small sedan might get tax benefits of even 4.000 dollars in relation to an owner of a bigger size vehicle.

In terms of trends the situation is more favorable since there is a reduction in emission levels from the automotive market. The most important reason is the penetration of diesel vehicles in the market showing a change in sales from 16% in 2005 to 22% in 2008. This process is critical in environmental terms since the benefit in the reduction of greenhouse effect gases has a counterpart of more local polluting emissions; such as particulate matter and Nitrogen Oxide. It is important to recall that NOx average emission of diesel light-duty vehicles segment is 10 times the average of gasoline light-duty vehicles segment. If we consider the growing interest on SUV's and pick-up trucks and take NOx average emission of diesel commercial vehicles this difference raises to twenty times.

This aspect is one of the most critical of the automotive market growth and requires a coherent integration of goals aimed to reduce local polluting agents and greenhouse effect gases.

Figure 22 also displays the goals for proposed Co2 reduction, showing that in case a national strategy is not implemented, our situation will substantially get worse.

From the energetic efficiency point of view, figure 23 displays the market national situation regarding the averages observed in the countries that have been studied by the ICCT. In this opportunity the information corresponds to the efficiency in miles per gallon of fuel determined for the driving cycle used by The United States CAFE Standard.

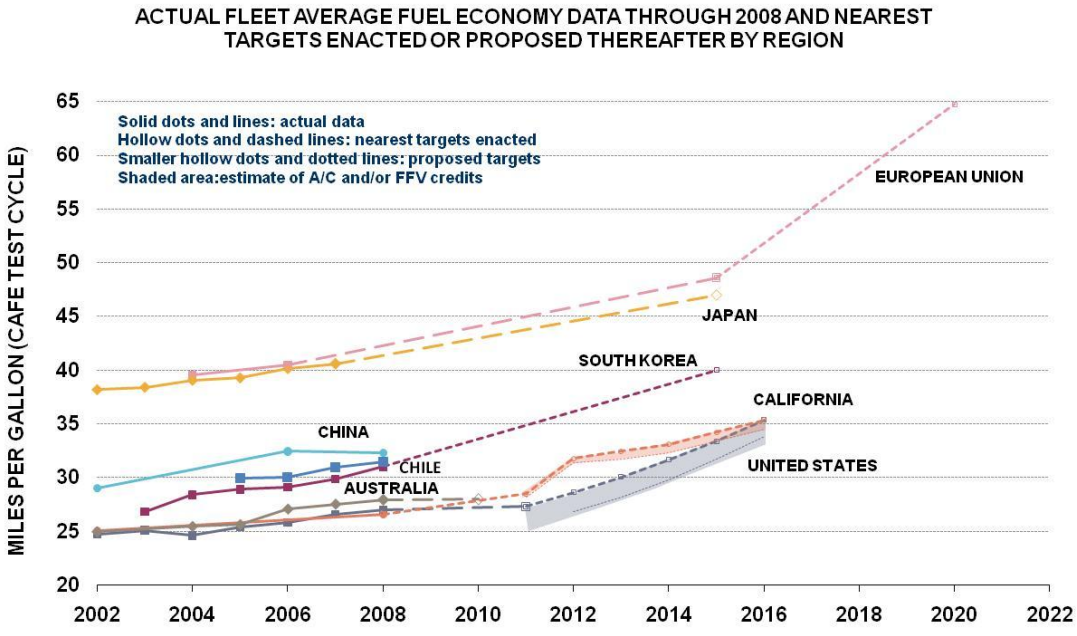


Figure 23: Fuel economy of vehicle fleets in different regions of the world.

***Shadowed areas correspond to the uncertainty generated when changing standards to mpg units. There are two uncertain conditions: credits granted to vehicles manufacturers to improve air conditioning system (A/C) compensating in this way a part of the emissions and by the use of biofuels in flexible fuel vehicles (FFV)**

In accordance with the information of Co2 emissions the situation of the country is once again deficient showing relatively low outputs, similar to the ones obtained in The United States with bigger size vehicles regulated under CAFE Standards and 30% lower than the ones obtained in markets such as Japan.

The consequences of this for a growing vehicular market is that the country will have a greater demand of gasoline and diesel than in a best-case scenario such as the one we could achieve by the incorporation of regulations and incentives aimed to boost imports of better technology vehicles and impose a sanction to bigger size and less efficient vehicles.

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ANNEX II: Methodology for the determination of average emission and consumption levels of light-duty and commercial vehicles in the National Market.

Sales amount corresponding to each vehicle model was obtained from the information given by the Control Center and Vehicular Certification (3CV), from the amount of vehicle identification numbers (VIN) given by each vehicle dealer. With all this information a database was made with all vehicle sales from 2006-2008.

In payroll of homologated vehicles dated November 20th, 2009 (prepared by the 3CV, also available in the web) you can find regulated polluting emissions (NOx, PM, CO, HC, HCNM and HC+NOx), category, vehicular gross weight (VGW) and the regulation under which each model was homologated. Values for CO2 emissions and fuel consumption were also provided by the 3CV.

A database was generated with the information mentioned before which contains the codes of each model, annual sales, emissions, fuel consumption and VGW (PBV).

NOx, PM (only Diesel vehicles) and Co2 average emissions as well as the VGW (PBV) were obtained through weighted average with the sales of each model as indicated in Equation 1[11]

$$Average\ annual\ emission = \frac{\sum_1^n sales\ model\ i * emission\ model\ i}{Total\ sales\ in\ the\ year}$$

Equation 1

Average fuel economy (mpg) was determined through "harmonic averages" (Equation 2)[12], since it doesn't have a lineal behavior as shown on Figure 24.

$$Harmonic\ average\ annual\ fuel\ economy = \frac{Total\ sales\ in\ the\ year}{\sum_1^n \frac{sales\ model\ i}{fuel\ economy\ model\ i}}$$

Equation 2

[11] Developed by ICCT

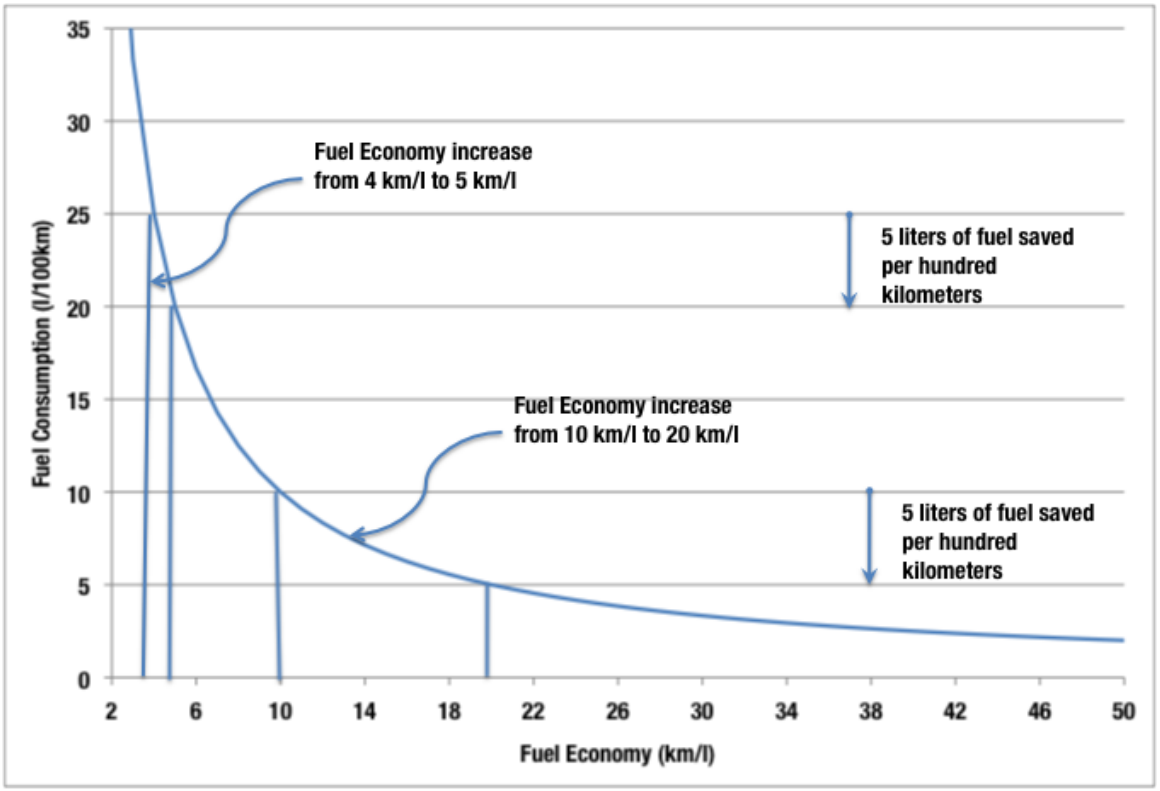

Figure 24: Relation between fuel consumption (l/100 km) and economy (Km/l).

ANNEX III: Methodology for Standards Adjustment.

Vehicles are homologated under two standards in the country: EURO and EPA. In order to determine emissions under EURO standards it is used the New European Driving Cycle (NEDC), and for those homologated under EPA it is used the FTP-75 cycle (Figures 25 and 26). In ICCT report Co2 emissions are compared under NEDC cycle and fuel economy with CAFE cycle. As a consequence the two standards used in the country must be adjusted.

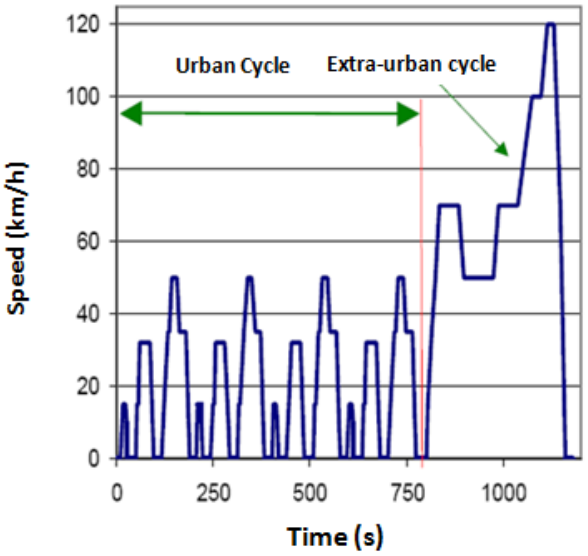

Figure 25: New European Driving Cycle (NEDC)

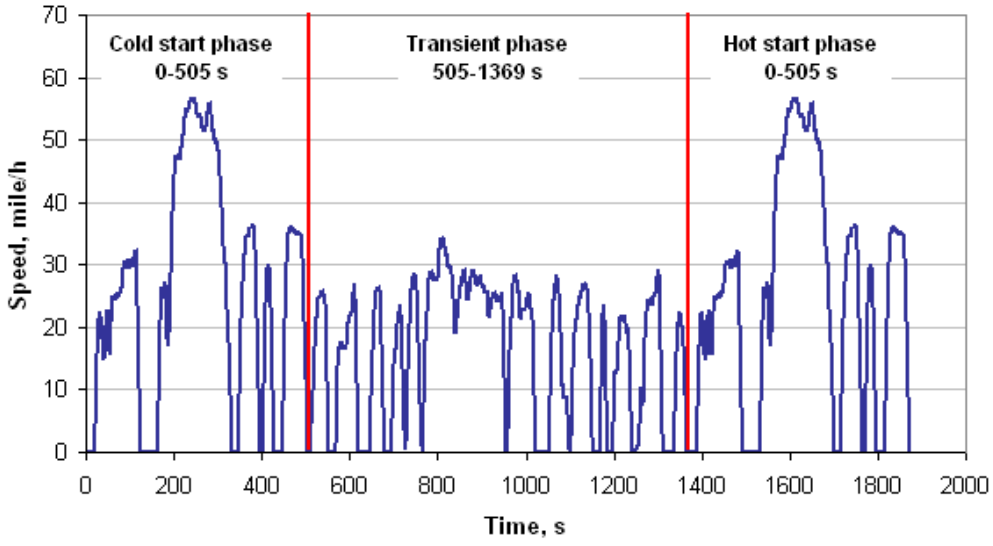

Figure 26: FTP-75 Cycle

Adjustment of Co2 emissions under NEDC cycle (Diesel and Gasoline vehicles)

Otto and Diesel vehicles CO2 emissions were considered for the adjustment. We followed diagram shown on figure 27

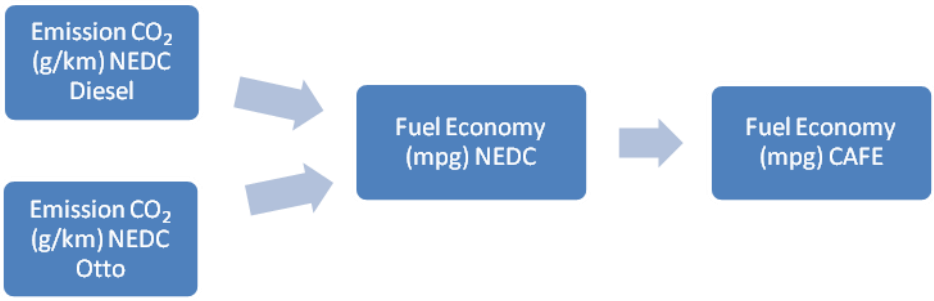

Figure 27: Values Adjustment Diagram from NEDC to CAFE cycle

On First stage, Co2 emission in g/km is converted to fuel economy in the same cycle (NEDC). Afterwards, by means of a conversion equation[13] between cycles the efficiency value obtained under NEDC cycle is converted to CAFE cycle (Combined US)

Adjustment Fuel Economy under EPA Cycle

Fuel economy values of vehicles homologated under EPA standards were considered for the adjustment. Outputs were converted from FTP-75 cycle to the US combined cycle using a conversion factor[14].

[13] Determined as from the Modal Energy and Emission Model MEEM. For more details refer to Passenger Vehicle Greenhouse Gas and Fuel Economy Standards: A Global Update, ICCT 2007

[14] Available from ICCT information to convert from FTP72 cycle to combined US. It is assumed that consumption is equal to that of FTP 75, since the third phase of hot start-up is related only with the operation of the catalytic converter.

Conversions are shown on Figure 28.

Figure 28: Values Adjustment diagram from US city cycle to combined US economy and Co2 emission in NEDC cycle.

As a result of this we obtain economy fuel values in km/l for vehicles homologated under EPA standards (There are not diesel homologated vehicles under EPA standards in the country. All vehicles are under Otto cycle). These values are converted into fuel economy in km/l under combined cycle (CAFE). Then, by means of a conversion factor we obtain values in miles per gallon; unit in which fuel economy is compared.

Co2 emission values under NEDC cycle were obtained using a conversion equation between the Combined US cycle and NEDC to finally use a factor to get the emission value in g/km.

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