Greenhouse Gas Emissions Scenarios

ARGENTINA - 2012

Argentine Business Council for Sustainable Development – CEADS.

Introduction

This report summarizes the methodology and results of the Greenhouse Gas Emissions Scenarios project developed by the Argentine Business Council for Sustainable Development (CEADS). This project aims at developing a number of Argentine scenarios with internal consistency, describing the possible futures regarding Greenhouse Gas (GHG) Emissions.

This project arose in response to the CEADS's Scenarios Unit concern for undertaking a practical approach of the Scenario methodology, taking the climate change issue as a thematic axis, considering that the same is a strategic issue both at private and governmental level. Within such a framework, it was decided to develop GHG emission scenarios for the different economic sectors in Argentina, so as to be allowed a sound tool for the analysis of their future position faced to this problem.

The development of several sustainable development scenarios by the WBCSD together with Council multinational member companies has been an essential precedent for the companies comprised by the CEADS's Scenarios Unit (Techint, DOW, Acindar, Petrobras and Ford) to understand the meaning of the work to be done.

The reason for Scenario planning derives from a situation wherein, given the impossibility to know for sure what is ahead of us, in the future, a good measure is found in adopting a strategy that evolves positively through different future conditions.

Scenario planning tackles uncertainty via the generation of more than one future alternative. The purpose is placed in showing how different driving forces may exert an influence on future scenarios, in different directions.

The analysis of possible future developments in the country and the effects they may bring forth as to GHG emissions, constitutes a valuable tool for research and diagnosis, for mitigation policy formulation and selection, and contributes to the definition of positions, to the establishment of principles and to the formulation of proposals grounded on technically supported surveys.

The final result of this process has produced three GHG emissions scenarios for 2012, in a framework of different social, economic, political and technological forces. These scenarios do not seek to predict the future of Argentina, but rather to become a tool for the analysis of consequences deriving from different GHG emissions growth patterns. There is not only one scenario, with a higher degree of likelihood; no probability value is associated to any of these scenarios.

Methodological Approach

Scenario Methodology:

The construction of Scenarios is methodologically developed in stages following each other in a logical order and pursuant to an increasing complexity. For the development of scenarios, this project has adopted the methodology created by Peter Schwartz, founder of the Global Business Network (GBN)[1] and Kees Van der Heijden[2], co-founder.

This process fostered a broad participation, and the representatives of CEADS member companies in the Scenarios Unit were actively involved, as well as members of other companies. Also, one of the main process stages accounted for inquiries formulated to renowned personalities, who were asked to provide their vision on this issue both of the private and public institutions, and also NGO's, among which we can mention the Secretariat of the Environment and Sustainable Development, the Argentine Foreign Office, Greenpeace and Bariloche Foundation.

The first step in the construction of Scenarios consists of defining the key question for which an answer is sought precisely via those scenarios. The question for these scenarios was: How will this country's GHG emission evolve in the future considering the different development patterns that Argentina may adopt?

In order to answer this question, three scenarios describing the country's possible future, with internal consistency, were proposed, in connection with economic, social, technological and environmental aspects.

The steps for the construction of these scenarios consisted of a determination, based on the main objective, of the social, economic, political and technological driving forces that provide the dynamics for modeling the future of emissions. For this purpose, work groups were organized, where the driving forces that definitely influence the path of GHG emission were identified.

The identified variables or driving forces were then classified pursuant to their degree of uncertainty, so as to characterize those that are considered to be predetermined and those that pose the possibility of discontinuance and critical uncertainty for the aims of the goal sought. The results of this exercise were further enhanced with the results of interviews held with personalities, as a result of which the scenario modeling parameters were defined:

Economic Dynamics:

- GDP broken out per economic sector
- Evolution of commodities prices
- Changes in the use of soil

[1] *Schwartz, Peter. "The art of the Long View". Doubleday. 1991:ISBN 0-385-26731-2.*
[2] *General and Strategic Management at Graduate Business Shcool of Strathclyde University, UK.*

Social Dynamics:

- Social Stability
- Waste Generation and Treatment

Political Dynamics:

- Institutional Stability
- Transportation Policies

Technological Dynamics:

- Power Efficiency
- Carbon Intensity
- Clean Technologies

The driving forces that were classified as predetermined were Argentine population in 2012, the degree of urbanization and the household refuse generation rate, considering that these predetermined forces are fairly predictable and will be a part of any story on the future.

Future GHG emissions will result from these complex dynamic systems, such as the demographic, socio-economic and technological development. Once these driving forces that will model the future of emissions were determined, different "Story Lines" were developed. Each Story Line is a story on the possible future ahead, in terms of economic, demographic, political and technological development and the consequent evolution of GHG emissions levels.

Scenarios were constructed defining and quantifying each one of these variables in a different way for each of them, giving them a distinctive nature in each Scenario, so as to foster the diversification of results.

Base Scenarios:

These scenarios correspond to the base scenario category. They represent the future condition of society and the environment that is likely to develop if no sustainable development policy is applied for the explicit purpose of mitigating GHG emissions, or if said policies do not exert a clear influence on society or the environment. A general rule is that these scenarios must exclude the impact of all policies that are directly related to GHG emissions.

The determining forces that drive the evolution of GHG emissions may follow different directions and future GHG emissions shall derive from these complex dynamic systems, such as demographic, socio-economic and technological development. Given the large uncertainty implied in developing only one base scenario, considering the unpredictability of the future, the higher the number of future alternatives in hand, the higher the use of scenarios for the performance of an analysis that may be applicable to the future reality.

It is for this reason that, in order to foster further seriousness and to reflect the different trends, three base scenarios were developed. Each one of these base scenarios shall be the starting point for possible mitigation scenarios.

Quantitative Scenarios:

As the object lies in analyzing GHG emissions in this country in 2012, the need to develop quantitative scenarios is brought about. This means that three gas emissions were quantified, namely carbon dioxide (CO_2), methane gas (CH_4) and nitrous oxide (N_2O) making a distinction of the same according to their source.

The emissions for these gases were calculated for the different production sectors in the country: Households, Services, Agricultural/Livestock, Industrial, Energy, Transportation and Waste.

A program called PoleStar, designed by the Stockholm Environmental Institute was used for this quantification. The PoleStar system provides a flexible framework for the construction and evaluation of alternative development scenarios. PoleStar is a an accounting and modeling framework that can be adapted and that has been designed to provide assistance in the analysis of sustainability studies.

A specific methodology was used for the calculation of emissions for each production sector. Said methodology has many aspects that coincide with the methodology proposed by the IPCC[3]; in turn, however, it contains two variations: the guidelines proposed by the software were followed and, in some cases, our own methods, of a higher degree of specificity for our country, were used.

In general terms, for all emission sources computed, the calculation of emissions is based on the calculation of two factors:

1) the activity level of each emission sector or source, the units of which vary pursuant to the sector under consideration.

2) the emission coefficients in each source, which represent the quantity of gas released per business unit in the sector.

The total emissions in a certain sector are given by its level of activity and by the level of emissions implied by that activity.

Below is a summary detail of all different sectors considered and of emissions computed in each one of them.

Household Sector:

This chapter considers emissions deriving from burning fossil fuel for household energy purposes.

[3] *Revised 1996 IPCC Guidelines for National Green house Gas Inventories: Reference Manual. 1998. IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. 2001*.

Service Sector

This chapter considers emissions deriving from burning fossil fuel for energy purposes in the service production sectors, including the public administration.

Transportation Sector

Mobile source emissions were considered. The emissions of this sector comprise the use of fossil fuel (gasoline, Diesel fuel, fuel oil, CNG and jet fuel) by the different means of transportation: road, railway, ocean and airway, both for passengers and cargoes.

Industry Sector

The industrial sector accounts for two different emission sources: on the one hand the emissions deriving from burning fossil fuel for the sector energy purposes were considered, and, on the other, the emissions deriving from industrial processes in each industrial branch (classified as per the ISIC Groups).

Agriculture/ Livestock Sector

The emissions generated by agricultural and livestock activities were considered. The following livestock sector emitting sources were found: methane emissions from cattle enteric fermentation and methane and nitrous oxide emissions generated by manure treatment. The following agricultural sector emissions were considered: nitrous oxide emissions from manure treatment and agricultural soil management. The latter category includes emissions deriving from nitrogen application to soil through cultivation practices, such as the use of fertilizers and animal manure, and the production of nitrogen fixing cultures (leguminous cultivation). Also, N_20 emissions produced from animal urine and manure deposited in the fields were considered. Finally, methane emissions generated by rice cultivation were taken into account[4].

Energy Sector

This sector considers the emissions generated throughout the power product generation, storage, transportation and distribution process. Grouping can be made as follows:

- ✓ Emissions from fuel burning: deriving from thermo-electric generation and the sector use of fuel in refineries, electric power stations, oil and gas fields and transfer stations, intended to meet their power requirements.

- ✓ Escape emissions: they occur along the entire production chain, from well outlet vents, transportation and distribution leakages, to refinery leak out emissions.

[4] *The sector statistical information, as well as certain emission factors, was taken from surveys corresponding to the Secretariat of Agriculture, Livestock, Fishing and Food, Universidad de Buenos Aires (School of Agricultural Science) and INTA.*

Waste Sector

Methane emissions from urban solid waste were calculated. For this purpose, and based on statistical data and on the opinions obtained from companies and governmental institutions, both the generation and the type of household refuse disposal were considered. Both the emissions generated in sanitary landfills or similar sites, and those generated in open-air dumps, were considered.

Industrial or hazardous waste treatment emissions were not considered, as there is not sufficient information regarding the generation of these wastes or the type of treatment thereof. Based on estimates made at the National Inventory, however, it can be concluded that the omission of such an emission source does not significantly affect the total sector result.

Scenarios

It was decided to develop scenarios that, instead of differing in terms of GDP evolution, differ as to the growth pattern that prevails in each. Thus, the following scenarios were developed in accordance with the production sector that is most important in each one of them: the Industrial Model, the Agro-exporting Model and the Power-based Model.

The scenarios developed do not represent scenarios in opposition, but rather scenarios that respond to a type of discrete scenarios. This implies that the events determining the scenarios are framed within a logical sequence, which is consistent with the time frame of this survey. In the end, a higher degree of truthfulness and accuracy was fostered in this type of scenarios over the higher analytical richness of scenarios in opposition.

For this reason, the production structure of scenarios is not biased towards the corresponding prevailing sector, but rather a reasonable share of the other sectors is maintained. The sector GDP share in each scenario can be analyzed in further detail in Annex 1.

All three scenarios developed are briefly described below. Each scenario is framed within a certain economic, political, social and technological context, which determines the activity level of the different economic sectors in this country.

Based on such activity levels, GHG emissions for each sector were calculated, specifying the results in each scenario.

All three scenarios comprise the following predetermined variables that can be reasonably predicted and will be a part of all of them:

Argentine population: 42 million inhabitants

- **Urbanization degree:** 91% [5]
- **Generation of Urban Solid Refuse:** 0.85 kg/ person/ day [6]

[5] *INDEC, Proyecciones de población(1995-2025). Serie Análisis Demográfico 7.*
[6] *National average calculated based on refuse generation data for 70% of the population and average rates calculated for the remaining 30%.*

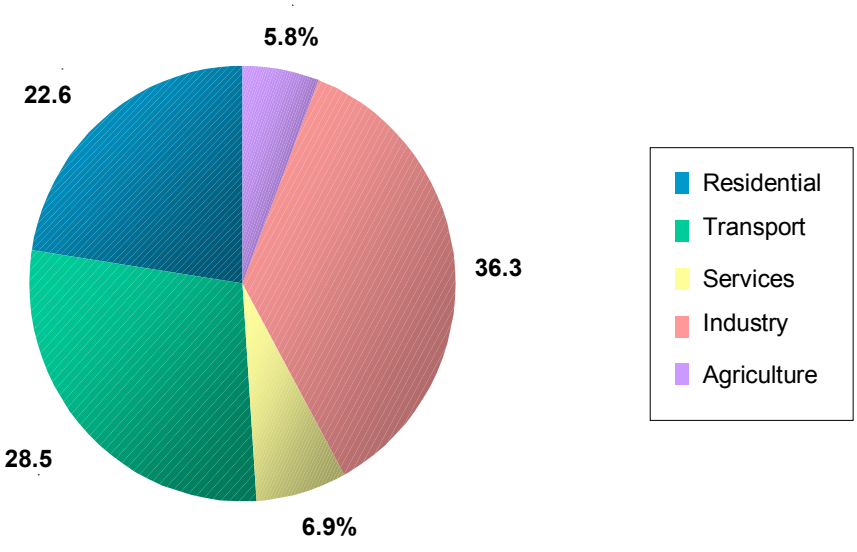
Industrial Model

The country's economic development adopts an industrial growth, as this economic sector increases its share in the national GDP at a rate higher than the remaining sectors, reaching 19% in 2012.

Industry recovers the leadership based on the momentum gained by foreign demand as a consequence of a high actual foreign exchange rate that has only declined at a slow pace during the last decade. Low labor cost has allowed the country to gain an international position in intensive labor activities within the region that also benefit from natural advantages on account of resources available. Thus, the industrial sector finds an expansive dynamics mainly in agriculture related manufactures. In this evolution profile, all transaction sectors gain weighting at the expense of services, to a higher or lower extent, whether services are associated with the local or foreign sector.

As to the energy consumption levels of the different economic sectors in Argentina, the economy experiments a 2.96% increase per year, a value that exceeds the records of the 1991 – 2001 decade. Both main fuels used for final consumption are natural gas (44%) and oil by-products (30%).

Graphic No. 1: Energy consumption per Final Consumption sectors:



The higher activity level in the industrial sector brings about a higher use of the installed capacity and a consequent improvement of efficiency. The industrial consumption, however, increases not only owing to the higher activity level but also by reason of the prevalence of energy intensive industries. Natural gas accounts for 48% of the sector's power consumption, followed by electricity with 27%.

Energy consumption of families and shops has been less affected by the economic oscillations of the economy than the total energy final consumption of the country. In these sectors, natural gas represents the main energy source used that, together with electricity, accounts for almost 90% of the total consumption.

As to transportation, the higher economic activity contributes to an increase of emissions owing both to the increase in the motorization rate and in the use of automotive means of transport. Fuel consumption, however, is mitigated by the incorporation of more efficient energy units and by Diesel Fuel and CNG substitution. Diesel fuel consumption accounts for 52% of the sector total consumption, while CNG represents 23%.

Table No. 1: Main features of the Industrial Model

VARIABLE	
GDP	$ 344,902 Million
Average growth	2.5 % per year
Economic sector in the process of expansion	Industrial
Increase of energy consumption	2.96% per year
Fuel that is most used	Natural Gas

Agro-Exporting Model

Under this type of expansion, primary activities expand at a higher rate. The primary agro-exporting sector is not the only one to expand, mining also does. An almost non-existent internal market, however, does not allow for the development of an associated industry that may foster a vertical integration with the primary sector. The economy is an export led growth, with no generation of a higher value added. Employment levels do not improve and infrastructure and services grow at the pace of the primary sector needs. The actual foreign exchange rate remains high, although the lack of internal absorption causes a decrease of its rate during the decade, at a higher pace than in the case of the industrial exporting model.

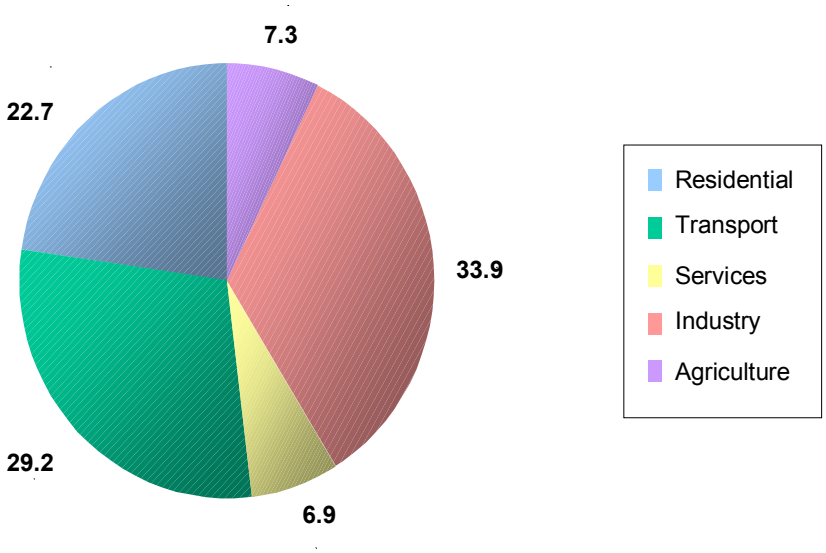
Grain production has benefited from cereal high prices, while beef price has failed to experiment an equal raise. Grain production levels have grown at a rate that exceeds cattle production, as a logical consequence of the agriculturization process that the Argentine agricultural/ livestock economy has undergone for some decades so far. Both agricultural and livestock exploitation have experimented a considerable yield improvement in recent years, a fact which, together with the increase of the agricultural area, has given rise to current, high production levels.

The pasture breeding area has diminished in favor of cultivated areas.

As to energy consumption levels by the country's economic sectors, the economy has experimented a slow-down, reaching 2.28% per year. This value is lower than

such record during the 1991 – 2001 decade. Both main fuel types used for final consumption are natural gas (42%) and oil by-products (33%), followed by electricity (17%).

Graphic No. 2: Energy Consumption per Final Consumption sectors:



In the household and industrial sectors, the fuel that is most used is natural gas, followed by electricity. Instead, the Service sector mainly uses electricity (68%), followed by natural gas (30%).

Logically, there is an increase of inputs used by the agro-farming sector (fuel and fertilizers) in hand with the production growth pace. There are two variables, however, that play a role in the determination of fuel consumption and which have to do with the determination of these values in an opposite way: the larger directly sown area, which causes fuel demand to decline and the higher automation of the activity. Thus, the sector increases its share in the total use of fossil fuel in the country, Diesel fuel occupying a primary position in the sector (94%).

As to the use of variable inputs (fertilizers and agrochemicals), sustained increases are recorded (especially in the light of high agricultural prices), in hand with a revolution in genetics and biotechnology areas.

In the Transportation Sector, the most used fuels are Diesel fuel and CNG, followed by different types of gasoline.

Table No. 2: Main features of the Agro-exporting Model

VARIABLE	
GDP	$ 321,414 Million
Average growth	1.8 % per year
Economic sector in the process of expansion	Agro-farming
Increase of power consumption	2.28 % per year
Fuel that is most used	Natural Gas

Power Based Model

The benefit of energy resources and infrastructure available in this sector and in the service area, in general, together with a low domestic absorption, allow for an exporting expansion of energy intensive intermediate goods.

In many cases, this takes place with a vertical integration of energy companies. Also, the Brazilian recovery and the U.S. energy deficit cause these new energy developments to appear as an independent sector itself.

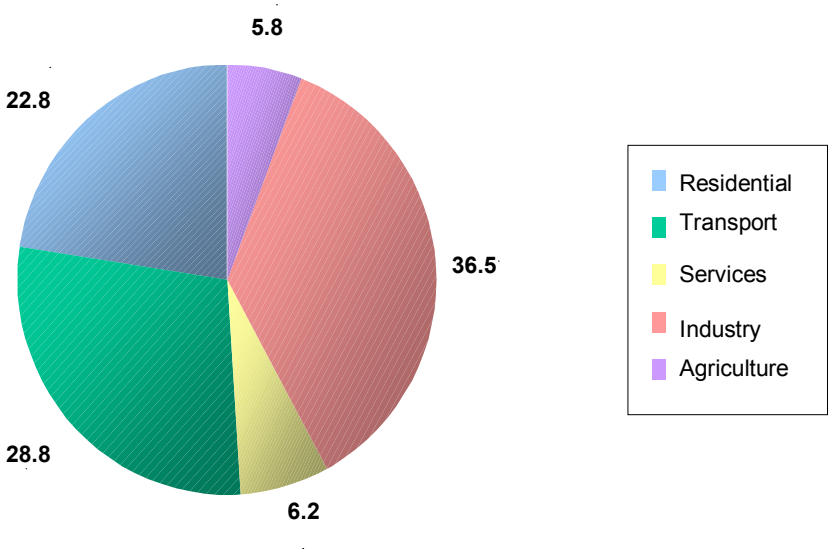
The service sector that makes progress in this framework is associated with developments such as gas pipelines, oil pipelines, electrical transmission networks, ports and roads.

In this context, foreign investment once again gains momentum in the expansion of these sectors.

The energy consumption of the economy as a whole grows at an average rate of 2.78% per year; this value, although higher than the value recorded in the 1991 – 2001 decade, is lower than the increase experimented in the industrial model.

The main energy source for final consumption is found in natural gas, accounting for 43.4% of the total consumption, followed by oil by-products, with 31.5% and electricity, with 17.25%.

Graphic No. 3: Energy Consumption per Final Consumption sectors:



Naturally, the energy sector increases its share as a final consumer of energy in the country's energy matrix. The consumption of this sector for its operations amounts to 7% in respect of the base year.

In the Transportation Sector, the most used fuel types are Diesel fuel and CNG, followed by different types of gasoline. The Service sector consumption is based on almost 100% gas and electricity, same as in the case of the Household sector. Liquefied petroleum gas, however, has a small share in the latter. Gas is also the main energy source in the industrial sector (46%) followed by electricity (26%).

Table No. 3: Main features of the Power Based Model

VARIABLE	
GDP	$ 328,417 Million
Average growth	2 % per year
Economic sector in the process of expansion	Power based
Increase of energy consumption	2.78 % per year
Fuel that is most used	Natural Gas

Greenhouse Gas Emissions

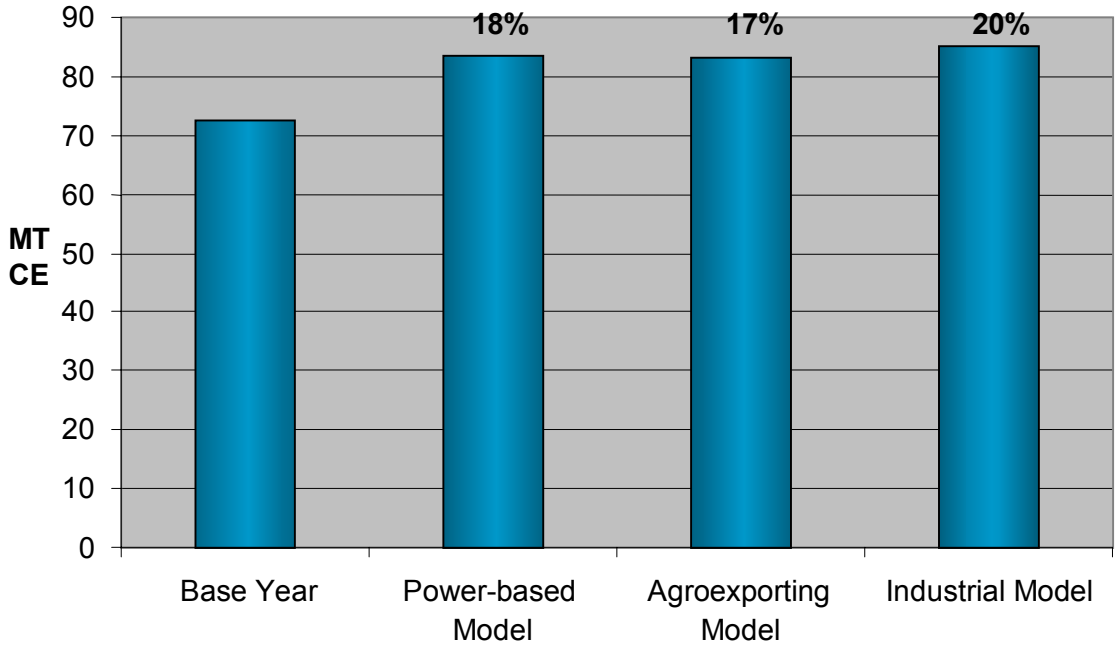
The following chart specifies the resulting GHG emissions for 2012 for each Scenario. Values are stated in Million Tonnes Carbon-Equivalent (MTCE).

Table No. 4: GHG emissions per GHG type (in MTCE)

	Industrial Model	Power Based Model	Agro-exporting Model
CO2	51.69	46.69	48.81
CH4	19.44	19.45	19.70
N2O	14.17	14.41	14.53
TOTAL	85.30	83.55	83.00

Future GHG emissions will vary in accordance with the development pattern adopted by the country. In 2012, the higher emissions would occur under a development Industrial Model, followed by the Energy Based Model and finally, by the Agro-exporting Model. Results vary from a maximum of 3 MTCE between the higher and lower emission scenarios.

Graphic No. 4: GHG emissions in year 2012



Under the ***Industrial Model***, the highest increase of emissions is generated, from 71 MTCE in 1997 to 85.3 MTCE in 2012. This represents a 20% increase in respect of 1997.

The ***Agro-exporting Model*** shows an 18 % increase amounting to 84 MTCE in year 2012.

Finally, in the ***Power Based Model***, emissions amount to 83 MTCE, accounting for 17% in respect of the base year.

Emissions per Economy Sector

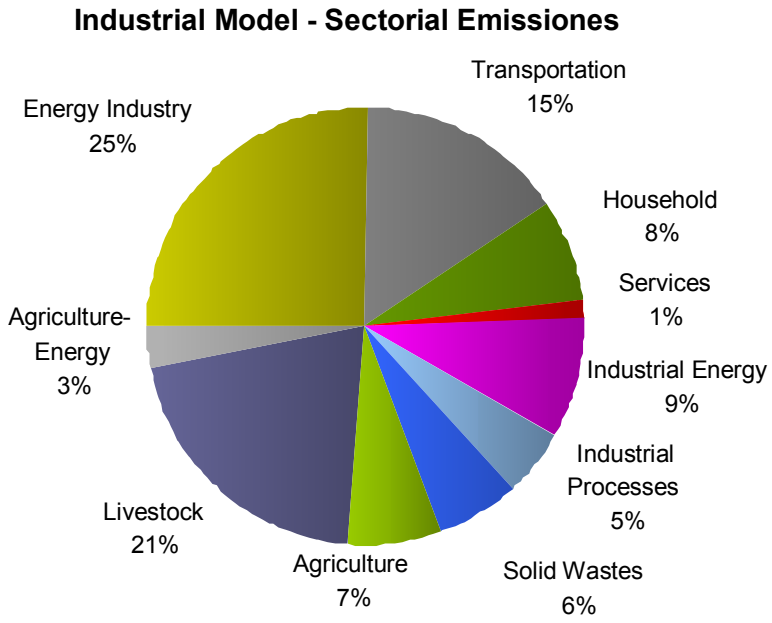
The distribution of emissions according to each emitting sector was evaluated in each Scenario.

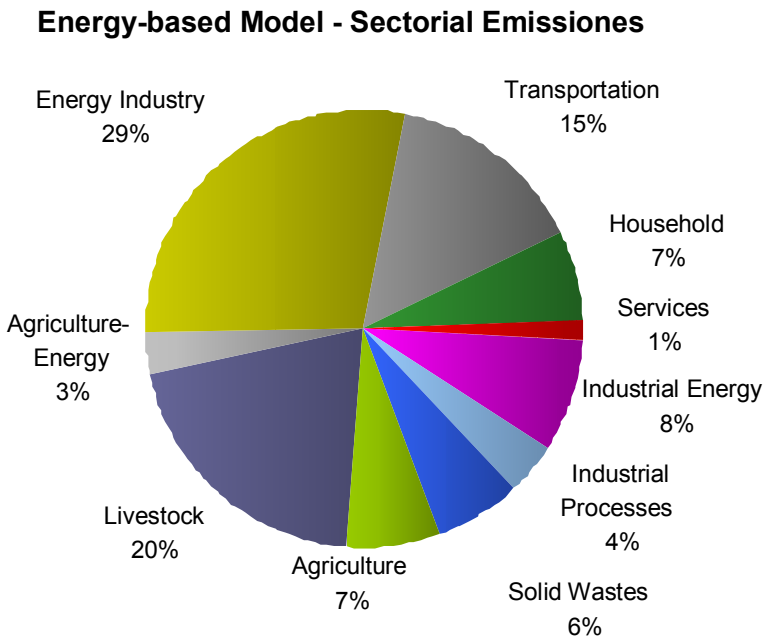
Table N° 5: GHG emissions per sectors (in MTCE)

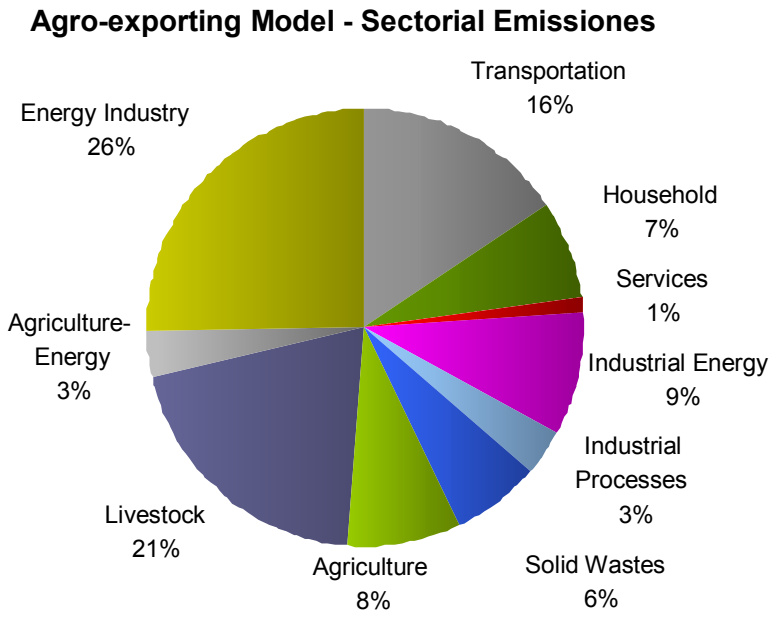
SECTOR	Industrial Model	Energy-based Model	Agro-exporting Model
	MTCE		
Energy Industry	21.5	23.7	21.0
Livestock	17.5	17.0	16.5
Transportation	13.0	12.3	12.9
Industrial Energy	7.7	7.0	7.5
Household	6.5	5.6	6.0
Agriculture	5.9	5.9	7.0
Solid Wastes	5.4	5.4	5.4
Industrial Processes	4.1	3.2	2.9
Agriculture-Energy	2.5	2.5	2.9
Services	1.0	1.0	1.0

In general, almost the same percentage share for the different sectors in the total emissions is observed in all three scenarios. The sector that generates most emissions, in all scenarios, are the Energy Industry and Livestock sectors, followed by the Transport, Industry, Households, Agriculture, Solid Waste and Services sectors.

Graphic No. 5: GHG emissions per sectors in different Scenarios

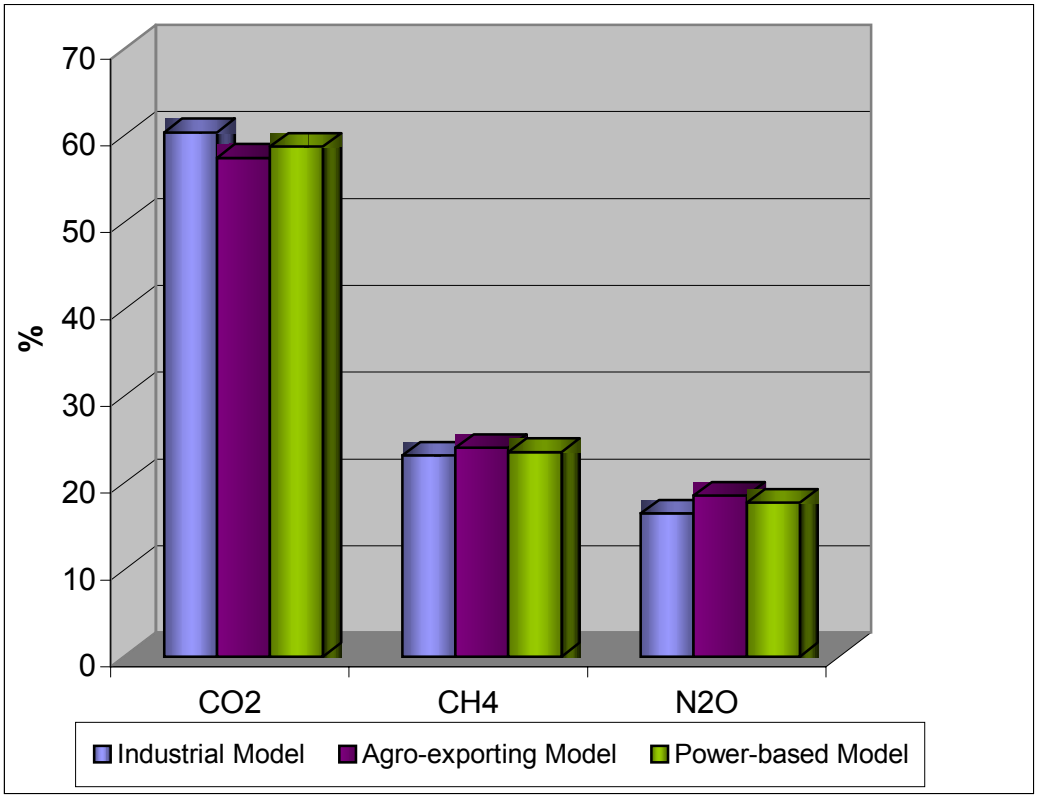






Emissions according to GHG type

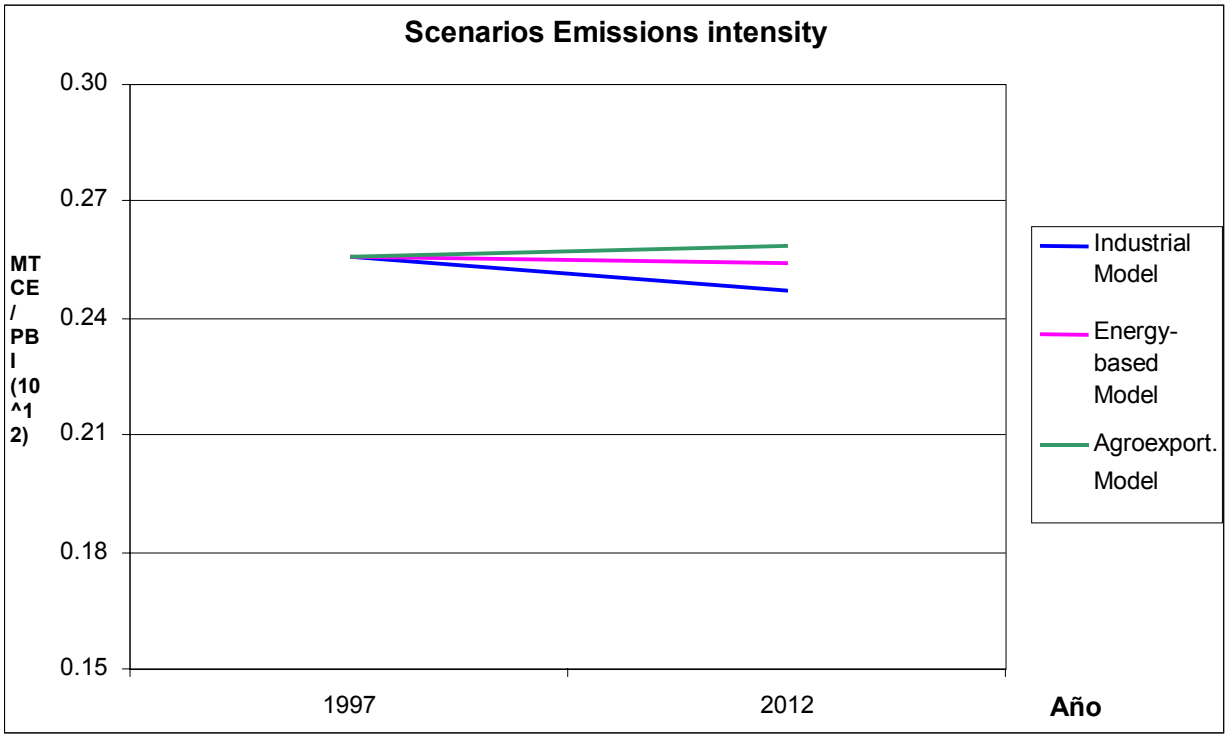
In all three Scenarios, the gas that contributes most to total emissions is carbon dioxide. Notwithstanding this, methane acquires a significant weight while nitrous oxide represents a lower contribution to total emissions.



Emissions Intensity

Emission intensity is an index that measures the amount of GHG emitted per GDP unit. Thus, it is an indicator of the emission level in a certain economy. The emission intensity units are MTCE/GDP (10^12).

In the base year, this index showed a value equal to 0.256, decreasing in all three scenarios. In the Industrial Scenario, the index takes the lowest value, 0.247. In the second place, the Power-based Scenario shows an index equal to 0.254 while in the Agro-exporting Model the intensity increases to 0.258.



The drop of emissions intensity is more significant in the Industrial Model, which shows a 3% reduction from the base year index. Under the Energy-based Model the emissions intensity index shows a drop of less than 1%. This decreases responds to a number of reasons, such as a higher level of economic turnover, a higher use of the installed capacity and the consequent improvement of production efficiency.

Conclusion

The emissions scenarios developed represent a first step ahead towards the "*creation of capacity for the use of modeling instruments and emission scenarios*", as recommended by the IPCC in its report on Emission Scenarios.

It is for this reason that the development of such scenarios has fostered new analyses and surveys about the most important emission sources, but, at the same time, it has detected deficiencies and lacking aspects in connection with the development and availability of essential data and information for calculation of the true impact of different source emissions. In this respect, the need to develop our own emission factors for application in Argentina, in many emitting sectors, should be pointed out.

The first conclusion arising from scenarios is that GHG emissions in Argentina will increase in the next years, regardless of the prevailing economic model. This, depending upon the scenario basic assumption whereas the national economy will experiment growth with respect to the base year. Under the Industrial Model, a 20% increase is generated with respect to 1997. Under the Energy Based Model, emissions increase by 18% and under the Agro-exporting Model, there is a 17% increase in year 2012.

In all of them, the higher emission generation implications are found in the Energy Industry and Livestock sectors, followed by Transport and Industry. Upon breaking out the emissions among the different productive sectors in the country, it can be observed that the shares of the different sectors in the total emissions within Argentina are of a similar magnitude. Thus, it is evident that all sectors have a significant impact on the national emissions, and consequently, play a major role in the reduction of emissions.

These scenarios not only constitute a tool for analysis and decision-making affecting the future evolution of GHG emissions, but also represent a platform for future studies aimed at the search for better mitigation alternatives for each one of the sectors involved.

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ANNEX 1: Economic Scenarios for 2012.

GDP ARGENTINA HISTORICAL EVOLUTION			BASE SITUATION		INDUSTRIAL MODEL		PRIMARY MODEL		ENERGY BASED MODEL	
ECONOMIC SECTOR *	**GDP YEAR 1992**		**GDP YEAR 2001**		**GDP YEAR 2012**		**GDP YEAR 2012**		**GDP YEAR 2012**	
	%	Value $	%	Value $	%	Value $	%	Value $	%	Value $
SERVICES (REST)	59.0%	120,169	59,8%	147,351	56.0%	181,246	57.8%	173,572	57.7%	176,988
AGRICULTURE, LIVESTOCK, FORESTRY AND FISHING	5.8%	11,785	6,1%	15,148	6.3%	20,525	8.5%	25,371	6.8%	20,969
MINES AND QUARRIES	1.6%	3,204	2,1%	5,105	2.1%	6,917	2.6%	7,859	2.6%	7,859
MANUFACTURING INDUSTRY	18.2%	37,006	14,9%	36,732	18.4%	59,610	13.9%	41,882	15.2%	46,666
ELECTRICITY, GAS and WATER	2.0%	4,040	2,9%	7,188	3.0%	9,636	3.0%	8,937	3.6%	11,065
CONSTRUCTION	5.9%	12,039	5,1%	12,627	4.7%	15,200	4.6%	13,784	4.6%	14,088
TRANSPORT and COM.	7.5%	15,293	9,1%	22,446	9.4%	30,414	9.6%	28,826	9.5%	29,137
TOTAL GDP	100.0%	203,537	100,0%	246,597	100.0%	323,547	100.0%	300,230	100.0%	306,772
TAXES	8.6%	19,054	6,6%	17,399	6.6%	21,354	6.6%	19,788	6.6%	20,219
TOTAL		**222,591**		**263,997**		**344,902**		**321,414**		**328,417**
(**) at 1993 constant prices	Annual GDP growth average =			**1.91%**		**2.5%**		**1.8%**		**2.0%**

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