Municipal measures to reduce greenhouse gas emissions in Vigo

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Index

Reasons for the implementation of this study

According to the Brundtland report, sustainable development means the process of change "in which the exploitation of resources, the direction of investments, the orientation of technological development and the institutional adjustment are aware of the needs of both present and future" (World Commission on Environment and Development, 1987). For this reason, the process of socio-economic change seeks to improve the quality of life as well as to develop the privileges of individuals in a society, without degrading the vitality and diversity of the natural environment on which they depend.

According to the European report on sustainable cities (1996), which promotes the use of indicators to measure progress towards sustainability, the fundamental aim should be to get citizens involved in the dynamics that will lead to a continuous improvement in daily life.

The indicator will permit a brief, understandable and scientifically valid reading of the phenomena to be studied, such as the level of development, welfare, and so on, and therefore constitutes a dynamic tool that should be strengthened and adapted over time through a continuous process of review.

In 1999 a team of experts on urban environment of the European Commission proposed 10 indicators (5 principal or mandatory and 5 additional ones) and set the foundations for establishing a monitoring methodology. One of these indicators, A2, relates to "the local contribution to global climate change", and focuses on the improvement of environmental pollution.

This reason behind this indicator is that a sustainable community should combat global climate change and avoid or reduce consuming non renewable energy resources. In the case of Vigo, the aim is to measure the city's contribution to global climate change, as well as to quantify anthropogenic emissions, mainly CO_2 and ascertain the measures to be employed in order to reduce them.

In a previous study "Analysis of the contribution of the town of Vigo to climate change", electricity consumption was shown to produce the highest percentage of CO_2 (36%), followed by the city transport system and fishing sector (28% and 15%, respectively). Pollution from combustion in manufacturing and construction industries, as well as waste incineration, only accounted for 7% and 4% respectively.

In this paper actions aimed at minimizing the local contribution to global climate change are analysed and quantified. However, it should be noted that the success of the reduction of greenhouse gases (GHGs) will depend on the involvement of the whole society, including governments, consumers and so on.

Part of the content of this paper is provided by the results obtained by means of a cooperation agreement for the project "municipal measures for the reduction of emissions of greenhouse gases". This agreement was signed in June 2007 by the Mayor of Vigo, represented by former local councillor and main driving force behind the idea, Corina Porro and, representing the Rector's Office of the University of Vigo, Vice President for Research, Manuel J. Reigosa

Introduction

A recently published study has outlined the global phenomenon of climate change. It has discussed the consequences and causes of this phenomenon in depth. The global scale of this phenomenon may raise doubts about how it may best be dealt with. Indeed, since the entire population of the world is affected by this problem, all sectors (from international organizations, through national, regional and local governments, to individuals) should be involved in fighting it

The measures to be taken and the methodology to be used in each country need to be defined according to the particular circumstances of that country. They cannot simply be extrapolated from one country to another without taking into account the individual situation of each.

An analysis of the situation in Vigo has allowed us to identify which sectors, and to what extent, are the most responsible for the emission of greenhouse gases and therefore which should be the main areas on which to focus efforts.

Vigo does not have the power to influence some strategies against climate change but it is possible to see how these international, national and regional strategies have a bearing on the municipality's emissions.

In May 2004 the VIGO INTERMUNICIPAL ENERGY MANAGEMENT AGENCY FOUNDATION (*Fundación Agencia Intermunicipal da Energía de Vigo*, FAIMEVI) was set up under the Protectorate of the Galician Council for Innovation, Industry and Commerce and with the support of the EU. This was as a result of a consensus among various public and private companies who are committed to sustainable development, energy saving and efficiency, and renewable energy. The main activities that have been carried out since then have been:

- Awareness campaigns on energy saving and efficiency.

- “Municipal Regulation on the Collection and Utilization of Solar Energy for Thermal Use in Buildings and Facilities”. (Text approved at the plenary assembly of Vigo City Council on the 23rd of July, 2005).

- “Municipal Regulation on Street Lighting Installations in the Municipal Area of Vigo”. (Text approved at the plenary assembly of Vigo City Council on the 31st of March, 2006).

Similarly, through information and awareness-raising campaigns, the municipal council can encourage different attitudes and behaviour patterns that have a positive impact on the overall balance of emissions.

We will outline the proposed measures, both at the local and supramunicipal levels, as well as how the sources of emissions from the different GHG (greenhouse gases) have been analysed.

Methodology employed

IPCC CLASSIFICATION

Internationally, emissions calculations are done based on the methodolgy developed by the IPCC. This methodology is used by different industrialized countries to produce their greenhouse gases inventories. Emissions are classified into seven large groups: Energy; Industrial Processes; Use of solvents and other products that contain volatile components; Agriculture; Change in use of soil and forestry; Treatment and elimination of residues; Others.

These large group are further divided into sub-activities as follows:

1. Energy

A. Combustion Activities: 1. Energy Sector Industries; 2. Manufacturing and Construction Industries; 3. Transport; 4. Other Sectors; 5. Others

B. Fugitive Fuel Emissions. 1. Solid fuels; 2. Petroleum and natural gas

2. Industrial Processes: A. Mineral products; B Chemical industry; C. Metallurgical production; D Other industries; E. Halocarbon and SF6 production; F. Halocarbon and SF6 usage; G. Others.

3. Use of solvents and other products that contain volatile components

Paint, degreasers, dry cleaning, the production and manufacturing of chemical products and other diverse activities, for example the use of anaesthetics in hospitals which release volatile organic compounds (VOCs) when they evaporate.

4. Agriculture: A. Enteric fermentation; B. Management of fertilizers; C. Rice cultivation; D Agricultural soil; E. Stubble burning; G. Others

5. Change in use of soil and forestry. A. Changes in forest stocks and other ligneous biomass; B. Restructuring of woodlands and meadows;
C Abandonment of cultivated fields; D Emission/Capture of CO_2 in soils; E. Others

6. Treatment and elimination of residues: A. Deposits at dumps; B. Treatment of residual water; C. Incineration of waste materials; D. Others

7. Other

01 ENERGY

Combustion activities were the primary cause of emissions in 2004, representing 96.58% of the net emissions of GHG. This means that a significant reduction in emissions by this sector would see a considerable decrease in global emissions. It is therefore logical that the main aim should be to reduce these emissions, either by reducing energy consumption, or by increasing energy efficiency (or a combination of both of these).

We are no going to study changes in emissions in 2004 for this sector, assuming for the purposes of this study that the others sectors remained constant. Another reason for this is that some of these sectors, for example agriculture or forestry show higher margins of error than other sectors, as highlighted in an article in Good Practice Guidance (IPCC 2001b) which analyses general uncertainty in estimations of national inventories.

ENERGY SECTOR INDUSTRIES

Galicia's Energy Balance shows that thermoelectric coal power stations continue to be the main producers of electrical energy in Galicia. In 2004 they increased their production even further to produce more than half of all the energy produced. The second fastest growing energy source was that of wind power, which is fundamentally due to the increase in installations. A slight increase in Natural Gas was also evident.

CO_2 equivalent emissions resulting from electricity consumption

TYPE OF POWER STATION	Fuel	2003	2004	Variation respect to total
Thermo-electric coal	Lignite	613,138	729,160	14,62%
Thermoelectric oil products	Fuel-oil	17,196	12,690	-0,57%
Cogeneration with oil	Fuel-oil	30,555	32,605	0,26%
Cogeneration with gas-oil	Gasoil	15,620	6,017	-1,21%
Cogeneration GLP	GLP	12,626	0.00	-1,59%
Cogeneration with natural gas	N. G.	5,376	12,982	0,96%
TOTAL EMISSIONS	**694,512**	**793,454**	**12.47%**	

The measures to be taken in the Galician region will fundamentally consist of promoting renewable energy sources in place of combustible fuels, and using the most efficient methods possible.

Promotion of renewable energy sources.
I. Wind power
II. Biomass
III. Minihydraulic power
IV. Solar Power
V. Wave power

The following table shows trends in power stations in Galicia:

Electrical Power from renewable energy sources and its evolution (MW)

Production	Installed Power		Predicted Power
	2002	2003	2010
Hydraulic (P>10MW)	2.945	2.945	2.945
Mini Hydraulic (P=10MW)	173	203	315
Wind	1.297	1.579	4.000
Biomass	43	45	93
Solar	0	0	5
Total	**4.458**	**4.772**	**7.216**

As we have already said, Vigo City Council has no authority to promote the development of renewable energy sources, unless one of its mountains are declared suitable for the exploitation of wind energy or subsidies are created by the city council to promote solar installations. The impact of these potential actions cannot be measured. On the other hand, the impact of the promotion of use of renewable energy sources by Galicia on emissions in the Vigo municipality can be quantified.

To build an approximation, we will accept the hypothesis that the consumption of electricity in the municipality of Vigo will rise at an annual rate of 1.3%, in line with the European average (statistic from the Nuclear Forum on the evolution of electricity consumption for 2005). This approximation puts Vigo's energy consumption at 1,339,722,086 kWh for 2010. If we consider that the output from transport and distribution will be similar to that in 2004 (95.78%), the figure for electricity consumption rises to 1,398,766,000 kWh. The other supposition we can make is to consider the rest of the energy that is produced in coal-fired power stations in order to look at the worst case scenario.

A reduction in energy consumption from coal and in CO_2 equivalent emissions from thermo-electric power stations is as high as 56.32% while a reduction in emissions resulting from the production of electricity is as high as 63.58%. If all other contributions were to remain constant, we can say that with an increase in production of renewable energy, emissions in the Vigo municipality would reduce by 22.74%, bringing total emissions down to 1,500,713 tons per year and the per capita contribution to 5.13 metric tons of CO_2 equivalents.

As we can see, a major effort in one of the structural sectors produces a substantial decline in emissions. It is therefore advisable to support the development of renewable energies as much as possible.

1.1 Household sector. Responsible consumption.

According to the IDAE (*Instituto para la Diversificación y Ahorro de la Energía*, Spanish Institute for Energy Diversification and Saving), energy consumption in the Spanish home accounts for 30% of the country's total. Half of this can be accounted for by cars and the other half is used within the home itself.

Within the home, we can distinguish between the consumption of electricity and of fossil fuels. The latter is mainly used in central heating and domestic hot water.

The consumption of electricity in the city of Vigo is considerable: in 2004 1,208,200,898 kWh were used, accounting for around 35% of consumption in the province.

The domestic sector accounts for 33.1% of global consumption of electricity. This is a considerable percentage of the total. CO_2 emissions from the electricity sector were of 694,512 metric tons in 2004, accounting for 37.47% of the total and the domestic sector was responsible for emitting 217,382 metric tons of CO_2 equivalent gases (from electrical consumption). Because of all this it is vitally important to establish policies that encourage the reduction of consumption in the home and thus reduce emissions.

The relevant authorities need to establish model programmes for the reasonable use of energy that the people can follow. These practical guides on the efficient use of energy can be found at national level (IDAE) and at regional level (INEGA – *Instituto Enerxético de Galicia*, the Galician Institute for Energy). Their main objective is to provide citizens with the information and knowledge they need to be able to become more efficient, less dependent on energy sources and more aware of the effects of their actions on the environment.

In order to know which energy source to concentrate on, it is useful to know how electrical consumption is distributed in the average Spanish home.

Distribution of electricity consumption	**%**
Refrigerator	18.0
Lighting	18.0
Heating	15.5
Television	10.0
Stove top	9.0
Washing machine	8.0
Small electric appliances	7.0
Electric oven	4.0
Hot water	3.0
Dishwasher	2.0
Microwave	2.0
Tumble drier	2.0
Air conditioning	1.0
Computer	1.0

As we can see, the main electricity-consuming devices in Spanish homes are lighting and refrigerators (18% each) although if we consider all electrical appliances together, their combined consumption is 63% of the total. Electrical appliances are the things to focus on.

A) Electrical appliances

When purchasing electrical appliances, it is important to choose them carefully as the energy they will use during their lifetime is more expensive than the appliances themselves.

When talking of buying electrical appliances, it is important to mention the energy label which gives buyers information about the appliance. This label classifies appliances according to their energy-efficiency compared with the average (A is the most efficient, D is of average efficiency and G is the least efficient).

I am now going to give a summary of the practical advice given by the IDAE and the INEGA for the different types of electrical appliances.

• Refrigerator

Almost every home has one of these and although it is not all that powerful, it is on all the time. It is therefore the appliance that uses the most power in the home, accounting for 18% of the total. Since it is the biggest energy consumer, two new grades have been created for it's energy efficiency: A+ (means that it consumes 44% of energy compared with the average fridge) and A++ (means that it consumes less than 30% of the average).

• Washing machine

This is the appliance that uses the most energy (8%) after the refrigerator and the television. Almost all households have a washing machine that is used on average 3 to 5 times a week.

Most of the energy used goes into heating the water (80-85%) which is why it is advisable to run low-temperature programmes. Among other measures, it is advisable to buy washing machines classified as A for efficiency, always wash full loads, run a cold wash whenever possible, use a spin dryer and dry clothes outside in the sun, etc.

Bithermic entry washing machines are now available which have two separate water inlet pipes for hot and cold water. The water is heated in the home's central water heater, thus reducing washing time and energy consumption by 25%.

• Other electrical appliances

A quarter of all Spanish homes have a dishwasher and this, like the washing machine, uses most of its energy (90%) on heating the water. New models with economical programmes and bithermic entry mean that their consumption can be reduced considerably (by up to 25%).

At this stage it is also worth mentioning that appliances such as televisions and music and video equipment use energy when left on stand-by. On stand-by a device like this will use up to 15% of the power it consumes when in use (with increases in electrical consumption of up to 3%).

B) Lighting

Lighting our homes, shops, streets, shops and buildings accounts for 3% of the total amount of energy used in Spain, causing 6% (approximately 16 million tons per year) of CO_2 emissions from energy sources.

Households are the largest consumers of electricity after shops, contributing 26% and 27% respectively. Lighting in dwellings accounts for 18% of electrical consumption. The need to increase energy efficiency in lighting is a known, and in part accepted, fact.

As we can see, the domestic sector has a great potential for making a difference, since a reduction of power consumed in the home would contribute to a reduction in GHG emissions. As well as information campaigns that aim to encourage consumers to be more efficient, public authorities can take a number of other measures including:

• Encouraging consumers to purchase A grade electrical appliances.

This could be done by way of schemes of purchasing incentives, promotional campaigns, voluntary agreements with sales agents, etc. According to the Spanish Strategy for Energy Savings and Efficiency, the goal is that these appliances make up 40% of sales by 2010.

At the same time, some environmental organizations propose more aggressive action: that products that do not carry at least A or B grade efficiency labels should be withdrawn from sale within a short amount of time. This would not be an innovative policy as it is already being done in Australia and is being reviewed by other countries such as Canada and the United States.

With these measures it is estimated that reductions of around 15% in electrical consumption, and therefore also in emissions, could be achieved.

• Replacement of equipment

Some environmental groups propose that some electrical appliances that use large amounts of power, such as cookers (9%) and heaters (15%) should be replaced by gas appliances (because they are more energy-efficient).

As mentioned in the previous section, domestic electrical consumption in Vigo accounts for 31.3% of the total, being responsible for the emission of 217,382 metric tons of CO_2 equivalent. The measures to be taken by various authorities could lead to a reduction in energy consumption of up to 35% in coming years. As this estimation has been made by an environmental group (and they usually indicate the best possible scenario) we will take this figure as being the maximum possible.

The following tables show the reductions in emissions in relation to various decreases in consumption.

Firstly, we can calculate emissions reductions that would result from a reduction in current electrical consumption.

Redution in emissions due to measures in electrical consumption

Reduction consumption	Reduction Tn eq CO_2	Reduction emissions electrical sector	Reduction emissions energy sector	Reduction in emissions total
5%	10.869	1,56%	0,59%	0,56%
10%	21.738	3,13%	1,17%	1,12%
15%	32.607	4,69%	1,76%	1,68%
20%	4.476	6,26%	2,35%	2,24%
25%	54.346	7,82%	2,93%	2,80%
30%	65.215	9,39%	3,52%	3,36%
35%	76.084	10,95%	4,10%	3,92%

As we can see, the possibility of reducing emissions is very varied but always considerable. A 5% reduction in domestic consumption would mean 10.869 metric tons less of CO_2 equivalents. And the best-case scenario (as we have seen) would mean 76.084 fewer metric tons of CO_2 equivalents would be emitted.

If we consider that electricity consumption will rise by 1.3% annually (as we saw in the previous section) and that the distribution of electrical consumption will stay the same (by sector) as will the methods of generating energy (we are not taking the development of renewable energy sources into account here), the changes in consumption and the emissions associated with it are as follows:

Changes in electrical consumption and emissions in Vigo

	Consumption kw/h	Emissions Tn Co_2 equiv
Domestic	437.813.758	241.046
Electric	1.398.766.000	770.114
Energy emission		1.929.303
Emission total		2.017.890

Within this new framework of energy consumption and emissions, the savings gained by the reduction in consumption will be somewhat different with regard to the energy sector and the global sector.

Reduction in emissions due to mesures in domestic consumption of electricity (ref 2010)

Reduction in consumption	Reduction in Tn CO_2	Reduction emissions electrical sector	Reduction emissions energy sector	Reduction emissions total
5%	10.052	1,57%	0,62%	0,60%
10%	24.105	3,13%	1,25%	1,19%
15%	36.157	4,70%	1,67%	1,79%
20%	48.209	6,26%	2,50%	2,39%
25%	60.261	7,83%	3,12%	2,99%
30%	72.314	9,39%	3,75%	2,58%
35%	84.366	10,96%	4,37%	4,18%

In this case the reduction in emissions will be greater in all cases because energy consumption will be greater (and so emissions will also be higher).

Regardless of the year we choose as a reference, each measure to reduce emissions will be the same.

% contribution to a reduction in domestic consumption of electricity	
Lighting	42
Efficient electrical appliances	29
Good practice	14
The use of gas appliances	9
Other	6

1.2 Commercial and institutional sectors

In the city of Vigo, contribution by these sectors to a reduction in the consumption of electricity is very important. The services sector accounts for 26.83% of the total and the public sector for 11.29% placing these two sectors third and fourth after the industrial and domestic sectors.

The measures that have been put forward for these sectors by the different governmental agencies focus primarily on lighting.

Within public administration we should bear in mind that street lighting is currently responsible for 1% of the country's electricity consumption. Although this only represents 9% of all national lighting, the functioning of these 4.2 million lights accounts for 42% of electricity consumption in the public services sector. The potential for saving is clear if we consider that 95% of energy consumption relates to facilities owned by local councils.

In the municipality of Vigo, an electromechanical service is carrying out a project to reduce electrical energy consumption in street lighting. Currently consumption in street lighting stands at 25,489,943 kWh, which equates to emissions of 13,767 metric tons of CO_2 equivalents. The following table shows the effects of these measures.

Reduction in emissions due to measures in street lighting

Reduction in consumption	Reduction in emissions Tn CO_2 eq	Reduction in emissions electrical sector	Reduction in emissions total
30%	4.396	0,63%	0,23%

The reduction here is great and though the results do not seem to illustrate this, as they only represent 0.6% of emissions from electrical consumption, they signify a reduction in emissions comparable to those achieved by the farming and agricultural sectors.

02TRANSPORT

Internationally it is believed that decreases in the size of the engines used by light vehicles, which users would amortize in three or four years, could reduce specific emissions by between 10% and 25% by 2020. Also, if diesel, natural gas or propane were to be used instead of petrol, technically emissions could be reduced by between 10 and 30%, and if fuel came from renewable sources this figure would be close to 80%. In addition, if leaks in coolant were controlled, another 10% reduction would be made in emissions. The implementation of fiscal measures on motor fuel, particularly in countries where prices are low, could reduce emissions from road transport by about 25%. This would have indirect economic implications for other sectors though.

Mobility has increased throughout Spain in recent years. This increase has not been across the board, rather, road transport has seen greater growth than any other type of transport. Since the mid-1980s urban mobility of individuals has doubled, while the transportation of goods has increased by about 25%.

If public transport were to be used instead of the private car, a notable reduction in emissions caused by urban transport would be produced. We should note that in the EU, 50% of emissions are produced in cities where cars are very inefficient. Galicians spend about one hour per day travelling and the private vehicle (car or motorbike) is the preferred means of transport accounting for about 58.9% of the total. Use of public transport is very low: about 3.9% of Galicians use city buses and about 2.8% use intercity buses.

A mobility survey has been carried out recently in Vigo to find out which means of transport the city's inhabitants use. 42% of people usually make their journey on foot, while the rest are primarily made by bus (25%) or by car (24.3%). According to the survey, 197,640 journeys per day are made by car in Vigo, to which we need to add 4,880 journeys using a combination of transport methods, giving us a total of 200,520 journeys per day. This number is very high and raises the question of whether the people of Vigo would be prepared to use public transport more regularly. The signs seem positive since the number of journeys made by bus each day is a significant 25%. In addition, 87% of these journeys are made within the city and 77% are of less than 10 km. Almost 50% (47.1%) of people use their car because they have no alternative. 34% use their car because it is more convenient. For these reasons it appears that a significant improvement in public transport could see car users choosing to take the bus instead.

In order to calculate the reduction in emissions that would be caused by more people using the bus instead of their car, we will use approximations based on the reduction in kilometres that would be travelled. In other words, we will assume that a percentage of the kilometres that were travelled by car will now be travelled by bus, taking into account the corresponding conversion factor. This conversion factor refers to the occupancy levels of the different modes of transport. While the survey showed that the average occupancy of a car is 1.8%, there is no data for bus occupancy levels. I am taking this to be 50 people. This means that each kilometre travelled by bus is approximately the same as a kilometre travelled by 25 cars. The following tables show the results according to the percentage of kilometres travelled by bus:

Increase in public transport due to reduction in use of private car

% Reduction do use of private car	Reduction Km / year	Conversion factor (pers. bus/car)	Km travelled bybuses	Increase in public transport
5%	112.334.461	27,8%	4.044.041	13,65%
10%	224.668.921	27,8%	8.088.081	27,31%
15%	337.003.382	27,8%	12.132.122	40,96%
20%	449.337.843	27,8%	16.176.162	54,62%
25%	561.672.304	27,8%	20.220.203	68,27%
30%	674.006.764	27,8%	24.264.244	81,92%

Reduction in CO_2 emissions in Vigo due to promotion of public transport

% Reduction use of cars	Reduction in car emissions (Tn Co_2 eq year)	Increase in bus emissions (Tn Co_2 eq year	Net reduction in emissions (Tn Co_2 eq year)	Reduction in emissions for road transport
5%	19.441	3.177	16.264	2,95%
10%	38.882	6.355	32.527	5,90%
15%	58.323	9.532	48.791	8,86%
20%	77.764	12.709	65.055	11,81%
25%	97.205	15.886	81.319	14,76%
30%	116.646	19.064	97.582	17,71%

The effectiveness of this measure could be very significant, even at quite low percentages. In addition, since car transport contributes so greatly to GHG emissions, any reduction in this sector would mean a significant reduction on a global level.

Impact of encouraging public transport on other sectors

% Reduction use of cars	Reduction in transport emissions	Reduction in energy emissions	Reduction in emissions total
5%	2,83%	0,88%	0,84%
10%	5,66%	1,75%	1,67%
15%	8,49%	2,63%	2,51%
20%	11,32%	3,51%	3,35%
25%	14,15%	4,39%	4,19%
30%	16,98%	5,26%	5,02%

Other measures that could be introduced to complement this could include:

I. Route planning in cities, transport plans for companies with more than 200 employees, mobility plans for new urban developments, park and ride schemes on the outskirts of cities, an increase in the transportation of goods by train (new operators), priority lanes for public transport.

II. A more efficient use of transport

A) Measures to encourage efficient driving

Car drivers can contribute to reducing emissions by the way they drive. This measure requires no investment, simply a little effort on the part of the driver.

Buying energy efficient cars and using them sensibly contributes to achieving the emissions objectives set by the European Union and ratified by Spain.

The many measures proposed by the government to encourage drivers to do this include: the introduction of efficient driving programmes as part of the Ministry for Transport's training programme, the standardization of an efficient driving system, support for and launch of efficient driving courses, the establishment of drivers' certification, mechanisms to enforce the holding of driver certification, the establishment of in-vehicle devices that aid efficient driving (speed control, on-board computers).

These measures would be very useful in Vigo when we consider that road traffic contributes 574,755 metric tons of CO_2 equivalents to emissions. To be precise, road traffic accounts for 96% of these emissions and car drivers, the main focus of these efficient driving measures, account for 67.6% of the total and 388,819 metric tons. The potential for reducing emissions is thus very high, but also variable as it depends largely on how many drivers adopt these efficient driving measures.

Reduction in emissions due to efficient driving

Reduction in emissions of CO_2 eq	% Drivers who adopt efficient driving measures	Reduction in emissions of Co_2 eq	Reduction in emissions Transport	Reduction in emissions total
15%	5%	2.196,1	0,51%	0,15%
	10%	5.832,3	1,01%	0,30%
	15%	8.748,4	1,52%	0,45%
	20%	11.664,6	2,03%	0,60%
	25%	14.580,7	2,54%	0,75%
	30%	17.496,9	3,04%	0,90%
	50%	29.161,5	5,07%	1,50%
	75%	43.742,2	7,61%	2,25%
	100%	58.323,0	10,14%	3,00%

This table shows the wide variety of results that would be obtained according to the percentage of drivers who adopted the measures.

B) Measures relating to a better use of means of transport.

Car-pooling is a highly efficient way of reducing emissions but one that is used very little in Vigo. Proof of this lies in the extremely low occupancy rate of vehicles:

in 62.97% of journeys the driver travels alone. Car-pooling can be difficult to organize, but when we are talking about travelling to work or to school, which is at the same time each day, it is much easier to arrange. In Vigo 45% of people driving to schools have two or more passengers. On the other hand, 51.7% of people driving to work travel alone. Work is the principal motive for travel in Vigo accounting for 36.6% of the total. 50% of these journeys to work are made by car. In trying to encourage car pooling, travel to work should be the main focus of attention because the car is used so much and because of the tendency to travel alone or with one passenger. (92% of drivers travelling alone are going to work and when there are two occupants to a car, 72.4% of them are going to work.)

Based on the fact that, in Vigo, 75.9% of car usage is accounted for by people travelling to work, we will take it that the same percentage of GHG emissions applies to it. In other words, travelling by car to work is responsible for the emission of 295,157 metric tons of CO_2 equivalents. The occupancy rate of cars travelling to work is 1.64 people (according to the mobility survey mentioned previously). In order to appreciate the reduction in emissions resulting from car pooling, let's see how much emissions decrease as the occupation rate of cars increases.

Reduction in emissions in Vigo due to car-pooling

Number of occupants	Reduction factor	Reduction in emissions Tn Co_2	Reduction in road traffic
1,8	0,089	26.236	4,76%
2,0	0,180	53.128	9,64%
2,2	0,255	75.131	13,64%
2,4	0,317	93.466	16,96%
2,5	0,344	101.534	18,43%
2,6	0,369	108.981	19,78%
2,8	0,414	122.279	22,19%
3,0	0,453	133.805	24,28%
3,5	0,531	156.855	28,47%
4,0	0,590	174.143	31,61%
5,0	0,672	198.346	36,00%

Impact of car-pooling on other sectors

Number of occupants	Reduction in emissions in transport	Reduction in emissions in energy	Reduction in emissions total
1,8	4,56%	1,42%	1,35%
2,0	9,24%	2,87%	2,74%
2,2	13,07%	4,05%	3,87%
2,4	16,26%	5,04%	4,81%
2,5	17,67%	5,48%	5,23%
2,6	18,96%	5,88%	5,61%
2,8	21,28%	6,60%	6,30%
3,0	23,28%	7,22%	6,89%
3,5	27,29%	8,46%	8,08%
4,0	30,30%	9,39%	8,97%
5,0	34,51%	10,70%	10,21%

III. An improvement in the energy efficiency of transport methods

• The production of cars that emit less CO_2

In line with the objectives set by the Kyoto Protocol, the European Automobile Manufacturers Association has come to an agreement with the European Commission that CO_2 emissions from new cars sold in 2008 will be 25% less than in 1995. This equates to a reduction in emissions of 140 g/km.

This measure has a tremendous impact in terms of car emissions, but we have to bear in mind that if in 2003 average emissions from cars in Vigo was 140 g/km, the CO_2 equivalents produced would be 494,142.2 metric tons. 56,885 metric tons less would mean a reduction in road transport emissions of 10.32% and in overall transport of 9.89%.

In 2005, a hydrogen-powered bus in Vigo would have avoided the emission of 95 metric tons of CO_2 equivalents.

Another gas which is being used as fuel in this kind of bus is natural gas, which reduces pollutant emissions by about 90% compared with traditional diesel engine buses. In addition, sound pollution is reduced by about 50% compared with a normal bus. As with hydrogen buses, natural gas buses need to refuel at a plant that can provide the pressure the engine needs. Some cities are already using this technology. Malaga, for example, has tried various prototypes since 2004.

In parallel with the comparison made previously, we can say that a bus powered by natural gas in the city of Vigo would have avoided 85 metric tons of CO_2 equivalents being emitted in 2003.

IV. Other proposals

In this section we can include measures aimed at restricting the movement of traffic in cities, thus encouraging people to use public transport or non-motorised transport. These measures could include:

Pedestrianizing historic centres.
- Limiting traffic movement and parking in some areas of the city.
- Encouraging non-motorised transport: pedestrian and bicycle.

03 RESIDENTIAL SECTOR

In this section we will try to establish the total quantity by which a home in Vigo could make reductions. This will be based on various studies, patterns of behaviour and consumer habits which will allow us to make realistic calculations. For the other sectors (industrial, service and institutional) there are not enough repetitive patterns available to build a complete picture from which to make a more rigorous comparison.

As end users, households make up one of the sectors of the economy. The other sectors are industry, transport and services. From an environmental point of view, they have a significant impact on air pollution, water and energy consumption, and waste production. We can also consider expenditure per household as a parallel indicator to the growth of the productive sectors.

According to the definition used by the National Statistics Institute, a “private home” is considered one that is made up of a person or a group of people who together occupy a family dwelling – or part of a family dwelling – and use or share food and other goods (vehicle, electrical appliances,…) from the same family budget and who generate waste as a result of this consumption. Together, these activities cause greenhouse gas (GHG) emissions.

The first step is to calculate an approximate average emission per home in the municipality of Vigo, taking into account the following considerations:

1. Firstly, there are 93,419 occupied dwellings in Vigo.

2. Electrical energy consumption includes that used in transport and distribution.

3. The number of vehicles is calculated based on the 93,419 homes owning 1.52 similar to the total.

4. The amount of rubbish produced is calculated based on 292,566 inhabitants producing 332 kg of rubbish each per year and the fact that 44% of rubbish is of natural origin.

5. The rate of recycling waste is distributed as follows: 10,7 Kg of paper, recycled cardboard… per person / year / (blue container); 7,8 kg of glass per person / year/ (green container) and 8,5 kg of plastic, cans, tetra-brik,... per person/year (yellow container).

	Emissions (Metric tons of CO_2 equivalents)		
	Total	**Homes**	**%**
Electrical energy consumption	694.512	217.399,96	31,03%
Fuel consumption (Industrial, domestic and commercial)	189.485	97.359,52	51,38%
Use of private vehicle (road transport)	550.997	350.390,62	63,59%
Rubbish production	73.473	53.488,15	72,80%
TOTAL	**1.942.287**	**718.638,25**	**37,00%**

Households are therefore directly responsible for 37% of GHG emissions.

In weighing up which activities produce the most emissions, we can see that vehicle use accounts for almost half. This is basically due to two factors:

• The fact that the population is very spread out across the municipality: approximately 90,000 of the almost 300,000 inhabitants live in rural areas. We also need to remember that public transport is not well used.

• The temperate climate means there is little need for heating/cooling systems.

	Emissions (Metric tons of CO_2 equivalents)	
	Homes	**%**
Electrical energy consumption	217.399,96	30,25%
Fuel consumption (Industrial, domestic and commercial)	97.359,52	13,55%
Use of private vehicles	350.390,62	48,76%
Rubbish production	53.488,15	7,44%
TOTAL	**718.638,25**	**100,00%**

In this section we will try to raise awareness of the importance of our everyday activities in the fight against climate change. Every one of us can help to solve this problem simply by changing our habits and behaviour patterns. Adopting a more responsible attitude to consumption will improve our quality of life in the medium term.

Active participation by citizens in government initiatives is the key to their success. For example, when it comes to establishing possible measures to reduce GHG emissions in the energy sector, two parameters come into play:

- Controlling our consumption: saving energy by using it responsibly or by using systems and equipment that are more energy efficient.

- Controlling our waste production: using renewable energy sources or substituting the use of fossil fuels for others with lower GHG emission indexes.

Although it may seem that these two parameters are not linked, they are. For example, if we were to opt for solar power, a renewable energy source, to heat our water, this process would be much more efficient than heating the water by means of combustion or electricity, but we would need a deposit to keep the hot water in so that we could use it at night. On the other hand, if we heat water using an electrical device, although this system is the least efficient, we can be sure that we will have hot water at any time of day. Also, if this electricity is obtained exclusively from renewable energy sources, this process will not produce any GHG emissions.

Thinking that renewable energy sources alone can solve the problem of climate change is still a long way from being achieved. Currently, levels of energy consumption make a supply of energy exclusively from renewable sources impossible. Firstly, this is because the technological development of these energy sources has not enabled them to produce the same amount of energy as fossil fuels. Secondly, renewable energy sources cannot guarantee a continuous supply of energy since they depend on the weather (that it is day-time, that it is raining, that it is windy, etc.) Therefore, the less energy we need to provide us with our level of well-being, the fewer the situations we will find ourselves in which energy from renewable sources cannot cover this need at any given time. In the case of hot water, the key would be in the hot water deposit guaranteeing that it could meet the hot water needs for the night. And this can only be achieved with a more careful and efficient use of this water.

In short, any measures that can be taken to reduce consumption will facilitate the creation of systems that can produce renewable energy and the combination of these factors will mean greater reductions can be achieved.

On the 28th of November 2003, the Council of Ministers approved the Strategy for Energy Saving and Efficiency in Spain (E-4) for 2004-2012. The Strategy includes measures which will not be too difficult to achieve for the authorities and productive sectors for the development of the technology itself and for measures that can be taken by these authorities and the productive sectors to encourage energy saving, contribute to sustainable development, with public aid that does not endanger the equilibrium of the budget.

The objective is to reduce energy use by 7.2% during this period (energy necessary per unit of product) which consequently will reduce CO_2 emissions by 190 million metric tons.

This strategy is being developed through two action plans: one for the period 2005-2007 (approved by the Council of Ministers on the 8th of July, 2005); the other for the period 2008-2012 (approved by the Council of Ministers on the 20th of July, 2007).

Based on the efficiency standards set in the strategy, the reduction of CO_2 emissions for the different energy-consuming areas of the home will be established.

3.1 DWELLINGS

The domestic and services sectors represent more than 40% of the European Union's end consumption of energy. By applying energy efficiency measures to buildings, 450 million fewer metric tons of CO_2 would be emitted, a figure which represents one eighth of current EU emissions. The construction and maintenance of buildings use 25% of the world's wood, 17% of its water and 40% of its energy, as well as causing 32% of the world's CO_2 emissions.

The creation of the Council for Sustainability, Innovation and Quality in Buildings (*el Consejo para la Sostenibilidad, Innovación y Calidad de la Edificación*, CSICE) as a body for the authorities and for construction brokers, and, above all, the approval of the new Technical Building Code (CTE, *Código Técnico de la Edificación*) in which the basic requirements for quality, safety and habitability are set out, are measures which, although late in coming, should see a change in trends in this area. Constructors will have to make changes in order to meet certain requirements (regarding economic, energy and environmental sustainability) so that buildings are safer, more habitable, more sustainable and of a higher quality.

The CTE (published in the Spanish State Bulletin, BOE number 74, on the 28th of March, 2006) establishes measures including limiting the amount of energy a building needs to use, reducing the energy consumption of buildings, and using renewable energy sources to provide this energy. It also includes regulations on meeting energy efficiency criteria and the use of solar, thermal or photovoltaic energy in new build houses or those that are going to be renovated.

The following is an analysis of the reductions that could be made by applying these measures.

RENOVATION OF THE INSULATION LAYER IN EXISTING BUILDINGS

The new CTE demands that insulation layers should be almost doubled. The insulation in roofing should be increased by 70% and in the building's facade by 40%. Whereas before 3-4 cm of polystyrene would have been used to insulate brick walls, now no less than 6 cm must be used. And in roofing, no less than 7cm will need to be used. Windows will have to be double-glazed or even treated, especially those that are south-facing. In sanitary installations, the amount of insulation needed will depend on the permeability and type of land they sit on. They will have a waterproof layer and insulation, and will be at a certain distance from the ground.

An improvement in the insulation of buildings as set out in the new CTE regulations (HE-1) could mean savings in total consumption by thermal installations (domestic hot water and heating) and lighting installations of 13% for individual houses and of 8% for apartments.

To calculate the annual savings this measure will see in the domestic sector, the following facts need to be taken into account:

- Emissions from domestic energy consumption (electricity and fuels) in 2003 were of 305,921.2 metric tons of CO_2 equivalents).

- Thermal and lighting installations represent 73% of consumption by apartments and 76% of individual houses.

- According to the 2001 Population and Dwelling census, updated with information from the Galician Institute of Statistics on new builds, built-up surface area amounted to 8,686,000 m^2 in Vigo in 2003.

- According to the 2004 SEOPAN Annual Builders' Report, the average size of a house is 159 m^2 and that of an apartment is 102.4 m^2.

Therefore, the annual reduction in emissions will be achieved by:

IMPROVING THE ENERGY EFFICIENCY OF THERMAL INSTALLATIONS IN EXISTING BUILDINGS

On the 20th of July, 2007, the Council of Ministers approved the new Regulations for Thermal Installations in Buildings which updates the old one, which was dated the 31st of July, 1998. Among the main measures included in the new regulations the following are important:

The adaptation of thermal installations in existing buildings in line with the new regulations set out in the CTE (HE-2) could mean a saving of 16% of total consumption in a house and of around 18% in an entire apartment block.

Bearing in mind the previous hypotheses, the annual reduction in emissions would be:

	Houses	**Apartments**
Kg CO_2 /m^2 dwelling-year	35,22	35,22
Average size of dwelling (m^2)	159	102,4
Metric tons of CO_2 /m^2 dwelling-year	4,26	2,62
Saving /building	18%	16%
Reduction in emissions/home (Met.tons CO_2)	0,77	0,42

IMPROVING THE ENERGY EFFICIENCY OF INTERIOR LIGHTING INSTALLATIONS IN EXISTING BUILDINGS

The Strategy for Energy Saving and Efficiency aims for there to be 1.6 incandescent light bulbs per low energy consumption lights in each household, which could mean a 2% saving on the total energy consumption of a house and a 4% saving on a whole apartment block. The objective is to achieve this aim within three years.

Bearing in mind the previous hypotheses, the annual reduction in emissions would be:

	Houses	**Apartments**
Kg CO_2 /m² dwelling-year	35,22	35,22
Average size of dwelling (m²)	159	102,4
Metric tons of CO_2 /m² dwelling-year	4,26	2,62
Saving /building	2%	4%
Reduction in emissions/home (Met.tons CO_2)	0,09	0,10

INCREASING THE PERCENTAGE OF BUILDINGS HOLDING THE MAXIMUM ENERGY QUALIFICATION

As of 2007, new build projects or buildings that are being renovated must, by law, have an energy certification. This will be similar to that already used in electrical appliances, lightbulbs and vehicles. By way of this certification, the buyer - or tenant in the case of rented accommodation - will be able to compare and evaluate the energy efficiency of the building.

The certification should appear in any advertisement for the sale or letting of the building. Each building will be assigned level of certification for energy efficiency according to a seven-letter, seven-colour scale – from the most efficient building type (category A) to the least efficient (category G). The evaluation will be made according to the amount of CO_2 that is emitted by heating, refrigeration, domestic hot water (DHW) and lighting installations. So, to give an example, a category A building will have to reduce its CO_2 emissions by 60% more than a building that complied with the minimum regulations set by the Spanish Technical Building Code.

In order to calculate the demand for energy in dwellings, we will start with the hypothesis put forward by the IDAE for the Energy Qualification Scale. The starting point for this hypothesis is that the existing building park of dwellings (which is subdivided into houses and apartment blocks) is divided as follows:

- 40% of the buildings in the area would be category F.
- 10% of the buildings would be category G.
- The remaining 50% would be in the other 5 categories, although the majority would be category E and some would be category D.

With regard to new builds:

- 90% of the buildings that strictly comply with the CTE –HE regulations will be in categories C and D (35% in C and 55% in D).
- Of the remaining 10%, the most efficient 5% of buildings will be category B and the least efficient 5% would be category E.

We will now go on to calculate the boundaries between categories for dwellings in Pontevedra, taking the data from the provincial capital as a reference and extrapolating them to Vigo.

A) Houses

REFERENCE VALUES BEFORE TAKING INTO CONSIDERATION THE MIMIMUM SOLAR CONTRIBUTION STIPULATED IN CTE-HE4 FOR NEW BUILD HOUSES THAT STRICTLY COMPLY WITH THE REGULATIONS CONTAINED IN THE 'HE' SECTION OF THE TECHNICAL BUILDING CODE FOR PONTEVEDRA PROVINCE

Demand for heating kWh/m^2	41,2
Demand for refrigeration kWh/m^2	0,0
Demand for DHW kWh/m^2	17,5
Emissions from heating kg CO_2/m^2	13,2
Emissions from refrigeration kg CO_2/m^2	0,0

According to the CTE, Vigo is situated in the C1 climate zone which implies the following values for R (dispersion indicator)

- Demand for heating in houses: R= 1.5
- Demand for refrigeration in houses: R= -
- Emissions from heating in houses: R= 1.5
- Demand for refrigeration in houses: R= -

• Demand for domestic hot water in houses: R= 1.2

Therefore, the values of the ratio $I_{object}/I_{regulation}$ for the different R-values are:

		R	
Limits	**C1**	**1.2**	**1.5**
A-B	0.15	0.68	0.37
B-C	0.5	0.80	0.60
C-D	1	0.97	0.93
D-E	1.75	1.22	1.43

B) Apartment buildings

REFERENCE VALUES BEFORE TAKING INTO CONSIDERATION THE MINIMUM SOLAR CONTRIBUTION STIPULATED IN CTE-HE4 FOR NEW APARTMENT BUILDINGS THAT STRICTLY COMPLY WITH THE REGULATIONS CONTAINED IN THE 'HE' SECTION OF THE TECHNICAL BUILDING CODE FOR PONTEVEDRA PROVINCE

Demand for heating kWh/m²	26,5
Demand for refrigeration kWh/m²	0,0
Demand for DHW kWh/m²	12,9
Emissions from heating kg CO_2/m²	8,5
Emissions from refrigeration kg CO_2/m²	0,0

Boundaries between categories for apartment buildings

CATEGORY	Emissions from heating Kg CO_2/m²	Emissions from cooling Kg CO_2/m²	Emissions from DHW Kg CO_2/m²
A	<1,87	-	<1,33
B	1,87-4,25	-	1,33-1,6
C	4,25-7,82	-	1,6-1,9
D	7,82-13	-	1,9-2,4
E	> 13	-	> 2,4

Thus the reduction in emissions from a category A dwelling according to the reference values will be at least 9.2kg CO_2 /m² for houses and 7.3 kg CO_2 /m² for apartments.

Therefore, the annual reduction in emissions will be:

	Homes	**Apartments**
Reduction kg CO_2 /m² dwelling-year	9,2	7,3
Average size of dwelling (m²)	159	102,4
Reduction in emissions/home (Met. tons CO_2)	1,46	0,75

C) Measures to be taken on equipment

The aims of these measures are to increase the use of appliances or systems which consume less but produce the same amount of energy, and to encourage the use of renewable energy which does not produce GHG emissions.

At this point we should mention the development of the new, high performance, low consumption boilers. Like traditional boilers, these use fossil fuels, but they are about 95% efficient which means they save around 20-30% compared with traditional boilers. When used in combination with solar panels, these boilers can achieve savings of up to around 60% in energy consumption. Another more innovative type of boiler is the steam boiler which can produce outputs of up to around 106%. It uses steam to pre-heat the water, providing an additional return of 11%. This does not mean that it produces more energy than it consumes.

The new regulations on thermal installations will encourage the installation of these boilers (or other, more efficient, boilers than are currently being used). This will apply to 50% of boilers and air-conditioning equipment. Current equipment will have to be renewed or replaced to meet these regulations.

With the coming into force of the new European guidelines, new boilers will need to be purchased in all new buildings as well as in some old ones, in all Spanish cities. Therefore it seems logical to me to estimate how homes in Vigo would be affected by this.

Savings in energy consumption in the residential sector by the use of high output boilers

Saving factor	Proportion bought	Saving emissions Tn eq CO_2
20%	1%	417,4
	2%	834,8
	3%	1.252,2
	5%	2-087,0
	10%	4.174,0
	15%	6.261,1
	20%	8.348,1

Another measure is the installation of thermal panels that can use solar energy to heat domestic water. Since domestic hot water consumes around 20% of the total energy used in the home, this measure would see a great reduction in energy consumption. The cost of installing this kind of equipment ranges from around 1,100 - 1,400 €. The lifetime of the equipment is around 25 years and its capacity for saving is around 50-70%. So, savings made in energy used for domestic hot water would equate to around 110€ per year.

As well as being economically preferable, solar energy is important for the environment. Each home that installs a system of this kind will avoid emitting 1.6 metric tons of CO_2 equivalents every year.

In the municipality of Vigo, a municipal bylaw has been drafted setting out how solar energy can be used to heat water in new buildings with high energy consumption. This bylaw has been agreed by developers, installers and IDAE members. Current studies show that investment in these schemes will be returned within five years.

04FORESTRY

There are three ways of boosting carbon captation by forest ecosystems: the protection of existing forests; reforestation; and sustainable forest management. The time scales for each of these is different and so they have different short-term, medium-term and long-term effects. A decline in deforestation together with reforestation are key elements in effectively compensating for the emissions generated by other human activity. Whatever the commercial exploitation of forests may produce wood to make products that last a long time, or products that can replace fossil fuels, the benefit to net emissions can be up to four times higher than the captation of carbon by forests.

The forests of Galicia contain 133 million cubic metres of wood and grow at a rate of more than 12 million cubic metres each year. With regard to climate change, the mountains can be thought of as ‘sinks’ since they absorb a greenhouse gas that is floating around in the atmosphere. A carbon reservoir will become a carbon sink if, during a specific time period, the amount of carbon that enters it is larger than the amount that leaves it.

Measures are being taken in the municipality of Vigo to ensure that its mountainous forests are properly managed. In 2003 there were a total of 2,892.18 hectares of forest land (according to estimations), of which 1,400 hectares had been regarded as forest since 1990. These 1,400 hectares are used to calculate the increase in carbon stored in the mountains, in accordance with international regulations The management of the forest in the municipality produced a net absorption (not counting timber and firewood) of 22,971 metric tons of CO_2 equivalents. According to the IGE, there are 3,229 hectares of forest in the municipality, of which 2,892.18 hectares are wooded. According to this data, there are 336.82 hectares of de-forested land which are susceptible to being exploited for timber. The amount of carbon that can be absorbed depends on the amount of land available for planting and on the species of tree that are chosen. To simplify calculations we are going to see how the absorption rates for carbon vary according to the amount of forest land. We will assume that the variety of species will remain the same as it is now and that the same number of trees will be felled for timber and firewood.

Although the measures do not mean a great potential for reduction in emissions (a maximum of 0.42%), they will mean that the amount of CO_2 that is absorbed will be greater than all that produced by agriculture/livestock farming, marine and rail transport and almost all that produced by the purification of waste water.

Reduction in emissiones due to an increase in the forested area

% reforestation	Forested Area (ha)	Capture Tn CO_2	Increase in absortion	Net Increase in absortion	Reduction in emissions
25%	84,20	2.020,0	6,01%	8,79%	0,10%
50%	168,41	4.040,2	12,02%	17,59%	0,21%
75%	252,61	6.060,3	18,04%	26,38%	0,31%
100%	336,82	8.080,5	24,05%	35,18%	0,42%

05WASTE MANAGEMENT

At present, the separate collection of recyclable wastes is limited to paper/card and containers (plastic, glass or metal). All other rubbish is incinerated at the Cerceda Plant in A Coruña.

With the coming into force of the II National Plan for Urban Waste 2007-2015 (II PNRU *Plan Nacional de Residuos Urbanos*), recycling objectives have been set. At least the following percentages aim to be achieved by the years 2009 and 2012:

- For packaging waste:

	2009	**2012**
Paper/card	60	75
Glass	70	80
Metals	60	80
Plastics	30	50
Wood	25	50
Fabrics	30	40
Total recycling	**25**	**45**

• For organic matter:

	2009		2012	
	(1)	(2)	(1)	(2)
Composting	10	50	50	30
Biomethanization and other similar methods	5		10	

(1) From the separate collection of organic matter from urban waste and from garden waste.

(2) From urban waste, that has not been collected separately.

We are now going to calculate the amount of waste per type per household, bearing in mind the following:

• The rate of waste generation is 332 kg/person/year.

• The average home in Vigo has 2.89 inhabitants.

The average composition of urban waste is as follows:

Component	**Average Composition (%)**
Organic matter	44
Paper/card	21
Plastics	10,6
Glass	7
Ferric metals	3,4
Non-ferric metals	0,7
Wood	1
Other	12,3

Therefore, bearing in mind that each ton of waste that is incinerated emits the following quantities of GHG:

	CO_2	**CH_4**	**N_2O**	**CO_2 eqiv.**
Emission factor (Kg/tn waste)	985	0,00309	0,1	1016,06

The reduction in emissions will be of 0.28 tons of C O_2/household, if we take the recycling percentages set for 2009.

In this context it is clear to see the two ways in which we can reduce emissions. We could reduce the amount of urban waste that is produced in Vigo which would thus reduce the amount of waste that is burned and the amount of emissions. Or we could increase the amount of natural waste in the total which would reduce the amount of non-natural waste that is burned, and thus the amount of CO_2 that is emitted.

We can help reduce the amount of waste that is to be burned by choosing to buy products that are easy to dispose of, and products without excessive amounts of packing. A reduction in the production of waste is connected to recycling. The more products that can be recycled, the less will have to be incinerated.

Impact of a reduction in urban waste on CHG emissions in Vigo

Reduction in waste	Waste generated Tn	Reduction emissions Tn Co_2 eq	Reduction emissions waste management	Redución emissions total
5%	114.010	3.674	4,30%	0,19%
10%	108.010	7.347	8,60%	0,38%
15%	102.009	11.021	12,90%	0,57%
20%	96,009	14.695	17,20%	0,76%
25%	90.008	18.368	21,50%	0,95%
30%	84.008	22,042	25,80%	1,13%

Although recycling is not the best option, it does contribute greatly to reducing the environmental impact of managing urban waste. By increasing the amounts of waste we recycle, we are increasing the amount of organic matter in the total waste that is to be burned. Waste with a high concentration of natural matter causes less emissions, according to the IPCC's methodology.

Impact of more recycling on CHG emissions in Vigo

Fraction natural material	Reduction in emissions Tn Co_2 eq	Reduction in emissions from incineration	Reduction in emissions waste management	Reduction in emissions total
0,45	4.728,43	6,44%	5,53%	0,24%
0,50	10.638,98	14,48%	12,45%	0,55%
0,55	16.549,52	22,52%	19,37%	0,85%
0,60	22.460,06	30,57%	26,29%	1,16%
0,65	28,370,60	38,61%	33,20%	1,46%
0,70	34.281,14	46,66%	40,12%	1,76%
0,75	10.191,68	54,70%	47,04%	2,07%

Contribution by these different measures to reduce emissions

For methodological reasons, the results are divided into two separate but interrelating sections. In the first section the influence of measures that can be taken in the home are detailed (because they are so specific). In the other section the contributions to cutting emissions that can be made by all areas, including building, will be clarified.

1. THE DWELLING

Beginning with a hypothetical situation in which 100% of homes in Vigo applied all the previously cited measures to their lives (using average values and considering a newly built terraced house as a benchmark), the reduction in emissions could be up to 412,158.09 metric tons of CO_2 equivalents. This effectively means that households would reduce their emissions by half.

This figure would also represent a 21.5% reduction on the total GHG emissions for 2003, which is a considerable figure when we remember that emissions from households account for 37% of the total. The following table shows the percentage of savings in respect of total emissions, according to the percentage of households that adopt all the measures previously mentioned.

% Homes	Saving in emissions (Met. Tons CO_2)	% Total emissions
1%	4.140,59	0,22%
2%	8.281,18	0,43%
3%	12.421,77	0,65%
5%	20.702,96	1,08%
10%	41.405,92	2,16%
15%	62.108,87	3,24%
25%	103.514,79	5,39%
33%	136.639,52	7,12%
50%	207.029,58	10,79%

Although it may seem that those measures which see the greatest percentage reductions require a lot of financial investment, we need to bear in mind that the increased efficiency of these means that the investment is returned in a relatively short time. Also, the objectives for reducing emissions in households are set higher than those for other sectors.

For example, the Proposal for a Directive of the European Parliament and of the Council on the Promotion of End Use Efficiency and Energy Services establishes that member states fix and comply with an obligatory objective to save energy each year in the public sector by acquiring energy services, energy programmes and other measures for energy efficiency. The objective for the public sector will be to save a minimum of 1.5% per year of energy that is distributed or sold which will represent an annual reduction of 27,805.5 metric tons of CO_2 This figure could be achieved by only 6% of the households in Vigo adopting the measures we have talked about.

If electrical consumption grew at a rate of 3.6% during the period 2000-2006 and the anticipated growth for 2006-2012 is of 3.9% , putting the measures planned in the Energy Plan for Galicia (2007-12) into action would see an annual reduction in GHG emissions compared with 2003 of 53,497.80 tons of CO2 which represents around 2,79% of emissions for that year. This figure could be achieved by approximately 13% of the households in Vigo adopting the measures mentioned before.

In the previous study it was discovered that a family can contribute to reducing GHG emissions in certain activities, as follows:

Houses	%
Dweeling	56,88
Transport	37,76
Waste	5,35

Apartment buildings	%
Dweeling	46,75
Transport	46,63
Waste	6,63

In global terms and according to the number of households in Vigo within each typololy, reductions in each sector are as follows:

Dweeling	48,89%
Transport	44,76%
Waste	6,35%

II. OTHER CONTRIBUTIONS

When comparing different actions that can be taken, we need to bear in mind that many of them are not totally comparable since they start from different hypotheses.

When the effect of the alternatives depends on the participation of citizens, it is difficult to make an accurate approximation of the saving factor that will be achieved To try to make the comparison as accurate as possible (even if the savings in emissions are not) we have decided to take average similar reductions that are slightly below to measure of reduction of each activity.

At the same time the measures have been considered independently of one another, without taking into account interactions between them. The final result for each sector is not the sum of all the different, individual activities, since the possibilities for making reductions in each could be altered by changes in others. An increase in the use of renewable energy in the production of electricity would cause a decrease in emissions from electricity consumption and therefore the capacity to reduce emissions in the domestic sector.

The following table shows the results obtained and clearly show the different capacity that each activity could have on the cutting down of emissions.

Comparison of the different measures in reducing emissions

Measure	Saving factor considered	Estimated average	Reduction Tn Co_2	Saving sector	Saving total
Promotion renewables	Promotion of Ren. energy	83%	441.574	56,32%	22,73%
Consumption in appliances	Reduction in consumption	10%	24.105	3,13%	1,19%
Street lighting	Reduction in consumption	30%	4.396	0,63%	0,23%
Public Transport	Reduct. in private transport	10%	32.527	5,66%	1,67%
Fuel efficient driving	% drivers using it	10%	5.832	1,01%	0,30%
Car pooling	Occupation factor	2%	53.128	9,24%	2,74%
Insulation	Reduction in consumption	21%	1.958	0,96%	0,10%
Heating	% boilers replaced	5%	2.087	1,35%	0,11%
Waste reduction	Reduction in wastes	10%	7.347	8,60%	0,38%
Recycling of waste	Natural wastes incinerated	55%	16.550	19,37%	0,85%
Development of forest	Deforested surface area	50%	4.040	12,02%	0,21%
Average total saving			**565.477**		**29,46%**
Saving without renewables			**142.430**		**7,42%**

If these measures were put in place and the average values for the respective savings factors were achieved, a reduction in emissions of 565,477 metric tons of CO_2 equivalents (around 29.46% of the total) could be made. This would mean that emissions from the municipality of Vigo would decrease to 1,353,839 metric tons of CO_2 equivalents. Without taking the promotion of renewable energy into account, the emission of 142,430 metric tons of CO_2 equivalents would be avoided, which means that emissions would be reduced by 7.42% to the value of 1,776,886 metric tons of CO_2 equivalents.

Although there are some measures that depend directly on regulations (such as the materials used to cover buildings), or regional projects (such as the promotion of renewable energy sources) or municipal projects (such as street lighing), the majority depend on the participation of the public. This is why the city council should concentrate its efforts on creating awareness campaigns as well as providing the means for the public to be able to participate. Encouraging people to use public transport can be achieved by improving infrastructure and the quality (and quantity) of the service provided. Companies could give their employees incentives to car-pool. An increase in the number of recycling bins and a wider distribution of these would increase the amount of recycling done.

In the following table the contribution from the promotion of renewable energy has not been taken into account since this is not within the jurisdiction of the Vigo municipality and their authority does not allow them to meet the objectives of this project. It seems more logical to refer to the measures in which the municipality has a direct, or indirect influence.

Comparison of the different measures in teh reduction of emissions

	Metric Tons of CO_2 eq
Car-pooling	53,128
Encouraging people to use public transport	32,527
Use of electrical appliances	24,105
Recycling of waste	16,550
Reduction in waste production	7,347
Efficient driving	5,832
Street lighting	4,396
Development of forests	4,040
Heating	2,087
Building materials (insulation)	1,958

From this comparative analysis we can see that the areas in which a higher reduction in emissions could be experienced are electricity, transport and waste management. Measures taken by the local council should be concrete and aimed at encouraging a reduction in the consumption of electricity, increasing the use of public transport and car-pooling as well as encouraging more people to separate their rubbish so that it can be recycled.

Epilogue

This study has analysed the changes in emissions in Vigo in 2004 as well as the maximum reductions that could be made in the municipality as a result of the various measures proposed by the *Strategy for Energy Saving and Efficiency*. The following conclusions can be drawn from these studies:

1. GHG emissions in 2004 increased by 270,963 metric tons of CO_2 which represents a 14.12% increase compared with the previous year. This is much greater than the national increase, which was of around 5%.

2. The Strategic Plan for Galicia 2007-2012 aims to increase the generation of electricity by 14,500 GWh/year which is an increase of around 50% of current production and which would reduce CO_2 emissions by about 7%. From these predictions we can deduce that the indicator for metric tons of CO_2 /MWh generated will be:

	MWh generated	**Met tons of CO_2 emitted**	**Met tons of CO_2 /MWh**
2004*	29.825.581,40	12.807.558	0,57
2012	44.325.581,40	11.911.028,94	0,36

***Data from Energy Balance of Galicia, 2004

This reduction in emissions is due to:

- The increase in renewable energy sources, in particular, wind energy which will increase from 1,824 MW to 6,500 MW, and, even more so, solar voltaic energy which will increase from the 1.2 MW currently installed to 25 MW as predicted by the plan.

- Production through high efficiency systems such as the combined cycle power plants installed at Sabón and As Pontes (1,200 MW), cogeneration and trigeneration. While the generation of electrical energy in a conventional thermoelectric power station can produce outputs of between 33 and 40% depending in the type of fuel used, the use of residual heat can increase outputs to between 50 and 60%.

- Fuel substitution:

  - National coal (brown lignite) will be substituted for imported coal (coal, subituminous coal and anthracite) which is more efficient environmentally since it emits less CO_2.

	CO_2 Emission Factor (Kg/GJ)	**Source**
Lignite	100,2	EMEP/CORINAIR
Coal/subbituminous	94,70	EMEP/CORINAIR

Moreover, by adapting boilers so that they can use imported coal an additional output of around 45% compared with the current 36-38%, which would also mean a reduction in emissions.

  - Combined cycle power stations use natural gas as their fuel and this fact, combined with the technology they employ, gives rise to atmospheric emissions that contain 2.3 times less CO_2 than coal-fired power stations and 1.8 times less than oil-fired power stations.

Emissions	**NO_X (gr/MWh)**	**CO_2 (kg/MWh)**
Conventional coal	1790	920
Conventional oil	1040	760
Conventional natural gas	680	505
Combined cycle gas turbine	250	392

  - By converting the whole country to using gas, cogeneration and trigeneration plants can be linked together, all using this fuel.

Type of Power Station	Output	Emission factor			Source
		CO_2 KG/GJ	NO_2 gr/GJ	CH_4 gr/GJ	
Cogeneration with oil	50	76,6	2,5	3	EMEP/CORINAIR
Cogeneration with gas-oil	50	73	2,5	1,5	EMEP/CORINAIR
Cogeneration with GLP	60	62,7	4	2,7	EMEP/CORINAIR
Cogeneration with natural gas	60	55,5	2	4	EMEP/CORINAIR

If electrical consumption grew at a rate of 3.6% during the period 2000-2006 and the anticipated growth for 2006-2012 is of 3.9%, putting all these measures into action would see an annual reduction in GHG emissions compared with 2004 of 53,497.3 metric tons of CO_2, which represents around 3.37% of emissions for that year. This figure could be achieved by approximately 13% of the households in Vigo adopting the measures.

3. From the study of the measures implemented by the *Strategy for Energy Saving and Efficiency*, the percentage savings in homes according to the sector and type of dwelling are:

	Houses (%)	Apartments (%)
Dwelling	56,88	46,63
Transport	37,76	48,75
Waste	5,35	6,63

Overall, according to the number of dwellings of each type there are in Vigo, the reductions in each sector are:

	%
Dwelling	48.89
Transport	44.76
Waste	6.35

4. With regard to dwellings we can say that a new build house that strictly complies with the regulations of the new Technical Building Code will emit (because of consumption by heating and domestic hot water installations), 17.2 kg/ m^2 of CO_2 for houses, 11.4 kg/m^2 for terraced houses. This is compared with the 26.8 kg/m? and 25.7 kg/m^2 that they currently emit. This is largely because:

- According to data from the European association of glassmakers, GEPVP, sales of windows with low-emissivity glass accounted for only 0.3% of all windows in the year 2000.

- According to a study carried out by EURIMA (European Insulation Manufacturers' Association), in 2001 Spain was the country where most energy was lost because of inefficient windows (180MJ/m^2) and second only to Italy in the amount of energy lost through lack of roof insulation (135MJ/m^2)

On the other hand, in 2001 only 25.46% of dwellings had a collective heating system. If we add to this the fact that heating is not often needed because of the mild climate and that Natural Gas is not often used, we can assume that the majority of households use electric heaters or other kinds of heater which use electrical energy. The fact that so many people seem to use electric heaters, and that it is costly for people to change the heating systems in their homes, indicates that the best way to achieve savings will be by reducing the emissions created by producing electrical energy. As we have already said several times though, the saving would be greater if it there were also a reduction in consumption, reducing the amount of peak consumption hours when, generally, it is necessary to rely on energy from fossil fuel power stations.

5. Although the biggest overall savings can be made in the home, we also need to remember the important savings that can be made in the use of the private car. The home and the car between them account for 93.65% of emissions and the figure for the home is only 8.5% higher than that for the car. We also need to take into account that:

   - The cost and therefore the life expectancy of a car is less than that of a house which means that the substitution rate of old technology for new technology is more efficient and higher.

   - The market for cars is much more mature and there is fierce competition which can compensate for the increase in prices for the most efficient cars.

   - The greatest part of the reduction depends more on changing habits than investing in new technology.

Among measures to reduce the use of private cars, replacing a car with a new, more efficient one represents 60.76%. This shows the need to opt for replacing vehicles above all with measures that favour the oldest. The average life of a car is around 13.4 years, one of the highest in the EU, according to data from the “Automobile and Road Safety and Environment” report which was produced as the result of an investigation carried out by the mechanical engineering department of Valencia University. According to data from ACEA (European Automobile Manufacturers’ Association), average emissions from new cars were 175 gr/km and 152 gr/km for 1995 and 2004 respectively. (In the EU the figures were 185 gr/km in 1995 and 161 gr/km in 2004.) The introduction of the new car tax established in the Air Quality and Atmospheric Quality Act encourages people to buy more efficient vehicles but it does not guarantee that cars that are more than 13 years old are replaced. This measure should be complemented with incentives to replace these old vehicles.

Another aspect is modal shift, which despite only representing 5.57% of reductions in emissions, assuming everyone has a vehicle that emits 120 gr/km, does have great potential for reducing emissions, particularly in urban areas. The mobility survey that was carried out in Vigo highlights the fact that the split between private vehicle and public transport is almost equal for the three zones that were studied: urban, semi-urban and rural.

	Total	**Urban Area**	**Semi-urban Area**	**Rural Area**
Public transport	19,25%	19,07%	19,30%	19,58%
Private vehicle	80,75%	80,93%	80,70%	80,42%

The percentage of kilometres travelled and the population density of each zone also hardly varied.

	Urban Area	**Semi-urban Area**	**Rural Area**
Kilometres	45,11%	34,96%	13,09%
Population	51,95%	37,20%	17,69%

One would suppose that in urban areas journeys would be shorter and there would be more access to public transport. However, the figures do not show this.

The municipal area of Vigo

Before making any statistical study, it is worth highlighting some of the features of Vigo: 108.13 km^2 (210,000 inhabitants in the "centre" and 80-90,000 in "rural and/or semi-rural areas"). The city is spread over a large area and average annual temperatures range from 14.8ºC in the "centre" to 13.1ºC around the university which is situated 14km from the city centre. Annual rainfall also varies with 1,200 mm in the "centre" and 1,400.. in the university area. Some settlements are made up of buildings of basic rural type. There are 17 parishes in Vigo.

Population distribution by district

DISTRICT	MEN	WOMEN	TOTAL
1	9.844	11.129	20.973
2	16.513	19.349	35.862
3	21.420	23.814	45.234
4	25.756	27.712	53.468
5	7.740	8.220	15.960
6	14.445	15.584	30.029
7	28.189	30.488	58.677
8	9.728	10.448	20.176
9	9.230	9.770	19.000

BIRTH RATE

Between 1995 and 2005 the number of births increased by 30%. The birth rate is recovering in the region with a growth of 3%. 2,153 boys and 2,289 girls were born in Vigo in 2005. Not all of these will stay in the city till adulthood.

POPULATION DENSITY

Population density in Vigo and its area of influence (2005)

Area	Population	Km^2	Density
Baiona	11.521	34,5	333,9
Cangas	24.849	38,1	653,9
Fornelos	2.057	83,1	24,7
Gondomar	12.685	74,5	170,2
Moaña	18.415	35,1	524,6
Mos	13.996	53,2	263
Nigrán	17.281	34,8	496,5
Pazos de Borbén	3.160	50	63,2
Porriño	16.576	61,2	270,8
Redondela	29.863	52,1	573,1
Salceda de C.	7.176	35,9	199
Salvaterra do M.	8.375	62,5	134
Soutomaior	5.956	25	238
Vigo	298.112	109,1	2.692,2
Galicia	2.762.198	29.424	93,8

IMMIGRATION

The municipal register for Vigo city only has a record of 13,813 immigrants, although there are believed to be around 15,000. The registered foreign population of the city has increased by 168% since the year 2000.

MAKE UP OF HOUSEHOLDS

Type of home

Uniparental	17.137
Several people not in the same family	873
Family	73.304
Family plus other people (not related)	312
Two or more families	286
Various families plus other people (not related)	40

Make up of house

People	Number
1	17.137
2	21.204
3	21.306
4	20.947
5	8.278
6	3.146
7	830
8	314
9	128
10 or more	135
TOTAL	93.425

FLOATING POPULATION

Vigo has the largest floating population in Galicia, with 293,725 inhabitants according to the INE (National Statistics Institute) census. However, the real demographic figure is of up to 44,593. 110,000 people travel to Vigo every day to go shopping. We should bear in mind that local shops have a potential market of over 1 million customers who come from as far away as northern Portugal.
32,000 people travel to Vigo for work or study or because they have a second home there.

ECONOMY

Average income

The average per capita income is 9,854€ which is 300€/year higher than the average for Galicia. Despite this, it is the fifth-lowest paying city in Galicia. It is also a long way behind the national average income of 11,000€.

COMPANIES

Industrial companies	Commercial companies	Hotel/Catering and turism
3.493	7.583	2.145

ECONOMIC SECTORS

Number of employee (economic sectors)	**Total**	**Men**	**Women**
Agriculture	663	400	263
Fisheries	1.673	1.279	394
Industry	29.975	21.178	5.797
Construction	7.543	6.651	892
Services	76.176	36.535	39.641

DWELLINGS IN VIGO

Dweeling census	
First homes	93.425
Second homes	10.459
Empty	17.846
Buildings	33.755
Shops	15.167

Second homes	
Number who have	13506
Number who do not have	79919

VEHICLES

None	13.341
1 vehicle	42.921
2 vehicle	16.872
3 or more	3.820

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Enclosure I

BASIC GUIDE LINES RELATED TO CLIMATE CHANGE

EUROPEAN UNION

A. ENERGY

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B. GAS EMISSIONS

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Orientations for the member States on the application of the criteria of the enclosure III of the Directive 2003/87/EC in which a regime for the trade of rights on the emission of greenhouse gases in the Community is established and in which Directive 96/61/EC of the Council is modified, and circumstances in which the existente of force majeure was demonstrated.

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E. RESIDENTIAL, COMMERCIAL AND INSTITUTIONAL

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F. AGRICULTURE AND CATTLE BREEDING

Directive 91/676/EEC of the Council, 12th December 1991, concerning the protection of waters against contamination produced by nitrates used in agriculture.

Enclosure II

LOCAL GOVERNMENT MEASURES

1. LOCAL GOVERNMENT AS CONSUMER, SERVICE PROVIDER AND ROLE MODEL
2. LOCAL GOVERNMENT IN PLANNING, PROMOTING AND REGULATING.
3. LOCAL GOVERNMENT'S MOTIVATING AND ADVISORY ROLE
4. LOCAL GOVERNMENT AS PRODUCER AND PROVIDER OF ENERGY

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1. LOCAL GOVERNMENT AS CONSUMER, SERVICE PROVIDER AND ROLE MODEL

Local government has a large number of buildings (for offices, etc). In carrying out their work they use large amounts of energy for heating and illuminating these buildings as well for supplying them with hot water. If plans were made and put into action to save energy in public buildings, a considerable reduction in energy consumption could be made. By saving energy they will also save money.

1.1 BUILDINGS

Buildings should be audited so that faults can be found and improvements made. A good audit should define:

- How much energy each building needs.
- The best way to meet this need.

Possible measures that can be taken in each of the processes in which energy is consumed in a building are:

Building elements

Thermal insulation

1. Ensuring that windows are fitted properly.
2. Using insulating materials.
3. Installing a double door in the entrance and automatic closing mechanisms in other doors.
4. Eliminating draughts.
5. Establishing a maintenance programme for windows, doors and roofs.

Materials used

Using natural materials (stone, wood).

Thermal installations

a) Heating

1. Choosing an efficient heating system that produces low emissions.
2. Studying how many people use the building.
3. Keeping the temperature at around 20ºC.

4. Introducing temperature control systems.
5. Programming temperature control systems according to the number of people in the building.
6. Splitting up the heating system so that only the areas that need to be heated are.
7. Progress in the heating system.
8. Regular inspection and maintenance of the system.
9. Including energy efficiency clauses in maintenance contracts.

b) Cooling

1. Installing cooling systems only when necessary.
2. Selecting systems for their energy efficiency rather than their aesthetic appeal.
3. Hanging blinds or other sun protection.
4. Ventilating the building by pumping outside air into it at night.
5. Turning off equipment when it is not in use.

If it is decided that cooling systems need to be installed:

1. Keeping the temperature at around 25ºC.
2. Choosing energy efficient systems.
3. Installing separate machines.
4. Suitable management and design.
5. Ensuring that use is regulated and temperature is controlled.
6. Regular checking and maintenance of the system.

c) Domestic hot water

1. Keeping the thermostat set at 60º.
2. Disconnecting the system at weekends, during holidays, long weekends, etc.
3. Installing efficient pipes and taps.
4. Using solar power to heat water, at least to the minimum value set by the *CTE.
5. Installing a programming timer.
6. Improving the distribution system.
7. Daily maintenance of taps.Increasing the efficiency of washing operations

Electrical installations.

1. Lighting
    1. Efficient design of the lighting system in order to reduce the amount of light needed.
    2. Controlling the level of light.
    3. Establishing a protocol by which people are responsible for ensuring that no lights are left on when the building is empty.
    4. Making use of natural light means the amount of electricity used is reduced.

5. Regular cleaning of lights.
6. Replacing conventional incandescent light bulbs with low-consumption bulbs which can produce the same amount of light.
7. Selecting lamps for their energy efficiency (design and system).
8. Selecting materials and colours for interiors that reduce the amount of light.

2. Lifts
   1. Avoiding making the lift capacity too big, otherwise the lift will require more energy when not in use.
   2. Replacing old "taxi style" lifts which are not regulated.
   3. Installing separate mechanisms for each lift when there is more than one so that the number of trips can be optimized.
   4. Installing systems where you can see how long you need to wait for a lift, where the lift is and whether it is travelling up or down. This will prevent people pushing the button more than is necessary.

Reducing electrical energy consumption in lighting.

3. Kitchen equipment:
   1. Installing more efficient equipment. When replacing equipment look for gas appliances, choose ones that are well-insulated and are of category A or B forefficiency.
   2. Make guides for efficient use.

4. IT equipment
   1. Establish a protocol by which people are responsible for ensuring that all equipment is switched off at the end of the day. Office computer systems usually have a pilot light to show when a machine is on stand-by.
   2. Avoid leaving other office equipment (printers, scanners, tracers, fax machines, etc.) switched on when it is not being used.
   3. Design an efficient Local Area Network.
   4. Buy computer equipment that incorporates an energy saving mode.

5. Mobility

Design and introduce a mobility plan for people who work in local government and people who use their services.

The objective of this plan would be:

1. To reduce the need to move:

Staff:

- Eencouraging flexi-time, continuous days and working from home.
- Using technology (video, audio, videoconferencing, working from home, etc.) which avoid the need for people to be physically present at meetings.
- Planning routes.

People using services:

- Reducing the amount of bureaucracy and, if possible, combining and simplifying procedures so that people have to make fewer visits to accomplish their goals.
- Enabling people to accomplish these goals online, or by telephone or fax, etc.
- Decentralizing services and administrative procedures.

2. To favour a change towards more efficient means of transport including a reduction in the use of private cars. Measures such as these could help in this:

Encouraging people to use public transport

- Posting notices of how to get to the building on public transport, in advertising, on the website. A "Transport Noticeboard" in the centre itself could show the nearest bus stops to the building and bus timetables.
- Helping employees to pay to get to work by public transport.

Reduce the incentive to travel to work by car.

- Control parking: charge a parking fee, give discounts on parking to people who car-pool, reserve spaces for motorcycles.
- Support employees in creating car-pools (give priority in choosing whose turn it is, subsidize fuel expenses, etc.)
- Creating an in-house transport system.

1.2 STREET LIGHTING

The three fundamentals for an excellent quality of service in street lighting are:

1. Presentation of the initial project, adjusted to suit the real situation (lighting levels, type of operation).
2. Continual management of installations, with constant monitoring of electrical, lighting and safety parameters.
3. Awareness raising and citizen participation between public services and citizens. Active participation in defining, decision-making and care of the area of "daily welfare of the city".

The main measures that can be taken to optimize this service are:

1. Choosing the most suitable and most efficient lamps for each situation.
2. Choosing lights according to what they need to illuminate.
3. Installing regulation and control systems.
4. Daily maintenance of installations.
   - Annual schedule for cleaning of lights.
   - Schedules for changing bulbs.

1.3 TRANSPORTING MUNICIPAL SERVICES

1. Keeping vehicle maintenance up-to-date.
2. Choosing the most efficient vehicles, those that best meet needs of the users.
3. Acquiring vehicles for use by employees in carrying out municipal services in the near vicinity.

1.4 PUBLIC CONTRACTING

Contracting for new buildings or redecoration

1. Incorporating energy efficiency criteria into urban development plans, choosing solar energy, drafting the project, even accepting projects.
2. Requiring a high energy qualification of buildings. The European Directive on Buildings (Directive 202/91/CE regarding energy efficiency in buildings) requires that they are equipped with highly efficient equipment.
3. Requesting the production and delivery of a users' manual which includes recommendations for using energy efficiently.

Supply contracts

4. Buying green energy. Spanish electrical companies are going to need to adapt to Directive 2001/77/CE on the promotion of electricity from renewable energy sources. This Directive demands that member states can guarantee that electricity comes from renewable sources in accordance with objective, transparent and non-discriminatory criteria. Local government should prioritize this type of energy in its supply contracts. In Directive 2003/30/EC, the EU also sets a market share for bio-combustibles. To comply with this regulation local government should set the same percentage for bio-combustibles.
5. Including energy efficiency requirements in individual technical planning documents.
6. Including execution clauses in works or services contracts. For example, when transporting products or tools to the building site, the following measures should be taken:

- Delivering products to the site in bulk and distributing them around the site later
- Using reusable containers for transporting products.

7. Including execution clauses in contracts for the supply of goods – Using a model for the drawing up of contracts to do with energy services and integral maintenance for thermal installations and interior lighting in public buildings.

In public service concessions

8. Demand that concessionary companies of these services produce plans for reducing emissions (group transport, collection and treating of rubbish, purification, treatment and supply of water).

1.5 STAFF

Social and educational measures

1. Establish measures relating to good practice in the use of energy (by general consent).
2. Staff should be aware of the characteristics of the systems and equipment they use every day at work.
3. Provide training for those employees responsible for energy management in public buildings.
4. Awareness raising among users and managers of public buildings.
5. Introduce energy efficiency criteria into participation and motivation schemes.

Staff selection

Establish energy efficiency criteria in staff selection.

1.6 WASTE

Solid waste: Office material

1. Using the blank side of printed sheets of paper as rough note paper or for printing rough drafts.
2. Double-sided photocopying and printing. It is possible to buy printers that can do this.
3. Re-use envelopes for sending internal mail.
4. Use white boards with erasable pens or blackboards with chalk instead of boards that require paper.
5. Increase the use of intranet networks and email for communication.

Waste water

1. Reduce the volume of water that needs treating
    - Fit buildings with separate systems for collecting rain water (on the roof, terraces, etc.) and sewage, especially if there are separate systems in place at the site.
    - Protect the natural drainage of the ground and landscape gardens accordingly.
    - Collect rainwater whenever possible. In residential buildings rainwater can be used in the bathroom, in the dishwasher and in the garden. In commercial buildings rainwater can also be used in bathrooms, for cleaning, in the garden, etc.
    - Install a system to use the building's "grey water". "Grey water" can be described as waste water from the shower, bathroom and dishwasher. This water can be purified (by treating it biologically, by helium filter, etc.) and then re-used in the bathroom, for cleaning, for watering plants, etc.
2. Replacing technology so that it is more efficient.
3. Introducing electronic equipment for regulation and control.

2. LOCAL GOVERNMENT IN PLANNING, PROMOTING AND REGULATING.

The roles and responsibilities of Local Bodies in environmental matters are set out in State Legislation and in the Sectorial Legislation of the Regional Communities.

2.1 THE ORGANIZATION, MANAGEMENT, IMPLEMENTATION, URBAN MAINTENANCE AND PROMOTION AND MANAGEMENT OF DWELLING

Planning objectives should include making the most of favourable environmental conditions as well as controlling those that are not so favourable. Microclimatic and energy conditions should be taken into account when classifying land for use.

1. Establish priority zones in the city for sites of renewable energy production.
2. Reduce the amount of building in green belt zones. Encourage building in run-down areas. Keep a percentage of the land forested.
3. Urban planning should ensure that buildings are positioned in such a way that they make the most of solar radiation.
4. Encourage multifunctional use of the land – a balance between new buildings, services and office buildings so that the amount of energy used in transport is reduced.
5. Establish municipal bylaws that promulgate the use of energy saving systems.
6. Promote energy efficiency and the use of clean energy in new buildings, especially when they have been built on land sold by the local council. Establish a percentage of buildings that must have energy certification A.
7. Avoid building shopping centres outside the city centre. Promote open shopping centres with pedestrianized zones in the city centre.
8. Urban design and the use of green zones for energy saving. Relief from heat in summer can be provided by lining streets with trees, water features and the porosity of the road surface.
9. Encourage architectural elements as set out in Urban Development Regulations such as entrances and exits, porches, balconies or galleries or any other transitional space between inside and outside that help to control the building's temperature.

2.2 PROTECTING THE ENVIRONMENT AND PUBLIC HEALTH

1. Produce an up-to-date bylaw for the Protection of the Environment in general, and specifically for the protection of the Atmosphere. This should regulate how activities (industrial, public and private works, transport of people and goods) are carried out in the municipal area.
2. Ensure the control and monitoring of contaminants which European legislation requires are kept under control in the assessment and management of air quality (Directive 96/62). A network of equipment to measure levels of carbon monoxide, nitrogen oxides, etc. should be in place as

well as equipment for taking samples to determine levels of metals (lead, cadmium, arsenic, nickel and mercury).

2.3 REGULATION OF TRAFFIC, PEDESTRIANS AND PUBLIC TRANSPORT

The European Union's report "Towards a Thematic Strategy on the Urban Environment" (COM 11) envisages cities with more than 100,000 inhabitants developing a Sustainable Urban Mobility Plan which will aim to ensure a balance between the need to move around the city and the need to protect the environment, public health and economic development.

The objectives of mobility plans should be:

- To use efficient means of transport (boat, train and collective road transport) to move people and goods around instead of inefficient means of transport (the private vehicle) and to encourage people to walk or use bicycles since these do not use fossil
- A more efficient use of vehicles and infrastructure.
- Encourage people to replace the most inefficient vehicles with more efficient ones, from both energy saving and environmental points of view.

Mobility in general

- Develop legislation which obliges companies and business centres to present a transport plan. This should apply particularly to companies with more than 200 employees and to business centres such as industrial estates and shopping centres, and also hospitals and university campuses, etc.
- Establish physical traffic-calming measures such as the layout of roads, installation of barriers, etc.

Walking

Improve conditions for pedestrian movement by:

1. Creating more public space.
    - Creating more pedestrian areas (islands for crossing roads) and zones of pedestrian priority (which other means of transport also use) especially in busy shopping areas.
2. Improving the quality of the road surface so that is it is easier and safer to go on foot.
3. Allow pedestrians to walk along the main roads of the city.
    - Providing enough zebra crossings so that pedestrians can walk from one area to the next easily.

Bicycle

Increase the percentage of people habitually travelling by bicycle by creating the necessary infrastructure, managing traffic and providing road safety education.

1. Design a safe “bicycle lane” network (protected lanes with traffic lights).
2. Provide enough bike racks that are conveniently located and safe.
3. Change traffic light sequences so that bicycles have priority over private motor vehicles.
4. Encourage the setting-up of bicycle renting schemes.

Public transport.

Encourage the use of public transport over the use of the private car by offering a quality public transport system that is financially competitive.

1. Design a public transport network suited to potential demand. This should be characterised by:
2. An improvement in bus stops/ train stations:
    - Make payment cards universal so that people get on quickly and time spent at stops is reduced.
3. Improve transport management:
    - In order to offer the best and most efficient service possible, provide indicators of occupancy levels, how many passengers can get on at each stop, etc.
4. Equip some stops (bus, train or taxi rank) with shelter and up-to-date information on the current public transport available. Ensure that these are safe and accessible to all users.
5. Ensure that access to buses and trains as well as to bus-stops and train stations are well conditioned and safe.
6. Encourage medium-sized capacity vehicle systems to be put in place.
7. In low-density population areas (where houses are spread out, or in urbanizations) provide public transport according to demand, such as taxi-bus.

Private vehicles.

Encourage people to use their cars sensibly and create measures that put people off using their cars or encourage them to car-pool.

Measures to maximize occupation.

1. Create a network of separate or reserved car-pooling lanes that have priority at traffic lights.
2. Provide plenty of motorcycle parking spaces in the city.
3. Encourage policies to improve the use of the private vehicle, like car-pooling or others, as well as encouraging people to use taxis instead of their own vehicles in the city.

Measures to discourage private vehicle use.

1. Set up a controlled rotation parking scheme for the city centre.
2. Implement a toll scheme in city centres.

Urban distribution of goods.

1. Encourage the building of a Centre for Transport and Logistics Platform on the outskirts of the city, and give transport companies and logistics operators incentives to move there.

2. Do not allow large, heavy vehicles to drive into the city but provide alternative routes for them. Control and comply with regulations concerning the movement and parking of heavy vehicles in the city centre.
3. Limit loading and unloading hours so they do not coincide with rush hours.
4. Provide incentives for the distribution of goods to be shared between companies, thus reducing the number of deliveries and promoting organised distribution in smaller, less contaminating vehicles.
5. Set up meeting points between companies and professionals to maximize occupation levels in cars (sharing cars etc.)

Intermodality

Encourage people to use different means of transport to complete their journey.

1. Allow people to take their bicycles onto public transport.
2. Design an integrated transport system. Ensure that timetables are coordinated and that bus stops/train stations are suitably located. Make fares (urban and inter-urban) integrated too and make sure that the quality of service is the same.
3. Build park-and-ride car parks near train stations and inter-city bus stops. (park-and-ride parking and/or peripheral car parks on properly urbanized land, with street lighting and with security)
4. Ensure that changing from one means of transport to another is easy and safe so that this system of transport does not create difficulties for the traveller.

2.4. COLLECTION AND TREATMENT OF WASTE

Collection of solid waste

1. Provide a network of recycling bins according to the needs of the people. Whenever possible there should be separate bins for paper, glass and containers wherever there is a general bin.
2. Provide a doorstep rubbish-collection service for small businesses, large apartment buildings, public buildings and schools etc.

Sewage treatment

1. Set up systems in which rain water can be collected separately from waste water. Systems for rainwater collection can use surface water channels. Another possibility is to filter this water into the ground. Infiltration is particularly useful in areas with little underground water and where the risk of flooding is high.
2. Draw up a bylaw for the Management and Efficient Use of Water in order to reduce the volume of water reaching the treatment plant.
3. Plan urbanization and green belt areas to facilitate natural drainage.

3. LOCAL GOVERNMENT'S MOTIVATING AND ADVISORY ROLE

As well as establishing minimum regulations designed to change habits and behaviour in order to reduce GHG emissions, local government can also create incentives for and raise awareness in citizens. This should mean that citizens will be willing to do more than is required of them In short, this means that citizens are continually motivated. The success of these measures is very closely linked to the proper development of the previous point. In other words, bad planning of resources and regulations that are not consensually agreed, that result in the majority of people ignoring them, do not create a solid basis from which to develop motivational measures.

According to factors which determine behaviour, we can distinguish different types of motivation.

- Intrinsic Motivation: A person does something because he enjoys doing it.
- Extrinsic Motivation: A person does something because of the consequences this will have for him.
- Transcendent Motivation: A person does something because of the consequences this will have for other people.

The most viable and direct extrinsic motivation for citizens to behave in such a way that CO_2 emissions are reduced is to make them pay taxes to the local government. There are two kinds of taxes that are paid to local government: obligatory and optional.

Obligatory:

1. Taxes on assets.
2. Taxes on economic activity.
3. Taxes on mechanical traction vehicles.

Optional:

1. Taxes on building, installations and works.
2. Taxes on the increase in value of urban land.

Other possible measures for extrinsic motivation could be:

1. Creating subsidies schemes for:
    - Plans to improve the energy efficiency and performance of equipment and installations, or a reduction in emissions.
    - Energy certification.
    - Making use of renewable energy sources or the energy assessment of waste generated by an activity.
    - The use of more sustainable means of transport.
2. Awarding prizes in order to encourage the spread of good practice in the affected sectors.

3. Increasing control in order to avoid people doing things that create high GHG emissions (which are punishable).
    - Ensuring that people get their cars inspected regularly to reduce contaminating emissions.
    - Ensuring that people keep to the speed limit in urban areas
    - Ensuring that motorcycle exhaust pipes work properly.
    - Controlling the unloading of fuel tankers at service stations.
    - Carrying out regular emissions measurements in companies who use processes involving significant use of solvents.

Finally, local government can also encourage intrinsic and transcendent motivation by means of:

1. School projects and education on energy saving.
2. Publicity campaigns in the press, radio and television, mailings, etc on the problems and possible ways individuals can help solve these problems as well as the possible short and long-term benefits whether they are:
    - Individual: by making savings in energy consumption, improving the home, etc. (intrinsic motivation)
    - Collective helping the environment, cleaning up the city etc. (transcendental motivation)

The measures should be aimed at consumers as well as at professional service suppliers:

Professionals:

1. Provide information and training courses.
2. Advice on energy criteria, the applications of these on works licenses, waste management and mobility.
3. The creation or updating of guides and codes of good practice.

Consumers:

1. Advice on the analysis of electrical tariffs.
2. The creation of a guide for businesses and professionals which supplies services aimed at energy efficiency (energy service companies) and the installation of renewable energy generation equipment.
3. Provide more information to citizens through the local media on how to get around by different means of transport.
4. The creation or updating of guides and codes of good practice.

4. LOCAL GOVERNMENT AS PRODUCER AND PROVIDER OF ENERGY

Local government can promote the local production of energy, especially that from renewable energy sources. Locally produced energy has positive repercussions on local employment and on social and regional development. It also helps to reduce dependency on energy resources that are produced in other parts of the world and the losses that are incurred by the transport and distribution of these. As well as encouraging the installation of power stations or energy parks in areas where some natural resource is available, local governments can also generate energy by using their own installations and resources:

1. Mini-hydraulic power stations could be built on reservoirs containing the city's water supply
2. Solar voltaic panels could be placed on the roofs of public buildings
3. Solid biomass could be produced from the city's waste wood (be this waste from the maintenance of public gardens, from industry or from individuals)
4. Urban waste management and management of mud from sewage treatment plants by biomethanization in digestors means these wastes do not go to the tip. Degasification systems in these could be improved. And finally, a local supply of electricity could be produced from the biogas generated in these processes.
5. The demand for thermic energy for swimming pools or refrigeration in municipal markets, or for both in hospitals, could be put to use in installing cogeneration/trigeneration power stations.

Another role local government can perform is that of an energy provider, analysing the viability of centralised heating and cooling systems in residential areas or industrial estates. The advantages of this would be:

- That by being bigger, this kind of equipment can produce much higher outputs. This would also avoid the need to install electric systems in which the useful energy that is produced is a small fraction of the energy that was used in its production.
- That the system can be designed to a certain size so that the need for thermal energy can achieve a return on the installation of a cogeneration plant.
- That the cost for the users would be considerably reduced because consumption is shared. The best thing to do though would be to invest this saving into improvements to the municipal energy system.