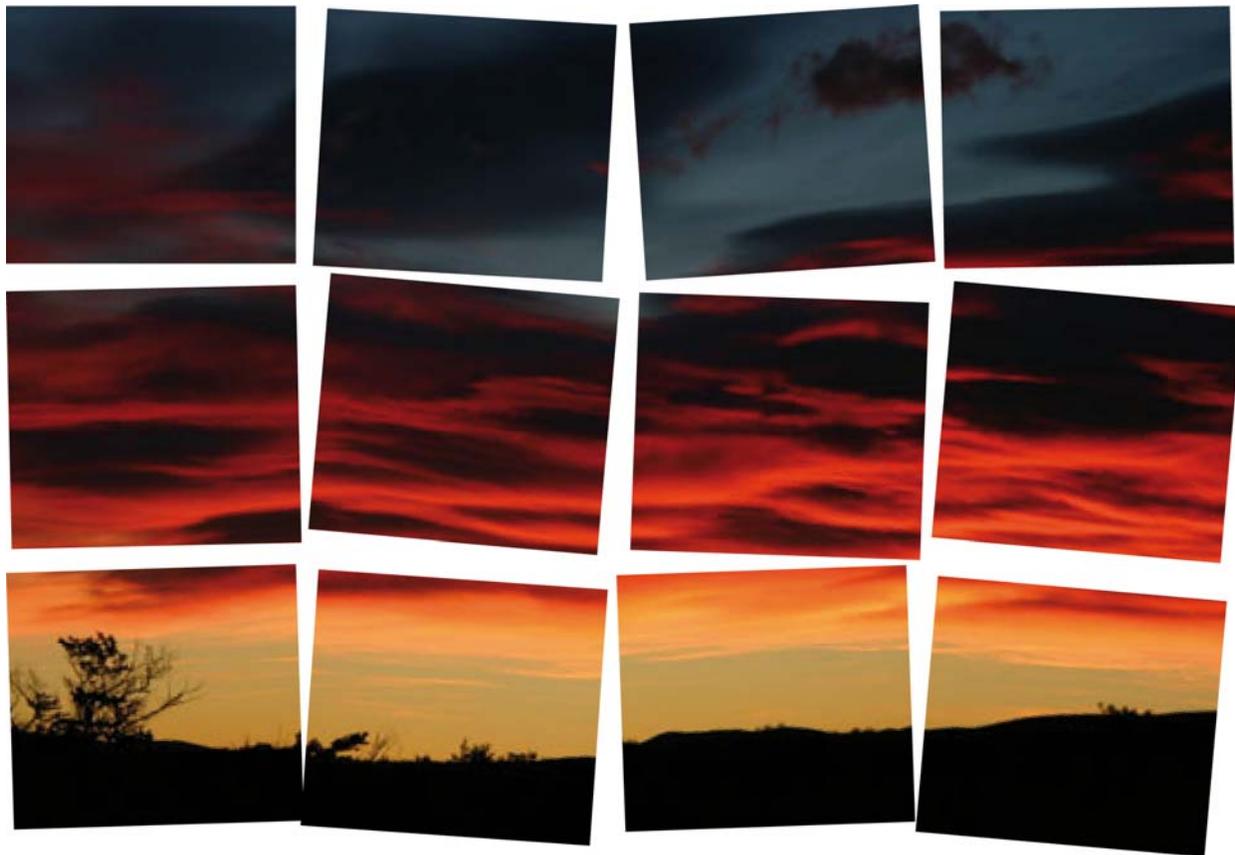




# mobGAS

disclosed model



Tiago de Sousa Pedrosa, Ângela Guimarães Pereira, Paulo Rosa

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# CHANGE CLIMATE CHANGE

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## What you can find on this help

Welcome to mobGAS. This help contains useful information on how to use and explore mobGAS functionalities on your mobile device and on the Internet.

It is much more than a simple help. It provides detailed information about the consumptions and Greenhouse Gases (GHG's) emissions calculations, as well as about the type of outputs provided.

It is organized in 6 main chapters:

- **Climate change**– preliminary notions about climate change *problematique*, its relation with greenhouse gases and with lifestyles.
- **mobGAS application** – Provides an overview of mobGAS project and principles, on how to use mobGAS, how it is structured and its main functionalities.
- **Groups description** – Detailed overview on each activity and appliance available on the software, including energy and fuel consumptions calculations, assumptions and references. This includes also the numerical model in *pseudo code* (i.e. an outline of the computer program, written in a shorthand language giving a conceptual view of the steps that have to be implemented when writing the actual program's code).
- **Greenhouse Gases calculation** - description of main sources of emissions, emission factors, assumptions and references. This includes also the numerical model in *pseudo code* (i.e. an outline of the computer program, written in a shorthand language giving a conceptual view of the steps that have to be implemented when writing the actual program's code).
- **Results** – an interpretative framework to better understand the outputs provided by the mobile application and on-line consultation.
- **References** – all bibliographic and internet references organised by Chapter.

### *What will you not find in this help*

First of all this help is not aimed at expert audiences engaged in studying climate change issues from the viewpoint of science. Also, it is not a 'treatise' about links between lifestyles and the emissions of GHG's, although trying to be as exhaustive as possible. The modelling concepts are not based on 'lifecycle analysis': the GHG's emission processes considered are mostly at consumption levels. Finally, the user will not find the source code of the software!



# 1 Climate change

## 1.1 Climate Change & Greenhouse Gases

Human activities are deemed to be increasing the emission of greenhouse gases (GHGs) into the atmosphere. Carbon dioxide (chemical formula: CO<sub>2</sub>), methane (chemical formula: CH<sub>4</sub>), nitrous oxide (chemical formula: N<sub>2</sub>O) and halocarbons, inter alia, are some of the gases that are at the greenhouse effect's origin (reflected solar radiation trapped in the Earth's atmosphere<sup>1</sup>. The greenhouse effect is a natural process but there are hypotheses that say that it is very likely that is being enhanced by the concentration of those gases in the atmosphere which is considered to be the cause of climate change. The most recent studies predict that 'For the next two decades, a warming of about 0.2°C per decade is projected for a range of SRES emission scenarios. Even if the concentrations of all greenhouse gases and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1°C per decade would be expected.' (IPCC, 2007, pp. 12).

The first three gases occur naturally, whilst for most halocarbons' (carbon compounds containing fluorine, chlorine - HCFC's and CFC's -, bromine or iodine) the only source is due to human activities.

In this project only the first three gases are considered - CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O - because the other gases are dealt with in a specific protocol - the Montreal Protocol - and hopefully the trend of their emissions will be reduced substantially in the next 50 years as a result<sup>2</sup>.

### 1.1.1 Early warnings

The hypothesis that changes in concentrations of greenhouse gases, such as water vapour and carbon dioxide, could cause global warming was already postulated by Tyndall as early as 1861. By 1896, the Swedish chemist Arrhenius had developed a quantitative 'climate model' to estimate that a tripling of CO<sub>2</sub> concentrations in the

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<sup>1</sup>see for instance <http://www.eea.europa.eu>

<sup>2</sup>more information about Montreal Protocol at UNEP webpage <http://ozone.unep.org/>

atmosphere could increase the average air temperature of the earth by about 8-9 °C [degrees Celsius]. For a doubling of CO<sub>2</sub>, that would mean a warming of about 6 °C (McBean, 1995).

## 1.2 Climate Change convention

Climate change was recognised as a serious problem by the First World Climate Conference in 1979. A number of intergovernmental conferences focusing on climate change were held during the 1980's. In 1988 the Intergovernmental Panel on Climate Change (IPCC) was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organisation (WMO) which was given the task of assessing the state of existing knowledge about the climate system and climate change, including impacts and system responses. In 1992, the United Nations Framework Convention on Climate Change (UNFCCC) was signed by 154 states at Rio de Janeiro and thereafter at the United Nations Headquarters until June 1993 by other 12 states. The UNFCCC entered into force in 1994 and those states that have not signed the Convention may accede to it at any time<sup>3</sup>.

The FCCC's main objective is to 'stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner' (UN, 1992).

The Convention is grounded on a number of guiding principles, among them the precautionary principle stating that the lack of full scientific certainty should not be used as an excuse to postpone action when there is a threat of serious or irreversible damage. Other principles are: equity between countries and concern for present and future generations.

The UNFCCC conference held in 1997 in Kyoto has set commitments for legally-binding reductions of carbon dioxide emissions by major industrialised countries. The Protocol requires developed countries to reduce their GHG emissions below levels

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<sup>3</sup> List of signatories & Ratification of the convention may be found here:

[http://unfccc.int/files/essential\\_background/convention/status\\_of\\_ratification/application/pdf/unfccc\\_conv\\_rat.pdf](http://unfccc.int/files/essential_background/convention/status_of_ratification/application/pdf/unfccc_conv_rat.pdf)

specified for each of them in the Treaty. These targets must be met within a five-year time frame between 2008 and 2012, and add up to a total cut in GHG emissions of at least 5% against the baseline of 1990<sup>4</sup>.

The Kyoto protocol entered into force on 16 February 2005 and by the time of writing this document it has been ratified by 176 parties<sup>5</sup>.

Every year there is a Conference of the Parties (COP) (the highest decision making authority of the protocol), the last one was held in Bali – Indonesia where a post-Kyoto protocol was discussed.

### 1.3 Climate Change & Lifestyles

The public debate on climate change and emissions of greenhouse gases (GHGs) is heavily focused on the impact of industry. Yet according to Eurostat (2007) for the year 2004, only 21% of actual emissions are related to industrial processes, manufacturing industries and construction, while 31% are related to energy production, 20% to transport, 9% to agriculture, 3% to waste and 16% to other activities.

In other words, if we consider that 25% of all energy produced is consumed by households and that emissions caused by transport, agriculture and waste are partly related to the citizen's every-day life, it is evident that lifestyles and consumer choices are having a major impact on greenhouse gas emissions. Lifestyle and consumer choices are a key factor, so it is important that people are aware of the implications of their personal choices. Individuals can have a significant impact on reducing emissions.

IPCC (2001) points out two main reasons for why lifestyles are an important issue for implementing a climate policy:

- consumption patterns (an essential element of lifestyles in developed countries) can alleviate the emissions of GHGs; and,
- changes in lifestyles are required by the introduction of new technologies.

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<sup>4</sup> See Kyoto protocol: [http://unfccc.int/kyoto\\_protocol/items/2830.php](http://unfccc.int/kyoto_protocol/items/2830.php)

<sup>5</sup> See status of ratification: <http://maindb.unfccc.int/public/country.pl?group=kyoto>

However, the importance of lifestyles should not be limited to these two types of reasons:

1. a great deal of emissions is directly associated with individual ways of living (e.g. transports choice, food habits, waste management at home, etc.) and so a direct consequence of our daily actions;
2. many policy measures impact on the way we perceive our quality of life and our personal preferences, challenging individual freedom in terms of lifestyles (see Brimblecombe and Schuepbach, 2006 for some examples);
3. consumption patterns can create demands on the market for more 'eco-friendly' products; and last but not least,
4. our lifestyles are a reflection of the society we live in and of its values, and ethical considerations regarding inter and intra-generational equity (which is one of the most important aspects of Climate Change (CC)) influence our social behaviour.

We may distinguish two main aspects in lifestyles that are important to cope with CC targets: on one hand, there are consumption changes at several levels, including energy consumption, as well as products with their associated production cycles; on the other hand, there are routine changes (e.g. changes in transportation, food habits, etc.). Both these consumption dimensions are complex and influenced by several aspects (Michaelis, L., 2000) such as: individual habits and consequently needs and motivation; cultural and social context (society values); individual perception of quality of life; financial-economic restrictions; possible alternatives and access to information. Even if some claim that technology is ready (Pacala and Socolow, 2004), technological fixes can have a limited function due to the continuous growth on consumption (IPCC, 2001). Environmental damage will not be solved by technological innovation alone. Wilsdon and Willis (2004) note that, in general, technological innovation has to be accompanied by political and social changes. Indeed, technological innovation poses changes on the side of users and so, the motivations for their adoption have to be understood by those concerned. So, a need exists to raise awareness of and initiate a debate on the connection between lifestyles and their impact to the CC problematique involving those concerned in this debate.

It is not just a case for policy making but one where society has a vital role in the changes towards a sustainable future.

Lifestyles and behaviour changes are an opportunity to mitigate the impact of CC: Lifestyle changes can reduce GHG emissions (IPCC, 2007, pp.12).

## 2 mobGAS application

### 2.1 mobGAS

Challenging issues such as Greenhouse Gas (GHG) emissions and Climate Change (CC) may seem very remote, but there are ways that can help to better perceive our contribution to such problems. And that is where mobGAS comes into play.

The European Commission's Joint Research Centre (JRC) has developed mobGAS - a new mobile application that indicates how much our daily activities contribute to CC. mobGAS can help raising awareness and stimulate the debate among European citizens on the fact that CC is not a remote issue and that each individual can contribute to reduce the emissions of GHGs by adopting small changes in their daily lives. mobGAS aims to make the connection between daily activities and the emissions of GHGs and when possible suggest changes to improve individual performances. It is a kind of diary of users' behaviour through the emissions of GHGs.

mobGAS embeds new concepts of communication of science to non-scientific audience, integrating natural sciences and social behaviours in a tangible way.

With mobGAS, citizens can relate their lifestyle, first with the emissions of gases and later with their impact in the environment.

The mobGAS aim is not just educational or to be a part of an awareness exercise, but empowerment on sustainability issues and corresponding responsibility, thus enhancing the governance process.

mobGAS deals with the uncertainty inherent to CC and with modelling uncertainties. To face these kinds of uncertainties a number of Quality Issues were considered (Guimarães Pereira, 2001):

- quality of information: reliability of sources, outline of data uncertainty and ignorance
- quality of the science used: outline of uncertainty of modelling, transparency of the calculation core
- quality of the user interface, concepts and software operation: intuitive, easy to use, aiming at non-scientific audiences

mobGAS is built upon previous experiences such as VGAS© (<http://kam.jrc.it/vgas>), extending its functionalities and proposing a different type of interface.

Such tools are deemed necessary to show how CC is not a scientific abstraction, but a relevant issue related to human activities.

Models such as in mobGAS and VGAS aim at providing the basis from which individual choices and their effects at a larger scale can be linked. For instance, energy demand can be assessed at point of use, at a regional level (share of the regional/national power generation system) or at a global level (global energy policies). Thus, the awareness is evinced that, regardless of the scale at which energy demand is evaluated, the effects of choices will eventually have impacts at the aggregated levels.

mobGAS© was initially developed for the 27 EU countries, and available in 21 languages.

mobGAS© is an original idea developed by the KAM group (<http://kam.jrc.ec.europa.eu>) at the JRC - European Commission, Italy and implemented by MobiComp©, Portugal. mobGAS© materials are copyright of EUROPEAN COMMUNITIES, 2006-2007. All rights reserved.

## 2.2 Why to register

In order to download, install and use mobGAS on a mobile device, it is not mandatory to register at the website, **BUT** to take advantage of all mobGAS features you should be registered. Registering at mobGAS' website will allow you to keep a daily record of your emissions for a one year period, giving you the possibility to consult your detailed record of emissions (i.e. to explore the main sources of emissions), look at the changes in emissions along the weeks or months and be part of the ranking of users.

The registration is free and it only takes one minute.

## 2.3 Why mobile

mobGAS is the first application of this kind about climate change to run in a mobile phone, thus allowing the user to have an easy and fast access to the information at any time of the day. Nowadays mobile phones are much more than devices to talk. They are always with us and have an enormous potential to be a source of information in those quieter moments like seating on the bus or waiting for an appointment. It is these slots of time that mobGAS intends to take.

Mobile applications, due to their accessibility, have the potential to be an important source of information for concerned citizens. Its aim may not be just educational or to be the prop of an awareness exercise, but also empowerment on sustainability issues and enhancement of collective debate about these. This empowerment is often a key element in social reform. Individuals become agents of change, participating in a democratic transformation of society (Diduck, 1999).



## 2.4 mobGAS structure

mobGAS is organised through a main menu from where you may access all mobGAS' functionalities. This menu includes 7 options or functionalities (by order of appearance) as you can see in figure 1 (to have more detailed information about each one of the main menu options, please see 'mobGAS main menu' section on this manual).

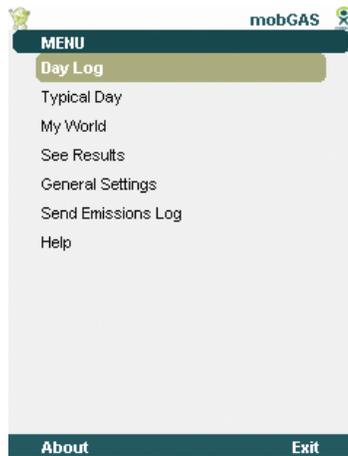


Figure 1 Main menu

- Day log - where you input the daily usages.
- Typical day - creates a default profile of the most used appliances
- My World - General settings regarding your house and country.
- See results - access the emission charts for the three GHGs (CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O).
- General Settings - Login username and password settings
- Send Emissions log - Send record of emissions to mobGAS server
- Help - brief help on the main functionalities of mobGAS

Figure 2 provides an overview of the information accessed from the main menu:



Figure 2 information accessed from the main menu

## 2.5 Navigation on mobGAS

There are four types of screens in the application: List screen, Tabbed List screen, Input Screen and Text Screen.

In this sub-section it will be explained where these screens are showed and how they can be accessed, as well as the actions related to each screen.

It is also given information regarding the keys that can be used in each screen and the correspondent actions.

The navigation on mobGAS is strongly based on the mobile joystick, but this may be replaced by the keys: 2 – up; 8 – down; 4 – left; 6 – right and 5 – select (see figure 3).



Figure 3 Navigation on mobGAS – joystick

### 2.5.1 List screen (Main menu)

The main menu lists the type of options that user can access. You may scroll up or down using the mobile joystick up and down button and select the desired option with the 'fire' key of the joystick or with the key number 5. Figure 4 shows how the main menu looks like. In Table 1 it is listed the keys that can be hit on the main menu and the correspondent actions.

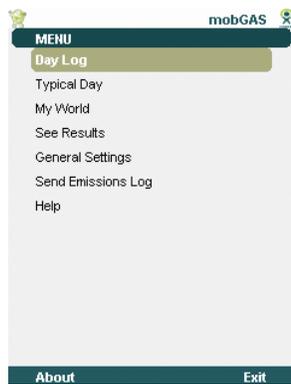


Figure 4 mobGAS main menu

Table 1 Keys' action on the main menu

Key	Action
Fire (or 5)	Option selection
Left Softkey	About text presentation
Right Softkey	Exit application
Up (or 2)	Scroll up
Down (or 8)	Scroll down

## 2.5.2 List and tabbed list screen (day log; typical day and my world)

The major group lists, accessed through 'day log'; 'typical day' or 'my world' buttons, presents the set of appliances / activities of the selected major group (detailed information on the 'groups description' chapter).

Selecting an appliance/activity will make the application to display the input screen of that appliance.

Some major groups are divided in sub-groups. In these cases the different subgroups are tabbed lists where each tab represents each sub-group and selecting it (scrolling left/right) will show the set of appliances of that sub-group, as you can see in figure 5.

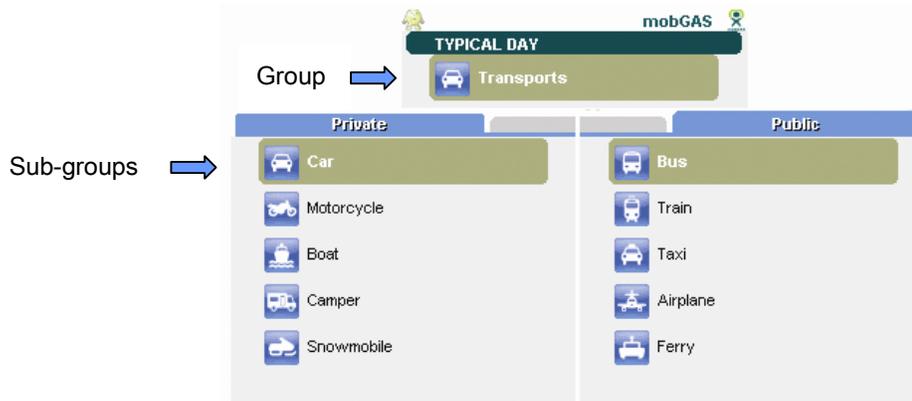


Figure 5 Groups and sub-groups on mobGAS

All major groups list have the option to show a tip related with the appliances / activities that may be found on that group (this option is available on the bottom left corner of the screen and may be accessed by pressing the left softkey).

Table 2 lists the keys that can be hit on the major groups list and the correspondent actions.

Table 2 Actions of the different keys on the major groups

Key	Action
Fire (or 5)	Option selection
Left Softkey	Tip presentation
Right Softkey	Back to previous menu
Up (or 2)	Scroll up
Down (or 8)	Scroll down
Left (or 4)	Tab Scroll left on tabbed lists
Right (or 6)	Tab Scroll right on tabbed lists

Figure 6 shows major groups list, the one on the right is a tabbed list (sub-group).



Figure 6 Major groups list – tabbed list on the right

### 2.5.3 Input screens (appliance / activity usage)

On input screens you can insert the data referring to the usage of the appliance / activity selected. The insertion of values on text boxes is not direct, i.e., to insert a value it is necessary to select the text box with the 'fire' button of the mobile device, type the value on the text area displayed and then press 'OK' or 'fire' as indicated in figure 7. To insert the decimal separator, the user should use the usual mobile default key to access the symbol menu.

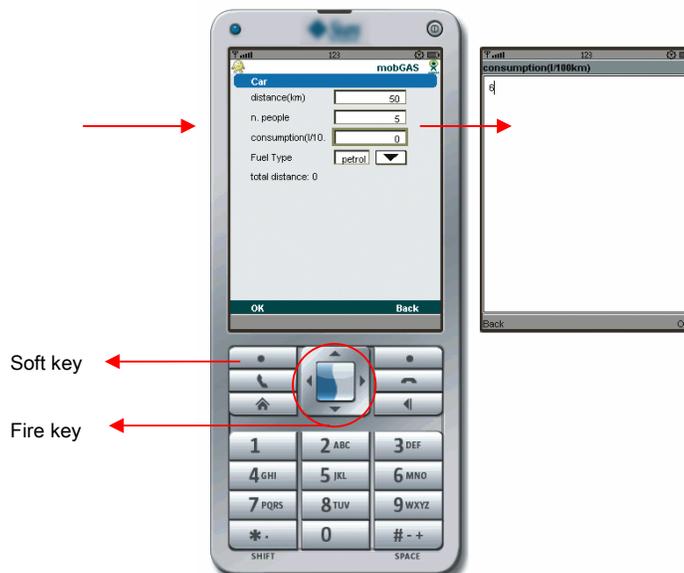


Figure 7 Input screen – insertion of values

Some of the options are not text boxes but drop lists as you can see in figure 8. To change the selected item on the drop list you need to select the drop list (with 'fire' or 5 keys) and then choose the option on the list displayed.

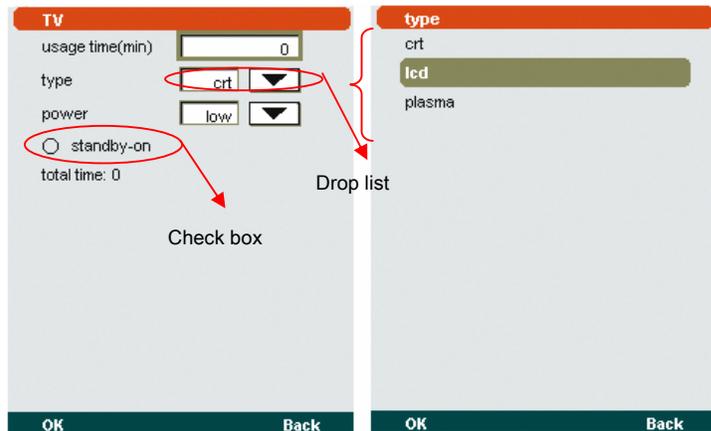


Figure 8 Input screen – drop list and check box

There are some items on this screen that are check boxes. To check/uncheck the option hit 'fire' key when the check box is selected.

Table 3 lists the keys that can be hit on the input screens and the correspondent actions. An example of an input screen is shown in figure 8.

Table 3 Actions of the different keys on the input screens

Key	Action
Fire (or 5)	Open input box/drop list
Left Softkey	Save data and go back to previous menu
Right Softkey	Back to previous menu discarding any changes
Up (or 2)	Scroll up
Down (or 8)	Scroll down

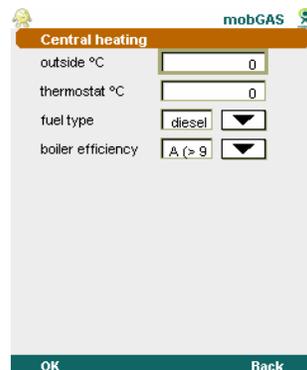


Figure 9 Input screen

## 2.5.4 Text screen (tips and help texts)

When a tip or a help text is selected a text box will display the requested information (tip or help). To aid the user to read, a small cursor is shown in the left of the current selected line.

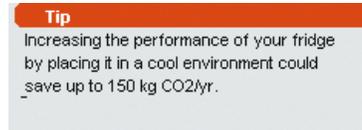


Figure 10 Text screen – tip

The cursor also leads the user when scrolling the text. An example of a text screen is shown in figure 10. In this case the text is related to a major group tip.

Table 4 lists the keys that can be hit on the text screens and the correspondent actions.

Table 4 Actions of the different keys on text screens

Key	Action
Fire (or 5)	N/A
Left Softkey	N/A
Right Softkey	Back to previous menu
Up (or 2)	Scroll line up on text
Down (or 8)	Scroll line down on text

## 2.6 mobGAS main menu

### 2.6.1 Day log

You should access the 'day log' to register your daily activities. This menu enables the user to change the values of appliances' usage for the day. There you will find more than 60 activities or appliances organised on 8 main groups (see groups description section).

These activities or appliances may be set along the day reflecting your daily choices.

This will finally be converted in individual emissions of GHG that may be compared with the weekly average or with country and world average (see Results section).

A very important note is that the values inserted on 'day log' menu **ARE CUMULATIVE**, for example, if you say that today you travelled 10 km by car and then you access again the car menu and insert 5 km, the emissions computed for the car this day will be of 15 km. This way you can go on adding values on the appliances as you use them along the day.

Other good example is the food menu. After lunch you may access the application and insert what you have eaten at lunch and then at dinner you may access again the food menu and insert what you have eaten at dinner. mobGAS will accumulate the values, i.e., compute both lunch and dinner food for the emissions' calculation.



Figure 11 Day Log menu and 'Typical Day' activities

The option 'my day' (first button on the 'day log' menu, see image on the left) displays the appliances set on 'typical day', i.e. it is a shortcut for those activities / appliances that are used on a daily basis. By accessing 'my day' menu you will be able to simply confirm the values pre-set on 'typical day'. This avoids all the work to input again the information related with the appliance / activity.

Changing the values will not change the 'typical day', but only the values computed for that day.

The appliances or activities included on 'my day' are always considered for the calculation of the emissions for that day. In order to discard a specific appliance or activity you should insert zero (0) as the usage value for that appliance or activity. The next day the 'typical day' values will be loaded again.

If you do not access mobGAS for one or several days, your 'day log' emissions will be the same of your 'typical day' emissions.

The values inserted on this menu will be cancelled in the end of the day (midnight) and the 'typical day' values will be loaded again.

## 2.6.2 Typical day

The first time you run mobGAS you may want to set the 'typical day'.

'Typical day' works as a profile of the appliances you use every day. This option avoids the need of the user to input every day the values, as this values are considered to be the most common values. Once you set the usage and characteristics of these appliances or activities, the values will be saved, and next time you run mobGAS the default values will automatically be loaded.

Select the appliances used every day and pre-set their typical usage. The appliances selected will be accessible directly from 'day log > my day' option. This will save you time when inputting values at the 'day log'.

The data on 'typical day' can be changed in order to add or discard each appliance from the normal day usage. To 'discard' an appliance it is only needed to change the values of usage time/distance/amount to zero (0).

Finally if you do not insert any new values or do not run mobGAS on a specific day, the 'typical day' profile emissions will be taken on consideration for that specific day.

The structure of the 'typical day' is the same as on 'day log'.

The values inserted on this menu will be cancelled in the end of the day (midnight) and the 'typical day' values will be loaded again.

**TIP:** Include those 5-8 activities that you do every day, such as mean of transport for work or school, usage of computer, etc.

You may also include here the appliances you keep on stand-by without the usage values.

### 2.6.3 My world

My world includes the general settings regarding your house and country default values. This is a tabbed menu, i.e. to move from one group to another you should press left or right on you joystick or 4 or 6 keys on the keypad.

The house settings are the settings the user described the first time (s)he uses mobGAS. On the country options menu you may select a different country, a different share on the power production (already pre-set according to available literature) and different type of waste management. More information on this menu on section '2.8 My world'.

### 2.6.4 See results

The user may access the emissions of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O produced during that day and compare them with the week average and with the national and world average per capita (further information on 'see results' section).

### 2.6.5 General Settings

Here the user may set or change the username and password used when registered at mobGAS website ('account settings'). These credentials will be used to send the emissions log to the server and to later access the record of emissions through the website. The 'account settings' (login and password) must be set before sending the emissions log to the server.

If you forgot the username or password you may request the credentials at <http://mobgas.jrc.it>, by selecting the option 'I've forgotten my password!' in the 'Login' page.

## 2.6.6 Send Emissions log

Send your emissions for detailed visualisation at mobGAS webpage.

To send the emissions to server, the correspondent option on main menu should be selected. Each time the mobile application sends the emissions, it updates its own data. This update is imperceptible to the user and done while the emissions are sent to the server. The data updated involves new tips, change of country/world emissions default values and update on the emissions calculation.

The data stored on the device is sent to mobGAS server through GPRS or 3G data transfer and it may be accessed through the mobGAS webpage. Sending your emissions to the server may incur on costs associated to the data transfer<sup>6</sup>, depending on your mobile operator price plan. Please consult your service provider for more details. There is **NO** extra cost associated with the transfer of data.

Depending on your cell phone settings, it will be asked if you want to access the web in order to carry with the action. It is possible on the JAVA settings of the cell phone to avoid this message, to make it always visible when a web access is needed or to make it visible only once for each usage of the application. This depends on the cell phone settings, not on the application.

The application sends not only the emissions for the current day, but also the emissions of the last 7 days.

To send the emissions to the server the user needs to be registered on mobGAS web site and insert the account settings (credentials) on the 'general settings' menu of the mobile application (see 'general settings' subsection).

Each time you send the emissions log, it is also checked if a new version of mobGAS mobile application is available. If there is a new version, you will be asked if you want to update the application. The version update can be critical and therefore mandatory so you will be notified and the update done at that time.

The installation of a new version works the same way as the first time installation of the application, i.e., when you accept the update, the application is shutdown and it is launched the mobile phone browser that will enable you to download the new version.

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<sup>6</sup>The size of file is of approximately 1 kb.

## 2.6.7 Help

From the main menu you can access the Help menu. This menu will show help texts for different aspects/features of the application, for instance what is represented in each menu, the storage of data, account settings and how emissions are sent.

## 2.7 How to use MobGAS

mobGAS has an easy and intuitive interface to help user navigation.

The application has four different types of screens; all described on section '2.5 Navigation on mobGAS'.

### 2.7.1 First time user



Figure 12 First time user - to select country and general settings for the house

The first time you run the application, you should first select a country and later define general settings for your house, as figure 12 shows.

These general settings include the number of people living in your house, the area of the house and of the garden and if your windows have double glaze.

This information is only asked once, but can be changed by accessing 'my world' button from the main menu, as you can see in the following sequence of images.

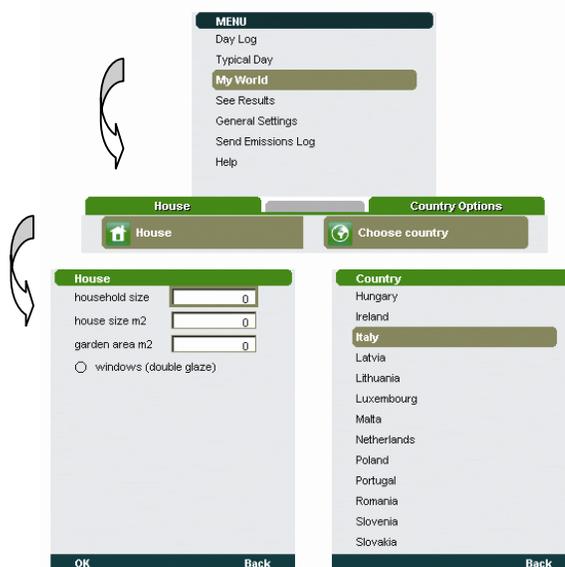


Figure 13 Access to country and general settings for the house

After these initial settings you access the main menu of the application.

The first time you run mobGAS you may want to set the Typical day. Typical day works as a profile of the appliances you use every day (see 'typical day' topic on this help).

## 2.7.2 Regular user

Now that the house details are set you may start using mobGAS.

For a daily use of mobGAS you should access the 'day log' button from the main menu, choose the group of activities / appliances desired, select the activity considered and insert the required information in the displayed fields.

During the day, if you use an appliance more than once you may add several partial usages.

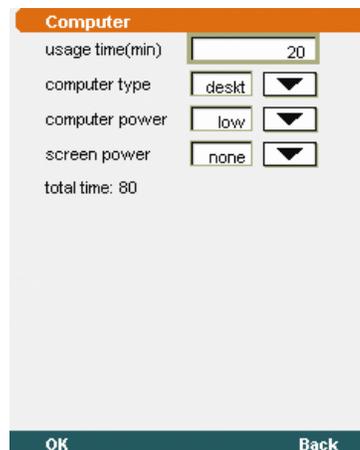


Figure 14 Total usage – accumulation

mobGAS accumulates the different daily inputs and aggregates them as an indication of the total usage (on amount, time or distance depending on the activity/appliance considered) on the input screen menu (see figure 14).

The values are saved automatically everyday at midnight, and the default values (from the typical day) are loaded. The activities set on 'typical day' may be accessed through the 'my day' option.

By accessing 'my day' menu you will be able to select the activities or appliances defined on 'typical day' and simply confirm the values pre-set. This avoids all the work of input again the information related with the appliance / activity. If you use differently the specific appliance you may change the values of the fields or even add zero (0) as usage and the appliance will not be taken in consideration for the emissions calculation.

The data on 'typical day' can be changed in order to add or discard each appliance from the normal day usage. To 'discard' an appliance it is only needed to change the values of usage time/distance/amount to 0 (zero). If this change is made on the 'day log' the change has effect for that day. If the change is made on the 'typical day' the specific activity is removed from the 'my day' menu.

Finally if you do not insert any new values or do not run mobGAS on a specific day, the 'typical day' profile emissions will be taken on consideration for that specific day.

Along the day you may consult your emissions by accessing the 'see results' button from the main menu.

Your emissions are saved for a period of 7 days. To keep the emissions logs, the emissions should be sent to mobGAS server. For that you should press 'send emissions log' (more on section '2.4 mobGAS structure').

## 2.8 My World



This section includes the general settings regarding your house and country. Here you are asked about your house and household size as well as some information about your country. It is divided in two sub-groups:

- House
- Country Options

### 2.8.1 House

This section refers to general information about you and your house. You are asked to introduce general information about your household.

**Household size:** This parameter will influence individual energy consumption due to appliances, heating and cooling, and lights which are divided by the household size.

**House Size:** Area of your house or apartment in square meters. This does not include external areas, such as gardens or balconies. The house size will influence the calculation of the heating and cooling requirements of your home.

**Garden Area:** Area of your garden in square meters. It is assumed that your garden is taken care of and therefore it is cleaned at least once a month.

N.B. A Ha (hectare) is equivalent to 10 000 m<sup>2</sup> (square meters).

**Windows double:** Select this option if you have double windows in your house. Your energy losses will be lower due to the double windows.

This information is important for some of the calculations of the Greenhouse Gases (GHGs) emissions. Figure 15 illustrates the relation of the household variables with the emissions of carbon dioxide (chemical formula: CO<sub>2</sub>), methane (chemical formula: CH<sub>4</sub>) and nitrous oxide (chemical formula: N<sub>2</sub>O).

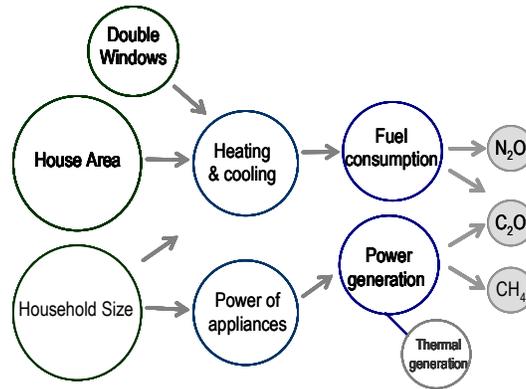


Figure 15 Relation of household variables with emissions of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O

To see the relation of the garden area variables with the emissions of carbon dioxide (chemical formula: CO<sub>2</sub>) and methane (chemical formula: CH<sub>4</sub>) see Figure 16.

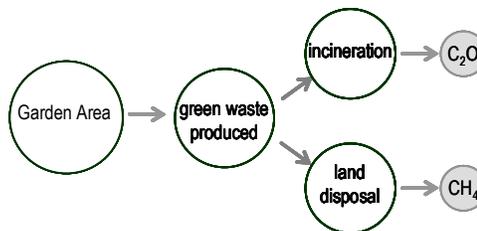


Figure 16 Relation of the garden area variables with emissions of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O

## 2.8.2 Country Options

This menu is divided in three sub-groups:

- Choose country
- Power production
- Waste treatment

### *2.8.2.1 Choose Country*

This menu allows you to choose one of the 27 countries of the European Union (Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and United Kingdom) as the default country where you currently live. By doing so, the country specific variables (such as Power Production sources) correspond to publish statistic figures for the country of concern.

If your country is not represented, you may still use the software by changing the values shown in the menu for Power Production. However, you should be aware that other internal variables cannot be changed from the user interface and remain equal to those of the country chosen (for instance, the average country emissions per capita of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O).

### *2.8.2.2 Power Production*

In this section you are asked to choose the relevant sources for production of electricity in your country as well as their percentage in the mix. The combination of the different power production sources will determine the calculation of emissions of all 3 greenhouse gases: carbon dioxide (chemical formula: CO<sub>2</sub>), methane (chemical formula: CH<sub>4</sub>) and nitrous oxide (chemical formula: N<sub>2</sub>O).

The values in the fields are the default values for the country you have chosen based on the literature. If you have more accurate information about these figures, you may

alter them in the fields. The figures are percentages, hence the total fuel mix must sum 100%. To see the Power Production shares used in mobGAS go to section '4 Greenhouses Gases calculation'.

The power production sources can be divided into those that because of their manipulation do produce greenhouse gases and those that do not. Only emissions from the phase of production of electricity are considered. Transport of materials or other phases of operation are not considered.

#### *Non-producers of greenhouse gases*

**Hydro:** electric power produced by dams placed on rivers, controlling the flow of water and increasing the elevation. 'Hydropower plants' capture the kinetic energy of falling water generating electricity. A turbine and a generator convert the energy from the water to mechanical and then electrical energy. For more information see the web links on 'further reading' topic.

**Solar:** One of the processes of producing electricity is through the use of photovoltaic (PV) cells that convert sunlight directly into electricity. PV cells are made of semi conducting materials similar to those used in computer chips. When sunlight is absorbed by these materials, the solar energy knocks electrons loose from their atoms, allowing the electrons to flow through the material to produce electricity. This process of converting light (photons) to electricity (voltage) is called the photovoltaic effect. For more information see the web links on 'further reading' topic.

**Wind:** wind turbines convert the kinetic energy in the wind into mechanical power, which through a generator can be converted into electricity. For wind energy facts see for instance the EWEA - Wind Energy in Europe, Wind Energy Program of the US government.

**Nuclear:** electric power produced in nuclear power plants through fusion. In 1996, 17% of the world's electricity came from 442 nuclear power plants; nuclear energy accounted for 77% of France's electricity, 52% of Sweden's, and 22% of the United States'. For information about nuclear energy facts, controversies, etc. have a look at the suggested web links on 'further reading' topic.

*Producers of greenhouse gases*

**Coal:** Coal is a fossil fuel used to produce electricity. The most common process is called 'steam turbine generation', the fuel being used to produce the steam. For information about the process have a look at, for example, the EPA Sector Notebook. There are other generation processes, but for simplicity all data adopted in the calculation of emissions refers to the coal fired steam turbine generation process.

**Oil:** Fuel oils to be used to produce electricity are refined from petroleum or crude oil. In the process called 'steam turbine generation', oil is fired to produce steam. For information about the process have a look at, for example, the EPA Sector Notebook. There are other generation processes, but for simplicity all data adopted in the calculation of emissions refers to the oil fired steam turbine generation process.

**Natural gas:** A gas fired power plant in a simple cycle configuration generates all its power from a gas turbine coupled to an electrical generator (e.g., have a look at the web site developed by Transcanada power LP). However gas can be used also in steam turbine generation processes.

**Further reading**

**Hydro:**

US Environmental Protection Agency –

<http://yosemite.epa.gov/oar/globalwarming.nsf/content/ImpactsWaterResourcesHydropower.html>

US Department of Energy – [http://www1.eere.energy.gov/windandhydro/hydro\\_research.html](http://www1.eere.energy.gov/windandhydro/hydro_research.html)

Idaho National Laboratory - <http://hydropower.inl.gov/>

N.B. All links are US links.

**Solar:**

US National Renewable Energy Laboratory - [http://www.nrel.gov/learning/re\\_solar.html](http://www.nrel.gov/learning/re_solar.html)

and [http://www.nrel.gov/learning/re\\_photovoltaics.html](http://www.nrel.gov/learning/re_photovoltaics.html)

US Department of Energy - <http://www1.eere.energy.gov/solar/>

N.B. All links are US links.

**Wind:**

European Wind Energy Association - <http://www.ewea.org/>

US Department of Energy - [http://www1.eere.energy.gov/windandhydro/wind\\_research.html](http://www1.eere.energy.gov/windandhydro/wind_research.html)

US National Renewable Energy Laboratory - [http://www.nrel.gov/learning/re\\_wind.html](http://www.nrel.gov/learning/re_wind.html)

**Nuclear:**

OECD Nuclear Energy Agency - <http://www.nea.fr/>

US Nuclear Energy Institute - <http://www.nei.org/>

US Department of Energy - <http://www.ne.doe.gov/>

International Atomic Energy Agency - <http://www.iaea.org/>

Greenpeace International - <http://www.greenpeace.org/international/campaigns/nuclear>

Environmentalists For Nuclear Energy - <http://www.ecolo.org/>

The ABC of Nuclear Science - <http://www.lbl.gov/abc/>

A book reference for this issue is: Standard Handbook of Power Plant Engineering by Elliot, Thomas C. Published by McGrawHill, Inc. New York, 1989.

**Coal:**

EPA Sector Notebook, 'Profile of the Fossil Fuel Electric Power Generation Industry', 1997 -

<http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/fossil.html>

**Oil:**

EPA Sector Notebook, 'Profile of the Fossil Fuel Electric Power Generation Industry', 1997 -

<http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/fossil.html>

**Natural gas:**

TransCanada - <http://www.transcanada.com/>

***2.8.2.3 Waste Treatment***

You are asked here how the waste is managed in your region. The list contains the most usual ways of managing waste: uncontrolled dump, land-fills, incineration and composting. Recycling is considered in the menu Waste.

### *Dumping, Land-fill, Incineration and Composting*

**Dumping:** Consist in one of the most traditional method of waste disposal where the waste is collected and accumulated in an open air site with a minimum human control. Usually they are not constructed with any special environmental protective measures.

**Landfilling:** Modern landfills consist of well designed waste disposal sites with a system of measures that minimizes their impact on the local environment. These measures include impermeable membranes which prevent the contamination of soils and aquifers, the compaction and of the waste to increase its density and stabilize the new landform, and it's covering to reduce the amount of wind-blown litter. Major gases emitted are CH<sub>4</sub> and CO<sub>2</sub>. Avoiding the production of CH<sub>4</sub> encompasses alternative methods to dispose of organic waste or methods to collect and use the gas at the land-fill. The CO<sub>2</sub> emissions are not accounted because the carbon is of biogenic origin.

**Incineration:** Waste incineration is defined as the combustion of solid and liquid waste in controlled incineration facilities. Modern refuse combustors have specially designed combustion chambers which provide high combustion temperatures, long residence times, and efficient waste agitation while introducing air for more complete combustion. The incineration of waste is a source of greenhouse gas emissions, like other types of combustion. Relevant gases emitted include CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O. Normally, emissions of CO<sub>2</sub> from waste incineration are more significant than CH<sub>4</sub> and N<sub>2</sub>O emissions. CH<sub>4</sub> emissions from incineration are a result of an incomplete combustion (IPCC, 2006). The main contaminants resulting from the combustion process are polycyclic aromatic hydrocarbons, dioxins, and furans, dust and heavy metals.

**Composting:** Composting is a biological process in which micro-organisms convert degradable organic matter into carbon dioxide and water vapor using oxygen in the air and leaving a bulk-reduced stabilized residue known as compost.

Figure 17 shows the relation between the different waste management options and the type of Greenhouse Gases (GHGs) emitted.

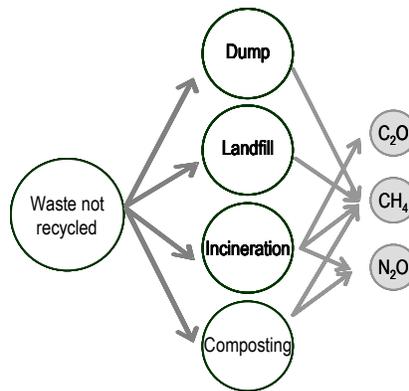


Figure 17 Relation between the different waste management and the GHG emitted

### Emissions calculation

The estimation of GHGs emissions from waste treatment were done based on the '2006 IPCC Guidelines for National Greenhouse Gas Inventories – Volume 5'.

#### *Dumping and Landfill*

$$CH_4 = \left( \left( \text{Waste} \times \sum (\text{DOC}_{[\text{material}]}) \times \text{DOC}_f \times \text{MCF} \times F \times \frac{16}{12} \right) - R \right) \times (1 - \text{OX})$$

Where:

[material] - different types/materials of waste (i.e. organic waste, paper, plastics, aluminium and glass)

DOC<sub>[material]</sub> - degradable organic carbon in fraction

DOC<sub>f</sub> - fraction of DOC that can decompose

F - fraction of CH<sub>4</sub> in generated landfill gas

MCF - CH<sub>4</sub> correction factor for aerobic decomposition

OX - oxidation factor

R - recovered CH<sub>4</sub> in kg

Waste - total amount of waste deposited in kg

$\frac{16}{12}$  - molecular weight ratio CH<sub>4</sub>/C

CH<sub>4</sub> Emission - CH<sub>4</sub> produced by dumping and landfill in kg

### *Incineration*

$$\text{CO}_2 \text{ Emission} = \text{Waste} \times \sum \left( \text{WF}_{[\text{material}]} \times \text{dm}_{[\text{material}]} \times \text{CF}_{[\text{material}]} \times \text{FCF}_{[\text{material}]} \times \text{OF}_{[\text{material}]} \right) \times \frac{44}{12}$$

Where:

[material] - different types/materials of waste (i.e. organic waste, paper, plastics, aluminium and glass)

Waste - total amount of incinerated waste in kg

WF - fraction of waste type/material of component in the total amount of waste incinerated

dm - dry matter content in the component

CF - fraction of carbon in the dry matter (i.e. carbon content) of component

FCF - fraction of fossil carbon in the total carbon of component

OF - oxidation factor of component

44/12 - conversion factor from C to CO<sub>2</sub>

CO<sub>2</sub> Emission – CO<sub>2</sub> produced by incineration in kg

$$\text{CH}_4 \text{ Emission} = \text{Waste} \times \text{EF} \times 10^{-6}$$

Where:

Waste - amount of incinerated waste in kg

EF - CH<sub>4</sub> emission factor in kg for each Gg of waste incinerated

CH<sub>4</sub> Emission – CH<sub>4</sub> produced by incineration in kg

$$\text{N}_2\text{O} \text{ Emission} = \text{Waste} \times \text{EF} \times 10^{-6}$$

Where:

Waste - amount of incinerated waste in kg

EF - N<sub>2</sub>O emission factor in kg N<sub>2</sub>O for each Gg of waste incinerated

N<sub>2</sub>O Emission - N<sub>2</sub>O produced by incineration in kg

### *Composting*

$$\text{CH}_4 \text{ Emissions} = \text{Waste} \times \text{EF} \times 10^{-3} - \text{R}$$

Where:

Waste - amount of organic waste sent to composting in kg

EF - CH<sub>4</sub> emission factor in g for each kg of waste treated

R - total amount of CH<sub>4</sub> recovered in kg

CH<sub>4</sub> Emissions - CH<sub>4</sub> produced from composting in kg

$$\text{N}_2\text{O Emissions} = \text{Waste} \times \text{EF} \times 10^{-3}$$

Where:

Waste - amount of organic waste sent to composting in kg

EF - N<sub>2</sub>O emission factor in g for each kg of waste treated

N<sub>2</sub>O Emissions - N<sub>2</sub>O produced from composting in kg

### **Assumptions**

All the assumptions regarding the calculation of the emissions from the different types of waste treatment were done having in consideration the '2006 IPCC Guidelines for National Greenhouse Gas Inventories – Volume 5' good practices.

### *Dumping and Landfill*

The values assumed in the calculation of the CH<sub>4</sub> Emission from Dumping and Landfill are in Table 5.

Table 5 Values assumed in the calculation of CH<sub>4</sub> emission from dumping and landfill

Type of waste treatment	DOC <sub>f</sub>	MCF	F	R [kg]	OX
Dumping	0.5	0.6	0.5	0	0
Landfill	0.5	1.0	0.5	0	0.1

In Table 6 you have the values assumed for the degradable organic carbon (DOC) content in the different types/materials of waste.

Table 6 Values assumed for DOC content in the different types/materials of waste

Type/material of waste	DOC
Organic Waste	40%
Paper/Cardboard	20%
Plastics	0%
Aluminium	0%
Glass	0%

*Incineration:*

In Table 7 you can consult the values assumed in the calculation of the CO<sub>2</sub> Emissions from Incineration.

Table 7 Values assumed in the calculation of CO<sub>2</sub> Emissions from Incineration

Type/material of waste	WF	dm	CF	FCF	OF
Organic Waste	31%	0.4	0.49	0	100%
Paper/Cardboard	29%	0.9	0.46	0.1	100%
Plastics	8%	1	0.75	1	100%
Aluminium	11%	1	0	0	100%
Glass	5%	1	0	0	100%

The values assumed in the calculation of the CH<sub>4</sub> Emissions and N<sub>2</sub>O Emissions from Incineration can be consulted in Table 8.

Table 8 Values assumed in the calculation of CH<sub>4</sub> and N<sub>2</sub>O emissions from Incineration

	EF [kg/Gg waste incinerated]
CH <sub>4</sub> Emission	6
N <sub>2</sub> O Emission	50

### *Composting*

In Table 9 you can consult the values assumed in the calculation of the CH<sub>4</sub> Emissions and N<sub>2</sub>O Emissions from Composting.

Table 9 Values assumed in the calculation of CH<sub>4</sub> emissions from Composting

	<b>EF</b>
CH <sub>4</sub> Emission	4
N <sub>2</sub> O Emission	0.3

N.B When the user chooses more than one type of waste treatment; the amount of waste treated by each type of treatment will be the same, meaning that the total amount of waste sent for treatment will be divided equally by all the treatments chosen.



### 3 Groups description

Although very easy to use, mobGAS is a complex application that takes into account several parameters: it calculates the emissions of the three main greenhouse gases (carbon dioxide CO<sub>2</sub>, methane CH<sub>4</sub> and nitrous oxide N<sub>2</sub>O) according to the choices made by the user in several daily activities, such as setting the house heating, choosing the means of transport and using various household appliances. These activities or appliances may be set along the day reflecting users' daily choices.

They are organised in 8 main groups for a better navigability: Transports; Appliances; Lights; Climate; Hygiene; Food and waste; Outdoor leisure; Others. These are then divided in subgroups which include the icons corresponding to the activities or appliances (more than 60) – see following schemas.



Figure 18 mobGAS structure with all the activities organised by group and subgroup



### 3.1 Transport



The type of transport considered here, refer to transport that you may usually find in your country. It is divided in two sub-groups, private and public transport. For each one of the sub-groups type different means of transport are available.

#### 3.1.1 Private

The following private means of transport were included: car, motorcycle, boat, camper and snowmobile. For each of these you are directly asked about a number of parameters as described in Table 10.

Table 10 Parameters in Private means of transport menu

Transport	Distance [km]	Average Consumption [fuel unit/100km]	Fuel Type	Nr. of people travelling in the same vehicle	Specific parameters
Car	x	x	x	x	-
Motorcycle	x	x	x	x	-
Motor boat	-	x	-	x	time [h]
Camper	x	x	-	x	-
Snowmobile	x	x	-	-	-

For each transportation mean you should indicate the distance made, the fuel type used by the vehicle, as well as the average fuel consumption (see figure 19). You are also asked about the number of people travelling with you in this journey.

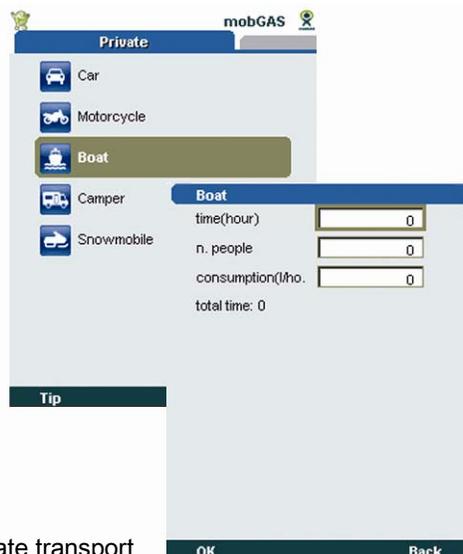


Figure 19 Private transport menu

In Table 11 you can see reference fuel consumption for the transportation considered.

Table 11 Reference fuel consumption for Private means of Transport

Transportation means	Type of fuel	reference values	reference values
		[km/l]	[l/100 km]
car	petrol	11	9.09
	diesel	13.7	7.30
	lpg	11	9.09
	electric	5 km/kW	
motorcycle	petrol	13.3	7.52
motorcycle < euro1	mix	30	3.33
camper	diesel	6.7	14.93
motor boat	petrol	17 l/h at cruise speed	
snowmobile	petrol	5.6	17.86

Sources: several vehicle makers available in the market. See 'references' chapter for more detail (under 'appliances producers' websites')

### Emissions calculation

The calculation of fuel/power consumption and associated emissions of carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) from using private transportation is calculated as follows. Except for the motor boat, consumption calculations are based on fuel consumption.

#### *Calculation based on fuel consumption*

$$\text{Fuel}_{[\text{vehicle}]} = \frac{\text{DIST}}{\frac{\text{Conspt}_{[\text{vehicle}]}}{\text{PP}}}$$

Where:

[vehicle] – the type of vehicle

Conspt<sub>[vehicle]</sub> – average consumption (in km/l)

DIST – distance (in km)

PP – number of people using the vehicle in the same journey

Fuel<sub>[vehicle]</sub> – fuel (in l) or power (in watts per hour) consumption for the journey

*Calculation based on usage time*

$$\text{Fuel}_{[\text{boat}]} = \left( \frac{\text{Time}_{[\text{boat}]}}{60} \right) \times \frac{\text{Conspt}_{[\text{boat}]}}{\text{PP}}$$

Where:

[vehicle] = boat

Conspt<sub>[boat]</sub> – average consumption (in l/hour)

Fuel<sub>[boat]</sub> – fuel consumption for the journey (in l)

Time<sub>[boat]</sub> – time usage of boat (in minutes)

PP – number of people using the vehicle in the same journey

*Greenhouse gas emissions*

The values of Table 12 are adopted as greenhouse gases emission factors for all vehicles – please note that those for power consumption are associated to the energy mix that is used to generate electric power and therefore should be consulted on Table 44 of section ‘4 Greenhouse Gases calculation’.

Table 12 GHG emission factors for all vehicles

Fuel	CO <sub>2</sub> [kg/l]	CH <sub>4</sub> [kg/l]	N <sub>2</sub> O [kg/l]
petrol	2.385	0.000625	0.000045
diesel	2.666	0.000068	0.00014
lpg	1.536	0.00054	0
Mix for euro 1 motorcycles	2.385	0.00657	0.00003

Source: EEA, 2002; IPCC 2006.

The general equation to calculate greenhouse gases is the following:

$$\text{GHG\_emission} = \text{Fuel}_{[\text{vehicle}]} \times \text{GHG\_Factor}$$

Where:

Fuel<sub>[vehicle]</sub> – fuel consumption for the journey (fuel unit)

GHG\_Factor – fuel emission factors for each of the 3 greenhouse gases (kg/l)

GHG\_emission – production of one of the 3 greenhouse gases considered: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) (in kg)

### 3.1.2 Public

The following public transportation categories were included: rail, bus, ferry, taxi and airplane. For each of these you are directly asked about distance made during your journey and if appropriate the type of transport within the category – see Table 13 for all types included.

Table 13 Parameters on Public means of Transport menu

Category	Type	Distance [km]	nr of passengers
bus	Diesel	x	-
	Trolley-bus	x	-
	Biodiesel	x	-
	natural gas	x	-
rail	train (high speed electric)	x	-
	train (diesel)	x	-
	tram	x	-
	metro	x	-
ferry		x	-
taxi		x	x
airplane		x	-

#### Emissions calculation

The calculation of fuel/power consumption and associated emissions of carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) from using public transportation is calculated as follows (calculations are based on fuel consumption.)

N.B. Emissions due to airplane travels are calculated separately as the journey in an airplane has two phases, LTO (landing and take-off operations) and cruise phases where distinctive consumptions of fuel occur.

*Calculation based on fuel consumption*

$$\text{Fuel}_{[\text{vehicle}]} = \text{DIST} \times \text{Conspt}_{[\text{vehicle}]}$$

Where:

[vehicle] – the type of vehicle

Conspt<sub>[vehicle]</sub> – average fuel consumption (in l/km or watts/km/hour)

DIST – distance (in km)

Fuel<sub>[vehicle]</sub> – fuel (in l) or power (in watts per hour) consumption for the journey

Calculation variations

$$\text{Fuel}_{[\text{taxi}]} = \frac{\text{DIST} \times \text{Conspt}_{[\text{taxi}]}}{\text{PP}}$$

Where:

Conspt<sub>[taxi]</sub> – average fuel consumption (in l/km or watts/km/hour)

DIST – distance (in km)

Fuel<sub>[taxi]</sub> – fuel (in l) or power (in watts per hour) consumption for the journey

PP – number of passengers in the same journey

Airplane

See Greenhouse Gases emissions topic on this section

*Greenhouse gas emissions*

The values in Table 14 are adopted as greenhouse gases emission factors for all vehicles – please note that those for power consumption are associated to the energy mix that is used to generate electric power and therefore should be consulted in the table of the ‘Greenhouse Gases calculation’ chapter.

Table 14 GHG emission factors for all public vehicles

Transportation	TYPE	CO <sub>2</sub> [kg/l]	CH <sub>4</sub> [kg/l]	N <sub>2</sub> O [kg/l]
bus	Diesel	2.666	0.000068	0.00014
	Biodiesel	0.587	0.0000204	0.00135
	natural gas	0.002639	0.000047	0.0000047
rail	diesel train	2.666	0.000068	0.00014
ferry		2.666	0.000068	0.00014
taxi		2.666	0.000068	0.00014
airplane	Cruise phase	2.495	0.000018	0.000072
	LTO phase	0.024	5.99401x 10 <sup>-7</sup>	9.99001 x 10 <sup>-7</sup>

Source: EEA 2002; IPCC 2006.

The general equation to calculate greenhouse gases is the following:

$$\text{GHG\_emission} = \text{Fuel}_{[\text{vehicle}]} \times \text{GHG\_Factor}$$

Where:

Fuel<sub>[vehicle]</sub> - fuel consumption for the journey (fuel unit (per passenger))

GHG\_Factor - fuel emission factors for each of the 3 greenhouse gases for all vehicles except airplane (in kg/unit of fuel)

GHG\_emission - production of one of the 3 greenhouse gases considered: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) (kg of greenhouse gas)

*Variation for the airplane*

$$\text{GHG\_emission} = (\text{DIST} \times \text{Conspt\_Cruise}_{[\text{airplane}]} \times \text{GHG\_Factor\_Cruise}) + (\text{Conspt\_LTO}_{[\text{airplane}]} \times \text{GHG\_Factor\_LTO})$$

Where:

DIST - distance (in km)

Conspt\_Cruise<sub>[airplane]</sub> - fuel consumption due to cruise phase by the airplane (in l)

Conspt\_LTO<sub>[airplane]</sub> - fuel consumption due to LTO operation (in kg)

GHG\_Factor\_Cruise - fuel emission factors for each of the 3 greenhouse gases for the cruise phase for airplane (in kg per l)

GHG\_Factor\_LTO - fuel emission factors for each of the 3 greenhouse gases for the LTO phase for airplane (in kg per kg)

GHG\_emission – production of one of the 3 greenhouse gases: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) (kg of greenhouse gas)

### Assumptions

The fuel consumption for the transportation considered is indicated in Table 15.

Table 15 Fuel consumption

Category	TYPE	Consumption [l/km per passenger]
bus	Diesel	0.0140
	Trolley-bus	0.0911
	Biodiesel	0.0070
	natural gas	0.8700
rail	train (high speed electric)	0.0398
	train (diesel)	0.0080
	tram	0.0085
	metro	0.0145
ferry		0.0470
taxi		0.1100
airplane	Cruise phase	0.035
	LTO phase	5.923 kg fuel/passenger

Source: EEA 2002; IPCC 2006.

The calculations for the airplane are based on Airbus 320 model. The cruise consumption is: l/km passenger, whereas the LTO is on kg fuel/passenger. These values are gathered from IPCC (2006).

## 3.2 Appliances



The type of devices considered here, refer to appliances that you may usually find in your house or even in your office.

The appliances group is divided in four sub-groups related with everyday life activities.

- electronics
- cleaning
- cooking
- DIY (do it yourself)

### 3.2.1 Electronics

The electronics sub-group gathers commonly used appliances at home and/or office that are related with entertainment or deskwork.

You should check the appliances that you use, indicating the appliances' power (Watt), usage time (minutes) and standby usage (except for computer and battery recharger).

The usage and electrical consumption are considered as individual, i.e. not divided by the household size.

#### Consumption ranges

For the majority of the appliances you should indicate whether your appliance has low, medium or high power consumption (Watts). In the case of DVD/video, printer and battery recharger, examples of appliances' models are given, indicating representing different ranges of consumption. If you know the exact power consumption of your appliance you should insert the value after choosing the option 'real' from the power menu. Usually, old appliances consume more energy than the last generation of appliances - say last 5 years. So, this might be an indication of the appliances wattage.

Seven common types of appliances are listed below, being also those with major energy consumption. For each of them it is indicated the assumed consumption values

for low, medium and high power consumption in watt hour, as well as the consumption in standby.

To choose the power range of your appliance, consider the following example and check Table 16. Example:

TV: First you should choose the type of TV – CRT (classic colour TV), LCD or Plasma. Depending on the choice of the TV type, the values attributed to the power consumption change. Choosing LCD TV you may then select LOW, meaning that your TV consumes 75 Watt-hour or less; if you select MEDIUM means that your TV consumes between 76 and 249 Watts-hour BUT the figure adopted in the calculator is 125 Watt-hour. Selecting HIGH means that your TV consumes 250 Watt-hour or more. Finally you should indicate if you use the standby option on.

Table 16 Wattages of appliances

Appliance	LOW	MEDIUM	HIGH	STANDBY	Sources
TV CRT	≤50	125	≥200	3	LG CORP., Sony, Phillips; Grundig; Enel
TV LCD	≤75	125	≥250	3	LG CORP., Sony, Phillips; Grundig; Enel
TV Plasma	≤200	350	≥400	3	LG CORP., Sony, Phillips; Grundig; Enel
Satellite set	≤10	20	≥25	5	LG CORP.; Grundig
Hi-fi	≤40	150	≥300	3	Sony; Grundig
Computer Laptop	≤25	100	≥150	-	DELL; Fujitsu-Siemens; Toshiba
Computer desktop	≤25	150	≥200	-	DELL; Fujitsu-Siemens; Toshiba
Computer screen	≤50	100	≥200	-	DELL; Fujitsu-Siemens; Toshiba
Printer	≤15	25	≥300	5	Epson; Canon INC.
Video Game console	≤20	70	≥150	2	DX Gaming (2008)
console screen	≤50	175	≥300	3	LG CORP., Sony, Phillips; Grundig; Enel
Battery recharger	≤10	35	≥200	-	Nokia, Motorola, Minwa Electronics, Thomas Distributing; batterystuff.com (2008)

The battery rechargers and printers models suggested in the respective icons are indicative of low, medium or high power consumption. You may consider other

appliances with the same power consumption or insert the power consumption of your appliance.

In the case of the DVD/Video, 4 options are available covering the most common types of models in the market as you can see in Table 17.

Table 17 Wattages of DVD/Video

Appliance	DVD player	VCR	DVD recorder	DVD Hard-disk	Standby	Sources
DVD/video	10	15	25	50	3	LG CORP., Sony, Phillips and Grundig

### Consumption calculation

#### *Power consumption calculation variables*

The power consumption calculation and associated emissions of carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) from the use of electronics device takes into account the wattage, the number of minutes that the appliances are used and if they are on standby when not in use.

$$PC\_electronics = \sum \left( \left( \left( \frac{wattage_{[appliance]}}{1000.0} \right) \times \left( \frac{minutes_{[appliance]}}{60.0} \right) \right) + \left( \frac{wattage\_standby_{[appliance]}}{1000} \times 24 \right) \right)$$

Where:

[appliance] – may be TV; DVD/video; Computer; screen; printer; Video game console; battery recharger

minutes<sub>[appliance]</sub> – number of minutes used

wattage<sub>[appliance]</sub> – power consumption in watts

wattage\_standby<sub>[appliance]</sub> – power consumption in watts

PC\_electronics – Total Power consumption for electronics appliances in kWh

## **Assumptions**

It was assumed that the different models of the same type of appliances have similar values of power consumption for standby.

The standby power consumption is calculated for a period of 24 hours independently if the appliance was used during that period.

### **3.2.2 Cleaning**

At this sub-group you may find those appliances related with all type of cleaning activities (from clothes to house floor) that consume energy.

You are asked to tell about the types of appliances you use for cleaning (including power consumption used), time spent with the activities (in minutes) and standby usage (except for vacuum cleaner and iron). It was considered that these activities usually are in benefit of the entire household (e.g. the dishwasher, for each cycle, will probably wash dishes from other members of the household) and so the total consumption of energy is divided by household size.

The type of standby consumption considered - for washing machine; dishwasher and dryer- is related with the electrical consumption of these appliances when they are left turned on for long periods of time after they finish the washing cycle.

### **Consumption ranges**

For these appliances you should indicate whether they have low, medium or high power consumption (Watts). If you know the exact power consumption of your appliance you should insert the value after choosing the option 'real' from the power menu. Usually, old appliances consume more energy than the last generation of appliances - say last 5 years. So, this might be an indication of the appliances wattage.

Five common types of appliances are listed below, being also those with major energy consumption. For each of them is indicated what does low, medium and high consumed electrical power in watt hour, as well as the consumption in standby.

To choose the power range of your appliance, consider the following example and Table 18.

Dishwasher: Choosing LOW, means that your dishwasher consumes 950 Watt-hour or less; if you choose MEDIUM means that your dishwasher consumes between 951 and 2119 Watts-hour **BUT** the figure adopted in the calculator is 1500 Watt-hour. Choosing HIGH means that your dishwasher consumes 2200 Watt-hour or more. Finally you should indicate if you leave your washing machine, dishwasher or dryer on after finish the cycle (this is done by selecting the standby option).

Table 18 Wattages of cleaning appliances

Appliance	LOW	MEDIUM	HIGH	STANDBY	Sources
Vacuum Cleaner	≤700	1300	≥1900	-	Enel; whirlpool
Washing machine	≤850	1700	≥2700	3	Enel; whirlpool
Dishwasher	≤950	1500	≥2200	3	Enel; whirlpool; NAEEEEC (2003)
Iron	≤800	1500	≥2200	-	Enel; whirlpool
Dryer	≤1000	2500	≥4000	3	Enel; whirlpool

## Consumption calculation

### *Power consumption calculation variables*

The calculation of power consumption and associated emissions of carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) from the use of cleaning devices takes into account the wattage, the number of minutes that the appliances are used, if they are on standby when not in use and the household size.

$$PC_{\text{cleaning}} = \frac{\sum \left( \left( \left( \frac{\text{wattage}_{[\text{appliance}]}}{1000.0} \right) \times \left( \frac{\text{minutes}_{[\text{appliance}]}}{60.0} \right) \right) + \left( \frac{\text{wattage\_standby}_{[\text{appliance}]} \times 24}{1000} \right) \right)}{HH}$$

Where:

[appliance] – may be vacuum cleaner; washing machine; dishwasher; iron; dryer

minutes<sub>[appliance]</sub> – number of minutes used

wattage<sub>[appliance]</sub> – power consumption in watts

wattage\_standby<sub>[appliance]</sub> – power consumption in watts

HH –household size

PC\_cleaning – Total Power consumption for cleaning appliances in kWh

### **Assumptions**

It was assumed that appliances such as dryer and washing machine have the same energy consumption on standby as dishwasher machine.

It was assumed that the different models of the same type of appliances have similar values of power consumption for standby.

The standby power consumption is calculated for a period of 24 hours independently if the appliance was used during that period.

### **3.2.3 Cooking**

You are asked to tell about cooking habits, types of appliances you use for cooking (including type of fuel or power consumption used) and time spent cooking (in minutes). In the case of wood and charcoal you should mention the amount of fuel used (in kg) instead of the time spent cooking. The total consumption is divided by household size.

#### **Consumption ranges**

For electrical appliances you should indicate whether your appliance has low, medium or high power consumption (Watts). If you know the exact power consumption of your appliance you should insert the value after choosing the option 'real' from the power menu. Usually, old appliances consume more energy than the last generation of appliances - say last 10 years. So, this might be an indication of the appliances wattage.

Eight common appliances are listed below, being also those with major energy consumption. For each of them is indicated what does low, medium and high consumed electrical power in watt hour.

To choose the power range of your appliance, consider the following example and check Table 19.

Hood: choosing LOW, means that your hood consumes 120 Watt-hour or less; if you choose MEDIUM means that your hood consumes between 121 and 249 Watts-hour BUT the figure adopted in the calculator is 180 Watt-hour. Choosing HIGH means that your hood consumes 250 Watt-hour or more.

Table 19 Wattages of cooking appliances

Appliance	LOW	MEDIUM	HIGH	Sources
Hoods	≤120	180	≥250	Sakura Home Products Co.; Whirlpool Corporation
Microwave	≤700	1100	≥1500	Bosch; LG CORP.; Hoover; Enel
Toaster	≤500	1200	≥1800	DeLonghi; Enel
Coffee Machine	≤850	1100	≥1400	Bosch; Braun; Enel
Kettle	≤1000	2000	≥3000	Bosch; Braun
Fridge	≤700	900	≥1000	Indesit; Bosh; Hoover; Whirlpool; LG CORP.
Freezer	≤500	700	≥900	Indesit; Bosh; Hoover; Whirlpool; LG CORP.
Other appliances	≤20	300	≥800	Delonghi; Singer; Braun; Moulinex

The fridge refers to an ordinary model that may contain a small freezer compartment  
The appliances suggested in the icon other appliances are indicative (yogurt maker as low; handprocessor as medium and fryer as High power consumption). You may consider other appliances with the same power consumption or insert the power consumption of your appliance.

For other appliances not electrical you should choose the type of fuel. The consumption figures adopted for the calculations are listed in Table 20.

Table 20 Fuel consumption of cooking appliances

Appliance	Electricity	Natural Gas	Butane gas	Sources
Oven	2500 W-h	0.22 m3/h	0.28 l/h	Indesit; Hoover; Whirlpool
Hobs	2000 W-h	0.21 m3/h	0.25 l/h	Corporation; Westinghouse;
Grill	1500 W-h	0.21 m3/h	-----	Bosh; Engineeringtoolbox; Measurement Canada

Note: In case you choose wood or charcoal, you should insert the amount in kg in the same field of time usage.

### Consumption calculation

#### *Power consumption calculation variables*

The calculation of power consumption and associated emissions of carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) from cooking takes into account the wattage, the number of hours that the appliances are used and the house hold size.

$$PC_{\text{cooking}} = \frac{\sum \left( \left( \frac{\text{wattage}_{[\text{appliance}]}}{1000.0} \right) \times \left( \frac{\text{minutes}_{[\text{appliance}]}}{60.0} \right) \right)}{HH}$$

Where:

[appliance] – may be Microwave, Kettle, Coffee Machine, Toaster, Hoods or other appliance. The oven, hobs or grill are only taken in consideration if electric. In the case of the Fridge and Freezer it is consider a 24 hours period

minutes<sub>[appliance]</sub> – number of minutes used

wattage<sub>[appliance]</sub> – power consumption in watts

HH –household size

PC<sub>cooking</sub> – Total Power consumption for cooking in kWh

#### *Natural gas or Butane gas calculation variables*

The calculation of natural gas and associated emissions of carbon dioxide, methane and nitrous oxide (N<sub>2</sub>O) and of butane gas and associated emissions of carbon dioxide and methane from cooking takes into account the fuel consumption, the number of hours that the appliances are used and the house hold size.

$$FC_{\text{cooking}} = \frac{\sum \left( \text{fuel}_{[\text{appliance}]} \times \left( \frac{\text{minutes}_{[\text{appliance}]}}{60.0} \right) \right)}{HH}$$

Where:

[appliance] – may be oven, hobs or grill

minutes<sub>[appliance]</sub> – number of minutes used

fuel<sub>[appliance]</sub> – fuel consumption (natural gas in m<sup>3</sup>/hour; butane in l/hour)

FC<sub>cooking</sub> – Total fuel consumption of cooking (natural gas in m<sup>3</sup>; butane in l)

HH –household size

The total amount of fuel consumed is multiplied by the emission factor to have the amount of GHG's produced (see assumptions).

#### *Wood or charcoal calculation variables*

The calculation of wood and charcoal consumption and associated emissions of carbon dioxide, methane and nitrous oxide from cooking takes into account the fuel consumption the house hold size and type of appliance.

$$FC_{\text{cooking}} = \frac{\sum \text{amount}_{[\text{appliance}]}}{HH}$$

Where:

[appliance] – may be oven or grill

amount<sub>[appliance]</sub> – fuel consumption (kg of wood of charcoal)

FC<sub>cooking</sub> – Total fuel consumption of cooking

HH –household size

The total amount of fuel consumed is multiplied by the emission factor to have the amount of GHG's produced (see assumptions).

#### **Assumptions**

The values used for the hobs take in consideration identical use of medium and large burners, and so the value is an average of the power consumption of a medium and a large burner.

It was assumed the following emission factors:

Table 21 Emission factors for cooking appliances

Fuel	[kg CO <sub>2</sub> / TJ]	[kg CH <sub>4</sub> / TJ]	[kg N <sub>2</sub> O / TJ]
Charcoal	112000	30	4
Wood	112000	30	4
Natural Gas	56100	1	0.1

Source: IPCC, 2006

It was assumed the following net calorific values<sup>7</sup> (source: IPCC, 2006):

Charcoal	47.3	MJ/kg
Wood	15.6	MJ/kg
Natural Gas	48	MJ/m <sup>3</sup>

The emission factors of consumed fuel taking in consideration the emission factors used in IPCC (2006) and the net calorific value of the fuel can be consulted in Table 22.

Table 22 Emission factors of consumed fuel for cooking appliances

Fuel	[kg CO <sub>2</sub> / kg]	[kg CH <sub>4</sub> / kg]	[kg N <sub>2</sub> O / kg]
Charcoal	5.192	0.00139	0.000185
Wood	1.72	0.000459	0.0000612
	[kg CO <sub>2</sub> / m <sup>3</sup> ]	[kg CH <sub>4</sub> / m <sup>3</sup> ]	[kg N <sub>2</sub> O / m <sup>3</sup> ]
Natural Gas	2.639	0.000047	0.0000047
	[kg CO <sub>2</sub> / l]		
Butane*	1.51	---	---

All values based on IPCC (2006) with exception of butane emissions based on Mike Weatherley (2008)

<sup>7</sup> 1.0 kilowatt (kW) = 3412 Btu/hr (source: IEA, 2006)

1.0 megajoule(MJ) = 947.82 Btu (source: IEA, 2006)

Btu – the British thermal unit describe the heat value of the fuels and also the power of heating and cooling systems

1.0 TJ= 10<sup>6</sup> MJ = 10<sup>12</sup> Joule

### 3.2.4 DIY (do it yourself)

The DIY sub-group gathers commonly used appliances at home and/or office that may be related to small reparations, maintenance or, even leisure.

You should check the appliances that you use, indicating the appliance's power (Watts) and usage time (minutes).

The usage and electrical consumption are considered as individual, i.e. not divided by the household size.

#### Consumption ranges

In the case of the garden machine you should indicate whether your appliance has low, medium or high power consumption (Watts). In the case of small appliances, examples of different devices are given, to provide an indication of the power consumption. If you know the exact power consumption of your appliance you should insert the exact value after choosing the option 'real' from the power menu.

There are two icons available in this sub-group: garden machine and small appliances.

To choose the power range of your appliance, consider the following example and check Table 23.

Small appliances: choosing LOW, means that your small appliance consumes 250 Watt-hour or less (similar to a screwdriving); if you choose MEDIUM means that your small appliance consumes between 251 and 1499 Watts-hour BUT the figure adopted in the calculator is 1000 Watt-hour (similar to a chainsaw). Choosing HIGH means that your small appliance consumes 1500 Watt-hour or more (similar to a hot air gun).

Table 23 Wattages of DIY appliances

Appliance	LOW	MEDIUM	HIGH	Sources
Small appliances	≤250	1000	≥1500	Bosh
Garden Machine	≤250	800	≥1500	Bosh

## Consumption calculation

### *Power consumption calculation variables*

The calculation of power consumption and associated emissions of carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) from the use of electric device takes into account the wattage and the number of minutes that the appliances are used.

$$PC\_DIY = \sum \left( \frac{\text{wattage}_{[\text{appliance}]}}{1000.0} \times \frac{\text{minutes}_{[\text{appliance}]}}{60.0} \right)$$

Where:

[appliance] – may be garden machine; small appliance

minutes<sub>[appliance]</sub> – number of minutes used

wattage<sub>[appliance]</sub> – power consumption in watts

PC\_DIY – Total Power consumption for DIY appliances in kWh

## 3.3 Lights

In this group you may find the 4 types of light bulbs considered in mobGAS:



- Incandescent – the most common bulbs for domestic use.



- Low consumption – energy saving lightbulb or compact fluorescent bulbs recognizable by their colour and often spiral tube structure.



- Halogen - Halogen lamps are usually much smaller and with brighter light than standard incandescent.



- Fluorescent – typically used on offices and kitchens they have the form of a tube

You are asked to account for the light bulbs use during the day, indicating the number of minutes during which power is on and number of bulbs used at the same time.

Along the day you may add new entries of use. Often we use the same light bulbs for very short periods several times a day. You may consider the possibility to make an approximated calculation of the average total time of use of these bulbs, and insert this value only once, adding longer uses according to the day.

## Consumption ranges

Low consumption bulbs have usually a reference to the watts equivalence of an incandescent bulb. This comparison is made based on the luminance of the bulbs, i.e. a low consumption bulb (consuming 18 watts per hour) has the same luminance (quantity of lumens, which are a measure of light output from a bulb) of an incandescent bulb that consumes 75 watts per hour.

## Emissions calculation

The calculation of power consumption and associated emissions of carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) from lighting takes into account the number of bulbs kept on, as well as their wattage and also the number of hours that they are kept on.

$$PC\_light = \sum \left( \frac{wattage_{[bulb]}}{1000.0} \times \frac{minutes_{[bulb]}}{60.0} \times number_{[bulb]} \right)$$

Where:

[bulb] – can be incandescent, low consumption, halogen or fluorescent

number<sub>[bulb]</sub> – number of bulbs selected

minutes<sub>[bulb]</sub> – number of minutes used

wattage<sub>[bulb]</sub> – power consumption in watts

PC\_light – total Power consumption of lighting in kWh

## 3.4 Climate



The type of devices considered here, refer to appliances or systems that you may usually find in your house. The appliances group is divided into three sub-groups related with your comfort as far as house climate is concerned.

- heating
- cooling
- moisture

### 3.4.1 Heating

You are asked to tell about heating choices, types of systems you use for heating (including type of fuel or power consumption used). You are either asked about the usage time or this is inferred from different information that you are asked. Hence, usually when you use small heating appliances, you are asked directly about the time you have them on. Otherwise, especially with central heating, you are asked about the thermostat temperature and so time is calculated indirectly as a function of temperature maintenance. The total consumption is in any case divided by household size.

#### *3.4.1.1 Central Heating*

If you have central heating, you should indicate the type of fuel used by the central heating system (natural gas, LPG or diesel), temperatures set in the thermostat and the average daily temperature outside the house, as well as the efficiency of the boiler.

#### **Emissions calculation**

The calculation of fuel consumption and associated emissions of carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and Nitrous oxide (N<sub>2</sub>O) from heating with a central heating system takes into account the type and amount of fuel used, the temperature difference, the

house area, the use of double gaze windows, as well as the household size. The calculations are based on the concept of Heat loss, U values for the several house surfaces and fuel energy content.

*Calculation of Heat loss (in Watts):*

$$\begin{aligned} \text{HeatLoss} = & \sqrt{\text{Harea}} \times \text{Hheight} \times 4 \times \text{UextWall} \times (\text{Tconf} - \text{Twinter}) + \\ & + (0.2 \times \text{GLAZED}) \times \sqrt{\text{Harea}} \times \text{Hheight} \times 4 \times \text{UWindow} \times (\text{Tconf} - \text{Twinter}) + \\ & + \text{Harea} \times \text{Uceiling} \times (\text{Tconf} - \text{Twinter}) + \text{Harea} \times \text{Ufloor} \times (\text{Tconf} - \text{Twinter}) \end{aligned}$$

Where:

Harea – House area in m<sup>2</sup>

Hheight – House height in m

Uceiling – U value for the ceiling in W/(m<sup>2</sup> °C)

UextWall – U value for external wall of a house in W/(m<sup>2</sup> °C)

Ufloor – U value for the floor in W/(m<sup>2</sup> °C)

UWindow – U value for windows in W/(m<sup>2</sup> °C)

Tconf – Comfort temperature set by a thermostat in °C

Twinter – Average winter temperature or average day temperature in °C

GLAZED – whether the user has double glazed windows; this will influence insulation and therefore heat loss

HeatLoss – lost of heat due to house conditions, in W

*Calculation of fuel consumption*

These are calculations for **1 day**.

$$\text{FuelConsHeating} = \frac{\frac{\text{seconds\_per\_day} \times \text{HeatLoss}}{\text{FuelEnergyContent}}}{\text{HH}}$$

Where:

seconds\_per\_day – number of seconds in a day

HeatLoss – as calculated by the equation above in Joule per second

FuelEnergyContent – for the 3 fuels considered here, in J/mass unit (see assumptions)

HH – Household

N.B. 1 Watt = 1 Joule / second.

### *Calculation of Emissions*

$$\text{GHG\_Emission} = \text{FuelConsCHeating} \times \text{GHG\_ConvFactor}$$

Where:

GHG\_Emission – greenhouse gas (CO<sub>2</sub>, CH<sub>4</sub> or N<sub>2</sub>O) produced by heating in kg

FuelConsCHeating – Fuel consumption in central heating as calculated above, in mass unit per day

GHG\_ConvFactor – greenhouse gas conversion factor for each of the greenhouse gases (see assumptions).

#### ***3.4.1.2 Electric Powered***

##### **Consumption ranges**

For electrical appliances you should indicate whether your appliance has low, medium or high power consumption (Watts). Usually, old appliances consume more energy than the last generation of appliances - say last 10 years. So, this might be an indication of the appliances wattage.

Six common heating appliances are listed below. For each of them it is indicated what does low, medium and high consumption of electrical power in watt hour is.

To choose the power range of your appliance, consider the following example, checking Table 24.

Oil/water radiator: choosing LOW, means that your hood consumes 1000 Watt-hour or less; if you choose MEDIUM means that your oil/water radiator consumes between 1000 and 2500 Watt-hour BUT the figure adopted in the calculator is 1750 Watt-hour. Choosing HIGH means that your oil/water radiator consumes 2500 Watt-hour or more.

Table 24 Wattages of Electric Powered heating appliances

Appliance	LOW	MEDIUM	HIGH	Sources
Oil/water radiator	≤1000	1750	≥2500	DeLonghi
Electric panel	≤500	1000	≥1500	Termozeta SpA
convection	≤750	1400	≥2000	DeLonghi
Heating fan	≤900	1500	≥2000	DeLonghi, Termozeta SpA
Radiant wall fires	≤1500	2000	≥3000	Termozeta SpA
Towel rail	≤600	900	≥1200	Pyramid UK Trading Ltd., DeLonghi

If your electrical heating appliance is not listed, you may consider choosing one whose power range fits with the existing ones.

### Emissions calculation

#### *Power consumption*

The calculation of power consumption and associated emissions of carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) from heating with electric powered heating appliances takes into account the power of the appliance, the time during which it is used, as well as the household size.

$$PC_{\text{heating}} = \frac{\sum \left( \frac{\text{wattage}_{[\text{appliance}]}}{1000.0} \times \frac{\text{minutes}_{[\text{appliance}]}}{60.0} \right)}{HH}$$

Where:

[appliance] – can be oil/water radiator, electrical pane, convection, heating fan tower rail or radiant wallfires

minutes<sub>[appliance]</sub> – number of minutes used

wattage<sub>[appliance]</sub> – power consumption in watts

PC\_heating – Total Power consumption for electronics appliances in kWh

HH –household size

### Greenhouse gas emissions

$$\text{GHG\_emission} = \text{PC\_heating} \times \text{GHG\_Factor}$$

Where:

PC\_heating – as calculated above, i.e. this is the power consumption

GHG\_Factor –greenhouse gases emission factors, in this case dependent on primary energy mix – see ‘Greenhouse Gases Calculation’ chapter

GHG\_emission – GHG produced from electric powered heating appliances in kg of greenhouse gas

#### 3.4.1.3 “Fireplaces”

##### Consumption ranges

For systems that use direct burning of wood, wood derivatives or gaseous fuels, you should simply indicate the type of ‘fireplace’ that you use at home. Six different heating systems are listed on Table 25. For each of them you have to introduce the time used or the quantity of fuel used – see column mass/usage time.

Table 25 Heating systems

Fire ‘places’	Fuel	mass/usage time	Sources
Open fireplace	Wood	kg	Mike Weatherley (2008)
Wood stove	Wood	kg	Construction Resources (2008)
Pellet stove	Pellet	kg	BFIN (2008) Jannasch <i>et al.</i>
Butane gas heater	Butane	minutes	
Natural gas stove	Natural gas	minutes	
LPG stove	LPG	minutes	

If your fireplace heating system is not listed, you may consider choosing one whose characteristics are similar to the ones listed.

## Emissions calculation

### *Natural gas or Butane gas calculation variables*

The calculation of power consumption and associated emissions of carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) from heating with fire 'places' takes into account the amount of fuel used or both the type of fuel and the time it takes to burn, as well as the household size.

Table 26 summarises the consumption figures.

Table 26 Consumption factors for Fire 'places'

Fire 'places'	Fuel	Consumption factor	Sources
Butane gas heater	Butane	0.362 l/h	Resurgence, (2008) Beer, <i>et al.</i> (2008) Orkney Renewable Energy Forum (2008)
Natural gas stove	Natural gas	602.5 l/h	Jøtul (2008) The Chimney Sweep (2008)
LPG stove	LPG	0.822 l/h	IPCC (2006)

The equations below are the basis of calculation of consumption of the 3 gaseous fuels by the 'fireplaces' listed above:

$$\text{BUT\_fireplace} = \frac{\text{fireplace}_{[\text{Butane}]} \times \frac{\text{minutes}_{[\text{fireplace}]}}{60.0}}{\text{HH}}$$

$$\text{NAT\_fireplace} = \frac{\text{fireplace}_{[\text{Natural gas}]} \times \frac{\text{minutes}_{[\text{fireplace}]}}{60.0}}{\text{HH}}$$

$$\text{LPG\_fireplace} = \frac{\text{fireplace}_{[\text{LPG}]} \times \frac{\text{minutes}_{[\text{fireplace}]}}{60.0}}{\text{HH}}$$

Where:

fireplace<sub>[fuel]</sub> – consumption factor; fuel can be Butane, natural gas or LPG in l/h

HH –household size

minutes<sub>[fireplace]</sub> – number of minutes used

BUT<sub>fireplace</sub> – Consumption of butane gas heater in l

NAT\_fireplace – Consumption of natural gas stove in l

LPG\_fireplace – Consumption of LPG stove in l

The calculations below are the basis for calculation of greenhouse gases based on time (usage time of the appliance):

$$\text{GHG\_emissions} = \text{Fuel\_fireplace} \times \text{GHG\_ConvFactorFuel\_TIME}$$

Where:

Fuel\_Fireplace – Consumption of BUT\_; NAT\_ or LPG\_fireplace in l

GHG\_ConvFactorFuel\_TIME – GHG emissions conversion factor for each fuel per unit of time – listed in Assumptions section in litres of GHG per hour

GHG\_emissions – GHG produced from heating fire ‘places’ in kg of greenhouse gas

#### *Wood or Pellet calculation variables*

The calculation of wood and pellet consumption, as well as associated emissions of carbon dioxide, methane and nitrous oxide from heating, takes into account the fuel consumption, the household size and type of system.

$$\text{FC\_timber\_fireplace} = \frac{\text{consumption}_{[\text{timber\_fireplace}]}}{\text{HH}}$$

Where:

[timber\_fireplace] – may be wood fuelled open fireplace; wood fireplace insert or stove and pellet stove

consumption<sub>[timber\_fireplace]</sub> – fuel consumption (kg of wood or pellets)

FC\_timber\_fireplace – Total fuel consumption of wood derivatives fireplaces in kg

HH –household size

The following calculations are the basis for calculation of greenhouse gases based on mass of fuel consumed:

$$\text{GHG\_emissions} = \text{FC\_timber\_fireplace} \times \text{GHGConvFactorFuel\_Mass}$$

Where:

FC\_timber\_fireplace – Total fuel consumption of wood derivatives fireplaces in kg

GHG\_ConvFactorFuel\_Mass – GHG emissions conversion factor for each fuel per unit of mass – see assumptions.

### Assumptions

Regarding calculation of heat loss of a house, the following assumptions were made:

- Squared Detached House (4 external walls)
- Thermostat placed on a 'Top floor'
- 20% windows; IF DOUBLE GLAZED, Loss is minus 2% from windows
- House Height is 2.75 m
- NO HEAT LOSS FROM VENTILATION IS CONSIDERED WHICH CAN BE VERY SUBSTANTIAL!!

**U** values averages [ $W/(m^2 \text{ } ^\circ\text{C})$ ] are from British Standards.

Sources: Plumbingpages.com (2008); BSI British Standards (2008)

- External wall = 0.92
- Ceiling=0.34
- Floor=1.36
- Windows=5

N.B. A default boiler efficiency in case of central heating was set to 85%, but the user can change the efficiency.

The following net calorific values<sup>8</sup> were assumed (source: IPCC, 2006):

Wood	15.6	MJ/kg
Natural Gas	48	MJ/m <sup>3</sup>
butane	20	MJ/m <sup>3</sup>
LPG	28.7	MJ/l
Diesel	37.8	MJ/l

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<sup>8</sup> 1.0 kilowatt (kW) = 3412 Btu/hr (source: IEA, 2006)

1.0 megajoule (MJ) = 947.82 Btu (source: IEA, 2006)

Btu – the British thermal unit describe the heat value of the fuels and also the power of heating and cooling systems

The Emission Factors used for central heating in the calculations above are in Table 27. Emissions from the burning of fossil fuels may be calculated based on the duration of combustion or on amount of fuel consumed.

Table 27 Emission factors 'fireplaces'

Fuel	CO <sub>2</sub> [kg]		CH <sub>4</sub> [kg]		N <sub>2</sub> O [kg]	
	per time (h)	per mass (kg)*	per time (h)	per mass (kg)*	per time (h)	per mass (kg)*
Wood in open fire	N/A	1.72	N/A	0.000459	N/A	0.0000369
Wood in stoves	N/A	1.035	N/A	0.000459	N/A	0.0000612
Pellet	N/A	0.158	-	-	-	-
Natural gas	1.59	2.639 (per m <sup>3</sup> )	0.000283	0.000047 (per m <sup>3</sup> )	0.00225	0.0000047 (per m <sup>3</sup> )
LPG	1.262	1.536 (per l)	-	0.00054 (per l)	-	-
Butane	0.544	-	-	-	-	-
Diesel	-	2.685 (per l)	-	0.000068 (per l)	-	0.00014 (per l)

\* The unit of mass is kg except when stated differently (m<sup>3</sup> or l in case of Diesel, and Natural Gas; for LPG in l)

Sources: CO<sub>2</sub> conversion factors are those of IPCC, 2006 except Diesel: from USA DOE, specifically for heating oil (diesel).

### 3.4.2 Cooling

Three types of systems for cooling the house temperatures are considered here. They are all electrical systems, but their operation may be based on time or thermostat. Hence, you may be directly asked about the time you have the appliance on, or the temperature set in your thermostat, and in any case about the wattage of the appliances. The total consumption is divided by household size.

#### Consumption ranges

For each appliance you should indicate whether it has low, medium or high power consumption (watts). Usually, old appliances consume more energy than the last

generation of appliances - say last 10 years. So, this might be an indication of the appliances wattage.

The cooling appliances are listed below. For each of them it is indicated what does low, medium and high consumption of electrical power in watt-hour is.

To choose the power range of your appliance, consider the following example and check table 28.

Ceiling ventilation: choosing LOW, means that your ceiling ventilator consumes 75 watt-hour or less; if you choose MEDIUM means that your ceiling ventilator consumes between 75 and 100 watt-hour BUT the figure adopted in the calculator is 90 watt-hour. Choosing HIGH means that your ceiling ventilator consumes 100 watt-hour or more.

Table 28 Wattages of cooling appliances

Appliance	LOW	MEDIUM	HIGH	Sources
Ceiling ventilation	≤75	90	≥100	Progress Energy
Fan (desk or vertical)	≤60	150	≥250	Termozeta SpA
Air conditioning	≤1900	3000	≥5000	Toshiba DeLonghi, Mitsubishi Electric Europe BV

### Emissions calculation

The calculation of power consumption and associated emissions of carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) from cooling your house with electric powered appliances takes into account (in the case of ceiling ventilation and fans) the power of the appliance, the time during which it is used, as well as the household size, but it is calculated in two different ways for air conditioning. If the latter is based on time of operation the same rules apply as for the other types of appliances. However, if the usage is based on setting of a thermostat, then the calculations are based on 'heat loss', i.e. on the insulation of the house and temperature 'loss'.

#### *Time based usage*

Power consumption of ceiling ventilation, fan (desk or vertical) and air conditioning (when based on usage time):

$$PC\_cooling_{[appliance]} = \frac{\frac{wattage_{[appliance]} \times minutes_{[appliance]}}{1000.0} \times \frac{minutes_{[appliance]}}{60.0}}{HH}$$

Where:

[appliance] - type of appliance (ceiling ventilation, fan or air conditioning)

minutes<sub>[appliance]</sub> – number of minutes used

wattage<sub>[appliance]</sub> – power consumption in watts

PC\_cooling<sub>[appliance]</sub> – Power consumption of appliance, in kWh

HH –household size

### *Thermostat based usage*

Power consumption for air conditioning appliances whose usage is based on a thermostat setting. It takes into account the wattage of the appliance, the temperature difference (thermostat set and average summer temperature), the house area, double glaze windows, as well as the household size. The calculations are based on the concept of Heat loss and U values for the several house surfaces.

### *Calculation of Heat loss (in Watts):*

$$\begin{aligned} \text{HeatLoss} = & \sqrt{Harea} \times Hheight \times 4 \times UextWall \times |(Tconf - Tsummer)| + \\ & + (0.2 \times GLAZED) \times \sqrt{Harea} \times Hheight \times 4 \times UWindow \times |(Tconf - Tsummer)| + \\ & + Harea \times Uceiling \times |(Tconf - Tsummer)| + Harea \times Ufloor \times |(Tconf - Tsummer)| \end{aligned}$$

Where:

Harea – House area in m<sup>2</sup>

Hheight – House height in m

UextWall – U value for external wall of a house in W/(m<sup>2</sup> °C).

UWindow – U value for windows in W/(m<sup>2</sup> °C).

Uceiling – U value for the ceiling in W/(m<sup>2</sup> °C).

Ufloor – U value for the floor in W/(m<sup>2</sup> °C).

Tconf – Comfort temperature set by a thermostat in °C

Tsummer – Average summer temperature or average day temperature in °C

GLAZED – whether the user has double glazed windows; this will influence insulation and therefore heat loss

HeatLoss - lost of heat due to house conditions, in W

*Calculation of power consumption*

These are calculations for **1 day**.

$$\text{PowerConsAirCond} = \frac{\text{HeatLoss}}{\text{HH}}$$

Where:

HeatLoss – as calculated by the equation above in Joule per second

HH – Household size

PowerConsAirCond – Power consumption of the air conditioned appliance in Watt

N.B. 1 Watt = 1 Joule / second.

*Greenhouse gas emissions*

$$\text{GHG\_Emission} = \text{PowerConsumptionCooling} \times \text{GHGConvFactor}$$

Where:

GHG\_Emission – greenhouse gas (CO<sub>2</sub> or CH<sub>4</sub>) produced by cooling in kg

PowerConsumptionCooling – Power consumption in cooling as calculated above in Watt

GHGConvFactor – greenhouse gas conversion factor for each of the greenhouse gases, dependent on primary energy mix – see ‘Greenhouse Gases calculation’ chapter.

## Assumptions

Regarding calculation of heat loss of a house, the following assumptions were made:

- Squared Detached House (4 external walls)
- Thermostat placed on a 'Top floor'
- 20% windows; IF DOUBLE GLAZED, Loss is minus 2% from windows
- House Height is 2.75 m
- NO HEAT LOSS FROM VENTILATION IS CONSIDERED WHICH CAN BE VERY SUBSTANTIAL!!

U values averages [ $W/(m^2 \text{ } ^\circ\text{C})$ ] are from British Standards.

Sources: Plumbingpages.com (2008), BSC British Standards (2008)

- External wall = 0.92
- Ceiling=0.34
- Floor=1.36
- Windows=5

### 3.4.3 Moisture

Two types of electrical appliances that regulate house moisture are available: humidifier and dehumidifier. You are asked about the time you have them on and about the wattage. The total consumption is divided by household size.

#### Consumption ranges

For each appliance you should indicate whether it has low, medium or high power consumption (Watts). Usually, old appliances consume more energy than the last generation of appliances - say last 10 years. So, this might be an indication of the appliances wattage. For dehumidifiers, wattages are higher if the apparatus is combined with a heating function.

The moisture appliances are listed below. For each of them it is indicated what does low, medium and high consumption of electrical power in Watt-hour is.

To choose the power range of your appliance, consider the following example and check Table 29:

Humidifier: choosing LOW, means that your humidifier consumes 100 Watt-hour or less; if you choose MEDIUM means that your humidifier consumes between 100 and 500 Watts-hour BUT the figure adopted in the calculator is 300 Watt-hour. Choosing HIGH means that your humidifier consumes 500 Watt-hour or more.

Table 29 Wattages of moisture adjustment appliances

Appliance	LOW	MEDIUM	HIGH	Sources
humidifier	≤100	300	≥500	Termozeta SpA AirControl Systems
dehumidifier	≤350	500	≥1500	DIO (dry it out)

### Emissions calculation

The calculation of power consumption and associated emissions of carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) from controlling the moisture of your house with electric powered appliances takes into account the power of the appliance, the time during which it is used, as well as the household size.

$$PC\_moisture_{[appliance]} = \frac{\text{wattage}_{[appliance]} \times \text{minutes}_{[appliance]}}{1000.0 \times 60.0} \times HH$$

Where:

[appliance] – type of appliance (dehumidifier, humidifier)

minutes<sub>[appliance]</sub> – number of minutes used

wattage<sub>[appliance]</sub> – power consumption in watts

PC\_moisture<sub>[appliance]</sub> – Total power consumption for moisture appliance in kWh

HH –household size

### 3.5 Hygiene



The type of activities considered in this group are related to aspects of body caring; in this group mobGAS addresses the issue of water heating and electricity consumption. The group is divided into four sub-groups:

- Shower
- Bath
- Hair drying
- Usage of small appliances (linked to body caring)

Through shower and bath, mobGAS considers only emission from heating water.

#### 3.5.1 Water heating for shower or bath

If you choose 'shower', you are asked about the type of boiler and fuel, as well as usage time. If you choose 'bath' you are just asked about type of boiler to heat water and fuel. Six types of boilers are considered here, as you can see in Table 30.

Table 30 Types of boilers

Type	Fuel
GAS boiler (only sanitary water)	LPG
	Butane
	Natural Gas
GAS boiler (sanitary water + central heating)	LPG
	Natural Gas
Electrical	

#### Emissions calculation

The calculation of energy consumption to heat water is based on the following concepts: boilers' heat loss, heat needed to increase of 1 degree Celsius the temperature of a certain amount of water and energy content of fuels. The quantity of water used in a 'shower' is inferred from the time spent in the shower (assuming that a

normal faucet delivers 5 l water per minute). The quantity of water assumed to be used in a bath is 70l.

*Calculation of Heat need*

$$\text{HEATNEED} = \text{WaterQuant} \times 4200 \times (\text{TempHotW} - \text{TempCoIW})$$

Where:

4200 – conversion from kcalorie to Joule

TempCoIW - 12 °C

TempHotW - 50 °C

TIME – shower usage (minutes)

WaterQuant – assumed to be for a shower 5 l/min x TIME and for a bath 70 l.

HEATNEED – necessary heat to warm the water needed (in J)

*Calculation of Fuel needed*

*Tankless boiler*

$$\text{FuelNeed}_{[\text{fuel}]} = \frac{\text{HEATNEED}}{\text{EneContentXl}_{[\text{fuel}]}} \times 1.15$$

Where:

1.15 – assumption that all boilers are 85% efficient, therefore you have to add 15% on fuel needed

[fuel] = three types of fuel considered: Butane, Natural Gas and LPG

EneContentXl<sub>[fuel]</sub> – energy content per l of fuel (in J/l): see Table 31.

HEATNEED – necessary heat to warm the water needed (in J)

FuelNeed<sub>[fuel]</sub> – quantity of fuel needed to warm the water needed (in l)

Table 31 Energy content of fuel for water heating

Fuel	Energy content [MJ/l]
Natural Gas	0.034
LPG	27.7
Butane	28.7
Diesel	35.5

Source: IPCC, 2006

### *From Central Heating*

If water is warmed through a central heating system, heat loss from the tank should be considered. Heat loss is assumed to be the same for all types of fuel and it is divided by the household size.

$$\text{Heatloss}_{[\text{fuel}]} = \frac{1.5\% \text{ loss}}{\text{HH}}$$

Where:

1.5% loss – heat loss of a tank, which was assumed to be 1.5kW (for 24h); heatloss depends on capacity of the tank (Dimplex Limited (2008))

[fuel] = LPG, natural gas, diesel.

HH – Household size

Heatloss<sub>[fuel]</sub> – heat loss from the tank (in J)

Hence, fuel need is calculated as follows:

$$\text{FuelNeed}_{[\text{fuel}]} = (\text{HEATNEED} + \text{Heatloss}_{[\text{fuel}]}) \times \text{EneContentXl}_{[\text{fuel}]} \times 1.15$$

Where:

1.15 – assumption that all boilers are 85% efficient, therefore you have to add 15% on fuel needed

[fuel] = three types of fuel considered: Butane, Natural Gas and LPG

EneContentXl<sub>[fuel]</sub> – energy content per l of fuel (in J/l) – see table above

Heatloss<sub>[fuel]</sub> – heat loss from the tank (in J)

HEATNEED – necessary heat to warm the water needed (in J)

FuelNeed<sub>[fuel]</sub> – quantity of fuel needed to warm the water needed (in l)

### *Electric boiler*

If water is boiled through an electric boiler, the tank's heat loss in 24 h should be considered. The following is adopted in view of specialised literature:

$$\text{Heatloss}_{[\text{power}]} = 1.5 \text{ (kW)} = 0.0625 \text{ kWh} = 225000\text{J}$$

Source: Dimplex Limited (2008)

Hence, power needed is calculated as follows:

$$\text{PowerNeed} = \frac{\text{HEATNEED} + \text{HEATLoss}_{[\text{power}]}}{\text{HH}}$$

Where:

Heatloss<sub>[power]</sub> – heat loss from the boiler’s tank (in J)

HEATNEED – necessary heat to warm the water needed (in J)

HH – household size

PowerNeed – Power needed to warm up water used (in kW)

#### *Greenhouse gas emissions calculation*

The calculation of power consumption and associated emissions of carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) from water heating is calculated as follows:

#### *Gas boilers:*

$$\text{GHG}_{[\text{fuel}]} = \text{FuelNeed}_{[\text{fuel}]} \times \text{GHG\_Factor}$$

#### *Electrical boilers:*

$$\text{GHG}_{[\text{power}]} = \text{PowerNeed} \times \text{GHG\_Factor}$$

Where:

FuelNeed<sub>[fuel]</sub> – fuel needed to warm up a quantity of water from a certain temperature to another.

PowerNeed – Power needed to warm up water used (in kW)

GHG\_Factor – Greenhouse gas emission factor as in Table 32

Table 32 GHG emission factors for water heating

Fuel	CO <sub>2</sub> [kg/l]	CH <sub>4</sub> [kg/l]	N <sub>2</sub> O [kg/l]
Natural gas	0.002639	0.000047	-
Butane	1.51	-	-
LPG	1.536	-	-
Diesel	2.685	0.000068	0.00014

Source: IPCC, 2006

The greenhouse emission factors being determined by the energy mix to produce electricity in your country.

### **Assumptions**

For electric boilers, heat loss depends on capacity of the tank; for instance in Vaillant models, it varies between 1.4 kW (125 l tank) in 24 h to 2.4 kW (310 l tank). Source: Dimplex Limited (2008). We adopt an intermediate value.

Assumption: 85% efficiency for all gas boilers.

It was assumed that a normal faucet delivers 5 l water per minute and that the water needed for taking a bath is 70l.

It was also assumed an initial water temperature of 12 °C and a water temperature at boiler of 50 °C.

## **3.5.2 Hair drying and use of small appliances**

### **Consumption ranges**

In the case of the hairdryer you should indicate whether your appliance has low, medium or high power consumption (Watts). In the case of small appliances, examples of different devices are given, to provide an indication of the power consumption. If you know the exact power consumption of your appliance you should insert the exact value after choosing the option 'real' from the power menu.

To choose the power range of your appliance, consider the following example, checking Table 33.

Small appliances: choosing LOW, means that your small appliance consumes 3 Watt-hour or less (similar to a toothbrush); if you choose MEDIUM means that your small appliance consumes between 4 and 99 Watts-hour BUT the figure adopted in the calculator is 15 Watt-hour (similar to an epilator/shaver). Choosing HIGH means that your small appliance consumes 100 Watt-hour or more (similar to a hairstyler).

Table 33 Wattages of Hygiene appliances

Appliance	LOW	MEDIUM	HIGH	Sources
Small appliances	≤3	15	≥100	Enel
Hair dryer	≤500	1250	≥2000	

### Consumption calculation

#### *Power consumption calculation variables*

The calculation of power consumption and associated emissions of carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) from the use of electrical device takes into account the wattage and the number of minutes that the appliances are used.

$$PC\_Hygiene = \sum \left( \frac{\text{wattage}_{[appliance]}}{1000.0} \times \frac{\text{minutes}_{[appliance]}}{60.0} \right)$$

Where:

[appliance] – may be Hair drier or small appliance

minutes<sub>[appliance]</sub> – number of minutes used

wattage<sub>[appliance]</sub> – power consumption in watts

PC\_hygiene – Total Power consumption for Hygiene electrical appliances in kWh

### 3.6 Food and Waste



In this group you are asked about the diet you have and how you manage the waste you produce. It is divided in two sub-groups:

- Food habits
- Waste

#### 3.6.1 Food Habits

In this menu you are asked to indicate your food habits and food consumptions in terms of meat (pork, poultry, lamb and cow), dairy (i.e. cheese, milk, and butter), eggs, rice and vegetables. Your choices and consumptions will imply different emission of different greenhouse gases.

The consumption of meat, dairy and eggs leads to the emission of methane ( $\text{CH}_4$ ) from enteric fermentation in livestock and of both methane and nitrous oxide ( $\text{N}_2\text{O}$ ) from manure management. Cattle are an important source of  $\text{CH}_4$  because of their large population and high  $\text{CH}_4$  emission rate due to their ruminant digestive system (IPCC, 2006).

With the consumption of rice is associated the emission of  $\text{CH}_4$ . The continuous flooding of the rice fields cut cuts off the soil's oxygen supply, normally leading to anaerobic fermentation of organic matter and consequently to the formation of  $\text{CH}_4$  (IPCC, 2006). If fertilizers are used in the field, then  $\text{N}_2\text{O}$  emissions are also released.

Regarding the consumption of vegetables, if they have an organic origin then they do not lead to the production of  $\text{N}_2\text{O}$  once it wasn't applied nitrogen fertilizers.

Figure 20 shows the relation between the consumption of the different types of food and its emissions.

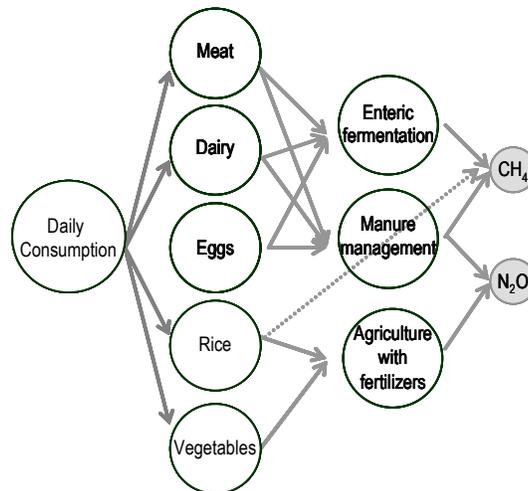


Figure 20 Relation between consumption of different types of food and its emissions

N.B. The emissions from energy consumed for transportation of the goods, their storage and display or processing at the source are not considered.

### Emissions calculation

The estimation of CH<sub>4</sub> and N<sub>2</sub>O emissions from food habits were done based on the following equations:

$$\text{CH}_4 \text{ Emissions} = \sum (\text{Daily Consumption}_{[\text{category}]} \times \text{CH}_4 \text{ Emission Factor}_{[\text{category}]})$$

$$\text{N}_2\text{O Emissions} = \sum (\text{Daily Consumption}_{[\text{category}]} \times \text{N}_2\text{O Emission Factor}_{[\text{category}]})$$

Where *category* represents the different types/categories of food (pork, poultry, lamb, cow, dairy, eggs, rice and vegetables).

The calculation of the CH<sub>4</sub> and N<sub>2</sub>O emission factors for the different types of food were based on '2006 IPCC Guidelines for National Greenhouse Gas Inventories – Volume 4' and on 'Emission Inventory Guidebook'. Table 34 shows the different emission factors for each kg of type of food consumed (except if indicated differently).

Table 34 Emission Factors for each livestock

Livestock	CH <sub>4</sub>	N <sub>2</sub> O
	[kg CH <sub>4</sub> /kg of livestock/year]	[kg N <sub>2</sub> O/kg of livestock/year]
Pork	0.200	0.00067
Poultry	0.020	0.00067
Lamb	0.184	0.00271
Cow	0.360	0.00382
Dairy (per litre)	0.027	0.00021
Eggs (per unit)	0.003	0.00003
Rice *	0.059	0.00009
Vegetables *	-	0.00049

\* If it is produced through organic practices (i.e. no fertilizers are used) the emission factor is zero.

*Pork, Poultry, Lamb, Cow, Dairy and Eggs:*

$$\text{CH}_4\text{Emission\_Factor}_{[\text{category}]} = \frac{\text{EF1}_{[\text{category}]} + \text{EF2}_{[\text{category}]}}{\text{N}_{[\text{category}]}}$$

Where:

[category] - species/category of livestock (i.e. pork, poultry, lamb, cow and dairy)

EF1<sub>[category]</sub> - CH<sub>4</sub> emission factor from Enteric Fermentation in kg CH<sub>4</sub> per head per year

EF2<sub>[category]</sub> - CH<sub>4</sub> emission factor from Manure Management in kg CH<sub>4</sub> per head per year

N<sub>[category]</sub> - average meat production of one carcass of the defined livestock (except if indicated otherwise), in kg, l or amount of eggs, depending on the situation

CH<sub>4</sub> Emission Factor<sub>[category]</sub> - CH<sub>4</sub> Emission Factor for each specie/category of livestock in kg CH<sub>4</sub> per kg of livestock per year

$$\text{N}_2\text{O Emission Factor}_{[\text{category}]} = \frac{\text{N}_{\text{rate}[\text{category}]} \times \frac{\text{TAM}_{[\text{category}]}}{1000} \times 365 \times (\text{MS}_{[\text{category},\text{system}]} \times \text{EF}_{[\text{category},\text{system}]}) \times \frac{44}{28}}{\text{N}_{[\text{category}]}}$$

Where:

[category] – species/category of livestock (i.e. pork, poultry, lamb, cow and dairy)

[system] – manure management system (i.e. lagoon, solid storage, pit, daily spread, poultry with litter, liquid/slurry and pasture/paddock)

EF<sub>[category, system]</sub> – emission factor for direct N<sub>2</sub>O emissions in kg N<sub>2</sub>O-N/kg N

MS<sub>[category, system]</sub> – fraction of total nitrogen excretion

N<sub>[category]</sub> – average meat production of one carcass of the defined livestock (except if indicated otherwise), in kg, l or amount of eggs, depending on the situation

N<sub>rate [category]</sub> – default excretion rate in kg N per 1000kg of animal mass per day

TAM<sub>[category]</sub> – typical animal mass in kg<sup>-1</sup>

44/28 – conversion of (N<sub>2</sub>O-N) emissions to N<sub>2</sub>O emissions

N<sub>2</sub>O Emission Factor<sub>[category]</sub> – N<sub>2</sub>O Emission Factor for each specie/category of livestock in kg NO<sub>2</sub> per kg of livestock

*Rice and Vegetables:*

$$\text{CH}_4 \text{ Emission Factor}_{[\text{type}]} = \frac{\text{EF}_{[\text{type}]}}{\text{Fp}_{[\text{type}]}}$$

Where:

[type] – species/type of production (i.e. rice or vegetables)

EF<sub>[type]</sub> – CH<sub>4</sub> emission factor for flooded rice fields in kg CH<sub>4</sub>

Fp<sub>[type]</sub> – average production of the field per year, in one hectare, in kg

CH<sub>4</sub> Emission Factor<sub>[type]</sub> – CH<sub>4</sub> Emission Factor for each species/type of production in kg CH<sub>4</sub> per kg<sub>[type]</sub> per year in one hectare

$$\text{N}_2\text{O Emission Factor}_{[\text{type}]} = \frac{\text{Fsn}_{[\text{type}]} \times \text{EF}_{[\text{type}]} \times \frac{44}{28}}{\text{Fp}_{[\text{type}]}}$$

Where:

[type] - species/type of production (i.e. rice or vegetables)

EF<sub>[type]</sub> - N<sub>2</sub>O emission factor for flooded rice fields in kg N<sub>2</sub>O-N per kg N

Fp<sub>[type]</sub> - average production of the field per year, in one hectare, in kg

Fsn<sub>[type]</sub> - annual amount of synthetic fertilizer N applied to soil in kg N in one hectare

44/28 - conversion of (N<sub>2</sub>O-N) emissions to N<sub>2</sub>O emissions

$N_2O$  Emission Factor <sub>[type]</sub> -  $N_2O$  Emission Factor for each species/type of production in kg  $NO_2$  per kg <sub>[type]</sub> per year

N.B. If it is produced through organic practices (i.e. no fertilizers are used) the  $N_2O$  emission factor is zero.

### Assumptions

In order to calculate the different Emission Factors, several assumptions, which are listed below, were made. These assumptions were based on the best practice recommendations of the '2006 IPCC Guidelines for National Greenhouse Gas Inventories – Volume 4' and on the 'Emission Inventory Guidebook'.

*Pork, Poultry, Lamb, Cow, Dairy and Eggs:*

Table 35 shows the values assumed in the calculation of  $CH_4$  Emission Factor for the variables EF1, EF2 and N.

Table 35 Parameters for the calculation of  $CH_4$  Emission Factor for each livestock

Species/categories of livestock	EF1 [kg $CH_4$ .head <sup>-1</sup> .year <sup>-1</sup> ]	EF2 [kg $CH_4$ .head <sup>-1</sup> .year <sup>-1</sup> ]	N
Pork	1.5	12.5	70 kg
Poultry	0	0.05	2.5 kg
Lamb	8	0.28	45 kg
Cow	57	15	200 kg
Dairy	109	52	6000 l <sup>[1]</sup>
Poultry Broiler (Eggs)	0	0.7	220 eggs <sup>[2]</sup>

Source: Values based on IPCC, 2006

[1] - average milk production per year of one Dairy cow

[2] - average amount of eggs laid per year per one broiler

The values assumed in the calculation of  $N_2O$  Emission Factor for the variables  $N_{rate}$ , TAM and N are shown in Table 36.

Table 36 Parameters for the calculation of N<sub>2</sub>O Emission Factor for each livestock

Species/categories of livestock	N <sub>rate</sub> [kg N.(1000kg of animal mass) <sup>-1</sup> .day <sup>-1</sup> ]	TAM [kg <sup>-1</sup> ]	N
Pork	0.51	75	70 kg
Poultry	0.83	3.5	2.5 kg
Lamb	0.85	50	45 kg
Cow	0.33	420	200 kg
Dairy	0.48	600	6000 l <sup>[1]</sup>
Poultry Broiler (Eggs)	0.83	1.5	220 eggs <sup>[2]</sup>

Source: Values based on IPCC, 2006.

[1] - average milk production per year of one Dairy cow

[2] - average amount of eggs laid per year per one broiler

Table 37 shows the manure management systems considered in the calculation of N<sub>2</sub>O Emission Factor and values assumed for the variables EF and MS.

Table 37 Parameters to calculate N<sub>2</sub>O Emission Factor for manure management systems

Manure management systems	EF	MS					
		Pork	Poultry	Lamb	Cow	Dairy	Poultry Broiler (Eggs)
Lagoon	0	8.7%					
Solid storage	0.005	13.7%		100%	39%	36.8%	
Pit	0.002	72.6%					
Daily spread	0	2%			1.8%	7%	
Poultry with litter	0.001		100%				100%
Liquid/Slurry	0.005				25.2%	35.7%	
Pasture/Paddock	0.002				32%	20%	

Source: IPCC, 2006.

*Rice and Vegetables:*

The values assumed in the calculation of CH<sub>4</sub> Emission Factor for the variables EF and Fp are shown in Table 38.

Table 38 Parameters for the calculation of CH<sub>4</sub> Emission Factor for rice and vegetables

Specie/type of production	EF [kg CH <sub>4</sub> ]	Fp [kg ha <sup>-1</sup> yr <sup>-1</sup> ]
Rice	360	6100
Vegetables	0	8000

Source: IPCC, 2006; EEA, 2006.

In Table 39 you can consult the values assumed in the calculation of the N<sub>2</sub>O Emission Factor for the variables Fsn, EF and Fp.

Table 39 Parameters for the calculation of N<sub>2</sub>O Emission Factor for rice and vegetables

Species/categories of livestock	Fsn	EF	Fp
	[kg N <sub>2</sub> O-N (kg N) <sup>-1</sup> ]	[kg N <sub>2</sub> O-N (kg N) <sup>-1</sup> ]	[kg ha <sup>-1</sup> yr <sup>-1</sup> ]
Rice	113	0.003	6100
Vegetables	200	0.0125	8000

Source: IPCC, 2006; EEA, 2006.

### 3.6.2 Waste

In this menu, you are asked to indicate your daily production of waste and also to specify what type of recycle you do.

When you indicate the amount of waste you produce daily, be aware that this amount should reflect the waste you produce individually and not the waste produced by your entire household. Therefore, if you are taking into account the entire amount of waste produced at your home, you should divide it by the household size. Also, if you do not have an idea of your waste daily production, you might have one for the week.

You are also asked here what types of recycling programs are in your region (i.e. what material you recycle). For instance, if there are conditions to collect different types of waste, that in principle indicates that there might be recycling facilities in your country or in your region. According to EEA (2005) the packaging recycling rate in EU (EU-15) as increased from 45% in 1997 to 54% in 2002.

If waste production cannot be prevented, its materials should be recovered, preferably by recycling. Figure 21 presents the relation between the waste produced and the emission of Greenhouse Gases (GHGs).

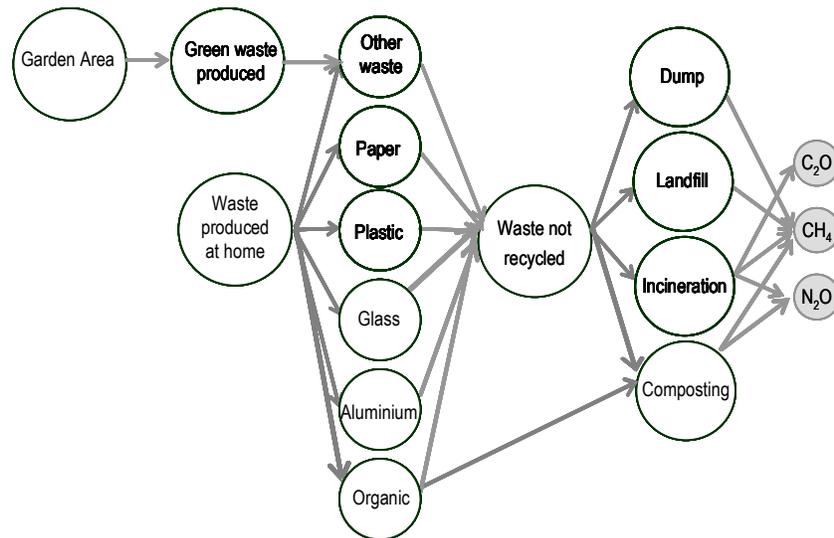


Figure 21 Relation between the waste produced and the emission of GHG

### Organic Waste, Paper, Plastic, Aluminium and Glass

Although there might be other materials on recycling programs where you live, the ones considered here are listed below and are the most relevant as far as when emission of greenhouse gases are concerned:

- Organic waste
- Paper
- Plastic
- Aluminium
- Glass

When you indicate that you recycle one of these materials/types of waste, a fraction of your total amount of waste produced is removed, hence this fraction does not account for the production of greenhouse gases.

Have also in mind that the type of greenhouse gases produced is also dependent on the final destination given to these different types / materials of waste. For more

information about the available waste treatments, please visit the 'waste treatment' section on the '2.8 My world' section.

**Organic Waste (Green Waste):** The waste produced may have an organic fraction, i.e. contain rests of food or other animal or vegetal origin materials. Usually, organic waste represents the major fraction of the waste produced daily. If this type of waste is separated from the others fractions at home it can be used for composting.

The decomposition of organic material leads to the production of CH<sub>4</sub>.

**Paper:** Making new paper from old uses only 10% of the water and 50% of the energy used in making paper from trees, and it reduces related air pollution by a large percentage (hence, CO<sub>2</sub> is also reduced).

The disposal of paper in land-fill increases the production of CH<sub>4</sub>.

**Plastic:** The production and disposal of plastics has a big impact on the environment. The production requires significant quantities of resources, primarily fossil fuels, both as a raw material and as energy for the manufacturing process. Also, the majority of plastic is not biodegradable (meaning that it will never break down completely), although some plastics can be recycled, by producing more plastic. In the EU, in 1996 only 20% of plastic waste was subjected to material recovery or energy recovery, while 80% was disposed of (EEA-ETC/W, 1999).

The incineration of waste containing fossil carbon, e.g. plastics, is the most important source of CO<sub>2</sub> emissions in the waste sector. When disposed in a landfill, plastics occupy large volumes.

**Aluminium:** Aluminium can be recycled indefinitely making it the most cost-effective material to recycle. Recycling aluminium cuts related air pollution in a very large percentage. Producing aluminium from recycled aluminium requires 95 percent less energy than producing it from basic raw material and therefore contributes to reduce the emission of CO<sub>2</sub>.

**Glass:** Glass is 100% recyclable and can also be recycled indefinitely. In Europe (EU), in 1996 13.3 million of tonnes of glass were generated. From those, around 55% were

recycled (EEA-ETC/W, 1999). The making of new glass containers from recycled ones saves energy and therefore contributes to reduce the emission of CO<sub>2</sub>. When disposed of in a landfill or dump, glass containers occupy large volumes.

### Emissions calculation

The estimation of GHGs emissions from the amount of waste produced and recycled is directly connected with the waste final destination (waste treatment).

For the complete waste emissions model visit the 'waste treatment' section on the '2.8 My world' section. Here, we will only indicate how to calculate the amount of waste sent to treatment (Waste Not Recycled).

$$\text{Waste Not Recycled} = \text{Waste} - \sum (\text{Waste} \times \text{FW}_{[\text{material}]} \times \text{FR}_{[\text{material}]})$$

Where:

[material] - different types/materials of waste (i.e. organic waste, paper, plastics, aluminium and glass)

FR<sub>[material]</sub> - fraction of component recycled

FW<sub>[material]</sub> - amount of component in the waste

Waste - total amount of waste produced in kg

Waste Not Recycled – amount of non-recycled waste in kg

### Assumptions

The following assumptions indicated in this section were done taking in consideration the '2006 IPCC Guidelines for National Greenhouse Gas Inventories – Volume 5'.

The values assumed in the calculations of the different components of waste and fractions recycled are shown in Table 40.

Table 40 Parameters for the calculation of waste not recycled

Type/material of waste	FW	FR
Organic Waste	31%	98%
Paper/Cardboard	29%	47%
Plastics	8%	8%
Aluminium	5%	16%
Glass	11%	52%

Source: IPCC, 2006

N.B. When you indicate that you recycle one of these materials/types of waste, a fraction of your total amount of waste produced is removed, hence this fraction does not account for the production of greenhouse gases.

### **Further reading**

*Paper:*

<http://www.wasteonline.org.uk/resources/InformationSheets/paper.htm>

*Plastic:*

<http://www.wasteonline.org.uk/resources/InformationSheets/Plastics.htm>

*Aluminium:*

<http://www.wasteonline.org.uk/resources/InformationSheets/metals.htm>

*Glass:*

<http://www.wasteonline.org.uk/resources/InformationSheets/Glass.htm>

### 3.7 Outdoor leisure



With outdoor leisure we have considered 3 activities, although many activities not listed in this section (which imply the consumption of energy) can be taken from the transport section. The 3 activities considered here, are:

- Alpine ski (it refers to the ski lifts)
- Water ski (it refers to the motorboat usage)
- Water motorbike

Other activities that you may consider as outdoor leisure and imply heavy energy consumption are the following:

- Motorboat usage
- Motorbike races
- Car races and kart races
- Camper trips
- Snowmobile trips

These can be found in the menu Transport. Please refer to this group, when you carry out these activities.

Table 41 provides an overview of the type of parameters necessary to carry out the calculation of energy consumption and greenhouse gas emissions arising from the three activities listed above.

Table 41 Outdoor leisure parameters

Activity	Time [hours]	Distance [km]	Average Consumption of energy
Water ski	x	-	x
Water motorbike	-	x	x
Alpine ski	x	-	-

For each activity you should indicate the time spent on it or the distance made, as well as the average fuel consumption.

The reference energy consumption for the activities considered here are the following, in Table 42, which can be used as guidance for you.

Table 42 Default energy consumption for outdoor leisure

Transportation means	Type of fuel	Reference values
Water ski	petrol	30 l/h
Water motorbike	petrol	10 km/l (10 l/km)
Alpine ski	Electric power	250 watthour/person – <i>N.B. this cannot be changed</i>

Sources: several motorboat and motorbike makers available in the market (see ‘appliances producer’s websites’ section on ‘References’ chapter). For Alpine ski we used data gently supplied by LEITNER, a major company that supplies ski lifts.

### Emissions calculation

The calculation of fuel/power consumption and associated emissions of carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) from carrying out these activities is calculated as follows.

#### *Calculation based on fuel consumption and distance*

$$\text{Fuel}_{[\text{activity}]} = \frac{\text{DIST}}{\frac{\text{Conspt}_{[\text{activity}]}}{\text{PP}}}$$

Where:

[activity] – the type of activity, in this case water motorbike

Conspt<sub>[activity]</sub> – average consumption (in km/l)

DIST – distance (in km)

PP – number of passengers

Fuel<sub>[activity]</sub> – fuel consumption for the journey (in l)

#### *Calculation based on fuel consumption and usage time*

$$\text{Fuel}_{[\text{activity}]} = \frac{\text{Time}_{[\text{activity}]}}{60} \times \text{Conspt}_{[\text{activity}]}$$

$$\text{Power}_{[\text{activity}]} = \frac{\text{Time}_{[\text{activity}]}}{60} \times \text{PowerConspt}_{[\text{activity}]}$$

Where:

[activity] - the type of activity, in this case water skiing and alpine skiing

Conspt<sub>[activity]</sub> – average consumption (in l/hour)

PowerConspt<sub>[activity]</sub> – average consumption of power (in watthour)

Time<sub>[activity]</sub> – time spent in activity (in minutes)

Fuel<sub>[activity]</sub> – fuel consumption for the activity (in l)

Power<sub>[activity]</sub> – power consumption for the activity (in watthour)

### Greenhouse gas emissions

The following values, in Table 43, are adopted as greenhouse gases emission factors for the vehicles used in the activities considered in this group – please note that those for power consumption are associated to the energy mix that is used to generate electric power and therefore should be consulted in the chapter of ‘Greenhouse Gases calculation’.

Table 43 GHG emission factors for outdoor leisure

	CO <sub>2</sub> [kg/l]	CH <sub>4</sub> [kg/l]	N <sub>2</sub> O [kg/l]
petrol	2.385	0.000625	0.000045

Source: EEA 2002, IPCC 2006

The general equation to calculate greenhouse gases is the following:

$$\text{GHG\_emission} = \text{Fuel}_{[\text{activity}]} \times \text{GHG\_Factor}$$

Where:

Fuel<sub>[activity]</sub> - fuel consumption for the journey (fuel unit)

GHG\_Factor – fuel emission factors for each of the 3 greenhouse gases (kg/l)

GHG\_emission – emissions of one of the 3 greenhouse gases considered: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) (in kg)

The calculation of greenhouse gases arising from Alpine ski, is dependent on the energy mix for power production in your country, but can generally be formulated as:

$$\text{GHG\_emission} = \text{Power}_{[\text{activity}]} \times \text{GHG\_Factor}$$

Where:

GHG\_Factor – fuel emission factors for each of the 3 greenhouse gases (kg/kwatt)

Power<sub>[activity]</sub> - power consumption for the activity (in watthour)

GHG\_emission - emission of one of the 2 greenhouse gases considered: carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) (in kg)

### 3.8 Others



In this group you may find appliances and/or activities very specific that did not match with the definition of the other groups establish at mobGAS, but due to their daily use are relevant for the calculation of the emissions of Greenhouse Gases.

In this group you may find the 2 types of appliances and activities considered in mobGAS:

- automatic garage door
- elevator

You are asked to indicate how many times you use your electrical automatic garage door and how many travels you do per day by elevator, taking in consideration how many people travel with you.

Along the day you may add new entries of use. Often we use several times a day the elevator. You may consider the possibility to make an approximated calculation of the average total use of the elevator and insert this value only once.

The usage and electrical consumption are individual (not divided by the household size), except in the case of the elevator which is divided by the number of passengers.

#### **Consumption ranges**

It was considered that an average automatic garage door consumes 17 Watts per hour per each use (Shenzhen Goalway Tech Co., Ltd. (2008), Yourgreendream (2008) and ABS Alaskan (2008)) and that an elevator has an average consumption of 30 Watts per travel (Kone, 2008).

## Consumption calculation

### *Power consumption calculation variables*

The calculation of power consumption and associated emissions of carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) from the use of electric device takes into account the wattage and the number of minutes that the appliances are used.

$$PC\_other = \frac{\sum \frac{wattage_{[appliance]}}{1000.0} \times usage_{[appliance]}}{passengers_{[elevator]}}$$

Where:

[appliance] – may be automatic garage door, elevator

passengers<sub>[elevator]</sub> – number of people using elevator

usage<sub>[appliance]</sub> – number of times used

wattage<sub>[appliance]</sub> – power consumption in watts per hour

PC<sub>other</sub> – Total Power consumption for other appliances in kWh

**Note:** the variable passengers<sub>[elevator]</sub> is only used if the appliance chosen is elevator.

## Assumptions

The power consumption of an automatic garage door may range from 120 to 750 watts/hour. In mobGAS it was considered an average consumption of 400 watts/hour. It was also assumed that each door opening (including closing) takes 2 minutes and 30 seconds, which is equivalent to a consumption of 17 watts/hour per use.

The industry provides information about the average total consumption for an average number of travels per year (typically 100.000 and 200.000 travels per year). Five different models were considered with different engine systems (2 for 6 people and 3 for 8 people) (Kone, 2008). In mobGAS it was considered an average of 100.000 travels per year with an energy consumption for these models ranging from 1500 to 4200 kwatt/hour, but for mobGAS it was adopt an average figure of 2920 kwatt/hour, which represents approximately 30 watts per travel.

According to Nipkow & Schalcher (2006) up to 58% of the energy consumption of the elevators is due to the standby-mode.

The value adopted of 30 watts already includes the energy consumption on standby.



## 4 Greenhouse Gases calculation

In this section it will be described the main sources of emissions, emission factors, assumptions and references. This includes also the numerical model in *pseudo code* (i.e. an outline of the computer program, written in a shorthand language giving an abstract view of the steps that have to be implemented when writing the actual program's code).

### 4.1 Emissions from electricity generation

In mobGAS, the mix of fuels to produce electricity will determine the calculation of emissions of two greenhouse gases: carbon dioxide and methane. You are asked to choose the relevant fuels for production of electricity in your country (or in the region if you think it is substantially different from those of the country), as well as their percentage in the mix. mobGAS has **default values for the 27 countries of the European Union based on the literature**. To consult or change this values, you should access from the main menu of mobGAS application 'my world > country options > power production'. If you don't have further information about these figures, do not alter the figures in the fields. The figures are percentages, hence the total fuel mix must sum to 100%.

Possible sources of electricity are divided into those that because of their manipulation do produce greenhouse gases and those that do not. Only emissions from the phase of production of electricity are considered. Transport of materials or other phases of operation are not considered.

To know more about electricity sources see section '2.8.2.2. Power production'.

## CO<sub>2</sub> emissions from electricity generation

CO<sub>2</sub> emissions derived from electricity consumption were calculated taking in consideration conversion factors from the literature and the shares on power production.

$$\text{CO}_2\text{emissions}_{\text{power}} = \sum (\text{TOTAL\_PC} \times \%_{[\text{fuel}]} \times \text{CO}_2\text{conv\_factor}_{[\text{fuel}]})$$

Where:

[fuel] – can be oil, coal or natural gas

CO<sub>2</sub>conv\_factor<sub>[fuel]</sub> – conversion factor for the fuel

TOTAL\_PC = total power consumption in kWh

%<sub>[fuel]</sub> – share of electricity generation due to oil, coal or natural gas

CO<sub>2</sub>emissions<sub>power</sub> – emissions of CO<sub>2</sub> due to the production of electricity (kg)

### Assumptions

It is assumed the following conversion factors in kg of CO<sub>2</sub> per kWh of electricity produced (based on IPCC guidelines 2006)

$$\text{CO}_2\text{conv\_factor}_{\text{oil}} = 0.259$$

$$\text{CO}_2\text{conv\_factor}_{\text{coal}} = 0.334$$

$$\text{CO}_2\text{conv\_factor}_{\text{natural\_gas}} = 0.198$$

#### 4.1.1 CH<sub>4</sub> emissions from electricity generation

CH<sub>4</sub> emissions derived from electricity consumption were calculated taking in consideration conversion factors from the literature and the shares on power production.

$$\text{CH}_4\text{emissions}_{\text{power}} = \sum (\text{TOTAL\_PC} \times \%_{\text{coal}} \times \text{CH}_4\text{conv\_factor}_{\text{coal}})$$

Where:

CH<sub>4</sub>conv\_factor<sub>coal</sub> – conversion factor for coal

TOTAL\_PC - total power consumption in kWh

$\%_{\text{coal}}$  – share of electricity generation due coal

$\text{CH}_4_{\text{emissions\_power}}$  – emissions of  $\text{CH}_4$  due to the production of electricity in kg

### Assumptions

It is assumed the following conversion factors in kg of  $\text{CH}_4$  per kwh of electricity produced (due to coal mining operations) (based on IPCC guidelines 2006).

$\text{CH}_4_{\text{conv\_factor}_{\text{coal}}} = 0.00186$

### Further reading

HYDRO:

DOE - <http://hydropower.inl.gov/>

EPA - <http://yosemite.epa.gov/oar/globalwarming.nsf/content/ImpactsWaterResourcesHydropower.html>

NREL- [http://www.nrel.gov/learning/re\\_hydropower.html](http://www.nrel.gov/learning/re_hydropower.html).

N.B. All links are US links.

SOLAR:

NREL- [http://www.nrel.gov/learning/re\\_photovoltaics.html](http://www.nrel.gov/learning/re_photovoltaics.html)

WIND:

EWEA - <http://www.ewea.org/>

EERE - <http://www.eere.energy.gov/RE/wind.html>

NUCLEAR:

NEA - <http://www.nea.fr/>

NEI - <http://www.nei.org/>

DOE - <http://www.ne.doe.gov/>

LBL - <http://www.lbl.gov/abc/>

France - <http://www.ecolo.org/>

Greenpeace - <http://www.greenpeace.org/international/campaigns/nuclear>

International Atomic Energy Agency - <http://www.iaea.org/>

EPA - <http://es.epa.gov/oeca/sector/#fossil>

TRANS-CANADA - <http://www.transcanada.com/>

A book reference for this issue is: *Standard Handbook of Power Plant Engineering* by Elliot, Thomas C. Published by McGrawHill, Inc. New York, 1989.

On mobGAS it was considered the following shares of production of energy for the year 2004 (Eurostat, 2006) – Table 44.

Table 44 Shares of production of energy

Power generation	Hydric	Coal	Nuclear	Oil	Wind	Natural Gas	Solar
<b>EU 25 *</b>	11	32	31	4	2	20	0
<b>Belgium</b>	2	13	55	2	0	28	0
<b>Bulgaria</b>	8	46	40	2	0	4	0
<b>Czech Republic</b>	5	50	27	2	4	12	0
<b>Denmark</b>	2	13	55	2	0	28	0
<b>Germany</b>	11	28	32	5	2	21	0
<b>Estonia</b>	3	60	31	0	0	6	0
<b>Ireland</b>	0	93	0	0	0	7	0
<b>Greece</b>	0	55	0	4	16	25	0
<b>Spain</b>	13	29	23	9	6	20	0
<b>France</b>	12	5	78	1	0	4	0
<b>Italy</b>	17	17	0	20	1	45	0
<b>Cyprus</b>	9	60	0	14	2	15	0
<b>Latvia</b>	66	1	0	1	1	31	0
<b>Lithuania</b>	5	0	79	2	0	14	0
<b>Luxembourg</b>	21	2	0	0	1	76	0
<b>Hungary</b>	1	27	35	2	0	35	0
<b>Malta</b>	0	0	0	100	0	0	0
<b>Netherlands</b>	0	28	4	3	2	63	0
<b>Austria</b>	61	16	0	3	1	19	0
<b>Poland</b>	2	93	0	2	0	3	0
<b>Portugal</b>	22	37	0	13	2	26	0
<b>Romania</b>	29	38	10	4	0	19	0
<b>Slovenia</b>	27	35	36	0	0	2	0
<b>Slovakia</b>	14	19	56	2	0	9	0
<b>Finland</b>	40	6	51	1	1	1	0
<b>Sweden</b>	40	6	51	1	1	1	0
<b>United Kingdom</b>	2	36	20	1	1	40	0

Note: the values extracted from Eurostat were in *GWh* (Gigawatt hour) of Gross electricity generation. On mobGAS the share of coal aggregates the shares on electricity generation from coal, lignite and biomass fired power stations. The share on natural gas aggregates the share on electricity generation from natural gas and derived gas fired power stations.

\* EU 25 average not including Bulgaria and Romania



#### 4.2.1 Total CO<sub>2</sub> emissions

$$\begin{aligned} \text{CO}_2\text{EMISSIONS} &= \text{CO}_2\text{emissions\_power} + \text{CO}_2\text{emissions\_butane\_gas} + \\ &\text{CO}_2\text{emissions\_natural\_gas} + \text{CO}_2\text{emissions\_wood} + \text{CO}_2\text{emissions\_wood\_stove} + \\ &\text{CO}_2\text{emissions\_charcoal} + \text{CO}_2\text{emissions\_pellet} + \text{CO}_2\text{emissions\_biodiesel} + \\ &\text{CO}_2\text{emissions\_petrol} + \text{CO}_2\text{emissions\_petrol\_motorcycle} + \text{CO}_2\text{emissions\_LPG} + \\ &\text{CO}_2\text{emissions\_LPG\_boiler} + \text{CO}_2\text{emissions\_kerosene} + \text{CO}_2\text{emissions\_waste} \end{aligned}$$

Where:

CO<sub>2</sub>\_emissions\_biodiesel - emissions of CO<sub>2</sub> due to the burning of biodiesel on public transports

CO<sub>2</sub>\_emissions\_butane\_gas - emissions of CO<sub>2</sub> due to the burning of butane gas (e.g. cooking, heating)

CO<sub>2</sub>\_emissions\_charcoal - emissions of CO<sub>2</sub> due to the burning of charcoal for barbecue

CO<sub>2</sub>\_emissions\_kerosene - emissions of CO<sub>2</sub> due to the burning of kerosene for airplane travels

CO<sub>2</sub>\_emissions\_LPG - emissions of CO<sub>2</sub> due to the burning of LPG on transports

CO<sub>2</sub>\_emissions\_LPG\_boiler - emissions of CO<sub>2</sub> due to the burning of LPG in boilers

CO<sub>2</sub>\_emissions\_natural\_gas - emissions of CO<sub>2</sub> due to the burning of natural gas (e.g. cooking, heating)

CO<sub>2</sub>\_emissions\_pellet - emissions of CO<sub>2</sub> due to the burning of pellet for heating

CO<sub>2</sub>\_emissions\_petrol - emissions of CO<sub>2</sub> due to the burning of petrol (e.g. transports, outdoor activities)

CO<sub>2</sub>\_emissions\_petrol\_motorcycle - emissions of CO<sub>2</sub> due to the burning of petrol on motorcycles with mix fuel (< EURO 1)

CO<sub>2</sub>\_emissions\_power – emissions of CO<sub>2</sub> due to the production of electricity

CO<sub>2</sub>\_emissions\_waste - emissions of CO<sub>2</sub> due to waste incineration

CO<sub>2</sub>\_emissions\_wood - emissions of CO<sub>2</sub> due to the burning of wood (e.g. cooking, fireplace)

CO<sub>2</sub>\_emissions\_wood\_stove - emissions of CO<sub>2</sub> due to the burning of wood on stoves

CO<sub>2</sub>\_EMISSIONS – total emissions of CO<sub>2</sub>

To have an overview of how the emissions from CO<sub>2</sub> were calculated, please consult the ‘emissions from electricity generation’ section on this chapter and ‘groups description’ chapter.



here, such as disposal and treatment of organic waste, rice cultivation, raising of cattle and poultry, etc.

CH<sub>4</sub> is the second most important greenhouse gas. Its main sources in EU are agriculture (48%) followed by waste treatment and disposal and also leakage from natural gas distribution networks (European Commission, 1999). According to the EEA (2005), EU methane emissions fell by 25% between 1990 and 2003. Fugitive emissions of CH<sub>4</sub> decreased due mainly to the decline of coal mining, followed by the waste sector, due mainly to reducing the amount of biodegradable waste in landfills and installing landfill gas recovery.

#### 4.3.1 Total CH<sub>4</sub> emissions

$$\begin{aligned} \text{CH}_4\text{\_EMISSIONS} &= \text{CH}_4\text{\_emissions\_power} + \text{CH}_4\text{\_emissions\_natural\_gas} + \\ &\text{CH}_4\text{\_emissions\_wood} + \text{CH}_4\text{\_emissions\_wood\_stove} + \text{CH}_4\text{\_emissions\_charcoal} + \\ &\text{CH}_4\text{\_emissions\_biodiesel} + \text{CH}_4\text{\_emissions\_petrol} + \text{CH}_4\text{\_emissions\_petrol\_motorcycle} + \\ &\text{CH}_4\text{\_emissions\_LPG} + \text{CH}_4\text{\_emissions\_LPG\_boiler} + \text{CH}_4\text{\_emissions\_kerosene} + \\ &\text{CH}_4\text{\_emissions\_meat} + \text{CH}_4\text{\_emissions\_rice} + \text{CH}_4\text{\_emissions\_dairy} + \text{CH}_4\text{\_emissions\_eggs} + \\ &\text{CH}_4\text{\_emissions\_waste} \end{aligned}$$

Where:

CH<sub>4</sub>\_emissions\_biodiesel - emissions of CH<sub>4</sub> due to the burning of biodiesel on public transports

CH<sub>4</sub>\_emissions\_charcoal - emissions of CH<sub>4</sub> due to the burning of charcoal for barbecue

CH<sub>4</sub>\_emissions\_dairy - emissions of CH<sub>4</sub> due to breeding of cows

CH<sub>4</sub>\_emissions\_eggs - emissions of CH<sub>4</sub> due to breeding of poultry

CH<sub>4</sub>\_emissions\_kerosene - emissions of CH<sub>4</sub> due to the burning of kerosene for airplane travels

CH<sub>4</sub>\_emissions\_LPG - emissions of CH<sub>4</sub> due to the burning of LPG on transports

CH<sub>4</sub>\_emissions\_LPG\_boiler - emissions of CH<sub>4</sub> due to the burning of LPG in boilers

CH<sub>4</sub>\_emissions\_meat - emissions of CH<sub>4</sub> due to breeding of animals (pork, poultry, cow and lamb)

CH<sub>4</sub>\_emissions\_natural\_gas - emissions of CH<sub>4</sub> due to the burning of natural gas (e.g. cooking, heating)

CH<sub>4</sub>\_emissions\_petrol - emissions of CH<sub>4</sub> due to the burning of petrol (e.g. transports, outdoor activities)

CH<sub>4</sub>\_emissions\_petrol\_motorcycle - emissions of CH<sub>4</sub> due to the burning of petrol on motorcycles with mix fuel (< EURO 1)

CH<sub>4</sub>\_emissions\_power – emissions of CH<sub>4</sub> due to the production of electricity

CH<sub>4</sub>\_emissions\_rice - emissions of CH<sub>4</sub> due to production of rice (enteric fermentation)

CH<sub>4</sub>\_emissions\_waste - emissions of CH<sub>4</sub> due to waste management (dump, landfill, incineration and composting)

CH<sub>4</sub>\_emissions\_wood - emissions of CH<sub>4</sub> due to the burning of wood (e.g. cooking, fireplace)

CH<sub>4</sub>\_emissions\_wood\_stove - emissions of CH<sub>4</sub> due to the burning of wood on stoves

CH<sub>4</sub>\_EMISSIONS – total emissions of CH<sub>4</sub>

To have an overview of how the emissions from CH<sub>4</sub> were calculated, please consult the ‘emissions from electricity generation’ section on this chapter and ‘groups description’ chapter.

#### **4.3.2 Facts about CH<sub>4</sub>**

1. Wetland or ‘paddy’ rice farming produces roughly 1/5 or 1/4 of global methane emissions from human activities. This emission is due to bacteria and other micro-organisms in the soil of the flooded rice paddy that decompose organic matter producing methane (UNEP/IUC, 1997).
2. Livestock account for about 1/4 of the CH<sub>4</sub> emissions from human activities.
- 3 There is a great deal of UNCERTAINTY on the emission estimates of CH<sub>4</sub> because the emissions from agricultural and waste management sources are not well quantified.
4. The greenhouse effect of CH<sub>4</sub> is estimated to be 72 times that of carbon dioxide over a 20-year period and 21 times over a 100-year period (IPCC, 2007).
5. Methane is estimated to be the cause of 14% of the global greenhouse effect (IPCC 2007) methane from landfills has been estimated to make up 28% of total methane emissions from EU in 1995 (EEA-ETC/W, 1999).
6. Methane emissions from the waste management sector fell by 38 % between 1990 and 2005 (EEA, 2007).

## 4.4 N<sub>2</sub>O calculations

The nitrous oxide (N<sub>2</sub>O) model consists of an account of the yearly nitrous oxide emissions derived from personal consumption of vegetables produced with fertilisers, raising of cattle, burn of fossil fuels and waste management (incineration and composting).



Indeed, fertiliser use increases nitrous oxide emissions, because the nitrogen

contained on nitrogenous fertilisers enhances the processes of nitrification and denitrification performed by microorganisms in the soil - those processes lead to the emission of nitrous oxide.

There is, however, a great deal of uncertainty in the measurement of how much quantity of N<sub>2</sub>O is emitted per unit of fertiliser applied. This is because dependent upon the soil conditions and also local climate, as well as on the type and quantity of fertiliser applied.

### 4.4.1 Total N<sub>2</sub>O emissions

$$\begin{aligned} \text{N}_2\text{O\_EMISSIONS} &= \text{N}_2\text{O\_emissions\_natural\_gas} + \text{N}_2\text{O\_emissions\_wood} + \\ &\text{N}_2\text{O\_emissions\_wood\_stove} + \text{N}_2\text{O\_emissions\_charcoal} + \text{N}_2\text{O\_emissions\_biodiesel} + \\ &\text{N}_2\text{O\_emissions\_petrol} + \text{N}_2\text{O\_emissions\_petrol\_motorcycle} + \text{N}_2\text{O\_emissions\_kerosene} + \\ &\text{N}_2\text{O\_emissions\_meat} + \text{N}_2\text{O\_emissions\_rice} + \text{N}_2\text{O\_emissions\_dairy} + \text{N}_2\text{O\_emissions\_eggs} + \\ &\text{N}_2\text{O\_emissions\_vagetables} + \text{N}_2\text{O\_emissions\_waste} \end{aligned}$$

Where:

N<sub>2</sub>O\_emissions\_biodiesel - emissions of N<sub>2</sub>O due to the burning of biodiesel on public transports

N<sub>2</sub>O\_emissions\_charcoal - emissions of N<sub>2</sub>O due to the burning of charcoal for barbecue

N<sub>2</sub>O\_emissions\_dairy - emissions of N<sub>2</sub>O due to breeding of cows

N<sub>2</sub>O\_emissions\_eggs - emissions of N<sub>2</sub>O due to breeding of poultry

N<sub>2</sub>O\_emissions\_kerosene - emissions of N<sub>2</sub>O due to the burning of kerosene for airplane travels

N<sub>2</sub>O\_emissions\_meat - emissions of N<sub>2</sub>O due to breeding of animals (pork, poultry, cow and lamb)

N<sub>2</sub>O\_emissions\_natural\_gas - emissions of N<sub>2</sub>O due to the burning of natural gas (e.g. cooking, heating)

N<sub>2</sub>O\_emissions\_petrol - emissions of N<sub>2</sub>O due to the burning of petrol (e.g. transports, outdoor activities)

N<sub>2</sub>O\_emissions\_petrol\_motorcycle - emissions of N<sub>2</sub>O due to the burning of petrol on motorcycles with mix fuel (< EURO 1)

N<sub>2</sub>O\_emissions\_rice - emissions of N<sub>2</sub>O due to production of rice

N<sub>2</sub>O\_emissions\_vegetables - emissions of N<sub>2</sub>O due to fertilizers used on agriculture

N<sub>2</sub>O\_emissions\_waste - emissions of N<sub>2</sub>O due to waste management (incineration and composting)

N<sub>2</sub>O\_emissions\_wood - emissions of N<sub>2</sub>O due to the burning of wood (e.g. cooking, fireplace)

N<sub>2</sub>O\_emissions\_wood\_stove - emissions of N<sub>2</sub>O due to the burning of wood on stoves

N<sub>2</sub>O\_EMISSIONS – total emissions of N<sub>2</sub>O

To have an overview of how the emissions from N<sub>2</sub>O were calculated, please consult the groups section.

#### 4.4.2 Facts about N<sub>2</sub>O

1. N<sub>2</sub>O is removed from the atmosphere by photolysis (breakdown by sunlight) in the stratosphere.
2. The greenhouse effect of N<sub>2</sub>O is estimated to be 289 times that of carbon dioxide over a 20-year period and 310 times over a 100-year period (IPCC, 2007).
3. The increase in N<sub>2</sub>O concentration is primarily due to agriculture.
4. Current estimates are that about 40% of total N<sub>2</sub>O emissions are anthropogenic but individual source estimates remain subject to significant uncertainties (IPCC, 2007).
5. Agriculture is the source of 52% of N<sub>2</sub>O emissions in the EU (European Commission, 1999).

## 4.5 GHG calculations

mobGAS provides an indication of the total emissions of Greenhouse Gases (GHG) in equivalent carbon dioxide emissions for the three GHG considered (Carbon dioxide, methane and Nitrous oxide).

Equivalent carbon dioxide is the amount of carbon dioxide emission that would cause the same integrated radiative forcing, over a given time horizon, as an emitted amount of a well mixed greenhouse gas or a mixture of well mixed greenhouse gases. The equivalent carbon dioxide emission is obtained by multiplying the emission of a well mixed greenhouse gas by its Global Warming Potential for the given time horizon. For a mix of greenhouse gases it is obtained by summing the equivalent carbon dioxide emissions of each gas. Equivalent carbon dioxide emission is a standard and useful metric for comparing emissions of different greenhouse gases but does not imply exact equivalence of the corresponding climate change responses (IPCC, 2007).

In mobGAS, when an indication of total GHG emission is provided (e.g. users ranking, emissions log, etc.) it is only referring to the aggregate emissions of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O. Even though these are the most important GHG, there are other important GHG (see Climate Change & Greenhouse Gases section).

For each GHG it is considered a global warming potential (GWP). The GWP represents the combined effect of the differing times these gases remain in the atmosphere and their relative effectiveness in absorbing outgoing thermal infrared radiation (IPCC, 2007).

The equivalent carbon dioxide emission is obtained by multiplying the emission of the GHG by the global warming potential.

On mobGAS we used the GWP for a 100-year time frame (the same GWP of the Kyoto Protocol). The GWP for a 100-year time frame is 21 for CH<sub>4</sub> and 310 for N<sub>2</sub>O (Forster *et al.*, 2007).

$$\text{GHG\_emissions} = \text{CO}_2\text{\_emissions} + 21 \times \text{CH}_4\text{\_emissions} + 310 \times \text{N}_2\text{O\_emissions}$$

Where:

CO<sub>2</sub>\_emissions – Total amount of CO<sub>2</sub> emissions calculated by mobGAS in kg

CH<sub>4</sub>\_emissions – Total amount of CH<sub>4</sub> emissions calculated by mobGAS in kg

N<sub>2</sub>O\_emissions – Total amount of N<sub>2</sub>O emissions calculated by mobGAS in kg

GHG\_emissions – total amount of GHG's emissions in kg calculated by mobGAS taken in consideration CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O in equivalent of CO<sub>2</sub>

## Assumptions

For the calculation of Total GHG it was considered the following Global Warming Potentials for a 100-year time frame:

CH<sub>4</sub> – 21 CO<sub>2</sub> eq.

N<sub>2</sub>O – 310 CO<sub>2</sub> eq.

### 4.5.1 Facts about GHG

1 - Greenhouse gas emissions in the EU-27 decreased by 7.9 % between 1990 and 2005. (EEA, 2007)

2 – EU-27 greenhouse gas emissions are projected to remain approximately at 2005 levels by 2010, but with planned additional policies, EU-27 greenhouse gas emissions could decrease from 2005 levels down to 11 % below their 1990 levels by 2010. (EEA, 2007)

3- Under the Kyoto Protocol, the EU-15 must reach an average annual level of greenhouse gas emissions 8 % lower than in the base year (close to 1990), during the whole period 2008–2012.

4 - In 2005, a 2 % reduction of EU-15 greenhouse gas emissions compared to base-year levels had been achieved. (EEA, 2007)

## 5 Results

### 5.1 Mobile results

The mobile application includes a screen where you may access your daily emissions of carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O). From the main menu select 'see results' to access a list screen where you may select one of the three Greenhouse Gases considered on mobGAS.

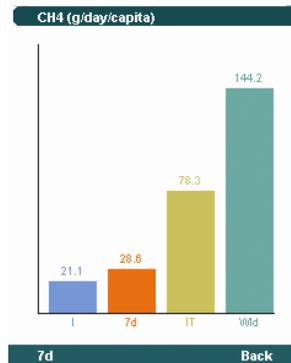


Figure 22 Mobile results chart

When you select one of the gases a chart will be displayed with four bars: individual emissions, last 7 days daily average emissions, daily national average per capita and daily world average per capita (see figure 22).

The values of emission are in kilograms for CO<sub>2</sub> and in grams for CH<sub>4</sub> and N<sub>2</sub>O.

The charts keep the updated values of emissions for that day and so you may consult them at any time of the day.

In order to calculate the average of the last seven days you should select '7d' button (from the bottom left corner of the screen) with the left softkey.

To know more about how emissions are calculated you may consult the 'Greenhouse Gases calculation' and 'groups description' sections of this manual.

#### 5.1.1 World emissions

The world average emission per capita is calculated by dividing the total amount of emissions by the world population. The calculations were made for the year 2000 (being this the most updated values of emissions at the time of development of the software).

## Assumptions

To calculate the daily average emissions per capita of the world it was assumed:

World population – 6070586 (1000)

Global CO<sub>2</sub> emissions – 23310000 (1000 tons)

Global CH<sub>4</sub> emissions – 319500 (1000 tons)

Global N<sub>2</sub>O emissions – 12600 (1000 tons)

Days of the year – 365

All values are for the year 2000. World Population value from FAOSTAT (2007) ; emission values from Netherlands Environmental Assessment Agency (Aardenne, J.A. van *et al.*, 2000) - EDGAR:

<http://www.mnp.nl/edgar/model/v32ft2000edgar/docv32ft2000/index.jsp>

### 5.1.2 National emissions

The national average emissions per capita are calculated by dividing the total amount of emissions of a specific GHG of the chosen country by the country population. The calculations were made for the year 2003 (being this the most updated values of emissions at the time of development of the software).

## Assumptions

To calculate the daily average emissions per capita of the country it was assumed the following values of Table 45.

Table 45 GHG emissions in each country

Country	population	Annual emissions (1000 tons)			Daily emissions [kg]		
		CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O
<b>Austria</b>	8102.2	76213	372	18	25.71	0.125	0.006
<b>Belgium</b>	10355.8	126331	406	36	33.36	0.107	0.010
<b>Bulgaria</b>	7845.8	53321	446	21	18.67	0.156	0.007
<b>Czech Republic</b>	10203.3	127124	483	26	34.12	0.130	0.007
<b>Denmark</b>	5383.5	59329	280	26	30.15	0.142	0.013
<b>Germany</b>	82536.7	865367	3582	205	28.73	0.119	0.007
<b>Estonia</b>	1356	19106	94	1	38.67	0.190	0.002
<b>Ireland</b>	3963.7	44450	607	31	30.48	0.416	0.022
<b>Greece</b>	11006.4	109977	484	43	27.33	0.120	0.011
<b>Spain</b>	41663.7	331762	1765	90	21.64	0.115	0.006
<b>France</b>	61615.26	408155	2862	241	18.06	0.127	0.011
<b>Italy</b>	57321.1	487282	1646	137	23.18	0.078	0.006
<b>Cyprus*</b>	715.1	7177	47	3	27.21	0.179	0.012
<b>Latvia</b>	2331.5	7427	91	4	8.75	0.107	0.004
<b>Lithuania</b>	3462.6	12287	171	4	9.75	0.136	0.003
<b>Luxembourg</b>	448.3	10692	22	0	65.10	0.137	0.001
<b>Hungary</b>	10142.4	60461	452	40	16.35	0.122	0.011
<b>Malta*</b>	397.3	2474	17	0	17.00	0.114	0.000
<b>Netherlands</b>	16192.6	176861	831	56	29.86	0.140	0.009
<b>Poland</b>	38218.5	321304	1805	74	23.04	0.129	0.005
<b>Portugal</b>	10407.5	64293	499	20	16.87	0.131	0.005
<b>Romania</b>	21772.8	111393	1132	23	14.04	0.143	0.003
<b>Slovenia</b>	1995	16103	94	5	22.11	0.129	0.007
<b>Slovakia</b>	5379.2	43053	217	13	21.93	0.110	0.006
<b>Finland</b>	5206.3	73185	236	21	38.46	0.124	0.011
<b>Sweden</b>	8940.8	55995	263	26	17.13	0.080	0.008
<b>United Kingdom</b>	59437.7	557462	1932	130	25.64	0.089	0.006

All values are for the year 2003. Emission and population values from Eurostat database (2007).

To calculate the daily average emissions it was assumed that a year has 365 days.

### 5.1.3 YU



Further to these charts, a character named YU (in the picture) will indicate your performance regarding the Kyoto Protocol. YU is always present on the top left screen of the mobile device.

YU may have three levels (green, orange and red) depending on your emissions regarding Kyoto target for the selected country as you can see in the chart (Figure 23). Taking in consideration the emission target agreed on the Kyoto protocol, mobGAS calculates how far you are from reaching the target (or if you already exceed the target), considering that all population of the chosen country would emit the same as you.

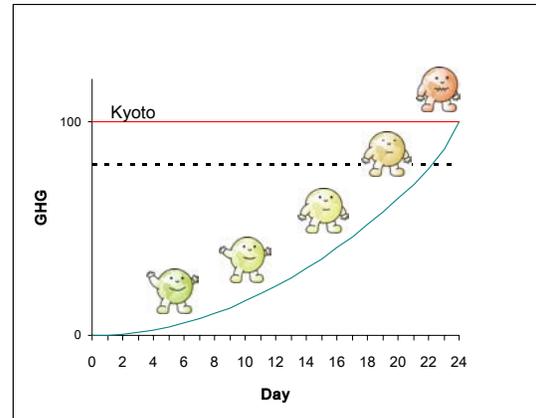


Figure 23 YU levels depending on emissions

Even though mobGAS does not consider industrial processes, neither the other three GHG covered by Kyoto protocol (Hydrofluorocarbons (HFCs); Perfluorocarbons (PFCs); and Sulphur hexafluoride (SF6)), this indication provides a link to the Kyoto protocol and to the type of changes one should do.

If your emissions are almost at the levels established by the Kyoto protocol (orange or red), the TIPS available on your mobile phone are displayed automatically.

The emissions target per capita is calculated through the following equation:

$$d\_DailyKyoto_{[COUNTRY]} = \frac{d\_GHG_{[COUNTRY]} \times \frac{d\_Target_{[country]}}{100}}{\frac{d\_Population_{[COUNTRY]}}{days\_year}} \times 1000$$

Where,

days\_year – number of days in a year

d\_GHG<sub>[COUNTRY]</sub> – emissions of GHG for a specific country in 1990 (1000 tons)

d\_Population<sub>[COUNTRY]</sub> – population of a specific country (1000)

d\_Target<sub>[COUNTRY]</sub> – percentage of reduction established by Kyoto Protocol (%)

d\_DailyKyoto<sub>[COUNTRY]</sub> - emissions target per capita for a specific country in kg

To calculate how far you are from reaching the Kyoto emissions target, the following equation is used:

$$d\_LevelGHG = \frac{d\_IndividualGHG}{d\_DailyKyoto} \times 100$$

Where,

d\_DailyKyoto - emissions target per capita for a specific country in kg

d\_IndividualGHG – individual greenhouse gases emissions in kg (to know more about how it is calculated visit ‘GHG calculations’ section)

d\_LevelGHG – percentage of emissions regarding Kyoto target (%)

Table 46 shows the different colours YU can assume.

Table 46 YU colours

Percentage	YU Colour
≤80 %	Green
>80 & ≤100%	Yellow
>100%	Red

## Assumptions

On mobGAS it was assumed the values in Table 47 of emissions and population.

Table 47 Emissions and population assumed for each country

Country	GHG emissions (1000 tons) on 1990	Kyoto reduction	Kyoto target emissions for the period 2008-2012	population (1000) at 2003	emissions target per capita [kg GHG / day / capita]
Austria	78573	-13	68358	8102.2	23
Belgium	145660	-7.5	134735	10355.8	36
Bulgaria	119921	-8	110327	7845.8	39
Czech Republic	192077	-8	176710	10203.3	47
Denmark	69328	-21	54769	5383.5	28
Germany	1243622	-21	982461	82536.7	33
Estonia	43491	-8	40011	1356	81
Ireland	53908	+13	60916	3963.7	42
Greece	109419	+25	136773	11006.4	34
Spain	283857	+15	326435	41663.7	21
France	567976	0	567976	61615.26	25
Italy	511214	-6.5	477985	57321.1	23
Cyprus*	6030	-8	5547	715.1	21
Latvia	25351	-8	23322	2331.5	27
Lithuania	50935	-8	46860	3462.6	37
Luxembourg	12737	-28	9170	448.3	56
Hungary	103346	-6	97145	10142.4	26
Malta*	2216	-8	2038	397.3	14
Netherlands	211705	-6	199002	16192.6	34
Poland	459776	-6	432189	38218.5	31
Portugal	59374	+27	75404	10407.5	20
Romania	232938	-8	214302	21772.8	27
Slovenia	18566	-8	17080	1995	23
Slovakia	72092	-8	66324	5379.2	34
Finland	70353	-0	70353	5206.3	37
Sweden	72210	+4	75098	8940.8	23
United Kingdom	747979	-12.5	654481	59437.7	30

Source: Eurostat (2007) database.

\* Cyprus and Malta do not have target emissions established. On mobGAS it was considered for these countries the overall reduction target for European Union of 8 % regarding the emission values of 1990.

To calculate the daily average emissions it is assumed that a year has 365 days.

## 5.2 On-line results

The mobile application is supported by a website, where you may upload your daily records in order to keep a record of emissions and evaluate your performance along different periods of time (week, monthly and yearly). Sending your emissions to the server will also include you in the user ranking list.

After you login in mobGAS webpage (<http://mobgas.jrc.it/>) you may select 'Emissions Log' button from the left menu. If you still did not login when you access the emissions log, you will be redirected to the 'login' page where after you enter your credentials (username and password) you will be automatically redirected to emissions log Webpage.

The emissions log on the website is available when you send your emissions from the mobile device. You must send your emissions at least every seven days not to lose information (see 'mobGAS structure' section).

In the emissions log you may access a total of 24 different combinations of charts, depending on the GHG, consumption and time period considered.

You find in the middle of the page two dropdown boxes. The first one has six options regarding the type of GHG or consumption. On the second one you may choose for which period you desire to consult your log (last log, week, month or year).

You should select one option in each dropdown box to create the chart dynamically (see Figure 24).

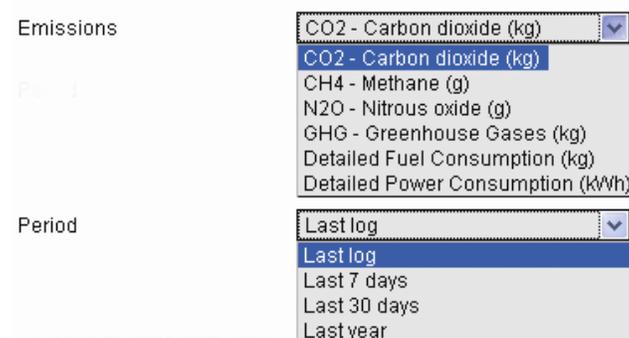


Figure 24 On-line results options

## 5.2.1 Carbon Dioxide emission chart

If you select *Carbon Dioxide (CO<sub>2</sub>) emissions* and *Last log* as the reference period, you will access a bar chart illustrating the amount of emissions due to the combustion of petrol, Natural Gas, Butane gas, diesel, LPG, aircraft Jet fuel, Wood, electricity consumption and waste management (see Figure 25).

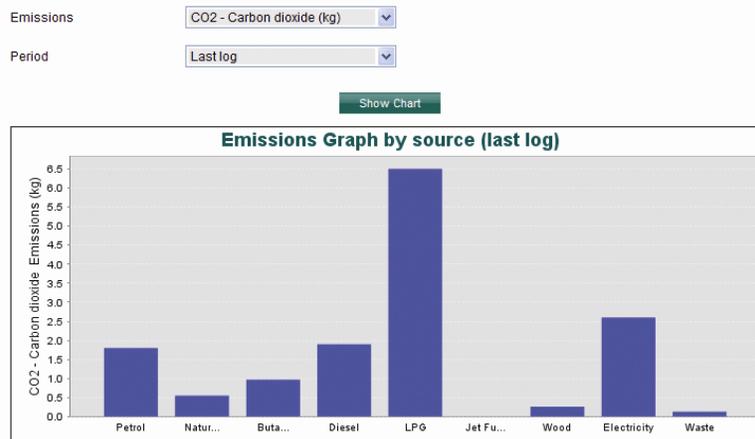


Figure 25 Carbon dioxide emission chart for last log

If you select the *last 7 days* or *last 30 days* as reference period you will access a line chart illustrating the daily emissions of CO<sub>2</sub> (in kg) calculated by mobGAS.

In case you choose the *last year* period, you will access a chart with the daily emissions average for each week (see Figure 26).

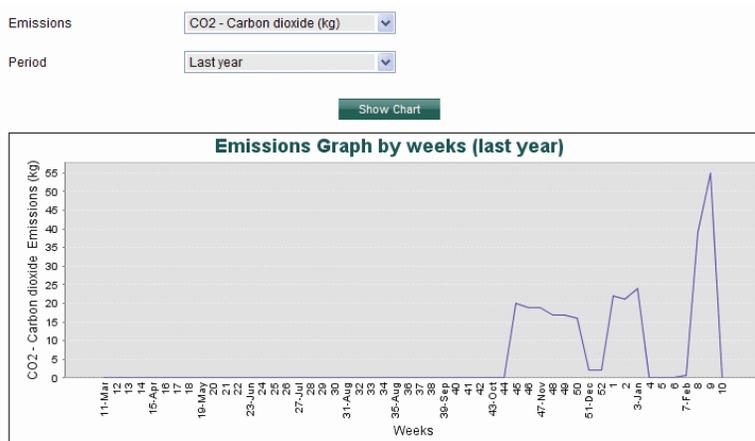


Figure 26 Carbon dioxide emission chart for last year period

## 5.2.2 Methane emission chart

If you select *Methane (CH<sub>4</sub>) emissions* and *Last log* as the reference period, you will access a bar chart illustrating the amount of emissions due to cattle breeding, waste management, rice production, coal mining, transports and heating (see Figure 27).

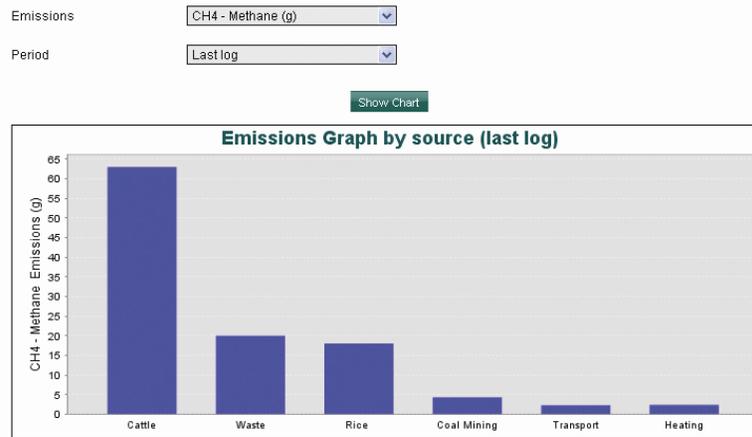


Figure 27 Methane emission chart for last log

If you select the *last 7 days* or *last 30 days* as reference period you will access a line chart illustrating the daily emissions of CH<sub>4</sub> (in g) calculated by mobGAS.

In case you choose the *last year* period, you will access a chart with the daily emissions average for each week.

## 5.2.3 Nitrous oxide emission chart

If you select *Nitrous Oxide (N<sub>2</sub>O) emissions* and *Last log* as the reference period, you will access a bar chart illustrating the amount of emissions due to agriculture (consumption of vegetable and rice), cattle breeding, waste management, cattle breeding, transports and heating (see Figure 28).

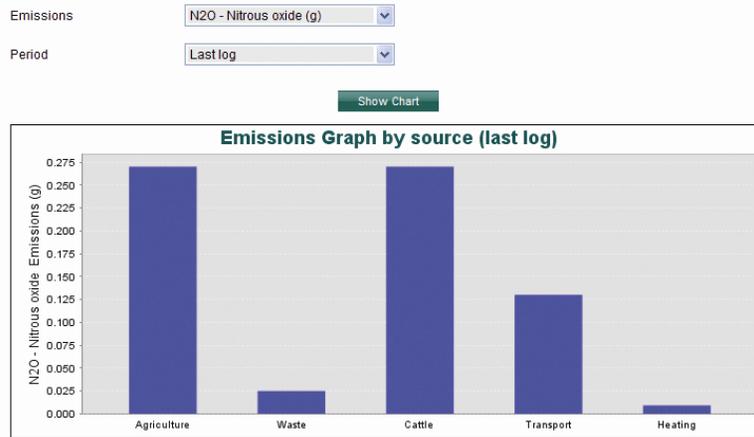


Figure 28 Nitrous Oxide emission chart for last log

If you select the *last 7 days* or *last 30 days* as reference period you will access a line chart illustrating the daily emissions of N<sub>2</sub>O (in g) calculated by mobGAS.

In case you choose the *last year* period, you will access a chart with the daily emissions average for each week.

#### 5.2.4 Greenhouse Gases emissions chart

If you select *Greenhouse Gases (GHG) emissions* and *Last log* as the reference period, you will access a bar chart illustrating the total amount of emissions of the three GHG considered on mobGAS (CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O in equivalent carbon dioxide (see 'GHG calculations' section and Figure 29)).

If you select the *last 7 days* or *last 30 days* as reference period you will access a line chart illustrating the daily emissions of GHG (in kg) calculated by mobGAS.

In case you choose the *last year* period, you will access a chart with the daily emissions average for each week.

Further to these charts, a character named YU will indicate your performance regarding the Kyoto Protocol (see Figure 29).

YU can have three levels (green, orange and red) depending on your emissions regarding Kyoto target for the selected country.

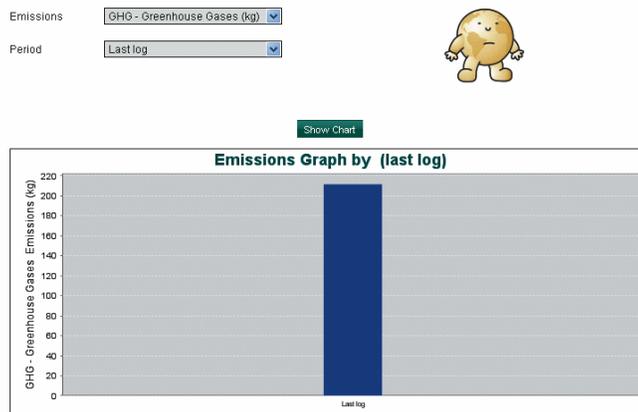


Figure 29 GHG emission chart for last log – total amount

To know more about YU indications please consult 'YU' section on this chapter.

### 5.2.5 Detailed Fuel consumption chart

If you select *Detailed Fuel consumption (kg)* (independently of the reference period), you will access a bar chart illustrating the amount of fuel consumed for the chosen reference period of petrol, natural gas, butane gas,

diesel, LPG, jet fuel (aircraft) and wood (see Figure 30).

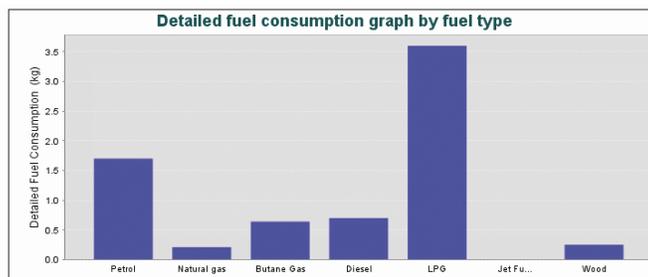
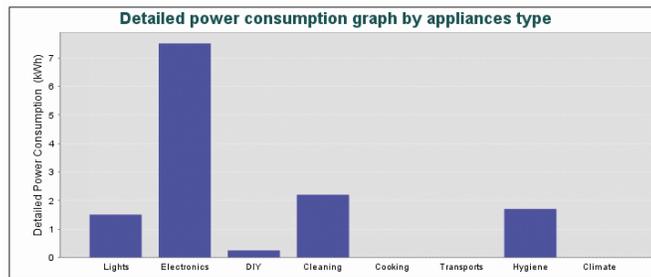


Figure 30 Detailed Fuel Consumption chart

## 5.2.6 Detailed Power consumption chart

If you select *Detailed Power consumption (kWh)* (independently of the reference period), you will access a bar chart illustrating the amount of electricity consumed by type of appliance or activity.



6 % of power consumption in electronics group is due to standby appliances. ←

Figure 31 Detailed Power Consumption chart

The groups considered are lights, electronics, DIY (Do-It-Yourself), cleaning, cooking, transports, hygiene and climate.

It is also provided an indication of how much electricity is spent on standby appliances for the electronics group (see Figure 31).

## 5.2.7 User Ranking

When you send your emissions to mobGAS server, you will be able to compare your emissions with the emissions of other mobGAS users. To do so you should access 'User rankings' page from the left menu. A ranking of mobGAS users will be displayed taking in consideration the emissions sent to the server throughout the previous week. The display of your emissions takes place automatically with the sending of your emissions from your mobile device.

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## 6.6 *Appliances producers' websites*

**Note:** the websites were last accessed on March 2008.

ABS Alaskan - <http://www.absak.com/design/powercon.html>

AirControl Systems - <http://www.humidifiers-shop.co.uk/>

batterystuff.com - <http://www.batterystuff.com/battery-chargers/24-volt/>

BFIN – Bioenergy feedstock information network - <http://bioenergy.ornl.gov/>

Bosch - <http://www.bosch.com/>

Braun - <http://www.braun.com/>

Canon INC. - [www.canon.com/](http://www.canon.com/)

Construction Resources - [www.constructionresources.com](http://www.constructionresources.com)

DELL - [www.dell.com/](http://www.dell.com/)

DeLonghi - <http://www.delonghi.fr>, <http://www.delonghi.it>

Dimplex Limited - <http://www.dimplex.co.uk/>

DIO (dry it out) - <http://www.dry-it-out.com/>

DX Gaming - <http://www.dxgaming.com/?p=6&page=2>

Enel - [www.enel.it](http://www.enel.it)

Epson - [www.epson.com/](http://www.epson.com/)

Engineeringtoolbox - <http://www.engineeringtoolbox.com/>

Fujitsu-Siemens - [www.fujitsu-siemens.com/](http://www.fujitsu-siemens.com/)

Grundig - [www.grundig.com/](http://www.grundig.com/)

Honda – <http://www.honda.com>

Hoover - <http://www.hoover.com/>

Indesit - <http://www.indesitcompany.com/>

Jøtul - <http://www.jotul.us/>

Leitner SpA - <http://www.leitner-lifts.com/>

Kone - <http://www.kone.com>

LG Corp. - <http://www.lg.net/>  
Measurement Canada - <http://www.ic.gc.ca/>  
Mike Weatherley - <http://www.mikeweatherley.org.uk/carboncalculator/index.htm>  
Minwa Electronics - [minwa.com.hk](http://minwa.com.hk)  
Mitsubishi Electric Europe BV - <http://www.mitsubishi-aircon.co.uk/>  
Motorola - <http://www.motorola.com/>  
Moulinex - <http://www.moulinex.com/>  
Nokia - <http://www.nokia.com/>  
Opel – <http://www.opel.com>  
Orkney Renewable Energy Forum - <http://www.oref.co.uk/>  
Peugeot – <http://www.peugeot.com>  
Phillips - [www.philips.com/](http://www.philips.com/)  
Pyramid UK Trading Ltd. - <http://www.towelradiator.co.uk>  
Progress Energy - <http://www.progress-energy.com/custservice/carres/energytips/ceilingfans.asp>  
Resurgence, United Kingdom - <http://www.resurgence.org/carboncalculator/>  
Sakura Home Products Co. - <http://www.sakura-canada.com/>  
Shenzhen Goalway Tech Co., Ltd. - <http://www.made-in-china.com/showroom/luwilly/product-list/catalog-1.html>  
Singer - <http://www.singer.com/>  
Sony - <http://www.sony.com/>  
The Chimney Sweep - <http://www.chimneysweeponline.com/pacsupdv.htm>  
Thomas Distributing - [nimhbattery.com](http://nimhbattery.com)  
Termozeta SpA - <http://www.termozeta.com>  
Toshiba - [www.toshiba.com/](http://www.toshiba.com/) , <http://www.toshiba-aircon.co.uk>  
Toyota – <http://www.toyota.com>  
Volkswagen - <http://www.volkswagen.com>  
Westinghouse <http://www.westinghouse.com/>  
Whirlpool Corporation - <http://www.whirlpool.com/>  
Yourgreendream - <http://www.yourgreendream.com/forum.php?showthread=44>



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**Abstract**

This report contains useful information on how to use and explore mobGAS functionalities on a mobile device and on the Internet. It is much more than a simple help. It provides detailed information about the consumptions and Greenhouse Gases emissions calculations, as well as about the type of outputs provided.

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