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Research regarding the reduction of the greenhouse gases emissions in the academic laboratories; case studies

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Abstract. The emissions of greenhouse gases (GHG) represent one of the main causes of the process of global warming. The research and the academic didactic activity in the technical field must become real centers of development and of implementation of initiatives for the reduction of the emissions of GHG. In this paper is presented the modality of evaluation of the emissions of greenhouse gases which come from the activity of research and of academic didactics at the laboratories center of the Department of Engineering and Management of the Technological Systems, Drobeta Turnu Severin, in accordance to the ISO 14064-1:2012 Standard greenhouse gases – Part 1.
Key Words: greenhouse gases, indirect emissions, climate change.

Introduction. The emissions of greenhouse gases (GHG) represent one of the main causes of the process of global warming. The following are part of the range of GHG: carbon dioxide (CO_2), nitrous oxide (NO_2), methane gas (CH_4), ozone (O_3), chlorofluorocarbons (CFC), hydrofluorocarbons (HFC), hydrochlorofluorocarbons (HCFC), sulfur hexafluoride (SF_6). In order to be within the regulations of the Kyoto Protocol regarding the 'total emissions of greenhouse gases', action must be taken in every country in order to reduce GHG.

The responsibility to reduce the emissions of GHG cannot be given to just some actors such as the Government, the Ministry of Environment and Climate Change, the National Environment Agency, the Environmental Guard. This responsibility must be extended at the level of the organizations and the communities. The ISO 14064-1:2012 Greenhouse gases – Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals, defines as organization: company, corporation, enterprise, authority or institution.

In the National Romanian Strategy regarding Climatic Changes 2013-2020, one of the horizontal strategic objectives which must be realized until 2020 is reprezented by the reduction of the greenhouse gases with 20% as compared with the year 1990 (MMSC 2013). In this regard, three scenarios were sketched: one which considers that in the nowadays economic conditions the target can be reached without investments; the second scenario is based on investment in order to reduce emissions of GHG and the third scenario which, by mantaining the level of investment from the previos scenario, leads to supplimentary reductions by a moderate growth in economy (Purica et al 2012). The same document shows that in order for the assumed obligations to be fulfilled, there are necessary, apart from other actions, the increase in the degree of information and awareness of the citizens and the development of activities of research in the field of climatic changes for all areas of activity.

The research and the academic didactic activity in the technical field must become real centers of development and implementation of initiatives to reduce the emissions of GHG and the European Union finances actions of research and innovation regarding climatic changes (CE 2013). This objective can be realized by applying the newest

concepts and the best available techniques in the field, by impelling ecodesign (Negoescu et al 2009) and by forming eco–responsible behavior of future engineers.

The evaluation of the emissions of GHG for the analyzed case is made by following the principles of the the Standard ISO 14064-1:2012 Greenhouse gases – Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals (EN ISO 14064-1:2012).

The presentation of the area of research laboratories and of didactic applications of the Department of Engineering and Management of the Technological Systems, Drobeta Turnu–Severin in order to establish the limits of the organization. The study of GHG emission is realized in the laboratories center of research and of didactic applications (for BA and MA) of the Department of Engineering and Management of the Technological Systems from the Faculty of Mechanics, University of Craiova, for a period of 1 year. The research and the didactic activity take place in parallel, so, in average, the activity takes place over 5 days a week and 8 hours a day during the entire university year.

The laboratories are equipped with adequate apparatus for the subjects taught and for the research activities in the following domains (Figure 1):

- elaboration of micron, nanometric and nanostructured powders using the PULVERISETTE 6 Planetary Mill or the PULVERISETTE 4 Vario – Planetary Mill;
- the morphologic characterization of powders with the aid of the Nanoparticle Analysis System NANOSIGHT LM 10 and the 90 Plus Particle Size Analyzer BROOKHAVEN;
- the elaboration of micro-parts through injection of powders with the GOCERAM GC-MPIM-3-MA-X Injection Machine;
- tribologic measurements with the CMS Instruments TRN 01 – 02541 Tribometer;
- the elaboration of steels through specific proceedings of powder metallurgy;
- the application of microwave energy to the processing of various materials.

Figure 1. The laboratory center of the Department of Engineering and Management of the Technological Systems, Drobeta Turnu-Severin.

The building has a surface of 990 m^2 and is structured on ground floor and one storey. It is connected to the centralized heating system of the city. During winter, at the same time with ensuring the heat in the teaching spaces, hot and cold water are also ensured; in the rest of the year, hot water is ensured by using boilers that function with electric energy. The neccesary comfort for study is provided through lighting installations with fluorescent tubes and through conditioned air. The building is insulated.

Establishing the operational limits. Through the character of the activities that take place in the laboratory area, the GHG emssions are of the following types:

a) Indirect emissions of GHG that come from imported electricity, heat or consumed steam. The data for quantification come from the invoices issued by the suppliers of utilities;

b) Other indirect emissions of GHG: the transportation of employees and of consumables with the own autovehicle.

Selecting the quantification methodologies. The quantification of the emissions of GHG, according to the ISO 14064-1:2012 can be made by calculus, by measurements or combined. For the presented case, the method selected is that of calculus based on the correlations between the consumers and the specific emission factors.

The calculus of the indirect emissions of GHG

Emission of GHG that comes from the fuel used to heat the building and to produce hot water. The building is heated with thermal agent produced by ROMAG TERMO S.A. Halânga large combustion plant. The raw material used to obtain thermal agent is coal. The building is heated from the centralized system for five months, but with the possibility of reducing the consumption during free days and holidays, until the limit imposed by the well functioning of the apparatus and the devices from its endowment. According to the invoices issued by the supplier, the total consumption of thermal energy is of 32.05 Gcal.

In specialty literature, the following equivalence is established:

1 Gcal = 0.143 tons of conventional fuel

Therefore, the consumption of coal is of: 32,05 x 0,143= 4583 tons of conventional fuel.

In the burning process, 1 kg of coal issues 1.922 kg of equivalent CO_2 (IPCC Guide 1996):

4583 kg coal x 1.922 kg CO_2e/ kg coal = 8808.5 kg CO_2e

Emissions of GHG coming from public energy consumption. Every year, for the laboratories in the Department of Engineering and Management of the Technological Systems, 2150 kWh are consumed. In Table 1 is presented the structure of the consume of electric energy depending on its usage.

Table 1

Activities that consume energy

Electricity consumer	*Consume (kWh)*
Ventilation	4092
Boilers of hot water	1365
Lighting	4183
Electric apparatus	7496
Electronic apparatus	3236
Apparatus in stand by	778
Other	410
Total	21560

The specialty literature indicates for the production of 1 kWh of electric energy an emission of equivalent carbon dioxide of 0.53865 kg. It results a total equivalent emission of 11613.3 kg of equivalent CO_2.

In order to establish the ways of reducing the consumption of electric energy and the emissions of GHG, the diagram of the consumption of electric energy, which is shown in Figure 2, is analyzed.

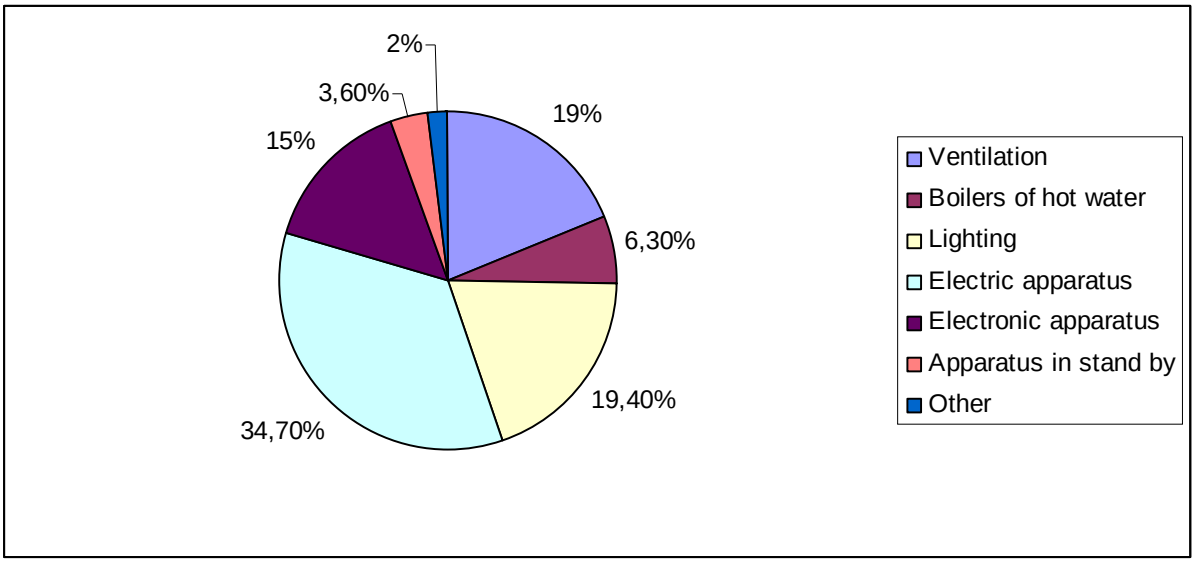

Figure 2. The diagram of the consumption of electric energy.

The calculus of other indirect emissions of GHG – emissions coming from the endowed car. During the academic year, the Cielo car, manufactured by Daewoo in 2005, having a cylindrical capacity of 1598 mc, runs, in average, 5600 km. The CO_2 emission for this type of car is of 178 g CO_2e/km:

5600 x 0.178 = 996 kg CO_2 equivalent

The total GHG emissions of the laboratories center of the Department of Engineering and Management of the Technological Systems. The total emissions are calculated by summing the three categories of emissions previously calculated. Therefore the activity that takes place in the laboratory center of the Department of Engineering and Management of the Technological Systems produces every year GHG emissions of 21417.8 kg CO_2 equivalent.

Research regarding the ways of reducing the GHG emissions. The analysis of the GHG emissions has as scope the application of solutions to reduce them. In the context of sustainable development, our research addresses improvements in environmental performance of process by selecting suppliers, reducing raw materials and energy consumptions, considering the life cycle analysis of products, activities which implicitly lead to a reduction in the indirect GHG emissions. Important progress has been made in the field of obtaining steels through specific proceedings of powder metallurgy, by reducing the time of sintering and of carburation, which consume electric energy (Ghermec et al 2013). Another direction of research is reprezented by the carburation with microwave energy.

In order to reduce thermic consume, the following measures can be applied:

- during winter, a temperature of 15ºC for the bathroom and the hallways and of 20-21ºC for the working rooms can lead to a decrease in consume of 5%;
- if thermostatic taps are installed for the balanced allocation of the consume of thermic energy in the conditions of mantaining the constant temperature in the building, the saving will be of 10%.

The reduction of the consume of thermic energy can take place through the following actions:

- using economy devices for lighting without affecting its quality leads to savings of 20% in the consume of electric energy;
- installing a solar pannel in order to produce household hot water can reduce the consume of electric energy with 15%;
- shutting down the computer monitors that do not work or commuting the monitors to 'sleep' when they are not used leads to savings of 3%.

Conclusions. The GHG emissions of the Department of Engineering and Management of the Technological Systems have their values calculated in the conditions in which the building has been thermically rehabilitated (thermal insulation and windows with double glass). The main contribution in the reduction of the GHG emissions is made by the research activity whose results are extrapolated on the environmental performance of the beneficiaries of the research.

The measures to reduce the consumption that generate GHG represent in the first phase investment, but which will be amortized from the savings realized by the subsequently costs. The analysis of these measure with the students will have a great importance in their future actions when then will be familiar with the actions to reduce the GHG.

This study represents a first phase in the analysis of GHG and must be periodically resumed in order to quantify the efficiency of the measures applied for reduction.

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