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Propuesta de programa de producción más limpia en instituciones universitarias: caso de estudio Tecnológico de Antioquia

A proposal for a cleaner production program in university institutes: case study Tecnológico de Antioquia

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Resumen

Una correcta gestión ambiental es implementar un programa de Producción Más Limpia y Consumo Sostenible (PML y CS) en los procesos productivos, lo que significa, básicamente, establecer prácticas preventivas tendientes a reducir la generación de residuos y emisiones al utilizar mejor los recursos disponibles y optimizar, r así, la producción, competitividad y sostenibilidad. Esto deriva, finalmente, en un manejo ambiental responsable. El presente artículo pretende analizar el comportamiento de tres indicadores ambientales básicos: consumo de agua, energía y papel en la institución caso de estudio "Tecnológico de Antioquia" con el fin de plantear opciones de prevención de la contaminación en términos generales para su posterior aplicación en los planes de acción ambientales de la institución. Dichas opciones están dadas por la implementación de buenas prácticas, cambio de actividades, cambio de procesos o, como última instancia, cambio de tecnologías que permitan mejorar el comportamiento de los indicadores. También se propondrán otros indicadores para tener en cuenta más adelante.

Palabras clave: indicador, gestión ambiental, producción limpia, producción sostenible

Abstract

Proper environmental management means implementing a program for Cleaner Production (CP) and Sustainable Consumption (SC) in industrial processes. This basically means establishing preventive practices aimed at reducing the generation of waste and emissions, making better use of available resources, optimizing production, competitiveness and sustainability. This finally results in responsible environmental management. This paper intends to analyze the behavior of three basic environmental indicators: water, energy and paper consumption in the case study "Tecnológico de Antioquia". The purpose is to suggest ways of preventing pollution in general for subsequent application in environmental action plans of the institute. Such ways arise from the implementation of good practices, change of activities, change of processes, or, as a final instance, change of technologies to improve the performance of the indicators. Other indicators will also be proposed, so that they can be considered later.

Keywords: indicator, environmental management, clean production, sustainable production

1. Introduction

Currently, the government, academia and society share concerns for environmental issues. Phenomena such as ozone layer depletion, global warming, desertification, droughts, loss of biodiversity; atmosphere, soil and water pollution affect human health and threaten the very existence of life on Earth.

UNEP (The United Nations program for the Environment) defines cleaner production (CP) as "the continuous application of an integrated preventive environmental strategy applied to processes, products and services to reduce risks to humans and the environment" (PNUMA, 2009).

Área Metropolitana del Valle de Aburrá (AMVA), in its handbook for cleaner production in the food and drinks sector (Tobón, 2007) defines CP as a proven strategy recognized worldwide as a means to improve the use of natural resources and minimize waste, pollution, and risks to human health and safety at the beginning, rather than at the end of processes, such as the so-called "end of pipe" process. This practice, at the same time, generates tangible economic savings by improving general production efficiency and cutting final treatment and disposal costs (Tobón, 2007).

In the industrial sector, environmental management is a fundamental feature to supply national and international market demands. For this reason, CP has been implemented in industrial processes, including the use of more efficient non-polluting technologies necessary to this end (Restrepo, 2007a). In this sense, implementing cleaner production measures in companies, whatever their size, basically means establishing preventive practices that aim to reduce the generation of waste and emissions, using available resources better in order to optimize production in a more competitive and sustainable way. Thus, companies contribute to fighting global warming and its terrible consequences (Tobón, 2007).

Generally, CP requires a change of attitude, responsible environmental management, and an evaluation of technological options. The practice and application of CP does not imply a "situation" of production systems, but of their "continuous improvement". Thus, CP follows a dynamic and systematic process, which is not applied once, but continuously in each stage of the process, product or service.

In this paper, we will analyze three basic environmental indicators of the activities carried out at Tecnológico de Antioquia Institución Universitaria. The indicators evaluated are: water, energy and paper consumption. By analyzing these indicators, we aim to bring about environmental management based on indicators in order to implement plans of action that allow for reaching goals that improve each indicator's performance.

The paper is divided into six sections: Introduction in Section 1, where we have the definition of Cleaner Production, and what the purposes are. In Section 2, we present the theoretical framework and a general description of the CP methodology with a company's basic indicators. Then, in Section 3, with TdeA's CP indicators, we propose and analyze the graphs for water, energy and paper consumption indicators from 2010 to 2012. In Section 4, we present pollution prevention options to be implemented in TdeA plans of action. In this section, there is a table with the items to consider for each resource. An example of energy consumption is presented in this table. To make clearer what is aimed at with CP, Section 5 deals with the benefits of this program. Finally, in Section 6, we present the conclusions and propose a line of future work for TdeA.

2. Theoretical Framework and Previous Work

Management is defined as the set of organized activities implemented to reach a company's goals. It implies a certain degree of formality, a level of administration, the existence of a management cycle that includes revisions and changes, a level of commitment to the goals, involving work teams and a managerial position (Área Metropolitana del Valle de Aburrá, 2007).

CP is preventive. It is an approach that prevents and minimizes environmental issues by preventing pollution through preventive measures. It often solves the problem instead of dealing with the symptoms. As a consequence, CP cuts costs and generates better product quality.

Basic indicators are the point of departure when assessing any organization's environmental situation. Thus, we have that Tecnológico de Antioquia Institución Universitaria will be the subject of study, and indicators to be examined are: water, power and paper consumption.

2.1. General Description of the CP Methodology

The assessment of the indicators to be analyzed in this paper is very simple, but equally meaningful. To this end, it is convenient to make a *diagnosis* of the current and historical situations of water, energy and paper consumption. Basically, historical data of consumption within the university are gathered, with a minimum of three years.

We make a *database* with periods of three years of consumption based on bills of public services for *water and energy consumption*. For *paper consumption,* we used the amount of reams per year provided by the warehouse. Likewise, it is necessary to take into account the *amount of people* that consumed these resources. For TdeA, such people are students, associate and full-time professors, and administrative and maintenance staff.

Once we have the data of consumption and amount of people, the next step is getting the ratio of how much water, energy and paper are consumed by these people. For this purpose, it is necessary to analyze the *ratio between consumption and people*. That is, for water consumption, it is convenient to take into account all the people that usually enter the university campus. For paper consumption, only administrative and associated teaching staff must be taken into account.

Once a *historical record of per capita consumption* is obtained, it is convenient to *analyze* each *performance over time* to find out whether the

system works correctly. Otherwise, if unexpected variations are observed, it is necessary to start suggesting general *pollution prevention options* for later application in *action plans* per evaluated resource or indicator. Action plans consist basically of implementing better practices, change of activities, change of processes, or ultimately, change of technologies. Such implementation allows the indicators to have better performance.

Each option to be considered in the action plans must have established terms. They can have either a frequency basis or a deadline for reaching goals. It is necessary to establish these guidelines in order to provide order and continuity in the activities to be carried out.

Likewise, it is necessary to *set goals*, so that each activity or set of activities aims at a *goal.* The goal is the point that we want an indicator to reach, where the system standardization begins. In this case study, such process results in less and efficient use of water, energy and paper.
In short, CP proposes the possibility of cutting costs and increasing production only with the application of good management practices, minimizing risks both to human health and the environment.

3. CP Indicators at TdeA

Indicators are quantitative measures that show changes over time, and allow for determining a system's situation in relation to the average, or national and international indicators in the same productive sector. This way, it is possible to determine whether what is being done is right (Restrepo, 2007b).

The purpose of environmental indicators is to show information about industrial environmental performance. This allows for setting goals to improve such indicators and implement management strategies. Establishing indicators leads to raising awareness of how necessary measuring is because what cannot be measured cannot be improved.

The purpose of an indicator is to determine how well a system is working, and show a red flag in case there is a problem. Thus, solutions can be provided. For an indicator to do this effectively, it must be: relevant, easy to understand, based on reliable information, transparent, verifiable, and based on specific information regarding place and time.

Below, we present a graph of the indicators to analyze in this paper: water, energy and paper consumption, according to the data collected for 2010, 2011 and 2012. After the graphs, there will be a brief analysis of performance over time to be able to propose a series of activities or options for plans of action. Thus, we support continuous improvement of the environmental management implemented in the institute to date.

The indicators assess the amount of water, energy and paper needed by and/or available for TdeA population for their basic needs. For analysis of each indicator, possible solutions can be found in the section "Pollution Prevention Options to be implemented in the Action Plans for the CP Program at TdeA". A few tips about good practices, activities, processes and technologies will be given. They can be the beginning of the CP Program implementation.

3.1. Yearly, Monthly and Daily per Capita Water Consumption

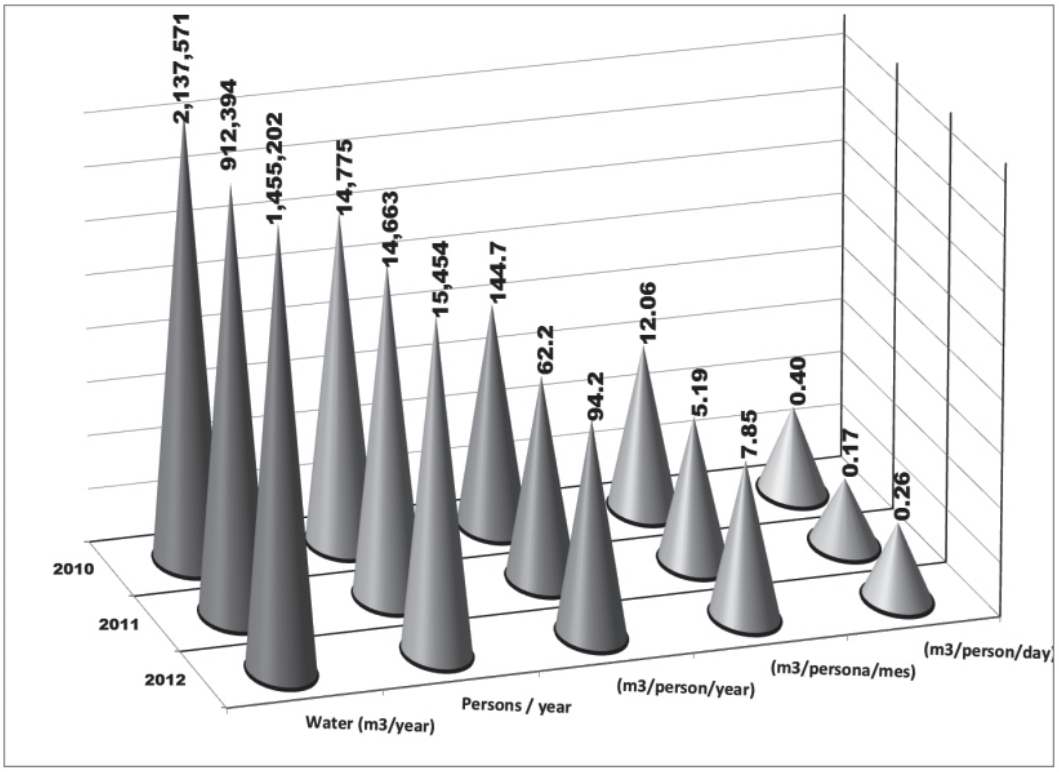

Figure 1. Yearly, monthly and daily per capita water consumption (2010-2012)

An analysis of the previous graph shows that 2010 was the year of highest consumption per capita. For 2011, consumption per capita dropped almost by half. For 2012, when the institute had the most people (of the years evaluated), consumption of water increased 22% compared with 2011.

The increase in water consumption for 2012 may be due to bad habits of students and employees, lack of monitoring and maintenance of water consumption equipment, such as leaks, toilets, taps, and other devices with high outflow of water, among other factors that need to be evaluated.

These situations, inasmuch as they present an unexpected performance by an indicator, must be analyzed and investigated to find out the cause(s), and begin to implement the needed solutions.

3.2. Yearly and Monthly per Capita Water Consumption

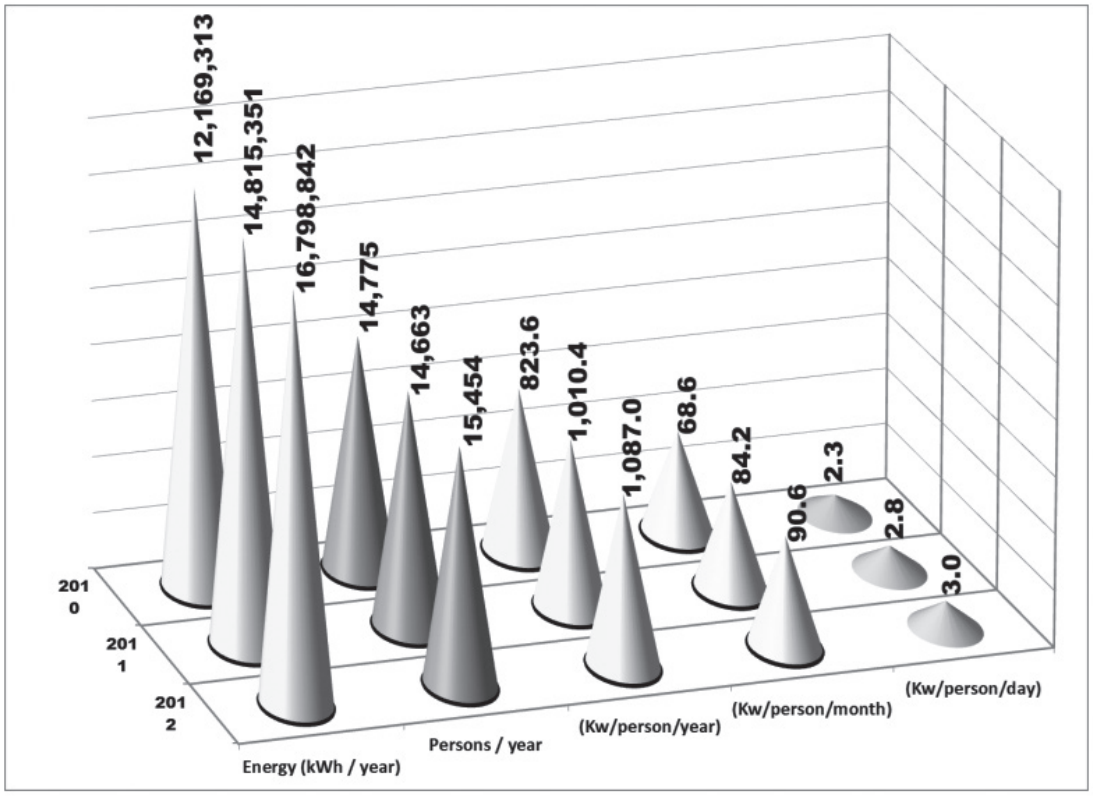

Figure 2. Per capita energy consumption (kWh/year, month, day)

The graph for per capita energy consumption shows an increase in yearly consumption. The year 2011 shows a 24% increase compared to 2010. For 2012, there was only a 7% increase compared to the previous year.

It may be said that this yearly consumption increase is the result of the purchase of several devices for the institute, such as screens for class rooms, routers, equipment for computer rooms and associated professors, etc.

3.3. Yearly, Monthly and Daily per Capita Paper Consumption

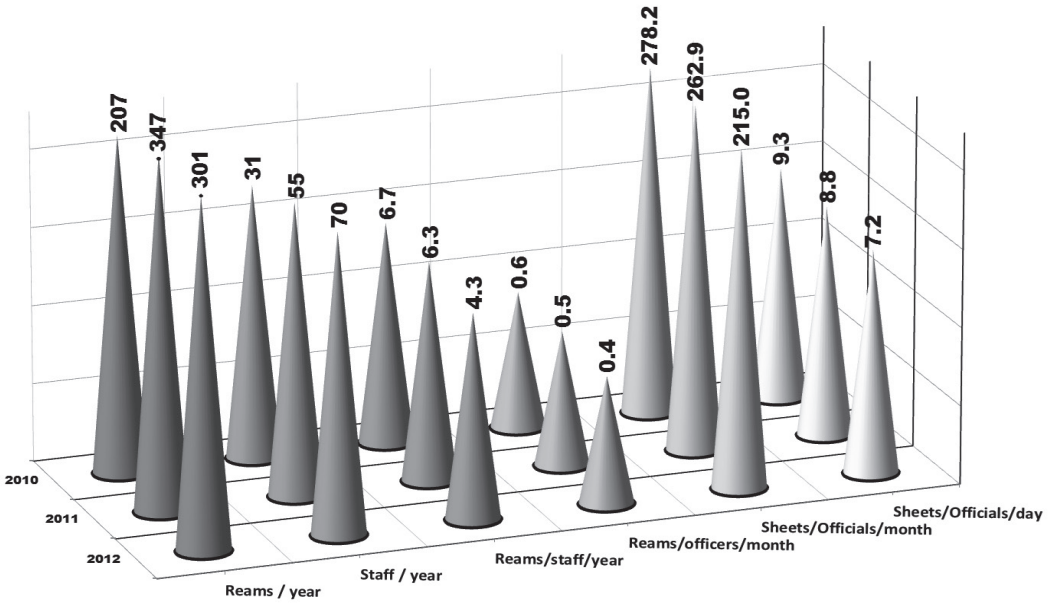

Figure 3. Per capita paper consumption (sheets/year, month, day)

In the previous graph, it is observed that throughout the three years evaluated, the consumption of paper has progressively decreased, even though the amount of employees per year has increased. Before this situation, it may be said that such behavior is the product of the environmental awareness that employees have developed over time. They re-use paper, print on both sides of a sheet of paper, avoid printing unless necessary, etc.

4. Pollution Prevention Options to Be Implemented in the Action Plans for the CP Program

Good practices, activities, processes and technologies vary exclusively depending on each company and its activities.

Below we mention some options to be implemented in the action plans:

- Identifying and fixing all leaks in pipes, devices and other equipment
- Setting up water meters to identify consumption in key activities of the area of processes
- Comparing these values with entry values to make sure there are no great losses without explanation
- Setting up a system so that people can report leaks more quickly and easily
- Turning off lights, air conditioning, and computers when they are not being used
- Using printers and photocopiers with low consumption options

- Verifying that lights are off in security checks
- Asking suppliers for re-usable or returnable merchandise packing, such as boxes and containers.
- Avoiding products with surplus packing, or asking the supplier to reduce it
- Raising environmental awareness, aimed at staff, students, visitors and suppliers
- Designing a media campaign for cultural change and greater environmental awareness that contributes to minimizing negative impacts on natural resources
- No paper campaign

4.1. Action Plans

Action plans are a means that helps trace the path to follow in academic institutes in order to reach goals. Action plans allows for deciding beforehand which activities need to be carried out and how, periods of time, who will be in charge of implementation, and how results will be evaluated. Based on pollution prevention actions, we propose an example to implement action plans in the institute.

Table 1 only deals with energy consumption, which is why it is necessary to generate and complete it for each resource.

Table 1. Example of action plans for energy consumption.

OBJECTIVE		Implement a program of saving and rational use of energy for optimal use of energy resources in all activities developed by the company.						
GOAL		Reduce energy consumption by 2% in 2011, and for the following years to keep consumption according to the levels of production in each plant.						
ENVIRONMENTAL ASPECT INVOLVED		Electricity Consumption				**ENVIRONMENTAL IMPACT INVOLVED**		Demand for Natural Resources
No.	**ACTIVITY**	**GMP**	**CP**	**CT**	**RESPONSIBLE**	**SUPPORT GROUP**	**ECONOMIC RESOURCES**	**TERM**
1	Conduct sensitization for all personnel in the efficient use and conservation of energyía	X			Environmental Assistant Maintenance Coordinator	Person expert in Topic	Video beam Posters Flyers	Permanent
2	Conduct an assessment of electrical installations of the company		X		Maintenance Coordinator	Maintenance Staff	camera	Apr-11
3	Making connections adjustment to lower or maintain consumption			X	Maintenance Coordinator	Maintenance Staff	Changing luminaire / Energy Devices	Jun-11
4	Evaluate of electrical energy saving devices		X	X	Director of Purchasing Manufacturing Director	Director of Purchasing Environmental Assistant	$ Savers Electric Power	May-11
5	Tracking and monitoring energy consumption on the premises of the company	X			Environmental Assistant Maintenance Coordinator	Environmental Assistant Program Leaders	$ Maintenance and program Operating Locative	Permanent
6	Promote the purchase of electric energy saving devices		X	X	Director of Purchasing Manufacturing Director	Director of Purchasing Environmental Assistant	$ Savers Electric Power	May-11

Table 1 presents the objective and the goal in a given period of time. To accomplish this, we have the activities that TdeA will carry out in a given period of time. These are classified as follows: Good Manufacturing Practices (GMP), Change of Process (CP), and Change of Technology (CT), people in charge, support group, economic resources, and deadline per activity.

5. CP benefits

By applying pollution prevention options through strict and organized action plans, the following benefits are observed over time:

- Cost reduction thanks to resource optimization
- Reduction of associated investment levels
- Profit increase
- Improved relationship with the community and environmental authorities
- Increased personal motivation
- Better corporate image of the company
- Higher sales and profit margin
- Easier entry into new markets
- Better chances for corporate improvement and total quality goal achievement which integrate environmental responsibility, industrial safety and occupational health
- Savings in payment of compensation rates
- Higher likelihood of access to financial resources for environmental conversion (Smith, 2006).
- Impact reduction throughout the cycle
- Reduction of risks to employees, the community and future generations
- Waste generation reduction
- Reduction of environmental restructuring costs
- Reduced end of process treatment (Agencia de Protección Ambiental, 2009)

6. Conclusions and Future Work

It is important to point out that the philosophy of CP is to prevent, rather than minimize, control or treat (foresee and prevent). This philosophy is based on maximum reduction, in this case, of water, energy and paper consumption. However, there is no Clean Production as it is. Consumption is attached to any productive process. The goal of the process is to avoid excessive consumption, since, on the one hand, misuse means economic loss, and on the other hand, it affects the environment. For this reason, reduction allows for preventing negative environmental impacts. Therefore, the approach of CP is to prevent continuous consumption.

Finally, energy consumption is what must be seen to first and foremost because of its yearly increase during the last three years. Second, parallel to this, water consumption requires attention. Third, what remains to be done is simply to apply more strategies, and monitor paper consumption.

As future work, we suggest assessing, analyzing, monitoring and generating pollution prevention options for the proposed indicators, which can be taken into account later on. However, it is important to stress that the amount and specificity of indicators depend on the company and its activities.

- Monthly solid waste generation (kg/month)
- Paper separation for monthly recycling (kg/month)
- Recycling rates (%)
- Savings percentage of water and energy per month and per year [(m^3/month, m^3/year) – (kWh/month, kWh/year)]
- Savings in water and energy bills per month and per year [$($m^3$/month), $($m^3$/year) – $(kWh/month), $(kWh/year)]
- Percentage of ordinary waste reduction (%)

We also suggest creating action plans per resource, and foster their fulfillment with the institute's professionals.

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