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Carbon Footprint as a basis for a cleaner research institute in Mexico

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ABSTRACT

Mexico has set a desirable 50% reduction goal of Greenhouse Gas emissions by 2050, compared to the 2000 baseline. In this regard, all the activity sectors, including universities and research institutions, are encouraged to adopt similar targets. As a contribution to the national efforts on the subject, this paper presents the 2010 Greenhouse Gas emission inventory of the Institute of Engineering at Universidad Nacional Autónoma de México based on the academic and research activities developed in 2010. The inventory report, generated according to the Greenhouse Gas Protocol and under a consumption based methodology integrating life-cycle assessment, considers the following activity categories: electric energy generation, vehicle fleet, purchased electricity, commuting, air travels, courier shipments, paper consumption and solid waste. The total Carbon Footprint of the Institute of Engineering in 2010 was calculated in about 1577 tCO_2e, where 42% of the Greenhouse Gas emissions were generated by the use of electricity, 50% by transportation; including its own fleet and commuting vehicles, 5% by air travel, 1% by shipments, 1% by use of paper and 1% associated to the final disposal of solid waste. Four scenarios of potential reduction are proposed based on changes in commuting activity. From the proposed scenarios, the one with a combination of teleworking and carpooling is the most effective.

1. Introduction

Climate change is recognized as an international concern since 1992 by the United Nations Framework Convention on Climate Change (UNFCCC). In 1997 the Kyoto protocol strengthened the global commitment for Greenhouse Gas (GHG) emission reductions, oriented by national and regional priorities and reduction targets within an established time-frame. To date, 195 parties belong to the convention and they participate in 2 excluding groups: Annex I and Non-Annex 1 countries. In the first group there are 1) Industrialized countries with an active participation in the Organization for Economic Cooperation and Development (OECD) and, 2) Countries catalogued as economies in transition. Annex I parties were expected to have the highest reductions due to its nature, by the year 2012 achieving similar emission levels as those in 1990. They are requested to submit yearly a greenhouse gas emissions inventory taking into account the base year in order to evidence the reductions. On the other hand, Non-Annex I countries are the second group, which comprises developing countries that also report their actions within climate change, but do it less frequently and are not required to reduce emission levels.

Mexico is a Non-Annex I country; nevertheless, it has a strong commitment with climate change and the UNFCCC. An evidence of this fact is the submission of national communications, 4 in total, from 1997 to 2009. As a consequence of such awareness, from public and private efforts all over the country, a National voluntary carbon accounting and reporting initiative emerged from the industrial sector: *Programa GEI México*. Over the years, other sectors have joined the program such as: commerce, services, municipalities, entertainment, and transport among others (SEMARNAT/CCE/CESPEDES/WRI/WBCSD, 2012).

In order to limit the increase of future global warming in 2 °C, it is necessary to stabilize the atmospheric concentration of CO_2 equivalent in about 450 ppm. For that purpose, it is required that both Annex I and Non-Annex I countries implement actions to contribute to the reduction of GHG emissions during a time frame of 40 years (from 2010 to 2050). To achieve this objective, Mexico has set by a federal law a desirable 50% reduction goal of GHG emissions by 2050, compared to the 2000 baseline (DOF, 2012), when 643.6 Mt were estimated. In this regard, all the activity sectors are encouraged to adopt similar targets.

In this context, the participation of independent organizations with high public credibility, such as universities, may be regarded as necessary and strategic. Their role should be as observers of the implementation and the results the Mexican public policy on the matter, but also as actors by putting into practice mitigation and adaptation measures in their facilities. Moreover, establishing their

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own GHG emissions targets, monitoring and improving the carbon performance by means of cleaner activities result in a very relevant issue, due to their role in knowledge generation, integration of sustainability in education and research projects, and promotion of environmental issues in the society (Larsen et al., 2013; Lozano, 2010; Stephens and Graham, 2010; Waas et al., 2010).

According to Cortese (2003), universities bear to increase the values, awareness, knowledge, and skills for sustainable future; however, in spite of the increasing number of universities improving education for sustainable development, it is necessary that they include the sustainability as an integral part of the institutional framework Lozano et al. (2013). In this sense, although some Mexican universities have been doing efforts (Bremer and López-Franco, 2006; Espinosa et al., 2008; Juárez-Nájera et al., 2006, 2010; Lozano et al., 2013; Martinez et al., 2006; Velazquez et al., 1999) but there are no published reports of GHG emissions into the academic and research sector in Mexico.

The Carbon Footprint concept has been proposed in order to track over time the carbon performance, and to make it comparable with other sectors (Peters, 2010; Wiedmann and Minx, 2008). It is defined as the total amount of greenhouse gas emissions directly and indirectly emitted by an organization considering all relevant sources, in both consumption and production, within a specified spatial and temporal system boundary (Ozawa-Meida et al., in press). Carbon Footprint has been calculated for various scales: the entire planet (Davis and Caldeira, 2010; Hertwich and Peters, 2009; Peters and Hertwich, 2008; Peters et al., 2012), countries (Brown et al., 2009; Hertwich and Peters, 2009; Peters and Hertwich, 2006; Peters et al., 2011; Wiedmann et al., 2010), cities (Erickson et al., 2012; Fong et al., 2009; Sovacool and Brown, 2010), and production supply chains (Davis et al., 2011; Lee, 2011; Minx et al., 2008; Sundarakani et al., 2010). Recently, some studies focused on education institutions carbon accounting (Baboulet and Lenzen, 2010; Klein-Banai and Theis, 2013; Larsen et al., 2013; Ozawa-Meida et al., in press; Thurston and Eckelman, 2011).

In the case of GHG inventories of institutions, it is necessary to account and report the emissions occurring within an organizational defined area, focusing on direct (Scope 1) and indirect emissions associated to the purchased electricity used by the organization (Scope 2) and other indirect upstream and downstream emissions, caused by personal transportation and by the use and disposal of goods and services (Scope 3), but produced outside its boundaries (IPCC, 2006a; WRI/WBCSD, 2004). From a productive perspective, it is common to cover only Scopes 1 and 2 (Hoffmann and Busch, 2008) leaving Scope 3, due to its complexity, as just optional. Recently it has been discussed the fact that the most relevant emissions are due to the Scope 3 (Downie and Stubbs, in press; Huang et al., 2009b; Lee, 2011).

The Carbon Footprint may be calculated following two approaches: Bottom-up, including life cycle assessment approaches (Scipioni et al., 2012, 2010) and top-down, including input–output analysis approaches (Huang et al., 2009a; Minx et al., 2009).

In this paper the GHG inventory of the Instituto de Ingeniería at the Universidad Nacional Autónoma de México (II-UNAM), calculated for the year 2010, using a 100-year time horizon, according to the GHG Protocol standards (IPCC, 2006a; WRI/WBCSD, 2004) and a methodology integrating consumption patterns and bottom-up approaches is presented. The Carbon Footprint is calculated considering scopes 1 to 3, and the emission sources considered several categories (transportation, energy purchase, energy generation and solid waste generation) in order to calculate the emissions of a particular scope.

The results were analyzed in order to generate specific actions to contribute to the II-UNAM emissions reduction. Additionally, four emission reduction scenarios were developed and the analysis may be considered as a pilot-study on Carbon Footprint of universities and research centers in Mexico. The significance of this work lies in the fact that constitutes the first academic paper on the subject for research centers and universities in the country.

2. Methods

The II-UNAM is the biggest of the twenty-nine scientific research entities belonging to the Universidad Nacional Autónoma de México (UNAM). The institute main facilities are located in Ciudad Universitaria Campus in Mexico City and two decentralized laboratories in the states of Querétaro and Yucatán. The campus located in Mexico City was the only considered for this work.

In 2008 the II-UNAM launched its environmental responsibility project (RAM, the Spanish acronym), which aims to adopt a sustainability culture by means of the promotion of responsible habits on energy and water use, office supplies consumption and programs of environmental education. In this sense, carbon emissions were identified as one of the convergent points of the project subjects: waste, climate change, green areas, energy, mobility, and environmental awareness. Therefore, it became very relevant for the institute.

During 2010, the period considered in this work, the II-UNAM had a total population of 1076 people: 54% undergraduate and graduate students associated to research projects, 18% academic personnel, 13% administrative staff and 15% short-term hired researchers and technicians, distributed along 25,240 square meters of constructed areas in 15 office buildings with laboratories and meeting rooms.

The Carbon Footprint presented in this paper has been generated according to the corporate (private and public organizations) GHG Protocol (WRI/WBCSD, 2004). It considers the activity categories presented in Table 1 according to their Scope (1–3).

2.1. Activity data and emissions factors

The activity data acquisition was done with a bottom-up approach according to Putt del Pino and Bhatia (2002), separating the overall activities of the II-UNAM into different components according to Barrett (2001); Chambers et al. (2000); Gottlieb et al. (2012); Simmons et al. (2000) (Table 1). The existing information

Table 1
Emissions types and sources considered in the Carbon Footprint indicator estimation.

Emission type	Activity	Description
Scope 1 Direct emissions	Electric energy generation in II-UNAM	Emission linked to fuel consumption
	II-UNAM vehicle fleet	Emission linked to fuel consumption
Scope 2 Indirect emissions	Purchased electricity	Emission linked to the national energy mix
Scope 3 Indirect emission	Commuting	Emission linked to the transportation mode, distance traveled and fuel consumption
	Air travels	Emission linked to fuel consumption during air travels
	Shipments	Terrestrial and aerial transport, emission linked to fuel consumption
	Paper	Emission linked to paper consumption
	Solid waste	Biowaste, including paper in landfill