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Water efficiency scenarios for green commercial buildings in Mexico and related CO_2 emissions mitigation

Escenarios de consumo de agua para edificios verdes de uso comercial en México y sus emisiones de CO_2

Montserrat Serrano-Medrano[1] and Alissa Kendall[2]

RESUMEN

En este estudio se evaluan las oportunidades de eficiencia de agua en edificios verdes de uso comercial en México, por medio de tres escenarios para estimar las reducciones potenciales en consumo de agua potable, consumo de energía, y emisiones de CO_2 hasta el año 2050. Los escenarios incluyen (1) un escenario base donde la tasa de uso de agua corriente permanece estática, (2) un escenario donde las nuevas construcciones adoptan el Código de Normas de Construcción Ecológica de California (Calgreen), y (3) un escenario donde las nuevas construcciones adoptan medidas adicionales al Calgreen (CalgreenPlus). El consumo de agua en el sector comercial puede alcanzar alrededor de 4,099 milliones, 2,900 millones y 2,700 millones de metros cúbicos en los escenarios base, Calgreen y CalgreenPlus, respectivamente. Lo anterior representa un 29% y 32% de reducción en consumo de energía comparados con el escenario base. Reducciones en emisiones de 1.3 millones de ton de dióxido de carbono (tCO_2) y 1.4 millones de tCO_2, así como ahorros monetarios equivalentes a 44% y 50% del presupuesto de México para educación superior, se pueden alcanzar a partir de implementar los escenarios Calgreen y CalgreenPlus, respectivamente.

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ABSTRACT

This study evaluates green commercial building water efficiency opportunities in Mexico through three scenarios to estimate potential reductions in potable water consumption, energy consumption, and CO_2 emissions through the year 2050. The scenarios include (1) a baseline scenario where current water use rates remain static, (2) a scenario where new constructions adopt the 2010 California Green Building Standards Code (Calgreen), and (3) a scenario where new constructions adopt additional measures to Calgreen (CalgreenPlus). In 2050 water consumption in the commercial sector would reach about 4,099 million, 2,900 million, and 2,700 million m^3 in the baseline, Calgreen and CalgreenPlus scenarios, respectively. Reductions reached are equivalent to about 100% of the current annual water consumption of Mexico City.
Energy consumption related to water use is estimated to reach 7 TWh, 5 TWh, and 4.7 TWh, for the baseline, Calgreen, and CalgreenPlus scenarios, respectively. This represents a 29% and 32% energy consumption reduction in the saving scenarios compared to the baseline scenario. Emissions reductions of 1.3 million t carbon dioxide (tCO_2) and 1.4 million tCO2, as well as monetary savings equivalent to 44% and 50% of Mexico's budget for higher education would be achieved from implementing the Calgreen and CalgreenPlus scenarios, respectively.

1. INTRODUCTION

Water supplies for drinking and sanitation are critical for the health and welfare of human populations particularly in urban environments. Yet approximately twenty percent of the world's population face water scarcity today, and water demand continues to rise in growing urban and industrial systems leading to the

*Autor para correspondencia. Montserrat Serrano-Medrano
Direccion de correo electrónico: mserrano@cieco.unam.mx
1 Instituto de Investigaciones en Ecosistemas y Sustentabilidad, Universidad Nacional Autónoma de México, Campus Morelia, 58190, Morelia, Michoacán, México.
2 Dept. of Civil and Environmental Engineering, University of California, One Shields Ave., Davis, CA 95616, USA

potential for even greater water scarcity in the future, particularly at local scales (UN Water and FAO, 2007). In addition, climate change is likely to increase the severity and frequency of water shortages, so unless water systems and water use become more efficient, water scarcity is likely to increase significantly over time.

Mexico faces many of these challenges. The country encountered a severe drought in 2009 with significant consequences, including considerable reductions in the potable water supply to its largest cities. For example, the Sistema Cutzamala, a system of dams from which Mexico City depends on 20% for its potable water, reduced flows by 30% during the drought (Sistema Meteorológico Nacional, 2009). Groundwater has historically been used to meet the city's water demand as well. However, the city has exceeded the limit of sustainable groundwater withdrawal rates, as evidenced by dramatic subsidence in some areas of the city.

These shortages and constrained supplies are occurring as Mexico's demand for water continues to increase. Mexico's public water consumption has increased from about 8,400 million m^3 in 1998 to 10,300 million m^3 in 2003 to 11,200 million m^3 in 2007 (Instituto Nacional de Estadística Geografía e Informática, 2004, Comisión Nacional del Agua, 2008a). The public supply sector, which integrates all the water delivered by the potable water distribution system, accounted for 14% of water use in the country. Of this 14%, non-residential use accounted for about 18%, or 2,250 million m^3 (Comisión Nacional del Agua, 2008a).

Given the conditions of constrained supplies, rapid urbanization, and increasing potable water demand, understanding current water use in the built environment as well as identifying opportunities to improve efficiency can help to mitigate the effects of climate change on water availability. However, many countries, particularly those categorized as developing nations, lack detailed information about their building stock and water use in buildings. For example, there is no inventory or reliable estimate of the existing non-residential building stock, nor is there reliable database documenting the performance of the existing building stock in Mexico (Adelaar et al., 2008). This lack of information makes it difficult to design, implement and evaluate efficient potable water management practices in non-residential buildings.

This study attempts to improve the availability of information on water use in buildings by estimating water use in non-residential buildings in Mexico. This effort requires that, first, the commercial building stock be estimated, then water use rate for different building types be estimated, and finally that current and future water use be estimated under different water consumption scenarios. To date Mexico has only limited standards regarding water use efficiency. Shower head specifications (NOM-008-CNA-1998), and toilet specifications (NOM-009-CAN-1998) are the only regulations that currently affect water efficiency practices in buildings (Comisión Nacional del Agua, 2008a), so a number of additional water efficiency standards and approaches are considered.

The goal of this study is to estimate current and future water use in commercial buildings under a number of different policies for water efficiency standards which could be implemented in new buildings. The effectiveness of enhanced water efficiency standards are tested by developing three scenarios: a baseline scenario where no changes to current water use rates occur; a scenario where water efficiency standards implemented in the 2010 California Green Building Standards Code, or Calgreen, are adopted in Mexico (California Building Standards Commission, 2010); and a third scenario where additional efficiency actions beyond the Calgreen standard are implemented, referred to as CalgreenPlus.

2. METHODS

2.1 Estimation of commercial building stock

Commercial building stock data in Mexico is very limited. This gap in data for the number of building units and their floor area has been identified in previous studies (Adelaar et al., 2008, de Buen, 2009).

The most recent estimation, developed by de Buen (2009), used a variety of data sources such as the websites of chambers of commerce and business associations. De Buen presented building information in terms of building type and estimated floor area, relying on several key assumptions to generate a reasonable, but conservative, approximation. The building types included in de Buen's study were aggregated in the following service sectors: (1) warehouses, (2) hotels and restaurants, (3) office buildings, (4) wholesale and retail buildings, (5) theaters and recreational facilities, (6) hospitals and health facilities, and (7) schools.

Table 1 shows the estimated area for each building sector.

2.2 Water use by building type

Mexico lacks data on end-uses of water in commercial buildings. The most detailed report available regarding potable water in Mexico states that non-residential use accounted for 18% of potable water use in 2003. Non-residential uses included commercial, industrial, public services, and "other" subsectors with a contribution of 10.8%, 3.7%, 3%, and 0.5%, respectively (Instituto Nacional de Estadística Geografía e Informática, 2004). The "public service use" and commercial subsectors are combined in this analysis to capture commercial buildings in public service (i.e. schools, hospitals, etc.). The "other" subsector includes water users that, for example, obtain water by tankers. Because the "other" subsector generally supplies residential segments where no potable water distribution services exist, and the "industrial use" is not part of the commercial building sector, these are excluded from this analysis.

The "public service use" subsector includes public offices, government buildings, schools, and irrigation water for parks and public gardens. Irrigation water use is excluded since only building water use is considered. Thus, the percent of "public service use" water consumption is decreased by 0.5%. This is a conservative reduction percentage because irrigation is not a daily task in most of the parks across the country, and therefore its contribution to the public service use is far less significant than the other uses included in this subsector.

Data on non-residential water consumption from the year 2008, as reported in de Buen (2009), is used in this study and is combined with the breakdowns identified for the year 2003, since no detailed breakdown is available for 2008 water use. Thus the water consumption rate for commercial buildings is estimated at 1210 million m^3, and public service uses, excluding parks and recreation areas, is 280 million m^3.

Table 1. Estimated total building area by building service sector.

Type of building	Total building area (million m2)
Warehouse	5.0
Hotels & Restaurants	14.0
Office Buildings	4.6
Wholesale & Retail	15.2
Theatres & Recreational Facilities	2.8
Hospitals & Health Facilities	6.0
Schools	121.0
Other buildings	110,000,000
TOTAL	278,600,000

Source: Adapted from (de Buen, 2009)

There is little or no information regarding average water use per type of building, and even less on water end-uses in the country. For this reason and because a considerable area of Mexico has a similar climate to that in California, data on commercial and institutional building water use in California generated by the AWWA Research Foundation were used as substitute values for Mexican commercial buildings (Dziegielewski et al., 2000). Some modifications were done to incorporate clear differences between Californian and Mexican buildings, however.

The AWWA collected water use data from direct field measurements in buildings located in four different locations in California: Irvine, Los Angeles, San Diego, Santa Monica; and one location in Phoenix, Arizona. Data from this report distinguishes between annual and seasonal uses; however, only annual use is considered for Mexican buildings. Because of the dissimilar classification of building type between the AWWA study and the Mexican classifications, the AWWA categories had to be mapped to the Mexican building classifications. The following describes how the AWWA report was adapted to estimate water consumption for Mexican buildings.

1. Warehouses are not studied by the AWWA report therefore potable water consumption is considered to be 20% of the estimated average consumption of the building type with the lowest value in the AWWA report - schools. There is a significant difference between water uses in warehouses, where there are few people, compared to other commercial buildings.

2. Office buildings, theaters, and recreation facilities were grouped into the same "Office Building" category because, generally, these places are likely to involve similar consumptive water uses, such as lavatories without showers, and limited or no food preparation.

3. Hotels and hospitals were grouped into the same "Hotels" category because, in general, similar water uses take place in both facilities. For instance, personal hygiene and laundry activities as well as food preparation. There are some possible exceptions, such as swimming pools available in some hotels (though they recycle water), and extra washing required in hospitals (gowns, curtains, etc.).

Direct field measurements from the AWWA report are classified into three different end-uses: indoor use, continuous use, and outdoor use. These three end-uses were disaggregated further according to the type of building.

Several additional assumptions were required in order to adapt AWWA´s data on water consumption. For instance, ice machines which were considered in hotels in AWWA's study were eliminated from the same sector in Mexico because, generally, ice is delivered by companies. In addition, because water fountains are uncommon in Mexican buildings, water use reported for water fountains in the AWWA report was omitted.

In contrast, some other uses were assumed to increase. Continuous uses such as leaks were considered as twice the value reported from AWWA study data because maintenance rates in Mexico are generally very low (Comisión Nacional del Agua, 2008b). Also, shower, cooling and swimming pool uses in schools were assumed to be zero because these amenities are rarely provided.

Finally, the "other buildings" category comprises nearly 40% of the building stock area, yet little is known about the services provided and thus the water consumed. For the results presented in this study, water consumption is assumed to be the median of all other building types. However, because there is high variability among building types, this assumption is a significant source of uncertainty and therefore it may affect the final results. Thus, a sensitivity analysis is included to assess the influence of this assumption.

3. RESULTS

Taking into account the commercial building stock mentioned above and the estimated average potable water use in commercial buildings, the total potable water consumption in 2008 for each type of building is shown in Table 2.

The "other services" sector is the main contributor to 2008 potable water consumption followed by hotels, schools; wholesale, retail, and supermarkets; office buildings; and restaurants. However, if the other services sector is left out of the analysis; the contribution of hotels and schools is considerable. In both cases, with and without the other services sector included, it is clear that although restaurants have the largest water consumption per m^2, their contribution to the total water consumption by the commercial sector is one of the lowest (just above warehouses) due to their small total floor area. On the other hand, regardless of

Table 2. Total potable water consumption for building type for 2008.

Type of building	Consumption (m^3/m2-year)	Total building area (Mm^2)	Total use (Mm^3)	Percentage contribution
Warehouses*	0.296	5.0	1.478	0.2
Office buildings	4.898	7.4	36.244	3.8
Restaurants	17.704	2.0	35.408	3.7
Whole sale, retail, and supermarkets	2.728	15.2	41.467	4.3
Hotels	13.754	18.0	247.579	25.8
Schools	1.478	121.0	178.845	18.6
Other services**	3.813	110.0	419.426	43.7
Total		278.6	960.447	100.0

*Warehouses consumption value (in m3/m2-year) was assumed to be 20% of the lowest estimated potable water consumption value; this is the schools' value.

**Other services consumption value was assumed to be the median of the other 6 types of buildings' values.

schools' low water consumption per floor area, their important contribution to the total water consumed is attributable to their large built area.

Total potable water consumption by building type can be broken down into the following end-use categories: irrigation, leaks, cooling, toilets/urinals, faucets, other indoor uses, and a miscellaneous category referred to as 'other'. The 'other' category includes end-uses such as dishwashing for restaurants as well as bathtubs, showers, laundry, and swimming pools for hotels. The end-uses and their contribution to the total average potable water consumption vary significantly between each building category, as illustrated in Figure 1. The 'Other' building category is not included in Figure 1, because data regarding end-uses in this building category were not available.

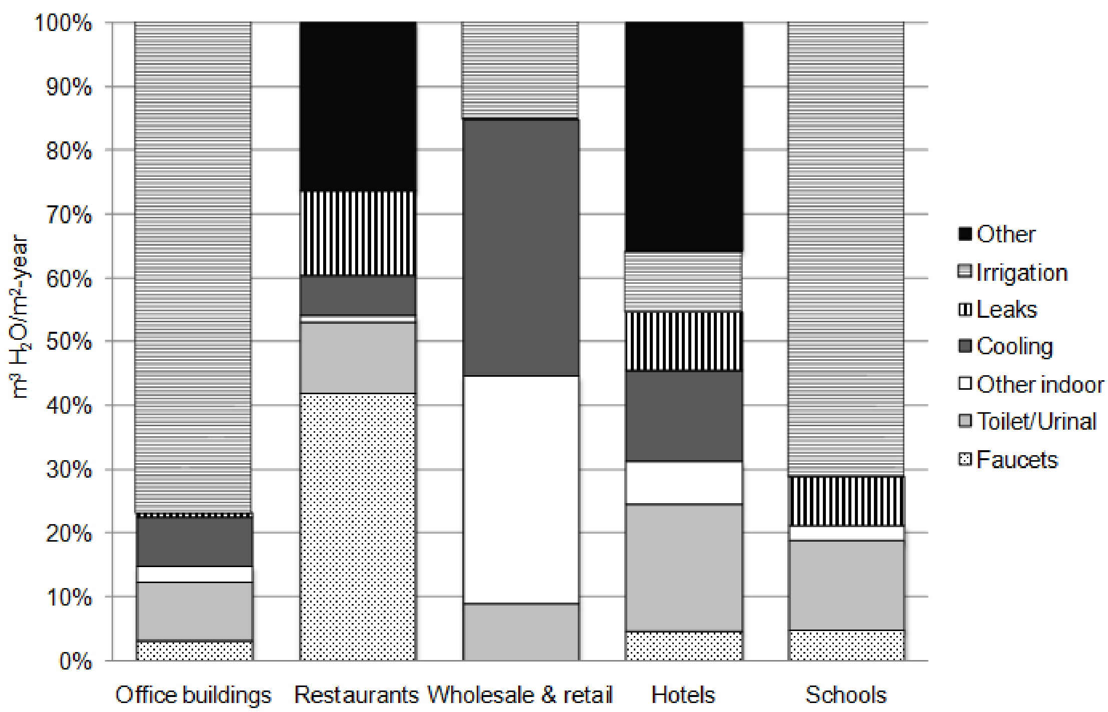
On a per-floor area basis, there are significant differences between buildings types. Indoor uses are the main contributors to water consumption in restaurants, wholesale and retail, and hotels. On the other hand, irrigation for landscaping has a large impact on water consumption for office buildings and schools.

4. SCENARIO ANALYSIS

A baseline water consumption project and two other scenarios are assessed over the period from 2008 to 2050. Despite its important contribution to commercial building water consumption, the 'other' building category is not included in the scenario analysis due to its high level of uncertainty.

The baseline scenario for the commercial building uses the current estimated potable water consumption rate overlaid with a growing stock of commercial buildings in Mexico. De Buen estimated a growth rate per year of about 4% for warehouses, hotels,

Figure 1. Proportion of water consumption by end-use.



restaurants, office buildings, and whole sale, retail, and supermarkets; and a growth rate of about 3% for schools, and the other services sector (de Buen, 2009). These growth rates were defined to establish a baseline for energy use in commercial buildings that would match with Mexico´s Secretaría de Energía (SENER) projections. Applying these growth rates to the building area for the specified building types, the baseline scenario predicts that 2050 water consumption in the commercial sector will reach about 4,099 million m^3, as shown in Figure 2.

The Calgreen profile was calculated by combining the mandatory and voluntary reductions established by the 2010 California Green Building Standards code (California Building Standards Commission, 2010). These measures establish a mandatory 20% reduction in the non-residential indoor water use and a 50% voluntary reduction in the outdoor water use. Indoor overall use of potable water will be reduced by means of providing the building with plumbing fixtures (e.g. water closets and urinals) and fittings (e.g. faucets and showerheads). Outdoor water use could be reduced by means of, but not limited to, the following methods: preferring low-irrigation coefficient plants; irrigation efficiency and distribution uniformity; use of captured rainwater; use of recycled water; and water treated for irrigation purposes and conveyed by a water district or public entity. These measures are set forth in Chapter 5-Division 5.3 and Appendix A5- Division A5.3 of the Calgreen code. The estimated consumption, with these adopted reductions, is then correlated with the projected building stock growth to yield the water consumption profile shown in Figure 2. Water consumption in the Calgreen scenario would reach about 2,898 million m3 in the 2050. This represents about 1,200 million m3 saved or about a 29% reduction with respect to the baseline figure.

An important factor contributing to water consumption in the commercial sector in Mexico is consumption related to leaks. Leaks have a great impact considering that maintenance rates are low in Mexico. For instance, due to the lack of maintenance in the potable water distribution system, losses from leaks can reach 50% (Comisión Nacional del Agua, 2008b). Hence, the CalgreenPlus scenario considers an 80% reduction in water lost in leaks in addition to the Calgreen scenario considerations in order to achieve a 10% lake rate, the average leak rate in USA utilities (ONTAP, 2005). Figure 2 shows that the water consumed in this scenario would reach about 2,754million m^3 in 2050. This represents about 1,350 million m^3 saved or about a 33% reduction compared to the baseline conditions scenario.

5. Estimation of co-benefits: CO^2 emissions reductions

Potable water consumption savings confers co-benefits in the form of reduced electricity and related CO_2 emissions. Electricity consumption related to potable water use includes electricity for pumping and treating water as well as electricity consumption due to wastewater treatment and collection. Thus, total electricity consumption associated to potable water use was estimated with the following equation:

$$TEC= ESEC + ISEC + FDEC$$

Where TEC is the total electricity consumption used to supply and treat potable water and to collect and treat wastewater; ESEC is the electricity consumption used for “external” water sources supplying urban centers (i.e. electricity used for pumping and/or to treat water from reservoirs); ISEC is the electricity consumption used for internal water sources supplying urban centers (i.e. electricity used for pumping from wells or springs); and FDEC is the electricity consumption required for wastewater treatment and collection.

The electricity consumption per m^3 for each of the three different water-use categories was estimated by examining the following cities: Mexico City, Monterrey, Morelia and Pátzcuaro. These cities were selected because of 1) information availability, 2) they account for about 30% of Mexico´s total population and 3) because they are also representative of a range of typical city sizes in Mexico (very big, big, and medium) where commercial building are located. Very small cities have few commercial buildings. Information from direct sources (i.e. by means of surveys to municipal water boards) was obtained for Morelia and Pátzcuaro (OOAPAS Mo-

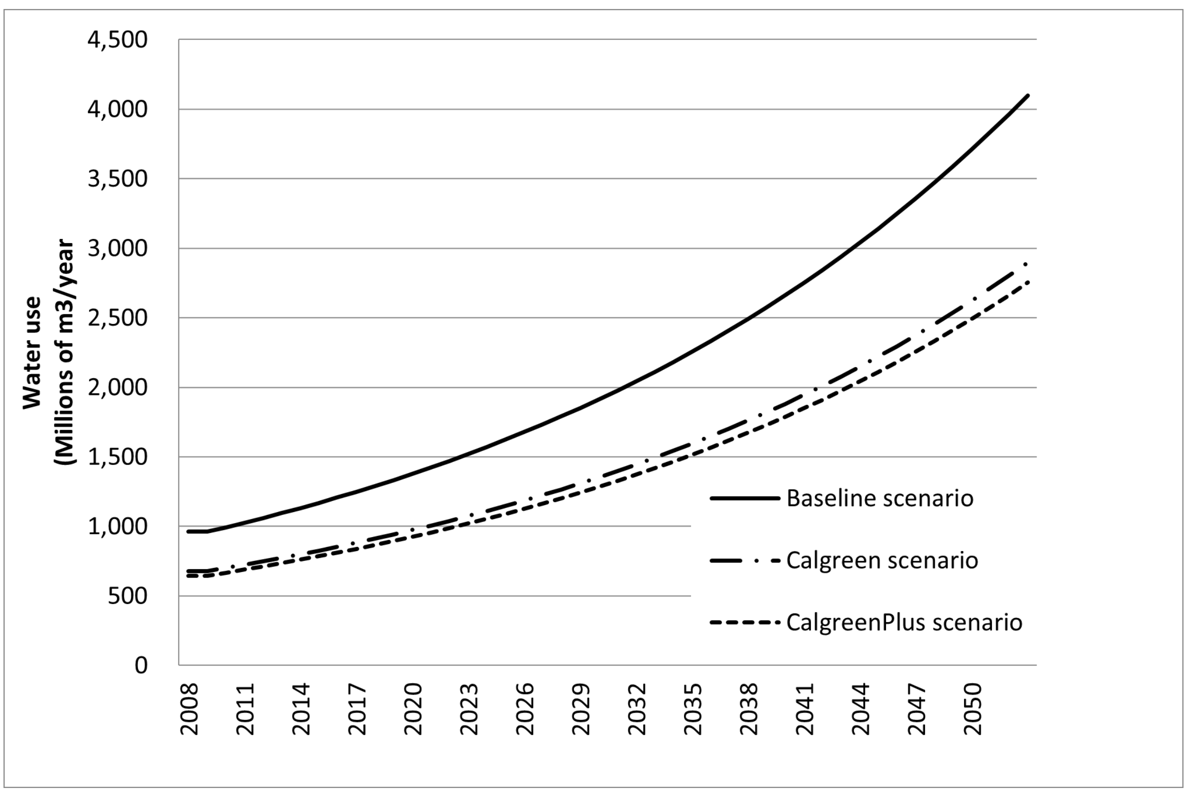


Figure 2. Evolution of Potable Water Consumption for Baseline, Calgreen, and CalgreenPlus Scenarios for new commercial buildings (2008-2050).

relia, 2010, OOAPASP, 2010); and reports regarding electricity consumption for water supply and treatment were available for Mexico City and Monterrey (Breceda-Lapeyre, 2004, James, 2003). Information derived from direct surveys is based on monthly bills for electricity consumption at each treatment or water supply plant, while information available from reports is based on average electricity consumption.

TEC was estimated taking into account a mean value to a) treat and pump water and another mean value to b) treat and collect wastewater from the cities mentioned above. As a result, estimated values were of the order of 1.65 kWh/m^3 and 0.11 kWh/m^3, respectively. These two mean values are only a rough estimate due to variability in electricity use for potable water systems and water treatment across the country.

Applying the electricity intensity values for potable water and wastewater volume projections, emissions of CO_2 due to energy consumption can be calculated using the IPCC Methodology (IPCC, 2006):

$$CO_{2E} = \Sigma CEF_e \, e$$

Where CO_{2E} are the CO_2 emissions related to energy consumption, CEF_e is the CO_2 emissions factor for electricity generation, and e is the total electricity consumption. This factor is dynamic over time because its estimation relies on factors such as the proportion of all the primary energy sources to produce electricity and the efficiency of the power generation. Rosas et al. (Rosas et al., 2010, Rosas-Flores et al., 2011) recently estimated this CEF factor to be 178.8 t CO_2/TJ or 0.64 t CO_2/ MWh for 2006 for Mexico. Table 3 reports electricity consumption for potable water use and wastewater treatment, as well as the CO2 emissions from electricity use for the baseline, Calgreen, and CalgreenPlus scenarios for 2050.

Table 3. Estimated electricity consumption for potable water use and waste water treatment, and CO_2 emissions-reductions for 2050.

Potable Water consumption	(Mm^3)	Baseline	4,099
		Calgreen	2,898
		CalgreenPlus	2,754
Percentage of water going to wastewater treatment*	(%)	Baseline	0.5
		Calgreen	0.6
		CalgreenPlus	0.7
Total electricity consumption for potable water use and disposal	(TWh)	Baseline	6.9
		Calgreen	4.9
		CalgreenPlus	4.7
CO_2 emissions	($MtCO_2$)	Baseline	4.5
		Calgreen	3.2
		CalgreenPlus	3.0

*Percentage of water going to wastewater treatment was estimated by ignoring the volume of leaks and irrigation applications included in the potable water consumption.

6. ECONOMIC IMPLICATIONS

As a consequence of water and electricity consumption reductions, economic savings from water efficiency actions could also be achieved. From the customer's perspective, there is a high variability in the cost of potable water across the country. Each municipality establishes its own customers' rates depending on user type (i.e. residential, commercial, and public, etc.) and a range of volumetric consumption per billing period (i.e. low, medium, and high). There are also many locations where a fixed price is used to charge for potable water consumption because many users lack water meters (POGM, 2010). Potable water costs for utilities in Mexico are generally higher than rates charged to consumers, because many of these utilities are run by local governments that absorb part of total costs. Therefore, the consumers' cost reduction estimation was done using an average of $2.3 USD/m^3 based on rates from several municipal potable water boards (Grajeda, 2009, SAPDM, 2011, POGM, 2010). Table 4 shows the financial savings in the Calgreen scenario and CalgreenPlus scenario with respect to the baseline scenario for 2050.

Monetary savings may also be realized for reduced electricity consumption resulting from decreased potable water use and treatment, thus utilities could also benefit from efficiency measures. This does not necessarily imply that they will pass along these cost reductions to the customer (for example they can use them to fund infrastructure improvements). Accordingly to the Federal Electricity Board (CFE, its acronym in Spanish), the cost per kWh for Service type 6 (potable and wastewater pumping) was on the order of USD$ 0.11/ kWh for October 2010 (CFE, 2010). Table 5 shows the financial savings due to a decrease in electricity consumption for potable water consumption reduction concept.

Table 4 Consumers' financial savings for water consumption reduction in 2050.

Costs to consumers for potable water use (Million dollars)			Cost reductions to consumers (Million dollars)	
Baseline	Calgreen	CalgreePlus	Calgreen	CalgreenPlus
9,427	6,665	6,333	2,762	3,094

If monetary savings from water consumption reduction to consumers and from electricity consumption reduction for utilities are summed, total savings may reach about 2,900 million dollars and 3,200 million dollars for the Calgreen and CalgreenPlus scenarios in 2050, respectively.

7. CONCLUSIONS AND RECOMMENDATIONS

Due to the lack of available primary data, a model was developed to estimate potable water consumption in commercial buildings. Commercial building potable water consumption for 2008 was estimated to be close to 1 billion m^3. To put this in context, this value represents almost the total current potable water consumption of Mexico's largest city, Mexico City.

The baseline scenario shows that by 2050 commercial buildings potable water consumption would reach about 4.1 billion m^3. Potential reductions to the

Table 5 Total financial savings for electricity consumption reduction in 2050.

Electricity consumption costs for water utilities (Million dollars)			Cost Savings (Million dollars)	
Baseline	CalGreen	CagreenPlus	Calgreen	CagreenPlus
769	547	521	222	248

baseline scenario consumption are assessed in the Calgreen and CalgreenPlus scenarios. The Calgreen scenario shows that in 2050 commercial building water consumption would reach about 2.9 billion m^3. This represents a 29% reduction in potable water consumption, or about 1. 2 billion m^3 saved compared to the baseline scenario. The CalgreenPlus scenario shows that in 2050 commercial building water consumption would reach about 2.7 billion m^3. This represents about a 33% reduction in potable water consumption, or about 1.4 billion m^3 saved. Reductions reached by these scenarios scenarios are similar in magnitude to the total 2008 commercial building water use in Mexico. With respect to energy savings from electricity, approximately 2 million MWh and 2.3 million MWh would be saved in 2050 for the Calgreen and CalgreenPlus scenarios, respectively. In addition, about 1.3 million and 1.4 million t CO_2 in 2050 would be saved for the Calgreen and CalgreenPlus scenarios, respectively. This represents a reduction of about 29% and 32% for the for electricity consumption and consequent CO_2 emissions compared to the baseline scenario.

The approximate 2,900 million dollars in savings for the Calgreen scenario and 3,200 million dollars in savings for the CalgreenPlus scenario for 2050 demonstrate monetary saving compared to the baseline of 29% and 32%, respectively. These monetary savings are not inconsequential at a national scale. For example, these savings are equivalent to between 44% and 50% of Mexico's current annual budget for higher education.

Nevertheless, it is worth emphasizing that these savings do not account for the cost of implementing the water saving scenarios. Including leak reduction through improved maintenance in the CalgreenPlus scenario, which could be costly. So, further analysis need to assess the cost of implementing either the Calgreen or CalgreenPlus scenarios.

Base on the results obtained in this study, the following recommendations are provided:

1. Establish a reliable commercial building database, by means of government resources; for example, through the Instituto Nacional de Estadística, Geografía e Informática. The database should contain attribute information such as building type, building stock, floor area, age, and water consumption rates.

2. Engage in data collection efforts to determine water end-uses by type of building to establish a baseline for the current building stock.

3. Promote legislation that encourages the adoption of green building practices, like Mexico City's, "Programa de Certificación de Edificicaciones Sustentables" (PCES, 2008) throughout the country. This voluntary program was launched on 2008 and made effective in 2009. It is similar structure and content to the US Green Building Council's LEED certification system (USGBC, 2012). LEED provides green building certification at multiple levels based on credits (or points) earned based on building design, construction and/or operation. For example, LEED water efficiency points can be achieved through

1) water use reduction by means of increasing water efficiency within buildings (required reduction percentages range from 30% to 40%), by implementing potential technologies such as high-efficiency fixtures (e.g., water closets and urinals) and dry fixtures such as dry toilets;

2) the use of water-efficient landscaping to limit or eliminate the use of potable water for landscape irrigation, for example by planting native or drought tolerant plants to reduce or eliminate irrigation; and

3) the use of innovative wastewater technologies to reduce wastewater generation and potable water demand by means of, but not limited to, high-efficiency fixtures and dry fixtures and the use of on-site wastewater treatment (USGBC, 2012).

Unfortunately, the adoption rates of the "Programa de Certificación de Edificicaciones Sustentables" have been very low mainly because the process to obtain the certification is slow and not very clear (RECONECTA, 2011, OBRASWEB, 2012). Hence, green building practices could be encouraged by simplifying the certification process stages as well as by instituting mandatory commercial building codes similar to Calgreen.

4. Promote the inclusion of mandatory clauses in the current municipal construction codes which ensure the installation of efficient water equipment such as toilets, urinals, faucets, and showers in new construction as well as a program to replace the existing inefficient ones. This type of replacement program has proven successful in the energy sector. For example, where government incentives are used to encourage replacing old inefficient refrigerators with a new efficient ones, as well incandescent lamps for fluorescent ones (SENER, 2011, FIDE, 2011).

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