A BAN ON INCANDESCENT LAMPS? AN ANALYSIS OF THE PROPOSED NRCAN LIGHTING STANDARD

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Overview

Natural Resources Canada (NRCan) has proposed to “phase-out inefficient lighting in common uses by 2012 [1]”, where “common uses” refers to general service incandescent “bulbs” (40 to 100 watts). To do this it has proposed a Tier 1 efficacy (lumens per watt) standard roughly 50% higher than the best fit curve of current efficacies for incandescent lamps as a function of total lumen output. Proposed Tier 2 standards, scheduled to go into effect in 2015, represent a 100% increase from current efficacies [2]. At this time the most efficient commercially available technology for general purpose residential lighting in the 40 to 100 watt range is compact fluorescent lamps (CFLs) [3]. CFLs are a “drop in” replacement for incandescent bulbs that offer higher efficacies and are therefore the focus of this study. There are technological, environmental, economic and social issues involved in replacing a large number of incandescent lamps with CFLs. Acceptance of CFLs in the current unregulated context has been slow: as of 2001 only 2% of installed lamps in all residential buildings in the United States were CFLs [4]. Our analysis reviews energy, greenhouse gas emissions, mercury impacts and cost as they pertain to the Canadian residential market as an aid to development of NRCan policy.

Methods

The electricity used for residential lighting was calculated using a method proposed by Fung & Ugursal [5]. In this method average wattages and average usage hours are assumed for a particular lighting technology. The annual energy used per household by lighting type is calculated as follows:

$$\text{Energy used} = \text{Average wattage} \times \text{Average hours} \times \text{Number of lamps} \times 365$$

Using the above formula, the energy used by all lighting types was obtained and summed, resulting in the total annual lighting energy used per household. The average wattages by lamp type and the average usage hours published by Fung & Ugursal [5] were used for this analysis. The sensitivity of the results to hours of use is examined as part of this study. However, the values for CFLs were not included in the aforementioned study. Generally, CFLs are used as replacements for incandescent lamps. Therefore the average usage hours of a CFL were assumed to be the same as for an incandescent lamp.

The lighting profile of a household was estimated using 1993 and 2003 SHEU data [6,7]. The total number of light bulbs in a household is reported in the 1993 SHEU on a provincial basis. However, in the 2003 SHEU data, the Prairie provinces (i.e., Alberta, Sasketchewan and Manitoba) were lumped together. Since the 1993 SHEU data was thoroughly analyzed and more detailed than that of 2003, the 1993 SHEU values for number of lamps by lamp type per household were used. The percentages of different types of lamps reported in the 2003 SHEU data were applied to the 1993 lamp totals to calculate the number of different types of lamps used in a household.

The calculated electricity end use for lighting was then divided by the electricity transmission and distribution losses to obtain the actual primary energy use. Transmission and distribution losses depend on the transmission infrastructure and level of line loading. Values in the range of 7-12% are available in published sources [8,9]. In this analysis a flat value of 10% transmission and distribution losses was assumed for all the provinces. This value was selected by considering the published average values and line loading at times of peak demand.

Results

Our findings indicate that replacing 90% of 40 to 100 watt general service incandescent lamps with CFLs could reduce residential lighting electricity use by 12.5 TWh, a 58% reduction from 2003 use. After considering the effect on space conditioning systems, the net reduction in the residential sector will be 37% (8.0 TWhr/yr) of the baseline scenario. Greenhouse gas (GHG) emissions from the residential lighting sector would be reduced by 46% (2.7 MtCO2e/yr). This represents a 0.4% reduction in national GHG emissions (758 MtCO2e/yr). However, some provinces (i.e., Manitoba, Quebec and Newfoundland) with low GHG intensive electricity generation mixes may see an increase in residential lighting related GHG emissions. The "freed" hydroelectric generation might reduce GHG emissions in other areas and this should be evaluated.

CFLs contain mercury; a national transition to CFLs would therefore increase the amount of mercury in the residential sector's waste stream by 176 kg/yr. However, the reduction in electricity use would reduce mercury emissions from coal burning power plants by 67 kg/yr. These impacts have different effects in terms of toxicity potential [10]. Overall, as a result of the regulation, human toxicity potential decreases by 28%, marine sediment and marine aquatic ecotoxicity potentials decrease by 34%, freshwater aquatic ecotoxicity potential increases by 259%, freshwater sediment ecotoxicity potential increases by 264% and terrestrial ecotoxicity potential increases by 195%.

Conclusions

Electricity is shown to be the major contributor to a household's annual lighting expenditure. The regulation would reduce the annual cost of electricity for lighting per household by CDN$85. Taking into consideration annual lamp replacement costs and additional heating fuel costs resulting from the regulation, the average Canadian home could see a reduction of CDN$73 per year in costs associated with lighting. If it is the sole intent of this regulation to reduce Canada's national GHG emissions, this analysis has found the regulation could be a low cost means of doing so. In fact, this regulation has the potential of meeting 1% of Canada's Kyoto emission reduction target (195 MtCO2e/yr). If this regulation has been developed with such goals in mind, policymakers may wish to consider implementing it sooner as the purported savings will only be realized once the transition to a CFL dominant residential lighting profile is complete.

References

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