

## Mexico: Efficient Lighting and Appliances project

### CTF review: Team's response to UK Comments

#### COMMENT #1:

However, I think it would be worthwhile doing the full lifecycle emissions calculation anyway in order to make the case for this project as robust as possible. I did some quick investigation into this and the research I came up with seems to support replacement of energy inefficient fridges (see attached study) even when factoring full emissions in. I'd be interested to see what you come up with.

#### RESPONSE:

We have calculated emissions due to manufacturing CFLs and appliances and the results are summarized in the table below:

Items manufactured	Emissions due to manufacture (tCO <sub>2</sub> e)	Emissions Reductions from 2011 through June 2014 (tCO <sub>2</sub> e)	Emissions Reductions through entire useful life of item <sup>1</sup> (tCO <sub>2</sub> e)	Emissions Reductions through entire useful life of item factoring CFCs (tCO <sub>2</sub> e)
45 million CFLs	95,000	3,300,000	10,800,000	10,800,000
1.7 million appliances	1,400,000	1,900,000	7,400,000	16,200,000

The data used is based on Model-Year 1997 refrigerators. It was assumed that the materials composition of the refrigerators remained unchanged between Model Years 1997 and 2014 (the final year of project implementation). This assumption can be justified since the overall design of refrigerators remains essentially unchanged. However, the change in refrigerants and blowing agents between 1997 and 2014 is included by factoring the emissions reductions due to the phase out of CFCs. New fridges no longer use CFCs but several existing fridges still do and the recycling centers utilized in the Project will avoid venting of CFCs.

It was also assumed that the manufacturing process remains unchanged between Model Years 1997 and 2014 and that transportation of refrigerators from plants to customers in Mexico was included in the manufacturing stage. This assumption does not reflect the efficiency gains under activities related to the Montreal Protocol; the results of this analysis are therefore conservative and lend credence to the merits of an appliance replacement program.

The Emissions Factor of 0.514 tCO<sub>2</sub>e/MWh was provided by CFE, *Comisión Federal de Electricidad* in Mexico. All energy consumed in the phases of Material Production and Manufacturing & Assembly was assumed to be electrical.

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<sup>1</sup> CFL useful life set at 8000 hours, Refrigerator useful life set at 10 years

**CONCLUSION IN RESPONSE TO COMMENT #1:**

Results based on LCA data are indicative as there could be differences between the data used to perform calculations and the actual emissions from the product manufacture. This analysis was intended to approximate and emissions reductions from the appliance replacement program are orders of magnitude greater than the emissions due to material production and manufacturing & assembly of appliances.

**COMMENT #2:**

Secondly, can you clarify how the marginal cost of abatement falls from US\$7/tCO<sub>2e</sub> to US\$3.08/tCO<sub>2e</sub> when CFC emissions are included? This is not a major point but clarification would be useful.

**RESPONSE:**

We are not using the marginal cost of abatement but rather the cost-effectiveness of CTF resources. Cost-effectiveness is calculated by dividing the amount of the investment by the number of emission reductions. The cost-effectiveness improves once CFCs are factored because the amount of the CTF investment (in the numerator) stays constant but the CO<sub>2</sub>-equivalent amount of emissions (in the denominator) increases once the global warming potential of the CFCs used as coolant is factored.

## ANNEX 1

Information for CFLs prepared using:

1. "LCA of CFLs - Appropedia: The Sustainability Wiki." Appropedia. Web. 15 Sept. 2010. <[http://www.appropedia.org/LCA\\_of\\_CFLs](http://www.appropedia.org/LCA_of_CFLs)>.

Information for appliances prepared using:

1. Horie, Yuhta A. Life Cycle Optimization of Household Refrigerator-Freezer Replacement. Rep. no. CSS04-13. Ann Arbor: University of Michigan, 2004. Print.

### Methodology for calculation of Emissions due to manufacture of 45 million CFLs

Manufacturing energy requirement per bulb = 4.1 kilowatt-hour (see LCA of CFLs – Appropedia)

$$\text{Emissions due to manufacture} = 4.1 \frac{\text{kilowatt hour}}{\text{bulb}} \times 0.000514 \frac{\text{tCO}_2\text{e}}{\text{kilowatt hour}} \times 45,000,000 \text{ bulbs}$$

### Methodology for calculation of Emissions due to manufacture of 1.7 million appliances

Material Production per appliance=1010 MJ (see Horie, 2004)

Manufacturing and Assembly per appliance = 4930 MJ (see Horie, 2004)

- Manufacturing Energy Requirement per appliance = 5940 MJ

$$\begin{aligned} \text{Emissions due to manufacture} \\ = 5940 \text{ MJ} \times 0.2777778 \frac{\text{kilowatt hour}}{\text{MJ}} \times 0.000514 \frac{\text{tCO}_2\text{e}}{\text{kilowatt hour}} \times 1,700,000 \text{ bulbs} \end{aligned}$$

Results based on LCA data are indicative as uncertainties could be quite large depending on differences between the data used to perform calculations and the actual emissions from the product manufacture.

The data used in the report by Horie is based on Model-Year 1997 refrigerators. It was assumed that the materials composition of the refrigerators remained unchanged between Model Years 1997 and 2014 (the final year of project implementation). This assumption can be justified since the overall design of refrigerators remains essentially unchanged. However, the change in refrigerants and blowing agents between 1997 and 2014 is included by factoring the emissions reductions due to the phase out of CFCs.

It was also assumed that the manufacturing process remains unchanged between Model Years 1997 and 2014 and that transportation of refrigerators from plants to customers in Mexico was included in the manufacturing stage. This assumption does not reflect the efficiency gains under activities related to the Montreal Protocol; the results of this analysis are therefore conservative and lend credence to the merits of an appliance replacement program.

The Emissions Factor of 0.514 tCO<sub>2</sub>e/MWh was provided by CFE, Comisión Federal de Electricidad in Mexico. All energy consumed in the phases of Material Production and Manufacturing & Assembly was assumed to be electrical.