Proposal for Decorative Light Strings for Inclusion as Part of the ENERGY STAR Program Version 1.1

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I. Introduction

Even though the holiday season last only a few weeks of the year, the conversion of holiday lights from incandescent to more efficient light sources would generate considerable energy savings. One of the latest technology developments for this application is the light emitting diode (LED) technology that has only become available to Canadian consumers in the last few years. This energy efficient product, which uses up to 90% less energy than its incandescent counterpart, would have a considerable impact during critical heating season months, reducing demand during peak periods.

Due to recent technology developments and the potential for energy savings, the Office of Energy Efficiency (OEE) of Natural Resources Canada (NRCan) is proposing that this product be considered as a candidate for the ENERGY STAR Program. To determine the feasibility for any new ENERGY STAR product category and the corresponding performance-based specifications, EPA and DOE follow a set of six key principles (EPA & DOE, 2003).

1. Significant energy savings can be realized on a national basis
2. Product performance can be maintained or enhanced with increased energy efficiency
3. Purchasers will recover their investment in increased energy efficiency within a reasonable period of time
4. Energy-efficiency can be achieved with several technology options, at least one of which is non-proprietary
5. Product energy consumption and performance can be measured and verified with testing
6. Labeling would effectively differentiate products and be visible for purchasers

The purpose of this document is to show that creating an ENERGY STAR program for decorative light strings is in line with these six key principles. This document provides preliminary market and testing information, focused primarily on the benefits of decorative LED strings. A draft ENERGY STAR eligibility criteria document (Attachment 1) and test procedure (Attachment 2) for light strings are also included with this proposal.

II. Energy Savings (Guiding Principle #1)

Even though the holiday season is just a few weeks of the year, the conversion of holiday lights from incandescent to more energy efficient sources, such as LEDs, would generate considerable energy savings.

In Canada

A study conducted in British Columbia (BC) on consumption for residential holiday lighting in 2002, shows the electrical consumption attributable to holiday lighting was **73.1** gigawatt-hours (GWh). Extrapolating this figure by population for total decorative

energy consumption, the national consumption is approximately **584.8 GWh** per year. The potential annual energy savings of a complete market shift to decorative light-emitting diode (SLED) strings would be approximately **555 GWh**. Converting only **20%** of the 10 million strings sold in Canada from incandescent to LED in Canada would result in annual energy savings of approximately **110 GWh.**

In 2003, approximately 470,000 sets of SLED stings were sold in the province of British Columbia. It is estimated that the province of BC saved approximately **4 GWh** in 2003 (based on an annual savings estimate of 8.5 kWh per string).

In the United States

Holiday lights in the U.S. can be found donning the thirty-four million holiday trees sold annually in the U.S., as well as decorating the exteriors of residential and commercial buildings. A 2003 study estimates the annual energy consumption of *miniature* holiday lights based on the product of the installed base of lights in the U.S., the annual operating hours, and the wattage of each lamp. Consuming 0.4 watts each, the installed base of 37.1 billion miniature incandescent lamps operating for 150 hours per year consumes approximately **2220 GWh** of electricity (NCI, 2003).

An LED miniature holiday light consumes only 0.04W, or 90% less than its incandescent counterpart. The potential annual energy savings from just a 20% market shift to LED holiday lights is approximately **400 GWh** (NCI, 2003). If this estimate included light strings other than miniature lamps, such as C-7 or C-9 lamps, the potential savings would be even greater.

III. Product Performance (Guiding Principle #2)

Along with significant energy savings, the adoption of LED sources would be accompanied by other benefits, including a longer operating lifetime and a safer and more durable product. Each year, the performance of products released into the market improves. For instance, several years ago, LED products appeared dim when compared with incandescent products. However, products introduced in 2004 and 2005 were significantly brighter, almost on par with incandescent strings.

Not only do LEDs have significantly longer operational life characteristics than incandescent lamps, but they also produce little heat and remain cool to the touch, making them safer around combustible materials. SLED lamps are also encapsulated in an epoxy plastic resin, making them more resistant to shattering or impact damage during installation or disassembly.

Because LED chips generate little heat and do not rely on deteriorating materials to generate light, LEDs are proven to have a long operating life. That said, this statement does not take into consideration the fact that the light output of LED lamps (LED chips mounted in an encapsulant) does decrease slowly over time, and at present, there is no industry-accepted test standard to measure operating lifetime of these devices. Manufacturers offer up to a 5 year limited warranty on LED decorative lights, but claim

product lifetimes up to 200,000 hours (more than 20 years of continuous operation). This claim would have to be considered in the context of the life of the product envelope. The issue of warranty, stated operating life, and appropriate test procedures for determining operating life will be discussed during the development of the ENERGY STAR criteria for this product.

Being a relatively new product on the market, there are some instances of SLED strings having had a high failure rate. Study of these failures was found to be related not to the LED source itself, but rather poor manufacturing quality. Through the introduction of an ENERGY STAR program for decorative light strings, higher quality products can be more readily identified and consumer confidence in this technology can be constructed. This program would be an important strategic move for ENERGY STAR, particularly in regard to the emergence of white-light LEDs in general illumination applications around the world.

The specification document (Attachment 1) provides a list of proposed product characteristics and performance specifications for decorative light strings. A test protocol (Attachment 2) was developed by Powertech Labs for BC Hydro to further qualify this product for quality purposes. Related test standards are also listed in the specification document.

Although the technology has been proven to be energy-efficient and long lasting, there are still several quality issues that must be addressed. A series of tests on **outdoor** SLED strings were conducted in 2004 by Powertech Labs in British Columbia to determine the durability of this product compared to the existing incandescent light bulbs in varying weather conditions. The test cycles included periods of rain and periods of intense heat. It is estimated that this test procedure simulates approximately 10,000 hours or about 14 months of actual outdoor exposure. The study pointed out specific problems with the SLED stings, where corrosion became a problem in some models when they were exposed to high humidity levels. This issue will be discussed during the development of the criteria for this product, as the problem is not related to the LED lamp itself, but rather the packaging and product envelope. As manufacturers improve product design and packaging, this issue is being addressed.

IV. Payback on Investment (Guiding Principle #3)

A simple economic and energy consumption analysis of decorative light strings shows that C7 LED and miniature LED lamps are cost effective replacements for C7 incandescent decorative light strings, which are often used in outdoor applications. This analysis is based on decorating one 8-foot tree for ten holiday seasons. In this example, five C7 incandescent strings (25 lamps/string), are replaced with two alternative energy-efficient options: (1) five C7 SLED strings (25 lamps/string), or (2) four “miniature” SLED strings (70 lamps/string).

The assumptions for the analysis are outlined below:

- Hours of operation: 5 hrs/day for 30 days (150 hrs/year)
- Price of electricity (national average): CAD$0.12 per kWh.
- Estimated life span for incandescent light string: 5 years
- Estimated useful life span for SLED string: 5 years
- Average cost of C7 SLED string: $14
- Average cost of “mini” SLED string: $13
- Average cost of incandescent C7 string: $5

Based on data from BC Hydro and holiday light manufacturers, the following table outlines the cost, monetary savings, energy savings, life-cycle cost, and payback of LED holiday lights compared to C7 incandescent decorative light strings. The simple payback for C7 LED light strings is approximately 5.5 years. The simple payback for “mini” LED lights strings is approximately 3.1 years.

Table 1: Economic Analysis of Replacing Incandescent Light Strings with LED Strings

	C7 Incandescent Tree (5X25-lamp strings)	C7 LED Tree (5X25-lamp strings)	"Mini" LED lights (4X70-lamp strings)
Wattage	500 watts	50 watts	11.2 watts
Initial Cost	$25	$70	$52
Replacement Strings	1	0	0
Hours of Operation	150 hours	150 hours	150 hours
Annual Electricity Cost ($CAD)	$9.00	$0.90	$0.2
Total Life-Cycle Cost (including Replacements)	$70	$75	$76
Simple Payback		5.5 years	3.1 years
Energy Consumed per Year	75 kWh/year	7.5 kWh/year	1.68 kWh/year
Energy Saved		67.5 kWh/year	73.3 kWh/year

Sources: BC Hydro Website, 2005; WSU & NEEA, 2005; NCI, 2003; Carillon Products, 2006..

If a homeowner replaced the decorative lights on only his tree, he would save over $5 each year on energy costs, and between 68 and 73 kWh of energy would be saved. If that same homeowner were to replace all the lights used for decoration outdoors, these savings would increase several fold. And, if this number is extrapolated over the population of Canada and the U.S., significant energy savings would accrue.

V. Technology Options and Product Availability (Guiding Principle #4)

The province of British Columbia has witnessed consumer acceptance following the promotional activities held there in the past few years. The success of the promotional campaigns influenced retailers to sell this product nationally, with some exclusively carrying the LED products as decorative light strings. Another retailer has decided that

50% of its light strings would be SLEDs. Consumers across Canada have reacted positively to adopting this new product when decorating their homes for the holiday season.

Distributors of SLED strings in Canada offer a whole range of products characterized by the string's length and the color and size of the lamps. While decorative lighting technology is still in its infancy, there are a growing number and selection of SLED strings available every year. LED lights strings are currently available in strings from 25 to 150 lamps, in a variety of colors including red, green, blue, white, yellow, and multi-colored. These lamps are also offered in several styles including: miniature, ball-shaped (raspberry), C-7, C-9, candle shaped, and icicle-style lamps. In 2005, several new products entered the market, including rope lights, strings with lamps that can change colors, and strings with commercial-grade plugs that allow more than 100 strings to be connected end-to-end (NEEA & WSU, 2005).

Each holiday season, as manufacturers improve on the existing delivery envelope of this technology, consumers have witnessed continual improvements in the quality and reliability of these products.

VI. Performance Testing (Guiding Principle #5)

Powertech Labs in British Columbia has developed a preliminary decorative light test procedure specifically for SLED strings (see Attachment 2) (PowerTech Labs, 2005). This test procedure, "Powertech Labs / BC Hydro Decorative Light String Test Protocol" was originally developed to test products for a BC Hydro rebate program. NRCan would like to continue the development of this protocol, so that it can serve as the test procedure for an ENERGY STAR program for this product.

There are also two safety standards available for decorative lighting:

- CSA-22.2 No.37-M1989 (R1999) *Christmas Tree and Other Decorative Lighting Outfits*
- UL 588-2000 *Standard for Seasonal and Holiday Decorative Products*

VII. Product Visibility (Guiding Principle #6)

BC Hydro has introduced this product into the Canadian marketplace by promoting SLEDs strings starting in 2002. In 2003, based on the huge success of the 2002 campaign, the province contacted Canadian retailers to bring SLED lights into the province on a trial basis. In order to raise awareness about the technology, BC Hydro and the Office of Energy Efficiency, Natural Resources Canada, held a highly successful product promotion in the autumn of 2003. Through the BC Hydro program in 2005, over 46,000 in-store coupons were distributed, over 18,000 mail-in coupons have been redeemed, and nearly 57,000 incandescent strings were collected.

Since SLEDs are a fairly new technology for decorative lighting strings, the SLED product is not yet easily recognized by the consumer as an superior, energy-efficient

product compared the incandescent strings. Distributors will also likely be marketing the SLED strings as an "energy-efficient" lighting product to attracting customers. The addition of an ENERGY STAR label will increase the perception that these products are an energy-efficient, quality alternative to conventional incandescent strings.

VIII. Conclusion

With new technology offering the possibility of energy savings, lower consumer consumption during peak hours, longer operating life, higher operating efficiency, high durability, and a good payback on the initial investment, NRCan's Office of Energy Efficiency strongly supports the initiation of discussions with stakeholders in time to enable the ENERGY STAR label to be available for the 2006 holiday season. To this end, NRCan is convening a one-day stakeholder meeting to review the draft ENERGY STAR test procedure and qualification criteria in Toronto, Ontario, on Monday, March 6, 2006.

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