ENVIRONMENT COMMITTEE – APRIL 13, 2010

ENERGY EFFICIENT STREET LIGHT PILOT PROJECT
CITY WIDE

Recommendation

The Commissioner of Engineering and Public Works recommends that:

1. The City of Vaughan use Light Emitting Diodes (LED) luminaire technology for the Street Light Retrofit Capital Project PW-2033-09 based on the initial results of the pilot project and the independent review of the current energy efficient street light luminaire technologies by Lumentech Engineers Inc.;

2. Staff be authorized to issue a Request for Proposal to a targeted list of suppliers for the supply and installation of LED street lights and the removal and recycle/disposal of existing street lights based on the terms of reference outlined in this report and the technical specifications provided by Lumentech Engineers Inc. with funding from Street Light Retrofit Capital Project PW-2033-09;

3. Lumentech Engineers Inc. provide assistance in the evaluation of the Request For Proposals; and,

4. Staff undertake a review of the City's engineering design criteria and standards to assess the appropriateness of requiring the use of LED luminaire technology in new and retrofit situations wherever practical.

Contribution to Sustainability

The energy efficient street light retrofitting project is in keeping with the Goals and Objectives of sustainability and the Green Directions Vaughan because it involves the replacement of old street lights with luminaires that:

- are more energy efficient;
- produce better quality of light (white light versus amber light);
- have a lower carbon footprint with consideration of the manufacturing process, longer life and the recycling capability; and
- lower maintenance/cleaning costs.

The outcome of this project will provide input to the development of new street light standards in the City which are more environmentally friendly, sustainable and cost effective.

Economic Impact

There is no economic impact upon the adoption of this report.

The City was successful in obtaining contribution funding through the Building Canada Fund, Infrastructure Stimulus Fund Program (ISF) for an energy efficient streetlight retrofit project. A total of $1.5 million dollars was awarded to cover the project cost with one third contribution from each level of government ($500,000 Federal, $500,000 Provincial and $500,000 City). It is expected that this funding will provide for the retrofitting of some 1,500 to 2,000 existing street lights in the City with energy efficient luminaries. The mandatory completion date for the street light retrofit project is March 31, 2011 pursuant to the requirements of the ISF Program. The Energy Efficient Street Light Retrofit Project is included as Project PW-2033-09 in the approved 2009 Capital Budget.

Communication Plan

A communication plan will be developed in conjunction with the implementation stage of the Energy Efficient Street Light Retrofit Project.

Purpose

The purpose of this report is to provide the Environmental Committee with the initial results of the Energy Efficient Street Lighting Pilot Project which was approved by Council on June 15, 2009, and to seek authorization from Council to issue a Request for Proposal for the retrofitting of older existing street lights in the City with Light Emitting Diodes (LED) luminaire technology.

Background

Council, at its meeting on June 15, 2009, adopted Item 1, Report No. 5, of the Environmental Committee which recommended:

1. *That the proposed energy efficient street lighting pilot projects be implemented as outlined in this report;*

2. *That staff report back on the results of the pilot projects after one full year of testing; and*

3. *That staff be authorized to test and evaluate additional energy efficient lighting systems subject to the lighting supplier providing the City with at least five luminaires at no cost for a period of one year.*

Two status update reports were presented to the Environmental Committee, one on December 14, 2009, and the other on March 9, 2010.

Installation of pilot lights

In response to Council's direction, staff established a program to test three different types of street lights including Induction Lighting (IL), High Efficiency Fluorescent Lighting (HEF) and Light Emitting Diode Lighting (LED). Each of these lights was purported to provide substantial energy savings while meeting the City's street light illumination standards. The three light types were installed on September 21, 2009, in groups of five lights on existing street light poles along Islington Avenue in Kleinburg next to the existing High Pressure Sodium (HPS) street lights. Each street light pole included a sign tab which identified the specific type of light on the pole. In late January 2010, a LED street light from a new manufacturer was added to the pilot project.

Public Survey

A survey was placed on the City's web page to solicit public feedback and comments on the various different luminaire types being tested in the pilot project. A total of 48 survey submissions were received. About 39% of the people who responded preferred the LED lights and about 34% expressed a preference for the light from the Induction/High Efficiency Florescence luminaires. Interestingly, 10 respondents or 26% of those surveyed expressed a preference for the existing HPS lights because it produces a softer and warmer light.

Pilot Project Field Test Results

In October 2009, the City retained RTG Systems to conduct field testing on the different luminaires to determine the adequacy of the light in terms of intensity, distribution and light

quality. The light intensity and distribution of each light type was established in the field by using a light meter. In addition, the City retained the firm of Langley Utilities Contracting Limited to bench test each light type to measure the actual energy consumption. The collected data on each light type was compared to the existing City standards and the manufacturer's specifications.

In the field measurement analysis, none of the test lights met the City's design criteria from a light level and uniformity perspective. This may be attributed to the fact that along Islington Avenue the poles are offset from the edge of pavement substantially more than the norm. Accordingly, the test results cannot be used to compare the performance of the luminaires.

The bench test measurements revealed that the actual energy consumption for each pilot street light was greater than specified by the manufacturers.

Independent Consultant Review

The City retained the services of Lumentech Engineers Inc. to undertake a technical review of the energy efficient street light technologies that were included in the pilot project. The scope of the assignment included an analysis of each light type in the pilot project with consideration for the following factors:

- Life span
- Adequacy of light (intensity & distribution)
- Quality of light and colour
- Energy consumption
- Capital and maintenance costs
- Retrofit compatibility
- Recyclability & environmentally sensitive by-products

In March 2010, Lumentech produced a report that documented their review and findings. The Lumentech report provides an overview of the present and new streetlight technologies which is summarized below:

Present Street Light Technology

Present street lighting technology is based on High Intensity Discharge (HID) light sources. There are two HID light sources commonly used for street lighting applications, in particular, High Pressure Sodium (HPS) and Metal Halide (MH). Both of these light sources were developed in the 1960's, and until recently, were considered to be the most efficient light sources available in terms of energy efficiency and optical controllability. HPS is the more efficient light source compared to MH. However, when colour rendering is important, MH lamps are used.

New Street Light Technology (LED & Induction)

Street lighting technologies have evolved in the past several years because of the availability of new light sources. Two of the new light sources available at present are solid state device Light Emitting Diodes (LED) and Induction Lighting (IL).

Light Emitting Diodes (LED)

A typical LED luminaire used for street lighting applications has highly engineered optical control systems designed to distribute the light uniformly onto the road pavement surface. The LED units have built-in micro-optics such that each LED acts as an independent luminaire to produce the desired light distribution characteristics. The results are that luminaires can be spaced far apart to minimize pole quantities and installation costs. LED lamps require special drivers to convert

the standard AC voltage to constant current DC power. These drivers consume small amounts of power during operation.

Research into more efficacious LED's is ongoing, and new technical breakthroughs are being engineered at a rapid pace. The forecast is that we will see LED's in commercial production that will produce 150 to 200 lumens per watt within two to three years, perhaps even less.

The general characteristics of a LED Luminaire are:

- High lumen output
- High lumen per watt energy consumed (80 Lumens per Watt)
- Long lamp life, 100,000 hours
- Low carbon footprint
- Instant on (no warm-up time)
- White light, excellent Colour Rendering Index (CRI) – 75 CRI
- Starting temperature as low as -40 F
- Low maintenance/cleaning costs

Induction Lighting

Induction lighting technology is based on the well-established fluorescent lamp design. It is effectively a fluorescent technology without the electrodes. This system consists of an inductively coupled florescent lamp and high frequency ballasts. In this case, magnetic induction is used to power the lamp instead of electrodes at each end. Removal of the electrodes eliminates one of the major life limiting components of florescent lamps. However, owing to the relatively large size of the light source, Induction lamps lack precise optical controllability, and this compromises the uniform distribution of light, which is a major consideration in street lighting application.

The general characteristics of an Induction Luminaire are:

- High lumen output
- High lumen per watt energy consumed (72 Lumens per Watt)
- Long lamp life, 100,000 hours
- Fast warm-up time
- White light, excellent Colour Rendering Index (CRI) – 80 CRI
- Starting temperature as low as -40 F,

Both Induction and LED luminaires have long lamp life and good colour rendering; however, LED lights have slightly better energy efficiency. In addition, LED luminaires have highly engineered optical control systems which distribute light onto the road pavement surface more efficiently than Induction luminaires.

<u>Retrofit Application</u>

The objective of the Energy Efficient Street Light Project is to retrofit some 1,500 to 2,000 existing cobra head style street lights in the City with energy efficient luminaries. Accordingly, a key component of Lumentech's assignment was to assess the applicability of each of the pilot luminaires to a retrofit situation. To undertake this assessment, Lumentech used specialty engineering software to determine whether the test luminaires could provide the necessary illumination levels and light distribution to meet City standards in a retrofit situation. The software uses photometric distribution tables that were provided by the manufacturer of each luminaire to model light levels for a specified pole spacing, pole height and road cross-section. Lumentech modeled each luminaire under both a standard local and collector road scenario. The City's current illumination standards outlined below.

Road Classification	Illuminance Level	Light Uniformity
Collector Road (Std. B-10)	10 Lux	3:1
Local Road (Std. B-11)	6 Lux	6:1

It is important to note that the City's illumination standards for local roads are higher than a number of the neighbouring municipalities.

The numeric results of the modeling exercise are shown on the following two tables.

Retrofit Luminaire System Performance Comparison Local Road (6 Lux – 6:1 Uniformity Ratio)					
	Manufacturer	**Illuminance**	**Uniformity**	**Input Watts**	**Unit Power Density**
LED	(A)	**5.9**	**2.03**	**105**	**0.23**
	(B)	**7.0**	**5.4**	**105**	**0.23**
	(C)	3.6	36.1	107	0.23
INDUCTION	(A)	5.5	13.7	137	0.30
	(B)	8.1	9.01	100	0.22
HPS	Cooper	**6.2**	**3.1**	**135**	**0.30**

Retrofit Luminaire System Performance Comparison Collector Road (10 Lux – 3:1 Uniformity Ratio)					
	Manufacturer	**Illuminance**	**Uniformity**	**Input Watts**	**Unit Power Density**
LED	(A)	**12.05**	**1.67**	**160**	**0.39**
	(B)	**11.24**	**2.4**	**135**	**0.34**
	(C)	5.8	28.9	107	0.27
INDUCTION	(A)	11.9	5.9	200	0.49
	(B)	10.2	4.4	120	0.29
HPS	Cooper	**12.5**	**2.08**	**185**	**0.45**

The computer modeling exercise revealed that only two of the LED luminaires plus the existing High Pressure Sodium luminaires produced light levels that met City standards under both the local and collector road scenarios. In addition, the Unit Power Density (which is the amount of energy that is used to illuminate one square metre of roadway) associated with the LED luminaires is relatively low compared to the other bulb types, which is an indicator of greater energy efficiency.

Summary of Evaluation

The following table captures the main results of the evaluation:

Criteria	LED Manufacturer "A" and "B"	LED Manufacturer "C"	Induction	HPS
Meet City Illumination Design Criteria	Yes	No	No	Yes
Approximate Cost per Unit	$725-$745	$380	$375 -$475	$300
Energy Cost	Low	High	Medium-High	Medium
Annual Maintenance Cost	Nil	Nil	$20	$20
Approx. Lamp Life	100,000 hours	100,000 hours	100,000 hours	20,000 hours
Retrofit Capability	Yes	No	No - Light levels and uniformity did not meet City standards	Existing Luminaires
Carbon Footprint	Low	Low	High	High

As shown in the above table, LED luminaires offer a number of tangible benefit compared to the Induction lights.

Economic Considerations

The initial capital expenditure and life cycle operating and maintenance costs are key considerations in making the right decision on a preferred luminaire type. Accordingly, Lumentech undertook a life cycle cost analysis for the luminaires that met the City's illumination standards under a retrofit scenario. The scope of the financial assessment included the capital costs associated with the supply and installation of 100 luminaires, and the associated operating and maintenance costs over a 30 year life cycle. The results of this analysis are presented in the table below.

Retrofit Life Cycle Cost Benefit Analysis	
Luminaire Manufacturer	**Present Value Life Cycle Cost**
Manufacture "A" LED	$153,644.07
Manufacture "B" LED	$162,997.02
HPS	$159,679.01

It can be seen from that the LED luminaire offers good value from a life cycle cost perspective when compared to the current HPS luminaires. A life cycle cost assessment wasn't conducted on the Induction luminaire because the modeling results showed that the expected light levels from

the luminaire didn't meet City Standards. Notwithstanding this, the present value life cycle cost for an Induction Luminaire is not expected to be lower than the LED because of the extra energy and maintenance costs associated with this luminaire technology.

Street Light Projects by other Municipalities

Many municipalities across Canada and the United States are assessing the cost benefit of using new energy efficient street lighting systems in both new and retrofit situations. Through their experience, Lumentech has provided the following recent examples of street light projects in other municipalities.

- **North Bay, Ontario**
  The City of North Bay has installed a small quantity of induction and LED luminaires on a retrofit basis. The luminaires were supplied by various manufacturers on a trial basis. The City staff is planning on carrying out some test on the installations. They have not come to a definitive conclusion as to the preferred type of light.

- **City of Mississauga, Ontario**
  The City of Mississauga in collaboration with Enersource Hydro has retained the services of an engineering consultant to review "New Technology" street lighting and its application to the streets of Mississauga. A preliminary report has been completed and based on its recommendations; the City is planning on a trial installation of 10 luminaires each from four manufacturers on local and collector streets. This installation will be installed in May of this year. The City and the consultant will carry out illumination measurements and visibility assessments. Based on the results of the evaluation the City proposes to install a large number of luminaires on a retrofit basis.

- **Town of Cobourg**
  The entire Town's street lighting system was changed to induction luminaires with reported good success. It is unclear whether the light levels meet the uniformity criteria set out in the IES illumination standards for local and collector roads.

- **Town of Penetanguishene, Ontario**
  The Town retrofitted a total of 278 of their existing 250W mercury street lights with 104W LED luminaires. The resultant energy savings was estimated to be 63.6%. Mercury lamps represent 50 year old technology and are no longer available for street lighting applications.

- **The City of Brockville**
  The City of Brockville is in the midst of retrofitting 1,200 70-watt old street lights along local street, with 40-watt Induction Lighting from Everlast (a manufacturer in South Korea), at about $400 each, supply and install. Staff understands that the City of Brockville's decision to use Induction lighting was based on the manufacturer's claimed energy savings.

- **City of Greensburg, Kansas**
  In May of 2007 a tornado struck the community and devastated the community with less than 10% of the buildings standing. As part of the rebuilding program the City decided to upgrade their street lighting to energy efficient and environmentally sensitive LED light sources. 303 HPS street lights were changed to LED. It was estimated that the City will save 70% in energy and maintenance costs and 40 Tons in CO2 emissions.

- **City of Los Angeles, California**
  6th Street Bridge, Los Angeles uses 100 LED luminaires streetlight with 40 LEDs, each consuming 90W. LED streetlights replaced 100 watt to 150-watt high-pressure sodium (HPS) fixtures. LED streetlights reduce the City's energy use by approximately 40% and lower carbon emissions by an estimated 40,500 tons per year (or the equivalent of taking 6,700

cars off the road). The City is expected to save approximately $10 million annually from a combination of reduced energy use and lower maintenance costs.

- **City of Ouray, Colorado**
  The City replaced approximately 100 – 400 Watt old technology mercury street lights with 105 Watt & 90 Watt LED luminaires. Estimated energy savings is 50%.

University of Pittsburgh – Life Cycle Assessment of Street Light Technologies

In July 2009, the University of Pittsburgh PA released a very detailed report that presents a cradle-to-grave assessment of current streetlight technologies. A key finding of this assessment indicates that LED street lights strike the balance between brightness, affordability, and energy and environmental conservation when their life-span from production to disposal is considered.

Ontario's Guiding Lights Document

An organization called Local Authority Services (LAS), published a report entitled "Ontario Guiding Lights – Street Lighting" to help inform Ontario municipality's decision making around existing and new street light applications. This report assesses various aspects of street lighting including technological, economic, and environmental performance of current and emerging technologies. The key findings of the report are abbreviated below:

1. A retrofit solution exists for HPS fixture replacement programs that enhances energy efficiency and mitigates environmental issues.

2. The significant energy savings for LED and Induction street lighting stated in the product design evaluations have been verified by actual field testing. Induction products have proven acceptable as a new fixture retrofit. Current LED products proved to unsatisfactory as an economic application to existing infrastructure due to light output and coverage weakness.

It is important to note that the LED luminaires that were assessed under the LAS study appear to be older "first generation" technology. It is apparent from the City's pilot project that LED technology has advanced since the LAS study to address the illumination concerns associated with the early generation technology.

Request For Proposal

Given the technical and logistical complexities associated with a street light retrofit project, it is recommended that a Request for Proposal (RFP) procurement process be followed to select a suitable supplier/installer consortium in accordance with City Purchasing Policies.

The RFP will include the City's standard requirements plus a rigid performance specifications based on road geometry, and fixed system geometry and the design criteria set by the City. In addition, each bidder will be required to perform lighting calculations using independent software. These calculations will have to be reviewed by a lighting consultant/engineer for compliance. Those manufacturers who can meet the City's street light design criteria based on fixed pole spacing will be considered as candidates for submitting a RFP. The RFP will require the bidder to engineer, supply and install of new luminaires, and disposal of the old street lights and hardware in an environmentally friendly manner. The submitted Proposals will be evaluated based primarily on the quality/warranty of the product, reputation of bidder in the lighting industry, technical competency, pricing, and being able to comply with the City's tight schedule (The finish date is March 31, 2011).

Site Selection

Site selection is an important aspect of new energy efficient street lighting technologies. A combination of collector and local roads will be part of the retrofit program.

Luminaire Sizes

Based on the sites selected, the luminaire watts will relate to the road classification. Collector roads with high pedestrian conflict may require 150 to 200W and local roads 50 to 100W luminaire types. Prior to initiating the purchase, sites will be selected and the required type and number of luminaires established.

Delivery

The delivery period for LED luminaires is generally 6-8 weeks. The delivery period will be specified due to the limitations imposed by funding for this project.

Installation

The RFP shall include removal and disposal of the existing HPS luminaires in an environmentally friendly manner.

Following receipt and analysis of the proposals, staff will prepare a report to Committee of the Whole to recommend a contractor for the supply and installation of new street light fixtures and to obtain approval of the specific streets on which the fixtures are to be installed.

Relationship to Vaughan Vision 2020/Green Directions Vaughan.

In consideration of the strategic priorities related to Vaughan Vision 2020, and the "Green Directions Vaughan" (which is the Community Sustainability and Environmental Master Plan", this pilot project will complement/assist the following:

- Enhance and Ensure Community Safety, Health & Wellness;
- Lead and Promote Environmental Sustainability;
- Pursue Excellence in Service Delivery; and
- Actions planned under Objective 2.1.4. of the Community Sustainability and Environmental Master Plan:- "Examine Energy Conserving Streetlight Pilots"

Regional Implications

There is no immediate Regional implication resulting from the adoption of this report.

Conclusion

The Energy Efficient Street Lighting Pilot Project was initiated in early September 2009, to assess the suitability of LED and Induction luminaire technologies as a retrofit solution. Staff has advanced the timing of the pilot project to meet the requirements of the Infrastructure Stimulus Funded Program.

Based on the results of the pilot project, it is clear that both LED and Induction luminaires have long lamp life and good colour rendering. In addition, LED luminaires have highly engineered optical control systems which distribute light onto the road pavement surface more efficiently than Induction luminaires. Based on testing and computer modeling, LED lights are expected to have slightly better energy efficiency than Induction luminaires. LED has the lowest carbon footprint as compared to HPS and Induction Lighting. By all accounts, LED technology and luminous efficacy will continue to improve rapidly over time. Accordingly, there is little doubt that the future of street lighting will be based on LED technology.

Accordingly, it is recommended that the City use Light Emitting Diodes (LED) luminaire technology for the Street Light Retrofit Capital Project PW-2033-09 based on the initial results of the pilot project and the independent review of the current energy efficient street light luminaire technologies by Lumentech Engineers Inc.. The targeted areas of retrofit will be the older areas where the street lights are scheduled to be replaced, or contemplated to be replaced, in the near future.

The next step in the project is to issue a Request for Proposal to a targeted list of suppliers for the supply and installation of LED street lights and the removal and recycle/disposal of existing street lights based on the terms of reference outlined in this report and the technical specifications provided by Lumentech Engineers Inc. Should Council concur, the recommendations of this report could be adopted.

Attachments

There is no attachment associated with this report

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