ENVIRONMENT COMMITTEE – MAY 26, 2009

ENERGY EFFICIENT STREET LIGHTING REVIEW

Recommendation

The Commissioner of Engineering and Public Works recommends:

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.

Economic Impact

Each pilot project is estimated to cost the City approximately $5,000 for the installation of the new street light fixtures and the retainer of a consultant to investigate the adequacy of the test street lights. Sufficient funds are available in the 2009 Public Works Operating Budget to cover the cost of three pilot projects.

Communication Plan

Once the logistics of the pilot project are finalized, the property owners in the immediate vicinity of test street lights will be notified of the undertaking and promotional information will be placed on the City's web site.

Purpose

This report represents an analysis of present technology in the field of energy efficient street lighting and a proposal to implement two pilot projects.

Background - Analysis and Options

Council, at its meeting on May 22, 2007, adopted without amendment Item 3, Report No. 25, of the Committee of the Whole Working Session which recommended:

1. *That the recommendation contained in the following report of the Commissioner of Engineering and Public Works, dated May 8, 2007, be approved;*

2. *That staff provide a report on alternative opportunities with respect to this matter, including reducing light pollution, energy use and related costs;*

3. *That staff review the results of Toronto's pilot project in relation to the subject matter and report back;*

4. *That the subject report be forwarded to the Environmental Task Force to assess the associated environmental issues;*

5. *That alternative energy efficient lighting methodologies be explored, including the use of LEDs and that a report be provided to a future CW (WS) meeting for discussion; and*

6. *That the presentation of the Supervisor, Infrastructure Management, and presentation material submitted entitled, "Pole and Streetlight Maintenance and Rehabilitation Program", be received.*

This report addresses Items 2 and 5 of Council's direction noted above. The initiative with respect to reducing lighting pollution in the City is a complex problem which requires considerable investigation and a thorough evolution of potential solutions. Accordingly, this matter will be the subject of a subsequent report to Council. This report also provides an update on the City of Toronto's pilot project referenced in Item 3 above.

Street light Inventory

The City owns and operates the street lights on all City and Region roads with the exception of the street lights at Regional road intersections, on Yonge Street and on Highway # 7 between Yonge Street and Kipling Avenue. All of the Region's street lights have an identification band on them showing the Region's logo and pole number.

The City currently has an inventory of almost 31,000 street lights. The majority of these street lights are mounted on City owned poles; however, some street lights are mounted on hydro poles owned by PowerStream. The City's street light system is operated and maintained by the Public Works Department and includes a variety of luminaire types, styles, bulbs, pole types and bulb wattages. In particular, the luminaires in the City include:

- Cobra head
- Coach lamp (2 styles – top mount and side arm mount)
- Shoe box
- Saucer

Illumination Types (Light Bulbs):

- High Pressure Sodium (HPS)
- Mercury Vapour (Approx. 30-40 decorative fixtures left in the City)

Poles:

- Concrete (both plain and decorative types)
- Steel
- Wood

Wattages:

The wattages range from 70 to 400.

The cost to maintain the current street light system is almost $3.13 million per year, of which $1.49 million is energy costs. Since the cost of energy is almost 48% of the total cost to operate the system, it is important that the City investigate alternative street lighting types in order to ensure that the system is not only cost effective, but energy efficient as well.

The common light bulb has undergone continuous improvements to its efficiency and make up since it was first invented. From the early incandescent to mercury vapour to the current High Pressure Sodium (HPS) bulbs, the City's street lighting standards have been updated to keep current with the changes in technology.

Now, there is a new generation of energy efficient street lighting on the market including Light Emitting Diodes (LED's), Induction Lighting, and High Efficiency Fluorescent bulbs (HEF). In addition, new electronic ballasts are more energy efficient and longer lasting than traditional

magnetic ballasts, and remote controllers are now being used by some municipalities to dim or turn off street lights as a means of reducing energy consumption.

Present-Day Streetlight Technology

The present-day street light luminaire technology can basically be grouped under four (4) categories:

1. High Intensity Discharge (HID) Lighting
2. Light Emitting Diode (LED) Lighting
3. Induction Lighting
4. High Efficiency Fluorescent (HEF)

The advantages and disadvantages of each of the above luminaire types are overviewed below.

High Intensity Discharge (HID) Lighting

High Intensity Discharge fixtures have been predominant throughout Ontario and continue to be the standard for the street lighting industry. The basic HID lamp styles are metal halide, low pressure sodium, high pressure sodium (HPS), and mercury vapour. While all variations of these products are known to be used in the street lighting applications, high pressure sodium (HPS) lamps are the dominant application. HPS produces a high intensity amber-white light.

A HPS lamp together with a magnetic ballast street light assembly initially operate with a high reliability factor and failure rates that would be considered very low (in the 1% range) during the start-up and early operating years. Twenty five (25) years have passed since the last major street light upgrade and the failure rate has grown. At this point, the replacement rate can be as high as 15% per year. This rate could be significantly mitigated through a group re-lamping program; however, funds for this project fell below the funding line for 2009.

The life expectancy of HPS lamp is approximately 24,000 hours. The replacement cost for the bulb is approximately $40 and the replacement cost of a ballast is approximately $110. Although it is not normally required, fixtures are replaced at a cost of approximately $250 each (excluding parts).

Light Emitting Diode (LED) Lighting

LED technology is widely known to be the best replacement technology for traffic signal lights and exit signs in buildings because it can produce significant energy savings over a 24 hour / 365 days operating time period. Rapid development in this technology is expected in the next 1-1/2 to 2 years. LED produces white light requiring a coloured lens for these applications.

A few municipalities in the Province have pilot tested LED street lighting. The City of Welland installed five 120-watt and forty-two 90-watt LED street lights on streets in their community and the City of North Bay recently installed two (2) 45-watt LED lights. In both cases the lighting coverage was unsatisfactory. The City of Toronto also conducted a project evaluation at the CNE grounds which eventually resulted in the selection of HPS over LED. To obtain the “light output coverage” required the installation of additional lamps and poles at closer spacing to achieve the specified application level.

The claimed life expectancy of LED fixtures is approximately 50,000 hours, and the cost per fixture is in the range of $850.00 to $1,600.00. The saving in energy consumption, although unverified, is estimated to be 50% plus. The claimed life expectancy of 50,000 hours may not be achieved as the luminaires are being “pushed” to obtain higher levels of light output to meet Illuminating Engineering Society (IES) standards.

In summary, the expected advantages of LED (pending independent testing) are:

- Longer lamp life, 50,000 hours (as compared to HPS of 24,000 hours);
- Emit light in a specific direction, reducing the need for reflectors and diffusers, i.e. more efficient lighting;
- Instant on with no warm up time;
- Breakage and vibration resistant;
- Life unaffected by rapid cycling;
- Compact size;
- Improved performance in cold weather;
- Colour control ability;
- Can be dimmed; and
- Big advancement in this technology expected in the next 1-1/2 to 2 years

Disadvantages of LED:

- Light output is insufficient according to independent test results;
- Heat dissipation is a problem;
- Produces directional light, hence creating dark zones between lamp poles;
- High cost for the fixture, on average $850.00 to $1,600.00 per fixture;
- Requires more streetlights and poles, as compared to HPS, to get the equivalent light output coverage; and
- Fixture is too heavy for the existing cobra arms.

The Public Works Department had two early LED models installed on streets as a mini-pilot project. These were provided at no cost, but were subsequently removed when residents raised concerns with respect to poor lighting levels.

In staff's opinion, LED technology is not advanced enough for widespread street light application. They may become the technology of choice in the future, but not at this time.

Induction Lighting

Induction Lighting has virtually no lamp parts to wear out because they do not utilize traditional electrodes or filaments. Instead, they utilize an electro-magnetic field to excite the lamp's internal gases to transmit energy. Induction lighting is unaffected by vibration so it is suitable for street light applications. Development of this technology is close to its maturity. Induction fixtures put out "white light" as well.

The Town of Cobourg has replaced all the existing street lights along major streets with the induction lighting fixtures on one-to-one basis. A field trip to Cobourg was conducted by staff on January 19, 2009. Lighting levels were observed and conclusions were drawn based on a visual examination rather than lighting level measurements. It was snowing on that particular evening and even with snow skewing the visual observation in a favourable way, the lighting levels seemed to be lower and less uniform than the Illuminating Engineering Society (IES) standards. The luminaires would have to be independently tested for commonly accepted light levels before the acceptance of the claimed increased efficiency.

The City of North Bay also installed twenty-four 100-watt induction lighting fixtures at approximately $420.00 complete per fixture. Based on their assessment of induction lighting, the City of North Bay is proposing a city-wide change out program.

The claimed life expectancy of induction lighting is also 100,000 hours, and the cost per fixture is in range of $420.00 to $800.00. The saving in energy consumption is 50% plus, assuming equivalent light level output to be verified by an independent test.

Possible advantages of induction lighting (pending on an independent test):

- Longer lamp life, 100,000 hours (as compared to HPS of 24,000 hours);
- Light output is claimed to be sufficient;
- High efficiency (if equivalent light output can be verified), less than 5% of energy consumed is lost to heat;
- Possible energy saving in the range of 51%, (if 100 watt induction can replace 150 HPS);
- No flickering, no strobing, and no noise (HPS lamps cycle on and off at the end of their lives);
- No electrode, wireless lighting, no lamp parts to wear out;
- Good for places which are hard to get to because of its long lamp life; and
- Virtually vibration resistant.

Disadvantages of Induction lighting:

- High cost for the fixture, range is $400.00 to $800.00 per fixture depending on wattages and suppliers;
- Cannot be dimmed; and
- Development and advancement of induction lighting is getting close to the end.

<u>High Efficiency Fluorescent</u>

High Efficiency Fluorescent (HEF) lighting has been in use in parts of Europe, Asia, Africa and the Caribbean for many years now but is not widely used in North America. Based on the available literature and specifications from the manufacturer, the HEF lighting technology provides good light quality, long lifespan and excellent efficiency. Presently, HEF street lighting is being piloted by a number of GTA municipalities including the Town of Milton, City of Burlington, City of Waterloo and the County of Dufferin.

Based on manufacturers' literature, the advantages of High Efficiency Fluorescent lighting are:

- Long lamp life- 125,000 hours (as compared to HPS of 24,000 hours);
- Light output is excellent (up to 180 pupil lumens/watt);
- High efficiency (up to 70% savings over traditional bulbs)
- No flickering or strobing
- Vibration resistant;
- Dark sky compliant
- Dimmable ballasts
- 10 year warranty on lamp and ballast

Some potential disadvantages of High Efficiency Florescent lighting are:

- High cost for the fixture, range is $400.00 to $525.00 per fixture depending on wattages and suppliers;
- Un-proven in Canadian climate

Summary Comparison

The table below provides a summary comparison of the energy efficient street lighting technologies that are reviewed in this report.

Summary Comparison of Energy Efficient Street Lighting Technologies

Luminare Technology	Lamp Life (hours)	Energy Efficiency	Light Output (1)	Dimmable	Cost per Luminaire	Retrofit Compatibility	Overall Rating
High Pressure Sodium	24,000	poor	acceptable	no	$250	N/A – currently in use	poor
Light Emitting Diodes (LED)	50,000	good	good	yes	$850 to $1,600	Too heavy for cobra arms	good
Induction Lighting	100,000	very good	very good	no	$400 to $800	yes	very good
High Efficiency Fluorescent	125,000	excellent	excellent	yes	$400 to $525	yes	excellent

Note: (1) based on pupil lumens

Recommended Pilot Project.

A pilot test of new technology is an important part of a successful street light changeover. Based on the above information, staff has concluded that LED technology is not advanced enough for widespread street light application. Induction lighting has been tested in the Town of Cobourg and the City of North Bay with good results. High Efficiency Fluorescent street lighting is an emerging technology in Canada which reportedly provides good light quality, long lifespan and excellent efficiency.

Accordingly, it is recommended that the City undertake a pilot test of both the Induction and High Efficiency Florescent street light technologies. The pilot projects will be conducted on a short section of street or cul-de-sac using five loaner luminaires. Staff has received commitments from two lighting suppliers, Lakefront Lighting Inc. and ConxCorp, that they will provide five demo street lights for a period of one year to the City of Vaughan at no charge. These loaners will be returned to the suppliers at the end of the pilot project with no further obligation to the City.

The pilot projects will provide information on lighting levels and lighting adequacy compared to existing HPS lighting and would provide real operating cost comparison to conventional HPS lighting systems. This pilot would provide unbiased data that would allow the City to fully evaluate the costs and benefits of moving forward with energy efficient lighting on a broader scale.

The estimated cost for each pilot project is approximately $5,000, which includes the installation of the new street light fixtures and the retainer of a consultant to investigate and evaluate the adequacy of both the Induction and High Efficiency Florescent lighting systems. There are sufficient funds in the operating budget of the Public Works Department to cover up to three pilot projects in one year.

Additional Pilot Projects

As was noted earlier, advances in energy efficient lighting are being made on an ongoing basis. In order to keep up with these changes, staff will continue to review new technologies and consider undertaking additional pilot projects of alternative energy efficient lighting types provided that the supplier provides the City with a minimum of five light fixtures at no cost for a one year evaluation period. The number of individual pilot projects will be capped at three per year to limit the impact on the Public Works Operating Budget.

Toronto Pilot Project

It is worth noting that Toronto Hydro is conducting an Adaptive Lighting Asset Management Program (ALAMP) which is designed to identity the best street lighting solutions for the City of Toronto, with three (3) phases complete with "Developed Standards" which all types of street light technologies will be tested against. The Program started in September 2007. Phase 3 of this Program, involving a number of large scale installations, is scheduled to commence in 2009. It is anticipated that the recommendations from ALAMP (which may be 1-1/2 years away) will provide guidance for the development of the City's street light strategy.

Relationship to Vaughan Vision 2020/Community Sustainability and Environmental Master Plan.

In consideration of the strategic priorities related to Vaughan Vision 2020, and the Community Sustainability and Environmental Master Plan, the recommendations in this report 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"

This report is therefore consistent with the priorities previously set by Council.

Regional Implications

There is no immediate Regional implication resulting from the adoption of this report. However, should the City eventually decide to undertake a street light change out program to high efficiency luminaires, the Region would be consulted to assess any implications on the illumination of Regional roads.

Conclusion

There are new technologies in the field of street lights whose manufacturers claim they are more efficient in terms of energy consumption and maintenance costs. The results of staff's investigation to date indicate that LED technology is not advanced enough for widespread street light application. Induction lighting has been tested in the Town of Cobourg and the City of North Bay with reportedly good results. High Efficiency Fluorescent (HEF) lighting has been in use in parts of Europe, Asia, Africa and the Caribbean for many years now but is not widely used in North America. Based on the available literature and specifications from the manufacturer, the HEF lighting technology provides good light quality, long lifespan and excellent efficiency. Presently, HEF street lighting is being piloted by a number of municipalities in the GTA. Accordingly, it is recommended that Induction and High Efficiency Fluorescent street lighting be pilot tested at locations in the City to be determined by Public Works staff.

In an effort to keep current with the fast changing technology of energy efficient lighting, staff is supportive of testing further energy efficient lighting types subject to the supplier providing the City with at least five light fixtures at no cost for one year evaluation period. The number of pilot projects will be limited to three per year so there is no impact on the Public Works Operating Budget.

Attachments

N/A

Report prepared by

Anthony C.K. Ching, P. Eng., Environmental Engineer, ext. 8711
Rob Meek, C.E.T., Manager of Environmental & Technical Services, ext. 6100

Respectfully submitted,

Bill Robinson, P. Eng.
Commissioner of Engineering and Public Works

Brian T. Anthony, CRS-S, C. Tech
Director of Public Works

Andrew D. Pearce, C.E.T.,
Director of Development/Transportation Engineering