PAPER #13: A SURVEY OF LOCAL TRANSPORTATION AGENCIES ABOUT LED TRAFFIC SIGNALS

J. D. Bullough, M. C. Forget, S. Hayes, A. M. Gibeau, D. C. Frering and M. G. Figueiro
Lighting Research Center, Rensselaer Polytechnic Institute, Troy, NY, USA 12180

IESNA Annual Conference: Ottawa, ON, Canada; August 5-8, 2001

ABSTRACT

Traffic signal applications continue to be an area in which light-emitting diode (LED) light sources are being used widely and successfully. Municipal and county transportation agencies were surveyed regarding their experience with, knowledge about, and opinions of traffic signals using LEDs. Survey respondents, consisting of agencies in New York State, appeared to have less experience with LED traffic signals than elsewhere in North America, although they typically expressed positive views of LED technology. Respondents were also less aware of potential energy use impacts of LED signals than users in other regions, although they had greater awareness of potential impacts of LEDs on maintenance costs. This dichotomy might relate to flat-rate billing practices that have been employed in some regions, whereby the number of signals (or intersections), rather than their electrical usage, determined the energy costs of traffic signals. While the bulk of information that survey respondents received about LED signals came from manufacturers and distributors of LED products, respondents cited the lack of objective information about their potential benefits and drawbacks as a barrier to increased implementation of LED signals. Overall, the survey results indicate that such objective information, along with assistance in quantifying the economic impacts of LED signals, would assist potential users in New York State and elsewhere in making informed decisions about the use of this evolving lighting technology.

PURPOSE

The primary purpose of this telephone survey was to generate information that could be used to help develop a "baseline" of existing and potential markets for light-emitting diode (LED) traffic signals in New York State (in this paper, "traffic signals" refer to colored circular and arrow signal indications, colored flashing signals and pedestrian signals). In particular, information about factors that act as barriers to more widespread use of LED signals, as well as those that act to facilitate the use of LEDs, was gathered.

METHOD

A telephone survey containing 33 questions (see Appendix 1) was developed, based on a literature review of state and local experiences with LED signals, and on a December 1998 telephone survey of 30 municipalities in California.[1] Results from that survey were found to be highly consistent with a larger scale mail-in survey of several hundred California municipalities;[2] the telephone survey was therefore implemented as a way to rapidly obtain information. Individuals from 22 municipalities and counties (see Appendix 2) in New York State participated in the telephone survey, which was conducted in April 2000. Respondents ranged in size from large counties to small villages, and were selected from a randomized list of public works departments in New York State. Each interview took approximately 20 to 30 minutes. Three participants asked to complete the survey in writing and to return it by fax; and their responses were tabulated together with the verbal telephone responses. Not all municipalities were able to provide answers for every question. As the purpose of the survey was to identify general trends and not to provide a comprehensive overview of the market, the relatively small sample size was deemed sufficient. Furthermore, the results were compared with information from other sources, including the literature review and other surveys with similar objectives[1,2] to minimize potential misinterpretation of the results.

SURVEY PARTICIPANT PROFILE

Electric utility representation. The municipalities surveyed represent more than 8400 traffic signals (each with 3 or more colored heads). Of the 22 municipalities, one reported not having any traffic signals at all. Approximately 77% of the respondents reported that the same municipal department paying for and maintaining traffic signals is also the department paying for electricity costs, while 18% reported that a different department pays for electricity costs, and one municipality (5%) was unsure. Six electric utilities (listed as A through F in Figure 1) were represented among survey respondents (percentage totals will not always add to 100% because of rounding and because some questions permitted multiple answers) as indicated in Figure 1. Some respondents (about 9%) indicated that more than one utility provided electrical service for traffic signals, either in separate locations or jointly.

The method for billing also varied among survey respondents, with 59% stating that at least some signals were billed on a flat-rate basis, either per intersection or per signal. About 41% reported that some of their signals were billed using meter reports and nearly 23% were uncertain of billing methods. Here, percentages exceed 100% because some respondents reported that some of their signals were billed using flat rates and some using meters.

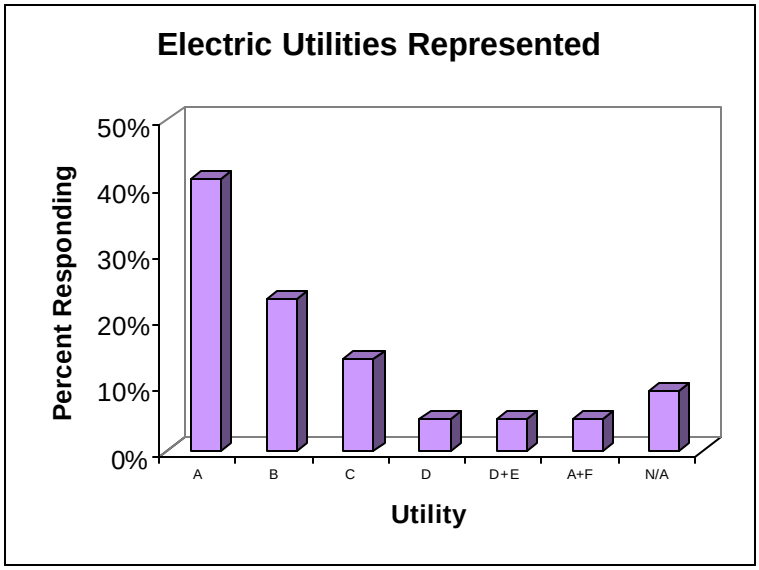

Figure 1. *Electric utility representation among survey participants.*

Traffic signal electricity and maintenance costs. Some municipalities reported their electricity costs for traffic signals on a per-intersection basis and others on a per-signal basis. More than half (55%) were not able to provide this information. Annual electricity costs per intersection with traffic signals averaged $545, and annual electricity costs per signal averaged $108. The figures are consistent with an average of 4 to 10 signals per intersection, depending upon traffic density.

In general, traffic signal maintenance costs were less well-defined. The largest number of respondents (45%) reported that traffic signal lamps are replaced only as needed after burn out. Of the remaining municipalities, 27% replaced lamps on an annual basis, 5% replaced lamps every two years, 5% replaced them on a regular but undefined basis, and 18% were unsure of their signal lamp replacement method. On average for those municipalities (32%) who responded to this question, the annual maintenance cost per intersection with traffic signals was $216. The average cost for a replacement incandescent lamp was $1.48. The average cost for an entire incandescent signal head (lens, reflector, housing and lamp) was $126.

Most of the municipalities surveyed (77%) were aware of the use of LEDs in traffic signals. However, fewer municipalities (50%) had actually installed at least one LED signal at the time of the survey.

BARRIERS TO INSTALLATION OF LED SIGNALS

Of the 11 municipalities that had not installed any traffic signals, just over half (55%) were aware of the use of LEDs in these systems. Most of those who were aware of LED traffic signals (80%) have considered using them. All of the municipalities were asked why they had not installed or tested them. More than 45% cited economic factors among the reasons for not installing LEDs (Figure 2): high cost of the signals and peculiarities in the way billing is performed (flat rate) making them less economical to use. The same number (45%) cited a lack of information about them as a principal reason for the lack of use. One respondent (9%) reported that improvements in LED technology would be required before they could be considered for use in traffic signals.

When asked what could be done to help overcome these factors, respondents were again split between those who would like financial assistance with purchase price or electricity billing (27%) and those who would like more information about LED traffic signals (27%).

PROFILE OF LED TRAFFIC SIGNAL EXPERIENCE

Market penetration. This section describes those survey respondent municipalities who have used LED traffic signals. What is very clear from responses by municipalities is that the penetration of LED traffic signals is generally quite low. Around 64% had installed a small number of signals, either one or two, or in 1% or 2% of their signals. One municipality (9%) had installed LEDs in about half of its intersections and another (9%) in about 15% of its intersections. Yet another (9%) had converted all of its orange pedestrian signals to LEDs. This penetration profile appears to be lower than an estimated 10% U.S. penetration rate[3] for red signals.

The percentage of surveyed municipalities using LEDs (50%) is also lower than the 74% of municipalities that had installed LED traffic signals, in the 1998 survey of agencies in California.[1]

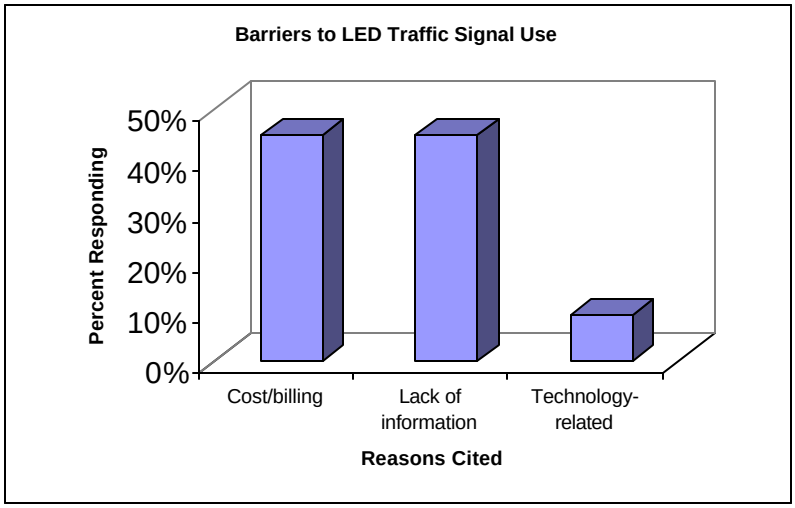

Figure 2. *Stated barriers to the use of LED traffic signals.*

Information sources. When asked about the sources of information from which they learned about LED traffic signals (Figure 3), the largest number (45%) reported that vendors provided them with initial information about them. About 27% of survey respondents learned about them from New York State agencies [e.g., Department of Transportation], and 27% from technical and professional bodies such as the Institute of Transportation Engineers (ITE) or the International Municipal Signal Association (IMSA). About 18% had read about LED signals in trade magazines or journals, 9% from their local utility and 9% from word of mouth.

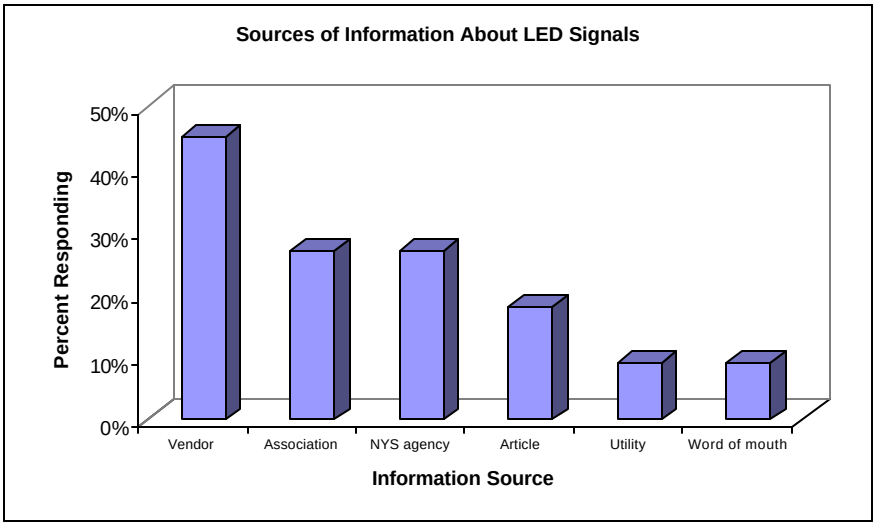

Figure 3. *Sources of information about LED traffic signals.*

Reasons for LED use. Reasons for the installation of LED signals were similar to those conventionally understood and offered by many LED signal manufacturers and by those organizations promoting the use of LEDs: energy cost savings (55%) and maintenance savings (82%). About 18% each also stated that LEDs were being installed because of visibility advantages and as trials of this technology. Interestingly, more respondents cited maintenance savings than energy savings in this survey, in contrast to the December 1998 survey in California[1] where 96% of respondents cited energy savings and only 26% cited maintenance savings. This difference might reflect differences in utility billing methods (e.g., flat rates) or a growing awareness in general about potential maintenance impacts of LED signals.

Type and cost of LED signals. Most (82%) of those municipalities using any LED traffic signals at all have used red signals. Fewer reported using green (45%) or yellow (27%) LED signals or orange pedestrian LED signals (36%). The average reported prices for LED signals were as follows:

- $137 for 8-inch red signal heads (range $100-$160)
- $170 for 12-inch red signal heads (range $150-$200)
- $400 for 12-inch yellow signal heads
- $100 for 8-inch green signal heads
- $200 for 12-inch green signal heads
- $80 for orange pedestrian signal heads

The prices for orange, yellow and green signals were provided by only one survey respondent and may not be typical; with the exception of the 8-inch green signal head, these colors were found to be more expensive than red and orange signals. In general, these prices are somewhat higher than those for red signals stated by respondents in the 1998 survey of municipalities in California,[1] despite the 16-month difference in time between the surveys.

LED signal performance. Few municipalities (18%) using LED traffic signals reported that they had experienced any cost savings resulting in reduced electricity use (Figure 4). Because many municipalities are billed on a flat rate regardless of energy use, another question probed whether any reductions in energy (kilowatt-hour) use had been experienced. Again, only 18% reported reductions in energy use. Of particular interest, though, 45% of respondents stated that although they had not been able to document cost savings from reduced energy use, they were still waiting to see if such savings would manifest themselves (e.g., "too early to tell"). Similarly, 18% were still waiting to document reduced electrical energy use.

As for maintenance savings, a higher percentage of municipalities using LEDs (55%) had experienced savings caused by reduced maintenance costs. Again, 18% were still waiting to document savings in this area. However, the majority of respondents (55%) reported that their signal maintenance and relamping cycle had not changed as a consequence of using LEDs, compared to about 18% who did alter their maintenance cycles.

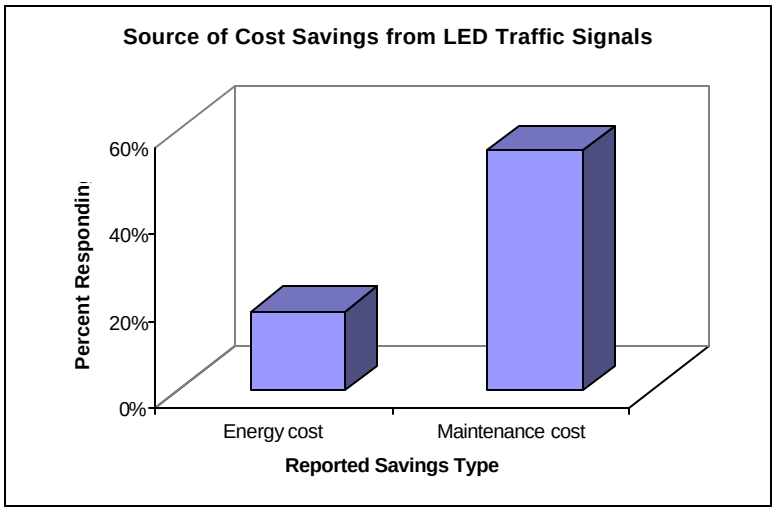

Figure 4. *Source of cost savings when using LED traffic signals.*

Purchase and specification. More than half (55%) of the municipalities who have used LEDs were aware of the New York State Office of General Service's procurement services program, whereby municipalities in the state can purchase LED traffic signals (and other equipment) together with statewide purchases, thus increasing volume and (hopefully) reducing prices. Only 18% of respondents reported that they had used the program to purchase LED signals. One municipality (9%) had used a different group purchasing agreement before using the statewide program. (Municipalities interested in the program were referred to the New York State Office of General Services Procurement Services Group.)

When asked about how they purchased traffic equipment in general, 41% of respondents have used a bidding process, 27% had purchased equipment through the state or county, 5% purchased equipment through their utility, and 23% simply contacted a suitable vendor directly to purchase equipment. About 23% of survey respondents did not provide an answer to this question. Specifications for traffic equipment were often prepared by individual municipalities (55%), although in some cases they are based on those of the state Department of Transportation (9%) or specifications provided by vendors (5%). When municipalities did not write their own specifications they reported using those of the state Department of Transportation (62%), or of their utility (12%).

Few municipalities (27%) received any type of financial assistance (e.g., rebates, grants, loans) in their purchase of LED traffic signals. One of these municipalities (9%) is using an energy service company to provide initial funding for LEDs. Most municipalities (73%) received no financial assistance of any kind. This is much different from the December 1998 survey of California municipalities,[1] where 56% of the respondents stated that rebates, loans or grants were used.

Opinions about LED traffic signals. Several survey questions asked respondents about their knowledge and opinions about LED traffic signal technology. Most respondents (68%) stated that there were differences between conventional incandescent signals and LED signals; 14% stated that there were no differences, and 18% were unsure. Among the differences cited between LED and incandescent signals were longer life (50%), improved visibility (e.g., brighter, more even, no reflections) (45%), reduced visibility from large angles (5%), reduced energy use (23%), reduced weight (5%) and less stress on control equipment (5%). A separate question asking whether LED signals were more visible or less visible than incandescent signals found similar trends to the previous question: 45% stated that LED signals were more visible, 14% that they were less visible (under certain conditions such as wind or large-angle viewing), and 9% that they were equally visible.

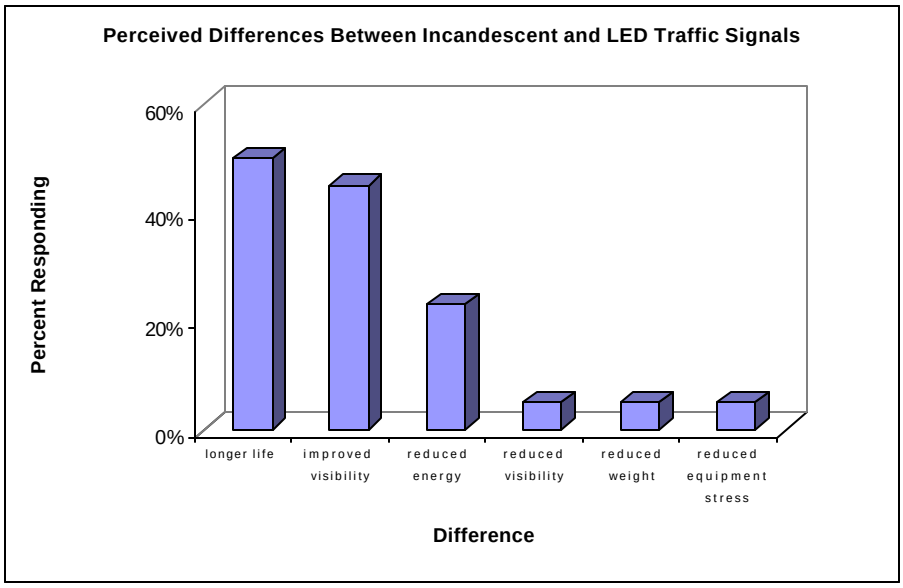

Figure 5. *Perceived differences between LED traffic signals and conventional signals.*

Most of the municipalities that had installed LED traffic signals reported no problems with them (82%). Of the 18% that did, visibility problems under conditions of windiness were always cited as the only problem experienced. These municipalities were the same that identified differences among different types of installations, with pole-mounted LED signals less susceptible to wind-driven visibility problems than suspended installations. Similarly, the only weather-related visibility issues cited with respect to LED traffic signals were in conditions of high wind (5%). About 36% stated that weather made no difference in the performance of LED traffic signals, and 59% were unsure or

had no opinion. Survey respondents were evenly divided when asked whether they were aware of any differences among different LED signal colors (e.g., red, yellow, green, orange), with about 36% each stating that there were or were not differences (27% were unsure or had no opinion).

SUMMARY

Based on the results of this survey, and comparing them to earlier surveys of California municipalities about LED traffic signals,[1,2] the municipalities surveyed in April 2000 had the following characteristics:

- LED signal penetration appears to be lower in New York State than the national average[3] and lower than California municipalities in 1998[1]
- financial assistance is either less available in New York State, or there is less awareness of it than in California in 1998
- municipalities in New York State appear to be more aware of maintenance savings than of energy savings with LED traffic signals

In general, the municipalities surveyed did not experience any major problems with LED traffic signals, nor were they aware of major problems. The primary perceived shortcoming is the possible visibility reduction of LED signals when seen from large angles or during windy conditions. This may be related to the determination of luminous intensities for traffic signals in the traffic signal specifications of the ITE,[4,5] which requires minimum intensities to be achieved out to certain angles. There might be an underlying assumption in the ITE specification that signals meeting the requirements at the specified angles will also produce some light at larger angles, but because LEDs are highly directional light sources, some signal configurations using LEDs might not generate such large-angle light. New-generation signals appear to overcome this problem, but the existing installed base of older LED signals might aggravate this perceived problem. Overall, however, the results of this survey suggest that the following efforts would increase penetration of LED traffic signals:

- an increase in programs to provide municipalities with financial assistance designed to help overcome the high initial costs of LED traffic signals
- where relevant, efforts to restructure utility billing to more accurately reflect energy use of LED traffic signals
- dissemination of objective information about LED traffic signals, including documentation of both energy and maintenance savings (documentation and understanding of maintenance savings are particularly important if utility rates are not structured to provide energy cost savings commensurate with their kilowatt-hour savings)
- in the long term, revisitation of specifications for traffic signals including those using LEDs[4,5] to incorporate wider viewing angles, especially for locations where such viewing angles are commonly experienced by drivers

Such efforts coincide closely with the responses of those municipalities who had not installed LED signals. They also appear to meet the needs of even those who have installed them. Most of the surveyed municipalities that have installed LED traffic signals learned about them either through vendors or through word of mouth, and most have installed very few LED signals. A more systematic approach to objective information dissemination could help municipalities make objective decisions about the value of LED traffic signals, could help reduce the perceived risks and uncertainties associated with LEDs, and could increase the penetration of energy-efficient technologies in traffic signal systems.

ACKNOWLEDGMENTS

This work was supported by the New York State Energy Research and Development Authority (NYSERDA) and conducted through the Lighting Transformations Program of the Lighting Research Center (LRC) at Rensselaer Polytechnic Institute. Rachel Winters, NYSERDA Project Manager, oversaw the survey and provided valuable input on the survey questionnaire. Margaret Suozzo of the American Council for an Energy-Efficient Economy and Paul Vrabel of ICF Consulting, Inc. also provided helpful comments on the survey questionnaire.

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APPENDIX 1: SURVEY QUESTIONNAIRE

The Lighting Research Center at Rensselaer Polytechnic Institute is conducting a survey of counties and municipalities in New York State about the use of light-emitting diode (LED) lamps in traffic signals. This survey is being conducted in cooperation with the New York State Energy Research and Development Authority. The survey should take approximately 20 to 30 minutes of your time. Is this a good time, or should I call back later?

Section 1. Preliminary questions for all municipalities

1. In your municipality, what departments are principally responsible for specifying, purchasing, installing, and maintaining the lamps used in your traffic signals? Does the same department pay electricity costs for your traffic signals?
2. What is your electric utility company?
3. Are your electricity costs for traffic signals based on energy use, or is there a flat rate per signal or intersection?
4. How many intersections do you oversee with traffic signals? How many signals does this represent?
5. Are you aware of the use of LEDs in traffic signals?
6. For conventional traffic signals, how much do you pay annually or monthly in electricity costs, either per signal or per intersection?
7. For conventional traffic signals, how often do you maintain and relamp signals? Do you maintain them on a fixed schedule, or only when they burn out?
8. For conventional traffic signals, how much do you pay annually or monthly in maintenance costs, either per signal or per intersection?
9. Have you installed any LED lamps in any traffic signals? *If "no," continue to section 2. If "yes," skip to section 3.*

Section 2. Questions for municipalities not using LEDs

10. Have you considered installing LEDs?
11. What are your reasons for not installing LED traffic signals? What would help you overcome these reasons? *If "cost:" - assistance with purchase price? change in the way electricity is charged? If "lack of information" or "not aware:" - what kind of information would be helpful? If "LEDs are not good:" - what would make them better? Now, go to section 4.*

Section 3. Questions for municipalities using LEDs

12. Where did you learn about LED traffic signals?
13. What were the principal reasons for installing LEDs in traffic signals?
14. In what percentage of intersections have you installed LEDs?
15. What types, sizes and colors of LEDs have you installed? Can you estimate the number, or percentage, of each? How much does each type cost? Red LED signals (8/12 inch)? Yellow LED signals (8/12 inch)? Green LED signals (8/12 inch)? Red LED arrows? Yellow LED arrows? Green LED arrows? Orange LED pedestrian signals? White LED pedestrian signals?
16. Are you aware of the NYS Department of Transportation's statewide purchasing contract to purchase LEDs? Have you used this contract?
17. Did you use another group purchase arrangement? If so, which one?
18. Have you experienced any electrical cost savings from installing LEDs? Any maintenance cost savings?
19. Have you estimated any kilowatt-hour savings from using LEDs?
20. Has your relamping cycle changed as a consequence of installing LEDs?
21. Do you require newly-installed signal heads and intersections to use LEDs? What colors and types?
22. Have you received rebates, grants, loans, or other financial assistance for installing LEDs? From whom?
23. Did you work with an energy service company to purchase LEDs? If yes, which company?
24. Have you experienced differences in the performance of LED traffic signals, in different types of installations (pole-mounted, suspended, etc.)?
25. Have you experienced problems with LEDs? If so, describe them.

Section 4. Questions for all municipalities

26. How much do you pay for conventional traffic signal lamps (bulbs)? How much does a new conventional signal head cost (lens, reflector and lamp/bulb)?

27. In your opinion, are there major differences between LED traffic signals and conventional signals? What are they?

28. In your opinion, are there major differences among the different colored LED signals?

29. In your opinion, are LED traffic signals more visible or less visible than conventional traffic signals?

30. In your opinion, how well do LED traffic signals work in different kinds of weather?

31. How do you procure, order and purchase traffic signal equipment?

32. Do you prepare your own specifications? If not, whose specifications do you use?

33. Do you have any specific questions or comments about LED traffic signals?

Thank you for your time! If you are interested in more information about LED traffic signals, please visit the following web site: **`http://www.lrc.rpi.edu/ltgtrans/led/`**

APPENDIX 2: SURVEY PARTICIPANTS

Auburn
Buffalo
Cortland
East Hampton
Fulton
Ithaca
Jefferson
Kingston
Lockport
Mechanicville
Monroe County
Newburgh
Niagara Falls
Onondaga County
Oswego
Pleasantville
Poughkeepsie
Saratoga County
Saratoga Springs
Seneca Falls
Westchester County
Yonkers