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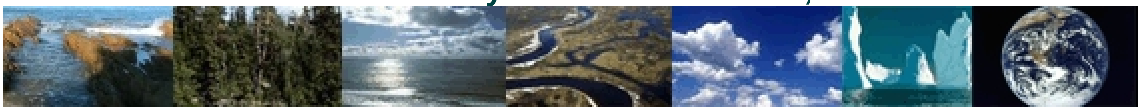

City of Oswego: Toward Municipal Sustainability

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Executive Summary

This report presents the findings of a four-week study on the City of Oswego's near-term opportunities for improving municipal sustainability. We present a series of detailed recommendations focused on reducing energy costs and developing renewable sources of electricity.

We based our analysis on two years of recent data on the city's energy consumption and expenditures by fuel type, city department, and end use. We identified departments with high energy use, then examined those departments' options for reducing energy costs. We considered changes in operating procedures and capital equipment, as well as the potential for the city to generate some of its own electricity via renewable technologies. Also, we examined the effects of previous city initiatives on energy consumption and based relevant benchmarks for the city's performance on other municipalities' energy saving endeavors. Finally, we used this data and analysis to make recommendations that are financially, as well as environmentally, sustainable.

Our key findings are divided into short-term and long-term recommendations. The short term recommendations can be implemented within a two-year time frame, while the long-term recommendations will take longer to carry out.

Key Short-term Findings:

Street Lighting: The City has the potential to save street lighting energy costs in two ways. First, additional lamp removal could save the City around $30,000 annually. Although removal involves up-front costs, we estimate a payback period of three to six years. The second strategy is improving the efficiency of street lights by switching city-owned lights to LEDs as they come up for replacement under their usual maintenance schedule; do not ask National Grid to change lights it owns, because the City will still pay the old tariff. When National Grid develops a new tariff, ask it to change more bulbs to LEDs.

Midtown Garage: The City could save approximately 70% of the Midtown Garage's operating budget by prioritizing a transfer of the garage's electrical assets from National Grid to the City and removing thirty-two bulbs on the lower level of the garage. These savings are equal to approximately $25,000 annually. In addition, by removing the four high pressure sodium lamps on the upper level of the garage the City could save upwards of $4,000 annually.

Vehicle Fleets: Rising gasoline costs make fuel-efficient vehicles an increasingly economical choice. While law enforcement may require large, heavy-duty cars, other government users need reliable, efficient transportation. Switching the Department of Public Works motor pool to Toyota Priuses would reduce life-cycle costs per vehicle by $5,450 from the status quo of reusing police sedans.

Water Resource Management: A voluntary metering program would raise awareness about water consumption, which would help reduce water consumption and lower expenses for water treatment. In addition, a voluntary program with a long-term commitment to citywide metering would allow the City to introduce a water metering gradually, lowering public resistance. Other cities have successfully carried out similar plans. The City should implement a voluntary metering program, with a commitment to have all single-family residences metered by 2013.

Key Long-term Findings:

Wind Energy: Oswego is in a prime location for wind energy generation because of its high, consistent wind speed and location off Lake Ontario. Large-scale, horizontal-axis turbines are the most efficient type to harness Oswego's strong, steady winds. While the exact location of the turbines within the city depends on specific connection options and the operations that need direct power, the first steps should be to engage stakeholders and inform the public of this opportunity to save money and generate revenue that would benefit the city. Next, soliciting bids from vendors will help determine the best location for wind generation. A financial analysis shows that investing in a publicly-owned wind energy generation facility would produce a positive net present value over twenty-years of operation.

Solar Energy: We considered the potential for photovoltaic solar energy powering the City's Conway Building. The high price of producing solar energy and the limited amount of space on the roof of the Conway Building make this investment non-viable without significant outside funding from grants.

Lake Source Cooling (LSC): The technological advance of lake source cooling makes it an increasingly plausible solution to energy demands. Learning from the experiences of Cornell University and Toronto, the City should engage their staff and the public regarding the benefits of lake source cooling. Although LSC requires large upfront costs, this system can be incrementally deployed if the integration is coordinated with HVAC replacement and utility system updates.

Green Roofs: Because green roofs are very costly and have stringent structural specifications, the City of Oswego should consider them only for the purpose of rainwater catchments to reduce storm water overflow.

Throughout the duration of our capstone study we were especially lucky to work with and encounter a group of very capable, highly qualified, and extremely helpful individuals. We gratefully acknowledge the encouragement and constructive suggestions from our advisor Dr. Peter Wilcoxen and our client Mary Vanouse, Director of Community Development for the City of Oswego. We would also like to thank the following individuals for their time and assistance throughout the capstone project:

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Short-term Recommendations

The following recommendations are considered short-term because each recommendation can be implemented within a two year time frame. The following section focuses on major cost drivers in terms of energy consumption. We have provided a concise recommendation, information on the current situation, a financial analysis of the recommendation and an implementation plan. In the following section we will focus on four topics; Street Lighting, Midtown Garage, Vehicle Fleets and Water Resource Management.

Street Lighting[i]

Recommendation

We recommend that: (1) the City determine candidate fixtures for removal and request data on them from National Grid; (2) regard routine renovation as an opportunity for removing lamps; and (3) adopt the gradual implementation scheme that is already tested by the City. We also recommend that: (4) the City follow the technological advancement of LEDs; (5) regard the timing of renovation as an opportunity for upgrading; and (6) gather information on street lights to prepare for upgrading.

Status Quo

According to the Operations and Maintenance Center of Excellence, Federal Energy Management Program, "over 20% of the [U.S.] electricity consumption is related to various types of lighting products and systems" (Sullivan et al. 2004, 9.83). It is clear that the City uses a significant amount of energy for street lights: according to Michael Riley and documents for the 2009 budget, the City consumes around 2.5 million kWh annually.

The situation surrounding street lighting has drastically changed in many respects. First, the rising concern for saving energy is quite pertinent to street lighting as a main energy user of municipalities. Second, the awareness of light pollution has risen. For example, many communities in New York State have light pollution control ordinances (Sensible and Efficient Lighting to Enhance the Nighttime Environment of NY 2008). Third, the advancement of technology in lighting is contributing to energy and cost savings, while maintaining safety standards.

In attempting to keep up with these changes, the City has already started addressing lighting concerns. It uses light emitting diodes (LED) for traffic lights and high pressure sodium (HPS) lamps for street lighting. The City has also started to turn off street lights in overlit areas.[ii] In what follows, we examine two strategies, namely additional lamp removal and adopting more efficient technologies, for further savings of energy and taxpayers' money.[iii]

Lamp Removal

The City is already aware of over-lighting in some areas and just started removing lamps along two roadways: State Route 104 West and State Route 481. The main motivation was that there seemed to be an excessive number of lights compared to neighboring municipalities.

Turning off lights should be a straightforward strategy for saving energy costs; however, the City's agreement with National Grid complicates the situation. The agreement states as follows (Niagara Mohawk Power Corporation, 30):

> The alteration of existing equipment for … decreased illumination or for a conversion to a different type of lamp will be made at [National Grid's] expense if the existing facilities have been in service *15 or more years*. If the customer wishes to have one conversion prior to this time, the customer *may* be required to pay [National Grid] the depreciated book cost less net salvage value of the facilities removed. (Italics added)

One obstacle is that it is not clear what the word "may" in this agreement means: the cost of conversion appears to be subject to negotiation. Another challenge is that National Grid owns a majority of the lights but the City also owns some and the City does not have its own maps or inventories of the lights readily available.[iv]

Accordingly, to conduct the cost-benefit analysis of lamp removal, the City needs to refer to National Grid. According to National Grid and the delivery and supply rates for the 2009 budget of $0.155 per kWh, the payback period of current lamp removal is less than one year.[v] Although this is useful information for other cases, the payback period of each street light depends largely on its depreciated book value: the City is required to be financially responsible for investments by National Grid. For instance, our calculation reveals that the average cost of removing lamps on State Route 481 is $222, whereas that on State Route 104 is $348. Moreover, Timothy Murphy explained that depreciated book values of the majority of the removed equipment were zero.

Candidates for Additional Lamp Removal

We believe that this effort of the City is laudable and should be furthered. Given that the City regards parks along the shore of the Oswego River (West and East Linear Parks) and Bridge Street as the next targets, we surveyed those areas. Specifically, we conducted an inventory of street lights, including pole identification numbers where possible, and determined which lights are candidates for removal on the following four sections highlighted in Figure 1 below: a part of State Route 104 West that is not yet de-lamped (West Bridge Street and Seaway Trail) (1), State Route 104 East (2),[vi] West 1st Street (3), and West and East Linear Parks (4).[vii]

We selected candidates for removal in the following way. First, we chose lights that appeared unnecessary (for example, lights in bushes). Second, we adopted two scenarios: removing every third light ("scenario 1") or removing every other light ("scenario 2"). Both scenarios keep lights at the intersection due to safety concerns.[viii] The full list appears in Appendix A and is summarized in Table 1 below.

Next, we conducted a cost-benefit analysis. The benefit of removing lamps can be calculated using data in the tariff schedule. Information on lamp sizes (100W ~ 400W), lamp types (HPS or metal halide (MH)), and luminaire types (architectural or standard), as well as the ownership of street lights, came from Michael Riley. Appendix B presents detailed estimates of annual savings under the two scenarios, and Table 2 summarizes the key results below. Cost reductions come mainly from two sources: reduced energy consumption and reduced facility charges. The amount of the former is obtained by the hourly power consumption of each type of the lamps multiplied by annual operation hours; the cost saved is the summation of reduced annual wattage for each light multiplied by the unit price of electricity. Facility charges are for the utility-owned lamps and luminaires.

Figure 1: Overlit Sections Considered

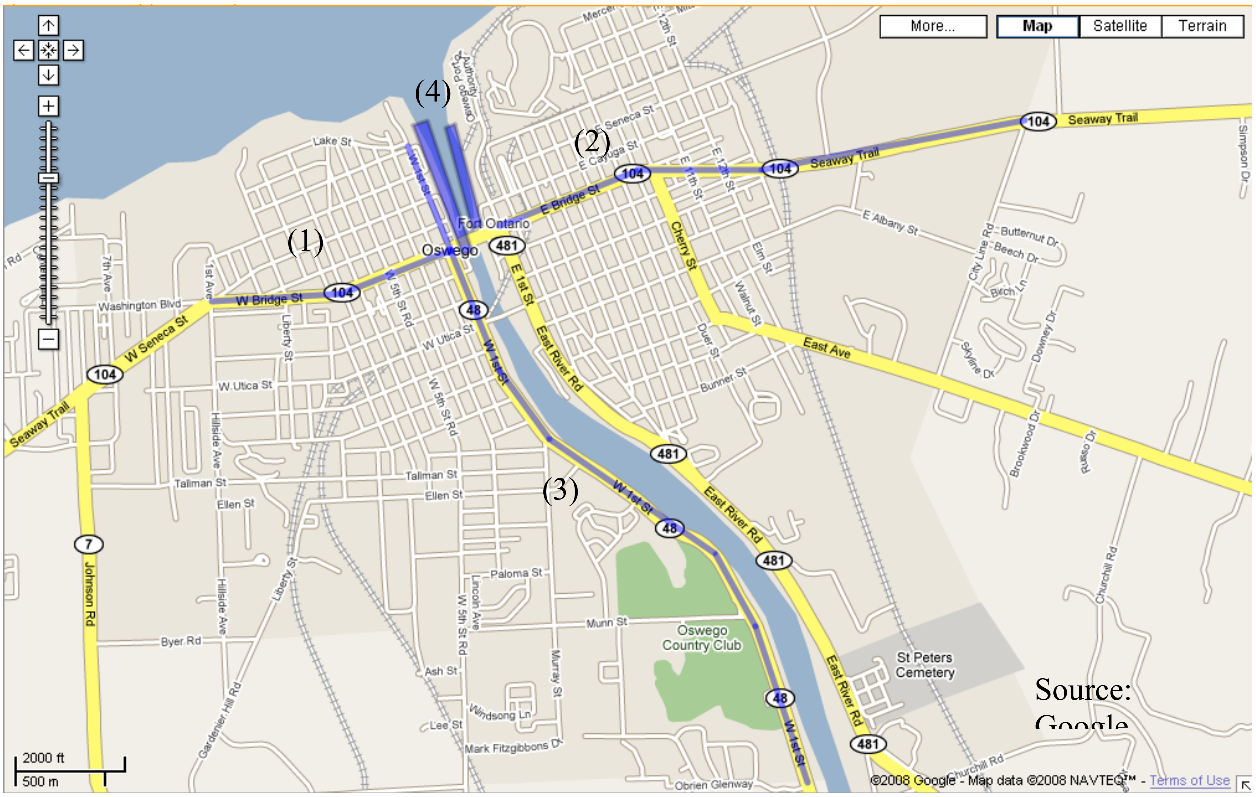


Table 1: Street Lights Considered

Type (Luminaire Owner)	400W HPS			250W HPS			150W HPS			100W HPS			175W MH			Total
	Total	NG		Total	NG		Total	NG		Total	NG		Total	NG		
		arc	std		arc	std		arc	std		arc	std		arc	std	
104 W	0	0	0	90	0	90	0	0	0	0	0	0	0	0	0	90
104 E	0	0	0	96	0	96	0	0	0	0	0	0	0	0	0	96
W 1st St.	12	12	0	29	0	29	14	14	0	85	42	43	0	0	0	140
W Linear Park	0	0	0	0	0	0	0	0	0	97	97	0	0	0	0	97
E Linear Park	0	0	0	0	0	0	0	0	0	25	25	0	23	0	0	48
Total	12	12	0	215	0	215	14	14	0	207	164	43	23	0	0	471

*NG = National Grid; arc = architectural street lights; std = standard street lights

As for the cost of removing lamps, we needed data on depreciated book values which can be produced only by National Grid. However, it appears to take a few weeks for the National Grid office in Buffalo to prepare the data, and Timothy Murphy, who works with the City on street lighting, was unwilling to proceed without a formal request from the City. Instead, he gave a rough estimate of the cost of lamp removal ranging from $500 to $1,000 per light. Based on the above, the payback period is around six years under the conservative scenario (the cost of lamp removal is $1,000); it is less than three years under the assumption that the cost of lamp removal is $500.[ix] Further, the payback period will become even shorter as the depreciated book values decline with the passage of time.

Table 2: Annual Savings from Lamp Removal

	Total $ savings	Energy savings		Facility charge savings	
		kWh savings	$ savings	Luminaire	Lamp
Scenario1	$27,275	118,724	$18,402	$7,995	$877
Scenario2	$35,103	149,953	$23,243	$10,711	$1,149

Therefore, our recommendation is, first, to finalize candidates for lamp removal and formally request information on the cost and annual savings of additional lamp removal from National Grid. Second, the City should not allow National Grid to renovate any street lights until after it fully considers alternatives, such as removal and equipment upgrading, as mentioned below. This is because the depreciated book values of the street lights to be renovated, which are equivalent to the cost of turning them off, are expected to be minimal at the end of their useful lifetime. Third, as for removing lamps, we propose a gradual approach like the one that the City already adopted in removing lamps so far.[x] This kind of experimental approach has been widely and successfully used, as described in the next section.

Adopting More Efficient Technologies

The second strategy for reducing the energy costs of street lighting is taking advantage of more efficient technologies. The City uses HPS lamps for street lights, which are much more efficient than traditional incandescent bulbs. LEDs are even more efficient but in outdoor applications they are used mainly for traffic and pedestrian signals, largely due to technological and cost constraints. (The City currently uses LEDs for traffic signals.) In fact, HPS lights using an “intelligent lighting” system in the city of Oslo, Norway are “cited as a ‘best practices’ example” (C40 Cities b; BNET Business Network 2008).

Although high initial cost and rapid lumen depreciation were regarded as major disadvantages of LEDs only a few years ago (Sullivan et al. 2004, 9.87), LED technology is dramatically improving. For example, “the cost for LED modules is approximately 50% less today [2007] than in 2001” and “the new LED modules [in the fall of 2007] will be more efficient than the existing LED modules [of 2001], using about 75% as much power” (C40 Cities c). Additionally, the City of Welland, Canada declares itself as “the first municipality in North America to implement LED streetlighting on a municipal roadway” (City of Welland 2007):

> With significant improvements in LED technology over the past several years LED streetlight products have become appropriate for roadway lighting applications. The benefits of employing LED technology are reduced electricity costs, fewer burn-outs and resultant replacements, and lower maintenance costs than those associated with the conventional high-pressure sodium lamps.

Regarding the comparison of HPS and LED lamps, Pacific Gas and Electric Company issued a report on the LED street lighting of Oakland, California in January 2008. According to this report, advantages of LEDs include energy savings, more uniform brightness, and a much lower lumen depreciation curve (in other words, the brightness of LEDs is constant over their lives) (Bryan et al. 2008, ES1-2). As for energy and cost savings, "the metered LED luminaire drew an average of 77.7 watts, roughly 35% (43.3 watts) less than the metered HPS luminaire." This turns into a savings of 178 kilowatts per year under an assumption of 4,100 annual hours of operation (Bryan et al. 2008, ES1) and an annual savings of $27.6 under the delivery and supply rates for the 2009 budget of $0.155 per kWh.

Although the payback period calculated in the Pacific Gas and Electric report is at least 10 years, it does not take into account the longer lifetime of LEDs. In fact, the report assumes that the lifetime of HPS luminaires is 30,000 hours, whereas the International Council for Local Environmental Initiatives (ICLEI), Oceania estimates the life of LEDs at 80,000 to 100,000 hours.[xi] This suggests that the payback period could be shorter, as demonstrated below in Table 3 and Figure 2. Both show present values of the total cost of HPS and LED lamps over a 21-year period under a few scenarios. Given these figures, at (or close to) the end of the lifetime of HPS lamps, replacing them with LEDs can make financial sense. Again, depreciated book values of equipment to be replaced are a key factor. The replacement appears increasingly promising, considering the fact that "the cost of LEDs … is declining rapidly" (Bryan et al. 2008, 20).

Table 3: Comparison of HPS and LED Lamps

	Year	0	1	2	3	4	5	6	7	8	9	10
Total Cost in $ (PV)	HPS (N)	346.0	417.4	485.3	550.0	611.7	670.4	726.3	1,025.4	1,076.1	1,124.4	1,170.4
	HPS (R)	0.0	71.4	139.3	204.0	265.7	324.4	380.3	679.4	730.1	778.4	824.4
	LED (a)	833.0	873.2	911.5	947.9	982.7	1,015.7	1,047.2	1,077.2	1,105.8	1,133.0	1,158.9
	LED (b)	833.0	883.6	931.9	977.8	1,021.6	1,063.2	1,102.9	1,140.7	1,176.7	1,211.0	1,243.6

	Year	11	12	13	14	15	16	17	18	19	20	21
Total Cost in $ (PV)	HPS (N)	1,214.2	1,255.9	1,295.7	1,508.3	1,544.3	1,578.6	1,611.3	1,642.4	1,672.1	1,700.3	1,727.2
	HPS (R)	868.2	909.9	949.7	1,162.3	1,198.3	1,232.6	1,265.3	1,296.4	1,326.1	1,354.3	1,381.2
	LED (a)	1,183.6	1,207.1	1,229.5	1,250.8	1,271.1	1,290.5	1,308.9	1,326.4	1,343.1	1,359.0	1,374.2
	LED (b)	1,274.7	1,304.3	1,332.6	1,359.4	1,385.0	1,409.4	1,432.6	1,454.7	1,475.7	1,495.7	1,514.8

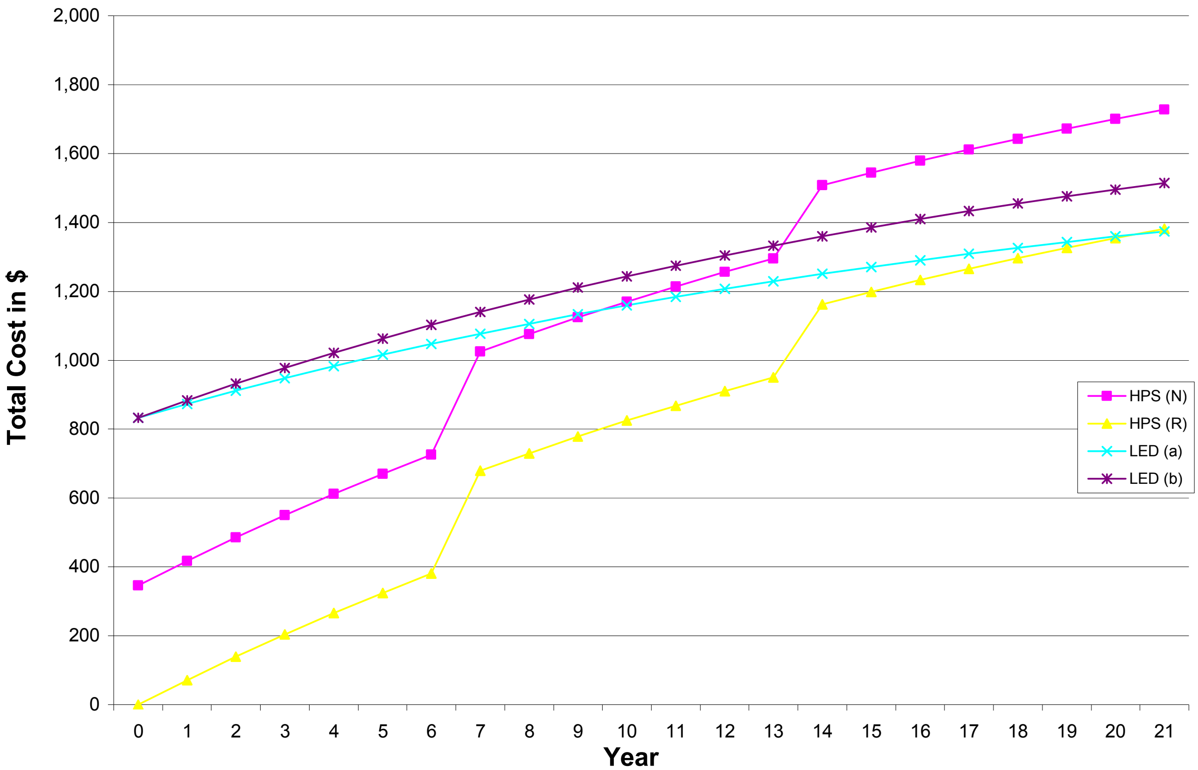
Source: Tables 8-10 of Bryan et al. 2008, 18-9

Assumptions:

(1) Calculations are based on assumptions adopted in Bryan et al. 2008 (shown below) unless otherwise specified.
(2) A time horizon is 21 years.
(3) Lamp lives of HPS and a LED are 7 years and 21 years, respectively.
(4) A HPS lamp is replaced at the end of the seventh and fourteenth year: under the new construction scenario (HPS (N)), there are three installments in total, while only two under the retrofit scenario (HPS (R)).
(5) LED (a) assumes that the annual maintenace cost is zero as in the report, while LED (b) assumes the same cost as a HPS lamp.
(6) The discount rate is 5%.

Type	Lamp cost	Installation cost	Annual maintenance cost	Annual energy cost	Total annual cost
HPS	$177	$169	$10.97	$63.95	$74.92
LED (a)	$664	$169	$0.00	$42.21	$42.21
LED (b)	$664	$169	$10.97	$42.21	$53.18

Figure 2: Comparison of HPS and LED Lamps



Nonetheless, the National Grid tariff schedule could be a barrier to upgrading street lights. The current schedule contains "Mercury Vapor," "High Pressure Sodium," "Fluorescent," and "Incandescent," and does not contain LEDs (Niagara Mohawk Power Corporation, 19-20).[xii] Timothy Murphy implied that National Grid would not add LEDs in its tariff document in the near future because there are many customers other than the City but no other request of this kind has been made. Ann Arbor, Michigan, which started a trial migration to LEDs from incandescent lamps for general lighting purposes in 2006, also seems to have this tariff problem: without a new tariff taking "into account the lower energy use and maintenance requirements of the LED fixtures[,] … it will not make financial sense to upgrade … utility-owned fixtures" (C40 Cities a).

From the above analysis, we recommend at least three actions. First, the City should keep an eye on technological and cost improvements of LEDs relative to HPS lamps. Second, before exchanging old lamps for new ones, the City should examine the possibility of upgrading equipment. This is especially true of the MH lights in East Linear Park whose lamps and luminaires are owned by the City. The current tariff scheme, however, seems to prevent the City from realizing the benefit of reduced energy consumption, whether equipment is owned by the City or National Grid. Third, the City should gather additional information on street lights in its jurisdiction, beyond those included in Appendix A. This action could enable more precise cost-benefit analysis of the replacement of HPS lamps with LEDs. We would recommend a gradual approach with a grace period for public comments if the City decided on the replacement, but experiments of other cities seem quite successful: Ann Arbor, Michigan (C40 Cities a), Oakland, California (Bryan et al. 2008), and Welland, Canada (City of Welland 2007).[xiii]

Midtown Parking Garage

Recommendation

We recommend removing four lamps upper level and thirty-two lower level lamps in the Midtown Center Parking Garage. In addition, we suggest prioritizing the transfer of assets from National Grid to the City. We calculate that these changes, if implemented today, could save the City upwards of $25,000 by this time next year.

Status Quo

The Midtown Garage is located at Bridge and East First Streets and provides parking services to patrons at the surrounding shops, including a grocery store, a pharmacy, and a number of specialty shops and restaurants. These shops open in the morning and close by ten or ten-thirty in the evening. Shoppers do not pay for parking; instead, the retail outlets subsidize part of the cost of operating the garage.

The City owns the structure which recently underwent a one million dollar renovation by the Diment Construction and Engineering Company. There is no heating or cooling in the garage. The major operating expense is light.

Light is provided by National Grid which owns the lighting circuitry, fixtures, and bulbs. There are seventy-six 175-watt mercury vapor (MV) lamps that provide continuous light (24 hours a day, every day of the year) on the lower level of the garage. These services are billed under National Grid's tariff system. The tariff contract permits National Grid to charge the City for the circuits, fixtures, and electricity supply. The estimated annual cost of these lamps is $35,000.

In addition, National Grid owns four 400-watt high-pressure sodium (HPS) lamps on the upper level that provide light at night. These lamps use photo sensors to detect ambient light conditions and turn on in the late evening. Similar to the lower level lights, these are unmetered and are charged under the tariff system based on billable hours. For these lamps, billable hours are set by National Grid as the number of dark hours each month. Both evenings our team was in the city, three of the four lamps were off, and the other failed to provide constant light. Because of the tariff structure, however, these lamps are billed at full cost whether they are on or off. The estimated annual cost of these four lamps is $3,750.

The total cost of lighting, including the lower-deck level and street level cost the City an upwards of $40,000 per year.

Lamp Removal

The City recognized that there was an opportunity for cost savings in the garage as early as five years ago. In 2003 a police officer toured the garage with the goal of determining whether it was overlit. The officer determined that the garage was indeed overlit and identified thirty-two MV lamps that could be removed without any detriment to public safety. The officer drew a map of the parking spaces and lighting in the garage and highlighted those lamps which he or she felt could be removed (Appendix D). A plan was made to turn these lamps off on a temporary basis to gauge the public response. However, such a trial period never occurred.

We recommend initiating a public comment period by temporarily removing the thirty-two bulbs. These lamps should be removed permanently if there is no significant public response. The long-term removal of thirty-two bulbs will result in savings of over $13,000 per year (see Appendix C).

In addition to the lamps on the lower level, there is an opportunity to decommission the four HPS lamps on the street level of the garage. As noted previously, these lamps are unreliable and do not provide constant light, regardless of whether the City is paying for light.

Although the current poorly-lit condition of the street level suggests that there will be no public response to a permanent lamp removal, we recommend initiating a public comment period by temporarily removing the four bulbs. Again, these lamps should be removed permanently if there is no significant public response. Michael Riley, the City's Purchasing Agent, estimates that the long-term removal of these lamps would save the City approximately $3,750 per year.

To restate, we recommend initiating a trial period through an immediate removal of the 32 MV lamps and 4 HPS lamps. In addition to the potential cost savings as outlined above, that would decrease revenues to National Grid, which may encourage it to expedite the transfer.

Transfer of Assets

In consideration of this recommendation, the term assets is defined to include the circuits, fixtures, and lamps currently owned by National Grid,

As early as 2003, the City entered negotiations with National Grid about a transfer of the parking garage assets. These assets date from circa 1970 and are fully depreciated. National Grid has offered to transfer the assets to the City free of charge. The transfer includes only the MV lamps on the lower level of the garage, not the HPS lamps on the upper level.

As mentioned earlier, the City is currently billed under a tariff in which the City pays National Grid for the assets as well as the electricity supply. A transfer would result in a tariff change, after which electricity would be metered and the City would pay only for the electricity consumed.

We recommend prioritizing the transfer. Without any reduction in lighting, the transfer would save the City approximately $16,000, or fifty percent of the Midtown Garage's utility budget (see Table 4 below and Appendix C). Further, we recommend that the City negotiate with National Grid to have the upper level HPS lamps included in the transfer.

Recommendation: Transfer and Lamp Removal

After considering both of these alternatives separately, we recommend a combination of a transfer and lamp removal. Including only the assets on the lower level of the garage, this combination would result in savings of almost $23,000 per year, or seventy percent of the garage's budget (see Table 4 below and Appendix C). Additional removal of the four street-level HPS lamps would increase the savings to over $25,000 per year.

Table 4: Estimated Benefits of Midtown Garage Alternatives

	Status Quo	32 Lamps Removed	Transfer	Transfer and 32 Removed
TOTAL COST	$32,520	$19,072	$16,414	$9,138
Savings From Status Quo		$13,447	$16,106	$22,752
Savings as Percent of Status Quo		41%	50%	70%

Additional Considerations: Lamp Changes

Finally, once the transfer of assets occurs, the City should consider alternative lamp options for the lamps remaining in use. The MV lamps in the garage use relatively inefficient and outdated technology. Prior to the transfer, there is no incentive to update technology, because assets are owned by National Grid and the fee paid by the City would be unaffected. However, following a transfer, the City could reduce its electricity costs further by upgrading to more efficient HPS and LED technologies.

Vehicle Fleets

Recommendation

We recommend the City purchase Toyota Prius gasoline-electric hybrid vehicles for the Department of Public Works motor pool. Rising gasoline costs make fuel-efficient vehicles an increasingly economical choice. While law enforcement may require large, heavy-duty cars, other government uses need only reliable, efficient transportation. A financial analysis shows that using gasoline-electric hybrids, specifically the Toyota Prius, reduces life-cycle costs over the status quo of reusing police sedans.

Status Quo

Presently, the Department of Public Works relies on vehicles purchased with Police Department needs in mind. The City acquires Ford Crown Victoria Police Interceptors under contract through the New York State Office of General Services. These cars join the Department of Public Works motor pool after four years of police use at a rate of two cars per year. The Department of Public Works employs the cars until the end of their useful lives. The total life cycle of each vehicle amounts to roughly ten years and 150,000 miles.

This practice is simple and easy to administer. Also, because it uses the same vehicles throughout their life spans, it minimizes the costs inherent in buying and selling vehicles. However, because of their poor fuel efficiency, police vehicles potentially cost the Department of Public Works more to own than other types of vehicles, a problem growing in importance as gasoline prices rise.

The financial analysis described below finds that purchasing Toyota Prius gasoline-electric hybrid cars for the Department of Public Works costs less than reusing Crown Victorias. The 2008 Toyota Prius is a mid-sized car with excellent mileage relative to both gasoline-only cars and most other hybrids. Furthermore, hybrids are available through New York State contracts.

Assumptions

Comparing these two alternatives requires a number of simplifying assumptions. The comparison encompasses the costs over ten years of the following two options: driving a Ford Crown Victoria Police Interceptor 15,000 miles per year for ten years; driving a Ford Crown Victoria Police Interceptor 15,000 miles per year for four years (simulating police use), then selling that vehicle and buying a new Toyota Prius, which is then driven 15,000 miles per year for six years. In both cases, cars at the end of their term of use are sold. Relevant cash flows, therefore, include the costs of purchases, revenues from sales, and fuel cost for the vehicles involved.

Purchase information comes from current contract prices listed on the website of the New York State Office of General Services. Besides representing the City's established method of purchasing vehicles, these contracts are likely to remain competitive with other purchasing alternatives, due to the state's unified negotiating power on behalf of many government buyers statewide. According to these contracts, a 2008 Ford Crown Victoria Police Interceptor costs $19,437, and a 2008 Toyota Prius costs $20,122. Interestingly, the purchase prices differ by less than one thousand dollars.

Determining the resale prices of the vehicles presents a greater challenge. The City sells its vehicles via auction, likely an efficient method for obtaining a favorable selling price. The average dealer's retail price for the same vehicle serves as a proxy for the auction value. Current retail prices for used vehicles in Oswego's area can be obtained from the National Automobile Dealers' Association. Thus, the average resale price of a four-year-old Crown Victoria Police Interceptor is $9,600, that of a six-year-old Prius is $10,750, and that of a ten-year-old Crown Victoria Police Interceptor is $4,550.

The Environmental Protection Agency (EPA) estimates the fuel economy for vehicles sold in the United States. According to these estimates, the Toyota Prius drives 48 miles per gallon in city driving and 45 in highway driving. In clear contrast, Crown Victoria Police Interceptors drive 14 miles per gallon in the city and 21 miles per gallon on the highway. In obtaining an overall mileage figure, the analysis follows the EPA in assuming that 55 percent of overall miles are in city driving and 45 percent are in highway driving.

Gasoline cost depends not only on efficiency, but also on the cost per gallon. Like vehicle purchase prices, the price of gasoline comes from a New York State contract. Specifically, the May 22, 2008, contract price was $3.2799 for mid-grade gasoline, the grade the City currently buys. This price is used as a constant throughout the ten-year horizon of the analysis.

In addition to the above cost parameters, the analysis assumes a discount rate of five percent. Because the costs and benefits of the compared options do not involve sizable risk, a low discount rate is appropriate.

Results

The net present values (NPVs) of the two alternatives, each over a ten-year horizon, appear in Table 5 below. The life-cycle cost of the two-car approach is $2,725 less than that of the status quo. In other words, the decision to replace each used police car with a hybrid at the end of year four generates savings equivalent to $2,725 in present value. At a turnover rate of two cars per year, this yields an annual savings of $5,450 to the City's budget.

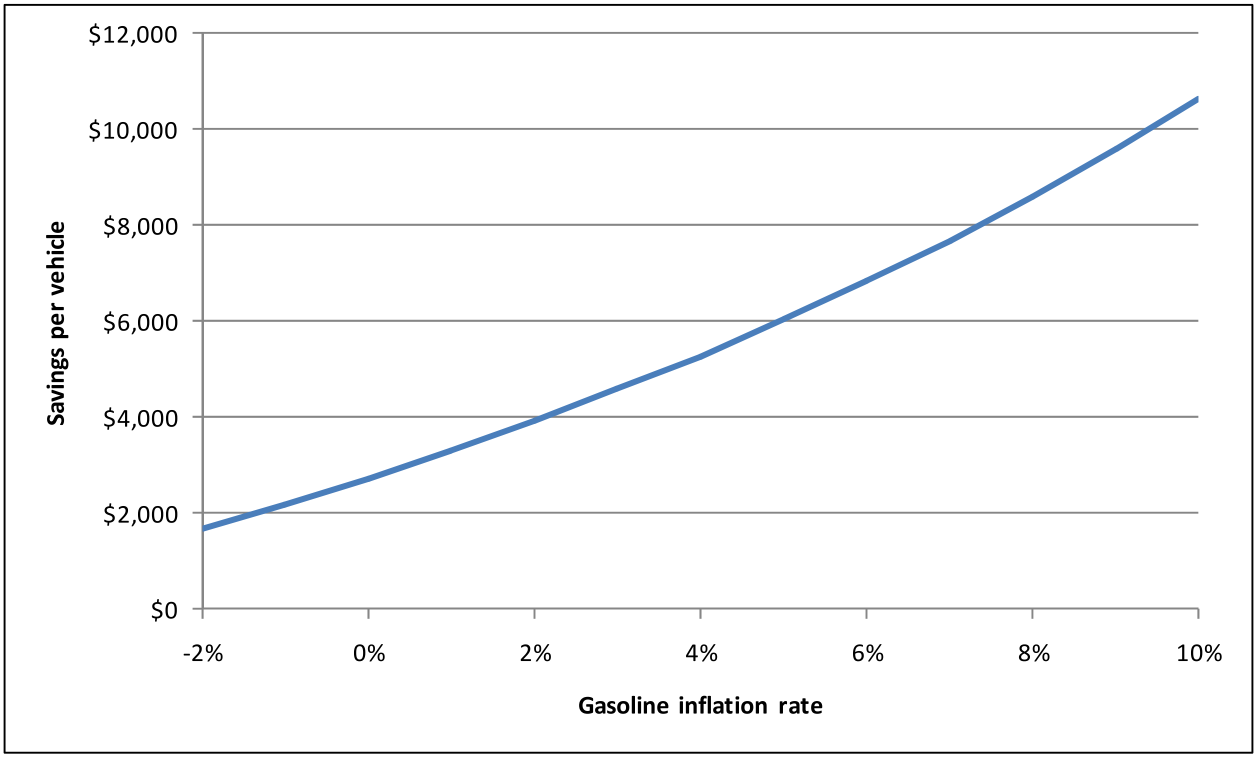
Table 5: Life-cycle Costs of Vehicle Purchasing Options

Costs per vehicle	Status Quo	Two-car Alternative
Purchase price (Crown Victoria)	$19,437	$19,437
Resale value (Crown Victoria)	$2,793	$7,898
Purchase price (Prius)	—	$16,554
Resale value (Prius)	—	$6,600
Fuel costs	$22,151	$14,576
Net Present Value	$38,795	$36,070

As the table also shows, fuel cost drives the overall result. Accounting for 57 percent of the status quo net present value, it falls to 40 percent of the alternative's net present value. The savings from fuel more than offset the extra spending required to buy new Priuses.

The above results hold even if gasoline prices change. Figure 3 shows the effect on life-cycle savings per vehicle if relative gasoline prices rise or fall at a constant annual rate. While recent trends may lead to further price increases, buying Priuses remains desirable even with a 2-percent-per-year fall in prices. In fact, the Prius option has a higher NPV unless the gasoline price falls by more than about six percent per year.

Figure 3: Savings Rise with Gasoline Prices

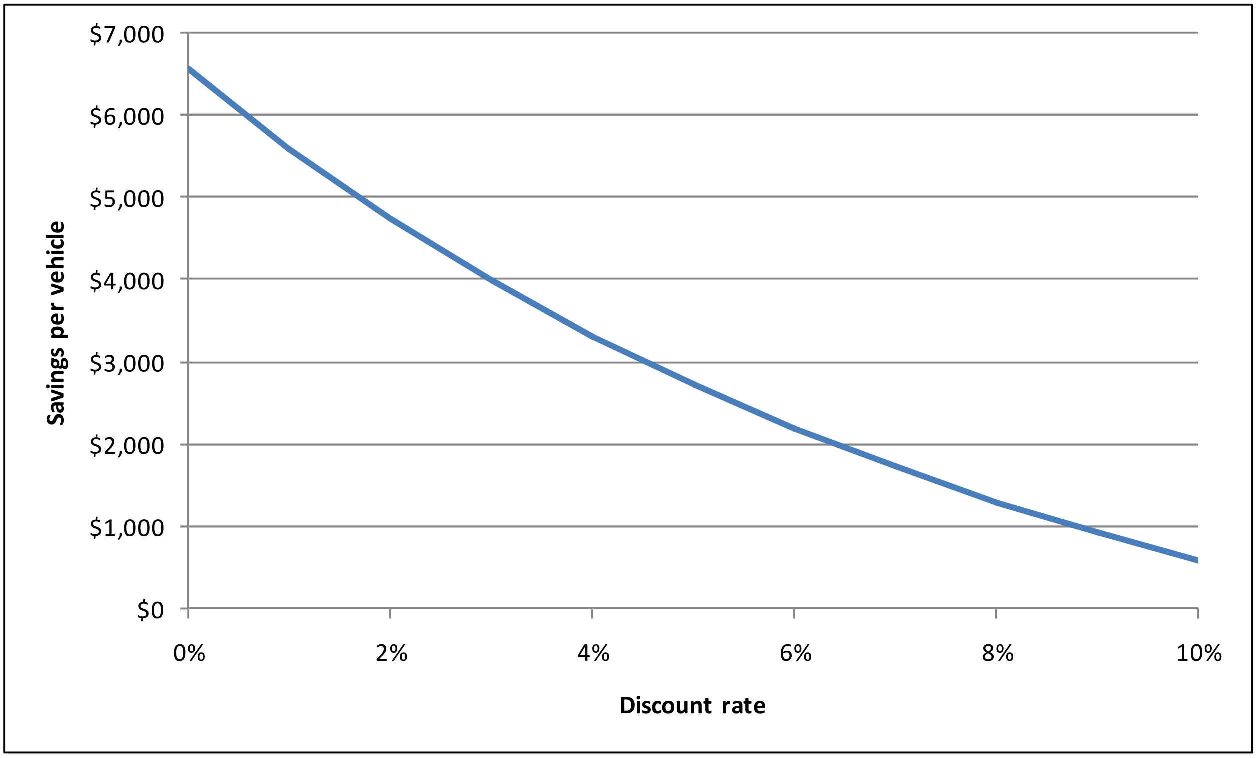


Likewise, Figure 4 shows the effect of different discount rate assumptions. Higher rates reduce the present value of savings from buying Priuses, but some savings remain even at a 10 percent discount rate.

Our analysis does not include insurance and maintenance costs. Because the scenarios under consideration comprise identical driving locations and functions, insurance costs are likely to be proportional to the residual value of the vehicles. Because the Prius depreciates more slowly than the Crown Victoria, insurance costs for the two-car scenario may be somewhat higher than those of the status quo.

Maintenance costs, in contrast, have more ambiguous implications. Currently, city mechanics have experience maintaining Crown Victorias but not Priuses. Adding Priuses to city fleets entails both a one-time cost of learning and adapting to the new cars and, possibly, an ongoing added cost of dealing with an additional type of vehicle. On the other hand, Priuses have a stronger overall reliability record than Crown Victorias, probably reducing ongoing maintenance costs. In the absence of quantitative data about these suppositions, it is unclear whether the total maintenance costs of adopting Priuses are higher or lower than current costs.

Figure 4: Savings Fall at Higher Discount Rates



Recommendation: Utilize Prius hybrids for non-police use.

Based on the financial analysis above, employing Prius hybrids for non-police uses would save the City thousands of dollars each year. Furthermore, investing in fuel-efficient vehicles reduces the budgetary impact of a particularly volatile cost, gasoline prices, which have increased over twenty percent in the last year alone. With these considerations in mind, we recommend considering auctioning used police vehicles and buying Priuses for the Department of Public Works.

Water Resource Management

Recommendation

We recommend the City implement a voluntary metering program with a commitment to have all single family residences metered by 2013.

Status Quo

The City charges residents of single-family homes a flat rate for their water usage. Citywide there are 2,200 metered customers and 4,050 unmetered customers. Table 6 below shows the respective pricing structures.

Table 6: Water Rate Schedule

	Cubic Feet (ft3)	Gallons	RATE (per 100 ft3)	Total (ft3)*	Total($)*
~2,200 Customers					
FIRST	900	6,732	$45.00 - minimum charge	900	$ 45.00
NEXT	3,000	22,440	$0.80	3,900	$ 69.00
NEXT	41,100	307,428	$0.60	45,000	$ 315.60
NEXT	105,000	785,400	$0.45	150,000	$ 788.10
NEXT	150,000	1,122,000	$0.35	300,000	$ 1,313.10
NEXT	600,000	4,488,000	$0.25	900,000	$ 2,813.10
OVER	900,000	6,732,000	$0.15	1,800,000	$ 4,163.10
	Flat Rate		$91.00 (water $65/sewer $26)		
	~4,050 Customers				

Water Metering

A voluntary water metering program will not only promote water conservation but it will also offer city residents the opportunity to potentially save money on their utility bill. Furthermore water use is inextricably linked to waste water use, which is a huge cost to the City: the energy needed to power the waste water plants is a major expense. As such, a voluntary metering program with a commitment to have all single family residences metered by 2013 is one way of reducing the cost burden of the waste water treatment plants. Moreover, there are other benefits to metering water including customer awareness, long-term cost reductions, and better city planning:

- *Customer Awareness*: Customers that are more aware of their water use will be able to make educated decisions about their water use.

- *Long term cost reductions*: Potentially alleviate capacity constraints, defer infrastructure replacement costs, and reduce operational costs

- *Planning Ahead*: Water meters enable the City to monitor water use and compare it with historical data to determine future needs and demands, which is important for long-term planning purposes.

A voluntary metering program would generate resident awareness about water consumption and provide an opportunity to initially self-select into having one's water metered. Self-selection is an important characteristic of this particular program because it gives residents the initial freedom to make a choice about having their water metered while potentially saving money. Further, a voluntary metering program with a long-term commitment to citywide metering allows the City to incrementally introduce a water metering policy, giving the public time to grow accustomed to metering and decreasing public resistance. Consequently, this approach will make metering water a more politically feasible option.

Benchmark Cities

We identified several cities that have recently implemented voluntary metering programs. Below we will discuss in detail the methods employed by three cities. By identifying what other cities have done right, we believe that Oswego can be more prepared to create a successful program.

Richmond, British Columbia

Richmond implemented a voluntary water meter program in 2005 with plans to raise the flat water rate approximately 14 percent per year. Residents that entered into the program during the first year were offered free water conservation devices including low-flow showerheads and faucet aerators, as well as a pop-flush toilet device[xiv]. Additionally, if metered residents found that their water costs exceeded the flat rate in the first year, they could apply for the difference to be credited to their account. Both of these incentives were only available for the first year of the program.

Public outreach was an important component of Richmond's plan. In an effort to reach the residents, the City revamped its website to provide residents with easy access to information about this program and water conversation in general. Shortly after unveiling this program, Richmond sent informational brochures to each home in the city. Richmond plans to make metering mandatory by 2010.

"In Alberta, Edmonton households are metered, while most Calgary households pay a flat rate. A study that compared use in both cities showed that the unmetered houses used 50% more water. The study also showed that metered users in both cities used about the same amount."

Source: http://www.watermeter.ca/english/about.html

The program has been a success in terms of raising resident awareness about water use, as well as being a politically acceptable option. To date over fifteen percent of residents have entered into the voluntary water meter program. This number continues to grow even after the first year incentives have expired. (City of Richmond Volunteer Water Meter Program)

West Sacramento, California

In April 2007 West Sacramento began a voluntary metering program with the goal of having all 45,000 residents metered by 2013. From 2007 to 2009 the City will encourage residents to voluntarily enter the program and the City will pay for meter installation costs As part of the program, West Sacramento will develop customer-specific water usage reports for residential customers that will provide information on monthly water consumption as well as a comparison of flat rate and metered rate water bills (The Reed Group 2007, p. 5). After 2009, the City plans on implementing a mandatory metering program at which point metered installation will not be subsidized and the customer-specific water usage reports will not be available.

Similar to Richmond, public outreach was important in West Sacramento. The City held two community workshops to provide residents information about the program and give the City government a forum to address public concerns (West Sacramento Public Notices).

West Sacramento has been overwhelmed by the response to this program indicating it has been a wide success in getting residents to switch from flat to metered rates (West Sacramento Water Metering Program).

Bellingham, Washington

The Bellingham City Council adopted a voluntary metering program in 2005 for the purposes of promoting water conservation. The program is intended to provide residents with an alternative pricing option to the flat rate structure. The City will increase flat rate prices every four years beginning in 2007 but does not plan to make metering mandatory.

Like the other cities, Bellingham made public interaction an integral part of this program. The City created a new website specifically for the program, as well as an online tool for residents to calculate water consumption. Residents that wanted to enter the program were required to submit an application and $150 payment for the meter installation cost to the Department of Water Works. Once residents entered into this program they were not allowed to go back to flat rates if they were unhappy.

"The town of Elmira, Ontario, estimated that replacing all toilets with ultra-low flow devices would result in a 30% flow reduction, and defer construction of a $33.5 million sewage treatment plant. This would save them up to $9.3 million over a 5-year period."

Source: http://www.watermeter.ca/english/about.html

The City of Bellingham has yet to release an evaluation of the program; however, the program is still available. (Voluntary Metering Program—City of Bellingham)

Again, we recommend the City implement a voluntary metering program with a commitment to have all single family residences metered by 2013. Below we have outlined an example implementation plan for the City to follow.

Implementation Plan

1) Determine the appropriate price of water for household use.

2) Launch a One-year Pilot Voluntary Metering Program.

   a) Subsidize cost of meter installation for the first year.

      (1) With 10 percent participation: 1,700 * 93 (avg. meter cost) = $158,100

      (2) With 15 percent participation: 2,550 * 93 (avg. meter cost) = $237, 150

   b) Plan to increase the fixed rate cost every year by 12 percent for the next four years.

c) Consider offering other incentives, such as customer-specific water usage reports or free water conservation devices.

3) Begin a Community Awareness Campaign

a) Update the Oswego Water Website to reflect a description of the program, long-term City plans for metering water, and general water conservation information

b) Send a newsletter/information packet to all residents

c) Hold a series of community workshops to give citizens a platform to discuss their concerns and provide the City a chance to debunk myths pertaining to metering water potentially mitigating resistance.

Program Evaluation

a) If successful, implement permanent voluntary metering program

   a. The program is successful if at least 7 percent of residents (1,190) enter within the first year.

b) If unsuccessful, conduct a community survey to understand why residents didn't enter the program. Revamp the program to address these concerns.

   a. This may be a politically unfeasible program, at which point the City may have to end it and look for other ways to cover the cost of operations.

Long-term Recommendations

The following recommendations are considered long-term because we expect they will take up to ten years to carry out, yet are still feasible to put into action. The following section focuses on sources of energy, rather than its consumption. In the following sections we have provided background information, relevant funding sources, and any useful contact information. The long-term recommendations are in order of what we consider should be the greatest priority according to the City's potential to carry out the suggestions successfully: invest in publicly-owned wind energy generation; install solar panels connected directly to the Conway Building and City Hall meters; consider installing a lake source cooling facility incrementally with renovations of current water facilities and HVAC systems; and consider installing a green roof on City Hall and the Conway Building.

Wind Energy

Recommendation

We recommend that the City invest in a publicly-owned wind energy generation venture by engaging stakeholders and soliciting bids from turbine manufacturers.

Analysis

We based our analysis on a typical one-megawatt (MW) horizontal-axis wind turbine. Horizontal-axis turbines are most efficient at lower wind speeds and operate well in more consistent winds, similar to the winds observed near coastal regions. In addition, far more horizontal-axis turbines are currently in use around the world, and the basic design has been thoroughly tested.

Wind Classification

In 1986 the US Department of Energy (DOE) created a range of wind power classes from 1(lowest) to 7 (highest). The wind classification system is designed to rate the strength of wind according to the average annual wind speed. Each class represents the average speed of the wind at the specified height above the ground. Table 7 displays the corresponding wind speeds and the related wind power class measured at 50 meters above the ground.

Capacity Levels

Since wind consistency varies throughout the day and throughout the year, turbines usually operate at below their rated capacity. The ratio between an installed turbine's average power output and its full capacity is known as its "capacity factor":

$$\text{Capacity Factor} = \frac{\text{Actual amount of power produced over time}}{\text{Power that would have been produced if turbine operated at maximum output 100\% of the time}}$$

For example a one MW turbine (1,000 kilowatts - kW) running for one hour would generate 1 MWh of electricity if it ran at 100-percent capacity. Due to that fact that the wind speed changes during the day and varies annually, however, the average output of the turbine might be closer to something like 20 percent of 1 MWh; if so, it would have a capacity factor of 20 percent. According to the American Wind Energy Association, a reasonable capacity factor is 25 to 40 percent (American Wind Energy Association). The differences in capacity factors are linked to the turbine height and model, as well as location, average wind speeds, and the type of wind (consistent vs. turbulent). Although a turbine's output depends on the time of the year and varies over the course of the day, the average level is the turbine's capacity factor.

Wind Energy: Oswego's Potential

The City of Oswego is located on the eastern shore of Lake Ontario in the Northwest region of New York State. Wind strength off the lake reaches DOE class five or six. During winter, the lake-effect weather patterns can provide even stronger, faster winds. However, during summer, wind power potential is closer to class three (Wind Energy Resource Atlas of the United States). The city has an annual average wind speed of 14 to 17 miles per hour at 50 meters (AWS Truewind). According to the American Wind Energy Association, New York State ranks 15th nationwide among states for wind energy potential. Its annual wind energy potential is 62 billion kWh (American Wind Energy Association). Figure 5 below displays these state-wide variations in wind speeds according to the scale provided. In addition, it can be seen from both Figure 5 and

Table 7 above that the city's wind class ranges, as noted above, between three and five (National Renewable Energy Lab).

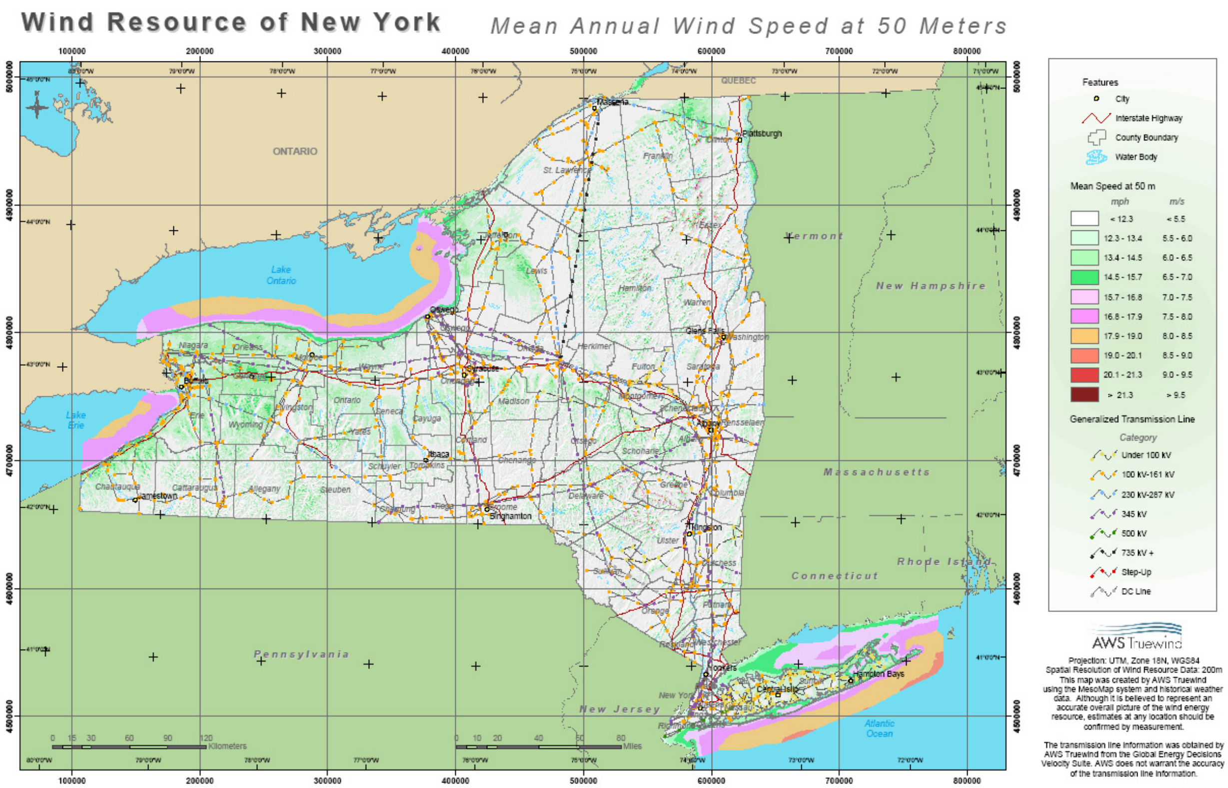
Table 7: Classes of Wind at 50 Meters

Wind Power Class	**50 m (164 ft)**
	Speed m/s (mph)
1	0
	5.6 (12.5)
2	
	6.4 (14.3)
3	
	7.0 (15.7)
4	
	7.5 (16.8)
5	
	8.0 (17.9)
6	
	8.8 (19.7)
7	
	11.9 (26.6)

Source: National Renewable Energy Lab

According to the American Wind Energy Association, class four winds or higher are preferred for commercial wind farms. For it to be profitable to connect a wind farm to the electricity grid, average annual wind speeds usually must be at least class five (American Wind Energy Association). Throughout the day the amount of electricity the turbine generates varies. This means that sometimes there may be excess power and at other times insufficient power. Thus, we recommend that the City first explore directly utilizing the wind energy produced, and then selling the additional electricity not needed back to National Grid. This allows the City to both make revenues from electricity sold back to the grid and save on energy bills it would normally have to pay if it did not produce its own electricity.

Figure 5: New York State Mean Annual Wind Speed at 50 Meters



Source: AWS Truewind

Types of Wind Turbines: Horizontal vs. Vertical Axis

To understand Oswego's full potential for wind energy generation, it is important to distinguish between the two basic types of wind turbines.

Horizontal-Axis

Currently, the more common wind turbine in use is the horizontal-axis (propeller-style) turbine consisting of two or three blades. The energy in wind turns these blades in a circular motion like a rotor. The blades are connected to a hub, which drives an electrical generator. Wind turbines operate at higher capacity factors when mounted on towers at least 100 feet above the ground. Horizontal-axis turbines operate best in consistent, high speed winds (U.S. DOE). These utility-scale turbines are often used for large-scale commercial generation ranging above 100 kW (American Wind Energy Association). Horizontal-axis turbines tend to be large-scale but may be appropriately applied to municipal and local use.

Vertical-Axis

The other basic type is the vertical-axis, or "egg-beater" style, turbine. Vertical-axis wind turbines (VAWT) currently come in two different forms: lift- and drag-based designs. Lift-based designs tend to be more efficient and can generate more power. Since these turbines are mounted on a central axis, they can make use of wind from any direction and perform well in gusty and turbulent areas. However, they usually require stronger winds than horizontal-axis turbines. Vertical-axis turbines tend to be smaller in scale and may be installed directly on top of buildings or structures. Yet the downside to vertical-axis turbines is that there is a limited number of designs available in the current market and many have yet to be tested full-scale. In addition, VAWT produce less wind energy in comparison to large horizontal-axis turbines. Thus, we recommend focusing on horizontal-axis turbines in terms of being able to generate enough electricity to power all the municipality's operations.

As the map of New York State displayed Oswego's potential to build wind turbines that would capture the energy of wind at 50 meters or 150 feet above the air. This photo shows a typical example of a large, horizontal-axis turbine with three large blades and the height of the hub ranging between 164 and 260 feet.

Source: Bennett Associates

Financial Analysis

To determine if a large-scale publicly-owned wind energy generation project would be a financially sustainable investment, we conducted a cost-sensitivity analysis using net present value (NPV) calculations. Throughout our financial analysis, we kept three specific variables constant: 1) maintenance/operation costs, 2) average life of a turbine, and 3) the annual interest rate. The sensitivity analysis highlights three specific variables: initial capital cost of turbine, the price paid for electricity produced and sold back to the grid (per kWh), and the turbine's capacity factor. These variables tend to have a greater impact on the profit margin.

According to NYSERDA, maintenance costs, including the cost of operations, typically range between one and three percent of the initial capital costs of the turbine. In our analysis we assumed that maintenance on a one megawatt turbine would be $20,000 per year, or two percent of the capital cost of a $1 million turbine. Similar to maintenance costs, the average lives of turbines vary among manufactures. For this analysis, however, we assumed the turbine would last for 20 years. Finally, we used a five percent real interest rate in our net present value calculations.

To examine the influence of the remaining variables, we created a matrix displaying net present value results for a range of selling prices and capacity factors. We used a range of electricity prices from $0.08 to $0.13 per kWh and then cross-referenced these prices with a range of capacity levels from 15 percent to 25 percent. Since it is rare for any wind power facility in New York to achieve a capacity level greater than 30 percent due to the fact that class four winds are the minimum necessary for commercial wind projects, we considered the best case scenario to be a 25 percent capacity factor (Abraham, Gary).

With this matrix of calculations, we were able to identify the sensitivity of the turbine's net present value to the variation in electricity prices and the capacity factor. Finally, we constructed a series of these matrices to highlight how the net present value would change as the capital cost of the turbine increased.

We started with a base scenario in which electricity could be sold for $0.11 per kWh, the turbine operated at a 20-percent capacity factor, and it cost $1 million to build and install (American Wind Energy Association, Large Utility Wind). We found a $1 million investment would deliver a positive NPV of $1.15 million over the turbine's 20 year life. Using the matrix of NPV calculations, we can determine which combinations yield negative NPVs and thus which combinations are not financially sustainable investments.

Table 8: One Million Dollar Turbine

Present Value of Revenue Stream compared to costs				
		Capacity Factor (%)		
		15%	20%	25%
Selling Price ($/kWh)	0.08	$ 60,783	$ 497,459	$ 934,135
	0.09	$ 224,537	$ 715,797	$ 1,207,057
	0.10	$ 388,290	$ 934,135	$ 1,479,980
	0.11	$ 552,044	$ 1,152,473	$ 1,752,902
	0.12	$ 715,797	$ 1,370,811	$ 2,025,825
	0.13	$ 879,551	$ 1,589,149	$ 2,298,747

The matrix shows the variation in NPV due to the various combinations of selling price per kWh and capacity levels.

Utilizing the base scenario for electricity prices and the capacity factor, we next considered the effect of an increase in capital costs to $1.25 million. We found that the profit margin drops to $902,473, exactly a quarter-million dollars less under the previous case. Since the base scenario ($0.11, 20%) still yields a positive NPV even with the quarter-million-dollar increase in capital costs, we still recommend that the City invest in a public-owned wind energy generation project. Although typical commercial prices of turbines are closer to the $1 million average (American Wind Energy Association, Large Utility Wind), we extended our analysis above $2 million to explore the effect of unexpected costs or higher than anticipated installation costs and connection charges.

Table 9: 1.25 Million Dollar Turbine

Present Value of Revenue Stream compared to costs			
	Capacity Factor (%)		
Selling Price ($/kWh)	15%	20%	25%
0.08	$ (189,217)	$ 247,459	$ 684,135
0.09	$ (25,463)	$ 465,797	$ 957,057
0.10	$ 138,290	$ 684,135	$ 1,229,980
0.11	$ 302,044	$ 902,473	$ 1,502,902
0.12	$ 465,797	$ 1,120,811	$ 1,775,825
0.13	$ 629,551	$ 1,339,149	$ 2,048,747

The base scenario still yields a positive NPV even if the initial capital costs increase by a quarter-million dollars.

In addition, considering even higher capital costs reveals that it is still feasible for the net present value of the investment to be positive. Potential reasons for higher initial capital costs include: difficulty to find a proper site, high demand for turbines, and underestimated installation costs.

Table 10: Two Million Dollar Turbine

Present Value of Revenue Stream compared to costs			
	Capacity Factor (%)		
Selling Price ($/kWh)	15%	20%	25%
0.08	$ (939,217)	$ (502,541)	$ (65,865)
0.09	$ (775,463)	$ (284,203)	$ 207,057
0.10	$ (611,710)	$ (65,865)	$ 479,980
0.11	$ (447,956)	$ 152,473	$ 752,902
0.11	$ (284,203)	$ 370,811	$ 1,025,825
0.13	$ (120,449)	$ 589,149	$ 1,298,747

If the City was able to purchase turbines for 2 million dollars each, the matrix shows a greater sensitivity to lower selling prices and lower capacity factors.

Table 11: Three Million Dollar Turbine

Present Value of Revenue Stream compared to costs				
		Capacity Factor (%)		
		15%	20%	25%
Selling Price ($/kWh)	0.08	$ (1,939,217)	$ (1,502,541)	$ (1,065,865)
	0.09	$ (1,775,463)	$ (1,284,203)	$ (792,943)
	0.10	$ (1,611,710)	$ (1,065,865)	$ (520,020)
	0.11	$ (1,447,956)	$ (847,527)	$ (247,098)
	0.11	$ (1,284,203)	$ (629,189)	$ 25,825
	0.13	$ (1,120,449)	$ (410,851)	$ 298,747

Anything over 3 million dollars is not recommended for the City to invest.

Private Wind Energy Generation Facility

Although our analysis has shown that a publicly owned wind facility offers direct financial benefits to the City, such as savings on electricity bills, if it is difficult to incur investment to pay for upfront capital costs of turbines, then there is another option. The city can attract a private developer to bear the upfront investment risks while receiving a premium for allowing the wind generation facility on city property. For example, Empire State Wind, LLC collaborates with communities to develop large commercial wind farms. Empire State shares the net revenue of the project with the municipal government. The city's share is typically about 25 percent, depending on the contract negotiated (Empire State Wind, LLC). The contract is developed in partnership with city officials and then reviewed by a third party. Private developers are responsible for all costs related to leasing the land, turbine bids, and installation costs. Municipalities have little to no financial obligation.

Privately developed projects are generally located on privately owned land. It is possible to set up a wind facility on publicly owned land, but this case is rare since the amount of land required, 10-30 acres per turbine, is not often owned by a municipality. The land is leased by the corporation and land owners are often given a monthly "rent" check and in some cases neighboring land owners receive a "good neighbor" check to reduce the likelihood of lawsuits. After the wind farm is built, the company the company connects directly to the grid and sells the power to either a wholesale buyer or to an independent system operator. This is considered the "day-ahead market" in which the company sells the power at a price established a day ahead. The company's revenue comes from selling the power. The share of the revenue going to the municipality can allow it to reduce property taxes, which is often an incentive for citizens to be more receptive toward the idea of a wind farm in their community.

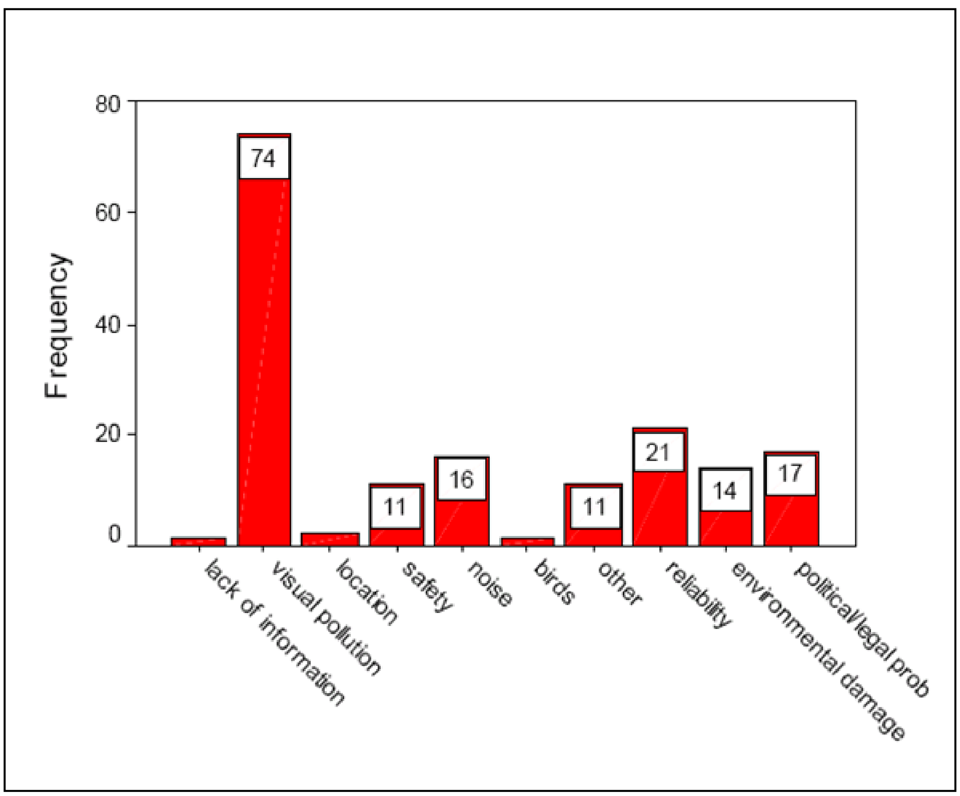
Another option would be for the wind farm to sell power to the City to offset and stabilize electricity bills. However, the market price of electricity is often higher than the cost of production so if the corporation was to sell at market price and then cut a monthly check to the city; it is assumed that the community will receive greater financial benefit in the long-run. After all loans used to finance the wind farm are paid off, then the private developer will sometimes offer a city the option of "buying back" the wind farm. The number of years before the "buy back" option is available depends on the contract.

In summary, the main advantage of a privately owned wind farm is that the developer carries all the risks for the project and pays all the costs. However, privately developed farms have the following disadvantages: more negative responses from the public are likely; the City has less control over the location and construction of turbines; and private development may increase social inequities. Since private landowners get paid for leased land, while neighbors do not, this option does not benefit the entire community. Private developers concentrate on large-scale commercial wind farms and on horizontal-axis wind turbines. Thus, if a city wants to have more control over the development, a public facility is preferred.

Potential Challenges of Commercial Wind Power

The primary challenge faced by wind power initiatives is overcoming negative public opinion. A study was performed by Dennis O'Grady, a professor at Appalachian State University, to measure public attitudes in North Carolina towards the development of utility-scale wind energy. The largest issue among the public was the aesthetic effects of wind turbines. Other major concerns were noise and the possibility of environmental damage (O'Grady, Dennis). As seen in the chart below, areas of concern were prioritized among 400 respondents in North Carolina.

Figure 6: Problems with Turbines



Source: (O'Grady, Dennis)

As stated above, citizens are often concerned with the aesthetics, noise, and environmental impacts of wind turbines. Each municipality must determine an appropriate approach and raise public awareness accordingly. For example, in the case study of Spirit Lake, Illinois, a local school district was able to incorporate a wind turbine project into its school curriculum, building public support in that way. The Town of Caroline, near Ithaca, NY, solicited public opinion and comment through a community survey. The Town of Fabius, near Syracuse, NY, created a council made up of government administrators and citizens to create an energy sustainability plan for the City.

Although wind turbines have far less impact on the natural environment compared to conventional energy sources such as coal or natural gas power plants, there are still some likely disadvantages. Wind turbines kill 1.4 million birds worldwide annually (Boyle, Godfrey). Yet according to the American Wind Energy Association, birds die from other various issues and these other instances should be taken into account when determining the potential for wind energy generation. Each year in the U.S., an estimated:

- 57 million birds die in collisions with motor vehicles,
- 1.25 million birds die in collisions with tall structures (towers, stacks, buildings),
- 97.5 million die in collisions with plate glass
- 4 million - 10 million night-migrating songbirds die in collisions with telecommunications towers
- 100 million die due to household cats in the U.S.

On the other hand, it is calculated that each wind turbine kills 0 - 2 birds per year at worst (Boyle, Godfrey). Problems such as vulnerable bird collisions are being resolved or significantly lessened as there is more development of technology or better planning of wind generation sites.

In each of the cases mentioned above, municipalities gained public support through engagement. Specifically, they created action committees made up of a mix of experts in the field, citizens, business interests, and government officials.

Fenner Wind Farm

Commercial Wind Farm

The Free Center, Inc.

Located in Fenner, NY the Fenner Wind Farm, consisting of 20 GE manufactured wind turbines, is fully owned by Canastota Windpower, LLC, a wholly owned Subsidiary of Enel North American, Inc. The total capacity of the wind farm is 30 megawatts. Each GE manufactured wind turbine has a capacity of 1.5 megawatts. Per year, the Fenner Project is projected to produce enough electricity to power about 10,000 average American homes (*The Fenner Wind Power Facility*, NYSERDA). The wind power is transferred to New York state citizens through such utility companies as Niagara Mohawk. The energy produced by the wind turbines is captured and transmitted to Niagara Mohawk. The project was completed in 2001, with capital costs partly funded by NYSERDA. As part of the wind farm project, the Fenner Renewable Energy Center was established to educate the public about the potential of wind power.

Source: *The Free Center, Inc*

www.fennerwind.com

Conclusion

The next steps for the City of Oswego include engaging the public and soliciting bids. We recommend that the City organize a community focus group to hold presentations and forums. The mayor's office and appropriate department heads should organize a trip to a local wind farm. And most importantly, the City should consider developing and distributing a public opinion survey that serves as an information tool and a way to gage public opinion. Simultaneously, the City should start soliciting pricing and bids from potential vendors of wind turbines. We have compiled a database of turbine vendors and listed relevant contact information below to aid in the process.

> **Case Study: Spirit Lake, Iowa**
>
> ***On-site Wind Power Generation***
>
> ***ICLEI***
>
> In 1993, Spirit Lake Community School District installed a 250kW Windworld Turbine. This turbine has provided the school an average of 350,000 kWh of electricity per year, providing more energy than is needed for the 53,000-square-foot school. By selling the excess electricity to the local utility, the school made between $20,000 and $25,000 in its first five years of operation. The wind turbine project cost the school $358,500, but with a grant of $119,000 they were able to pay off the remaining cost in four years. From 1993 to 2001, the wind turbine saved the school $124,900 in electricity costs.
>
> Source: *Case Study: Spirit Lake, Iowa from ICLEI*

Funding Sources

NY State Renewable Portfolio Standards

The Renewable Portfolio Standard (RPS) was implemented on September 24, 2004 by the New York Public Service Commission. The RPS will require by 2013 that at least 25 percent of New York's electric use be from renewable resources. The RPS will use incentives to encourage the development of renewable resources. Wind is a potentially eligible resource category (American Wind Energy Association). The purpose of the RPS is to reduce energy dependence and increase security, attract "green industry" to create more jobs and income for New York State, and improve the environment and air quality in New York State (NYSERDA).

On Site Small Wind in New York

This organization provides cash incentives for eligible wind power investment. Incentives are passed on to the owner of the system. If the City were to own the system, then the incentive would be passed onto it. Metering and energy production monitoring systems are included and will be monitored by NYSERDA for the first two years. This will help the City track the financial benefits of a wind power system (NYSERDA). This information is accessible at the NYSERDA website under funding opportunities, wind incentives. For more information please visit: www.powernaturally.org

New York Energy Smart Loan Program

This program offers "interest rate reduction off a participating lender's normal loan interest rate for a term up to ten years on loans for certain energy-efficiency improvements and/or renewable technologies." The interest rate reduction ranges from 4 to 6.5 percent, depending on the state. In order to qualify for this program the City must pay the System

Benefits Charge to one of several utility providers, one of which is National Grid. This funding information is available at the NYSERDA website under funding opportunities.

Energy Efficiency and Renewable Energy

The Office of Energy Efficiency and Renewable Energy offers financial assistance to encourage the development and/or demonstration of renewable energy and energy efficiency technologies. The department’s phone number is (877) 337-3463, more information please visit: www.eere.energy.gov. Address: US Department of Energy, Mail Stop EE-1, Washington DC 20585.

Additional Information[xv]

National Grid Connection FAQs[xvi]

Per Kilowatt Hour Revenue

National Grid is required pursuant to Service Classification No. 6 ("SC-6") of the Company’s tariff (Niagara Mohawk's P.S.C. No. 207 – ELECTRICITY, Schedule for Electric Service) to purchase the excess electricity produced by customers with qualifying on-site generating facilities. A qualifying facility ("QF") as defined under the Public Utility Regulatory Policies Act of 1978, as amended ("PURPA") and the regulations of the New York State Public Service Commission and Federal Energy Regulatory Commission promulgated there under and the regulations implementing PURPA. I have attached a copy of the SC-6 tariff language for your review.

The Company offers a two year power purchase agreement that provides payment for excess electricity delivered to the Company at a rate equal to the market price of electricity as established and posted by the New York State Independent System Operator.

The following steps should be followed to see historical energy prices that National Grid would pay for energy:

1. Go to www.NYISO.com
2. Under the Market Data pull down menu click Pricing Data
3. Under Time Weighted / Integrated Real - Time LBMP click Zonal
4. Under the Custom Report section at the bottom, choose the date range of historical data you would like to review and choose the CENTRL zone (Oswego is in the Central zone).
5. Choose CSV format and click on Generate Report
6. An EXCEL spreadsheet will open, the prices in column D will provide you with hourly energy prices (in $/MWh).

Contracts Between National Grid and Municipalities

To be eligible for an SC-6 contract, the following requirements must first be met:

A separate interconnection agreement ("IA") with National Grid must be in place. Execution of this agreement is dependent upon a review and approval of the design of the on-site generating unit to the satisfaction of National Grid's Engineering Department.

The on-site generating facility must be a qualifying facility ("QF") under PURPA or New York Public Service Law 66-C. The owner of the generator(s) must review these Federal Energy Regulatory Commission guidelines and submit to National Grid in writing that they are a QF.

After these requirements are met, the Company will provide a standardized form of power purchase agreement ("PPA"). Customer specific information must be provided to complete the PPA.

Interconnection Costs

A wholesale generator connecting to National Grid's electric system is required to pay for the cost of the interconnection. A cost estimate is provided in an interconnection study conducted by the Company as part of the IA process. The Transmission Commercial Services group at National Grid is responsible for interconnecting wholesale generators. This group is currently led by Susan Hodgson (315) 428-5048, her E-Mail address is susan.hodgson@us.ngrid.com

Contacts

Fabius Energy Steering Committee

Doug Lyon
Phone: (315) 696 5989
E-Mail: Dlyon16@hotmail.com

National Grid

Jeffery A. Glose
Principal Analyst- Power Purchase Agreements
Regulated Electric Load & DG Services
300 Erie Boulevard West, A-4
Syracuse, NY 13202-4250
Phone: (315) 428-5608
Fax: (315) 428-3103
E-Mail: jeffery.glose@us.ngrid.com

NYSERDA

Paul Thompson
Phone: (315) 422-8276

Office of Energy Efficiency & Renewable Energy
US Department of Energy

Mail Stop EE-1
Washington, DC 20585
Phone: (877) 337 3463
URL: www.eere.energy.gov

Energy Independent Caroline
Town of Caroline

Steve Nicholson
E-Mail: scnfish@gmail.com

Solar Energy

Recommendation

We recommend the City consider solar energy as the primary power source for the Conway Building and pursue grants to cover the fixed cost of buying and installing the solar panel system.

Solar Energy: Oswego's Potential

Solar panels will significantly reduce the Conway Building's electric bills by directly supplying electricity. The building will still require some electricity from the grid, since the solar photovoltaic (PV) system will not be able to produce enough electricity to fully power the building. According to Google Earth, the building's roof area is approximately 4,000 square feet. This area cannot support the number of solar modules needed to meet the building's electricity demands, which peak between 81.6 and 107.2 kW (see Table 12). In comparison, the City of Toronto recently installed a 15,368-square-foot solar PV system to provide for electricity demand that peaks at 100kW (Ontario Power Authority).

Table 12: One Year Snapshot of the Conway Building's Electricity Bills

Read Date	Days	Total kWh	Avg. kW	Charges	Peak kW
4/30/2008	29	37920	54.48	$1,646.19	81.6
10/31/2007	30	39680	55.11	$1,692.72	84.8
12/3/2007	33	43040	54.34	$1,850.52	86.4
4/1/2008	29	43840	62.99	$1,846.80	86.4
2/1/2008	29	43840	62.99	$1,786.50	92.8
3/3/2008	31	49760	66.88	$1,910.02	92.8
6/4/2007	33	41760	52.73	$1,917.91	94.4
1/3/2008	31	49280	66.24	$2,014.32	97.6
10/1/2007	31	46880	63.01	$1,952.29	99.2
8/31/2007	29	48960	70.34	$2,057.05	102.4
7/3/2007	29	47520	68.28	$2,031.86	107.2
8/2/2007	30	51680	71.78	$2,197.15	107.2

Our study assumes only half of the roof can be used for the solar PV system because of the historical nature of the building. Under this assumption, the Conway Building can house a solar PV system generating more than 10kW (see Table 13). Under NYSERDA's estimate of 10W of power generated per square foot of PV module, the 2,000 square feet of available roof space could accommodate a 20kW system.

Table 13: Required Area for Photovoltaic Solar

Roof Area Needed in Square Feet							
PV Module Effiency (%)	PV Capacity Rating (Watts)						
	100	250	500	1,000	2,000	4,000	10,000
8	15	38	75	150	300	600	1,500
12	10	25	50	100	200	400	1,000
16	8	20	40	80	160	320	800

Source: U.S. Department of Energy

Financial Analysis

In accordance with recent research, we conducted a financial analysis for a 10kW system, assuming a useful life of 25 years and maintenance equal to 2 percent of total cost (Photovoltaic Economics). Other key assumptions include an average bond rate of 5 percent and revenue set at $0.15 per kWh, which is the same rate the City currently pays National Grid (Solarbuzz). We make this revenue assumption because we expect that the Conway building will use all of the electricity produced.

In terms of the cost of solar panels, Solarbuzz, a solar consultancy group, reports that the average retail price for a solar panel that peaks at 125W is $4.81 per watt as of May 2008. This cost is only 40 to 50 percent of the total installation cost of a solar PV system (Solarbuzz). Therefore, the estimated price of such a system is ten dollars per watt.

For this financial analysis, costs are greater than benefits (see Table 14 below). Under these circumstances, the City should apply for grants in order to cover the deficit.

Funding Sources

Below, we have provided a list of potential funding sources.

NYSERDA Solar Electric Incentive Program

This program provides cash incentives for the installation of new solar electric or photovoltaic (PV) systems by listed eligible installers. There are approximately $13.8 million of incentives available through 2009. This program exists in conjunction with the New York State Renewable Portfolio Standard. Depending on demand and program success, additional funding may be made available. Grant applications will be accepted through September 30, 2009, and awarded on a first-come, first-served basis, until funds are fully dedicated (DSIRE).

For more information, please see: http://www.powernaturally.com/Programs/Solar/incentives.asp

Table 14: Matrix of Net Present Values

Present Value of Revenue Stream compared to costs				
		Capacity Factor (%)		
		8%	12%	16%
Total Cost ($/kW)	7,000	(57,598)	(51,047)	(44,497)
	8,000	(67,697)	(61,147)	(54,597)
	9,000	(77,797)	(71,247)	(64,697)
	10,000	(87,897)	(81,347)	(74,796)
	11,000	(97,996)	(91,446)	(84,896)
	12,000	(108,096)	(101,546)	(94,996)

Town of Greenburgh in Westchester County, is one of 12 municipalities in New York State that received a NYSERDA grant to fund a photovoltaic solar project on Greenburgh's Town Hall building. The town supervisor, Paul Feiner, actively pursued the state grant in hopes that "businesses and residents will be motivated to pursue solar panels and other energy alternatives at their homes/businesses (nylawline)." The grants originated from a $2.1 million settlement brought against Dominion Virginia Power, formerly known as Virginia Electric Power Company (VEPCO). NYSERDA administered the fund and made grants available to local governments for government-owned buildings throughout the state. The panels were installed on March 28, 2006, and the town celebrated with a dedication ceremony and energy conservation fair on Saturday, May 13th. The city's energy conservation coordinator, Nikki Coddington, organized the event with a special ribbon cutting ceremony for the Town Hall's new solar electric system.

SOURCE: http://nylawline.typepad.com/greencounsel/2006/05/does_your_town__1.html

Solar America Initiative by the U.S. Department of Energy

This federal initiative's objective is to make solar electricity from photovoltaics (PV) more cost-competitive with conventional forms of electricity. By 2015, The Department of Energy (DOE) is strategically pursuing opportunities for research and development as well as significant funding opportunities through the Solar America Initiative. Funding is granted to industries, university entities, state governments, non-governmental agencies and other federal agencies to further develop solar energy technologies. The DOE provided $159 million of initial funding. It is estimated an additional $200 million will be granted, subject to congressional approval (DSIRE).

For more information please see: http://www1.eere.energy.gov/solar/solar_america/index.html

Interstate Renewable Energy Council (IREC)

IREC is a non-profit organization whose mission is, "To accelerate the sustainable utilization of renewable energy sources and technologies in and through state and local government and community activities" (IREC). Based in Latham, New York, IREC's nationwide network includes state energy offices, city energy offices, other municipal and state agencies, national laboratories, solar and renewable organizations and companies, and individual members (DSIRE).

For more information please see: http://www.irecusa.org/index.php

The Town of Hempstead, similar to the Town of Greenburgh, received a portion of the 2.1 million Clean Air Act Settlement to fund a solar energy system. Hempstead is home to over 750,000 residents and is setting an example for "money- and energy-saving 'green' innovation in local government (nexttekpower)." In 2005 the town received a NYSERDA-administered $260,000 grant to install 256 40kW photovoltaic panels on the southern face of the Hempstead Town Hall (see above). The solar PV system powers a part of the building's heating, ventilating, and air conditioning (HVAC) system. The solar transition matches the HVAC system motors with adjustable frequency drives to improve efficiency. The system may set to an idle to match the energy needs of the HVAC system. If there is full sun, the frequency drives are completely powered by solar. Town Supervisor Kate Murray collaborated with Nextek Power Systems and Rockwell Automation to transition to an alternative energy source that also creates monetary savings for taxpayers. It is estimated that the solar system will save the town $19,000 annually in energy costs. The town of Hempstead offers residents educational classes and information sessions about solar energy.

SOURCE: http://www.nextekpower.com/news/mar07.html

Lake Source Cooling

Recommendation

We recommend that Oswego investigates possibility of a lake source cooling facility and construct the facility incrementally in coordination with renovations of current water facilities and the HVAC systems in municipal buildings.

Lake Source Cooling: Oswego's Potential

Lake source cooling (LSC) originated from the desire to utilize the cool deep waters of lakes as air conditioning for buildings. Many lakes have layers of water of different temperatures. The deepest layers maintain a constant temperature of 40 degrees Fahrenheit. Lake source cooling systems pump the cool deep water from the bottom of a lake and use it to cool a series of buildings. Located on the shore of Lake Ontario with a water pump plant that already pumps water from the lake, the City could build a lake source cooling system to cool municipal buildings. Oswego could not only use the system to cool buildings but also supply the municipality's drinking water. The City has the potential to create a closed loop system where they pump the water from Lake Ontario, exchange the hot water for the cold water to cool its municipal buildings, and then send the warmed water to its water treatment facilities to be used as the City's drinking water supply. The intake pipe would have to be moved deeper into the lake to access the cooler waters. The largest expense would be the pipes. However, if the City coordinates the building of an LSC facility with scheduled renovations of the current water plant and HVAC system, the City could decrease the cost of constructing an LSC facility.

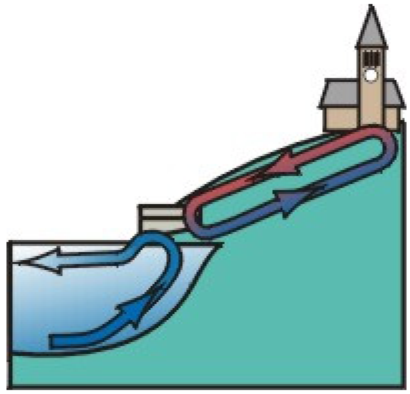
There are two nearby examples of functioning lake source cooling facilities: one at Cornell University in Ithaca, NY, and one in Toronto, Ontario, Canada. These facilities were both built for the purpose of cooling buildings and reducing their city's carbon footprint and energy costs. However, they differ in a very distinct way. The Cornell system releases the warmed water back into the lake while Toronto does not.

Cornell University's Lake Source Cooling Facility

Several years ago Cornell was faced with the necessity of having to replace its air conditioning system. Previously they had used conventional chillers that cost $30 million more in the long run than a Lake Source Cooling facility. Cornell decided that in the long run a Lake Source Cooling facility would be less expensive to maintain, replace, and run than conventional chillers. At a cost of $57 million dollars, six years of planning, and 48 permits, the Cornell LSC facility has a life time of 75-100 years and the payback period is ten to thirteen years. Before the construction of the facility began, an environmental impact statement had to be written that cost $5 million.

Cornell University's facility contains two loops. The open looped system (the lake loop) draws cool water from the depths of Cayuga Lake and heat exchangers transfer the cooler temperature to the closed loop system (the loop that circulates through campus). The campus closed loop system circulates the cold water through campus to cool the campus buildings. Metal plates are used to exchange heat between the open loop and closed loop system, much in the same way that a car radiator works. The closed loop water circulates by the pressure that is created by water and gravity. The water in the closed loop circulates through the heat exchanger opposite the cold lake water and the heat is transferred from the closed loop (campus loop) to the open loop (lake loop). The warm lake water is then returned to a shallow part of the lake where the natural water temperature is similar to the temperature of the water that is released.

Figure 7: Lake Source Cooling at Cornell



Source: http://www.utilities.cornell.edu/utl_lscfte_howlscworks.html

The lake loop pumps water from Cayuga Lake through an intake pipe that is 250 feet below the surface. The return water pipe that is part of the open lake loop is located 500 feet off shore and returns the water to the lake at a temperature of 55 degrees Fahrenheit. The normal temperature of the lake water where the warm water is returned is naturally 56-70 degrees. 2 ½ miles of steel pipe create the closed loop system that circulates the water through Cornell to cool the building. The system requires little in-person monitoring. Three miles from the LSC facility, a computer reports the status of the system 24/7 to a single employee.

At full capacity, the facility can cool 75 campus buildings. It produces 18,500 btu/hour versus a conventional chiller facility that produces 6,000 btu/hour. To cover part of the costs, Cornell received rebates from NYS Gas & Electric totaling a half million dollars.

Lessons Learned from Cornell

Cornell's greatest struggle was gaining public approval and they still struggle to maintain public support for the facility. As the first entity to ever build a LSC facility, their struggle with the public probably stems from the fact that there is no past data to prove or disapprove the environmental impact of LSC. Toronto may have had an easier time getting the facility approved due to the fact that they were not the first. Also, the diverse make up of Ithaca may have differed from Cornell, affecting citizen's political stance and opinions about the possibility of an LSC facility.

Toronto's Deep Lake Source Cooling Facility

Due to demand from citizens for better water quality, the need to reduce energy costs, and the demand from the Canadian national government to create more sustainable city infrastructure, the City of Toronto decided to build a district wide LSC facility. At a total cost of $169 million, the facility currently cools ten downtown buildings, but has the capacity to cool one hundred.

The Toronto system, constructed by Enwave, works differently than the Cornell system. Still built to cool buildings, the Toronto system does not release the warmed water back into Lake Ontario. They instead draw enough water from the lake to satisfy the City's drinking water supply needs. After the water is used to cool municipal buildings, they then use the water for their water supply needs and the waste water is then treated by their waste water facilities before it is released back into the lake or the grey water is used for other purposes.

Table 15: Challenges and Benefits of Lake Source Cooling

Challenges of LSC	**Benefits of LSC**
<u>Cornell</u> • The system maxes out seven days a year so they must have a back-up conventional chiller system • Took 6 years to get the system planned and approved before construction could begin • Every year, the system kills enough mysid shrimp to prevent the growth of one Lake Trout • Zebra mussels plug the tube. But in the past seven years they have not had to clear the tube of Zebra mussels <u>Toronto</u> • Large capital costs	<u>Cornell</u> • Cuts electricity usage for cooling by 86% (Smith, 2004) • Saves $2 million per year on electricity (Syracuse Post Standard, 2004) • Saves enough energy per year to power 2,500 average homes in Ithaca (or 20 million kWh) • The system has a life of 75-100 years, where typical chillers last 30-40 years • LSC uses only 10% of the energy that conventional chillers use • Low maintenance and monitoring costs <u>Toronto</u> • Reduces energy use by 75% compared to conventional chillers, and could ultimately free more than 59 MW from Ontario's electrical grid (City of Toronto, 2008) • Reduces carbon dioxide emissions by power plants by 4,000 tons which is the equivalent of taking 8,000 cars off the road (Syracuse Post Standard, 2004)

The construction of the facility was jointly agreed upon by the City of Toronto and the publicly-owned Toronto District Heating Corporation (TDHC). Toronto's system was built with the intent to be district wide. Local businesses have the option of connecting into the system. The Toronto system has enough capacity to cool 3.2 million square meters of office space. All costs for the project were covered by TDHC, but the facility is fully owned by the City of Toronto (Environmental Assessment Report, 1998).

Contacts

City of Toronto:

Lawson Oates, Director of the City of Toronto Environment Office
Toronto City Hall
100 Queen Street West
21 East
Toronto, Ontario M5H 2N2
(416) 392 9744
loates@toronto.ca

Cornell University:

- Engineer: Laney Joyce
- Authors of the Environmental Impact Statement: Pat McNall & Burt Bland
- Chilled Water Manager: Ed Wilson, 266-6648

Green Roofs

Recommendation

We recommend that Oswego utilize green roofs only if rainwater catchment is the primary purpose due to the large structural investment required.

Green Roofs: Oswego's Potential

Green roofs are great additions to large urban buildings but only if the building structure is capable of supporting the weight added and the main objectives is to reduce rainwater runoff. In the Southwest region of the United States, many cities suffer from the heat island effect, thus green roofs help reduce the surface temperature of the rooftop. A green rooftop has a cooler air temperature, than a traditional rooftop which can be up to 90°F (50°C) warmer (Environmental Protection Agency).

We learned that the Conway Building will be receiving a U.S. Department of Transportation grant of 1.5 million since it was an old U.S. Customs Building. If the City plans on investing in restructuring the building's infrastructure and support, then green roofs is a potential option. Since the Conway Building is in need of sandstone renovation, these funds should primarily go towards its reconstruction. A green roof is an aesthetically appealing option. It is important to keep in mind that green roofs are only beneficial for a city like Oswego if rainwater catchment is the primary purpose for the large structural investment.

Intensive and Extensive Green Roofs		
Characteristic	**Intensive Green Roof**	**Extensive Green Roof**
Soil	Requires minimum of one foot of soil depth	Requires only 1 to 5 inches of soil depth
Vegetation	Accommodates large trees, shrubs, and well-maintained gardens	Capable of including many kinds of vegetative ground cover and grasses
Load	Adds 80-150 pounds per square foot of load to building structure	Adds only 12-50 pounds per square foot depending on soil characteristics and the type of substrate
Access	Regular access accommodated and encouraged	Usually not designed for public accessibility
Maintenance	Significant maintenance required	Annual maintenance walks should be performed until plants fill in
Drainage	Includes complex irrigation and drainage systems	Irrigation and drainage systems are simple
Source: Schloz-Barth, Katrin. 2001. "Green Roofs: Stormwater Management From the Top Down." Environmental Design & Construction. January 15.		

Advantages of Green Roofs

According to the United States Environmental Protection Agency, an alternative to traditional roofing is a rooftop garden, also known as a "green roof." There are two main types, intensive and extensive. A basic green roof comprises of vegetation, soil, and potentially a waterproofing membrane. Green roofs may also include additional layers, such as a root barrier and drainage/irrigation system. Green roofs may be used in several different applications:

- Industrial facilities
- Residences
- Offices
- Other commercial property

Green roofs are commonly used in Europe to aid in storm water management and energy savings, as well as aesthetic benefits (Environmental Protection Agency). Acting like sponges, green roofs absorb rainwater that would otherwise run off into the municipal drainage system. The EPA website lists that an estimated three to five inches of soil or plant medium can absorb up to 75 percent of rainwater, which is equivalent to one-half inches or less of rainwater. In addition, green roofs and its plant life may also:

- Absorb carbon and particulates
- Protect underlying roof material from ultraviolet (UV) radiation
- Serve as a living environment for migratory birds and other small animal species
- Offer an attractive urban quality of life
- Act as a barrier to outdoor noise

- Insulate the building from extreme temperatures, particularly help in keeping the interior cool on warm days

Disadvantages of Green Roofs

To capture the full benefits of a green roof investment, such as storm water mediation, this may require an in-depth structural investment. In addition to material costs, maintenance should also be considered. The full cost of a green roof project varies depending on the type and depth of the selected plants. According the U.S. EPA, the up-front fixed cost (materials, preparation, and installation) of an extensive green roof in the United States starts at around $8 per square foot. In comparison, a traditional built-up roof starts at $1.25 per square foot, while cool roof membranes start at about $1.50 per square foot. Extensive green roofs cost more because they require more material and labor. In addition, green roof contractors are of limited supply, so a growing demand for green roofs adds to the price of installation. As the number of contractors available increases to meet this demand it is likely fixed installation costs will decrease. However, the true cost of a green roof will be hinging on other factors such as, the price per gallon of water since these roofs need to be watered in the summer and unforeseen maintenance costs (Environmental Protection Agency).

Green Roof Examples around the Nation (Environmental Protection Agency):

- The Gap Headquarters in San Bruno, CA - 69,000 sq. ft. extensive - 1997
- Ford Motor Company - corporate headquarters
- The Church of Jesus Christ of Latter-Day Saints Conference Center in Salt Lake City, Utah - 348,480 sq. ft. extensive and intensive - 2000
- Montgomery Park Business Center in Baltimore, Maryland - 30,000 sq. ft. extensive
- Ducks Unlimited - national headquarters, two green roofs totaling 28,190 sq. ft.
- City of Chicago and the City of Portland – private/public interests have installed or are planning to install over 43 and 42 green roof projects, respectively

Grants and Potential Partners

Green Roofs for Healthy Cities North America (GRHCNA) is a not-for-profit industry association which promotes green roofs throughout North America. In 2004, GRHCNA became a formal industry association registered as a not-for-profit 501(c)(6). (Green Roof for Health Cities).

Table 16: Additional Resources for Green Roofs

Eco Roofs	http://ecoroofsystems.com/grnRoof.html (no www)
Green Products	www.greenproducts.net/index.html
Green Roofs – Healthy Cities	www.greenroofs.org
Green Roof Companies	www.greenroofplants.com/green_roof_links.htm
MSU Green Roof Research	www.hrt.msu.edu/greenroof/
National Resources Defense Council"	www.nrdc.org/water/pollution/gutter/gutterinx.asp
Roof Gardens: Design& Construction	www.oikos.com/shop/product_info.php?cPath=21&products_id=104
Roofscapes	www.roofmeadow.com/
Smart Communities Network	www.smartcommunities.ncat.org
Xeroflora	www.xeroflora.com

Potential Opportunities for Energy and Cost Savings

Through the course of our analysis we noticed many areas that deserve further investigation. We realize that these are important opportunities and we have identified the following areas for potential energy and cost savings.

Energy Profiler

The City recently installed National Grid's Energy Profiler Online at the East Side Waste Water Treatment Plant. This program allows the Waste Water Treatment Plant operator to reflect on the site's energy consumption with a 24-hour delay. The operator can alter the plant's daily operations and see the effects on energy consumption. The city may wish to initiate an official experimental period where the plant monitors its activities and energy consumption to determine the most energy-efficient protocol. This may be a beneficial program to apply city-wide. More details of the Energy Profiler Online program can be found online at National Grid's website.

Mitigation and Treatment of Run Off

The City experiences many difficulties at the West Side Waste Water Treatment Plant due to overflow during heavy precipitation events. These events are extremely costly, both because of the legal implications of overflows, but also because of the cost of treating waste water. The mitigation and treatment of the adverse impacts of runoff can take several forms: land use development controls, erosion controls for farms and construction sites, flood control programs and chemical use and handling controls for both residents and industry. We recommend that the city consider these as opportunities for water management and cost control in waste water treatment.

Additional Resources:

Bioretention Stormwater Management: Filterra Bioretention Systems. Bioretention Stormwater management. http://cfpub.epa.gov/npdes/stormwater/munic.cfm

City of Santa Monica: Urban Runoff. City of Santa Monica. http://www.smgov.net/epd/residents/Urban_Runoff/urban.htm

Environmental Protection Agency: Stormwater Discharges From Municipal Separate Storm Sewer Systems. Environmental Protection Agency. http://cfpub.epa.gov/npdes/stormwater/munic.cfm

Environmental Protection Agency Stormwater Permit Program. Environmental Protection Agency. http://cfpub.epa.gov/npdes/home.cfm?program_id=6

United States Department of Agriculture: National Resources Conversation Service. United States Department of Agriculture. http://directives.sc.egov.usda.gov/

Selling Water

The City's water treatment plant has an approximate capacity of 20 million gallons per day. When compared with a daily flow rate of between five and ten million gallons per day, we find that the city has the capacity to supply at least twice its current flow. Therefore, it may be economical to sell some of this excess capacity. We suggest conducting research to determine whether there are potential water customers in the surrounding area (http://www.oswegony.org/DEPT_water.html).

Street Lighting

This sub-section briefly discusses other issues revealed through this study. First, the City should secure updated information on its assets in general. An inventory and maps of street lights would contribute to the transparency of the government as well as policy-making on street lighting. Second, the City also needs to notice that the necessity of street lights may be seasonal. For example, Michael Riley pointed out that lights in Linear Parks in winter could be turned off, but should remain on in summer for public safety. Third, the City should foster a good working relationship with National Grid, which determines how quickly the City can take action. In the long run, in cooperation with other municipalities and/or environmental groups, requesting National Grid to revise the tariff schedule (e.g., including LEDs and updating data on which the tariff is based) can be a policy option.

Additional Resources

New York State Energy Research and Development Authority. (October 2002). *NYSERDA. How-to Guide to Effective Energy-Efficient Street Lighting for Municipal Elected/Appointed Officials*: http://www.rpi.edu/dept/lrc/nystreet/how-to-officials.pdf

New York State Energy Research and Development Authority. (October 2002). *NYSERDA. How-to Guide to Effective Energy-Efficient Street Lighting for Planners and Engineers*: http://www.rpi.edu/dept/lrc/nystreet/how-to-planners.pdf

Sullivan, G.P., Pugh, R., Melendez, A.P., & Hung, W.D. (July 2004). *Operations & Maintenance Best Practices: A Guide to Achieving Operational Efficiency*, Release 2.0. Operations & Maintenance Center of Excellence, Federal Energy Management: http://www1.eere.energy.gov/femp/pdfs/omguide_complete.pdf

Toronto's Sustainability Lenses: A Useful Case Study

According to Meg Shields, the Senior Corporate Management & Policy Consultant of the Strategic and Corporate Policy Division for the City of Toronto, the sustainability lenses, a set of written guidelines for decision-makers, were proposed as a way to provide staff and councilors with appropriate sustainability information as they deliberated on a City report, recommendations or expenditures. It could also be extended to department heads to be used as a set of criteria, or a "frame of mind", when considering renovating older facilities or building new ones. They have yet to be implemented. However, they are currently testing a similar idea that addresses equity. For more information, contact Meg Shields.

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Strategic and Corporate Policy Division
City Manager's Office
City of Toronto
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[i] This section is based on interviews with Michael Riley, Purchasing Agent for the City of Oswego, and Timothy Murphy at National Grid.

[ii] At the same time, policies focusing on the energy consumption of street lights should be compatible with the 2020 Vision Plan of the City, which refers to street lighting many times ("pedestrian scaled lighting," "attractive street lighting," etc.) especially in the section of Design. (City of Oswego 2002)

[iii] Other issues include "proper spacing and placement" (New York State Energy Research and Development Authority 2002, 6), the height of utility poles, and fixture head types.

[iv] National Grid currently shares an inventory of its street lights with the City.

[v] The total cost of lamp removal is $11,884.26, while the total annual cost savings is $15,595.30. The information from National Grid from which these figures were derived is based on 45 lamps/luminaires, 42 out of which are actually removed.

[vi] Between 2nd Street and 6th Street on State Route 104 East, there are also pedestrian lights, which can be candidates for removal.

[vii] Other candidates include East Avenue and other parks than West and East Linear Parks.

[viii] This may be regarded as conservative because an intersection does not always require four street lights at each of its four corners. Additionally, 400W HPS lamps on West 1st Street, which are excluded from our calculation for simplicity, can be candidates for removal.

[ix] As stated above, the payback period is expected to widely vary among street lights, depending on their depreciated book values.

[x] According to a memorandum dated January 11, 2008, from Timothy Murphy to Michael Riley, "lights have been 'red-capped' for several months to gauge the community's reaction before permanently removing them."

[xi] Bryan et al. go so far as to assume that "the LED luminaires … have zero regular maintenance cost over the course of their useful life, due to the robust nature of LED technology and its tendency towards rare catastrophic failure." (2008, 17)

[xii] Another concern is that information on wattages is based on General Electric data in 1974.

[xiii] In Ann Arbor, "all the test installations have signs requesting input, and the response from the community has been overwhelmingly positive …." (C40 Cities a)

[xiv] A pop flush device conserves water by preventing toilets from running after each flush.

[xv] Please see the enclosed Microsoft Excel spreadsheet that lists horizontal and vertical-axis turbine manufacturers, potential cost information, and links to websites.

[xvi] If the City is interested in selling power back to the grid, the following steps explain how to set up a contract with National Grid and an interconnection agreement. The following is an email from Jeffery A. Glose, Principal Analyst- Power Purchase Agreements.

Appendix A: Candidates for Lamp Removal

Table A1: Candidates for Lamp Removal (State Route 104 West: 250W HPS & Standard)

Southern Side							
#	Pole #	Scenario1	Scenario2	#	Pole #	Scenario1	Scenario2
				8th Street			
1	-			24	NM24		
2	-			25	NM25	√	√
1st Street				26	NM25 1/2		
3	-			27	NM26		√
4	-	√	√	28	NM27	√	
5	-			29	NM28		√
2nd Street				30	NM29		
6	-			31	NM30		
7	-	√	√	Lathrop Street			
8	NG8			32	NM31		
3rd Street				33	NM32	√	√
9	NM9			34	NM33		
10	NM10	√	√	Liberty Street			
11	NM11			35	NM34		
4th Street				36	NM35	√	√
12	NM12			37	NM36		
13	NM13	√	√	38	NM37		√
14	NM14			39	NM38	√	
5th Street				40	NM39		√
15	NM15-1			41	NM40		
16	NM16-1	√	√	42	NM41	√	√
17	NM17-1			43	NM42		
6th Street				44	NM42 1/2		√
18	NM26 1/2-2			45	NM43	√	
19	NM19-1	√	√	46	NM43 1/2		√
20	NM20-1			47	NM44		
7th Street				48	NM44 1/2		
21	NM21-1			1st Avenue			
22	NM22-1	√	√	Count		14	17
23	NM23-1						

Northern Side							
#	Pole #	Scenario1	Scenario2	#	Pole #	Scenario1	Scenario2
49	-			8th Street			
Water Street				73	NM24-1		
50	-			74	NM25 1/2-1		
51	-			9th Street			
1st Street				75	NM27-1		
52	-			76	NM28-1	√	√
53	-	√	√	77	NM30-1		
54	-			78	NM31-1		√
2nd Street				79	NM32-1	√	
55	-			80	NM33-1		
56	-	√	√	Liberty Street			
57	NM8			81	NM34-1		
3rd Street				82	NM35-1	√	√
58	NM9			83	NM36-1		
59	NM10	√	√	John Street			
60	NM11			84	NM38-1		
4th Street				Cayuga Street			
61	NM12			85	NM39-1		
62	NM13	√	√	86	NM40-1	√	√
63	NM14-1			87	NM42-1		
5th Street				88	NM42 1/2-1		√
64	NG15			89	NM42 1/2-2	√	
65	NM16	√	√	90	NM43 1/2-1		
66	NM17			1st Avenue			
6th Street				Count		12	12
67	NM18						
68	NM19	√	√				
69	NM20						
7th Street							
70	NM21						
71	NM22	√	√				
72	NM23						

* √ indicates that the light is a candidate for removal.

Table A2: Candidates for Lamp Removal (State Route 104 East: 250W HPS & Standard)

Southern Side								
#	Pole #	S1	S2	#	Pole #		S1	S2
1st Street				Duer Street				
1	-			27	177074	9G23N4		
2	-	√	√	28	177074	9G30D4		
3	-			10th Street				
4	-			29	177074	9G23N4		
2nd Street				Judson Street				
5	-			30	177074	9G23N4		
6	-	√	√	31	177074	9G30D4		
7	-			E Oneida Street				
3rd Street				32	NM35-1	M089 5-35		
8	-			12th Street				
9	-	√	√	33	-			
10	-			34	NM2?		√	√
4th Street				35	NG3			
11	-			36	-			
12	-	√	√	13th Street				
13	-			37	NM12	W87 SPP155		
5th Street				George Street				
14	-			38	NM13	SPP250		
15	-	√	√	39	NM13-1			
16	-			40	NM14			
6th Street				41	NM14 1/2			
17	-			42	NM15			
18	-	√	√	City Line Road				
19	-			Count			9	9
7th Street								
20	-			67	NM29			
21	-	√	√	68	NM30	√	√	
22	-			69	NM31			
8th Street				E Bridge Street				
23	-			70	177074			
24	-	√	√					
25	-							
9th Street								
26	-							

* √ indicates that the light is a candidate for lamp removal.

Northern Side								
#	Pole #	S1	S2	#	Pole #		S1	S2
1st Street				Judson Street				
43	-			71	177074			
44	-	√	√	72	177074	9G30D4		
45	-			73	177074	9G23N4		
2nd Street				E Oneida Street				
46	-			74	NM36-1			
47	-	√	√	13th Street				
48	-			75	156 U21-C 0616 4S780-99 11561-1			
3rd Street				76	156 U21-C 0616 4S780-99 11561-1		√	√
49	-			77	156 U21-C 0616 4S780-99 11561-1			
50	-	√	√	78	156 U21-C 0616 4S780-99 11561-1			√
51	-			79	156 U21-C 0616 4S780-99 11561-1		√	
4th Street				80	156 U21-C 0616 4S780-99 11561-1			√
52	-			81	156 U21-C 0616 4S780-99 11561-1			
53	-	√	√	82	156 U21-C 0616 4S780-99 11561-1			
54	-			George Street				
5th Street				83	NM16			
55	-			84	NM18		√	√
56	-	√	√	85	NM19			
57	-			86	NM20			√
6th Street				87	NM21		√	
58	-			88	NM22			√
59	-	√	√	89	NM23			
60	-			90	NM24		√	√
7th Street				91	NM25			
61	-			92	NM26			√
62	-	√	√	93	NM27	SPPA 3-55	√	
63	-			94	NM28	SPP 4-40		√
8th Street				95	NM29	3-50		
64	-			96	NM29 1/2	SPPA 45A 3-55		
65	-	√	√	City Line Road				
66	-			Count			15	18
9th Street								

Table A3: Candidates for Lamp Removal (West 1st Street)

Western Side							
#	Pole #	S1	S2	#	Pole #	S1	S2
Seneca Street				Utica Street			
1	856			43	-		
2	855		√	44	1		
3	854	√		45	1-3	√	√
4	853		√	46	1-2	√	√
5	852			47	1-1		
6	851	√	√	Erie Street			
7	850			48	1		
8	-		√	49	56-1		√
9	(flower)			50	-		
10	-	√		Niagara Street			
11	-		√	51	58-1	√	√
12	-			52	62		
13	-	√	√	53	63		
14	-			54	64	√	√
15	(flower)			55	65	√	√
16	-		√	56	66	√	√
17	-	√		57	67		
18	-		√	Murray Street			
19	-			58	69		
20	-			59	75		
21	(flower)			60	71	√	√
Bridge Street				61	72	√	√
22	(flower)			62	73	√	√
23	-			63	74		
24	-	√	√	Ellen Street			
25	-			64	-		
26	-		√	65	72,78		
27	-	√		66	79	√	√
28	(flower)			67	80	√	√
29	-		√	68	-	√	√
30	-			69	80		
31	-	√	√	70	81		√
32	-			71	82	√	
33	-		√	72	83		√
34	(flower)			73	85		
35	-	√		74	87	√	√
36	35		√	75	97		
37	36			76	98		√
38	37			77	100	√	
Mohawk Street				78	102		√
39	-			79	104		
40	-	√	√	80	106	√	√
41	-			81	108		
42	-			82	110	√	√
				83	113		
				84	114		√
				85	117	√	
				86	119		√

Eastern Side							
#	Pole #	S1	S2	#	Pole #	S1	S2
Seneca Street				Mohawk Street			
87	849			127	-		
88	848		√	128	-	√	√
89	847	√		129	-		
90	846		√	130	-		√
91	845			131	46	√	
92	844		√	132	48		√
93	843			133	49	√	√
Cayuga Street				134	50		
94	-			135	51		√
95	(flower)			136	52	√	
96	-		√	137	53		
97	-	√		Erie Street			
98	-		√	138	55		
99	-			139	57		√
100	-	√	√	140	58		
101	(flower)						
102	-						
103	-		√				
104	-	√					
105	-		√				
106	-						
107	(flower)						
Bridge Street							
108	(flower)						
109	-						
110	-	√	√				
111	-						
112	-		√				
113	-	√					
114	(flower)						
115	-		√				
116	-						
117	-	√	√				
118	-						
119	-		√				
120	(flower)						
121	-	√					
122	-		√				
123	-						
124	-	√	√				
125	-						
126	-						

Count	Scenario1		Scenario2		#
	arc	std	arc	std	
400W HPS	0	0	0	0	(flower)
250W HPS	0	11	0	14	40-56, 128-
150W HPS	3	0	6	0	1-7, 87-93
100W HPS	12	15	20	18	others

* √ indicates that the light is a candidate for lamp removal

Table A4: Candidates for Lamp Removal (Linear Parks)

West Linear Park: 100W HPS & Architectural

North End

#	Pole #	S1	S2
1	-		
2	-	√	√
3	-		
4	-		√
5	-	√	
6	156		√
7	157		
8	158	√	√
9	-		
10	160		√
11	-	√	
12	-		√
13	-		
14	167	√	√
15	-		
16	168		√
17	170	√	
18	172		√
19	173		
20	180	√	√
21	181		
22	-		√
23	-	√	
24	184		√
25	185		
26	171		
Parking Lot Enter			
27	174		
28	175	√	√
29	176		
30	177		√
31	178	√	
32	186		√
33	187		
34	188	√	√
35	-		
Bridge Street			
36	-		
37	-	√	√
38	912		
39	913		√
40	-	√	
41	915		√
42	916		
43	-	√	√
44	918		
45	-		√
46	-	√	
47	921		√
48	922		
49	923	√	√
50	924		
51	925		√
52	926	√	
53	-		√
54	928		
55	929	√	√
56	930		
57	-		√
58	-	√	
59	-		√
60	-		
61	-	√	√
62	936		
63	937		√
64	938	√	
65	939		√
66	-		
67	-	√	√
68	-		
69	-		√
70	-	√	
71	-		√
72	-		
73	-	√	√
74	-		
75	-		√
76	-	√	
77	-		√
78	-		
79	-	√	√
80	-		
81	-		√
82	398	√	
83	399		√
84	400		
85	963	√	√
86	962		
87	964		√
88	965	√	
89	966		√
90	-		
91	-	√	√
92	017		
93	-		√
94	034	√	
95	036		√
96	037		
97	038		

South End

Count		S1	S2
Count		31	46

East Linear Park: 175W MH or 100W HPS & Architectural

Port (North)

Riverside (West)			
#	Pole #	S1	S2
1	23	√	√
2	22		
3	21		√
4	20	√	
5	19		√
6	18		
7	17	√	√
8	16		
9	15		√
10	14	√	
11	13		√
12	12		
13	-	√	√
14	-		
15	-		√
16	-	√	
17	-		√
18	-		
19	-	√	√
20	-		
21	-		√
22	-	√	
23	-		√
24	-		
25	-	√	√
26	-		
27	-		√
28	-	√	
29	-		√
30	-		
31	-	√	√
32	-		
33	-		√
34	-	√	
35	-		√
36	-		
37	-	√	√

Eastern Side			
#	Pole #	S1	S2
38	24	√	√
39	25	√	√
40	26	√	√
41	27		
42	28		
43	29		
44	30		
45	31	√	√
46	32		
47	-		√
48	-		
Count			
100W HPS (others)		9	12
175W MH (15-37)		8	12

South

* √ indicates that the light is a candidate for lamp removal.

Appendix B: Cost-Benefit Analysis of Lamp Removal

Table B1: Annual Savings under Scenario 1

	250W HPS			150W HPS			100W HPS			175W MH			Total
(Luminaire Owner)	Total	NG		Total	NG		Total	NG		Total	NG		
		arc	std		arc	std		arc	std		arc	std	
104 W	26	0	26	0	0	0	0	0	0	0	0	0	26
104 E	24	0	24	0	0	0	0	0	0	0	0	0	24
W 1st Street	11	0	11	3	3	0	27	12	15	0	0	0	41
W Linear Park	0	0	0	0	0	0	31	31	0	0	0	0	31
E Linear Park	0	0	0	0	0	0	9	9	0	8	0	0	17
Total number	61	0	61	3	3	0	67	52	15	8	0	0	139
Wattage per unit			302			182			117			208	
Annual operation hours			4,170			4,170			4,170			4,170	
Annual kWh per unit			1,259			759			488			867	
Total kWh savings			76,820			2,277			32,689			6,939	118,724
$ per kWh (2009 budget)			0.155			0.155			0.155			0.155	
Savings			$11,907			$353			$5,067			$1,076	$18,402
Facility charge (lumianire) per unit		$80.00	$54.17		$59.93	$47.12		$73.46	$46.09		$59.93	$47.12	
Total facility charge (lumianire) savings			$3,304			$180			$4,511			$0	$7,995
Facility charge (lamp) per unit			$6.84			$6.75			$6.56			$5.42	
Total facility charge (lamp) savings			$417			$20			$440			$0	$877
Total facility charge savings			$3,722			$200			$4,951			$0	$8,872
Total savings	$27,275												

*NG = National Grid; arc = architectural street lights; std = standard street lights

Table B2: Annual Savings under Scenario 2

	250W HPS			150W HPS			100W HPS			175W MH			Total
(Luminaire Owner)	Total	NG		Total	NG		Total	NG		Total	NG		
		arc	std		arc	std		arc	std		arc	std	
104 W	29	0	29	0	0	0	0	0	0	0	0	0	29
104 E	27	0	27	0	0	0	0	0	0	0	0	0	27
W 1st Street	14	0	14	6	6	0	38	20	18	0	0	0	58
W Linear Park	0	0	0	0	0	0	46	46	0	0	0	0	46
E Linear Park	0	0	0	0	0	0	12	12	0	12	0	0	24
Total number	70	0	70	6	6	0	96	78	18	12	0	0	184
Wattage per unit			302			182			117			208	
Annual operation hours			4,170			4,170			4,170			4,170	
Annual kWh per unit			1,259			759			488			867	
Total kWh savings			88,154			4,554			46,837			10,408	149,953
$ per kWh (2009 budget)			0.155			0.155			0.155			0.155	
Savings			$13,664			$706			$7,260			$1,613	$23,243
Facility charge (lumianire) per unit		$80.00	$54.17		$59.93	$47.12		$73.46	$46.09		$59.93	$47.12	
Total facility charge (lumianire) savings			$3,792			$360			$6,560			$0	$10,711
Facility charge (lamp) per unit			$6.84			$6.75			$6.56			$5.42	
Total facility charge (lamp) savings			$479			$41			$630			$0	$1,149
Total facility charge savings			$4,271			$400			$7,189			$0	$11,860
Total savings	$35,103												

*NG = National Grid; arc = architectural street lights; std = standard street lights

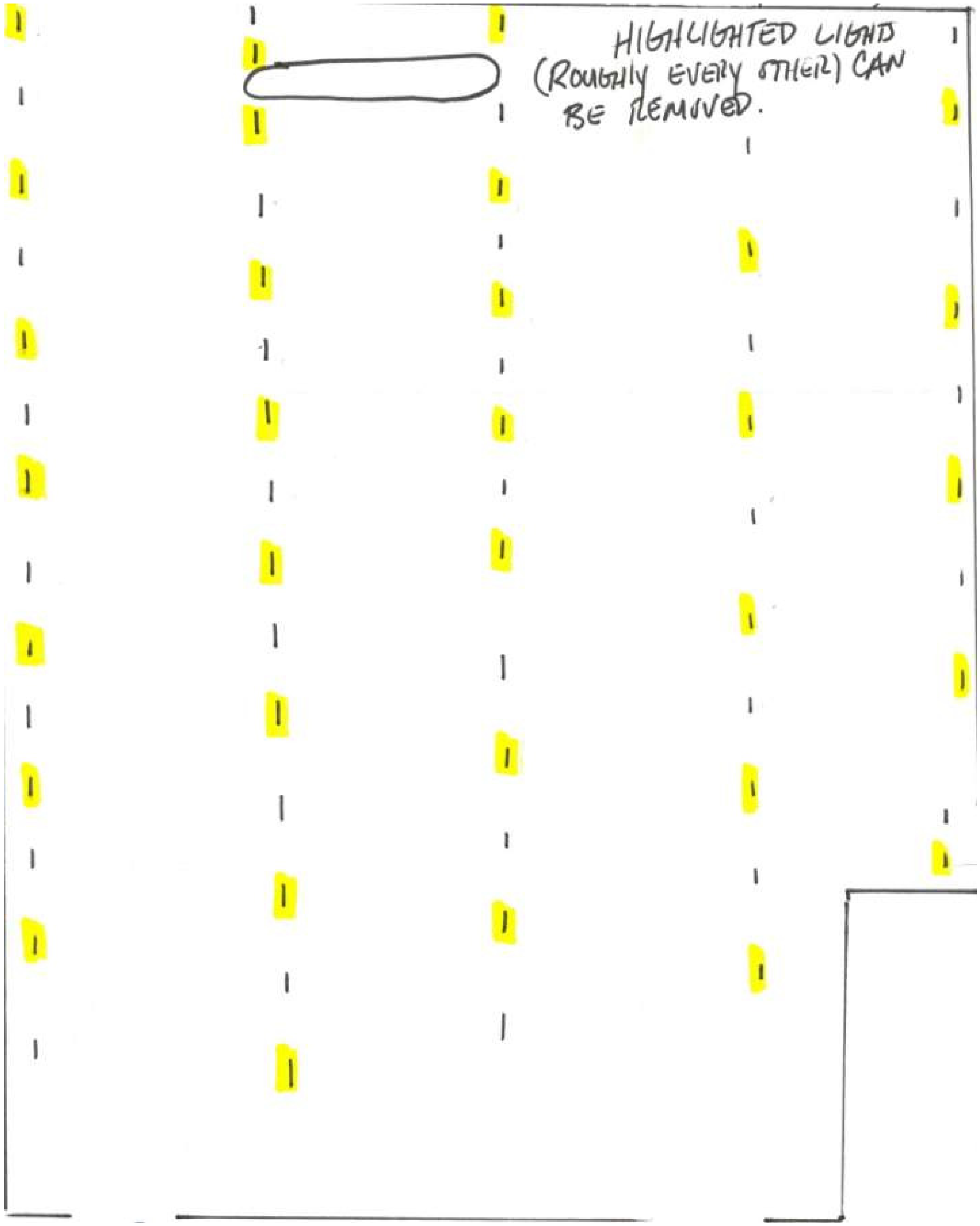
Appendix C: Midtown Garage Lighting Data

		Status Quo	Remove 32 Lamps	Transfer	Transfer and Remove 32 Lamps
Street Light Tariff PSC 214	1				
175 watt MV Lamp	5.42	76	44	76	44
175 watt Underpass Luminaire	80.79	76	44	76	44
175 watt continuous illumination per la	5.42	76	44	76	44
Circuit cost per unit, cable & conduit	79.35	76	44	76	44
Excess cable & conduit	581.94	1	1		
175 watt MV Lamp		$411.92	$238.48		
175 watt Underpass Luminaire		$6,140.04	$3,554.76		
175 watt continuous illumination per lamp		$411.92	$238.48		
Circuit cost per unit, cable & conduit		$6,030.60	$3,491.40		
Excess cable & conduit		$581.94	$581.94		
TOTAL Annual Facility Charges					
Delivery Charges per KWH	0.0786	$10,880.22	$6,299.08		
SBC/RPS per KWH	0.0022	$304.65	$176.38		
TRA per KWH	3E-05	$4.15	$2.41		
Supply Charges per KWH	0.056	$7,754.77	$4,489.61		
Electricity Tariff PSC 207 SC-2D	1				
Customer Charge	630.24			$630.24	$630.24
Delivery Charges per KWH	0.019			$2,626.93	$1,520.85
Demand Charges per KW	121.2			$2,181.60	$1,263.03
SBC/RPS per KWH	0.0022			$304.65	$176.38
TRA per KWH	6E-05			$8.31	$4.81
Supply Charges per KWH	0.077			$10,662.81	$6,173.21

	Status Quo	Remove 32 Lamps	Transfer	Transfer and Remove 32 Lamps
TOTAL COST	**$32,520.22**	**$19,072.52**	**$16,414.54**	**$9,768.52**
Savings From Status Quo		$13,447.70	$16,105.68	$22,751.70
Savings as Percent of Status Quo		**41.35%**	**49.53%**	**69.96%**

PSC 214	Lamp	Billable Watta	Hours Per Year	
Mercury Vapor	175w	208	8760	
High Pressure Sodium	100	117		0.4375
High Pressure Sodium	150	182		0.125
High Pressure Sodium	400	480		
watts per KW	1000			
PSC 207	76	44		
estimated KW	18	10.4210526		

Appendix D: Midtown Garage Lighting Survey (2003)



East 1st Street

SERVICE CLASSIFICATION NO. 6
PURCHASE OF ELECTRIC ENERGY AND CAPACITY FROM CUSTOMERS WITH QUALIFYING ON-SITE GENERATION FACILITIES

APPLICABLE TO:

Purchase of energy and capacity by the Company from a customer operating a generating facility qualifying under PURPA or PSL 66-C less than 80 MW ("QF"), subject to the Special Provisions of this Service Classification. Written application upon the Company's prescribed forms is required.

A customer electing to engage in simultaneous purchase and sale of energy with the Company must sell its energy output to the Company under this Service Classification or under a Special Contract and may contract for its electrical requirements under the appropriate Service Classification for full, supplemental, back-up and/or maintenance service.

A prospective customer operating a qualifying generating facility capable of electric generation in excess of 100 kVA (1) who agrees to provide firm service; or (2) who has, in the opinion of the Company, an installation which requires special facilities; or (3) who desires a long term contract, may negotiate a Special Contract with the Company.

CHARACTER OF SERVICE:

Single or three phase 60 Hz alternating current, delivered by customer to the delivery point at one standard delivery voltage with service metered at, or compensated to, the delivery point. Site-specific characteristics will be determined by the Company. "Delivery Point" shall mean the point at which the interconnection facility is connected to the transmission system as is indicated on a one-line diagram included as part of the Interconnection Agreement.

SERVICE CLASSIFICATION NO. 6 (Continued)

RATE TO BE PAID BY COMPANY:

Energy Only payment for QF's:

$$\sum_{i=1}^{n} (\text{Real Time LBMPi} * \text{Qi}) - \text{Incurred Cost}_m$$

Energy and Capacity payment for Qf's:

$$\sum_{i=1}^{n} (\text{Real Time LBMPi} * \text{Qi}) - \text{Incurred Cost}_m + (\text{LBMCP}_m * \text{Capacity}_m)$$

Whereby:

Real Time LBMPi is the Real Time LBMP in $/MWh pursuant to Rule 1.63 for each generator bus. In the event the NYISO does not post a price for the generator bus, the electrically nearest generator bus price shall be used. In the event the nearest electrical generator bus cannot be defined, at the discretion of the Company, the Load Zone Real Time LBMP shall be used;

$LBMCP_m$ is defined in Rule 1.64 for the respective calendar month. In the event no electricity is provided for the respective month the payment shall be zero.

$Capacity_m$ is the Unforced Capacity recognized by the NYISO as applicable to capacity requirements for the respective calendar month, as set forth in the NYISO Tariff, in kW. Unforced Capacity is the dependable maximum net capability times one minus the EFORd value assigned to a QF; (DMNC * (1 - EFORd). EFORd is the demand Equivalent Forced Outage Rate as calculated by the NYISO.

Q_i is the Energy quantity delivered, in kWh per hour, to the Delivery Point

i is the respective hour for the month;

n is the number of hours in the month;

Incurred cost is:

(1) any penalties assessed by the NYISO for units off base point, i.e. Automatic Generation Control penalties.

m is the respective month.

SERVICE CLASSIFICATION NO. 6 (Continued)

RATE TO BE PAID BY COMPANY: (Continued)

(1) To the extent that a minimum unit rate applied under Section 66-c of the Public Service Law, as implemented by the Commission in Opinion No. 91-2 (as modified by Opinion 91-2A) and prior orders issued in Case 90-E-0675 and other applicable proceedings, the rate to be paid under this service classification shall be no less than 6.0 cents per kWh, and averaged annually based on 12 months ended December 31, trued-up each month during that calendar year.

(2) In the event interval metering is not available the average LBMP shall apply.

(3) Qualifying small, random suppliers of energy (such as windmills) may elect to sell their output to the Company on a non-time differentiated basis. Deliveries will be measured using a standard kWh meter. The customer will pay the installed cost of the necessary metering equipment at the time of installation in lieu of all Metering, Minimum, and Distribution Demand Charges otherwise applicable under this Service Classification. This Provision is limited to secondary single phase service voltage. Applicable capacity payments to customers under this provision shall be made based upon (i) the $LBMCP_m$ divided by (ii) the number of hours in the respective month times (iii) the energy delivered for the respective month.

(4) The customer shall be entitled to receive direct payment from the NYISO for (I) NYISO Tariff Schedule II Reactive Supply and Voltage Control, and/or (2) NYISO Tariff Schedule III Regulation and Frequency Response, and/or (3) NYISO Tariff Schedule V Operating Reserve, and/or (4) NYISO Tariff Schedule VI Black Start Service. Payment from the NYISO for each of these services is conditioned upon the customers meeting the requirements of the NYISO and making the appropriate contractual arrangements directly with the NYISO.

SERVICE CLASSIFICATION NO. 6 (Continued)

PAYMENT

Company shall pay customer at customer's office, or at such other place as customer may designate in writing to Company, on or before the twenty-fifth (25th) day of each month for electricity delivery to Company by customer during the preceding billing period. Overdue payments shall accrue interest at the rate of one and one-percent (1 1/2%) per month from, and including, the due date to, but excluding the date of payment.

Upon providing five (5) day advance written notification, each party will have the right, at its sole expense and during normal working hours, to examine the records of the other party to the extent reasonably necessary to verify the accuracy of any statement, charges or computation made pursuant to the PPA. If requested, a party shall provide to the other party statements evidencing the quantities of electricity delivered at the Delivery Point. If any such examination reveals any inaccuracy in any statement, the necessary adjustments in such statement and the payments thereof will be made on the next months payment date and shall bear interest calculated at the rate of one and one-half percent (1 1/2%) per month from the date the overpayment or underpayment was made until paid; provided, however, that no adjustment for any statement or payment will be made unless objection to the accuracy thereof was made prior to the lapse of one (1) year from the rendition thereof.

SERVICE CLASSIFICATION NO. 6 (Continued)

SPECIAL PROVISIONS

A. The customer and the Company shall agree as to the operating mode, interconnection and equipment specifications in accordance with Electric System Bulletin (ESB) #756 - Supplement to Specifications for Electrical Installations - Parallel Generation Requirements, as amended from time to time, which are subject to Commission review and arbitration should a dispute arise.

The customer and the Company shall agree as to the manner of payments for interconnection costs which exceed the costs originally incurred in rendering the same Contract Demand under the applicable Service Classification. Upon the mutual agreement the customer may select from the following payment options:

(1) The Company will furnish, own, operate, and maintain all special equipment, in return for which the customer, or its successors on the site, will pay a monthly charge of 1.5 percent of the total investment costs for the duration of its/their operations on the site, whether or not the equipment is in use.

(2) The customer will furnish, own and operate all special equipment and the Company will maintain such equipment, in return for which the customer, or its successors on the site, will pay a 9 percent annual operating charge based upon the customer's total investment in such interconnection equipment.

(3) The customer will furnish, own, operate and maintain all special equipment, provided that the equipment and maintenance are suitable for interconnected operations. Such equipment shall be made available for Company inspection as may reasonably be required.

B. The Company will be relieved of its obligation to purchase energy during any period in which the Company suffers a System emergency. In such circumstances, the Company will notify the customer to cease supplying energy to the Company. For purposes of this Provision, a System emergency is defined as a condition which is imminently likely to endanger life or property or result in significant disruption of service to any customer.

SERVICE CLASSIFICATION NO. 6 (continued)

SPECIAL PROVISIONS

C. Customers selling bundled energy, capacity and ancillary services to the Company from a solar, biomass, hydro or wind powered generating facility less than or equal to 5.0 MW nameplate, may elect to be paid the following: (Provisions No 1 through No. 4 of Rate to Be Paid by Company remain):

$$\sum_{i=1}^{n} (\text{Day Ahead LBMP}_i + \text{Avoided Ancillary Services Rate}_m) * Q_i$$

The Company will receive the benefit of the generation facility's capacity at no cost

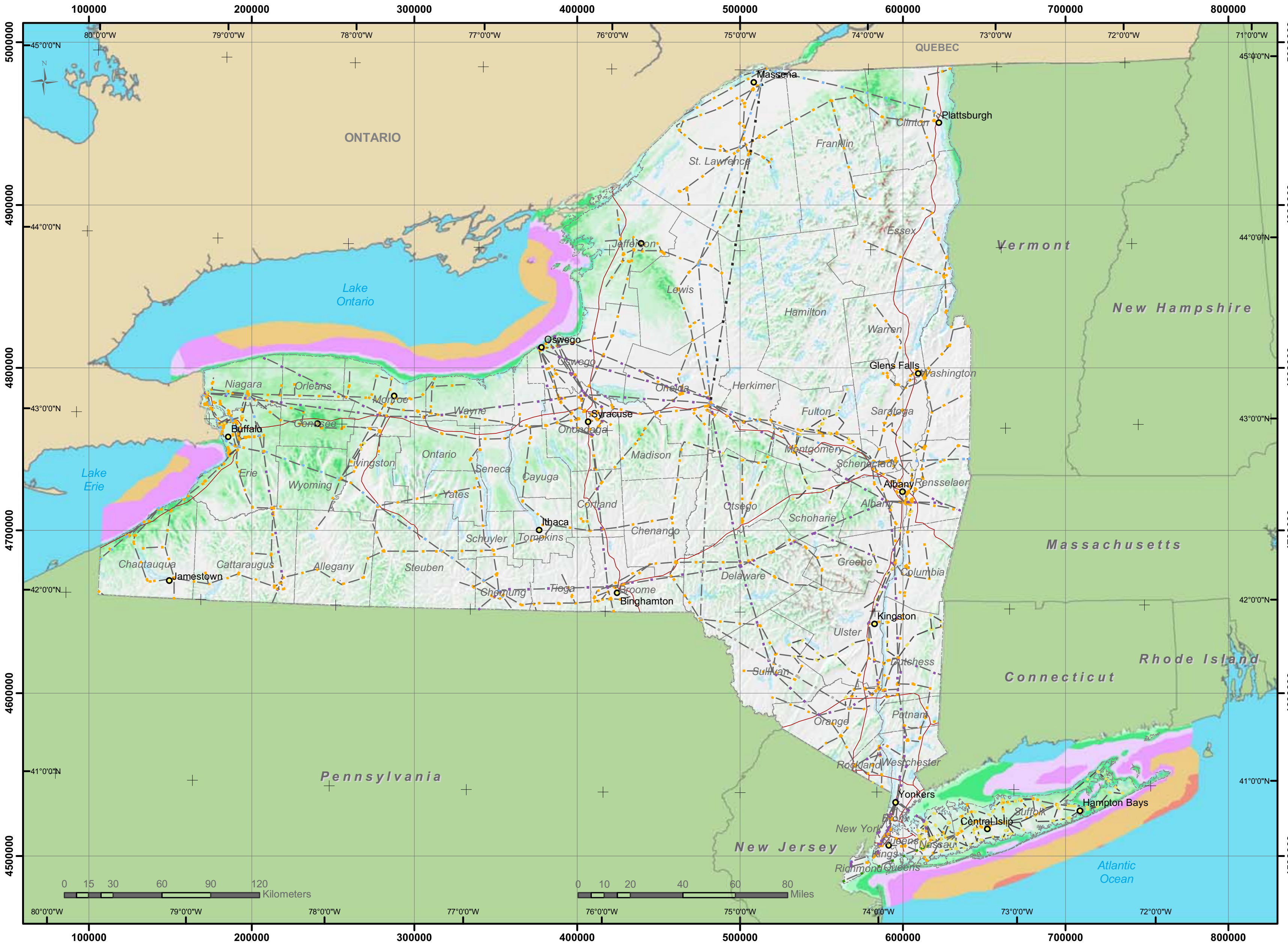
Whereby:

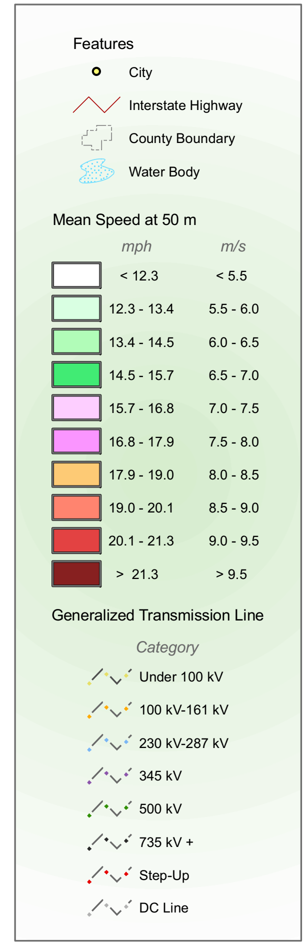
Avoided Ancillary Services Rate_m in $/MWh means for the calendar month in which energy is delivered, the total resultant of (i) the amount Company is charged by the NYISO for Ancillary Services: Rate Schedule 1 scheduling, system control and dispatch service, Rate Schedule 2 reactive supply and voltage support service, Rate Schedule 3 regulation and frequency response service, Rate Schedule 5 operating reserve service (including spinning reserve, 10-minute non-synchronized reserves and 30-minute reserves), and Rate Schedule 6 black start capability, divided by (ii) the total Ancillary Services MWh the Company purchased (including bilateral transactions) for its customers. Initial Monthly Settlement Statements provided to the Company by the NYISO shall be used to calculate the Avoided Ancillary Services Rate. Avoided Ancillary Services Rate shall be deemed to equal $0.0/MWh in the event the Company cannot utilize the generator as a load modifier in NYISO billing. In the event any such Ancillary Service cost in (i) is not avoided then such contribution to Avoided Ancillary Service Rate shall be $0.0/MWh;

Day Ahead LBMP_i is the Day Ahead Zonal LBMP in $/MWh as defined in Rule 1.70 for the NYISO Zone in which the Generation Facility is located.

Wind Resource of New York

Mean Annual Wind Speed at 50 Meters





AWS Truewind

Projection: UTM, Zone 18N, WGS84
Spatial Resolution of Wind Resource Data: 200m
This map was created by AWS Truewind using the MesoMap system and historical weather data. Although it is believed to represent an accurate overall picture of the wind energy resource, estimates at any location should be confirmed by measurement.

The transmission line information was obtained by AWS Truewind from the Global Energy Decisions Velocity Suite. AWS does not warrant the accuracy of the transmission line information.

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c *Portland, United States of America: Portland Replaces 1,000 Traffic Intersection Signals with LED Lights, Saving Millions of Kilowatt-Hours Per Year*: http://www.c40cities.org/bestpractices/lighting/portland_led.jsp

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