Installing energy efficient traffic signals

Stockholm (SE)

GENERAL ASPECTS

Stockholm, winner of the first European Sustainable City Award, is strategically positioned at the outlet of Lake Mälaren. It is the capital of Sweden as well as the country's largest municipality with 700,000 inhabitants. It lies at the centre of a conurbation of a million inhabitants which has gone through a period of rapid expansion in recent years

BACKGROUND

Over the past 30 years Stockholm has consistently followed policies designed to improve the environmental performance of the city and has devolved action to the local level within the city - for example every department in the city has their own energy consultant. Policies concerning energy in recent years have mostly been designed to increase the use of biofuels and these have been quite successful.

However almost none of the energy sources used in Stockholm are produced within the city. Fuel (coal, wood fuel, olive stones, pine tar oil etc.) is imported both from different parts of Sweden and also from other countries. Electricity comes from hydroelectric and nuclear power and, marginally, from the combustion of oil, coal and other fuels.

Stockholm converted its energy company, Stockholm Energi AB into a joint venture with another company in 1998 and founded Birka Energi AB. The company, has now been sold to Fortum, one of the leading Nordic energy companies with the city only retaining a 50% share in the district heating system. Prior to this restructuring and liberalisation, the company provided electricity to the lighting system free of charge, discouraging savings. However once the system was liberalised and privatised, the municipality was obliged to pay for the electricity it used. They became interested in the savings to be made.

ACTION UNDERTAKEN

The Traffic light system

In 1995, the city of Stockholm was one of the first major European cities to make an in-depth analysis of its use of energy and to take serious steps to reduce its energy consumption.
As a part of this analysis, a number of projects were studied for their energy-saving potential. Among the projects considered was the modernization of Stockholm's traffic light system. The overall objectives were to improve management of the traffic control system, reduce energy consumption, reduce maintenance costs while at the same time increasing reliability and public security.

The traffic signal system was equipped with ordinary incandescent bulbs, which have a high energy consumption and are expensive to maintain as they need frequent replacement. It was an ideal target for savings.

Stockholm's Traffic Control system in figures (1996)

Annual Preventative Maintenance (Euro) = 1,800,000
Annual Operating Maintenance (Euro) = 600,000
Annual Total Maintenance (Euro) = 2,400,000

530 traffic signal control points in different models
6 000 columns
4 000 pedestrian push buttons
2 500 loop detectors
10 500 signal heads
27 000 incandescent bulbs

Any new system had to be able to resist Stockholm's cold winter climate with temperatures around –20^{o} C for weeks on end. The long dark nights also make the reliability and visibility of traffic signals of critical importance. In addition, as Stockholm is a seaport, the traffic control system has to deal with both humidity and salt.

After some *in situ* testing of different traffic control systems and signal heads the choice fell on LED-based (light-emitting diode) traffic signals. These are exceptionally energy-efficient and have a short payback time. Unlike ordinary incandescent bulbs, LEDs work on the electron flow in semiconductors and do not burn out nor waste much energy as heat. They are the lighting equivalent of a standard transistor and have a similarly long life. The average consumption per lamp, using LED instead of bulbs, decreased from 70W to approximately 7W.

The specific aims of the project were to:

- Use market forces via a large purchase to reduce the price of LEDs, which will help others to carry out similar project without being dependent on subsidies,
- Reduce the cost for management and maintenance and thereby encourage other improvements in the signal system,
- Reduce energy consumption, bulb turnover and transport costs and thereby reduce the environmental impact of the signal system,
- Increase public security through increased visibility and a reduced risk that signals are out of order.
- Reduce maintenance on site and hence increase security for maintenance staff.

The project was introduced in stages. There was a learning process at each stage and the city could take account of the lessons learned as the installation progressed. The project was completed by the end of 2001.

The savings are summarised in the tables below.

Cost of lighting furniture, LEDs, installation and documentation (US$)

Furniture and installation	$3,000,000
LEDs	$3,000,000
Total cost	$6,000,000

Annual Saving from LED Traffic Signals (US$)

Power savings	$470,900
Maintenance savings	$243,000
Total savings	$713,900
Payback	4.2 years

Besides energy efficiency, LEDs have other advantages compared to incandescent bulbs. LEDs only contain a small fraction of electronic waste and most parts are made of plastic material that can be recycled.

Previously the 80 000 bulbs a year were placed in landfills, deposited 1,5 - 2 kilos of lead and other hazardous substances. Furthermore, as LED signals do not need to be replaced as often as ordinary bulbs, the estimated distance travelled by vehicles will decrease by approximately 14 000 km/year.

Results

While the objectives were met, as often with new technology there were some initial problems and a certain time is needed before an accurate evaluation can be made. However energy savings are larger than the original calculation.

Bulbs only	6,440MWh/year
LED only	640MWh/year
Savings	5,800 MWh/year

The project is unique in Europe with regards to its extent since no city other than Stockholm has exchanged their complete traffic signal system. Similar comprehensive exchange programmes were however common in California when subsidies were available.

Considerable awareness raising activity has followed this programme. Two workshops have been held by the Swedish National Energy Agency and one presentation to the Norwegian National Road Administration in Oslo. Furthermore, several articles have been published both in Swedish and international journals.

LESSONS LEARNED

The energy saving potential of this project is very significant, can easily be replicated and there is a clear financial benefit to the local authority. But the incentive was greatly increased by the changes induced by liberalisation and the change in the utility from a service mentality (providing electricity to the municipality as a service free of charge) to a business mentality (maximising sales and profits).

Other local authorities which have had a very close relationship with their energy utility will no doubt be finding the same change in incentives. Such local authorities should review **all** their energy using services since there will certainly be similar examples of extravagant use of energy resulting from services previously being available free of charge. One of the benefits of liberalisation is that it makes the cost of each service transparent and therefore encourages the user to reduce energy costs.

IMPLICATIONS FOR PUBLIC POLICY MAKERS

In general the separation of payment from responsibility is a disincentive to efficiency. In this case the provision of electricity was paid for by the utility but it had no means of reducing this cost. Once the municipality paid the bills, they took the necessary action to reduce the electricity consumption. Similarly in countries where street lighting equipment is provided by the utility but the electricity it uses is paid for by the municipality, there is no likelihood that the system will be run in an energy efficient way. Liberalisation accentuates these problems. It is clearly desirable that any such separation of responsibility should be removed during the liberalisation process and a clear relationship introduced between investment costs and running costs. This may mean revising a number of traditional practices developed during a period where utilities were seen as service providers rather than businesses.

FURTHER INFORMATION

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