3.143 Intelligent street lighting in Oslo, Norway

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Abstract

Over the last few years a lot of test and full scale intelligent street lighting installations have been installed both in Oslo as well as other municipalities. The experience gained and the developed skill within the field now opens up for rapid increase of the market. The technical challenges are not all solved, but the systems can demonstrate high quality performance although there have been some challenges to overcome.

The per unit investment cost is of vital importance for the decision makers, the only way to battle this is by increasing the number of units installed annually, in this case the 6.000 units in Oslo is a good start.

To really boost the market, there is still quite a long list of obstacles to overcome. But, there have also been quite good progress in this field. New standards from CIE will recommend adaptive lighting and hopefully later be adopted by CEN. New financing mechanism has been demonstrated within the E-street framework, and will in the future help streetholders with limited budgetary means to realise their projects.

A strong will within the European community to save energy, hence introducing new legislations to reach their ambitious goals, gives a strong support for further development of the intelligent streetlight. The saving potential is substantial, 38 TWh annually, and relatively easy to reach due to the relatively few decision makers within the market.

Introduction

Based on the struggle for saving energy and improve the sustainability of Oslo, the capital of Norway, efficiency of street lighting was highlighted as one of the prosperous options. The ambitious goals resulted in a plan for replacement of old fixtures containing PCB with new high performance fixtures.

When retrofitting, introduction of advanced data communication (powerline transmission of data) was obvious, automatically also major savings in maintenance were obtained. The development of an overall database structure independent of manufacturers delivering the light installations is in progress together with other European partners.

Energy savings, up to 60-70 % is most remarkable as result of increased performance of luminaries and lamps, and especially the introduction of electronic control gear together with individually dimmable ballasts. Hence the economy of retrofitting of old installations is quite profitable.

A side effect of the work is to measure the energy consumption. By electronic gears in each lamp, it is now possible to address all the consumption to the various clients, street authorities on several levels, park and forest departments and private companies with façade and street light integrated into the public power grid.

Introduction of light level adapted to the real situation is also implemented, for example when the ground is covered with snow, the need for light output from the lamp is down to 20 % of the original value.

The consequences are also less light pollution going out in space: a very positive side effect for those who want to see the stars and “aurora”, the Northern lights, over Oslo.

Intelligent streetlight - Technical status

Intelligent streetlighting, or adaptive lighting, covers today active monitoring, measuring and control of each lamp individually by establishing two way communication between the central system and the luminaries.

The two way communication opens up for individual stepless dimming of the lamp according to the changing conditions on the road, as well as improved planning routines for daily maintenance operations.

By monitoring basic information from the lamp, such as burning hours, energy consumption, voltage, temperature, dimming level and whether it is in operation or not, it is possible to schedule service intervals according to the actual status and in most cases extend the lifetime of the bulb.

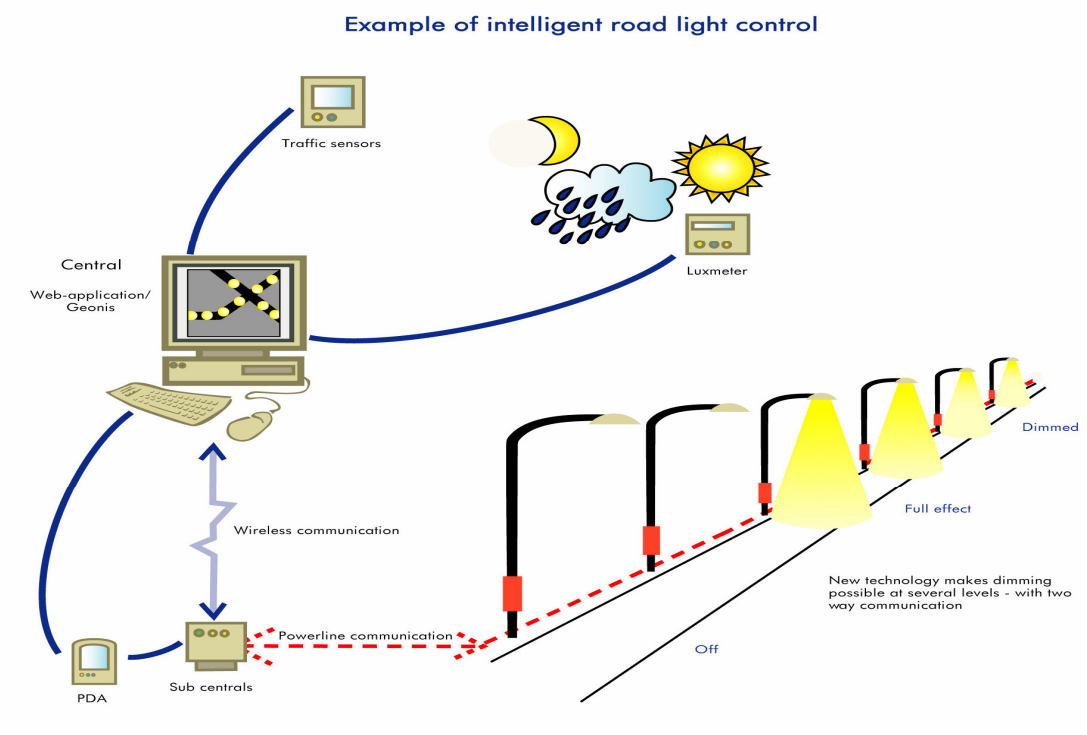


Fig 2. Design of intelligent street lighting

E-street project

In the E-street project 11 European countries, supported by EIE (Intelligent Energy for Europe program), are struggling to expand the market for energy efficient street lighting. The partners are all convinced about the prosperous future for this technology, its significant energy saving potential, environmental and economical benefits and the increased level of traffic safety for the public.

The objectives are achieved by active procurement, performed by the involved street light owners themselves, and by provoke and participate in further development of standards and legislation that take into account the new options. Further, by communicating to the market players the customers needs, accelerate more cost effective solutions and administrative tools for optimized design and operation of the intelligent street lighting. The project is also working on new financial instruments within street lighting such as Energy performance contracting. To obtain a significant change in the demand for intelligent street lighting, active demonstration of intelligent street lighting in operation and distribution of selling arguments, are essential.

Saving potential, market survey

The overall energy saving potential for the European market is evaluated to be approximately 38 TWh. This is based on the following assumptions when retrofitting from an old to an entirely new installation: replacing the lamp, luminaire and ballast will alone account for about 37% reduction in energy consumption. Intelligent streetlight in such an installation can be as high as 45% off this number when applied, fully bringing the total energy savings up to about 66% of a conventional older installation.

In Oslo some 6.000 intelligent street light units is by now installed, representing about 10 % of the total. The installations have been divided into several phases:

- 117 units (2003) - Pilot project (67 % savings)
- 2.000 units (2004) - Full scale test project (62 % savings)
- 4.000 units (2005/6) - Full scale project (52% savings)

In January 2007 the central administrative data handling tool, including customer client services will be implemented. This system is tailored for Oslo, based on existing databases and a new data integration model including a street light history database.

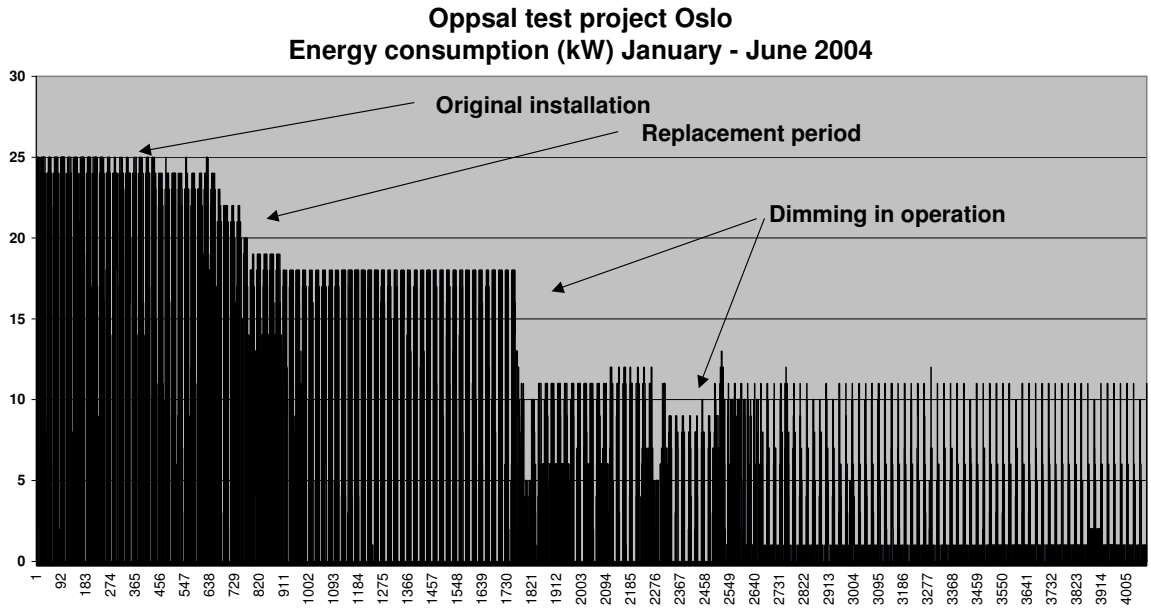
Utilizing the system

In the coming years, the development of managements systems for motorways and highways as well as specific sensors for streetlighting purposes will develop. Already today Dutch road authorities regulate the light output based on real time traffic volume and speed as well as weather and astronomical indicators such as rain, fog, snow, sky and clouds etc. This kind of information will in the near future in combination with intelligent streetligting systems increase the safety of the public and at the same time reduce the energy consumption even more.

Positive Driving forces

Symbolic value of the municipality to be the first

As we see it today, there are many positive driving forces for introduction of more energy efficient solutions for outdoor public lighting, and more specifically streetlighting. Among those drivers the political focus on energy efficiency itself is important, because of the symbolic effect of i.e dimming the light during sleeping hours in the night. In this way the municipality may show the public, in an effective way, that it is possible and quite simple to reduce their consumption in a quite substantial way by simple means. And everybody will recognize it!



Environmental aspects

Other positive effects are of course the positive environmental aspects by reduced light pollution. By dimming the light in the night, even the insects are not so negative affected.

Safety first

As a result of the substantial savings potential, also the economy for the municipality is quite good, and actually the savings also lead to improved safety for both the users of the road, as well as the public in general. This is due to the fact that the installation may be designed for “worst case”, and then dimmed when not needed for.

Prevention of crime

The introduction of intelligent streetlight will also make it possible to be integrated into the design of control systems for city beautification by new light installations, as we see it in many cities. In stead of “dubble up”, the streetlight may be reduced during the opening hours of the shops and later increased. This active way of both planning and operating the installations, again, also will prevent crime. In Oslo, for instance, the main “bar street” today is equipped with high level streetlight to prevent crime during closing hours. In the future this installation may be further upgraded according to normal light level in the street, but of course dimmed before and after the critical period. In many cases, especially for the “inner city areas”, new installations may lead to use of lamps with improved colourendering. This will make the public feel more safe and happy as the colour performance is much better and the clothing colours, as well as facial recognition, is much more precise.

Public services

Today the only way to detect dark streetlight is by reports from the public, or by visual inspection of each street or road. When introducing intelligent streetlighting, the municipality immediately will detect a failure, and even more advanced, will know it in advance, and may plan the replacement respectively. (As the performance of the lamp changes over the lifetime, it is possible to make an early warning some 2-300 hours before the lamp will fail.) This will lead to less response time for changing bulbs, increasing the overall level of light in the street during peak hours.

As a result of all these information collected by the system, easily accessible information are extracted and in a user-friendly manner will continuously be published on the web. The public then may get information of the given time for the replacement of the dark lamp in "their street".

Free electricity market

In many cities and villages there may be a mixture of street light "clients", such as the municipality, national road authorities, parks and harbour facilitators and private companies or individuals (private roads). Ad they will be asking for diversified services of operation time and light levels. At the same time some of them want to link their energy consumption to the real consumption values (not estimated) and to be supplied by electricity purchased on the free electricity market in a competitive manner. By installing intelligent streetlight systems it is possible to measure the consumption individually and address it to the individual consumer and energy supplier respectively.

Improved maintenance

The valuable information given by the system makes it possible to plan and organize the maintenance tasks in a much more cost effective way. In the Nordic countries, many installers now are using handheld PDA/PC's as well as GPS (geographical positioning systems) in their daily work. When combining these systems, the operation will be planned and worked out in a much more time- and cost efficient way. This again leads to substantial cost reduction, typically between 40-60 %.

Establish common technical specifications

As a part of the E-street project the partners have developed specifications for intelligent streetlight solutions. The idea behind this is to standardize the "customers" demand, opening up a larger market for the manufacturers and vendors. Such standards will again be easy to integrate into standard contracts, either for new installations, retrofitting or maintenance, but also within self financing models.

Financing mechanism

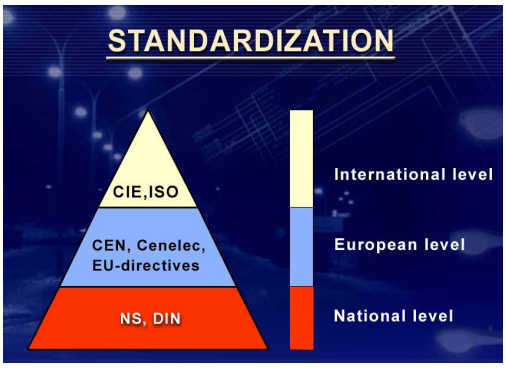
Performance contracting and third party financing models are developed for many energy efficiency activities already. Here you can find contract models and specifications for different models, dependent on the activity as well as the preferred contract model by the client. Within the E-street project such models are now also outlined and developed for streetlight. These documents are based on existing contract documents, already developed and put into force, in real projects. The city of Oslo is also looking into utilize such a model in the near future.

Hindrances for the introduction

The technology behind the intelligent street light solution is quite new. Despite of that the techniques have been tested out for a long time under indoor conditions, there are still a lot of "early stage" experience to overcome outdoor. In general the system now seems to function quite well. But still the unit prices as well as integration costs are too high for mass introduction. This fact, added to several non technical barriers still hampering the development. In the E-street project some of the non-technical barriers have been addressed and are in good process to be partly overcome. One of them is the lack of standardization.

Light design guidelines and standards

Based on an initiative from Mr. Eirik Bjelland, Hafslund, Norway, it was established a technical committee under the international standardization organisation for lighting (CIE), TC4-44 in May 2005. This committee have been actively working on the document "Recommendations for the lighting of roads for motor and pedestrian traffic". The document is expected to be ready for vote during the early spring 2007. The recommendations open up for adaptive lighting and hence intelligent streetlight solutions. All CIE recommendations are of great value when developing new legislations and standards in Europe (CEN). The parallel development of adaptive lighting within CEN is by now possible to initiate.



Ownership

The physical design of the power supply of public streetlighting varies quite a lot from city to city and country by country. In some cases the grid are owned by the electricity utility, in other cases the grid is owned by the municipality. In other cases the municipality (owner) are only responsible for the operational and maintenance costs without any real ownership at all. In addition to that some gridowners are private companies operating under vague national regulations, only focusing on profit making for their shareholders.

All these variations of ownership will in one way or another predict uncertainty for future development of the installations. In Warsaw, the private streetlight owners will not make any investments because it, in the near future, is expected to be transferred to the public/municipality, while in Portugal some municipalities have already 15-20 years duration contract, including energy costs and maintenance, on fixed annual rate with the electricity company.

Electricity tariffs

In some European countries, like UK and Norway, free electricity market has existed for more than 15 years, while in others it is just about to begin. In combination with the broad number of models for ownership this leads to a high number of different tariffs, not always giving incentives for saving energy and costs.

In some cases "per point" annually fixed tariffs may give negative incentives for the installer to replace broken bulbs and luminaries, while the municipality at the same time has no incentives for investments in new technology within the contract period. In other cases the electricity company set high p.u. fixed rates for the grid cost, leaving the marginal cost/savings very small. In Belgium, the night tariff is 1/3 of peak hour tariff.

These disincentives could easily be handled by developing European guidelines and regulations for electricity tariffs for public lighting.

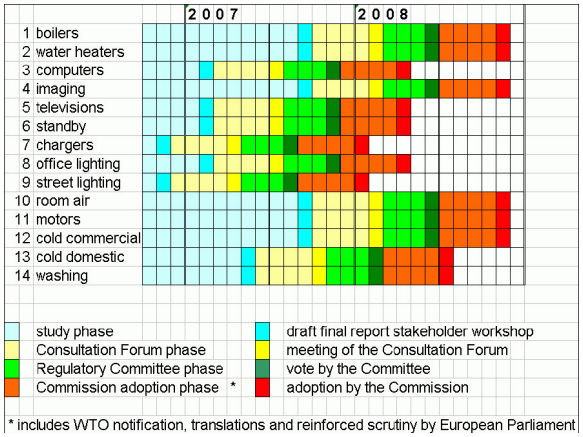
Drivers to come

Introduction of a directive on energy consumption for outdoor lighting

The ongoing work for establishing a minimum energy performance standard for street-lighting will lead to more focus on streetlight in general, and energy performance more specific. This is of high importance as long as the directive is based on the real situation for the streetholders. It is crucial that the standard is based on, and is in line with, the international CIE and CEN quality standards for light distribution design.

Eco-design directive

The eco-design directive will pay more focus to life cycle cost analysis, which again will increase the competitiveness for high technological energy saving solutions. This will gain intelligent streetlighting solutions. The plan for introduction of new directives also includes streetlighting for the near future.

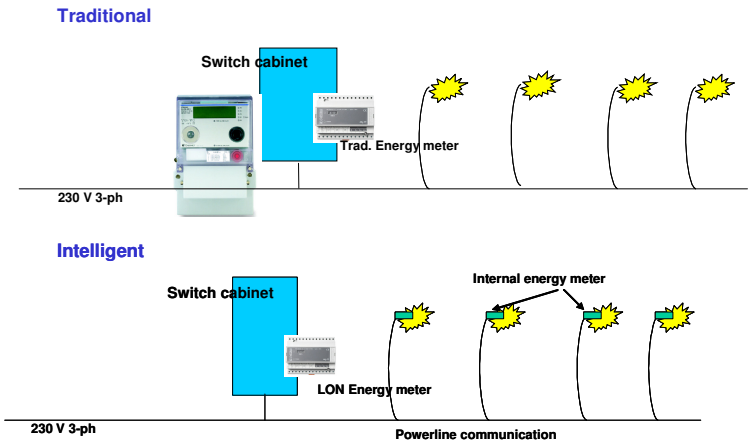


Information about the electricity supply quality

Today, a lot of street light installations have poor electricity supply and old grid systems. Detection of voltage and other electricity performance criteria will in the future make it necessary to improve the installations, then opening up the “window” for introducing new technology.

Metering

A high percentage of all European streetlights are not directly metered. It means that a lot of clients really do not know their exact consumption. New regulations forcing all trade of energy to be metered will stimulate introduction of two way communication into the switch cabinets/sub station power supply for the streetlight. Then, when first established this communication, marginal cost for introduction of intelligent management systems are lowered and more easily acceptable.



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