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Intelligent Road and Street Lighting in Europe (E–Street)

Grant Agreement: EIE/05/157/SI2.419662

WP 3: Market penetration and procurement activities

D 3.2: Report on small scale test projects

WP Leader: BSREC

On behalf of the E-Street project (www.e-streetlight.com)

And supported by:

30 July 2007, Sofia

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For the elaboration of this report we asked (twice by e-mail) our partners to answer the following questions:

1. What kind of small scale test projects are realized in your country up to now?
2. Could you send us a short technical description for the realized small scale projects, including the equipment and which firms fulfilled the projects?
3. What kind of findings in connection the functioning of the realized projects you may share with us? Do you find specific for your city or country assets or problems along the realization and work of the new intelligent street lighting systems?

In the next pages is presented in summarized form the information we have received from our partners or we have found ourselves, published in different places (Conferences, CIE Sessions, Internet etc.). The information from different partners is not always relevant to our questions. The most valuable information we have from Norway, Sweden, Finland and Czech Republic. The experience of the city of Graz (Austria) is also valuable.

INFORMATION FOR THE PARTNERS OF E-STREET PROJECT

NORWAY

Over the last 5 years Hafslund ASA, the street lighting operator in Oslo, in corporation with Oslo Municipality-street department, has been testing and implementing the most advanced intelligent street lighting in the world.

By using electronic dimming gear and power-line communication each luminaries are individually controlled, monitored and manipulated to both save energy and increase safety level for the ordinance. More detailed information can be found in the next quotations.

Intelligent Road Lighting – "Light – on the road"
CIE Session 2003/Author: Mr. Eirik Bjelland, Viken Nett, Norway
(Partial quotation)

Energy savings of 30%:
Each lamp can be step-less dimmed individually depending on traffic, climatic conditions etc. In periods when the traffic is low or when snow covers the streets the need for light is lower and the illumination level can be reduced. In addition, the life expectancy of lamps and equipment is prolonged when the fixture is dimmed. The figure on the left illustrates the obtainable cost reduction for different energy prices after installing a light control system for the highway between Oslo and Asker.

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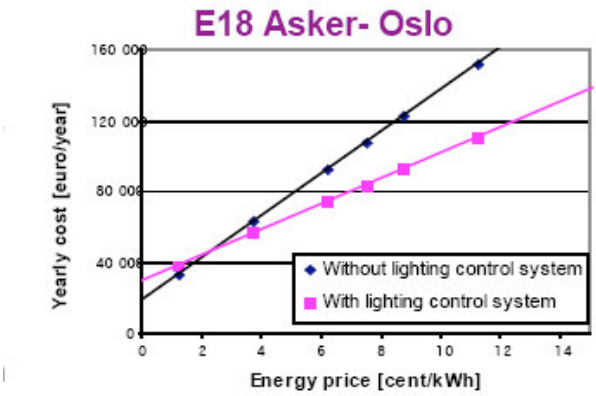

Reference projects:

1. Intelligent road lighting – technology development and demonstration.
Partners: Viken Nett, Philips, Norwegian Water Resources and Energy Directorate (NVE), Norwegian University of Science and Technology, ENOVA and Municipality of Oslo and Bærum and the Norwegian Directorate of Public Construction and Property. The project has been supported financially by NVE and ENOVA. The concept that is to be introduced includes the building up of an infrastructure for measurement, control and surveillance of the road lighting and it has the potential of serving several "road owners" independent of where they are situated.
The energy saving potential has been estimated to 1, 5 GWh
2. Oslo by Light – integrated approach to efficient running and maintenance of street lighting in Oslo Partners: Viken Nett, the Norwegian Public Roads Administration, ENOVA and the Municipality of Oslo. Elements in the project are:
- Energy efficiency integrated into overall lighting planning of the inner Oslo area.
- changing of inefficient lamps and fixtures
- Installation of control systems.
- Fine-tuning and maintenance of photo-cells (sensors)

The energy saving potential has been estimated ***to 5 GWh***
3. Highway lights – energy efficiency in the main road network in Norway, including tunnels Partners: Viken Nett, the Norwegian Public Roads Administration, ENOVA and Interconsult ASA. The project is a response to the difficult electricity situation in Norway last winter. Elements in the project are:
- Fine-tuning and maintenance of photo-cells (sensors)
- changing of inefficient lamps and fixtures
- Installation of control systems
- Optimization of tunnel ventilation and pumps

LUX EUROPA'2005
Intelligent street lighting in Oslo, Norway
Eirik Bjelland, Tom Kristoffersen, Tor Mjøs, p. 498

Over the last 3 years Hafslund ASA, the streetlight operator in Oslo, in cooperation with Oslo Municipality -street department, has been testing and implementing the most advanced intelligent street lighting in the world. In close cooperation with government (Enova), University of Trondheim (NTNU) and the municipalities of Oslo, Asker og Bærum, Hafslund can now demonstrate energy savings potential up to 70 % when retrofitting old installations. By using

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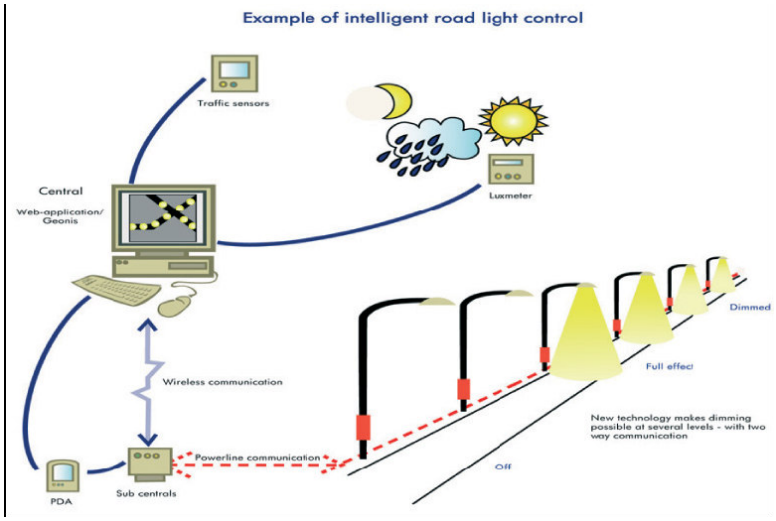
electronic dimming gear and power line communication each lantern are individually controlled, monitored and manipulated to both save energy and increase safety level for the ordinance.



ID RL6# Paper ID 067

Intelligent street lighting in Oslo, Norway

(Partial quotation)

Eirik Bjelland
c/o Hafslund ASA

Tom Kristoffersen
c/o Oslo Kommune Samferdselsetaten

The City of Oslo has signed cooperation agreements with 5 cities/regions, namely Schleswig-Holstein in Germany, Vilnius in Lithuania, St. Petersburg in Russia, and Shanghai in the People's Republic of China. The City of Oslo, Norway's Capital was honoured to be "The sustainable City of the year Europe" 2003. It is also the City of Oslo's ambition to be the European Cultural city of the year 2011, and to develop to be the most environmental City of the world within 2014! Hafslund is more than 50 % owned by the City of Oslo. A full-scale test made in Oslo (2003-2004) clearly demonstrates the enormous potential for savings when retrofitting old installations. When redesigning and changing from mercury lamps to high-pressure sodium lamps, energy savings are up to 70 %. This is due to individual steeples dimming of each lamp depending on weather condition, especially in winter time with snow, and in the summer light night hours.

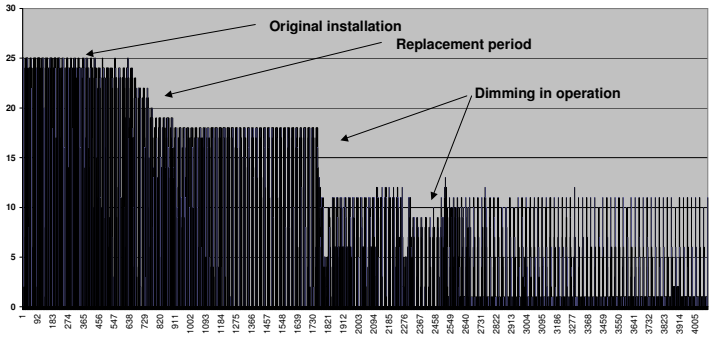


***Figure 21** Energy savings of intelligent street lighting*

Retrofit and new design of 20.000 – 30.000 luminaries in Greater Oslo (2005-2007)

The budget including new ignition system for old fittings is more than 10 million Euros /13 million USD.
The investment will perform annual savings of **14.5 GWh/year.**

Retrofit of 2.000 luminaires in Greater Oslo (2004) and 4000 (in 2005)

The investment will perform annual savings of **2.0 GWh/year**.

SWEDEN

Author: Ingemar Johansson

Intelligent street lighting, Högsboleden and Tuveleden.

The project was initiated in August 2006 and will be finished in September 2007. In this project the whole street light system was rebuilt in this road section. All 366 old luminaries have been replaced with 283 new intelligent luminaries. The system is installed along two different road sections in Gothenburg, Högsboleden and Tuveleden. Earlier, there has been installed at least two different systems by the Swedish National Road Administration in Stockholm. The two systems are:
- Philips Starsence, installed in 2002 at Åkersberga
- Thorn Luxmate, installed during 2005-2006 on a motorway section on the E4.

The two different systems are based on two different, older system concepts.
More information about these systems can be delivered on request.

A short technical description of the system installed in Gothenburg
The system consists of two main parts – ÖSÖ, a Supervisory Control and Monitoring System and a local intelligent street lighting system. ÖSÖ is developed for the moment and new functions will be included continuously.

Supervisory Control and Monitoring System - ÖSÖ
The main functions in ÖSÖ are:
- Map overview based on information from the Traffic Authorities own GIS-system
- Status monitoring
- Fault monitoring and fault distribution by SMS to service personnel
- Light control – On/Off on the basis of light intensity or manually from a Web Site
- Statistics such as fault Reports
- Data collection and report (energy consumption, burning hours, etc)

Local Controller – MP-01
The street lights, installed along each road section, are controlled by single local controller, MP01.
The MP-01 communicates with ÖSÖ through a wireless network communication (GSM/GPRS). The MP-01 also communicates with each luminary over power-line communication (Lon). In the MP-01 there are *functions* such as:
- Databases (the local installation) covering installed luminaries
- Communication - with each luminary and with ÖSÖ

- Alarm monitoring / individual luminary
- Clock and date synchronization
- Control of dimming levels
- Control light on/off
- Parameter setup, for example rush hours, dimming levels etc.

Light On/Light off

The MP-01 controls the light on/off according to a signal from ÖSÖ.

The system can also be controlled on/off by a local individual solar calendar in each MP-01. The dimming level in each luminaire is dependant of the following aspects:

Normal scenario:

- The local time

A local schedule is programmed in the MP01.

- During rush hours, the dimming level increases up to 70%.
- During night, the dimming level is lowered to 35%.
- In the time in between, the dimming level is 50%.

- Dimming level for each luminary can also be controlled individually.

Note: Dimming levels can easily be adjusted in each MP-01.

Lamp controller - LC-20D, LC-20C and HID

In each lamp there is a local controller installed, LC-20D and ballast, Philips HID. The communication protocol between LC-20D and Philips HID is based on the DALI-protocol. The LC-20C local controller is developed to control existing lightings with conventional on/off function /luminary which get their voltage from the one example of this is an existing lamppost near a bus-stop.

The controller turns the lamps at the bus-stop on/off on the signal from MP-01.

The communication protocol between MP-01 and the LC-20D is based on Lon Talk over Power Line Communication.

Function

The local function in the lamp is:

- Turning a luminary on/off depending on orders from the MP-01
- Monitoring statistics such as

Momentarily:

- Lamp status On/Off
- Lamp Voltage Level
- Lamp Current Level
- Power consumption
- Dimming Level
- Frequency

In the LC-20D there are also functions for measure

- Accumulated energy consumption
- Accumulated burning hours

A function to reset the energy meter and the burning hours counter in case of a lamp exchange is also included. Fault safe functions – if communication fails the lamp automatically is turned on/off at the same time as yesterday.

The Project

The project consists of two different projects:

- Development of ÖSÖ
- Development and installing a local intelligent street lighting system.

The main contractor in developing and delivering the intelligent street light system is the Swedish National Road Administration in Gothenburg.

The technical concept for the intelligent street light system has been developed by Capelon AB, seated in Stockholm. ÖSÖ is developed by Infracontrol AB in Gothenburg. All system functions has been designed and developed in near cooperation with the Local Traffic Authority in Gothenburg.

Conclusions

It is too early to make an evaluation of all possibilities and benefits by using the system. The energy consumption figures available are based on the bright part of the year in Sweden and during fall and winter we expect the light will burn a lot more. However, until now we can see, the average energy consumption per burning hour is reduced to 37% of full energy consumption of a single luminary.

This will of course increase during winter. The estimation today is that the increase will grow up to 45-50% of full energy consumption per burning hour (calculated as an average value over one year). This is a prototype construction and the investment cost for each installed lamp therefore is very high. For each lamp the cost is almost twice compared to a conventional street light installation.

The payback time of the investment, in this early stage and with energy prices as today, is now somewhere in between 8 to 12 years. However, this is due to the small volumes and high development costs. In an industrial stage, with high quantities, this will not be a problem.

FINLAND

Intelligent road lighting system has been installed in Helsinki Ring Road III in autumn 2005. Altogether 492 luminaires are controlled on 4 km road and 4 interchange areas.

The system collects traffic, weather and luminance information and controls road lighting based on this data.

With this installation is guaranteed the quality of the road lighting, to save energy and other maintenance costs and to reduce obstructive light and in the same time to increase the traffic safety.

The installation provides possibilities to study the visibility conditions of road users in different conditions and to apply mesopic lighting dimensioning in practice. The following pictures:

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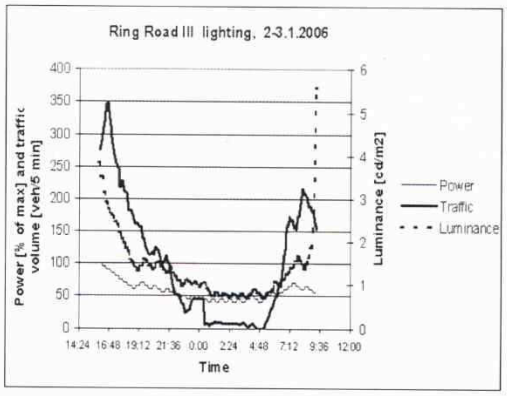

Figure 3. The lamp power, traffic volume and road luminance level as a function of time. Data collected from the road lighting control system from two days in January.

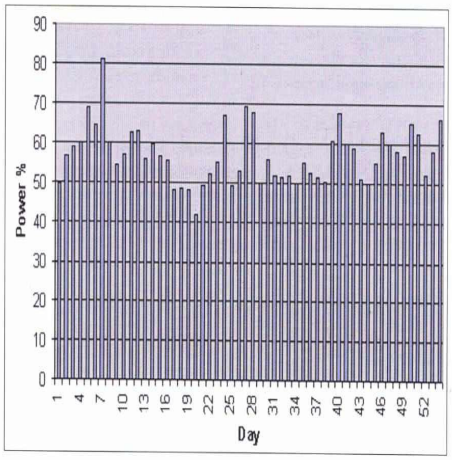

Figure 4. The mean power (% of maximum) of the Ring Road III lighting system during January-February 2006.

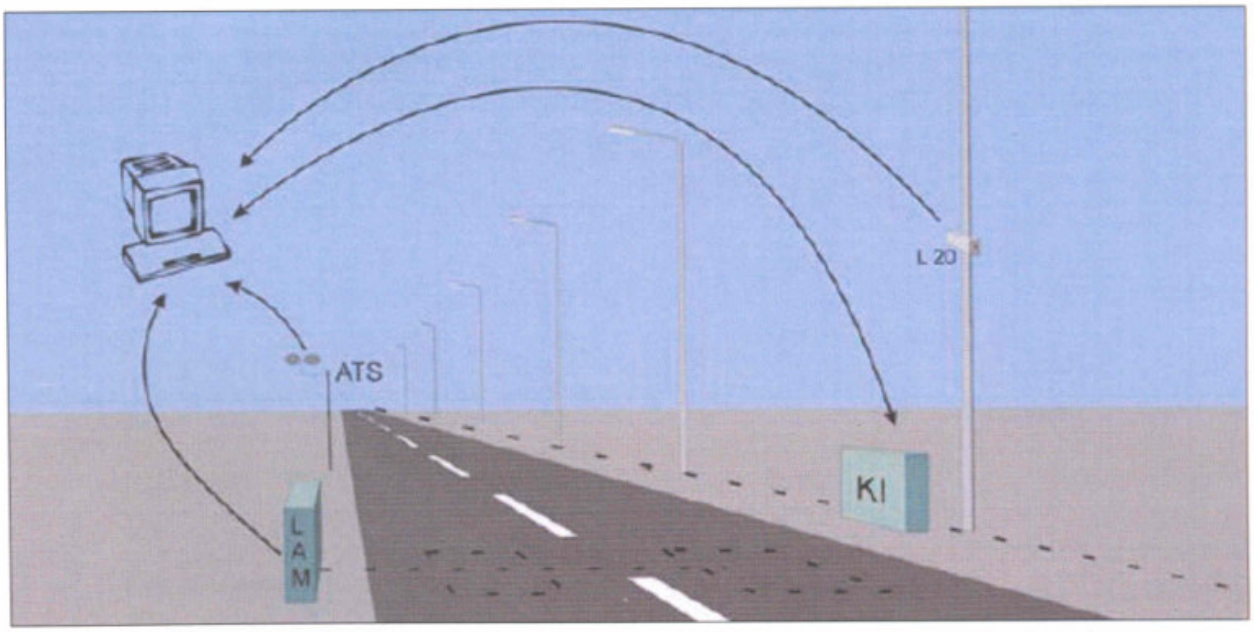

Figure 2. Information source devices, (ATS - road weather station, LAM - traffic monitoring system, L20 - luminance meter, KI - electrical distribution box).

SLOVENIA

THE INFORMATION IS GIVEN IN SEPRATE PDF FILE

CZECH REPUBLIC

Author: Luděk Hladký

There is being tested **Luxicom** telemenagement system for outdoor lighting in Prague public lighting (www.luxicom.com). The communication is provided via power line carrier and each lamp is managed by one UDC (Output Lighting

Control). The system allows controlling each lamp in real time, supervising complete network, managing updated data, and optimizing the interventions with efficient method. There are installed 60 pieces of UDC units at the moment. There is being also tested 60 pieces of dimmable electronic ballasts **Ecolum EC3** in Prague public lighting (www.apein-lumtec.com).
Another conceptual solution of outdoor lighting network is **DATMO.** This system provides considerable electricity savings, economic system realization, tailor-made custom software visualizing separate switching points and gathering data from distributing boards as well as single lamps, data transfer using radio modems and GSM modules, the analysis used for maintenance optimization. DATMO system application was performed in the city of Brno (www.datmolux.cz). There have been fitted 270 switching points with intelligent distributing boards, 60 of which is equipped with voltage regulation.
Another application of telemenagement system, based on the power controllers **Reverberi** (www.mpes.it), is installed in the city of Zlín. The central voltage stabilizator reduces the amount of power by reducing the voltage in accordance to estimated traffic density. There are installed 200 of Reverberi power controllers, 55 of them are equipped with GSM module for on-line communication with the central office.
Another telemenagement system is called **S.E.R.V.O.** This system manages data from the distributional boards, data transfer is provided via GSM modules. There are installed 29 pieces of intelligent distributing boards in the city of Plzen (www.pechman.cz).
There is being also tested 60 pieces of dimmable electronic ballasts **Ecolum EC3** in Prague public lighting (www.apein-lumtec.com).

POLLAND

(Partial quotation from document WP 3 Market penetration and procurement activities)

- No answer of our questions.
Most of the luminaries - 89%, installed here in Warsaw are the High Pressure Sodium lamps (SON). 10% of the rest are High Pressure Mercury lamps (HPL) and Mixed lamps (ML) - 0,40%, Low Pressure Sodium lamps (SOX) - 0,19%, incandescent lamps - 0,16%, fluorescent lamps - 0,14% and halogen and others lamps -0,09%.
On the area of Warsaw, here is implemented the system of energy efficient lighting cabinets. This system allows achieving savings of electricity consumption up to 40% during the working period of luminaries. The annual potential of savings of electricity consumption with energy efficient cabinets carries out over 16%. Lowering of energy consumption together with the dimming of the lamps when less light level is required and traffic density is small are made real in the middle of the

night between 23 pm until 5 am. Nowadays, **55 energy efficient lighting cabinets are installed on the area of Warsaw.**

All new reconstruction and updating street lighting works in Warsaw are hold on according to the Standard PN-EN-13201. From the other point of view the energy efficient lighting cabinets working with lowering luminaries' power supply reduce light density. European standard EN – 13201 permits during the night period significant changes of lighting parameters but it has an influence on lowering of road classification as a result of traffic density reduction. Nowadays specialists from Warsaw Municipality lead on "Street lighting map of Warsaw" according to which should be known where energy efficient lighting system could be implemented.

THE NETHERLANDS

At the moment begin the realization of project for new adaptive street lighting system in the city of Eindhoven.

Dynamic Public Lighting (DYNO), Netherlands (2004) - In the Netherlands, the origins of dynamic roadway lighting can be traced to the Energy Crisis of the 1970s. During that period, some luminaires were turned off to save energy. While there was an increase in accidents, it was not a large increase. Over the following 15 years, there was movement by the Netherlands to lower the lighting levels from 2 cd/m2 to 1 cd/m2, while at the same time retaining the recommended uniformity ratios. Since 1995, the Netherlands has installed and operated a dynamically lighted roadway that can be adjusted to any of three lighting levels, depending on the amount of traffic, time of day, and weather conditions. The low level is 0.2 cd/m2, the normal level is 1 cd/m2 and the high level is 2.0cd/m2. The different light levels are obtained through the use of electronically controlled, dimmable HPS ballasts. To set a baseline for the dynamic road section, Dutch experts have collected and analyzed accident data. Unfortunately, the dynamic section was too short and the statistical sample size was too small to draw conclusions between the 1-cd/m2 and 2-cd/m2 light levels. In an evaluation of an extensive set of methods (inductive loop detectors, instrumented vehicles, video observations, questionnaires), it was concluded that, under low traffic volumes (less than 800 vehicles per hour) and favorable weather conditions, the low level (0.2 cd/m2) can be applied.

BULGARIA

1. It is planned during the next year to be realized in **SOFIA** relatively big Pilot project for Intelligent street lighting with the support of the Municipality.

2. SIEMENS has developed a project for Intelligent street lighting for the city of **SLIVEN**, which is partially realized.

3. System for adaptive control of street lighting in **VARNA –** only Design
The adaptive control street lighting system consists of four levels:

- control – information center;
- segment controllers;
- lamp controllers;

- Lamp units (dimmable electronic ballasts or controlling magnetic ballasts).

The offered system will measure the electricity consumption in different points of the street lighting system. The system realizes monitoring of each units of street lighting equipment. Control communication in two directions through:

- existing power lines;
- GSM (GPRS).

4. Intelligent Street lighting system in **SMOLIAN** – only Design

The system structure consists of four levels:

- control – information center;
- segment controllers
- lamp controllers
- lamp units (dimmable electronic ballasts or controlling magnetic ballasts)

The offered system will measure the electricity consumption in different points of the street lighting system and monitors each units of street lighting equipment.

5. The city of **KARLOVO** is planning:

- Close cooperation with the Sub-Balkan Energy Agency, established under the Intelligent Energy – Europe Programme
- Reconstruction and modernization of the street lighting of the municipality of Karlovo and introducing automated system of centralized radio control of the lighting.

6. The project of **VRATZA** for street lighting reconstruction expects the lighting control to be achieved by:

- Networking telecontrol by power cables.
- Radio control by USW transmitter and receivers in the local points at the street- the transmitter code impulse will be received by the proper one receiver and switch on/off the power line.
- Street lighting control system using controllers with microprocessors connected to GSM devices – each controller can react independent leading by computer program or by dispatcher signal the switching on/off process of the separate power lines. The controllers are collecting data acquisition for the status of the devices. The information is sending back to the control center by GSM devices. It may alarm for possible vandalism or destruction of the system and electrical thefts.

The devices of this system must perform the following functions:

- Metering of the electrical current level for each power line for street lighting and the average value due to 15 min.
- Saving this information in the middle RAM of the controller.

- Periodical sending of the collected data to the central dispatching centre by GSM module.
- Preparing of inquiry for power traffic and consumed electrical energy for illumination at previous period.
- Generating of warning message when diversion from the standard parameters occur.

➢ Installing of Geographical Information System for street lighting control and visualization. The system must be able to exchange information with the devices mentioned above.

INFORMATION FROM CONGRESSES, CONFERENCES, JOURNALS, INTERNET

BELGIUM

1. Tyco Electronic systems for Intelligent street lighting (Light on Demand Using Environmental Sensing G. Heremans, E. Maurer, B. Pfeiffer, G. Clarke, Proceedings of URBAN NIGHTSCAPE 2006, Athens, Greece, p. 232-234)

An "Intelligent Street Lighting and Street Light Monitoring" system has been developed which maximizes energy saving and minimizes unwanted light (as light pollution), but takes account of the environment and safety standards needed in all traffic conditions. The energy saving is achieved by driving each light source to the minimum illumination, needed for specific time and weather conditions. Planned settings can be overruled by environmental conditions such as heavy rain, visibility, frost, traffic density and much more. The requirement for the light level needed during each condition can be predefined.

The developed system provides light zones which are independent of the physical area of substation, but are related to the needs of the lighting system.

The lowest platform at street level of this system is based on Power line modem and RF technology, supported by stand alone Network Controllers and web based monitoring graphical user interface (GUI).

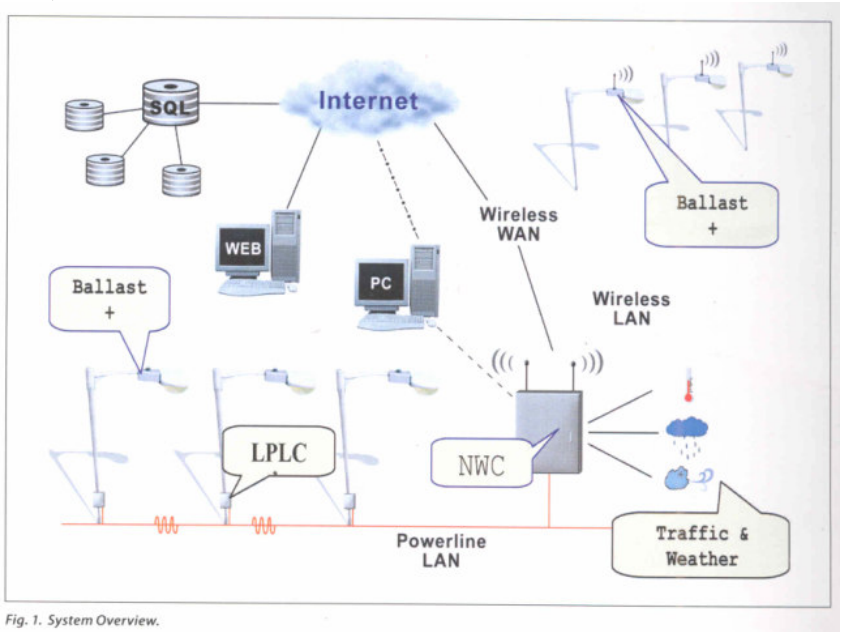

Fig. 1. System Overview.

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2. ***Zele, Belgium***

(Lighting control in street lighting – An overview of the state of the art in technology and application – **Authors**: Dr.Nguyen van Tien –Institute of Materials Science, VAST Hanoi, Vietnam Email: THANGLONGNEON@HN.VNN.VN
Mr.Yodsak Unhavaithaya –Meridian Technologies Co., Ldt
Dr.Nguyennang Dinh – Institute of Materials Science, VAST, Hanoi, Vietnam)

Location:	Zele, Belgium
The overall installed power	1,008 KW
Type of controller:	Dimming electronic ballast with IDM
Manufacture:	Verdeyen N.V
Quantity of used controllers:	60
Annual energy consumption KWh:	4,231kwh
Reduced annual energy consumption KWh:	2,943.4kwh:
Annual energy saving KWh:	12,876
Annual energy saving %:	30%

UNITED KINGDOM

Dynamic Dimming: The Future of Motor way lighting?

Andy Collins, Tom Thurrell, Robert Pink and Dr. Jim Feather report on a recent lighting installation in north Lancashire involving new methods of dimming and control, ***The Lighting Journal September/October 2002*** 25

The research under taken by University of Manchester (UMIST), England indicates that significant improvements in driver comfort are obtained where dimmable lighting was installed. While not specifically measurable, it is likely that general road safety is improved by reducing ocular stress, enabling motorists to remain more alert and reduce the risk of accidents.

As the first motorway in the UK to incorporate traffic controlled dimming, the M65 project represents both a pioneering achievement and a model for future motorway lighting development. With ever-increasing pressure on public bodies to save energy and limit environmental damage, it is likely that dimmable lighting will become a much more common feature of our motorways in the future.

The M65 in Lancashire is one the country's lesser known motorways, carrying only a fraction of the traffic of the busy M6 which it joins close to Preston. Running eastwards towards Yorkshire, the M65 provides access and bypass for the towns of Blackburn and Burnley and ends at Colne, just beyond Nelson. At its eastern end, the seven-mile, two-lane stretch from junctions 10 to 14 is under the ownership and management of Lancashire County Council (LCC).

However, this small and relatively insignificant part of the national motorway system is at the heart of a pilot project that may revolutionize the way all motorways are lit in the future. In collaboration with WRT L Exterior Lighting, Royce Thompson and Peak Traffic Management Systems, LCC's Street Lighting Group recently replaced the lanterns along this stretch of road with a dimmable lighting system controlled by traffic flow. The scheme, the first of its kind to be implemented in the UK, was installed by Lancashire County Council Engineering Services. Running in parallel with this scheme, research is being undertaken by the Optometry and Neuroscience Department of the University of Manchester Institute of Science and Technology (UMIST) into ocular stress whilst driving at night. Measurements made on the M65, under different lighting levels, have produced important information on the relationship between ocular stress and motorway lighting. Taken together, these developments are expected to produce significant energy savings for LCC, contribute towards Government targets in the reduction of CO2 emissions - and lead ultimately to safer night-time driving conditions on UK motorways.

Energy Efficiency Leaders

LCC's leading role in lighting innovation and energy management was recognized in November 1999, when it became the first Highway Authority to achieve Energy Efficiency Accreditation Status. This award is conferred by the Institute of Energy and is recognized as the national benchmark standard in energy management. Subsequently, the Street Lighting Group won the Major Energy Users Council's 'Best Energy Strategy' Award at the Energy Awards in September 2000(1). Energy Strategy and Management between 1997 and 2001, a number of events and developments contributed to demands for better energy management by major consumers, including local authorities. These included: Andy Collins is Principal Lighting Engineer, Lancashire County Council; Tom Thurrell is head of corporate marketing at WRTL Exterior Lighting; Robert Pink is national sales manager of Royce Thompson; Dr. Jim Feather is a researcher at the Department of Optometry & Neuroscience, UMIST l The Kyoto Protocol and the subsequent Climate Change Levy introduced by the UK Government Load Research and Power Factor Measurements on Unmetered Supplies 1 the introduction of 'Best Value'as a statutory obligation for all local authorities. All of these created pressure to reduce energy use, improve energy efficiency and encourage energy conservation (2). Due to these pressures, LCC entered discussions with electronic control gear manufacturers whose equipment was able to offer LCC a number of advantages, including a reduction of circuit wattage and the ability to achieve near unity power factor correction, thereby lowering energy consumption.

Technological Developments

The system chosen for this project was Royce Thompson's Elgadi electronic control gear, complete with power line modem, and the Horus street lighting control system. Elgadi incorporates high frequency electronic ballast for high pressure sodium lamps from 50W to 250W. This means that it can offer reductions in gear losses, an improvement in power factor and longer lamp life. Dimmable down to 30%, the system requires no external igniter and maintains constant lamp power within a stable spectrum. Built-in features also include an intelligent controller and two-way remote communication facility. Horus, named after the Egyptian God of sky and light, combines with Elgadi to provide a total street lighting management system. This allows for activated lighting, dimming control by time and traffic flow, with peak saving and tele-metering capabilities. Luminaires can be individually controlled, faults identified and maintenance data recorded to ensure complete and constant control of the lighting operation.

Institution of Lighting Engineers in the UK —TECHNICAL REPORT 27 CODE OF PRACTICE FOR VARIABLE LIGHTING LEVELS FOR HIGHWAYS—Advice and information on dimming and enhancement of road lighting levels - This Code of Practice defined recommendation for applying variable lighting technologies to roadway lighting systems.

JAPAN

The Illuminating Engineering Institute of Japan: Volume 29 Number 1, April 2005—The Influence of dimming in Road lighting on the Visibility of Drivers - This paper presents experimentation with observers, who were asked to assess the visibility of targets on the road surface under different levels of illumination promoted by dimming). The paper notes dimming does not influence the visibility of drivers. The report concludes, luminous flux reduction must be done with good and homogeneous lighting installations otherwise road users may have problems of visibility and comfort.

CHINA

City University of Hong Kong - Through the support of a City University associated company, Energy Technology; a central dimming technology (patent pending) has been

successfully applied to road lighting systems. It is suitable for applications both in indoor and outdoor large lighting systems such as roads and highways, parks and gardens, multi-storey car parks, public housing estates, industrial and commercial buildings, and airports, hotels, universities, and sports stadiums. The central dimming control system has been tested in China since September 2004, registering an average electricity savings of 30%. "Not only can this technology reduce power consumption and pollution in China, it can be exported as a global technology from China," said Dr Chung. It is now being installed in a mainland city, Heshan, in Guangdong province, for controlling over 7000 street lamps.

USA

One such adaptive lighting product, the Streetlight Intelligence (STI) Lumen IQ, was used on major road in the City of Prince George, British Columbia. The project was undertaken by DMD and Associates for BC Hydro, the local electrical utility, provider to determine the viability of this technology. For this project the STI Lumen IQ was retrofitted into existing and new cobra head street light housings (refer to Figure 3). The Lumen IQ system was designed to vary lighting output, monitor lamp depreciation, sense and report outages and measure power usage. A copy of the detailed report for the Prince George project can be found on the DMD web site at www.dmdeng.com. The purpose of this paper is to define some of the features of the system installed in the Prince George Project. The Lumen IQ, when implemented, allowed the light output of individual street lights to be varied at defined times of the night which reduced energy consumption. The street lighting control was provided from a central location over the Internet. Signals are sent from the Internet through wireless links to each luminaire. Figure 2 defines a basic overview of the system. Additionally, the product allowed owners to monitor performance of individual street lights, assess energy consumption and savings provided by dimming, perform data collection and provide improved maintenance through the use of their software that provides data analysis and information integration.

From the investigation other products are available which retrofit into street lights to allow for the variation of lighting levels. The projects which have been undertaken to date have focused on the STI product as a result of its many features. From the Prince George pilot project was found that the application of the STI Lumen IQ technology system provided a number of benefits to owners and the public. These benefits include significant energy conservation, reduction in obtrusive light during periods when the luminaires are dimmed, improved maintenance efficiency, electrical component protection for cycling luminaires, accurate measurement of power usage, and monitoring of equipment performance. Findings from the Prince George project were as follows: **Energy Savings -** The STI Lumen IQ technology provides up to a 40 percent reduction in energy consumption based on dimming. This has been verified through both independent laboratory and field testing. The Lumen IQ technology did not provide a 1:1 reduction in power consumption for a corresponding reduction in lumen output due to electrical losses of magnetic ballasts. **Percentage of Lumen** The Lumen IQ dimming technology allows for 60 steps of dimming at approximately 1 percent increments. This allows the unit to dim the street light from 100 percent of output (no dimming) to 31 percent of full output. Application of the Lumen IQ technology would allows the street light to operate at its maintained level for the entire maintenance cycle based on reduced power input and saving energy. To accomplish this, the Lumen IQ units are programmed to reduce the lamp lumen output when the lamp is new and as the lamp output depreciates over time the system increases the lumen output. The result being maintained lighting levels

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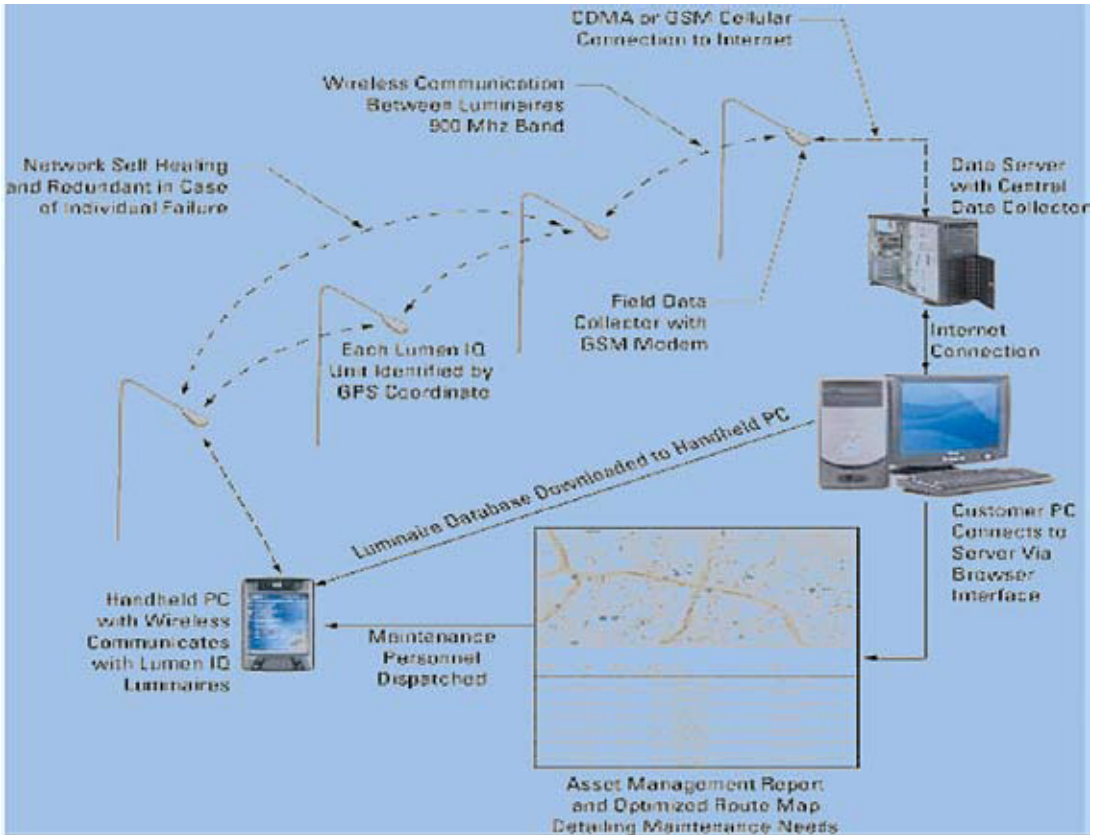

Figure 2 – Lumen IQ System
A) Microprocessor B) WiFi Interface C) Lamp Lumen Sensor D) Day/Night Sensor

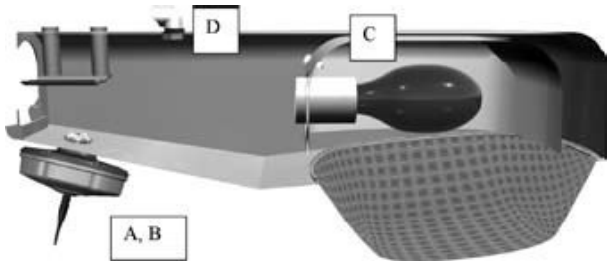

Figure 3 – Lumen IQ in Cobra Head Luminaire

Improved Maintenance Efficiency – Monitoring the operation and performance of individual street lights from a desktop computer for conditions requiring maintenance will allow owners to provide maintenance in a more efficient manner. Individual street lights that are inoperable for any reason (electrical supply problem, component failure, knockdown, etc.) is identifiable using the Lumen IQ technology. In addition, the integrated mapping software, using Microsoft MapPoint server, is able to provide routing for maintenance activities. Figure 4 – Maintenance Routing Map shows an example map. An owner's current process is typically driven by logging trouble complaints from the public which may take many man hours per day in a large city. The database software not only marks the location of the luminaire, it provides information regarding the fault and optimizes the best route for repairs. When maintenance personnel arrive at the trouble call site, the flashing LED on the bottom of the luminaire allows for easy identification in daylight, and through use of a handheld device the that contains maintenance and asset information, the maintenance personnel can switch the light on to observe its operation.

• **Electrical Component Protection for Cycling Luminaires -** A key feature of the STI Lumen IQ product is the ability for the individual unit to turn off a lamp that is experiencing cycling, reducing negative impacts on other components of the street light (ballast, capacitor, igniter, etc.). This feature is provided by internal algorithms built into the Lumen IQ microprocessor unit that sense the characteristic electrical feedback associated with cycling. If cycling is detected, the Lumen IQ unit turns off the street light, energizes a flashing LED indicator visible from the street, and transmits a flag to the server noting the state of the luminaire and that it has been shut off due to cycling.
• **Accurate Measurement of Power Usage -** Most street lights in North America are provided power on an un-metered (flat rate) basis, with power charges based on the hourly energy consumption of the devices for approximately 4100 hours of use per year. For un-mete red street lights, the STI Lumen IQ technology allowed for accurate measurement of power consumption regardless of the state of the street light (dimmed or undimmed). Once accepted by utilities as an accurate means to measure power consumption, owners will be billed for power actually used, taking full advantage of the energy saved. Use of this technology will end the shortcomings
• **Electrical Component Protection for Cycling Luminaires -** A key feature of the STI Lumen IQ product is the ability for the individual unit to turn off a lamp that is experiencing cycling, reducing negative impacts on other components of the street light (ballast, capacitor, igniter, etc.). This feature is provided by internal algorithms built into the Lumen IQ microprocessor unit that sense the characteristic electrical feedback associated with cycling. If cycling is detected, the Lumen IQ unit turns off the street light, energizes a flashing LED indicator visible from the street, and transmits a flag to the server noting the state of the luminaire and that it has been shut off due to cycling.
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• **Equipment Performance Data -** Because detailed records are kept with respect to individual street lights as measured by an accurate photoreceptor unit, and date-logged activities, the database of power use, lumen maintenance and other factors will serve as an accurate picture of the performance of luminaires, lamps and other components in the field. This information was not previously available and will allow them objectively compare the performance of products, track knockdowns and other maintenance problems, and provide for other analysis that may be specifically relevant to design, operations, and maintenance.

VICTORIA, British Columbia, October 5, 2006

– Streetlight Intelligence Inc. (STI, TSX-V: SLQ) today announced that it has granted stock options to purchase 500,000 common shares of STI to certain directors, senior officers and a consultant. The exercise price of these options is $1.55 per common share and they shall vest over a five (5) year period or upon achievement of certain established performance criteria. The options will expire on October 5, 2011.

Streetlight Intelligence Inc. is a public company listed on the TSX Venture Exchange (trading symbol: SLQ). STI designs, manufactures and markets products and services for the street light industry. STI's proprietary Lumen IQ™ technology allows street lights to be remotely turned on/off or dimmed at specified times, which results in significant energy savings and reductions in Greenhouse gas emissions and light pollution. The Lumen IQ™ network also immediately identifies malfunctioning street lights allowing substantial maintenance cost savings. For more information, access www.StreetlightIQ.com.

ITALIA

(Lighting control in street lighting – An overview of the state of the art in technology and application – **Authors**: Dr.Nguyen van Tien –Institute of Materials Science, VAST Hanoi, Vietnam Email: THANGLONGNEON@HN.VNN.VN
Mr.Yodsak Unhavaithaya –Meridian Technologies Co., Ldt
Dr.Nguyennang Dinh – Institute of Materials Science, VAST, Hanoi, Vietnam)

Location: city of Costello, Italia

The overall installed power	650KW
Type of controller: power reducer by chopping wave shape with built in time switch SEC St /QIR	
Manufacture:	Merloni-Progetti, Italia
Quantity of used controllers:	71 pieces
Annual working hours:	4200 h
Reduced rated working hours:	2270 h
Investment cost:	202,349.32 Euro
Annual energy saving %:	34, 9
Annual electricity cost saving:	74363.37 Euro
Pay back time:	2.7 years

THAILAND

(Lighting control in street lighting – An overview of the state of the art in technology and application – **Authors**: Dr.Nguyen van Tien –Institute of Materials Science, VAST Hanoi, Vietnam Email: THANGLONGNEON@HN.VNN.VN
Mr.Yodsak Unhavaithaya –Meridian Technologies Co., Ldt
Dr.Nguyennang Dinh – Institute of Materials Science, VAST, Hanoi, Vietnam)

Location:	Bangkok, Thailand
The overall installed power	3.320 KW
Type of controller:	bi-level ballast
Manufacture:	Meridian Technologies Co. Ltd
Quantity of used controllers:	40
Annual energy consumption KWh:	39,686
Reduced annual energy consumption KWh:	27,351
Investment cost Bth:	100,000.00
Annual energy saving KWh:	12,335
Annual energy saving %:	31
Annual electricity cost saving Bth:	30,838
Pay back time:	3.24 years

Conclusion from the above quoted case studies:
The lighting control system in street lighting allows to save up to 40 % energy cost and up to 50 % maintenance cost.

• For small city and town:
  - The bi-level ballast with built-in time-switch is cheapest solution for new installation.
  - The power reducer using transformers is most suitable solution to existing street lighting systems.
• For most developed cities:
  - the remote control technologies should be used

AUSTRIA

Green Light Graz - Modernization and saving energy at street lighting in the City of Graz - ***Graz Energy Agency, Austria***

Summary

In 2005, the Pilot Project "Green Light Graz I" (modernizing street lighting along the main traffic route Wienerstraße – Gürtel and other main streets) was started. 718 lamps in main streets were renewed and provided with state-of-the art technologies and control engineering. The Graz Energy Agency has taken over the whole project handling for contract management as an overall package by order of the City of Graz. As for technical implementation and financing, the Graz Energy Agency co-operates with Energy Graz. Together these two organizations guarantee the calculated energy savings! The costs are amortized by the savings. No additional investment costs accrue to the City of Graz. On April 26, 2006, the City of Graz was presented with the **Green Light Award 2006** in Frankfurt for its programme!

Context

At the moment street lighting in the City of Graz has approx. 24,000 lamps plus special illumination, such as on the Hauptplatz or over the Mursteg. These lamps are directly controlled by approx. 1,400 switch boards. The electricity costs (incl. energy fee and VAT) amount to about Euro 1.17 million a year. Many lighting installations are from the 1960's and are up to 40 years old. Therefore, there is a tremendous need for modernization! Big energy saving opportunities are offered by the use of up-to-date technologies – new highly efficient lighting equipment, new lamps with mirror technology and light regulation as well as control adjusted to the needs (reduction of power consumption over night). However, the funds required for putting all this into action have been missing up to now.

Process

In 2005, the Pilot Project "Green Light Graz I" (modernizing street lighting along the main traffic route Wienerstraße – Gürtel and other main streets) was started. 718 lamps in main streets were renewed and provided with state-of-the art technologies and control engineering.

- die cast aluminum lamp with the System of Protection IP66;
- no need for tools when opening and thus ease of replacing the lighting equipment;
- highly efficient reflector with a facet look;
- glass vessel made of safety glass;
- switching and reducing control for reducing power consumption over night

Financial resources and partners

In the course of this project, all the project costs (engineering, investment, management, controlling, etc.) are pre-financed and re-financed by the City of Graz paying a monthly contracting rate (energy cost budget). This means no investment costs accrue to the City of Graz.
Order value: 1.804, 174.-€ (gross)

Results - The energy savings

Lighting hours: 4161 hours
Power consumption before the measures: 905,766 kWh

Energy savings – guaranteed! 524,000 kWh (- 58 %)
Energy savings, actual: 533,100 kWh (- 59 %)
Savings of energy costs: 67, 200, - €/year
This means the guaranteed savings are even exceeded. The additional savings to the amount of € 2,000 - are for the benefit of the City of Graz.

Lessons learned and repeatability

It is true savings to a similar amount as at the first project can no longer be achieved. Nevertheless, the use of up-to-date technologies still offers significant economic energy saving opportunities. An estimate made by the Graz Energy Agency and Energy Graz shows that economic saving measures might be taken at about 15,000 light points. In addition to the use of efficient lamp and control technologies, such innovative measures as LED technology and solar lamps can be integrated. As for the considered light points, there is a saving potential of about 20%. This results in energy cost savings of approx. Euro 120,000. - a year for the City of Graz. Even in this case implementation using a Thermo profit Model could take place in such a way that the City of Graz can immediately profit from the savings and the budget is thus relieved.

DUBAI, MUSCAT, DAMMAN, RIDYAD, JEDDAH

Author: Thomas Beanziger

In all these cities are tested one or more management and control systems. In all cases multistep transformer based system not using triacs showed the best performance. In all cases energy savings of 30 – 40 % were achieved. The software platform was the deciding factor for choosing the lighting system in all installations. In the cities the trial phase has concluded in the installation of large size control and management systems for the public lighting network.

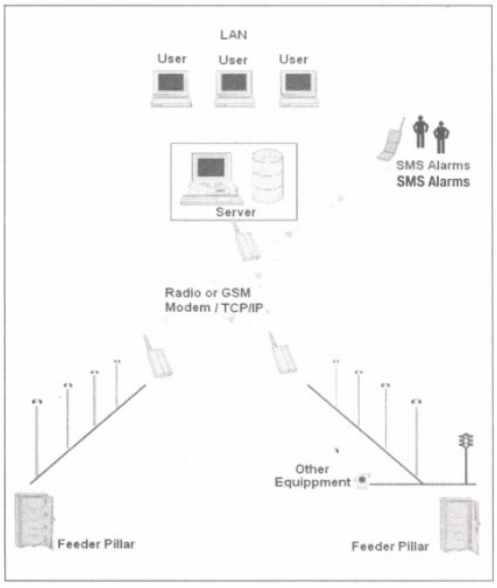

Fig. 1. The management system, GSM / GPRS or TCP/IP is used for communications between the FP and the central computer

The information is prepared by:

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