Project Report

Intelligent Road and Street lighting in Europe

E-street

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

And supported by:

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1 EXECUTIVE SUMMARY

The Project Report will give an introduction into the work of the E-Street Project. The project is supported by the EU-IEE Save programme and has been carried out for the period of 30 months from January 2006 until July 2008.

The partners, 13 organisations from 12 European countries are all presently involved with street lighting. The outstanding expertise of the team was utilized into a very successful work performed all over Europe.

The main objective of the projects where defined into seven main work packages:
1. Generally increase the market for intelligent street lighting/management
2. Describe and document the market potentials and energy savings
3. Demonstrate the technology by initiating new installations
4. Introduce adaptive lighting into international standards and guidelines
5. Develop administrative tools and identify customers needs
6. Develop financial schemes adequate for intelligent street lighting
7. Dissemination activities

Intelligent street lighting

The phrase “Intelligent street lighting” includes a total system with dimmable luminaires, advanced lighting control solutions, communication systems and administrative tools. The solution focuses on low energy consumption and high functional standard. It also, in most contexts, automatically declines the maintenance costs for the operator in combination with increased safety for the street user.

In most cases Intelligent street lighting in its practical design is identical to “Adaptive lighting”. Anyway one should distinguish between the two descriptions, remembering that Adaptive lighting only describes the performance of the light on the road, while Intelligent streetlighting also includes the more operational elements, back office software solutions and both energy and labour cost saving potentials.

Streets or roads equipped with such a solution will dynamically adapt the street lighting performance according to the actual needs for the given period/time of the road. Typically it will lead to lowered lumen output from the lamp during good conditions, when low traffic volumes or low average speed appears in combination with non-foggy weather. This will also be the case if the surface is covered with snow.

Market potential

The market for intelligent streetlighting is huge. Based on the existing installations within Europe, the project have identified an annual saving potential of 38 TWh electricity by retrofit old installations with adaptive lighting. 38 TWh saved electricity represents as much as 63.7% of present annual consumption for streetlighting purposes within the community.

Outcome of the project - highlights
– During the project period more than 20,000 intelligent street lights has been initiated and installed by partners
– Under the International Commission on Illumination, CIE, a new standard is developed taking into account adaptive streetlighting
– An administrative tool for handling adaptive lighting is set into operation in Oslo
– The energy performance contract (EPC) model is modified for streetlighting purposes. A calculation model is developed.
– The project partners has performed a high number of seminars, workshops and presented papers at several international events
The project clearly identifies Intelligent streetlighting not only as an “up and coming” technology but rather as a proven technology in many market segments. The high number of reported new projects clearly states this observation.

With energy saving potentials between 50-70% combined with today’s high energy prices, the market is expected to increase rapidly over the coming years. This again will lead to a need for more education of a significant numbers of market players as well as decision makers to prevent negative feedback after commissioning of projects due to lack of skills.

As a partner in E-street project Philips has delivered a majority of luminaires of the 30,000 units in Denmark. Selc(Ireland), as ballast manufacturer have provided the City of Oslo with more than 7000 dimmable ballasts. Echelon has also delivered communication solutions for a high number of installations, incl. Oslo, Gothenburg and Warsaw.

The partners of Prague (Eltodo) and Ljubljana (Javna) have by themselves installed intelligent solutions for larger parts of their home cities, while IB (Germany), BSERC(Bulgaria) and Ageneal (Portugal) all have facilitated supporting schemes for their regions.

The consultants SITO(Finland) have made several specifications on behalf of their governmental street authorities, including one of the new highways into Helsinki. In addition Sito have performed hard work within several standardisation organisations.

Hafslund (also Coordinantor) have initiated and installed new hardware and software technology solutions in the region of Oslo.

**Partners**

| Hafslund Nett AS (coordinator) | Norway |
| City of Oslo | Norway |
| Agência Municipal de Energia de Almada | Portugal |
| Black Sea Regional Energy Centre | Bulgaria |
| City of Gothenburg | Sweden |
| Javna Razsvetljava d.d | Slovenia |
| Invesitionsbank Schleswig-Holstein | Germany |
| Philips Lys A/S | Denmark |
| Eltodo EG | Czech Republic |
| Krajowa Agencja Poszanowania Energii S.A | Poland |
| Selc Eireann Teorante/Selc Ireland Limited | Ireland |
| Echelon BV | The Netherlands |
| SITO Oy | Finland |

**Work packages**

The work is performed under several work packages as defined in the project description. The work packages have reported their activities in several reports, all available at the project web-site. The structure of the work has been as listed below:

WP 1 Report on administrative matters
WP 2 Market Assessment and Review of energy savings
WP 3 Evaluation report on Market penetration and procurement activities
WP 4 Report on Provoke a faster development of legislation, standards and guidelines
WP 5 Report on Administrative tools and data handling, ”customers need”
WP 6 Comprehensive report on financial instruments
WP 7 Report on dissemination and replication of success
WP 8 Report on specific notes/discussions/conferences etc.
1.1 Outcome – Highlights

The main outcome of the project may be highlighted into four main results as outlined below. Hopefully, and in line with the strategy of the project, the really MAIN result will only be seen in the future, when the market for intelligent streetlighting starts to increase dramatically. Then the expert input to the industry, the developed standards, the financial schemes and “marketing” effort will be judged as valuable contribution to the development within the field.

1.1.1 20,000 Intelligent streetlights

During the project period more than 20,000 intelligent street lights has been initiated and installed by partners. This is in fact a clear message to the market on the advantages of the intelligent solutions. The partners have within their own organisation initiated and performed investments in the technology to both demonstrate the savings potential, but also, and this is even more important based on the short pay back period on the investment.

In cities such as Prague, the renovation of the streetlights now is directly linked to intelligent solutions. In Ljubljana, new installations are on its way, in Warsaw one of the main streets will be renovated based on the experience gained from several pilot projects. In Denmark, a semi intelligent system now is up and running in the capital, counting 30,000 units. The list of activities can be enlarged for all of the participating partner countries.

Also in the so called “low cost regions” also the new technology is profitable due to extremely high present costs for renovating projects. Typically 400 W units, due to bad lamp and reflector performance, easily can be replaced with 150 W, and even in some cases down to 100 W for new installations without illumination levels reduced.

1.1.2 Adaptive lighting in Standards

Under the International Commission on Illumination, CIE, a new standard is developed taking into account adaptive streetlighting. This is a direct result of the involvement of the E-street partners. Based on findings, experiences and discussions within the project, the results are transformed into the wording of the standardisation world. Professionally guided by the Sito representative, the worked based on consensus among technical committee experts have resulted in new guidelines. These guidelines quite often reappear as “standards” in national settings.

Based on findings within the project consortium it was possible to define the most important factors for energy efficient solutions, and their connection to the technical guidelines. Hence, the development of a new weighting factor system for the individual parameters was developed. The information was merged into at new table as design criteria for the lighting installation, not only static (construction design) but also dynamic depending on the actual status on the road surface.

The result is developed in the revision of the CIE 115 document; “LIGHTING OF ROADS FOR MOTOR AND PEDESTRIAN TRAFFIC”

1.1.3 Administrative tools

An administrative tool for handling adaptive lighting is set into operation during the project period. Introducing dynamic lighting also leads to a more complex management of the system. In contradiction to the old “on/off” technology, the dynamic streetlighting require more sophisticated operational input parameters. Hence also giving the operator the possibility to really manage and monitor the performance. When the system reaches a larger scale, this is no longer a manual job, but should be left to data
processing systems. The project defined the most important aspects, parameters and valuable output from the system. The first full scale administrative tool was set into operation in Oslo during the project.

1.1.4 Financing schemes and models

The energy performance contract (EPC) model is modified for streetlighting purposes. A calculation model is developed. Based on previous experience from other TPF markets, the Berliner Energie Agentur was subcontracted for the work. Together with Investitionsbank Schleswig-Holstein, who has a lot of experience with the financing of energy efficient investments in their region, the project developed an adapted contract model for public lighting based on intelligent streetlight solutions.

The contract model incorporates the “baseline” and relevant contract model into a complete package of “turn key solution” for the investor. Beside the contract the WP also developed a calculation model for refurbishment projects. The model calculates both the investment, the cost savings and financing costs incurred and outlines the cash flow analysis of the tentative project.

One of the main obstacles for renovating public lighting is lack of financial recourses among public street light holders. With the EPC model, independent investors can sign up for a contract over a given time period.

1.1.5 Dissemination activities

The project partners has performed a high number of seminars, workshops and presented papers at several international events.

The dissemination activities have been focused on 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 solutions. Further, by communicating to the market players the customers needs, accelerate more cost effective solutions and administrative tools for optimal design and operation of the intelligent street lighting. The project also wanted to test new financial instruments within street lighting such as Energy performance contracting and third party financing.

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 to other street light holders around Europe have been essential.

The main elements of the dissemination activities have been:
- Meetings with stake holders
- Dedicated seminars
- Presentations at conferences
- Web-pages
- Supporting documents

Meetings with stake holders

The E-street partners have been active in arranging small scale meetings with the industry in particular, but also with street light holders and universities. By disseminate our findings, the customers need and the prosperous environmental and energy (cost) savings to the audience, the industry develop improved solutions, a larger number of manufacturers now can supply the market and a growing number of cities and towns distributes tenders providing intelligent solutions.

Via the standardisation activities, also the universities and consultancies have been given valuable information.
Dedicated seminars
Beside “normal” market activities performed by the manufacturing partners, the rest of the partners have held and participated in strategic seminars. This includes seminars with governmental street authorities, street light operators, municipalities and regions, manufacturing industry and lighting business in general.

The E-street Forum also performed several meetings all over Europe, inviting dedicated local personnel. The Forum will continue its work after the termination of this project.

Presentations at conferences
Dedicated selections of conferences have hosted presentations from the E-street project. Conferences such as LuxEuropa (2007), LonMark (2006 and 2008), ECEEE (2007) and CIE mid term(2006) and Main session (2007) have opened up their floors for E-street presentations. Also regional conferences such as Balkan Light (2008), Light 2007 (Bulgaria) and “Nordlys” (Nordic light conference, Helsinki, 2008) have had E-street on the agenda.

Web-pages
gives a short introduction to the project as well as Intelligent street lighting in general. At the web-pages all the developed documents over the project period is downloadable.

Supporting documents
The project also has developed several brochures and leaflets. The “Guide for energy efficient street lighting installations” gives a brief introduction to almost all aspects of intelligent streetlighting, inclusive general design guidance. Also additional guides in national languages are available via the E-streetlight web.
2 MARKET ASSESSMENT AND REVIEW OF ENERGY SAVINGS

2.1 Introduction

Telemanagement is all about Market Assessment and Review of Energy Savings for outdoor lighting systems. In this document I have provided an overview of what we think is a realistic estimate of the energy savings that can be accomplished in Outdoor Lighting Systems by implementing new technologies available to us today. We have also described the additional benefits that implementing new telemanagement systems bring on top of the energy savings. In calculating the total savings potential for Europe we had multiple discussions on the total number of outdoor lights in Europe since this number is an estimate. Other estimates in the energy calculation are the divisions in lamp type and mix of installed base in luminaires since this information is not available. Using the experience of the E-street members and the market data from lamp and ballast manufacturers I believe these estimates are accurate.

The second part of the report deals with the environmental aspects of outdoor lighting and the positive impact that replacing older systems by new manageable systems can have on the environment. This is a non-quantitative description of the subject. Dimming and using better luminaires are discussed as well as the positive impact that removing hazardous chemicals has on the environment. An interesting contribution to this subject is about the increase of safety by managing outdoor light.

Legislation is different per country but there are some common denominators that are used throughout the entire EU. They are listed in a separate chapter. Per item there is a short description given on the subject of the legislation and how it impacts management of outdoor lighting.

The market blueprint in this report gives an overview of the different types of players in this market and the solutions offered by them. It discusses the various roles of the companies involved and explains their interest in this market. As part of this chapter we have assessed the changes that will take place in this market and the new players that will enter because of the developments that are taking place.

Last but not least, as in any initiative, there are barriers to overcome and this chapter defines the ones we found. An interesting part in this chapter, is about the lack of knowledge and the advice given to overcome these barriers.

The report is also based on the contributions of the E-street participants and the knowledge we collectively have about (managed) outdoor lighting. The possibilities that exist today are implemented in a growing number of installations both on highways as well as in cities. Telemanagement of outdoor lighting gives us a significant opportunity to save energy and decrease the environmental impact outdoor light has on our environment.

2.2 Market Blueprint

The street light market like any other market consists of three basic entities that interact to find common solutions to problems in outdoor lighting. The three basic entities are the providers of equipment and services on the offering side, the private and governmental users on the demand side and third the group of influencers in associations and other working structures. The scope of this part of the document is to give an overview and insight in the offering side of the Outdoor Lighting market in a dynamic outdoor lighting system. The current situation is described as well as the changes that can be expected by the implementation of E-street systems.
2.2.1 Equipment and service providers

On the offering side we see that the market is divided in equipment and service providers that all provide parts of the solutions that complement each other to a full working Dynamic Street System. In all cases service providers use the equipment from multiple vendors to build a complete solution. No manufacturer in the industry that we know of today delivers a total solution except for Philips and SELC. The key players in the market are roughly connected to the key components of a dynamic outdoor lighting system.

Apart from the pole a dynamic outdoor lighting system consists of:

- Luminaires that hold the fitting the lamp and in some cases the electronics
- The lighting electronics or ballasts that keep the lamps burning
- The lamp manufacturers
- The controls that drive and switch the ballasts and the network between the controls electronics and segment controllers in the power supply cabinet
- The segment controllers in the power supply cabinet that handle and manage a segment of outdoor lights
- The wide area network that provides the communications between de segment controllers and the back office or central control system
- The central control system that allows for the management of all poles
- The existing IT infrastructure that every company has that needs information from the street light system

To get all of this to function as a logical system in almost all cases end-users ask consultants to help them define and specify the system that suits their needs. Often times these consultants also play a crucial role in the whole procurement and installation process. Even in the operational phase they monitor performance and advice for improvement.

Because of the complexity of the system and the use of IT technology we see that apart from the physical installation there is a new group of companies evolving into this market that we call “IT integrators” that approach the systems from the networking and IT part of the world.

2.2.2 Luminaire manufacturers

There is a fast plethora of luminaire manufacturers. Hundreds of companies make luminaires for various applications in Outdoor Lighting. Depending on the application it is often possible to find a luminaires manufacturer specializing in a certain field:

- heavy industry
- train stations
- tunnel lighting
- parking
- harbor
- signaling
- sports facilities
- parking lots
- parks
- airports
- railway crossings

Looking at “regular” street lighting luminaires manufacturers that operate on a European scale there are four companies dominating this market. Thorn, Schreder, Philips and Siteco claim
they produce more than 80% of all luminaires use in street lighting in Europe. In every country there are one or two manufacturers that have a significant local market share but do not work on a European scale.

Luminaires manufacturers are typically mechanical engineering companies. They specialize in molding, folding, and assembling non electronic equipment. The ballast and lamps are bought from different vendors usually on end user specification. The luminaires manufacturers normally use a wholesale channel or direct sales teams per country to approach end-users.

Telemangement, networking and electronics are normally not part of the luminaires manufacturer’s scope of delivery and they do not have the sales channel to sell it. Philips forms the exception to the rule since they employ their own controls department focusing on telemangement solutions for indoor and outdoor. In their normal market approach to telemangement there is certain reluctance since it could slow down the selling process and requires specific knowledge. Interestingly enough the last few years a shift can be seen towards a more open focus towards telemangement.

**Lighting Electronics Manufacturers**

The electronics that regulate the power to the lamp and earlier in this report referred to as ballast are produced by the Lighting Electronics manufacturers. Also here there are numerous larger and smaller companies active in the market of building these electronics. Philips, Zumtobel, MagnaTek and Siemens/Osram are the key European players in this market. Also here there are various local players that often produce very innovative products or high quality products for special purposes. Selc is a good example of such a company.

The use of fluorescent light is seen more and more in city lighting applications. However the main focus for street light today is on the HID side. Basically ballast manufacturers produce two types of ballasts:

- Magnetic HID ballasts for mercury, metal halide and high and low pressure sodium lamps.
- Electronic HID ballasts bring significant performance enhancements to every aspect of HID lighting systems, with greater energy efficiency, more consistent lamp color and maximized lumen maintenance and lamp life.

All ballast manufacturers produce both types of ballasts. There are various dimming ballasts but roughly there are two categories. The self dimming ballast is one that can be set once and then at fixed (moving) times it dims and switches itself. Second there are the controllable ballasts that expect an external signal to switch or set a dim level as described in the telemanagement section of this report.

The ballast manufacturers that have telemangement systems all produce a separate box that controls their ballast or rely on third parties to do that. The communications between the luminaries and the segment controller is not one of their competence areas and they all buy networking chips or ready made solutions from third parties. Today Powerline communication is becoming the leading edge technology to establish this part of the network although there are some manufacturers working with RF solutions. LonWorks today is the most reliable and widely use Powerline technology with over 30 million installed nodes. It is also the only formally standardized technology under ANSI (ANSI 709.2).

Ballast manufacturers do not have the channel to build and support complete solutions so they stop by offering components to the luminaires manufacturers.
Lamp Manufacturers
The lamp manufacturers that dominate the market are Philips and Osram in Europe. They produce all sorts of HID and fluorescent lamps that are used on Outdoor Lighting. Lamp manufacturers have a vested interest in making their lamps more energy efficient. Although in the end it is not in their interest to make lamps that last longer when dimmed they are more and more trying to anticipate on this development.

The lamp manufacturer that is most innovative in bringing a lamp that works well in a dimming environment in combination with controllable ballasts has the best cards for telemanagement solution. A key point here is the warranty given by these manufacturers on the lamp once it is dimmed.

Today there are no lamp manufacturers apart from Philips in Europe that have telemanagement systems available It is not their business to produce electronics and software.

2.2.3 The Controls and networking market
The controls that drive the ballasts in a telemanagement system have been briefly touched on in the ballast section. Today there are two basic ways to communicate between luminaires and the power supply cabinet where the segment controller is built in PLC (or power line communications) and RF (or radio frequency).

The use of RF is in some instances implemented but with limited success. The huge amount (growing fast) of cellular phones, hotspots and wifi routers and the fact that due to regulation RF is more or less bound to use the same frequencies makes it a challenge to build a working RF solution. Therefore it will take time for the producers of RF components and equipment to become a player in the outdoor lighting market.

The common way to communicate in Street Lighting is by using the existing power cables between the luminaire and the power supply cabinet. The way this Powerline communications is done is by using transceivers (little modems) that put the signal on the Powerline. There are several vendors of this type of technology known and they are all trying to enter this market. Echelon builds components for the ANSI 709.2 standard Powerline communication and with close to 30 million units installed in the field is the most experienced player in this market today.

The key question is what does one need to look for in a power line communication solution and how to choose the solution provider? In the case of power line transceivers, a side-by-side analysis of product specifications may not yield much information about their reliability. Two transceivers with the exact same specifications may have completely different performance characteristics. The only meaningful and effective method of evaluating a power line transceiver is by actually testing its performance in the target environment. Therefore it is important to have background on Powerline communication.

Nevertheless, there are a few key characteristics that one should look for:

1. Total number of components required for a complete communication device and the total cost associated with it. One must also factor in the need for external microcontrollers, memory, filters, or amplifiers. The cost of implementing the appropriate power supply is also a very important factor to take into account when evaluating various power line solutions.

2. The frequency spectrum it uses for communication and its compliance with regulations. This is particularly important to ensure a common networking platform that you could develop and implement in products you ship worldwide. Europe has very stringent regulations in place for power line communications, while other countries in North America, Asia, Africa and Australia are pursuing similar restrictions. Note: In Europe, power line signaling must be confined to the 9kHz - 148.5kHz frequency range. This spectrum is further divided in to "bands" and allocated for specific applications, as
follows:
· A-band: 9-95 kHz for electricity suppliers
· B-band: 95-125 kHz for consumer use without protocols
· C-band: 125-140 kHz for consumer use with the CENELEC protocol
· D-band: 140-148.5 kHz for consumer use without protocols
· Above 148.5 kHz: power line communications prohibited

Using the C-band (with the CENELEC protocol) for communication ensures that only one device communicates at a time thereby minimizing collisions and improving communication reliability. The B and D-bands, although legal for communication, are more prone to collisions and interference from other solutions operating in this band.

These bands are more suitable as alternate / secondary communication bands that may be used when the C-band is blocked by noise.

The CENELEC protocol already implemented in Echelon's power line transceivers, eliminating the need for users to develop the complex timing and access algorithms mandated under CENELEC EN50065-1. The most stable solution at this moment is ANSI 709.2 (LonWorks) Powerline communications.

3. Communication performance in the presence of the "noisy" appliances such as low-voltage halogen lamps, computers, printers, fax machines, hairdryers, etcetera. Note that some television sets induce very high levels of signal distortion that could make it impossible for some receivers to decode the transmitted signal.

4. Requirement for "conditioning circuitry" or other wiring modifications that would require the services of a professional electrician and therefore add costs. This includes:
   - Phase couplers required by some solutions to ensure communication between sockets on different phases in a home with multiple phases.
   - Wiring modifications to support "switched-leg" circuits. A "switched-leg" circuit is a common wiring architecture used to wire lamp switches in many parts of the world including the US, Australia, New Zealand, etcetera.

5. Availability of easy-to-use tools for testing the performance of the transceiver in the target environment prior to investing in any development effort.

6. Availability of comprehensive support documentation that describes in detail every stage of the design-in process including recommendations on system architecture, power supplies, and coupling circuit design.

7. The types of applications and the number of actual deployments (not pilot projects) in the field using the technology.

So in summary there are two basic technologies that are used in PLC. Spread spectrum and narrow band noise filtering. With the current CENELEC rules a regulations it is hard to use the spread spectrum technology reliably in such a way that it is also compliant with the CENELEC. The reason being that CENELEC only allows for limited "spread". The ANSI 709.2 narrow band solution from Echelon today is allowed in all parts of the world and works within the European CENELEC EN50065-1 standard.

2.2.4 WAN providers

The second part of the network is the connection between the segment controller and the central management system. The protocol of choice for this part of the communications is IP.

For this part of the communication it is possible to use:
- ADSL (broadband internet connections) over fixed lines or wireless
- POTS/ISDN (analog or digital telephone lines with regular modems)
- GSM/GPRS/UMTS
ADSL provides a fast way to communicate with relatively easy installation. The down side is that it requires the infrastructure to be present either in cabling or in wireless form. In many instances GPRS is the technology of choice for the WAN communication when there is no wire available.

This group of market players is relatively new in the market of Street Light and they have limited experience today. The good news is that they have a lot of experience in providing service for M2M communications in general and that is actually identical to street light.

Service Providers are locked in a highly competitive battle for IP services revenue, with enterprises demanding increasingly stringent Service Level Agreements (SLAs) that are specifically needed in Outdoor Light applications. Yet, while production IP services have matured, operations groups still struggle to achieve the level of predictable reliability expected by customers who depend on IP service offerings for their mission-critical WAN infrastructure. This is the reason that it is very important that the telemanagement system is distributed and can operate on a per segment basis.

New solutions are underway but it will take time to get these implemented.

2.2.5 IT companies

It goes without saying that whenever there are computers and software involved like at the central management level for telemanagement there are IT companies that play an important role. Today there are three types of companies interesting to the Outdoor Lighting Market:

- Network integrators
- Software developers
- IT integrators

In the following there is a brief description of these market parties.

**Network Integrators**

These companies usually know a lot about device networking and the implementation and commissioning of the automation part of the outdoor lighting system on the street side as well as on the WAN side.

The implementation of an outdoor lighting system requires planning both for the lighting and for the network part of the system. When Powerline communication is deployed a key success factor for the Telemanagement system is the communication between the luminaire and the segment controller. Powerline analysis and network design are very important in this phase.

Network Integrators have the skills necessary to specify and implement control systems based on the technology used. These integrators have also made Open Systems a fundamental part of their delivery strategy and provide proven solutions that incorporate the best breed of products.

The WAN communication part is also important to look for as a skill set for these companies. Load balancing in the network as well as the whole WAN design and network management is important to the success of the system.

**Software developers**

Telemanagement systems require software on the Outdoor Luminaire Controller level on the segment controller level (firmware) as well as on the PC level. The key in finding the right software partners is to see if open technologies are used for their software. IP SOAP/XML and SQL are all well known abbreviations in this market.
In many cases the smaller more innovative software companies start development for software to be used in new markets. Over time when the market grows the larger players start to build software for Telemanagement as well. Due to the fast development in the technologies used for IP based applications it is hardly ever seen that a large traditional player in the market will develop their own software.

**System integrators**

When it comes to integrating existing enterprise applications like billing, work order management and maintenance systems with the outdoor lighting system usually a systems integrator is involved.

In general these companies competences are in the areas of systems design, database design and customer software development. Because this type of integration affects the primary business processes often times large corporations are doing this work.

### 2.2.6 Consultants

To be able to design and implement a full scale telemanagement system it is advisable to ask for the help of a consultant. The consultant needs to be organized in such a way they can ensure that there are close ties between experts working within the different technical fields. Because of the complexity and the diversity of a telemanagement system and the many disciplines it touches as described above this is not an easy task.

Larger consulting companies usually have such a structure in place.

### 2.2.7 Service providers

The management, operation and maintenance of the outdoor lighting system is outsourced to special companies in many instances. In a number of cases these companies are part of electrical utilities but there are examples of private companies that do this as well.

The public owners of street lighting systems have the duty to keep the systems in order to ensure road safety and to fulfil the other functions of public lighting. The lack of public budget has led to a stagnation of investment in energy efficiency of the public street lighting. Now there is a critical situation with regard to high operating costs and large refurbishment necessities without public funding possibilities.

There is a “drive” towards cost reductions and outsourcing of these services and such Public-Private-Partnership (PPP) models like Contracting and especially Performance Contracting can be successful. The number of service providers offering these contracting options is growing fast.

A short study is available “Status quo on Street Lighting Contracting in Europe (Draft of the short study)” from Berlin Energy Agency.

### 2.2.8 Influencers

A in any market there is large number of influences in this market as well. It is impossible to list them all but some key players need to be mentioned.

Apart from many local bodies and organizations some organizations on a European level influence this market.
International Commission on Illumination CIE
As its name implies, the International Commission on Illumination - abbreviated as CIE from its French title Commission Internationale de l'Eclairage - is an organization devoted to international cooperation and exchange of information among its member countries on all matters relating to the science and art of lighting.

The CIE is a technical, scientific and cultural, non-profit autonomous organization. It has grown out of the interests of individuals working in illumination.

Since its inception 90 years ago, the CIE has become a professional organization and has been accepted as representing the best authority on the subject and as such is recognized by ISO as an international standardization body.

Within the CIE the work group TC 4-44 Management and Maintenance of Road Lighting has the task to revise Publication CIE 115-1995 in such a way that lighting performance requirements may vary depending on actual status of environmental and traffic conditions. The CIE 115-1995 RECOMMENDATIONS FOR THE LIGHTING OF ROADS FOR MOTOR AND PEDESTRIAN TRAFFIC is an earlier document about road lighting.

CELMA
CELMA is a Federation established for an unlimited period, representing 16 National Manufacturers Associations for Luminaires and Electro technical Components for Luminaires. CELMA members’ Associations are representing some 1150 companies in the Luminaires and Electro technical Components for Luminaires industries in 11 European countries. These 1150 producers, which include a majority of small and medium-sized companies, directly employ more than 52,000 people and generate around 10 billion Euro annually.

CELMA acts as a Body of contact, co-ordination, representation and assistance for the National Associations, Federations and Organizations in the EU manufacturing of Luminaires and electro technical components for the Luminaires Industry. The scope and objectives of CELMA are to study all matters of common interest, with particular emphasis on their scientific, educational, legal and institutional aspects and provides policies such as contact, co-ordination, representation and assistance for European and national associations, federations and organizations in the EU involved in the manufacture of Luminaires and electro technical components for the Luminaires Industry.

Intelligent Energy – Europe (IEE)
IEE is a main means of converting EU policy for smart energy use and more renewables into action on the ground, addressing today’s energy challenges and promoting business opportunities and new technologies.

IEE supports European projects, one-off events and the setting up of local/regional energy agencies with a total budget of €250 million, covering up to 50% of the costs.

The program currently supports more than 200 international projects, 30+ local/regional energy management agencies, and almost 40 European events in the areas of

- new and renewable energy sources
- energy efficiency, notably in buildings and industry
- energy aspects of transport
- co-operation with developing countries

The E-street initiative is one of the project support by the IEE. This working group will have a lot of impact on the deployment of Telemanagement because it will document and research many questions that exist about this way of saving energy today.
2.3 Documentation of Energy Savings

Street lighting in Europe today is a mix of technologies that have been available in the market for the last 30 - 40 years. Needless to say that in most of the earlier technologies the energy efficiency was not considered a design goal. The development in lamps, ballasts and luminaires over the last years have focused around the efficiency of these critical items in an outdoor light system and as described in this chapter already give significant saving opportunities. Existing installations are a mix of new and old technologies. We estimated the ratio of this mix based on the market input from major lamp and ballast producers and the market data that exists.

Over the last years new technology has been developed and implemented in multiple systems that can help to save even more energy; telemanagement. Networking and automation technology allows for the adjustment of light levels to the exact need to keep the roads safe based on weather conditions, traffic density and other external factors. Telemanagement systems also account for significant savings in maintenance and increased safety because they instantly report failures in the system. In this chapter we have taken this information into account.

LED lighting also has great potential to help save energy in outdoor lighting. However the technology is still in the development phase and there is relatively very little experience with it at the moment. We wrote this report to document what we know today about outdoor lighting technology that can be deployed today. For this reason we have not incorporated the opportunity that other light sources (e.g LED) will lower the energy consumption even further in the future.

2.3.1 Estimate of the energy used for street lighting in Europe today

Below is a best estimate of the total energy consumption in Outdoor Light for Europe. The assumption is that we have 725 million people living in Europe including the Russian republic and Turkey.

The number is calculated based on the best estimates we can execute, given the current information available to us.

The number of light points

First of all we calculated a best estimate of the total number of outdoor light points (not on private housing) that can potentially be improved by replacing parts of the system or by upgrading the total system to use new energy efficient technology and telemanagement.

The number of light points has been estimated based on luminaires market data available from various large companies in the industry. The data from specific countries indicate a relation between the number of inhabitants and number of light points for street and road lighting. The most accurate data came from Germany where the total number of outdoor light points is known. The total number for Europe has been recalculated based on information from various E-street members.

For each 9 inhabitants we find there is 1 light point on average. The example from Germany shows 82 million inhabitants and approximately 9 million street light luminaires installed. Based on the information from other countries this is found to be a high number to apply to all of Europe since other countries (and cities) show lower numbers of luminaires per person.

Weighing all information available we estimate for Europe, with 820 million inhabitants, that the total number of outdoor light points is 91 million.
The average installed wattage
The wattage used in road and street lighting varies typically between 50 and 400 Watt. Based on the market and production data we have from a large lamp manufacturer we know that a smaller number of countries in Europe traditionally have high output wattage levels and the rest uses an average or lower level.

Estimate and vendor assessment of the total market for relevant lamp types and wattages indicates that the average wattage for lamps used in road and street lighting is 180 Watt. This number includes the losses in the ballast.

Average burning hours per year
Burning hours vary because of the geographical natural light situation. Interestingly enough we find that on average the calculations used do not show significant changes between northern and southern European countries. Normal calculation of burning hours without dimming and switching on/off based on the remaining daylight level is 4150 hours per year on average throughout Europe.

All calculations for Dynamic Outdoor Lighting System in this report are based on this average of 4150 burning hours per year.

Average burning level
The most important issue when applying dimming in a dynamic outdoor lighting system is the fact that the safety needs to be guaranteed. The influence on the safety on the road is hard to quantify because it consists of accident prevention as well as crime prevention. There is legislation on various levels per city, per country and on a European level that in many cases is based on a non-dimming situation. Currently the CIE is working on a proposal for new legislation taking the possibilities to calculate safe light levels based on weather conditions, traffic density and hours of the day. This is not yet ready and cannot be used as part of this report.

Saving as much energy as possible, means switching off and dimming light levels when ever possible. One has to make sure that this is in accordance with the regulations. At all times it needs to be possible to go to a full 100% situation if the circumstance requires this. In some recent installations switching of every second luminaire or dimming when there is low traffic density is already installed but the number of installations where this is deployed today is so small that in this report we assume it does not significantly influence the current energy usage. We have therefore decided not to use a modifying factor for this type of savings measures in our calculation.

Outdoor Lighting energy consumption in Europe
Based on the estimates we discussed the total energy consumption for street and highway lighting in Europe can be calculated as follows:

\[
80 \text{ million light points} \times 180 \text{ W lamp wattage} \times 4150 \text{ burning hours per year}:
\]

\[
59.760.000.000.000 \text{ Watt hours} = 59,760 \text{ TWh per Year}
\]
2.3.2 Overview of energy savings possibilities per system part

An outdoor lighting system consists of various parts that could contribute to energy savings when replaced by products that improve the energy efficiency. Below is a description of the various single opportunities that exist and can be deployed today.

In existing street light systems it is also wise to see if improvement can be reached by renovating the power supply system. Other things that can influence the efficiency e.g. cabling, transformer, or the load division across the phases are not within the scope of this report and will not be discussed.

When replacing components in the outdoor lighting system it is wise to look at the overall solution. Dimming luminaires for example influences spacing as uniformity.

Lamps
Over the years the efficiency of lamps has improved significant. In this paragraph we describe the various lamp types available today. Based on market data the estimated mix of existing lamp types is covered.

The most common lamp types used for street and road lighting:

**High-pressure mercury vapor lamp**
High-pressure mercury lamps are one of the most common types used in outdoor lighting, first used in the early 1960’s. This lamp is very inexpensive and lasts around three years. It has a good voltage “tolerance” and burns universally. It is extremely energy in-efficient and contains mercury. Mercury lamps provide white light.

**Low-pressure Sodium**
This lamp type is commonly used in the BENELUX and the UK. The first installations with this lamp date as far back as the early 1930’s. It is very energy efficient, lasts for around three years and contains no mercury. There are various disadvantages with this lamp. There is no color rendering which lowers the distinctive capacity for the road user. It is rather large in size what causes a lot of the light to be wasted because it is hard to focus it. The lamp has a long run-up time what means it needs to be switched on earlier than necessary. Low-pressure Sodium lamps provide a monochrome orange light.

**High-pressure Sodium**
This lamp is very energy efficient and lasts up to four years. The lamp is optically efficient but shows a long run-up time. It has limited color rendering and does not allow for retro-fitting. In some version of the lamp mercury is used. High-pressure Sodium lamps provide an orange/yellow colored light.

**Metal halide**
Metal halide lamps are based on the latest technology and trends in street lighting. They are very energy efficient and provide a high quality white light. There are various types of metal halide lamps suitable for street lighting including the CDO-TT and CosmoPolis lamps. With CosmoPolis the miniaturization of the lamp and the gear has made it possible to use smaller luminaries with better optics that allow for bigger spacing. The total cost of ownership is low because of the long life time. These lamp types offer significant environmental advantages because of very low mercury levels and the energy efficiency.
Energy saving based on lamps
At present approximately one third of the European roads and motorways are lit using energy in-efficient 1960's technology with mercury vapor lamps. These lamps consume a relatively large amount of electricity during their lifetime with limited efficiency. In addition they contain mercury and are therefore environmentally unfriendly.

By shifting to High-pressure Sodium lamps or Metal halide lamps efficiency improvement in the lamp itself an go as high as 40%. This could reduce total energy consumption for street lighting for Europe with approx. 15% taking into account 1/3 of the installed base is really old. A normal replacement would be from 250W to 150W means 40% reduction per lamp. Shifting all lamps (also the newer types to most efficient lamps could reduce energy consumption another 5 - 10%. The total energy saving potential in lamps used is therefore approx. 20%

Luminaire
The luminaire development over the last 30 years has focused on improving the optical performance made possible because of the characteristics of the new lamp types.

Ovoid opal lamps with a large volume and low relative luminance can now be replaced with clear small lamps with high luminance.

This development in lamp size and the characteristics in optical design mean that the efficiency of modern luminaries can be 25 – 30% higher than those based on optical systems for old ovoid lamps.

If all street lighting luminaries in Europe were updated to the latest luminaire technology with high optical performance, the energy saving potential is estimated to be around 15%. Of course we need to take into account that the savings can only be accomplished in combination with new lamps.

Ballasts
Arc discharge lamps such as fluorescent and HID sources require a device to provide the proper voltage to establish the arc and to regulate the electric current once the arc is struck. This is what the ballast does. Ballasts also help compensate for voltage variation in the electrical supply.

The technology for ballasts is changing rapidly from magnetic to electronics ballast. Magnetic ballasts use coiled wire and create magnetic fields to transform voltage. Magnetic ballasts do not change the frequency of the power to the lamp—it remains the same as the input power.

Electronic ballasts use solid state components to transform voltage. It also changes the frequency of the power from 60 Hz to 20,000 Hz, or higher, depending on the ballast. Because the electronic ballast doesn't use coils and electromagnetic fields, it can function more efficiently and cooler than magnetic. The frequency change also greatly reduces any flicker in the lamp due to burn in or improper power.

The availability of reliable power electronics makes it possible to build more electronic ballast for different applications.

Description of most common types of ballasts used for street lighting
Below are two graphs of dimmable ballasts from Philips as an example for the control voltage output as a function of the power output. Plus a second graph that shows the light output as a function of the control voltage.
Example for Dynavision Controller 400W

Example for Dynavision Ballast 150W

**Energy saving possibilities based on ballasts**
The system of precise electronic power control extends the lamp life by 30% while reducing power consumption by about 7%. On top of this electronic ballast give the opportunity to provide for the possibility of stepless dimming.

In many cases the dimming level is set by an external module that communicates with the ballast’s control interface. Today there are three types of control interfaces known:

1-10 Volts controlled
A ballast with 1-10 v input dims the output according the voltage level of its set point input in a range of 1-10 volts (1 volt means minimum level, 10 volts means maximum level). To switch the light on and off the power to the ballast is interrupted.

DALI controlled
A ballast with DALI input dims the output according to digital commands encoded in the DALI protocol (Digital Addressable Lighting Interface). By using a DALI protocol the ballast can switch on and off without the need to interrupt the power. DALI also enables other data from the ballast to be communicated to the controller for example for the purpose of burning hour calculation.

Proprietary controlled
There are various ballast manufacturers that provide for their own proprietary interface limiting the freedom of choosing the ballast separate from the controller.
The dimmable ballast plus controller gets it commands from an external module (segment controller) normally situated in the feeder pillar cabinet. This unit communicates over Powerline or RF to the actual controller in the pole. This brings us to the next paragraph on managed outdoor lighting better revert to as Telemanagement.

Another technology of dimming outdoor lamps is by regulating the voltage level for the entire segment at the power supply cabinet. This technology is not reported on in this project because it is not considered to be optimal for energy savings.

### 2.3.3 Dynamic Outdoor Lighting Control Systems “Telemanagement”

The best name for systems that do dynamic outdoor lighting control is probably Telemanagement systems.

A Telemanagement system enables the lighting system to automatically react to external parameters like traffic density, remaining daylight level, road constructions, accidents or weather circumstances. The data communication on the street level can be based on the LonWorks Powerline communications protocol that supports a large number of media which makes integration with complex traffic management and geographic information systems easier.

Public lighting managers have known that they could lower the operating costs of their systems if they could cost effectively collect the critical data needed to make better planning and operational decisions. Lighting engineers have conceived of new designs to improve public safety and reduce energy consumption only to be stymied by an inability to economically control every luminaire in the system. Without a suitable network to gather the information and exercise control, these designs could not be implemented in a public lighting system. Today power line based communication networking can achieve significant operating and energy cost savings while improving both the reliability and the quality of public lighting systems. In combination with IP technology it is relatively easy to build a Dynamic Outdoor Lighting Management or “Telemanagement” System.

This network approach when based on an open network standard enables many manufacturers’ devices to share the same network and provide data across a single infrastructure. Many applications can then be used to manage the public lighting system-effectively expanding the value of each installation. A communication network that is open would enable monitoring, control, metering and diagnostic applications that can transform the economics of operating public lighting systems.

If this network is also available to monitor the age and condition of every lamp, that information would eliminate the guesswork inherent to cost benefit calculations. Decisions could be made with confidence that the real-time data from the public lighting system supported the return on investment.

Furthermore, the Telemanagement system can be used to monitor failed lamps and report their location, maintenance expenses (materials, routing, labor, etc.) could be minimized by considering the remaining life of nearby lamps that might be replaced during the same service call.

Finally, data collected by the Telemanagement system that tracks the hours of illumination for each lamp can be used to claim warranty replacement, establish unbiased product and supplier selection criteria, and validate energy bills for the system.
Telemanagement based on a Powerline communication network is cost effective today for monitoring, control, metering and diagnostic applications that save energy, reduce maintenance costs and improve system reliability.

So apart from the energy savings realized by dimming the light to the level required Telemanagement systems have significant other benefits that will be discussed in this chapter as well.

**Telemanagement system functions**
The required functions for telemanagement system differ from user to user. However there are several basic functions the system needs to perform to be able to perform the basic tasks needed for optimal energy savings.

**Dimming**
Lighting level requirements often depend on external parameters such as traffic volume, ambient brightness and weather conditions. When there is very little traffic on the road drivers do not require the light level they need when the traffic density is high. One can imagine that the weather situation influences the visibility as well and in return the light level needed. To avoid rapid changes around these switching criteria the system must smooth out these changes (hysteresis).

**Energy saving by dimming on time, traffic density and weather conditions.**
Demands to the light intensity often depend on external parameters, such as traffic intensity, daylight, road constructions and weather conditions.

These factors may vary at different points in time, different seasons or a combination of both. Therefore it is not an optimal solution to maintain the same illumination intensity for a pre-defined period. There is no need for the same light intensity if there is very little traffic with a
clear sky on a dry road. Regulation of the light level based on the desired situation can easily be realized with the Telemanagement system.

There are some ground rules that apply that are listed below:

Precipitation, slipperiness and fog sensors
Precipitation is a local phenomenon. Therefore it must be detected locally, that is once in every weather section. A weather section is several kilometers long. A precipitation switch is installed, unless a good visibility meter is available, which can also detect precipitation.

Slipperiness data are obtained from a Slipperiness Detection System. Because of the local character of slipperiness, it is not necessary to install additional sensors for this but the telemanagement system needs to anticipate the situation.

Fog is detected by visibility meters. In areas where fog detection is available, the available sensors will be used to set lighting levels.

The switching criteria currently used for dynamic lighting are:

- precipitation: presence of raindrops (precipitation, heavy precipitation)
- slipperiness: presence of slippery conditions as detected
- visibility: visibility 140 meters

**Energy saving by dimming to compensate depreciation factor**

When planning a new lighting installation a maintenance factor is taken into account because of the reduction in flux of the lamp during its lifecycle. Therefore, depending on the lamp type, a new installation or an existing installation, right after re-lamping, may produce up to a 20% light excess. With telemanagement it is possible to reduce this effect to 0 by dimming based on the actualized lamp database to correct for this gradual reduction of light flux during the lamp life.

This is called the CLOU function (Constant Light Output) and may count for up to 10% of the total energy consumption depending on the lamp type. There is no negative effect on the service, safety or comfort for the public. Next to the evident economical advantages, these options mentioned above will also contribute to the reduction of light pollution and energy consumption.

Stepless dimming allows adjusting the lighting level down to approximately 40 - 50% of the flux accounting for energy savings of around 30 - 40%.

Similarly there is little point in the esthetic illumination of monuments in city centers in the early hours of the morning. The same goes for office buildings in industrial areas in the weekends. There are no numbers available on the energy savings this will bring.

**Main financial benefits of telemanagement**

Telemanagement goes beyond issuing commands and obtaining feedback. Up-to-date information at all times enables you to forecast and plan with far greater accuracy leading to more effective maintenance and a reduction in time use.

Adding a Telemanagement function for example to an already scheduled lamp/ballast or luminaire upgrade can dramatically improve the payback on the investment in the following ways:

1. direct cost reductions through dimmable ballasts and networked controls: Controlling light intensity to correctly engineered levels throughout the lamp’s entire life to minimize energy consumption as described above
2. direct cost reductions through measuring each lamp's energy consumption at the fixture
   a. this enables for detecting lamps that are nearing the end of their economic life and replacing them prior to the excessive energy consumption that occurs in lamps prior to burning out
   b. It eliminates excessive wear on the ballast and starter caused by lamp cycling that usually results in replacing the fixture or gear rather than just the lamp if undetected
3. direct cost reductions through a centralized database that integrates data from the control network with a wide area network, (such as GPRS), in turn making the data available to central office GIS software
   a. contains timely status information on every fixture that the GIS-software then links to standardized location co-ordinates. The result is alarm messages from the fixtures and their precise locations can be easily combined into optimized maintenance and refurbishment route plans with an estimated 30\% increase in efficiency.
   b. graphical User Interface to the city-wide GIS system can be used to detect power outages and inform the utility, create ad hoc lighting schedules for special events or prioritize the response to safety critical alarms such as ground faults
4. direct cost reductions through embedding intelligence in each control device can deliver diagnostic information with alarm messages
   a. reporting the exact repair needed, with customized instructions, and even the replacement part number to the technician eliminates spurious lamp replacements and minimizes time on each job
   b. Interfacing with software applications that generate work orders, order spare parts and manage inventory reduces the total amount of labor time per repair across the organization. Cost savings can be achieved in many parts of the enterprise as a result of data integration
   c. expensive and time consuming methods of scouting and visits are no longer required
   d. the urgency of the failure can also be determined, the urgency to take direct action (on critical places) the possibility to wait and organize a combined and therefore cheaper intervention
5. creating a “closed loop” system essential to lower inventory levels of spare par
6. direct cost savings because of the longer life expectancy of the lamp circumstances present in real life do sometimes deviate considerably from the conditions under which the lamp’s data, such as service life expectancy have been calculated (especially fluctuations in the electricity grid). A combination of electronic “constant wattage” ballasts and Telemanagement ensures one that these differences are almost eliminated. In practice this brings a significant increase in the lamp’s service life expectancy, which will reduce the maintenance costs.

A significant portion of any lamp or ballast replacement program is installation cost. By installing “network ready” control devices at the same time as a new lamp, additional savings in energy, maintenance, and public safety can be achieved. The benefits of networked controls exceed the minor initial installation costs.

Example calculation
The pay back period of the initial investment in telemanagement will have to be analysed case by case and is studied in another work pack. It depends on a large number of factors as might be clear from the above mentioned. In summary it is essential to take the required dimming period, the possible reduction in flux, the price per kilowatt hour, the potential reduction of early lamp failures as a consequence of voltage peaks etc. Furthermore, the pay-back period strongly depends on the current practices in managing the installed base.

The first approach is to consider a regular outdoor installation like for example a highway with 1000 light points of 150 W lamps each.
Switching and dimming based on astronomical clock scheduling.

This is the most common way to dim outdoor light. The scheduler depends on the real geographical position of the system (each cabinet will have his scheduler and will control an approximate number of 100 light points) and adapted to the sunrise and sunset in that location. Therefore you have more savings during winter than in summer.

### ENERGY SAVINGS

<table>
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<tr>
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**Energy savings with telemanagement**

![Energy savings chart](image)

**Real life example**

In Oslo There has been over the last years done 3 test/retrofitting-installations on telemanagement systems.

Starting back in 2003 with 120 luminaries, next installation was 2000 luminaries in 2004, and finally 4400 luminaries in 2005.

The below figures are relative numbers for the installation done in 2005. The retrofitting was done in the north eastern area of Oslo city, including both rural living areas, industry areas and some collector roads.

The old installations were in some cases a bit over dimensioned and we could in some cases (approx 5 %) go from dual-sided lighting down to single-sided lighting. For the project area the old installation had an installed power of 677,8 kW divided on 4500 luminaries this results in an average lamp output of 150,6 W (without losses included).

As mentioned the retrofitting installation contained 4400 luminaries representing 444,3 kW of installed power. In average this represents 101 W per luminarie and a reduced installed effect output of 34,4 %.
2.3.4 Conclusion on energy savings

In conclusion it is possible to reduce the amount of energy used significantly going from an old to an entirely new situation. Replacing the lamp, luminaire and ballast will account for about 37% reduction in energy consumption.

Telemanagement 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.

Based on our total consumption calculations this means for Europe that we can save as much as 63.7% on our energy consumption in outdoor light what would mean an annual saving of 38,06 TWh.
3 EVALUATION REPORT ON MARKET PENETRATION AND PROCUREMENT ACTIVITIES

3.1 Discussion and conclusions

One of the main purposes of this project is to enable the market enlargement of the adaptive street lighting. The large scale effect of the new technology is of great importance for the right and reliable definition of the investment budgets and later the real assessment of the running costs of realized systems of adaptive street lighting. At present in most of the countries, where such systems are realized, these systems are newly installed and the real effect is not possible to be assessed as a whole by the end of this project. Assessing the collected by the moment information for the small scale pilot projects, the first results show about 80 000 luminaires working in intelligent street lighting systems. The realized or assessed energy savings are between 20% and 50% depending of scope of the system renovation, country place of the new installations and other specific factors. The payback period varies from 3 to 5 years by the moment. The products from more than 22 firms are put into the realized projects. About 40 municipality and/or road administrations of 14 countries are involved in the implementation process of the new technology (see the table with procurements above). For the moment it is too early for the development of unique assets for each country. Since each country (and in each country each municipality is independent) act independently in the field of Pilot projects the Forum could only assist with affording opportunity for reliable information.

The established E-street Forum (of street lighting owners) must be of real importance for the catalysis of the technology implementation process. It was the place where was exchanged experience between the partners of the project as well from the newly involved members of the forum. The E-street Forum was and should continue to be a place for exchange of knowledge and experience, for education of good practice examples. In the frame of the project were organized 5 forums with 200 participants.

The most important for the successful future procurement activity was the elaboration of a Tender documentation for Adaptive street lighting. It was collected a reliable data information for the practice in the field of low procedures, directives and general and technical standards from the countries – members of this project. On the base of it was elaborated tender document, where are described the technical requirements of an Adaptive Street Lighting System. The legal and financial questions are not object of this tender documentation. As all countries –members of the projects are following the directive of EU commission about public tenders this document should be of real public benefit for each country – member of EU. As well it was exchanged information about local tenders among the partner network. At present it is difficult to coordinate or arrange joint and/ or parallel tenders based on local and/ or international vendors.

3.2 Tender documentation for Adaptive Street Lighting

3.2.1 General

It would be hardly possible to elaborate a universal form for the tender documentation, considering the specific conditions, the existing practices and possibilities in each country. The elaborated tender document describes the technical requirements of an Adaptive Street Lighting System with the following components:

- Lighting equipment (roadside equipment);
- Power supply system;
- Dynamic Adaptive remote control;
- Central supervisory control system;
- Local control system;
3.2.2 Introduction

The traditional implementation and organization of street lighting have no possibilities for improving and development any more.

The dynamic changes in economy, energy supplies and ecology on a national, European and world like scale require an adequate modernization of street lighting. However, this would be possible only with a quite new functional conception which in fact means adaptability of street lighting. Simultaneous ensuring of the conditions of safe traffic and decreasing the energy consumption and operational costs could be realized in conformity with the constantly changing parameters of the environment. In conformity with the 24 hours change of daylight, the highly changeable traffic, the variable meteorological conditions and some extreme situations on the roads, the intensity of street lighting should change in a dynamic manner. New technical devices and methods that are offered by technical progress will be necessary obviously for the realization of adaptive lighting.

The tender documentation states the goals of the E-street Project and the ways of their implementation. It describes the system structure and the technical requirements towards its subsystems: roadside equipment, power system, local control system, central supervisory system and communication network.

The content and project requirements for the implementation of Adaptive street lighting - project management, quality assurance and installation requirements - are given.

3.2.3 Overall architecture

Fig.1 presents the architecture of an “Adaptive Street Lighting System”. Five subsystems are defined depending on the functions to be performed:

- Roadside equipment
- Power system
- Local control system
- Central supervisory control system
- Communication system/network

Overall architecture of the Monitoring System for Adaptive Street Lighting
The Roadside equipment includes lamps, luminaires, gears, light pools.

The Power system consists of transformer stations, power cabinets and power lines.

The Local control system can be considered in terms of function as composed of two levels:
- **Level One** includes:
  - Luminaires with dimmable electronic ballast (DB) with power line modem;
  - Controlling high pressure sodium or metal-halide lamps;
  - Power line controller (PLC) with power line modem;
  - Controlling magnetic ballast and any sensor, such as camera or weather monitor connected to the power grid.
- **Level two** includes:
  - Substation (Sub Central) with local segment (network) controller **LSC**;
  - Local power line controller **PLC** (with power line carrier)

The Central supervisory control system (CSCS) system is web–based. The complete monitoring, programming and control are achieved by web–site programs. All the information is collected in a host server. The system and the visible sites or installations are protected by log-in usernames and passwords as well as password level limited actions.

Communication system/network performs information exchange between the different subsystems of E-Street and data collection in the Central Supervisory Control System and in the Lighting Sub Central.

The organization of weather condition station depends on the local possibilities, practice and conditions.

The street lighting control centre receives information about traffic volume from the traffic centre – TM.
The sensor system provides information about precipitation, slipperiness, snow, fog.

### 3.2.4 Future expansion / integration

The system shall be adjusted for expansion and development over time. The supplier shall suggest a plan how this can be executed. For example it could be with more luminaires, more functionalities or connections to new/other external systems. The built Adaptive lighting system should not be a “closed system”.

### 3.2.5 Data exchange with an external system

The Adaptive street lighting is a “living system”. It has permanent contact with other systems like: Traffic Management, Weather Sensor system, Central Lighting Application, etc. The efficient operation of E-street system is impossible without reliable contact to other systems.

### 3.3 Small scale test projects

A contemporary and technologically new lighting system as Adaptive street lighting system usually are tested first like small scale or pilot projects! Such projects begin to be realized in the years 2001-2003 in different places – Europe, USA, Canada and al. One of their main purposes is to assess the potential of energy savings in street lighting using the new managing system. Here, in this report is summarized the experience gathered in the counties, participants in this project, as well the approachable results from other countries.

A high variety of projects are realized in connection scope, used elements, products and systems, duration of the project and the working time of the new street lighting system.
the situation and the status of the street lighting installations are rather different from country to country and from city to city. Some of the counties start with full renovation of the systems changing High pressure Mercury lamps with Sodium lamps and introduction of the intelligent control system. As result the energy savings reach 60-70%. Other countries introduce only the new management system and the energy savings are about 20-25%. One of the main conclusions is that it is too early for definite results and conclusions.

We have received information for pilot projects from the following partners:

- Norway, Sweden, Finland, Czech Republic, Slovenia, Poland, the Netherlands, Germany, Portugal and Ireland.
- At present in Bulgaria there are only projects of adaptive street lighting systems for Sofia, Smolyan, Vratza, Varna and Sliven.

Additional information is found for such projects in:

- USA, UK, Belgium, Italy, Austria, Japan, China, Thailand, United Arab Emirates.

The main actors in these projects are:

- Firms as: Powel, Hafslund, Echelon, Lumintext, Selc, Capelon AB, Apein-lumtec, Datmolux, Mrp, Edelcom, Philips, Eltodo, Umpi, Sitemco, Schreder, Rac
d.o.o., Kongsberg Analogic, Osram, Thorn, Telensa, Urban, Havard etc.
- the Municipalities,
- the Public road and traffic administrations,
- Universities,
- Energy agencies.

On the next pages in concise form and with ciphers is presented the experience in some of the countries listed above.

**SWEDEN**

Adaptive street lighting, road sections Högsboleden and Tuveleden in Goteborg

<table>
<thead>
<tr>
<th>Adaptive lighting</th>
<th>Supervisory Control and Monitoring System – ÖSÖ and local intelligent street lighting system - Local Controller – MP-01 (developed by Capelon AB and Infracontrol AB in Gothenburg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name:</td>
<td>Supervisory Control and Monitoring System – ÖSÖ and local intelligent street lighting system - Local Controller – MP-01 (developed by Capelon AB and Infracontrol AB in Gothenburg)</td>
</tr>
<tr>
<td>Number of luminaries before adaptive lighting</td>
<td>366</td>
</tr>
<tr>
<td>Number of luminaries after adaptive lighting</td>
<td>283</td>
</tr>
<tr>
<td>Kind of lamps</td>
<td>high pressure sodium lamps</td>
</tr>
<tr>
<td>Energy savings</td>
<td>~ 37% in summer and ~ 40-45% in winter</td>
</tr>
</tbody>
</table>
**SLOVENIA - Pilot projects from Ljubljana:**

**Project A.) Highway junction:**

**PROJECT A): Highway junction:**

<table>
<thead>
<tr>
<th>Adaptive lighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name: Javna razsvetljava centralized power control system</td>
</tr>
<tr>
<td>Number of luminaries: ~105</td>
</tr>
<tr>
<td>Kind of lamps: high pressure sodium lamps</td>
</tr>
<tr>
<td>Wattage of lamps [W]: 100 W / 150 W / 250W</td>
</tr>
<tr>
<td>Installed power of the adaptive lighting [kW]: 96 kW</td>
</tr>
<tr>
<td>Energy savings (predicted): 20-25%</td>
</tr>
</tbody>
</table>

**Project B.) Road and Street lighting in Lubljana**

<table>
<thead>
<tr>
<th>Adaptive lighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name: Javna razsvetljava centralized power control system</td>
</tr>
<tr>
<td>Number of luminaries: 498</td>
</tr>
<tr>
<td>Kind of lamps: high pressure sodium lamps</td>
</tr>
<tr>
<td>Wattage of lamps [W]: 100 W /150 W / 250W</td>
</tr>
<tr>
<td>Installed power of the adaptive lighting [kW]: 84.6 kW</td>
</tr>
<tr>
<td>Energy savings (predicted): 20-25%</td>
</tr>
</tbody>
</table>
**CZECH REPUBLIC**

Example No. 1 - Luxicom telemanagement system (Prague, Novodvorská):
- control unit in luminaire
- PLC communication
- remote management at “switchboard level”

<table>
<thead>
<tr>
<th>Adaptive lighting</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Luxicom telemanagement system</td>
</tr>
<tr>
<td>Number of luminaries</td>
<td>60</td>
</tr>
<tr>
<td>Kind of lamps</td>
<td>high pressure sodium lamps</td>
</tr>
<tr>
<td>Type of lamp</td>
<td>SON -T PIA Plus</td>
</tr>
<tr>
<td>Wattage of lamps [W]</td>
<td>100 W</td>
</tr>
<tr>
<td>Energy consumption before adaptive lighting [kWh/a]</td>
<td>5 080</td>
</tr>
<tr>
<td>Energy consumption after lighting [kWh/a]</td>
<td>3 911</td>
</tr>
<tr>
<td>Energy savings</td>
<td>23%</td>
</tr>
</tbody>
</table>

Example No. 2 – Revereri power control system (Prague, Jižní spojka):
- power control unit in the cabinet
- remote management at “switchboard level”

<table>
<thead>
<tr>
<th>Adaptive lighting</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Revereri telemanagement system</td>
</tr>
<tr>
<td>Number of luminaries</td>
<td>600</td>
</tr>
<tr>
<td>Kind of lamps</td>
<td>high pressure sodium lamps</td>
</tr>
<tr>
<td>Type of lamp</td>
<td>SON -T PIA Plus</td>
</tr>
<tr>
<td>Wattage of lamps [W]</td>
<td>70,100,150, 250 W</td>
</tr>
</tbody>
</table>
Energy consumption before adaptive lighting [kWh/a]  |  748 000
---|---
Energy consumption after lighting [kWh/a]  |  575 000
Energy savings  |  23%

**UNITED KINGDOM**

*Milton Keynes*

<table>
<thead>
<tr>
<th>Adaptive lighting</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Name:</td>
<td>Echelon remote control system</td>
</tr>
<tr>
<td>Number of luminaries</td>
<td>400</td>
</tr>
<tr>
<td>Kind of lamps</td>
<td>high pressure sodium lamps</td>
</tr>
<tr>
<td>Kind of ballasts</td>
<td>SELC electronic ballasts</td>
</tr>
<tr>
<td>Wattage of lamps [W]</td>
<td>70,100,150 W</td>
</tr>
<tr>
<td>Energy savings (predicted)</td>
<td>~40%</td>
</tr>
</tbody>
</table>

### 3.4 E-street Forum

The E-street Forum was also after some initial tumbling established (E-street Forum of street lighting owners) It must be of real importance for the catalysis of the technology implementation process. It was the place where was exchanged experience between the partners of the project as well from the newly involved members of the forum. The E-street Forum was and should continue to be a place for exchange of knowledge and experience, for education of good practice examples. In the frame of the project it was organized 5 forums with not less than 200 highly dedicated participants. All together the Forum meetings has taken place at the following places:

- Prague (Czech Republic), on the 09.06.2006
- Berlin (Germany) on 26.11.2006
- Oslo (Norway) on 09.05.2007.
- Sofia (Bulgaria) on 26.11.2007
- Lisbon (Portugal) on 15.05.2008

Presentations given in the forummeetings are available at the E-street web-pages.
### 3.5 Intelligent street lighting project in Europe

Identified projects in Europe.

<table>
<thead>
<tr>
<th>Name Location Country</th>
<th>Number of Luminaires</th>
<th>Installed Wattages/Type of Lamp (i.e. 70/100W HPSL)</th>
<th>Technology: Power line (PLC)</th>
<th>Regulation: Step less dimmable (SD) Reduced level at night (RLN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poznan, POLAND</td>
<td>1540</td>
<td>70/150/250 HPS</td>
<td>PLC</td>
<td>SD</td>
</tr>
<tr>
<td>Kalisz town, POLAND</td>
<td>78</td>
<td>150/250 HPS</td>
<td>PLC</td>
<td>SD</td>
</tr>
<tr>
<td>Motorways, POLAND</td>
<td>1000</td>
<td>70/150/250/400 HPS</td>
<td>PLC</td>
<td>SD</td>
</tr>
<tr>
<td>CZECH REPUBLIC</td>
<td>10 000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belfast, NORTHERN IRELAND</td>
<td>600</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dublin, IRELAND</td>
<td>5000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown, the NETHERLANDS</td>
<td>7000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2, the NETHERLANDS</td>
<td>1523</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hammerfest, NORWAY</td>
<td>3000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Øvre Eiker, NORWAY</td>
<td>300</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tingvold, NORWAY</td>
<td>3000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bærum, NORWAY</td>
<td>21</td>
<td></td>
<td></td>
<td>SD</td>
</tr>
<tr>
<td>Bærum, Skitrack NORWAY</td>
<td>100</td>
<td></td>
<td>RF</td>
<td></td>
</tr>
<tr>
<td>Fornebu, NORWAY</td>
<td>350</td>
<td></td>
<td>PLC</td>
<td>SD</td>
</tr>
<tr>
<td>Drammen, NORWAY</td>
<td>71</td>
<td></td>
<td>RF</td>
<td>SD</td>
</tr>
<tr>
<td>Oslo, NORWAY</td>
<td>7500</td>
<td>70/100/150 HPS</td>
<td>PLC</td>
<td>SD</td>
</tr>
<tr>
<td>Gothenburg, SWEDEN</td>
<td>1125</td>
<td>70/100/150 NaH</td>
<td>PLC</td>
<td>SD</td>
</tr>
<tr>
<td>Road 276 to Akersberga north to Stockholm, SWEDEN</td>
<td>85</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staketleden north of Stockholm, SWEDEN</td>
<td>270</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Location</td>
<td>Number of luminaires</td>
<td>Installed wattages/type of lamp (i.e. 70/100W HPSL)</td>
<td>Technology: Power line (PLC) Radio (RF) Other (specify)</td>
</tr>
<tr>
<td>---------------------------</td>
<td>---------------------------------</td>
<td>----------------------</td>
<td>-----------------------------------------------------</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>Allerpark Wolfsburg,</td>
<td>GERMANY</td>
<td></td>
<td></td>
<td>GSM</td>
</tr>
<tr>
<td>Werk Biberach,</td>
<td>GERMANY</td>
<td>350</td>
<td></td>
<td>Internet, SMS</td>
</tr>
<tr>
<td>Highway, Ljubljana,</td>
<td>SLOVENIA, 2007</td>
<td>368</td>
<td>100/150/250 HST</td>
<td>PLC Optical link</td>
</tr>
<tr>
<td>Bundeswehr Schillkaserne</td>
<td>Wesel, GERMANY</td>
<td>140</td>
<td></td>
<td>PLC</td>
</tr>
<tr>
<td>Stadt Böblingen,</td>
<td>GERMANY</td>
<td>22</td>
<td>70W HSE</td>
<td>Fiber optic cable</td>
</tr>
<tr>
<td>Milton Keynes, 2007</td>
<td>UK</td>
<td>400</td>
<td></td>
<td>PLC</td>
</tr>
<tr>
<td>Dong,</td>
<td>DENMARK</td>
<td>30 000</td>
<td>CFL: PL-T 42W</td>
<td></td>
</tr>
<tr>
<td>HELSINKI RING III,</td>
<td>Vantaa and Helsinki, FINLAND</td>
<td>500</td>
<td>ST 150-600 W</td>
<td>PLC</td>
</tr>
<tr>
<td>MOTORWAY HELSINKI-TURKU</td>
<td>Section Kolmerä-</td>
<td>760</td>
<td>ST 150-600 W</td>
<td>RF</td>
</tr>
<tr>
<td>Espoo, Kirkkonummi and</td>
<td>Lohjanharju, Muurla, Pertteli,</td>
<td>1100</td>
<td>ST 150-600 W</td>
<td>PLC</td>
</tr>
<tr>
<td>Vihti, FINLAND</td>
<td>Kiikala, Suomusjärvi, Sammatti,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NUMMI-PUSULA and Lohja,</td>
<td>FINLAND</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MOTORWAY HELSINKI – PORVOO</td>
<td>Section Västersundom-</td>
<td>1240</td>
<td>ST 150-600 W</td>
<td>PLC</td>
</tr>
<tr>
<td>PorvooVantaa, Sipoo and</td>
<td>Porvoo, FINLAND</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VUOSAARI HARBOUR ROAD</td>
<td>Helsinki and Vantaa, FINLAND</td>
<td>200</td>
<td>ST 150-600 W</td>
<td>PLC</td>
</tr>
<tr>
<td>Elvas, PORTUGAL</td>
<td></td>
<td>300</td>
<td>ST 150-600 W</td>
<td>PLC</td>
</tr>
<tr>
<td>Getafe</td>
<td>SPAIN</td>
<td>1000</td>
<td>150W</td>
<td>PLC</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4 WP 4 REPORT ON PROVOKE A FASTER DEVELOPMENT OF LEGISLATION, STANDARDS AND GUIDELINES

4.1 International Commission on Illumination (CIE)

Report CIE 115-1995 is under revision, Technical Committee TC 4-44 will revise the publication in such a way that lighting performance requirements may vary depending on actual status of environmental and traffic conditions.

Technical committee, consisting 23 active members and 5 advisors representing 15 countries, has carefully considered the whole content of report. The committee has met several times and has prepared the final draft in March 2008 for committee ballot Divisional and Board ballot will be conducted in 2008. The report will hopefully be published during 2009.

It is also to be mentioned that five of the above mentioned committee members are active participants with E-Street project.

Compared to the existing publication the revised version gives basis for the adaptive lighting and includes practical, easily used method for selection of lighting class. This selection procedure has same parameters as in the technical report CEN/TR 13201-1. See paragraph 2.2.2.

Because the draft is in the voting stage and it is not yet accepted by the CIE Board only few subjects are presented as an example.

From the E-Street Project point of view the most important chapters are presented in the following extract from the final draft. Quotations are written in italics.

1. INTRODUCTION

1.2 Need for road-lighting
Rehabilitation of obsolete and uneconomic installations is important. It is possible to obtain higher luminance values with lower energy consumption. Upgraded lighting and control systems will often result in good cost-benefit ratios and short amortization periods.

The visual needs of road users under reduced traffic volumes during certain periods of night or under varying weather conditions, and the positive benefits of reduced energy consumption and potential environmental improvements, are some of the considerations for the installation of adaptive road lighting. There are suitable instruments, devices and methods which can be used for the intelligent control of a road lighting installation. The control systems range from very simple to the most modern applications.

6. QUALITY CRITERIA AND LIGHTING CLASSES

6.2 Selection of lighting classes
6.2.1 Normal lighting
Normal lighting is that class which is appropriate if the same level is to be used throughout the hours of darkness, selected from table. In selecting the normal class the maximum value of the selection parameters likely to occur at any period of operation should be considered, e.g. for traffic volume consider peak hourly value.

The installation should be designed to comply with all the quantitative and qualitative requirements of the selected class. Many countries have developed valid systems to determine the appropriate normal lighting class. (CEN CR 14380:2003, CEN TR 13201-1:2004, CERTU 2007, BS 5489-1:2003 Code of practice for the design
of road lighting - Part 1: Lighting of roads and public amenity areas. A system which can be used to
determine the normal lighting class for motor traffic, conflict areas and road lighting for pedestrians is
given.

For simplicity only the most important parameters are summarized in table 1 for ordinary motorized
traffic. The descriptions of the parameters and the associated options are broad so that they can be
interpreted to suit individual requirements for national recommendations. In some cases risk analysis or
other consideration (environmental for example) could lead to the consideration of other parameters.
When a selection is made, all road users, including motorists, motor and pedal cyclists, and pedestrians
should be considered.

Examples of the selection of lighting classes using this system are given.

6.2.1 Adaptive lighting
As indicated in clause 6.2.1, the normal lighting class is selected using the most onerous parameter
values, and the application of this class may not be justified throughout the hours of darkness. (This
might be under changing conditions e.g. weekends, different weather conditions) Temporal changes in
the parameters under consideration when selecting the normal class could allow, or may require, an
adaptation of the normal level of average luminance or illuminance, usually by reducing the level. The
most important parameters in this respect are likely to be traffic volume and composition, weather
conditions but ambient luminance can also have an influence.

The adapted lighting level or levels should be the average luminance or illuminance from a class or
classes in the same table from which the normal class has been selected.

Table 1 can be used to select the appropriate adapted lighting class or classes for different periods of the
hours of darkness when the value of the selection parameters is significantly different.

The examples of the use of the tables include the selection of the adapted lighting classes, and it can be
seen that only the average level of luminance or illuminance is varied.

It is important that the changes in the average lighting level do not affect the other quality criteria
outside the limits given in the system of lighting classes. Reducing the light output from every lamp by
the same amount using dimming techniques will not affect luminance or illuminance uniformity, or the
object contrast but the threshold contrast increases. Reducing the average level by switching off some
luminaires will not fulfil the quality requirements and is not recommended.

The use of adaptive lighting can provide significant reduction in energy consumption, compared with
operating the normal lighting class throughout the night.
Where the pattern of variation in parameter values is well known, such as from a record of traffic counts
on traffic routes, or can be reasonably assumed, as in many residential areas, a simple time based
control system may be appropriate.

In other situations an interactive control system linked to real-time data may be preferred. This
approach will permit the normal class to be activated in the case of road works, serious accidents, or
bad weather or poor visibility.
7. REQUIREMENTS FOR MOTORIZED TRAFFIC – THE LUMINANCE CONCEPT

The M lighting classes are intended for drivers of motorized vehicles on traffic routes, and in some countries also on residential roads, allowing medium to high driving speeds. The lighting recommendations, given in classes M1 to M6, depend on the geometry of the relevant area and on the traffic and time dependent circumstances. The appropriate lighting class has to be selected according to the function of the road, the design speed, the overall layout, the traffic volume and composition, to the environmental conditions.

For the determination of the M lighting class to be applied the appropriate weighting factors for the different parameters have to be selected and added up to find the sum of the weighting values (SWV). The number of the lighting class M is then calculated as:

Number of lighting class \( M = 6 - \text{SWV} \)

Careful selection of appropriate weighting factors will yield numbers between 1 and 6. In some cases it may be necessary to round to the nearest whole number, or to limit the range from one to six.

Table 1: Parameters for the selection of M lighting class

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Options</th>
<th>Weighting Factor WV</th>
<th>WV Selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
<td>High</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Traffic volume</td>
<td>Very high</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>-0.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Very low</td>
<td>-1</td>
<td></td>
</tr>
<tr>
<td>Traffic composition</td>
<td>Mixed with high percentage of non-motorized</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mixed</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Motorized only</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Separation of carriageways</td>
<td>No</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Intersection density</td>
<td>High</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Parked vehicles</td>
<td>Present</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Not present</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Ambient luminance</td>
<td>Very high</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>-0.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Very low</td>
<td>-1</td>
<td></td>
</tr>
<tr>
<td>Visual guidance / traffic control</td>
<td>Poor</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Good</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Very good</td>
<td>-0.5</td>
<td></td>
</tr>
</tbody>
</table>

The controlling criteria for the lighting of roads for motorized traffic are the luminance level and uniformity of the carriageway, the illuminance level of the surrounds of the road, the limitation of
disability and discomfort glare, and the requirements for direct visual guidance. Recommended values are given in Table 2 for the lighting classes M1 to M6, reflecting various traffic situations.

The lighting criteria used are the maintained average road surface luminance \( L_{av} \), the overall \( U_o \) and longitudinal \( U_l \) uniformity of the luminance, the surround ratio \( SR \), and the threshold increment \( TI \). These values apply to roads which are sufficiently long so that the luminance concept can be used, outside conflict areas and/or outside areas with measures of traffic calming. The surround ratio is considered for roads with adjacent footpath/cycle path only when no specific requirements are given.

Table 2: Lighting requirements for motorized traffic, based on road surface luminance

<table>
<thead>
<tr>
<th>Lighting class</th>
<th>Road surface luminance</th>
<th>Threshold increment</th>
<th>Surround ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( L_{av} ) in ( \text{cd/m}^2 )</td>
<td>( U_o )</td>
<td>( U_l )</td>
</tr>
<tr>
<td>M1</td>
<td>2.0</td>
<td>0.40</td>
<td>0.70</td>
</tr>
<tr>
<td>M2</td>
<td>1.5</td>
<td>0.40</td>
<td>0.70</td>
</tr>
<tr>
<td>M3</td>
<td>1.0</td>
<td>0.40</td>
<td>0.60</td>
</tr>
<tr>
<td>M4</td>
<td>0.75</td>
<td>0.40</td>
<td>0.60</td>
</tr>
<tr>
<td>M5</td>
<td>0.50</td>
<td>0.35</td>
<td>0.40</td>
</tr>
<tr>
<td>M6</td>
<td>0.30</td>
<td>0.35</td>
<td>0.40</td>
</tr>
</tbody>
</table>

*Applicable in addition to dry condition, where road surfaces are wet for a substantial part of the hours of darkness and appropriate road surface reflectance data are available.

Furthermore is the draft there are considered in the same way as above the following subjects:
- lighting of conflict areas
- road lighting for pedestrians
- appearance of environmental aspects
- vision concept
- references
- annexes
- economic calculations
- road lighting under snow conditions
- threshold increment
- control of glare in pedestrian and low speed traffic
- examples for lighting classes
4.2 European Committee for Standardization (CEN)

Document CEN/TR 13201-1. “Road lighting. Selection of lighting classes” is a technical report. This is informative not a standard.

This document should be revised in accordance with the revised report CIE 115:2008. Selection of lighting class cannot be standardised because the subject is depending of the national lighting and traffic safety policy as well as financial possibilities and allocation.

The German delegate in CEN/TC169 has presented the situation in CIE/TC 4-44 and E-Street project at the committee meeting 27.9.2007 in London.

The committee made the following resolution.

CEN TC/169 agreed to re-establish the CEN/TC 169/226 JWG under the Convenorship of David Coatham with the first task to develop EN 13201-5: Energy efficiency requirements and subsequent revision of TR 13201 Part 1 and EN 13201 Parts 2-4.

4.3 New standards

4.3.1 International Organization for Standardization (ISO)

When the report CIE115:200X (cf 4.1) is approved and published CIE/Central Bureau will negotiate about the possible ISO standard.

4.3.2 European Committee for Standardization (CEN)

Existing standards are presented in the paragraph 2.3.2.

These standards, parts 2, 3 and 4 should be reviewed and revised, especially part 2, in accordance with the revised publication CIE 115:2008. Cf 3.1.4.3.

The Finnish delegate in CEN/TC 226 presented activities of CIE/TC 4-44 and E-Street project at the committee meeting on 14.-15.6.2007 in Oslo. The committee decided to consider the revision of standards.

This matter was treated again in the committee meeting on 12.-13.6.2008 in Milano. Committee made the following resolution.

CEN/TC 226 agrees to the reactivation of CEN/TC169/226 JWG and request CEN/TC169 to launch an appeal to NSB for candidate nomination(s) for a new convenor in accordance with the CEN rules.
5 REPORT ON ADMINISTRATIVE TOOLS AND DATA HANDLING, "CUSTOMERS NEED"

5.1 General

With introduction of intelligent street lighting with two-way communication and the possibility for control and energy metering from different suppliers, street owners is dependent of an effective coordination and administration of the streetlights. This new options and efficiency potentials also raises new challenges in utilise the possibilities. This means that streetlight is no longer a stand alone system, rather a highly integrated part of the street owners administrative system for operation, maintenance, energy metering and billing, as well as interfaced with customers services, geographical systems and administration of sub-contractors.

This report gives a short introduction to administrative aspects and challenges regarding streetligting and new technology, furthermore it gives a description of a administrative system for streetligting witch gives the streetlight owners a tool to handle all streetlights, including the complexity of intelligent street lighting.

5.2 Topology of streetlighting

A streetlight system without any new technology known as "Intelligent streetlighting" is quite simple when it comes to the equipment used. In short it consist of luminaries, poles, lines/cabels, switchcabinet and for instance a photocell for ignition and switch off the light. In some cases there are one or a few photocell which is centralized, and the signals for ignition and switch off are sendt through signal cables to a contactor in each switch cabinet.

Introducing intelligent streetlighting, the street light system will be a lot more complex with new technology in both luminaries and switch cabinets as well as new datasystems controlling the streetlights.
5.3 Administrative aspects and challenges

The number of streetlights in a city or within a municipality is often of a great number, it is therefore crucial to have a system to administrate this assets. Introduction of different types of intelligent streetlight systems within the same city or municipality demands a common interface of all the systems for the operator and other users.

The infrastructure can also be suitable for other purposes, such as managing Trafficlights. The system should be expandable and it should have the flexibility to be used for other purposes.

5.4 Operation and maintenance

Operation and maintenance of the street light is a huge challenge because of the large number of components in a street light system. It is therefore required to install a system which take care of all the information concerning the state of each component, including information about ongoing activities and historical information. Hence of this each luminare/component must have a unique objectnumber in the database.

There are various scenarios on the maintenance strategy you can implement. Of course there is the “run-to-failure” maintenance scenario sometimes called "crisis maintenance" in this form the management is done based on the actual status of the overall system. Most management solutions work this way.

Second it is possible to set up periodic preventive maintenance, or "historical" maintenance. This is where the history of each lamp type is analyzed and periodic replacement is scheduled before the statistically expected problems occur.

Most sophisticated is to set up predictive maintenance, which is based on the determination of the lamps condition while in operation. By using the information from the database some solution make it possible to sense the symptoms by which the lamp warns that it will break down.

The latest innovation in the field of maintenance is called predictive maintenance or so-called pro-active maintenance, which uses a variety of technologies to extend the burning hours of the lamps and to virtually eliminate reactive maintenance. The major part of the pro-active tools is what is called "root cause failure analysis". The fundamental causes of lamp failures like frequent power supply issues can be identified and corrected and using this technique failure causes can be gradually engineered out.

The maintenance part of the software should offer a fully automated work order and workflow management system as well as the possibility for tracking and tracing maintenance task in various ways.

5.5 Energy metering and monitoring

The energy consumption is rarely measured with a meter, but calculated based on run hours and installed effect. This gives an inaccurate metering, thus both the grid company and the streetlight owner wish the streetlight to be measured with an energy meter. The easiest way to do this is by installing a meter in the switch cabinet, but this require that the streetlight is built as an electrical network, and not integrated with other types of energy consumptions.

Intelligent streetlighting gives the possibility to meter the energy consumption in each luminare, hence the streetlight owner is not dependent on having the meter in the switch cabinet. However there are some challenges that have to be solved with this type of new technology:

- The technology is not yet authorized to use for billing purposes
- The meter has to be certified, and this can be an time consuming and expensive process
- Ownership and maintaince responsibilities of the meter in the luminaire.
5.6 Human/machine interface

The public and the service providers are both dependent on information about the streetlight from the streetlight operator. The public are interested in a system for fault reporting on the street lighting, and to observe the status on each street light. The service providers are interested in a system for accurate information on the luminaires and reported failures. They are also dependent on a system for reporting the work that has been done regarding failures and other relevant information. The interface for the user should be a GIS system. GIS is very important for maintenance services, it makes it easier to find and identify the failures. The user interface on the web should be simple and easy to handle for everybody.

The front end software allows you to find, manipulate and view the information from your street light system. It will also let you change the settings in your system and monitor the health of your networks.

Normally the front end software is modular and allows for multiple extended functions when needed. In the basis the software should offer a complete Street Light Management System with all basic functionality integrated. It should allow you to look at multiple sites, check and set your schedules, analyze your lamp and equipment behavior as well as your energy usage. It has a simple reporting mechanism that allows for pre-defined reports to be generated and printed. Color coding and letters in one screen should give a first overview and general impression on the segment controller and the lamps. By Clicking on the various items information regarding the object you clicked should be presented to you in lists, tables or graphs.

5.7 Principal description

Below find a principal system sketch with adjoining system where communication channels are to be established. The communication channels are in the sketch shown in red in a “common” intermediate layer solution.
It is recommended that the communication channels should be a part of the administration system in an implemented solution.

This will be favourable for the customer-center through an effective and accurate feedback to the public on errors on the street lighting, and an improvement of the economic system due to better control with the different suppliers. The solution requires an automatic administration system for technical and economical reporting.

The system will in most cases be integrated with the existing IT solutions. The main functionality will be:
1. Administration system for street lighting
2. Customer service solution including a communication facilites
3. Active control of street light and integration to the Customer system and energy metering
4. Integration to order system and a fully developed CRM-system.

The customer-service application shall include a web/internet portal adjusted to non-professional user (public) for access and directly reporting of errors etc.
Open technology should be used so the complexity can be added step by step.

5.8 Administration system for street lights
The administration system shall consist of an administration database for street lighting, communication channels to surrounding (connected) systems (intermediate layer), an separate user applications with construction record, task list with job orders, plus history and reporting.

The administration database have a data model adjusted to the data delivered from the functional controlled street lighting operation range. Available data from the traditional street lighting is also to be stored in the database. The administration database shall handle construction structure and all the basis data with attributes for both the functional controlled and the conventional street lighting. Data from the user application in the administration system shall also be stored in the database.

It is important that the different communication channels/integrations to the surrounding systems are based on open solutions.

The software should allow for management of two main hierarchies for user Groups: one for access to the Front-end (so users can log in to the web site and view designated sections and pages) and one for the Back-end Administration access.

5.8.1 Task list
The system offers a task list with functionality, such as:
- An order functionality with a task register (a list of job orders).
- A list over customer information for the fixture identities is to be generated.
- Predefined templates for different tasks shall be available.
- The solution is to contain a calendar- function with a display of job orders.
- A given constructor shall be limited only to see his own tasks.
- The job orders are to be given mutual priority.
- The purchaser of tasks shall be able to see the status and the progress for his orders.
- Orders have to be related to individuals or groups in the construction register (i.e. switch cabinet).
- The service supplier must be able to print out finished tasks with the date and the failure cause.
- The service supplier must be able to print out a prioritized list for correction of errors for the fixtures.
5.8.2 History

The administration system has to handle reporting of condition reports from the service suppliers, with the following-up of remarks. The remarks are to be categorized depending on the error.

The task registers must report back with a joint history. It shall also be possible to register special history for individual orders in the task register.

The history from completed job lists is to be related to the fixture identity. The adm. system shall present the history generated from the functional controlled street lighting.

5.8.3 Reporting

Since reporting is a very important part of the system there should be an extension that allows you to build your own reports. There should be functions to set up the reporting the way your organization and your service providers require it with your fonts, logo’s and lay-out. Ideal is a WYSIWYG editor to make your report layouts and allows for different output formats like .pdf or word.

5.8.4 Administration database for streetlight

This application shall be used only by the operator and have a lot of functionality regarding maintenance tasks and reports. In this system all the components (such as liminares and switch cabinets) are structured in a hierarchy. Such a structure can be based on electrical structure, geographical structure or other.
5.9 Customer service application

The Customer service application shall handle reception and following-up of customer messages for street lighting. The application shall be the case handler’s tool for reception and following-up of customer inquires.

The application shall have a web-based map interface for visualization of street lighting with accompanying attribute/quality data (as errors, dimming etc). The solution shall use the standard formats Shape, SOSI and Oracle Spatial as data source for the map presentation.

The application will be related to a “living” map. It means that the map will be updated/changed frequently. Therefore it is a neccessary that the Customer service application can relate directly to the primary data source without converting to a proprietor format.

The Customer service application shall present data from the administration database for street lighting in a way that supports the operators proceedings. It will be given access to general construction data, status information, overview of ongoing tasks and history etc. from the administration database.

5.10 Data collection from street light

Functional controlled street lighting

The system must handle fixtures from different intelligent streetlight suppliers. Suppliers built their solutions on different types of standards and technologies for instance LNS-database (a database solution from Echelon) for exchange and storage of data. In connection with the introduction of a common administration system, the existing street lighting databases will be used as a data source. In the next phase, the existing system will be omitted, and the administration system will be related directly to each fixture, but still via a concentrator (subcentral).
A common used structure is based on two-way communication of data through the luminaries power supply, so called "power line communication". The information to and from the different luminaries are transferred to a concentrator located in the fixture's electrical supply (switch cabinet). The concentrators then communicate, via telephone (GPRS with MDA Mobil Data Access) with the central database or via fibre optic cables.

**Traditional street lighting**
The fixtures and the attributes is registered in the cartographic information. It is important that the luminaries have the right type of attributes, for instance x- and y coordinates.

Further, data from some energy meters for traditional street lighting is to be collected. Here, an energy meter which is connected to the same type of concentrator as for the functional controlled light is used. This way the collection of data will be similar, but with limited data size on the concentrator.
6 WP 6 COMPREHENSIVE REPORT ON FINANCIAL INSTRUMENTS

6.1 Introduction
Numerous street lightings of the communes have been getting on a bit which means that renovation has also become increasingly necessary. Due to this the sum of the yearly electricity expenses for street lighting of a commune can be equal to the yearly costs for the electricity for the commune's real estates.
According to actual investigations an average savings potential of up to 40% is possible. Optimised operation of street lighting can be a factor in consolidating the budget of a commune.

The first step in sustainable optimising street lighting is to provide transparency of purposes and to compile a street lighting register which contains the present operational condition of the street lighting.
The number of different types of lamps, illumination lanterns and masts should be held as low as is possible. It is therefore very important to introduce standards. This regulation must also apply to the illumination requirements and to the text of the public tenders.

Economical aspects and the possibilities of financing are important for the energy and cost conscious operation of the street lighting:

- **Economical planning** e.g. by implementation of economical and long-life illuminating means.
- **Economical operating methods** e.g. by optimising lamp exchange and by use of up-to-date techniques and
- **Reduction of electricity expenses** e.g. by technical measures (lamp exchange, optimised regulation, etc.)
- **Implementation of financial aids** e.g. by energy conservation contracting.

The previous report is mainly concerned with contents of the last paragraph and addresses financial instruments in detail which are helpful in the area of optimised operation of street lighting.

The specific target of the partial project is dealt with in the following chapter.

6.2 Intention of the project
Increasing energy costs have caused the expenses of communal street lighting to become a serious cost factor for the commune: With modern illumination techniques and intelligent regulation a high savings effect can be realised, so that the expense of modernising the street lighting can be quickly recovered.

Street lighting is long ago a European wide global theme. Bundling the know-how of the individual EU-Countries provides the opportunity of generating an optimised solution in this sector.

The project, "Intelligent Road and Street Lighting in Europe", was started in January 2006 under the participation of 12 European countries. The project, initiated by the companies Norconsult and Hafslund (Norway), has a duration of 2 1/2 years. The project partners come from the areas of consulting and supply organisations, energy agencies, lamp manufacturers, banks and communes. This constellation of major business partners participating on the project ensures that an intelligent street lighting will be realised.

Apart from the following themes and important work priorities in the project, such as;

- Estimation and evaluation of the energy saving on the market,
Market penetration and efficiency of procurement (material and energy),
Accomplishing larger renovation projects,
Optimising tender contents and other documents,
Acceleration of development regarding laws, standards and regulations,
Customer requirements regarding administrative instruments and issuing of information,
Practical tests of the project results in the communes and
Propagation and duplication of the results.

Also finance technical instruments should be compiled in the project. The work package 6 deals with this theme.

When planning renovation measures for street lighting the savings realised by the reduction in electricity requirements and the savings arising from the reduction in maintenance and repair are included in the project economics. For this it is necessary that simple understandable EDV instruments be made available with which one can carry out the corresponding economical calculations. It is further helpful to illustrate different financing possibilities of renovation projects in a calculation tool.

One possibility of financing saving measures in street lighting is the implementation of energy conservation contracting. This variant can be more cost-effective for the commune than by the implementation of communal own saving performances.

The energy agency of the Investitionsbank Schleswig-Holstein has compiled, within the framework of leading and processing the partial project "financial instruments" together with a calculation tool for economical and financial calculation (calculation model) also a directive for carrying out an energy conservation contract with a model agreement (Saving Guarantee Contract for the lighting of streets, roads and places). Furthermore, the calculation tool and the model agreement were matched to one another with regards to their data structure.

The project participants of the present project have agreed that telemanagement as an utilisation technique for intelligent street lighting should be concentrated upon. Different examples of street lighting and different approaches of different European countries were examined in a short study within the partial project WP6 Contracting. The energy agency has also illustrated a renovation case in conservation contracting in the area of telemanagement in the “calculation model”.

6.3 Guideline for (energy) saving contracting in streetlighting

Saving Contracting projects usually are complex projects requiring thorough preparation and appropriate know-how. Therefore, anyone not yet familiar with the subject should seek support from energy representatives, energy agencies, consulting firms or responsible persons of current projects. Furthermore, a functioning energy consumption and cost registration is one of the most important prerequisites for successful project preparation and development. The time needed until project implementation is approx. 6 – 12 months from project development to contract conclusion. After the decision of the owner of the street light to implement such a project the lighting system needs to be evaluated in the course of project development and the operating (energy and maintenance) costs baseline needs to be determined to serve as the reference value for the operating costs in the contractual period of the Saving Guarantee Contract. Furthermore, the system requirements should be defined already at this stage. This requires clarification of the interfaces with regard to maintenance and above all definition of the minimum savings to be expected and the client’s share in it.

The client compiles the tender documents with the Saving Guarantee Contract as a main component. The next step is publication in the official gazette, other official publications for public contracts and above all in special databases. Prospective bidders may then express their
interest and those apparently best suited are invited to tender in a functional invitation to tender.

The bidders are given the opportunity to inspect all installations and devices and validate the technical data. The most important characteristics of the tenders to be submitted are the guaranteed cost cuttings, data on investment volume and structure and on the required extent of maintenance. The best offers should be substantiated as the negotiation process progresses; only after this step the best bidder is finally selected.

Following the conclusion of the contract, the Energy Service Company (ESCO) implements the saving measures in street lighting system during the preparatory phase. Only on completion of the preparatory phase the period of main obligation to perform will commence in which the savings achieved are determined and the ESCO will have to answer for his saving guarantee. The following figure shows the steps and responsibilities for the project preparation, development and the implementation of the Saving Guarantee Contract:

Implementation of Saving Guarantee Contract
Regarding the implementation and realisation of contracting projects there are some general issues to consider. Contracting is a win-win model for both partners, but it needs good preparation and partnership collaboration on the basis of adequate and proven contract models like the Hesse Energy Saving Guarantee model contract for Saving contracting projects in the building sector. The Federal Environmental Agency of Germany (UBA) states that the ecological and economical benefit of Saving Contracting depends significantly on the quality of the tender and the evaluation of offers.

6.4 Project identification and preparation

First step is the inspection of data availability and a selection of appropriate parts of the street lighting system for the Saving Contracting project. A fundamental element of the project identification process is the energy audit (expert examination). The results of the audit indicate the technical scope of the necessary refurbishment measures, the prospective volume of investment, and a cost-benefit ratio, which is a starting point for the definition of the financial needs.

A street light analysis including costs for energy and maintenance tells the extent of the economic saving potential. In the course of a street light analysis, the possibilities of technical improvement are identified and economically assessed. Measures are considered efficient if the cost savings are sufficient to cover investment costs over a certain period of time.

Principally, if there is no street light analysis available the following approaches are possible:

- You commission a street light analysis,
- You contact an ESCO directly, or
- You assess the energy and maintenance savings potential according to street light-specific indicators. For the assessment the calculation tool developed in the E-Street project can be used.

If the public authority commissions a street light analysis, you will get a detailed picture of the savings potential of the street light installations in question. There is, however, the disadvantage that such an analysis requires a lot of time and money. It may be necessary for the street light owner to employ an external partner.

You can also directly commission a neutral Energy Agency to examine the suitability for a Saving Contract project. An experienced company will, without too much effort, be able to tell you whether or not a Saving Contracting project is worthwhile for the object in question.

The third alternative is to assess the lighting according to selected street light-specific indicators. Based on these indicators (in particular: lamp-related energy consumption and maintenance costs per year) one can assess, in a relatively simple (and therefore both time- and cost-saving) way, whether a street lighting system offers favourable conditions for a Saving Contracting project. The indicators of the street lights in question must be compared to the respective desired value. The desired energy values for the use of energy of old and new street lights can be found in the National Standard.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Bad values</th>
<th>Actual average values</th>
<th>Desired values after renovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luminous efficacy [lm/W]</td>
<td>&lt; 60</td>
<td>50 – 80</td>
<td>90 – 120</td>
</tr>
<tr>
<td>Nominal lifetime [h]</td>
<td>8000</td>
<td>15000</td>
<td>18000</td>
</tr>
<tr>
<td>Failure rate after 16,000 h [%]</td>
<td>30</td>
<td>15</td>
<td>5 – 10</td>
</tr>
</tbody>
</table>

**Table 1: Specific Indicators of Street lighting**

If you wish to carry out energy-oriented improvements in street lighting, you should aim to reach the indicators given in table 1. If the actual values of the respective installations are
significantly different than the desired values, one can assume that the street lighting system in question shows an economically viable potential for the reduction of operating costs.

*Which requirements have to be fulfilled for an economical Saving Contracting?*

- above-average energy consumption, energy and maintenance costs
- a long term usage concept
- guaranteed contractual relationships and ownership

### 6.5 Project Development

The next step is the constitution of a steering committee that works out targets and a time schedule. On the basis of energy and maintenance costs the reference value for the contractual period - the so-called **operating costs baseline** for the expected savings - is calculated. This can be done for energy costs on the basis of existing utility bills or calculative regarding number of lighting points, energy consumption, yearly operating hours and the definition of reference prices, while the costs for maintenance depend on material costs, wages, cleaning and disposal costs for a single change of lamp. Detailed calculation models can be found in the *Calculation Instructions* (Annex 8). The operating costs baseline is the sum of all operating costs for the last annual period before the beginning of the planned Saving Contracting.

The steering committee now has to stipulate the **system requirements** for the bidding documents with the **minimum level of operating cost savings** (e.g. 15% compared to the operating costs baseline) and other general conditions. From the targets defined for your Saving Contracting project, criteria can be deduced for the assessment of incoming offers. In addition, it has to be decided whether to give the Energy Service Companies a certain predefined general framework for preparing their offers. Set standards make it easier to compare incoming offers. A general framework should be established for the following general aspects:

#### 6.5.1 Duration of Contract

The longer the period available for the amortisation of investment expenses, the easier it is to also include less efficient energy-saving and/or more expensive investments in the project. It is easier to compare different offers if the ESCOs are given a definite contractual term on which to base their offers.

#### 6.5.2 Quality criteria

To avoid inconveniences between the contract partners the client should predefine minimum desired quality criteria for all parts of the system and compile these. This should include aspects like minimum lifetime expectations, protection rates, design, luminous efficacy or possibilities to dim the lamp. All equipment provided and installed by the ESCO will have to meet at minimum these criteria.

#### 6.5.3 Standards

In Germany there is no duty to retrofit old installations after the coming into force of DIN EN 13201. There is, however, the duty to follow these norms for any new installations and refurbishments. The contractor has to follow these regulations for any refurbishment and it also might have to be considered for the preparation of the operating costs baseline. If refurbishment measures are applied for older parts of the street lighting system, the baseline may have to be calculated for the theoretical energy consumption if the old installation would fulfill the DIN EN 13201. This is due to the fact that energy saving measures might not show their full saving potential because the DIN has to be followed and e.g. additional lighting posts are necessary.
6.5.4 Investment Costs Grants

If a measure is to be implemented by means of Saving Contracting, sufficient economic efficiency is a precondition. On principle, less profitable energy efficiency measures can be cross-subsidised within a whole package of measures. As an alternative, such measures can also be included in a project if the client offers to contribute to the investment costs. Such financing is called “additional contribution model” and may also enable the realisation of compulsory measures and/or a reduction of the contract duration. Subsidies make sense if the client can obtain more favourable terms of financing or if the attainable savings do not completely cover the ESCO’s expenses within the desired contract period. You should inform the ESCO on a willingness to grant a contribution towards investment costs at the beginning of the tendering procedure to make it possible for the ESCO to consider this factor in their project calculation.

6.5.5 Financing

The following refinancing variants and contract constructions are possible, subject always to the precondition that funds are available (each separately or in combination):

- The client takes over all costs (full subsidy)
- The client takes over a reasonable portion of the costs (part subsidy)
- The client waives his share in the cost savings
- Longer contract duration
- Combination of Saving Contracting and energy supply contracting

6.6 Tendering procedure

The search for the best Saving Contracting provider begins. The project is advertised for bids. The offers received are compared and individually negotiated. Based on the suitability criteria stated, bidders are selected which will receive the tender documents and are invited to submit tenders.

The bidders are now given the opportunity to inspect the lighting system, validate the technical data, and perform a draft analysis with regard to energy on which they will base their tender.

Through a call for tender the most appropriate provider will be found and charged with the financing, planning, implementation and maintenance of saving measures for these street lights.

Even if a public call for tender is not necessary for you, as a client you will, as a rule, profit from awarding a contract on competitive conditions.

6.6.1 Invitation to Submit Tenders / Call for tenders

The amount of time and money to be spent on the second stage of the awarding procedure depends on the estimated project scope. As a general rule, one can say, the larger your project, the more time should be invested in the preparation of the tender documents. If the project is small, it will be enough to lay down a number of essential framework conditions. As for larger projects, in order to reach your targets, it is important to use the basic principles described in the following section as a means of orientation.
6.6.2 Contents of the Tender Documents

It is helpful and/or necessary to address various aspects in the tender documents of a Saving Contracting project:

- subject matter and targets of the project
- tips for preparation of documents
- determination of remuneration
- general framework
- a draft of the Saving Guarantee Contract
- time planning
- assessment criteria
- street light installation-specific data

6.7 Validation phase

It is assumed that all costs covered by ESCO in connection with operating efficiency investment shall be repaid from the operating cost savings achieved. Thus, the savings achieved during the effective period of the contract have to be large enough to cover the bank interest and the very costs of the investment as well as the costs incurred by ESCO in connection with the provision of operation services.

In order to assess whether the savings achieved will cover all the costs incurred by the ESCO, a detailed analysis has to be carried out by the ESCO. The focus of this analysis is:

- precise assessment of the technical condition of the applied street lights,
- identification of all potential savings that could be achieved,
- planning of improvement measures and the scope of the modernisation,
- precise determination of shares in the investment and in the operation costs.

The specification of the street light's technical parameters before and after the modernisation makes it possible to determine the level of energy savings. Then, those savings have to be presented in the financial dimension.

The identified technical parameters and financial possibilities create a basis for the planning of the optimum modernisation measures, the guaranteed savings and the calculation of own costs and risks by the ESCO. This basis is used for the offer of the ESCO.

6.7.1 Identification of the best offer

The best offer will be determined from the incoming offers with the help of a defined procedure. The bidders have to be aware of the procedure and the criteria for identifying the best offer. The criteria are based on the predefined priorities and also the weights assigned to individual criteria may differ.

During the evaluation of the offers, both financial and non-financial effects of the selection of a particular offer should be considered. In order to be able to assess an offer comprehensively, the assessment of these two parts must be combined.

Monetary Assessment / Evaluation

A Saving Contracting contract leads first of all to a reduction of energy costs. However, during the contractual period other costs (e.g. maintenance costs) may be reduced too.

To compare the offers all cost categories under which changes will take place as a result of the ESCO’s work (e.g. yearly share in the savings, operational costs etc) have to be considered.

A method to compare the different guaranteed yearly energy cost reduction is the “net present value method”:
\[ K = \sum_{t=1}^{t_v} E_t \cdot (1 + i)^t \]

net present value of savings over the entire operating life with the interest rate \( i \), at time \( t=1 \)
saving in the year \( t \)
interest rate (e.g. 0.06 for 6 %)
contract duration

As savings achieved may be different in different years, it is most profitable to take into consideration the effects to be achieved over the whole period of operation of the installed equipment and elements, and to measure the project’s economic effects by means of its net present value (NPV).

**Non-Monetary Evaluation**

The following non-financial qualitative evaluation criteria can be applied:

- reduction in the emission of pollutants,
- quality of the products,
- energy management measures,
- guarantees for maintenance and service,
- the ESCO’s references and experience in implementing similar projects.

In this context it is necessary for you to formulate the criteria for the assessment of the qualitative effects of these measures on the basis of your project targets and to weight them according to their respective importance.

Using the point system or a “cost-benefit analysis” adopted for the project, it is possible to identify the offer which as a whole meets the non-financial requirements best. However, it should be remembered that the evaluation of non-financial effects is usually non-objective and as such should be carried out independently by several persons.

The following table includes a model form to be used for the cost-benefit analysis for the evaluation of the best offer (the weighting may be adapted):
Weighing points

1a. Net present value of the budgetary relief within the contract period (guaranteed savings less basis remuneration)

1b. Net present value of the budgetary relief after the end of contract

2. Investment in hardware

3. Reduction of CO₂-emissions

4. Compatibility of energy concept with existing structures

5. Compliance of energy management (measuring and metering concept) with the characteristics of performance features

6. Services offered maintenance/troubleshooting

7. Quality, useful life and future availability of replacement parts

<table>
<thead>
<tr>
<th>criteria</th>
<th>assessment</th>
<th>Weighing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>Low (Rating is calculated)</td>
<td>High</td>
</tr>
<tr>
<td>1b</td>
<td>Low (Rating is calculated)</td>
<td>High</td>
</tr>
<tr>
<td>2</td>
<td>Low (Rating is calculated)</td>
<td>High</td>
</tr>
<tr>
<td>3</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>4</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>5</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>6</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>7</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Sum</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Cost-benefit Analysis for Saving Contracting

We would like to point out once more that tender assessment is a sensitive area. Quantification often gives the impression of a high degree of objectivity, but it is merely an expression of subjective will and individual objective. However, the cost-benefit method used and explained here will meet with the best acceptance among bidders, as the underlying economic principles to a great extent correspond to the calculation principles of the enterprises. As a rule, hard criteria should always add up to more than 75% of the weighting. Too detailed scaling for soft assessment such as from 1 to 10 is not very plausible in practice. Scaling will be easier to justify if it is coarser, as in the example below:

<table>
<thead>
<tr>
<th>Points</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 points</td>
<td>Very good, ideal</td>
</tr>
<tr>
<td>8 points</td>
<td>Good, fully realisable</td>
</tr>
<tr>
<td>5 points</td>
<td>Good, but with minor flaws</td>
</tr>
<tr>
<td>3 points</td>
<td>Satisfactory, with major flaws</td>
</tr>
<tr>
<td>0 points</td>
<td>Not realisable, not existing</td>
</tr>
</tbody>
</table>

6.7.2 Optimisation of offers / Conclusion of the contract

The bidders explain their offers, and the most appropriate Saving Contracting provider with the best offer is found. Based on the offers submitted by the ESCOs, it is possible to negotiate with the bidders any changes required in the offer. The Saving Guarantee Contract, finally signed from client and ESCO, is the result of these negotiations.
6.7.3 Final result

If one and the same offer turns out to be the best according to both financial and non-financial evaluation criteria, it should be selected as the winning one. If the two evaluation procedures give different results, all subjective criteria should be considered in detail.

6.8 Saving Guarantee Contract

This contract serves as a contractual framework for the implementation of Saving Contracting models. Since Saving Contracting is a comprehensive concept ranging from the planning of measures via their implementation to guaranteeing the cost-saving results, the contract regulates a whole series of services.

The analysis, planning and implementation of saving measures, including a permanent guarantee of the saving effect, are the central services contained in the Saving Guarantee Contract like the following figure:

In general, it is recommended that the contract that is to be used as the basis for the Saving Contracting project is always drafted by the client himself, and that tenderers are then invited to submit their offers on the basis of this contract. In the course of the final negotiations, individual items of the contract can then be adapted or specified.

Even though each Saving Contracting project must be adapted to the relevant project environment as well as to the client's specific interests and situation, a model contract can serve as a valuable standard tool and can provide the client with useful information and assistance.

6.9 Manual for “Street-Lighting”- software development: Calculation model for evaluation of economic efficiency

6.9.1 Basis

The financial situation of the street-lighting can be positively influenced by using the replacement or relamping situation or the normal replacement of equipment in combination with the implementation of Telemanagement. The calculation method of the present software will show technical measures and the direct effect to the payback- period of the investment; in other words: Is the project profitable or not?!

The software programmed in MS Excel 2002. To reach the aim, it was better to choose calculation software, than database software.

This report is written as a guideline or reference book, most there are used listings. A main aspect is, to find the information in an easy way.
Most of illustrations are described as a comment in the work-sheet!

The basis parameters are recorded in chapter 3.
The Enlight- report describes further information’s in detail:
• main terms lighting engineering:
  
  www.energiekonsens.de/Downloads/Projekte/Enlight-Zwischenbericht.pdf

The software development conforms to requirements of deliverable D6.2. The Investitionsbank Schleswig-Holstein is not liable for defects of the software and for their consequences and also not liable for damages.

The software is downloadable free of charge from E-street web-pages:

http://www.e-streetlight.com/

6.10 Pilot cases financial instruments in the calculation model

The market analysis in the report of chapter 1 shows, that there are only a few pilot cases in contracting. For these cases it is difficult or impossible, to get further detailed information’s.

In the consequence this chapter covers pilot cases of telemanagement additional to WP 6.1 Performance contracting in street-lighting. The following example illustrates a planned reconstruction of street-lighting in Schleswig-Holstein (Germany)
A consulting company made the data base available. The reduction by telemanagement is pointed up by changing the averaged lighting hours (in this case 36% savings).

The calculation model shows the employment of telemanagement. The reconstruction is financed by annuity- credit.
Also it is demonstrated performance contracting examined by an ESCO:

Investment for new installation = credit (from sight of ESCO)
Investment costs for refurbishment
Running costs for processing contracting, risk sharing, etc.

The annuity = contracting rate of End-user

The rules to use the calculation model are described in the manual.
### Basics

Data from the electricity bill of the last year:

<table>
<thead>
<tr>
<th>Electric power consumption and costs for electric work</th>
<th>Costs for luminaire wattage</th>
</tr>
</thead>
<tbody>
<tr>
<td>from the energy management system or from the electricity bill of the last year</td>
<td>luminaire wattage (relevant for costs)</td>
</tr>
<tr>
<td>[€/kWh]</td>
<td>[kWh/a]</td>
</tr>
<tr>
<td>HT</td>
<td>0.100</td>
</tr>
<tr>
<td>NT</td>
<td>0.090</td>
</tr>
<tr>
<td>total average</td>
<td>0.098</td>
</tr>
<tr>
<td>total</td>
<td>130,000</td>
</tr>
</tbody>
</table>

### Taxes

<table>
<thead>
<tr>
<th>tax 1</th>
<th>tax 2</th>
<th>tax 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0130 [€/kWh]</td>
<td>[€/kWh]</td>
<td>[€/kWh]</td>
</tr>
</tbody>
</table>

### Total costs for electric power (exclusive VAT)

| total | 14,365,00 [€/a] |

### Total costs for electric power (inclusive VAT)

- VAT: 16.0 %
- average costs for electric power inclusive VAT: 0.111 [€/kWh]
- total costs for electric power (inclusive VAT): 16,663,40 [€/a]

### Actual - group of consumption: existing installation

<table>
<thead>
<tr>
<th>description of lamp</th>
<th>type of lamp (international)</th>
<th>Luminaire wattage (system)</th>
<th>number</th>
<th>total Luminaire wattage (system)</th>
<th>average lighting hours (100% power)</th>
<th>operation power</th>
<th>electric work (100% power)</th>
<th>reduced power</th>
<th>average lighting hours (reduced power)</th>
<th>operation hours (reduced power)</th>
<th>electric work (reduced power)</th>
<th>total electric work (without cable loss)</th>
<th>cable loss</th>
<th>total electric work</th>
</tr>
</thead>
<tbody>
<tr>
<td>HME 125</td>
<td>142</td>
<td>172</td>
<td>24.42</td>
<td>11.20</td>
<td>4.088</td>
<td>99,845.31</td>
<td>127,287.62</td>
<td>3</td>
<td>131,085.64</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TC - LE 35</td>
<td>35</td>
<td>172</td>
<td>6,71</td>
<td>11.20</td>
<td>4.088</td>
<td>27,422.30</td>
<td>127,287.62</td>
<td>3</td>
<td>131,085.64</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TC - LE 30</td>
<td>35</td>
<td>172</td>
<td>6,71</td>
<td>11.20</td>
<td>4.088</td>
<td>27,422.30</td>
<td>127,287.62</td>
<td>3</td>
<td>131,085.64</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TC - LE 30</td>
<td>35</td>
<td>172</td>
<td>6,71</td>
<td>11.20</td>
<td>4.088</td>
<td>27,422.30</td>
<td>127,287.62</td>
<td>3</td>
<td>131,085.64</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>total</td>
<td>344</td>
<td>31.13</td>
<td>127,287.62</td>
<td>127,287.62</td>
<td>131,085.64</td>
<td>131,085.64</td>
<td>131,085.64</td>
<td>131,085.64</td>
<td>131,085.64</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Actual - maintenance costs

<table>
<thead>
<tr>
<th>description of lamp</th>
<th>type of lamps (international)</th>
<th>operation hours (100% power)</th>
<th>operation hours (reduced power)</th>
<th>nominal life of lamp</th>
<th>exchange cycle</th>
<th>price per lamp</th>
<th>labour costs</th>
<th>costs lamp exchange</th>
<th>total exchange costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>[h/a]</td>
<td>[h]</td>
<td>[h]</td>
<td>[h]</td>
<td>[€/unit]</td>
<td>[€/unit]</td>
<td>[€/a per unit]</td>
<td>[€/a]</td>
</tr>
<tr>
<td>HME 125</td>
<td></td>
<td>4.088</td>
<td>8.000</td>
<td>0.55</td>
<td>3.00</td>
<td>30,00</td>
<td>16,37</td>
<td>17,24</td>
<td>2.902,18</td>
</tr>
<tr>
<td>TC - LE 36</td>
<td></td>
<td>4.088</td>
<td>8.500</td>
<td>0.48</td>
<td>5.65</td>
<td>30,00</td>
<td>17,24</td>
<td>2.965,58</td>
<td></td>
</tr>
<tr>
<td>total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5.867,77</td>
</tr>
</tbody>
</table>

### Actual - electric power costs

<table>
<thead>
<tr>
<th>description of lamp</th>
<th>type of lamps (international)</th>
<th>Luminous flux</th>
<th>spec. costs</th>
<th>electric power costs</th>
<th>electric power costs</th>
<th>sum costs maintenance-electric power [€/a]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>[lm]</td>
<td>[€/1000 lm]</td>
<td>[€/a unit]</td>
<td>[€/a]</td>
<td></td>
</tr>
<tr>
<td>HME 125</td>
<td></td>
<td>6.500</td>
<td>11,79</td>
<td>76,64</td>
<td>13.182,12</td>
<td>16.084,31</td>
</tr>
<tr>
<td>TC - LE 36</td>
<td></td>
<td>2.900</td>
<td>7,26</td>
<td>21,05</td>
<td>3.620,44</td>
<td>6.586,02</td>
</tr>
<tr>
<td>total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>16.802,56</td>
<td>22.670,33</td>
</tr>
</tbody>
</table>

In that case the refurbishment works by the reduction of the average lighting hours. It is more correct to reduce the luminaire wattage to simulate the installation of a telemanagement system.
### New - maintenance costs

<table>
<thead>
<tr>
<th>Description of lamp (international)</th>
<th>Nominal life of lamp</th>
<th>Operation hours (100% power)</th>
<th>Operation hours (reduced power)</th>
<th>Exchange cycle</th>
<th>Price per lamp</th>
<th>Labour costs lamp exchange</th>
<th>Costs lamp exchange</th>
<th>Total exchange costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>HME 125</td>
<td>2,628</td>
<td>8,000</td>
<td>0,33</td>
<td>3,00</td>
<td>30,00</td>
<td>10,85</td>
<td>10,85</td>
<td>1,865,70</td>
</tr>
<tr>
<td>TC - LE 36</td>
<td>2,628</td>
<td>8,500</td>
<td>0,31</td>
<td>5,85</td>
<td>30,00</td>
<td>11,08</td>
<td>11,08</td>
<td>1,906,44</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>3,772,14</strong></td>
</tr>
</tbody>
</table>

### New - electric power costs

<table>
<thead>
<tr>
<th>Description of lamp (international)</th>
<th>Luminous flux</th>
<th>Spec. costs</th>
<th>Electric power costs</th>
<th>Electric power costs</th>
<th>Sum costs maintenance + Electric Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>HME 125</td>
<td>6,500</td>
<td>7,58</td>
<td>49,27</td>
<td>8,474,22</td>
<td>10,339,91</td>
</tr>
<tr>
<td>TC - LE 36</td>
<td>2,900</td>
<td>4,67</td>
<td>13,53</td>
<td>2,327,43</td>
<td>4,233,87</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>10,801,64</strong></td>
</tr>
</tbody>
</table>
Project: **Intelligent Road and Street Lighting in Europe**

Acronym of Project: **E-Street - WP 6.3 pilot cases**

Agreement N°: **EIE/05/157/SI2.419662**

Work Package 6: **Financial Instruments**

municipality: **in northern part of Germany**

object: **employment of telemanagement**

### Savings - Summary

<table>
<thead>
<tr>
<th></th>
<th>Actual</th>
<th>New</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[kW]</td>
<td>[kWh/a]</td>
<td>[kW]</td>
</tr>
<tr>
<td>total Luminaire wattage (system)</td>
<td>31,13</td>
<td>84,269</td>
<td>0,00</td>
</tr>
<tr>
<td>total electric work</td>
<td>151,689</td>
<td>46,816</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Actual</th>
<th>New</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[€/a]</td>
<td>[€/a]</td>
<td>[€/a]</td>
</tr>
<tr>
<td>Maintenance</td>
<td>2,099,56</td>
<td>6,000,91</td>
<td>3,901,35</td>
</tr>
<tr>
<td>Power reduction</td>
<td>5,867,77</td>
<td>3,772,14</td>
<td>2,095,63</td>
</tr>
<tr>
<td>Total cost savings</td>
<td>8,896,55</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Choose: Average useful life of reconstruction: 15 a

### Efficiency (static calculation)

<table>
<thead>
<tr>
<th></th>
<th>excl. VAT</th>
<th>VAT</th>
<th>incl. VAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment costs</td>
<td>[€]</td>
<td>[%]</td>
<td>[€]</td>
</tr>
<tr>
<td>total</td>
<td>44,720,00</td>
<td>16,00</td>
<td>51,875,20</td>
</tr>
<tr>
<td>Payback period</td>
<td>6,41 a</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Financing of reconstruction by annuity-credit

Investment for new installation: 51,875,20 [€]

Duration: 12 a

Rate of interest %: 4,00%

Rate of payment in %: 10,66%

Annuity (rate of payment) in €: 5,527,42

Date of out-payment: 2006

<table>
<thead>
<tr>
<th>current year</th>
<th>interest (€)</th>
<th>repayment (€)</th>
<th>annuity (€)</th>
<th>rest- capital after repayment (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>previous period</td>
<td>51,875,20</td>
<td>2,075,51</td>
<td>3,652,41</td>
<td>51,527,42</td>
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<tr>
<td>Year 1</td>
<td>2,075,51</td>
<td>3,652,41</td>
<td>51,527,42</td>
<td>48,422,79</td>
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<tr>
<td>Year 2</td>
<td>44,822,79</td>
<td>1,936,91</td>
<td>3,090,50</td>
<td>44,832,29</td>
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<tr>
<td>Year 3</td>
<td>44,832,29</td>
<td>1,793,29</td>
<td>3,734,12</td>
<td>41,098,17</td>
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<tr>
<td>Year 4</td>
<td>41,098,17</td>
<td>1,643,90</td>
<td>3,883,49</td>
<td>37,214,68</td>
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<tr>
<td>Year 5</td>
<td>37,214,68</td>
<td>1,486,59</td>
<td>4,036,83</td>
<td>33,175,85</td>
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<tr>
<td>Year 6</td>
<td>33,175,85</td>
<td>1,327,03</td>
<td>4,200,38</td>
<td>28,975,47</td>
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<tr>
<td>Year 7</td>
<td>28,975,47</td>
<td>1,159,02</td>
<td>4,368,40</td>
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<tr>
<td>Year 8</td>
<td>24,607,07</td>
<td>984,28</td>
<td>4,543,13</td>
<td>20,063,94</td>
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<tr>
<td>Year 9</td>
<td>20,063,94</td>
<td>802,56</td>
<td>4,724,86</td>
<td>15,339,08</td>
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<tr>
<td>Year 10</td>
<td>15,339,08</td>
<td>613,56</td>
<td>4,913,85</td>
<td>10,425,23</td>
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<tr>
<td>Year 11</td>
<td>10,425,23</td>
<td>417,01</td>
<td>5,110,41</td>
<td>5,314,82</td>
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<tr>
<td>Year 12</td>
<td>5,314,82</td>
<td>212,59</td>
<td>5,314,82</td>
<td>0,00</td>
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</table>

Total: 66,328,98 Payment

### Payback period

<table>
<thead>
<tr>
<th>Static calculation (interest = 0)</th>
<th>Payback period by annuity credit</th>
<th>Average useful life of reconstruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>6,41 a</td>
<td>8,19 a</td>
<td>15 a</td>
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</tbody>
</table>
Project: Intelligent Road and Street Lighting in Europe
municipality: in northern part of Germany
object: employment of telemanagement

Cost schedule

<table>
<thead>
<tr>
<th>Current year</th>
<th>interest + repayment</th>
<th>interest [€]</th>
<th>repayment [€]</th>
<th>annuity [€]</th>
<th>rest-capital after repayment [€]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>60,000</td>
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<td>6</td>
<td>60,000</td>
<td>60,000</td>
<td>0</td>
<td>60,000</td>
<td>0</td>
</tr>
</tbody>
</table>
Project: Intelligent Road and Street lighting in Europe
municipality: in northern part of Germany
object: employment of telemanagement

Payback period

- Payback period static calculation
- Payback period by annuity credit
- Average useful life of reconstruction

Luminaire wattage system

- bill
- actual
- new
- savings
**Total electric work**

- Bill [kWh]: 130,000
- Actual [kWh]: 131,085.64
- Savings [kWh]: 84,269
- Total Savings: 46,816

**Total cost for electric power**

- Bill [€/a]: 16,663.40
- Actual [€/a]: 16,802.56
- New [€/a]: 10,801.64
- Savings [€/a]: 6,000.91
Project: Intelligent Road and Street lighting in Europe

municipality: In northern part of Germany

object: Employment of telemanagement

### Total costs for maintenance

<table>
<thead>
<tr>
<th></th>
<th>Actual [€/a]</th>
<th>New [€/a]</th>
<th>Savings [€/a]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sum (el. power + maintenance) costs</td>
<td>22,670.33</td>
<td>14,573.78</td>
<td>8,096.55</td>
</tr>
</tbody>
</table>

### Sum (el. power + maintenance) costs
7 WP 7 REPORT ON DISSEMINATION AND REPLICATION OF SUCCESS

7.1 Introduction

In this report we present the actions taken to disseminate the work that has been performed in the seven work packages of the E-STREET “Intelligent road and street lighting in Europe” project in the period of time of two and half years, January 2006 – June 2008. The purpose of this report is to highlight the main achievements within that period and we shall attempt to forecast the future implication of the advancing of telemanagement technology of the street lighting.

This document will list the dissemination events in detail according to the Dissemination Plan presented at the Kick-of-meeting Jan-Feb 2006 at Leusden, Nederland. Additionally, in the aim to increase E-STREET project external communication and dissemination activities, Swedish Consultant Company Nils Borg, Borg Co. has prepared E-STREET communication and dissemination plan. All the dissemination materials used at the activities of the project are attached.

7.2 DISSEMINATION PLAN

The objective of the Dissemination Plan is to identify and organize the activities to be performed in order to promote of the E – Street project results and the widest dissemination of knowledge from the project.

The plan has been expanding in two directions: towards the marketing activities in order to enhance the potential of the intelligent street and road system and towards the notification of the project’s results into the local authorities, policy makers, designing and manufacturing sector. All Partners have discussed possibilities of the co-operation on dissemination process and the results of these discussions were presented to other Partners.

Dissemination is a horizontal activity and concentrates on disseminating the results of E-STREET project itself to a wide range of existing or potential stakeholders. Special attention was also paid to the transfer of knowledge to Eastern European countries through conference presentations in these countries (see attached presentations in Russian language).

The E-STREET project aims to address issues relating to the intelligent street and road lighting at both the strategic and practical level. The practical experience and guidance to emerge from the project work are of the relevance to an array of stakeholders within the street lighting components manufacturers and beyond and will be of the value across different sectors and internationally.

To fulfill these aims, the E-STREET project partners work through various carefully focused groups and committees through formal and informal mechanisms. Clear channels of communications between the project partners themselves as well as with the wider community play a crucial role in the success of the project.
7.3 The information and communication infrastructure at the E-STREET project

At the E-STREET project we have established an infrastructure for communications and dissemination by building a robust framework in which dialogue and interaction can take place. This applies equally to internal and external communication.

7.3.1 Electronic mailing lists

Through the whole period of the E-street project subsistence each of the partners creates his own external e-mailing list of the target groups, decision makers from each country, to inform and communicate with them regarding the market changes and the energy savings potential. Due to Data Protection this list cannot be disclosed in this report.

E-STREET Partners use these common mailing lists to inform in respect of the aims, final products and possibilities of their exploitation to the national institutions, professional lighting associations, higher professional schools, exhibitions and conferences e.t.c.

As an example of using e-mail frame, in Sweden the E-STREET project partner Ingemar Johanssons, project manager of the Traffic & Public Transport Authority, to make e-mail more personal and more credible, use a special mail layout with the own picture and the logotypes of Göteborg Stad, E-STREET project and manufacturers. This mail information has been sent out to 620 people within different segments of the market and each message was repeated three times:

T&P use the mail to send all kind of information such as invitation or confirmation e.t.c. The advantages of this is that today with all the information people receive in Swedish society...
everything has to be repeated so the receiver knows and recognises when T&P is sending
information about E-street.

7.4 Publication programme

7.4.1 Printed publications

*Leaflets, brochures, pamphlets*

From the early stage of the E-STREET project, some of the partners have prepared and
produced printed copies of the selected information and instructional materials for distribution
on freely basis. The City of Oslo, by the Agency for Road and Transport, made a little pamphlet introducing the
term “dynamic lighting” and the basic principles in street lighting control system. Also it includes
a short presentation of the work being done in Oslo in respect of making it a “green town”. The
pamphlet was published in two languages - Norwegian and English.

As a project for the Norwegian Energy efficiency agency, ENOVA, a “Guide for energy efficient
street lighting installations” was written. The booklet is prepared for the personnel who is
responsible for the outdoor street lighting, like the road keepers and advisers/consultants. It
runs through all relevant aspects of the economical and political challenges concerning these
investments. It was published in Norwegian. Later the booklet was translated into English,
published and disseminated in all partners’ countries.
In Poland the under mentioned leaflet has been prepared and disseminated at the several meetings, conferences, seminars or workshops. Several times the leaflets were sent to the main actors of the Polish street lighting market, interested in the development of the E-STREET project.
The leaflet contains the information in respect of the structure of the telemanagement system and short examples of energy savings potential in Europe.

The electronic brochures prepared by SELC – Ireland in cooperation with Streetlight Vision contains various information intended for the street lighting specialists and municipality decision makers as well as for the customers meaning the local society.

In the brochure are mentioned strategic assets of the streetlight for a city, information of energy and maintenance savings costs, technical structure of the system, customer case studies and solutions towards an online monitoring centre. The second one provides more detailed technical overview of the separate components for the telemanagement system.
**Newspaper and specialist magazines articles**

During the whole period of the E-STREET project, the project partners have published a large amount of the articles in the newspapers, specialist magazines and journals, promoting an intelligent street lighting system. Streetlights illuminate the roads we drive on, the pedestrian paths we walk along and the public areas where we gather. But the number of streetlights in a city and their wide geographic distribution make them difficult and expensive to operate: lamp replacements every its lifetime period, increasing cost of electricity and outdated luminaries to retrofit, manpower and service trucks for outside maintenance. Street lighting systems add to carbon dioxide emissions. Light pollution also has a negative affect on the environment, impacting plants, animals and people's sleeping habits. The increased pressure for sustainable development, green and eco cities, reducing maintenance budgets and increasing safety and security for citizens are now pushing cities to find solutions to reduce their spending on streetlight networks while continuously improving light efficiency and safety. The increasing price of electricity is, by itself, responsible for the majority of the increase in streetlight operation budgets. It is now becoming strategic and compelling for cities to implement solutions to identify streetlight failures as well as to measure, analyze and reduce electricity consumption, in order to reduce energy spending, decrease maintenance costs, challenge their electricity providers and contribute to the reduction of CO2 emissions, as required by the Kyoto. This information mainly dominates in E-STREET project partners publications.

In Aftonbladet – the largest evening newspaper in Sweden and in Elininstallatören – the information for contractors.
The dissemination activities in Bulgaria were design with a number of publications in the Utilities Magazine - a specialized monthly b2b Bulgarian magazine for the infrastructure and energy, public services and utilities. Below are listed the examples of the various titles of these publications.

**FLEET MANAGEMENT**

How to Make Our Business More Profitable

**EMISSIONS MANAGEMENT**

A Threat to the Bulgarian Business
The Prices of Carbon Quotas

**LIGHTING**

An Innovative Project in Sofia
I Hope that Energy Efficiency Will Become Topic Number One

**MANAGEMENT**

Optimization of the Business Processes

**ENERGY MANAGEMENT**

Demand Management
Systems for Energy Management
COGENERATION

Cogeneration – Matter, Principles And Appliace
Decentralized Generation And Microgrids – The Future Of Energies?
There Is High Potential In Biomass Usage
12% Of Electricity In EU Is Produced By Cogeneration

STREET LIGHTENING

What Should Street Lighting Be

TELECOMMUNICATIONS

Operational Risk In Telecommunication Activities

TECHNOLOGIES

Nanotechnologies In Energy Sector

HISTORY

60 Years Electricity In Southwest Bulgaria

E-UTILITIES

COGEN Europe

INFRASTRUCTURE

The Microtunneling Technology

STREET LIGHTING

Street Lighting Poles
Is the Street Lighting in Sofia Efficient and Up-to-date?
The New European Project for Street Lighting
Street Lighting – Present & Future
Denvim 2001 Ltd
Maintenance of the Street Lighting Facilities
Cosmopolis – a New Standard in Street Lighting

MANAGEMENT OF FIELD WORKERS

Field Workers — the Heart of the Organization
Investments In Impartial Control
High GPS Technologies Serving Business
Modern Customer Service with Wireless Connectionware Technologies

E-UTILITIES

Future without Nuclear Power?

In Poland several publications were printed out in the specialist magazines (Elektroinstalator) and journals (Wspólnota – for local authority and EPS – Energy, Money, Environment)
The representatives of ELTODO EG from Prague have held several lectures regarding the “Energy efficiency in road lighting”, on various occasions within the last few years focusing mainly on the standards and technical issues. The effort and achievements have been mentioned repeatedly in the different magazines (e.g. ELTODO Magazín). The list below is incomplete.

The information for the market regarding the adaptive intelligent street lighting in Germany was presented mainly on a website base. The website www.strassenbeleuchtung.de is the most
famous information-portal in Germany, also for introducing the new technologies. Further it is important to consult the municipalities in **financing and contracting**. For example the Energy-Agency in Schleswig-Holstein (Germany) is the contact partner for the municipalities in reconstruction of the buildings and street-lighting.

In January 2008 Tom Kristoffersen from the City of Oslo, the Agency for Road and Transport and Bjørn Sandtveit, Hafslund was interviewed by the radio show “Norgesglasset” broadcasted by the NRK. The theme was smart street lighting and the energy savings that the City of Oslo has achieved.

### 7.4.2 The worldwide web site – Deliverable 7.4.

To obtain the better market penetration and response and hence an expand the market for intelligent street lighting the web site:


was designed and established in the beginning of the E-Street project. All information about the project:

- information about E-STREET and its activities including contact details, background information, working papers, events (seminars, workshops, conferences) etc.
- instructional and examples of developed materials as discussed above (the web in this respect acts as a principal means of publication);
- State-of-the-art lighting management and technology information;
- Links to EU Lighting Association, standardization organization,
- Links to national partners, organisations, cities, regional authorities, project offices, etc.;
- Links to manufacturers, dealers, installation companies and ESCO firms web-sites,
- Street lighting energy/cost survey/calculator,
- Multilingual lexicon with professional terms and definitions,
- frequent news and updates to keep the community informed

is possible to get at this web site. The project website has been available throughout all period of project. All deliverables are available for download from the site.
Logo of the project was prepared in several versions and one was selected to place on main web layout and on printed documents regarding the e-street project. The web site is available in the Portuguese, Polish and German languages also.
For internal communication, the web site is used by E-STREET partners as the principal means of distributing administrative, policy, and procedural documents. Where necessary, documents and sets of documents may be accommodated on password protected pages and thus made accessible to selected individuals and/or groups.

In Sweden since the beginning of E-Street project Traffic & Public transport Authority also have had information on T K web site about adaptive lighting and as soon as everything was clear for the seminary at Elfackmässan, Swefair in Göteborg T & P have had a short information on their web sight www.elfack.com about adaptive lighting with the same layout as in the e-mail.

7.5 PROMOTING DISSEMINATION AND REPLICATION OF SUCCESS

7.5.1 Training Events and Product Development

Dissemination planning provides an opportunity for dissemination goals, strategies, and activities to be conceptually and carefully considered:

- conferences,
- seminars,
- workshops,
- meetings,
- Exhibitions, fairs:
Mentioned at the below table conferences, workshops, seminars have been organised by the E-STREET project Partners:

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Name of the event (seminar / conference, workshop, consultation)</th>
<th>Numb of participants</th>
<th>Annexes (invitations, programme, registrations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portugal</td>
<td>2006</td>
<td>1. Meeting – Almada 2. Several meetings</td>
<td>20</td>
<td>Board of Administration, Electricity company Specialists - presentation</td>
</tr>
<tr>
<td>Year</td>
<td>Event Description</td>
<td>Participants/Details</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>-------------------</td>
<td>---------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>5th E-STREET Forum – Almada – May</td>
<td>Local and national authorities, energy agencies, ESCOs, SL Co. - presentations and discussion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>National Conference „Lighting’2007“ June, Varna</td>
<td>Presentation, lectures national and international participants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>Webb mail information about E-street/ IB to communities in Sweden</td>
<td>620 Webb mail, invitations, programme, PP, TK webb, articles in newspapers &amp; magazines, CD, information on Swefairs webb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>International Lighting Conference, Bled, Slovenia, Oct. D 7.2</td>
<td>Presentation of the E-street project to the Lighting Society of Slovenia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>Seminar on management of Public Lighting, March, Ljubljana</td>
<td>Programme, invitation</td>
<td></td>
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</tr>
<tr>
<td>2008</td>
<td>International Balkan Light Conference – October – D 7.2</td>
<td>Presentations, leaflets,</td>
<td></td>
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<tr>
<td>2007</td>
<td>Grundlagen von Licht und Beleuchtung – 11.06.2007 (Paderborn) und 13.06.2007 (Dortmund), Philips Lighting Akademie</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Country</td>
<td>Year</td>
<td>Event Details</td>
<td></td>
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<tr>
<td>Denmark</td>
<td>2008</td>
<td>1. Mini Conference at the International Fair „Light &amp; Biding“ Frankfurt, April</td>
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<td></td>
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<td>70 Presentation, discussion</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>120 Presentation, Proceedings</td>
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<td>2. International Conference LIGHT, October, Ostrava – D 7.2</td>
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<td>3. E-Street Forum, Sofia, November</td>
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<td>80 Presentation, Proceedings</td>
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<td>150 Presentation, Proceedings</td>
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<td></td>
<td>30 Presentation, Proceedings</td>
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<tr>
<td></td>
<td></td>
<td>70 Presentation, discussion</td>
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<td></td>
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<td>30 Presentation</td>
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<td>50 Presentation</td>
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<td>2. Energo Tab –Fair 12.09.06 – visiting, talks</td>
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<td>4 Leaflets/Photos/Catalog</td>
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<td>30 Leaflets/catalogs</td>
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<td></td>
<td></td>
<td>200 Leaflets/catalogs</td>
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<tr>
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<td>2007</td>
<td>1. Seminar OUID Kalisz – 12.01.2007</td>
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<td>2. Meeting POLLIGHTING – 11.01.07</td>
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<td>4. 1-day workshop PJCEE – 15.05.07</td>
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<td>5. Conference Kolobrzeg – 17-20.05.07</td>
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<td>6. Conference Warsaw-Philips – 28.05.07</td>
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<td></td>
<td>9. Workshop PHILIPS/PJCEE – 21.06.07</td>
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<td>10. Workshop Philips/PJCEE -</td>
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<td>150 Presentation , leaflets</td>
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<td>15 Presentation, training</td>
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<td>30 Agenda, leaflets,presentation</td>
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<td>15 Presentation, leaflets</td>
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<td>20 Leaflets/Photos/Catalog</td>
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<td>150 Leaflets/catalogs</td>
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<td>Ireland</td>
<td>2007</td>
<td>Various papers and presentations at ILE UK &amp; Ireland meetings.</td>
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<td>18th September. Presentations and discussions in Dublin Ireland.</td>
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<td>E-Street initiatives continually promoted with our new/existing customer base.</td>
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<td>100 Presentations and discussions with city leaders and street light engineers.</td>
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<td>15 Presentations and discussions with city leaders and street light engineers.</td>
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<td></td>
<td>2008</td>
<td>1. „Intelligent street lighting“ – Kalisz, January</td>
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<td></td>
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<td>2. Workshop Philips/PJCEE – April, Warsaw</td>
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<td>3. Mini-conference „Light&amp;Building“ – April, Frankfurt</td>
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<td>4. E-Street Forum – May, Almada</td>
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<td>120 Presentation leaflets – meeting with local authorities, specialists</td>
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<td>15 Presentation, training</td>
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<td>70 Presentation, training</td>
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<td>Finland</td>
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<td>Echelons</td>
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<td>1. Session of Municipal Technology – June, Espoo</td>
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<td>2. Conference of Traccic and Routes – October, Tampere</td>
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<td>300 Presentation, discusion, trials etc.</td>
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<td>900 Highway Administration, decision makers, contractors.</td>
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<td></td>
<td>2008</td>
<td>1. Joint Master Class Dynamic Outdoor Lighting between GE power and Luminext where the E-</td>
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<td>78 2 presentations followed by 2 demo’s of a working solution</td>
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</table>
street project was presented and the outcome shown.

- Post Academic Course) on outdoor lighting where the E-street project was presented and an example calculation was made using the calculator.

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
<th>Participants</th>
<th>Location</th>
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<tbody>
<tr>
<td>2008</td>
<td>the LonWorld in Amsterdam, a conference for LonWorks a technology that forms the basis for many Dynamic Outdoor Lighting companies</td>
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<td>Conference</td>
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<td>3 information meetings organized by SentreNovem</td>
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</table>

During the conferences, workshops, seminars mentioned above in the table, organised by the E-STREET project partners or with their participation with the presentations only, more than 5500 peoples have been:

- raised of the awareness about E-STREET project activities, resources, technologies etc.;
- acted as training venues e.g. for disseminating instructional material as required around a particular stakeholders;
- acted as for a more public discussion of research, development, collections, standards, or other strategic and substantive issues of interest to E-STREET and the wider community;

Papers or abstracts have been submitted to a number of conferences detailing the work of the E-Street project. Submissions were made by the each Partner to mentioned above at the table conferences from which more interesting and important were:

**Seminaries at the Swedish Fair**

Elfack 2007 is the most effective way of meeting Scandinavians electrical sector. This well established event started 1969 and enjoys a strong position among exhibitors and visitors. It puts you in direct contact with customers and exhibitors in installation, distribution, computers, lighting and security sectors. Elfack 2007 had 34,000 visitors during one week in May Ingemar Johansson had a lecture for three days on a road at Elfack, Swefair in Goteborg. A lot of visitors were listing from all of Scandinavia. The Swedish Road Administration and some municipalities in Sweden were very interested of the concept of adaptive lighting.

Information on Swefairs web site in April 2007 introducing adaptive lighting for the fair:

*Intelligent gatubelysning i fokus på Elfack:*

"Vi skulle kunna plocka bort några kärnkraftverk!"


At the Swefair T & P also showed a prototype of the system for Tuvevägen. Five luminaries were installed at the fair together with the installation of the computer programme. The system showed how the lighting worked in practice during twenty-four hours.

T & P believe that the information kept a high informative level at the seminars and the audience were achieving new knowledge that will come in handy working with adaptive lighting at different market segments.

Project manager Ingemar Johansson at Elfack, Göteborg having a lecture about the evaluation of adaptive lighting at Tuveleden

**Czech Republic:**
On the international conference “ENERGOMATIKA” focusing on the implementation of IT technology to the sector of power energy was presented the paper “Modern trends in controlling and dimming in public lighting”. The topic was very well welcome by the audience.
The Netherlands
The E-street project has been described and promoted at the following events:

- Joint Master Class Dynamic Outdoor Lighting between GE power and Luminext where the E-street project was presented and the outcome shown.
  2 Day event at GE Power Systems HQ in Haaksbergen, The Netherlands
  2 presentations followed by 2 demo’s of a working solution (2 ½ hour in total)
  78 participants attended over 2 days.

- Henk Walraven has given the POA (Post Academic Course) on outdoor lighting where the E-street project was presented and an example calculation was made using the calculator.
  2 Day post academic course on Outdoor Lighting
Delft Technical University in Delft, The Netherlands
Presentations, Demo’s and workshop
36 participants
- Henk Walraven is a member of the SentreNovem Special Task Force of Ministry of VROM where the E-street project and its information on legislation has been presented and promoted in almost all meetings.
  3 information meetings organized by SentreNovem
  2 workshops about Dynamic Street Light
  All meetings Held at the SentreNovem offices in Utrecht, The Netherlands
  Per session on average between 20-40 people
- Henk Walraven mentions and presents the E-street project in almost all sales calls with Road Authorities, Communes and Commercial customers. Especially the Calculator, the legislation and example RFP are use and explained. In regular business I present Dynamic Outdoor Solutions on a daily basis to end-users, installers and main contractor.
  All major cities and all major contractors in the Netherlands had presentations on various levels of the organization.
- Henk Walraven represented the E-street project During the LonWorld in Amsterdam, a conference for LonWorks a technology that forms the basis for many Dynamic Outdoor Lighting companies.
  5 day event with a tradeshow at The RAI Conference Centre in Amsterdam, The Netherlands
  3 presentations at various occasions (including the workshop on Dynamic Outdoor Lighting)
  12 demo’s of the Oslo Solution to various groups of people
  In total around 400 people has attended either one of them or both
- Because of the E-street Initiative a Knowledge Centre for Dynamic Lighting in the Netherlands started supported by 5 companies:
  o De Kok and Partners Consultants
  o Hoelake Installation Technology
  o Maaiken Dynamic Outdoor Lighting
  o Elspec Electrotechnical Products
  o Luminext Dynamic Outdoor Lighting
The prime target of this group is to share the know-how on dynamic lighting in the Dutch market in combination with the Dutch Association of Lighting Companies. The E-street Initiative finding and material will be promoted in this group as well. A web site will be build and Master Classes organized in the very near future

Slovenia:
Presentation of the “E-street” project at the annual International conference of the Lighting engineering society of Slovenia, 124 people present from different counties
Ireland:

Various papers and presentations at ILE UK & Ireland meetings. 18th September. Presentations and discussions in Dublin Ireland. 12 & 13th February. Mini conference. Manchester UK. 16th & 17th April Mini Conference & Seminar, Milton Keynes UK
E-Street initiatives continually promoted with our new/existing customer base. Presentations and discussions with city leaders and street light engineers.

**Portugal:**

The 5th E-street Forum meeting, on the topic of “Intelligent Street Lighting”, was held in Almada, on the 15th of May 2008. This event was promoted by AGENEAL with the support from the Municipality of Almada and the key target audience was: local and national authorities, energy agencies, ESCOs and street light companies.

The agenda of the Forum focused in the following topics:

- Organization of streetlight owners and contractors;
- Administration system for street lighting;
- Metering and billing;
- Upgrading of streetlight installations;
- Procurement procedures and financial instruments;
- Presentation of adaptive street lighting.

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**E-Street Forum**

*Intelligent Street Lighting*

*Museu de Cidades de Almada, Casa da Praia, Almada*

*15th of May 2008*

**Programme**

| 09:00 – 09:15 | Welcome and opening |
| 09:15 – 10:15 | Organization of streetlight systems and aspects of street lighting (uses) |
| 10:15 – 10:45 | Presentation of administrative system for street lighting (MUNIPEL) |
| 10:45 – 11:00 | Meeting with the representatives of local and national authorities |
| 11:00 – 11:15 | Official inauguration |
| 11:15 – 11:30 | Presentation of streetlighting installations and functionalities |
| 11:30 – 11:45 | Presentation of existing streetlighting and future streetlighting systems |
| 11:45 – 12:00 | Presentation of new streetlighting systems |
| 12:00 – 12:45 | Lunch break |
| 12:45 – 13:00 | Open discussion |

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Not available...
The Forum was well attended, as a result of the interesting lectures given by the experts invited to this session (AGENEAL, Municipality of Gothenburg, HAFSLUND, ELTODO, NORCONSULT, Investitionsbank Schleswig-Holstein and LCI).

This event was of great importance in order to overcome an important barrier to the introduction of intelligent street lighting in Portugal and, in particular, in Almada, related with the lack of know-how about the available technology, among the technicians involved in the management of street light installations.

Norway:
The involved partners from Oslo Norway has held several lectures at different occasions the last years on the topic “Intelligent Road lighting”, both concerning technical-, political- and investments-issues. The effort and achievements has also been mentioned several times in different newspapers and magazines. Below is a short but not complete list.

An abstract was entered for the 26\textsuperscript{th} session of the CIE 2007 in Beijing, with the title “Intelligent Road Lighting”. The paper was chosen by the CIE to be a presented paper, and Mr. Eirik Bjelland held a presentation in Beijing on the 6 July.

The City of Oslo, the Agency for Road and Transport, had a stand on the 2007 “Miljøtorget” in Oslo the 9\textsuperscript{th} of June. This is a yearly gathering were different environment organisations gather in the centre of Oslo to communicate with the public. The booth was well visited and a lot of people were given “the good message”.

The third E-street road light forum meeting was held in Sandvika outside of Oslo the 9\textsuperscript{th} of May 2007. The following topics were highlighted:

- Communication: power line, radio, W-lan etc
- Protocols: Lon-works, Zigbee, Dali and others
- Technology: Hardware, software, implementation, plug and play

Philips, both represented in Denmark and with the main office in Eindhoven in the Netherlands. The Philips people, spread over many subsidies all over Europe, continuously perform marketing activities of “telemanagement” within their regions. Some of the direct involvement in E-street initiatives can be mentioned: Meeting in Sofia fall 2006, participating in all Forum meetings, presentations in Poland, Lisabon and Oslo.
In **Poland** on 20 June 2007 The Polish National Energy Conservation Agency held the International Conference in respect of the "Energy efficient lighting – the perspective of development in Europe and in Poland" as a part of activities in Energy Intelligent – Europe projects New Green Light, E-Street, Proefficiency and EnERlin. The venue was held at the Palace of Culture and Science the largest congress center in Warsaw, at the main hall of Warsaw Counsel. The aim was to inform the significant policy makers - the local governments as well as the households energy consumers about the perspective of energy efficient lighting development and to integrate the lighting circles for sustainable development and energy efficiency. The event was organized together with The Municipality of Warsaw, the association of the Polish lighting equipment manufacturers – Pollighting and The Polish Committee on Illumination (CIE Poland) . The Honor Patronage was comprehended the President of Warsaw, Ms Hanna Gronkiewicz-Waltz and the Minister of Economy, Mr Piotr Woźniak.

The most interesting subject of the conference was the European Union policy and the strategies of the energy efficient lighting implementation presented by Mr Bogdan Atanasiu, JRC EU and Mr Gerard Stricland ELC/CELMA representatives.

The most important event in Bulgaria was the National conference with international participation Lighting'2007, where a session dedicated on adaptive street lighting have been included. In the conference participated more than 140 specialists from the country and about 15 participants from abroad. This was the largest forum dedicated to all problems on lighting.
The following papers were presented:

1. Intelligent Road and Street Lighting in Europe, N. Vassilev, B. Tashev, N. Yaneva, Bulgaria.
5. Realization of New Road Lighting in the Town of Sliven, S. Plakhanov, P. Trankov, Bulgaria.

10.45 – 11.00 a.m. – Discussion
In short their content was as follows:

**Intelligent Road and Street Lighting in Europe E-Stre et** - (Nikolay Vassilev, Boris Toshev, and Nicolina Yaneva). The so called “intelligent” or “adaptive” lighting is characterizing the new trends in the modernization and the improvement of street lighting. The energy efficiency and the quality of lighting are realized considering the vehicles traffic and the meteorological conditions. In the paper are presented the intelligent lighting “architecture” and the structure as well the devices through which is accomplished the permanent control and management of all elements of the street lighting, the communication connection between the different system levels, the information exchange and the storage.

**A Monitoring System for Dynamic Street Lighting Control** (Nikolay Vassilev, Angel Pachamanov, Radostin Pachamanov, Technical University – Sofia). The paper discusses a lighting control system that is consistent with the latest European developments regarding intelligent road and street lighting management. The hierarchy levels of the system for monitoring and control are described, as well as the requirements for the basic subsystems - power supply, lighting fittings and control sensors; local lighting devices; central system with data base about the most important luminaries’ parameters; communications system/network, providing data exchange among the different system levels. Main functions of the system for dynamic telemanagement are the control of the failures in lighting fittings and the provisioning of adaptive street lighting.

**STREET LIGHTING TELEMANAGEMENT SYSTEM IN Varna** – Assoc. Prof. Dr. D. Matev - This paper present technical and technological aspects of the design and building conception of Street lighting Telemanagement system in Varna, Bulgaria.

**ECONOMICAL ASPECTS OF STREET LIGHTING AUTOMATION SYSTEM IN Varna Town** – Assoc. Prof. Dr. R. Kirov - This paper present the economical aspects of novel dimming Street lighting Telemanagement system in Varna Town, Bulgaria.

**REALIZATION OF NEW ROAD LIGHTING IN THE TOWN OF SLIVEN** – Assoc. Prof. Dr. St. Platikanov, Assist. M. Eng. Pl. Tzankov - The paper presents the approaches to introducing new contemporary road lighting in the town of Sliven and the results of the implemented project. Energy audit, lighting engineering calculations and optimization are done. The energy efficiency of road lighting is increased by replacing the mercury lamps with high-pressure sodium lamps. The summary of the results of the modernization carried out in the city shows a 2.6-fold decrease in the old power installed.

**APPLICATION OF THE LON WORKS TECHNOLOGY FOR MONITORING AND CONTROL OF LIGHTING SYSTEMS** – Assoc. Prof. Dr. Kr. Velinov, Eng. O. Kichkilov - This paper describes the LONWORKS Technology for monitoring and control of Indoor lighting, Street lighting and Tunnel lighting. For more information to the LONWORKS Technology [http://www.echelon.com](http://www.echelon.com)

E-STREET Mini Conference at the Fair Light & Building in Frankfurt, Germany. The success story of Light & Building is set to continue. The trade fair was heading for record results for many sectors especially for lighting sector. This Light+Building was the biggest trade fair since its inception boasting over 2100 exhibitors for light, electro-technical supplies and building automation. Posting 1500 exhibitors Light+Building was the worlds biggest “light fair”. Exhibitors include all market leaders from Germany and abroad showcasing a holistic spectrum of products and solutions thereby linking functional with formal aspects.
In Finland the larger presentation to the market was conducted in connection with the Session of Municipal Technology organized by the Finnish Association of Municipal Technology in Espoo on 5.-7.6.2008. Audience consisted of 300 persons, mostly from cities and municipalities.

The content of slides are as follows:

1. Adaptive street lighting
2. Adaptive lighting-parameters
3. Saving measures - existing installations
4. - new installations
5. Development - starting points
6. E-street
7. Objectives
8. Savings of energy consumption and maintenance
9. Expected effects on additional construction costs, payback time and decrease of unit prices
10. Adaptive road lighting on public roads - projects already installed and under construction
11. Data transmission
12. System layout
13. Structure
14. Traffic monitoring system
15. Traffic flow, vehicles/5 min. Speed of traffic
16. Weather station monitors weather conditions - road surface: wet, semi-wet, dry, snowy
17. Other information from the automatic weather station
18. Luminance meter measures the real-time luminance of the carriageway pavement.
19. User interface – general map
20. User interface – in detail
21. User interface - luminaries and their groups, control parameters
22. First year experiences
23. Measured average daily power (% of the maximum) – example
24. Other systems with experiences
25. City of Goteborg – the system
26. City of Goteborg – savings
27. City of Oslo – introduction
28. City of Oslo – focus areas
29. City of Oslo – objectives
30. Holland – the solution architecture
31. Holland – the Luminex solution
32. Holland – server software key functions
33. Holland – use of standard web browser
34. Finland – an example of a very simple solution
35. Procurement

- invitation for offer performance and structure requirements
7.5.2 Supported and assisted dissemination

In time for the information evening T & P produced two rollups with pictures of Tuvevägen and Högsboleden with Göteborg stad logotype on each. We also used them at the Swefair for introduction to the guests about adaptive lighting.

DVD about E-street & Adaptive lighting

T & P are continually informing media about new project and have also produced a CD where we introduce politicians, municipalities and citizens about adaptive lighting in Goteborg.

At the DVD project manager Ingemar Johansson, responsible for the lighting in Goteborg have been interviewed about adaptive lighting both the project E-street and practical planning for the first pilot project in Goteborg - Tuvevägen.

DVD about adaptive lighting in Goteborg
Copyright Traffic Public Authority, Goteborg

Stephen Cross, EU-commission produced a DVD for Intelligent Energy Europe with material and interviews from different countries in Europe concerning adaptive lighting. Sweden was one of the chosen countries. The information was about adaptive lighting and the advances of the system also showing how it worked in practice in Goteborg.
The Polish E-STREET project partner has installed a small scale test/educational pilot case to demonstrate and gain experience of state-of-the-art technology and to hold a series of techniques events/workshops specifically aimed at target group like street lighting designers, local authorities decision makers etc. This event (or series of events) provided support for institutions (municipalities, design offices) concerned about intelligent street and road lighting.
Applying modern control networking technology at this stand permits to demonstrate to all target groups the dynamic network of the street lighting system. This street lighting system monitored and controlled from the management desk top, delivers light intelligently based upon real-time conditions such as time of day, traffic flow and its density, ambient light and weather conditions. At the stand is possible to present how this system reduces maintenance and service costs by communication essential information such as energy usage and remaining bulb life expectancy to maintenance crews, and to advise if a bulb has failed or suffered damage.

A key energy saving feature is the ability to dim some or all streetlights when traffic is light (according to statistics data it is equal to 1 % only) in the middle of the night. Dimming levels can be adjusted according to date or special events, or light levels can be easily increased under adverse weather conditions or high traffic density to make travel safer. Intelligent dimming reduces inventory costs by extending lamp life, lowers labor costs associated with frequent lamp replacement, and can mitigate liabilities associated with accidents that might be attributed to a lamp that has failed and has not been replaced.
7.6 COMMUNICATING WITH THE E-STREET STAKEHOLDERS

E-STREET identified those stakeholders which have a crucial stake in its activities of the street lighting investment process, the project will:

- assess its needs (contributions and uses) of the E-STREET project;
- identify the information and materials/resources necessary to maximise its use of and/or contribution to E-STREET activities;
- evaluate where and into what E-STREET activities, input may be most appropriately from the stakeholders.

The following groups have been identified as E-STREET project stakeholders:

1. Local authorities/municipalities,
2. Policymakers and governmental bodies,
3. Managers and management consultants,
4. National and regional design offices,
5. Energy installation companies,
6. Lighting professional associations and standardization organizations,
7. Professional and educational institutions, universities,
8. Lighting manufacturers, dealers,
9. ESCO companies

In many EU countries local communities companies have been in charge for distribution of the electrical energy as well as for maintenance and installation of the public lighting too. This approach resulted that designs and installations of the lighting systems in the past were very energy inefficient. In the recent years, according to the new law, specialized companies took over maintenance and construction of the public lighting.

By the our experience it is very important to separate the services between companies, because energy saving is not the main goal of companies which are distributing and selling energy.

7.7 Further dissemination

The website is one of the main instruments for the dissemination of the results of the project but not the only one. Additional means of dissemination planned after the project:

- Project partners will implement link to project website and relevant information relating to the project on their website. A quick and easy access to project outcomes is guaranteed.
- During the participation in relevant third party events, project members will present the E-Street project results
- Branch, specialist and practitioner publications are planned by the different project partners to announce the project results and to create awareness about the need for further telemanagement developments
- Norconsult will take care to maintain the project website at least in the next 1-2 years after finish the project. The deliverables and the final papers, calculation sheet, films and all project materials will be accessible in this period for free.

Since the results of the project are publicly available, the project partners as well as interested parties and experts involved throughout the project will have the opportunity of using the analyses and studies here developed for their further initiatives, speeches, etc – the condition is to refer to the sources accordingly.
8 CONCLUSIONS

The project activities have been performed for more than 30 months. Over this period, all the partners have been actively involved in studying, monitoring, writing, and giving presentations about intelligent streetlighting all over Europe.

This report tries to summarise over a limited number of pages the most distinguish outcome of this work. The project is supported by EU-programme IEE according to contract no IEE/05-157.

The Coordinator, Bjørn Sandtveit, Hafslund have been responsible for the project report, with a helping hand of Anette Ruud, Hafslund Fjernvarme and Tor Mjøs, Norconsult AS.

The E-street project acknowledges Mr Eirik Bjelland for his outstanding contribution to this project.

Further information is available at the web-pages:

http://www.e-streetlight.com/
9 CONTACT INFO

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Updated information will be available at the E-street web-pages:
http://www.e-streetlight.com/

For more detailed info about the intelligent energy programme:
http://www.managenergy.net/
http://ec.europa.eu/energy/intelligent/index_en.html

Partner info:

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<td>Hafslund</td>
<td>Sandtveit, Bjørn</td>
<td><a href="mailto:bjorn.sandtveit@hafslund.no">bjorn.sandtveit@hafslund.no</a></td>
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<td>2</td>
<td>Ageneal</td>
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<td><a href="mailto:ingemar.johansson@trafikkontoret.goteborg.se">ingemar.johansson@trafikkontoret.goteborg.se</a></td>
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<td>Mr. Marko Bizjak</td>
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<td>Mr. Hans Jørgen Jacobsen</td>
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<td><a href="mailto:pjordan@selc.ie">pjordan@selc.ie</a></td>
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<td>Mr Ken Leonard</td>
<td><a href="mailto:Ken@echelon.co.uk">Ken@echelon.co.uk</a></td>
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<tr>
<td>12</td>
<td>Oslo</td>
<td>Tom Kristoffersen</td>
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<tr>
<td>13</td>
<td>Sito</td>
<td>Pentti Hautala</td>
<td><a href="mailto:pentti.hautala@sito.fi">pentti.hautala@sito.fi</a></td>
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