"Intelligent Road Lighting"
Presentation at CIE Session 2007 – Beijing, China July 2007

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Introduction: Excerpt of 3D animation from NorConsult (Approx. 30-40 seconds)
It ends with the name of the presentation: "Intelligente Road Lighting".

"Good afternoon Ladies and Gentlemen"

My name is Eirik Bjelland from the company of Hafslund in Oslo, Norway.
I am now going to share with you some facts and thoughts on my topic for today: "Intelligent Road Lighting".

1. INTRODUCTION

1.1
There is a growing general awareness of the negative consequences of increased energy consumption. This has initiated a lot of activities to reduce the consumption level.

At the same time it is a fact that today's lighting equipment is substantially more efficient in a number of different areas than just a few years ago . This includes the general optical performance of luminaries like this one; - The performance of the electronics controlling these lights; - And the different options for light control.

This new, enriched technology represents an opening to new design concepts.

1.2

Several communications within the EU - lately the "Energy Efficiency Action Plan" - includes an address to energy savings in regard to outdoor lighting.

In this context, however, it is important to implement a good practice when performing savings.

1.3

A number of unfortunate initiatives have been observed from road light holders and civil servants eager to save energy: For example turning off installations completely during nighttime – Or even worse by switching off every second lamp in the grid.

1.4

To face this situation in a positive way, several initiatives have been taken to combine the need for energy savings with even increased safety standards for the road users. Among those are: The activity within the city of Oslo; - The establishment of the CIE TC4-44; - And lately the E-street project.

All of these are aimed at developing good guidance to meet the new requirements.

2. INTELLIGENT ROAD LIGHTING

2.1

Intelligent road lighting, or so-called "adaptive road lighting" - includes stepless dimming of lamps to meet changing demands based on varying traffic density - on weather conditions - and on the general conditions of the road.

It is made possible by introducing electronic communication systems within the lighting grid - and dimmable ballasts.

2.2
The ideas behind the development may be outlined as:

A) **Firstly - the electronic ballast which will give the best ignition and operational environment for the lamp eliminating low - or high - voltage fluctuations; - It will adapt for changes of the lamp characteristics over its lifetime; - And it reduces the electrical losses.**

B) **… and secondly - the communication between the ballast and the central control systems makes it possible to operate the lamp according to environment variations such as: Weather conditions; - Traffic volume-and-speed, and other relevant criteria.**
In addition it also makes it possible to plan maintenance in a cost effective way.

2.3
Today the CIE 115 does not give any guidance to the designers on how to design and operate such installations. It was therefore of vital importance to revise this document.
At the same time it was important to further develop the technology. Not only from the manufacturers point of view, - but from the end-user point of view as well.

2.4.
It was as a consequence of this realization that the E-street project was established.

3. DESIGN CRITERIA

3.1.

The present CIE recommendations for road lighting are based on a number of basic design criteria:

A) Traffic speed

B) Trafficvolume

C) Traffic composition and complexity based on road users present, and on weather conditions - Whether the roads are wet or dry

.... and finally

D) Road construction.

These parameters have lead to higher or lower required luminance level on the road respectively - depending on any given situation. Several of the design parameters are dynamic, such as traffic density, traffic speed, the mix of road users, as well as the weather conditions.

3.2.
Today's road-light designers have to meet complex and difficult requirements to conform to the guidelines.

An adaptive lighting installation will have to perform according to the actual present parameters under normal conditions, but also have to meet the given requirements under a "worst"-case scenario, which might include traffic accidents during dark hours.

Adaptive lighting will fulfill both the safety requirements, as well as other environmental and energy efficiency goals dynamically.

3.3
Adaptive road lighting will also make it possible to integrate city beautification and public street lighting in urban streets. Again, this will permit changing of the light output according to the use and population of the street during the dark hours.

3.4
When, for example, shops are open - and their windows are fully lit - the public lighting may be reduced. Then later - when the shops are closed - and the streets becomes more a place of public mingling, roaming and visiting restaurants - the public lighting will be adapted to this new situation. This may include some hours of temporary "over lighted" intensity values according to the requirements for the roaming public's safety during the late hours.

4. SAVINGS

4.1.

Let us now turn to the savings potential.

Energy and maintenance savings are essential to accelerate investment in the retrofitting of old installations. In the city of Oslo a substantial number of the road luminaries are more than 30 years old. This implies high energy consumption and increasing maintenance costs.

4.2

This graph shows the decrease in consumption during the installation and test periods in a local Oslo community.

Several small scale tests - as well as full scale ones - have shown that extensive energy savings of up to 70 % is attainable. This has been confirmed in evaluation reports by NorConsult in 2006.

In addition to this, energy savings of even higher values are found when the road surface is covered by snow. Under such conditions, the lamp may operate at only 20 % of its full light output, and still give the required light design value!

4.3

A number of similar test schemes in other countries under the "EU Enlight Project" show results similar to the ones found in Norway.

Of the 70% energy savings in Oslo a share of 40 % is based on the installation of new luminaires with new electronics – And a 30 % share by the dimming of the installations.

4.4.
Several "Master of Science" projects at the University of Trondheim in Norway have been initiated for more detailed studies of specific issues regarding the new technology. Among these is one concentrating on real time monitoring of the luminance of the road surface. This is one of several parameters for regulating the dimming profile.

4.5

The Oslo project covers two installations. One with 2.000 units , and a second one with 4.000 units. They include intelligent stepless dimming and two way powerline communication.

A third project, in a new township of the city - with 400 units - uses proprietary signalling on separate communication cables.

The communication is functioning well, and the installation of a fully centralized administrative handling tool was put into service in the spring of 2007.

4.6.

The E-street project covers presently 12 countries across Europe - all eager to develop and enlarge the Intelligent street lighting market in general.

The project focuses on the establishment of technical guidelines for purchasing of lighting goods; To stimulate the use of open communication protocols; As well as recruiting and building of a larger buyer group.

4.7.

The market assessment report by WALRAVEN indicates a total European market for retrofitting of existing installations to 80 million lighting points. This is said to represent an annual saving potential of up to 38 TWh!

One of the indicators for the project are 20 to 30.000 new intelligent road lights planned - or already installed - over the project period stretching from 2006 - to 2008.

4.8.

The project has also supplied valuable input to the EU commission regarding a tentative new label scheme for outdoor lighting installations.

This is referenced in the EU "Energy Efficiency Action Plan"

The commission is indicating a possible directive on this issue setting up energy performance classes - A to G - for outdoor lighting installations.

4.9.

The project also looks into new financing mechanism for street holders, including energy performance contracting and third party financing solutions.

The project will establish an "Intelligent Street Road Forum" for further development after the project period. The first forum meeting was held in Berlin in November of 2006. The second one in Oslo in May of 2007.

5. THE IMPORTANCE OF GUIDELINES

5.1.
The new technologies available and the options available calls for a new set of guidelines.

Today many civil servants and road authorities are eager to save on road lighting costs, and are switching off every second bulb in the grids - or turning them off completely during the night.

Reducing the installed wattage of the lamps also seems to be quite popular.

To avoid such inadequate solutions the lighting society will have to develop guidelines taking into account the given situation, and thus helping the servants to achieve their saving potential in a good manner. The establishment for updating the CIE 115 publication may be seen as one such initiative.

5.2.
The mandate of the work was 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 revision covers several sections of the present document. New research work has now been included which also covers measurements on snow.

In addition it covers an introduction of a new simplified method for calculating the weighting factors used to select the required lighting classes. The method is also applicable regarding adaptive lighting.

5.3.

There is, however, still a need for a continuous research on adaptive lighting.

But in many cases the presently available information is sufficient to make appropriate changes to the existing guidelines.

5.4.
Let me give you an example to illustrate this. It seems obvious that today's required luminance level for motorways is far too high when the traffic is slow moving or has come to a standstill.

One might claim that the required lighting level should be sufficient from the lighting of the car headlights alone! But it seems difficult to find studies documenting these "obviously over-lit" situations.

5.5.
Under snowy conditions the slightly darker road surface in combination with good visual guidance and low speed leads to good visual driving conditions.

Tests this year - by mr Augdal of SINTEF in Norway - indicates 3 – to 4 times as high luminance levels under such conditions than given by the theoretical calculation under so-called "normal" conditions.

6. CONCLUSION

6.1
The many benefits of intelligent – or adaptive - road lighting are clear and obvious: Energy savings - Increased traffic and public safety and security - And the various aesthetic issues.

The question we are faced with is how we best may exploit all these benefits.

6.2
It is firstly a technological challenge to further develop the basic foundations in terms of electronics, communications and the logic of the control systems. This kind of work is now being carried out in a number of private and university R&D environments.

6.3
Second is the update of regulations and guidelines which have to take into account both the new – and the coming - technological advances so that these may be implemented – and put to good use. This is where challenges lies for the update performed on publication 115 of the CIE TC4-44.

6.4
It is a momentous task – But a challenging and fascinating one.

Thank you for your attention!
