# Responsive City Lighting: Perspectives From Architecture & the Public Lighting Industry

Esben Skouboe Poulsen
Aalborg University
Department for Architecture,
Design & Media Technology, DK
espo@create.aau.dk

Hans Jørgen Andersen
Aalborg University
Department for Architecture,
Design & Media Technology, DK
Hja@create.aau.dk

Ole B. Jensen
Aalborg University
Department for Architecture,
Design & Media Technology, DK
Obje@create.aau.dk


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**Abstract**
This paper presents and discusses perspectives extracted from two interviews conducted during the experiments Urban Responsive Lighting. The interviews represent two different fields related to urban lighting: architecture & the public lighting industry. The experts were invited to visit a full-scale responsive light experiment, where 15 LED RGB Park lamps were controlled either by a wind sensor, a mobile phone app or by thermal camera tracking - all presenting new strategies for responsive public lighting. According to the specialists the social and aesthetical dimensions are more interesting than energy use and efficiency. This motivates an interdisciplinary discussion on applied technologies and responsive light design methodologies in the future smart city.

**Author Keywords**
Responsive Lighting, Interview, Experiment, Energy, Social.

**ACM Classification Keywords**
Documentation, design, human factors, security, experiment.

## Introduction
Within the last decade mobile and sensor technologies have become ubiquitous [6]. Massive research has

been pushing the use of technologies into the build environment within a wide range of scientific fields. The research is often technical and problem solving [8,12] or artistic and expressive [1,3,4,7,10].

Often the technical innovations end as features in new products and the artistic installations as temporary setups. However there is a need for a deeper understanding and critical approach to how the lighting can react intelligently in everyday life situations and the improvement of life qualities and efficiency in future cities. During the last years the authors have conducted a series of full-scale experiments within the research cluster of Urban Responsive Lighting [9]. We acknowledge that rethinking the paradigm of public lighting; into one of sensitivity and response demand an interdisciplinary and inclusive engagement from leading expects in the field. This motivates the article to ask leading Danish specialist in architecture and lighting: How do you see the future potentials and pitfalls for Responsive Urban Lighting?

## Interview

The two experts are Lars Kjær, product manger in Swarco Nordic and Peder Baltzer Nielsen city architect in Aalborg. Peder Baltzer Nielsen is educated from The Danish Royal Academy of Art and Architecture in Copenhagen in 1980. In his daily work he represents the architectural responsibility as city architect and set out new visions for future city development. His primary job is to secure a well-functioning and elegant development of architecture and to create good public spaces that afford a vivid life in the city.

Lars Kjær has been working in the lighting business since 1993 and has been taking the role as Pioneer in the development of LED luminaires. Because new technologies allow sensors to be distributed into the lamps, the capacity to enforce a better adapting light solution is immediately evident. However there is still no product on the market, which fully presents the technologies for a situation specific to public lighting.

*Perspective: Public Lighting Industry*

This year over 150.000 outdoor-lamps has to be replaced by new LED light fixture specified by Danish municipalities. In traffic, parks and on squares new LED lamps are primary choice due to the good energy performance and lifetime. The LED technology presents a huge potential for power saving, not only in the more effective light source, but also in the adaptive capacities of the control and regulation of the lighting.

Often the energy efficiency is a selling point for LED technology, however experiments such as [9] presents potential energy savings up to 92 % if the light is controlled in relation to occupancy patterns in the public spaces. Innovations in the field of regulation and control, goes hand-in-hand with new light technologies. Nevertheless the technologies are already very efficient. Lars Kjær takes us though a simple example to visualize his point: if you for example have a luminaire using 25 Watt at 100% and if you introduce a midnight dimming on 50% in 6 hours you save 50%, the average energy consumption will then about 16-17 Watt. Seen from a financial point of view, the luminaires are already doing a good energy performance. If we for example use the average energy consumption of 17 W and add sensors and control hardware the system would be able to save 50 % more this make an average energy consumption of 8,5 Watt. If the light are on 4000 hours a year it would make an

average consumption on 34 KWh. In Denmark the price for 1 kWh is: 1,89 kr./KWh, this make 64,3 dkr. in energy savings a year, which equal 8.6 € a year. Only if we can develop light fixtures that can standalone and thereby save establishment and maintenance cost will we find an economical argument in this perspective, Lars point out.

This notion indicates that energy consumption should not be the central driving force in development of responsive lighting solutions. Advanced control systems and distributed sensing networks needs other qualities such as better performing lighting that are able to present situation specific lighting dependent on time, weather and occupancy patterns. Lars Kjær reports from the field that: "We are testing how radars, microphones, new control software and traffic loggers can help us classify activity on the street. We can see how the weather are, the conditions of the lamps, the energy consumption. Due to this information the system are able to present 15% more light in rainy conditions, enabling a faster traffic flow on the roads, which again limit the cue of cars" - We utilize the information to make better performing light solutions for the city, Lars Kjær says

One of the greatest challenges for future intelligent lighting will be to share and communicate data between different systems. Hence new information technology infrastructures will need to be developed. Lars describe how most data already are digitalized and available in today's systems like Omnia [11], which are already installed in many cities. Within such systems data of traffic intensities, weather forecasts etc. are being collected and used to regulate the traffic lighting. It is now only a question of sharing a couple of values forth and back between the software applications often located on the same server. According to Lars Kjær is the technological infrastructure is very soon available, but it is the visionary politicians and innovative developers that need to take the lead the innovation of a new beautiful, safe and efficient responsive urban lighting strategies.

*Perspective: Architecture*
Within the last years we have experienced the emergence of mediated architecture. Media facades have become omnipresent in contemporary public spaces and the control of pixels has become trivial in contemporary public spaces. It is time for engineers and architects to develop a critical approach to the qualities of media architecture. Responsive light strategies could be one of the solutions that make future public lighting sensitive, beautiful, elegant, efficient, novel, safe and at the same time functional. All values, which are well known in the traditional Nordic architectural design tradition. City Architect Peder Baltzer Nielsen describe: "response design open up an additional design dimension in the process of making creative, attractive and enjoyable public spaces. I can see a new type of intimacy, which occurs on a square. It attracts me, even though it is difficult to see in the dark. Maybe these new interactive light strategies can extend some of the good qualities we design in daytime into the night?"

The new technology raises new potentials for the lighting to be adaptive. This notion challenge our existing norms and light regulations, because, the city lighting will be able to change intensity in relation to the city life and adapt to the situation. Peder Baltzer Nielsen describes this new approach: "I think there is a

balance in the normative approach. Thinking responsive solutions challenge this notion: because we are now able to detect the situations and adjust the lighting, such that you can have interesting experiences when traveling though or visiting the city."

These new responsive solutions challenges the traditionally role of the architect; as being the one who design the square, to be the one, who engage in a sensitive dialogue with the life on the street as well as micro climate in the city. Architects have to contribute to the creation of new adaptive and creative design solutions in Smart Cities [5]. Hence they have to master those technologies, which are often presented from the user's premise for design. This sensitive design approach is new and need to be developed and discussed.

Peder Baltzer Nielsen describes the role of the new role of the light designer, as: "The light designer who have the insight in the technology (and that they must have) will understand how to place these activities, so it ads an extra design dimension, beyond the fact that citizens can activate. We have to remember that the square should be beautiful in day-time, too. So maybe there is a topic for the architect in combining these interventions such that the square is living around the clock. I think this is an exiting new challenge for architects, and we need to explore how we can address these issues of response design. I think it will trigger many, because there is the element of surprise, which is always interesting."

## Discussion

It seems like discussions from the field of architecture can enrich and broaden the discussion on responsive urban design strategies in future cities. According to Peder Baltzer Nielsen we can utilize these control techniques to approach the design of new artistic and meaningful response strategies for public lighting. This notion challenge the existing light design approaches by asking: how can we develop mood sensitive lighting that generate intimate, calming, engaging feelings, when desired? According to the industry many of these data-infrastructures are already established in different applications, but often on the same server. Thus we need new strategies and standards for combining these types of situated data. Hence geographers can turn the information into meaningful cartographic outputs to support new and better light and planning solutions. To approach this challenge a first step could be to share information across different networked database structures, like ex. Cosm.com.

Another immediate potential is a participatory lighting. The adaptive capacity of responsive lighting, enable people to design the behavior according to certain events. Does this ability of user/citizens control of parts of the public lighting system afford new types of ownership, creativity and engagement? If so which tools and methodologies are used to interface these new types of interaction? Maybe the future strategies for responsive public lighting are not either or, but highly adaptive and in certain situations, more user control are allowed then others? Only though dialogue with leading advisers, architects and engineers in the field can these innovations facilitate a better performing responsive lighting.

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