REDUCING CO_2 EMISSIONS OF PUBLIC LIGHTING

Newsletter 06 | 2019-05 CE452 Dynamic Light

Light at night enables us to experience and interact with the built environment; it establishes social spaces, spaces for interactions and exchange. It can encourage positive social behaviour and provide a safe movement.

The central aim of the „Dynamic Light” project is to establish and demonstrate the advantages of a proactive, adaptive or in other words a dynamic lighting strategy for public lighting. Improving lighting quality and energy efficiency means providing light in the future as needed, at the desired time, for the desired duration and for a specific target group.

“Dynamic Light” is an EU funded research project involving 17 partners from seven different Central European countries, the various partners are cooperating in the project to investigate and evaluate typical lighting situations in the respective municipalities. The project has developed parameters for lighting control that reflect the social needs and demands of the user. These parameters have then been implemented across eight pilot installations across Central Europe.

1. Pilot Actions: Sušice - Czechia, Gorenjska Region-Slovenia, Glienicke Nordbahn-Germany, Rostock-Germany

1.1 SUŠICE - CZECHIA

The Town of Sušice lies in the Plzen Region and is often called the Gate to the Šumava Mountains, lies 465 m above sea level in the Svatobor Highlands. This former royal town spreads on both the banks of the once gold-bearing Otava River on the area of 16.6 square kilometers, and has about 11,500 inhabitants.

The dynamic lighting project includes the surroundings of the chapel of St. Angel the Guardian and the staircase from Alšova street right up to the chapel itself. The specificity of this location lays in the historical atmosphere and necessity of architectural lighting of the chapel (five architectural lighting fixtures are installed at the site of the chapel). The location is used exclusively by pedestrians. The whole concept of dynamic lighting of Kaple Anděla Strážce and its surroundings is designed in accordance with historic building preservation and ensures minimization of negative effects on environment.

// Kaple Anděla Strážce, Sušice, CZE

The objective of using dynamic control system and the associated renewal of public lighting in the proposed area was to improve lighting quality, to increase energy efficiency, to reduce light pollution and to verify the usefulness and impact of dynamic public lighting on the end-users. The investment contributes to a better atmosphere in the city center, increases tourist attractiveness and emphasizes the historical charm. In addition, the installed public lighting is be able to support a variety of cultural and other events organized by the city, thus not only increase the safety of these events (e.g. increase lighting levels at Christmas time, etc.), but also the aesthetics of the city (e.g. changing the color of lighting and the like).

In the process of modernization of the surroundings of the chapel of St. Angel the Guardian and the staircase from Alšova street, existing masts were removed to avoid failure in reaching the public lighting standards. The existing infrastructure was replaced by newly designed luminaires with LED technology (including dynamic control) leading to a significant reduction in the total installed power of the selected part of the public lighting in the pilot area.

In addition to the classical modernization of public lighting, a new system for management and control of the public lighting were introduced (Orcave 401-550 software) which, among other things, was allow for additional savings in electricity consumption. The design of new public lighting and the introduction of the management system are fully aligned with relevant regulations.

The road lighting class in the pilot area is defined in accordance with the Norm EN 13201-1.Class P5 public lighting for pedestrians with recommended minimum operating values of the quality of public lighting: Medium illuminance of the street surface - Em = 3 lx, Minimal illuminance of the street surface - Emin = 0,6 lx.

The Site

The solution concept is based on the possibility of changing the lighting parameters of both, the public and architectural lighting. The changes in lighting conditions of public lighting occurs on one hand based on centrally preset time modes, and on the other, based on information from motion sensors mounted directly on the masts. The level of illumination and the color tone of the light are variable parameters.

The level of illumination varies according to the time mode and, for a certain period of time, also according to the presence of people (dimming strategy varies between 40% - 100% of maximum Em). The color tone of the light is changing according to the time mode. Both variables are also adjustable for architectural lighting. The setup of both parameters are not change overnight, but by days (a weekday, weekend, holiday) and by season. This ensures the change of atmosphere and perception of the chapel during different seasons. Continuous luminous flow control allows to give more plastic look to the object. Both, light levels and chromaticity temperature can be individually adjusted by increasing their level above normal operating levels with regards to the social and cultural events in the area.

For public lighting, two operating modes are set with the following operating profiles:

a) common: i) On PL - 22:00, adaptive (presence) Em = 3 lx (60%), ii) 22:00 - 06:00, adaptive (presence) Em = 2 lx (40%), minimal (absence) Em = 1 lx (20%), iii) 06:00 - off PL, adaptive (presence) Em = 3 lx (60%)

b) festive: i) On PL - 22:00 maximum Em = 5 lx (100%), ii) 22:00 - 00:60 adaptive (presence) Em = 3 lx (60%), minimal (absence) Em = 2 lx (40%), iii) 06:00 - off PL. normal Em = 3 lx (60%)

Changes in the color tone of light in public lighting are independent of the operating modes and for defined time slots two levels of chromaticity are being used:

- evening / morning Tcp = 3,000 K On PL - 22:00 and 06:00 - Off PL
- Nighttime Tcp = 2,200 K 22:00 - 06:00

The architectural lighting is used on all the outer facades of the chapel, the chapel tower and the three west towers of the cloister. The surfaces of the illuminated outer facade have two colors, white and pink. The white color has a reflection factor pB = 85% and pink pR = 62%. The following architectural lighting brightness values were selected for the facade surfaces and for the corresponding illumination (determined for white facades): i) western facade: Lm, w = 7.5 cd / m2, Em, w = 30 lx, ii) eastern facade: Lm, e = 5.0 cd / m2, Em, e = 20 lx, iii) southern facade: Lm, s = 3.0 cd / m2, Em, s = 10 lx, iv) northern façade: Lm, n = 3.0 cd / m2, Em, n = 10 lx

Given parameters are defined as the highest values for lighting in exceptional cases such as cultural or social events. Under normal operating conditions, the brightness values is lower. Three operating modes (regular mode, weekend mode, festive mode) are set for architectural lighting from the point of view of brightness and illumination.

Architectural lighting of the chapel is from the point of light color tone designed to allow for change of chromaticity temperature in a minimal color temperature range from 3,000 K to 4,000 K. The chromaticity temperature is set according to the season and depending on the operating mode in a following manner:

a) Spring and summer: regular Tcp = 4,000 K, weekend and festive Tcp = 3 500

b) Autumn and winter: regular Tcp = 3,000 K, weekend and festive Tcp = 3 500 K

1.2 Gorenjska Region- Slovenia

Gorenjska region is alpine region situated in northwest of Slovenia with capital city of the region Kranj with 40.000 inhabitants. Gorenjska consist of 18 municipalities and 3 of them are our pilot municipalities with different type of areas. The investment is carried out on the territory of 3 local communities Bled, Jezersko and Tržič in region Gorenjska. Diversity of areas (touristic area- Bled, mountain settlement/protected area in Jezersko and urban industrial area in Tržič) contributes to capacity building and acceptance of dynamic lighting by stakeholders and users. It contributes also to lowering of costs of local communities for lighting (electricity costs) and reduction of the lighting pollution. At the same time pilot investments show the way to further improvement of public lightning in other areas in 18 local communities in Gorenjska region and contribute to the positive image of dynamic lighting.
The pilot investments corresponds with strategic framework of sustainable development policies of Gorenjska in particular the new Sustainable Energy and Climate Action Plan (SECAP), with a total reduction of CO_2 emissions by 40% in the Gorenjska region by 2030 compared to the base year 2005.

Figure 1: park Vile Zora (Bled), Figure 2: park Vila Bled

Figure 3: Industrial zone Mlaka (Tržič), Figure 4: Road near lake “Planšarsko jezero” (Jezersko)

We identified 4 pilot areas in 3 different municipalities. In municipality Bled we implemented two separate pilot areas, Park Vile Zora (pilot area 1) and green area under Park Vile Bled (pilot area 2). Bled is a town on Lake Bled. It is most notable as a popular tourist destination in the region and in Slovenia. Park Vile Zora is located on the eastern part of Lake Bled. The second location is situated in the park under Vila Bled. There lies connecting walking path that connects the existing regulated promenade of the touristic accommodation facility Vila Bled.
Pilot location in Municipality Tržič is a local connecting road within the Industrial zone Mlaka. Road is intended exclusively for motor traffic. Depending on the purpose of use in the area of illumination we can define that lighting need to ensure during night time adequate levels of illumination for the safety reason of transportation of cars and transport vehicles.
Last pilot location is regulated around the lake „Planšarsko jezero“ in municipality Jezersko, which is the highest located and smallest municipality in Gorenjska region with main focus in tourism. It is protected area, where we had to adapt the shapes of lamps and poles to the requirements of the Institute for the Protection of Cultural Heritage of Slovenia (state regulator in the subject area).

In preparation of pilot project we considered specific social needs, type of area, project focus and follow national legislative, norms about public lighting standards and also took into account requirements of the Institute for the Protection of Cultural Heritage of Slovenia where it was requested (Jezersko).

Pilot Bled
1A. Park Vile Zora
Supply and installation of 16 luminaires with sensors & controllers. 1 luminaire is financed within the scope of the project whereas 15 luminaires are financed by the municipality of Bled. These are road lighting lamp with basic technical characteristics - LED Type, maximum lamp width 19W, life

time 50,000h, colour temperature 3.000K, Ra> 70, min. Flow rate 1.800 lm; installation of 4m high pules (16 pieces). Lighting regulated according to user density - light control from 50% to 100% - from 24h to 5h, lighting is switched off.

Figure 5: new luminaires with sensors&controllers (Park Vila Zora)

1B. Park Vile Bled

-Supply and installation of 6 luminaires - Road lighting lamp with basic technical characteristics – LED Type, maximum lamp width 19W, life time 50,000h, colour temperature 3.000K, Ra> 70, min. Flow rate 1.800 lm); installation of 4m high poles (6 pieces). Lighting regulated according to user density - light control from 50% to 100% - from 24h to 5h, lighting is switched off.

-Supply and installation of 42 luminaires on existing poles, which with specific shape under cultural protection. 36 luminaire is financed within the scope of the project whereas 6 luminaires are financed by the municipality of Bled. These are footway lighting lamps built into urban furniture (concrete pillar) with basic technical characteristics - LED Type, maximum lamp width 13W, life time 50,000h, colour temperature 3.000K, Ra> 70, min. Flow rate 1.800 lm. The dimensions and

Figure 6: new luminaires on existing poles (Park Vila Bled)

method of assembly of lamps on the concrete pillars is determined by the existing lamps and urban furniture (concrete pillars) of Vila Bled and surrounding park.

Pilot Jezersko

- Supply and installation of 13 luminaires - Road lighting lamp with basic technical characteristics - LED Type, maximum lamp width 18W, life time 50,000h, colour temperature 4.000K, Ra> 70, min. Flow rate 2.500 lm. (Luminaire, LSL, Grah Lighting); installation of 6m high poles (13 pieces). Lighting regulated according to user density - light control from 50% to 100% - from 23h to 6h, lighting is switched off.

- Supply and installation of 7 luminaires - Road lighting lamp with basic technical characteristics - LED Type, maximum lamp width 112W, life time 50,000h, colour temperature 3.000K, Ra> 70, min. Flow rate 13.000 lm. (Luminaire, Lightstream LED maxi - 721734.1131.76, RZB); lamps will be only used for the purpose of cross-country skiing which area leads beside the road. Lighting for cross-country skiing will be mounted only on locations where recreational path will be active - based on the snow conditions.

In areas where only the road surface is illuminated 6m poles are used, while on the parts when the road surface illuminates and the “recreational path” combined poles are used with a total height of 8m (6m + 2m-mounting extension) on which the lamps are mounted on two different levels (6m and 8m).

Figure 7: new luminaires on combined poles in Jezersko

Pilot Tržič

- Supply and installation of 14 luminaire - Road lighting lamp with basic technical characteristics - LED Type, maximum lamp width 68W, life time 60,000h, colour temperature 4,000K, Ra> 70, min. Flow rate 9.300 lm. (Luminaire, STREET G (XP-L V4) Luxtella); Supply of 14 galvanized poles/candelabra with a height 9.8 m above the floor.

1.3 Glienicke/Nordbahn- Germany

Glienicke/Nordbahn is a city in Brandenburg, Germany, directly located at the border to Berlin, north of Germany's capital city. It is a city with strong growth, particularly since 1990, when after reunification people from Berlin started to relocate to Glienicke/Nordbahn. Between 1990 and 2015, the number of inhabitants grew by 176 % and has reached 12.155. Most buildings in the city are residential buildings with one or two floors. The next motorway is some 5 km away, and there are both national and county roads through Glienicke/Nordbahn. There is, however, no railway station.

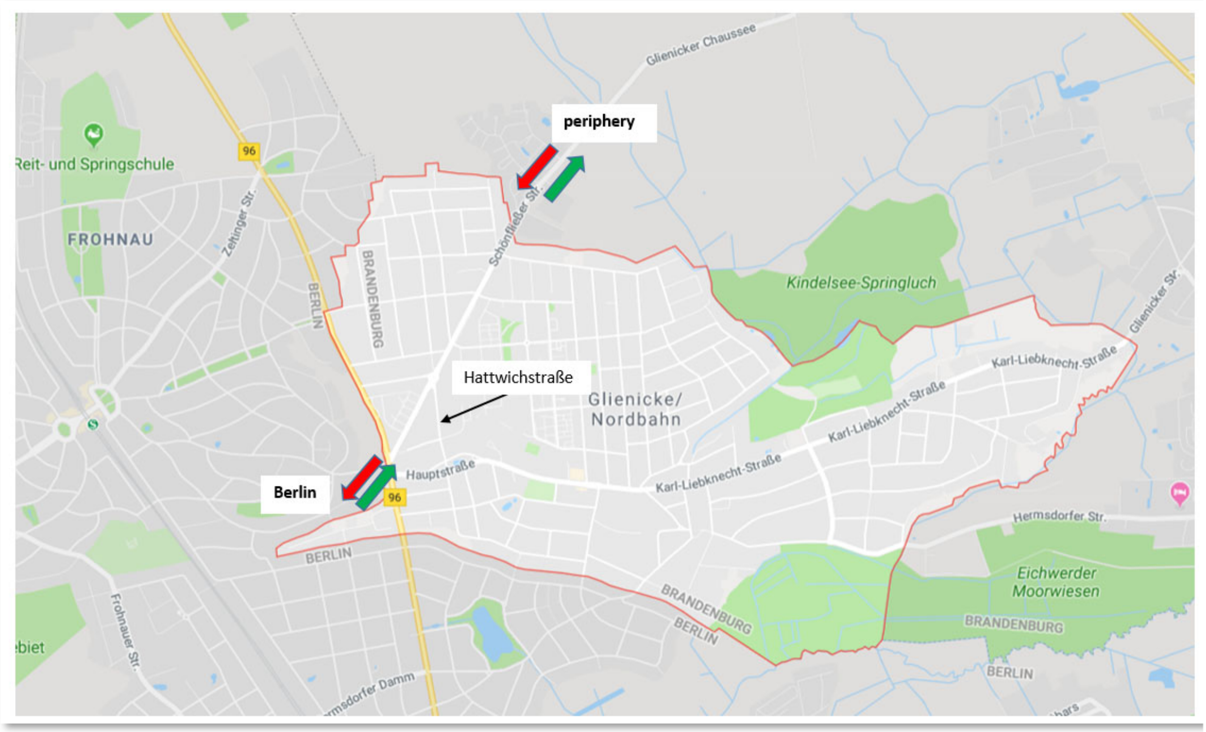


Figure 1: Geographic location of the pilot project in Glienicke/Nordbahn

Two different types of streets was chosen to implement the pilot dynamic lighting solution. Especially the Schönfließer Straße was selected, because this street is used by the transit traffic from Berlin to the periphery with an average traffic density with 9.000 vehicles per day. In comparison the second street of the pilot project, Hattwichstraße, is a residential street with about 4.000 vehicle per day. Also the traffic flows during the lighting times are very different in both streets. So that for the detection and designing of system answers at these streets various strategies was to solve.

The inventory lighting systems was consisting of technical luminaires (type Philips SGS 203) mounted on curved "whip-type" poles (high 6 m) where Philips SGS 203 luminaires equipped with 50 W HPS lamps at the Schönfließer Straße and 70 W at the Hattwichstraße. Total electric power of the entire luminaire are 62 W and 83 W. Such luminaires are old (more than 20 years), require extensive maintenance and have low energy efficiency, especially compared to LED technology. HPS lamps create "yellow" light, with significant disadvantages compared to "white" light, which is even more so due to the transparent cover turning yellow over time, because of ageing. The existing lighting systems in the test area had no control systems dimming issues. The switching on and off of the luminaries was realised over components at the electrical power line.
The lighting measurements appear a deficient lighting level at both streets. It could be measured an average illuminance level on the lane of 4.7 lx at the Schönfließer Straße and 2.5 lx at the Hattwichstraße. Also the uniformity U0 was with values about 0,15 underneath of normative references.

Figure 2 and 3: The new lighting situation in the Schönfließer Straße (left) and Hattwichstraße (right)

As new lighting systems LED luminaires (AREDO type from the manufacturer SWARCO) are installed. These luminaires were selected in a tender for the most recent modernisation project already, which means that the city has evaluated these luminaires in a transparent and independent process, including not only technical and price related, but also design criterions. The luminaires in the Schönfließer Straße have a total electrical power of 88,7 W and a total luminous flux of 10.500 lm. In the Hattwichstraße are luminaires used with a total electrical power of 44,8 W and a total luminous flux of 5.100 lm.

A dynamic lighting system is designed to give corresponding dynamic responses to external influence parameters such as number and type of traffic participants, time of day, weather conditions (e.g. wet road), environmental factors (e.g. CO_2 emissions) or occurrence of dangerous situations. The technical basis of such systems are the sensors (detecting influencing parameters), the actuators (triggering of system responses) and a telemanagement system with corresponding data processing and defined procedures. In the present pilot project the control system is implemented via a telemanagement system (Volumlight, Schréder), which is part of the luminaires and allows bi-directional communication between the luminaires, sensors and the central control platform. There were two influencing parameters considered in particular.

1. Detection and control of the lighting system based on the number of vehicles:

For this purpose, the number of vehicles are detected by suitable cameras (Quercus SmartLoop TS) for both roads. The experiences clarified that when higher traffic volumes occur, a system response only on the basis of an integrative method (counting of vehicles at certain time intervals, e.g. 15 or 30 minutes) makes possible an acceptable dynamic answer. On the other hand, in residential streets with very low number of traffic participants at certain hours at night, system responses to individual vehicles can be a satisfactory solution. In addition, it is to examine which holding times are useful for the detection of individual or integrative traffic volumes for the respective road type.

2. Detection of special situations and emergencies:

In the present project the operations of fire brigade vehicles and the time-limited increase of pupils around a high school are determined as specific situations, to which corresponding system responses was to generate. Both areas are located on Schönfließer Straße. At the fire brigade, the system response is provided by a signal generated parallel to the internal emergency signal and simultaneously transmit to the control system. At the Gymnasium, the detecting of pupil at the bus stops on both sides of the street in front of the school has proved suitable. Here the detection takes place by the cameras. In the case of emergencies (operations of fire brigade), the lighting level on both roads should then be increased to the maximum level (140%, see figure 4).

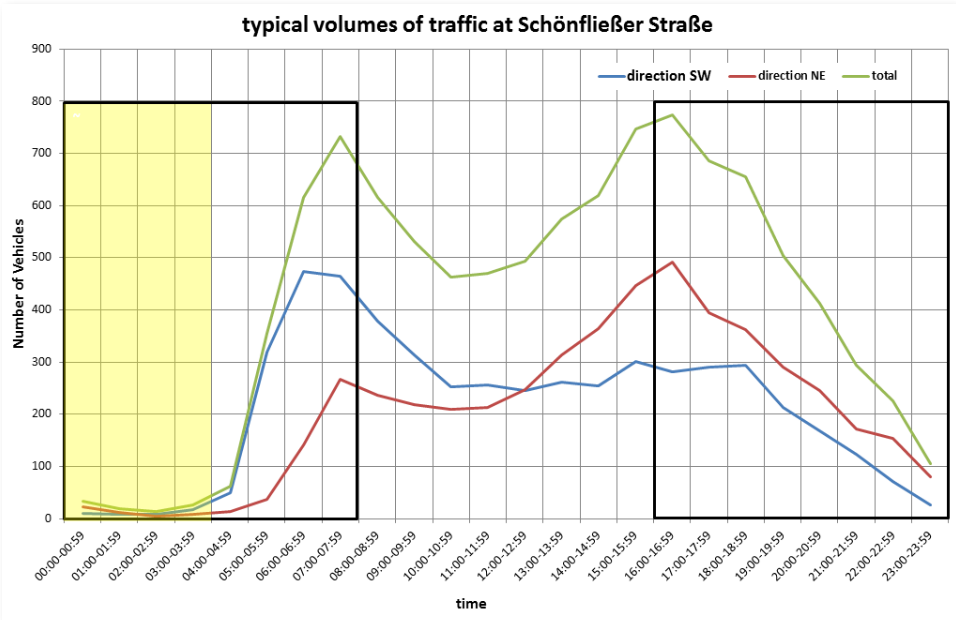


Figure 4: Traffic density at Schönfließer Straße

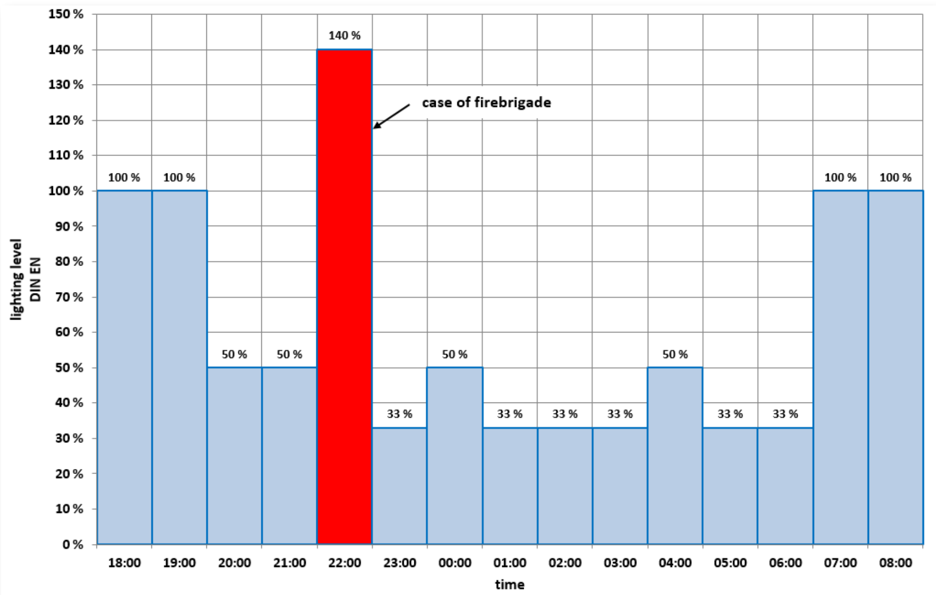


Figure 4: System Answers

1.4 Rostock-Germany

The Hanseatic and University City of Rostock is located in the north-east of Germany. With about 210.000 inhabitants, it is the most populous city of Mecklenburg- Western Pomerania and is considered as the economic and cultural urban center of the region. Rostock is characterized by its location by the sea, its harbor and the University.

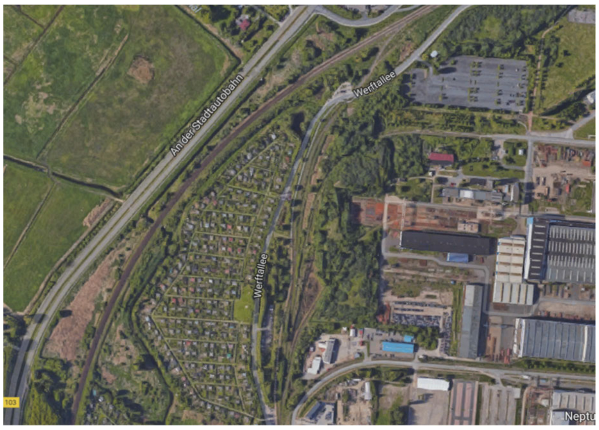
Within the framework of the climate protection initiative of the Federal Ministry for Environment, Nature Conservation and Nuclear Safety (BMU), the Hanseatic and University City of Rostock has applied successfully for the “Action Plan 100 % Climate Protection” in 2011. It aims to reduce CO2-emissions by 95 % and energy consumption by 50 % until 2050 compared to 1990 levels. The improvement of the lighting infrastructure is one part pointed out to reach these objectives.

Street lighting causes 6 % of CO2-emissions and requires 1/3 of the energy consumption of the city administration. In order to use saving potentials and to make public lighting more efficient, the Hanseatic and University City of Rostock has developed a new lighting strategy.

The strategy for public lighting is geared to the long-term conversion to efficient LED technology and includes options for demand-based lighting control.

Through the implementation of pilot plants, experience has been gained how modern technologies can be used and the lighting can be designed like it is needed.

The pilot plants provide knowledge about the reliability and applicability of dynamic lighting systems and are basically for innovative lighting concepts for municipalities.



The Site

The sustainable promotion of cycle traffic is of particular importance for the Hanseatic and University City of Rostock. Well-developed cycle paths, need an illumination which is harmonized to the use. For this reason, the 800 m long walking and cycling path along the road “Werftallee” was selected for the implementation of a dynamic pilot plant.
The path connects the two adjoining city districts and creates an important connection for the surrounding residential areas, the adjacent industrial area as well as for the tourism.

The lighting installation along the path was realized with 33 new technical LED luminaires (9 W) and is connected to the existing luminaires of the adjoining area. The luminaires have a control unit

and integrated infrared sensors for motion detection. If the sensors detect a user, the intensity of the lighting is adjusted specifically for a specific road section.
The basic brightness of the luminaires is between 0 % and 10 %, depending on the environment. If a user is detected by a luminaire, the illuminance adjusts. If no user is in the detection range of the luminaires, the illuminance will be reduced to the basic brightness after a fixed time of 30 seconds.
In order to ensure a uniform illumination of the path, the luminaires transmit a signal to defined neighboring lights when a user is detected. The lights communicate with each other via radio.
A gateway has been installed for remote control of the system. The gateway summarizes the data of all connected luminaires and makes them available in a user-friendly web application. The connected systems can thus be easily monitored, controlled and modified by any computer with internet access.

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