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D3.11 Design and implementation of the humble lampposts concept

Transition of EU cities towards a new concept of Smart Life and Economy

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Task description	Task 3.8: Public Lighting improvements – SMART LIGHTING [HAM] Subtask 3.8.2: Humble Lampposts. Design and deployment of a repurposing concept of 60 existing lampposts, reequipped with innovative features like WIFI, environmental sensors, asset management, CCTV for traffic measurements and adaptive lighting.

Date	Version	Author	Comment
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Abbreviations and Acronyms

Acronym	Description
mySMARTLife	Transition of EU cities towards a new concept of Smart Life and Economy
BUE	Behörde für Umwelt und Energie (in English: Hamburg Ministry for Environment and Energy)
BWVI	Behörde für Wirtschaft Verkehr und Innovation (in English: Hamburg Ministry for Economics, Transport and Innovation)
DIN	Deutsches Institut für Normung e.V.(in English: German Institute for Standardisation)
DWD	Deutscher Wetterdienst (German Meteorological Office)
HHVA	Hamburg Verkehrsanlagen (in English: State Agency for Hamburg Transport Infrastructure (analogue translation))
LSBG	Landesbetrieb Straßen, Brücken und Gewässer (in English: State Agency for Roads, Bridges & Waters)

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1. Executive Summary

The main objective of the mySMARTLife project is the definition of an innovative Urban Transformation Strategy to present best examples to the follower cities to support them in developing their own approach towards a smart city. In this context, street lights are currently being re-examined as a possible platform for new sensors and assistance systems. In addition, it is expected to be able to achieve energy savings in public spaces with new LED technology. The aim of this deliverable is to provide an overview about the Hamburg specific approach to integrate new smart lighting concepts in the existing lighting infrastructure.

The focus of this deliverable lies on the exchange of conventional lighting with LED lighting at existing lampposts and the description of first experiences of the implementation. Therefore this deliverable is close connected to deliverable D3.10 “Adaptive lighting”, which focuses on the deployment of new sensors and lighting control systems. Together, these two deliverables could be the first steps towards a further development of the existing Hamburg lighting concept.

Since the project is in the second year of the implementation phase, the text describes the technical construction and development of the intervention. The gathering and analysis of the energy data of the smart street lighting as well as the intended connection to the urban platform will be described in further deliverables.

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2. Introduction

2.1 Purpose and target group

This deliverable provides an overview about street lighting in Hamburg and a technical description of the practical implementation of LED lighting in best practice examples in Hamburg-Bergedorf. It contains a technical description and the description of the planning and decision process for interested follower cities and professional audience.

The present deliverable is structured as follows:

Chapter 3 shows the general background and framework in which this intervention happens, like the existing street light concept in Hamburg, the types of lighting in Hamburg and the evolution of the intervention. Since it describes the general conditions of smart lighting in Hamburg, this chapter from 3.1 to 3.3 is the same as in deliverable 3.10 “adaptive lighting”, with a supplement in chapter 3.4 that comprises an overview about the development of the lighting system in Hamburg.

Chapter 4 shows the technical description of the LED lighting.

Chapter 5 shows how the action is carried out, the regional framework and examples of the implementation of LED lighting.

Chapter 6:completes this deliverable with the conclusion, a review of the main challenges and a forward look of the integration of LED lighting as a possible new standard for Hamburg street lighting.

2.2 Contributions of partners

The following table depicts the main contributions from participant partners in the development of this deliverable.

Table 1: Contribution of partners

Participant short name	Contributions
HAM	Chapter 1-6

2.3 Relation to other activities in the project

This deliverable is allocated in Task 3.8 “Public Lighting improvements” and describes the results of subtask 3.8.2 “Humble lampposts”. This deliverable is connected to deliverable D3.10 “adaptive lighting”, which focuses on the deployment of new sensors and lighting control systems at the new planned bicycle connection in Hamburg-Bergedorf.

Table 2: Relation to other activities in the project

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Deliverable Number	Contributions
D3.10	This deliverable describes the deployment of new sensors and lighting control systems.
D3.2	This deliverable provides the description of the baseline report of Hamburg and the simulation models of the building stock, energy systems, transportation and urban infrastructure.

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3. Background and Framework[1]

The City of Hamburg is determined to see digitisation as an opportunity by using its potential for greater efficiency and thereby improve the economic power and quality of life for Hamburg's citizens. The fundamental goal of the Digital City Strategy is always one of the following: the use of technologies to improve service quality, the more efficient use of resources, to foster the quality of stay in the city and simultaneously the reduction of pollutants.

It is also a goal, to create the basis for the possibility for companies to develop fields of innovation, in which they can try out new options and technologies and develop them to market maturity in pilot projects.

Against this background, public lighting offers an existing infrastructure that can be used in the smart city for new services and it creates an opportunity for intelligent street lighting.

Smart lamps are characterised by the fact that the individual light point not only fulfils the function of the lighting, but also offers additional services for citizens. An increase in the scope of functions offers the linking of services and makes further services possible.

LEDs are the ideal luminaire for intelligent street lighting. The properties of the defined light direction and the variations in luminous intensity and light colour are main improvements compared to former illumination.

By introducing a smart street lamp concept, it is intended to save energy and maintenance costs and to reduce CO_2 emissions. Here not only the investment costs have to be considered, but also the subsequent operating costs.

The project is not intended to be an end in itself. Therefore not all technical possible sensors were built on the lantern masts, only those, from which an increase in value is hoped in this range.

3.1 Street light concept in Hamburg

As a service provider to the authorities and agencies, the State Agency of Roads, Bridges and Waters (LSBG) is responsible for the realisation and demand-oriented maintenance of technical infrastructure facilities in the Free and Hanseatic City of Hamburg.

This includes the planning, design, construction, project control, maintenance and operation of main and federal roads, coastal and inland flood protection, water bodies (except federal waterways), infrastructures (including bridges, tunnels, walls, locks, barrages and pumping stations), traffic signal and traffic

[1] This section is the same as in Deliverable D3.10. The reason is that framework conditions for new smart lighting (Deliverable D3.10) and humble lamppost retrofitting lighting assets (Deliverable 3.11) are the same in the City of Hamburg. It has been included to ease reading of the deliverable.

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telematics systems, public lighting and development measures of overall urban significance. Since the summer of 2018, all public lighting tasks have been the responsibility of the 100% municipal subsidiary “Hamburg Verkehrsanlagen GmbH” (HHVA).

As part of mySMARTLife, LSBG continues working on the two subprojects "Humble Lamppost" and "Smart Street Lighting" with the aim of providing citizens with additional services via public lighting infrastructure.

The Hamburg lighting is conceived on the basis of various planning principles. Regional legislation, e.g. “the Hamburg Roads Act” (so called *“Hamburger Wegegesetz, HWG”),* the “Hamburg rules and regulations for planning and design of urban roads” (so called *“Hamburger Regelwerke für Planung und Entwurf, ReStra”)* or the “Law on Green and Recreation Facilities” (so called *“Hamburger Gesetz über Grün- und Erholungsanlagen”*), are defining street lighting in public spaces.

Further basic principles are collected in the national regulations DIN 13201 Part 1-4 "Lighting technology for street lighting" (DIN, 2005), the "Guideline for the installation and equipment of pedestrian crossings" (R-FGÜ, 2001) and the "Act on measuring point operation and data communication in intelligent energy networks” (so called *“Gesetz über den Messstellenbetrieb und die Datenkommunikation in intelligenten Energienetzen, MsbG”*) which all apply nationwide. The "Measuring Point Operation Act" (MsbG) is an essential component of the “Act on the Digitisation of the Energy Turnaround" (so called *“Gesetz zur Digitalisierung der Energiewende”*) and reregulates the topic of measuring point operation and measurement new. It has been in force since 2nd of September 2016 and has been implemented in October 2017.

In order to reduce the planning effort required for a lighting system, the lighting requirements are transformed into geometric sizes, i.e. that the light point height is corresponding to the width of the traffic area (standard cross section). The selection of the optimum luminaire-mast combination is based on the cross section of the road and the assessment of lighting, electrical, operational and economic aspects. Depending on the function or traffic volume of different road users in the area to be illuminated, different lighting classes must be distinguished in terms of the brightness of the illumination.

In order to make the operation of public lighting more efficient, Hamburg has introduced standard masts and standard luminaires, therefore around 80% of the systems consist of 5 types of luminaire and 5 types of pole. The municipality operates a total of around 125,000 luminaires, 135,000 lamps and 105,000 masts. With this number of lamps, it is more economical to replace series lamps on a regular basis than to replace defective lamps individually.

The road traffic sets the standard for the intensity of lighting. The street lighting in Hamburg is centrally switched on via a computer. Several measuring points distributed over the entire city area measure the brightness. If defined brightness values are fall below or exceeded, a switching command for switching on

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or off is automatically sent via the power grid. If 3 of the 6 measuring points reach the corresponding switching thresholds, the corresponding switching command is sent. The street lighting is switched by audio frequency ripple control (frequency 283 1/3 Hz, amplitude 2% of the 50Hz voltage). Different switching commands are sent depending on the function of the lighting (street lighting, pedestrian crossings, fog area and illumination).

3.2 Types of lighting in Hamburg

As described in chapter 3.1 above, for operational reasons only a small number of luminaire types are used in Hamburg. In 2007, the European Union decided to reduce energy consumption by 20% by 2020 (compared to 1990). The climate protection target for 2020 is therefore: 32.5 GWh/a. The City of Hamburg has steadily improved its energy consumption for public lighting by introducing new technical components and increasing lamp efficiencies (lumen/watt) and by replacing conventional and low-loss ballasts with electronic ballasts. Thereby it was already possible to save energy in the 1990s. From the 2000s onwards, luminous traffic signs were increasingly dismantled. Instead, traffic signs and traffic equipment with retroreflective foils were used.

The following table shows the energy consumption of public lighting over the last years.

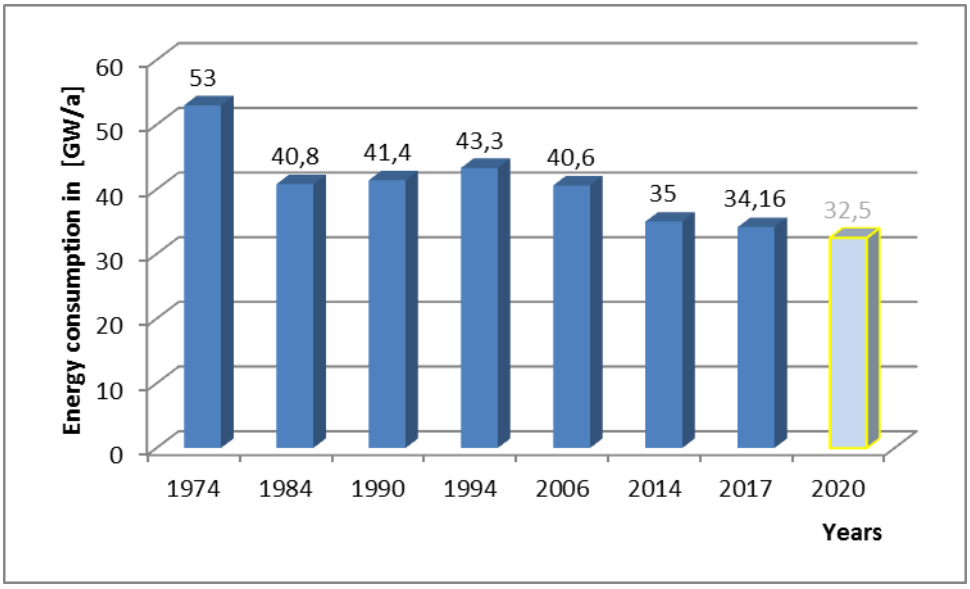

Figure 1: Energy consumption of public lighting (own representation)

In Hamburg different light sources have always been in competition with each other. The goal is to gain a lot of light with little effort (costs). The beginnings of public lighting were realized with oil lamps, followed by petroleum and gas. Then new types of electric lighting developed: first arc lamps, at the beginning of the 20th century until the mid-1970s incandescent lamps in their various stages of development. Since

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1950, fluorescent lamps have been used in public lighting. High-pressure mercury vapour lamps were used from the 1930s onwards and low-pressure sodium lamps from the mid-1970s. In the 1980s, the last gas lamp in Hamburg was switched off (Verg, 1984). The last high-pressure mercury vapour lamp was replaced in 2010.

More than 10 years ago, the first LED was installed as street lighting. In the beginning, the technical developments of the components were not yet so mature that an exchange of the new technology between cities would bring economic and ecological advantages. Hamburg therefore decided to wait until the technology gets to a point that conversion would pay off in every aspect.

The technical development of LED opens up new possibilities for street lighting. At the moment LED lighting is used more and more often in public lighting as it becomes more cost-effective. But today not all new street lights with LED built for economic reasons.

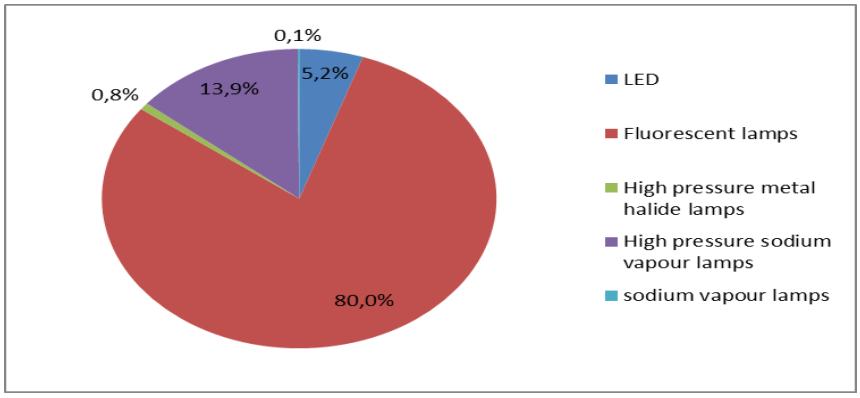

Figure 2: Overview of lamp types in Hamburg 2017 (own representation)

3.3 Project evolution

The work on the smart lighting intervention started in spring 2017 with a small internal workshop between the mySMARTLife partners HAM-LSBG, HAM-BGD and DTG about possible equipment and sensors. At this stage different problems like the question of responsibility for sensors and data, as well as technical problems regarding the metering and legal aspects have been identified and discussed. After the concretisation of the plans for the lighting along the bicycle path, several meetings with other authorities have been hold.

The first meeting has been organised with the Hamburg Ministry of Environment and Energy (BUE) to discuss the possibility to integrate environmental sensors at a lamp pole. The ministry made clear, that air quality is monitored by the Hamburg air measurement network with continuous

Figure 3: Smart street light in Munich (own source)

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measurements at stationary observation containers. The sensors for this measurement network are calibrated and harmonised to specific national standards to fulfil the "39. Federal Emission Control Ordinance" (so called *„Neununddreißigste Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes", 39. BImSchV*) and it is not possible to install these sensors in a lamp pole because of high technical requirements and the lack of space.

A meeting with the German meteorological service (Deutscher Wetterdienst, DWD) in December 2017 ended with the same conclusion, that the sensors for weather forecast are defined by international standards and in general placed away from buildings, traffic or other influences. Therefore a weather sensor at a lamp pole is not a meaningful solution.

Much more promising have been the meetings with the Department for Bicycle Traffic of the Hamburg Ministry for Economics, Transport and Innovation (BWVI) and with Hamburg Verkehrsanlagen (HHVA) which have been very interested in new LED lighting and sensors to count bicycle traffic. An agreement was made, to integrate sensors for bicycle counting in a lamp pole as part of bicycle traffic measuring network, which is currently under construction for the whole City of Hamburg.

Furthermore, partners from HAM-BGD, HAM-LSBG and HAM-LGV made in spring 2018 a study trip to Munich, where experts of the H2020 project "SmarterTogether" (Horizon 2020, Grant Agreement no. 691876) presented the local solution for smart lighting. It has shown that the City of Munich has taken much effort to develop and tender a new lamp pole type, for the integration of smart components in the lamp pole, while the approach of Hamburg is to develop the existing portfolio of poles.

After all these preparatory talks, the responsible partners decided to focus on implementing sensors related to the measurement and the improvement of bicycle traffic, because here is a realistic use case after the project given.

3.4 Existing public lighting systems

In the City of Hamburg, so far the lighting poles are replaced at the end of their life cycle. Yet not single poles are considered, but entire streets as a whole. In that process each street is completely redesigned and pole locations are moved or added. Also the luminaires are replaced at the end of their life cycle.

With regard to the use of new LED technic, it makes sense to consider the replacement of luminaires as part of a normal maintenance measure for the lighting poles and, if necessary, to adapt the locations using LED technology.

In many parts of Hamburg the distance between two lamp posts is up to 60 meters. Replacing the conventional luminaires by LED will lead to dark zones if not additional lamp poles are placed. This is caused by the different light characteristics of the LED and conventional luminaires.

The new constructed lighting systems are always connected to the power grid of the City of Hamburg, so that a continuous voltage existed, which is a necessary condition for additional sensors.

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Former installations are sometimes connected to the so-called "public lighting network" in Hamburg. This historical cable network is built completely autonomous and it is only used by public lighting. The cables of the single light poles of a street are connected to a central switch cabinet. This cabinet contains the fuses and the audio frequency ripple control receiver, which converts the switching signals. Only when the street light is switched on, the cables run electric current.

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4. Technical Description

The top priority in smart street lighting is always to ensure that lighting is guaranteed and that road safety is ensured. Ensuring the operation of public lighting must always be guaranteed. If additional services are installed on lighting poles, several operators have to operate on the same system.

For further services mounted on a lamppost, separate operating rooms must be created for the power supply. The electricity for the entire public lighting system is calculated on the basis of the lighting stock and compensated on a flat-rate basis. Due to the new legislation (MsbG, see chap.3.1), Hamburg is obliged to connect further consumers to a separate electric meter.

If a new service that should be mounted on an existing lighting pole, requires an antenna that is connected to other components inside the pole, the drilling of a hole and pulling the cables through the hole is cheaper than producing a completely new lighting pole. But if a second pole hatch is required to provide an additional separate operating room, the whole pole must be replaced.

This means, that the retrofitting requirements are different from those in the high performance area. The retrofitting of an existing system is often more compacted than installing a new one. In that process a central cost driver is the necessary underground work - especially for completely sealed surfaces (e.g. pavement or asphalt).

As described in Chapter 3.4, some light poles in Hamburg are not supplied with continuous voltage. Only very few of them have a telecommunication connection and generally the cable routes are not running directly beneath the light poles, but a few meters away. Therefore it is necessary to consider carefully whether an additional service should be mounted on the existing street light or it would be feasible to replace the existing lamp posts.

4.1 LED Light

The LED technic optimises the quality of the light. By using white light, a good colour rendering is achieved, which leads to an improvement of the quality of stay and a better perception in the public space. The colour temperature in Hamburg has been set to warm white with a high colour rendering index (Ra>80). Exceptions to this colour scheme are potential conflict zones like cross roads or pedestrian crossings, streets in the Hamburg harbour area or tunnels.

The City of Hamburg has developed a fixed lighting concept for the inner city area (see FHH, 2005).

In order to be able to use the LED light efficiently, the pole intervals and heights must be adapted to the beam characteristic of the luminaire. The adaptation creates a homogeneous illumination of the traffic area without glare. However, savings still can be made on the installed load, even if the interval between lighting poles has to be reduced and more lighting poles than before have to be installed. The possible

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savings of the LED is clearly illustrated by the system performance of the luminaire. The installed load is reduced by up to 35% per luminaire, depending on the type of the luminaire (LAI, 2012).

4.2 Other sensors

It has shown that in case of retrofitting existing light poles, the installation of sensors and additional services is very complicated. Depending on the location and equipment of the existing cable route, expensive underground work may be necessary, e.g. to connect to the telecommunications network or the power grid. As mentioned in chapter 3.4, for historical reasons, the lighting systems of some streets in Hamburg are supplied with their own network. The power cables of the single light poles are all connected centrally to an electrical cabinet. These cables are not continuous under voltage during the day. Sensors that have to be permanently supplied by voltage must therefore be connected separately to the power supply. The supply of components via a self-sufficient system, such as solar panels, is currently tested but not seen feasible from Hamburg perspective by now.

In a large scale project in Hamburg, sensors are mounted on traffic light systems and lighting poles to enable a traffic counting at important traffic junctions. The goal is a faster and more effective traffic planning. Traffic participants are detected by thermal imaging cameras and the data is supply in real time. Precise anonymous data for traffic planning enables quality assurance of traffic liquefaction measures. Thus the cost-intensive "manual counting" will be a thing of the past. This is a wide spread example in Hamburg of the use of public lighting as amount for additional sensors or services.

Also Wi-Fi or picocells (small radio cell to improve the mobile radio coverage) are retrofitted in Hamburg. This can only be done, if a permanent power supply and an existing telecommunication connection are available.

The implementation of environmental sensors, outside official measuring networks, are not considered sufficient by the responsible authorities and institutions (see Chapter 3.3). The collection of environmental data without further processing is not expedient. Therefore the installation of these sensors has been dispensed.

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5. Implementation Plan

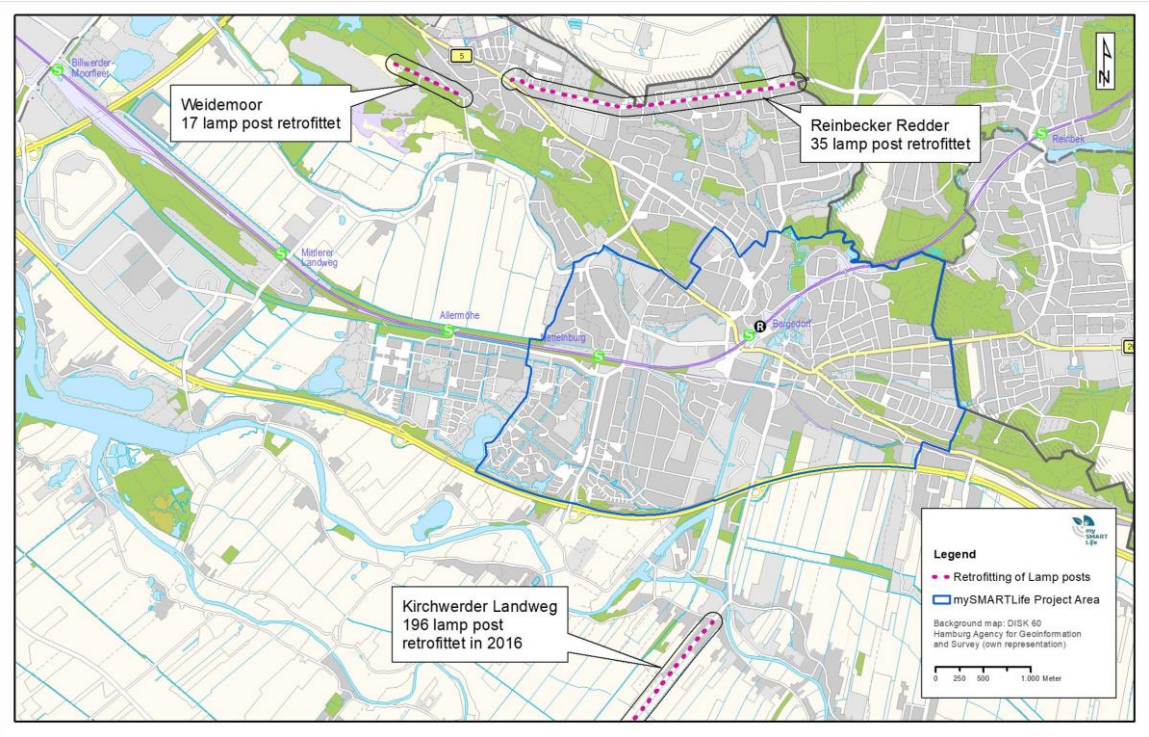

Figure 4: Overview of the retrofittet lamp post in the Borough of Bergedorf (own design)

5.1 Regional Framework

The objective of the "humble lamppost" subtask is to retrofit existing lighting poles in the project area with additional technology, such as sensors or Wi-Fi. This will also enable additional services to be offered to the public in the lighting stock.

During the identification phase, it became increasingly clear which additional services would be useful for retrofitting and an agreement was reached on LED retrofitting with additional bicycle counting and WLAN.

At first, the pedestrian zone of the inner city of Hamburg-Bergedorf was considered as a suitable possibility within the defined project retrofitting zone for a possible implementation site for Wi-Fi. But unfortunately the whole street was renewed a couple of years ago and no fibre cable were laid during that reconstruction.

The second possibility implementation, which was brought up by the project, was the redesign of the street “Brookdeich”. As a part of a road maintenance measure, the traffic area should be converted and rededicated into a bicycle street. In addition to replacing the conventional LED luminaires, bicycle counting points and WLAN were also to be retrofitted to the light poles. But at the end of the planning phase, the

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Transport Development Committee (in German: Fachausschuss für Verkehr und Inneres) of the Borough of Bergedorf decided not to change the character of the street to a bicycle street. Thea only will reduce the maximum speed to 30 km/h, to avoid expected legal complaints of local residents. This meant that the use case linked to bicycle traffic was no longer given.

In short-term an alternative location was found in the streets "Reinbeker Redder" and “Weidemoor”, which are not within the defined limits of the retrofitting zone, but within the district of Bergedorf. Within these streets, the lighting system has to be completely renewed due to their age with new LED lights.

5.2 Retrofitting of the lamppost at the street „Reinbeker Redder”

The street “Reinbeker Redder” is located in the northern part of the Borough of Bergedorf and is designed for general traffic. The lighting poles have reached the end of their service life and have to be replaced in November 2018. Some of the suspended lighting poles are double arms, which will be no longer used because of static reasons. An alternative light pole with a double-armed top section is not suitable for today's vegetation of the central green strip. For this reason, the masts are exchanged by standard lamp poles with arms and the secondary lane will be separately equipped with additional lighting.

Figure 5: Street “Reinbecker Redder” old lighting with double arms (own source)

In the course of this, the lighting will also be adapted and equipped with energy-saving LED technology. The existing road conditions are almost optimal, so that the characteristic of directional light emission can be easily applied.

At the same time, a new type of luminaire will be installed and tested. The LED luminaire is equipped in such a way that further adjustments to the luminous flux can be implemented in a controllable manner if

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necessary. A homogeneous illumination of the road makes it possible to reduce the light intensity and at the same time improve visibility.

When considering which additional services are appropriate at the respective location, the prerequisites must be checked. The DIN SPEC 91347(DIN, 2018) points out that a prerequisite for the installation of additional services is a telecommunications connection and a continuous power supply.

In the area of the Reinbeker Redder, public lighting is supplied via an old cabling structure. As described in chapter 3.4, the lighting poles are connected to a power grid that supplies power only when needed for public lighting (in the dark). The laying of a power cable to supply the additional services is not profitable.

This street primarily serves as a simple access road to the residential areas nearby and has little communication areas. Therefore a retrofitting with additional sensors (e.g. Wi-Fi) at this street was not rated reasonable and therefore not implemented.

Figure 6: The retrofittet lamppost with LED lights (own source)

5.3 Retrofitting of the lamp post at the street „Kirchwerder Landweg“

Shortly before the start of the project, a lighting system in the rural area of the Borough of Bergdorf was modernised as a part of a maintenance measure. The lighting system is placed at a road that leads through a nature reserve, which is a good example for the advantages of LED lights.

In this case the light poles and the luminaires were renewed altogether. The linear luminaires previously used were replaced by energy-saving LED technology, which reduces the emission of light into the surroundings and thus the impact on nature. The use of LEDs was particularly suitable in the area of the

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nature reserve, as hardly any scattered light is emitted into the surroundings and only the street is illuminated.

The used LED luminaires with warm white light colour will reduce the approach of insects due to the spectral properties of the emitted waves. In order to be able to use the light efficiently, additional masts are erected. With the reducing of the distance between the light poles a significantly better uniformity of the light could be reached, while simultaneously the use of LED light could reduce the total exposure of light at the street. It is expected that the homogeneous illumination of the street will reduce the risk of accidents for cyclist in the darkness. A total of around 196 LED luminaires have been installed on the approx. 6 km long route.

Figure 7: New LED lights at the street "Kirchwerder Landweg" next to nature reserve (own source)

5.4 Retrofitting of the lamp post at the street „Weidemoor"

Another retrofitting of lamp post in the Borough of Bergedorf was implemented in the street "Weidemoor", which is direct at the border of a nature reserve as well.

The lighting was an obsolete wooden pole system, which was completely dismantled. Instead of the old power lines above ground a new underground cable was pulled and the wooden poles were replaced by steel poles. In the context of this complete renewal and taking the nearby nature reserve into account, an environmentally friendly LED technology with reduced light emissions in the surroundings as luminaire was chosen.

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Figure 8: The street “Weidemoor” befor the retrofitting (source: googlemaps)

Figure 9: The street “Weidemoor” after the retrofitting (own source)

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6. Conclusions

The first two years of the project has shown that LED technology offers a lot of advantages and the City of Hamburg will continue with retrofitting of luminaires to LED in future.

Even if this technology is not yet listed as a Hamburg standard, the municipality has already started to test and to use LED luminaires in many places with different lighting requirements from a wide range such as harbour or housing areas.

It has shown that especially in places where the compact design is useful, e.g. in handrails or where day and night dependent control is required, like in tunnels, LED technology offers many advantages. Also in areas where traffic areas directly adjacent to nature reserves, LED offers a feasible solution with its defined beam characteristic and insect-friendly colour temperature.

The City of Hamburg will increasingly rely on LED technology, but always with a view to economic efficiency. The electricity savings generated by LEDs must be offset against the use of materials and other operating expenses as well as retrofitting cost, where the cost of the underground construction for new lines have a high share. Also it has to be tested how long LED luminaire will finally last and whether it will withstand the local weather conditions.

Another conclusion from the conception phase is, that many possibilities offered by new sensors for smart street lights, often do not match the requirements of public authorities (compare D3.10 “adaptive lighting”). The authorities and public agencies which have been quested often do not see the supposed added value through extra data collection. Therefore it has to be regulated which data should be gathered and who is responsible for the operating of the sensors. Furthermore it must be examined whether an investment is also worthwhile for economic reasons.

The separation between data holder and data user and their responsibilities are actually not identified. The expected results are often difficult to describe and delimit. Because of difficult and complex coordination processes, the selection process of additional sensors and where these sensors should be placed, has to be done very carefully.

During implementation of the humble lamppost in the project, it was a big challenge to find suitable locations and application examples within the project zone and limited project time. Therefore the initial idea of converting lighting poles to LEDs and also to integrate additional services and sensors could not fully be implemented in the first two years of the project, because of these external decisions. But the project mySMARTLife could create a lot of knowledge about smart lighting, adaptive sensors and how to implement these for the responsible agencies and authorities in Hamburg.

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In upcoming years, humble lamppost and LED technology will continue to make its way into the lighting design of the City of Hamburg, as the advantages of energy-saving technology and the reduction of light pollution caused by directional light emission are considerable.

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