MAtchUP

D3.6: Public lighting in Dresden – First Version

WP 3, T 3.4

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MAtchUP - SCC-1-2016-2017

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Technical References

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3	Michael Anz		15.09.2019

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Abbreviations and Acronyms

Acronym	Description
D	Deliverable
DRE	City of Dresden
ESS	Energy storage system
LED	Light-emitting diode
MCDA	Multicriterial Decision Analysis
PV	Photovoltaics
RES	Renewable energy source
ST	Subtask
T	Task
WLAN	Wireless Local Area Network

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Abstract

This deliverable is about the development of a solution in optimization in public lighting in Dresden. It shows the stages from the idea developed for an optimization in public lighting as developed for the MAtchUP proposal to the attempts to implement the chosen adaptive lighting solution. This deliverable describes the technical and strategic difficulties that lead to a cancelling of the first attempt to implement the proposed solution. Whether another solution will be developed depends on the results of the Smart District-Level Energy Renaissance Strategy that is developed in the MAtchUP action A45.

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1 Introduction

1.1 Purpose and target group

This report constitutes Deliverable *"D3.6: Public lighting in Dresden – 1st version"*, which is the main outcome of Task *"T3.4 - Smart Energy Infrastructures"* with the Subtask *"Subtask 3.4.3 Public Lighting"*. The final version of this report (i.e. D3.18) will be delivered in September 2020 (project month M36).

One of the core objectives of this document is to describe the detailed design of the interventions concerning public lighting in DRE as planed within MAtchUP.

Moreover, we give an overview on the strategic process implemented to implement a working solution.

1.2 Contribution of partners

Table **1**: Contribution of Partners depicts the main contributions from MAtchUP partners in the development of this deliverable.

Table **1**: Contribution of Partners

Participant	Contributions
DRE	Description of the strategic process and decision on technical solution

1.3 Relation to other activities in the project

Table **2**: Relation to other activities in the project depicts the main relationship of this deliverable to other activities (or deliverables) developed within MAtchUP and that should be considered along with this document for further understanding of its contents.

Table **2**: Relation to other activities in the project

Deliverable	Relation to D3.6
D3.11	New policies on Dresden city council - First Version.
D3.18	Final Version of document
D5.x	The objective of WP5 "Technical, social and economic evaluation" is to setup a strong evaluation framework to be deployed in each lighthouse city with the aim to assess the effectiveness of the proposed intervention, deployed in the associated individual actions. Therefore, D3.6 is linked to WP5 deliverables.
D6.x	The objective of WP6 "Exploitation and market deployment – innovative business models" is to design innovative business models and financial mechanisms to foster the implementation of smart city solutions, to identify exploitable results and to design an ad hoc strategy for their deployment and replication. Therefore, D3.6 is linked to WP6 deliverables.

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2 State of the art and future vision related to public lighting in Dresden

In the state capital Dresden, around 1,500 km of public roads and paths as well as squares, facilities and open spaces are illuminated. Around 46,000 luminaires are installed. The Public Lighting Department, with its 37 employees on behalf of the Road and Civil Engineering Office, ensures the technically safe operation of these systems. This includes all repairs, maintenance, the restoration of plant components after damage and services for third parties (LHD 2019a).

2.1 Lighting design

In addition to the requirements for road safety, energy efficiency, immission and species protection and crime prevention, design aspects play a major role in lighting planning. With the lighting design of streets and squares and the illumination of building facades, diversified, pleasant lighting moods and room effects can be created. The attractiveness of Dresden's cityscape and the quality of life in public streets and squares are enhanced by good lighting design, even after dusk, thus reflecting Dresden's importance as a cultural and tourist metropolis. With the aim of making the specific city structure more tangible by systematically and specifically using lighting design elements, the City Planning Office initially commissioned the lighting master plan for Dresden's city centre (LHD 2019b).

2.2 Optimization actions in public lighting as suggested in MAtchUP

In MAtchUP there was the idea to implement an adaptive street lighting solution. In essence, the aim is to optimise the lighting design of public spaces with dynamic light while at the same time minimising energy consumption and light pollution. The aim is to incorporate variable lighting solutions in terms of brightness, colour, light distribution and glare into standards and technical regulations (e.g. Licht 2017).

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3 Technical definition of the interventions

In this deliverable only one action is going to be described,

- Action 15 Demonstration of optimization actions in public lighting

will be taken into account. There is a connection to A45 Smart District-Level Energy Renaissance Strategy where there will be a discussion on public lighting as well and how it can benefit the demo site district. The results from A45 will be taken into account when implementing A15.

3.1 Action 15 Demonstration of optimization actions in public lighting

Smart public lighting is proving to be a compelling starting point for most smart city initiatives around the world. The motivation is the energy savings gained by replacing traditional luminaires with low-power LEDs and implementing urban micro-renewables, but the further benefits enabled through connectivity and control. Networked street lighting, in which data and services are integrated in Dresden Urban platform, delivers additional energy savings, reduced maintenance costs, improved safety and security. Integration with other smart city and smart grid projects yields yet greater potential. Inside MAtchUP 40 conventional street lamps will be switched to LED with Intelligent Auto-Dimming Lighting and will be supported by RES & ESS. 5 PV-collectors with 5 kW will be installed as micro-renewable systems and 5 charging spots for everyday applications integrated with authentication and billing systems will be also deployed. Connected functions like City WLAN Hotspots and Parking Spot surveillance will be implemented.

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4 Executive project description of each action

4.1 Action 15 Demonstration of optimization actions in public lighting

4.1.1 Management structure

The action is led by DRE (owner of public lighting) with technical and scientific support of EASD as a Third Party (information collection on adaptive lighting, monitoring concept e.g.).

Due to a change in strategy the endeavour to implementation adaptive street lighting as put forward in the action description in 3.1 was put on hold. After an new attempt with introducing expert knowledge via “A45 Smart District-Level Energy Renaissance Strategy“ there is a new approach to be followed that allows an optimization in public lighting.

4.1.2 Technical specification

In Dresden a strategic approach for an optimization of public lighting is followed that caters to reduce light smog for the population. Accordingly, the focus is on occupant impairments when public street lighting shines into a building. An adaptive street lighting shall be implemented.

In Deliverable D3.1 the strategic approach was described shortly. A digital lighting master plan was to be evaluated. This approach was not followed upon.

As there are strict guidelines as to lighting levels that demand intensive lighting especially on streets highly frequented the aim at the moment is on those streets most intensively lighted. To come to a decision on which streets an implementation of adaptive street lighting will be necessary a Multi-criterial Decision Analysis (MCDA) on the basis of geodata on various variables was implemented. Focus was on the demo site area in Dresden (see Table 3: Criteria for an MCDA).

Table 3: Criteria for an MCDA

Criteria	Relevance	Explanation for relevance
Area in building	20	Has importance but Priority 2 – effected people in the first rooms relevant -
Population density	40	Priority 1 - The higher – the more effected
Average daily traffic (DTV)	40	Priority 1 – the higher the brighter the street lighting has to be

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As result of the MCDA a map was developed. This map (Figure 1: Result of MCDA) allows to distinguish through its colouring those parts of streets where citizens are subject to “light smog”.

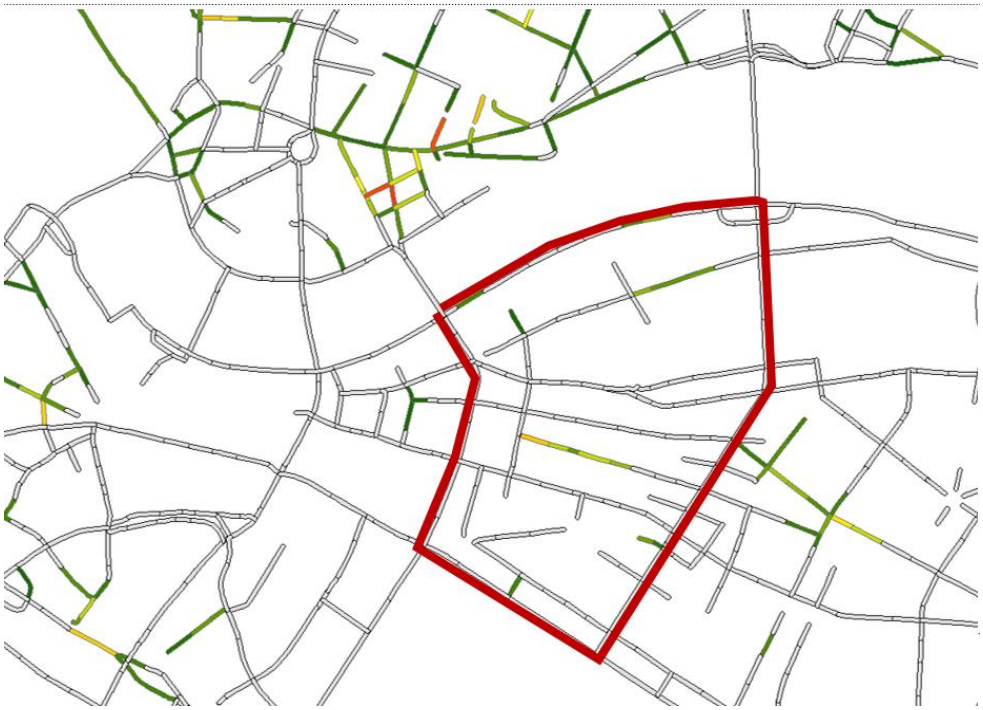

Figure 1: Result of MCDA

The colouring reflects the calculated necessity for adaptive street lighting. The red border of the district shows the focus area within MAtchUP. Green colouring shows a lesser necessity while red shows a higher usefulness for adaptive street lighting. Grey colouring was given to areas without relevance.

1) As result one has to admit that adaptive street lighting seems to be of lesser importance here from a strategic point of view as developed in a MCDA.

Further technical considerations where discussed:

1) Communication via radio transmission: The successful construction of an adaptive lighting system can only be achieved through the interaction of different components. It is important to optimize the coexistence of different radio technologies in order to ensure interference-free operation. Nevertheless, the disadvantages of the respective technologies do not cancel each other out, but multiply themselves: the malfunctions of an optical sensor in fog with the interference problems of wireless technology in the 2.4 GHz band.

2) Saving potential by adaptive lighting technology: The savings potential of an adaptive lighting system is less than 10 % compared to a conventional non-optimized lighting technology. The use of energy-efficient luminaires already saves an average of 40% to 60% of operating, maintenance and repair costs compared with conventional luminaires. The consideration of the use of an intelligent control technology does not result in practice-relevant values of the Return-Of-Investment.

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3) Maintenance costs: Although the service life of the lighting system is extended because the components are spared, the costs of installation and maintenance are out of all proportion to the result. The installation, repair and, above all, maintenance of an intelligent system are complex and require the knowledge and experience of qualified employees. In order to implement an intelligent lighting system, the staff of the Central Technical Services have to be extensively trained and instructed. The equipment (also mobile IT with the software programs for controlling and maintaining the system) for maintenance and repair work must be considerably expanded.

4) Market readiness: The large number of technologies and systems on the market shows that the technical solution for adaptive street lighting is in the test phase. It remains to be seen which systems are future-proof and which components will be replaced in the long term. Due to the susceptibility of adaptive systems to faults, we cannot guarantee safe lighting in accordance with technical standards. For the reasons given above, implementing an optimized public lighting system requires alternative approaches. This is done currently to allow an optimization of public lighting on the basis of state of the art technology.

4.1.3 Planning of the tasks

During the first two MAtchUP project years [M1-M24], the following steps could be finalized:

- Multi-criterial Decision Analysis (MCDA)
- Technical evaluation of technologies

Next Milestones:

- M1 Until 11/2019 [M26]: Reevaluation of approach on optimization in public lighting within A45 Smart District-Level Energy Renaissance Strategy
- M2 Until 09/2022 [M36]: Implementation of a solution for an optimized public lighting system
- M3 Until 09/2022 [M60]: Testing, monitoring, evaluation, e.g. citizen feedback gathering

Year 1				Year 2				Year 3	Year 4	Year 5	
Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8				
			(1)	(1)	(1)	(1)	(1)				(1) Design phase (2) Selection equip-ment/installers (3) Installation of hard-/software (4) Start of operation (5) Monitoring
							(2)				
							(3)	(3)	(3)		
								(4)			
									(5)	(5)	
							M1	M2		M3	

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Figure 2: GANTT diagram

4.1.4 Health, safety and waste management requirements

Does not apply here.

4.1.5 Risks considered ex-ante and proposed risk-mitigation measures

1. The conceptual discussion of a master plan that appears to be necessary will take time:

- Mitigation: Decision not to follow this course was taken. Mitigation measure: MCDA to be developed.

2. Resources to install the new lighting are not yet defined:

- Mitigation: MAtchUP funds allow for some flexibility to overcome initial shortage in funding

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5 Status of the intervention

5.1 Action 15 Demonstration of optimization actions in public lighting

5.1.1 Status of the intervention

Due to a change in strategy the endeavour to implement adaptive street lighting was put on hold. This decision bases on the results explained in chapter 3.1. The organizational reshuffling is a new attempt including a call on additional expert knowledge via “A45 Smart District-Level Energy Renaissance Strategy“. This provides a new approach to be followed that allows an optimization in public lighting.

5.1.2 Risks found and corrective actions performed

The proposed solution to optimization in public lighting via adaptive lighting was considered not to be worthwhile.

As corrective measures currently an alternative solution is developed within A45 Smart District-Level Energy Renaissance Strategy.

5.1.3 Business model and financial scheme applied

The Business model and financial scheme applied have yet to be developed. Currently the results from “A45 Smart District-Level Energy Renaissance Strategy” have to be waited for.

5.1.4 Citizen engagement strategy implemented

The results from the strategy developed in “A45 Smart District-Level Energy Renaissance Strategy” will be published while searching for options for implementing an optimization of public lighting by the municipality.

5.1.5 Next steps

To allow further development a re-evaluation of an approach of optimizing public lighting within the scope of the A45 “Smart District-Level Energy Renaissance Strategy” will take place. From this onward further steps will be developed.

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6 Conclusions

The expectations for public lighting as addressed in MAtchUP was to optimise the lighting design of public spaces with dynamic light while at the same time minimising energy consumption and light pollution.

When we started looking more deeply into this issue we identified technical and strategic aspects (chapter 3.1) that led to the decision to currently put further adaptive lighting on hold.

A new attempt including a call on additional expert knowledge via “A45 Smart District-Level Energy Renaissance Strategy” provides a new approach to be followed that allows an optimization in public lighting.

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