COPENHAGEN

CAPACITY

Lighting Metropolis

Initial benchmark analysis

Contents

1. Selection of cities to shortlist

This analysis is based on the inspiration catalog for the project description for Lighting Metropolis, see the application document (March & April 2015), pages 146-147. The purpose of the analysis is to map the lighting industry landscape abroad to plan the project's schedule, in order to ensure the aims of the Lighting Metropolis project and those of its participating partners are met.

The reason why the analysis is based on the project description's inspiration catalog is that the catalog outlines the desired professional benefits for each of the project's focus areas. The individual focus areas were examined separately, as well as their challenges, themes and project ideas. This was done without specific focus on individual cities, nations or the like, as the purpose of the initial survey was to map the general focus areas. Next, we researched the lighting industry, the results of which are reflected in the following data:

- **Global Magazines:** LightSearch, Lighting Magazine Arch Lighting, Darc-Magazine, LED Magazine, Enlighter Magazine and LED Professional
- **Smart City- and Light associations:** OASCities, C40 and LUCI
- **Event calendars:** LEDinside, LightSearch, Lighting-Inspiration and LUCI
- **Global associations:** CIE, GLA, ISO, IES and IEA
- **Reports:** Lighting Lab, SSL-Erate (EU), Lighting the Cities (EU), Licht.Wissen (no.19) and Lighting the Tay Perspectives (McKinsey)
- **R&D facilities for the following lighting companies**: Acuity Brands, Endo Lighting, Philips, Toshiba, Panasonic, Glamox, GE Lighting and Osram (it was not possible to locate R & D facilities for Hubbell Lighting)
- **University and architecture association:** IALD
- **Biological lighting associations:** Circadian Lighting and American Health Lighting
- **Interview:** 20 lighting experts and project partners in the Greater Copenhagen area

In addition, DOLL (Danish Outdoor Lighting Lab) was contacted to ensure that we had not overlooked any relevant information.

The above research resulted in us collecting data for 351 cities, spread across 81 different countries and six continents.

Due to the timeframe of the project, it was not possible to investigate all 351 cities: we needed to identify the most relevant cities for the project.
The following passage describes how the city shortlist was made.

Narrowing criteria:

1. The city must be a member of OASCities, C40 or LUCI ***and*** the country in which the city is located must be a member of either GLA, CIE or IEA.

   As a result, the 351 cities were reduced to 210 cities, spread over 50 countries and 6 continents.

2. The city must have at least ***one*** of the following; IALD project, IALD University, a planned event in 2017 or in one of the following years, or one of the above companies must have established an R&D department in the city.

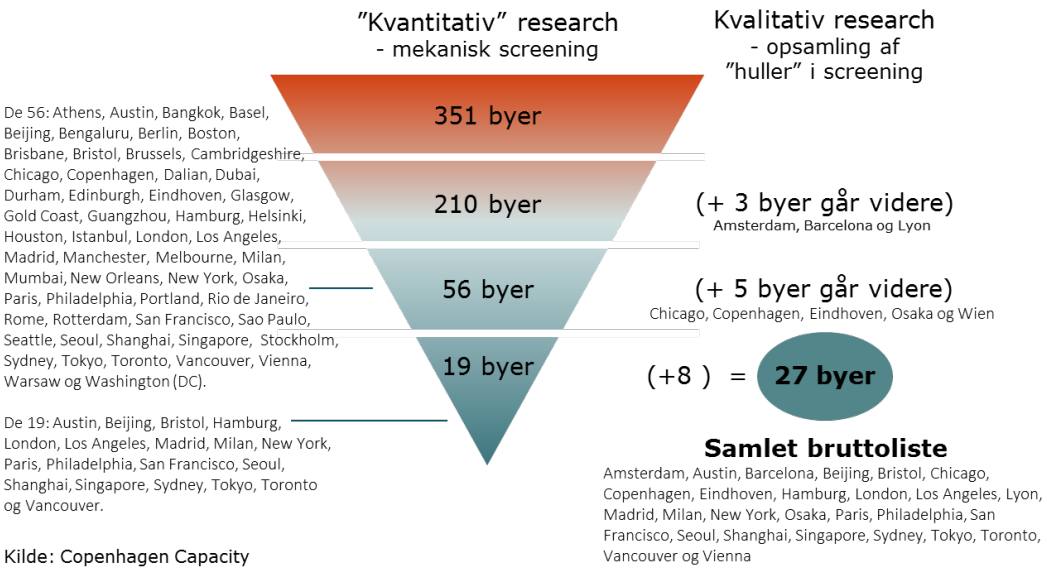
   As a result, the 210 cities were reduced to 56 cities, spread over 26 countries and 5 continents.

3. Instead of one, the city must have at least ***two*** of the criteria in the 2nd criterion filled up.

   As a result, the 56 cities were reduced to 19 cities spread over 12 countries and 4 continents.

The result of the above screening is shown in Figure 1. It is also apparent from the figure how the "quantitative" mechanical screening is supplied with a more qualitative assessment to ensure that the analysis does not ignore relevant projects and activities. Thus, there are three cities that only reached the second stage (with 210 cities), yet were considered to be interesting, along with another 5 cities from the third stage. Figure 1 and Table 1 (even more visibly) shows the 27 cities that are most interesting for the project, according to the above selection method. The 27 cities represent 15 countries and cover 4 continents.

Figure 1: Narrowing Down the Relevant Cities



Kilde: Copenhagen Capacity

2. Introduction to the gross list

The previous research showed that the following 27 cities are most interesting for a study trip, according to the inspiration catalog for the project description of Lighting Metropolis.

Table 1: Overview of city projects within each of the 5 focus areas

Cities	Lighting for People	Biological Lighting	Smart City Lighting	Climate and Environ-mental Lighting	Economic and Efficient Lighting	*Overall score*
Eindhoven	**5**	0	3	**3**	1	*12*
Los Angeles	3	0	**4**	1	**3**	*11*
Copenhagen	**3**	**2**	3	2	1	*11*
Lyon	**4**	0	2	3	1	*10*
Hamburg	2	0	**5**	1	1	*9*
Singapore	0	**1**	4	**4**	0	*9*
Barcelona	0	0	**5**	**3**	1	*9*
London	1	**1**	4	2	0	*8*
Chicago	1	0	3	3	1	*8*
Paris	0	0	3	3	1	*7*
Vienna	2	0	1	2	**2**	*7*
New York	1	0	1	3	1	*6*
Amsterdam	1	0	3	1	1	*6*
Sydney	1	0	0	2	**2**	*5*
Toronto	1	0	0	3	1	*5*
Seoul	0	0	3	2	0	*5*
San Francisco	1	0	1	2	1	*5*
Milan	0	0	3	1	0	*4*
Madrid	0	0	0	3	1	*4*
Bristol	1	0	2	1	0	*4*
Austin	0	0	2	2	0	*4*
Shanghai	0	0	2	1	0	*3*
Philadelphia	1	0	0	1	0	*2*
Vancouver	0	0	0	1	0	*1*
Beijing	0	0	0	1	0	*1*
Tokyo	1	0	0	0	0	*1*
Osaka	1	0	0	0	0	*1*

Note: The scale goes from 1-5, where 5 means that the city meets all the criteria within the focus area (see the application document's inspiration catalog), 3 means that half of the criteria are met, etc.

Source: Copenhagen Capacity

It is also apparent from Table 1, on the far right, that Eindhoven is the city with the most projects of interest to Lighting Metropolis. Copenhagen and Los Angeles share second place, Lyon takes fourth place, while Hamburg, Singapore and Barcelona share fifth. From Table 1 above, it is also apparent in which areas the cities have projects of interest.

Top 3 within each focus area

The following is an overview of the top 3 cities within each focus area, i.e. the cities that have the most relevant activities in the Lighting Metropolis. Top 3 listings are prioritized in terms of how cities' projects are consistent with Lighting Metropolis's expectations for a study trip, see the Application Document (March & April 2015), pages 146-147. It should be noted that it is expected that the study tours have overlapping elements between given focus areas. Below is a brief description of the projects in each city, which explains why these cities are ranked as follows. Finally, documentation and sources can be found in section 8.

3. Lighting for People

When it comes to the Lighting for People focus area, there are several cities that meet the criteria described in the Lighting Metropolis' Application Document (March & April 2015). Below are the top three best-performing cities, according to the Inspiration Catalog for the project description.

1. Eindhoven

Eindhoven calls itself the "City of Light". There, on a city street, it is possible for passers-by to control the street lighting and thereby create their own personal mood using the different-colored LED lighting installed in the street lamps. There are further sensors installed on the lampposts so that light intensity is adjusted according to who and how many people are using the street. The sensors also have memories, which means that if you regularly go for the same evening meal (with one dog, for example), the lights turn on in advance and guide you on your regular route. Due to the different-colored LED lighting, it is also possible to "warn" people in the neighborhood about a nearing storm, tide or the like using the red LED illumination. The street lighting can thus be used as a communication tool that guides residents and creates security.

When a run-down neighborhood in northwestern Eindhoven needed renewal, the city tried to use lighting as a city planning instrument. In Strijp-S (neighborhood), each light-emitting dot has its own IP address, and people in the area can control lighting via an app. This also applies to the area's sports fields.
Furthermore, Eindhoven wishes to include citizens as much as possible. Therefore, they encourage "quadratic helix" constellations, which are collaborations between government agencies, private actors, universities and citizens in the area.

On top of this, the city has installed special lighting constellations in particularly "dangerous" intersections where drivers, cyclists and pedestrians find it difficult to see each other. These light installations are implemented in the road/asphalt and blink to drivers if a pedestrian or cyclist is approaching the crossing. The purpose is, of course, to create more peace of mind in these intersections and increase security.

LED lighting is also installed on the Stratumseind party street. The light here can be adjusted to avoid unrest and controversy. The street's lighting can also be used to guide guests along the street when it is crowded.

Finally, the city has installed green LED lighting on a frequently-used cycle path that connects Eindhoven with its suburbs. 38 street lamps have been established over a distance of 1 km. The reason why the lighting is green is that this color emphasizes the surroundings as much as possible and is comfortable for both human and animal eyes, while also sufficiently illuminating the road.

2. Lyon
In Lyon the lighting on the Annonciade wall has been reinstalled and the lamps have been replaced with more energy-efficient alternatives. The wall and the street are special because they are home to illuminated paintings, which gives the street a safe and "homely" feel. The idea is that the tan lighting functions as a kind of social "lever".

There are places in Lyon with sensors on the streetlights so that the light can be automatically adjusted to the number of people using that public space. This also means the light can be customized for special events.

As an artistic element, the city's monuments are illuminated differently depending on the time of day. This changes the way the monuments are experienced, depending on what time of day they are seen. This is one way in which the city has used lighting as a city planning instrument.

In several parks in Lyon people have the opportunity to turn the lighting on and off. In this way, the city tries to invite citizens to participate and interact with their city.

Finally, the bridge of La Passerelle St Vincent is a pedestrian bridge where LED lighting and motion sensors have been installed. That is, the light will be downgraded to 10 percent of its maximum strength at 22.00 each day, but as soon as someone starts walking on the bridge, the brightness automatically adjusts to full power.

3. Copenhagen
Copenhagen is home to an exciting initiative that other cities have taken onboard, including San Francisco and Amsterdam. This is the "Green Wave", which is a little light along the cycle path that indicates the traffic lights are about to change. This means that cyclists can adjust their speed so that they are not "pushed" into a traffic light that is switching to yellow/red. These lights provide safety for cyclists, supporting them in a more comfortable journey through the city.

To further safeguard the many cyclists in the city, extra-sensitive lighting has been installed at intersections that is activated when a cyclist approaches a larger vehicle, such as a truck. The purpose of this installation is to provide security for both drivers of larger vehicles and cyclists in Copenhagen, and hopefully reduce the number of right-wing accidents.

The "Bicycle Trail" has been built around one busy area in Copenhagen. This bridge leads cyclists and pedestrians outside of busy intersections. In addition, LED lighting has also been installed in handrails, which, among other things, reduces reflection. In 2014 the project won second place at City People Light.

4. Biological Light

Biological light is one field within the lighting industry that is still largely at the research stage. A review of material in the focus area indicates that universities engage in the subject, but relatively few companies have established real solutions. This means that information on this topic is relatively sparse. Initial research provided just a few individual observations in London, Singapore and Copenhagen, but this immediately seemed a reasonable basis to establish further analysis. Therefore, Greater London and Greater Copenhagen (the areas around each of these cities) have been investigated intensively, as these cities were the only who offered the most (or only) upcoming projects within the project's focus area.

1. Greater Copenhagen

Chromaviso has installed ergonomic light and ergonomic circadian rhythm light at several hospitals in southern Skåne, as well as in the Copenhagen area, for the benefit of patients, hospital visitors and employees. One of the places where circadian rhythm lighting is tested is at Gentofte, Rigshospitalet. There they are running a research experiment where they have installed circadian rhythm lighting in different places in the hospital, so that the lighting inside matches the level of light outside. The lighting automatically adjusts as the sun moves across the sky. At nighttime, when patients (or staff) switch on the lights indoors, an orange-colored light illuminates the room. One of the benefits of circadian rhythm lighting is that it does not interact with the minds of inhabitants, thus avoiding the manipulation of the brain's cognitive centers. The research project is not finished d.d. December 2016. In addition to the above, the research project also aims to clarify other aspects of the circadian rhythm lighting and what it can do for humans. Among other things. circadian rhythm lighting is also tested in relation to its preventive and healing effects in in-patients.

In Albertslund Municipality, a partnership between several companies has been established for the construction of a care center (Albertshøj Care Center) with integrated, fully-dynamic circadian rhythm lighting. The project will cut costs and reduce CO2 consumption, while the integrated circadian-rhythm system will also improve the lives of the elderly residents.

At Hillerød Hospital, a preventative instrument has been established at one of the hospital's birth centers, in collaboration with Philips and Wavecare. Soft tones, changeable colored lighting and vivid images projected onto walls will create a soothing and stimulating atmosphere for the benefit of the child, their family and staff.

In Malmö, Lindeborg School has installed "Human Centric Lighting", which is a form of light that aims to promote a positive learning environment. This means that the lighting is based on circadian rhythm, but it can also be easily adjusted via a smart screen, for example, to make a room darker or soften the lighting for a more cosy time. The illumination is also a bit sharper at selected times of the day when it is

difficult for schoolchildren to concentrate. Here, circadian rhythm lighting helps school students focus, encouraging intellectual activity. A similar project has been trialled at a primary school in Albertslund, in collaboration with DTU.

Finally, a research project was undertaken between the Danish lighting company Light-Care, the innovation network DANSK LYS and circadian rhythm and sleep researcher Katharina Wulff from Oxford University. The research project took place in Horsens, dealing with dementia and how circadian rhythm lighting can help dementia patience.

2. Greater London

In London, Guy's and St. Thomas' Hospital has expressed interest in experimenting with circadian rhythm lighting. The purpose of the experiment is to investigate whether this type of lighting can reduce the length of hospital stays. Alexandra Hammond of Guy's has allocated 1 million GBP to the project. The funds will also be used to establish LED lighting in the hospital.

3. Singapore

Singapore's Smart Yuhua Residential Estate project won a prize for incorporating "smart living" into an already established building. One of the elements in the project is a monitoring system for elderly residents that will make their lives easier. Unfortunately, there is not much information available on the project.

5. Smart City

When it comes to the Smart City focus area, there are several cities that distinguish themselves, see Table 1 above. The three most prominent are the following:

1. Barcelona
In 2010, Barcelona, in collaboration with Endesa, installed LED light bulbs in the city, which can be individually controlled and equipped with motion sensors, in order to automatically assign the required level of lighting for pedestrians, cyclists, scooters or cars. These lampposts can be centrally controlled, and several of the city's lampposts have been since 2010.

In 2012, Barcelona changed 1,100 of the city's street lamps over to LED lighting. The public lampposts in District 22 are equipped with several sensors that can measure humidity, temperature, vibration, noise level and pollution and the lampposts are even equipped with surveillance cameras.

In addition, a Barcelona company and one of the city's universities have collaborated on the construction of lampposts that run exclusively on wind and solar power. These lampposts can provide light for 6 days without wind or sun. The lamps are located in several places throughout the city, for example at the beach.

Barcelona also houses several smart city solutions. Barcelona experienced a drought a few years ago and, as a result, a smart water meter has been installed in collaboration with Cisco. This solution interacts with the irrigation system used by the city. Due to its many smart city solutions, the city collects a lot of data, which is also made publicly available.

2. Hamburg
Hamburg uses lampposts in several different "smart" ways.

Via the Internet of Things (supplied by Cisco), Hamburg has connected the lampposts with various sensors and systems, thereby establishing a smart cloud management system. These systems capture traffic patterns and traffic lights are automatically adjusted to make traffic move as smoothly as possible. Since Hamburg is a port city with many incoming ships, the city's bridges are also raised relatively frequently. With Hamburg's new smart system, traffic is routed out of these open bridges to prevent traffic flow from being held up. This can be experienced at bridges like Kattwykbrücke.

Furthermore, street lighting at Hamburg's port has become intelligent and dynamic. The lamps are equipped with different sensors and cameras that capture pedestrians, cyclists and cars, and adjust to their required level of light, even following them on their journey. If no one is using the street, it will be automatically darkened. The sensors can also catch traffic accidents and inform authorities and emergency services if required. The street's data is confidential, but saved and analyzed

by the city and its partners to improve the street where possible.

Hamburg has also installed smart city solutions, including, among other things, a smart parking system, which allows motorists to orient themselves around vacant parking spaces before, during and after arriving at their desired destination.

3. Los Angeles

In collaboration with Philips and Ericsson, the city of Los Angeles (L.A.) has installed more than 100 smart lampposts. The city sees a lot of activity on its streets over the course of 24 hours, which is why traffic, both in and out of the city is an essential for L.A. Therefore, sensors have been installed in the asphalt, which can detect car traffic. These sensors are coupled with the city's smart management System (CityTouch), where some traffic lights can change color automatically in order to get traffic moving more swiftly.

The management system (CityTouch) has been incorporated into 110,000 lampposts and is one Internet of Things (IoT) solution. These lampposts have been made so intelligent through CityTouch that they should be able to report outbreaks of fire as well as guide emergency vehicles in emergency situations.

Finally, every single lamppost can distribute fast internet.

6. Climate & Environment

1. Singapore
In 2014 Singapore began the installation of 4,000 LED street lamps. The project was intended to save up to 30 per cent of the area's energy consumption.

One shopping center, Gargantuan CapitaLand Mall, has installed and tested Visible Light Communication (VLC). This is a communication system where the lights communicate with each other. You can then use the app to find your way through the shopping center. One disadvantage of VLC is that it can only be used with white LED lighting, which is why VLC has only been installed in various department stores in Singapore, along with the shopping center.

In Singapore, tests and demonstrations are also conducted in their applied research center, the Lighting Technology Center. There, the focus is on sustainable light.

The Punggol area has become a test area for smart solutions. Punggol's goal is to create an eco-town in collaboration with HDB and Panasonic. In Punggol, solar energy helps to power some of the lighting.

2. Barcelona
Barcelona has been installing smart lampposts since 2010. Thanks to their construction, the city has saved approximately 30 percent of its energy consumption.

Due to cooperation between a company and a university in Barcelona, lampposts around the city have been installed which use 100 percent wind and solar power via turbine generators and solar panels. This means that these lamps are 100 percent self-sufficient and environmentally friendly.

Barcelona also uses their 22@ Barcelona, as well as Siiur, as public testing spaces for smart city solutions, which has led to the completion of approximately 80 projects in Barcelona since 2008. These projects have ensured that approximately 90 percent of the participating SMEs have established offices in Barcelona.

In 2015, Barcelona was praised by Jupiter Research for all their environmentally-friendly projects as part of Jupiter Research's ranking of smart cities.

3. Eindhoven
Through the installation of LED lighting, Eindhoven has managed to reduce the city's energy consumption and pollution.

On the main road into Eindhoven, Tilburgseweg, 247 lampposts have been fitted with LED lighting that doesn't interfere with the fauna or residents of the area. Meanwhile, the installation has also taken into account that drivers must have sufficient light to drive safely.

A similar installation has been made on a large cycle path connecting Eindhoven to one of its suburbs. Here 38 LED street lamps have been installed, all of which have a green shade of light. The green shade lights up the cycle paths surroundings as best as possible, as well as providing excellent light on the path itself. In addition, the green LED lights do not interfere with wildlife along the route.

A run-down neighborhood in northwestern Eindhoven called Strijp-S was in need of renewal, and so the city decided to establish a "living" laboratory for lighting. Here it is possible for companies to cooperate, test, develop and create solutions and better organize the district. One important aspect of the project is that the materials used must be recyclable.

At Eindhoven University of Technology, the main building was renovated in September 2016 to make it one of the world's most sustainable educational institutions. This is supported by a BREEAM score of 93.86 per cent. Individuals at the university can adjust the ambient light through a smartphone app. The university also measures how to personalize and apply these solutions.

7. Economy & Efficiency

1. Los Angeles
In 2009, Los Angeles (L.A.) began to replace its old HPS street lamps with newer and more energy-efficient LED street lamps. The exchange took place gradually, ending in 2013. The city had previously consulted the Clinton Foundation and an economic analysis had been prepared prior to implementation. In 2015, L.A. collaborated with Philips to install a CityTouch Management System for 110,000 of their lampposts. Emphasis was put on the idea that the collaboration should not be dependent on one collaborator's products, so that the system (and products) would be easily interchangeable, allowing the city to use components from other companies if these turned out to be cheaper and more effective. Every 6 months, the city of L.A. searches the market for cheaper and better alternatives.

Prior to the implementation of the CityTouch Management System, the city tested several potential solutions, but eventually settled on CityTouch. This solution did not require any reconstruction of existing infrastructure, which gave it an advantage over other solutions.

The city of L.A. also has the ability to control each light pointer and its brightness via this platform. With the help of this platform, each lamp indicates if there is a need for components to be replaced. This makes maintenance work easier and it can also be automated. It should be possible to prevent streets from getting too dark and, at the same time, save on maintenance work.

Finally, L.A. has experience collaborating with two different industry experts, Ericsson (electronics) and Philips (lighting, etc.).

2. Sydney
In 2010, Sydney began testing different control systems and lighting sources throughout the city for the purpose of investigating which ones harmonized best with the city and its infrastructure. This test was made in collaboration with The Climate Group. In 2010, Sydney became a member of LightSavers so that the city's test results could be compared with those of other member cities'. Sydney conducted a survey among residents to canvas opinion on which LED products they preferred, and then city the city ran a tender round in which companies with the right expertise could participate. The company that won the project estimated that the city would save 40 percent on its energy bill and reduce emissions. Back in 2011, Sydney was still searching for funding options.

3. Vienna

Since 2013, when the city of Vienna installed LED lighting in its existing street-lights, a total cost of ownership calculation (TCO) was prepared, along with a plan for when the investment could be repaid (ROI). The economic analysis says that the project's full costs were repaid 10 years after implementation.

8. Sources

The main focus areas:

3. Lighting for People

Eindhoven:

https://livingcircular.veolia.com/en/innovations/eindhoven-city-light

http://www.heijmans.nl/en/projects/van-gogh-roosegaarde-cycle-path/

http://www.heijmans.nl/en/bikescout/

http://ec.europa.eu/environment/europeangreencapital/eindhoven-smart-lighting/

https://www.theguardian.com/sustainable-business/sustainable-smart-lighting-systems-cities

https://www.youtube.com/watch?v=b2Ycdu852Nc

https://www.theguardian.com/sustainable-business/sustainable-smart-lighting-systems-cities

https://inform.tmforum.org/sponsored-feature/2016/11/smart-cities-spotlight-connected-lighting-delivers-benefits-citizens/

http://lightingforpeople.eu/2016/wp-content/uploads/2016/05/20May16-Smart-lighting-for-smart-cities-Nikita-Junagade-LUCI-Association.pdf

http://www2.luciassociation.org/strijp-s-smart-lighting-eindhoven-netherlands.html

http://www2.luciassociation.org/tackling-light-pollution-with-green-leds-in-eindhoven-the-netherlands.html

Lyon:

http://www2.luciassociation.org/lyons-lighting-experiments-continue.html

http://cordis.europa.eu/fp7/ict/photonics/docs/ssl-cip/lighting-the-cities_en.pdf

http://lightingforpeople.eu/2016/wp-content/uploads/2016/05/20May16-Smart-lighting-for-smart-cities-Nikita-Junagade-LUCI-Association.pdf

http://www2.luciassociation.org/lighting-the-annonciade-wall-in-lyon-france.html

Copenhagen:

https://www.nytimes.com/2014/12/09/business/energy-environment/copenhagen-lighting-the-way-to-greener-more-efficient-cities.html?_r=0

http://www.digitaltrends.com/cool-tech/copenhagen-smart-traffic-lights-prioritize-buses-bikes/

http://www2.luciassociation.org/the-bicycle-snake-bridge-copenhagen-denmark.html

4. Biological Light

Greater Copenhagen region:

https://www.youtube.com/watch?v=ITma72RsXtU (Lindeborgskolan i Malmö)

http://lightingforpeople.eu/malmo-school-introduces-human-centric-lighting/

http://www.ledsmagazine.com/articles/print/volume-13/issue-2/features/luxlive-sileurope/smart-lighting-sounds-great-but-does-it-work.html

http://lightcare.dk/8301

Greater London:

http://www.ledsmagazine.com/articles/print/volume-13/issue-2/features/luxlive-sileurope/smart-lighting-sounds-great-but-does-it-work.html

Singapore:

https://www.tech.gov.sg/en/TechNews/DigitalGov/2016/11/National-Trade-Platform-grabs-Smart-City-Award

5. Smart City

Barcelona:

http://inhabitat.com/barcelona-introduces-led-streetlights-that-cut-energy-use-by-13/

http://ajuntament.barcelona.cat/seguretatiprevencio/en/noticia/barcelona-becomes-an-international-smart-laboratory-benchmark

http://www.22barcelona.com/content/view/724/898/lang,en/

http://www.trade.gov/markets/smartcities.pdf

https://www.youtube.com/watch?v=k1yJ1x4X8RA

http://www.urenio.org/wp-content/uploads/2011/12/Barcelona_Smart_City_Tour.pdf

http://www.techrepublic.com/article/smart-cities/

http://www.ioti.com/smart-cities/world-s-5-smartest-cities

Hamburg:

http://www.cisco.com/web/tomorrow-starts-here/cars/hamburg/index.html

http://www.cisco.com/web/tomorrow-starts-here/cars/hamburg/index.html

http://luxreview.com/article/2015/06/intelligent-streetlights-keep-the-big-ships-moving-in-and-out-of-hamburg

http://www.trade.gov/markets/smartcities.pdf

http://audi-urban-future-initiative.com/blog/smart-road-hamburg-germany-cisco-hpa

Los Angeles:

http://www.forbes.com/sites/justingerdes/2013/07/31/los-angeles-completes-worlds-largest-led-street-light-retrofit/#15c86d024b54

http://photos.state.gov/libraries/finland/788/pdfs/LED_Presentation_Final_June_2013.pdf

http://luxreview.com/article/2015/04/los-angeles-ties-its-led-streetlights-into-the-web

http://luxreview.com/article/2015/04/los-angeles-ties-its-led-streetlights-into-the-web

https://thestack.com/iot/2015/11/06/las-smart-led-street-lights-boost-wireless-connectivity/

https://www.nytimes.com/2014/12/09/business/energy-environment/copenhagen-lighting-the-way-to-greener-more-efficient-cities.html?_r=0

http://www.govtech.com/dc/articles/Los-Angeles-Deploying-Smart-Streetlight-Network.html

6. Climate & Environment

Singapore:

http://lightingforpeople.eu/2016/wp-content/uploads/2016/05/20May16-Smart-lighting-for-smart-cities-Nikita-Junagade-LUCI-Association.pdf

http://www.ioti.com/smart-cities/world-s-5-smartest-cities

https://www.lta.gov.sg/apps/news/page.aspx?c=2&id=1ea2b1da-a8b7-4dd1-b831-84774152643d

http://luxreview.com/article/2016/09/smart-lighting-to-guide-shoppers-around-huge-singapore-mall-

http://www.straitstimes.com/singapore/new-applied-research-centre-for-sustainable-lighting-by-2015

https://www.nccs.gov.sg/what-we-can-do/organisations/green-growth-opportunities/test-bedding

http://www.flandersinvestmentandtrade.com/export/sites/trade/files/market_studies/818130930125623/818130930125623_1.pdf

Barcelona:

http://inhabitat.com/barcelona-introduces-led-streetlights-that-cut-energy-use-by-13/

http://ajuntament.barcelona.cat/seguretatiprevencio/en/noticia/barcelona-becomes-an-international-smart-laboratory-benchmark

http://www.22barcelona.com/content/view/724/898/lang,en/

Eindhoven:

http://newatlas.com/philips-freestreet-suspended-street-lights/22335/

http://ec.europa.eu/environment/europeangreencapital/eindhoven-smart-lighting/

https://www.theguardian.com/sustainable-business/sustainable-smart-lighting-systems-cities

http://www2.luciassociation.org/tilburgseweg-eindhoven-the-netherlands.html

https://www.tue.nl/en/university/news-and-press/news/26-09-2016-renovation-to-make-main-building-worlds-most-sustainable-education-building/

http://www2.luciassociation.org/strijp-s-smart-lighting-eindhoven-netherlands.html

http://www2.luciassociation.org/tackling-light-pollution-with-green-leds-in-eindhoven-the-netherlands.html

7. Economy & Efficiency

L.A.:

https://e52.nl/en/philips-puts-the-internet-of-things-into-street-lighting/

http://luxreview.com/article/2015/04/los-angeles-ties-its-led-streetlights-into-the-web

http://www2.luciassociation.org/los-angeles-led-conversion-project-usa.html

http://www.dvrpc.org/energyclimate/eetrafficstreetlighting/pdf/CCI_Los_Angeles_LED_Streetlighting_Retrofit_Program_Report.pdf

https://www1.eere.energy.gov/buildings/publications/pdfs/ssl/msslc_la2012_ebrahimian.pdf

http://www.govtech.com/dc/articles/Los-Angeles-Deploying-Smart-Streetlight-Network.html

Sydney:

http://www.ledsmagazine.com/articles/print/volume-8/issue-6/features/led-outdoor-lighting-field-trials-demonstrate-benefits-to-potential-adopters-magazine.html

Vienna:

https://smartcity.wien.gv.at/site/en/projekte/umwelt-klimaschutz/led-technik-in-der-oeffentlichen-beleuchtung/

Project supported by: