Plus

Mainstream Guide

Guidelines from cities on sustainable public lighting strategies

Key issues in urban lighting

ENERGY EFFICIENCY | LIGHT POLLUTION | ENHANCING THE URBAN ENVIRONMENT...

Eindhoven, Bassano del Grappa, Birmingham, Burgos, Iasi, Leipzig, Lyon, Métropole Nice Côte d'Azur, Patras, Sofia, Tallinn, LUCI (Lighting Urban Community International)
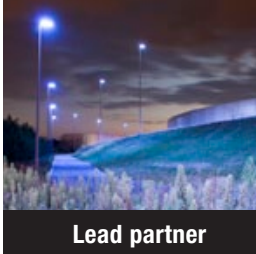
European Union
European Regional Development Fund

INTERREG IVC
INNOVATION & ENVIRONMENT
REGIONS OF EUROPE SHARING SOLUTIONS

Plus

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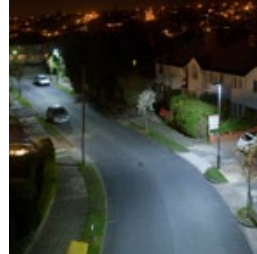
PLUS **partners**

Lead partner

Eindhoven
The Netherlands

Bassano del Grappa
Italy

Birmingham
U.K.

Burgos
Spain
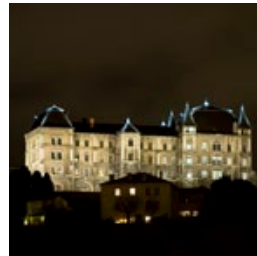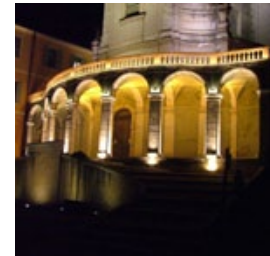
Iasi
Romania

Leipzig
Germany

Lyon
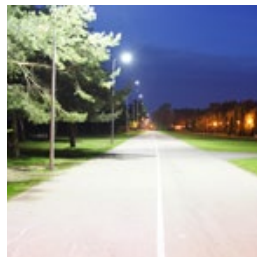France

**Métropole
Nice Côte d'Azur**
France

Patras
Greece

Sofia
Bulgaria

Tallinn
Estonia

Communication partner

LUCI Association

PREFACE

Time flies so the saying goes. To keep up with the speed of light in the daily innovations in urban lighting cities must find radical ways to embrace all these new technologies and in so doing be able to transform the way we live in our cities.

From the moment intelligence and interactivity became the main topics in lighting innovation we can say that it has gained the potential to become an almost mature section of urban development.

We first lit our cities merely to see in the dark, we then lit our cities to support a 24 hour society and economy. Light was serving us, no more and no less. Now lighting is a key tool of urban planning, creating value and wealth for the city, attracting investment, promoting heritage, changing perceptions, bringing together new partnerships, and also just illuminating roads and paths

It was in 2010 that the City of Eindhoven identified a need to match and accelerate existing and future knowledge in order to increase the quality of its lighting strategy.

One of our central challenges was how to compare and measure the different and diverse approaches to public lighting across Europe. Two years as the chair of the LUCI Sustainable Development Commission demonstrated clearly how cities' different viewpoints enrich your own opinions and help develop new lighting policies and strategies for city lighting.

The PLUS project could not have been executed at a better time. Universities, private companies and cities start to see the need of rethinking the future of public lighting together. The mainstream guide that you are reading will stimulate and inform the worldwide discussion on sustainable urban spaces and the role of lighting in urban development. It is written not only for those cities and regions who have participated in the PLUS project but hopefully for a wider range of policymakers. After all we are no longer working in a one dimensional discipline for lighting.

In the last 100 years public lighting has evolved into one of the most versatile creative and artistic mediums available to mankind. Public lighting is no longer a servant to the city. Today public lighting means creating experiences. With this in mind the PLUS project has attempted to strengthen the awareness of policymakers on the benefits of new sustainability based approaches to public lighting. On behalf of the PLUS partners I would like to thank you for your interest in this guide.

Rik van Stiphout
PLUS Overall Project Manager
City of Eindhoven

Burgos

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Part 3 : Towards a lighting strategy

Eindhoven

1 Introduction

PLUS (Public Lighting Strategies for Sustainable Urban Spaces), launched in October 2010 and financed by the EU's INTERREG IVC programme, brought the experience and knowledge of leading European cities together in an attempt to make a significant leap forward in public lighting. Lighting technologies have undergone major, almost seismic, evolutions in the last decade, and the PLUS cities wanted to explore the possibilities of these new technologies to provide high quality lighting for their citizens. At the same time, PLUS wants to make a significant contribution to reducing energy use and to rationalise energy consumption related to public lighting.

The Municipality of Eindhoven is the initiator and lead partner of this two-year European project in which 11 cities across Europe as well as LUCI Association participate. The PLUS cities are: Eindhoven (The Netherlands), Bassano del Grappa (Italy), Birmingham (UK), Burgos (Spain), Iasi (Romania), Leipzig (Germany), Lyon (France), Métropole Nice Côte d'Azur (France), Patras (Greece), Sofia (Bulgaria) and Tallinn (Estonia).

The project was more than a collection of best practices and an exchange of experiences. The cities committed themselves to make a comprehensive review of their own performance, and based on that, to develop a new lighting strategy. The cities supported each other by participating in each others' reviews (called Deep Dives) and by making suggestions of the emphasis and direction for their new lighting strategy.

This Mainstream Guide shares the lessons learned by the individual cities and by the PLUS network. The guide describes relevant issues of public lighting, how the PLUS cities are dealing with them, and how other cities can deal with these issues. The results of PLUS and the examples of PLUS cities illustrate the range of possible actions and initiatives that can be taken. At the end of this Mainstream Guide a method for developing a lighting strategy is described. The ways in which the Maturity Tool (developed by Eindhoven) can assist in assessing ambitions and making progress in developing strategic lighting policies is also explained.

This Mainstream Guide will focus on what has happened in the last two years. It will also explain how the PLUS cities want to continue with their partnership and learning. It also describes the main challenges for public lighting – as seen by the PLUS partner cities. Even though the PLUS cities have made enormous progress, not all barriers have been removed, and not all the questions have been answered. The development of new lighting technologies continues at a very rapid speed, with new possibilities and challenges occurring constantly. The PLUS cities have developed, based on what was learned in the PLUS project, new strategies and are now better prepared for both threats and opportunities.

The Mainstream Guide follows the same structure of themes as the "LUCI Charter on Urban Lighting". The project produced supporting magazines that included reference to this Charter (PLUS Magazine June 2012). This same structure was used for the Deep Dives and by many of the cities for their lighting strategies. By retaining this structure, the Mainstream Guide links more clearly to the good practices and projects as well as the PLUS cities' underpinning strategies.

2 | PLUS project activities

All PLUS cities are being confronted with rapid technical advancements in lighting, pressure to reduce energy use and increasing costs for their public lighting. Unlike many projects, PLUS decided not to collect the experiences of some leading pilot cities and then to disseminate that as best practice to the learning cities in the consortium.

PLUS cities recognise that solutions in one city may not be transferable to another city and that so called "leading" cities are equally confronted with the external pressures as set out above.

In PLUS, all partner cities were regarded as "learning", each from their own starting position. And at the same time all cities were also regarded as colleague experts that can assess each other's practice and policy. But PLUS also aims to draw much wider learning from this process. It has agreed that it wants to find out not only "what works" but also "what does not work", and "why".

The 3 branches of PLUS activities

Workshop

PLUS is a centre of learning. Through field visits (Deep Dives), training sessions and the mobilisation of local stakeholders (Regional Forums), cities develop new learning methods and build new partnerships. The innovative methodologies established within the PLUS project contribute to creating a permanent learning and training centre on urban lighting in each city.

Showcase

PLUS not only promotes best practices and innovative experiences in sustainable urban lighting, it also finds the right way to transfer this knowledge. The PLUS Showcase is an interactive tool that collects, presents and disseminates these best practices to raise awareness within and beyond the PLUS partner cities.
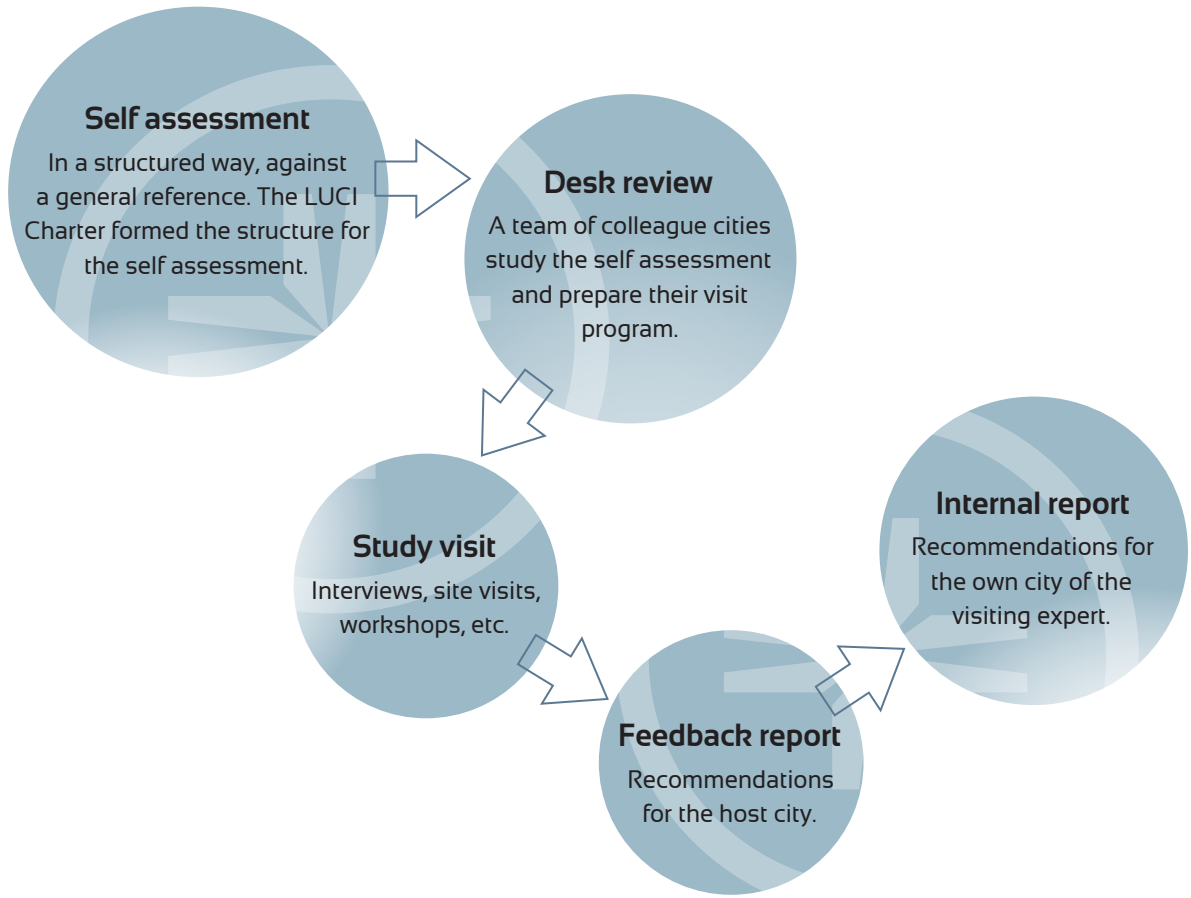
Forum

Through its innovative communication tools, PLUS constitutes a space for discussion and exchange of information on sustainable urban lighting. With LUCI (Lighting Urban Community International), the project also goes beyond the partnership to find inspiration in cities world-wide, making PLUS an international forum of discussion.

The Deep Dive process

In the Deep Dive approach developed for PLUS, the city-to-city relationship is crucial. At its heart stands a systematic comparison of practical experience from different cities, through dialogue between visiting experts and city experts, assessment and self-evaluation. The individual city which is reviewed should get insights into ways of working "smarter" and improving its performance.

For a detailed description of the deep Dive methodology one could look at the Deep Dive manual at the PLUS website. The core of the methodology is described below.

The existing lighting activities of each city in the PLUS project have been assessed by a team of inspired colleagues from other cities, who were specially trained in the Deep Dive methodology.

Self assessment

In a structured way, against a general reference. The LUCI Charter formed the structure for the self assessment.

Desk review

A team of colleague cities study the self assessment and prepare their visit program.

Study visit

Interviews, site visits, workshops, etc.

Feedback report

Recommendations for the host city.

Internal report

Recommendations for the own city of the visiting expert.

Iasi

As a starting point the host city makes a self assessment in a structured way, comparing itself against a general reference, in this case the themes of the LUCI Charter formed the basis for the self assessment.

Based on the self assessment, the visiting team (consisting of policy makers, lighting experts, politicians from the partner cities), carries out a desk review and prepares a programme for their own Deep Dive visit. Potential interview partners and projects to study are identified. The visiting experts contribute to the study programme.

The visiting experts use the Deep Dive as their principle opportunity to understand the PLUS host city because after the visit they are expected to write a common assessment report for the hosting city. In order to maximise the dissemination of learning, each individual expert is expected to give feedback of the lessons they have learned to their city and departmental colleagues and stakeholders.

During the two years, each PLUS partner city has made an active contribution by sending their experts to at least five Deep Dive visits. In turn,

each city received a Deep Dive team and a report.

Additional to the Deep Dives every city in the PLUS project organised three Regional Light Forums. In the 1st Regional Lighting Forum, the Self Assessment report was discussed with stakeholders.

Based on the results of the Deep Dives, every city has made a SWOT analyses with local stakeholders, during the 2nd RLF.

Each city has developed a new lighting strategy and action plan, based on all the knowledge that was learned in the process. The 3rd RLF is used to discuss and approve the new lighting strategy.

This Mainstream Guide uses mainly the results of all the Deep Dives to identify common problems facing cities, as well as excellent solutions. It demonstrates the barriers and solutions in strategy development of the PLUS cities.

Innovative solutions as expressed in the new lighting strategy have been used for this Mainstream Guide as well.

PLUS communication activities

The PLUS project's Deep Dives and meetings have been supported by an innovative communication plan which aimed not only to ensure proper internal communication among PLUS partners but also towards external stakeholders, professionals, decision and policy-makers beyond the partnership.

To that extent, the integration of LUCI Association, the international network of cities on urban lighting[1], as a project partner in PLUS has been of crucial importance in order to optimize communication and dissemination to other municipalities and lighting professionals at an international level.

The project's communication activities were organized around 6 main objectives:

● **Sharing knowledge within the PLUS consortium.** This implicated elaborating the tools (newsletters, website,[2] reviews…) that facilitated the sharing of information, of knowledge, and in the end the capacity to capitalize on the existing best practices of all partners.

● **Informing PLUS cities on latest trends in urban lighting** to help PLUS partners be regularly informed about the changes, the novelties, the latest research results and technological innovations in lighting.

● **Raising awareness beyond the PLUS partnership** by identifying accurate target audiences, organizing PLUS conferences (Brussels Briefing) and making use of the LUCI network and its events (Cities under Microscope, Annual General Meetings) to spread messages as widely as possible.

● **Promoting best practices,** through the creation of the first sustainable urban lighting database on the PLUS website. Emphasis has been put on identifying practices that have been evaluated or that show tangible proof of their capacity to reach the goals set (in the domain of energy efficiency in particular). PLUS has also sought to innovate on the presentation of these best practices in order for the data to be easy to understand, to access and to disseminate.

● **Liaising with other EU projects and initiatives in sustainable lighting,** such as BLISS (INTERREG IVB NWE project), ESOLi (IEE), LED - Light in Public Space (EU South Baltic) for example, in order to access accurate and usable content and to ensure appropriate synergies.

● **Ensuring durability of PLUS outputs.** Because PLUS is limited to a two year period, an important objective of the communication plan was to set up tools that will live beyond the project itself. In this perspective, the involvement of LUCI is of crucial importance to this objective, as it offers a general continuing infrastructure to take on the outputs and recommendations of PLUS, and continue their use and further development.

More specifically, two existing LUCI commissions will be in capacity to pursue the work led within PLUS:

- The "Sustainable Development Commission" chaired by PLUS lead partner Eindhoven.
- The "Charter on Urban Lighting Commission" chaired by PLUS project partner Leipzig.

The LUCI network therefore provides dedicated instruments to offer permanent guidance to cities to continuously feed and adapt their lighting strategies. Through its various partnerships, LUCI will continue to contribute to influencing policy-makers on lighting standards by making use of and also anchoring the knowledge generated within the PLUS project.

[1] LUCI (Lighting Urban Community International) www.luciassociation.org

[2] PLUS website (and best practice database) www.luciassociation.org/plus

3 Challenges for public lighting

The LUCI Charter provided a reference framework for the PLUS project. The lighting themes for the Deep Dives, the self assessment reports as well as the feedback reports were structured according to the LUCI Charter. Many of the new lighting strategies that were developed in the PLUS project follow the structure as well.

The guiding framework of PLUS:
the LUCI Charter on Urban Lighting

The LUCI Charter on Urban Lighting aims to bring cities together around common principles in lighting. It is the product of contributions from more than 40 cities around the world.

This Charter aims to give a clear view of the issues that should be taken into account by sustainable lighting strategies, while simultaneously indicating a common vision of urban lighting. The Charter addresses challenges common to all: the cultural and social dimensions of lighting, maintenance, recycling, light pollution, energy efficiency and improvement of the quality of life...
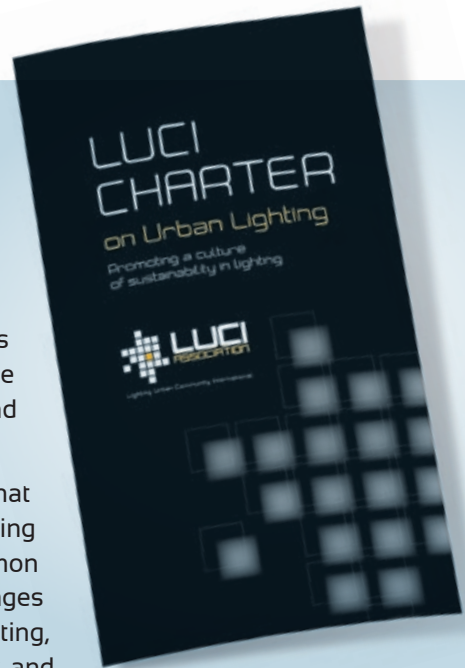
In total the LUCI Charter lists nine relevant aspects of public lighting. PLUS has added four more which are related to good governance.

Burgos

The main structure of the chapters to follow can be split in 3 main parts:

We hope that this structure helps the reader to find his/her way in this Mainstream Guide. The PLUS project was an intensive learning project for all cities involved, and this Mainstream Guide is an effort to share the most relevant lessons learned.

That it has become such a vast report is only a consequence of the fact that PLUS, with 11 leading partners in this field, with a concerted learning method like the Deep Dive, and supported by the world wide leading network of public lighting cities LUCI, has found so many valuable lessons learned to share.

Part 1:
Sustainable lighting

Public lighting interferes strongly in our cities. Sustainable lighting does that in a way that negative aspects are reduced to a minimum.

Ch **4** | On energy consumption – urban lighting is a major consumer of electric power in our cities and therefore contributes significantly to their carbon dioxide emissions. Public lighting makes up almost 60% of the energy bill of many municipalities.

Ch **5** | Describes environmental aspects of public lighting, which are more than energy use. Material use, transport, waste treatment, etc., including the activities cities can undertake, are the subject of this chapter.

Ch **6** | Covers maintenance, which is vital for the quality of the public lighting system, for energy efficiency and for managing the costs.

Ch **7** | Pollution from excessive light can also have an impact on natural areas, wildlife and people - this chapter provides some guidance on how cities can manage light to control pollution.

Part 2:
Light in the city

Modern urban lighting is used for more than bringing light in the darkness. It is a modern instrument to improve quality of life in our cities. This part describes the possibilities of public lighting in that sense.

Ch **8** Lighting can be seen as a service of general interest. Public lighting has its price and in a period of savings and financial cuts, public lighting is also under pressure. Cities must guarantee an equal and free access to urban lighting for all citizens, regardless of their social status and physical conditions.

Ch **9** Describes safety aspects. Lighting has played a historical role in making our cities safer, more secure and more comfortable to live in. Modern cities require a modern approach to this aspect.

Ch **10** Is on urban identity and the role light can play in city marketing and creating an image.

Ch **11** Demonstrates that lighting is not only a service to support safe traffic in the evening, but can also stimulate certain modes of transport, if properly implemented.

Ch **12** Finally describes that lighting can even support economic development in cities, by addressing visitors, but also by supporting specific activities.

Part 3:
Towards a lighting strategy

Strategic lighting is not as much related to the functioning or the functionality of public lighting but addresses more the governance and management aspects of the city.

Ch **13** Addresses the way lighting is integrated in other policy fields and if and how relevant stakeholders can be involved.

Ch **14** Addresses an often neglected but essential part of any successful strategy: the monitoring and managing based on facts.

Ch **15** Explores the qualities of cities that are leaders in public lighting. Leading cities do extraordinary well in public lighting, and it is described what is needed to become a leader.

Ch **16** Finally is a supportive description of how a city can develop a lighting strategy that includes all the elements of a modern lighting system.

Patras

Part 1
Sustainable lighting

4 | Optimising energy consumption

The European Union has set itself targets for 2020 of reducing emissions to 20% below 1990 levels and raising the share of renewables in its energy mix to 20%. With its "Roadmap for moving to a competitive low-carbon economy in 2050" the European Commission is looking beyond these 2020 objectives and setting out a plan to meet the long-term target of reducing domestic emissions by 80 to 95% by mid-century as agreed by European Heads of State and governments. It shows how the sectors responsible for Europe's emissions – power generation, industry, transport, buildings and construction, as well as agriculture – can make the transition to a low-carbon economy over the coming decades. Energy efficiency is one of the main vehicles to achieve the objectives of the European "2050 Low Carbon Economy Roadmap".

Many cities support the European goals or go even beyond that, and demonstrate that by signing the Covenant or Mayors. Urban lighting is a major consumer of electric power in our cities and therefore contributes significantly to their carbon dioxide emissions. Public lighting makes up almost 60% of the energy bill of many municipalities. Not surprisingly financial managers in most cities and towns look very critically at the activities of their public lighting department.

Street lighting consumed 35 TWh[3] for the EU25 representing about 1.3% of the final energy consumption of electricity in the EU25.[4]

The lifespan for street and decorative lighting installations is difficult to assess; lighting columns may last more than 40 years, luminaires 20 years, control gear 10 to 15 years and lamps 2 to 6 years. In most installations the lighting units are switched on for 4000 hours a year[5] with a lifespan of approximately 30 years. As such there is considerable potential for the adoption of a range of energy efficiency measures (e.g. technology changes, improved management and control).

The use of more efficient lamps and ballasts / control gear can reduce the energy consumption of decorative and street lighting. (The energy efficiency of street lighting is not only influenced by the lamps but also by the ballast used. Older ballasts can significantly increase energy consumption of street lighting.) Although standards have been set for the energy efficiency of luminaires and ballasts these have been very much overtaken by the rapid development and adoption of LED lighting and other technological developments. The EN standard 12665 defines the components of lighting systems.

EN 12665 Lighting System Component Definitions (adapted)

1. Lamp: a "source made in order to produce an optical radiation, usually visible"

2. Ballast: a "device connected between the supply and one or more discharge lamps which serves mainly to limit the current of the lamp(s) to the required value and may also include means for transforming the supply voltage, correcting the power factor and, either alone or in combination with a starting device, provide the necessary conditions for starting the lamp(s)"

3. Luminaire: an "apparatus which distributes, filters or transforms the light transmitted from one or more lamps and which includes, except the lamps themselves, all parts necessary for fixing and protecting the lamps and, where necessary, circuit auxiliaries together with the means for connecting the lamps to the electric supply"

[3] Terawatthours = 1,000,000,000 kWh

[4] Lot 9 Study: Public Street Lighting, VITO, January 2007, http://www.eup4light.net

[5] EN 12665 Light and lighting - Basic terms and criteria for specifying lighting requirements and EN 60598-2-3

Luminaires Part 2-3: particular requirements - luminaires for road and street lighting

4.1 | Clear energy efficiency targets

Before a city can make a contribution to energy efficiency, targets have to be set, the current state-of-the-art in the city has to be understood, finance must be secured and appropriate activities must be planned.

Most of the partner cities have signed the Covenant of Mayors, and submitted a Sustainable Energy Action Plan. Some have gone further in their ambitions; Eindhoven has ambitious goals to become carbon neutral in 2035 – 2045, Sofia has developed integrated targets for the use of renewable energy as part of its drive for energy efficiency.

Often these targets are for the city administration as a whole. In many cities these targets have yet to be apportioned or accepted by the departments and agencies. The ownership of these targets by departments and agencies is therefore a very important step that still needs to be carried out in many cities. Many cities (Birmingham, Tallinn) have taken the opportunity to integrate their public lighting strategies into their climate change or climate adaptation plans. In this way the contribution of energy optimisation for lighting can be seen in the context of the city wide actions for climate change.

Sofia

Leipzig

However some cities have not yet achieved this level of political commitment (Patras, Iasi) or, when they have, the politicians have yet to agree a "roadmap" to achieve the targets. Some cities are still in the process of developing their framework for optimising energy consumption and for setting energy efficiency targets and savings (Basanno, Burgos).

Although most cities have set targets for energy optimisation a number have yet to develop robust or transparent monitoring frameworks to confirm their progress or to allow reporting to stakeholders (Iasi, Sofia, Patras)

Data collection systems have to be developed to collect the necessary information that will allow targets to be monitored, and in some cities this is not yet possible. But many cities (Lyon, Nice Côte d'Azur, Leipzig) have completed their baseline studies and evaluation of the contribution that various investments can make to energy optimisation. These cities are now progressively implementing a wide range of investments, partnership initiatives and actions to reduce energy consumption.

In almost all of the partner cities the importance of optimising energy consumption has been

recognised and it is not a party political issue. But significant recent reductions in budgets, and in particular to investment and maintenance budgets, is threatening the achievement of many energy efficiency targets as set out in the investment and action programmes for the partner cities. It is recommended that all cities formalise the energy efficiency plans in a written form, so that political, financial and timely commitment to the plan can be made. Without clear goals, the public lighting departments cannot set clear priorities and will be confronted with permanent discussions and problems, as illustrated in the next paragraphs.

Lyon

4.2 | Quality versus reduction

The drive for reduction of energy use needs to be balanced with a need to meet other criteria (comfort, light quality, ambience, safety etc.)

Some cities (like Tallinn, Iasi, Sofia) still have many of the easy energy reduction quick wins from dimming, replacing mercury with HPS, etc. available to make. Most have plans in place to now make these quick wins. Once these easy wins have been secured (as in Leipzig, Eindhoven, Nice Côte d'Azur) then there is a need to look in more detail at the investments and initiatives needed to continue to make reductions in energy use. All cities are experiencing an almost ever increasing annual demand from businesses, tourists and residents for more public lighting. Whether to improve public safety, security or for economic development or to host festivals, all the project cities want more light. As cities expand then there is a need for the public lighting systems to also expand. In many cities the energy efficiency of the lighting installations is improving but the total energy consumption continues to increase as the street lighting network is extended and there are additional decorative lighting installations.

In order to make further improvements in energy efficiency and optimisation there is a need for a change in public attitudes to street and decorative lighting. The cities of Lyon and Nice Côte d'Azur recognise this and are putting in place education and awareness raising programmes in an attempt to lower expectations.

Local design codes can be adapted to reduce expectations from street lighting, like Tallinn's Eco- Design code demonstrates.

Few cities carry out ex post evaluations of investments and actions to confirm their expected energy savings and reductions in consumption. The dimming of street lights (during less frequented hours in the night) is a measure that is

widely implemented across most cities. However the cities do not always fully understand whether this delivers their expected energy savings. In a number of cities this dimming measure was poorly received by residents and businesses as they perceived that it was a negative influence on the light quality.

More used are "a priori" evaluations of the potential energy savings from particular investments and actions. However in some cities this work is carried out by lighting engineers with little involvement of economists or financial experts. Also these pilot projects remain isolated and the tested technologies seldom seem to become "mainstream". This was a particular concern of the Deep Dive experts who identified a significant number of isolated pilot energy optimization projects that remain in use but operationally and technologically isolated.

4.3 | Savings versus savings

In public lighting strategies a clear distinction should be made between energy savings and financial savings. The replacement of old installations with new energy efficient luminaires and ballasts requires planned capital investment,

training for staff and operatives and new adapted maintenance programmes. Achieving energy savings needs cities to follow the standard model of plan-act-review with a clear timetable for their roadmap of investments. In such a roadmap it should be made clear what changes and investments are needed to reach the requested energy reductions – and what is the cost and contribution of each and every investment. The Deep Dives of the partner cities identified that often it is only the cost savings from the reduction in energy use of the new luminaires that is calculated and communicated. The financial implications arising from changes in maintenance schedules, relocation and replacement of lights, and staff training are rarely considered and almost never communicated.

Some cities remain tied into historical public lighting contracts with subcontractors that are financially and technically restricting in the actions that can be taken to optimise energy consumption (like examples of Tallinn and Iasi have shown). The Deep Dives have helped these cities to recognise these restrictive practices and the ways in which new contracts promote and reward the optimising of energy efficiency.

Lyon

4.4 | Revolving investment funds

The financial practices and systems of many cities do not seem to be sufficiently adapted to take account of the fact that avoided expenditure on energy over several years is a saving, that if retained for new investments in energy efficient lighting, will generate further reductions in energy and further savings that are then available for investment.

The Deep Dives have helped the cities to recognise that "revenue" savings arising from energy efficient investments should be reused for future investments – and in so doing the cities recognise the value of creating a "revolving fund" for public lighting investments. It was very clear from the Deep Dives that keeping the budget for energy costs and the budget for energy efficiency separate is not an effective model for sustainable public lighting.

In the current financial situation it is clear that Public lighting professionals need to rise to the challenge of involving their financial and economic colleagues in making these saving/investment mechanisms more visible and in jointly developing new financial tools that deliver the much needed investments. Some of the PLUS partners are already using "revolving funds" and Bassano will do so in the future involving ESCOs in delivering the investments for their public lighting strategy.

Tallinn

Leipzig

Quick Wins

The PLUS project has learned that energy efficiency is not a simple matter of using LED lights and high-tech sensors, but more of well organising and changing systems. The quick advice below that one of the Deep Dive Teams formulated for one of the PLUS partners, is illustrative of that fact and could be useful for other cities.

● **STEP 1:** Lighting pillars with twin/trio luminaires – switch off one, clean the mirror and glass of the other(s) and replace one lamp with new high efficiency Sodium HP. This will result in higher lux with single lamp and less than 50% of original energy use.

● **STEP 2:** Replace those luminaires (in pillars with single and the second in twin pillar) with new Sodium HP with higher efficiency. Replace all spherical and mercury with higher efficiency luminaires.

● **STEP 3:** Monitor maintenance contracts (initially using simple spreadsheets as a control system).

● **RESULT**
Step 1 savings are invested in step 2 and this generates savings for financing of step 3.

5 | Minimising the environmental impact

The environmental aspects of public lighting systems are manifold. To get an overview, cities should consider the "life cycle" of all the materials associated with implementing their lighting strategies.

The PLUS partners identified four phases in the life cycle of lighting materials:

- manufacture
- distribution
- use and maintenance
- end of life

The different components of street and decorative lighting are:

- the lamp that provides the light
- the ballast or control gear that regulates current
- the luminaires that direct and shade the light
- the fixings or columns

Each will have different environmental impacts at the different stages of the life cycle.

5.1 | Energy use

There is limited number of studies looking at the life-cycle impacts of street lighting and traffic signals.[6][7] The key impact from the use of lamps in lighting is the "use" phase. Research demonstrates that over 90% of the environmental impact is from energy consumption and associated greenhouse gas emissions whilst the lights are switched on. The aspect of optimising energy use is considered elsewhere in this guide.

Iasi

5.2 | Material use and waste management

In selecting luminaires and lampposts, public lighting designers can choose from a wide variety of materials. Their choice is usually guided by criteria such as strength, cost, durability and ease of handling during construction. Criteria to measure the life cycle (or sustainability) are rarely considered. Almost all of the materials that are used to manufacture public lighting products are suitable for reuse, and if not, then certainly for recycling. The reuse and recycling of lampposts is becoming more and more common. In selecting lampposts many cities have decided to use "carbon free" aluminium posts, justified against life cycle criteria on the basis that all of the aluminium materials are recycled and the energy used for the production is from renewable sources.

Many more materials are used in lamps, luminaires and ballasts; glass, metals and plastics being the most important (for example, a 125W HPM lamp is largely glass (~80%) with the other contributors being brass for the cap (~10%) and soldering metals (tin, lead ~6.5%). An electromagnetic ballast for a 125W lamp contains

[6] http://www.elcfed.org/1_health.html
[7] http://www.eup4light.net/assets/pdffiles/Final/VITOEuPStreetLightingFinal.pdf

much more metal; ~85% steel, 8% copper, as well as 3% plastics. Luminaires are ~45% metal (largely aluminium, with some copper wire) and ~55% plastics.) It is important to note that different chemical gases can be used as the lighting medium and these can also be considered as part of the life cycle assessment.

The use of mercury vapour lamps for lighting purposes will be prohibited in the EU from 2015. Thus all cities are sooner or later confronted with the replacement of lamps that contain mercury. Whilst some cities are gradually replacing their mercury lamps, other cities like Iasi have already implemented a complete replacement programme. This is an example of how a change in environmental legislation can assist in reducing the environmental impacts of lighting. It is also a way of modernising the public lighting system, and ensuring the treatment of waste lamps is handled in a safe and structured way.

A key issue in the end of life management of lamps that contain mercury is the possible release of mercury vapour. Lamps should be sent to facilities that have the required technology to dismantle the lamps and recover the mercury appropriately. Other substances are contained in lamps, for example sodium and lead. It is equally important that the potential environmental impacts of these substances (e.g. eco-toxicity) are also effectively managed.

The legal requirement for lamps and ballasts to be recycled appropriately at the end of their lifetime is generally covered by the requirements of the Directive on Waste Electrical and Electronic Equipment (WEEE)[8].

The widely accepted waste hierarchy is reflected in most European waste policy documents and is based on the following priority of actions:

- prevention
- reuse
- recycling
- incineration with energy recovery
- waste disposal

The hierarchy is for guidance and should not be followed dogmatically. Each and every activity should be considered in detail. An illustration of this flexible approach is that one of the PLUS cities sends its redundant (but still working) luminaires and lamps to a partner city in Africa. This is assisting in setting up a public lighting system in that partner city. The reuse of some luminaires, lamps and ballasts can result in increases in the overall energy use in the supported city. PLUS partner cities recognise that if energy efficiency or avoiding light pollution etc is the reason for replacement, that reuse should not be the priority in the choice of how to manage the waste.

It is important to state that the recycling of all of the materials associated with public lighting is widely practiced in the PLUS cities and represents the "norm".

5.3 | Environmental management

All of the PLUS cities are well aware of the environmental aspects of the operation of a public lighting system. They all also recognise that Environmental Management Systems (externally certified or not), assist in understanding and controlling the significant aspects.

Environmental Management System (EMS) refers to the management of an organisation's environmental activities in a comprehensive, systematic, planned and documented manner. It includes the organizational structure, planning and resources for developing, implementing and maintaining policy for environmental protection.

Lyon, Sofia and Tallinn have certified Environmental Management Systems according to ISO 14001 in place. For smaller organisations a certified Environmental Management System may be seen more as an administrative burden. From the experience of the PLUS project it is recommended that all cities should (at least) understand the current baseline environmental impacts of all lighting in their city. And then report to politicians and civil society each year on the results of their efforts to manage the environmental aspects. These are the necessary steps that a city should take towards raising awareness of the environmental aspects of public lighting – to all stakeholders.

Where cities have outsourced aspects of the public lighting system (design, maintenance, monitoring etc.) the experience of the PLUS project is that private companies who are competing must have an externally certified environmental management system in place. This criteria has been included in the procurement policies of all PLUS cities that have outsourced their lighting activities.

5.4 | Procurement

Every product, from the lamp post, the luminaire, the maintenance vehicle or the computers controlling the systems, all have to be produced, transported, maintained and used. The right choices when procuring products can reduce environmental problems in the life time of the products. Cities like Eindhoven and Nice Côte d'Azur have systematically implemented environmental criteria in their procurement policy regarding materials for lighting.

Cities can develop their own criteria based on Life Cycle Analyses of all products to be procured, but it is easier to develop these criteria collaboratively with colleague cities. In the Netherlands, environmental procurement criteria have been developed on a national level for public lighting. The European Commission has developed environmental criteria for procurement of street lighting [9] including technical specifications, selection criteria, award criteria, contract performance clauses, etc.

Burgos
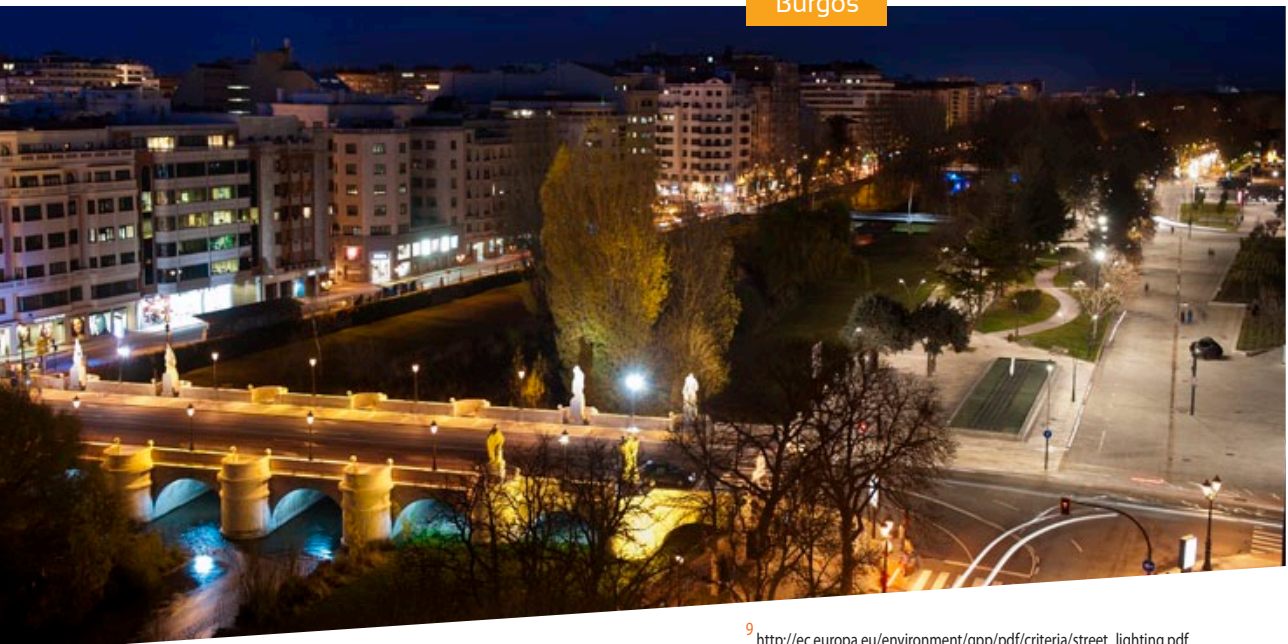
[9] http://ec.europa.eu/environment/gpp/pdf/criteria/street_lighting.pdf

The environmental impacts arising from services should also be considered and be reflected in the procurement specifications and tendering. As with lighting products, similar procurement criteria have been developed that allow the environmental impacts from lighting services (e.g. maintenance) to be understood and measured. Whenever services are tendered, there should always be specifications for the environmental performance criteria to measure and control the environmental impact of the service provider.

The PLUS experts have identified that in some cities no energy saving targets have been set as part of the outsourcing contract for public lighting. In these cases, the city has lost the opportunity to use the outsourcing contract as an economic driver for a more energy and cost efficient lighting system. It is recommended that energy efficiency targets are always part of the outsourcing contract for public lighting.

The specifications for the procurement of lighting can extend beyond the products and the services to specifying the source of the power used in the system. Some cities have set criteria that require the power to be from renewable sources whilst others have decided not to be concerned about the source of the power. Some cities have identified a desire to install renewable energy capacity and to feed their lighting systems from solar panels (Nice Côte d'Azur). It is recommended that cities consider including criteria for the energy source in their procurement. All technical work on public lighting requires transport. Cities can set an example with their own behaviour. Burgos has started an initiative by using only bio-diesel for the urban buses and with their adoption of hybrid cars. Cities like Lyon and Patras want to reduce the carbon footprint from transport in the first place and to stimulate their local economies – by showing a clear preference for local suppliers in their procurement policy.

Quick Wins

● Prevention – do not light where there is no need, where there are no people.

● Establish a baseline of the current environmental impact of all lighting in the city.

● Report each year to politicians and civil society on the environmental impact.

● Involve environmental criteria into your tendering for services regarding public lighting.

● Set an energy efficiency target in the outsourcing contracts and support this with financial incentives and / or penalties.

● Privilege lamps with high lamp efficacy to reduce energy consumption, in all phases, but especially the use phase of street lighting and traffic signals.

● Privilege energy efficient ballasts to reduce the use of materials and generation of waste (hazardous and non-hazardous).

● Replace and recycle mercury lamps and promote the use of energy efficient luminaires that can reduce the potential risks associated with pollution of air, land and water from hazardous materials (e.g. mercury).

● Promote the use of luminaires that limit light emitted above the horizon to reduce light pollution from street lighting.

● Encourage the use of dimmable ballasts where circumstances allow.

6 | Maintenance and quality control

Maintenance is vital for the quality of the public lighting system, for energy efficiency and for managing the costs.

Maintenance of public lighting systems is targeted at three elements:

- the lamp posts
- the luminaires
- the light source with power supply unit (ballast)

Each element has its own life time, lamps 3 to 5 years, luminaires up to 20 years and lampposts 25 to 40 years. Very often the three units are connected in a way that one cannot change the one without changing or adapting the other.

Some cities are replacing their lighting infrastructure without due consideration of long term maintenance, particularly the availability of specialist equipment (ballasts, luminaires, etc.). Cities are depending on their supply chain to continue to provide replacement luminaires, ballasts, columns and controls. Some cities with a high percentage of old/obsolete equipment struggle to obtain compatible replacement parts and are forced to install alternative parts.

As cities carry out renewal of their infrastructure, they must include consideration of the long term supply of parts as part of the tendering processes and secure both supply and price guarantees. The financial, human and material cost and impact of maintenance must be identified at the beginning of any project. If the costs for maintenance are made visible, then the choice of the lighting system to be installed can be influenced.

6.1 | Curative or preventative

Curative maintenance standards vary considerably across the partner cities. Contract specifications / service standards vary, with some requiring repairs to be carried out with 1 day (Lyon), 2 days (Bassano) and some within 5 days (Eindhoven). Where cities employ their own maintenance staff there seems to be greater flexibility in responding to curative maintenance issues.

All cities rely on complaints and feedback from residents and businesses to direct the curative maintenance staff. Some cities have programmes of inspection to identify defective installations. When the percentage of failures identified by residents is high, it may be good to increase the frequency of inspection of the lighting infrastructure. Curative maintenance can be economical in the short term. But depending on complaints too much will lead to higher costs, both financially and politically. The maintenance teams will have to come back repeatedly to the same area, each time to do one repair when another lamp is broken. The political costs are high because the city can only react when there are complaints, so in principle, it is based on the discontent of the citizens.

All of the PLUS cities are working towards establishing and investing in effective preventative maintenance regimes for street lighting in order to reduce the relatively more costly curative maintenance. This will maintain quality and reduce the long term costs of street

Iasi

lighting in the city. While some cities (Birmingham, Lyon, Nice Côte d'Azur, and Eindhoven) already have well established preventative maintenance systems and schedules; other cities (Sofia, Iasi, Patras) are largely focused on progressive renewal of their lighting infrastructure and curative maintenance for their old lighting assets.

With all of the partner cities experiencing reductions in maintenance budgets the planned luminaire and column replacement timetables and schedules need to be reconsidered. Some cities no longer have the budgets to replace according to existing schedules.

6.2 | Quality control

Cities use a variety of indicators to measure the quality of the maintenance work including the time taken to react when a lamp is reported as broken, or the costs of maintenance. The Deep Dives also discovered that the contract costs for maintenance and capital may vary significantly between similar European cities. As such there seem to be benefits in benchmarking and comparing the indicators used to measure maintenance, quality and the costs of maintenance. The PLUS cities are an example of an alliance between colleague cities that can be used for this benchmarking task.

Quality criteria for lighting are needed to set targets for maintenance. Simple indicators, like the number or percentage of broken lamps and the light level on the street, are indicators that can

easily be measured. Reporting on the indicators should be done independently and regularly.

If maintenance contractors are not meeting their contractual standards as the PLUS experts have seen mainly in outskirt neighbourhoods where lamps remain broken for longer than acceptable, then structural improvements can be made.

6.3 | Outsourcing

Just like other technical services, the maintenance of public lighting can, and is often, outsourced to private companies. As with all outsourcing, quality criteria with performance standards and penalty clauses must be agreed and regulated through the contract.

The quality control of the contracted activities should be independent. In some cities the PLUS experts have observed that the supervision of external maintenance contractors and verification of their work is carried out by the contractors themselves. In other cities, supervision is carried out by external (e.g. financial) consultants that do not always have the necessary lighting expertise.

When outsourcing, the city should also maintain the technical competence within its own organization, to make a structural and independent control on the activities possible. Some of the PLUS cities (Nice Côte d'Azur, Lyon, and Birmingham) have sophisticated contract monitoring staff that are responsible for close supervision and contract monitoring.

6.4 | Monitoring and databases

The frequency of reporting of the maintenance performance to politicians and civil society varies considerably between cities, from having reports on the internet accessible to all and annual reports to political leaders. The lighting departments of Tallinn, Leipzig, Bassano, Lyon and Nice Côte d'Azur receive monthly reports of the state of
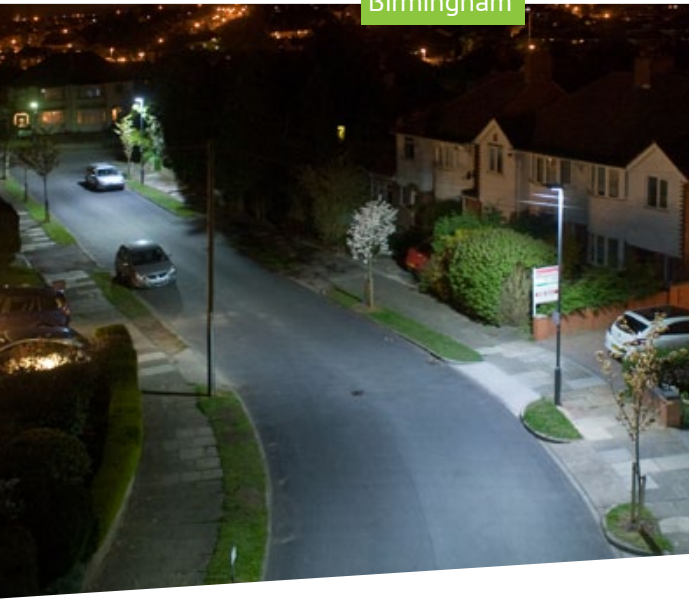
Birmingham

the citywide lighting and they are clearly used by management to continually improve the systems. Birmingham has real-time instant monitoring data from their recently installed new system.

A common issue for cities without a good understanding of their lighting infrastructure is the need for their contractors to be able to install and maintain almost every piece of lighting equipment imaginable! Without a database, contractors are faced with carrying spares of all the possible luminaires, ballasts and control equipment when called out to make a repair or replacement - wasting both time and money.

To support the database, some cities have installed GPS/GIS systems and are moving towards fully automated lighting systems (Birmingham). Other cities (Nice Côte d'Azur, Lyon) are testing different technologies and using pilots to learn about their relative benefits. Few of the cities have given full consideration to issues of ownership of data, sharing access to data with contractors, the legal interface with telecommunications contracts, and smart grids.

6.5 | Decorative and recreational lighting

Decorative lighting (of buildings, monuments and structures) and functional lighting of recreational, sport and open space facilities requires a very different technical approach to both design and maintenance (as compared to street lighting). The PLUS experts noted that the different maintenance requirements and aspects for non-street lighting were not taken into account in all cities when designing their maintenance specifications contracts and programmes.

Much of the decorative lighting installed in the cities is tailored to the particular site and installation. Many of the installations are jointly owned / operated with private sector partners.

The development of modern LED lights makes innovations possible and many cities are experimenting with spectacular lighting designs and effects. The accessibility of the light sources and luminaires must be guaranteed to keep maintenance possible and affordable.

Each of the partner cities has adopted a different approach to the maintenance of their diverse portfolio of decorative lighting installations – some cities (Bassano, Lyon, Nice Côte d'Azur, Patras) have integrated their maintenance of decorative lighting with that of their street lighting.

Some cities have included their decorative lighting installations in their citywide lighting databases. However most cities do not have a comprehensive understanding of the quality, scale, location, age, condition, consumption or maintenance needs of their decorative lighting.

From the PLUS project there is clearly a need for cities to adopt a more comprehensive approach to the maintenance of non-street lighting – one solution can be to regard all the individual "unique" lighting installations as a separate contract (to the street lighting contract) and to design / tender an appropriate maintenance programme / contract for them.

6.6 | Costs

Costs for street lighting maintenance vary dramatically between the PLUS partner cities. The greatest differences seem to be for costs associated with curative maintenance. This can be explained to a degree by the very different standards adopted by the cities (varying between 1-5 days). Some cities have very long term maintenance contracts that are relatively costly when compared with other cities. These contracts can also limit the cities' ability to install more efficient systems.

The Deep Dives identified that none of the cities have a framework for considering the relationship between the costs of maintenance, the number of complaints and the quality / performance of the lighting systems.

Clear and widely used indicators for the quality of the public lighting and for benchmark comparisons with other cities, seem to be missing.

Lyon

Quick Wins

● A database of the existing lighting stock is needed. Very sophisticated software systems with remote mobile access and detailed data are available, but often a simple excel file will do as a start.

● Implement a structural testing system. Blocks of lighting can be switched on and off to check the functioning of the lamps and the quality of the luminaire and the lamp post.

● Introduce night scouting. There are many cities that have no systematic control on the functioning of the lighting during night hours. In such a way you depend only on complaints from citizens.

● Set up an easy accessible report system. In some cities every lamppost has a small label with a unique identification number and a telephone number to report a defect.

● All cities should as part of their contract due diligence investigate the costs paid by other cities for similar contracts.

● Maintenance contracts should be output orientated and contractors should be paid according to verified performance and results.

● Contracts should be framework based that allow new maintenance regimes to be adopted, new lighting schemes to be included and maintained and include penalty clauses for poor performance.

● Contract monitoring should be carried out by lighting engineers.

● New lighting schemes should be designed to reduce maintenance and automatically be included in preventative maintenance schedules.

7 | Reducing light pollution

Light pollution or obtrusive light is defined as "that part of the light from a lighting installation that does not serve the purpose for which it was designed".

Examples of obtrusive light include light improperly falling outside the area to be lit, diffused light in the neighbourhood of the lighting installation and sky glow.[10] There is limited research available to allow obtrusive light to be quantified; however there are indications that it is affecting the natural bio-rhythms of terrestrial and aquatic ecosystems and is considered an important factor related to direct emissions in particular from street lighting.[11]

Light pollution obscures the stars in the night sky for city dwellers, interferes with astronomical observatories, and, like any other form of pollution, disrupts ecosystems and has adverse health effects. Cities should aim to create safe and comfortable environments that are lit in ways that protect darker areas.

7.1 | Avoiding light pollution and light nuisance

Most PLUS partners have given a high priority to the prevention of light pollution and light nuisance and have included polices aimed at preserving the dark sky in their public lighting strategies. In general most partner cities have adopted regional or national standards. Some regulations and policies are very detailed, up to date and informed by extensive research.

Few cities have quantitative targets for the reduction of light pollution. When there are rules or targets, then they are limited to avoiding upward "waste" light. In Italy the Regione Veneto was the first Italian region to enforce a law against light pollution in 1997. This regulation was updated in 2009, and ensures that new lighting schemes must satisfy well defined technical rules. Also other PLUS cities have catalogues of "recommended luminaires" to restrict the escape of light towards the sky. Some partner cities are making reductions in light pollution through comprehensive luminaire replacement programmes.

Some partner cities have identified biodiversity zones within their territories that are sensitive to light pollution – and have adopted specific policies to control light pollution in these areas.

In developing these light pollution policies some PLUS cities appoint external consultants, other partner cities have internal experts who are actively involved in advising lighting designers and engineers.

The potential impacts of new lighting schemes can be integrated in Environmental Impact Assessments (EIA) and Health Impact Assessments (HIA) (Birmingham and Eindhoven follow this strategy). In essence there are four aspects of unnecessary light:

- lighting levels that are too high
- light in the wrong places
- light at the wrong time
- disturbing colour of light

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[10] http://www.celma.org/archives/temp/First_edition_Celma_Guide_on_obtrusive_light.pdf - www.cie.co.at

[11] Guidance Notes for the Reduction of Obtrusive Light: http://www.lux-editions.fr/recommandations_guides.asp

7.1.1 | Lighting levels – too high!

In deciding what lighting levels are appropriate for different situations, EN 13201 is widely accepted and used as a design standard. It has been used to establish many national standards for the lighting of public areas according to classifications.

The PLUS experts identified during the Deep Dives that the general lighting levels varied between the different partner cities. Whilst some cities have very high lighting levels in all streets and areas in the city, other cities generally have much lower levels; seemingly without jeopardising traffic or public safety. This suggests that in some parts of some cities there is scope to reduce the lighting levels. The Deep Dives have identified that civil society is more likely to accept reduced lighting levels if the change is accompanied by improvements in the night-time colour rendition of the light and improvements in the distribution of light.

It is important to note that the Deep Dives identified that private lighting is in most cities the principal source of light pollution. However it seems that local lighting standards and regulations do not always cover night time advertising, decorative lighting or private lighting.

Few of the partner cities have systems in place to monitor the success or failure of their "Preserving the dark sky" polices and standards – few partner cities have any measurable targets for stopping or reducing light pollution – particularly from private lighting.

Even in cities that have regulations and standards against light pollution, artistic and architectural considerations are sometimes given priority - light festivals, extending and increasing decorative lighting schemes, upward projectors, or projectors with high lighting levels being installed that do not preserve the night sky. In many partner cities there is a tension between a desire to increase lighting levels (for tourism, safety, economic and marketing reasons) and preserving the dark sky.

Implementation of the adopted light pollution regulations and standards should be universal and comprehensive. The PLUS experts recommended that when cities agree contracts for the outsourcing of lighting design and maintenance, these contracts should include indicators of performance that reward the contractor for reductions in light pollution and for preserving the night sky.

7.1.2 | Light in the wrong places

Lighting those places that nobody uses or sees is not only light pollution but also a waste of energy.

The Deep Dives identified that much of the light pollution in cities is caused by "spotlighting" on buildings and (illuminated or spot-lit advertisement) signs. Guidelines in use in Italy include requirements that such lighting may only be from above in a downward direction. Although this may not be possible in the lighting of all historical buildings or monuments, in general it seems a workable and effective regulation.

Although it is difficult to control all private lighting, some cities have taken initiatives to reduce light pollution with particular industrial sectors and major areas generating light pollution (e.g.

harbours, refineries etc.) These local initiatives are to be commended and supported.

The Deep Dives identified that the careful selection of luminaires with appropriate light distribution characteristics will ensure that the light is better targeted and there is a reduction in light pollution. This attention to detail in the design stage can avoid light being directed upwards in the sky, and prevent glare and dazzling. Eindhoven has adopted LED lights for sporting areas, recognising the need for high lighting levels and the difficulty of avoiding glare and light spillage when using conventional lighting. Clearly LED lights with appropriate luminaires could allow for more effective targeting of light.

Before

After

Birmingham

Eindhoven
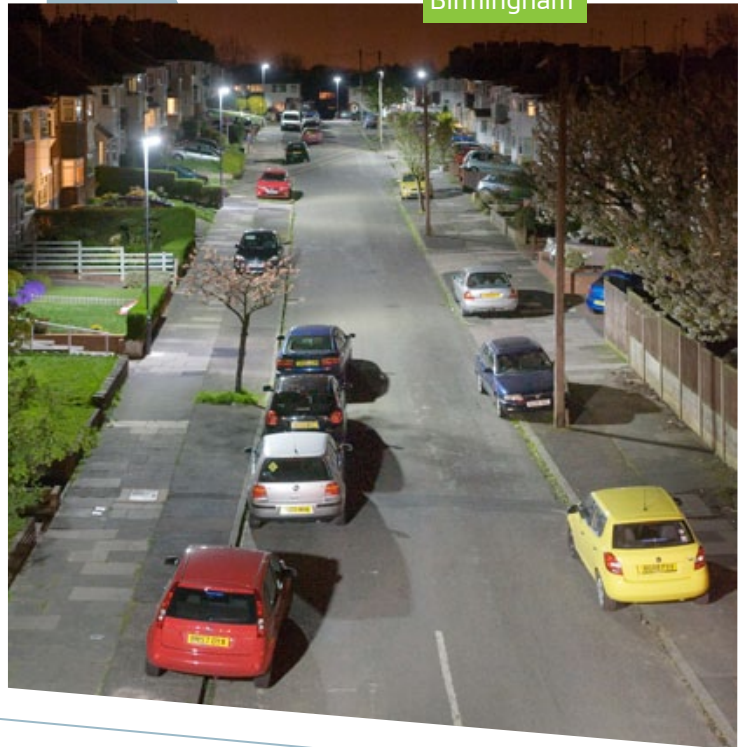
7.1.3 | Light at the wrong time

Lighting areas at times when it is not needed is pointless. The dimming of street lights during the late night hours, when there is less traffic, is a logical measure that reduces light pollution and costs. Modern electronic control systems now allow even more flexible arrangements. Eindhoven and Lyon have installed sensor activated systems that enable light levels to react to the presence of cyclists or pedestrians. Leipzig is developing a system where the traffic density on the ring road will be "sensed" and be used to manage the local lighting levels.

7.1.4 | Disturbing colour of light

Several PLUS cities are experimenting with other ways to reduce light pollution. Birmingham (and other partner cities), are changing the colour of the street lighting from yellow to more of a white light – which gives a brighter impression, thus allowing the level of lighting (in lumen) to be reduced, without losing visibility.

Another experiment is taking place in Eindhoven where the public lighting in a sensitive "nature area" has a green colour. At low lighting levels the human eye is more sensitive to green light and so in this area the lighting levels can be kept low. Approaching traffic (with headlights), is thus better detected by animals in the area because of the greater contrast with the surrounding dark areas.

7.2 | Education and stakeholders

Potential stakeholders regarding light pollution are environmental groups, astronomers, businesses, wildlife groups, tourist companies, residents, etc. Only a limited number of cities have an ongoing citywide dialogue with stakeholders. Although some cities have debates about the light pollution associated with particular projects, few cities have seriously considered who might be the citywide stakeholders when considering light pollution.

A few partner cities have school/education programmes that aim to influence perceptions of light pollution and night time illuminations. Within the PLUS partners, Basanno has initiated the most extended programme for awareness raising in schools. These are excellent but limited initiatives that should be independently assessed to understand how to reinforce their benefits.

During the Deep Dives, the experts did not review any "awareness raising" activities for preserving the night sky.

The experts recommend also that surveys are carried out to identify the sensitivity of legally protected and other species of wildlife to public lighting, so that new and existing public lighting can be designed to protect this wildlife.

Iasi

Part 2
Light in the city

8 | Equal and free access to urban lighting

Lighting is one of the basic needs for living in urban areas and can be seen as a service of general interest. It is widely agreed that cities should guarantee equal and free access to urban lighting for all citizens, regardless of their social status and the physical conditions in the territory. Lighting strategies should be for the entire city, including city centres, suburban areas and the periphery of cities, with no part of the territory excluded. Lighting should contribute to reducing social and economic inequalities and support integration policies.

It is widely accepted among the PLUS partners that the service of public lighting for the whole territory and for all citizens is a basic responsibility of the municipality. This acceptance does not however mean that all the cities are succeeding in delivering this service at equal levels across their entire territories.

Public lighting has its price and in a period of savings and financial cuts it is under pressure. The PLUS partner cities are convinced that all cities must resist the pressure and should not switch off lights in peripheral areas during the night hours. It is strongly recommended that dimming should be adopted as an alternative that at least provides a minimum level of lighting.

8.1 | Areas and standards

All of the PLUS partner cities have committed to implement the standards as set out in EN-13201 to provide equal and free access to public lighting along streets and roads. All partners have adopted the categorisation of types of areas and streets and lighting levels are regulated according that categorisation

Not all cities have adopted standards for the lighting of buildings or recreational spaces (parks etc.). In some cities this has resulted in a lack of coordination between municipal departments and unequal lighting across the cities. The streets are well lit, but parks are lit poorly because the responsible department does not have the money or the obligation to meet the standards.

Through the expansion of the housing and commercial areas, rural areas are becoming more and more urban. Some cities have regulations that ensure sufficient finance is in place for the investment necessary to upgrade the lighting system in these new urban areas. However some cities do not have these regulations in place or cannot meet the high additional costs for this upgrade. Faced with unaffordable costs, the City of Iasi has found a way to implement a basic lighting system in new residential areas, by using recycled luminaires and lamp posts. Iasi recognises that this can only be a temporary solution, but residents and the Deep Dive experts commend them for their innovation taking the first step.

The City of Patras has few financial resources but has made the political commitment that territories that have recently been absorbed into the municipality will achieve EU standards for functional public lighting.

Leipzig sees lighting also as an integral element of the quality of life of an urban area. If houses and areas are being renewed in the framework of city renewal, the lighting system in the area is also being included in the renewal activities.
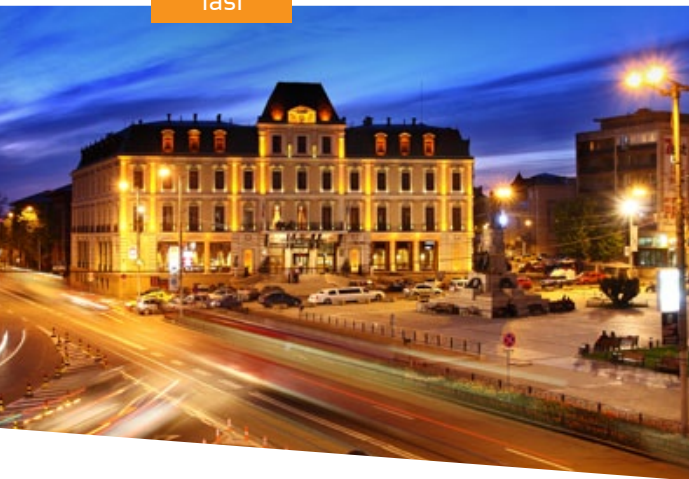
8.2 | User groups and stakeholders

Public lighting should meet the needs for all citizens, of all ages and abilities. People with visual and mobility disabilities require lighting to be designed to meet their different needs. The City of Lyon has participated in research in this field and the results are being used in adapting the design of lights at pedestrian crossings, bus stops, etc.

Public sporting fields, playgrounds and squares all need specific lighting qualities, modified to the different user groups and user times to meet safety and comfort standards for all.

Citizens' involvement in designing and implementing lighting systems is a basic democratic right. All PLUS cities and their local politicians are aware of the importance of equal and free access and have put in place consultation arrangements to understand local priorities and concerns. Some cities have yet to fully implement methods for stakeholders to report faults or concerns about the standards and maintenance of lighting – while other partners have internet and smart phone "app" based reporting systems to allow real-time monitoring of equal access.

Lighting is a decisive factor in the safety and atmosphere of residential areas of cities. A number of partner cities including Eindhoven have therefore developed consultation mechanisms to involve citizens in discussions about their areas.

8.3 | Implementation of equal and free access

Tools

Cities have a diversity of tools and techniques that can be applied to new developments, as part of city investments that will move the city more towards equal and free access according to the standards, including

- development agreements
- renewal and renovation of infrastructure
- building codes
- design codes
- development control systems

Finance

Capital and operational budgets for public lighting are under severe pressure. Investments are being reduced and operating budgets being cut – the latter resulting in some lighting systems being switched off with peripheral and outlying areas being most affected. Poor maintenance associated with budget cuts will result in lighting standards being unequal across parts of cities. Therefore cities are exploring new investment and funding models for public lighting that may have an impact on whether lighting remains free.

Governance

Sometimes the outlying and peripheral parts of cities are administered by other councils. When these adjacent councils do not have the budgets or competencies to implement the same standards for equal and free access, then the administrative boundaries are also boundaries for equal and free access to lighting. These boundaries rarely relate to any physical change on the ground and therefore mean that some adjacent residential and business areas have very different lighting levels and standards. Where this is the case cities must explore the local governance arrangements to see if lighting levels can be improved across the territories.

Lyon
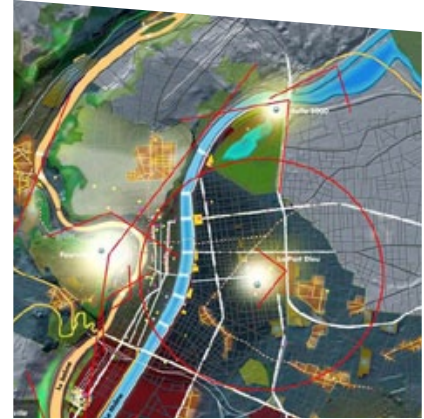
8.4 | Future developments

Equal access does not mean that cities will be illuminated in a uniform way. A diversity of lighting is essential to provide identity for specific areas and different functional areas. Citizens can be involved in defining the identity of their areas. The City of Eindhoven considers that the flexibility of new lighting techniques provides greater opportunities for citizens to influence local lighting designs. Cities can supply the lighting infrastructure and citizens and companies can add their own adaptations in a flexible way. Lighting systems can become open for individual initiatives, while the city protects the basic level. Just like in city planning, where the city supplies the basic structure in roads and infrastructure, but citizens can decide about the design of their own house and garden.

The City of Lyon highlights the different identities of the city through creating a lighting master plan for each neighbourhood. Commercial areas already are often illuminated in such a "non-regulated" way. The city delivers the basic lighting scheme and then local "shop keepers" and restaurateurs add their own individual lighting.

Innovative lighting technologies and systems will enable more of these individual initiatives to take place. It is therefore absolutely necessary that lighting suppliers and designers start and continue to work with open source software protocols for public lighting. Closed company protocols lead to monopolies in the supply of lighting and control systems and will not fit in such an open innovative lighting system.

The European Commission is requested to urgently review the need and importance of promoting open source protocols for the control of public lighting. This should be seen as an essential element of the promotion of the internal market within the EU. It is required to promote competition in the design and supply of public lighting control systems. Such a free market resolution by the EU will stimulate innovation, avoid the creation of monopoly suppliers and ensure that only open source control protocols are used in public lighting.

9 | Creating a safe and comfortable environment

Lighting has played a historical role in making our cities safer, more secure and more comfortable to live in. Urban lighting strategies should maintain this as one of their primary and most essential objectives. This involves creating a feeling of safety and creating objective safety when necessary, with a reasonable amount of light.

9.1 | Statistics

The difference between "real safety" and the "feeling or perception of safety" is important. There is little actual data on traffic accidents or crime related to lighting levels, and what is available is difficult to use for statistical analyses. At a strategic level, data on crime levels can only indicate those local areas where additional lighting could improve safety. Examples are parking spaces or pedestrian under-passes.

Most of the PLUS partner cities have relatively little crime. Consequently they are not actively using safety and crime data to influence their lighting levels and designs. Most of the cities are adopting the pragmatic approach and are using the knowledge and experience of their local police to improve the lighting in unsafe locations.

All the PLUS cities have established excellent working relationships with their local police. The intelligence gathered by the police (crime statistics, accidents etc.) is in most cities being used to nuance lighting designs, and adapt lighting levels to reduce the fear of crime and the threat of crime. In these cities the close collaboration includes the installation and use of security cameras and appropriate lighting.

Although it is indisputable that better public lighting levels improve the feeling of safety it remains conjecture whether higher lighting levels actually improve objective safety.

9.2 | Dark gaps

More than the level of lighting, the continuity of lighting seems to be important. Gaps in street lighting that result from luminaire failures are places where residents and tourists perceive the risk of crime to be high. It is these relatively darker areas that cause an uncomfortable feeling.

Most cities are aware of this fear of crime and have maintenance schedules that respond to these high risk areas more quickly than to other situations. Some cities (Iasi, Sofia, Bassano) recognise the need to adapt their maintenance regimes to ensure that lighting in "high risk areas" is maintained to higher standards. Even with a very short reaction time, there will be a "dark gap" and an uncomfortable situation.

Forced by reductions in budgets some cities are now switching off some luminaires during periods of the night. The PLUS experts strongly recommend that cities should install control systems that allow dimming as an alternative. This can maintain lighting levels sufficient for residents not to be concerned about increases in crime. Other cities (Leipzig, Bassano) have principally decided against switching off in order not to increase the fear of crime.

Burgos

9.3 | Traffic safety

Special attention should be given to lighting conditions in places where pedestrians and car traffic meet. Cities like Eindhoven and Burgos are experimenting with coloured lights in the pavement as supporting safety indicators for pedestrian crossings. The visibility of cyclists and pedestrians should always be a priority in designing public lighting.

Reducing the fear of crime for cyclists and those using public transport is clearly important if people are to be persuaded to not to use their cars – if they have cars. Most cities actively seek to understand the way in which lighting needs to be improved to maximise the use of cycle ways and public transport hubs.

Tallinn

9.4 | Special projects

Lights can provide atmosphere and comfort. The atmosphere of public squares and parks can be influenced by the lights that are used. Examples are numerous, in almost every city, special lighting for squares, bridges, streets is being used to support the aspiration to spend time there and to meet people. A completely opposite effect is being used in Eindhoven, where at the hour that bars and cafes close in the centre, the lighting level on the street is raised. People tend to leave the area faster as compared with retaining the lower lighting levels.

In Lyon, the approach has been to illuminate all those areas where there is the chance of crime taking place; "If you are a criminal, you cannot hide yourself in Lyon", was a comment of one of the Deep Dive experts.

In many of the cities the standard design solution for reducing the fear of crime has been to increase the lux levels and the brightness of the lighting. Many of the visiting experts are concerned that universal use of LEDs (Tallinn, Birmingham) or sodium (Iasi) do not deliver design quality, ambience or comfort. Clearly what is needed is greater involvement of lighting designers to ensure that areas feel safe with good ambiance and comfort.

Sofia

9.5 | Stakeholder involvement

In every lighting project it is important to involve citizens; at least one should ask feedback after new lights have been installed. In Lyon, a special committee looks at all spatial plans and evaluates different aspects of the plan, including the lighting. In such a committee, representatives of the main stakeholders, like the police, companies and citizens can have a seat.

The stakeholder engagement process in Birmingham allows the standard LED designs to be adapted to provide a locally bespoke solution that reduces fear of crime.

Iasi, Sofia, Eindhoven and Tallinn have all taken particular initiatives to discuss with park and recreational area user groups their concerns about lighting and safety. A number of innovative schemes have been implemented that have increased the use of parks during the evening and reduced the incidence of crime. Careful design has provided excellent ambience and comfort to users.

Many cities prioritise "less safe areas" for their investments in renewing lighting infrastructure and have flexible budgets to allow them to respond to incidents and local stakeholder concerns.

Some cities (Birmingham, Eindhoven) have adopted design codes for new developments and new infrastructure that explicitly allows the city to influence the designs so that public and private spaces are safer. They even require private developments to contribute to the costs associated with public lighting to improve safety and security.

Quick Wins

● There is "best practice" in designing new lighting schemes that could help reduce the fear of crime.

● A close cooperation with local experts (police) must be set up in order to make up for the lack of statistical data.

● Switching off alternate lights must be avoided.

● Perception that areas are unsafe should be taken seriously, at least as much as evidence that areas are unsafe.

10 | Urban and cultural identity

Lighting, whether temporary or permanent, is a powerful tool for city marketing and city enhancement. It can help create distinctive nightscapes and can define and enhance significant urban areas, buildings or monuments. Certain aspects of a city can be shown, others can be hidden.

City centres can be given an urban character only with light, as Time Square in New York demonstrates. During the daytime the place does not look much different from other busy places in the city, but in the evening it is an unmistakable urban location.

Most partner cities have adopted a strategy for using light to reinforce cultural and social identity and preserve and protect heritage sites and ancient city centres. The level of detail in these lighting strategies varies greatly between partner cities.

Many cities recognise that design codes which provide a framework for consistent and sensitive approach to the design of decorative lighting for historic and modern buildings should be the basis for a nuanced approach to lighting design that realises the potential of each and every building. Some partner cities (Lyon, Leipzig and Nice Côte d'Azur) have developed such design codes. .

Other cities have adopted a temporality approach to public lighting (for festivals and decorative lighting) as an effective strategy that balances the interests of preserving the night sky with promoting cultural identity.

The Deep Dives identified that city lighting strategies are rarely integrated with those for tourism and economic development.

Patras

10.1 | Economic, historical and cultural identity

The lighting of the monuments or notable buildings in a city can give support to the economic identity. PLUS cities have recognised that street and decorative lighting can be used to "brand" and market their city.

The lighting of the Rion-Antirion Bridge has provided Patras with a strong landmark and identity as a harbour city at an important road connection between Greece and the rest of Europe.

Eindhoven supports with many small but innovative lighting projects its image of a city of innovation and design.

Sofia is using its citywide lighting vision as a foundation for its bid for European Capital of Culture 2019.

Modern lighting design and technologies can reinforce cultural and historical identity and preserve heritage sites and ancient city centres. Bassano, Patras and Burgos have excelled in some of their lighting designs of historic areas of their cities.

Burgos
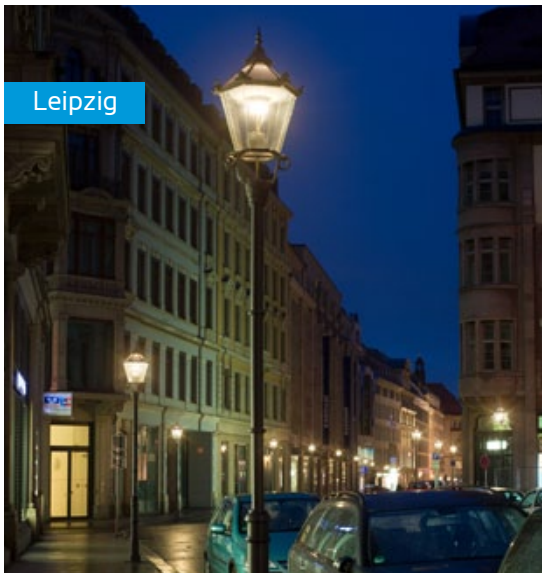
Leipzig

Historical cities can strengthen the feeling of intimacy by using the right colour and right lanterns. Leipzig has replaced their old classic luminaires by energy efficient LED lights. To keep the intimate feeling of the old city centre, special new luminaires were designed based on the historical models of the gas lanterns.

Burgos in Spain chose another approach and used deliberately modern luminaires to accentuate the historical character of the city. By using lampposts of limited height, the intimate character of the inner-city has been maintained.

Lighting buildings and structures is not only a matter of quantity and high lighting levels. Shadows and colours are just as important. And also the appearance during daytime should be regarded. Careful consideration should be given to the positioning and daytime appearance of luminaires and other electrical equipment at historic buildings or structures and in historic areas to ensure that they do not damage the physical fabric of buildings or detract from their appearance.

Bassano

10.2 | Social identity

Light defines in a strong way the atmosphere of public spaces in a city and has the capacity to build and/or reinforce the link between people and their urban environment. Lighting of parks and squares must be designed carefully to offer both safety and a pleasing environment.

Light can guide different activities to certain places and times. In the design of the lights of the Alpini Bridge in Bassano del Grappa, this aspect has been introduced. To move people from one side of the Alpini Bridge, where the restaurants are located, to the other side where bars are

located, the colours on both sides change slowly. The "preferred side" is made more attractive with warmer light.

In the Nice Côte d'Azur, the "stops" for public transport have a high level of lighting, not only to make them more visible for the traffic, but also to create a feeling of safety and comfort for the waiting people. Light contributes here to social contacts and cohesion, just as well as to safety and social well being.

Eindhoven

Lyon
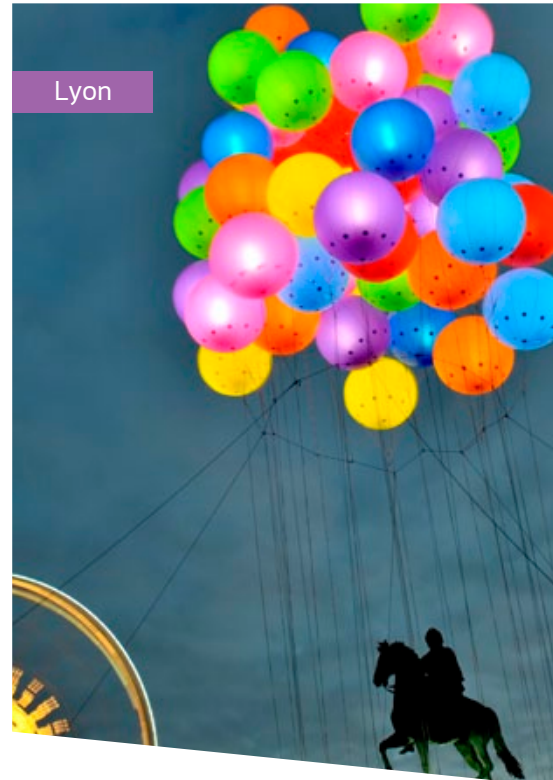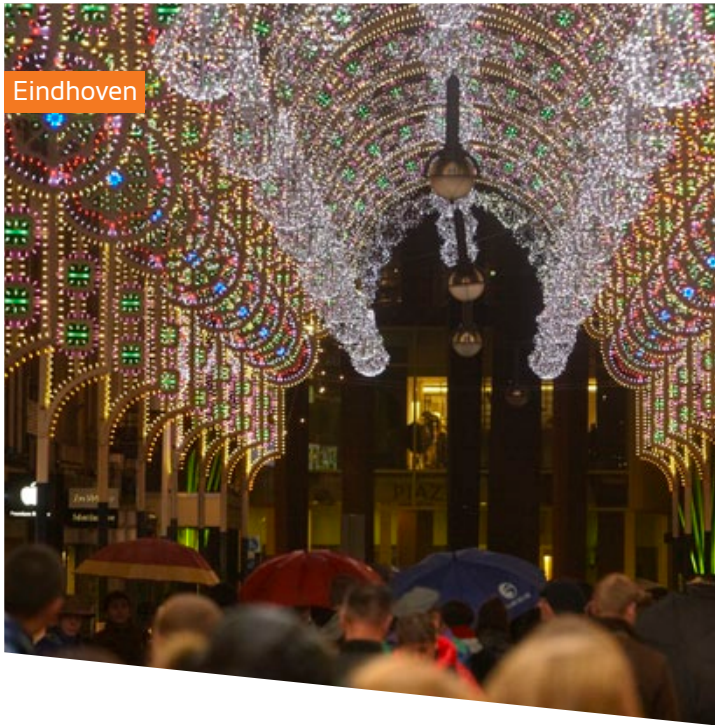
10.3 | Festivals

Events and festivals give expression to urban creativity, culture and art, and serve the social unity of cities. Some PLUS cities organise annual light festivals. These are events where light is not just a support to other attractions, but becomes an attraction on its own. The Lyon "Fête des Lumières" is acclaimed the first light festival in Europe. Some of these festivals are so successful that they become part of the city identity, like the GLOW festival in Eindhoven.

The light festival in Leipzig finds it roots in a political event, the peaceful revolution, which is celebrated with light. Birmingham and Tallinn also have light festivals.

These activities are well organised, generally well-funded and many have long standing valued private sector partnerships for their design and implementation. Tallinn made significant investments in lighting festivals and in decorative lighting for its European Capital of Culture 2011 programme and realised significant inward investment and increases in tourists.

Most cities carry out some simple evaluation of the benefits of the festivals but this rarely extends to a considered cost benefit assessment.

10.4 | Implementation and partnerships

Some of the PLUS cities have adopted highly sophisticated dynamic lighting designs that can be adapted to meet a diverse range of cultural events. But few partner cities are monitoring the success of their strategies and the economic costs and benefits for using light to build the urban and cultural identities of their cities.

PLUS cities have established partnerships with universities or design bureaus to design and implement strategies and lighting schemes. The extent nature and scope of these partnerships varies considerably. The Deep Dives have shown that in each of the partner cities there are many more potential partners who could contribute, like religious organisations, tourist industry, food sector, environmental groups, transport providers etc. Such stakeholders can contribute to building the urban and cultural identities of the city using light.

The Deep Dives have observed that in cities where the responsibilities for street lighting and decorative lighting are shared between agencies or departments, closer collaboration between departments is needed to deliver targets and the strategy.

Many cities focus on reinforcing the cultural identities of certain "obvious" geographical parts of their cities, mostly the cultural core areas. Many cultural, historic and iconic buildings, facades, skylines, parks and features that are valued and treasured by local people are not being illuminated. This represents an enormous potential for the cities to exploit to the benefit of the local economy and cultural identity.

10.5 | Energy and light pollution

The Promenade des Anglais in Nice Côte d'Azur has a very famous lighting installation. The 7 kilometres long promenade has a line of spherical luminaires which has become a key visual and cultural landmark of Nice Côte d'Azur, seen from both the sea and mountains around the city. The city is now involved in a difficult balancing act to reduce light pollution from the existing luminaires whilst maintaining the iconic line of luminaires – known as the "string of pearls".

Using light for improving the cityscape, for illuminating monuments or structures, for safety in public spaces, almost always means an increase in the amount of light, with the consequence of higher energy costs and a greater chance of light pollution or glare.

Although the emergence of new technologies may limit the increase in energy consumption, good design and an appropriate lighting strategy is still essential if the adverse impacts of lighting are to be minimised. Using light to create and support the identity of a city requires significant investment and is an important political and economic issue, and so should be done with great consideration.

Nice Côte d'Azur
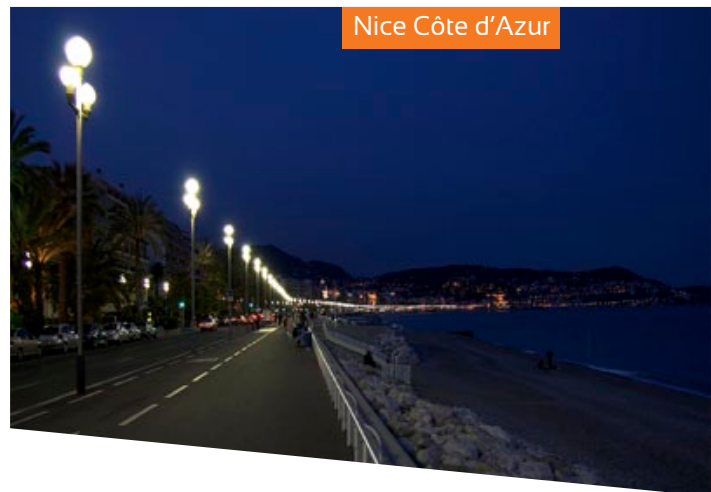
11 | Supporting an environmentally friendly mobility

Lighting has an important role to ensure safety for traffic. In such a way it can support green mobility as well. Bicycle lanes, local public transportation and pedestrian routes must be lit to an appropriate level to offer an adequate and safe alternative to transportation by car.

To decide what is "an appropriate level" of street lighting, cities throughout Europe use road classifications as set out in EN 13201-2. The type of road and the volume of traffic it carries dictate the required lighting levels.

A simplified classification system was used in the EU eco-design study for street lighting [12] and is summarised below with the equivalent European Norm classifications.

- **Category F "fast traffic"** with fast motorised traffic use only, having only luminance requirements (cd/m²). These correspond to the road classifications ME1, ME2, ME3a and ME4a in EN13201
- **Category M "mixed traffic"** with motorised traffic, slow moving vehicles, and possibly cyclists and pedestrians with only luminance requirements (cd/m²). These correspond to the road classifications ME2, ME3a and ME4a in EN13201
- **Category S "slow traffic"** for mainly urban and pedestrian areas, with illuminance requirements only (lx). These correspond to the road classifications CE2, CE3, CE4, S2, S4 and S6 in EN13201

Most European cities recognise that it is necessary to have good lighting to increase the modal share for walking cycling and public transport.

Only a few cities have further interpreted the EN standards by adopting specific lighting and mobility guidelines or standards for lighting of footways, cycle ways, pedestrian crossings and public transport hubs (Leipzig).

Most European cities are adopting energy or carbon reduction strategies; however few of the strategies acknowledge the contribution of improved night time lighting to reducing car use (and reducing carbon emissions). The necessary close cooperation between mobility planners and the lighting department is not generally taking place. The Deep Dives have identified that where responsibility for promoting urban mobility is outsourced to a mobility agency or company there is an increased risk that coordination with lighting will not be effective.

Most of the PLUS cities have recognised the benefits of linking their citywide mobility plans to their public lighting strategies but real progress in integrating these plans varies considerably. The Deep Dives have confirmed that for most cities their first priority is to invest in bringing their street lighting up to the EN standards and improving lighting. The promotion of sustainable environmentally friendly mobility is a low priority. The experts consider that nuanced investments and designs can deliver both!

[12] http://www.eup4light.net/

11.1 | Implementation

The PLUS Deep Dives identified and endorsed many innovative mobility projects in the partner cities. Some cities such as Lyon, Burgos and Nice Côte d'Azur have improved the illumination of cycle lanes and some streets and routes leading to transport hubs.

In PLUS cities where there is already an established strong culture of environmentally friendly mobility, the integration of these strategies is well advanced; Eindhoven and Leipzig are particular examples.

Examples of such strategies include the development and specific lighting of priority routes for pedestrians and cyclists as well as ensuring that crossings are safely lit and designed.

The new lighting strategy of Lyon emphasises the pedestrian and cycle bridges in the city.

Different parts of the road with different functions can get different lighting colours, to support the different colours of pavement. Cycle paths and motorcar lanes are better separated.

The contribution of some of the investments to increasing the modal share for cycling, pedestrians and public transport might have been greater had public lighting been considered earlier and as more central to the design process. In particular the lighting levels and design could have been much improved associated with new investments in trams and bus terminals and in the level of lighting at bike rental and bike sharing hubs.

The replacement of bus shelters provides cities with the opportunity to also illuminate many of these shelters. Greater cooperation with private companies, urban planners, energy planners and highway engineers in scoping and specifying these investments could assist in:

- reducing the fear of crime
- providing an income through sale of advertising
- reducing carbon dioxide emission by meeting energy demands through integrated solar panels
- introducing public art into the streetscape
- integrated urban renewal using common palettes of finishes and materials

Some of the PLUS cities have established integrated teams or contracts for the management of lighting associated with streets and transport hubs. These working arrangements are largely effective in ensuring that public lighting levels are appropriate to the level of use – lighting levels are reduced when public transport stops at night.

11.2 | Stakeholders

The Deep Dives included a number of workshops with key local stakeholders. In Sofia, Tallinn and Iasi, cycling and pedestrian stakeholder groups indicated that improved lighting would encourage greater modal share.

Across the partner cities the Deep Dives identified latent opportunities to increase the modal share for walking and cycling by improving lighting. Most of the cities are carrying out urban renewal and urban expansion projects and involving stakeholders in their design and implementation. In Eindhoven at Strijp-S, improved lighting and its contribution to increasing modal share for environmentally friendly mobility is being actively pursued. In most cities there is a need to work more in partnership with private investors, universities and students and make low cost investments in new cycle ways and their lighting.

Quick Wins

● Every investment in improving lighting infrastructure is an opportunity to increase the modal share of walking, cycling and public transport.

● Every investment in public transport as well as pedestrian and cycling routes should be supported by appropriate sustainable public lighting schemes.

● In most cities, the existing joint agency/departmental working arrangements and contracts should be more integrated so that they realise the full potential of lighting investments to affect modal split.

● More effective monitoring and customer feedback systems need to be put in place to better understand the effects of improved lighting on modal patterns – and increased opportunities for stakeholders to get involved in helping cities to identify priority lighting schemes for urban mobility.

12 | Strengthening local economic development

Well designed lighting can constitute an attraction for residents and tourists, as well as for commercial and economic activity. Cities can be made attractive for visitors and customers, both throughout the whole year, and at special occasions like at festivals or Christmas time. Innovative lighting can attract innovative industries, research institutes. and creative and imaginative people. Urban lighting investments can be decisive in stimulating economic development.

12.1 | Strategies

The PLUS partner cities have adopted a diverse range of strategies to use lighting to strengthen local economic development.

Modern cities move towards a 24 hour economy. Working hours of people and opening hours of shops become more and more flexible. Most PLUS cities are promoting a 24 hour city and using lighting to stimulate the nighttime economy and support a street café culture. It is clear that this can be a conflict of interests in densely built urban areas.

The City of Lyon has developed a "Charte pour la qualité de la vie nocturne" (Charter for the quality of night life). This charter recognises and seeks to balance the competing demands of businesses, residents and tourists associated with illuminating buildings, lighting festivals and extending opening hours of shops and businesses.

12.2 | Partnerships

All of the PLUS cities recognise that they could work more closely with local businesses to realise the potential of lighting.

Birmingham and Eindhoven have used their existing partnerships with local businesses to explore the way in which improved lighting of the historic cores (and district centres) can be used as a driver to increase employment and economic health of local shops and businesses.

Nice Côte D'Azur has developed a flexible approach to implementing lighting norms and standards. The city can be flexible and respond to the aspirations and needs of local businesses, which is helping to foster economic growth.

Most of the cities now recognise the benefits of working more closely particularly with their universities and higher education sector to establish local courses and expertise in lighting design and engineering. Lyon wants to challenge contributors (merchants, private and public landlords) to participate in the city's nocturnal image; transforming the notion of private lighting into "good citizen" lighting.

Eindhoven has adopted the triple helix approach and work closely with universities and businesses in their lighting strategies and to maximise the economic multiplier effects of public and private lighting.

Birmingham and their private sector partner Amey can further realise their first mover advantage of the Lighting PFI as a catalyst to strengthen local economy by now using it for lighting exhibitions, sectoral development, lighting training, apprenticeships and extending links with the universities etc.

12.3 | Lighting industry

Few cities have an understanding of the number of local businesses involved in the lighting sector or their contribution to the local economy. Economic development polices would profit from a better understanding of the existing contribution these companies make and their growth potential. Cities can then better support the local lighting sector to generate more jobs etc. (grants, training, specialist IT support etc).

Uniquely there is a vibrant lighting NGO sector in the PLUS partner city Tallinn, that is responsible for the lighting festivals in the city. The Deep Dive recommended that Tallinn and all cities need to support NGOs as part of supporting the economic health of their cities.

Eindhoven has reinforced its historic associations with lighting innovation and manufacturing companies. From this it has established a number of economic initiatives to promote jobs and inward investment.

Burgos

12.4 | Higher education

Cities such as Sofia, Bassano and Iasi are stimulating interest in the lighting sector by sponsoring lighting competitions for students at local universities. This is providing excellent stimulus to innovation and the opportunity for new products to be developed, tested and brought to market.

Eindhoven has developed close cooperation with the education sector in the city and particularly focuses on research activities (Triple Helix, Brainport, Smartest Region, etc).

Although many cities are working with the lighting departments of their universities, only few are working with their business schools to better understand the economic issues associated with public lighting. The Deep Dives recommended that cities establish a strategic partnership that extends the technical courses to look at the economic value of lighting investment, how to grow the emerging lighting cluster etc.

12.5 | Tourism

Iasi, Burgos and most of the other partner cities use lighting of their key gateways, monuments, churches and cathedrals to support the promotion of their cities to tourists. Associated with these investments, evening guided walks, tours, "son et lumière", musical events are organised for the tourists. Although most cities measure the increases in number of tourists there is little evaluation of the actual contribution that the lighting makes to the enjoyment of the tourists.

Most of the partner cities have Christmas lights installed during the season but only a few have recognised that this can be part of a seasonal design shift in the public lighting. Associated with a longer winter festival with tours, recreational events and markets, this has the potential to stimulate economic health.

12.6 | Advertising

Some of the PLUS cities have adopted a comprehensive illuminated advertising code of practice that is effective in maximising income whilst minimising light pollution and protecting the historic resources. Such codes can limit the visual damage and nuisance that advertising can cause. An associated initiative is that Leipzig is using the colour blue for city marketing purposes.

12.7 | Economic returns from investment in lighting

All of the PLUS partner cities make investments in lighting projects and infrastructure with the expectation that they will lead to economic returns – saving or creating jobs, bringing tourists, increasing turnover and profitability etc. Only in a few cities (Nice Côte d'Azur, Lyon, Eindhoven) are the economic development departments involved in these investments. Closer involvement of the economic development departments would allow their evaluation and marketing skills to add value to the investments and realise additional economic benefits.

Few cities have a framework for evaluating the indirect or direct economic benefits from investments in decorative lighting, in lighting festivals or improvements to lighting in shopping and cultural areas. If the cities carried out (or commissioned independent) cost/benefit assessments of the existing and new lighting schemes, it would provide additional justification in support of requests for extra investment funds.

Cities such as Sofia share the costs of investments in lighting , which clearly has some economic benefits. The model of a shared investment programme for architectural and public lighting with the Chamber of Trade/Businesses is one that has the potential to be replicated by all cities as a way of sharing risk and increasing investment in lighting.

Quick Wins

● Adapt local lighting to the opening hours of businesses.

● Adapt lighting to support new businesses – cafes and restaurants, evening markets, open air theatres.

● Agree with the private sector on a shared investment framework and priority list of new schemes.

● Prepare a list of "ready to go" lighting projects and business cases together with partners as part of long term lighting strategies.

● Work with university business schools to understand economic value of investments in lighting schemes and sectors.

● Use contracts creatively to "pump prime" and support local lighting businesses and jobs – write the tenders legally but flexibly, so that you can for example require contractors to train unemployed people, etc.

Part 3

Towards a lighting strategy

13 | External integration and stakeholders

In general there are two categories of stakeholders: primary stakeholders, who are positively or negatively affected directly by public lighting strategy or projects; and secondary stakeholders, who have an intermediary role.

Tallinn

Examples of primary stakeholders are the citizens, shop keepers, NGOs, businesses, etc. Examples of secondary stakeholders are research institutes, chamber of commerce, energy companies, etc. To make a lighting strategy effective, it is essential to involve all stakeholders as early as possible. This will facilitate the realisation of projects and the acceptance of changes.

The extent to which public lighting involves organisations and individuals from outside the city administration seems to depend upon the interplay of the following five factors:

- Politics of lighting.
- Extent to which lighting expertise is employed by local administrations or outsourced / purchased under contract.
- The local culture and traditions of stakeholder involvement.
- The capacity of local civil society to participate and make a contribution.
- Commitment and resources available to involve stakeholders.

13.1 | Implementation

Cities with mature approaches to their lighting strategies (Lyon, Birmingham and Eindhoven) have formalised systems and strategies for engaging with stakeholders. Eindhoven has a good overview of all relevant stakeholders (including "hard to reach" groups) and involves them in a very open and equal level in all kinds of projects, from strategy development to reconstructions on the street.

However the Deep Dives identified that even these mature administrations are missing some key stakeholder groups. Lighting strategies in all the cities would benefit from carrying out stakeholder mapping and gap analysis to further improve engagement with external stakeholders. There is a need within city administrations to have a common understanding of the way in which external stakeholders will be involved, who has responsibility for the engagement and when it will take place.

Where city councils rely on external consultants to design schemes, prepare draft policy option papers, develop lighting strategies and even write lighting procurement contracts, the involvement of stakeholders is even more complex and essential. The administration must very carefully plan all aspects of the procurement of lighting schemes so that stakeholders have an opportunity to contribute. The PLUS project has recognised that there are contracts such as with Amey and Birmingham which can also be very comprehensive in successfully involving stakeholders.

In smaller cities (such as Bassano del Grappa) cooperation between different departments and external stakeholders tends to be simpler and less formal than in larger administrations. But "less formal" does not mean "less committed". Bassano has set up an active and dynamic cooperation with regional authorities, knowledge institutes, local businesses, lighting experts, trade and professional associations, and its citizens (taking the example from Eindhoven's Triple Helix model). This cooperation takes place through permanent technical working groups.

In many cities there is involvement by stakeholder associations in developing lighting strategies and commenting on schemes but little direct involvement by individuals. Although it is simpler to involve associations and groups, great care is needed to ensure they are democratically legitimate and have a valid opinion to express.

The ways in which citizens can make comments on lighting policy and services vary dramatically between cities. Some cities have lighting shops (Eindhoven), customer service centres (Birmingham) or "Maison de l'Environnement" (Nice Côte d'Azur) as innovative and potentially very effective tools for communicating with external stakeholders. Telephone "hot lines" are also good communication and feedback tools. Particular initiatives have been taken to understand the views of students. Tallinn organises photo competitions for Christmas lighting and the city has involved the private sector to annually recognise the best external lighting solution for buildings with an award.

Despite these very positive actions, few cities seem to have taken similar initiatives to understand the views of minority groups such as migrants, the elderly, disabled or children.

13.2 | Private projects

Public authorities are themselves an important stakeholder, in private lighting projects. All the PLUS cities expressed a lack of tools and measures to control the impacts of private lighting. They can influence lighting designs and carbon emissions from private sector lighting only through partnerships with key external stakeholder groups and individuals.

Early involvement by these external partnerships can help to:

- prioritise lighting projects for safety and economic development;
- build commitment to reduce energy and lighting use in private sector;
- break down barriers of misinformation and misunderstanding;
- identify new ways of working, new ideas, new approaches;
- avoid conflict at later stages in a project / plan / programme.

13.3 | Regional lighting forum

In the PLUS project the partner cities organised three Regional Lighting Forums, meant to bring stakeholders together to discuss the different phases in the strategy development. The Deep Dives included an opportunity for the visiting experts to meet the participants of the Regional Lighting Forums and other stakeholders to discuss their involvement in local public lighting in the host cities. These workshops were for some of the partners a catalyst to critically review their existing stakeholder networks. In Sofia, Iasi and Tallinn these workshops provided the impetus for large numbers of new stakeholders to be identified and invited to the workshops. Some of these groups are now involved in the ongoing Regional Lighting Forums.

In some cities external stakeholders have historically been involved as consultees on the technical and environmental aspects of particular projects. Following the Deep Dives, these cities acknowledged the benefits of involving stakeholders in commenting on wider lighting aspects; energy, environment, maintenance, service standards etc.

Other cities are expanding and continuing the Regional Lighting Forums as permanent dialogue with relevant stakeholders. Bassano expanded the third Regional Lighting Forum to a three day event, in order to reach directly all target stakeholders and tackled in-depth all relevant aspects of the developed Lighting Strategy and Action plan.

Quick Wins

● Regional Lighting Forums are a useful communication method.

● Appoint a champion politician and champion officer to lead consultation with external stakeholders.

● External stakeholder engagement should be planned and managed to involve both individuals and associations.

● Don't forget to manage the collaboration between the lighting department and the other departments in the administration.

14 | Monitoring and update

Monitoring the performance of the lighting installations and systems is important because it helps to generate data that can be used to judge the success of plans and actions. Improvements in performance can only be realistically achieved when the management (of the city lighting department) is properly informed about the current performance. To be able to manage public lighting systems in cities, it is essential that data is collected that monitors the technical performance of the lighting system and the operational performance of contractors and staff.

14.1 | Data to be collected

In general, cities have an excellent understanding of the data associated with the capital and operational costs of their lighting systems. Financial systems are up to date and there is a system of regular reporting to management and city councils.

The collection of technical performance data is more complicated. It is not easy to decide which data is essential, and the costs for collecting the data. Many of the cities recognise that they need to collect more data more frequently and to monitor their lighting systems more systematically. However few cities understand the costs associated with monitoring their lighting systems. In many cities there remains too few staff that have the time and training to carry out the necessary monitoring.

Key Performance Indicators for both the systems and staff contractors should be identified and agreed with stakeholders. Where these are common to a number of cities, monitoring

data can be collected over a longer period and then be used as the basis for a benchmarking between cities. Some PLUS cities (Eindhoven and Birmingham) collect data and report against Key Performance Indicators which are based on national indicators.

When public lighting is outsourced, the performance of the lighting system must be monitored against the contract. It is therefore essential that Key Performance Indicators are clearly defined in the contracts.

Despite sometimes very sophisticated data monitoring systems, the Deep Dives identified data gaps that were common to many cities. These included: lighting ambience, carbon emissions, preserving the night sky, impacts on biodiversity, impacts on human health, economic benefits, contractors performance against contracts; stakeholder opinions and stakeholder satisfaction. The different chapters in the Mainstream Guide refer to these gaps.
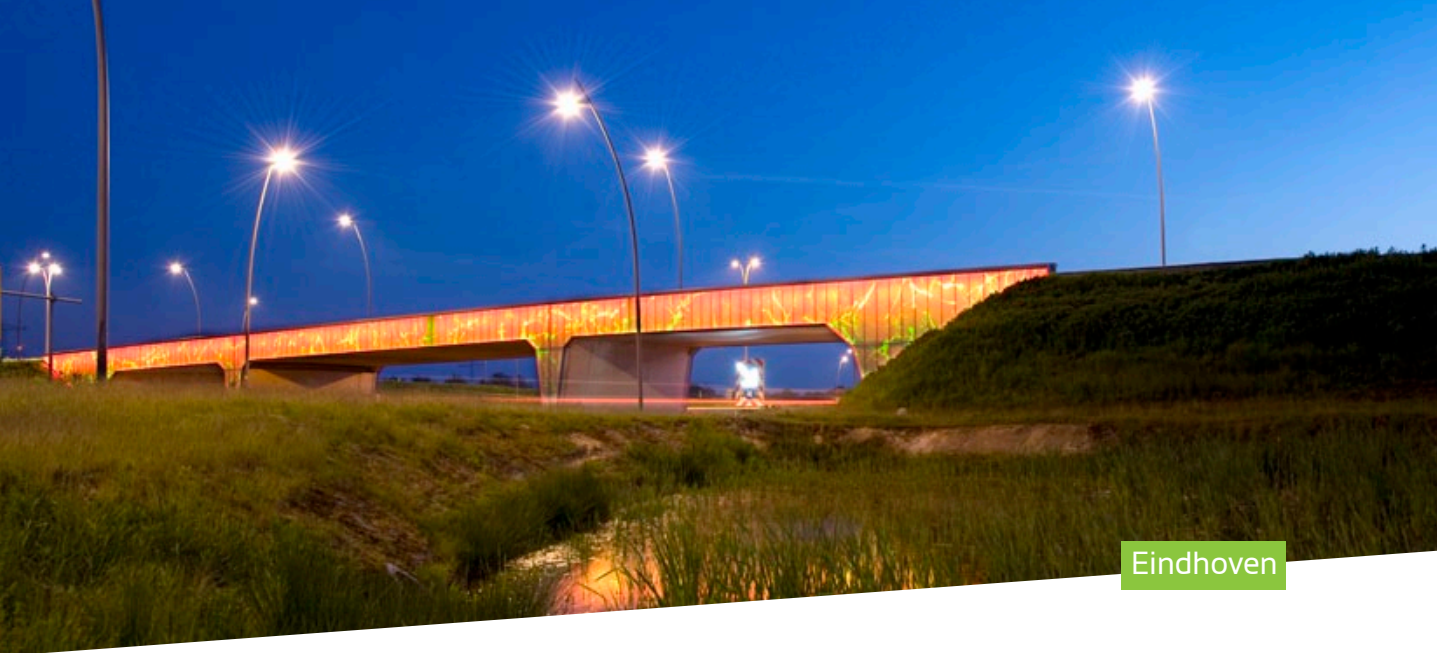
14.2 | Methods of data collection

Each city has adopted very different approaches to the way in which data is collected, updated and used. Some cities have simple paper based systems whilst others have highly complex remote monitoring systems that allow almost all of the parameters of the performance of the public lighting systems to be monitored in real time. GPS data and GIS are more used and implemented in the data sets.

Some cities have set up comprehensive systems for merging the technical data sets with customer satisfaction surveys, complaints through telephone hot lines, reports through web based systems. This can lead to a situation where unnecessary data sets are collected, leading to excessive costs and "data overload" for staff and management. Careful consideration must then be given by the council to which data sets can be collected less frequently without reducing the effectiveness of the contract monitoring or the operation of the lighting systems. This reduction

in data set collection will also lead to cost savings and as such is a rational and logical move, when too much money is being spent on unnecessary data collection.

The quality control of the contracted activities must be independent. In some cities, the PLUS experts have observed that the supervision of external maintenance contractors and verification of their work is carried out by the contractor themselves. In other cities supervision is carried out by external (e.g. financial) consultants that do not always have the necessary lighting expertise.

During the Deep Dive visit to Eindhoven particular attention was given to the development of the "Maturity Tool", an innovative management instrument. This has been further developed and is included in this guide as a tool suitable for monitoring of progress towards policy goals.

Quick Wins

The Deep Dives identified that in all of the cities some improvements could be made in the way that information was collected and used. In particular data should be:

● used to understand risks and to prioritise investments – structural condition of the assets;

● used in the design of preventative maintenance systems – age of luminaires;

● shared and merged to realise cross departmental objectives – location of accidents;

● reported regularly to civil society and politicians with an invitation for them to comment and give feedback – annual reports;

● used to set challenging performance targets – carbon emissions, time taken to repair, % of operational luminaires and outages;

● used in evaluating the performance of external contractors and internal maintenance staff – cost data collection and evaluation must be carried out independently of those who are being monitored;

● used in incentivising staff and contractors – paying only for agreed levels of performance;

● both qualitative and quantitative – facts and opinions;

● generated and evaluated as cost effectively as possible – real time data collection using GPS and GIS should be the long terms aim for all public lighting.

Part 3

15 | Leadership

The partner cities in the PLUS project all have contributed to the project by showing their best performance and good practices. Many of them present themselves as "City of Light" and express with this a clear ambition to be leading in the field of public lighting in Europe.

The Deep Dives considered the ways the cities could be regarded to be leaders in their field and ways in which they could further develop their leadership. The PLUS project and Deep Dives decided that for a city to be a "leader" it should demonstrate:

- Relevant and shared ambitions – reflecting a lighting vision for the area, including all relevant issues and opportunities, that are widely supported.

- Integrated ambitions – that are clearly reflected in the cities and their partners' investment plans and activities.

- Monitored and updated ambitions – the city knows whether its ambitions are being achieved and updates them to reflect changing circumstances.

15.1 | Relevant and shared ambitions

All of the PLUS partner cities have identified public lighting to be a key factor in the development and management of their urban areas.

In all of the cities a senior politician is made responsible for public lighting.

The Deep Dives identified that the arrangements for sharing and agreeing lighting policies, ambitions and investments varied considerably between the cities.

Some cities already have public lighting strategies that have been the subject of extensive city-wide consultation. These strategies include ambitions that are shared by the business community and civil society (Birmingham, Eindhoven, and Lyon). These cities are demonstrably leaders with their city wide approach in these aspects. Other cities have focused on preparing more "local" public lighting strategies for what are considered the most relevant and important areas for residents, tourists or businesses. These strategies put their focus on business districts, harbours, medieval areas, redevelopment areas and places where safety and security are a priority. These cities recognise they cannot work in all parts of the city and so are prioritising their city wide lighting ambitions in these priority areas.

Some city administrations have decided to focus on thematic areas and look for shared ambitions in these areas. The City of Eindhoven has adopted the theme of "innovation and experimentation" in public lighting and through a triple helix partnership approach has sought to build a shared vision and ambition for the city with the university and lighting industry.

The Deep Dives together with the Regional Lighting Forums have been a stimulus to some PLUS partner cities to share more widely their ambitions with stakeholders. These meetings

(as part of the PLUS project – and moderated by PLUS project experts) between politicians and officers from the cities, business and civil society have provided the opportunity for some cities to start to develop the process of agreeing the scope and priorities for their Public Lighting Strategy.

Considerable variation was found between the PLUS cities in the frequency and nature of the involvement of politicians in public lighting. In all of the cities where politicians have been involved in the contract negotiations, public meetings, technical specifications etc. the Deep Dives confirmed that these schemes / contracts / outcomes and projects were more supported by the public. It is clear that involving the politicians raises the profile of public lighting, raises ambitions and targets and leads to greater public support and involvement.

In most PLUS cities, public lighting is not considered a party political issue. Ambitions are shared and supported by politicians of all parties. Such cross party support is critical to realise the much needed long term investments.

Some cities have a significant shortfall of finance and are unable to carry out some of the basic maintenance and upgrading of existing lighting systems. The Deep Dives recognised that leaders are in a very difficult position and acknowledge that it is a political decision to prioritise other services before lighting. Clear and objective information is needed to make these difficult decisions. In most cities there is uncertainty in both political and technical decision makers over

new technologies and standards. In particular, the dilemma of whether to switch to LED based lighting systems is critical in most cities.

Some of the PLUS partners' lighting policies and practices are recognised as national best practice, and in some cases as international best practice. Cities like Lyon and Eindhoven are demonstrating their knowledge and experience, not only with lighting concepts in the city, but also with experimenting new techniques and applications. Leading cities are internationally active in presenting their results and communicating on their initiatives. To that extent, their participation in global networks such as LUCI (Lighting Urban Community International), which now brings together more than 65 cities worldwide, can definitely contribute to building leadership. This can offer cities the possibility to not only benefit from the progress made by other municipalities, but also to keep up to date with the latest trends and innovations and to promote and share their experiences at an international level.

15.2 | Integrated ambitions

Some of the cities have used public lighting and lighting festivals as a unique selling point (USP) and key element in their cultural strategies. Tallinn built a strong cross sectoral partnership with the business community and civil society to finance and deliver successful lighting festivals during its programme for the European Capital of Culture 2011. Political and administrative leaders in Sofia (2019) have established similar partnerships to agree, plan and finance the way in which lighting could support their application for European Capital of Culture.

In order to generate interest and support from civil society and businesses, it is necessary for the leadership to lift the public lighting strategy to a higher level; it must address more than generally expressed energy efficiency goals and "bringing light in the night". Where the leadership

of cities have recognised this need, business and civil society have partnered city administrations in setting higher ambitions, like the innovation strategy in Eindhoven, the tourist strategy in Burgos and Bassano, the promotion of the cultural aspects of the historic core of Leipzig or the creation of a different and unique nightscape in Lyon.

Most lighting strategies being prepared by the PLUS cities are now more integrated and include consideration of the climate crisis, energy crisis, sustainability, environment, financial crisis. Broadening the scope of a public lighting strategy to include the themes as discussed in this Mainstream Guide can clearly contribute to building a partnership with business and civil society. As a consequence the costs and benefits from improved public and decorative lighting can be shared by all.

Reference has already been made to the financing difficulties faced by most cities. Some cities are exploring and using innovative funding ideas, such as Tallinn's request to the Estonian Government for investment funds from the national carbon emissions trading fund – selling the carbon savings. Birmingham has a Public Private partnership for the citywide renovation and replacement of the street lighting. Following the Deep Dive, the city is now exploring how this can be extended to include the decorative lighting and ways in which businesses can contribute.

Sofia, Iasi, Nice Côte d'Azur and Lyon all have schemes where the city administrations have shared their vision with businesses that have then made financial contributions to delivering the shared ambitions.

The Deep Dives identified a need for closer collaboration between politicians and lighting staff of adjacent municipalities where they share common roads and urban areas. Some sharing of visions and joint funding across the boundaries of cities was identified (Tallinn, Iasi) but this seemed

to be the exception rather than the rule. Such sharing is forced by the administrative change in the governance of Nice Côte d'Azur where the lighting department is responsible for additional lighting in previously independent municipalities.

Horizontal collaboration between departments (in the same administration; transport/energy/lighting/development etc.) needs to be improved in almost all of the cities. There is a clear role for senior officers and politicians to ensure that this takes place.

The real innovation of lighting is not simply the introduction of new technologies like lamps and luminaires, but the more significant innovation is the flexibility of the whole lighting system. Depending on the time of day or year, on the number and sort of citizens on the street, or for special occasions, different lighting models can be developed and combined. The possibilities arising from these flexibilities are a big challenge for the PLUS cities. To be able to control so many aspects of the lighting levels in the city, very sophisticated control systems and software are required. Therefore cities need to use open source computer languages and software and open protocols that allow flexibility in the long term adoption of different lighting systems. The lighting industry is challenged to supply this flexibility to their customers, and not force them into a closed monopoly company protocols.

15.3 | Monitored and updated ambitions

Many cities have outsourced their public lighting. A good leadership is demonstrated with efficient and unique contracts where the goal of service of general interest can be guaranteed through effective political leadership. There must be ongoing active day to day participation by politicians to monitor contract outcomes and deliverables, and activities can be adapted when needed. Responsibility for quality cannot be outsourced.

Quick Wins

- Ongoing active day to day participation by politicians to monitor contract outcomes and deliverables.

- Create support from all political parties.

- To be recognised as national best practice, the projects needs to be promoted as such.

- Decide ambitious politically inspired targets that go further than energy efficiency.

- Keeping up to date with the latest trends and sharing and promoting your initiatives through worldwide networks.

16 | Further tools for strategy development

Eindhoven

16.1 | Maturity Tool

The City of Eindhoven has brought another strategic tool into the PLUS project, the 'Maturity Tool'.

The tool has evolved from an exchange of political and institutional ambitions and experiences between cities. It does not extend to technical or financial issues. The politicians and staff of some cities aspire to be a 'front-runner' and to implement innovative solutions whilst other cities prefer to be less ambitious. The Intelligent Lighting Institute at the Eindhoven University of Technology has developed what they call "a reference model" for sustainable urban lighting. This model enables cities to select their "ambition level".

Within the model, cities identify their current ambitions, targets and ways of working. The model then illustrates the changes and improvements that then need to be taken to achieve their ambitions. The model encourages cities to 'partner' another and exchange practices, polices and ways of working. To achieve the highest ambition levels the model illustrates how collaboration is required between different organisations: public organisations, businesses, knowledge institutes and citizens. The reference model provides a common language and framework for cities to mature their approach and ambitions in public lighting – with the most mature approach being based on a quadruple helix model of collaborative working between civil society, city administrations, universities and business.

16.2 | Strategy development process

The PLUS project required all partner cities to produce a "Public Lighting Strategy" and "Action Plan". The cities were encouraged to use the results of the Deep Dive visits, the three Regional Lighting Forums and the SWOT analyses to inform the content of these policy documents. This section provides includes some of the guidance provided to the cities on how to produce their strategies and action plans.

A Public Lighting Strategy is a document that describes and defines:

- the baseline context for the plan:
  - **Administrative,** including geographical extent of the strategy, interrelationship with other strategies and legal aspects etc.
  - **Technical aspects,** including review of the current state of the lighting systems and control equipment, emissions, efficiency etc. issues.
  - **Governance**, including the process for preparing the strategy including decision making framework and roles of all stakeholders.
  - **Financial**, including approach to procurement and contracts, sources of funding, availability of private investments, charges etc.
- The visions, goals, objectives, targets, and milestones to be achieved.
- The problems to be overcome.
- Logical framework.
- The stakeholders and their role – including "champions" who will speak for and lead on themes or initiatives.
- Consultation, review and monitoring arrangements for the strategy (and action plan).
- Launch.

Eindhoven

The **Action Plan** is focussed on translating the words of the strategy into action – it must make a difference and lead to changes! It implements the strategy and describes "who will carry out each action, when, and how", including the sources of finance, how success will be measured, monitored and used to review the strategy.

Most cities start this process with an existing lighting plan or strategy. In fact most cities find it more useful to evaluate and propose adjustments to the existing plan rather than starting anew. It is important to recognise it as the "plan-do-review-" process that is repeated and cyclical so that learning along the way and from other plans can be continually integrated.

The process of developing the strategy must explore, clarify and confirm the objectives, activities, responsibilities, timeline, funding, and so on. The PLUS project has developed some tools to help in preparing the strategy and action plans:

Baseline context

It is not possible to prepare a strategy or a plan without understanding the baseline. The PLUS project has developed three tools to help cities understand their baseline: the Self-Assessment Report, the Deep Dive Report and the SWOT

analyses. Cities are encouraged to use these tools to describe the existing situations and problems, including what already is being done and by whom.

Strategy structure

The PLUS project has enhanced the LUCI Charter by adding four chapters that recognise the roles of stakeholders and of governance in public lighting. This framework been tested and validated by the Deep Dive reports and the PLUS partners in preparing their new lighting strategies and so has been repeated for this Mainstream Guide:

- Optimising energy consumption
- Environmental impact
- Maintenance and quality control
- Reducing light pollution
- Equal and free access to urban lighting
- Creating a safe and comfortable urban environment
- Urban and cultural identity
- Supporting an environmentally friendly mobility
- Strengthening local economic development

Visions to action

Visions are the starting point for the strategy. Actions to achieve the objectives, outputs and activities are essential elements of an action plan.

Remark: The English language has many possibilities to express the different meanings of targets, goals, objectives, etc. In other languages there is often only one common used word for all this. In German: Ziel, in Dutch: Doel, in French: Objectif. In discussing your Lighting Strategy and Action Plan you may have misunderstandings on the meaning of these words. It might be useful to make a short list of definitions so that all readers and users use the same terminology.

Defining goals and objectives

One of the first steps of a strategy is to be as explicit as possible in describing the goals is the agreed and desired situation in the future. A goal should always have a time frame.

Example: "improve the energy efficiency in public lighting" is not specific. Better is to give a time frame and to specify "energy efficiency" and "public lighting". The goal above could then be: "We will reduce the need of energy by 20% by 2025 when compared to 2011. This will be done whilst maintaining the existing lighting levels in the city owned public street lighting."

Objectives can be even more specific than a goal. One can see them as steps towards the final goal.

Actions to achieve the goal

It is essential to involve stakeholders in generating the long list of all the possible activities that might bring your city closer to achieving your goal. Do not discard any possible actions – in time and with the right partnerships they may all be possible!

An action plan is short, sharp and to the point! It must be written to deliver!

Champions, timescale and resources

Who are your champions? – Who will inspire? Who will lead? Who will do the work? – an action plan always defines the roles of the stakeholders and organisations, it sets timetables and identifies the resources that will be used to make things happen – it also describes what will be done if something goes wrong, or in the event of a failure . When will the actions start? When will they finish?

What resources does each action need; not only finance but people as well! Are these resources available?

Define the expected outcomes of each action as precisely as possible (quantitative and qualitatively) – and make sure that these outcomes are measured so that you can celebrate success and learn from mistakes.

Success

Don't forget to describe the expected outcomes of all of the actions taken together – the successes you goal will bring! In simple terms the result of an action may be: 100% of the light bulbs in a house are energy saving bulbs. The success is then that the energy bill will be lower. So the outcome is a consequence of all actions, and describes the situation when the goal has been achieved – success!

Stakeholder analysis

Stakeholder analysis is a simple technique that can be used to establish whether the right people are involved in the Lighting Strategy and Action Plan. Stakeholders are all those with an interest in the Lighting Strategy and Action Plan.

In general there are two categories of stakeholders: primary stakeholders, who are positively or negatively affected directly by the theme; and secondary stakeholders, which have an intermediary role. The analysis is to identify all stakeholders; with their interests, their motivation, their capacity and their actions. Stakeholder analysis can be represented as a map or plan:

- **How relevant are they?** Write on a piece of paper the names/organisations of all stakeholders in a circle or cloud. If a stakeholder is important, make the circle bigger, less relevant stakeholders get a smaller circle.

- **What is their interest in solving, or not solving the problem?** The use of colours can make visible that some stakeholders have common interests, or just opposite interests.

- **How are the stakeholders connected to the issue?** Primary stakeholders coming very close to the subject, are more in the centre of the paper, secondary stakeholders are further away. Try also to involve the position of the stakeholders to each other.

- **If there is direct contact with the stakeholder,** then draw a line between the different clouds, if there is no contact at all, make that visible in the map. Draw also lines between the stakeholders among each other, if possible. Use different colours, and different kind of lines to indicate different sorts of contacts.

The above stakeholder mapping can and should be done with the stakeholders – this builds partnerships and trust. And gives insight into stakeholders' interests, their desire to participate, their solutions and the start of a dialogue.

Logical framework

A Logical Framework Analysis is a process of testing the logic of the Lighting Strategy and Action Plan. It starts with defining the expected outcomes from the goals of the strategy/action plan. It then tests to prove how the actions individually and collectively will deliver the outcomes; and that the outcomes lead to the desired goal. A logical framework prevents the production of strategies and plans that are just a 'wish list'. It will ensure that the scale of the solution fits to the problem and that there are ways to measure progress.

Consultation

Before the Lighting Strategy and Action Plan goes public, ensure stakeholders fully support and have the opportunity to make final amendments. At the very least the stakeholders that are mentioned in the individual actions, as leaders or as partners must support the draft!

The plan should be formally agreed between all partners - at the highest possible (political and financial) level. To make sure that plan will be broadly accepted and not forgotten one can make a formal launch of the activities. For that one should prepare a summary for general public (basic language), and as much publicity as possible should be given to the launch.

Photo credits

PLUS (Public Lighting Strategies for Sustainable Urban Spaces), financed by the EU's INTERREG IVC programme, capitalizes on existing urban lighting best practices on energy efficiency in European cities.

PLUS **partners**

- Lead Partner: Eindhoven (The Netherlands)
- Bassano del Grappa (Italy)
- Birmingham (U.K.)
- Burgos (Spain)
- Iasi (Romania)
- Leipzig (Germany)

- Lyon (France)
- Métropole Nice Côte d'Azur (France)
- Patras (Greece)
- Sofia (Bulgaria)
- Tallinn (Estonia)
- LUCI (Lighting Urban Community International)