ENIGMA

ENLIGHTENMENT AND INNOVATION, ENSURED THROUGH PRE-COMMERCIAL PROCUREMENT IN CITIES

# Scouting of solution space

*Deliverable 1.5*

SEVENTH FRAMEWORK PROGRAMME

Public report
Authors: P. Ambrosiussen, Drs. C.J.M. Erkamp, Ir. J.H. Hogema, Drs. Ing. N.J. Nauta, TNO
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## *About ENIGMA*

The goal of the European-funded ENIGMA project is to bring radical improvements to the quality and efficiency of public services by supporting the development and validation of breakthrough solutions in the field of public lighting through a joint Pre-Commercial Procurement (PCP). The partners also aim to demonstrate how PCP can be used in a transnational context to tackle common city challenges across the EU and improve the quality of life of their citizens.

## *About this report*

# 1 Introduction

This report is part of the first work package of the ENIGMA project that is being conducted in the Seventh Framework Programme (ICT research). ENIGMA aims at bringing radical improvements to the quality and efficiency of public services. This is done by supporting the development and validation of breakthrough solutions through a joint Pre-Commercial Procurement (PCP) process. The core activity of ENIGMA is the development of new, innovative ICT solutions finding their way into in public lighting systems in order to enhance urban safety and improve energy consumption, procured through a joint transnational PCP process.

The aim of Work package 1 is to define the state-of-the-art in innovative ICT based solutions for service delivery using urban lighting. This report contains a first exploration of the solution space. It provides an overview of the current state and future trends in smart city and smart lighting applications and the industry that is involved.

The project's partner cities Eindhoven, Malmö, Stavanger, Espoo and Bassano del Grappa, have defined a common public lighting challenge and will launch a European call for solutions. The call will result in solutions that are to be piloted in real life environments in each partner city. The partner cities have defined as common challenge for the joint PCP process (Den Ouden, & Valkenburg, 2013):

> *To upgrade their public lighting infrastructure and system, using ICT solutions, to enable cities to offer a wide range of intelligent and integrated services benefiting society and individual citizens and bringing the cities closer to the ambition of becoming Smart Cities.*

This common challenge already identifies two elements that will be discussed in this report: the Smart Cities perspective and public (smart) lighting. This publication will report the current state of art in these two aforementioned elements and shed light on the challenge that needs to be solved in the near future. Therefore we consider it as a "scouting" exercise, that not only discovers the R&D challenges of the industry, but also reveals how industrial partners are responding to the challenge as set by the cities. Thus, this report presents a 'solution space' for the common challenge, in which the challenge for the industry is ambitious, yet achievable in the near future.

The "scouting of the solution space" as presented in this report is based on the following elements.

- First, desktop research was performed in the area of market research reports on Smart Cities on the one hand (section 2.1) and Smart Lighting applications on the other (section 2.2). This was done based on material available at TNO, augmented by an additional search and a request for market research reports that was sent to all partners. From the resulting material, eight reports were selected and processed into a summary for this report.
- Secondly, it was deemed necessary to check the feasibility of the proposed solution space with the intended solutions providers. In order not to disturb the procurement process, a case was presented to clusters of the lighting industry (from different European countries) that illustrates the ambition level and types of outcomes that the participating cities are looking for when discussing the smart (lighting) ambition level. This is described in Chapter 3.

# 2 Scouting the solution space

## 2.1 Smart City approach

### 2.1.1 Smart City societal needs

The smart city societal needs have been investigated in the Deep Dive sessions of the ENIGMA project (Den Ouden & Valkenburg, 2013). The results were clustered as follows.

- *Lifestyle: activities*
  Having a high quality living environment (indoor and outdoor) that invites people to stay, to meet others and to explore entertaining activities.
- *Lifestyle: perception & attractiveness*
  Having a high-quality living environment (indoor and outdoor) that creates a coherent, enjoyable, inviting, healing atmosphere.
- *Lifestyle: smart solutions*
  Having a high quality living environment (indoor and outdoor) with smart & innovative solutions that adapts to changing time, people needs and activities.
- *Low cost & sustainability*
  Having a sustainable living environment (indoor and outdoor) with low energy use, low maintenance costs and that preserves nature.
- *Transportation & accessibility*
  Having good (public) transport connections that are easily accessible, affordable, safe, uniform and for all stakeholders to use.
- *Safety & security*
  Having a living environment (indoor and outdoor) that is perceived safe, secure and comfortable with low crime and vandalism.
- *Taking care of nature*
  Having a living environment that embraces wild life and taking care of nature as a unique place in the city.
- *Business environment*
  Having a living environment that provides a good basis for business and commercial activities.
- *Efficient processes*
  Operating a living environment in a way bureaucracy is reduced and efficiency and evidence based decision making are stimulated.
- *Lighting design*
  Lighting furniture to respect and or enhance the city characteristics and landscape.

This overview provides the first indication for the scope of the solution space. The solutions should fulfil societal needs that cover a wide range of diverse objectives.

### 2.1.2 Smart City Model

According to the definition from Navigant Research (2013):

*'a smart city is characterized by the integration of technology into a strategic approach to sustainability, citizen well-being, and economic development. As such, smart cities cannot be understood as a normal market. An incredible diversity of customers, suppliers, technologies, and requirements fall under the concept. Instead, the smart city should be seen as a complex confluence of several existing markets, as well as the driver for new, emergent solutions that span several of these traditional domains.*

*Many of the market drivers, technology innovations, and decision-making processes associated with smart cities continue to be focused on existing industry and operational siloes: energy, water, transportation, buildings management, and/or government services. Now, though, the smart city is also becoming a space for the testing and implementation of cross-functional technologies and solutions.'*

In order to become a smart city, an operating model should be defined to translate smart city policies and objectives into implementation strategies and actions. Navigant Research (2013) provides a Smart City Model that support this implementation process in an integrated way. Figure 1 provides an overview of the model.

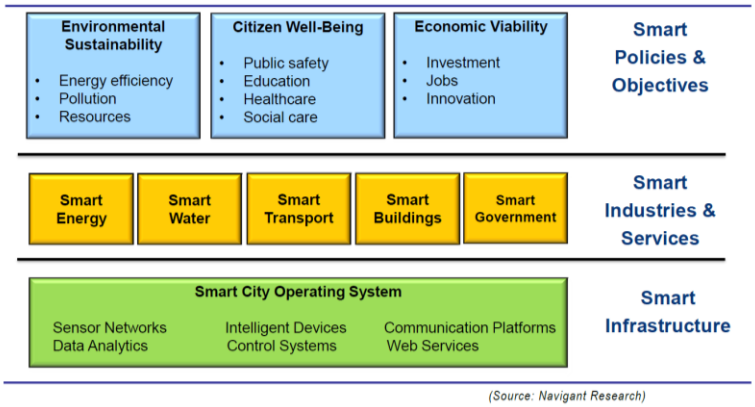


**FIGURE 1 A SMART CITY MODEL (SOURCE: NAVIGANT RESERACH, 2012).**

Following the model bottom up, it is clear that a common Smart Operating System should enable multiple innovation strategies that are implemented in different operating areas (smart industries & services).

Together these operating areas should realize a city that is environmental sustainable, has healthy and satisfied citizens and is economically viable. The societal needs identified by the ENIGMA partner cities (section 2.1.1) can easily be mapped on these three smart city objectives (i.e. Environmental Sustainability, Citizen Well-being & Economic Viability).

Note that public lighting (which plays a leading role in ENIGMA) is not explicitly labelled as a Smart Service here. Adding Smart Lighting as a service is a straightforward addition to the Navigant model, or alternatively it can be stated that smart lighting play an important role in most of the Smart Industries/Services identified by Navigant. Either way, innovative solutions can be implemented that involve different industries and technologies. The challenge is to integrate these strategies and technologies into a holistic concept.

### 2.1.3 Scouting the Solution Space

Based on the categorisation on the level of Smart Industries & Services from section 2.1.2, we searched for smart city applications and key technologies per operating area. The results are shown in Table 1. Moreover, example cities are shown, that currently implemented smart city applications. Sources used in filling this table are mainly: Navigant Research (2013) and Pike Research (2012).

**TABLE 1 SCOUTING THE SOLUTION SPACE; SMART CITY APPLICATIONS IN VARIOUS OPERATING AREAS.**

| Smart City Applications and Technologies | | | |
|---|---|---|---|
| **Operating Area** | **Smart City Applications** | **Key Technologies** | **City Examples** |
| Smart Energy | Demand management, EV support, energy efficiency program, renewable energy integration | Smart meters, home energy management, distribution automation, grid analytics, demand response systems | Austin, San Diego, Bilbao, Evora, Friedrichshafen, Lyon, Malaga, Yokohama |
| Smart Water | Water system upgrades, consumption monitoring, wastewater treatment, environmental safety systems, flood management | Smart water meters, sensor and communication networks, water monitoring and management systems, water system analytics, weather forecasting | Dubuque, Masdar City, Nice, Paris, Washington D.C. |
| Smart Transportation | Traffic monitoring and management, congestion management, road user charging, emergency response, public information systems, smart parking, integrated traffic light management | ITS, EV charging systems, vehicle infrastructure-communications, road use pricing systems, sensors networks, monitoring and management parking, traffic monitoring, digital signage, security camera's, predictive analytics, vehicle telematics, public portals and smart apps, open data platforms | Dallas, San Francisco, Stockholm, Amsterdam, Hamburg, Santander, Singapore, Shenzhen, Zhenjiang, Toyota, Rio de Janeiro |
| Smart Buildings | Public sector energy management programs, grid integration for renewables, EV charging stations, lighting/waste/water management | Building energy management systems, BAMs, energy performance management, grid integration, intelligent lighting systems, camera's | London, Amsterdam, Songdo, Tokyo, Yokohama |
| Smart Government | Public safety, social care, tele health, e-education, smart street lighting, citizen portals, waste collection | Sensor networks, cloud computing services, data analytics, open data platforms, lighting networks, emergency response systems | Chicago, Houston, New York, Amsterdam, Helsinki, Bristol, Barcelona, Sunderland, Busan, Seoul, Rio de Janeiro |

Table 1 shows that most cities focus on one Operating Area only, apparently not using a holistic view on smart city concepts in which all operating areas are integrated with one common infrastructure. This lack of integration (in the use of interoperable technologies) can also be found in other sources (i.e. Smart Lighting Conference, May 2013, Frankfurt). Reported difficulties to implement smart cities with an integrated solution that enables strategies in multiple operating areas are:

- The need for effective financial models for innovation;
- The need for complex collaborations between companies, government, citizens, local and international partners, sponsoring organizations etc.;
- Lack of larger scale developments with an integrated approach (focus on small scale pilots);
- Barriers to truly engage citizens.

According to the overview of Table 1, Amsterdam can be regarded as best practice city as it implements multiple applications in different operating areas (Buildings, Government, Transportation). Therefore, this case is described in more detail in the section 2.1.4.

### 2.1.4 Example case Amsterdam (Navigant Research, 2013)

Amsterdam's approach to smart city innovation is notable for several reasons. It initiated one of the first explicit smart city projects in Europe and has devised a rollout program that combines continued innovation with a progression to large-scale deployments. The program is notable for the breadth of its various projects, the ambitious environmental targets it is addressing, and the scope of its partner program. Amsterdam is now moving into the next phase, which will see the development of full-scale deployments, as well as continuing support for new innovation projects.

Amsterdam's city authority has set a number of ambitious environmental targets for the city, with the aim of making it one of the most sustainable cities in the world by 2020. Targets include

- a 40% reduction in CO2 emissions by 2025 (compared to 1990),
- a 25% reduction in energy use by 2025 (compared to 1990), and
- a city organization that is climate neutral by 2015

The city has a number of sustainability-focused projects underway. One program is Amsterdam Electric, which aims to encourage the move to Electrical Vehicles. Around 350 charging points have been installed in the city already, with that number expected to reach 1,000 in 2013. Amsterdam expects to have around 10,000 Electrical Vehicles on its streets by 2015. Subsidies are provided for commercial vehicles and the city council itself is moving to an electric fleet. Amsterdam is also aiming for the complete electrification of its transport system by 2040. Other projects include energy efficiency initiatives under the Amsterdam Saves Energy label.

Amsterdam Smart City was established in 2009. This is a collaborative program initiated by Liander, the energy network operator in Amsterdam, and Amsterdam Innovation Motor to promote innovative approaches to sustainability. The other founding members are the Dutch telecom operator KPN and the Amsterdam municipal government. Altogether, over 70 partners have signed up for the programme, including IBM, Cisco, Philips, and Vodafone.

This example illustrates the breadth of the programme and the projects involved, covering multiple operating areas, and also the large number and large variety of organisations involved. The important lesson is that an overall long term vision on how baseline infrastructure (in this case starting with a grid system for charging electrical vehicles in the public domain) could enhance multiple policy objectives by starting to upgrade at the level of the smart city operating systems (lowest level of Smart City Model), allowing interoperability of this system and therefore chances to create a holistic view how to best use the infrastructure for many purposes.

## 2.2 Smart Outdoor Lighting

In this section we descend from a Smart City model that describes services and outcomes and dril down to specific challenges that exist on a smaller scale level.

These elements are in line with the 4-layer model from Den Ouden, Valkenburg, and Aarts (2014), see Figure 2. In this four level model, technology is considered an enabler. Technological developments create new opportunities for applications. These applications become meaningful when they address relevant societal needs.

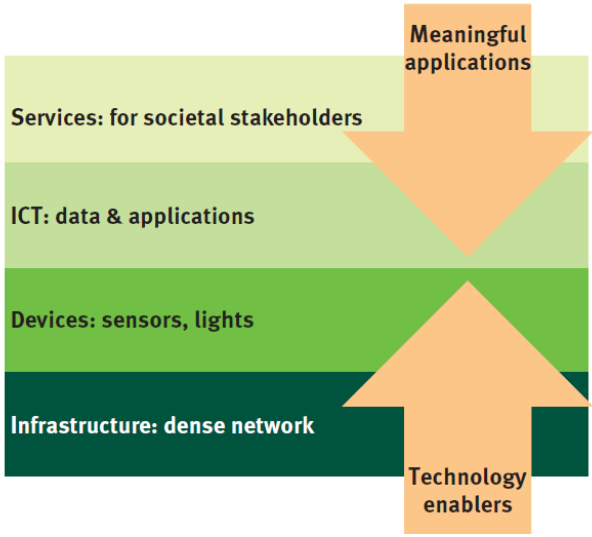


FIGURE 2 FOUR-LAYER MODEL (DEN OUDEN, VALKENBURG, & AARTS, 2014) .

We start by describing the current state of art of these technological developments (2.2.1), and discussing the technology trends (2.2.2) and future challenges (2.2.3). We will give some examples in section 2.2.4 and end with a discussion and conclusions (2.2.5).

In the context of the Smart Lighting Solutions Shared Research Program, TNO has performed a broad assessment of more than 39 Smart Lighting systems in the field of networked controlled outdoor lighting systems (TNO, 2013). To complete this analysis, we used the results from two US reports (NEEA, 2011; Pike Research, 2012) to create the following overview of section 2.2.

Smart lighting systems are systems that are able to sense (measure or estimate) its surroundings and/or its own state, and adjust its behaviour in response to that. This may include (but is not limited to):

- Adjustment of lighting levels to current environmental conditions (traffic, weather…) or presence of people (including switching off when nobody is present)
- Monitoring the technical functioning of the light, automatically report system failures and automatically adjust the lighting policy.
- In order to do so, remote control is needed for the lights (on/off or dimming).
- Typically, sensors, data communication, data processing, some form of Central Management System, and control and actuation are new or more strongly present compared to conventional lighting systems.

Altogether, this yields Networked Controlled Outdoor Lighting (NCOL). Note that some or all of these functions are needed for Smart Lighting, but once present, they become enablers for other Smart City technology as well.

### 2.2.1 Current state: Technology view

**Lighting technology**

In terms of lighting technology, the main trend is the increasing market penetration of LED technology. Pike Research report (2012) states:

> *"Dramatically falling costs and rising efficiencies of light emitting diode (LED) lamps are driving up sales. Costs have fallen as much as 50% over the last 18 months, and are expected to continue falling for years to come. LED lamps allow for better dimming control than standard street lights, and their electronics allow for easy integration of control nodes. Rising sales of LED lamps will therefore drive up the adoption of smart street lighting systems."*

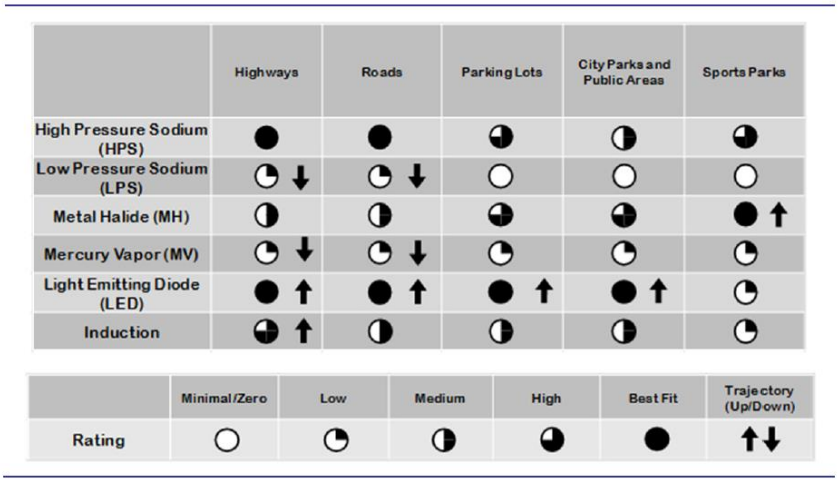


**FIGURE 3 SUITABILITY OF LAMP TECHNOLOGY BY STREET LIGHTING CATEGORY (SOURCE: PIKE RESEARCH, 2012).**

**Functional components**

Control of lighting systems can be organised on a local level or in a networked structure. For smart lighting, a networked approach is an obvious choice. Even then, local control can serve as a sensor platform in a smart lighting system, and local control can contribute to fail-safety of a networked architecture.

Local control opportunities that are being applied:

- Astronomical Timer: typically requires GPS to calculate dusk and dawn times
- Ambient Light Sensing: Sunrise and sunset trimming
- Presence detection and Motion sensing. Monitoring sensors control many outdoor security lights. Wider sensor applications can be envisaged that control roadway, parking lot, or park lighting.
- Lumen depreciation adjustments: saves energy, can be done algorithmic or sensor based.

Networked control opportunities that are being applied:

- Performance Monitoring: to remotely monitor a large network of street lights is one of the primary incentives. Eliminates night-time patrols to identify malfunctioning lights and ensures that problems can be fixed in a timely manner.
- Metering: Measure electricity consumption, which if done with utility-grade meters, can be used to lower electric bills.
- Traffic Conditions: making the lighting dependent of traffic volume can provide considerable energy savings.
- Weather Conditions: Rain and Snow may influence dimming policies.
- Emergency Response: e.g. flashing lights to mark a building or location that emergency responders have been dispatched to. Or flashing city-wide lights in the event of a disaster.
- Smart Grid Synergies: Load staggering / shedding or incorporation of Solar panel.

**Hardware components**

All systems that were reviewed have a similar high-level system set up. The components can be categorised as follows:

- Light engine
- Ballast
- Lumunaire
- Luminair Controller
- Segment Controller
- Central Server

**Quality and quantity of light**

Quantity and quality of light are the two key issues regarding outdoor lighting. The quantity of light is typically expressed as the illuminance[1]: the amount of light measured in the lighted space. The quality of light is more complicated to describe as there are multiple aspects influencing this. The top 3 aspects influencing the quality of light for outdoor lighting from the user perspective are (TNO, 2013): Colour Rendering Index (CRI), glare, and uniformity of lighting

Currently installed Networked Controlled Outdoor Lighting (NCOL) systems typically do not focus on the quality of light, but on the quantity of light (i.e., energy savings). We assume that there are three main reasons for this.

1. From the installed base 98%, has evolved from conventional lighting systems to which dimming functionality has been added.
2. There is no hard evidence of the relationship between quality of light aspect (like colour tunability or CRI) and improved safety and security for users. Note, however, that there are indications of such relationships, so future Smart Lighting might take this into account (e.g., Knight, 2010; Johansson, Rosén, & Küller, 2011).
3. There is no standard for the needed communication protocols, including information representation for outdoor lighting including the aspects for quality of light.

[1] It should be noted that we use “quantity of light” loosely as a metaphor for illumiance, i.e. not as the formally more correct lumen seconds.

**Sensors Technology and Intelligence**
Sensors and intelligence can be applied twofold in Networked Controlled Outdoor Lighting: firstly to understand and react on what is happening in the environment and secondly to understand its own "health status" and respond to that in order to optimize reliability and maintenance costs.

An important issue in sensor and intelligence adoption in Outdoor Lighting would be the costs per fixture. The 2013 TNO report assumed that a sensor set just for outdoor lighting would be too costly. Therefore to arrive at a viable business case lighting has to take an integrated approach with other domains, such as Intelligent Transportation, Security, and Healthcare and consumer life style.

Most sensing applied today in Networked Controlled Outdoor Lighting is for measuring internal aspects of the system in real-time: Failure detection, power metering, lumen output metering and lamp temperature. The trend is from reactive towards pro-active maintenance.

**Communication protocols**
The TNO (2013) report concluded that on the luminaire level, communication protocols look standardized (DALI or 1/10V). However, on segment level there is fragmentation on the physical layers (powerline, zigbee) and it is also unclear what protocols are used on the higher network layers or Central Management System level. Although some say to use IP it seems that the application layer protocols are proprietary or based upon proprietary data format using a standardized application layer protocol (like HTTP).

There are some initiatives towards standardisation at the Central Management System (CMS) level. For instance, TALQ consortium (http://www.talq-consortium.org). TALQ is a consortium of industry players with an industry-wide cooperation of members. It aims to set a globally accepted standard for the management of software interfaces to control and monitor for heterogeneous outdoor lighting networks and thus creates interoperability between outdoor lighting networks.

### 2.2.2 Technology trends
Based on the TNO (2013) report, the following technology trends can be observed.

Local, in luminaire, intelligence and adaptivity that will be able to fulfil its tasks given the available resources will improve ***robustness***. This graceful degradation principle is already implemented in other domains (e.g. Intelligent Traffic Systems: cooperative vehicles).

From reactive to ***proactive maintenance***. Application domains where maintenance is an important cost driver, such as off shore wind parks and infrastructures, start adopting the usage of real-time sensor data, life-time forecasting and load optimization.

***"Machine-to-machine" (M2M) or "Internet of Things"*** communication. Driven by the global *Internet of Things* developments, new communication networks will be rolled out, challenging the existing providers.

One important driver is obviously that the communication costs needs to be reduced, while its operation has to be fit-for-purpose in terms of reliability, security, latency, etc.

On top of this the amount of communication itself should be limited by transmitting information instead of huge amounts of raw data: this will require that the smart (lighting) systems are increasingly equipped with **local intelligence.**

### 2.2.3 R&D challenges Outdoor Lighting Outlook

With adding more sensors and more intelligence, energy efficiency could be increased. It is however unclear if this is a financially viable way to go. According to Pike research, motion sensors will not drop in price like the other electronic components (OLC's and SC's).

*Energy efficiency* is not the primary objective in the US to install networked controlled outdoor lighting systems. Hence, this can differ in Europe because of different owner models and energy prices. However, all user research results point towards more efficient maintenance as the number one objective.

*Real-time LED performance assessment*. This supports a more accurate life-time forecasting which will provide the foundation for more effective maintenance.

Further *transition from reactive to proactive lighting*. Questions for further research: Will there be big differences in expected life times of individual luminaires? Maybe through differences in heat (sun vs. shades) or in load (busy vs empty roads)? How much can there be saved by equalizing life times through load optimization?

*System reliability and robustness against system component failures* is not reported to be a big issue (yet). Maybe because there is no globally agreed manner to measure it, while current projects are often local pilots of which detailed results are not made publicly available.

### 2.2.4 Examples

The challenge for the ENIGMA project is to develop an integrated (ICT) solution that enables innovations in several operating areas of a smart city. Smart lighting systems have been identified as one of the means to implement smart city solutions. Therefore, once an integral smart city concept has been developed, smart lighting may be the starting point for the implementation, by systematically adding more value to system.

This section provides some examples to illustrate possibilities within this solution space (without pretending to be complete and without stating that the elements presented must necessarily be a part of what will be developed and realised though the ENIGMA project).

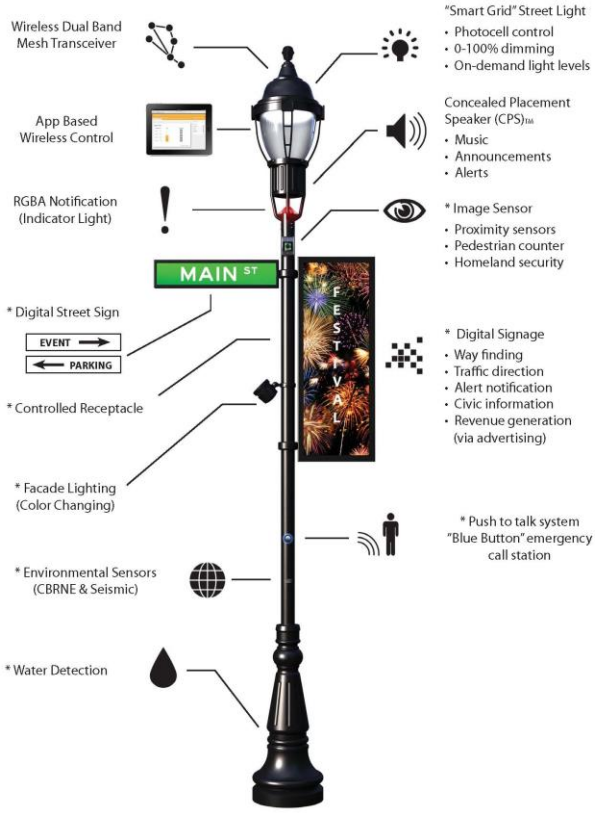


**FIGURE 4 INTEGRATED SMART CITY APPLICATIONS ENABLED BY SMART LIGHTING (SOURCE: WWW.INTELLISTREETS.COM)**

Loosely referring to Figure 4: having smart lighting as a starting point offers the possibility for various players (municipalities, inhabitants, passers-by) to use added functionality (the 'app-store' model).

Other possible elements:

- Bluetooth and WiFi sniffing is already a popular tool for marketing purposes or even public safety. This can also be applied for presence detection in smart lighting.
- Environmental services: Detection of noise and environmental, pollution, Noise, Ozone in low layers, PM10
- Dynamic road and traffic signs

### 2.2.5 Current state: Discussion and main conclusions

In the 39 systems that were assessed (TNO, 2013) all systems incorporated robust and mature information and control network components. No fundamental differences were discovered in system approach and design choices made, e.g. "centralized versus local control". The only thing would be the use of open protocols versus proprietary protocols and the possibility to host your own data and management software vs. a service provider.

Of course there are some exotic systems on the market like solar powered luminaires and more local sensor controlled systems.

A lot of vendors in the lighting domain are active in the market. The market is turbulent given all recently completed joint ventures, partnerships and take-overs. In 2012 new very large powerful corporations entered the market. Therefore, it is hard to say which vendors, and with them, which systems will survive the coming years.

TNO (2013) concluded that most networked controlled outdoor lighting systems are still in pilot phase. Only a handful of large-scale installations are in place to date. Cost remains the biggest obstacle to adoption. The additional costs involved in switching from conventional to Networked Controlled Lighting are difficult for towns and cities as they normally only have budgets available to renovate a limited fraction of their park.

There are no real useful measures of performance available yet to compare the networked controlled outdoor lighting systems in a systematic way. Quantifying system efficiency, system reliability or “ease” of installation is not defined in well-established methods.

As shown earlier, Smart Lighting (Figure 2) is characterized by not only lighting as such, but also by a network, by sensors, and by ICT. These elements make it possible for Smart Lighting to become the backbone for smart cities. It is difficult to make a forecast on the uptake of smart city developments, the main objectives for the city and its civilians and developments in standardization. However, lampposts could provide an excellent enabling platform as they already have the best “view” in town from regularly spaced points that are under the control of the public authority. On top of that they are already connected to a power grid for the necessary sensor and communication power. It really can boost new ownership models by adding more value to the (already) installed system through Multi-Use functionalities. At this time, lampposts are already used by authorities and commercial organizations to mount security cameras, license plate recognition cameras, other measurement systems, signage and advertisements. Integrating these existing functionalities and their power, computing and communication needs in to a smart city infrastructure could be a first step.

# 3 Reactions on the ambition level of the solution space from an industry perspective

On the basis of the solution space and the smart lighting ambitions of the participating cities, it was necessary to check the feasibility of the proposed challenge with the intended solutions providers. In order not to disturb the procurement process, a case was presented to clusters of the lighting industry (from different European countries). This case study illustrates the ambition level and types of societal outcomes that the participating cities are looking for when discussing the smart lighting ambition level and state of art in smart outdoor lighting. These ambitions were derived from an earlier version of this report.

The lightings clusters, as representatives of local entrepreneurs in smart lighting used the case study as the basis for the so-called “Silent Wall” discussion in a meeting in January 2014 in Lund, Sweden. In the Silent Wall, participants are invited to react to a written question or statement through writing their reactions on a wall. All discussions are captured on this Silent Wall and this feedback was analysed by the authors of this report.

In total, reactions from seven clusters in Europe were captured during the Silent Wall discussion (see Annex). Although the ambition level is deemed relatively high and the timeline challenging, the clusters are responding positively to the case study. There is a willingness to react to the challenge and to cooperate with other organisations in realising a solution. The ambition of the cities is to a large extent aligned with the technology development ambitions of the clusters and these again are supported by other on-going activities.

A further consultation was conducted based on the same case study via an open consultation on the ENIGMA website (http://www.enigma-project.eu/en/).This consultation has yielded no extra information.

On the basis of these first reactions to the ambition level of the cities the ambition level is seen as “quite a challenge” but on the same hand: doable within the time frame of the project. A Pre-Commercial Procurement opportunity is likely to “pull” the industrial partners to start developing solutions for the mentioned challenges. It is to be expected that a further market consultation will create more feedback towards the feasibility of the ambition level and the timescale attached.

# 4 Discussion and conclusions

For European cities, the move towards a smart city concept is unavoidable to help resolve the grand societal challenges in an effective way. In the ENIGMA project, we need to address these challenges by starting with a smart city perspective and subsequently focus on those measures that can be combined with smart lighting.

In the current phase of the ENIGMA project, it is important to realize that up to now the market acceptance of smart street lighting systems has been relatively limited. At the 2013 Smart Lighting Conference the assembled parties agreed that only a small percentage (2-3%) of street lighting points has so far have been made smart. After two decades of efforts, we have apparently not yet left the 'trial' and demo stage, despite a continuing, consistent interest of public authorities. Our view is that this cannot be attributed to one single factor.

A first reason for the lack of market acceptance seems to be the usage of proprietary protocols and the subsequent choice to host data at a service provider. The proprietary protocols prevent customers from combining products from different vendors, thus blocking them from applying a second supplier policy. Furthermore, data which are hosted by a lighting-specific service provider will be difficult to combine with other data flows in the urban environment.

A second reason is that the organizational benefits provided by smart lighting products is often difficult to realize as a city is only capable of only changing a small fraction of its light points in a single year. Consequently for many years to come the vast majority of the serviced light points will not be smart and operational processes will still have to accommodate for that.

A third reason is that the costs to implement a smart solution are still too high relative to the benefits that a lighting-only business case can offer.

*From the Smart City perspective*

There are difficulties to implement the concept of smart cities with an integrated solution that enable strategies in multiple operating areas. These difficulties appear to be the following.

- The need for effective financial models for innovation;
- The need for complex collaborations between companies, government, citizens, local and international partners, sponsoring organizations etc.;
- Lack of larger scale developments with an integrated approach (focus on small scale pilots);
- Barriers to truly engage citizens.

*From the Smart Outdoor Lighting perspective*

From a smart lighting perspective we conclude that many of the needed technologies are already developed but lack scale and (to a degree) enough interoperability to work in a coherent way with other smart systems. Most networked controlled outdoor lighting systems are still in pilot phase. Only a handful of large-scale installations are in place to date. Cost remains the biggest obstacle to adoption.

A way to overcome this obstacle is to position smart lighting infrastructure as a sensor and network backbone for smart cities solutions i.e., integrate it into the Smart City Operating System. After all, lampposts already have the best “view” in town from regularly spaced points that are under the control of the public authority. On top of that, they are already connected to a power grid that will be needed for the necessary sensor and communication power. It can boost new ownership models by adding more value to the (already) installed system through Multi-Use functionalities. On top of this Smart Lighting backbone, the other Operating Areas (Energy, Water, Transport, Buildings, Government) can also implement their innovative solutions, involving different industries and technologies.

Thus, ENIGMA should aim for an integral Smart City solution that not only fulfils the city needs in terms of lighting but could also positively influence and add value to other Smart City Policy Objectives.

## 5 References


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# 6 Annex

This case study was set up to collect spontaneous comments regarding the suitable ambition level and character of the ENIGMA procurement during the SSLerate meeting on the 21st of January 2014.

*The ENIGMA PCP project (www.enigma-project.eu) is currently developing its joint ambition document, as a basis for the Pre-Commercial Procurement process. We would like to invite to read the following document and reflect on the step-change in solutions that is needed in these five cities, as representatives of all European Cities.*

*The potential user value and business development potential for Smart Systems*

*ENIGMA aims to catalyse radical improvements of the quality and effectiveness of public services by supporting the development and validation of breakthrough solutions by means of a 36-month joint Pre-Commercial Procurement process.*

*The core activity of ENIGMA is the development of new, innovative ICT solutions finding their application in public lighting with a view to enhance the diverse policy ambitions of cities in Europe. The solution must therefore be generic and open enough, to be implemented anywhere across Europe and at the same be able to fulfil a multitude of value enhancing activities that serve the interest of both the general public and the Cities. These value-enhancing activities could for instance include (but is not limited to) increasing public safety, comfort & tourism, aiding with traffic management, providing performance feedback of lighting output or detection & measurements of pollution.*

*Smart lighting can be used as a means to become a smart city and as a living lab for innovations. Lampposts is an enabling platform as they already have the best "view" in town from regularly spaced points that are under the control of the public authorities. On top of that they are already connected to a power grid for the necessary sensor and communication power. This development can boost new ownership models by adding more value to the (already) installed system through Multi-Use functionalities. It is to be expected that solutions will need to integrate a series of technologies such as Sensor networks – Intelligent Devices – Communication Platforms – Control Systems – Web Services. Smart lighting systems should not be developed in isolation but be able to be integrated with other parts of smart city networks.*

*The ENIGMA cities are truly interested in your solutions for their desired functionalities. The PCP process provides an opportunity for new and old business actors, to develop, demonstrate and test solutions for the joint ambition, i.e. that is interesting for an articulated and extensive potential market. PCP provides a new form of development funding for innovative developments.*
*The expected timescale is that first ideas from industrial partners are expected within one year, and that these ideas need to become pilot projects within the next 2,5 years.*

*The questions that we would like to go into are:*
*- Would you/your cluster be interested in this challenge and why?*

*- What do you think of the timeline (from idea to pilot)?*
*- Would you be able to organize a solution from your cluster or does this require other types of knowledge/partners (and if so, which)?*
*- Other remarks or questions?*

## 6.1 Captured responses from the Silent wall discussion

**Attending:** AB/CPH (Denmark) , Cluster Lumière (France), Danish Lighting (Denmark), Luce in Veneto (Italy), Lighting Europe, GLV 2020 (Belgium) and Lyse/Smartly (Norway)

1. Would you/your cluster be interested in this challenge and why?

AB/CPH

Cluster members are SMEs → Challenges must be made simple/relevant/local

Cluster Lumière
Want to contribute to development of components (IT, Power, etc.), To be shared by large number of manufacturers . We have ability in development of integrated circuits measuring equipment

Danish Lighting
Yes we will because it falls great in line with our main topics.

Luce in Veneto
We aim to coordinate a local discussion involving companies and stakeholders to propose new solutions in lighting field (cites, indoor lighting…)

Lighting Europe
Yes. We have a working group addressing Green Public Procurement & Smart lighting!

GLV
Innovate or Die! Correlates with cluster ambition

Lyse/Smartly
Yes, Lyse is developing and using smart technology to save energy.

2. What do you think of the timeline (from idea to pilot)?

AB/CPH

Time line must be extremely condensed to make project interesting for SME's → R.O.I

With year 1 or 2.

There must be a viable incentive (money/funding) to ensure commitment and progress.

Cluster Lumière
2 years total

GLV
Ambitious, because it depends on development for other applications. This implies that you need to target and find those specific business actors that share this ambition. To be more specific: you need to find specific people within organizations and companies that immediately share your vision and you should not try to convince others within these companies and organizations (you should leave this to the before mentioned people who share your vision immediately).

Lyse/smartly
Maybe, but …? has a lot of what other similar projects we participate in.

Luce in Veneto
1 year: A) Find a new idea B) Think about the potential partners (and a leader); C) organize a meeting (something more than one..); D) To work with a group to find the final project

3. Would you be able to organize a solution form your cluster or does this require other types of knowledge/partners and if so, which?

AB/CPH
Will not organize solutions – rather framing and organization. Any partner is welcome!

Cluster Lumière
For integrated circuits, need other industrial partners to reach critical mass (>I mio units)

Danish lighting
I believe that we partly would be able to organize a solution but would also include other networks form e.g. transportation area/ICT etc.

Luce in Veneto
We would be able to be the leader but, sure, we need many other partner in network (universities, research centers, public author.) To find new ideas, together with our companies.
GLV
Partially, would invite other partners e.g Traficom (…?) An interesting partner could be iMinds: http://www.iminds.be/en/about-us/markets/p/detail/smart-cities

Lyse/smartly
It depends on what our role is.

4. Other remarks or questions?
AB/CPH

Smart people have already defined “open innovation” as a concept. No need to start from scratch – please focus on making the concept relevant for specified target groups instead.

Cluster Lumière
Would like to valorize metrology form aircraft developed by cluster (Light pollution, global efficiency)

Danish lighting
Important to make information “accessible” to others than scientists and larger companies – because otherwise you will not have a truly “open” innovation process.

Luce in Veneto
- think that it is important to work behind and before a meeting were the participants can match together. We must have a clear idea to propose a clear leader and a core of members that could be interested in developing this new idea.
- It is important to match different parts (social experts, lighting experts, economic experts)