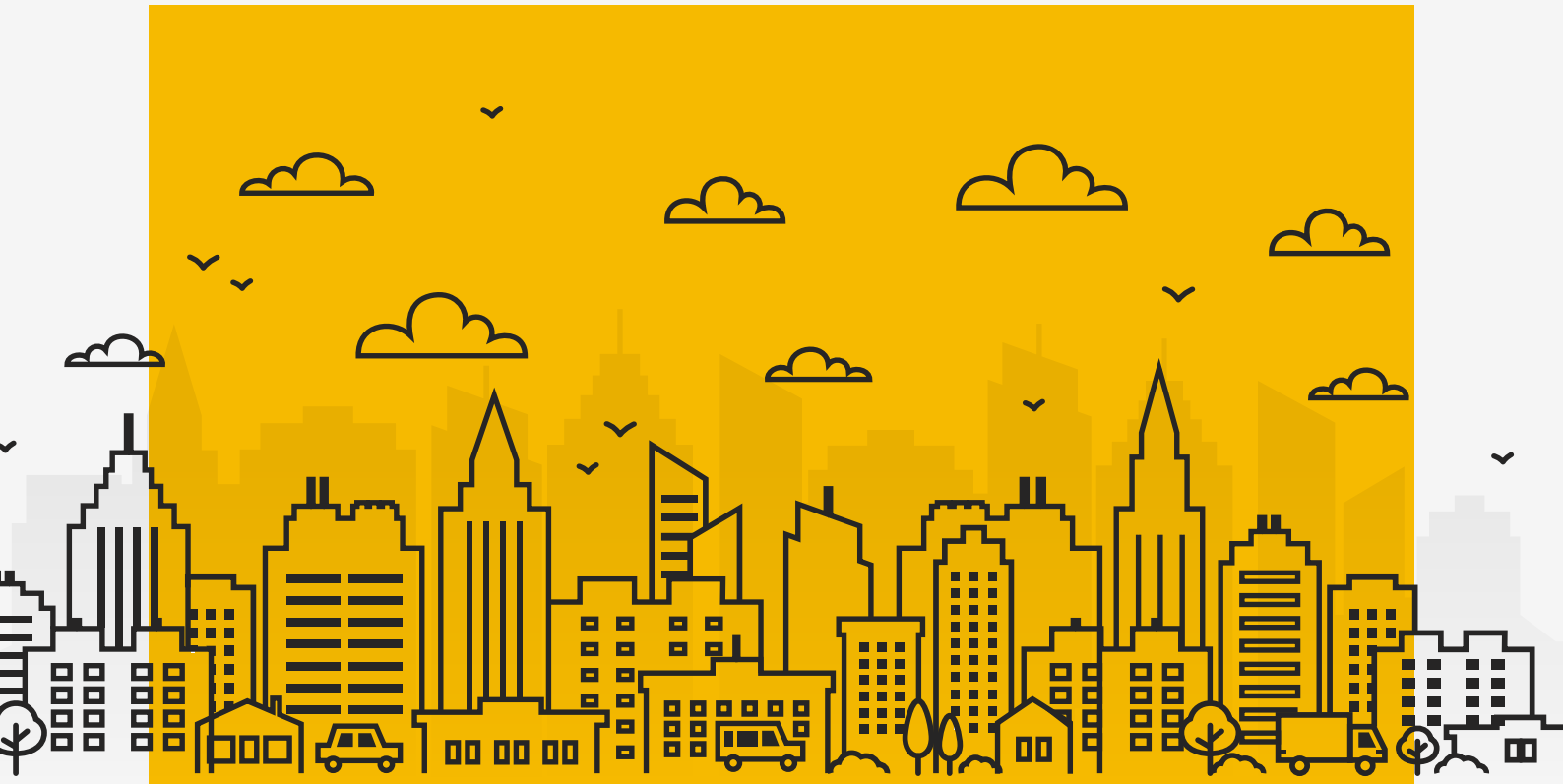

Shining a Global Light

The role of the 'Humble Lamppost' in a post-Covid green digital recovery

An initiative of the **Smart Cities Marketplace** #EUSmartCities

Hydro | Itrón | Lucy Zodion | Signify | SCIF Smart City Infrastructure Fund | UrbanDNA innovate incubate accelerate

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Introduction

The coronavirus pandemic has dramatically altered life as we know it, caused millions of deaths, had devastating effects on health and disrupted domestic economies around the world. Some governments are now easing their way out of lockdowns and others are moving in the opposite direction. They are aiming to try to depress the speed at which infections spread, slow further mutations and buy time to roll out booster jabs. But one "blink-and-you'll-miss it" object also helping governments with their Covid recovery and response plans is the smart lamppost. It is already saving lives and livelihoods.

A smart lamppost is a column that doesn't just give out light, but can enable many other functions. Cities around the world are upgrading lights to energy-efficient Light Emitting Diodes (LEDs) to reduce electricity bills, but a growing majority of leading cities are also enabling the lighting asset to deliver applications such as air quality monitoring sensors, Wi-Fi provision, video cameras for public security, and electric vehicle (EV) charging.

Globally, there are 326 million streetlights and this is expected to grow to more than 361 million by the end of 2029[1]. To date, a quarter of all streetlights globally have been converted to LEDs and more than 10 million smart streetlights have been connected.

In essence, a smart lamppost can be a key enabler of wider 'smart city' solutions.

A smart city is a place where traditional networks and services are made more efficient with the use of digital and telecommunication technologies for the benefit of its inhabitants and business. Essentially, it is an urban area that uses a variety of electronic methods and sensors to collect data. They share a focus on collecting data, often in real time, from a variety of different sources.

All these data sources are gathered together and analysed in the hope that this will allow the city to run more efficiently, more sustainably and even more democratically.

A growing body of evidence has shown that the efficient use of data sources has served a handful of countries well during the coronavirus pandemic, as they were successful in using track-and-trace systems to stem the tide of Covid infections. These include South Korea, China and Japan. Many of these countries cracked down on Covid-19 early, isolated infected people and their contacts and used personal data such as mobile-phone signals to track compliance.

In fact, worldwide lockdowns have helped to focus minds on digitalisation strategies and using advanced data analytics to improve the lives of citizens across the globe.

This report will highlight examples of proven smart lamppost projects across a variety of geographies, cities, and use cases in order to provide a basis for inspiration, comparison and learning. Smart cities such as Barcelona, Copenhagen, Munich, LA, London, and smart nations such as Singapore all feature, showing their varied advances in using technology, and the potential to go further.

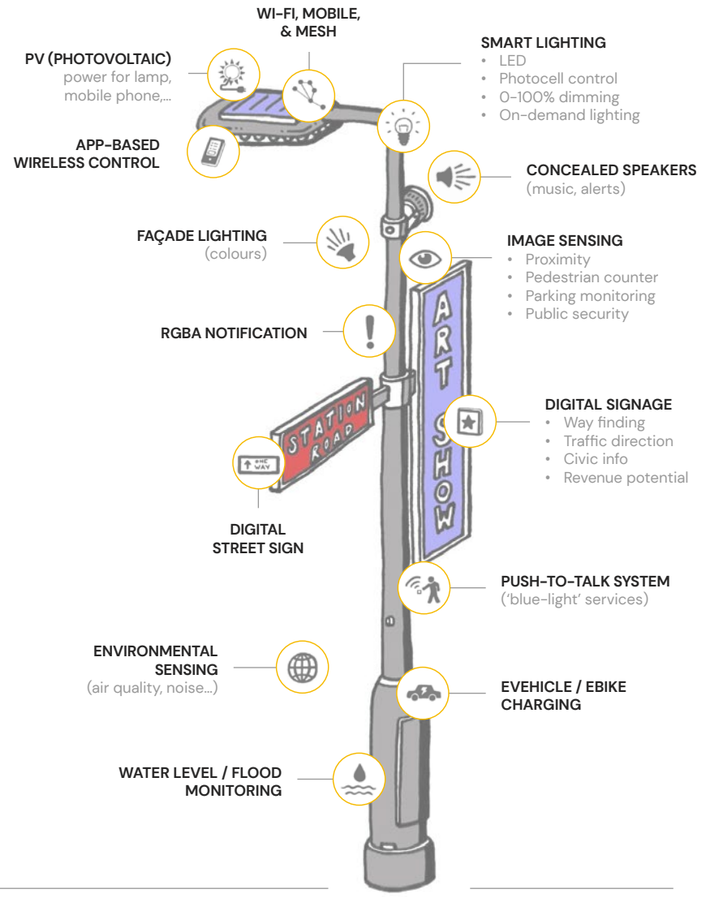
Three emerging insights are apparent:

- A small number of progressive cities have exploited their smart lamppost technologies to deliver benefits in tackling Covid-related use cases.
- A more significant number of cities have the technology, see the potential to apply it to address their recovery plans, but have yet to do so.
- There are significant opportunities for the majority of cities to reap the double benefits of both a better Covid recovery and bankable savings through implementing smart lampposts.

This paper argues that the smart lamppost is the gateway device for countries across the world to start their smart city journey. It also examines the barriers to introducing smart lampposts and sets out the means to overcome them.

Streetlights offer a unique opportunity for cities for several reasons:

1) LED conversion provides a strong business case to fund the costs of swapping out the older luminaires. The marginal, additional cost of adding smart controls is small, and increases the long-term energy and operational savings.
2) Street lights naturally follow where people and businesses are, and therefore are ideally placed where gathering sensor data is most useful to the provision of 'Smart Applications'.
3) A street light column, by definition, has electricity running to it, which can power additional sensors, mounted alongside the lamp.



1 *A quarter of streetlights could be smart by 2030 - Cities Today - Connecting the world's urban leaders (cities-today.com)*

Working Together

No one organisation can address the breadth of scope of the smart lamppost in isolation – be they a city, a supplier, or a financier.

The solution requires the insights and experience of all parties to tackle the physical, digital and human dimensions of the solution. Therefore, we brought together a representation from all the component parts.

(click on logos to see more details).

About the partners

Hydro

Hydro is committed to a sustainable future. Our purpose is to create more viable societies by developing natural resources into products and solutions in innovative and efficient ways.

Hydro is a fully integrated aluminium company with 34,000 employees in 40 countries on all continents, combining local expertise, worldwide reach and unmatched capabilities in R&D. In addition to production of primary aluminium, rolled and extruded products and recycling, Hydro also extracts bauxite, refines alumina and generates energy to be the only 360° company of the global aluminium industry.

Pole Products, business unit of Hydro, uses extruded profiles to manufacture aluminium light poles, flagpoles, traffic regulation installations and other smart city structures in the infrastructure.

Itron

Itron enables cities and utilities to safely, securely and reliably deliver critical infrastructure services to communities, and connects over 200 million IoT devices across more than 100 countries. Itron is the global leader in Smart Connected Lighting, with over 3 million smart lights connected globally in leading cities such as City of London, Westminster, Bristol, Glasgow, Copenhagen, Stockholm, Paris, Singapore, San Francisco, Chicago and Melbourne.

Our industry leading industrial IoT (IIoT) platform allows cities to connect and manage the assets they care about and bring the data together to deliver powerful outcomes to improve quality of life, meet sustainability objectives and deliver major reductions in operating costs. Our open, standards-based approach ensures we can connect a broad range of smart devices across our ecosystem of hundreds of partners in traffic management, intelligent lighting, asset monitoring, water management, electric mobility, renewables and more.

Lucy Zodion

For over 60 years, Lucy Zodion has been committed to developing tomorrow's street lighting control and power distribution solutions, today.

A tried, tested, and trusted partner supporting cities and municipalities worldwide, their next-generation products: electrical distribution and EV, and technology: their leading secure, interoperable, and scalable Ki. smart city platform, harness the power of IoT to ensure our cities meet their carbon and energy reduction commitments.

Designed and manufactured in the UK, you can trust in their experience and heritage to help you find the right solution.

Signifiy

Signify is the world leader in lighting for professionals and consumers and lighting for the Internet of Things. Our Philips products, Interact connected lighting systems and data-enabled services, deliver business value and transform life in homes, buildings and public spaces. With 2020 sales of €6.5 billion, we have approximately 38,000 employees and are present in over 70 countries. We unlock the extraordinary potential of light for brighter lives and a better world. We achieved carbon neutrality in 2020, have been in the Dow Jones Sustainability World Index since our IPO for four consecutive years and were named Industry Leader in 2017, 2018 and 2019.

Smart City Infrastructure Fund

The Smart City Infrastructure Fund is a responsible investment vehicle which provides long-term institutional capital for the development of sustainable urban ecosystems. The Fund helps cities deal with: continued urbanization, climate change and resource scarcity, development of sustainable communities, technological advancement and digitalisation. The Smart City Infrastructure Fund is at the forefront of responsible and sustainable investing, reports under GRESB and follows the United Nations Principles of Responsible Investment.

UrbanDNA

UrbanDNA is a specialist partnership that works with progressive cities and their industry partners, in collaboration, to deliver better solutions faster to common urban challenges. Our mission is to make a material difference to the transformation of cities worldwide.

We do so through our work with international institutions that are driving the smart city agenda, cities working together, standardisation bodies, working with innovative digital disruptors, and through strong sustained relationships with cities, experts, and partners that work with cities across the world.

UrbanDNA is UK based, with international operations and is deeply involved in the European Smart Cities Marketplace leading, amongst others, the EU 'Humble Lamppost' initiative.

Key Findings

Though much of the globe is slowly lifting coronavirus lockdown measures as positive cases decrease, the virus may still have a few tricks up its sleeve.

The disease is unpredictable and resilient, as demonstrated by the development of new strains. Covid-19 will be with us for a considerable time to come. The gloom of the virus has been lightened by vaccine roll outs, but they are not a silver bullet, able to 'switch off' the pandemic as suddenly as it appeared to 'switch on'. Not all nations are progressing at the same rate with their vaccination programmes – indeed much of the developing world might remain unvaccinated until well into 2023. Track and trace systems will remain an important device to manage the disease.

In the long-term, we need to make places safer and managing how we interact with safe spaces in a better way. In that light, cities are equipping their lampposts with various capabilities to help with urban planning and service delivery – otherwise known as 'smart' lampposts.

We have analysed best-practice use cases in a variety of geographies across the world in the shadow of the pandemic and our key findings are:

- **Smart lampposts can reduce the spread of coronavirus in cities, alleviate pressure on health services and save lives.** This has been demonstrated in Barcelona, Spain, where city officials used lampposts to implement crowd control measures at various hotspots amid concerns of crowding and poor adherence to social distancing rules.

- **Such technology could reduce the need for draconian lockdown measures that devastate cities' economies, public services and jobs.** City officials in London are experimenting with smart lampposts and how they could help with their Covid response and recovery plans. For instance, Westminster City Council is analysing whether lights from lampposts could be used to direct crowds away from popular tube exits and also how they could be used to encourage people back into the city by providing a pleasant experience to outdoor diners by using smart lampposts as a power source to provide electricity for al fresco dining spaces.

- **Smart lampposts can play an important role in helping city officials to implement public safety measures.** Copenhagen has been looking into using its connected lampposts to help with traffic safety. In some areas the lights dim according to a schedule, but sensors can enable lights to brighten when cyclists approach unsafe road junctions.

- **In a pandemic world and post-pandemic world, the newly developed need to minimise the risk of infection in public spaces will help increase the demand for smart technology such as smart lampposts.** By deploying a combination of vaccines, test and trace, supported isolation, safe environments, border controls and public space technology such as smart lampposts, governments could be seen to take their responsibilities seriously in keeping infections down. Wherever crowds congregate, smart technology can be used to encourage their dispersal and even to detect fever among those in the area.

- **Smart lampposts can have a wider impact on public safety.** For instance, LA is piloting air quality sensors, fire spotters, gunshot locators and investigating earthquake sensors. Munich officials currently have 60 smart lampposts and are considering whether it can install more lampposts near where it holds its Oktoberfest festival every year. The German city is assessing whether it could install speaker systems on the lampposts to give out public messages or a LED lighting display to use as a message system.

- **Lampposts will soon become hot property because the roll out of 5G telecommunications network technology will require the installation of transmitters on a dense network of masts taller than a double-decker bus.** However, concerns over negative perceptions of 5G roll outs, including privacy and surveillance issues, will need to be addressed by government officials to communicate the positive aspects of 5G to members of the public.

- **Ownership of lampposts and operational contracts are a common barrier to roll out of smart lampposts.** With all the city officials we interviewed these issues came up as a common obstacle. Most of the cities owned their lampposts and the importance of a city taking ownership of their projects was stressed. A Barcelona executive summed up the problem when he said: "In relation to rolling out smart lampposts, many questions still arise, including: "Who provides the power to the lamppost? Who is paying for the lights? Who is going to pay for all of it?"

- **A solid return on investment can be secured by updating lampposts.** More and more cities have started adopting energy efficient LED street lighting, which offers substantial (up to 50%) savings on energy consumption. There is a significant opportunity for a range of sensors to be added, to exploit the smart lamppost to save energy, and, at the same time, implement additional 'smart' services and help build a 'smart city'. Examples include LA, Copenhagen and Barcelona.

Barcelona, Spain

Background

Since hosting the Olympics in 1992, Barcelona, Spain, has become a world-famous brand, renowned for its architecture and famous football club. The city has embraced technology ever since it connected two municipal buildings with early fibre technology in the 1990s and this support for innovative technologies continues to this day. Gerardo Pisarello, who served as Barcelona's Deputy Mayor from 2015 to 2019, had a strategy to make sure that technology projects were aimed at having a social focus and digital solutions were applied to social problems.

In 2012, the city embarked on its 'Lighting Masterplan', which aimed to use smart technologies to enhance the efficiency and utility of city lampposts and improve the quality of life of its citizens. By 2014, more than 1,100 lampposts had been transitioned to LEDs, helping to reduce energy consumption. After this project, the Council embarked on its 2018-2020 street lighting renewal initiative, which included a scheme to remodel lighting in 200 city streets. In all, 10,000 new LED lights were due to be installed, offering a greater sensation of luminosity and safety in public places, and energy savings of around 5%.

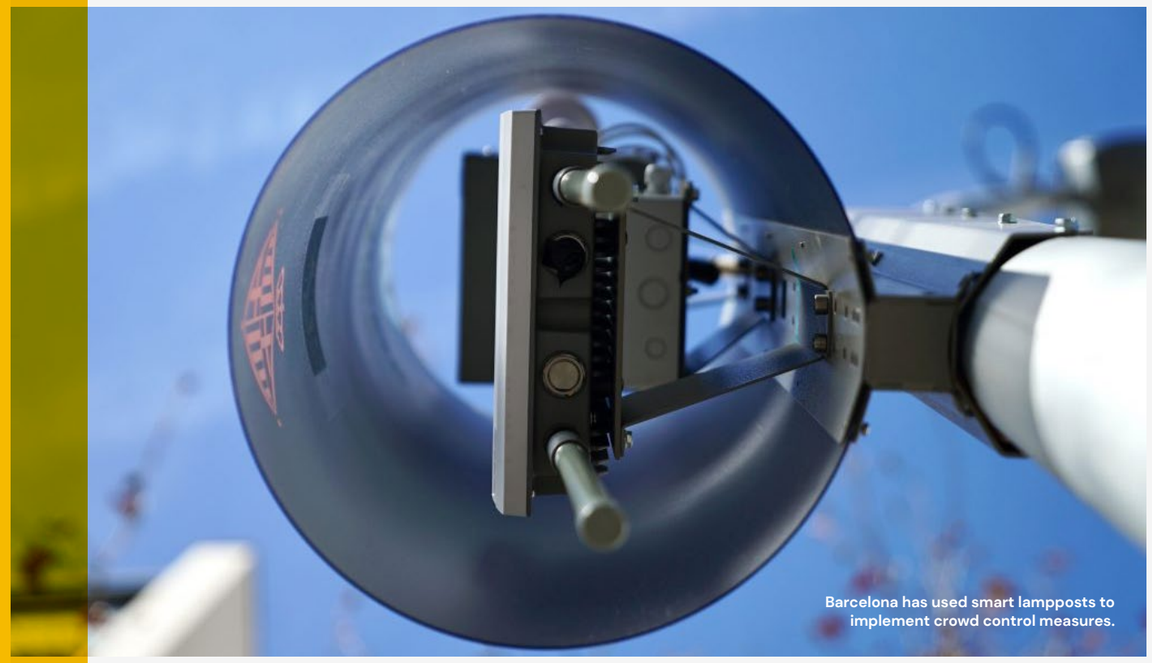
Street lighting accounts for 20% of the Council's energy consumption.

Street lighting accounts for 20% of the Council's energy consumption. In line with the 2018-2020 plan, 20% of the overall lighting system used LEDs, 64% sodium lights and 8% halogen lamps. All mercury vapour lamps were replaced, since these lamps pollute the most.

The Council has also installed 100 smart lampposts. In fact, El Parc i la Llacuna del Poblenou, a neighbourhood in the Sant Martí district of Barcelona, has around 100 smart lampposts which are part of the city's wi-fi network and provides free internet access throughout the city.

In June 2020, the Spanish government asked local authorities to open up their beaches to members of the public after lifting lockdown measures. The government also urged them to implement social distancing measures to help stop the spread of Covid-19. To combat the problem, Barcelona City Council developed a cutting-edge camera-based solution to count people on beaches to help tackle Covid. It essentially attached CCTVs to lampposts located near Las Ramblas beach in order to help stop the spread of the disease.

[IMAGE –©BARCELONA CITY COUNCIL.]



Barcelona has used smart lampposts to implement crowd control measures.

Opportunity

There are around 5km of sandy beaches located ten minutes away from Barcelona's city centre and around 200 lampposts line the outskirts of these beaches. The lampposts are around eight metres in height and are spread out across the beaches at intervals of 20 metres. Twelve of these lampposts had CCTV attached to them to help the Council implement crowd control measures.

"This initiative was quite challenging to implement," said Marc Perez-Batlle, innovation manager at Municipal Institute of Information and Technology at Barcelona City Council. "It's a really awkward space. On one side you have the sea, and on the other side you have streets that are beside the sand. There is not a lot of space to put electronics."

He added: "We used scanning devices to get the images and a bit of artificial intelligence to analyse these kinds of images to find out what portion of the beach was free in terms of lack of people and free space. We analysed the proportion of sand rather than identifying people's faces. This enabled us to look at the capacity that was free. Due to privacy concerns we anonymised the images."

Put simply, the sensor within the camera captured images every five minutes. Images were then sent via a 4G router to a main server for city officials to analyse. The server immediately anonymised the images and completely deleted the identifying data. The server then processed the anonymised pictures and estimated the total surface of sand that was free of objects. It did not count people and the camera was secured.

The main aim of using this system was to ensure that there were no concentrated gatherings of people in the same place, as this was one of the main requirements from Spain's Ministry of Health to ensure that beaches remained open over the summer. Beachgoers needed to be socially distanced from one another to stop the spread of Covid. The Council's system helped them close beaches every time they got near to full capacity.

In line with the 2018-2020 plan, 20% of the overall lighting system used LEDs, 64% sodium lights and 8% halogen lamps.

Untapped potential

Even though the system helped stop the spread of Covid, Perez-Batlle said smart lampposts could have created a stronger Covid prevention initiative. “If we had used smart lampposts more widely in this situation, it would have made it easier to implement crowd controls. This is because all the systems are in one place,” said Perez-Batlle.

Beyond Covid, Barcelona is looking at potentially adding 5G mobile telecommunications networks to its smart lampposts and rolling this out in 2022.

Obstacles

A number of factors are inhibiting the utilisation of smart lampposts in Barcelona, according to Perez-Batlle. These include the following:

- **Barcelona is renowned for its architecture and has a number of specially protected heritage sites.** Barcelona needs to ensure that the technology it deploys in the public space is not in conflict with the landscape – lamppost designs need to blend into the landscape. “We don’t want lots of wires hanging out. We want aesthetically-pleasing lampposts”, Perez-Batlle said.

- **EU regulation.** There may be an issue with 5G roll outs if one takes into account a rule embedded in the EU’s European Electronic Communications Code law. The study for the Commission ‘Light Deployment Regime for Small-Area Wireless Access Points (SAWAPs)’ maintains “that a volume limit of 30 litres should be sufficient to contain the main elements of a small-area wireless access point, while ensuring its unobtrusive character”[2]. Street lamps offer very valuable sites for deploying small cells, for instance, due to their density. So, the volume limit of 30 litres could be a challenge if one doesn’t have a big enough space within the lamppost to fit the cells in.

- **Safety.** Barcelona has to make sure that its workers are safe while maintaining these lampposts. This is because all of these smart lampposts hold more equipment and wires within them than conventional lampposts.

- **Ownership.** The Council owns all its smart lampposts. It is not clear how it will share different aspects of the lampposts going forward. In relation to rolling out smart lampposts, many questions still arise, including: “Who provides the power to the lamppost? Who is paying for the lights? Who is going to pay for all of it?”

2 *https://op.europa.eu/en/publication-detail/-/publication/463e2d3d-1d8f-11ea-95ab-01aa75ed71a1/language-en/format-PDF/source-112125706*

Copenhagen, Denmark

The new LED fixtures have allowed Copenhagen to cut its streetlight energy consumption by around 50%

Background

Copenhagen, Denmark's capital, is home to approximately 1.3 million residents[3]. Having set an ambitious target to become carbon-neutral by 2025, Copenhagen is currently transforming how it manages energy, and is planning to become the first carbon-neutral city in the world.

One of the requirements for achieving Copenhagen's carbon-neutral target, is a substantial reduction of the energy consumption from its street lighting. To help meet this target, in 2016, the city embarked on a street lighting replacement programme and replaced high-pressure sodium lamps with LED technology. The installations include a growing wireless mesh network of smart lampposts, but the city has yet to fully exploit them. The city also has the potential to use the lampposts to help stop the spread of Covid-19.

Opportunity

Since 2016, Copenhagen has been able to install an energy-efficient lighting solution that has been able to consume less energy. Prior to this, the city had a basic catenary system above its roads. The new LED fixtures have allowed Copenhagen to cut its streetlight energy consumption by around 50%, as LEDs require significantly less electricity than the high-pressure sodium lights that were previously in place.

There are two main elements to Copenhagen's 22,000 lamps - an Internet Protocol (IP) lighting system and a data transmission system (also known as a mesh network).

These lights can be controlled individually via their IP-address and can connect to one large network.

Additionally, the system can send and receive information. The benefit of a node system is that you have multiple contact points that can connect to one network, you can cover a large area and you do not need to set wi-fi routers for every sensor you mount.

Rasmus Reeh, Former Senior Developer for smart city solutions specialist Copenhagen Solutions Lab, explained: "All our light fittings have an IP address that enable us to connect to them."

Copenhagen has around 9,000 more lampposts to convert into smart ones in the hope of achieving a 70% reduction in energy consumption by 2025.

3 *http://data.un.org/en/iso/dk.html*

Untapped potential

Due to the city's ambitious aims, Copenhagen is an ideal test bed for new and innovative solutions.

"If sensors were installed you could monitor how many people are in a specific area at a specific point in time. Yet, our data transmitting capabilities have never been used," Reeh said. He added that analysis can be made in relation to street density and crowds could be controlled to help stop the transmission of Covid.

"You know the average number of people who are walking around on the streets. If you have a high footfall that is out of the ordinary, you could probably detect things like parties going on, where no social distancing is happening. You could then put out public warnings to tackle this.

"We are not necessarily sure that we would want do these things. Rather, it was a goal in the spring of 2020 to build services that could guide citizens to areas where they would not risk getting fines from the police."

Beyond Covid, the possibilities to use smart lampposts seem almost unlimited, and Reeh says that Copenhagen has been looking into using its connected lampposts to help with traffic safety. In some areas the lights dim according to a schedule, but sensors and the mesh network could enable lights to brighten when cyclists approach unsafe road junctions. The latter is important as half of commuter trips are taken by bicycle in Denmark's capital.

In 2016 , the city embarked on a street lighting replacement programme and replaced high-pressure sodium lamps with LED technology.

[IMAGE – © COPENHAGEN SOLUTIONS LAB]

As well as traffic safety, Copenhagen has also looked at use cases where smart lampposts with sensors could be used to monitor street temperature. We know, Reeh says some areas have lower temperatures on the streets than others, then the salt gritters could focus on salting the coldest part of the city optimising operational cost and lowering environmental impact. In addition, sensors already installed in street bins could connect with the mesh network rather than using mobile transmitters in the effort to optimise waste collections.

Smart lampposts lights could also be dimmed in order to tackle any light pollution that exists in residential areas. This helps with energy efficiency and "also adds a psychological element to an area, by calming it", Reeh stated.

Obstacles

A number of factors are inhibiting the utilisation of smart lampposts in Copenhagen, according to Reeh. These include the following:

- **The different incentive schemes for developing an internet of things (IoT) system next to the lighting system.** Copenhagen has set up incentives to lower energy consumption with the goal of a 70% reduction. These outdo incentives to use the IoT network as using the network drives up consumption.
- **Organisational priorities.** The department smart lampposts sit in is focused more on reducing costs and consumption than showing the business case for using the network. It is placed organisationally in the lighting department that has utilised the system on its end, but it also has perverse incentives to utilise the data transmitting capabilities due to procurement/KPI organisation.
- **Certification.** The new system has not been certified for operation. This will be strengthened in the next few years because EU member states must comply with new EU regulation on cyber security. New data networks will need new certifications to comply.
- **Price case.** There is no price case on what it costs to connect a sensor.
- **Lack of digital maturity system wide.** Not many people have knowledge about the benefits of using smart lampposts as a data network. So, looking for digital solutions is not the priority – even though Denmark is much more digital than other cities.

Copenhagen has around 9,000 more lampposts to convert into smart ones in the hope of achieving a 70% reduction in energy consumption by 2025.

Munich, Germany

Equipped with innovative sensors, the smart lampposts are also able to measure data on the local air quality, concentration of air pollutants, the weather.

[IMAGE – ©SMARTER TOGETHER/DOMINIK PARZINGER]

Background

In 2015, the City of Munich in Germany was asked to take part in an EU-funded 'Smarter Together' campaign, which focused on providing technological innovations to Neuaubing-Westkreuz/Freiham, a western-based district in the Bavarian city, to help improve the lives of its citizens. On the whole, work took place to replace old luminaires (lamps/lights/bulbs) with LED ones. As part of the Smarter Together project, it has not only been working on smart lampposts, but an energy system for refurbishment in housing complexes, mobility stations, and neighbourhood sharing boxes, among other things.

Home to around 23,000 residents, the Neuaubing-Westkreuz/Freiham district had 60 smart lampposts fitted around its streets at three dedicated locations. These smart lampposts stand out from the almost 80,000 old luminaires the city has. In fact, two features make the 60 lampposts 'smart'. One is that, on top of their lighting function, the posts have a separate second power supply that can allow sensors to measure and capture local data. The second is that each lamppost is internet-enabled thanks to either wireless LAN or fibre, allowing the sensors fitted in them to transfer their measurement data securely to a central repository. Additionally, they provide free Wifi (Munich "M-WLAN") for citizens.

The district has the potential to use smart lampposts to tackle Covid-19, but has no plans to use them to tackle the pandemic, preferring to use them to help positively benefit the city in other ways.

Opportunity

Munich has been able to save energy, reduce CO2 emissions and facilitate a cleaner, cleverer flow of traffic, since installing its smart lampposts. The LED lighting system combined with the sensor system has contributed to energy savings of around 5-10%.

"Under German regulations, the city council has responsibility for public safety and so when we did the roll out, we had to make sure that the power supply to the lighting system was always available when it was needed. Therefore, installing two power supplies (one for the lighting and one for the sensors) was very important," said Wolfgang Glock, IT strategist at the City of Munich and head of E-/Open-Government and Smart City. "That's why you separate any infrastructure you put inside the lamppost from the power supplies to the light."

He added: "For our smart lampposts, we designed them in a way that they looked like our conventional lampposts and used the same material that we would have done for our conventional lampposts. It's really important to keep the costs low. If the construction is the same as every other lamppost, you can use the same machines to build them and have no problem with standards or power supplies in the ground. This standardised way of doing things was really important to help the street lighting team deal with these smart lampposts the same way they would have done with the conventional ones," Glock said. For the lamppost static calculations – including considerations for the installation of sensoring systems – were done and a dedicated approval certificate exists. This is important for the acceptance and liability.

Equipped with innovative sensors, the smart lampposts are also able to measure data on the local air quality, concentration of air pollutants, the weather (rain, temperature, and wind direction), current traffic levels in real time and empty parking spaces.

It is not using the smart lampposts to tackle the spread of Covid by monitoring the movement or concentration of crowds.

However, the smart lampposts could be used to detect people walking around and disperse crowds by using sensors that trigger speakers to give public health advice and ensure they keep a distance. Nevertheless, one has to give a guarantee that no individual would be identified and will be anonymised to meet privacy laws (e.g.GDPR).

There were initial discussions with city officials and politicians around detecting crowded places all over the city to help with solutions for Covid and then enforcement officials would go to those areas to disperse those crowds. However, Glock maintained that it would take some time to build these kinds of solutions.

Untapped potential

The City of Munich is currently looking at other local areas where it can install its smart lampposts. “It might be interesting to put these lampposts up when the Oktoberfest festival is on. We could install speaker systems on the lampposts to give out public messages or a LED lighting display to use as a message system,” Glock maintained. “For example, you can say the temperature today is 20 degrees or the next parking space is free on the messaging system.”

Obstacles

A number of factors are inhibiting the utilisation of smart lampposts in Munich, according to Glock. These include the following:

- **Expense.** The installation of these smart lampposts are really expensive. “We were lucky that work was already underway to substitute old lampposts with new LED-based ones when we installed our smart lampposts. It was easy to convince people to use new ones. Yet, the City of Munich wanted to install an electric vehicle (EV) charging point within their smart lampposts but it decided against it because it would have been too expensive to install an additional power supply,” Glock said. Overall, the major costs are from the construction activities, power supply cables and fibre for the internet.
- **Noise sensor features.** The engineers building these potential systems say it’s complicated to do. It’s difficult to extract average noise levels from these lampposts to really get the data to find out what the ‘real-time’ situation is.
- **Time.** “It took us one and half years to install this infrastructure from the moment we planned it to installation. From 2016 to 2018. The construction took a while to do,” Glock said.
- **Ownership.** “It is important that a city can take ownership of their projects. We own our lamppost infrastructure. Yet, if we want to install our lampposts near to buildings, we can only use buildings that belong to the city. We need infrastructure that we can install our stuff on to,” Glock added.
- **Power supply.** “German law dictates that you need additional power supply. Could we remove this regulation and use existing power supplies for our smart lampposts (including for light and sensor systems)?” Glock said.

Privacy concerns

Workshops were held with local residents, experts from Munich and other interested parties to work together to think about the installation before the lampposts before the roll out. Top priority was always given to current privacy/data protection legislation and the implementation of leading-edge data protection requirements. Munich positioned itself as a ‘trusted data gatekeeper’ and maintained that it was always transparent with its citizens. The lampposts collect, analyse and provide access to data which delivers immediate benefits to local residents and/or the city as a whole.

Each lamppost is internet-enabled thanks to either wireless LAN or fibre, allowing the sensors fitted in them to transfer their measurement data securely to a central repository. Additionally, they provide free Wifi (Munich “M-WLAN”) for citizens.

Los Angeles, USA

Background

Los Angeles (LA) is known worldwide as a city of glamour and a town with around 400 different street light pole designs. LA owns the second largest municipal street lighting system in the US, with more than 220,000 streetlights that span over 7,000 miles of streets. The system is operated and maintained by the Bureau of Street Lighting (BSL), which was established in 1925. In 2009, the BSL launched a conversion programme to replace high-intensity discharge lamps with LED luminaires that use less energy and save money. The city was due to complete its streetlight conversion last year but due to the challenges of Covid, in relation to operations, it still has around 5,000 conversions left to do. It hopes to do this by the end of the year.

LA has committed itself to seeking a healthy balance between innovative technologies and solutions that are workable for people in their everyday lives. For example, it has more than 400 street light poles in the city that are equipped with electric vehicle (EV) chargers. It also has street lights that have remote monitoring devices attached to them.

There is potential to add more features to LA's street lights to tackle Covid or future pandemics, but the city is not using its lampposts to help with this.

By 2012, energy savings were around 50% and by 2021 we were saving around 75%.

[IMAGE – ©LA BUREAU OF STREET LIGHTING]

Opportunity

"This LED project spanned several years and the technology is constantly changing. In 2009, conversions resulted in energy savings of approximately 30%. By 2012, energy savings were around 50% and by 2021 we were saving around 75%. The technology has progressed substantially since we became aware of it," said James Quigley, Senior Engineering Manager, at Bureau of Street Lighting Los Angeles.

The BSL realised that once the LED street lights were installed, they not only achieved substantial energy and cost savings but also improved overall lighting quality and roadway safety for both vehicle and pedestrian traffic.

LA has put remote monitoring devices on its LEDs to inform the maintenance department when there are system outages. The Bureau of Street Lighting is also piloting air quality sensors, fire spotters, gunshot locators and investigating earthquake sensors.

Untapped potential

LA is not using its streetlights to help tackle the Covid pandemic. However, Quigley says that you could potentially install sensors in lampposts to help with crowd monitoring and temperature reading.

“Are people congregating where they shouldn’t be and how many of these people are exhibiting symptoms? A temperature sensor that is mounted on a lamppost is something that could be easily done,” Quigley maintained. “If your temperature is above 100 you can flag it up.”

Nevertheless, Quigley also pointed out that this is something the City of LA may have apprehensions implementing due to concerns of privacy and access.

Beyond Covid, the possibilities to use smart city technology seem almost unlimited, and Quigley said that LA is investigating occupancy sensors to help with parking spaces in crowded areas. The BSL is currently trialling parking occupancy sensors on a few of it lampposts, which could “come in handy, especially in downtown LA”, Quigley said.

In relation to EVs, sensors could be used in the smart lampposts to see if EV chargers are in use. “A lot of the time, people will be parking in the EV charging spaces for long periods of time and not actually be charging their cars – they just want the space. Sometimes combustion engines will be in there parking for free and you will like to alert the tow truck to tow them away,” said Quigley.

The lamppost could also ensure that the colour temperature of the lights are controlled according to a schedule, which will help provide bright white light to pedestrians and traffic at night.

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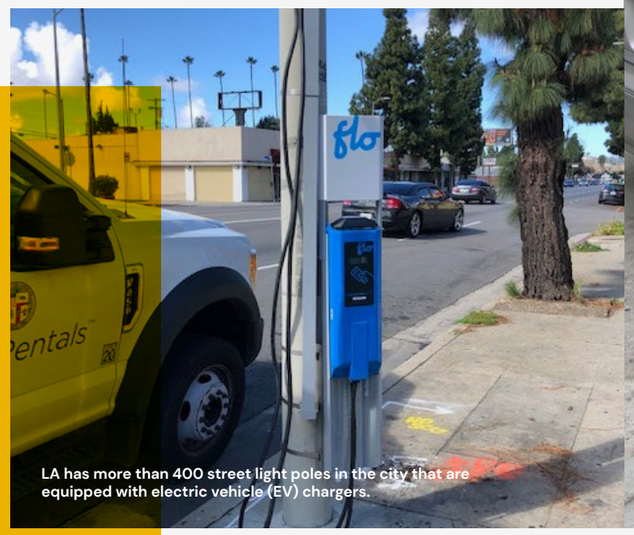


LA has more than 400 street light poles in the city that are equipped with electric vehicle (EV) chargers.

Obstacles

A number of factors could be inhibiting the utilisation of ‘smart’ lampposts in LA. These include the following:

- **Issues of privacy and data protection.** Top priority is always given to current privacy and data protection. “The question is ‘what are you doing with the data you receive from these sensors?’ If you have a big workforce that are utilising this data, then there is a lot of stuff you can do. If you have a bunch of gunshot locaters and the police aren’t able to use the data that has just outlined where the shot was fired from, what does it do for you? If you have fire locaters and the fire department doesn’t have access to this data to respond to the fire, how does this help you?,” Quigley said.
- **Trust.** “Who gets access to the data? Will it be police or private investigators? There are some trust issues with law enforcement in the city.
- **Legal issues.** In relation to street light dimming technology, there are concerns that if lights are dimmed say at 1:00 am and an accident occurs the city may have legal liability

City of Westminster, London, UK

Background

The streets of London are many and varied, but one of the most famous streets in London has to be Oxford Street. In fact, it is the UK capital's main shopping district and a key destination choice for domestic and international visitors. Yet, footfall on the street has taken a battering due to Covid lockdowns and city leaders are now looking at ways to attract tourists, residents, and visitors back to the iconic street.

Westminster City Council is the local authority that oversees Oxford Street and in February it launched an ambitious £150 million plan to revive the street and the wider district. Given that this borough has a significantly higher GDP than any other London borough, this blueprint hopes to reinvent the high street for a post-pandemic recovery, as well as for the long-term. Although smart lampposts are not part of the plan per se, they are being examined to see how they can positively contribute to London's Covid recovery plans.

Westminster has not just been busy with installing smart lampposts, but rolling out a wider LED lamp replacement programme, which it started in 2019, and a central management system (CMS) to automate when they switch on and off. So far, 8,000 have been converted and 5,000 more need converting, which will contribute to energy consumption reductions of around 40-50% and carbon emissions reduced over 60% from before the LED roll out.

There are a sporadic number of smart lampposts in use in the City of Westminster and in London as a whole due to understanding of what is currently available, and available funding to implement them. The smart lamppost development forms part of a wider European project called Sharing Cities, which is being led by the Greater London Authority (the governance body of London) and aims to exploit the digital technological capabilities in lampposts.

Opportunity

Westminster City Council is currently experimenting with several ideas on how it can use smart lampposts to encourage people back in to town and how it can use lighting as a way to keep certain areas clear. In fact, as part of a trial, the City Council is using smart lighting controls to dim lights around the Oxford Street area to change the ambience of certain spots along the street and to create a positive atmosphere.

"We also have direct lights to areas that highlight the corners to side roads to act like a guide device which can lead people into side roads that connect to other businesses and open spaces - specifically green ones," Dean Wendelborn, Project Manager, Street Lighting City Highways at Westminster City Council said. "Oxford Street is not just one street really, there are a lot of side roads connected to it and there are also pockets of green open spaces around the side."

Conversely, the City Council is looking at ways to disperse areas which may get too crowded like outside key tube stations. It is analysing an idea called 'nudge theory', which can use lights to direct people to certain areas. "It's simply about putting lights on the ground to either make people stand there or make people avoid it. This helps with crowd control when you are coming out of the train and out of tube stops to help curtail people mingling around exits," Wendelborn explained.

"For instance, somebody might come out of Bond Street station. That person comes out and looks at their phone out to figure out where they are going. This can make the exit crowded if more people gather outside it. If we can use our lights to 'nudge' them away from the entrance to make it clear for other users to feel happy approaching entrances, or use the lights to say 'hey, what's that over there? please move to the other side of the area and look at me', that would help with crowd control in a potential or continuing socially-distanced world."

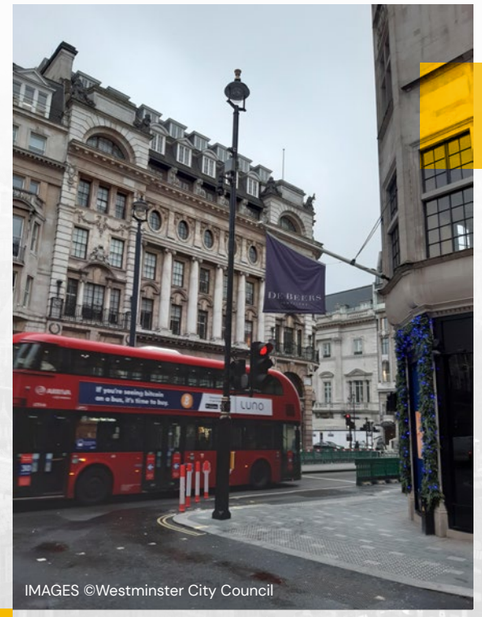
Untapped potential

Ultimately, the City Council is keen to use Information of Things (IoT) technology to improve the lives of the 200 million people (pre-Covid) who visit Oxford Street every year, as well as the City's 200,000-plus permanent residents to, reduce energy costs and possibly to bring income into the city.

Beyond Covid, smart lampposts may be used to monitor all types of traffic in real time. "Historically, we used conventional traffic monitors to collect two-weeks' worth of traffic count for the whole year and that's it. If we have got something going the whole time, it informs the engineers for potential roadwork schemes. What is the correct allocation for this road, is it a 60 to 40 ratio of people versus traffic or is it 80%? This could mean that we could make the roads traffic-free depending on what data we get on what's happening in the environment," Wendelborn said.

The smart lamppost could also monitor temperature, traffic, pedestrian and cycling composition, flood conditions, air quality, waste collection and more. This data can be gathered and used by city personnel to learn about the actual conditions happening along a section of road and implement future initiatives to improve the safety and quality of life for citizens and make them enjoy their time in the area. "Although we already have conventional air quality devices, they are large, expensive and very sparse around the city, if we were to put smaller sensors on smart lampposts, could we also link them to publicly available apps and then citizens can then get alerts on their phones to say avoid this area because it has high pollution or avoid it because there is localised flooding, or indeed to show the opposite, that there's good air quality today. We will have more accurate data," Wendelborn said.

By linking up crowd control, air quality, social distancing measures, lights, traffic control, and many other devices, city leaders can measure just about everything that is going on in their public realms to identify sticking points and create solutions, and monitor those areas that do already work.



IMAGES ©Westminster City Council

Ultimately, the City Council is keen to use Information of Things (IoT) technology to improve the lives of the 200 million people (pre-Covid) who visit Oxford Street every year,

London as a whole

Although Westminster is one borough in London, officials are looking at how London as a whole can look at using smart lampposts to help its citizens and is using smart infrastructure like electric charging systems, energy management systems and mobile phone masts. During the first UK lockdown, which officially began in March 2020 and eased during May, the Greater London Authority (GLA) team used street IoT sensors and various data sets to get a better idea of how people were moving around London. A combination of that information came from mobile phone masts and sensors on lampposts.

An expert from London's Sharing Cities team said: "If you investigate the future, when we might have 5G technology on every other lamppost, this information will be much easier to access and much more granular. Yet, there are also concerns and questions raised in relation to surveillance and privacy, which we have been exploring with a range of partners over the last year."

Elsewhere, the expert highlighted how smart lampposts could fit into the Mayor of London's Recovery Programme , which focuses on several missions, including a 'Green New Deal, 'High Streets for All' and 'Digital Access for All'. The expert said accelerating green technology across the city could promote access to green spaces, active travel and zero emissions. Digital signage could also be used to help revive high street businesses by alerting the public to potential warnings or giving them advice. Attracting workers back to the office could be made simpler with 5G technology included in smart lampposts to give them fast internet access, the expert maintained. Al fresco dining with outdoor seating could be provided with plug outlets via electricity that originated from smart lampposts, Wendelborn added.

Obstacles

There are many barriers to rolling out smart lampposts in London. A few are listed below:

- **Old columns.** Wendelborn said: "A lot of our columns are old. We don't have the income to maintain all of them. We have got the ambition to do things, but we have rusty old columns that may not manage to take all the equipment we need to put in them.
- **Contracts.** If we want to use smart lampposts for advertising, we must be wary of advertising contracts. For example, Transport for London (TfL) has advertising contracts at bus stops and roads. It needs to be part of any conversation on advertising.
- **Privacy and cyber security.** The GLA does not purchase lampposts. Yet, they want to provide help and coordination to all London boroughs and are producing an IoT framework to support this. This includes advice around cyber security, privacy, data collection and management.
- **Lack of communication with public.** "More needs to be done on the positive case for 5G and how it ties into London's mission to be carbon-neutral by 2030."
- **32 boroughs doing different things.** The Covid-19 crisis has shone a light on how smart infrastructure has been adopted in an uncoordinated and ad-hoc way over time, demonstrating a need for better city-wide collaboration.

Singapore

Background

Singapore has been one of the most successful countries in tackling the Covid-19 pandemic. The country has one of the lowest death rates per Covid-19 case numbers in the world. As of March 2021, it recorded around 59,800 cumulative cases and 29 deaths. Experts have pointed to Singapore's early and aggressive testing programme as part of the reason for the remarkably low death rate, while the country's health authorities have also manged to identify and isolate the demographic of people who were presenting clear symptoms.

At the start of 2020, Singapore had also launched a rapid test-and-trace programme and strict travel restrictions on people entering the country. The country appeared to have the pandemic largely under control while other countries were seeing a spike.

The country's government is also using technology to help with a new lamppost programme. Lampposts in Singapore are already serving than more than just a light source. They are being equipped with various capabilities to help with urban planning. The aim is to turn all of Singapore's 100,000 lampposts into smart platform.

It is not clear at the moment if the Singapore government is using lampposts to help tackle Covid-19 or looking to use them to tackle future pandemics. However, a Smart Nation and Digital Government Office spokesman said: "Some of these efforts or projects are still in the initial stages, so there isn't much that we can share at this point."

Opportunity

The country is currently trialling a Smart Nation Sensor Platform (SNSP) project – the Lamppost as a Platform (LaaP). It aims to maximise the use of Singapore's street lampposts.

Lampposts are currently being fitted with a network of wireless sensors and cameras that better support urban planning and operations.

The sensors detect and monitor changes to environmental conditions like humidity, rainfall, temperature and pollutants in the air. Noise sensors can be used to detect unusually loud sounds such as a car crash.

In relation to Covid-19 and future pandemics, the cameras have analytic capabilities to count and analyse crowd build-ups, as well as count, classify and monitor the speed of Personal Mobility Devices (PMDs) to enhance safety in public spaces. This data can also help city leaders to optimise the design of public infrastructure and provide more efficient transportation services to increase the safety of and improve the experience of commuters and pedestrians.

Navigational features can also be used to direct autonomous vehicles and speed trap sensors could be used to track speeding bicycles or personal mobility devices. Commenting on how smart lampposts could be put to good use, Smart Nation and Digital Government Office Tan Kok Yam told media channel Channel News Asia (CAN): "We want to look at places where people most frequently use active mobility devices. If we know where these places are, we can look at the infrastructure and the signage, to make the place safer.

"You want to know whether people are speeding or not for public safety reasons. If there is a bad collision, would a visual sensor be able to pick that up? And if that happens, would we be able to respond with emergency services?"

By 2022, the government will aim to replace all street lamps with LEDs and it claims that LEDs are 25% more energy efficient than the traditional lamps.

The aim is to turn all of Singapore's 100,000 lampposts into smart platform

According to the Smart Nation and Digital Government Office, a "smart nation" means people and businesses are empowered through increased access to data, more participatory through the contribution of innovative ideas and solutions, and a more anticipatory government that utilises technology to better serve citizens' needs.

This data can also help city leaders to optimise the design of public infrastructure and provide more efficient transportation services to improve the experience of commuters and pedestrians. Singapore's government is already used TraceTogether app as a successful contract tracing tool.

Despite their potential, some aspects of the smart lampposts have sparked concerns about privacy, especially the platform's prospective ability to recognise faces.

"We have no plans to use it to probe into how people live their lives," Kok Yam told CNA. "The whole point of the sensor platform is to look at improving services, look at how to run the city and operate the city better and how to plan the city better. We have no plans to do moral policing or things like that."

In terms of addressing cybersecurity concerns such as hacking and data leaks, a Smart Nation and Digital Government Office spokesman told CNA that the data collected will be safe, and there will be measures to prevent misuse.

Barriers

As demonstrated by the above, it is widely accepted that smart lampposts can help tackle pandemics like Covid-19, however there are a number of barriers inhibiting widespread adoption, as illustrated below.

	GOVERNANCE	TECHNICAL	FINANCIAL	PEOPLE-RELATED ISSUES
LONDON	The Covid-19 crisis has shone a light on how smart infrastructure has been adopted in an uncoordinated and ad-hoc way over time.	A lot of rusty old columns that may not host new technology.	A lack of income to maintain old columns.	Privacy and data protection. 5G roll outs lead to concerns over surveillance and privacy.
BARCELONA	The city is not clear how to share responsibility for different aspects of its smart lampposts programme. For example, where multiple services are provided by the column, who should fund the electricity supply? Expensive upfront costs of rolling out smart lampposts to tackle Covid.	Columns must not conflict with public landscape. More health and safety training required for workers due to more wires in columns. There's a technical metering and 24hr power availability question in some (southern) EU cities.		Maintenance workers need to be kept safe.
COPENHAGEN	The city is focused more on reducing costs and consumption, than on the potential of smart technology. There are perverse incentives to utilise the data transmitting capabilities due to procurement/KPI organisation.	The city has set up incentives to lower energy consumption. These outdo incentives to use the Internet of Things network as using the network drives up consumption.		Lack of knowledge amongst public and government departments on digital solutions.
MUNICH	Council can only install lampposts near to buildings that belong to the city because of national laws. There's a regulatory concern also for public bodies charging for electricity in some countries	National regulations stress the need for additional electricity supply to power smart system. Lack of time to install systems to respond to Covid.	Noise sensors difficult to install. Smart lampposts are expensive.	
LOS ANGELES	City may have legal liability if traffic accidents occur due to lights that have been dimmed.			Privacy and data protection. Who gets the data and what is done with it?

The adoption and implementation of smart lampposts will require considerable collaboration – from all quarters – resulting in a more productive market. This is what you can do to overcome the barriers mentioned above if you are…

A city government

In relation to organisational priorities, cities need pragmatically to analyse the opportunity of implementing smart lampposts, and do so beyond individual silos of city decision making. Where legal constraints exist, joined up thinking can assist in removing or mitigating these.

The distributed nature of connected lighting infrastructure and sheer number of attached components vastly increases the available cyberattack 'surface', therefore city authorities and system operators must ensure all networks and connected devices are secured appropriately.

Many cities deploying smart lighting-enabled camera solutions make it clear that video streams are analysed in real-time, on the device and reiterate that no data is stored. Cities will need to take actions to build trust with society by securing appropriate use of, or anonymising, data.

Cities also need to think beyond reliance on public funds to explore alternative forms of financing, and consider applying accounting rules such as Energy Performance Contracts[4] to keep investments "off-balance sheet" and avoid government debts.

An investor

To increase the number of viable projects, investors should be looking to stimulate and incentivise scale adoption and potentially demand aggregation. By offering deals to several cities as a package, economies of scale can be realised, as can lower interest rates where large sums are lent at a lower marginal cost. In simple terms, investors could seek to give cities better financial terms if they buy in volume. Switching from traditional lamps to smart lamps/LEDs can save up to 80% in energy costs and around 50% in maintenance costs. Investors should work with governments to stimulate programmes where savings are ploughed back into expanding the network of smart lampposts over time.

Investors could also support the process by adopting more inclusive, long-term measures of return on investment. For instance, saving lives and livelihoods by using smart lampposts to help tackle the spread of Covid in cities is not only about immediate financial returns to the bank, but long-term returns to society. By using these lampposts, the public could be prevented from getting ill – whether from Covid or from air pollution – and as such they avoid admission to hospital, absence from work and so on. The individual benefits, the city's coffers benefit, and – in turn – the original investor can realise a return.

4 *https://www.eib.org/en/publications/guide-to-statistical-treatment-of-epc*

A national government

The city case studies in this report highlight regulatory barriers to implementation. At a national level, governments should be working to remove these to take advantage of significant economic, environmental and social benefits that smart lampposts can deliver; including 'economic growth multipliers' where safer cities catalyse other investment for example in retail and hospitality. They should also search out opportunities to incentivise scale and demand aggregation. They should support development of guidelines and standards. And as with cities, national government must stress transparency standards to ensure privacy and surveillance concerns are addressed.

A solution or service provider

Working together is key. Few if any providers can legitimately argue that they can adequately cover the whole solution. And trust from cities also comes with consistency of messaging, helped by aligned communications and collaborative activities. Working together will strengthen market confidence; will support more and better innovation; and will help speed and strengthen activities to deliver more common trusted (standards-based) solutions.

The European Commission

If multiple cities across Europe pull together and show how smart lampposts are a "quick win" to help save lives and livelihoods, they may be able to draw financial support from the key stakeholders and investors who could bring these proposed projects to fruition. The market must own, respond to, and pick up the pace. But as a principal policy setter, the European Commission could lend further weight to the European Smart Cities Marketplace, helping to make good ideas more visible, stimulate common solutions and scale, and bring investor confidence. Europe has launched a 'Climate Neutral and Smart Cities' Mission; and also set itself the goal of becoming the first climate-neutral continent through its 'Green Deal'. The Deal forms part of the EU's Covid recovery package and highlights the need for the bloc to unlock the full benefits of the digital transformation to support the ecological transition. Smart lampposts play an important role in this.

Conclusion and Recommendations

From Singapore to Copenhagen to LA, right across the world cities are installing smart lampposts to improve citizens' lives. The technology is already helping public health officials and politicians to use innovative ways of controlling the spread of the virus without killing the economy. We are going to continue to live in a topsy turvy world as a result of Covid-19 and future pandemics. The smart lamppost is a smart way to help cities keep their residents and visitors both safe and informed. They have the potential to play a part not just in the response to further waves of the pandemic (should they occur), but to be integral to cities' recovery from this difficult period.

Smart lampposts offer local authorities an opportunity to move towards encouragement rather than enforcement of social distancing rules. This could engage the public with 'carrots rather than sticks'. For instance, the City of Westminster is looking at is looking at ways to disperse areas which may get to crowded like outside key tube stations. It is analysing 'nudge theory', as a means of using lights to direct people to certain areas, and away from others.

As restrictions are lifted, the Government should work with local authorities and providers to demonstrate that smart lampposts can help prevent Covid transmission. Covid is set to be with us for some years despite vaccines, particularly if new strains emerge, and winter pressures on health services require a renewal of social distancing measures.

Investment in smart lampposts can catalyse upgrades of an already often dated city infrastructure and provide a clear return on investment. LED lamps are just the beginning of the long-term cost savings which can be achieved by investing in smart lamp columns. In addition, there are savings to realise on separate security systems and on electric car charging infrastructure.

Smart lamppost technology can benefit citizens without probing into people's lives. Although there are concerns over privacy and cybersecurity threats, city officials can allay the fears of the public by committing to transparency, and the means to anonymise video footage. For instance, in Munich workshops were held with local residents and experts before the lampposts before the city rolled them out. In Barcelona, images of people's faces are automatically anonymised as their systems detect crowding on the city's beaches.

Smart lampposts can provide the public with free 5G internet, measure data on traffic levels in real time, monitor local air quality, and detect flooding and other weather-related events. In some parts of the world, this could be particularly useful with weather patterns becoming increasingly erratic as a result of climate change.

Governments and investors can work together to stimulate a blend of public and private financing to invest in smart lampposts as demonstrated in the EU's Green Deal. In 2020, the EU confirmed that 30% of its €750 billion Covid recovery fund would be spent on climate-related investments and contribute to the EU's green and digital transition goals. The fund is notable in that the bloc as a whole, rather than individual countries, will borrow money from the markets, with roughly half the recovery funds distributed as grants to the hardest-hit EU nations and low-interest loans making up the remainder – an example of private-public funding blending which could investment in smart lampposts. It's clear that smart cities urgently require new sources of capital investment, both private and public, if they are to rise to the challenges that the future will present.

And the beauty of it all is cities such as London and Barcelona in particular are lighting the way to a smart future for cities. There is scope for all the cities featured in this report, and hundreds of others around the world, to follow their example, and to go still further in the use of smart lamppost technology. Working together, city governments, lamppost technology providers and investors can make cities safer, healthier and smarter.

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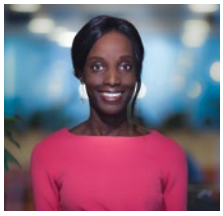
About the author



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