SEPTEMBER 2015

THE CLIMATE GROUP

PHILIPS

PRINCE ALBERT II OF MONACO FOUNDATION

THE BIG SWITCH:

WHY IT'S TIME TO SCALE UP LED STREET LIGHTING

The many benefits of transitioning street lighting to light-emitting diode (LED) technology are clear, but scale-up is not happening fast enough. Based on key findings from The Climate Group's consultation workshops, this briefing is the first in a series which analyzes the key non-technical barriers to the wide-scale adoption of LED street lighting – and how these barriers can be addressed through our new global campaign: LED = Lower Emissions Delivered.

Climate change demands large-scale action to avoid the worst predicted impacts. New policies, products and services are urgently needed to deliver a low carbon economy that secures both continued growth and a safe climate. But the technologies already exist to massively reduce emissions. And LED lighting is a prime example of a proven technology that must be implemented at scale, as rapidly as possible.

The Climate Group and Philips have called on every single city and utility around the world to schedule the switch of their street lighting to LED by 2025. We launched a major new global campaign called LED = Lower Emissions Delivered in September 2015, to encourage local governments, cities and utilities to embrace the carbon and cost benefits of LEDs.

"As an emissions-cutting and money-saving technology, LED street lighting is the big no-brainer. Our global trials and stakeholder consultations have shown that, when it comes to tackling climate change, LEDs are the lowest of the low hanging fruit and easiest to implement. It's technically proven, commercially viable, and already resulting in major savings for cities around the world. With the number of street lights around the world likely to hit 350 million by 2025, local governments, utilities and financial institutions need to work together to ensure that all new and existing street lights are LED or of equivalent energy efficiency by 2025."

– Mark Kenber, CEO, The Climate Group.

THE EFFICIENT DELIVERY OF LIGHT TO WHERE IT IS NEEDED, AND THE IMPROVED LIGHT QUALITY ALSO PROVIDES MOTORISTS AND RESIDENTS WITH AN ENHANCED NIGHT-TIME ENVIRONMENT THAT IS LINKED TO INCREASED PUBLIC SAFETY AND A BROAD RANGE OF ADDITIONAL SOCIO-ECONOMIC BENEFITS.

By 2050 it is estimated that around 75% of the world's population will live in urban[1] areas. Existing cities around the globe are already facing the three-fold challenge of needing to upgrade aging support infrastructure, reduce public service costs and reduce environmental emissions; all against the barrier of ever-decreasing central government funding.

But the latest predictions for rising population growth, migration to cities and energy requirements cannot be met with current generation capabilities. Urgent investment is needed in low carbon generation technologies, smart grids and energy storage, as well as the parallel implementation of available energy efficient solutions.

One of the most impactful and readily implementable options available to cities is the replacement of inefficient outdoor street lighting with LEDs[2]. The latest energy efficient LED-based street lighting technologies are able to deliver energy savings of up 50-70%[3]. With street lighting accounting for as much as 40% of a municipality's electric utility bill[4], LEDs offer city managers immediate savings in terms of energy, maintenance and running costs.

Availability of wireless connected-lighting technology can also provide city managers with full lighting asset control and performance monitoring, as well as facilitate the implementation of smart and adaptive city lighting and energy saving schemes. The lighting network can also play a key role in future smart city initiatives, such as linked sensor networks and data gathering to help co-ordinate other public services reliant on city lighting.

There are now many compelling examples of successful large-scale LED rollout in cities, where dramatic energy savings have been delivered over extended periods. Indeed, US mayors at the USA Conference of Mayors[5] in 2014 named LED and energy-efficient lighting as the 'top priority' energy technology in their cities within the next two years.

Research estimates that 350 million street lights are predicted to be in place by 2025, and when combined with other high-power outdoor city and commercial lighting[7], with each unit having the potential for a ~50% increase in efficiency, the scale of the potential global energy savings opportunity is truly staggering.

But the critical role LEDs serve in reducing energy costs in public service city lighting also goes far beyond the immediately addressable outdoor street lighting applications. And as more and more LED-based solutions become widely available for the variety of existing internal lighting fittings, we will see significant migration to LEDs for indoor public, office, retail and household lighting too. Some industry experts even predict that within 10 years, indoor and outdoor LED lights will deliver more environmental and economic benefits than any other clean technology[8].

It is clear then, that hard and compelling evidence of the benefits associated with LED lighting is now available. The technology is proven and new business models are creating new options for rollout. But scale-up of this technology is not happening at the pace we need to address the climate challenge.

1 http://www.treehugger.com/urban-design/2050-around-75-all-worlds-population-will-be-urban-good.html

2 LED - Light Emitting Diode as announced by The Climate Group, September 2015

3 http://thecleanrevolution.org/publications/lighting-the-clean-revolution-the-rise-of-leds-and-what-it-means-for-cities

4 http://www.dec.ny.gov/energy/64089.html

5 29% of the polled mayors identified LEDs as the top priority in their cities in the next 2 years.

6 Energy Efficiency and Technologies in America's cities – Jan 2014 – United States Conference of Mayors

7 http://www.northeast-group.com/reports/Brochure-Global%20LED%20and%20Smart%20Street%20Lighting-Market%20Forecast%202015-2025-Northeast%20Group.pdf

8 http://www.reuters.com/article/2013/02/08/us-china-led-idUSBRE91701H20130208

Based on the findings from consultation workshops we are holding around the world, this report is the first in a series that will spotlight the key non-technical barriers to adoption of LED street lighting. Our work to date makes it clear that such barriers are addressable.

So we now seek to drive actions and policy that can replicate the achievements made so far, and accelerate scale-up globally. The Climate GroupGroup's major global campaign major global campaign LED = Lower Emissions Delivered, ensures action is taken that enables local governments, cities and utilities to embrace the carbon and cost benefits of switching to LED street lighting as quickly as possible.

STREET AND OUTDOOR LIGHTING IN THE US

Outdoor lighting consumes a significant amount of energy, about 1.3 quadrillion Btu annually, costing about US$10 billion per year. A total shift to LED outdoor lights would save more than US$6 billion and prevent 40 million metric tons of carbon dioxide emissions per year[9].

- **Street lighting:** Converting all US street lighting to energy efficient LED lamps would save US$2.3 billion and prevent approximately 15 million tons of CO_2 from entering the atmosphere. This is equivalent to taking more than 3 million cars off the street.
- **All outdoor lighting*:** Shifting all the estimated 180 million outdoor lamps in the US to energy efficient LEDs would save more than US$6 billion and prevent 40 million tons of CO_2 from entering the atmosphere. This is equivalent to taking 8.5 million cars off the street[10].

*OUTDOOR lamps include street lighting, parking lots, building exteriors and all other outdoor lighting applications.

GLOBAL ECONOMIC OPPORTUNITY

There are an estimated 304 million street lamps around the world, with this figure expected to reach 352 million by 2025. Over the next decade LED street lights will transform cities and municipalities across the globe, with the global market expected to reach a value of US$53.7 billion. LEDs and smart street lighting are projected to represent respectively 84% and 37% of the global street lighting market by 2025[11].

GLOBAL INDOOR AND OUTDOOR LIGHTING

If the world leapfrogged to LED lamps in all sectors, global electricity consumption for lighting would be reduced by more than 52% and avoid 735 million tons of avoided CO_2 emissions each year[12].

This is equivalent to cutting[13 14]:

- 2.3 % of global CO_2 emissions;
- 14.2 % of US CO_2 emissions;
- the emission of Texas and Iowa combined over a year; and
- the emission of UK and Spain combined over a year.

9 US Department of Energy, Outdoor Lighting accelerator – Fact sheet, 2013 and NRDC Switchboard, LED outdoor Lighting – A $6 Billion annual savings Opportunity Ripe for the Picking, 2015

10 http://www3.epa.gov/otaq/climate/documents/420f14040a.pdf

11 http://www.northeast-group.com/research.html

12 http://www.se4all.org/energyefficiencyplatform/lighting/

13 https://www.iea.org/publications/freepublications/publication/CO2EmissionsFromFuelCombustionHighlights2014.pdf

14 http://www.eia.gov/

PIONEERING LED STREET LIGHTING

The Climate Group has been driving pioneering LED street lighting projects since 2008, when we first committed to supporting the scale-up of LEDs. Then in 2012, we presented results from a two and half year global pilot program, reporting the outcome of tests with LED street lamps in 15 separate trials across 12 cities around the world including New York, London, Kolkata and Sydney. One of the key findings was that LEDs were confirmed as a mature and robust technology for street lighting, with reported energy savings of between 50-70%; this figure even rises to 80% when combined with smart controls.

LED LIGHTSAVERS SUMMARY REPORTS[14] [15] AND SEPARATE CITY REPORTS:[16]

The full results were presented in the report, Lighting the Clean Revolution: The Rise of LED Street Lighting and What it Means for Cities. Following this work The Climate Group made a call at the United Nations Conference on Sustainable Development, Rio+20, that all new public lighting – both street lighting and in public buildings – should to be LED7 by 2015. The intention was for all future city street lighting upgrades to target LEDs or similarly efficient technologies.

CITIES

Real progress on scale-up of LEDs in cities has already been made. The City of Los Angeles was an earlier LED adopter and is now a case study in positive outcomes. In 2009, the city spent around US$15 million and pumped out 111,000 tons of CO2 to light up its streets. No wonder councils wanted to find ways of making lighting smarter and more efficient[17]. Then in January 2015, the City of Los Angeles Bureau of Street Lighting reported 157,000 units of LED lights, with energy savings of 63.1% and annual savings[18] of US$8.3 million.

Following its initial installation of LEDs, the city is also adding wireless web-based connectivity ('smart controls') for street light monitoring and control purposes[19] .

This large-scale upgrade to an existing LED installation highlights the inter-operability of LED-based technologies from different manufacturers. It also demonstrates that where city budgets may be very constrained, LEDs offer immediate savings and can be 'future-proofed', allowing cities to phase in additional connectivity and services.

14 http://www.theclimategroup.org/what-we-do/publications/lighting-the-clean-revolution-the-rise-of-leds-and-what-it-means-for-cities/

15 http://www.theclimategroup.org/what-we-do/publications/global-outdoor-led-trials/

16 City Reports: http://www.theclimategroup.org/led-trial-final-reports/

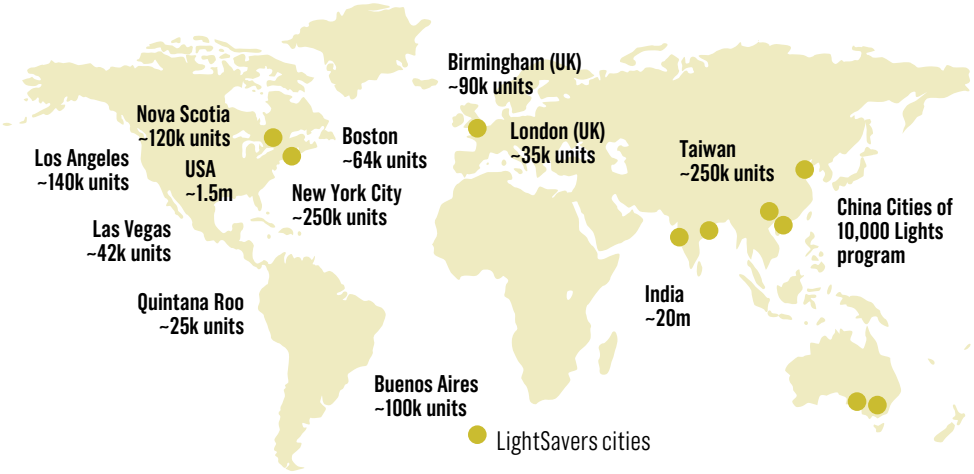
17 http://www.newscientist.com/article/mg22329814.100-massive-smart-light-lab-tests-tech-to-slash-emissions.html

18 http://bsl.lacity.org/downloads/led/LED_Energy_Savings_010215.pdf

19 http://www.fiercewireless.com/tech/story/los-angeles-upgrade-street-lights-gps/2015-05-14

New York City has a similar story. It is currently replacing 250,000 street lights with LEDs, the largest project of its kind in the country. By 2017, the city will be saving US$14 million in energy and maintenance costs. If the rest of the country followed in New York City's footsteps and every outdoor light in the US switched to LED, the nation would save a grand total of US$6 billion. The carbon reductions would be the same as taking 8.5 million cars off the roads[20].

EXAMPLES OF LED STREET LIGHTING ADOPTION



There is a growing list of cities announcing scale-up of LEDs for street lighting. The Climate Group's consultation workshops confirm that participating cities see LEDs as the primary option for upgrading their infrastructure – and that the vast majority of enquiries for new street lighting infrastructure upgrades are LED based[21].

Significant commitments to LED street lighting include President Obama's 'Presidential Challenge for Outdoor Lighting'[22] to retrofit 1.5 million LED street lighting poles by 2016 in the US with the Department of Energy, and India's[23] Domestic Efficient Lighting Program to upgrade 20 million street lights to LEDs, with an estimated saving of US$890 million a year.

The Clean Energy Ministerial Global lighting Challenge[24], which involves a coalition of governments such as Australia, China, Russia and South Africa, and was launched in May 2015, is similarly seeking to accelerate deployment of energy efficient and high-quality lighting across all sectors.

LED CONSULTATIONS

Despite the reported performance of LEDs and a growing number of high-profile commitments from cities and governments, many cities around the globe are still to announce their plans to upgrade.

So during 2014-15 The Climate Group, supported by Philips and the Prince Albert II of Monaco Foundation, undertook a series of lighting consultation workshops around the globe to identify the remaining regional barriers to adoption. An initial consultation document was prepared, with the intention of raising some of the key issues on LED adoption, and to prompt broader questions in the lead up to a consultation workshop.

The workshops convened local representatives from cities, government departments, and service and finance solution providers, and helped raise questions on regional challenges, as

20 https://www4.eere.energy.gov/challenge/sites/default/files/uploaded-files/BBChallenge-HighPerformance-OutdoorLighting-FactSheet_1.29.15.pdf

21 Philips Lighting, 2015

22 http://www.ledsmagazine.com/articles/2015/01/us-government-accelerates-led-street-light-push-in-doe-program.html

23 http://www.digitaltrends.com/cool-tech/india-led-light-bulbs-streetlights/

24 http://www.cleanenergyministerial.org/Portals/2/pdfs/CEM6-GlobalLightingChallenge-FactSheet.pdf

well as more general adoption barriers. Among these barriers are issues around developing tailored business models, achieving stakeholder consensus, addressing public concerns, project risk allocation, available financing solutions, technical queries and adapting to market trends.

Below are just a few examples of the high level and regional findings from city consultations.

- **LED technology for street lighting applications is now broadly accepted** by consultation participants **as mature and proven on large scales and over extended periods** – and is the primary technology being explored for future city lighting upgrades.

- Cities report that the development of their internal **economic business models and formalized case justification for upgrading street lighting is an urgent priority – and key cause for delay.** This activity is required to help achieve stakeholder consensus and accurately assess the benefits and operational changes before internal approval can be achieved.

- **Each city has a unique history in terms of existing lighting infrastructure status, funding capacity, asset ownership and political support.** Each city therefore needs to develop a unique technical and financial business case for their circumstances. The availability of lighting modelling tools, case-studies and online guides each provide useful guidance for cities. But reduced staff capacity and familiarity with the most suitable LED options and latest available financing schemes for their circumstances, can result in significant delays in finalizing tendering documentation and the subsequent procurement process. Availability of central government funding for short-term independent business support during the initial project analysis phase was a common request from city lighting managers.

- **The linked socio-economic benefits of enhanced and modern city lighting** are commonly presented as secondary to the energy efficiency claims, but nevertheless play a key role in the broader strategic business justification for cities to adopt energy efficient LEDs and smart control capabilities.

- **The limited range of available financing options in many regions remains a consistent barrier for cities seeking to upgrade their lighting.** A key adoption delay in many regions is the limited availability of suitable and flexible financing terms that accurately reflect the proven long-term capabilities and savings that LEDs can provide to cities, and the corresponding reduced risk profile that LED technology now represents for city infrastructure upgrades.

25 http://www.neep.org/sites/default/files/resources/DOE_LED%20Street%20Lighting%20Assessment%20and%20Strategies%20for%20the%20Northeast%20and%20Mid-Atlantic_1-27-15.pdf

- **A 'connected lighting' approach can facilitate future upgrading** of the lighting infrastructure and integration of smart city initiatives as they are developed and trialled. A broad range of smart city concepts are in development where city data collection and public services are envisaged to become more integrated to provide an enhanced and efficiently run city for residents. However, any uncertainty around future smart city concepts should not delay rollout and cities benefitting from energy efficient LED street lighting.

- Complexity around the ownership of street lighting assets **can also represent a key barrier to scale up in some regions**, particularly where lighting assets may be part or wholly owned by utilities, and where key utility electricity revenue streams could be detrimentally affected by the adoption of more energy efficient solutions. Adoption routes of LEDs in street lighting should seek to include mutually beneficial solutions for all relevant stakeholders.

- **The drive for energy efficiency should not be at the expense** of LED luminaire quality, nor result in the inappropriate replacement of traditional fixtures or lack of flexibility in light adjustment to help avoid excessive glare at installation. Early consultation with the end-users[25] and sample trials of lighting fixtures can help identify possible local challenges and refine specifications for final large scale rollout.

- **Caution is needed when comparing LED 'payback' periods.** A simple luminaire lamp retrofit payback period may be much shorter in one location than another, and depend on scale of the project or how it is financed. Some cities may elect to replace luminaire heads, lighting poles or cabling, or undertake a full highways infrastructure upgrade implying a far longer payback period; and where the LEDs may be a small part of a much larger city-wide infrastructure initiative.

- **Caution is needed when comparing LED 'efficiency' figures.** Simple comparisons of LED efficiency need clarification as different approaches can be taken. Efficiency may be presented for the core LED lighting chip component, the assembled LED module, the complete assembled luminaire, or based on the amount of light delivered to the street level.

- **Some LEDs have failed in the past in early installations. Clarification on the reasons for early adopter failures and answering any lingering public concerns will help accelerate their wide-scale acceptance.** Very early reported failures of LEDs have tainted opinions. Some early adopters have experienced failures[26] due to low cost or quality products, as well as examples of negative feedback from citizens where the lighting design has not been optimized for the local situation, or has not involved representative trials or consultations with the public.

This initial summary of consultation findings will be discussed and significantly expanded in a series of future briefing notes from The Climate Group. These will focus on framing LED business case options, associated socio-economic benefits from modern lighting, examples of supporting policy, addressing health related questions, LED quality thresholds, and topics of specific regional focus such as challenges of local LED product sourcing, regional funding approaches, and complexities around lighting asset ownership and control.

25 http://www.neep.org/sites/default/files/resources/DOE_LED%20Street%20Lighting%20Assessment%20and%20Strategies%20for%20the%20Northeast%20and%20Mid-Atlantic_1-27-15.pdf

CALLS TO ACTION

Since The Climate Group's 2012 call to accelerate the scale-up of LED street lighting (or technology as energy efficient) around the globe, progress has been slower than expected – and various general and regional causes for these delays have been identified in our consultation work. Importantly though, the challenges are addressable and are no longer around the performance of the technology – so we are now calling for accelerated scale-up.

LED products have now reached technological maturity for applications such as street lighting.

*or as energy efficient

The Climate Group calls on governments and every single city and utility globally to schedule the switch of their street lighting assets to LED (or energy-efficiency equivalent) by 2025.

To facilitate this we also called for more aggressive targets for energy efficiency and renovation rates in cities. With the prospect of over 50% energy savings, we demanded all cities to proactively explore more energy efficient options for public lighting and financing – and to not delay planning upgrades until existing infrastructure fails.

"The move to new LED and connected LED street lighting is encouraging," said Harry Verhaar, Head of Global Public & Government Affairs at Philips Lighting, "However, the current renovation rates of existing streetlights are too slow. We need to double the renovation rate so that we keep pace with the rising demand for energy. Renewing existing infrastructure with LEDs needs to be a priority if cities are to realize the benefits of saving in money and energy and better lit, safer streets."

We also called for central governments to explore opportunities whereby cities can access central funding to support their initial internal LED business case development. This would help facilitate sourcing of any required external expertise in the framing and selection of the business model and finance options which are appropriate for their unique city circumstances. Such early support could help to rapidly accelerate the subsequent tendering and bid processes.

The Climate Group also identified that in many locations scale-up of energy efficient street lighting can be delayed as a result of complex lighting asset ownership. For investor-owned utilities in particular the adoption of energy efficient technologies such as LED street lighting can provide particular challenges around management of existing lighting asset value which need to be accounted for, as well as risks of reduced revenues as a result of end users using less electricity.

2015: The Climate Group is now calling for utilities that part or wholly own street lighting assets, together with their city partners, to explore mutually beneficial routes to providing enhanced street lighting solutions and LED-based lighting tariffs.

End of 2016: We call on them to publish their intentions to explore the benefits of energy efficient street lighting for city customers, revenue impact and potential upgrade options.

Such challenges around complex asset ownership exist in many parts of the US and it is recognized that the very best new technologies will stay on the shelf if key stakeholders do not share in the benefits they can provide.

Where street lights are owned by the utility, the customer's choice of street light technologies is in most cases limited to the utility's offerings within the approved tariffs. While utilities generally offer several options for street lighting technologies, they can be slow to develop offerings for newer technologies, as is the case with LEDs. For example, as of August 2014, only 13 of 45 investor owned utilities in the Northeast and Mid-Atlantic of the US regions offer LEDs within their utility-owned tariffs[27].

It is recognized in such situations, that mutually beneficial solutions to upgrading to LEDs must be explored to allow cities and their citizens to benefit from enhanced modern city lighting, and for utilities to secure sufficient revenues and incentives, as well as facilitate a more resilient lighting infrastructure.

LED = LOWER EMISSIONS DELIVERED

Non-technical barriers to the adoption of LED street lighting clearly remain, but they are addressable – and many would benefit from policy support. The Climate Group's major global campaign LED = Lower Emissions Delivered, encourages local governments, cities and utilities to embrace the carbon and cost benefits of switching to LED and supporting global carbon emission reductions.

Over the next 24 months, The Climate Group is seeking to build upon our calls to action and develop solutions to regional barriers to LED adoption – and help our global call become a global reality.

"LED ISN'T JUST ABOUT CUTTING CO_2 EMISSIONS: FOR COST-CONSCIOUS CITY LEADERS LOOKING TO SAVE MONEY, IT ALSO LEAVES THEM WITH 'LOTS OF EXTRA DOLLARS'."

- Mark Kenber, CEO, The Climate Group

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The Climate Group benefits from the support of the Prince Albert II of Monaco Foundation http://www.fpa2.com

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