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## STREET LIGHTING REPORT



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# Smart Street Lighting Market

Lighting the path to the future.  
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## An overview

### Where does the light lead us moving forward?

As humanity moves into the next phase of the Fourth Industrial revolution, emerging technologies like machine learning, solar panels, and smart sensors, are leading the way when it comes to creating efficient, safer, and smarter cities.

Smart cities, which are going to be the primary drivers for the street lighting market, are beginning to pop up in developed nations all over the world like in France, Germany, Japan, China, and the United States. What is a smart city? By definition, a smart city utilizes different types technology connected to the Internet of Things (IoT) to collect data and use the insights gained from this data to manage assets, resources, and services efficiently, in order to improve operations across the city.

In terms of market share, this concept is the Wild West, and companies around the world are competing for real estate to implement their cutting edge technologies to better manage cities. In particular, lighting (street lighting) is a highly competitive market as major cities are looking toward the future to more efficiently and cheaply light their streets. But this hotly debated topic is far from resolved as various companies pitch their copious solutions.





When considering how to upgrade their street lighting, cities have to consider several factors, such as: 1) what are the costs associated with purchasing, installing, and maintaining lights, 2) what are the best suppliers of street lights, 3) what are the different types of street lighting, and 4) how much is their current array of street lights costing them.

## Getting Familiar with Street Lighting

Before diving into the details of the industry itself, it is imperative to understand and recognize the various types, and categories, of street lights.

**Wired:** relates to the older forms of street lighting due to their integrated nature into the existing power grid, typically powered directly using wires and cables. Wired street lighting, in essence, is in it's twilight years as the only areas actively installing larger numbers of wired street lighting are slow, developing nations who have yet to step into the arena of smart cities, although it is possible to upgrade traditional street lighting.

**Wireless:** relates to the newest versions of street lighting that requires little to no integration into the existing power grid due to their independent nature and being powered typically by solar energy.

## Types of Street Lighting

The various forms of street lighting, based on the type of bulbs used, and are ordered by relative brightness using the Color Rendering Index (CRI), include:

- Low-pressure sodium (LPS) - 0 CRI
- High-pressure sodium (HPS) - 20 to 40 CRI
- Metal Halide - 60 CRI
- Light Emitting Diodes (LEDs) - 70+ CRI

Currently, the type of lighting most common in cities is metal halide lights, which provide a relatively high level of brightness that allows for colors to be differentiated between during nighttime, and possess 7000 to 8000 hours worth of usage (about 1 year). But as cities begin to upgrade their street lighting networks, LEDs are beginning to take center stage due their longevity (50,000 hours or 5 to 7 years) and require minimal maintenance due to their long life cycles.

Although LPS and HPS lights were included in this list, they are sparingly used due to their low visibility and high energy costs.

On the following page, you will get a chance to see an in-depth guide on the various types of lighting and see the primary differences between them including lumens, cost per lumens, consumption, and wastage.



Comprehensive Street Lighting Guide				
	LED Light	High Pressure Sodium	Mercury vapor	Incandescent
Lumen	15,500	28,000	28,000	5,600
Watts	100	250	400	400
Lumen/Wats	155	112	70	14
Wastage %	0.00	0.50	0.50	0.50
Wasted Light (Lumens)	0	14,000	14,000	2,800
Actual light available (Lumens)	15,500	14,000	14,000	2,800
Available Lumens/Watt	155	56	35	7
Hours of operation per night	10	10	10	10
Cost of electricity (\$/kWh)	0.10	0.10	0.10	0.10
Annual consumption (kWh)	383	913	1,460	1,460
Annual electricity charges (\$)	38.3	91	146	146
Available Lumens/\$	411.9	153	96	19
Cost per 100 Lumens	0.24	0.65	1.04	5.21
Wastage (kWh)	0	456.25	730	730
Wastage (\$)	0	45.625	73	73
Average lifespan (years)	20+	5	4	3

via My LED Lighting Guide



## Market Trends For Street Lights

Now that we have a better understanding of the various types of lighting, we can better dissect the market at large.

With the numbers of street lights estimated to reach close to 500 million by 2025, the need for new solutions, as we move into a greener future, will incorporate sensors, cameras, and efficient sources of energy like solar. The street light market is projected at a whopping 28% CAGR between 2017 and 2023 with a \$73 billion market value, and countries planning to spend upwards of \$75 billion on street lights in the same time span. Although a competitive market, it is somewhat contracted to a few large market players overall which include companies like GE, Cisco and Itron.

As stated before, the primary drivers behind this market will remain dependent on the development of smart cities which will seek to leverage sensors, cameras, and renewable

energy in order to provide applications, such as video monitoring, auto-dimming based on whether conditions and pedestrian traffic, environmental monitoring (i.e. air quality), and even provide internet connection, which is currently being provided in some cities by using the light spectrum rather than Wi-Fi (cleverly termed 'Li-Fi').

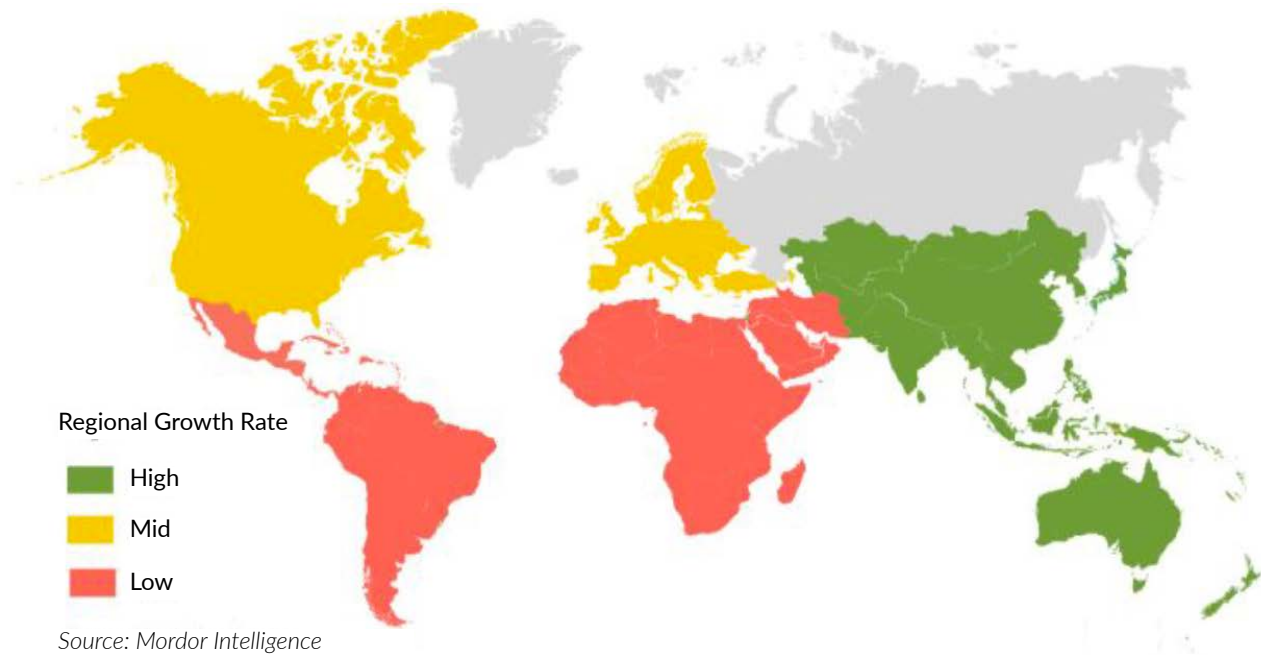
Along with the technological advances in street lighting, various geographic regions are making their own impacts on the market as North America currently has the largest market share of the street lighting market, but with the Asia-Pacific (APAC) region expected to register the highest incremental growth, due to the increasing technology awareness and technology adoption by governments in the region. This can be reflected in the increasing need in these regions for energy reducing technologies, another driving force in the market.



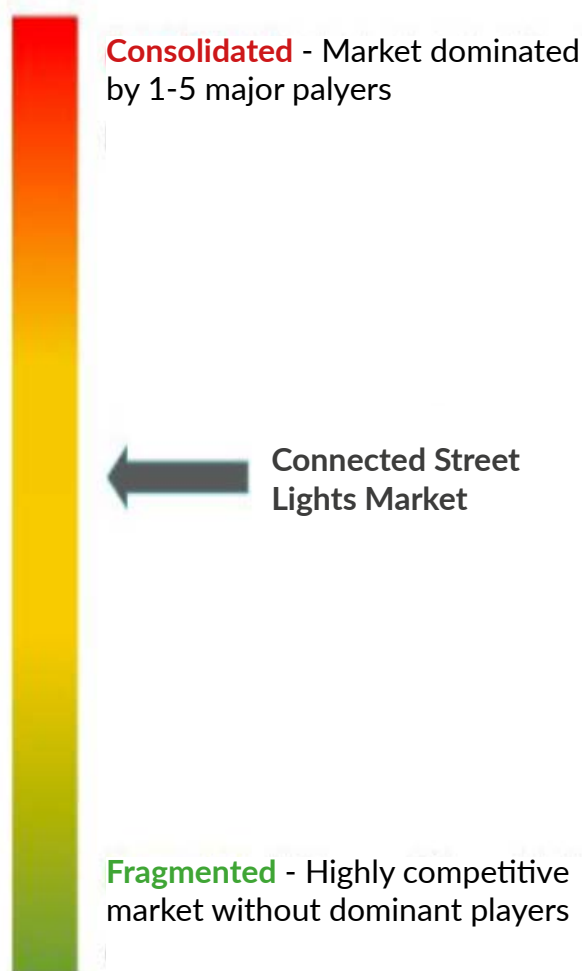
While Europe is not far behind North America and APAC, the South America, Middle East, and Africa regions are struggling to find their foothold due to the lack of access to new smart city technologies, poor infrastructure, and lack of internet penetration.

Lastly, with the expanding population around the world, an increase in the number of people living in urban areas, including the overall growth of urban population (81% of the total population that is living in cities) is the final major driver for the adoption of smart and intelligent solutions.

With CO2 emissions being at the forefront of discussions in the past decade, in the United States alone, the Boston Globe projected that the roughly 50 million street lights (including highway lights) uses the amount of energy equivalent to power 1.9 million homes or driving 2.6 million cars per year - a stark reality for our decrepit power grid.



## Market Concentration



via Mordor Intelligence

## The True Costs of Street Lighting

One of the primary factors that cities and municipalities have to take into account when deciding new street lighting is a costs-to-savings analysis in order to determine the costs of the various types of lighting, whether that's one year or ten years into the future. Check below for a detailed formula to better understand the costs of implementing new street lights provided by our friends at My LED Lighting Guide.

### Light Replacement Calculation:

1. Cost of replacement bulb +
2. Cost of lamppost +
3. Salary of 2 people +
4. Rental of lift +
5. Truck Rental or Truck Costs
6. Construction (varies)

Here are the projected costs for street lights:

- Traditional = \$1500 (every year)
- LED = \$3000 (every 5 to 7 years)

Where are all the street lights?	
City/ Country	No of Street Lights
United States	50,000,000
Los Angeles	209,000
Madrid	225,000
London	2,800,000
Paris	300,000
Delhi	200,000
Jakarta	140,000

## Top Street Light Manufacturers

- Current, Powered by General Electric
- Echelon Corp
- Cisco
- DimOnOff
- Philips
- Flashnet
- OSRAM
- Gridcomm
- Axiomtek
- Verizon
- Telensa
- Twilight
- Signify
- Acuity
- Itron
- Silver Spring Networks

Top Energy Producers in the United States			
Company	No. of customers	Sales (mWh)	Avg. retail price (C/kWh)
Pacific Gas & Electric (PG&E)	5,188,308	75,114,523	16.64
Southern California Edison	4,963,983	75,828,585	15.75
Florida Power & Light	4,708,793	104,431,096	10.08
Consolidated Edison	2,478,248	19,756,921	25.49
Georgia Power	2,410,042	83,740,365	9.86
Dominion Energy	2,381,312	75,562,974	8.84
DTE Energy	2,142,829	41,923,906	11.22
Public Service Electric & Gas	1,900,444	19,571,938	14.95
Duke Energy	7,400,000	52,700,616	8.55
Consumers Energy	1,791,366	33,253,922	12.34





## In Summary

The international street lighting market is one that will continue to speed up over the next decade as cities and countries begin to modernize. As stated before, factors like access to new technologies, access to internet, and the need to reduce energy expenditures will drive this market further.

When considering entering this market, it is important to understand that in a contracted market, gaining market share will depend wholly on novel ways to provide solutions that larger companies aren't always doing and/or partnering with said companies to piggyback off their implementation projects. Currently, there are dozens of startups creating internet-connected, solar-powered, smart lights that do more than just light up the streets.

Along with novel technologies revolutionizing the industry, it is going to take large innovations in every countries powergrid to keep pace. Without the ability to power the current array of traditional street lights effectively, and eventually power newer models of street lights using independent power sources, like solar energy, projects will not see their full benefits. It also should be noted that without an in-depth plan for municipalities to enact large scale street lighting projects, in regards to effective installation of newer lights, the cost-benefits will not be fully realized.

# Street Lighting Research

## A General look over Street Lighting market

Public lighting systems are consuming 3.19% of the world's total global electricity which equals the combination of the production of both nuclear and hydropower plants around the globe. <sup>[1]</sup>

In all cases of street lighting solutions, service providers are meant to work with various vendors to build a complete solution. Except for Philips Lighting(Signify) and SELC, no other service providers deliver a total solution. <sup>[2]</sup>





Apart from the pole, a dynamic outdoor lighting system consists of:

- Luminaires that hold the fitting the lamp and in some cases the electronics.
- The lighting electronics or ballasts that keep the lamps burning.
- The lamp manufacturers.
- The controls that drive and switch the ballasts and the network between the controls electronics and segment controllers in the power supply cabinet.
- The segment controllers in the power supply cabinet that handle and manage a segment of outdoor lights.
- The wide area network that provides the communications between de segment controllers and the back office or central control system.
- The central control system that allows for the management of all poles.
- The existing IT infrastructure that every company has that needs information from the street light system.

To have a functional system, parties need to define and specify a system that suits their needs <sup>[2]</sup>. Other than the installation of the street lights, there are extra costs of operation and maintenance, cost to replace the components and cost of energy.



## The costs associated with the purchase, installation and maintenance of street lights

When it comes to the pricing of street lights, there are so many different approaches depending on the needs and plans of the municipality, government, or highway operators. Because, if the pole construction is included, the cost of the system is increasing rapidly.

If it is all about changing luminaries, either the end of life products or whole system change to LED technology, then the cost of operation and maintenance agreements will be made.

In both concepts, it is understood from the examples that maintenance for a certain amount of years is included in the deal. The expense of the system is changing all around the world, so, found cases of agreements will be given below one by one.



## Case 1

The research explains that changing Italian capital Rome's street lights to LED technology requires 193,045 lamp replacement.

The financial approach is made on changing the luminaries, operation cost of the change, and maintenance if necessary. It appears that 208,5 M€ investment is necessary. But due to the long lifetime of LED (50 000 – 100 000 hours), less maintenance cost, and less energy usage, payback time is calculated to be 8 years.

In the tables below, the whole cost of light bulb change is given. <sup>[3]</sup>



Input data for the LED Substitution					
Type of lamp	Current Lighting System		Replacement Proposed		
	Electrical Power (W)	Number of lamps/luminaire	LED power (W)	Cost of LED lamp replacement (€)	Total cost of substitution (€)
High-pressure sodium lamp	70	812	22	700	568,400
	100	16,864	30	850	14,334,400
	150	80,421	60	975	78,410,475
	250	59,942	90	1200	71,930,400
	400	15,155	150	1635	24,778,425
Low-pressure sodium lamp	35	172	9	450	77,400
	55	37	15	650	24,050
	90	147	24	700	102,900
Metal-halide lamp	70	1672	45	850	1,421,200
	100	3041	60	975	2,964,975
	150	4879	90	1200	5,854,800
	250	828	155	1635	1,353,780
Mercury vapour lamp	35	8611	20	700	6,027,700
	125	263	70	1200	315,600
	250	180	135	1635	294,300
	400	9	215	2000	18,000
	1000	12	537	2500	30,000
Total		193,045			208,506,805

Main characteristics of the project		
	Estimate	Value
I	Total cost of LED investment (€)	208,506,805
A	Cost of energy - LED (€/year)	11,025,772
B	Cost of energy - current system (€/year)	36,631,574
C	Cost of lamp replacement - current system (€/year)	3,467,740
B+C-A	Annual saving (€/year)	23,073,538

Results of the traditional analysis	
Data	Value
Net present value (€)	23,650,910
Internal rate of return (%)	8.97
Return on investment	1.11
Simple payback time (years)	8

## Case 2

Asked questions to the Highways England Company Limited give proof on the purchase and installation costs of the street lights. <sup>[4]</sup> Here is the questions and answers:

- 1) The average cost of purchasing and installing a streetlight?
  - The average cost of installing a street lighting of the motorway is in the region of £2000 per lighting column this includes such costs as the column its self, the lantern, the cable for energy, labour costs and other costs such as fuses and switchgear. What is doesn't cover is the traffic management costs because these costs vary so much based on location and traffic.
- 2) The average annual maintenance cost of a streetlight?
  - On average we spend 1% of the areas overall maintenance budget on street lighting maintenance per year, however, because the lighting asset varies from area to area and year by year the maintenance costs are difficult to come by.
- 3) The average end of life disposal costs of a streetlight
  - We have to dispose of our street lighting in accordance with European legislation so there is a small cost per year for disposal, usually less than £5000 per year.



## Case 3

The town of Henniker in New Hampshire prepared a street light change report and it indicates that their HPS lights were costing around 130 to 260\$ for each luminaire. They are planning to change to use Affinity LEDs and in their financial report, the cost of each LED is around 74 to 150\$. The city energy committee's report includes a 110\$ purchase and installation cost for each street light. Here is the executive summary of their financial approach. <sup>[5]</sup>

Upgrade project costs						Incentive		
Purchase (Material cost for Eversource (Randy)		Installation		Total Purchase + Installation		To be verified by Eversource		
Cost per fixture	Total cost	Cost per fixture	Total cost	Cost per fixture	Total cost	Incentive/ Fixture	Product code	Total incentive
\$ 196.00	\$ 9,702.00	\$ 109.48	\$ 5,364.70	\$ 307.48	\$ 15,066.70	(\$ 100)		(\$ 4,900)
\$ 211.00	\$ 5,697.00	\$ 109.48	\$ 2,956.06	\$ 320.48	\$ 6,653.06	(\$ 100)		(\$ 2,700)
\$ 129.00	\$ 129.00	\$ 109.48	\$ 109.48	\$ 238.48	\$ 238.48	(\$ 75)		(\$ 75)
\$ 129.00	\$ 129.00	\$ 109.48	\$ 109.48	\$ 238.48	\$ 238.48	(\$ 75)		(\$ 75)
\$ 269.00	\$ 269.00	\$ 109.48	\$ 109.48	\$ 378.48	\$ 378.48	(\$ 75)		(\$ 75)
Avg. \$ 201.59	\$ 15,926	Avg. \$ 109.48	\$ 8,649	Avg. \$ 311.08	\$ 24,575			
						Incentive		(\$ 7,825)
						Net		\$ 16,750
						Simple payback		1.93 years

## Case 4

The smart led street light change project in Columbus explains that when they change to LED from conventional high pressure sodium lamps, their operation cost reduced from 60.37\$ to 27.17\$ per light. The cost associated with the luminaires is as seen in the table below for a total of 207 street lights. <sup>[6]</sup>



Conv. wattage	LED Equivalent	Quantity	Cost of Fixture	Installation cost	Total cost (LED)
55 W	30 W	15	\$ 185.00	\$ 170.00	\$ 5,325.00
100 W	60 W	140	\$ 225.00	\$ 170.00	\$ 55,300.00
200 W	100W	52	\$ 238.00	\$ 170.00	\$ 21,216.00
207					\$ 81,841.00

Bulbs per 100,000 hours	Lifespan (hours)	Lifespan (years)	Number of replacement during study	Full study luminaire cost
1.7	58,823.52941	6.715014773	3.723	\$ 304,694.04

Conv. wattage LED Equivalent	
Energy savings from LED conversion	55% - estimate provided by the city
Cost/KWh of LED lights	\$ 0.084 - assumes that the cost is the average of three different costs charged by the three different suppliers of electricity in Columbus, provided by the city



## Case 5

City of Portland's Bureau of Transportation (PBOT) in the United States, worked on planning the change of their street lights to LED from High Pressure Sodium (HPS) and it appears in their report that an HPS luminaire cost is 110\$ and a LED is 124\$. The agreement with the LED change has been made with ECobra-head LED roadway luminaires and their conversion of 45.000 lights is completed in 2019. City council is expecting a 75% reduction in maintenance cost since HPS's need to be replaced in every 5 years but LED lights are expected to last as long as 24 years because of their 100.000 hours life cycle <sup>[7]</sup>.

*PBOT purchased by the Leotek ECobra LED roadway luminaire to replace high pressure sodium residential street lights throughout the city.*

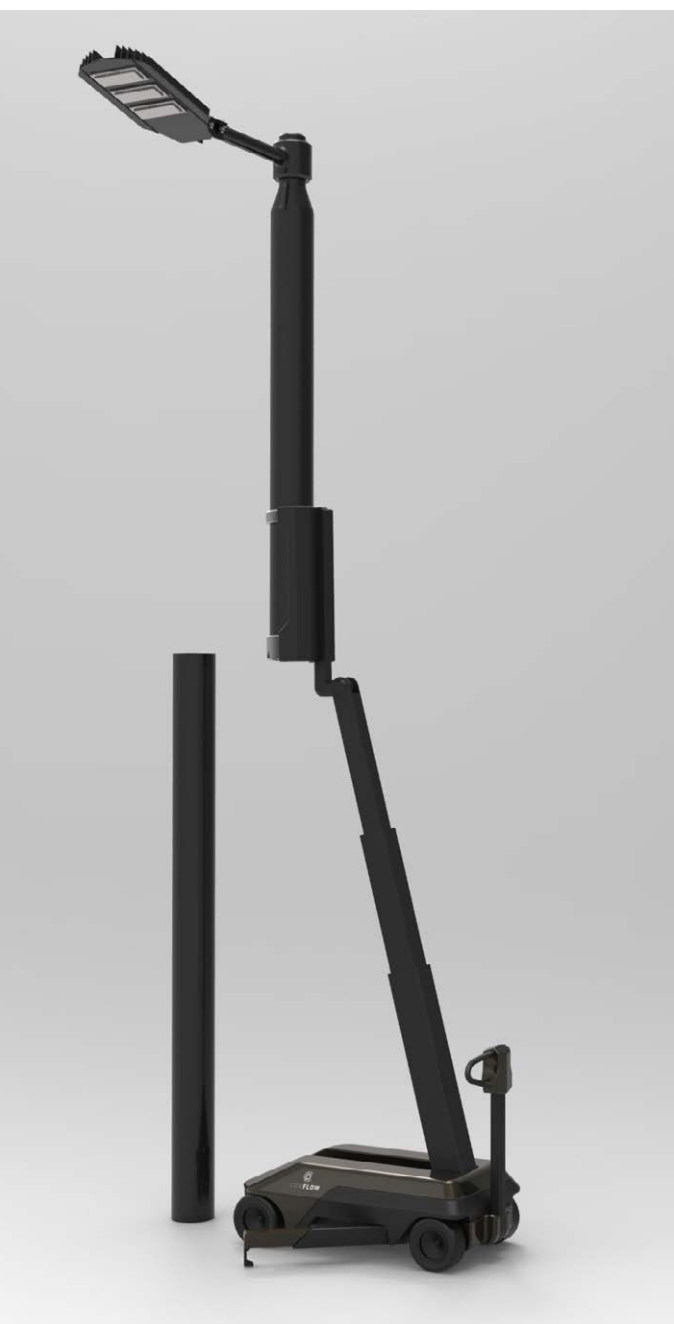
# Case 6

Since the cost of installing a new street lighting system requires a huge amount of first investment, some companies came up with strategic pricing for their service. First Energy provides 10 years service contract for its customers and bills the municipality on a monthly basis. Their service includes energy, labor, and fixture costs associated with the installation. But they do not cover mast arms, poles, transformers, brackets, and power supply lines. Below in the tables, their price for LED and HPS are given respectively. <sup>[8]</sup>

Watts/kWh per month	50/18	90/32	130/46	260/91
Lumens	4,000	7,000	11,000	22,000
Energy @ \$0.08/kWh*	\$ 1.44	\$ 2.56	\$ 3.68	\$ 7.28
Fixture	\$ 8.29	\$ 9.88	\$ 11.14	\$ 17.30
Total monthly costs	\$ 9.73	\$ 12.44	\$14.82	\$ 24.58

Type	HPS					
Watts/kWh per month	70/29	100/50	150/71	200/80	250/110	400/169
Lumens	5,800	9,500	16,000	22,000	27,500	50,000
Energy @ \$0.08/kWh*	\$ 2.32	\$ 4.00	\$ 5.68	\$ 6.40	\$ 8.80	\$ 13.52
Fixture	\$10.48	\$ 9.28	\$ 8.82	\$ 13.47	\$ 14.15	\$ 9.26
Total monthly costs	\$ 12.80	\$ 13.28	\$ 14.50	\$ 19.87	\$ 22.95	\$ 22.78





## Case 7

Lindon City in Utah published a Q&A form in order to answer questions coming from the public for their new street lights. The city council indicates that their contractor “Rocky Mountain Power” is no longer continues to be responsible for the installation and maintenance of street lights and they are looking for another private contractor. The city council guesses that the installation cost of 1 street light to be between 2.000\$–4.000\$. With the purchase and maintenance agreement additionally, the overall cost of 1 street light is expected to be 5.000\$–8.000\$ depending on the particular lighting style <sup>[9]</sup>.

## Case 8

Los Angeles is one of the first cities around the world that changed its lighting system to LED starting from 2008 with over 220.000 lights of the city. Los Angeles has its street light department as “The Bureau of Street Lighting” and they are responsible for electricity, re-lamping and cleaning, all needed repairs, eventual modernization, and replacement of the streetlights when necessary. In Los Angeles, property owners pay for the installation of street lighting in their street, and additionally, an annual bill will be added to their “country tax bill” for maintenance purposes. Because City Council indicates that their general fund budget does not include the installation of street lights. The related installation and maintenance costs are given in the below table <sup>[10]</sup>.

System	Residential		Commercial	
	Installation	Maintenance	Installation	Maintenance
Modern system	£ 3,000 - \$ 4,000	\$ 65/year	£ 3,000 - \$ 4,000	\$150/year
Ornamental system	\$ 7,000 - \$ 8,000	\$ 100/year	To be determined <sup>(a)</sup>	To be determined <sup>(a)</sup>
Energy @ \$0.08/kWh*	To be determined	\$ 160/ year	To be determined <sup>(b)</sup>	\$ 50 to \$100/year

(a) Cost based on unit chosen

(b) These values are greatly determined by the pedestrian unit chosen. This is a pedestrian unit installed on or between existing streetlights.

## Case 9

The city council of Novi in Michigan published a street light purchase of them explaining the cost of each required part bought from Detroit Edison Company (DTE). Construction of 3 unit 80 Watt Granville LED fixture including labor, materials, and overhead is determined as 20.623\$. DTE will be responsible for the operation and maintenance of these street lights but the energy costs will be paid by the City Council. The agreement is made on paying a total installation cost of 17.854\$ in once and an additional 923\$ for each luminaire in each year as a total of 3 years <sup>[11]</sup>.

Description	City Share	Developer/ Association share	Total
Installation costs	\$ 0	\$ 17,854.40	\$ 17,854.40
Annual operating costs	\$ 0	\$ 923.04	\$ 923.04

## Case 10

Zealand region in Denmark has already changed its 37.000 street lights to LED technology out of 160.000 in 2015 and the planning for the rest of the project is ongoing. The contract is made for 4 years including energy, maintenance, control system maintenance and development, and waste management. In addition, modernization of new street lights is expected to be in the deal with all construction work and installation of new units including disposal of existing ones. Total investment for 37.000 new LED streetlights is 39.465.000€ which happens to be 1.067 € per unit. The city explains that they saved 16.2€ per unit from maintenance due to the long life cycle of and efficient operation of LEDs. In total, the saved amount from operation and maintenance is 2.480.000€. The payback period is calculated to be 6-8 years depending on the existing infrastructure <sup>[12]</sup>.

## Case 11

The research made on the cost-effectiveness of the street lighting system investigates 3 different scenarios for Algeria. One of them is the off-grid solar islanded system. Even though it is not found to be the most suitable result, I believe investigating will help your project <sup>[13]</sup>.



## How many street lights are there around the world?

The total number of street lights around the world is 315 million and it is estimated that it will reach up to 359 million by 2026. 57\$ billion investment is expected between 2016-2026 in LED street lighting.

<sup>[14]</sup> The approximate number of street lights in specific countries are given in the below table.

Country	Number of Street Lights	Sources
European Union	56 Millions	Source
United States	55 Millions	Source
China	35 Millions	Source
India	35 Millions	Source
Brazil	18 Millions	Source
France	11 Millions	Source
Germany	9 Millions	Source
United Kingdom	7.5 Millions	Source
Turkey	7 Millions	Source
Australia	2.3 Millions	Source
Indonesia	1.5 Millions	Source

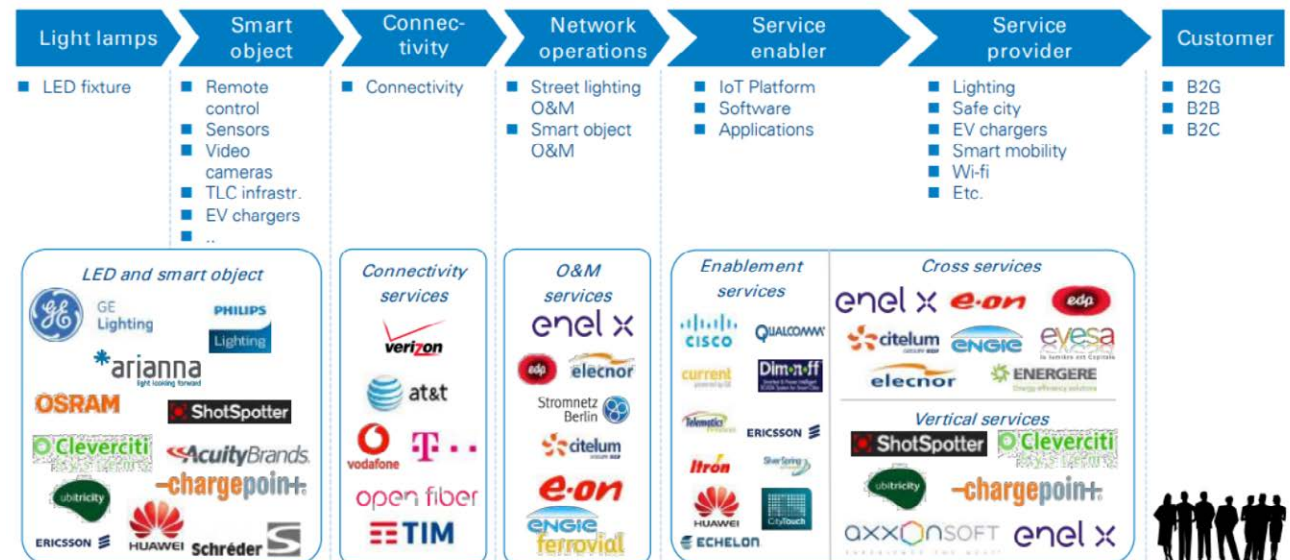




## The largest suppliers of street lights

There are so many company names written as powerful market players. But it appears to me that Signify (formerly known as Philips Lighting), Current, powered by GE, OSRAM, and Arianna. I have found 2 different pieces of research, the first one is on the companies work in all levels of street lighting and the other one is about leading companies in smart street lighting.

All top providers to the street lighting industry <sup>[15]</sup>.

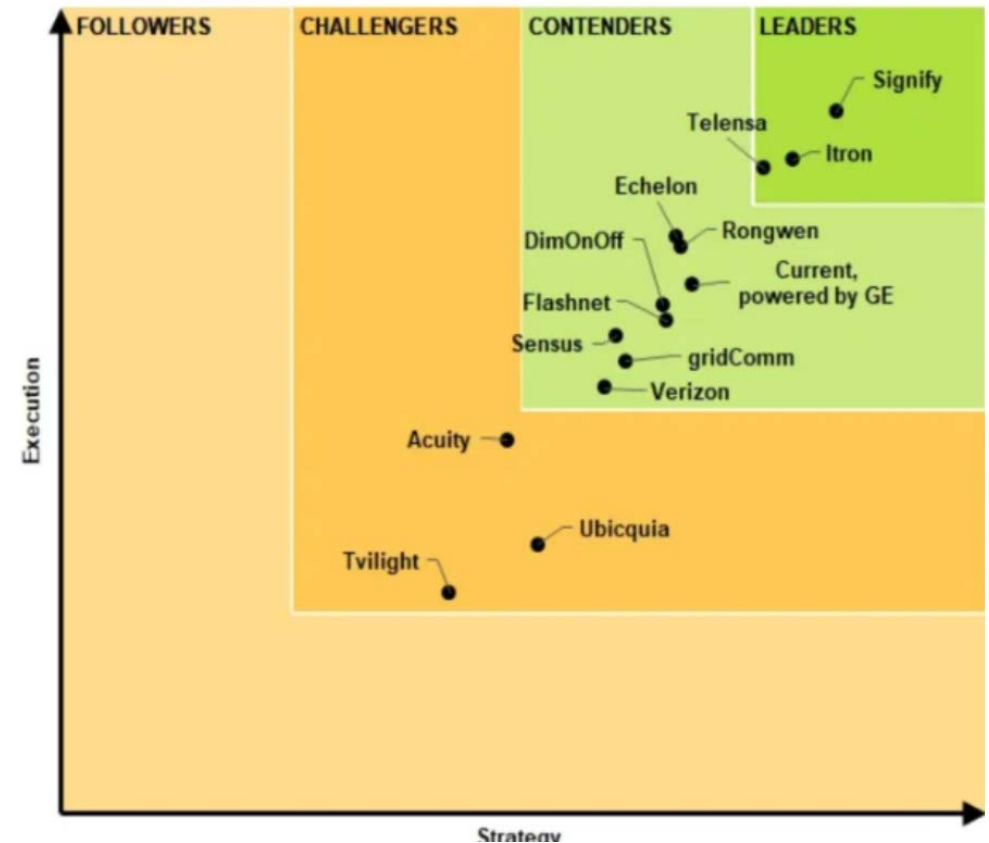


Advisory firm Navigant Research published leader companies in their report on smart street lights. According to them Signify, Itron and Telensa are the top leading companies for smart street lighting. Also, Echelon, Rongwen, and Current, powered by GE are innovative contributors to significant city developments. Navigant prepared the top 10 companies by comparing their value, market strategy, product strategy, sales, marketing and distribution, product features and portfolio, product integration <sup>[16]</sup>.

According to them, top 10 vendors are:

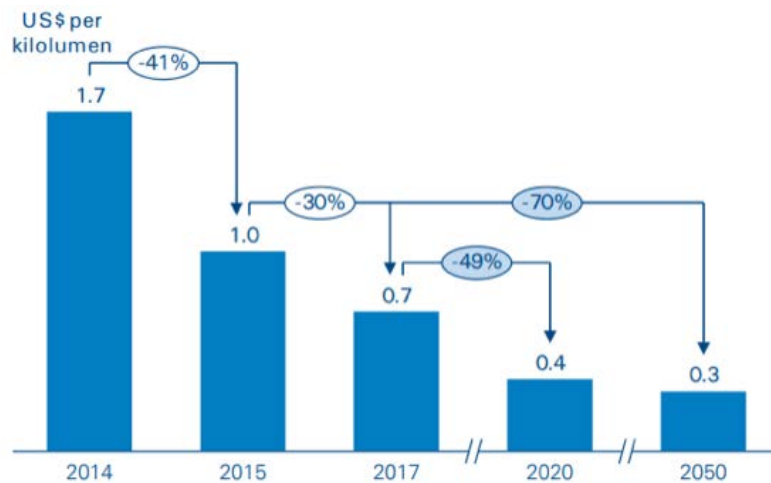
- |                 |                     |              |
|-----------------|---------------------|--------------|
| 1) Signify      | 5) Rongwen          | 8) Flashnet  |
| 2) Itron        | 6) Current, powered | 9) Sensus    |
| 3) Telensa      | by GE               | 10) GridComm |
| 4) Echelon Corp | 7) DimOnOff         |              |

And their productivity is rated as shown in the graph below :



## My observations throughout the research

It is expected that due to increased concern over global warming, the energy policies of countries will have to be re-shaped. LED technology creates a fantastic opportunity with its lower energy consumption. Your project even without the grid connection should have erased the energy bill at all and open a new perspective. But the market is thinking of street lights and their poles as the new technology center of their state of the art products due to their location advantage. An idea that came up to my mind is about guessing a dead luminaire before it dies. I believe there should be some instant changes before a light bulb dies. So by training a machine learning algorithm by looking at the current/time graph, it can guess if the bulb is about to die so maintenance can be planned in advance. Another important factor that I believe you implemented is dimming. I believe not all street lights should stay “on” all night time. A well-managed dimming system can save up a lot of energy, charge the battery to use it later in your off-grid system. Also, I found the graph for LED price change guess can be helpful for you, so I am adding below [15].



Source: DOE, EIA, Arthur D. Little analysis



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