Smart Road Lighting Solutions for Smart City Applications

IOTENA

An Excellent IoT Enabler

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Introduction

The phenomenon of electroluminescence as used in LEDs was first observed in a piece of Silicon Carbide (SiC) in 1907 by Henry Joseph Round. Then, further experiments were carried out in Germany in the late 1920s by Bernhard Gudden and Robert Wichard Pohl, using phosphor materials made from Zinc Sulphide doped with Copper. Although in both cases the level of the light was too dim to be used applicably, it did start the LEDs related research. Red, yellow and green LEDs were developed in 1970's and a commercial blue LED was finally developed by Shuji Nakamura in the 1990's and finally white light LEDs were possible. Thermal and packaging technologies were developed to perfect the LED component as a powerful and reliable lighting component [fig.1]. The new era of LED lighting started.

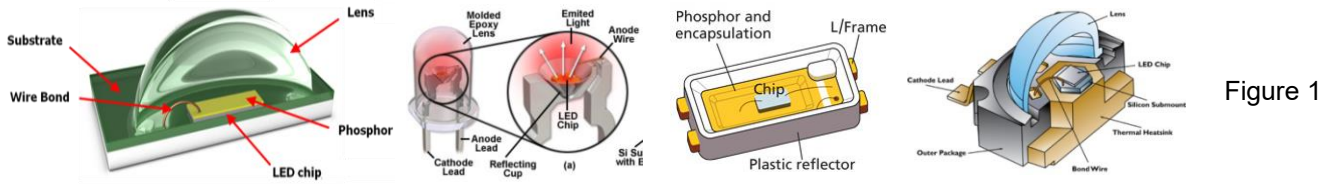


Figure 1

Today LED lighting is the most reliable, long lived and efficient white light illumination available and is used in the majority of all lighting applications. In the past decade LED road lights using LEDs have achieved exceptional visual performance, efficiency and reliability and therefore have become an important topic in city governance. Globally millions of dollars are spent daily to provide the required lighting to road users while striving for the lowest electrical, maintenance and replacement costs. LED road lights have the high reliability and best performance available at the lowest energy and maintenance cost. The savings from LED lighting come not only from their high lumen per watt (lm/W), but also from the integration within the lights and the system of new energy technologies related to automatic dimming, color temperature adjustment and automatic on/off. The savings capability of modern integrated LED road lighting fixtures, combined with a comprehensive control system, is significant and is an important part of a city wide saving plan.

Another important emerging technology is the Internet of Things (IoT). It is a breakthrough networking technology that is expected to connect more than 50 billion devices by 2022. The secure interconnection of almost all electronic devices via the internet leads to cost saving in terms of monitoring and control. With such wireless interconnectivity IoT will find greater and greater applications even in remote locations. IoT with its strong connectivity, excellent power efficiency, and reasonable cost, becomes the important technology to keep devices smart and connected. Centralized command, control, and status monitoring of a city's resources, including road lighting, will also become an important topic for city governance.

By using appropriate IoT enabled technologies and products, a good smart city system can be realized with reasonable cost. To aid in the planning and understanding of smart road lighting technologies, and how smart LED road lighting interacts and benefits a smart city, this report is organized as follows:

Section II is a discussion of the concepts of a smart city.

Section III talks about how smart LED road lighting systems could be used in smart city.

Section IV describes the hardware technologies for smart road lighting systems.

Section V outlines the software technologies of smart road lighting systems.

Section VI shows some existing applications of smart LED road lights and smart cities.

The conclusion is given in Section VII.

Smart city concept

Cities consist of large numbers of people living in close proximity. Cities are home to nearly half of the world's population and over the next 30 years most of the projected 2 billion increase in global population is expected to occur in cities. According to the 14th annual edition of "Demographia World Urban Areas", released in April, 2018, Hong Kong ranked as the 7th city among 1,758 urban areas of all sizes comprised of a total population of 2.38 billion people, which is 56% of the world's population [fig.2].

City	Population per square kilometer
Dhaka, Bangladesh	47,400
Mogadishu , Somalia	28,600
Al-Raqqa, Syria	27,200
Surat, India	26,600
Mumbai, India	26,400
Macau, Macau SAR	26,100
Hong Kong, Hong Kong SAR	25,900
Tshikapa, Congo	24,100
Vijayawada, India	23,700
Mategaon, India	23,200

Source: Demographia World Urban Areas

Figure 2

Due to the size and inherent nature of cities, there exists potential for severe problems such as overpopulation, environmental pollution, waste buildup, inefficient traffic and transportation, high crime rates, insufficient resources, slow governance and poor control capability. These issues and problems can be reduced by cities becoming Smart. Implementing a Smart City concept, utilizing modern IoT technology, can minimize the negative effects of these problems and in many cases provide a total solution.

A "Smart City" is an urban area that is connected and uses a variety of IoT sensors and IoT connected devices to collect data and then use the data to manage assets, control facilities, and allocate resources efficiently. The data can be collected from citizens, devices, equipment, assets and the environment. It is processed and analyzed to monitor and manage public systems and facilities, such as traffic and transportation systems, power plants, water supply networks, waste management, crime detection, information systems, schools, libraries, hospitals, and other social services.

The sensor network is a crucial part of smart cities. The data gathered is fundamental to efficient control all the city's services. To achieve the smart city goals, connectivity between all the sensors, devices, systems, and facilities is necessary. It is worth to consider wireless sensor networks which are inexpensive and have a low initial cost of installation. IoT applications for smart cities include pollution detection and prevention, waste management, structural health monitoring, smart buildings, surveillance, facility maintenance, intelligent transportation, traffic light control, autonomous vehicle systems, parking optimization, environmental monitoring, and energy management.

Smart road lights as an initial network of a smart city

Road lights are a fundamental part of every city. They are ubiquitous and designed into the city's infrastructure when it is built. They are everywhere already. Road lights have existing installed power connections; they include space around road light poles and numerous mounting points on the poles along their height and on their structure. Because of this Road lights are ideal locations for installing IoT related sensors and devices to start the smart city [fig.3].

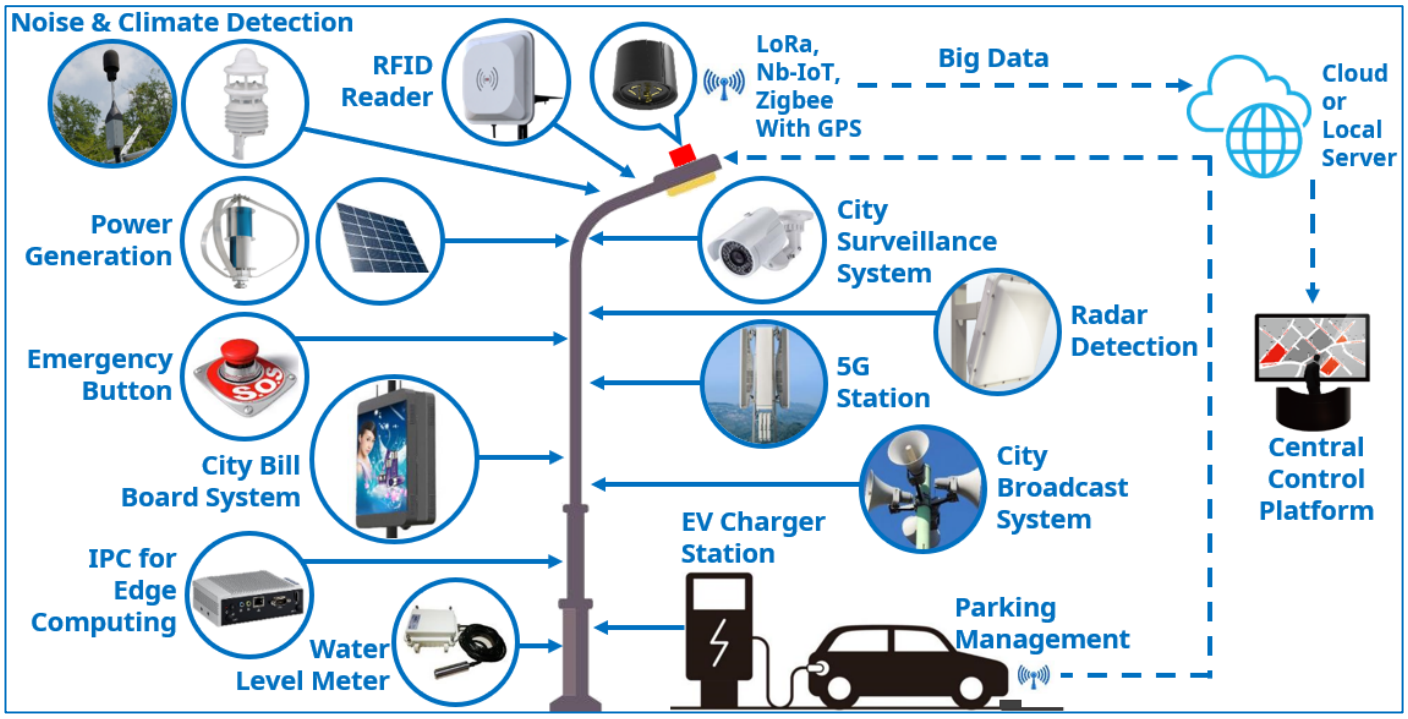


Figure 3

Road lights are also one of the largest energy expenses for a city. They are usually on all night including after midnight when there is little traffic. Occasionally road lights also remain on during the daytime. These situations are a potential waste of power. A smart road light intelligently provides illumination only as needed and is not only a great starting point for a smart city sensor network but it is also a great way for saving energy and reducing maintenance.

To make the road light smart, it needs to include smart capabilities and be connected to a smart road lighting system with certain automation capabilities:

1) Adjusting light output based on time of day/night, ambient brightness, usage and occupancy
2) Connection to different types of IoT sensors and devices for smart city operation
3) Reporting abnormal situations such as lamp failure, statistic result, and data from sensors

With above capabilities, a smart road lighting system can achieve energy and cost saving up to 50%~70%.

As smart cities invest in new IoT devices and systems, they should consider smart road lights as an initiating point. Smart road lights and IoT systems can provide large energy and costs savings for the city and provide an easy way make the city smart.

The hardware technology approach

In this section, the hardware technology related to LED road lights and IoT devices will be reviewed to provide a better understanding of currently available products and the market status.

1) LED road light

The general requirements of LED road lights usually cover standard specifications such as lm/W, lifetime, light pattern, surge protection, and corrosion prevention. A good LED road light product can usually meet these standard requirements, so does IOTENA products [appx.1]. In addition to these standard requirements, there are some other, perhaps more important, functions that should be considered:

A. ***The separation of electrical and power circuitry from the LED light engine*** enhances the heat dissipation efficiency of the fixture and extends the fixture's lifetime [fig.4].
B. ***A fully detachable driver system chamber*** provides for safer, faster and easier installation and maintenance of the fixture [fig.5].
C. ***The automatic power off connector*** mechanism removes all electrical power when the driver system chamber is opened ensuring the safety during maintenance [fig.6].

Figure 4

Figure 5

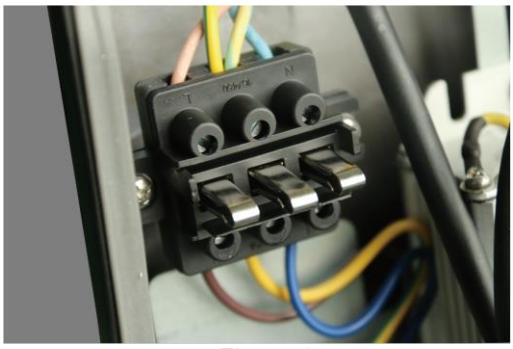


Figure 6

D. ***Tool free buckle for opening and closing the driver system chamber*** allows driver replacement to be totally tool free enhancing the efficiency and safety of maintenance [fig.7].
E. ***A built-in bubble level*** provides convenient, safe installation and adjustment. Engineers can install IOTENA LED road lights without needing to bring a bubble level tool to the pole top [fig.8].

Figure 7

Figure 8

F. ***A compatible NEMA socket*** is a must for smart LED road lights. Using a standard high quality and performance NEMA device additional control can be added to the light including full wireless control of the IOTENA LED smart road lights through LoRa or NB-IoT [fig.9].

G. ***A built-in respirator*** is a necessary design feature for waterproof road lights to balance air pressure between inside and outside of the fixture [fig.10].

Figure 9

Figure 10

H. ***Angle adjustable joint*** [fig.11]. With this specially designed joint, IOTENA LED road lights can be fitted onto many different kinds of light poles.

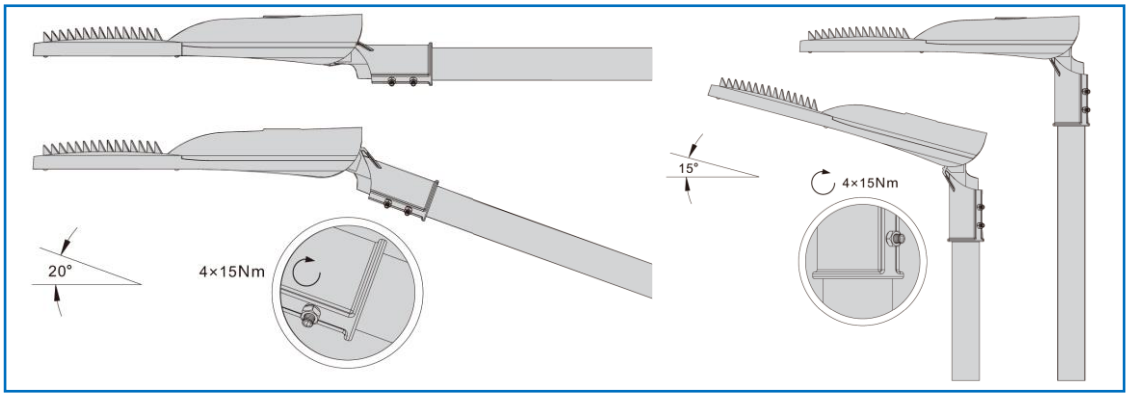


Figure 11

I. ***Light weight*** enhances the durability and safety of the installation. IOTENA LED road lights are only 3.5kg for 45W, 6.0kg for 90W, 7.0kg for 120W, 8.0kg for 150W and 8.5kg for 200W [appx.1].

J. ***Color temperatures***. Human vision response and feeling changes based on the time and environment. Being able to see clearly on a highway or feeling safe as a pedestrian and/or being able to see colors clearly are different examples that can be optimized with color temperature. Color temperature and CRI can be selected to optimize the safety and/or visibility needed for different applications, IOTENA LED road lights provide many options for color temperature, including 2200K, 2700K, 3000K, 4000K, 5000K and 6500K. A dual color temperature with a color adjustment function is also available.

2) Solar solution for LED road lights

In locations with sufficient sunshine, users can save energy by adding a solar panel and battery pack to LED road lights. At locations with no existing power supply, solar LED road lights allow road lighting and can save cost of providing power. Important Solar LED road lights considerations are discussed below:

A. ***Customization Capability*** [fig.12]. Solar LED road lights are usually used in special applications, IOTENA allows many key parameters to be optimized on a case to case basis, these include:

- Angle of solar panel – the sun's angle is dependent on the latitude of the location, therefore angle adjustment is provides for the solar panel to achieve maximum energy absorption. Sun tracking systems may also be available to minimize solar panel when space is critical (TBC by factory).
- Location and protection of battery pack – the battery pack is valuable and sensitive to the environment. It needs to be protected from being stolen, damaged and effected by adverse weather.
- Size of solar panel and battery pack – different operating conditions and locations require different solar panel and battery pack specifications including size, type and capacity. IOTENA can design and provide a suitable solar panel, battery pack and LED road light system optimized to the required application.
- Wireless connectivity and control system – provides convenient full remote control of the solar LED road light through wireless and is helpful in extending the system lifetime, avoiding running out of battery power, and reporting battery and solar panel status.

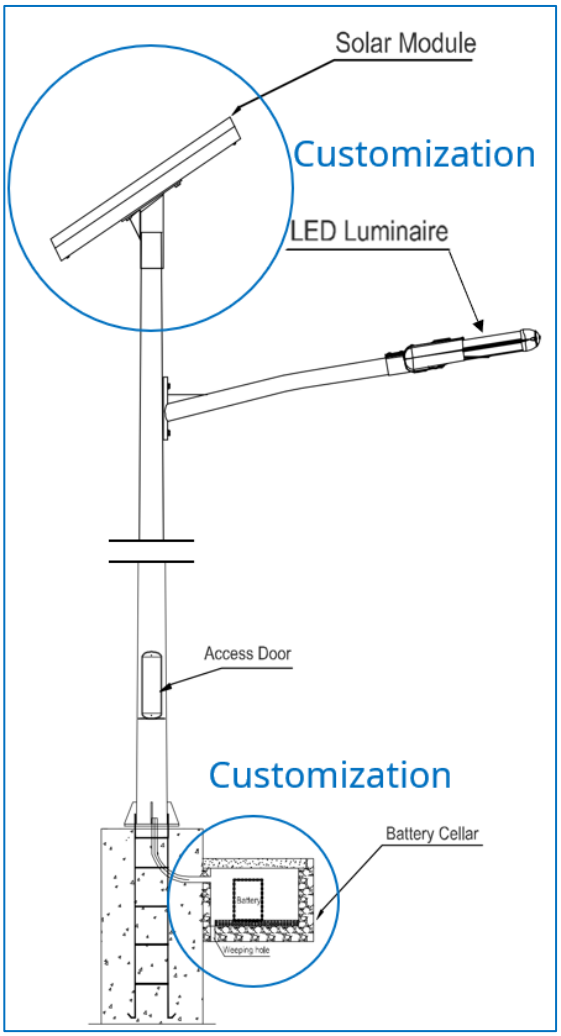


Figure 12

- Structural design is important. Since the drag coefficient of solar panel is relatively high, the structural strength of solar panel and its joint becomes an important factor to be considered.

A comprehensive specification is essential when planning to use a solar LED road light system. Having a professional supplier is important. Below we discuss some of the performance factors.

B. ***Performance of battery pack***. Capacity and lifetime are the two most important parameters of battery pack in solar road lighting system. Sufficient capacity must be designed in so that the lighting provided is with specification even as the system ages. Different applications have different requirements, and the battery pack performance should be carefully defined for the application optimized for effective cost and size.

C. ***Performance of solar panel***. There are several key parameters to define the performance of solar panel. These parameters are discussed as followings:

- IV Curve [fig.13] – The IV curve of a solar cell presents the light-generated current vs voltage. The light shifts the IV curve into the fourth quadrant where power can be extracted from the diode. The power curve has a maximum denoted as P_{MP} where the solar cell should be operated to give the maximum power output. Several other important parameters, short-circuit current (I_{SC}), the open-circuit voltage (VV_{OC}), the fill factor (FF) and efficiency, are used to define solar panel performance and are discussed below:

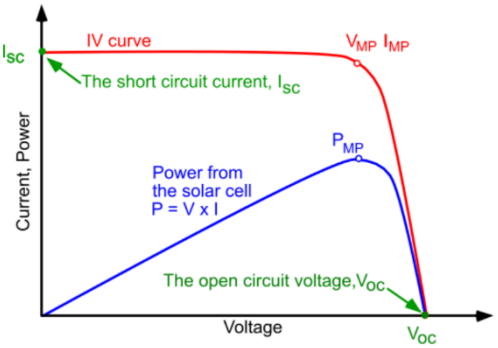


Figure 13

- Short Circuit Current (I_{SC}) – Refer to above IV Cure diagram [fig.13]. The current from the solar cell reaches it maximum possible level when the two terminals are directly connected with each other and the solar cell is illuminated by the sun. In the condition the output voltage is zero. The current in this case is called the “Short Circuit Current”.
- Open Circuit Voltage (V_{OC}) – Refer to above IV Cure diagram [fig.13]. When the cell is not connected to a load and illuminated there is no current flow, however the voltage across the solar cell is at maximum. This is called “Open Circuit Voltage”. When a load is connected to the solar cell current flows through the circuit and the voltage goes down.
- Power Max Point (P_{MP}) – Refer to above IV Cure diagram [fig.13]. The maximum potential power is dependent in part on the size of the connected load and is called the P_{MP} point on the IV curve above. It is determined by choosing the load and multiplying the voltage across the load with the current going through the load. There is an optimum load that maximizes the amount of power available and the load (the battery charging circuits of the solar road light) should be designed to operate at this P_{MP} point.

- Fill Factor (FF) [fig.14&15] – The Isc and the Voc are the maximum current and voltage respectively from a solar cell. However, at both of these operating points, the power from the solar cell is zero. The “Fill Factor”, more commonly known by its abbreviation “FF”, is a parameter which, in conjunction with Voc and Isc, indicates the maximum power from a solar cell. Solar cells with a high fill factor are desirable.

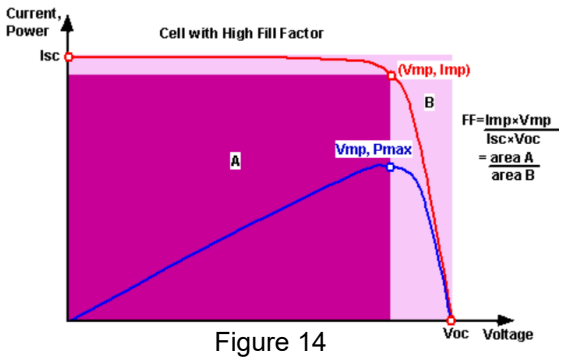


Figure 14

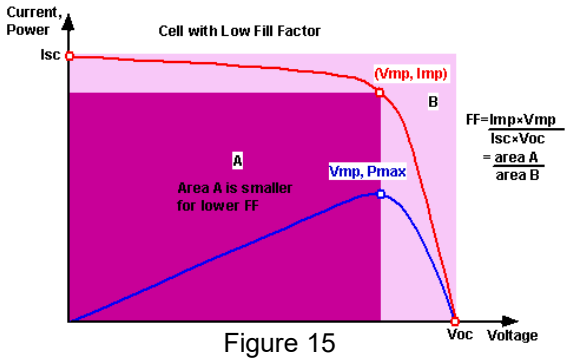


Figure 15

- Efficiency – the efficiency is most commonly used parameter to compare the performance of one type or variety solar cell to another. Efficiency depends on sunlight spectrum, intensity of sunlight and the temperature of solar cell. Efficiency is defined as the ratio of energy output from the solar cell to input energy from the sun. Therefore, conditions under which efficiency is measured must be carefully controlled in order to compare the performance of one device to another. The efficiency of a solar cell is determined as the fraction of incident power which is converted to electricity and is defined as:

$$P_{max} = V_{OC} I_{SC} FF \qquad \eta = \frac{V_{OC} I_{SC} FF}{P_{in}}$$

The following chart [fig.16] from NREL (National Renewable Energy Laboratory, www.nrel.gov) provides a good sense of the mainstream of solar technologies.

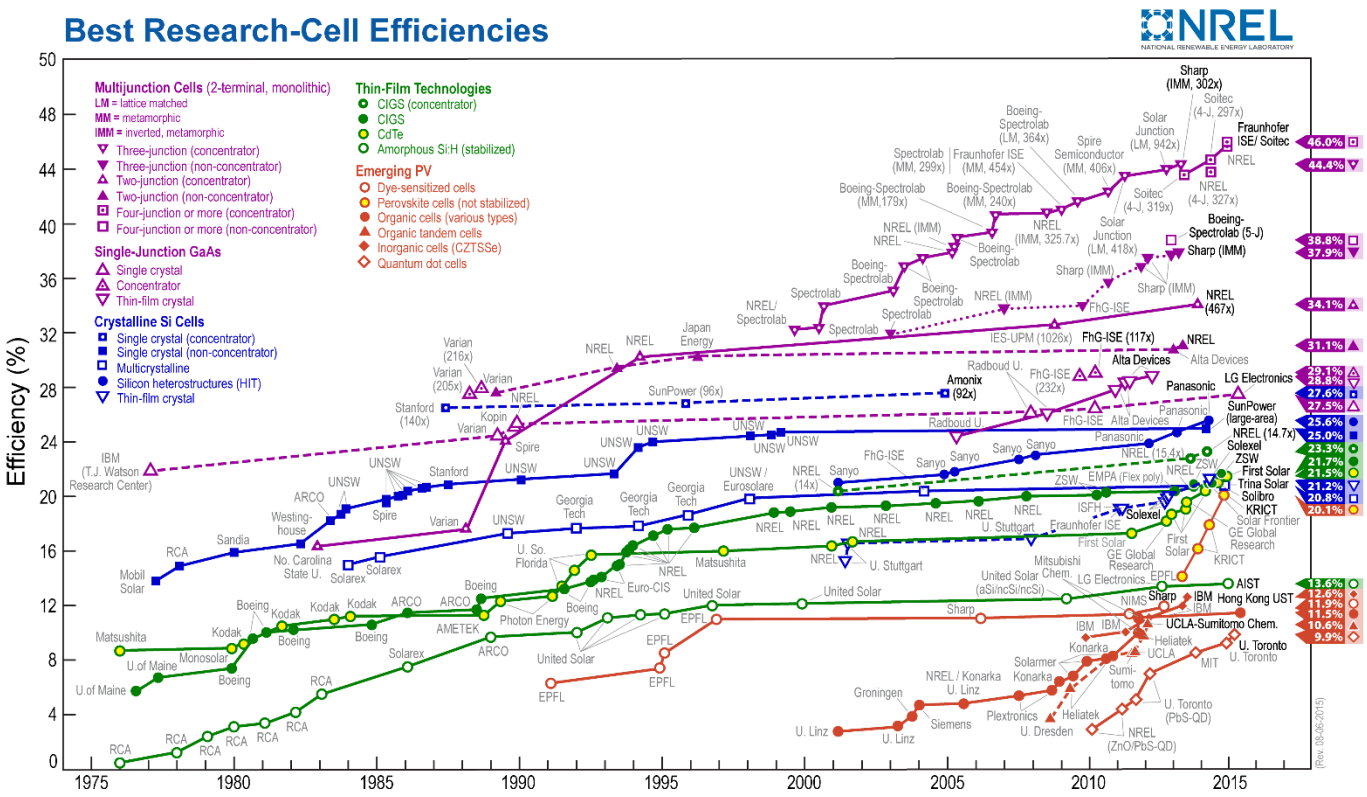


Figure 16

D. ***Control functions of entire system***. Wireless automatic remote control of the on-off time, dimming level and lights-on-interval is crucial to an effective solar LED road lighting system. This function extends system lifetime, maximizes battery capacity, in the case of insufficient sunlight - prevents dark zones at night, reduces initial cost, and lowers maintenance requirements. In a software section below, key functions of our smart LED road lighting control system are discussed.

3) Intelligent gateway for smart light pole

A standard road light pole can easily be converted into a smart light pole by the addition and integration of other devices onto the pole. Examples include surveillance cameras, noise and climate detection sensors, RFID readers, 5G stations, broadcast speakers, emergency buttons, LED displays, water level meters, radar detectors, electric car charger and power generation systems. These devices need connection to a powerful and reliable gateway so that they can be controlled, monitored and upload data to the cloud or a local server. Wireless networks, such as the low-power wide-area network (LPWAN), a cellular network or a mesh network are suitable. A reliable gateway with multiple protocols and flexible connectivity is a crucial part for smart light pole.

Figure 17

IOTENA developed a gateway product [fig.17] focused on smart pole applications.

Key features and functions:

A. Wan port *1
B. Lan port *4
C. RS485/RS232
D. Distributed-Input-Distributed-Output (DIDO) *2
E. USB *2
F. 4G, ETH, LoRa, Bluetooth Low Energy (BLE), and Zigbee Compatible
G. Communication and full compatibility for many off the shelf devices is already built-in (with new devices are being continuously added). These include:
   Climate detection sensor – 7 types
   Surveillance camera – 4 types
   Electrical vehicle charger – 3 types
   LED display system – 6 types
   Emergency button – 3 types
   RFID sensor – 2 types
   Broadcast speaker – 2 types
   Wi-Fi access point – 4 types

With our tested intelligent gateway and software (which will be demonstrated in the next section), a smart light pole system is ready for real operation.

The software technology approach

This section outlines key functions of the IOTENA smart LED road lighting system, gateway control and monitoring software [fig.18].

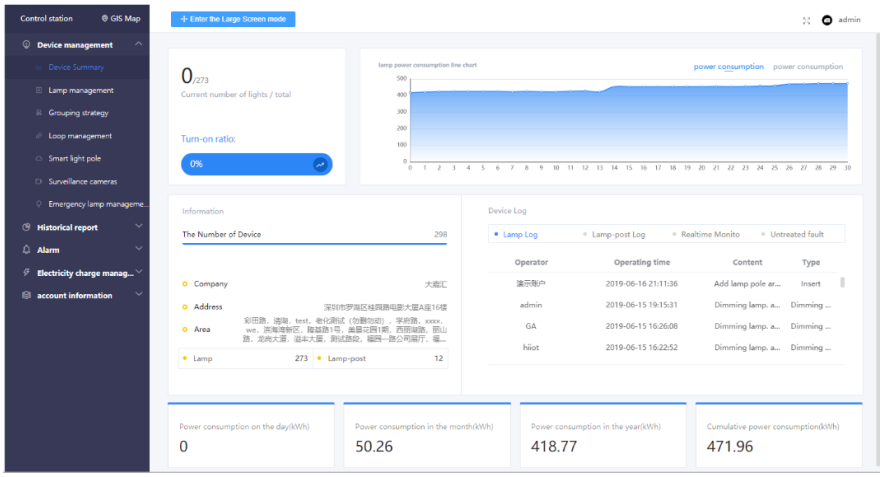
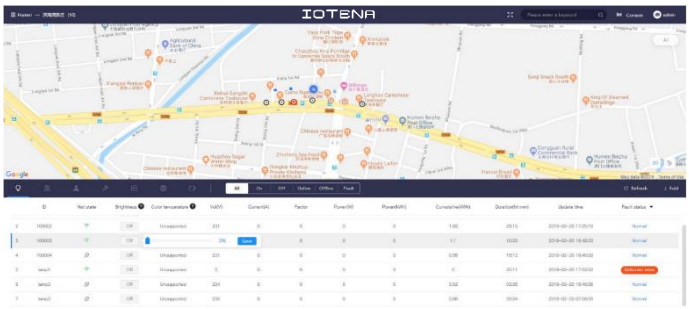


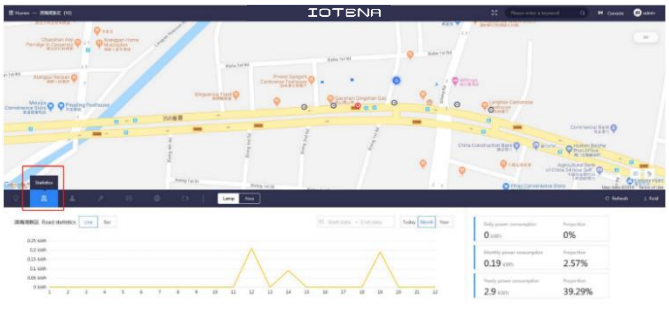
Figure 18

The IOTENA software can manage and control all the connected lighting devices and peripheral devices (such as Smart City Gateways) in the road lighting network. In addition to the usual automatic on/off and dimming control, the software can generate historical reports, set up alarm conditions, and calculate electricity consumption. The software includes GIS to show the location of all the road lights and devices for easier management. IOTENA can provide AI and machine learning modules also on request for special applications such as vehicle identification.

1) GIS system

Road lights, gateways and other devices could be managed by location and area grouping. The software functions include road light listing, grouping by area, single or group dimming, information display, data logging, statistical analysis, area statistics, and monitoring. The following screen shots are showing the user interfaces of these functions.



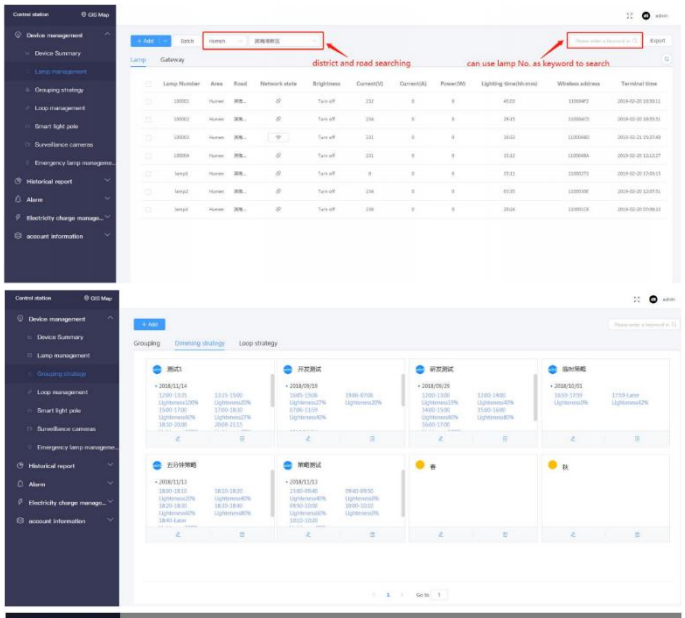


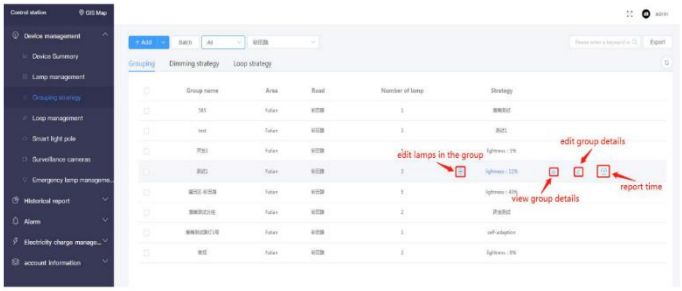
2) Device management

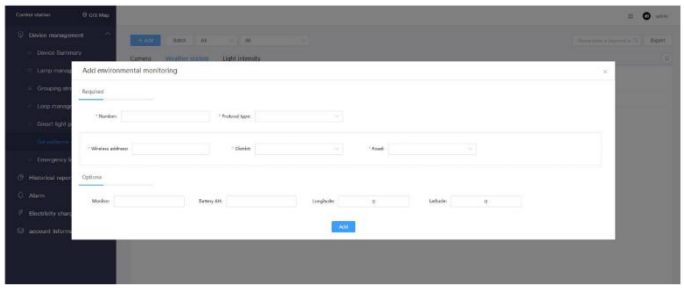
A dynamic dashboard for real-time monitoring of LED road light parameters [fig.19] is provided with the real-time status displayed on a single page.

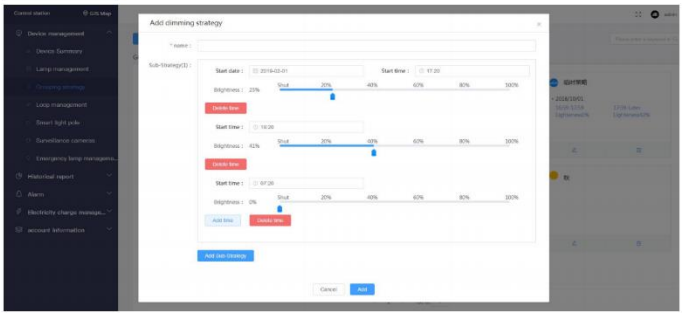
Figure 19

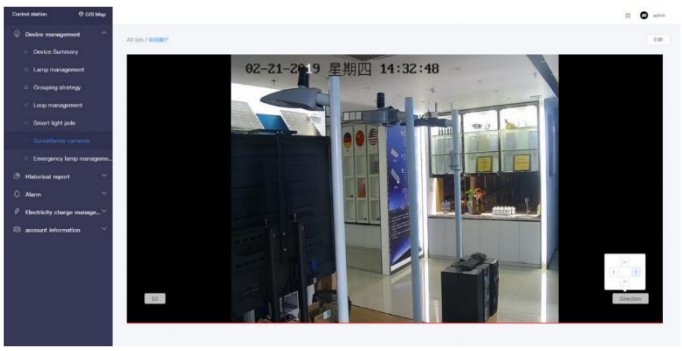
Other functions in this module include: setting up management groups of devices, defining dimming/on-off strategy of groups, adding or removing devices on a smart light pole, and managing the video files from the surveillance camera. This module also provides inbuilt access to the dedicated specialized control pages of other devices. The following are screen shots of these functions.











3) Historical report

Our software includes many different historical charts and diagrams [fig.20&21]. Customized reports and output formats are also available.

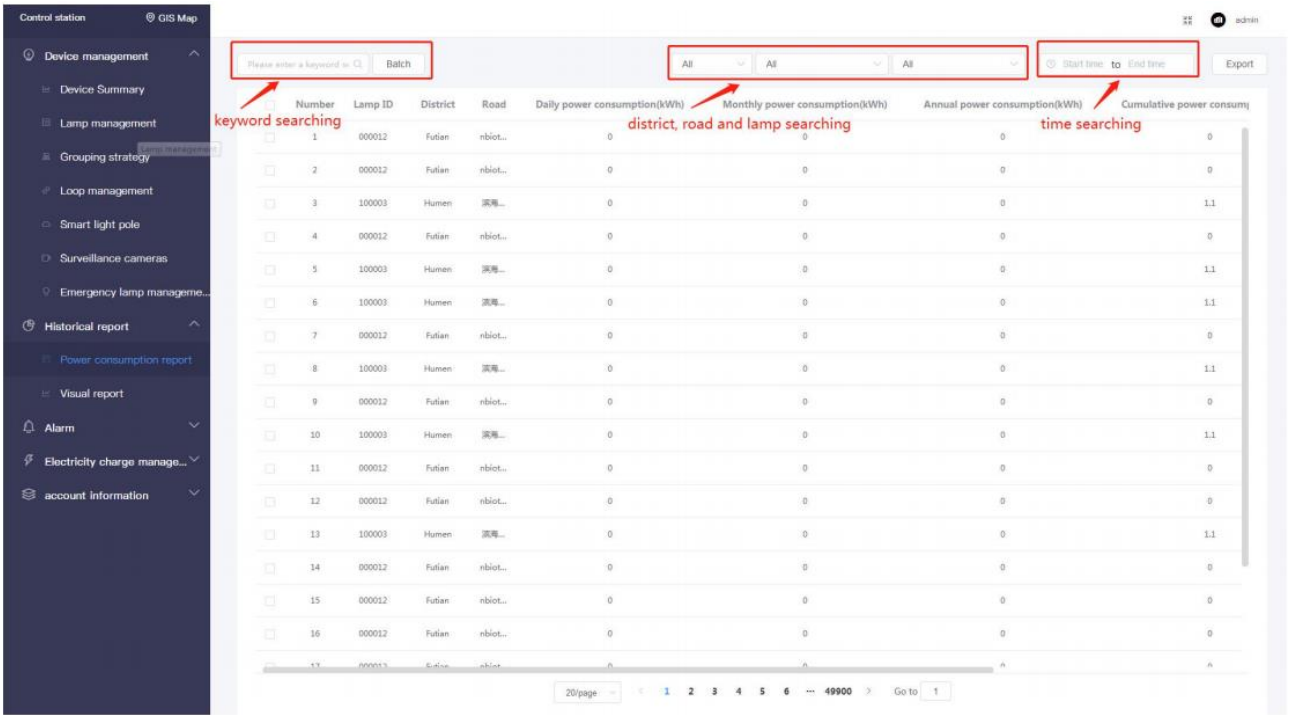


Figure 20

Figure 21

4) Alarm system

In this segment, Alarm functions include alarm strategy setting, alarm lists and records, and maintenance access records [fig.22&23]. Alarms can be forwarded to email, messaging and cell phone applications to instantly inform the responsible team members in real time.

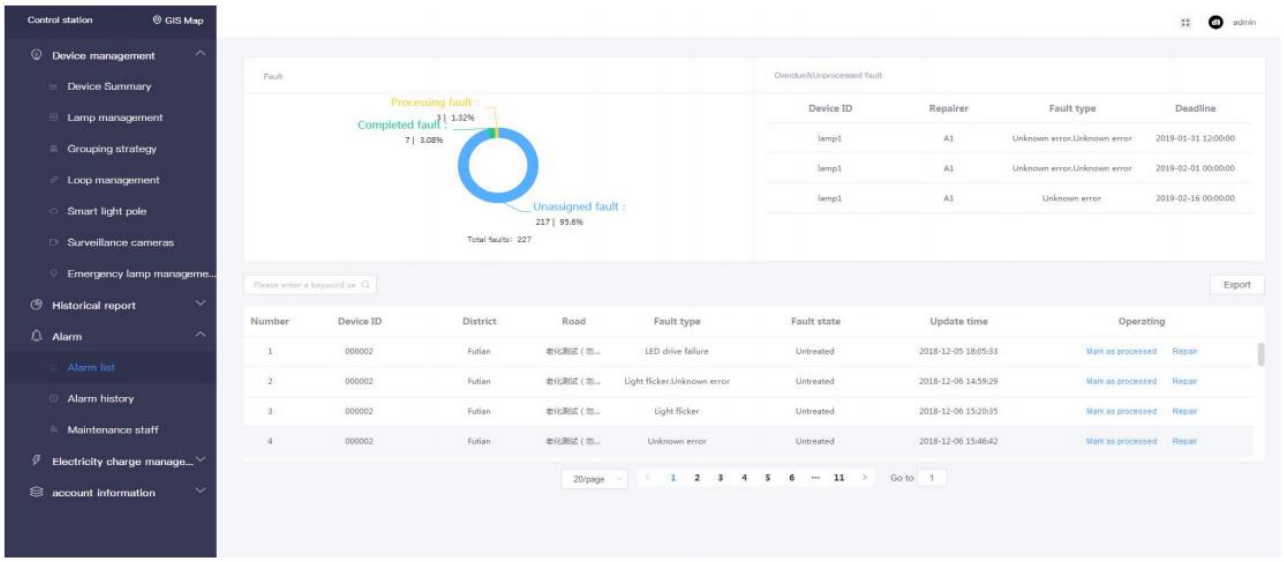


Figure 22

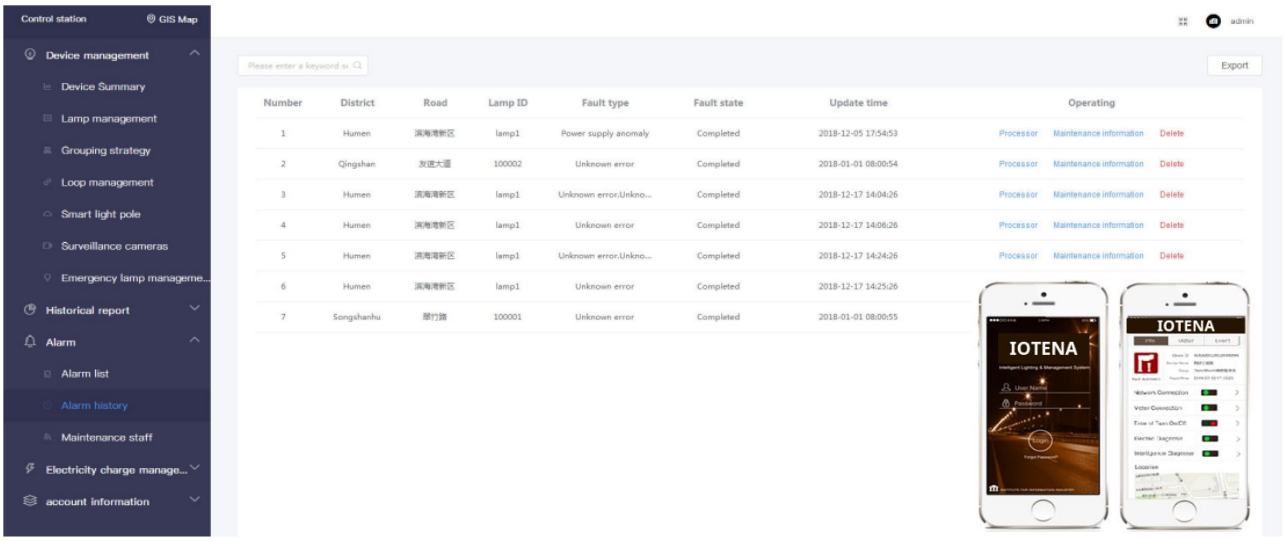


Figure 23

5) Others

Other housekeeping functions include: user authorization, user account management, and user log-in record. IOTENA happily provides and supports software customization, cloud connection, and local server establishment. IOTENA ensures that the smart road lighting system is built to fit customer needs and practical operation.

Smart LED road lights and smart city applications

In this section, some useful applications of smart LED road lights and smart city systems are discussed. By integrating sensors and devices, wireless technology and software, an era of smart daily life is coming. Applications introduced include smart LED road light control, parking management system, climate and environment detection systems, and traffic control systems.

1) Smart LED road light control

The control functions of IOTENA smart LED road light include dimming, interval on-off [fig.24], color temperature adjustment (with dual color temp. LED light), automatic on/off function at sunset and sunrise, and auto failure alarm system [fig.25].

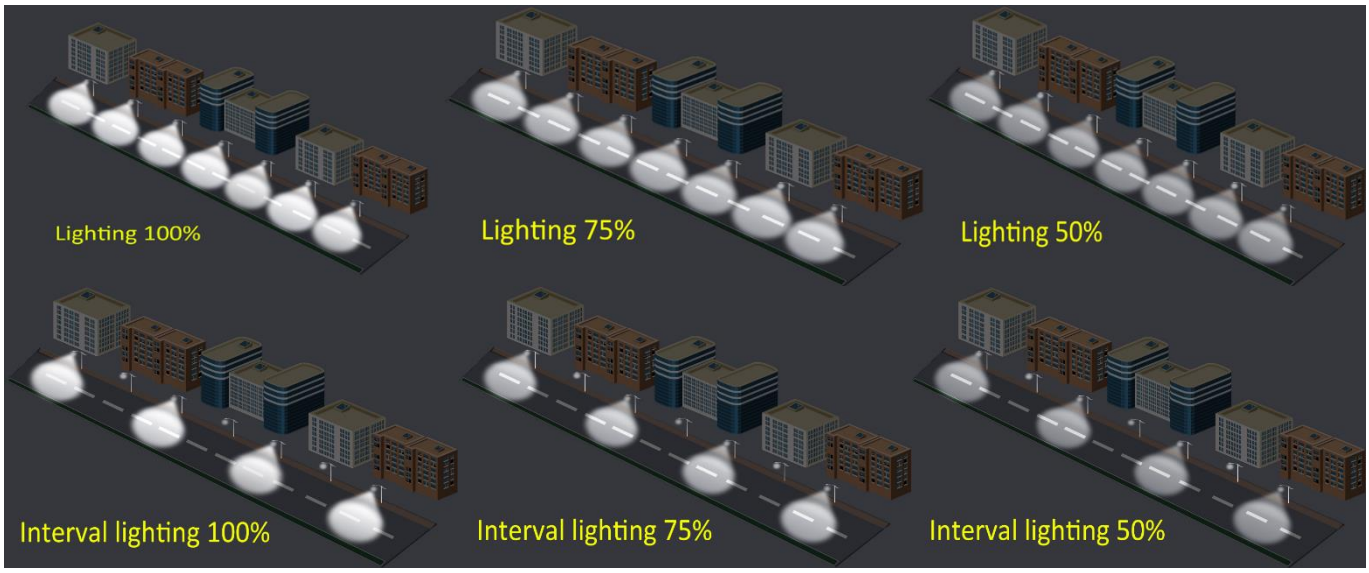


Figure 24

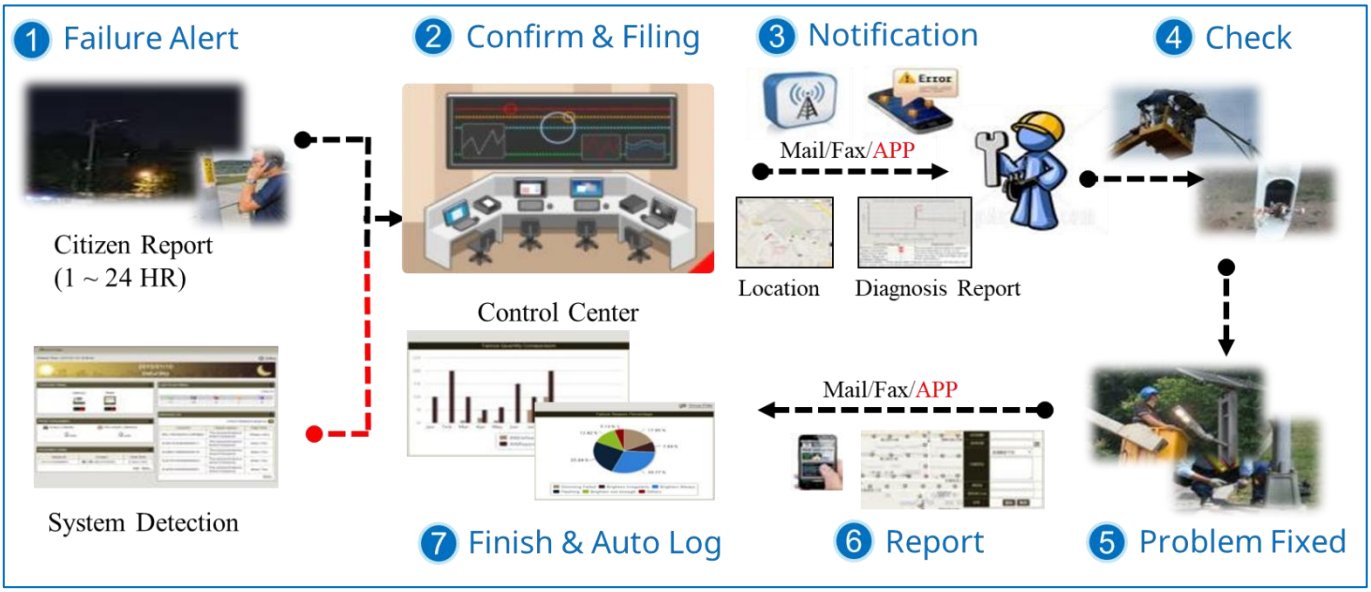


Figure 25

2) Parking management system

With LPWAN parking space sensors, a LPWAN gateway on smart road light pole and software, a parking management system [fig.26] is established. Functions of a parking management system include real time information of empty parking space, GIS integration and parking space guidance, auto billing system, data collection and analysis.

Figure 26

3) Climate and environment detection system

Climate/environment sensors [fig.27] and water level sensors can be installed directly on a smart light pole. With a LWPAN gateway, the climate and environment data can be collected 24 hours a day and recorded for city governance. Critical Information about pollution, flooding, very high temperatures can be monitored and acted on in a timely manner to save lives.

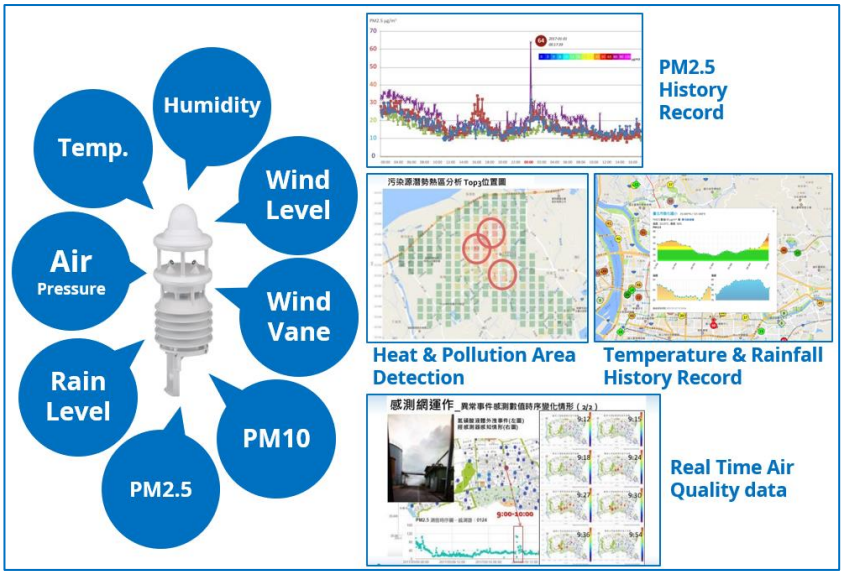


Figure 27

4) Traffic control system

Smart light poles are an efficient way to enable a real time and non-blind-spot traffic control. A high efficiency traffic control system can be made by placing camera(s), radar detection sensor(s), an edge computing industrial computer (IPC) on a smart pole [fig.28], and controlled by suitable software. The edge computing IPC is used to analyze the video from the camera and reduce the amount of data uploaded. Traffic control systems can provide speed detection, accident monitoring and alarm, abnormal behavior detection, and traffic flow monitoring.

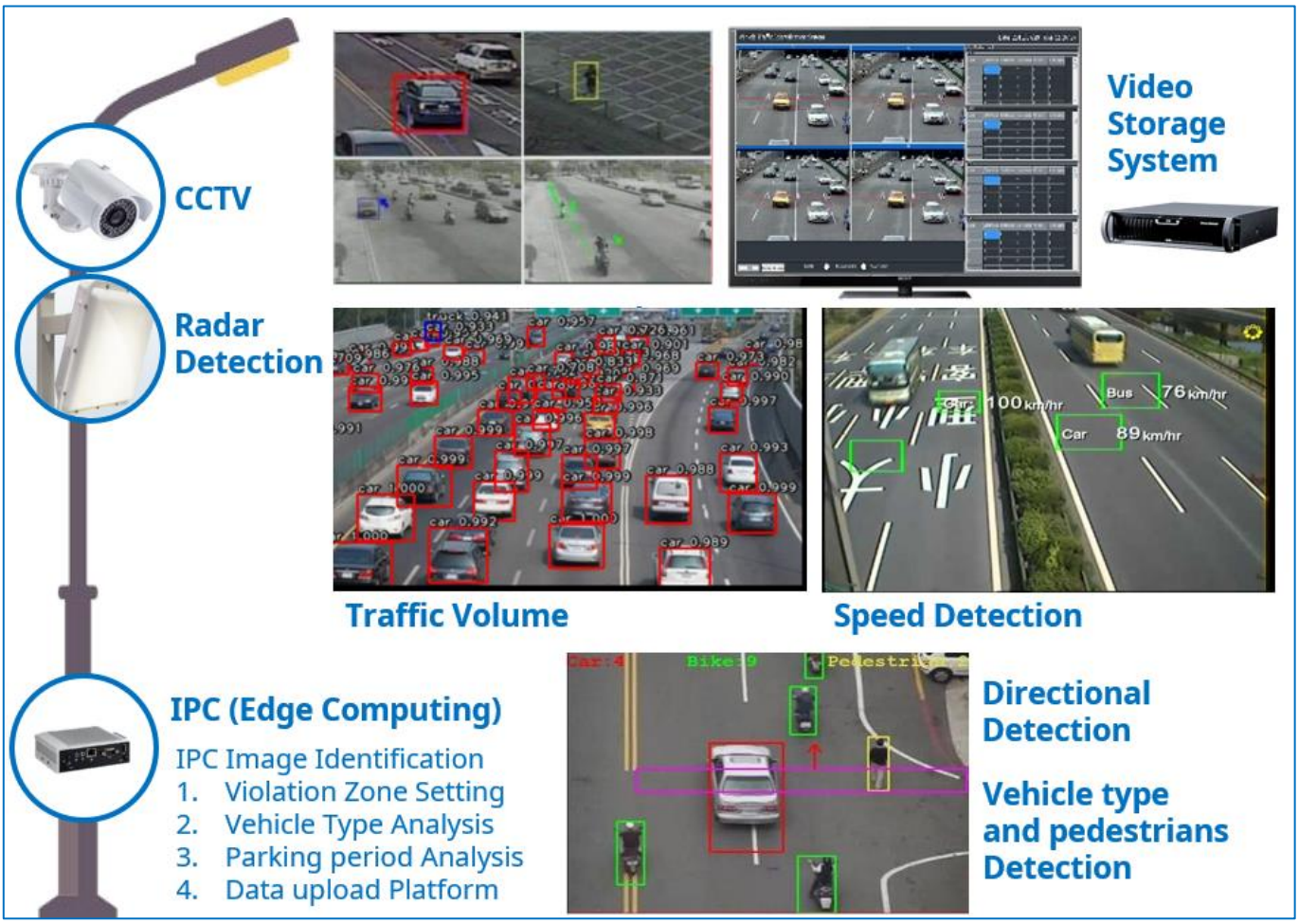


Figure 28

The above applications are just some of the possibilities of a smart city. With suitable hardware, wireless technology, well-designed software and advanced artificial intelligence the applications of smart city can be unlimited. This is all the more reason for to start planning a smart city today.

Conclusion

In this report, the concept of smart LED road lighting system, smart city, possible applications are discussed in both hardware and software. From above discussions, we can see the promising future of the smart city. Important points consider to when planning for smart road lighting and a smart city are key product features and performance, choice of wireless technology, availability and capability of customization service, system integration, execution, and communication.

As a professional IoT enabler, IOTENA is helping customers realize smart solutions at a reasonable cost, providing personal and professional technology support, and developing new customer focused technologies and products.

At the end, some reference projects are listed [appx.2] and some pictures are shown as the followings. Please contact us for any questions.







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APPENDIX 1

BLG Series

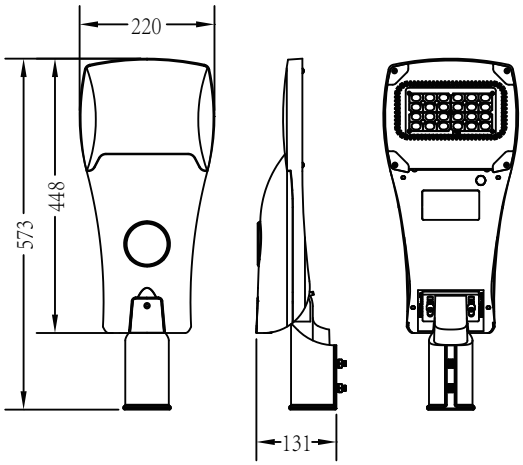
IOTENA

Professional Outdoor Road Lighting

BLG-MICRO

IOTENA

Dimension



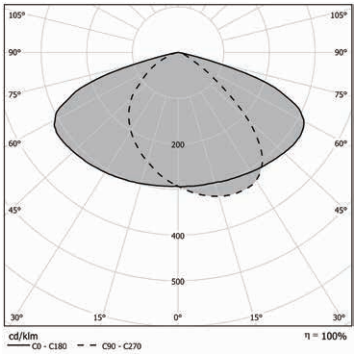
Parameters

Model No.	I-BL69400	I-BL69410	I-BL69420	I-BL69430
Power	15W	25W	35W	45W
Light Source	Osram/Philips			
Input Voltage	AC100-277V 50/60Hz			
Power Factor	0.95			
Power Brand	Inventronics / MOSO / Osram			
Surge Protection	10kV/20kV			
Insulation Class	Class I/ClassII (optional)			
Color Temperature (K)	3000/4000/5000/5700/6500±300K			
Control System	Photocontrol(NEMA), Timer Dimming/ 0-10V Dimming/ DALI Dimming/ Solar Compatible (optional)			
Operating Temperature Range	-40°C~50°C			
Operating Humidity Range	10%~90% RH			
Storage Temperature Range	-40°C~55°C			
Housing Material	die casting aluminum			
IP Rating	IP66/IK09			
Pole Dimension	Ø60mm, Ø42mm,/Ø76mm(optional) Preparation for CE/CB/ENEC/RoHS certification			
Maximum Pojected Area	0.10m²			
Luminaire Dimension (mm)	573×220×131			
Packing Dimension (mm)	655×300×210			
Net Weight (Kg)	3.5±0.2			
Gross Weight (Kg)	5.5±0.2			

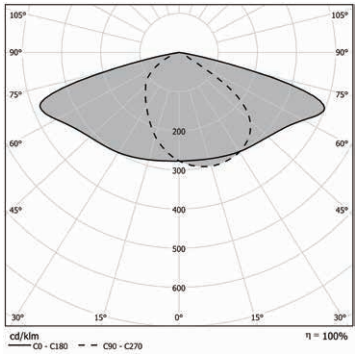
BLG-MICRO

IOTENA

Optical



BLG-540



BLG-618

3030 Light source

Power (W)	LED QTY (pcs)	Light Distribution	4000K Ra70@Tq=25℃		3000K Ra70@Tq=25℃	
			Luminaire Efficiency	Luminous Flux	Luminaire Efficiency	Luminous Flux
15	16	BLG-540	125 lm/w	1875	117 lm/w	1750
25	32	BLG-540	125 lm/w	3125	117 lm/w	2917
35	40	BLG-540	125 lm/w	4375	117 lm/w	4083
45	48	BLG-540	125 lm/w	5625	117 lm/w	5250

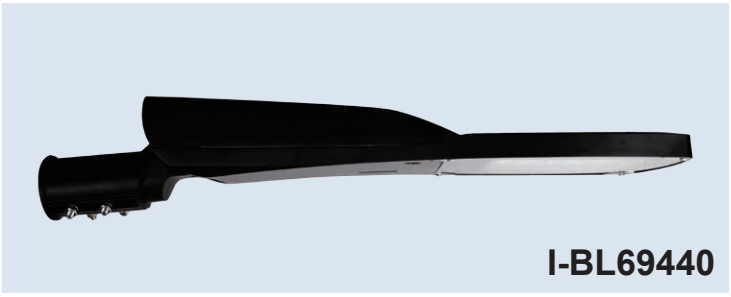
5050 Light source

Power (W)	LED QTY (pcs)	Light Distribution	4000K Ra70@Tq=25℃		3000K Ra70@Tq=25℃	
			Luminaire Efficiency	Luminous Flux	Luminaire Efficiency	Luminous Flux
15	6	BLG-618	140 lm/w	2100	130 lm/w	1950
25	12	BLG-618	140 lm/w	3500	130 lm/w	3250
35	12	BLG-618	140 lm/w	4900	130 lm/w	4550
45	18	BLG-618	140 lm/w	6300	130 lm/w	5850

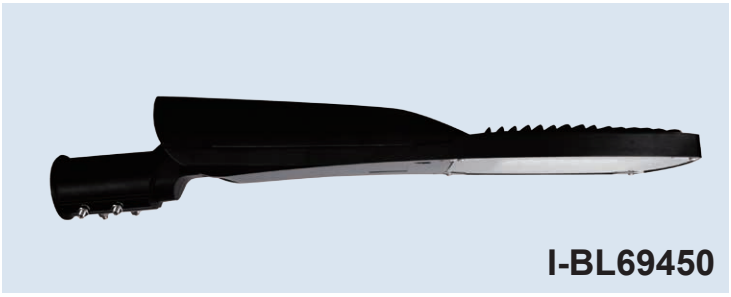
Power (W)	LED QTY (pcs)	Light Distribution	4000K Ra70@Tq=25℃		3000K Ra70@Tq=25℃	
			Luminaire Efficiency	Luminous Flux	Luminaire Efficiency	Luminous Flux
25	18	BLG-618	150 lm/w	3750	140 lm/w	3500
35	24	BLG-618	150 lm/w	5250	140 lm/w	4900
45	24	BLG-618	150 lm/w	6750	140 lm/w	6300

BLG-MINI

IOTENA

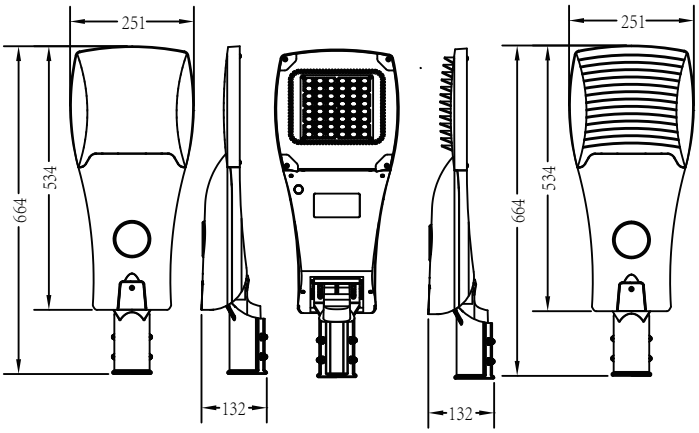


I-BL69440



I-BL69450

Dimension



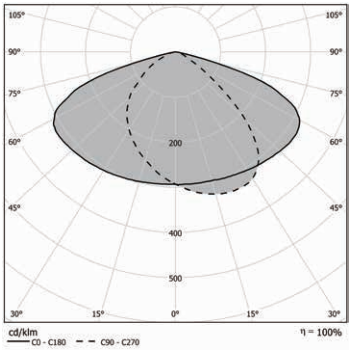
Parameters

Model No.	I-BL69440	I-BL69450
Power	60W	90W
Light Source	Osram/Philips	
Input Voltage	AC100-277V 50/60Hz	
Power Factor	0.95	
Power Brand	Inventronics / MOSO / Osram	
Surge Protection	10kV/20kV	
Insulation Class	Class I/ClassII (optional)	
Color Temperature (K)	3000/4000/5000/5700/6500±300K	
Control System	Photocontrol(NEMA), Timer Dimming/ 0-10V Dimming/ DALI Dimming/ Solar Compatible (optional)	
Operating Temperature Range	-40°C~50°C	
Operating Humidity Range	10%~90% RH	
Storage Temperature Range	-40°C~55°C	
Housing Material	die casting aluminum	
IP Rating	IP66/IK09	
Pole Dimension	Ø60mm, Ø42mm,/Ø76mm(optional) Preparation for CE/CB/ENEC/RoHS certification	
Maximum Pojected Area	0.15m²	
Luminaire Dimension (mm)	664×251×132	
Packing Dimension (mm)	725×330×210	
Net Weight (Kg)	6.0±0.2	
Gross Weight (Kg)	8.0±0.2	

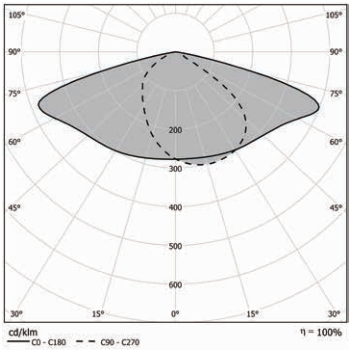
BLG-MINI

IOTENA

Optical



BLG-540



BLG-618

3030 Light source

Power (W)	LED QTY (pcs)	Light Distribution	4000K Ra70@Tq=25℃		3000K Ra70@Tq=25℃	
			Luminaire Efficiency	Luminous Flux	Luminaire Efficiency	Luminous Flux
60	64	BLG-540	125 lm/w	7500	117 lm/w	7000
90	96	BLG-540	125 lm/w	11250	117 lm/w	10500

5050 Light source

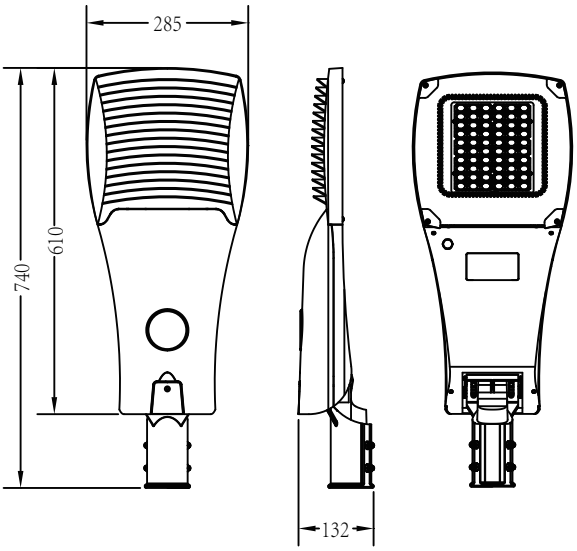
Power (W)	LED QTY (pcs)	Light Distribution	4000K Ra70@Tq=25℃		3000K Ra70@Tq=25℃	
			Luminaire Efficiency	Luminous Flux	Luminaire Efficiency	Luminous Flux
60	24	BLG-618	140 lm/w	8400	130 lm/w	7800
90	30	BLG-618	140 lm/w	12600	130 lm/w	11700

Power (W)	LED QTY (pcs)	Light Distribution	4000K Ra70@Tq=25℃		3000K Ra70@Tq=25℃	
			Luminaire Efficiency	Luminous Flux	Luminaire Efficiency	Luminous Flux
60	30	BLG-618	150 lm/w	9000	140 lm/w	8400
90	42	BLG-618	150 lm/w	13500	140 lm/w	12600

BLG-MIDI

IOTENA

Dimension



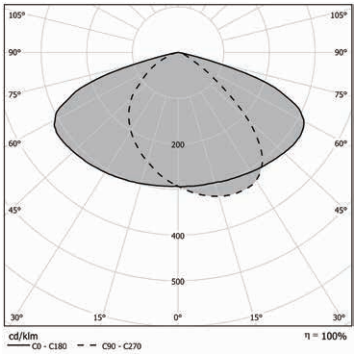
Parameters

Model No.	I-BL69460
Power	120W
Light Source	Osram/Philips
Input Voltage	AC100-277V 50/60Hz
Power Factor	0.95
Power Brand	Inventronics / MOSO / Osram
Surge Protection	10kV/20kV
Insulation Class	Class I/ClassII (optional)
Color Temperature (K)	3000/4000/5000/5700/6500±300K
Control System	Photocontrol(NEMA), Timer Dimming/ 0-10V Dimming/ DALI Dimming/ Solar Compatible (optional)
Operating Temperature Range	-40°C~50°C
Operating Humidity Range	10%~90% RH
Storage Temperature Range	-40°C~55°C
Housing Material	die casting aluminum
IP Rating	IP66/IK09
Pole Dimension	Ø60mm, Ø42mm,/Ø76mm(optional) Preparation for CE/CB/ENEC/RoHS certification
Maximum Pojected Area	0.20m²
Luminaire Dimension (mm)	740×285×132
Packing Dimension (mm)	820×365×210
Net Weight (Kg)	7.0±0.2
Gross Weight (Kg)	9.0±0.2

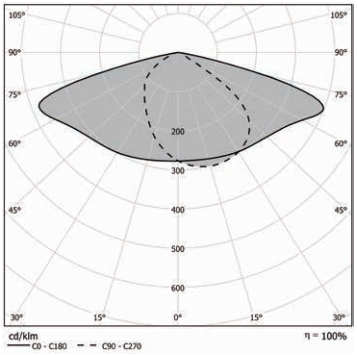
BLG-MIDI

IOTENA

Optical



BLG-540



BLG-618

3030 Light source

Power (W)	LED QTY (pcs)	Light Distribution	4000K Ra70@Tq=25℃		3000K Ra70@Tq=25℃	
			Luminaire Efficiency	Luminous Flux	Luminaire Efficiency	Luminous Flux
120	120	BLG-540	125 lm/w	15000	117 lm/w	14000

5050 Light source

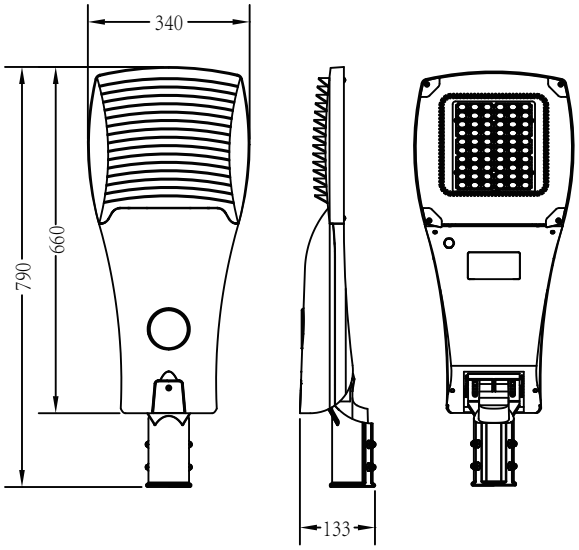
Power (W)	LED QTY (pcs)	Light Distribution	4000K Ra70@Tq=25℃		3000K Ra70@Tq=25℃	
			Luminaire Efficiency	Luminous Flux	Luminaire Efficiency	Luminous Flux
120	36	BLG-618	140 lm/w	12600	130 lm/w	11700

Power (W)	LED QTY (pcs)	Light Distribution	4000K Ra70@Tq=25℃		3000K Ra70@Tq=25℃	
			Luminaire Efficiency	Luminous Flux	Luminaire Efficiency	Luminous Flux
120	54	BLG-677	150 lm/w	18000	140 lm/w	16800

BLG-MAXI

IOTENA

Dimension



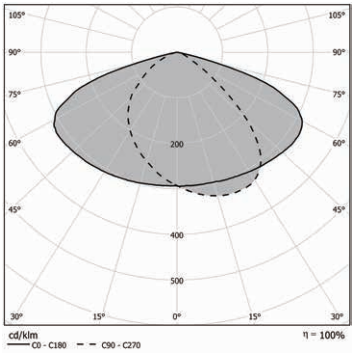
Parameters

Model No.	I-BL69470	I-BL69480
Power	150W	200W
Light Source	Osram/Philips	
Input Voltage	AC100-277V 50/60Hz	
Power Factor	0.95	
Power Brand	Inventronics / MOSO / Osram	
Surge Protection	10kV/20kV	
Insulation Class	Class I/ClassII (optional)	
Color Temperature (K)	3000/4000/5000/5700/6500±300K	
Control System	Photocontrol(NEMA), Timer Dimming/ 0-10V Dimming/ DALI Dimming/ Solar Compatible (optional)	
Operating Temperature Range	-40°C~50°C	
Operating Humidity Range	10%~90% RH	
Storage Temperature Range	-40°C~55°C	
Housing Material	die casting aluminum	
IP Rating	IP66/IK09	
Pole Dimension	Ø60mm, Ø42mm,/Ø76mm(optional) Preparation for CE/CB/ENEC/RoHS certification	
Maximum Pojected Area	0.20m²	
Luminaire Dimension (mm)	790×340×133	
Packing Dimension (mm)	870×420×212	
Net Weight (Kg)	8.0±0.2	
Gross Weight (Kg)	10.0±0.2	

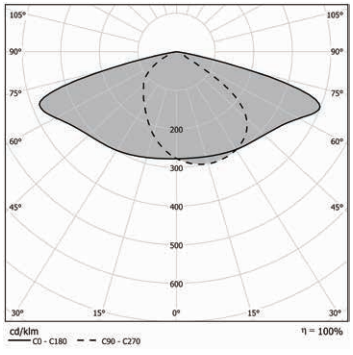
BLG-MAXI

IOTENA

Optical



BLG-540



BLG-618

3030 Light source

Power (W)	LED QTY (pcs)	Light Distribution	4000K Ra70@Tq=25℃		3000K Ra70@Tq=25℃	
			Luminaire Efficiency	Luminous Flux	Luminaire Efficiency	Luminous Flux
150	150	BLG-540	125 lm/w	18750	117 lm/w	17550

5050 Light source

Power (W)	LED QTY (pcs)	Light Distribution	4000K Ra70@Tq=25℃		3000K Ra70@Tq=25℃	
			Luminaire Efficiency	Luminous Flux	Luminaire Efficiency	Luminous Flux
150	54	BLG-618	140 lm/w	21000	130 lm/w	19500

Power (W)	LED QTY (pcs)	Light Distribution	4000K Ra70@Tq=25℃		3000K Ra70@Tq=25℃	
			Luminaire Efficiency	Luminous Flux	Luminaire Efficiency	Luminous Flux
150	84	BLG-677	150 lm/w	22500	140 lm/w	21000

APPENDIX 2

IOTENA

Recent Job References

Location	Items	Quantity	Year
Bangladesh	LED road light heads	45,000 pcs	2016~2018
Thailand	LED road light heads	1,000 pcs	2017
Malaysia	LED road light heads	1,100 pcs	2017
Czech	LED road light heads	4,970 pcs	2017
Spain	LED road light heads	3,500 pcs	2018
Ecuador	LED road light heads	12,270 pcs	2018
German	LED road light heads	3,800 pcs	2018
Russia	LED road light heads with LoRa solution	600 pcs	2019
Yuxi, China	LoRa solution for smart road lights	120,000 pcs	On-going
Thailand	LoRa solution for smart road lights	2,800 pcs	On-going
Pakistan	LoRa solution for smart road lights	1,200 pcs	On-going
Liuzhou, China	NB-IoT solution for smart road lights	17,000 pcs	On-going