Signify foundation

Guidelines for Outdoor Lighting Interventions in Humanitarian Contexts

Contents

Front Cover: Solar Street Light, Rhino Camp Settlement, Uganda, 2022

Preface

Purpose

The purpose of this document is to provide the United Nations High Commissioner for Refugees (UNHCR) and its relevant partners with a tool to aid in making a suitable choice of solar lighting systems. This applies for procurement and installation, as well as operation and maintenance – mainly for new lighting interventions, but it can also be applied to support the improvement of existing lighting system in camps. This is done, in turn, to enhance quality of life, productivity and safety of displaced population settlement sites during hours of darkness, in all possible applications and project scopes.

Scope and Limitations

These specifications are part of a lighting guidance focused on outdoor lighting requirements covering support and community applications in humanitarian settings including:

- Outdoor lighting at unsafe places to mitigate protection risks, within and at immediate surrounding of the displaced population settlements
- Outdoor lighting for productive use (businesses & markets)
- Outdoor lighting for community centers (health, schools, women safe house, vocational training centers, police stations and water tapping points when under use at night)
- Recreational, social, sports...

It is not intended to address indoor lighting requirements and it is also limited at the minimum lighting requirement to fit to the budget constraints (which is often a key factor in lighting intervention projects). Additionally, this guideline document is limited to lighting system specification guidelines for stand-alone systems only. It does not consider mini-grids because of their inherent complexities and costs. The pros and cons of mini-grids are discussed to give the user a better perspective of their possibilities. It should be noted that these guidelines do not cover domestic (inside the tent) lighting interventions.

The intent of these guidelines document is to:

- Clarify applications and roles for outdoor lighting and solar power lighting systems within forcibly displaced people's sites.
- Assist field officers and contractors (i.e. private partners) in determining minimum lighting requirement for the activities during dark hours and to choose appropriate lighting products through contextualization for establishing requirements.

This document is based on Signify's engineering judgment and expertise in lighting intervention, in conjunction with information gathered through a series of interviews with UNHCR officers.

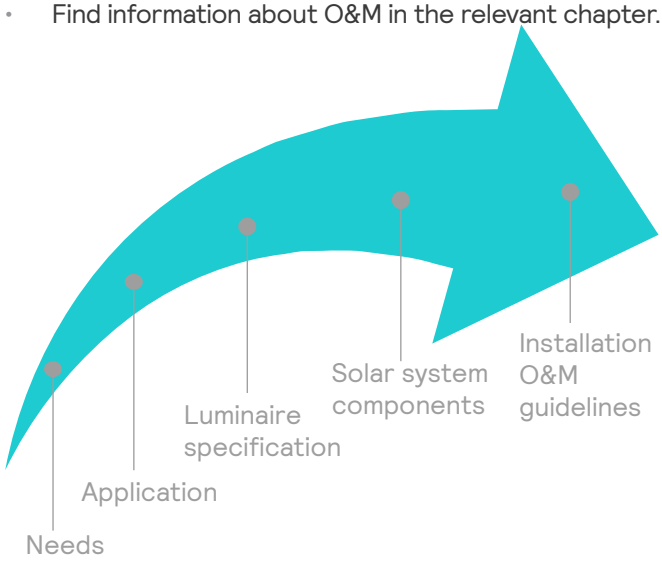
The specifications illustrated in this document are meant to allow for flexibility – meaning, they can be adapted. However, if there is any inconsistency or conflict between any of the guidance contained in the guidelines and the applicable legislative requirement, the legislative requirement shall prevail.

These specifications will be integrated in a lighting guideline tool which is intended to guide UNHCR field officers and partners (even without expertise in lighting) throughout the process of choosing and installing lighting in refugee camps.

Guideline navigation

This section will address a series of questions that might provide insights into this manual. This series of question is generic, and should be brought up when a decision for lighting a camp/settlement needs to be made.

- What is the need for lighting (e.g. security light for warehouse, street lighting for crossroad etc.)?
  - Run participatory assessment exercise [1]
- For which type of location does it apply (street, open areas, community building)?
- Find the luminaires that apply for such application in this guide (type and disposition).
- Based on the luminaire specification and the geographic location, identify the most suitable solar components from the table in the solar specification chapter:
  - PV panel
  - Battery
  - Charge controller
- Find information about installation of the specific component in the installation chapter.
- Find information about O&M in the relevant chapter.



[1] Community solar street lights and mobile charging stations – A practical guide to community-based projects – UNHCR DIP (2017), Desk review package.

Determining lighting specification for minimum lighting requirement

Background on lighting measurement

Illuminance is the measure of how bright an area is. The metric measure of the illuminance is lux, which represents the measure of the intensity of light (lumen) per square meter of surface on which it is spread. This is used to determine the kind of lighting installation required.

Environment	Typical/ Approximate Illuminance
Full Moon on a clear night	0.2 lux
Dark limit of civil twilight	3.4 lux
Night time on suburban residential street	5 lux
Well-lit main street at night (Pedestrian & roadways, cross-passages, junctions areas)	10 lux
Well-lit main street at night (Pedestrian & Aggregation areas)	15 lux
Very dark overcast day	100 lux
Full daylight (not direct sun)	10,000-25,000 lux

The characteristics of the light sources are important. These concern its colour appearance in °K, and its ability to reveal the colours (its colour-rendering index). Finally, lighting installations should not cause glare nor light trespass. To maintain the necessary light level throughout the time, one should consider roughly +20% for the sources flux to be installed to consider light depreciation over time.

Existing lighting standards

Internationally recognized outdoor lighting standards, which provide recommended illuminance values, were taken into consideration for this document – these are the **EN 13201:2015**, standard for road lighting (approved by the CEN European committee for standardization on June,6 2015), and the **EN 12464-2:2014**, standard for lighting of outdoor workplaces (approved by the CEN on December, 7 2013). Two other reference documents for lighting can be used: CIE 115:2010 (approved by the Commission Internationale de l'Eclairage, second edition) for Road lighting and the ISO/CIE 8995-3 (first edition 2018-03, prepared by CIE and ISO/TC274 the International Organization for Standardization on Light and Lighting) for lighting requirements for safety and security of Outdoor work places.

Application of EN 13201:2015 and EN12464-2:2014 for displaced people sites

Given the complexity of the relevant contexts in terms of variety of possible applications, three main categories have been defined. These categories reflect the physical characteristics of a specific area to be lit, while preserving the minimum lighting requirement necessary to guarantee safety and allow for all relative activities to be performed.

This simplification has been made to address the problem of possible absence of technical knowledge and/or experience in lighting within the field team. They will be the final users of the future guidelines and can be aided in the lighting intervention through such structured guidance, with the aim of being as user-friendly as possible. The three categories are:

- Street lighting
- Outdoor community lighting
- Open area lighting

Mobility Infrastructures

- Pedestrian roads between Shelters
- Pedestrian & Roadway
- Cross-passages & Junction areas

Community services building – outdoor lighting

- Schools
- Health-centers
- Other collective functions
- Sanitation

Open areas lighting

- Market
- Aggregation Areas
- Water collection & distribution points for food
- Security Lighting for merchandises & high-risk areas
- Living quarters -lighting inside & between shelters including Arrival centres

Besides this categorization in three groups, the present specification document considers the classes of area identified within the EN 13201-2:2015 standard: requirements for conflict areas, for pedestrians, and for areas within the EN12464-2:2014 standard, the available European standards of lighting specifications - these and are considered as the basis of all calculations, as there are no clear global standards for the chosen contexts.

Requirements for conflict areas
In general, this applies to refugee camps where, occasionally, there are drivers of motorized vehicle (humanitarian trucks, cars....) passing through:

- Street Lighting such as roadways, cross-passages, junction areas –Class C4
- Flood Lighting in areas such as market & aggregation squares –Class C3

C-Class lighting:

The C classes in Table 2 are intended for drivers of motorized vehicles on conflict areas such as shopping streets, road intersections of some complexity, roundabouts, queuing areas, etc. C classes can also be applied to areas used by pedestrians. The average illuminance (Ē) and the overall uniformity of the illuminance (Uo) are to be calculated and measured in accordance with EN 13201-3 and EN 13201-4.

Table 2 Iluminance class for conflict areas

Class	Horizontal Illuminance	
	E (Minimum maintained)	Uo (minimum)
C0	50	0.40
C1	30	0.40
C2	20	0.40
C3	15	0.40
C4	10	0.40
C5	7.5	0.40

Requirements for Pedestrians

- P Lighting Classes are applicable to Refugee Camps exclusively for the pedestrian passages.
- Street Lighting such as Pedestrian Roads generally through Shelters & Tents –Class P2
- Flood Lighting in areas close to Community Buildings & Tents as well as Shelters –Class P1

The P classes in Table 3 are intended for pedestrians and pedal cyclists on foot-ways, cycle ways, emergency lanes and other road areas lying separately or along the carriageway of a traffic route, and for residential roads, pedestrian streets, parking places, school yards, etc.

The road area for which the requirements of Tables 3 apply, can include all the road area such as carriageways on residential roads and reserves between carriageways, foot ways and cycleways.

Table 3 Pedestrian lighting standards

Class	Horizontal Illuminance	
	E^{a} (Minimum maintained)	E_{min} (maintained) lx
P1	50	0.40
P2	30	0.40
P3	20	0.40
P4	15	0.40
P5	10	0.40
P6	7.5	0.40
P7	Performance not determinate	Performance not determinate

Requirements for storage and high-risk areas

These requirements apply to both storage and high-risk areas – these will ensure the appropriate tasks realization, the security of people working and the security of merchandise.

The average recommended illuminance and uniformity as mentioned in the EN12464-2:

Table 2 Iluminance requirements of storage areas

Ref. No	5.7.1
Type of area, task or activity	Short term handling of large units and raw materials, loading and unloading of solid bulk goods.
E_m lx	20
U_o	0,25

Understanding Stakeholder Needs

Introduction

Lighting and solar energy initiatives benefit displaced persons communities and/or establishments in a variety of positive ways. Solar street lights can enhance the community's sense of security and local livelihoods and quality of life increase as market areas remain open longer, with lighted areas becoming social hubs for community interaction after sunset. Home lighting systems increase opportunities for children and youth to pursue study after sunset and make household chores easier for female household members.

Community Market, Rhino Camp Settlement, Uganda, 2022

Meeting the lighting and solar energy needs of displaced communities requires a deep understanding of their explicit needs and desires and careful consideration of how these needs are contextualized within the larger displacement ecosystem. This displacement ecosystem may comprise refugees of different profiles and geographic locations, government representatives, host community members, and other providers working alongside your organization.

Likely, your organization is already aware of these different stakeholders and how they interact with the displaced persons you and your organization provides services to.

A variety of methods, tools, and approaches exist for mapping and prioritizing the needs of displaced persons and community stakeholders. Your organization likely has a process or protocol for this crucial project phase, or perhaps you have personal experience implementing this process successfully.

This guideline does not intend to prescribe one process or methodology; rather, we wish to emphasize the crucial role of stakeholder-centric needs assessments for projects involving lighting and solar energy for displaced communities. If you are new to user-centric needs assessments, or simply wish to explore additional tools, we encourage you to visit the UNHCR Tool for Participatory Assessment in Operations web site [2] or other community assessment tools developed by the UNHCR. [3, 4]

Understanding Stakeholder Needs

Displacement settings and community needs vary widely and often require a tailored approach. As a result, taking a "ground-up" or "user-led" approach often surfaces stakeholder needs better than a "top-down" approach. Top-down approaches often result in implementing partners leading with a "product mind-set" that becomes fixated on the constraints of a particular product solution rather than an understanding of the needs and context of the displaced community. We believe that community stakeholders should be encouraged to define precisely what they require. This "ground-up" approach encourages a "how might we" mind-set grounded in collaboration instead of a "top-down" mind-set which may miss crucial contextual information or community needs.

[2] UNHCR. (2022). SDG Acceleration Toolkit
https://sdgintegration.undp.org/knowledge-bank?field_enablers_tid=All&field_category_name_value=All&field_tool_function_value=All&field_accelerator_tool_value=All

[3] UNHCR. (2022). Needs Assessment Handbook
https://im.unhcr.org/na/

[4] UNHCR. (2022). Needs assessment for refugee emergencies (NARE)
https://www.unhcr.org/publications/legal/450e963f2/unhcr-tool-participatory-assessment-operations.html

Understanding Stakeholder Needs:

Specific Populations:

For infrastructure projects such as solar street lighting, lighting placement should be considered in the context of the community needs assessment phase. This phase should encompass community led guidance of placement locations, with careful consideration for how lighting design and placment could impact women, girls and other marginalized and/or stigmatized community members. Depending on the context of the displaced community your organization works with, this may require specific discussions with community spokespersons representing these groups.

Utilizing Community Inputs:

People residing in displacement communities often have relevant information that could affect construction, installation, or sustainment strategies for your project. Likewise, the vendors you hire to install and maintain lighting and solar energy system will also have important insights about how site location will impact the use and sustainability of this infrastructure.

Vandalized Solar Light, Rhino Camp Settlement, Uganda, 2022

Utilizing Installation and Repair Vendors:

Including project vendors in site visits and, when relevant, interactions with the residing and host community, can be useful for extracting additional technical insights as well as contextualizing these project stakeholders to how lighting and solar energy products will be used. This will prove useful for ensuring optimal long-term service to members of the displacement community.

Understanding Seasonality & Climatic Affects:

Planning for multiple site visits to observe the impact of seasonal changes at the displacement location (camp, settlement, community etc.) will be helpful for identifying how weather and other climatic factors could affect the placement or use of the lighting or solar energy product.

For example, a visit in the rainy season may not fully capture how much dust can be generated during the dry season, resulting in coated solar panels and thus, increased cleaning. Conversely, a visit during dry season may not reveal how flash floods or rain-driven erosion during the wet season could impact the foundations of the solar street lights. In some cases, lack of consideration for these factors, combined with poor placement, have caused these street lights to topple over completely.

Once again, including your construction, installation, and repair vendors in these site visits could yield additional, relevant technical insights as well as crucial context to make future vendor engagements more efficient.

Specialized Community Needs Assessments:

Often, projects involving lighting and solar energy system are part of larger initiatives requiring specialized technical expertise. Examples include livelihoods programming featuring solar energy powered retail kiosks, or programs targeting sexual, gender-based violence (SGBV) via increased community street lighting.

For example, when deciding where to locate solar street lights, Protection and Gender staff would have essential insights and expertise when conducting community needs assessments with specific populations, in addition to knowledge about security and/or SGBV data that could further inform where street light placement could have the most positive impact.

Livelihoods provides another useful example: A focused market assessment conducted by someone knowledgeable in livelihoods or income generation can identify the most profitable service offerings of a solar powered retail kiosk, including potential market size, pricing strategy, and the impact of the proposed kiosk on other businesses within the displacement community (when applicable).

We have observed hair salons, copy shops, and movie parlors capable of screening football matches to be an aspirational service offering for local businesses due to their popularity in the community and potential for high profits. Obviously, such asset-intensive businesses also require greater start-up capital, which is why appropriate expertise is beneficial to ensure the most efficient return on investment.
Such an assessment can also help identify the most appropriate way to structure the business and the design of mechanisms for resolving customer service

Specialized Community Needs Assessments, Continued:

grievances or other potential conflicts between the business and the community.

The ability to model potential financial performance under various contexts relevant to the displaced community would prove useful for projecting long term sustainability, growth, and the opportunity costs for staff (Displaced community members must earn enough from the venture to justify their time at the business since they would be unable to spend this time on other essential tasks like farming).

Understanding the Impact of lighting and solar energy initiatives:

As we discussed previously, a thorough needs assessment ensures that whatever initiative is implemented remains "user-led," that is, stakeholder-centric to the needs and context of the displaced populations your organization works with.

Appropriate needs assessment (as well as specialized assessments when applicable) are also useful for generating the baseline data necessary for determining how the lighting or solar energy system is performing. While anecdotal community feedback is useful, tracking the performance of the intervention against a baseline is essential for understanding the viability of the current product solution or the feasibility of scaling the intervention to other displacement communities.

Example: Livelihoods metrics

The use of street lighting in community market areas to support livelihoods generation is a good example: Even basic data collection (E.g. the current number of shops and shop-owner profiles in the market area, hours of operation, average number of customers, and average daily revenues) provides useful metrics for evaluating how the installation of streetlights could create a beneficial impact for these stakeholders. Basic data collection, including qualitative "voice of the vendor" information will help your organization better understand the nuances of how such infrastructure is affecting the community.

In one example we observed, solar street lights were hailed by female shop keepers for prolonging retail hours at the local market. Indeed, this was true, operational hours at the market were extended as a result of the street lights. Digging deeper however, we found that many of the female shop keepers continued to cease operations around the original closing time. Why? Despite the addition of street-lights in the market, these stakeholders were expected back at their homes for childcare and household duties. As a result, male vendors would come forward to take their place. As the example shows, context matters, and can have a significant impact on the beneficiaries originally targeted for the intervention.

In the case of projects with greater complexity, such as community-run, solar-powered retail kiosks, regular financial reporting with clear reporting lines ensures that the displaced community members providing these services have the documentation required to optimize the efficiency, transparency, and profitability of their business.

Defining Project Stakeholder Communications for Maximum Efficiency:

Implementing community-centric lighting and solar-energy solutions is often a collaborative effort comprising multiple project stakeholders. Like any project in displaced persons context, understanding the roles and responsibilities of other partner stakeholders is essential for efficient implementation.

Identifying Project Stakeholder Roles & Responsibilities:

In the case of lighting and solar energy solutions, this not only includes vendors responsible for construction, installation, and sustainment, but any project stakeholders essential for ensuring the continued delivery of services the displacement community.

Community Market, Rhino Camp Settlement, Uganda, 2022

Ensuring Efficient Communications: Displacement Community:

Like any service, routine maintenance may be required throughout the service life of the product. It's highly likely that a member of the displaced community will be the first stakeholder to take note when solar light or energy system require repair or maintenance.

Ensuring that beneficiaries understand and are empowered to contact specific points of contact is the first step in ensuring continued community involvement and support of the lighting or solar energy solution.

Community Market, Rhino Camp Settlement, Uganda, 2022

Ensuring Efficient Communications: Project Stakeholders:

Depending on the project structure and stakeholders, such a request from the community may require the involvement of other project stakeholders beyond the implementing partner. For example the community may request a repair to one of the implemented systems. This could require a technical provider or the original vendor. If it relates to larger infrastructure, local government, or a multi-lateral's involvement may be required.

Having clearly defined communication channels could mean the difference between a timely resolution of the issue or a protracted delay that undermines the displacement community's trust in the service. We have observed that a clear understanding of roles and responsibilities between project stakeholders is essential for avoiding frustration and fatigue setting among project stakeholders.

We recommend that key project stakeholders have their responsibilities clearly described in table or similar format for easy reference. This resource can be included as an annex to the service agreement and signed-off by all parties.

In addition to the protocols your organization has in place for managing such collaborative programs, we advocate joint planning sessions with your project partners to "game" how different scenarios may stress or change your understanding of current roles and responsibilities in unexpected ways. These exercises can be useful for preparing funding and a response plan ahead of time, rather than having to address the situation in the moment when the project team may find themselves unprepared.

Ensuring Efficient Communications: Project Staff Turnover:

Another reality to plan for is the inevitable turn-over of project staff. Lighting and solar energy products are designed for durability and a long service life, often outlasting the project team responsible for implementation. As a result, clear transition plans should be in place to ensure continuity of the project team and sustainability of the original investment.
Like the defined communications channels described previously, a defined staff turn-over plan is a useful addition to any service agreement and can be included as an additional annex for easy reference.

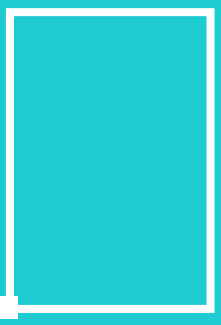
Open Area Lighting

Market & Aggregation Areas- Small size (10 x 20m) (Optimal configuration [3])

Position of surface in external scene:

Market point: 0.00m, 0.00m, 0.00m

Grid: 128 x 128 Points



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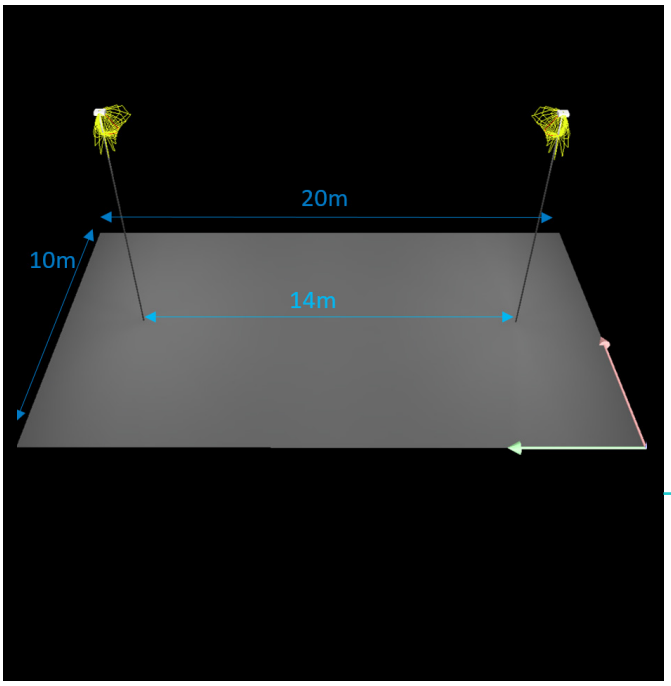
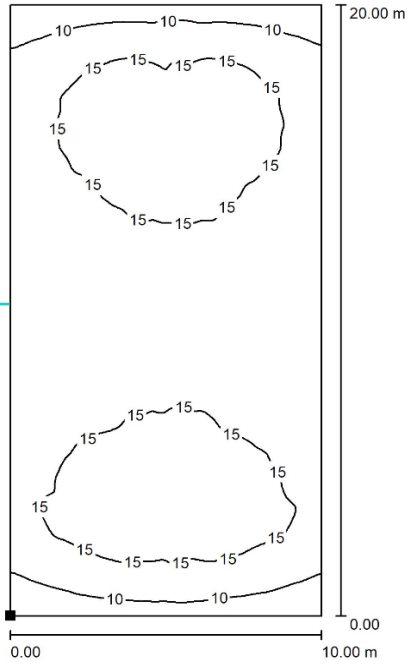
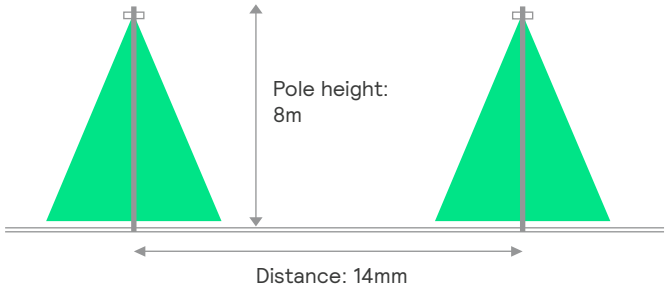




Defined Area: 10m x 20m

[5] It should be noted that optimal configuration has less poles compared to alternative configuration but poles are higher in length. Depending on the case, user can choose the suitable configuration.



Luminaire Specifications:

- Luminous Flux: 3000 lm
- Colour Temperature: 30000K
- Power consumption proposed: 17W
- Efficacy proposed: 175 lm/W
- Optic proposed: medium beam
- Protection degree: IP65 or IP66
- Electrical run: 12/24 V DC

Luminaires ranges :
Acceptable luminous flux range (depending on optic type and efficiency): 3000 lm - 4500 lm

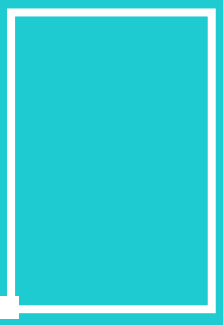
- Efficacy acceptable range: 150 to 190 lm/W
- Power consumption: range 16W to 30W

Market & Aggregation Areas –Small size (10x20m) (Alternative configuration)

Position of surface in external scene:

Market point: 0.00m, 0.00m, 0.00m

Grid: 128 x 128 Points



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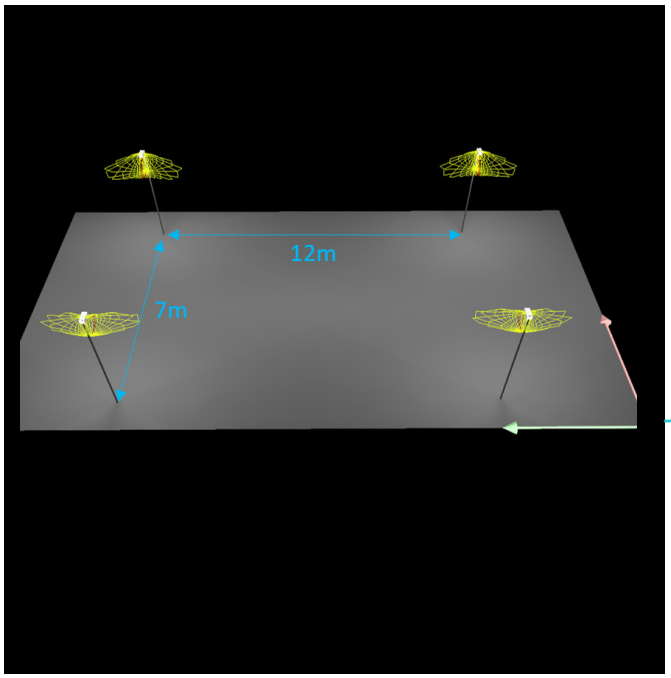
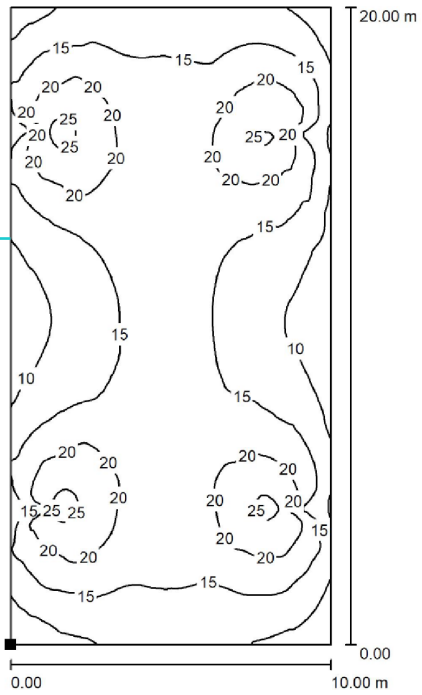
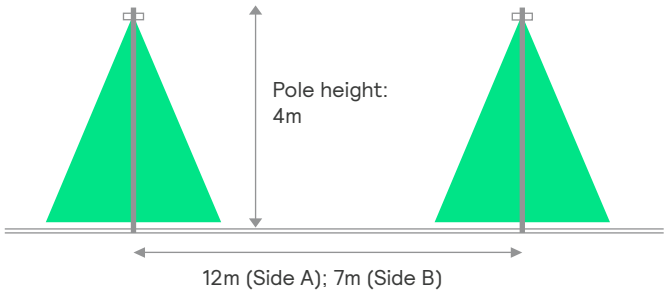




Defined Area: 10m x 20m



Luminaire Specifications:

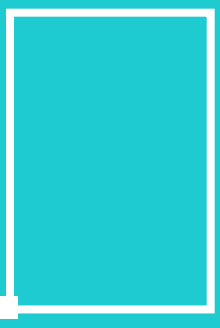
- Luminous Flux: 1500 lm
- Color Temperature: 4000K or warmer.
- Power consumption: range 8W to 10W
- Efficacy proposed: 188 lm/W
- Efficacy acceptable range: 150 to 180 lm/W
- Protection degree: – UNHCR actual standard is
- IP 6 5
- Electrical run: 12/24 V DC

Market & Aggregation Areas –Medium size (Optimal configuration) [22x30m]

Position of surface in external scene:

Market point: 0.00m, 0.00m, 0.00m

Grid: 128 x 128 Points



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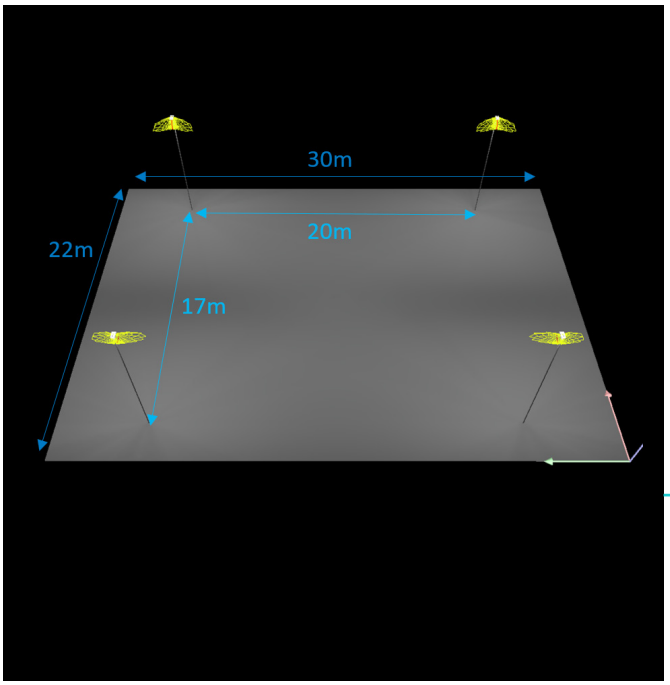
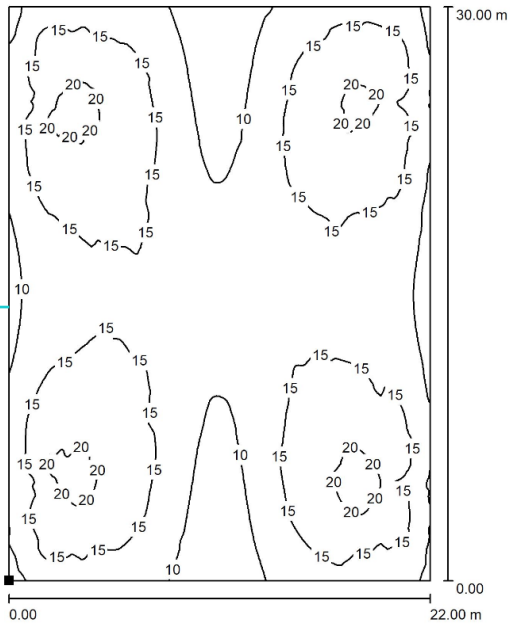
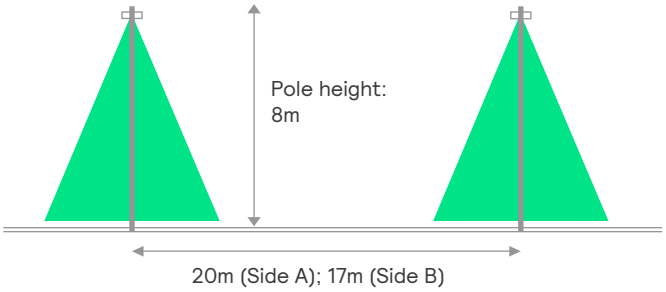




Defined Area: 22m x 30m



Luminaire Specifications:

- Luminous Flux: 4500 lm
- Color Temperature: 3000°K
- Power consumption proposed: 24W
- Efficacy proposed: 188 lm/W
- Optic proposed: medium beam
- Protection degree: IP65 or IP66
- Electrical run: 12/24 V DC

Luminaires ranges :
Acceptable luminous flux range (depending on optic type and efficiency): 3500 lm – 4500 lm

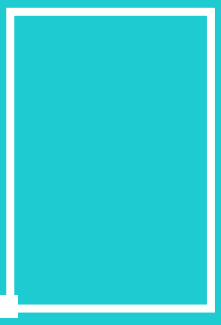
- Efficacy acceptable range: 150 to 190 lm/W
- Power consumption: range 20W to 30W

Market & Aggregation Areas –Medium size (Alternative configuration) [20x30m]

Position of surface in external scene:

Market point: 0.00m, 0.00m, 0.00m

Grid: 128 x 128 Points



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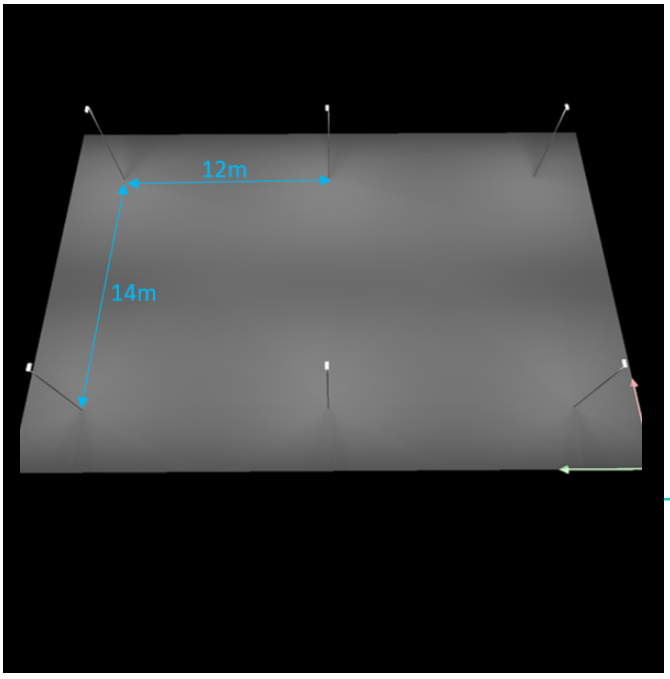
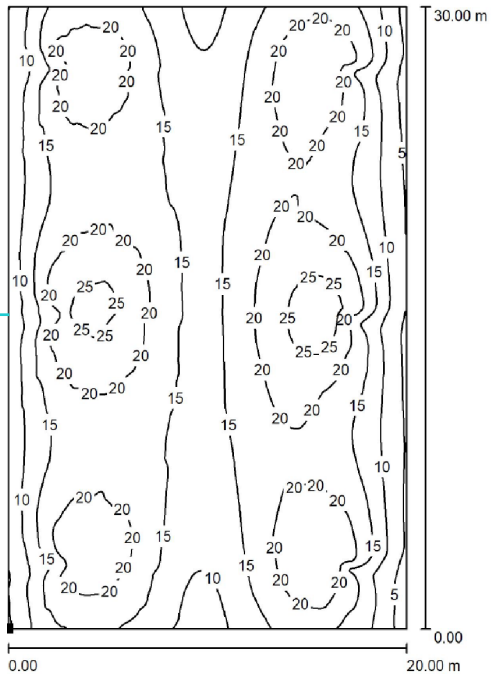
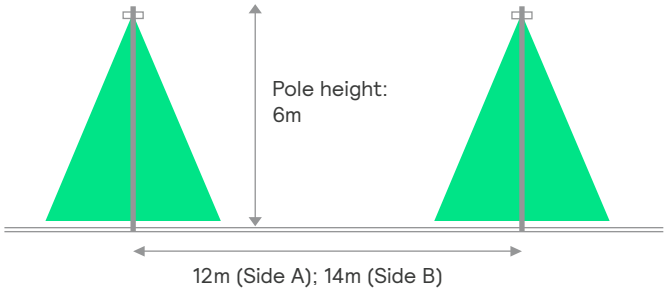




Defined Area: 20m x 30m



Luminaire Specifications:

- Luminous Flux: 3000 lumen;
- Color Temperature: 4000K or warmer.
- Power consumption: range 17W to 21W
- Efficacy proposed: 176 lm/W
- Efficacy acceptable range: 150 to 180 lm/W
- Protection degree: IP66 or IP67
- Electrical run: 12/24 V DC

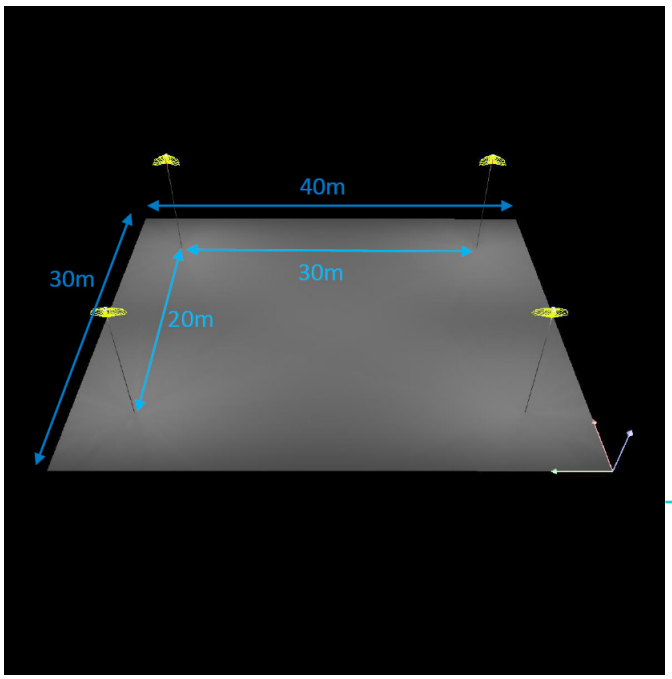
Market & Aggregation Areas –Large size (30x40m)

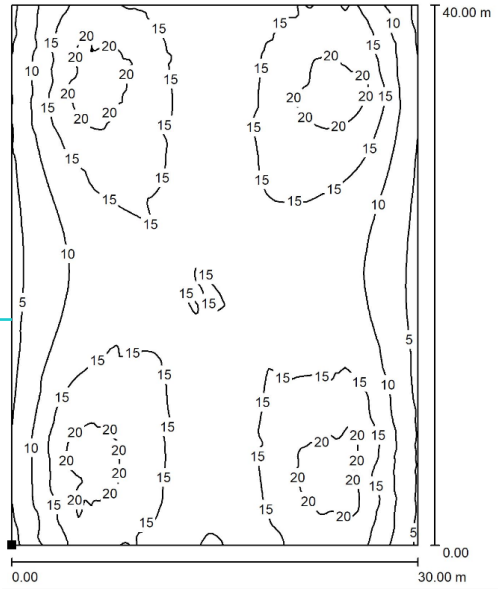
Position of surface in external scene:

Market point: 0.00m, 0.00m, 0.00m

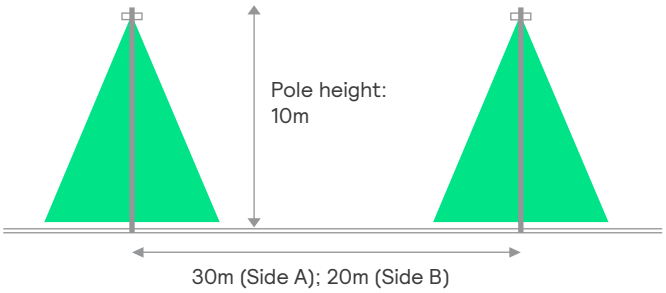
Grid: 128 x 128 Points

E_{av} [lx] = 14 E_{min} [lx] = 3.87 E_{max} [lx] = 23 u0 = 0.279





Defined Area: 30m x 40m



Luminaire Specifications:

- Luminous Flux: 6000 lm
- Color Temperature: 3000°K
- Power consumption proposed: 35 W
- Efficacy proposed: 175 lm/W
- Optic proposed: medium beam
- Protection degree: IP65 or IP66
- Electrical run: 12/24 V DC

Luminaires ranges :
Acceptable luminous flux range (depending on optic type and efficiency): 6000 lm – 7500 lm

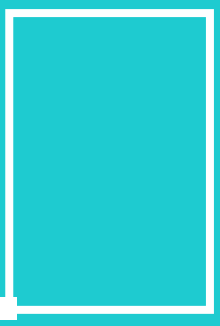
- Power consumption: range 40W to 53W
- Efficacy acceptable range: 140 to 190 lm/W

Water Collection & Distribution Points

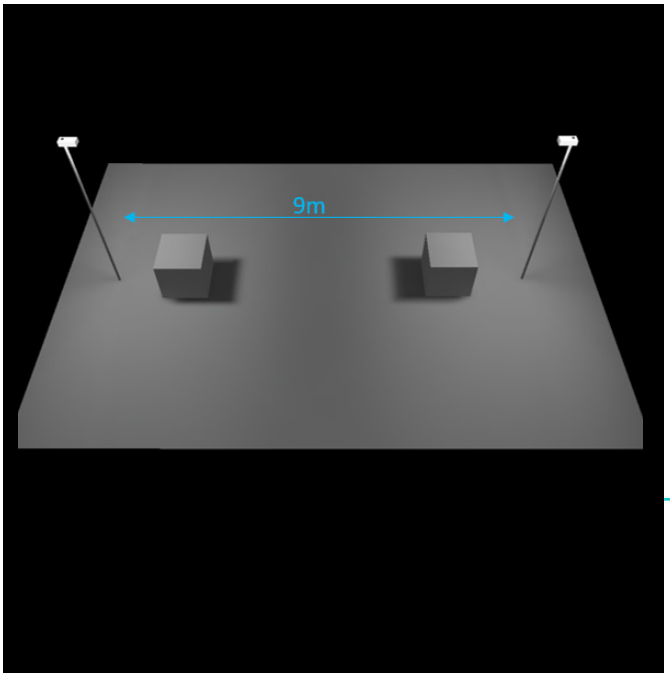
Position of surface in external scene:

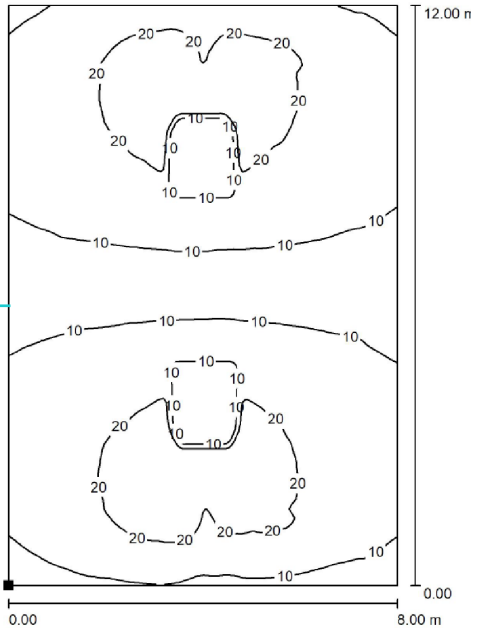
Market point: 4.981m, 7.987m, 0.000m

Grid: 128 x 128 Points

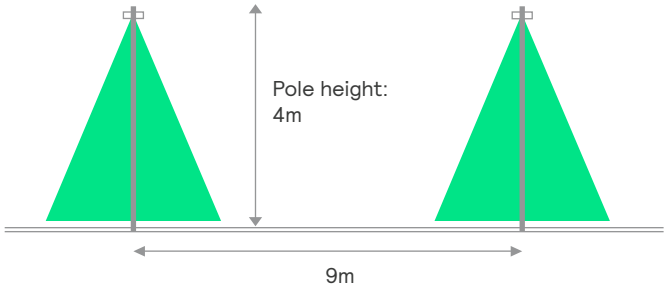


E_{av} [lx] = 14 E_{min} [lx] = 20.04 E_{max} [lx] = 29 (no requirement of u0)





Defined Area: 8m x 12m



Luminaire Specifications:

- Luminous Flux: 1500 lm
- Color Temperature: 3000°K .
- Power consumption proposed: 9W
- Efficacy proposed: 170 lm/W
- Optic proposed: medium beam
- Protection degree: IP65 or IP66
- Electrical run: 12/24 V DC

Luminaires ranges :
Acceptable luminous flux range (depending on optic type and efficiency): 1500 lm – 2000 lm.

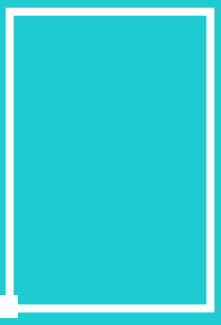
- Power consumption: range 8W to 13W
- Efficacy acceptable range: 150 to 190 lm/W

Security Lighting for technological, merchandises & high-risk areas (Optimal configuration)

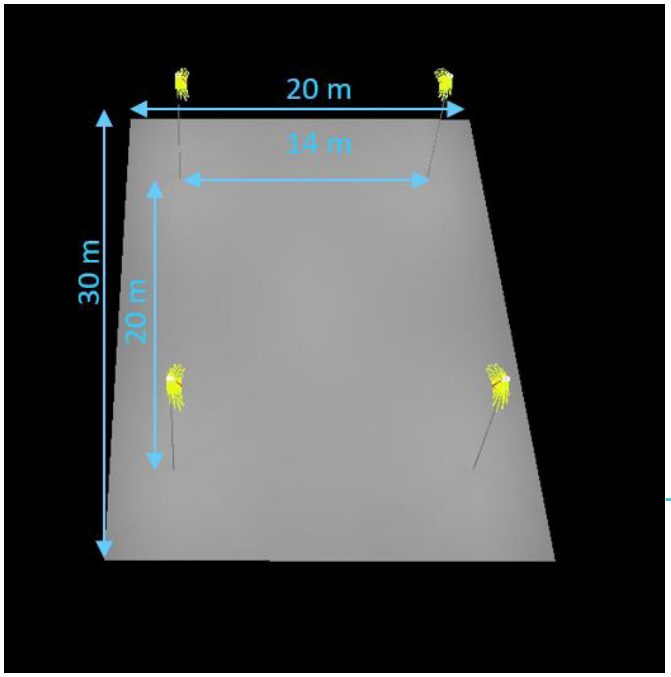
Position of surface in external scene:

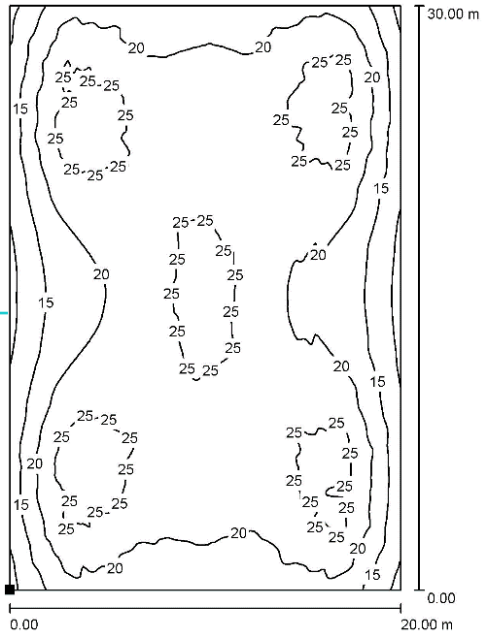
Market point: 0.000m, 0.000m, 0.000m

Grid: 128 x 128 Points

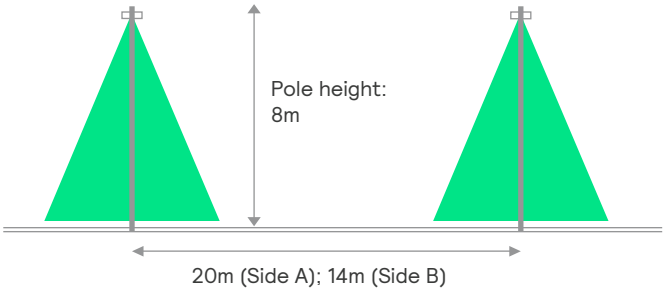


E_{av} [lx] = 21 E_{min} [lx] = 8.47 E_{max} [lx] = 28 u0 = 0.405 0.0





Defined Area: 20m x 30m



Luminaire Specifications:

- Luminous Flux: 6000 lm
- Color Temperature: 4000°K or warmer.
- Power consumption proposed: 34W
- Efficacy proposed: 175 lm/W
- Optic proposed: medium beam
- Protection degree: IP65 or IP66
- Electrical run: 12/24 V DC

Luminaires ranges :
Acceptable luminous flux range (depending on optic type and efficiency): 6000 lm – 7500 lm.

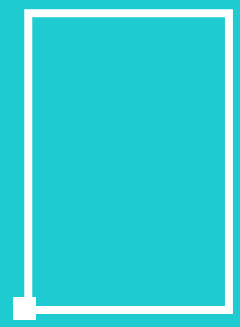
- Power consumption: range 35W to 50W
- Efficacy acceptable range: 150 to 190 lm/W

Security Lighting for technological, merchandises & high-risk areas (Alternative configuration)

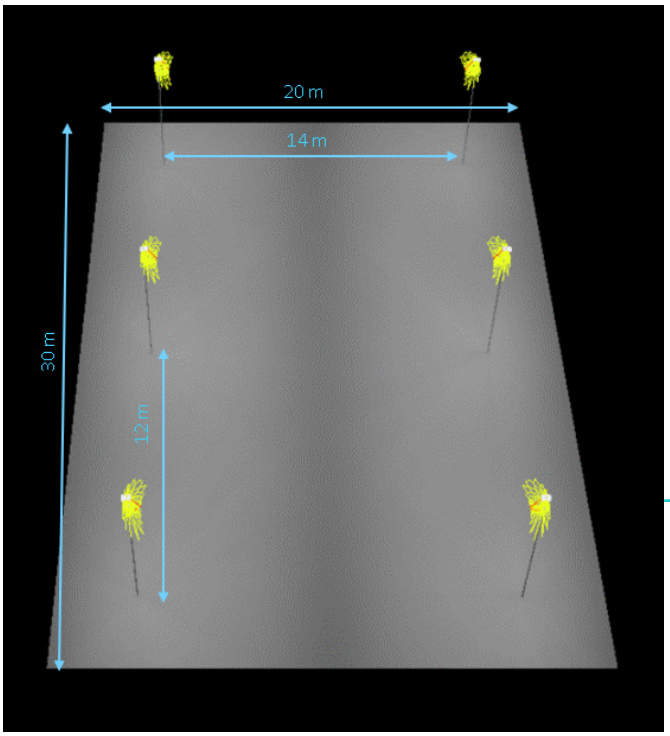
Position of surface in external scene:

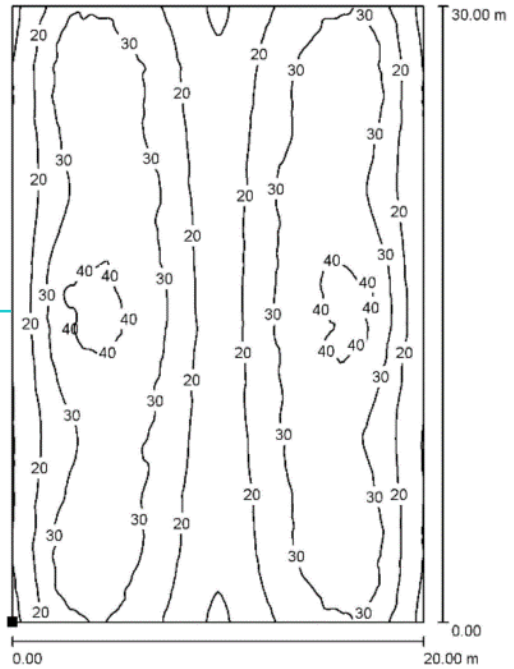
Market point: 4.981m, 7.987m, 0.000m

Grid: 128 x 128 Points

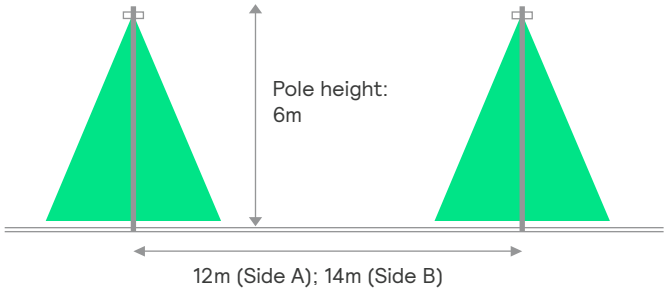


E_{av} [lx] = 26 E_{min} [lx] = 7.64 E_{max} [lx] = 47 u0 = 0.29





Defined Area: 20m x 30m



Luminaire Specifications:

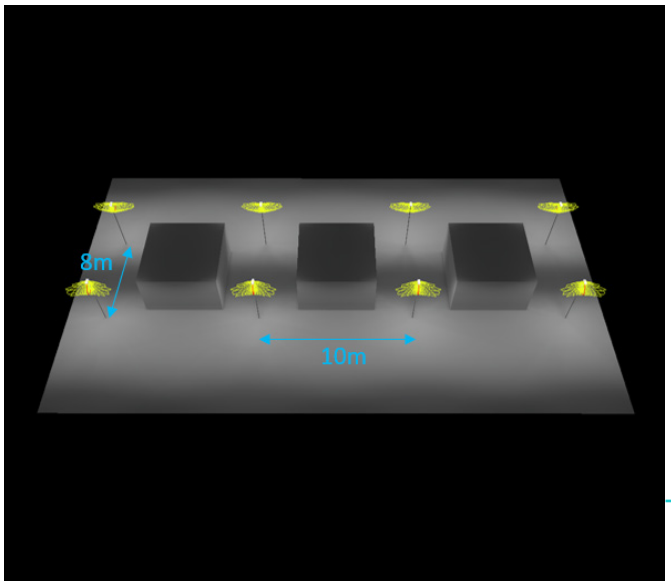
- Luminous Flux: 4500 lumen;
- Color Temperature: 4000K or warmer.
- Power consumption proposed: 26W
- Efficacy proposed: 175 lm/W
- Efficacy acceptable range: 150 to 180 lm/W
- Protection degree: IP66 or IP67
- Electrical run: 12/24 V DC

Living quarters -lighting between shelters

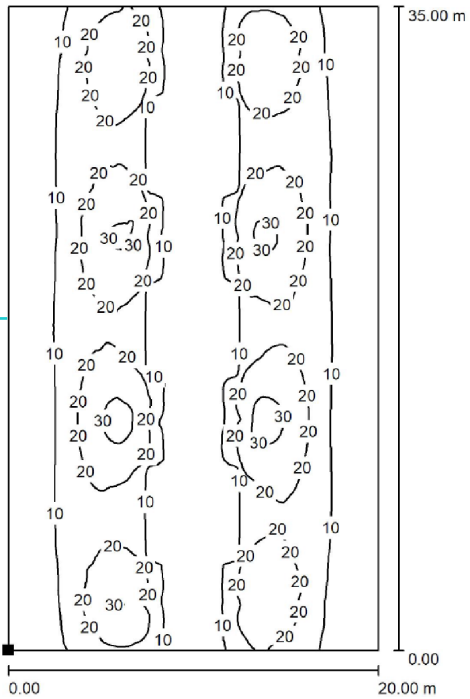
Position of surface in external scene:

Market point: 5.001m, 5.316m, 0.000m

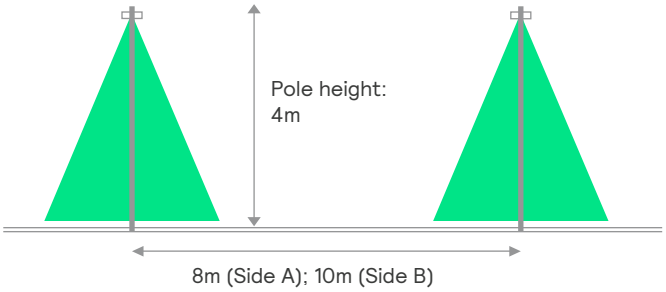
Grid: 128 x 128 Points



E_{av} [lx] = 12 E_{min} [lx] = 0.04 E_{max} [lx] = 34 (no requirement of u0)



Defined Area: 20m x 35m



Luminaires ranges :
Acceptable luminous flux range (depending on optic type and efficiency): 1500 lm - 2000 lm

Luminaire Specifications:

- Luminous Flux: 1500 lm
- Color Temperature: 3000°K.
- Power consumption proposed: 9W
- Efficacy proposed: 170 lm/W
- Optic proposed: narrow or medium beam
- Efficacy acceptable range: 150 to 180 lm/W
- Protection degree: IP65 or IP66
- Electrical run: 12/24 V DC

- Power consumption: range 8W to 13W
- Efficacy acceptable range: 150 to 190 lm/W
- The utilization of light beam with sharp cut-off will prevent the light trespass into the shelters

Community services building – outdoor lighting

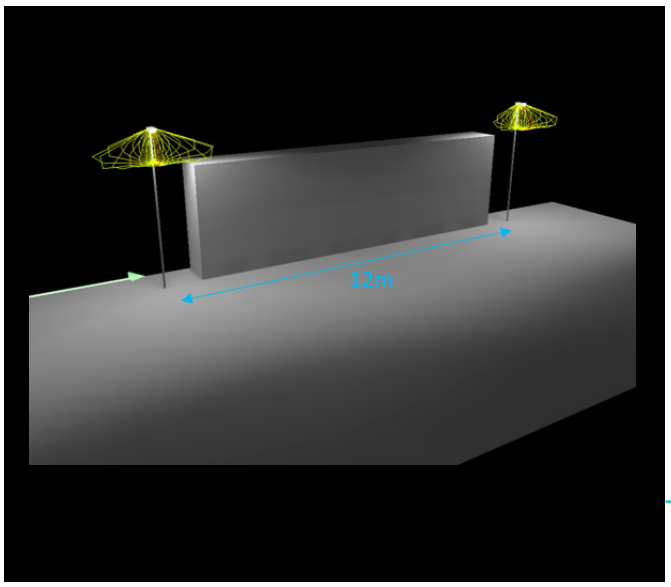
Community Buildings –Outdoor lighting for small-scale collective spaces (Schools, Health-Centers…)

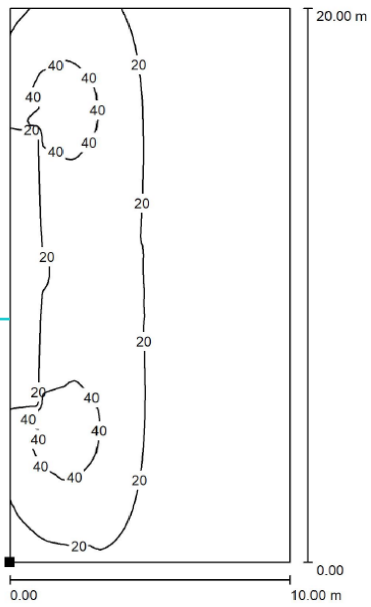
Position of surface in external scene:

Market point: 0.000m, 0.000m, 0.000m

Grid: 128 x 128 Points

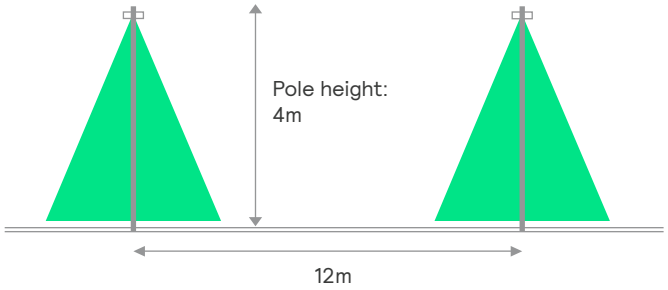
E_{av} [lx] = 15 E_{min} [lx] = 0.13 E_{max} [lx] = 51 (no requirement of u0)





Facade extension: Length 10m, Height 3m

Defined Area: 10m x 20m



Luminaire Specifications:

- Luminous Flux: 3000 lumen;
- Color Temperature: 3000°K
- Power consumption proposed: 20W
- Efficacy proposed: 150 lm/W
- Optic proposed: medium beam
- Protection degree: IP65 or IP66
- Electrical run: 12/24 V DC

Luminaires ranges :
Acceptable luminous flux range (depending on optic type and efficiency): 3000 lm – 4000 lm.

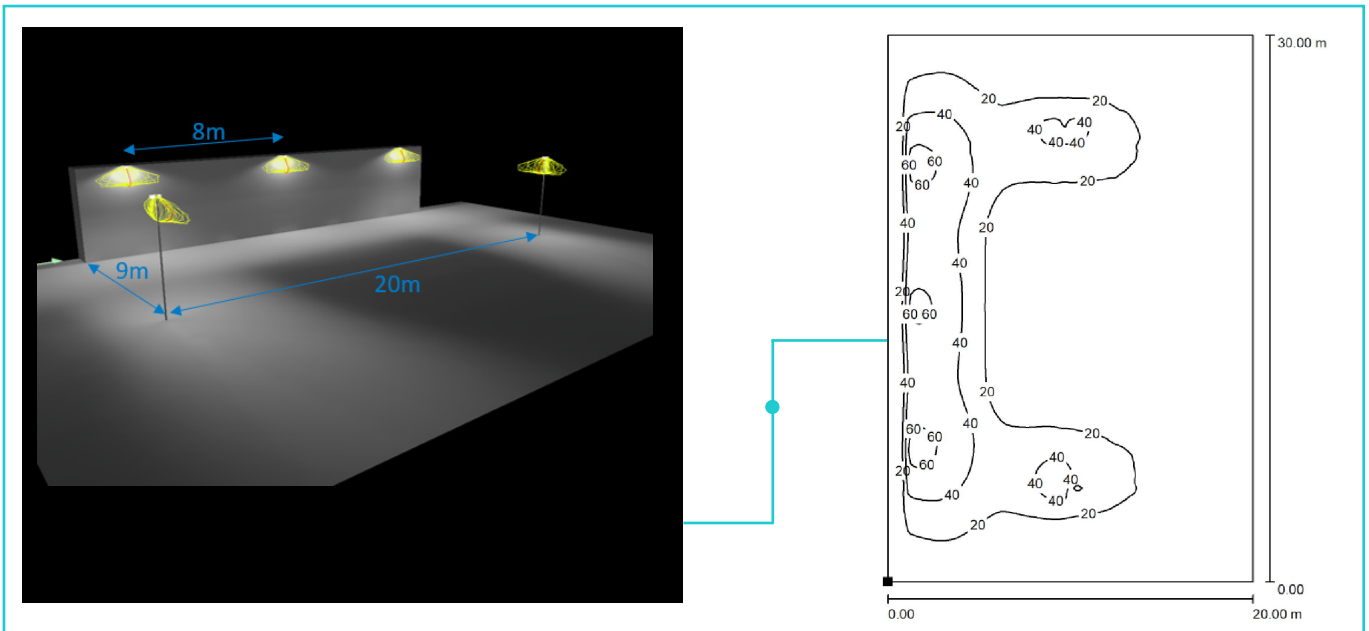
- Power consumption: range 16 W to 25W
- Efficacy acceptable range: 150 to 190 lm/W

Community Buildings –Outdoor lighting for Medium-scale collective spaces (Schools, Health-Centers..) Option I – Wall Mounted

Position of surface in external scene:

Market point: 0.000m, 0.000m, 0.000m

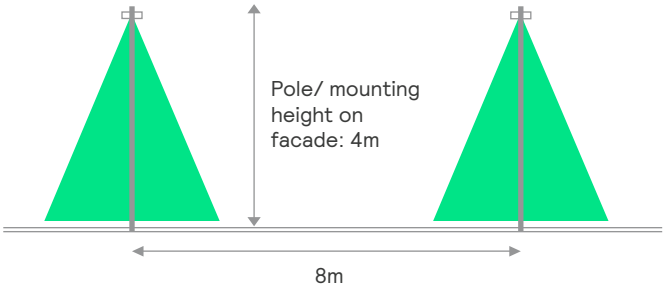
Grid: 128 x 128 Points



E_{av} [lx] = 16 E_{min} [lx] = 0.21 E_{max} [lx] = 66

Facade extension: Length 20m, Height 4m

Defined Area: 20m x 30m



Luminaire Specifications:

- Luminous Flux: 3000 lumen;
- Color Temperature: 3000°K
- Power consumption proposed: 17W
- Efficacy proposed: 176 lm/W
- Optic proposed: medium beam
- 3.Protection degree: IP65 or IP66
- Electrical run: 12/24 V DC

Luminaires ranges :
Acceptable luminous flux range (depending on optic type and efficiency): 3000 lm – 4000 lm.

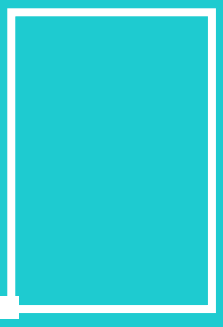
- Power consumption: range 16 W to 25W
- Efficacy acceptable range: 150 to 190 lm/W

Community Buildings –Outdoor lighting for Medium-scale collective spaces (Schools, Health-Centers..) Option 2 – Poles

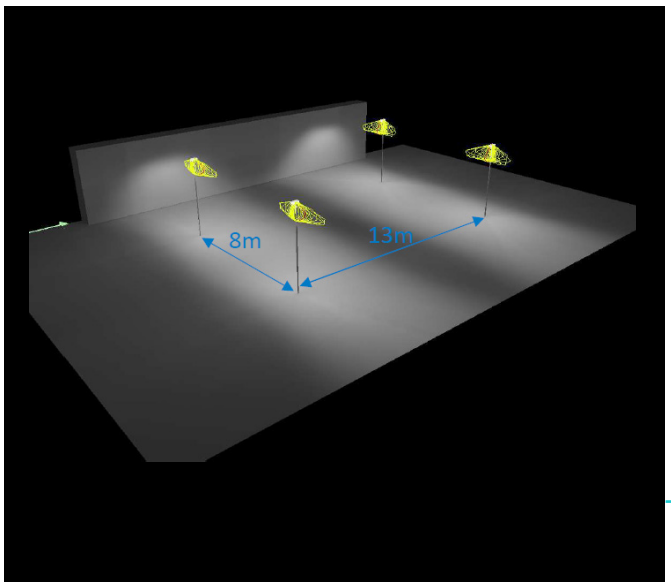
Position of surface in external scene:

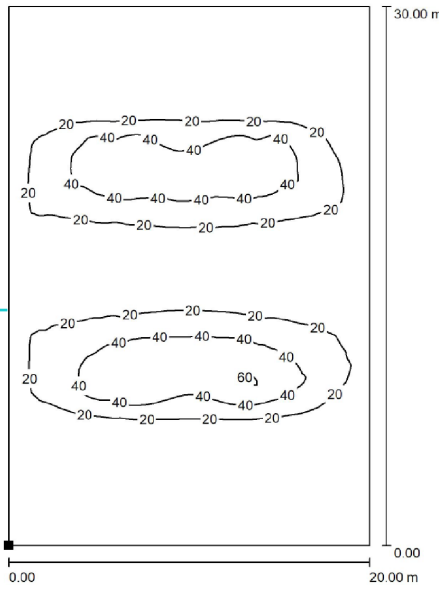
Market point: 0.000m, 0.000m, 0.000m

Grid: 128 x 128 Points



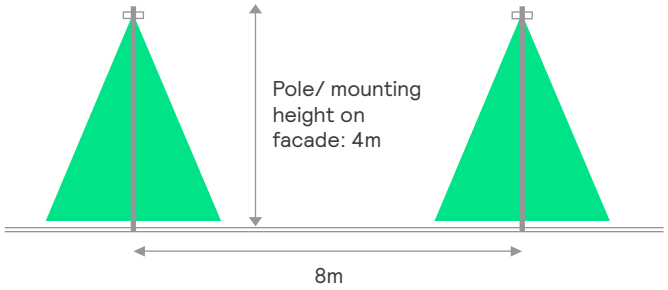
E_{av} [lx] = 15 E_{min} [lx] = 0.09 E_{max} [lx] = 62





Facade extension: Length 20m, Height 4m

Defined Area: 20m x 30m



Luminaire Specifications:

- Luminous Flux: 3000 lumen;
- Color Temperature: 3000°K.
- Power consumption: range 17W to 21W
- Efficacy proposed: 176 lm/W
- Efficacy acceptable range: 150 to 180 lm/W
- Protection degree: IP65 or IP66
- Electrical run: 12/24 V DC

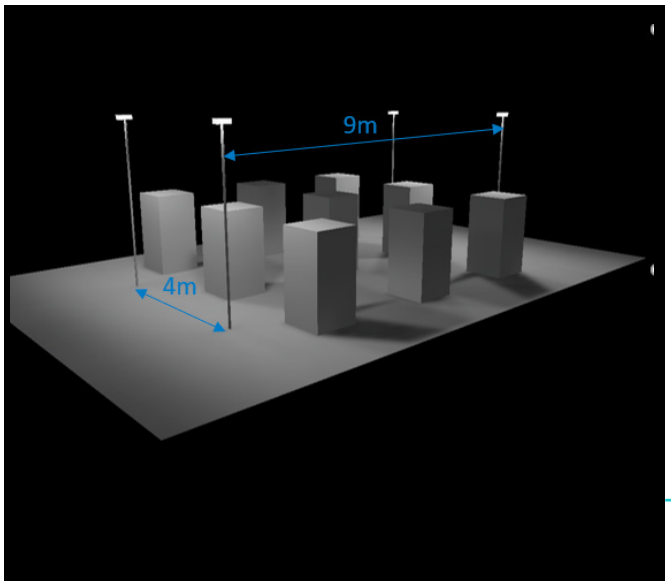
Community Buildings –Outdoor lighting for Toilets, Showers and latrines

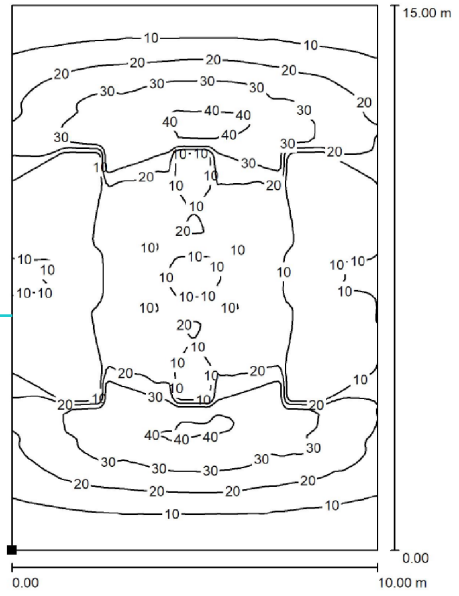
Position of surface in external scene:

Market point: 4.981m, 7.987m, 0.000m

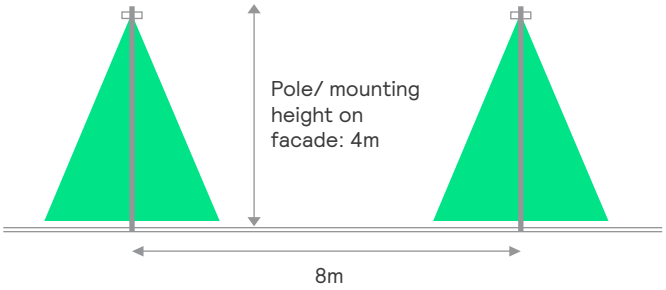
Grid: 128 x 128 Points

E_{av} [lx] = 16 E_{min} [lx] = 0.11 E_{max} [lx] = 42





Defined Area: 10m x 15m

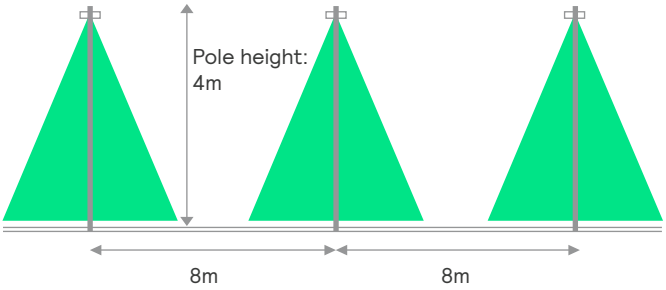


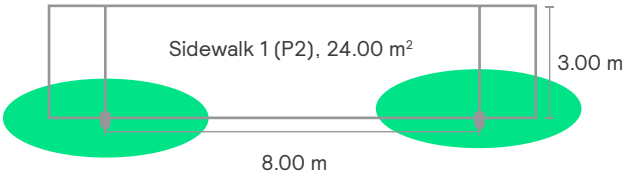
Luminaire Specifications:

- Luminous Flux: 3000 lumen;
- Color Temperature: 4000K or warmer.
- Power consumption: range 17W to 21W
- Efficacy proposed: 176 lm/W
- Efficacy acceptable range: 150 to 180 lm/W
- Protection degree: IP65 or IP66
- Electrical run: 12/24 V DC

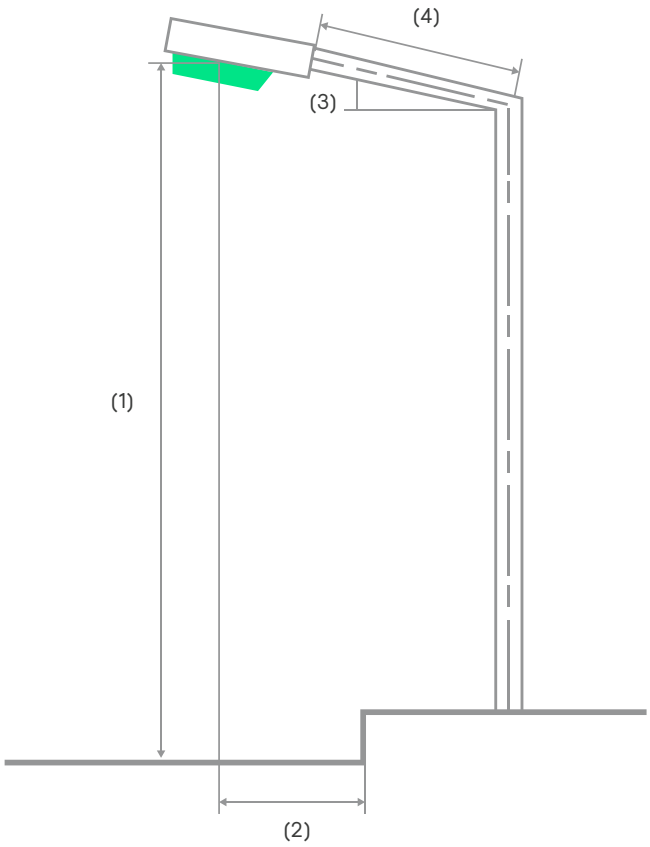
Mobility Infrastructures

Pedestrian roads between shelters





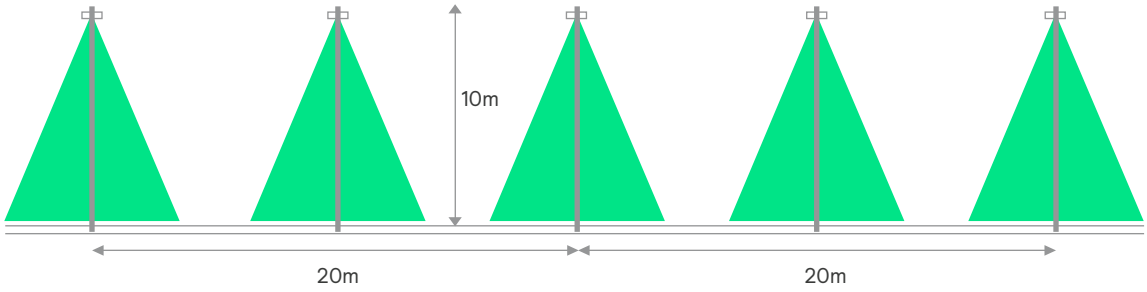
DIALux BRP391 LED15CW DM



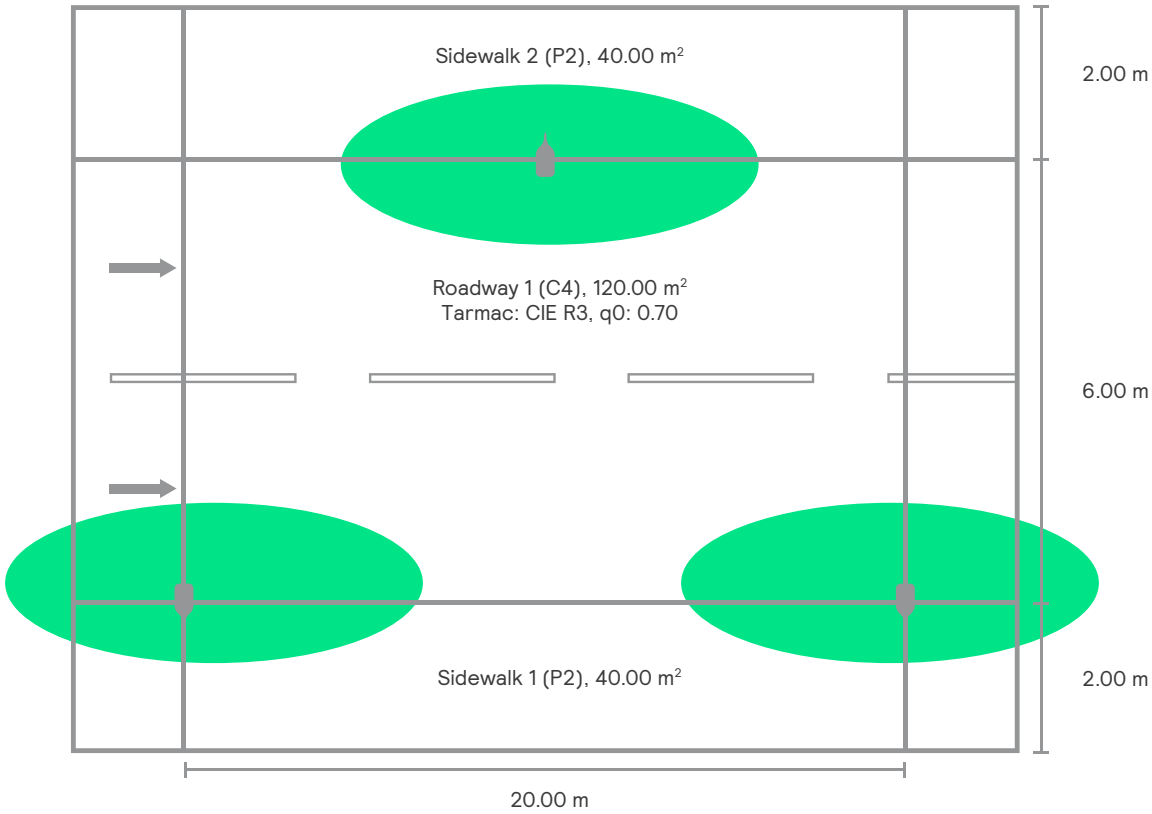
Luminaire Specifications:

- Lamp: 1xLED
- Luminous Flux: 1500 lm
- Color Temperature: 4000K or warmer.
- Optic proposed: medium beam
- Power consumption: range 8W to 10W
- Efficacy proposed: 188 lm/W
- Efficacy acceptable range: 150 to 180 lm/W
- Protection degree: IP65 or IP66
- Electrical run: 12/24 V DC
- Operating hours:
  4000h: 100.0%, 9.0W
  W/km: 1125.0

Pedestrian including Roadway (Optimal configuration)



Street – 6m Width & Pedestrian – H-10m according to EN 13201:2015



Luminaire Specifications:

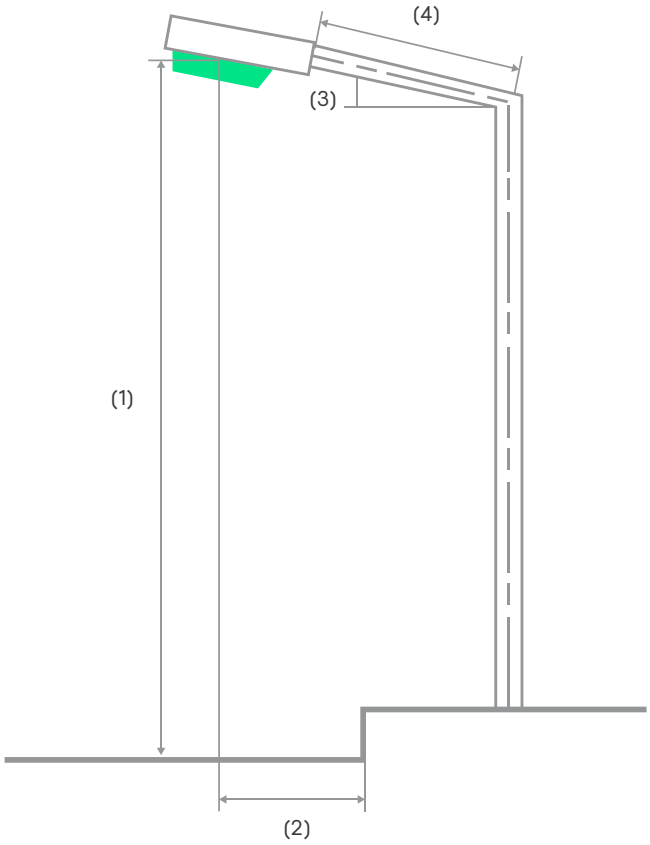
- Lamp: **1xLED**
- Luminous Flux: **4500 lm**
- Color Temperature: **4000K or warmer**
- Power consumption: **range 23W to 30W**
- Optic proposed: medium beam
- Efficacy proposed: **188 lm/W**
- Efficacy acceptable range: **150 to 190 lm/W**
- Protection degree: **IP65 or IP66**
- Electrical run: **12/24 V DC**
- Operating hours:
  4000h: 100.0%, 28.0W
  W/km: 2800.0

- Arrangement: **both the sides**
- Pole distance: **20.000 m**
- Boom inclination (3): **0.0 °**
- Boom length (4): **0.00 m**
- Light centre height (1): **10.00m**
- Light overhang (2): **0.000 m**

- ULR : **0.00**
- ULOR: **0.00**
- Maximum luminous intensities
  At 70 ° and above: 532 cd/klm
  At 80 ° and above: 19.6 cd/klm
  At 90 ° and above: 0.00 cd/klm

Result for valuation field:
Light loss factor: 0.80

DIALux BRP391 LED45CW DM



Sidewalk 2 (P2)

EM [lx]	Emin [lx]
≥ 10.00 ≤ 15.00	≥ 2.00
11.52	**5.00**

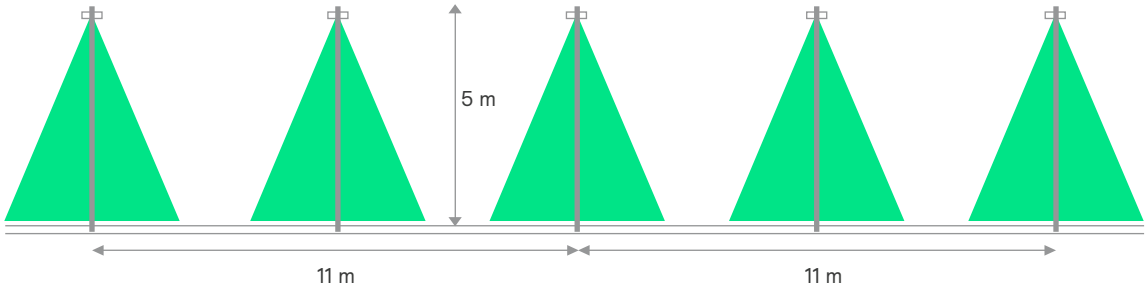
Sidewalk 1 (P2)

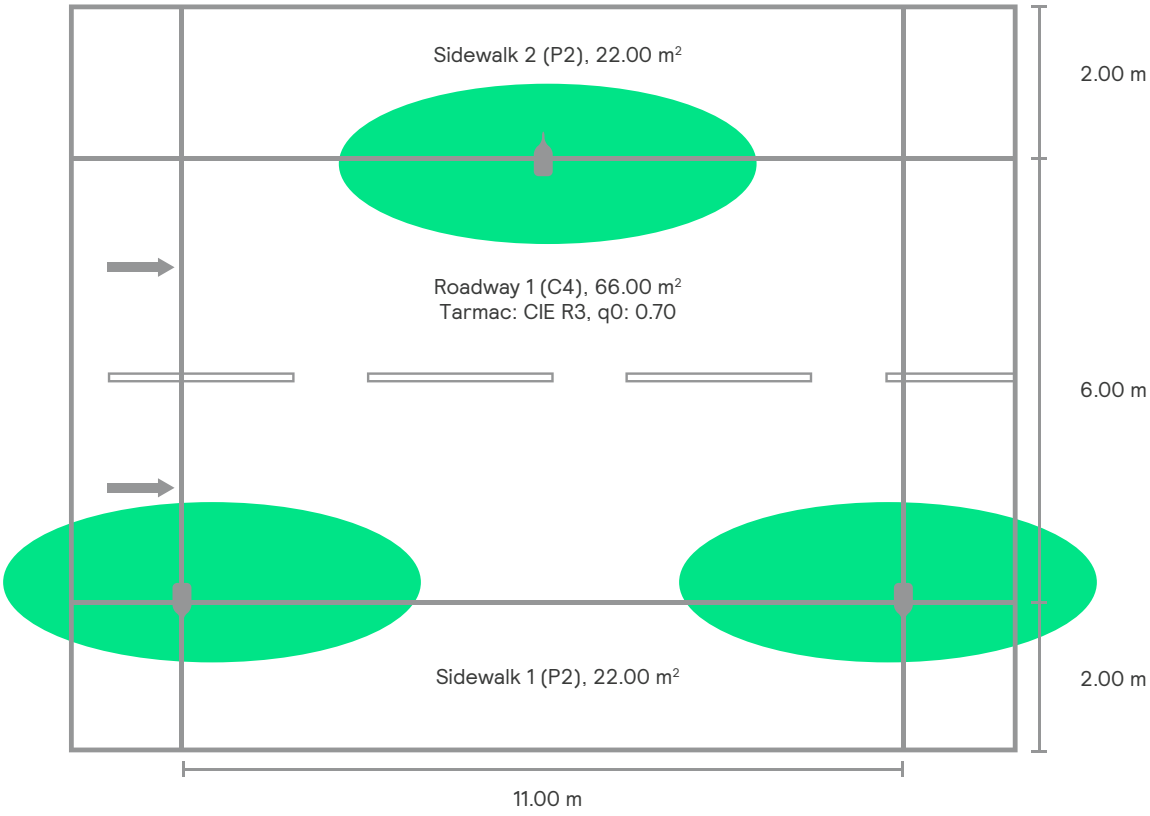
EM [lx]	Emin [lx]
≥ 10.00 ≤ 15.00	≥ 2.00
11.52	**5.00**

Roadway 1 (C4)

EM [lx]	Uo	TI [%]
≥ 10.00	≥ 0.40	
12.28	**0.44**	***2**

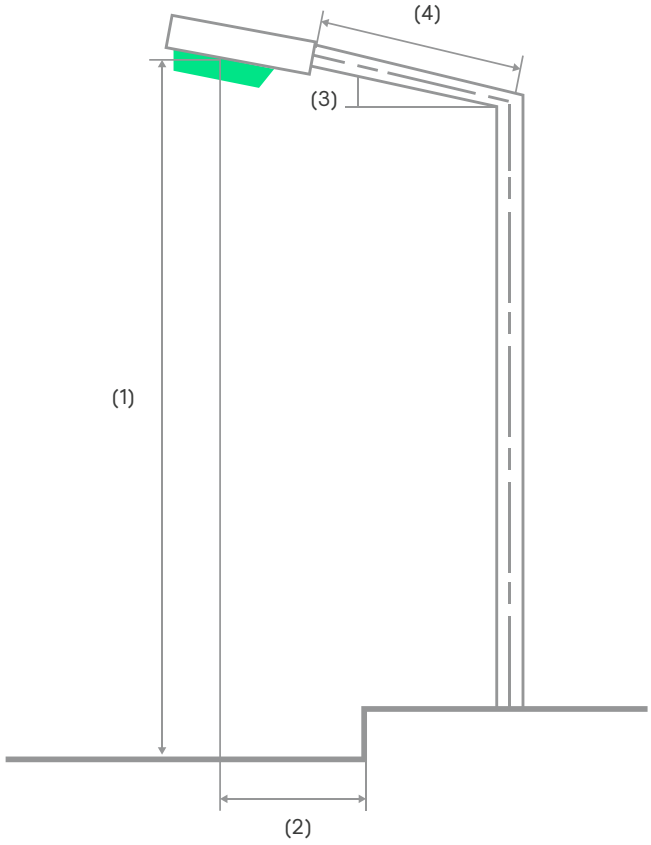
Pedestrian including Roadway (Alternative configuration)





Luminaire Specifications:

- Lamp: 1xLED
- Luminous Flux: 1500 lm
- Color Temperature: 4000K or warmer.
- Power consumption: range 8W to 10W
- Optic proposed: medium beam
- Efficacy proposed: 188 lm/W
- Efficacy acceptable range: 150 to 180 lm/W
- Protection degree: IP66 or IP67
- Electrical run: 12/24 V DC
- Operating hours:
  4000h: 100.0%, 9.0W
  W/km: 1638.0



Result for valuation field:

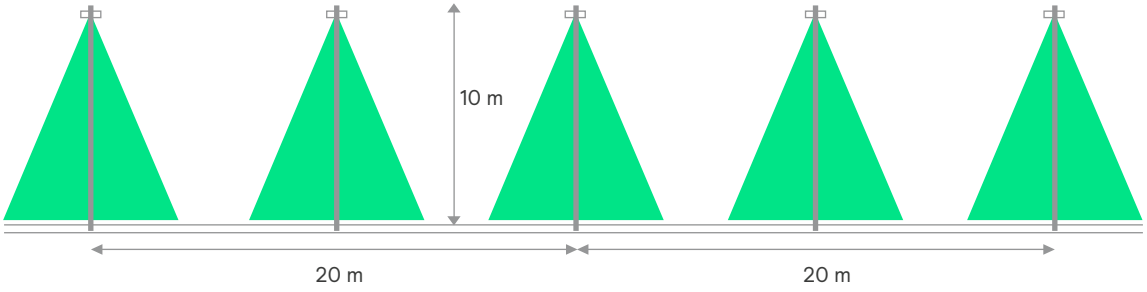
Sidewalk 2 (P2)	
EM [lx]	Emin [lx]
≥ 10.00 ≤ 15.00	≥ 2.00
11.17	**2.40**

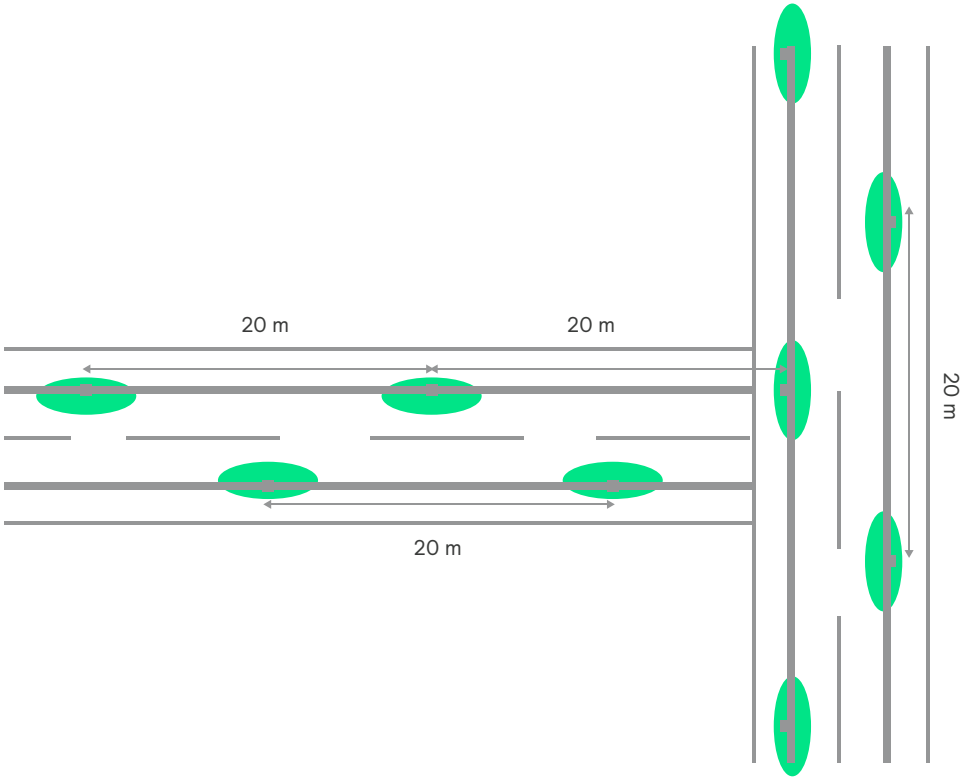
Light loss factor: 0.80

Sidewalk I (P2)	
EM [lx]	Emin [lx]
≥ 10.00 ≤ 15.00	≥ 2.00
11.17	**2.40**

Roadway I (C4)		
EM [lx]	Uo	TI [%]
≥ 10.00	≥ 0.40	
12.28	**0.44**	***2**

Cross-passages & Junction areas (Optimal configuration)





Result for valuation field:

Sidewalk 2 (P2)	
EM [lx]	Emin [lx]
≥ 10.00 ≤ 15.00	≥ 2.00
11.52	**5.00**

Sidewalk 1 (P2)	
EM [lx]	Emin [lx]
≥ 10.00 ≤ 15.00	≥ 2.00
11.52	**5.00**

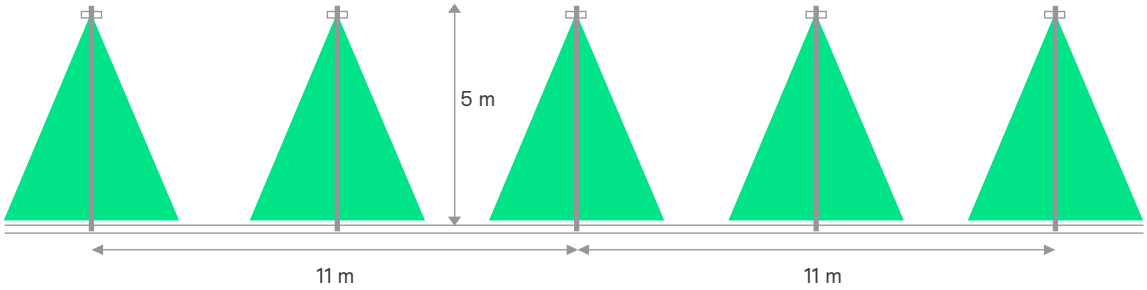
Roadway 1 (C4)		
EM [lx]	Uo	TI [%]
≥ 10.00	≥ 0.40	
12.28	**0.44**	***2**

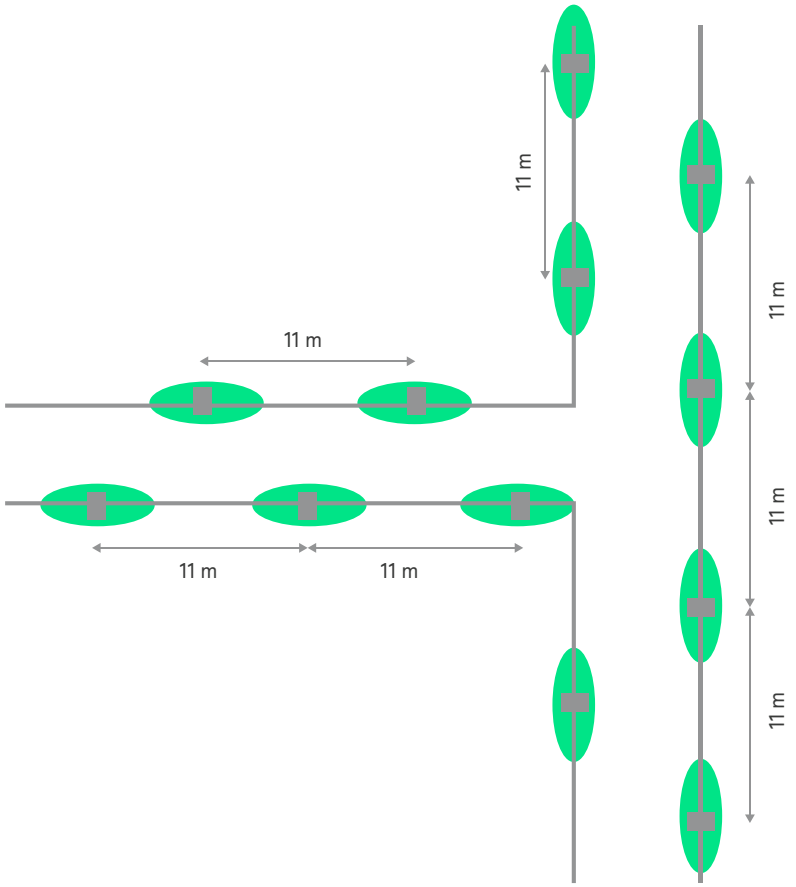
Luminaire Specifications:

- Luminous Flux: 4500 lm
- Color Temperature: 4000K or warmer.
- Power consumption: range 23W to 30W
- Optic proposed: medium beam
- Efficacy proposed: 188 lm/W
- Efficacy acceptable range: 150 to 190 lm/W
- Protection degree: IP65 or IP66
- Electrical run: 12/24 V DC

Note: Lighting specifications: The distance between poles and height of poles, in each of the scenarios mentioned, can be increased/decreased according to local and contextual necessities.

Cross-passages & Junction areas (Alternative configuration)



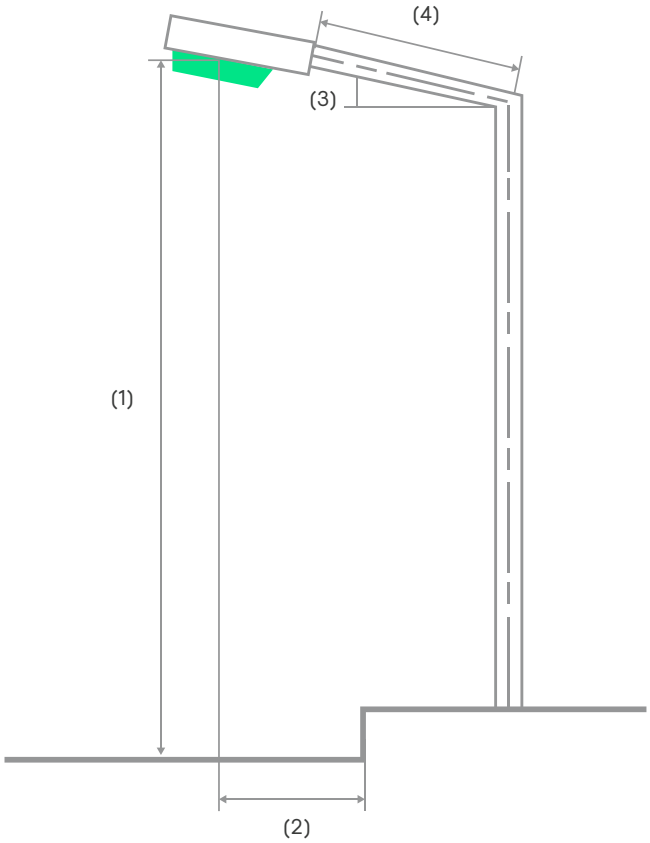


Result for valuation field:

Roadway I (C4)		
EM [lx]	Uo	TI [%]
≥ 10.00	≥ 0.40	
12.38	**0.40**	***2**

Luminaire Specifications:

- Luminous Flux: 1500 lm
- Color Temperature: 4000K or warmer.
- Power consumption: range 8W to 10W
- Optic proposed: medium beam
- Efficacy proposed: 188 lm/W
- Efficacy acceptable range: 150 to 180 lm/W
- Protection degree: IP66 or IP67
- Electrical run: 12/24 V DC



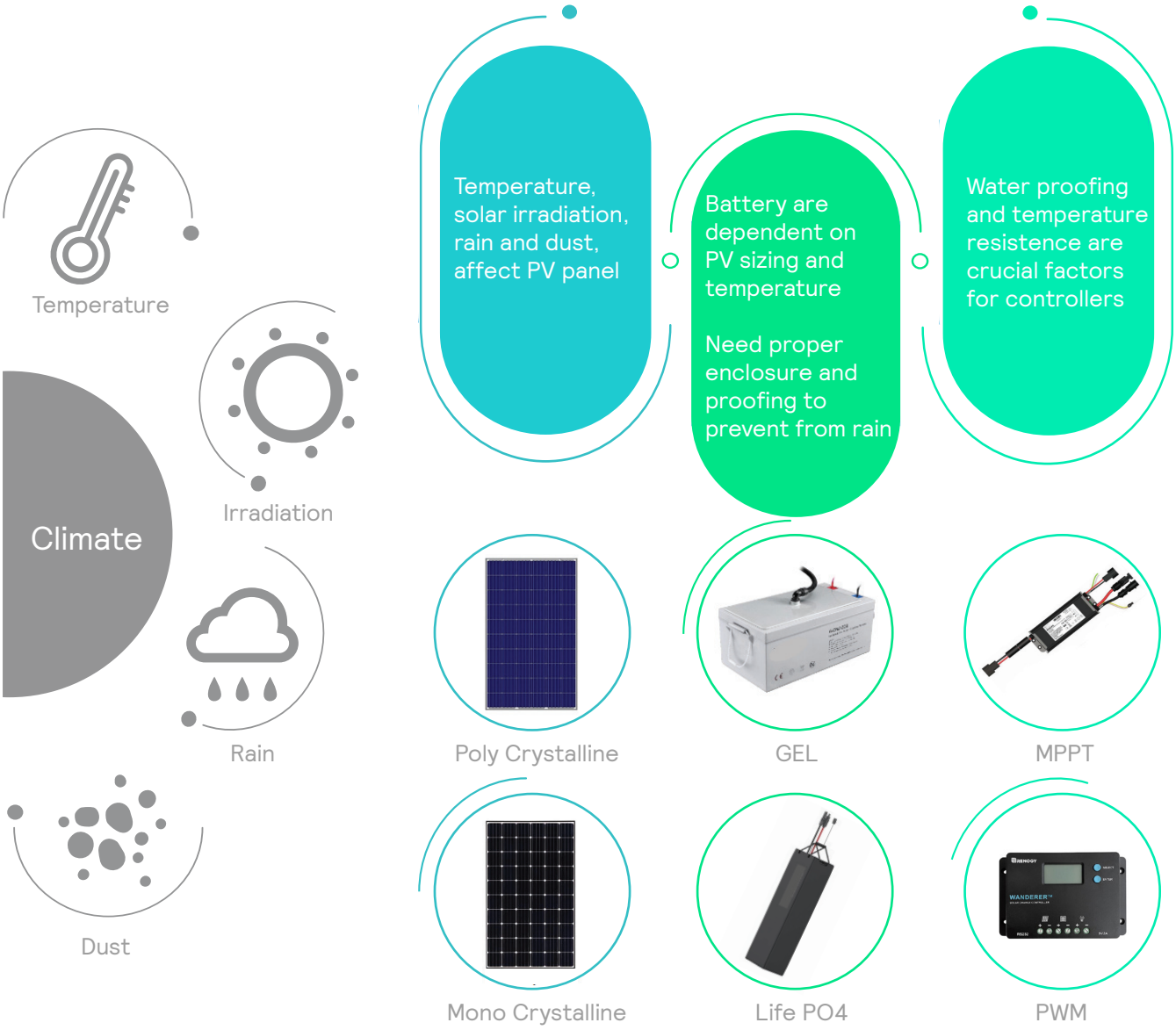
Determining system specification

In order to facilitate the choice of solar system components that form the part of a stand-alone or mini-grids lighting system, it is important to establish the climatic and geographical information of that location as they directly affect the system specifications and its durability.

The climatic factors that affect the specifications are:
- Minimum ambient temperature
- Maximum ambient temperature
- Relative air humidity [4]
- Dust level (low, medium or high)

Rainfall (low, medium or high) [5] The geographical information crucial for making the right choice of specifications are:
- Country
- Place
- Latitude
- Altitude
- Daily average irradiation in kWh/m2/day [6]
- Optimum angle to get best irradiation

Once all of these factors are established for a particular camp looking for lighting guidelines, then a suitable lighting product and solar system components choice can be made.



The optimum angle of panel for best irradiation is highly subjective in nature. To simplify decision making, the tilt angle can be based only on the latitude [7] with a principle that it should be inclined facing the equator and vary between minimum of 15 deg and maximum of 60 degrees. Other climatic factors like irradiation should be referred from the relevant country's meteorological department to have accurate data. The variation of the specifications with respect to these factors is further addressed in the later sections.

[6] Relative humidity – http://data.un.org/Data.aspx?d=CLINO&f=ElementCode%3A11
[7] Rainfall data – https://data.worldbank.org/indicator/AG.LND.PRCP.MM?end=2014&start=2014&view=map&year=2014
[8] Additional resource – https://globalsolaratlas.info/?c=13.326696,3.3373,3&s=22.898659,8.569495
[9] Solar panel tilt angle calculator – http://solarelectricityhandbook.com/solar-angle-calculator.html

Photovoltaic Panels

Photovoltaics (PV) is the conversion of light into electricity using semiconducting materials that exhibit the photovoltaic effect. A photovoltaic system employs solar panels, each comprising a number of solar cells, which generate electrical power.

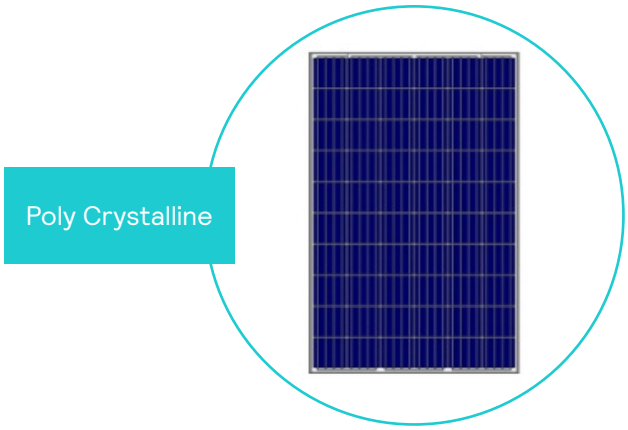
The key features of a PV panel most suitable for humanitarian settings are as follows:

- Polycrystalline or monocrystalline
- 25 years designed lifetime with power decrease less than 20%
- Laminated with tempered glass for safety
- Outdoor IP65 rating
- Water-proof plug and play connectors
- Able to operate at -40 ºC to +85 ºC
- TUV certified

In addition to these specifications, the solar panels chosen for these settings need to conform with the following standards:
TUV certifications issued by ISO/IEC 17025 qualified 3rd part test house shall be provided to prove the compliance.

- EN 61730-1:2007
- EN 61730-2:2007
- EN 61215:2005
- IEC 61215:2005

It should be included in the technical evaluation of bids for the systems using photovoltaic.
The two types of panels are as shown below:



Poly Crystalline

Mono Crystalline

The basic installation instructions will be given in the next chapter of the document.

Battery System for Solar

Battery is used to store the electrical energy converted by PV panels during the day time and during night it is used to supply energy for lighting or other application purposes.

The key features of a battery, most suitable for humanitarian settings are as follows:

- VRLA or LiFePO4 type batterie2s
- On pole or in ground installations
- In-ground installation to get less impact from ambient temperature
- IP68 rating water proof, tested by 3rd party test house
- Long cycle life time
- High ambient temperature range
- Outdoor IP67 rating water-proof plug and play connectors
- Ability to recover from deep discharge
- Well protected by thermal sensor
- Wide range from 65AH to 250AH
- Both 12V and 24V battery systems
- CE certified

Volve Regulated Lead Acid (VRLA)

Life Po4 Battery

There are a number of battery options available in the market nowadays. However, the most commonly used types are Gel and LiFePO4 and therefore, they are considered throughout this guideline. But depending on the need and technical inputs, a choice from the following can be made.

Type	Gel	AGM	Ni-Zn	LiFePO4	Lead Crystal
Cell Voltage	2V	2V	1.6V	3.2	2V
Weight Energy Density	30-50Wh/kg	30-50Wh/kg	60Wh/kg	120Wh/kg	40-60Wh/kg
Temperature range	-20°C - +50°C	-20°C - +50°C	-20°C - +60°C	-20°C - +60°C	-40°C - +65°C
Cycle Life 80% DOD	800~900	400~500	900~1000	2000	900~1000
Self-discharge/ Month	5-10%	3-10%	1%	5-10%	2-3%
Memory Effect	No	No	No	No	No
Energy Price USD/Wh	0.12	0.1	0.5	0.15	0.15
Charge time	8hrs	8hrs	4hrs	2-6hrs	2-6hrs

The factors affecting the battery selection are as follows:

- Operating temperature
- Depth of discharge
- Lamp cable loss factor
- Self-support nights
- System voltage selection

Battery type with respect to operating temperature

Operating temperature	Recommended battery type
0°C - 25°C	GEL
25°C - 35°C	GEL
35°C - 45°C	GEL or LiFePO4
45°C - 55°C	LiFePO4
55°C - 60°C	LiFePO4

Battery type with respect to operating temperature

Battery type	DoD	Factor
VRLA Gel type	70%	0.7
LiFePO4	90%	0.9

Lamp Cable Loss Factor

Pole Height	Expected cable losses in %	Factor
3m	8%	0.92
4m	8%	0.92
6m	10%	0.9
8m	10%	0.9
10m	15%	0.85

Self-support nights

Rain or dust	Recommended self-support nights
No or very little rain	2
Normal or heavy rain	3
Very heavy rain	4

System Voltage Selection

Luminaire Wattage	System voltage in volts	PV Panel Voltage in volt
<40W	12	17
40W – 80W	24	36

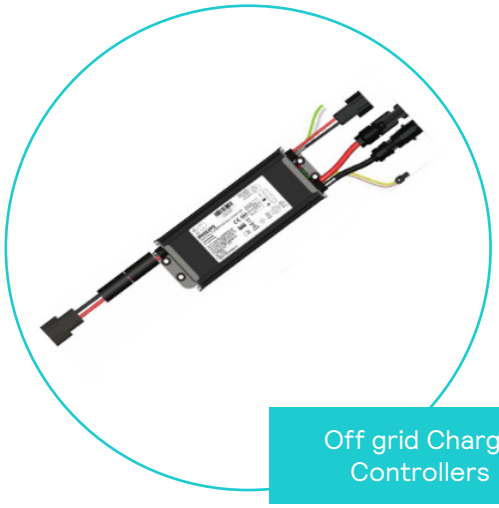
These factors are clearly summarised in a table with all the relevant variables for each scenarios.

Standalone Off-grid Charge Controller

A solar charge controller manages the power going into the battery bank from the solar array. It ensures that the deep cycle batteries are not overcharged during the day, and that the power doesn't run backwards to the solar panels overnight and drain the batteries. Some charge controllers are available with additional capabilities, like lighting and load control, but managing the power is its primary job.

A solar charge controller is available in two different technologies, PWM and MPPT. Both the technology helps in managing the battery charge and discharge, however MPPT is more efficient but expensive[8]. Now days MPPT is most popular technology for this purpose.

- Support PV charging current up to 13A (or PV power up to 380Wp)
- Support luminaires with high lumen package
- 12/24V system compatible and self-adaption
- Compact modular design for in-pole installation
- IP66 waterproof
- Support different battery technologies, e.g. VRLA and LiFePo4
- Application-related program configuration via RS485
- Temperature sensor to battery for charging voltage compensation to secure battery lifetime
- World-class and higher charging efficiency with MPPT (>99%) technology, and about 15% saving on panel size comparing with PWM charging technology
- Interface ready for Remote monitoring/control
- CE certified



Off grid Charge Controllers

Based on the inputs from the previous sections, the following table is made to help with the choice of lighting.

It must be noted that, there is no separate table for the minimum recommended system specification for 2 nights of self-support. This is due to the similar range and closeness of the values calculated for 2 nights and that found for 3 nights. In addition to this, the profile chosen for most scenarios involve 6 hours of lighting at 50% and 6 hours of lighting at 100% intensity. Therefore, it is recommended that 3 nights of self-support to be a minimum in any case to accommodate scenarios of 100% intensity all night, if and wherever necessary. On comparing the two tables, it can also be observed that the number of nights of self-support only affect the battery sizing.

[10] http://www.enerdrive.com.au/mppt-vs-pwm-solar-controllers/

Table 4 System specification for 3 nights & 4 nights shelf support

Areas of Applications	Lighting Information					Battery Selection		PV Panel Selection
	Recommended Illumination average levels (Em)	Luminous Flux in lumens	Height of Installation	Efficacy lm/watt	Wattage of the Luminaire (Watts)	Battery Capacity Required for 3NSS	Battery Capacity Required 4NSS	PV Panel capacity @ Average Daily Irradiation hours of 3hr/4hr/5hr
Street Lighting								
Pedestrian Road Between Shelters	>10 Lux	1500	4m-5m	188	8	30Ah	40Ah	55Wp/30Wp/30Wp
				140	11	40Ah	65Ah	60Wp/55Wp/55Wp
Pedestrian Including road ways (optimal configuration)	>10 Lux	4500	9m -10m	180	25	100Ah	120Ah	155Wp/100Wp/100Wp
Cross-passages & Junction areas (Optimal configuration)				140	33	120Ah	160Ah	2x100Wp/155Wp/115Wp
Pedestrian Including road ways (Alternative configuration)	>10 Lux	1500	4m-5m	188	8	30Ah	40Ah	55Wp/30Wp/30Wp
Cross-passages & Junction areas (Alternative configuration)				140	11	40Ah	65Ah	60Wp/55Wp/55Wp

Community Buildings - outdoor Lighting	Recommended Illumination average levels (Em)	Luminous Flux in lumens	Height of Installation	Efficacy lm/watt	Wattage of the Luminaire (Watts)	Battery Capacity Required for 3NSS	Battery Capacity Required 4NSS	PV Panel capacity @ Average Daily Irradiation hours of 3hr/4hr/5hr
Community Buildings – Outdoor lighting for small-scale collective spaces (Schools, Health-Centers...)	>15 Lux	3000	4m-5m	176	18	65Ah	80Ah	100Wp/75Wp/55Wp
Option 1 Wall Mounted								
Option 2 Pole mounted								
Community Buildings – Outdoor lighting for Toilets, Showers & Bathrooms				140	22	80Ah	120Ah	125Wp/100Wp/75Wp
Open Areas lighting								
Living quarters - lighting between shelters (Optimal configuration)	>15 Lux	1500	4m-5m	188	8	30Ah	40Ah	55Wp/30Wp/30Wp
Water Collection & Distribution Points (Optimal configuration)				140	11	40Ah	65Ah	60Wp/55Wp/55Wp

Market & Aggregation Areas – Small size (10x20m)	>15 Lux	3000	8m	176	18	65Ah	80Ah	100Wp/75Wp/55Wp
				140	22	80Ah	120Ah	125Wp/100Wp/75Wp
Market & Aggregation Areas – Medium size (22x30m)	>15 Lux	4500	8m	180	25	100Ah	120Ah	155Wp/100Wp/100Wp
				140	33	120Ah	160Ah	2x100Wp/155Wp/115Wp
Market & Aggregation Areas – Large size (30x40m)	>15 Lux	6000	10m	170	36	130Ah		265Wp/200Wp/200Wp
				140	43	150Ah		315Wp/265Wp/200Wp
Market & Aggregation Areas – Small size (10x20m) (Alternative configuration)	>15 Lux	1500	4m-5m	188	8	30Ah	40Ah	2x100Wp/155Wp/125Wp
				140	11	40Ah	65Ah	2x125Wp/2x100Wp/155Wp
Market & Aggregation Areas – Medium size (20x30m) (Alternative configuration)	>15 Lux	3000	6m	176	18	65Ah	120Ah	100Wp/75Wp/55Wp
				140	22	80Ah	120Ah	125Wp/100Wp/75Wp
Security Lighting for technological, merchandises & high risk areas (Optimal configuration)	>20 Lux	6000	8m	170	8	30Ah	40Ah	2x100Wp/155Wp/125Wp
				140	11	40Ah	65Ah	2x125Wp/2x100Wp/155Wp
Security Lighting for technological, merchandises & high risk areas (Alternative configuration)	>20 Lux	4500	6m	180	25	100Ah	120Ah	155Wp/100Wp/100Wp
				140	33	120Ah	160Ah	2x100Wp/155Wp/115Wp

- Number Luminaires per support : Single Luminaire
- System type : Offgrid system
- Operating Profile : 12hrs per night with 6 hrs 100% and 6 hrs 50%
- Battery Technology : VRLA Gel batteries
- Depth of Discharge (DoD) : 70%
- System Voltage : 12V DC
- Charge Controller : 10A < 13A, upto 200Wp

Recommendations:

Camp situation

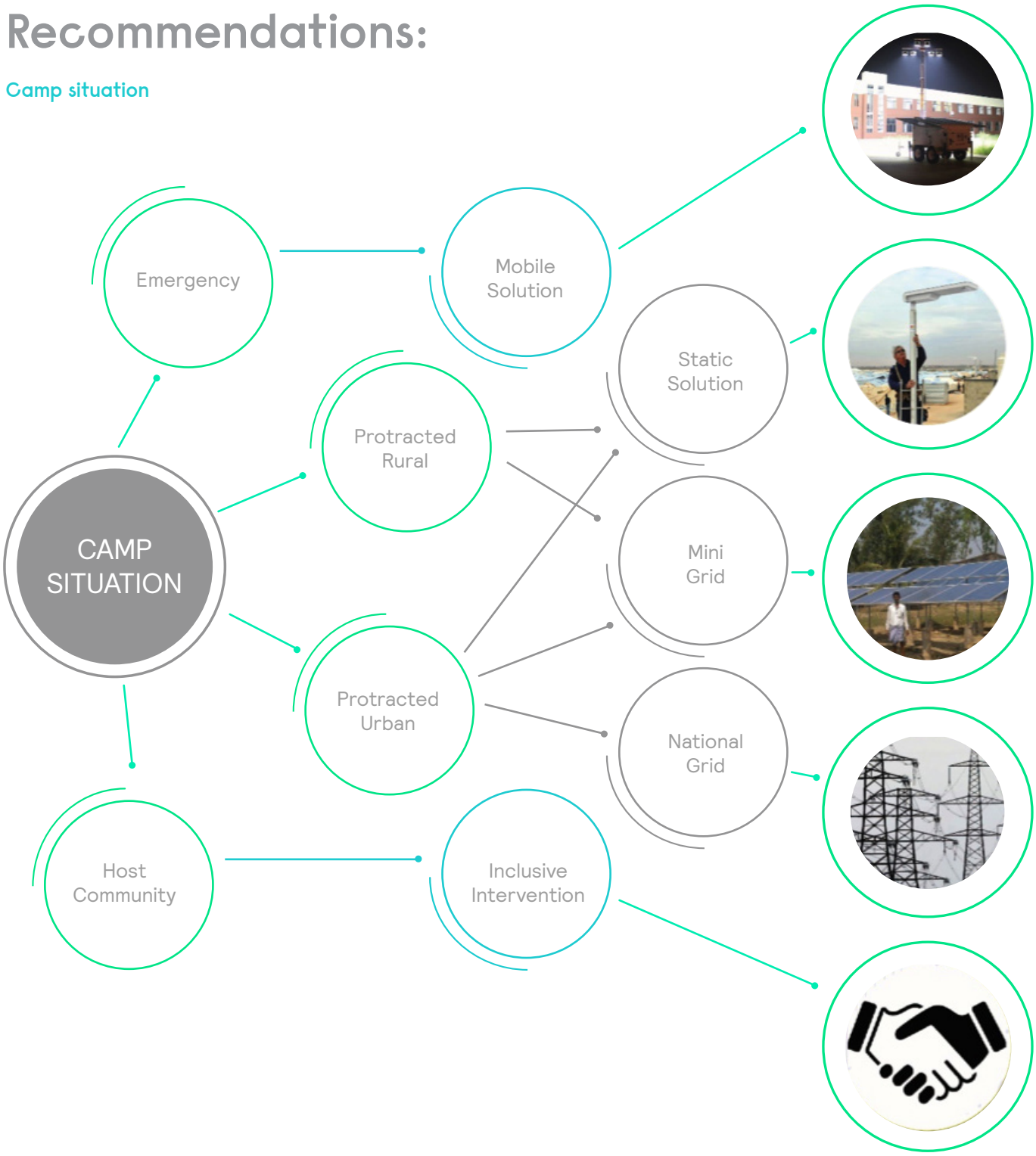


Figure 4: Camp variables to consider

Elements related to the camp characteristics, with respect to timing and stability (emergency vs protracted), topology and location (rural vs urban environment), must be considered in order to guarantee the lighting intervention most suitable for each situation. The general suggestion is to prefer a solution that, in the long term, would maximize the productivity, minimizing the cost. Therefore, one solution can be suitable for a specific camp in a specific situation, while may not be possible to adapt for others. Furthermore, proximity from the host community should be considered, in order to avoid disparity or conflicts between the groups.

In the emergency context, for instance, the high instability of the situation as well as the presence of other more urgent priorities does not allow a long-term intervention to fulfil lighting needs. This can be addressed with a temporary approach through flexible solutions, that can be moved and installed quickly in accord with the necessity of that specific situation.

While, for protracted context, where the setting is relatively more stable, long-term interventions like, stand-alone solutions, mini-grid or connection with the national grid should be preferred. Although, it must be noted that, the availability of the national grid attachment is subordinated at the specific policy agreement with the government, and the preference between mini-grid or stand-alone solutions can be taken after the evaluation of different factors that may influence their effectiveness.

Some of the pros and cons for mini grids and standalone systems, that will influence the decision, are shown in Table 4.

Table 4 Pros and cons of mini grids and standalone solar lighting systems

	Mini Grids	Stand-Alone
PROS	• When a mini-grid is built in a village, such source of energy is **usable also for other purposes** (households, productive usage, institution, facilities etc...) • **Easy to do maintenance due to its centralized nature** (security and ownership)	• **Easier to install** (no need of existing energy source/grid, no need of distributions cables) • **Easy to do the planning** • **Comparatively lower cost of the installation**
CONS	• Might need a **generation license and a distribution license depending on the local electrical regulations.** • **More complex to plan and install** – e.g. taking care of the cable layout. • **Higher cost than stand-alone**	• Needs **more security control** (higher probability to be damaged • **Higher maintenance service** required due their distributed nature. . • Performance of stand-alone solar energy lights **depends exclusively on the weather** (mini-grid can be hybrid)

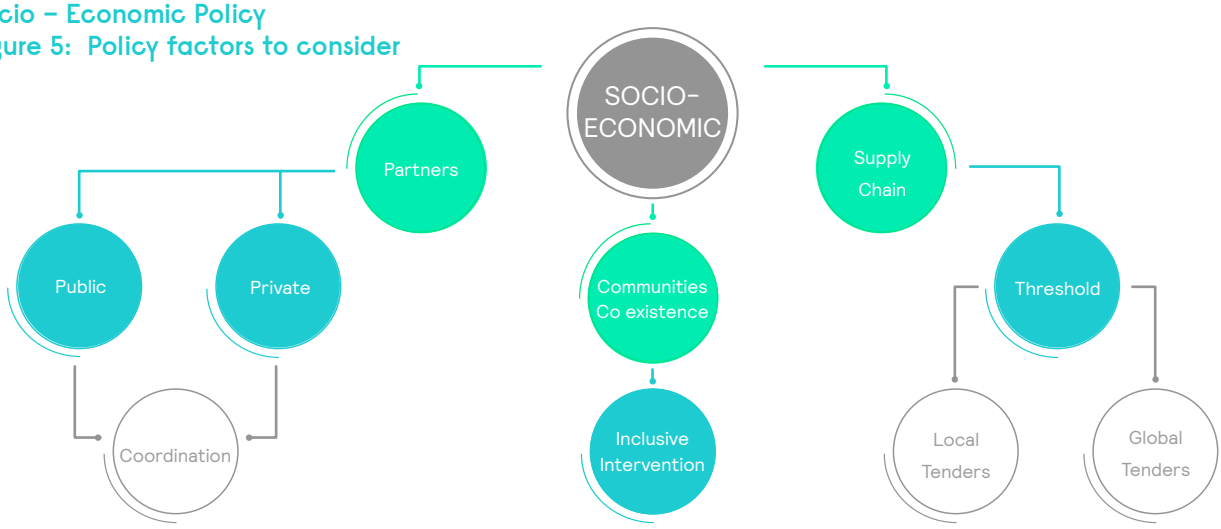
Another important aspect that should be considered, is the proximity of the camps and settlements with the host community. Given the delicate equilibrium that exists between these two groups, often within a territory already marked by a limited availability of resources, it is important to avoid a situation of imbalanced between them.

For this reason, wherever possible, the best approach during a lighting intervention would be to consider the possibility of accommodating and addressing the needs of both the host community and displaced (refugee) community. This is to avoid conflicts and to stimulate a mentality of cooperation and collaboration between the two.

A successful intervention may, indeed, reduce environmental and social pressure and also create livelihood opportunity for the local private sector by improving the available infrastructure.

Socio – Economic Policy

Figure 5: Policy factors to consider



Supply Chain

The key aspect of the procurement process is that it is highly context-dependent, and influenced by many factors such as policy agreements, the availability of a local market, logistic factors, etc. At this level, suggestions about context-dependent best practices may be provided to the field officers, who are in charge of the lighting intervention, guiding them towards making a suitable product and vendor choice.

Private and public partners

These agents are important stakeholders for lighting interventions. They are generally contracted as supplier and are in charge of the installation and maintenance (in case government policy prevents the refugees from being trained and participating in these activities). The suggestion is to try as much as possible involving the local private sector, in order to stimulate beneficial mechanisms which, on one hand, can empower the local community and, on the other hand, can facilitate the process of integration by a cooperation between the two communities.

However, a common challenge which may be observed, is the possibility of a lack of appropriate know-how of chosen partners/contractors to provide a proper service, especially in the installation process. To tackle such issues, guidelines and recommendations are provided (see installation chapter). In cases, where reliable local partners with a good track record, who understand the setting, are available, they should be preferred over external entities.

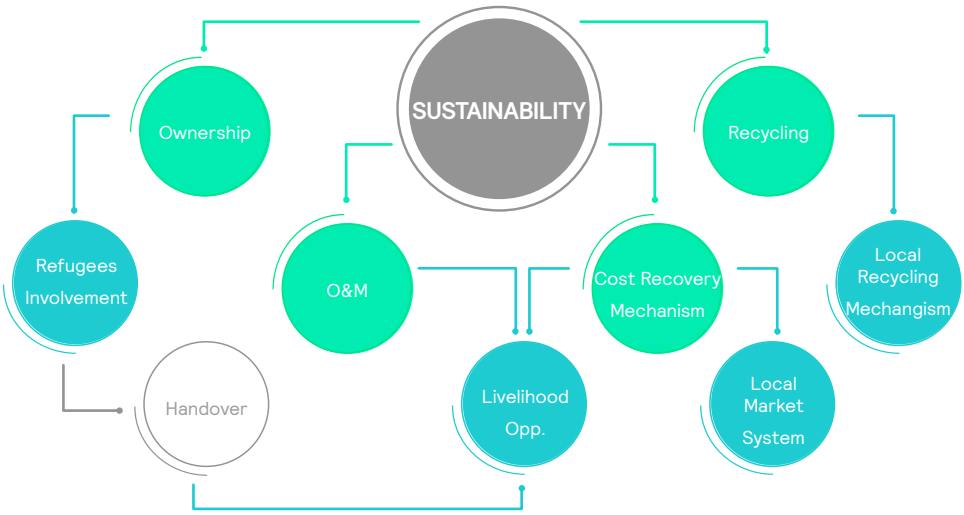
National plans and policies

With respect to the acquisition of the lighting system under the national energy infrastructure system of the country, this may occur after the period of warranty, when the camp situation becomes stable or if people of concern are relocated or repatriated

Communities coexistence

To guarantee a long-term sustainability of the lighting intervention, the equilibrium of the areas in terms of communities coexistence need to be considered. As suggested in the camp situation section, the intervention should take into consideration the proximity of the settlement to host community and, whenever is possible, both the community should be involved in the intervention to avoid situation of strain and conflicts.

Sustainability



In this section, recommendations about sustainability of the installed systems is provided to ensure the long-term operation of the systems and to address future environmental concerns.

Ownership and O&M

Ownership is an important factor to consider in order to guarantee the long-term functionality and cost recovery of any infrastructures in general and the lighting system in particular.

Different agents may take ownership of the equipment after installation. In general, UNHCR manages the assets during the period of warranty. However, the limited human resources may not guarantee a direct O&M support for the system. This can be solved by delegating the task to a selected group of trained/ qualified members of the camp, who can perform standard maintenance support (this approach is also one of the recommendations of the conference "Energy for Displaced People"[9]). In this case, the involvement of refugees, ultimately leading to an asset handover, requires a training period followed by periodic support from parties that put up the system. This allows people, without any technical background, to conduct simple operation and maintenance. In this perspective, the final version of guidelines may directly provide instruments to facilitate this procedure, through simple-to-understand tutorials, that can be

11 Energy for Displaced People: A Global Plan of Action for Sustainable Energy Solutions in Situations of Displacement Hosted by GIZ, Berlin, Germany, 15th – 16th January 2018 (https://unitar.org/ptp/sites/unitar.org.ptp/files/uploads/berlin_conference_summary.pdf)

tailored according to the specific products.

Recycling

Recycling is an important part of the process to avoid any environmental damage in the camps. The toxic discharge from the electronic components, especially from the batteries if not recycled properly, can cause health problems in the camp.

The recycle of the used battery should strictly follow the local laws and regulations. It is forbidden to handle the battery as normal garbage for disposal. Depending on the local regulation and facility available for recycle, this could be a factor to decide the type of battery technology to apply. Furthermore, the same consideration should be applied for other electronic components.

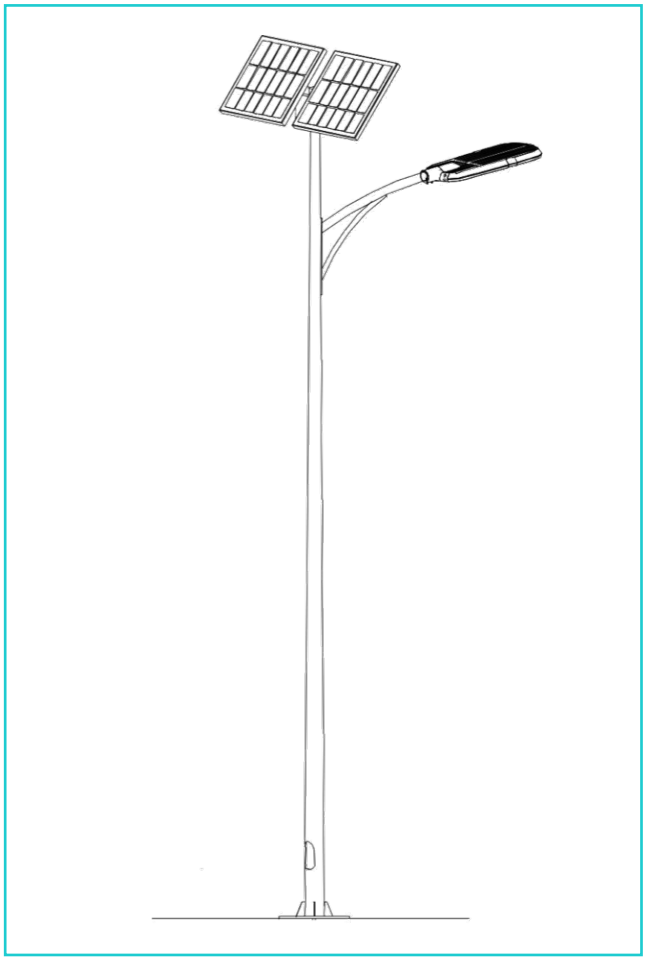
Remarks

Recycling is an important part of the process to avoid any environmental damage in the camps. The toxic discharge from the electronic components, especially from the batteries if not recycled properly, can cause health problems in the camp.

The recycle of the used battery should strictly follow the local laws and regulations. It is forbidden to handle the battery as normal garbage for disposal. Depending on the local regulation and facility available for recycle, this could be a factor to decide the type of battery technology to apply. Furthermore, the same consideration should be applied for other electronic components.

Installation Instruction

Field Installation



Important Safety Notice

The battery presents a risk of electrical shock and a high short circuit current. The mounting instructions must be strictly followed, otherwise potential application, reliability, or safety issues may arise. Contact your local service if the instructions cannot meet special field conditions.

Only a qualified service representative who is knowledgeable in batteries and the required precautions is permitted to service the battery. Keep unauthorized personnel away from batteries.

Danger

- The VRLA battery can generate hydrogen gas. Hydrogen mixed with oxygen is explosive and could be ignited by any spark/flame, static electricity, or overheated object. Smoking is strictly prohibited during all system installation, operation, and maintenance processes, such as welding.
- Use proper lifting techniques to keep the battery upright and avoid any discharge of acid when moving batteries. Wear all appropriate safety clothing and equipment.
- Do not dispose of the batteries in a fire. The batteries may explode.

Caution

- The misuse of this equipment could result in human injury and/or equipment damage. In no event will the company be responsible or liable for either indirect or consequential damage or injury that may have resulted from the misuse of this equipment.
- Use tools with insulated handles to avoid inadvertent shorts.
- Verify circuit polarities before connecting.
- Disconnect the charging source and load before connecting or disconnecting the battery.

Warning

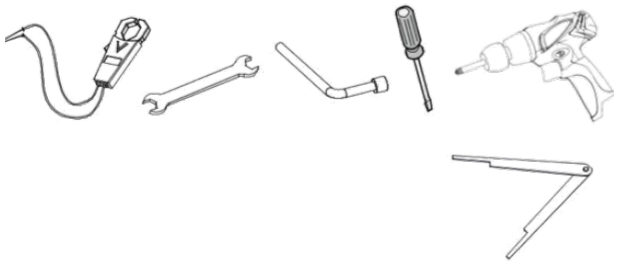
- The solar lighting system contains VRLA batteries. Lack of preventative maintenance could reduce the battery's lifetime or even be dangerous. Check the application environment regularly (lighting performance, PV panel shading).
- Failure to replace a battery before it becomes exhausted may cause the case to crack, possibly releasing electrolytes from inside the battery and resulting in secondary issues such as odour, smoke, and fire.
- The battery system must be in proper maintenance according to the "Troubleshooting & Maintenance" manual. This is essential for safety and the reliability of the lighting system
- Do not dispose of lead acid batteries except through channels in accordance with local, state and federal regulations.

Notice:

The mounting instructions in this document is for standard solar lighting system installation. If any large deviation (such as multi systems sharing pole/base/component, component change, wiring change, installation location change, ect.) from standard solar lighting system is needed due to special application, it is required to contact with representative for special instructions. Otherwise, the deviation from standard instructions may cause abnormal system operation or even dangerous situation.

Battery Box Installation

AI Installation Preparation

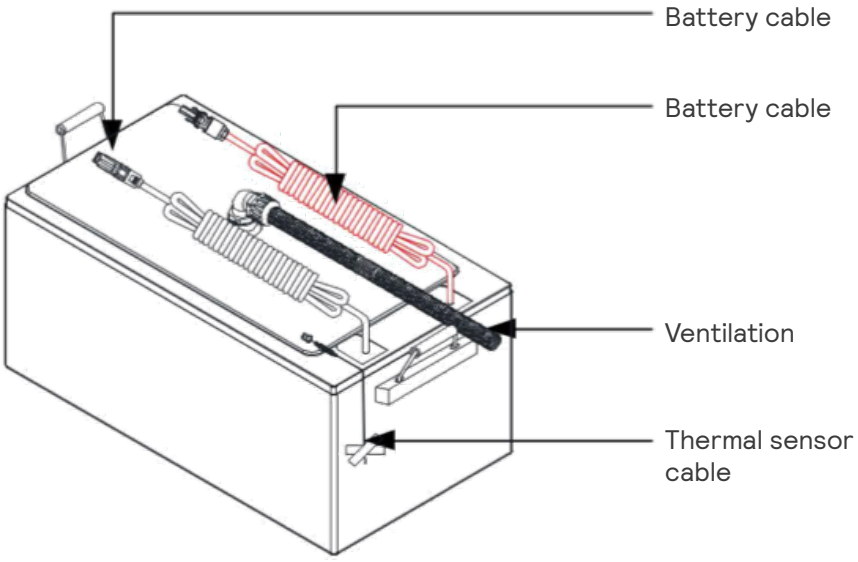


Note: The tools listed do not include items needed for pole installation and other construction work.

Testing Tool List
Compass and Protractor
Electrical Screw Driver
Multimeter
DC Clamp Meters
Triangular Spanner (opens hatch door)
Other tools: a.Waterproof tape b.Screw driver c.Spanner d.Diagonal Pliers e.Nose Pliers

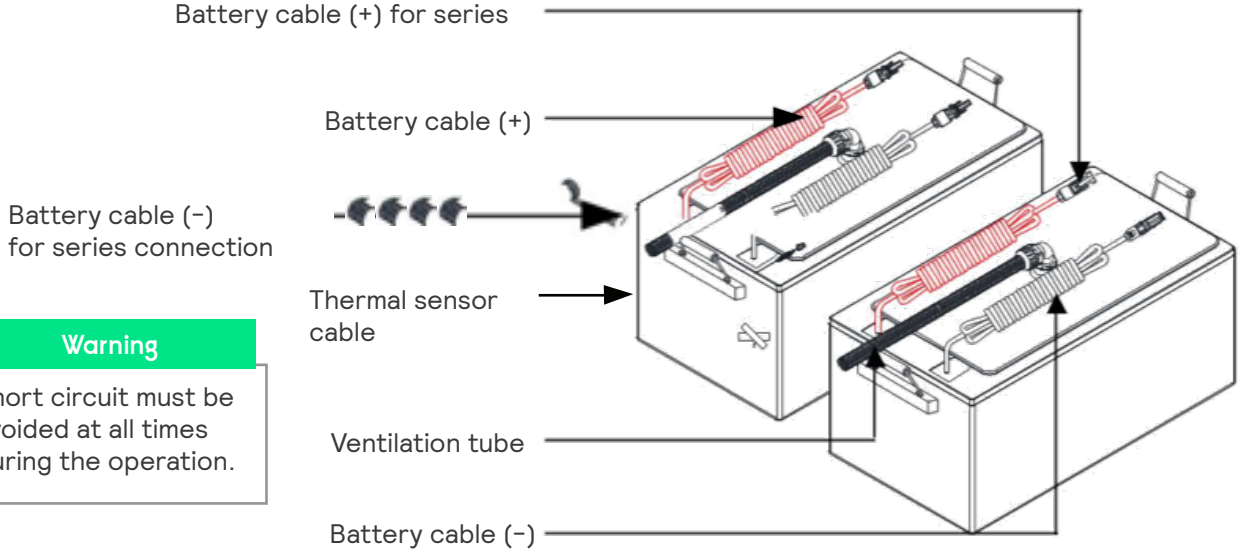
A2 Installation Preparation

A: 12V Battery Subsystem



- The tightness and integrity of the battery should be checked before installation.
- Carefully check the battery voltage before installation to ensure it is more than 12.5V. If less than 12.5V, field charging is necessary. (For 24V battery subsystems, make sure that the voltage is more than 25V).

B: 24V Battery Subsystem



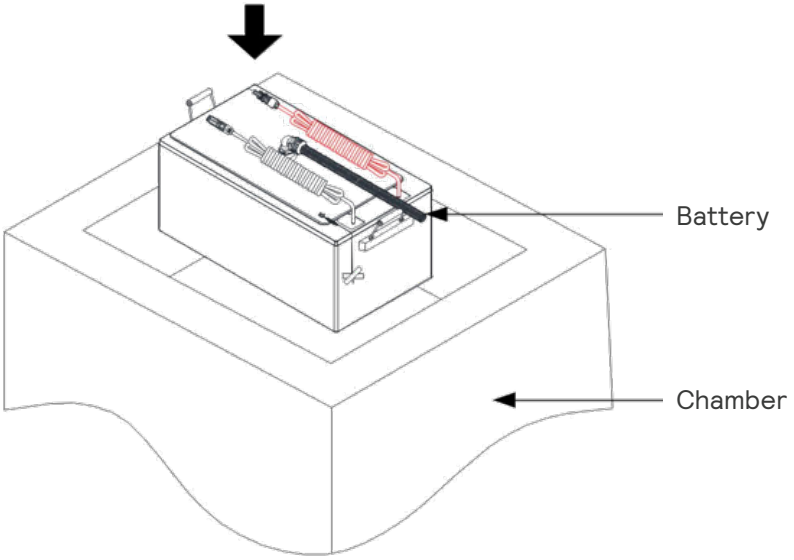
Warning

Short circuit must be avoided at all times during the operation.

A3 Placing the Battery into Chamber

A: 12V Battery Subsystem

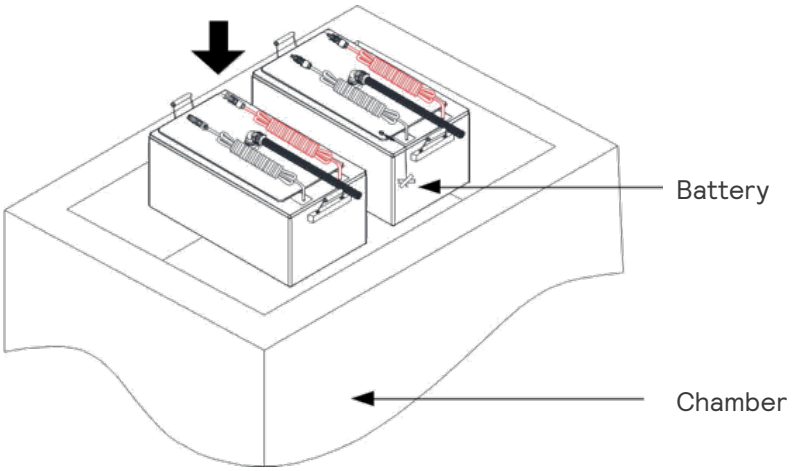
Lay the battery carefully into the chamber.



Warning

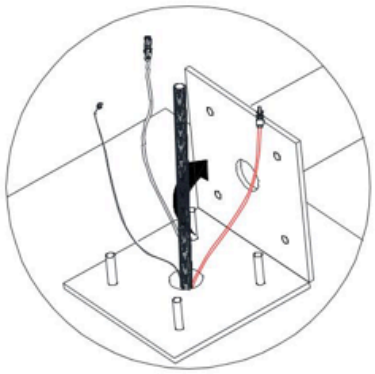
Do NOT pull the cable during installation and delivery.

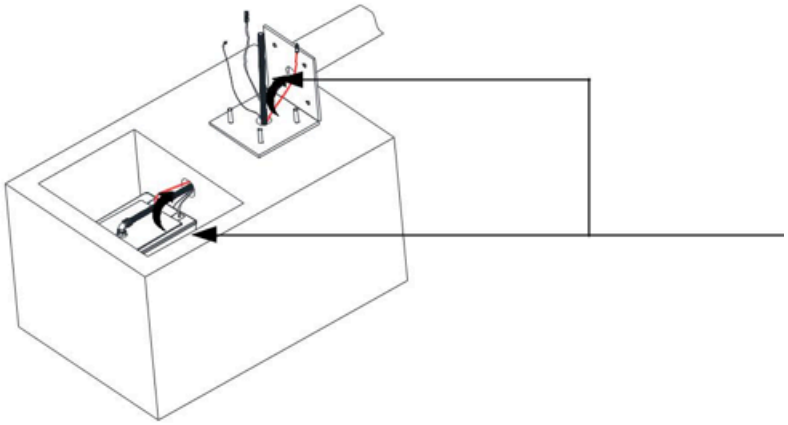
B: 24V Battery Subsystem



A4 Laying Battery Subsystem Cables

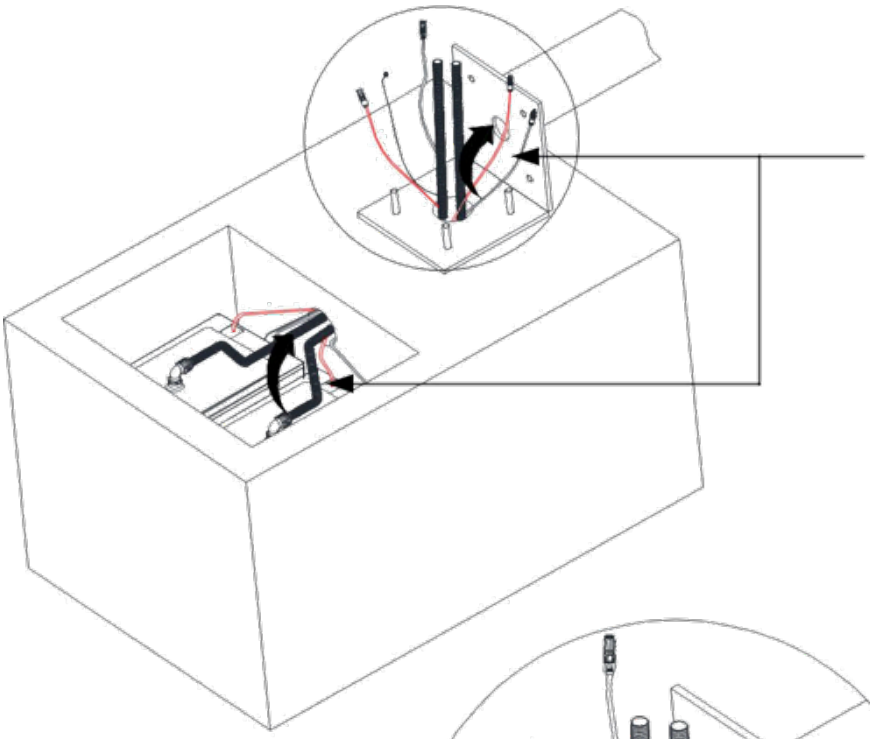
A: 12V Battery Subsystem



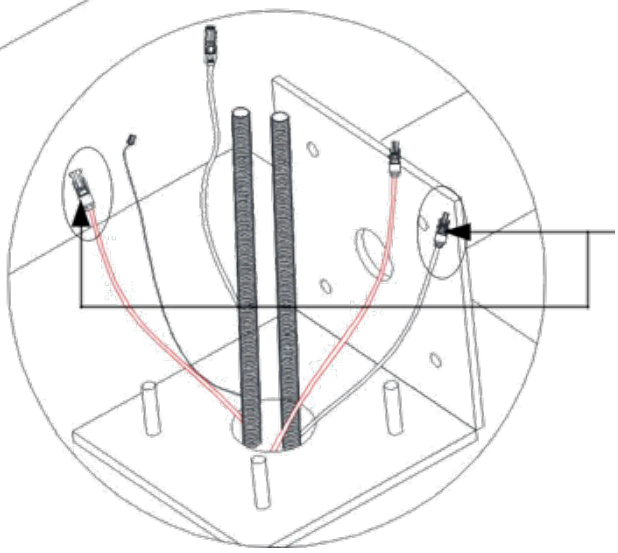


Lay battery cables, thermal sensor cable,and ventilation tube penetrating the embedded duct, pulling them into the pole from the bottom.

B: 24V Battery Subsystem



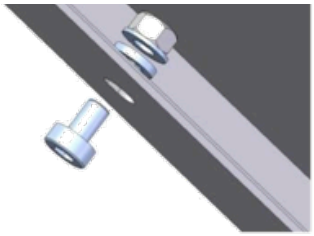
- Lay the battery cables, thermal sensor cable, and ventilation tube penetrating the embedded duct, pulling them into the pole from the bottom.
- Series connect the batteries with one red cable and one black cable.

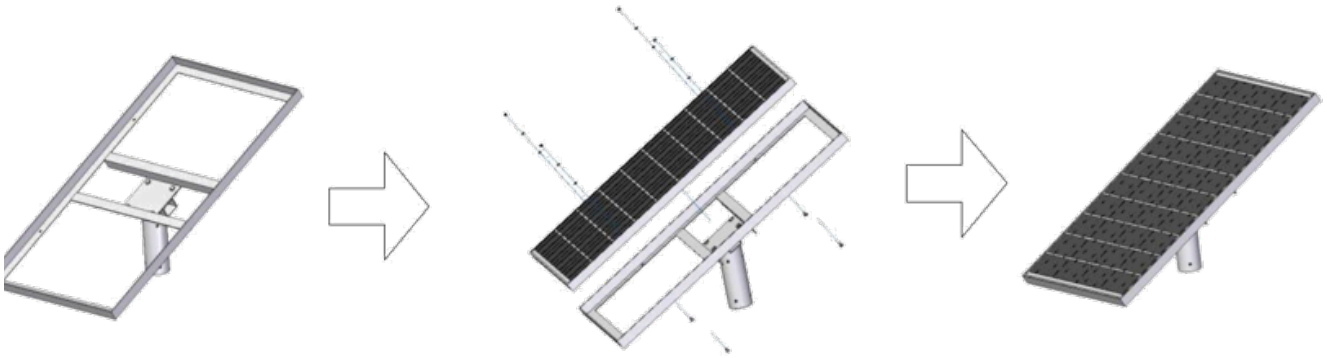


Warning

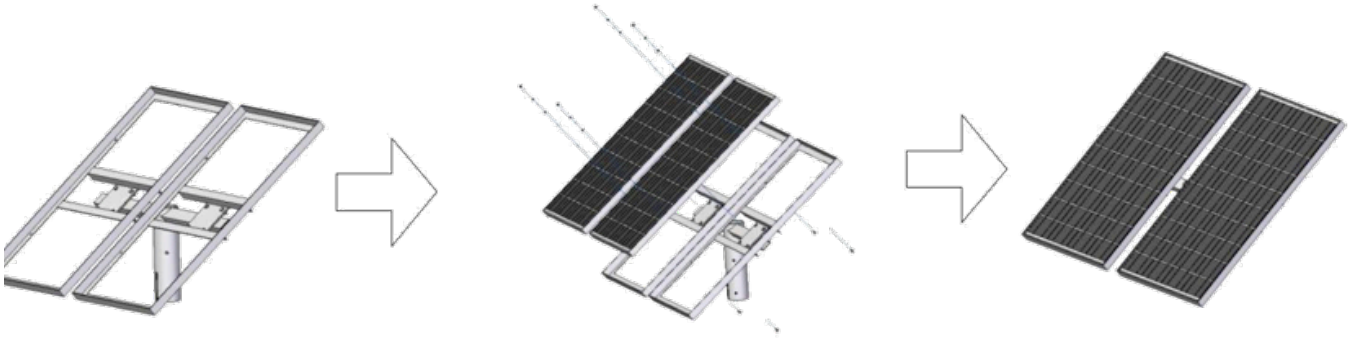
Series connect the batteries with MC4 Male(RED) and MC4 Female (Black).

Single PV Panel

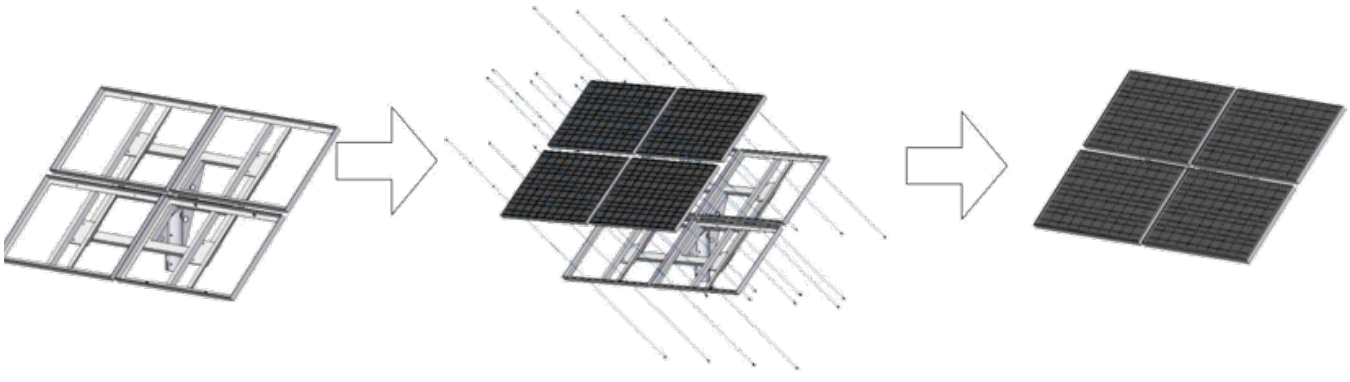




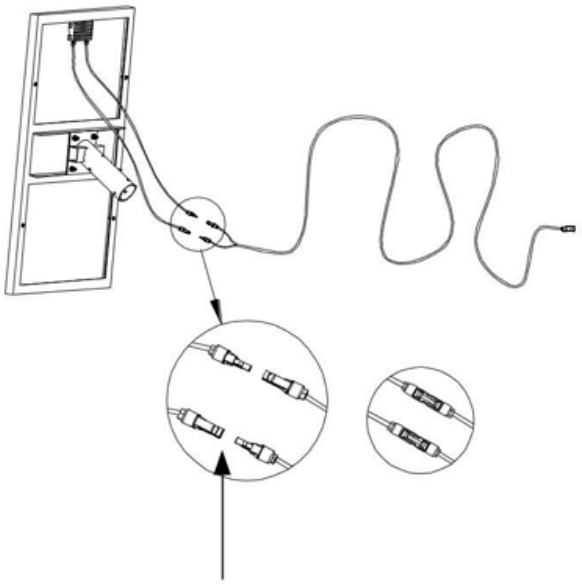
Dual PV Panels



Four PV Panels



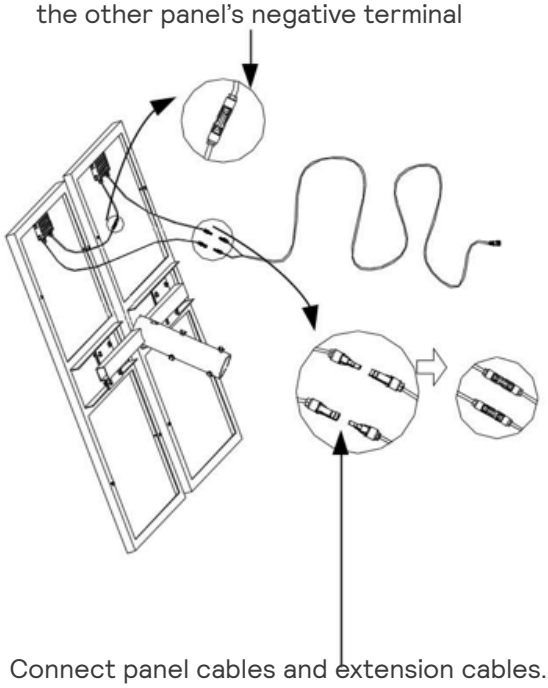
Single PV Panel



Connect panel cables and extension cables.

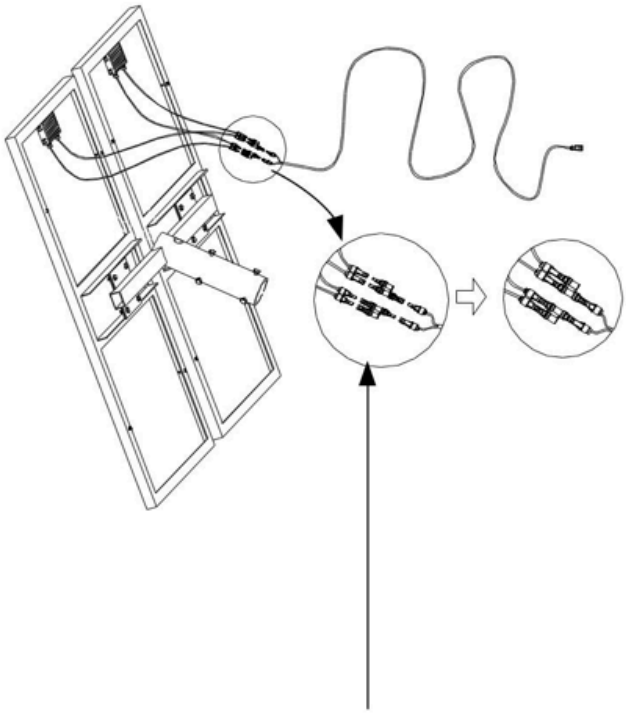
Dual PV Panels in Series Mode

Connect one panel's positive terminal to the other panel's negative terminal



Connect panel cables and extension cables.

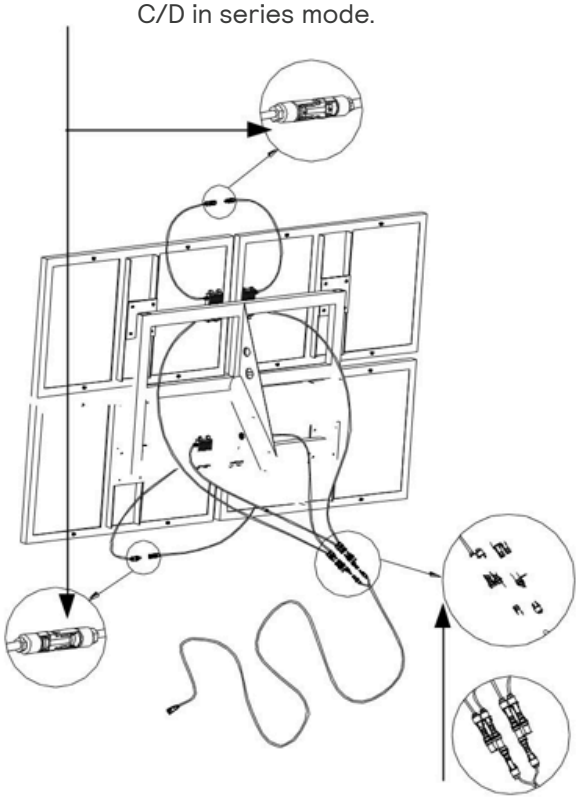
Dual PV Panels in Parallel Mode



Connect positive terminals and negative terminals to the 2-to-1 connectors

Four PV Panels (Series- Parallel Mode)

Group PV A/B in series mode, Group PV C/D in series mode.

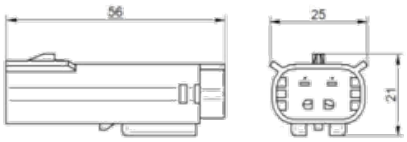


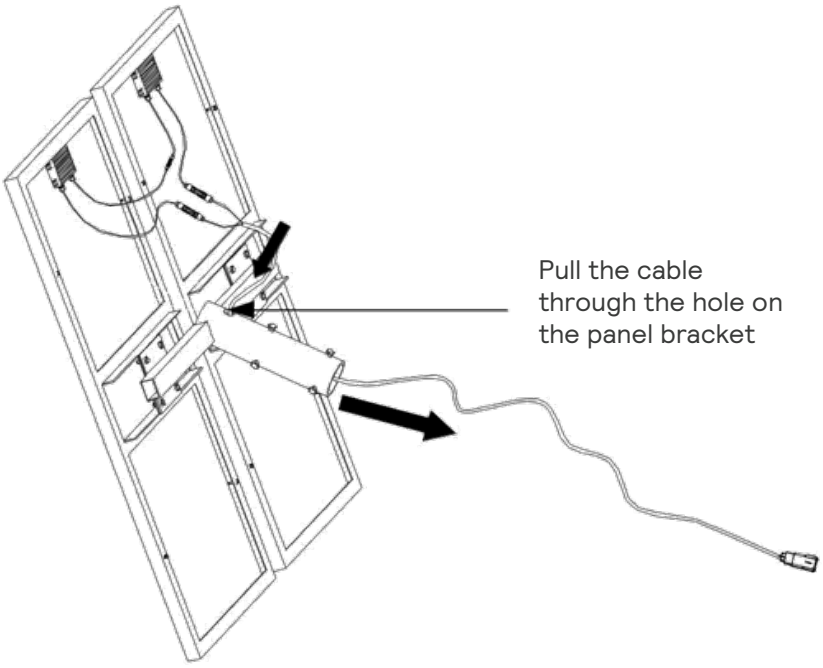
Connect the two PV groups to the 2-to-1 connectors

B3 Pull The Cable Through the Panel Bracket

(Dual PV panels as example)

Connector Size





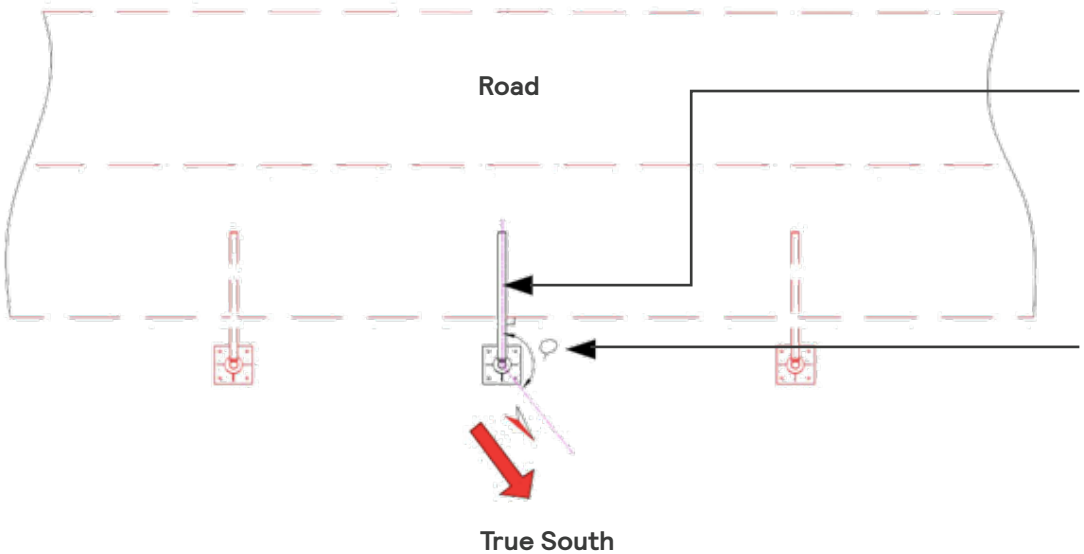
Pull the cable through the hole on the panel bracket

Warning

- The hole size must be more than Ø40 mm.
- Cutting the cable connector will breach the warranty and may cause water ingress, cable short circuit, or even safety issues. (If the cable length is not long enough, an extension cable is available for order)

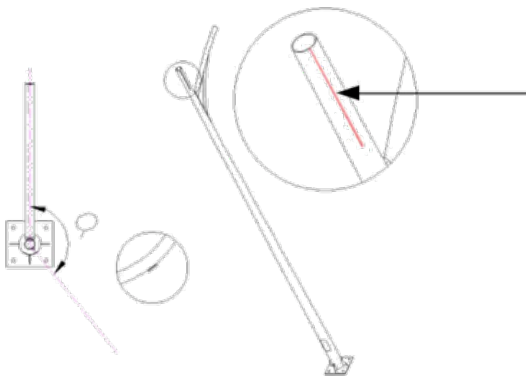
Note: The way the cable goes into the bracket may be different due to the actual design.

B4 Mark the Angle between True South and Luminaire Arm



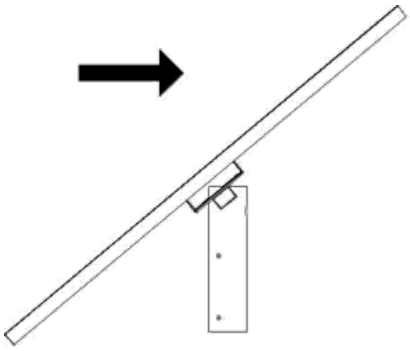
Ensure the luminaire arm is perpendicular to the road side

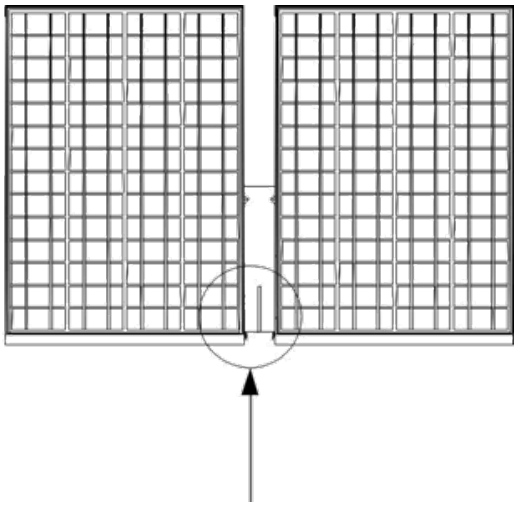
- Measure the angle (a) between true south and luminaire arm (facing south for the northern hemisphere and facing north for the southern hemisphere)



- Draw a mark by using pen on the pole where facing the true south (a). (Please notice the angle direction)

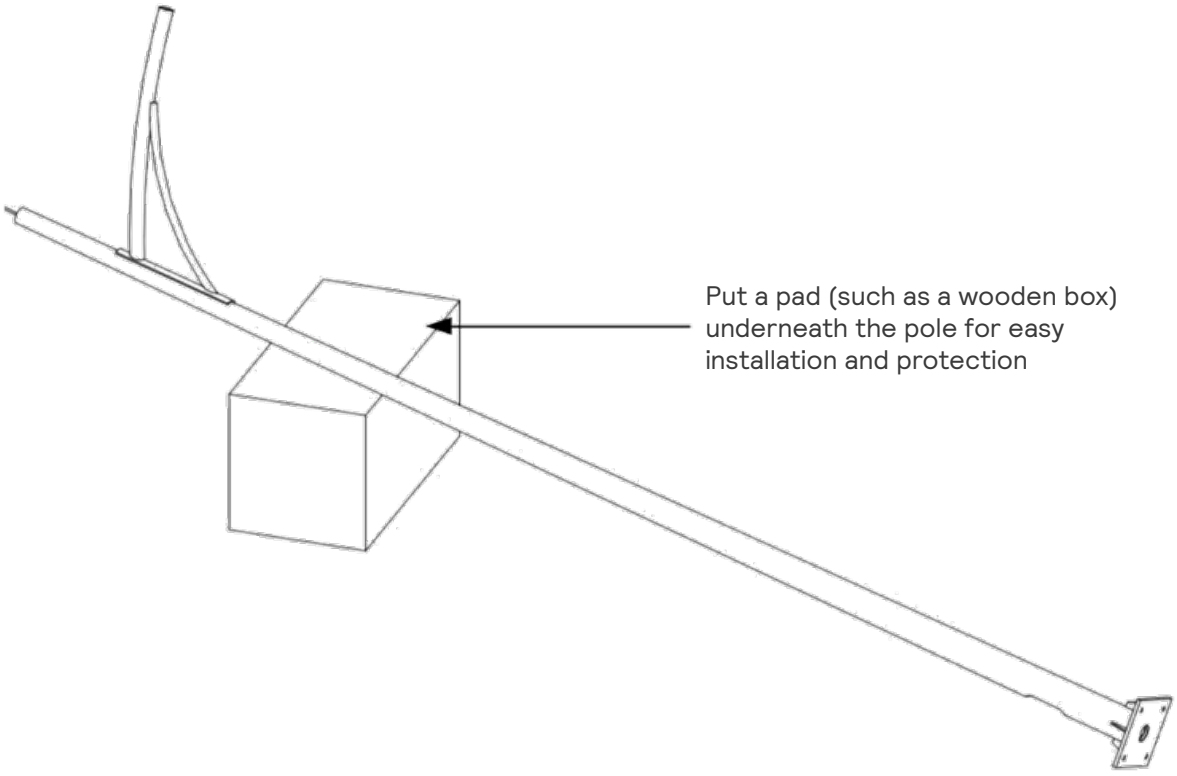
B5 Draw a Mark on the PV Panel Bracket





On the PV panel bracket, draw a mark on the side facing the panel

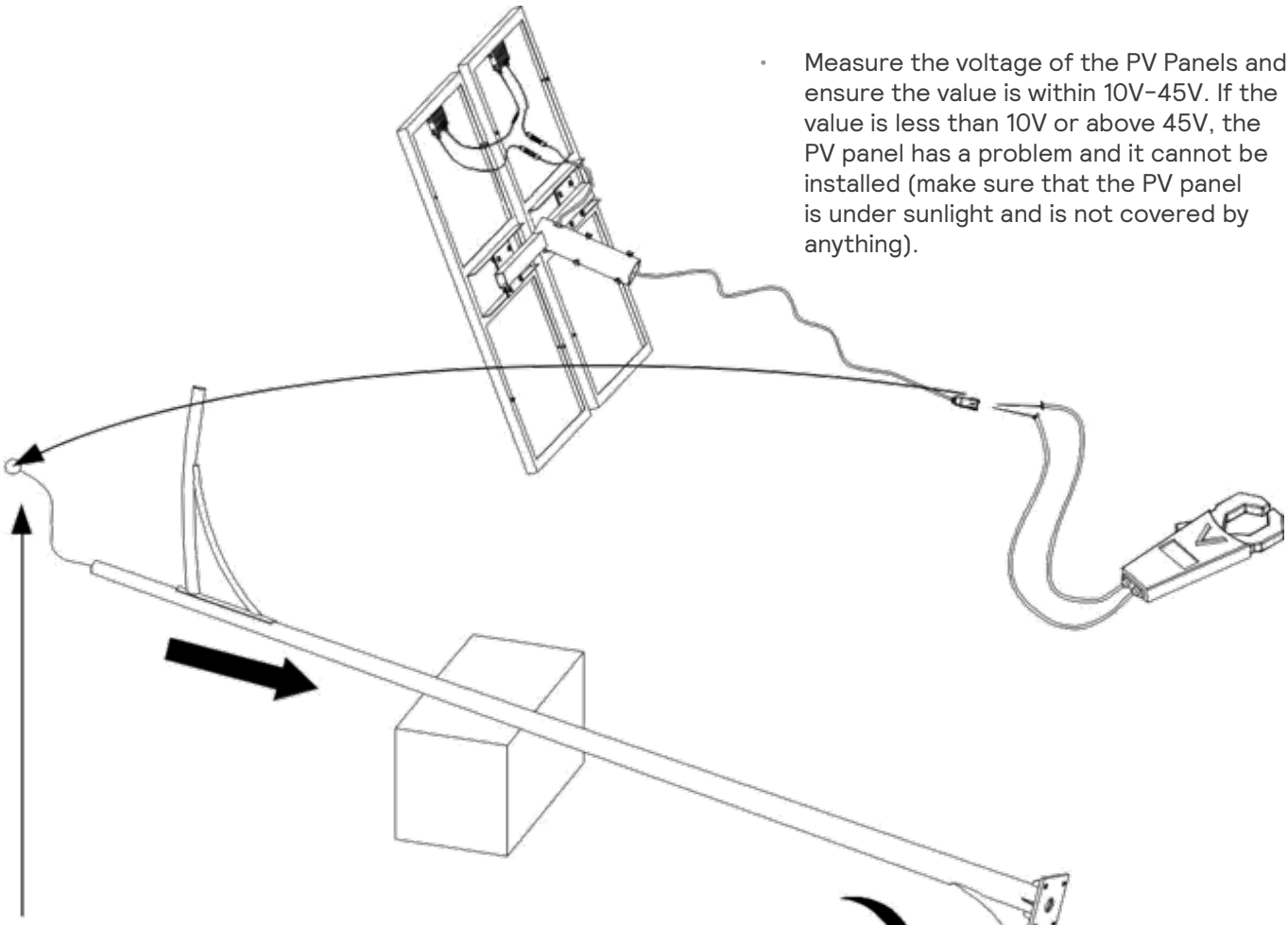
B6 PV Panel and Luminaire Fixation Preparation



Put a pad (such as a wooden box) underneath the pole for easy installation and protection

B7 Test Voltage of PV Panels and Lay the Cable

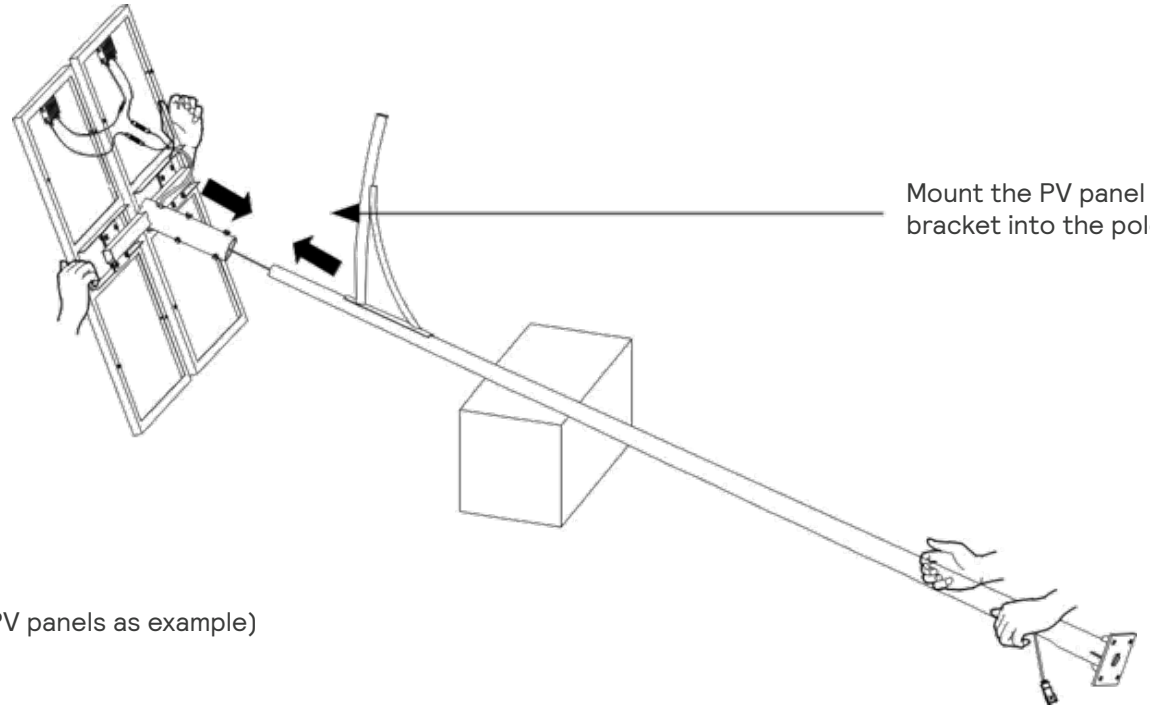
- Measure the voltage of the PV Panels and ensure the value is within 10V-45V. If the value is less than 10V or above 45V, the PV panel has a problem and it cannot be installed (make sure that the PV panel is under sunlight and is not covered by anything).



Pull the cable through the pole

(Dual PV panels as example)

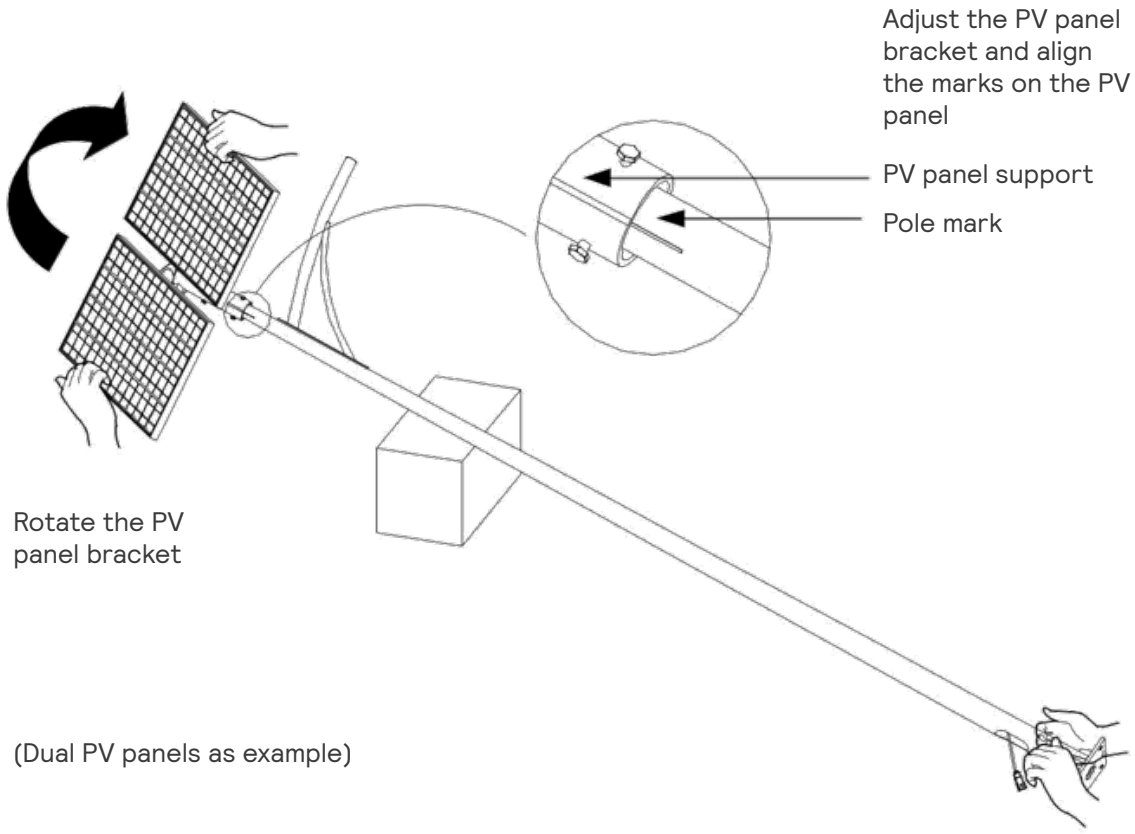
B8 Mount the PV Panel Bracket



Mount the PV panel bracket into the pole.

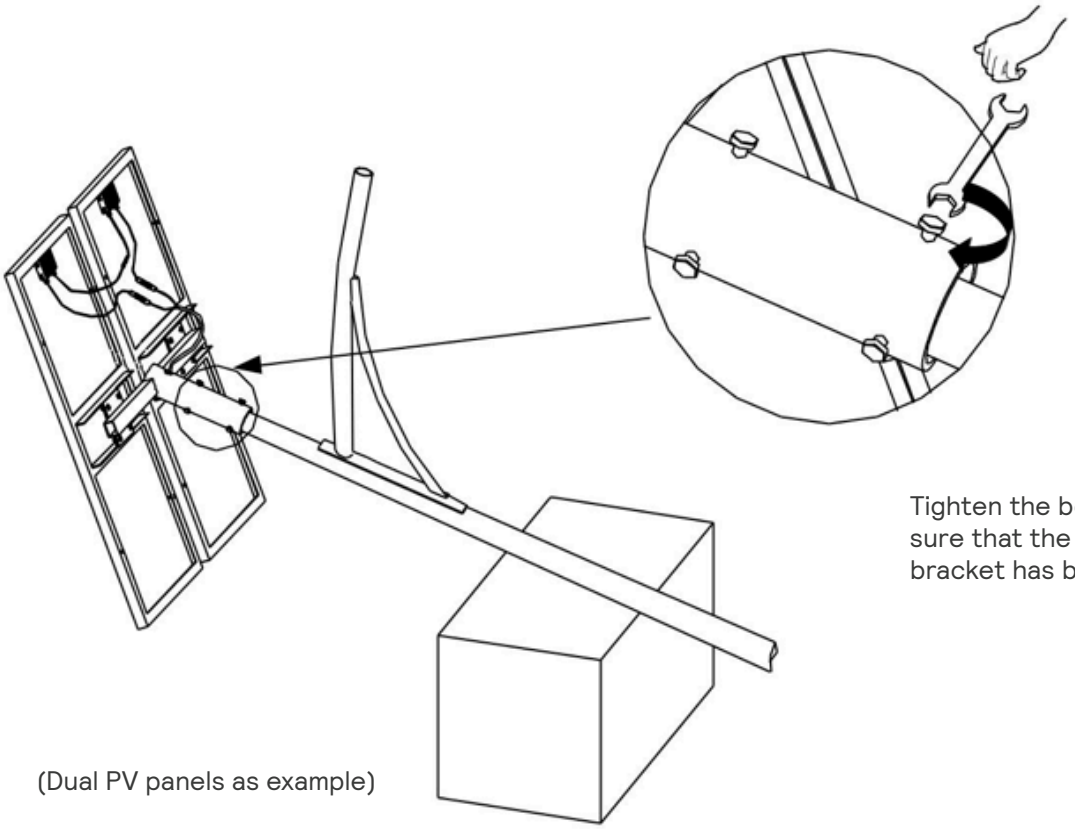
(Dual PV panels as example)

B9 Adjust the PV Panel Angle



(Dual PV panels as example)

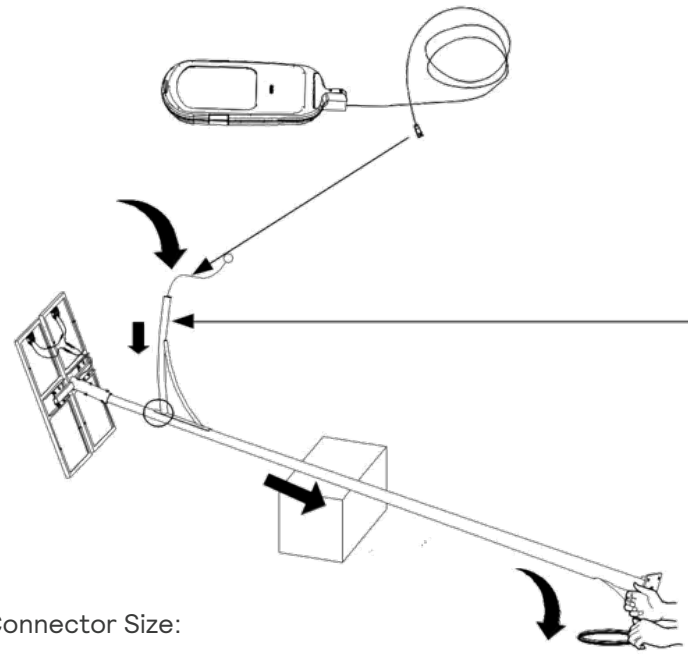
B10 Affix the PV Panel Bracket



(Dual PV panels as example)

3.Luminaire System Installation

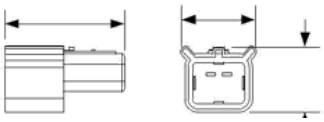
C1 Mount Luminaire



It is recommended to check the luminaire, connector, and wire appearance before installation

Pull the luminaire cable through the pole.

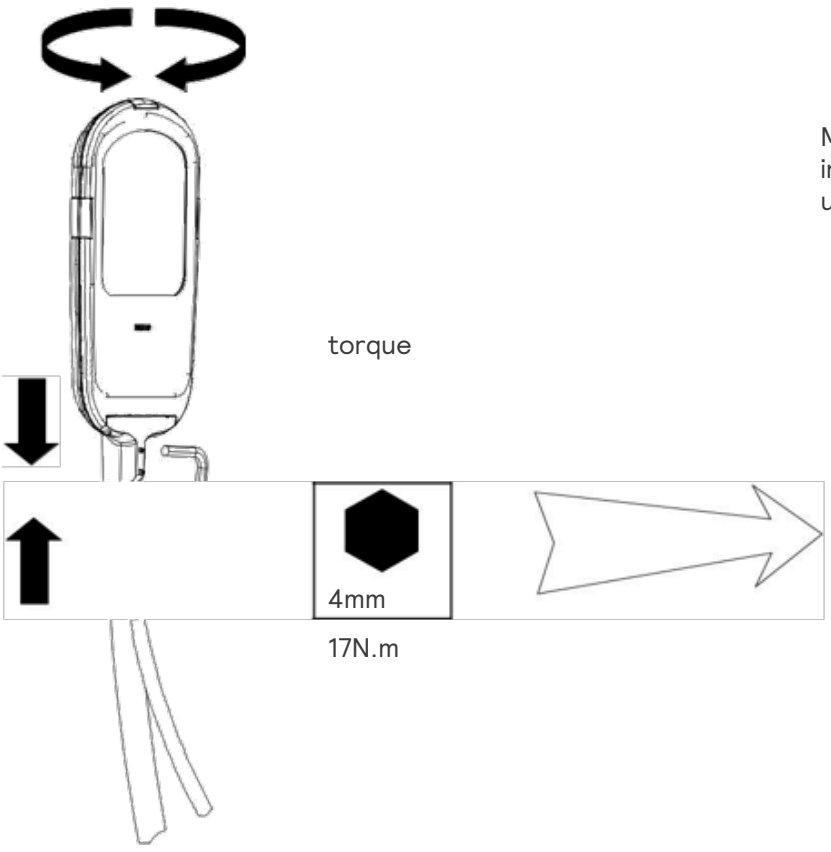
Connector Size:



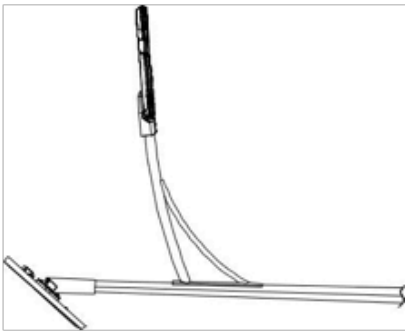
Warning

- Make sure that the cable connector can pass through the narrowest part of the pole (more than ⌀40mm).
- Cutting the cable connector results in a breach of the warranty and may cause water ingression, cable short circuit, or even safety problems.

C2 Luminaire Fixation

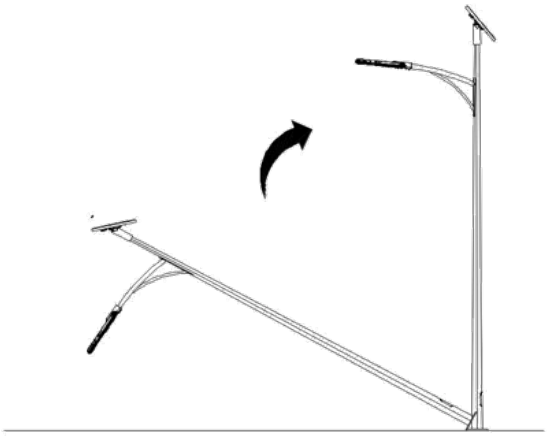


Mount the luminaire and adjust the installation angle to make sure it is unbiased. Tighten screws.



4.Pole and Controller System Installation

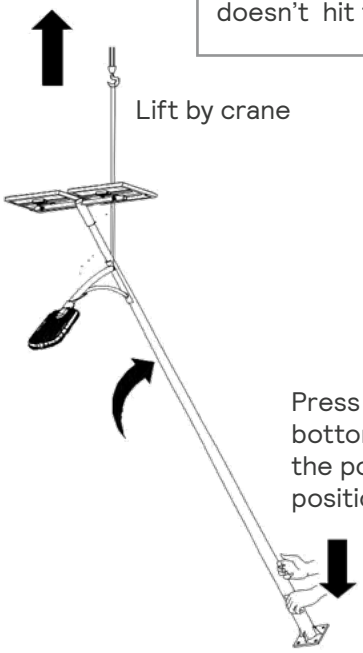
DI Erect the Pole



Solution 2 by crane

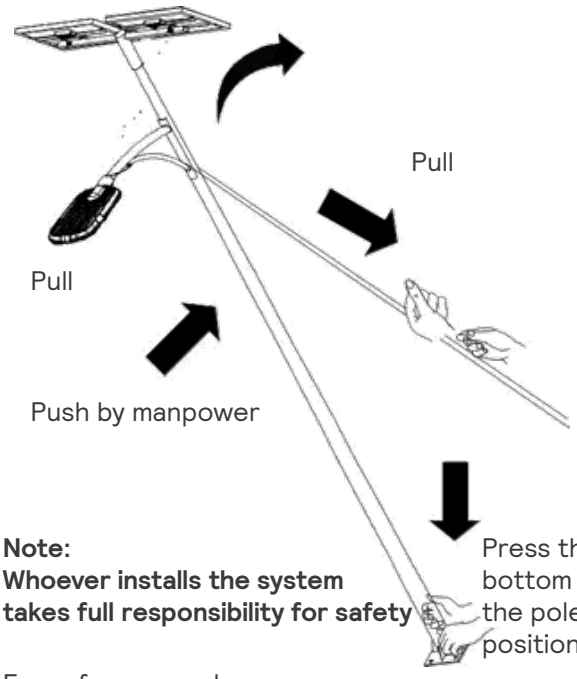
Warning

Be careful that the luminaire doesn't hit the crane arm.



For reference only

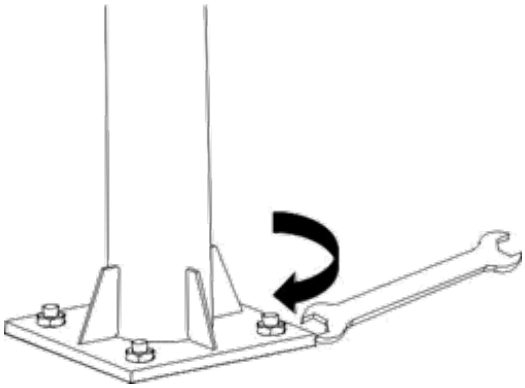
Solution I: By man-power



Note:
Whoever installs the system takes full responsibility for safety

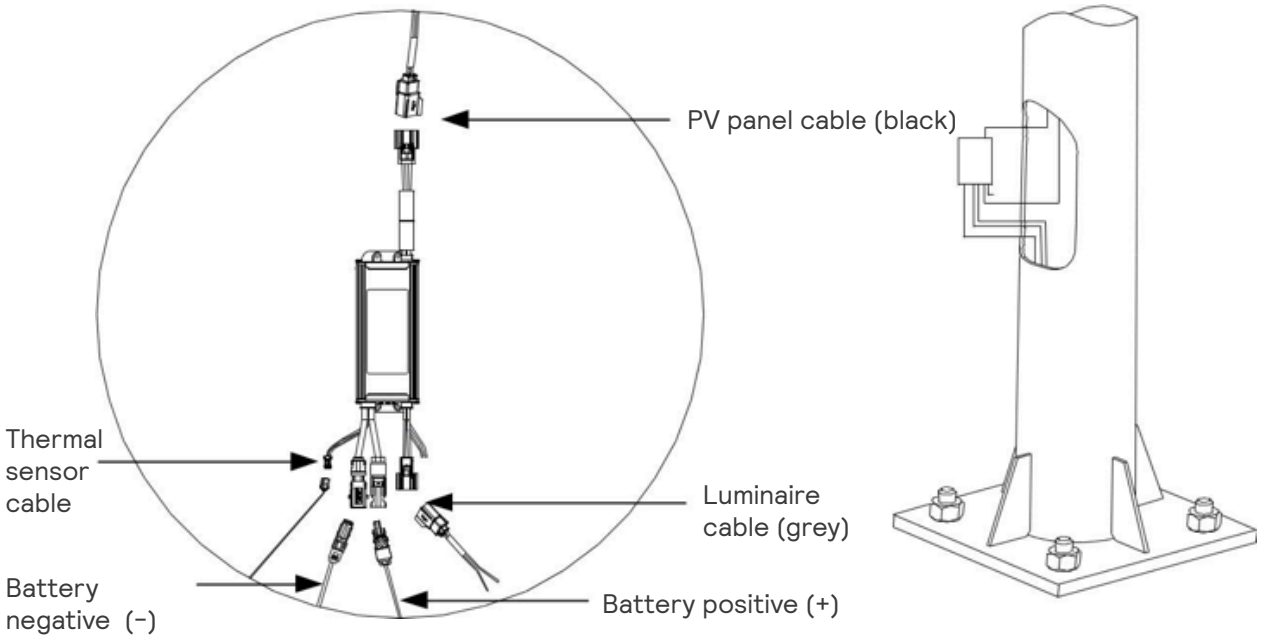
For reference only

Affix the pole



For reference only

D2 System Connection—Off grid solar system



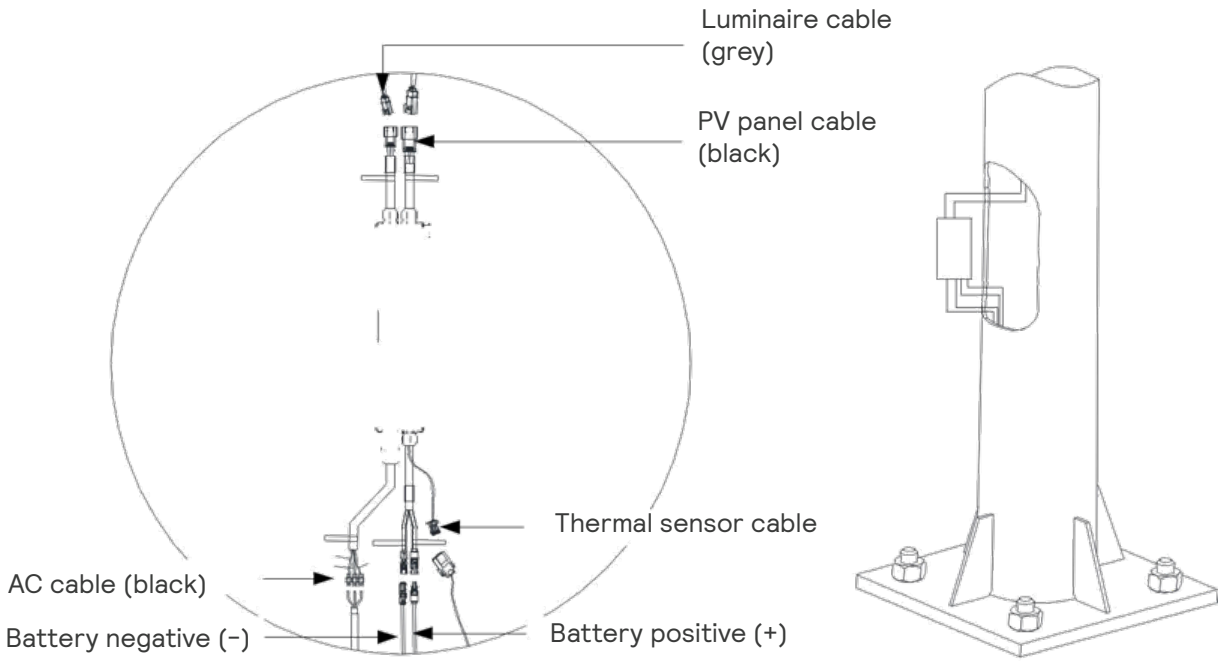
Step 1: Connect the battery cable and thermal sensor cable

Step 2: Connect the PV panel cable and luminaire cable

Warning

The thermal sensor must be connected well, otherwise the battery will be damaged, potentially causing a dangerous situation.

D2 System Connection—On-grid solar system



Step 1: Connect the battery cable and thermal sensor cable

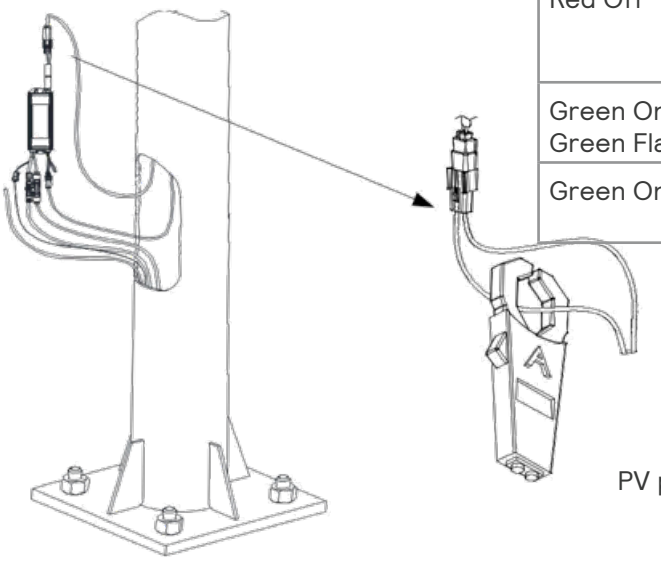
Step 2: Connect the PV panel cable and luminaire cable

Step 3: Connect the AC cable, making sure the AC connector is protected by the electrical insulate tape

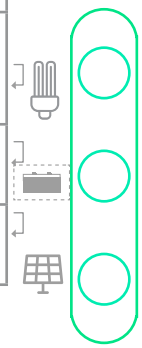
Warning

- If there is no AC connection, the warranty will be breached, the battery's lifetime reduced, and the system's performance will be downgraded.
- The thermal sensor must be connected well, otherwise the battery will be damaged, potentially causing a dangerous situation.

Off grid solar system



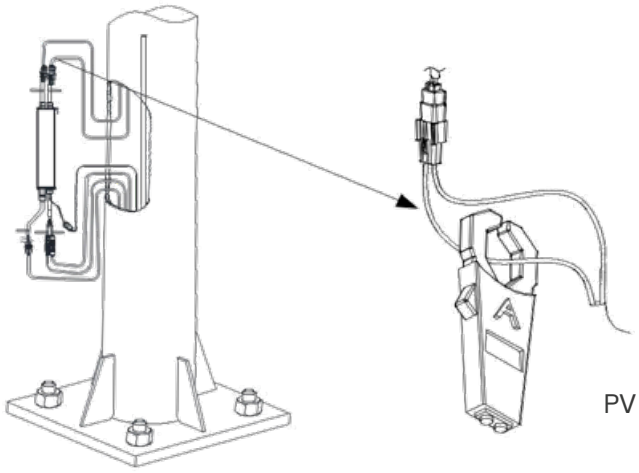
Normal Status	Abnormal Status
Red Off	Red On: NTC disconnect/LVD/ Overload
Green On or Green Flash	Green Off: LVD
Green On	Green Flash: Charging failure



PV panel cable (black)

After installing during the daytime, use a clip-on current meter to test the charge current. If sunlight is normal, a current value above 0.5A means the charge loop is fine. Disconnect the PV panel and wait for 10 minutes. If the luminaire turns on, it means that the discharge loop is fine (you can also use hand-held terminal testing system).

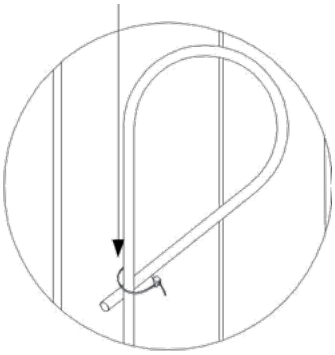
On grid solar system

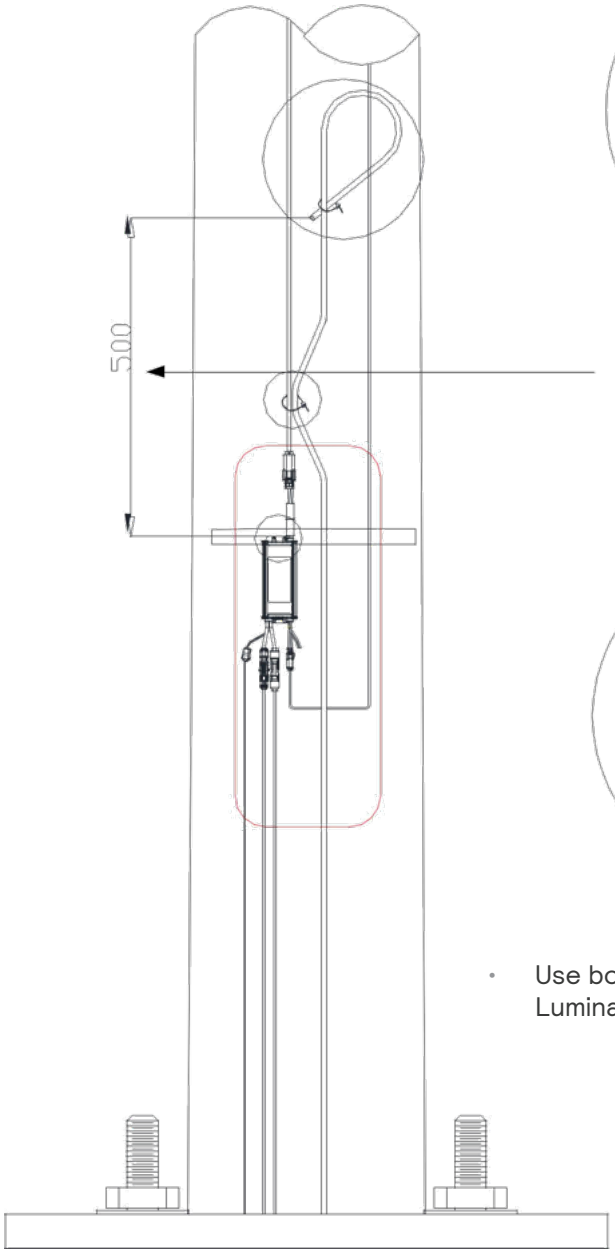


PV panel cable (black)

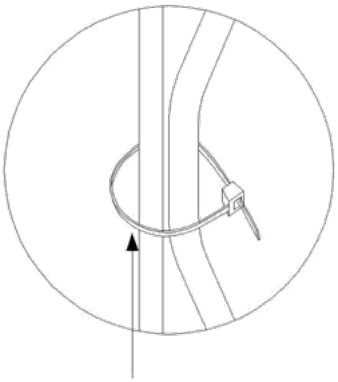
D4 Ventilation Tube Fixation

- Bend the end of the tube and affix it with a tape to prevent water ingress. You must affix the tube with a round avoid deformation, damage, or block ventilation, otherwise potential safety issues may arise.





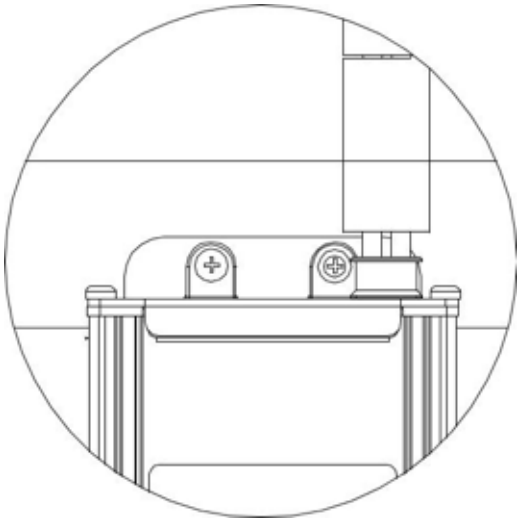
- The open end of the ventilation tube must be installed 500mm higher than the charge controller

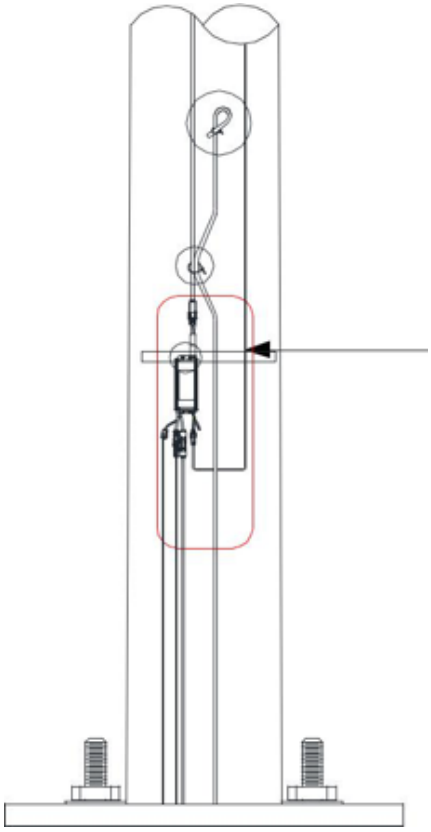


- Use bonding tape to affix the tube with Luminaire cable or PV cable

D5 Charge Controller Fixation

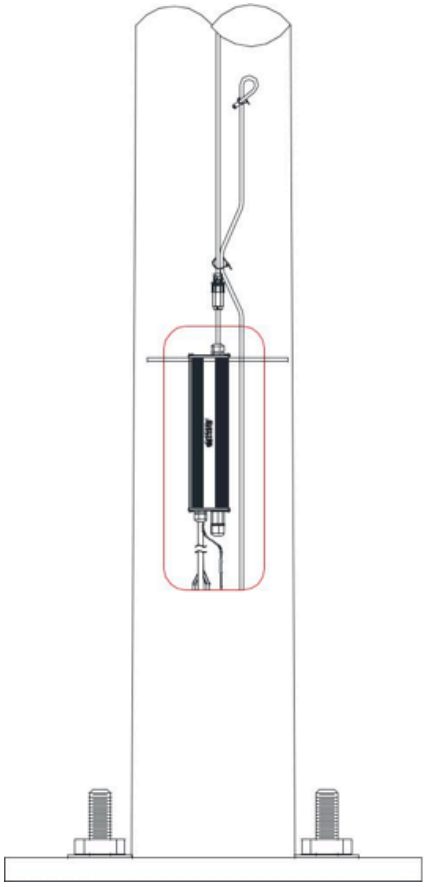
Off-grid solar system

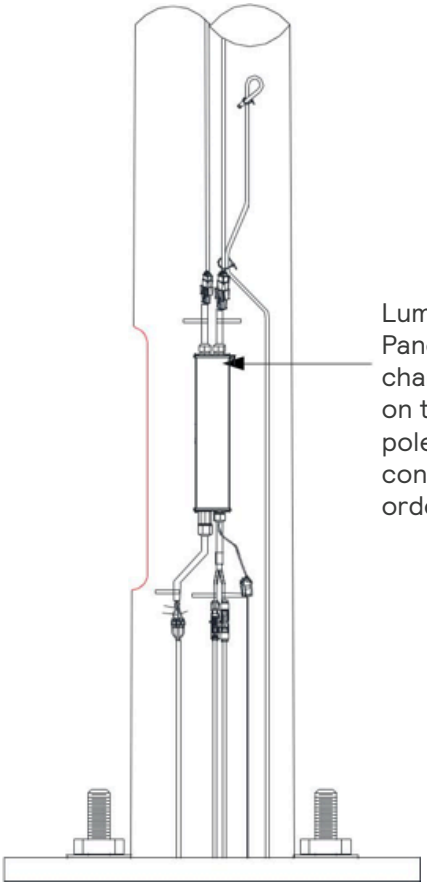




Affix the charge controller on the beam in the pole with an iron wire or screw. Straighten out the cables in order to prevent wiring issues and avoid further maintenance.

On-grid solar system

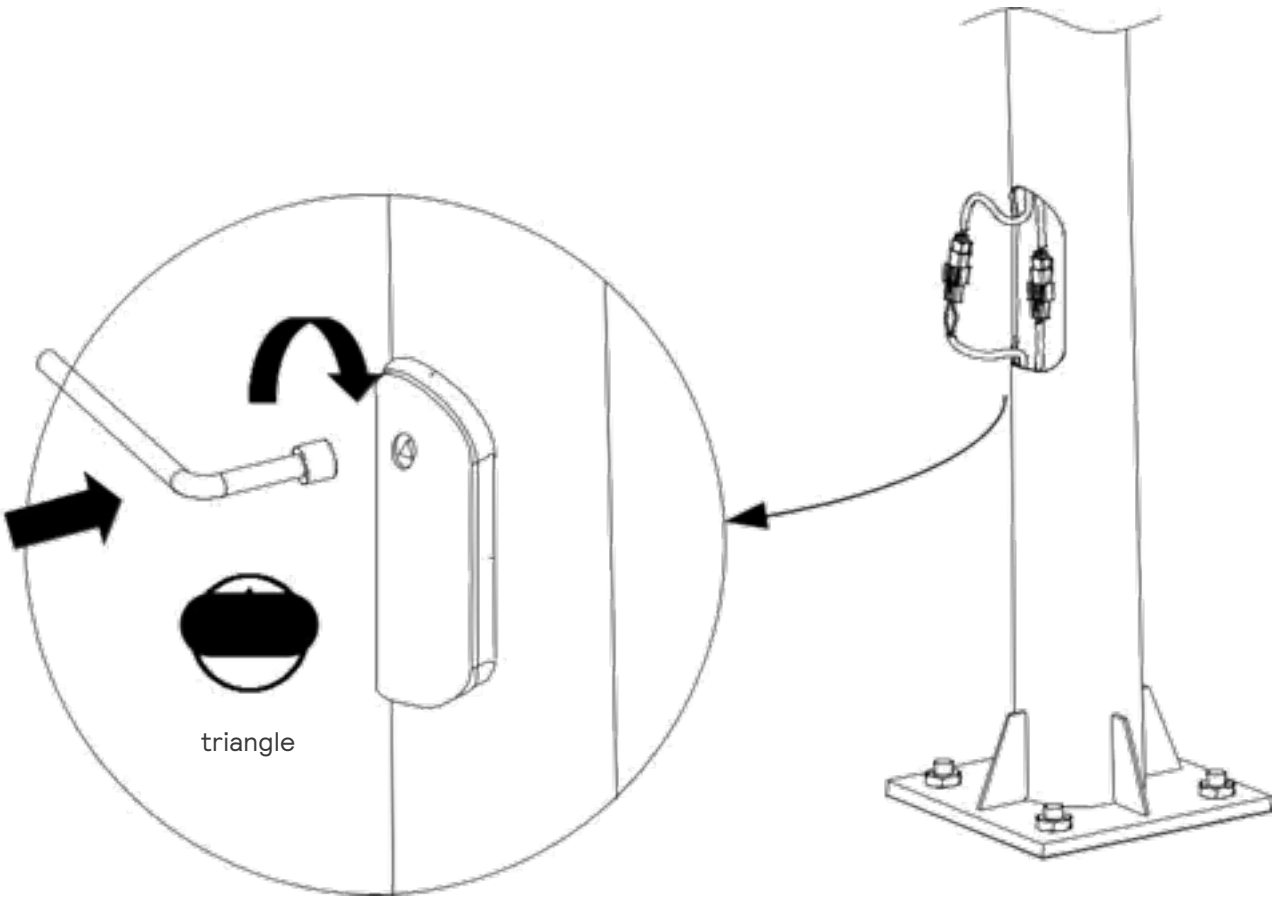




Luminaire cable Panel cable Hang the charge controller on the beam in the pole to keep the controller wiring in order.

5. Installation Completion

E1 Close the Service Hatch

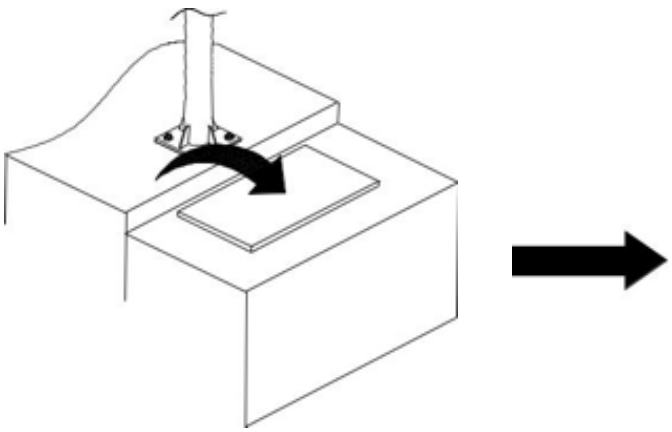


E2 Backfilling

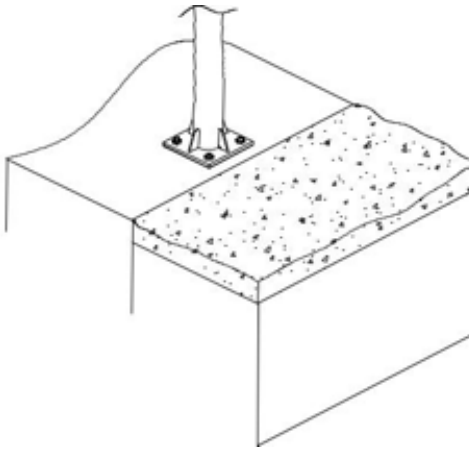
Warning

- Burying the battery directly into soil is not allowed.

- Close the battery chamber cover.



- Restore the ground to its original appearance.



Anti-theft depending on customer needs.

Solar LED Lighting System

Check List for Field Installation

(This checklist MUST be signed by the installer before system installation handover)

Project Name	Project Location
Site Constructor	

No.	Item	Ref.	Description	Results	Remarks
P1	**Site Installation Requirements**				
1.1	Battery System Installation	A2	The battery is integrated and properly sealed before installation.	☐ Yes ☐ No	
1.2		A2	The 12V battery system voltage is more than 12.5V before the installation. The 24V battery system voltage is more than 25V before the installation.	☐ Yes ☐ No	
2.1	Panel System Installation	B7	The panel voltage is between 10V-45V.	☐ Yes ☐ No	
2.2		B9	The panels face true south (facing south for northern hemisphere, facing north for southern hemisphere).	☐ Yes ☐ No	
2.3			Any shading at panel facing direction	☐ Yes ☐ No	
3.1	Installation Completion	D2	HCU AC connection check	☐ Yes ☐ No	
3.2		D3	After cable connection, there is charge current in the panel cable. The charge loop is fine.	☐ Yes ☐ No	
3.3		D4	The end of the tube is 0.5 m above the controller and facing down. The tube has no blockage, deformation, or damage.	☐ Yes ☐ No	
3.4		E1	After testing, the access door of the service hatch is closed.	☐ Yes ☐ No	
3.5		D2	Thermal sensor connection is checked.	☐ Yes ☐ No	

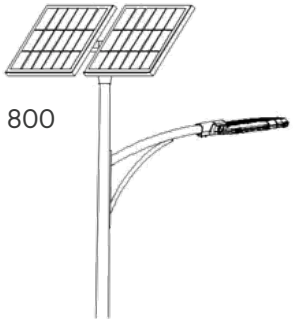
Person in charge of site construction _____ Signature/ Date

Pole Installation Instructions

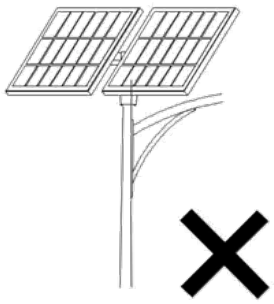
Solar LED Lighting System

A1 PV Panel Position

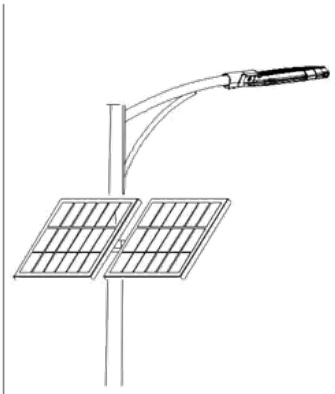
The vertical distance from bracket bottom to lamp arm must be more than 800 mm, avoiding conflict between the PV and luminaire.



Panel bracket in correct position

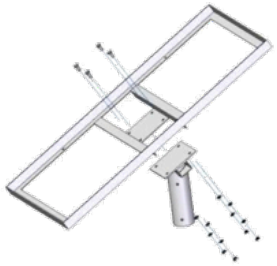


Panel bracket too close to the lamp



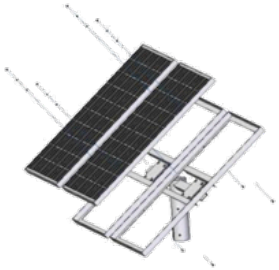
Panel bracket below the lamp

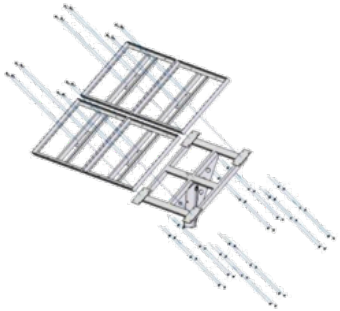
A2 PV Panel Bracket Diagram



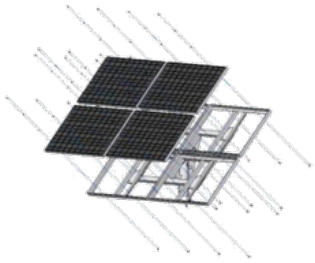
Single PV Panel

Dual PV Panels



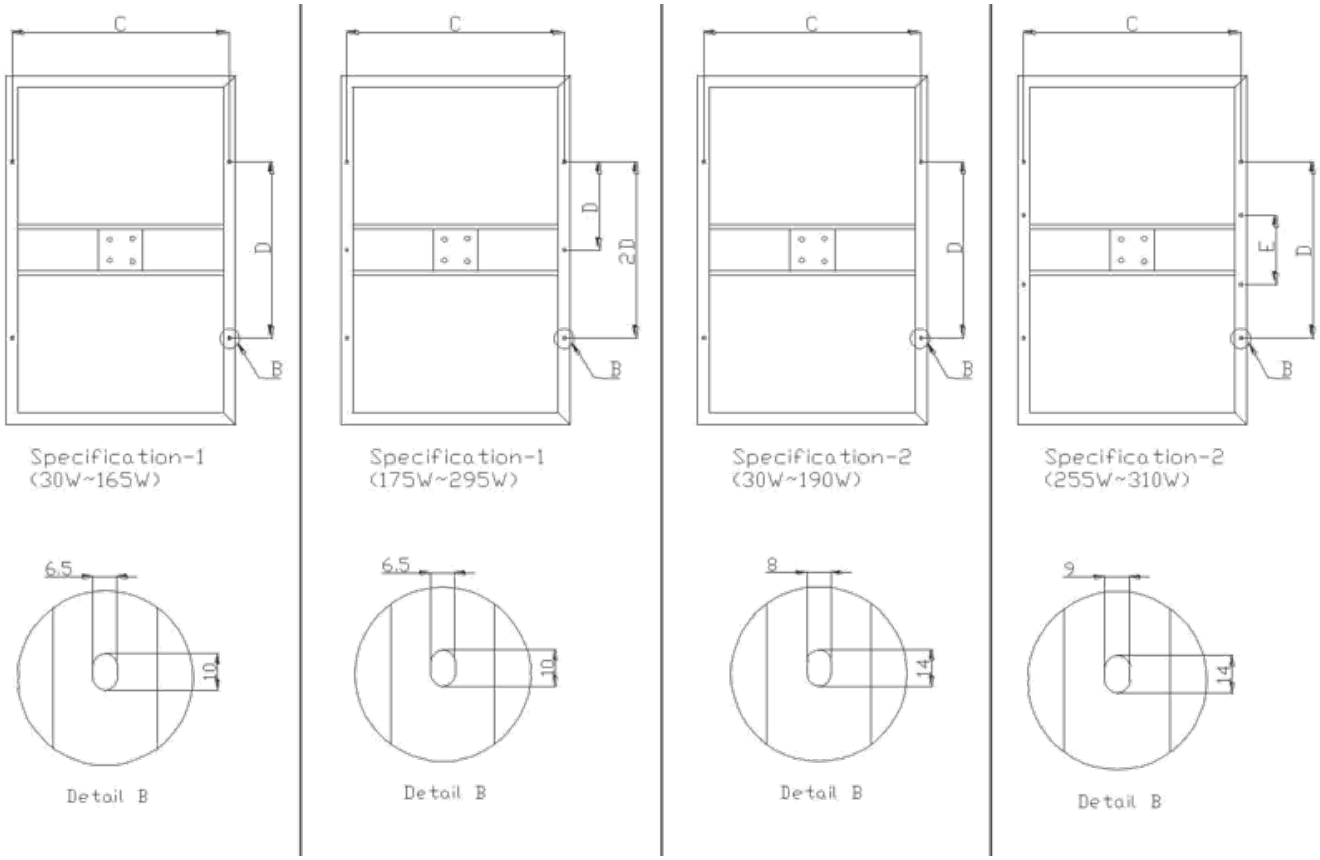


Four PV Panels



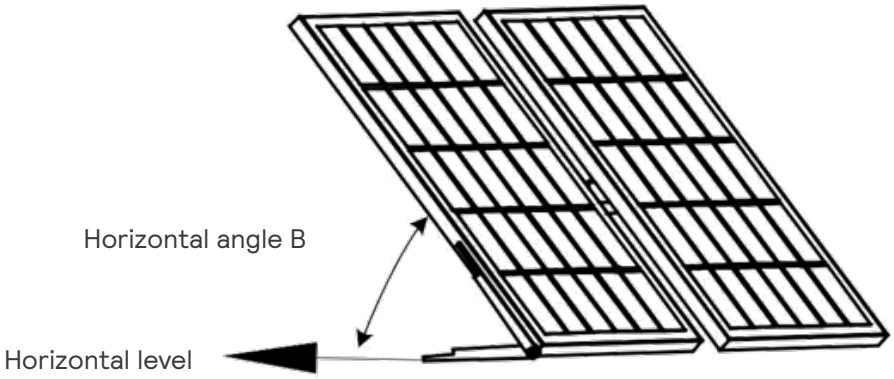
A4 Location of Holes on Bracket

The holes on the bracket (C,D,E) must align with the holes on the panel (c,d,e). Refer to A3. M6 bolts□M6 nuts and D6 spring washers must be anti-corrosion

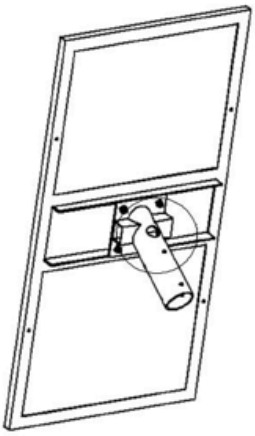


A5 Panel Bracket Tilt Angle

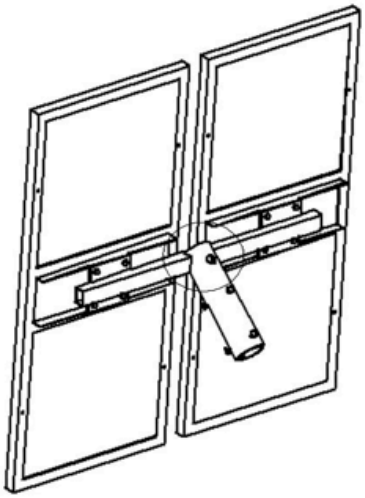
The tilt of the bracket must follow requirements to ensure the maximum amount of sunlight is gained.



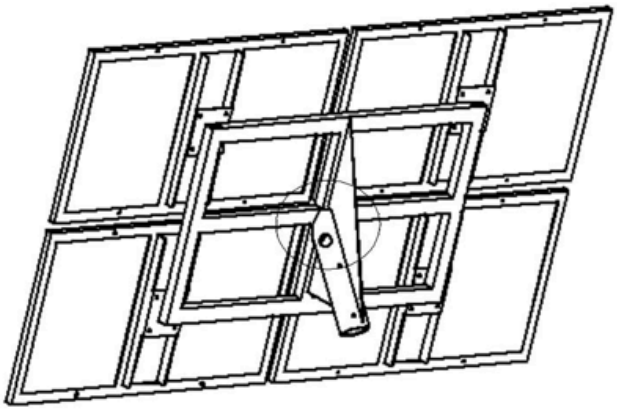
A6 Cable Entry Requirements on Bracket



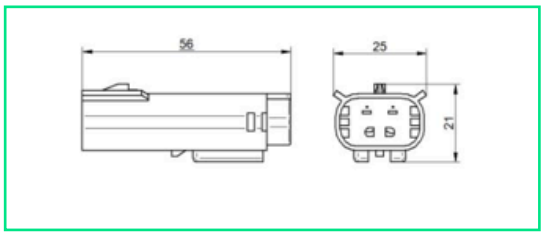
Single PV Panel Bracket



Dual PV Panels Bracket



Four PV Panels Bracket

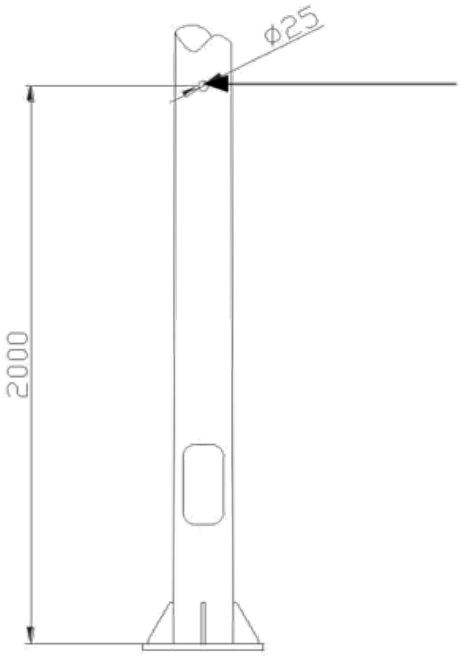


- The size of cable entry MUST NOT be less than Ø40mm;
- The bracket must be well grounded with the pole, with a resistance value ≤0.5Ω;
- The type of cable entry may vary with bracket design. It must prevent rain water from ingress and allow the cable connector to penetrate through.
- It is recommended to adopt a cover like below on the hole to avoid rain ingress. Sealing the cable entry hole is prohibited to avoid hydrogen concentrate.

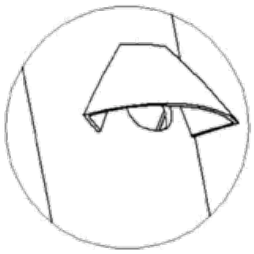
Cover on hole

Ventilation Hole

A7 Ventilation Hole on Pole Requirements

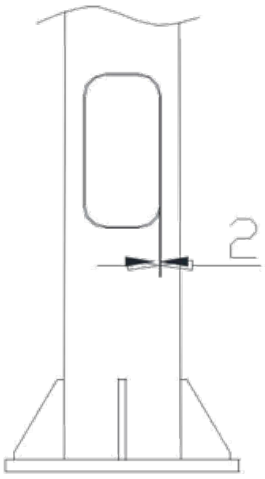


A hole (at least 25 mm) must be drilled 2 meters from the bottom of the pole and attached with a cover to avoid rain ingress, as shown in the picture.

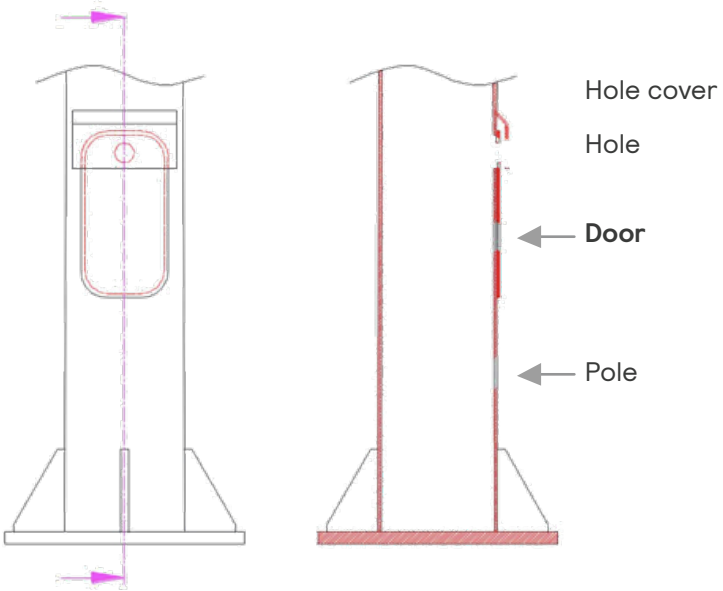


Ventilation Hole on Service Hatch Requirements:

Option 1. After assembling the door, keep a 2 mm gap between the pole

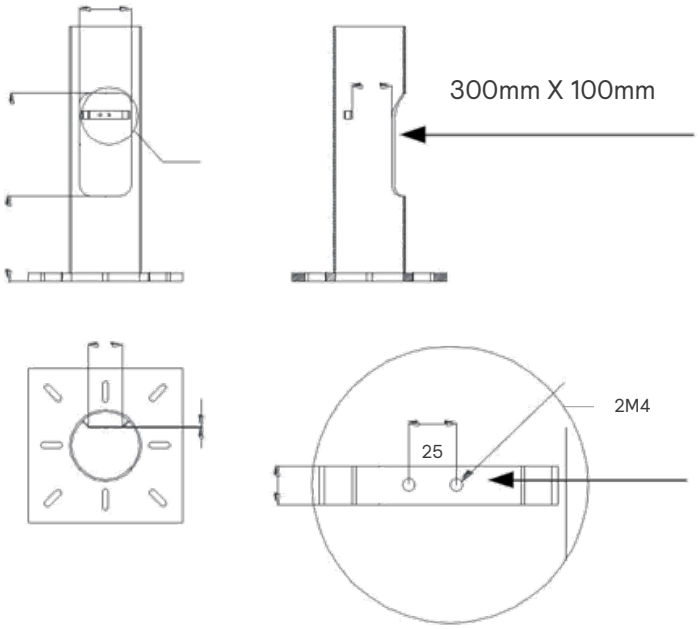


Option 2. Drill a 25 hole on the door and attach a cover over it in case of rain ingress.



Service Hatch Requirements:

A3 Off-grid solar system

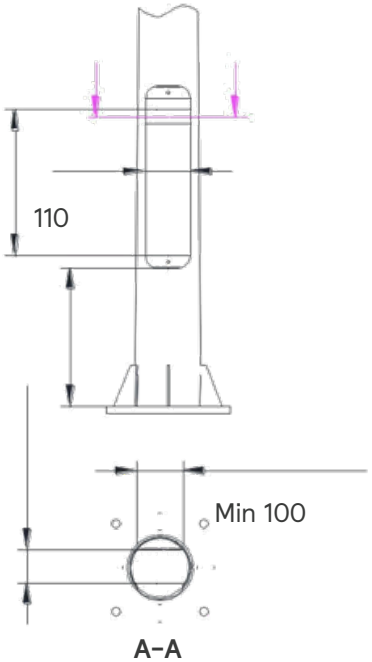


The service hatch must be located over 300 mm from the ground. The distance between the beam and hatch door should be over 100 mm.

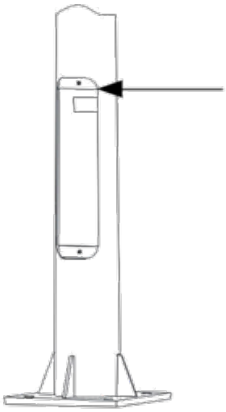
A beam in the service hatch is required with two M4 screw holes drilled into it.

Detail B

On-grid solar system



A-A



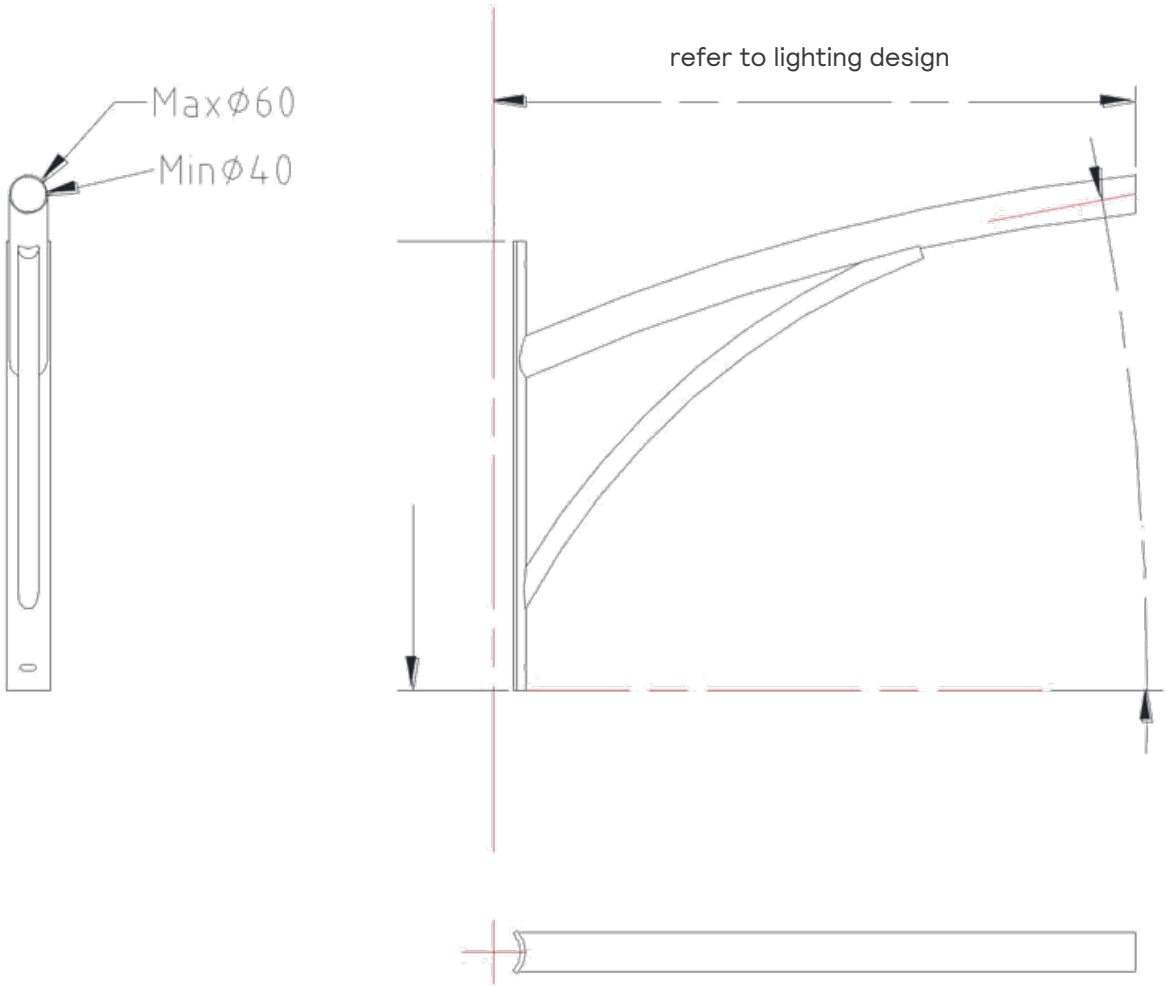
The beam in the service hatch is required to hang HCU on it.

Note:

The pole must be grounded and connected firmly to the foundation base.

A9 Luminaire Arm Requirement

- The inner diameter of the arm must be more than Ø40 mm
- The outer diameter of the arm must be less than Ø60 mm



Solar LED Lighting System

Check List for Site Installation Preparation

(This checklist must be signed by the subcontractor (installer/constructor) before system handover.

Project Name	Project Location
Site Constructor	

No.	Item	Ref.	Description	Results	Remarks
1	Panel Position	A1	The vertical distance from the bracket bottom to **lamp arm is more than 800 mm.**	☐ Yes ☐ No	
2	Bracket Size	A4	The bracket size & screw hole position align with **the panel.**	☐ Yes ☐ No	
3	Tilt Angle	A5	The tile angle of the bracket follows Philips' **design.**	☐ Yes ☐ No	
4	Cable Entry Hole	A6	The size of the cable entry is no less than 40 mm	☐ Yes ☐ No	
5			A cover is placed on the hole to avoid rain **ingress.**	☐ Yes ☐ No	
6			The cable entry hole must not be sealed.	☐ Yes ☐ No	
7	Ventilation Hole	A7	Drill a hole (at least ⌀25mm) 2.0m from the **ground with a cover.**	☐ Yes ☐ No	
8	Service Hatch Dimensions	A8	The serice hatch dimensions must be according **to the diagram.**	☐ Yes ☐ No	
9	Luminaire Arm	A9	The inner diameter of the arm must be more than ⌀40 mm. **The outer diameter of the arm must be less than** ⌀60 mm.	☐ Yes ☐ No	
10	Pole and Bracket Strength		The pole supplier is responsible for the pole **strength. The pole design must follow local design standards.**	☐ Yes ☐ No	
11	Other Accessories		The quantity of the screws, nuts, and washers is **correct.**	☐ Yes ☐ No	

Person in charge of site construction _____

Signature/Date

Foundation Installation Instructions

Solar LED Lighting System

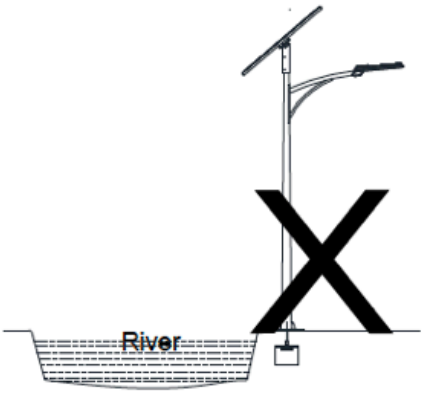
Installation Preparation

A1 The embedded duct is used for routing the ventilation tube and cables from pit to pole.

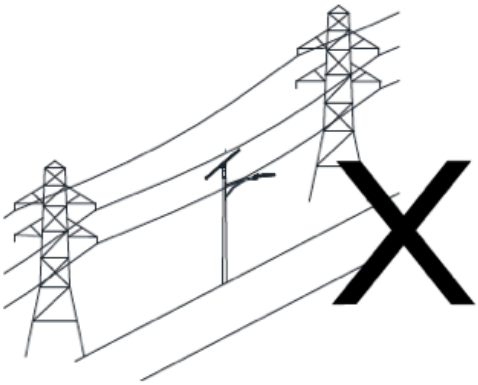
Material : PVC
Inner diameter:

Ø50mm for 12V system
Ø70mm for 24V system

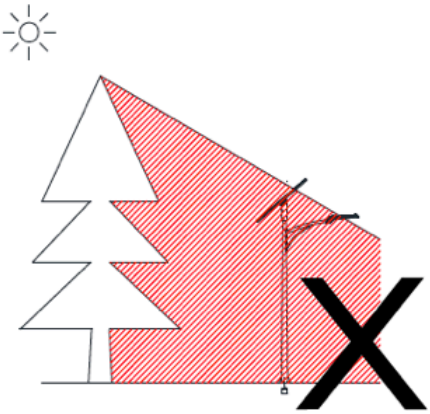
A1 The embedded duct is used for routing the ventilation tube and cables from pit to pole.

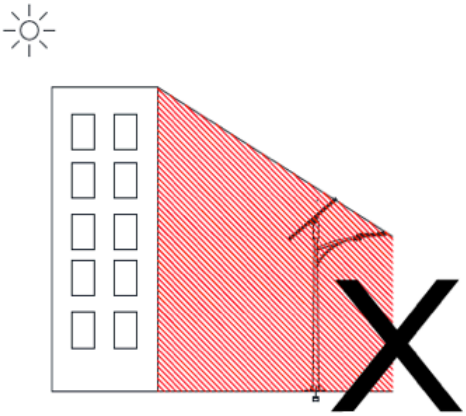


Avoid locations close to water



Avoid locations close to AC grids



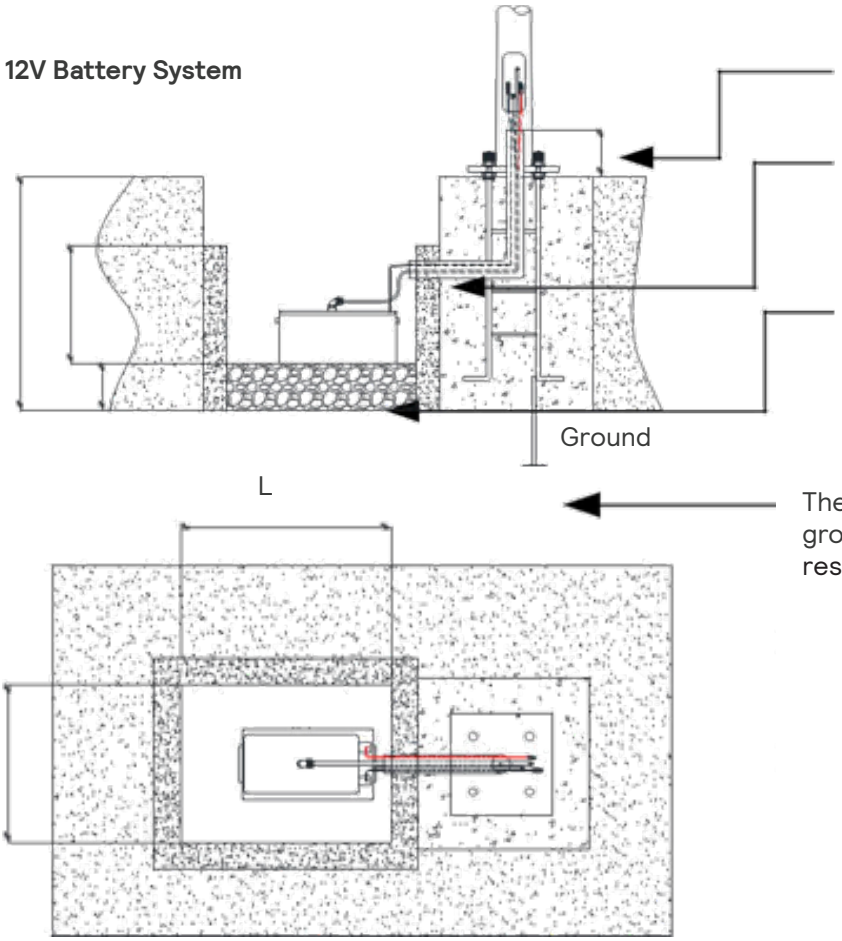


Avoid locations in the shade of the trees or buildings

Solar LED Lighting System

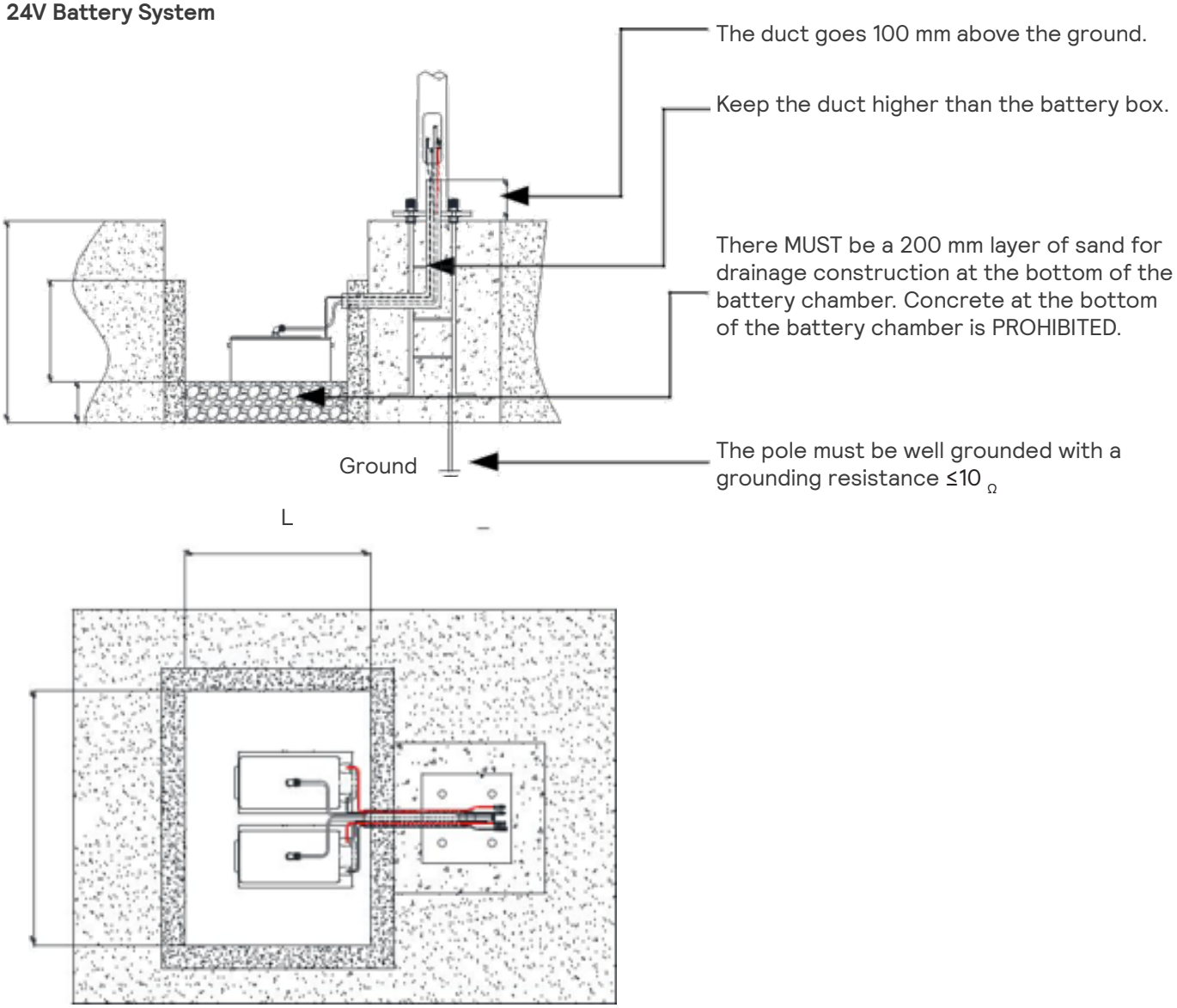
A3 Build the Foundation

12V Battery System



12NC	SAP	Product Size (cm) LxWxH	Net Weight (kg)	Chamber Size (cm)		
				L	W	H
9114 018 97801	XGS321 12V/65Ah IP68 gel battery subsys	35x16.6x23.5	20.6	60	40	60
9114 018 97901	XGS321 12V/80Ah IP68 gel battery subsys	32.9x17.2x27.3	26.30	60	40	60
9114 018 98001	XGS321 12V/100Ah IP68 gel battery subsys	32.9x17.2x27.3	30.10	60	40	60
9114 018 98101	XGS321 12V/120Ah IP68 gel battery subsys	40.6x17.4x26.6	37.50	70	40	60
9114 018 98201	XGS321 12V/150Ah IP68 gel battery subsys	48x17x30	42.50	70	40	60
9114 018 98301	XGS321 12V/180Ah IP68 gel battery subsys	52.2x23.8x21.8	56.00	80	50	60
9114 018 98401	XGS321 12V/200Ah IP68 gel battery subsys	52.2x23.8x21.8	59.00	80	50	60
9114 018 98501	XGS321 12V/220Ah IP68 gel battery subsys	52.2x23.8x21.8	59.50	80	50	60
9114 018 98601	XGS321 12V/250Ah IP68 gel battery subsys	52x26.9x22	68.00	80	50	60

24V Battery System



12NC	SAP	Product Size (cm) LxWxH	Net Weight (kg)	Chamber Size (cm)		
				L	W	H
9114 018 98801	XGS322 24V/65Ah IP68 gel battery subsys	35x33.2x23.5	41.20	60	70	60
9114 018 98901	XGS322 24V/80Ah IP68 gel battery subsys	32.9x34.4x27.3	52.60	60	70	60
9114 018 99001	XGS322 24V/100Ah IP68 gel battery subsys	32.9x34.4x27.3	60.00	60	70	60
9114 018 99101	XGS322 24V/120Ah IP68 gel battery subsys	40.6x34.8x26.6	75.00	70	70	60
9114 018 99201	XGS322 24V/150Ah IP68 gel battery subsys	48x34x30	85.00	70	70	60
9114 018 99301	XGS322 24V/180Ah IP68 gel battery subsys	52.2x47.6x21.8	112.00	80	100	60
9114 018 99401	XGS322 24V/200Ah IP68 gel battery subsys	52.2x47.6x21.8	118.00	80	100	60
9114 018 99501	XGS322 24V/220Ah IP68 gel battery subsys	52.2x47.6x21.8	119.00	80	100	60
9114 018 99601	XGS322 24V/250Ah IP68 gel battery subsys	52x53.8x22	136.00	80	100	60

Solar LED Lighting System

Check List for Site Installation Preparation

This checklist MUST be signed by the subcontractor(installer/constructor) before system handover)

Project Name	Project Location
Site Constructor	

No.	Item	Ref.	Description	Results	Remarks
1	Embedded Duct	A1	Size ≥Ø50mm (12V system) ; **≥Ø70mm (24V system).**	☐ Yes ☐ No	
2	Location	A2	**Avoid locations close to water**	☐ Yes ☐ No	
3		A2	**Avoid locations close to AC grids**	☐ Yes ☐ No	
4		A2	**Avoid location in the shade of the trees or buildings**	☐ Yes ☐ No	
5		A3	The battery chamber must be positioned close to **the foundation**	☐ Yes ☐ No	
6	Chamber	A3	Depth and size of chamber comply with **requirements**	☐ Yes ☐ No	
7	Duct End	A3	Keep the duct higher than the battery box	☐ Yes ☐ No	

Person in charge of site construction _____

Signature/Date

Maintenance Instructions

Troubleshooting and Maintenance

Important Safety Notice

The battery presents a risk of electrical shock and a high short circuit current. The mounting instructions must be strictly followed, otherwise potential application, reliability, or safety issues may arise. Contact your local service if the instructions cannot meet special field conditions.

Only a qualified service representative who is knowledgeable in batteries and the required precautions is permitted to service the battery. Keep unauthorized personnel away from batteries.

Danger

- The VRLA battery can generate hydrogen gas. Hydrogen mixed with oxygen is explosive and could be ignited by any spark/flame, static electricity, or overheated object. Smoking is strictly prohibited during all system installation, operation, and maintenance processes, such as welding.
- Use proper lifting techniques to keep the battery upright and avoid any discharge of acid when moving batteries. Wear all appropriate safety clothing and equipment.
- Do not dispose of the batteries in a fire. The batteries may explode.

Caution

- The misuse of this equipment could result in human injury and/or equipment damage. In no event will the company be responsible or liable for either indirect or consequential damage or injury that may have resulted from the misuse of this equipment.
- Use tools with insulated handles to avoid inadvertent shorts.
- Verify circuit polarities before connecting.
- Disconnect the charging source and load before connecting or disconnecting the battery.

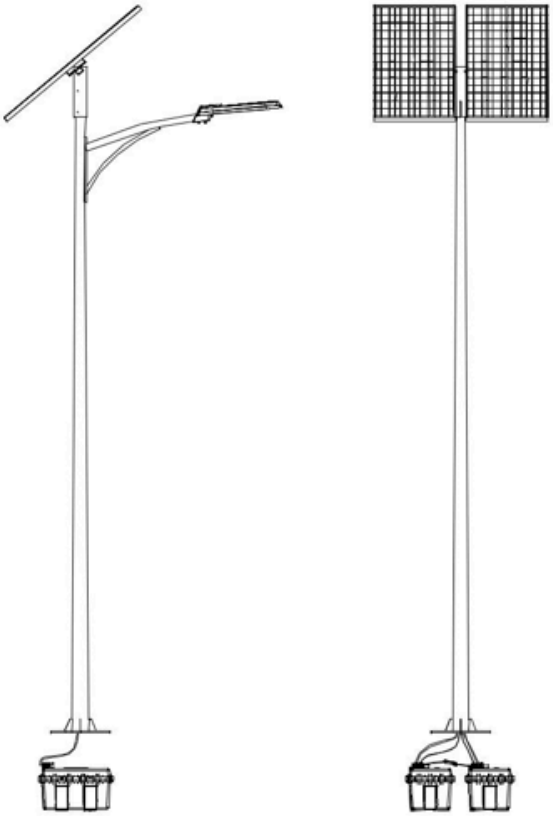
Warning

- The solar lighting system contains VRLA batteries. Lack of preventative maintenance could reduce the battery's lifetime or even be dangerous. Check the application environment regularly (lighting performance, PV panel shading).
- Failure to replace a battery before it becomes exhausted may cause the case to crack, possibly releasing electrolytes from inside the battery and resulting in secondary issues such as odour, smoke, and fire.
- The battery system must be in proper maintenance according to the "Troubleshooting & Maintenance" manual. This is essential for safety and the reliability of the lighting system
- Do not dispose of lead acid batteries except through channels in accordance with local, state and federal regulations.

Solar LED Lighting System

Mounting Instruction

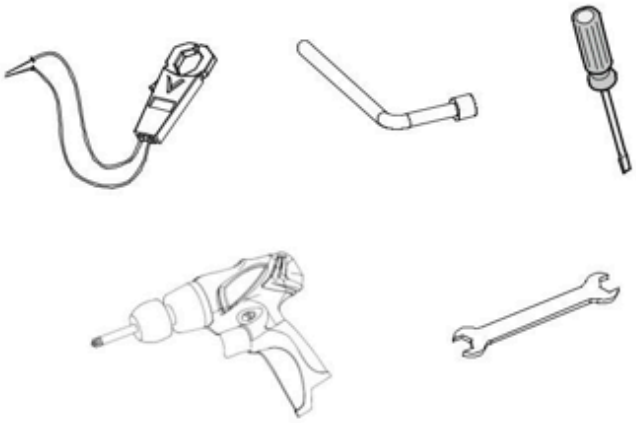
A1 (Reference for 5m pole)



Unit: mm

A2

Note: The listed testing tools using for troubleshooting. (not limited)



Compass and Protractor
Electrical Screw Driver
Multimeter
DC Clamp Meters
Triangular Spanner (opens hatch door)
Other tools: a.Waterproof tape b.Screw driver c.Spanner d.Diagonal Pliers e.Nose Pliers

Parts List

PV Panel sub-system: 1 sets
Luminaire sub-system: 1 pcs
Pole sub-system: 1 pcs (not supplied by Philips)
Control sub-system: 1 pcs
Battery sub-system: 1 sets

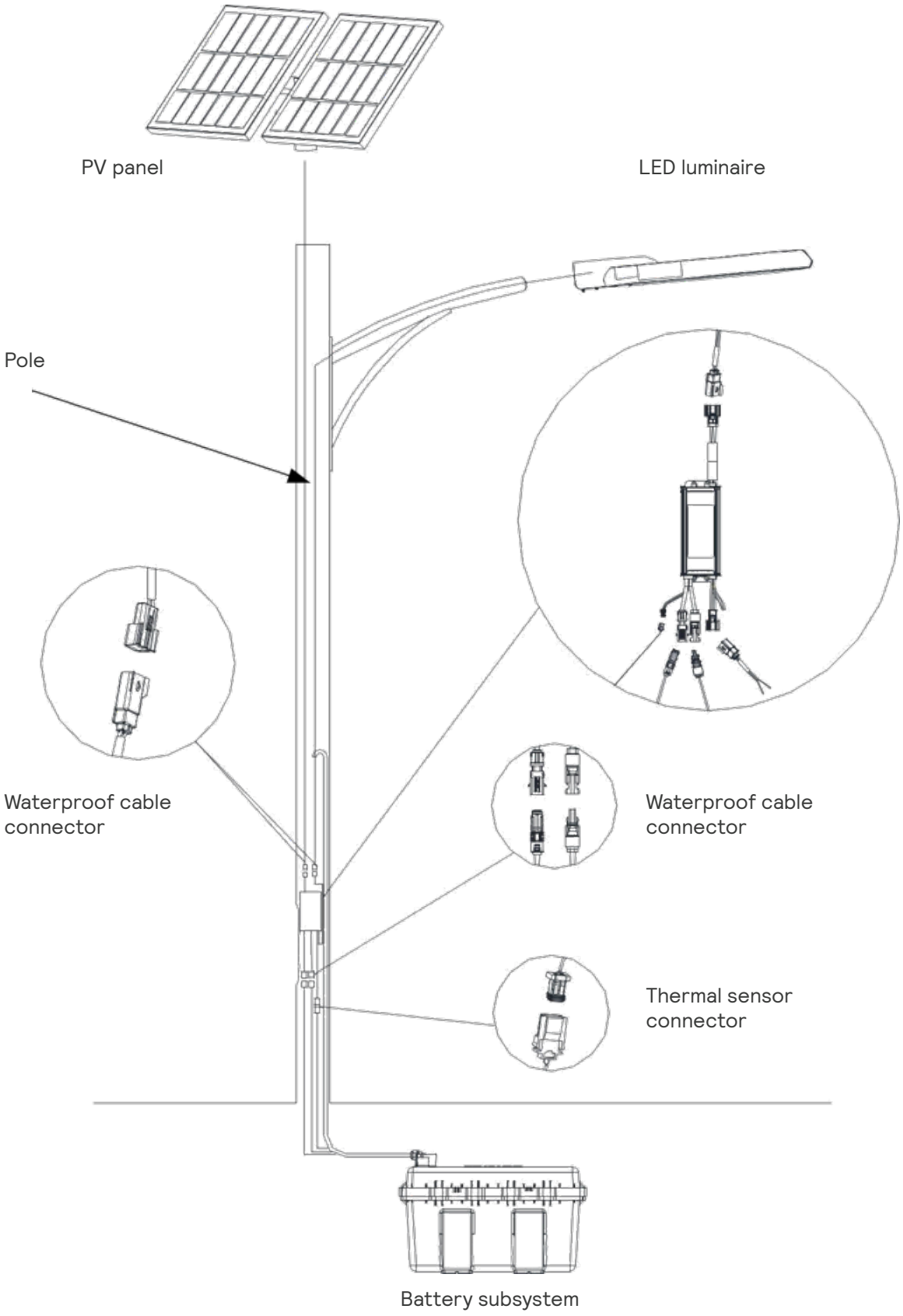
Technical Parameters

PV panel nominal voltage : 12V system: 17Vdc ~ 17.5Vdc 24V system: 34Vdc ~ 35Vdc
Battery output voltage 12Vbattery- subsystem: 12Vdc 24Vbattery- subsystem: 24Vdc
Luminaire input voltage:12Vdc ~ 24Vdc
IP classification : IP66 for luminaire-subsystem IP68 for battery-subsystem (Note: ventilation tube not included) IP66 for control-subsystem
Application : outdoor use only

Solar LED Lighting System

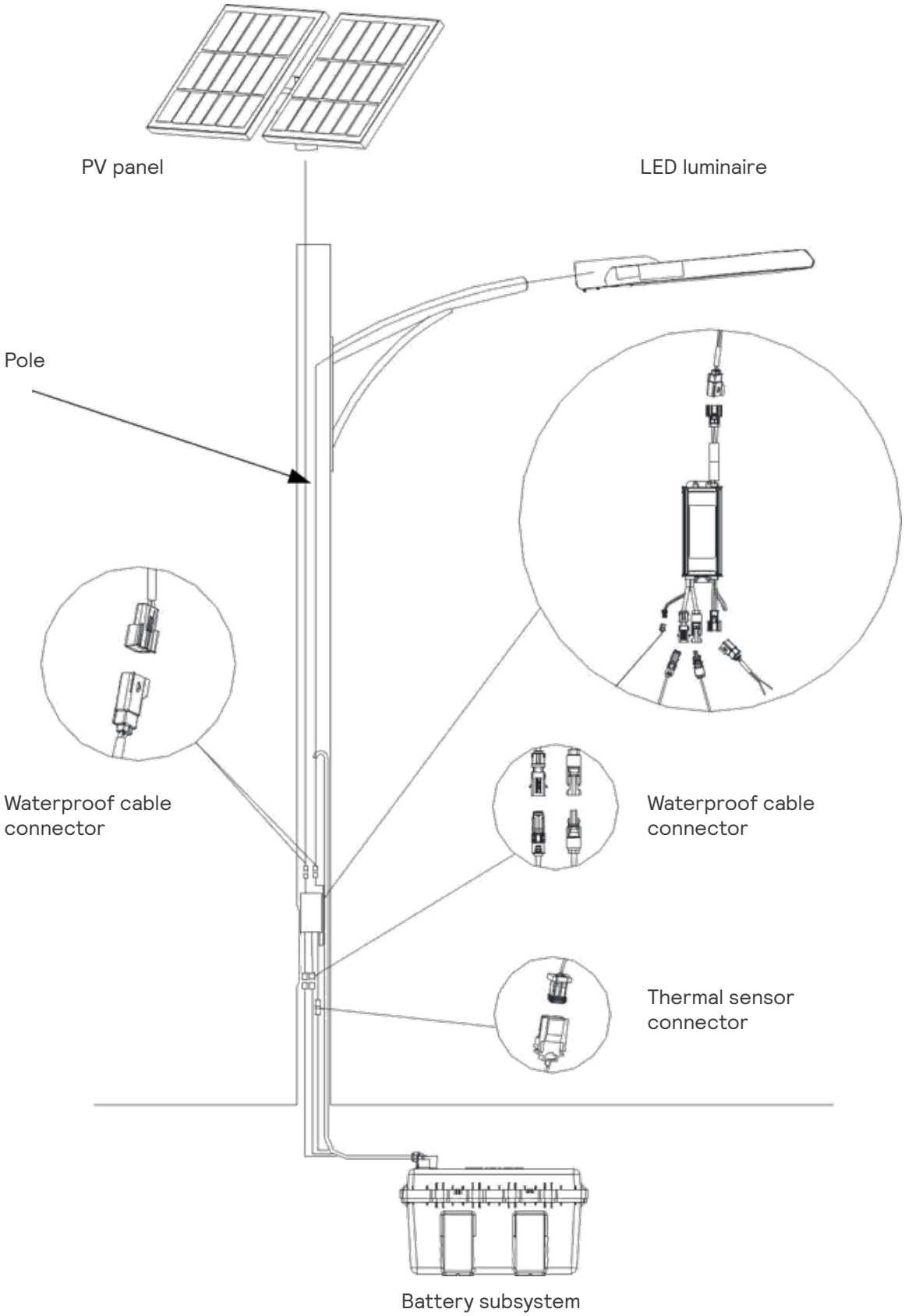
Please read the instruction manual carefully before taking any action to obtain the best results from your purchase.

Solar LED Lighting System Structure



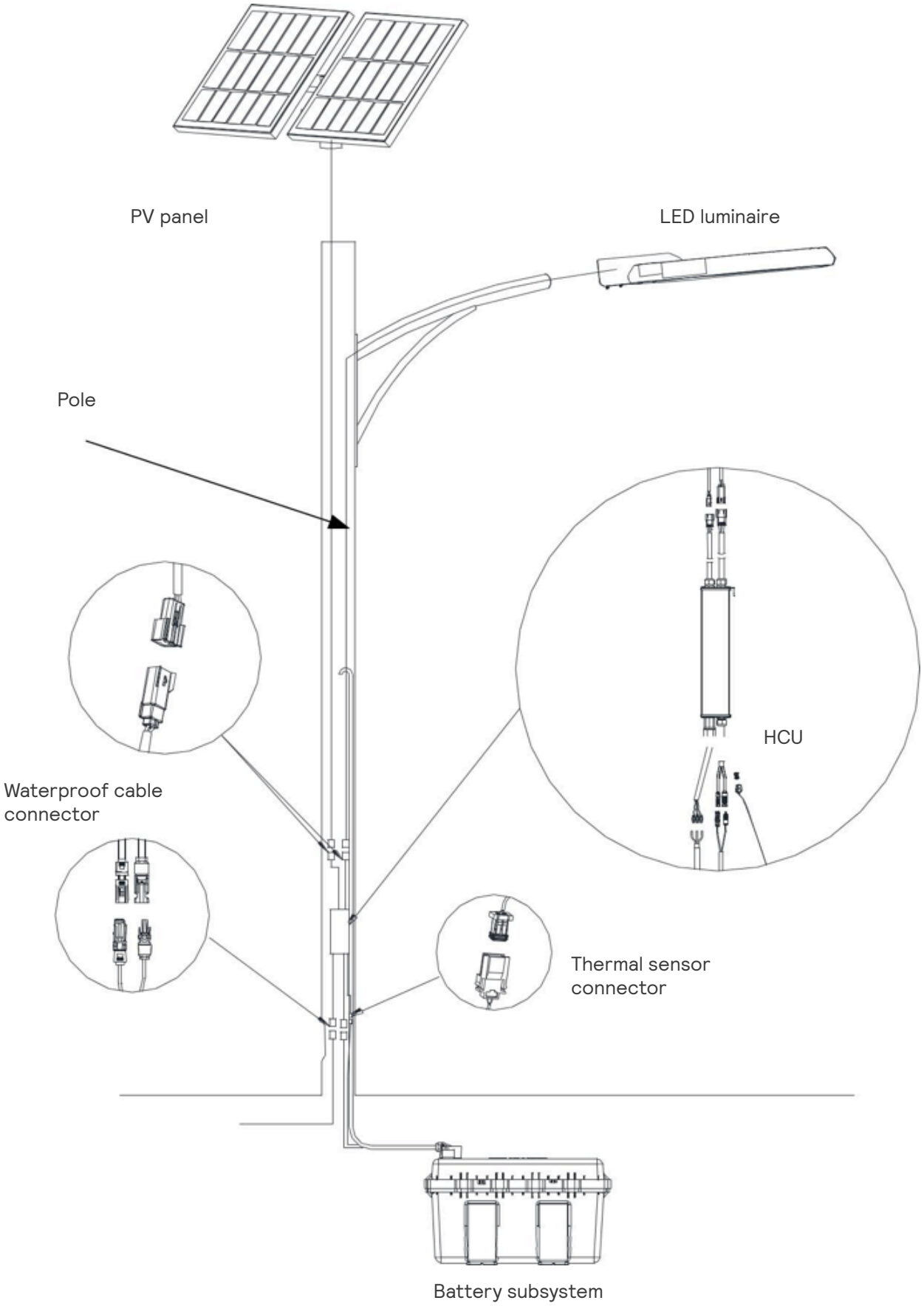
Solar LED Lighting System

Solar LED Lighting System Structure – Off-grid system



Solar LED Lighting System

Solar LED Lighting System Structure – On-grid system



Troubleshooting and Maintenance

I,Troubleshooting

Parts List	Cause	Technical Parameters
No charge current at daytime	Battery is full	From the battery cable, the tested battery voltage more than 13.5V for 12V system, or 27V for 24V system is normal status
	Panel cable wrong connection	Check the connection at the junction box at rear of the panel
	Disconnection between panels and controller	Check the connection from panels to controller for cable loosing or wrong polar connection.
	Disconnection between battery and controller	Check the connection from controller to luminaire for cable loosing or wrong polar connection.
No discharge current; No light at night	Disconnection between luminaire and controller	Check the connection from controller to luminaire for cable loosing or wrong polar connection.
	Disconnection between battery and controller	Check the connection from controller to luminaire for cable loosing or wrong polar connection.
	Battery voltage too low	Check the indicator of the controller, if the red indicator of the controller light up, it shows the over discharge protection has been activated. Then test the battery voltage, if it is more than 12.8V for 12Vsystem,or 25.6V for 24V system, the lamp will be light up during that night.
	Broken of the lamp (Discharge loop cannot work)	Connect the small size 12V/24V battery to the lamp system directly, testing if the lamp can be light up, otherwise lamp shall be replaced.
Abnormal Lighting	Panel is interfered by other light source	Check if there is other light source irradiate at panel system
	Failure of controller program	Use controller remote to refresh the controller program

Note

- The tools needed for site testing and troubleshooting are listed in ”A2”
- If encounter any abnormal situation or failure, please immediately contact Philips professional technician. Do not try to repair system by yourself to avoid any damage to the system and injure to people.

Troubleshooting and Maintenance

2 Maintenance

Panel

- Normally you don't need to clean the panel frequently. It depends on the local environment;
- In heavy dust areas, it is required to clean the solar module regularly with a damp towel to guarantee optimum performance of the solar panel.
- Do not use any type of solvent for cleaning and be careful not to put too much pressure on the module while cleaning.

Battery

- Battery normally does not need any maintenance within the warranty. If any abnormal symptom or special requirement, suggest following test can be taken:
- Check whether there is some loose connection;
- Check cleanliness of battery and damage signs of terminals ;
- Measure and record ambient temperature in battery chamber and case temperature on battery;
- Measure and record total voltage and float current of battery sub-system;
- Conduct a discharge test (10H) rate with actual load to check batteries.

Battery Storage

The battery should be stored in clean and dry environment.

Storage time: battery is ex-work in fully charged, storage time should be limited. For ensuring battery performance, do not exceed storage time as following definition:
Under 25'(, six months;

Under 30'(, three months;

Under 40'(, six weeks;

The battery supplemental charge method : charge battery with 14.2V/12V battery block for 8 to 12 hours at 20'(, and the charge voltage temperature compensation is -21mV /'(/12V battery block.

It is necessary to limit the current, and the optimum limiting value is within 0.2C20 (A).

Notice

Although the battery is recharged every 3 to 6 months, the battery's life time still will be impacted for long time storage.

Improper maintenance will shorten the battery service life or decrease the service performance.

Maintenance after the Warranty

It is suggested to conduct a battery capacity test (10h rate) after the warranty ends and later once a year.

Replacement

If the battery capacity is actually less than the rated capacity of 60%, it is required to be replaced with new one to comply with the designed system requirement.

Warning

The recycle of the used battery should strictly follow the local laws and regulations. It is forbidden to handle the battery as normal garbage for disposal;

- Do not open, short circuit, or mutilate batteries as injury may occur;
- Do not put the battery box into a pool;
- Never move battery box by pulling the cables of the battery;
- Note to handle the panel and battery box with great care during the installation and transportation;
- The installation is highly suggested during the day. The controller system need sun light input to activate for normal working status. Any system installed at night may not light up properly at first night. The system will work normally at second night;
- In case the dimming curve is set, the control system require 3 nights to bring system working at designed dimming;
- If the battery voltage is lower than 12.5V for 12V system, and 25V for 24V system, We suggest to recharge the battery before installation to ensure proper working.

Troubleshooting and Maintenance

Battery system replacement

Warning

Batteries can generate gases which, when released, can explode, causing blindness and other serious personal injury, also generate acid misting which can cause burns and other serious injuries. Always follow the generally accepted safety procedures for handling batteries. In addition, it is vitally important that you observe the precautions recommended in this manual.

YOU SHOULD BE **TRAINED** IN HANDLING, INSTALLING, OPERATING AND MAINTAINING BATTERIES BEFORE YOU WORK ON RRPLACE BATTERY SYSTEM.

You **MUST** understand the risk of working with batteries and BE PREPARED and EQUIPPED to take the necessary safety precautions. If not, contact Philips service.

- **ALWAYS** keep sparks, flames and smoking materials away from the battery
- **ALWAYS** wear protective clothing and use nonconductive or insulated tools when working with battery system.
- **Remove** all jewelry that could produce a short circuit.

In case of SKIN CONTACT with sulfuric acid misting, **IMMEDIATELY**

- **REMOVE** contaminated **CLOTHING**
- **FLUSH** the area THOROUGHLY with **WATER**
- Get **MEDICAL ATTENTION**, if required.

In case of EYE CONTACT with sulfuric acid misting, IMMEDIATELY

- **FLUSH THOROUGHLY** for at least 15 minutes with large amounts of WATER.
- Get **MEDICAL ATTENTION**, if required.

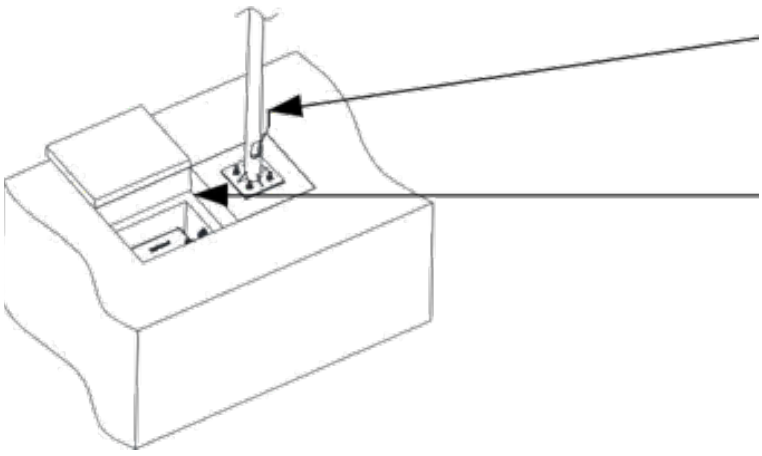
In case of **FIRE:** To extinguish a fire in a battery room containing lead acid batteries, use CO2, foam, or dry chemical extinguishing media. **Do NOT** discharge the extinguisher directly onto the battery. The resulting thermal shock may cause cracking of the battery case/ cover.

Important

Warning:

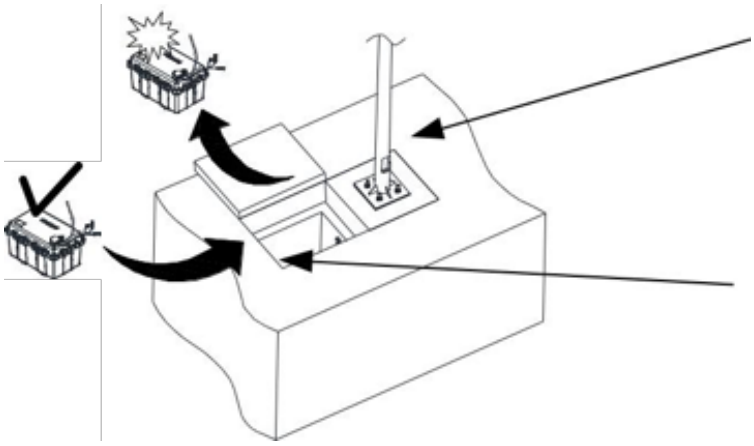
If you have ANY question concerning safety when working with the battery system, contact your local prduct sales/service representative to clarify any of the noted safety precautions, or, call the corporate office number listed on the back of this manual and ask for professional service.nce.

The battery presents a risk of electrical shock and a high short circuit current. The Philips mounting instructions must be strictly followed, otherwise potential application, reliability, or safety issues may arise. Contact your local Philips service if the instructions cannot meet special field conditions. Only a qualified Philips service representative who is knowledgeable in batteries and the required precautions is permitted to service the battery. Keep unauthorized personnel away from batteries.



3. Open the serve hatch (Figure -1) and pull the ventilation tube end out. Place the open tube end upwards to release the hydrogen.

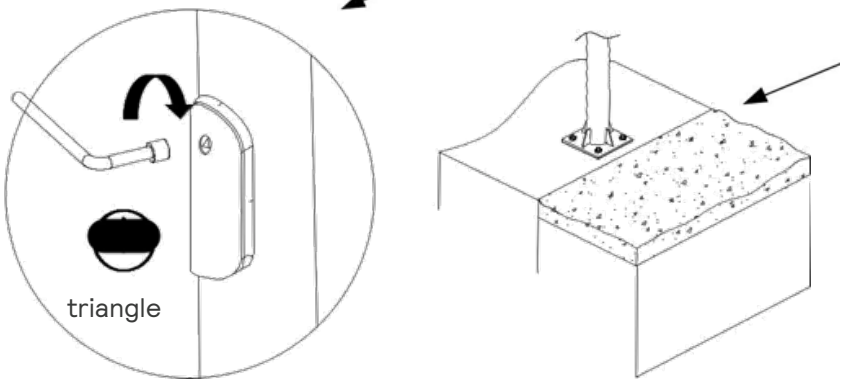
3. **WAIT 10 minutes** for the hydrogen to release.



6.Disconnect the PV panel and luminaire connectors on the controller **before any other disconnection** is made.
Disconnect the battery and thermal sensor connectors on the controller to power off the system
5. Pull out the battery cable and thermal sensor cables and vent tube.

6.Take out the old battery system and replace the new one.

2. Pull the new battery system cables and vent tube through the embedded duct into the pole



3. Connect all the cables,(First, connect battery , then connect the PV panel, luminaire and thermal sensor) and
put vent cable open end 500mm higher than controller. Then make the tube open end towards to the ground, and tie it to the PV panel cable for fixing.

3. Lock the service hatch and restore the ground to its original appearance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