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| **20kWp PHOTOVOLTAICS APPLICATION AND ELECTRIC CAR CHARGING STATION AT BITOLA** |

**TECHNICAL DESCRIPTIONS**

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**FEBRUARY 2020**

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**TECHNICAL DESCRIPTIONS**

# Introduction

This paper is the technical description issue of the study about 20kWp photovoltaics installation and charging station at the sports hall of Bitola. It is part of the project “Integration of Green Transport in Cities” with acronym “Green Inter-e-Mobility”.

It concerns all the tasks and interventions needed for the construction of the project and is inseparable from the rest of the papers delivered.

# Technical Description of the Project

## General Information

In order to charge the two electric cars given to the municipality of Bitola, there is the need to construct a proper charging station, as well as the need to install a grid connected photovoltaic (PV) system that produces electric energy.

The connection of the PV system will be according to the instructions of the new legislation that applies on the subject of the installation of photovoltaic units by self-generators in order to meet their own needs, by applying net-metering.

If the power demand of the charging station is greater than the energy production of the PV system, all the energy produced will be channeled through the Low Voltage General Board for consumption. If the demand for energy is lower, the photovoltaic system will fully cover the electricity consumption of the charging station and the surplus will be channeled to the public grid, having previously been recorded.

At the end of each year, offsets will be made between electricity absorbed by the Network and the electricity generated by the PV panels and assigned to the Network. The Municipality of Bitola will be required to pay the financial compensation for the difference in the energy absorbed by the network.

The PV system will follow the conventional design and construction rules. It will consist of PV array panels connected in series and/or parallel, PV frame mounts, inverters, DC and AC cabling, low voltage electrical boards, electrical energy meter and equipment for the control and protection of the equipment. Moreover, a charging regulator will be included in the system.

## Building Topology

The photovoltaic panels will be installed in the municipality of Bitola and specifically on the roof of the sports hall of the area.

A number of factors have been taken into account when designing the photovoltaic installation project, such as:

• Optimal generation of the PV system

• Optimal utilization of available space

• Reduce as much as possible any intervention required.

• Harmonious integration of the whole installation into the environment and as much as possible reduction of the environmental nuisance

• Compliance with relevant legislation

• Avoidance of factors that can cause station malfunctions, such as shading from trees or buildings.

In a location that has been chosen after consultation with the municipality, will be installed a DC-AC inverter to convert the alternating current (AC) to direct current (DC). The location chosen is the room of the Low Voltage Board of the installation.

The following image shows the location of the selected building.



Image 1 The sports hall of Bitola



Image 1 The sports hall of Bitola

## Installation Equipment

### Photovoltaic Panels

Photovoltaic panels should be all of the same manufacturer, of the same rated power, of the same electrical characteristics and of the same geometric dimensions.

They will be placed on the roof of the City Hall and the space they occupy will be approximately 114m2.

Photovoltaic panels (polycrystalline silicon technology) with 72 elements (cells) per panel will be installed on the available surface of the building's roof. Each panel will have a rated power of at least 330Wp in Standard Testing Conditions (STC), that is, solar radiation intensity 1000W / m², temperature 25 ° C, and air mass (AM) 1.5. In total, it is envisaged to install 57 photovoltaic panels with total power of 18810Wp, as shown in the calculations’ issue.

The PV modules will be connected in series (strings) and them the strings’ groups in parallel at the inputs of the power inverters.

The slope of the frames will follow the slope of the roof.

### PV Frame’s Mounts

The photovoltaic panels will be installed and mounted on suitable aluminum mounts, placed on the roof. The chosen building has an industrial type roof, so the appropriate bases will be selected. Each aluminum base will allow frames to be installed in portrait or landscape layout, for maximum coverage of the roof.

### Moving E/M Equipment

If there are materials on the roof of the building, at the spots where the PV mounting structures will be placed or at spots where they cause shading at the panels, they should be removed.

### Inverters

Given that the PV modules generate at their output direct current and voltage (DC), their connection to the Network requires the conversion of the above sizes into ACs. The conversion is done by the power inverters (PV Inverters).

The above-mentioned PV modules will be connected via special DC cabling with three-phase inverters of rated output power equal to 20kVA (AC).

The output of all types of inverters will be three-phase, voltage 400V (polar) and frequency 50Hz. When adjusting their operating values, for safety and protection, if the voltage drops below -20% of the rated or increases above + 15%, each inverter must turn off. The same will happen if the frequency changes ±0.5Hz on the nominal. The total harmonic distortion (THD) of the current of each inverter shall not exceed 5%. In addition, each inverter must be in accordance with DIN VDE 0126-1-1 for protection against islanding. Each inverter will also have certifications against emission or reception of electromagnetic interference, as required by the relevant European directives. All inverters will be IP 65 protected and will operate at temperatures between -25 ° C to + 60 ° C.

Installation of one (1) power inverter is foreseen.

The following figure shows the exterior view of the inverter and their wall installation method. The inverter should be mounted at a minimum height of 0.70m above the ground and it must be ensured that its ventilation requirements are met in each layout.

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| 10  Image 3 Power Inverter | 11  Image 4 Wall Mounted Inverter Installation |

At the inverter will terminate all the strings via positive and negative pole DC wiring. Terminating the DC wiring on the inverter will be implemented via MC4 connectors.

According to the calculations issue, the following will be taken into account for all power inverters:

A total of 57 PV modules will be installed corresponding to a rated power of 18810W.

The inverter will have built-in Class II surge protection devices and DC switch.

Finally, an FTP cat.6A cable will end up at the inverter for interconnecting, transferring, and recording data to a remote computer (SCADA).

### Electric Boards

The power inverter will end up to a local low voltage wall panel which will be located approximately 1,00m from it. The sub-board will be three-phase, rated voltage 400V and frequency 50Hz. Hereafter this sub-panel will be referred to as the General Low Voltage Photovoltaic Board (LVB-PV) and will be wall mounted in the room. Through a new supply cable, the LVB-PV will be connected to a new panel, called the New General Board.

All switchboards will be provided with 30% backup switch positions.

The boards will be resistant to sunlight, and their door will be opened and closed only by locking components of the manufacturer.

The boards will be equipped with a set of four brackets for wall mounting.

### Cabling

#### DC Cabling

The DC side of wiring will be connecting the PV modules with the inverters. The frames that belong to the same string will be connected to each other by the factory pre-installed 1.00m long cables. The positive pole of the first (or last) panel and the negative pole of the last (or the first) panel will be connected with the inverter by power cables with specifications for:

• Continuous exposure to solar radiation (external neoprene or polychloroprene insulation),

• Resistance to maximum system voltage (1000V),

• Resistance to high ambient temperatures (90 ° C).

These cables will be connected to the PV module pre-installed cables and to the inverter via special MC-4 connectors. The figure below shows the form of female and male MC-4.

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| 12  Image 5 MC-4 Connectors |

The general DC routing path will be on perforated metal racks 50x60mm. The racks will be mounted with special "Π" type supports and at least 10cm away. Individual DC wiring paths from each string to the metal rack will be embedded in a Ø16mm cross-section flexible plastic tube with resistance to direct sunlight. The pipe support will be made from the aluminum purlins of the mounting brackets (below the panels).

All DC wirings should have a permanent marking on both ends (start and end) of the thermoplastic material, that will be bearing a printed (and / or engraved) string number to which it belongs and the type of pole it supplies e.g. A1.1 + or B2.2-. At the same time, the external insulation of DC cables should be red for the connection of each positive pole and black for the connection of each negative pole.

General routing instruction: Avoid - as far as possible - the parallel routing of positive and negative pole of the same string for safety reasons (see figure below).

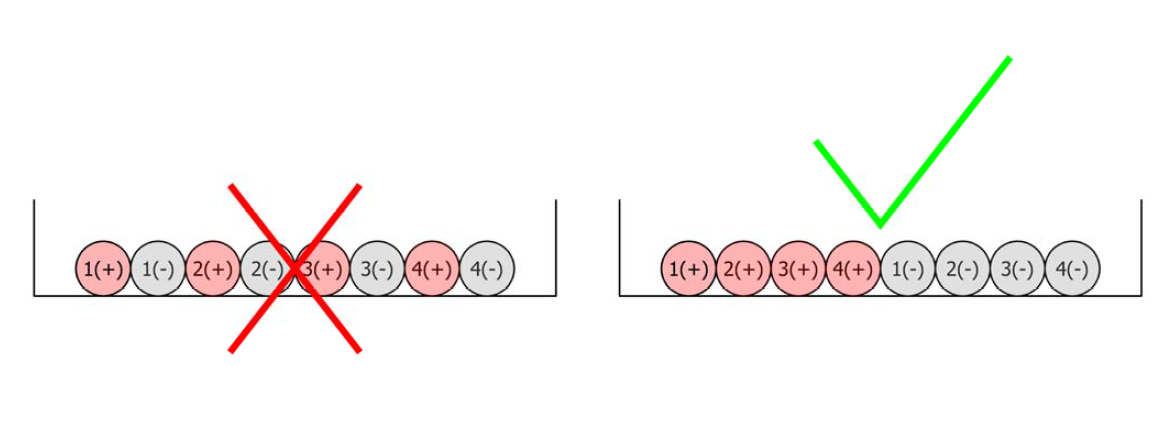


Image 6 Parallel wiring arrangement inside the grate of multiple strings

#### AC cabling

The AC cabling will include the connection cable between the three-phase inverter and the board LVB-PV, the LVB-PV with the New General Low Voltage Board and also the cables between the LVB and the charger.

The cables will be flexible with ethylpropylene (G7 type) insulation, multipolar. As AC cabling will mostly be on the roof, they will be exposed to sunlight, inside metal grates and will operate during the summer (high ambient temperature). Therefore, the chosen specification is operation up to 90 ° C. The cable type will be FG7OR. The exact number of cable poles is determined by the maximum current and the nominal cross-section of the cable. Specifically, cables with cross-section of up to 25mm² will be five-polar (3ph / N / PE), while those with larger cross-sections will be quadrupole for phases and neutral (3ph / N) and independent monopole for protective earth conductor (PE).

The AC cables should be suitable for operating voltages of 600V (phase) and 1000V (polar) at a minimum. Neutral (N) and protective (PE) conductors should be painted in accordance with European legislation. Yellow-green insulation wiring should be used exclusively for PE.

### Circuit Cable Routes

All electrical cables shall be routed through metal grates and flexible plastic electrical hoses, as appropriate.

Bulk routing of AC / DC cables will be carried out through heavy-duty perforated grates with a lid. These grates will go:

• On special supporting mounts

• On the wall on vertical outdoor paths

The dimensions of the roof grate will be 50x60mm.

All metal grates will have a lid and must be connected to the grounding system.

In cases of single cable routing before entering the metal rack, the cables will route to flexible heavy-duty hoses Ø16mm or Ø63mm, that will have a specification for solar radiation resistance.

### Supply Protection

The protection of the inverter will be carried out by Miniature Circuit Breaker (MCB) with characteristic type B operating curve. The sub-board LVB-PV supply cable will be protected by MCB type B.

### Grounding System

All AC circuits (inverter, sub-board LVB-PV) will be connected to the grounding system via a suitable protective earth (PE) conductor.

### Electrical Connection Configuration

The application of net-metering requires the installation of two bi-directional metering devices, bridged on the side of the generator, to record the sizes of absorbed (A), injected (E) and total PV produced energy (Π). Absorbed (A) energy is defined as the energy supplied by the Network to the station's consumption. Injected (E) is the energy supplied by the PV system to the Network (in the rare to impossible case where the PV system will generate a greater amount of electrical power than the demand). Produced energy is defined as the total energy produced by the PV system. Therefore, to measure or calculate the above sizes, two electricity meters are required.

Consequently, the metering scheme can take the following form, by installing two measuring devices,

That must be bridged at the side of the producer:

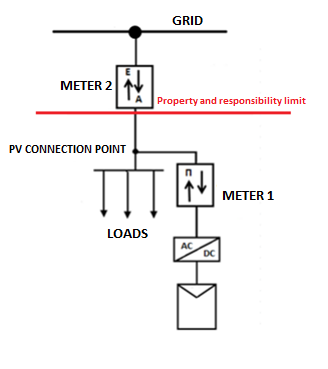


Image 7 PV system connection method

### PV Energy Production Counter (Counter 1)

Counter 1 will be installed on the LVB-PV board. It will be able to access telemetry with a GSM card

The selection of the counter made by the Contractor shall be according to the laws and legislations.

The image below shows the existing counter of the facility, which is located in a room inside the sports hall, in the area of the Low Voltage Board.



Image 2 The existing counter of the installation

### Monitoring System

The PV system should have a built-in system for recording, registering, storing and remotely monitoring (internet) all energy, electrical quantities as well as the history of warnings and failures of the installation.

The PV system should have a built-in system for recording, registering, storing and remotely monitoring through internet all energy, electrical quantities as well as the history of warnings and failures of the installation.

Data should be accessed by all kinds of telecommunications devices (e.g. computers, tablets, mobile phones) and all kinds of software (Windows, MacOS, iOS, Android).

In order to implement the surveillance system, the inverter will be connected via RJ45 port and four twisted-pair FTP cable, class 6 (EIA / TIA 568 - 1000Mbps) to a local area network multiplexer (Switch). From this switch will depart a new cable of four twisted pair FTP class 6 (EIA / TIA 568 - 1000Mbps) which will terminate at the nearest telecommunication rack of the building

In order to implement the surveillance system, the inverter will be connected via RJ45 port and four twisted pairs of FTP cable 6 (EIA / TIA 568 - 1000Mbps) to a local network multiplexer (Switch). From this switch will depart a new cable of four twisted pairs, FTP class 6 (EIA / TIA 568 - 1000Mbps) which will terminate at the nearest telecommunication rack of the building.

The logging system should provide excel files and graphs of at least three years for the following sizes:

• Instantaneous power, voltage, current of all AC and string (DC) phases for each inverter

• Day, Month and Year energy production for each inverter,

• Day, Month and year energy production for all inverters

• history of reports,

• History of faults and alarms,

• Send alerts (via email, sms) of malfunction / alert statuses to authorized users,

An energy analyzer will also be placed on the front of the LVB-PV board.

### Network Multiplexer

The management of the inverter information requires the provision of an Ethernet network with transmission speed of 100Mbps (minimum). For this reason, it is foreseen to install a modular IE switch, which will be mounted on a rail inside the sub-board.

The switch will be powered by an **independent single-phase power supply** from the nearest board.

The following figure shows the indicative form of the switch.



Image 9 Indicative industrial switch

## Other Installations

### Charging Station

A charging station will be installed, that will allow two cars to be charged simultaneously. The installation will be made according to the applicable laws and legislation.

The charger will receive power from the LVB of the installation.

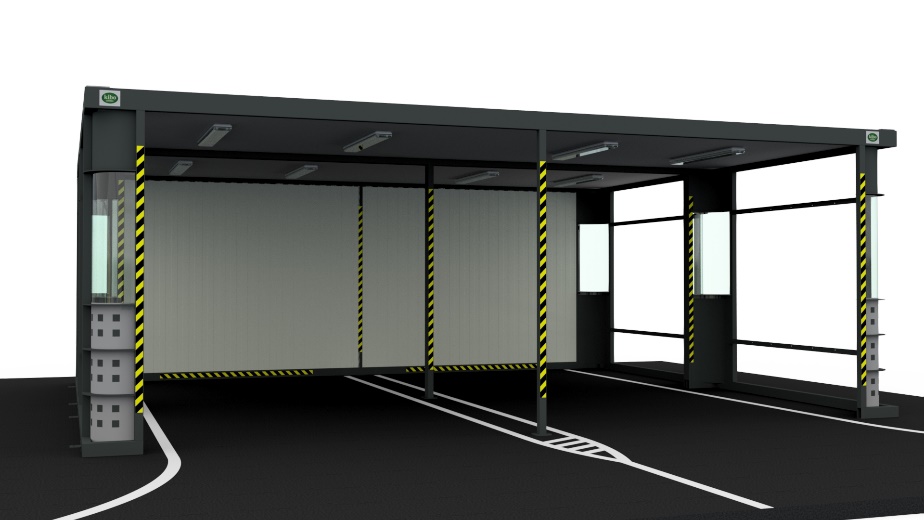
The charging station is planned to be installed outside the sports hall. Its indicative position is shown below.

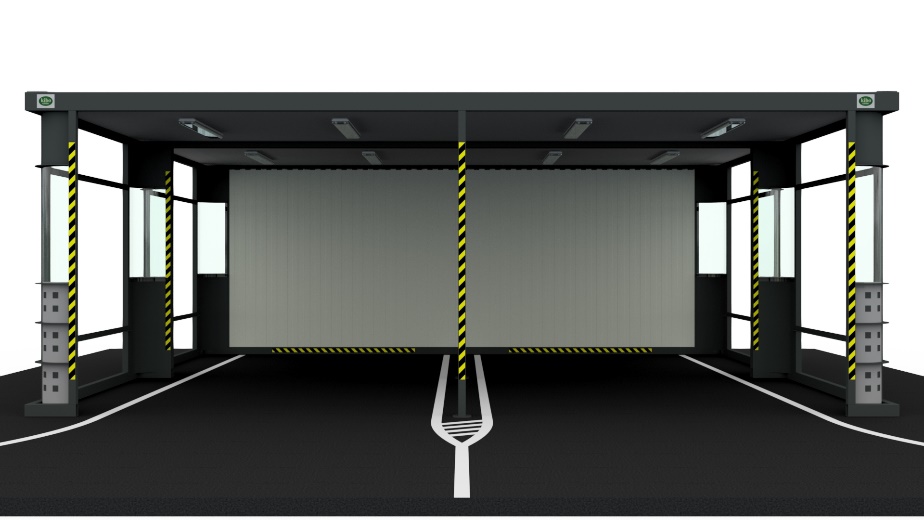


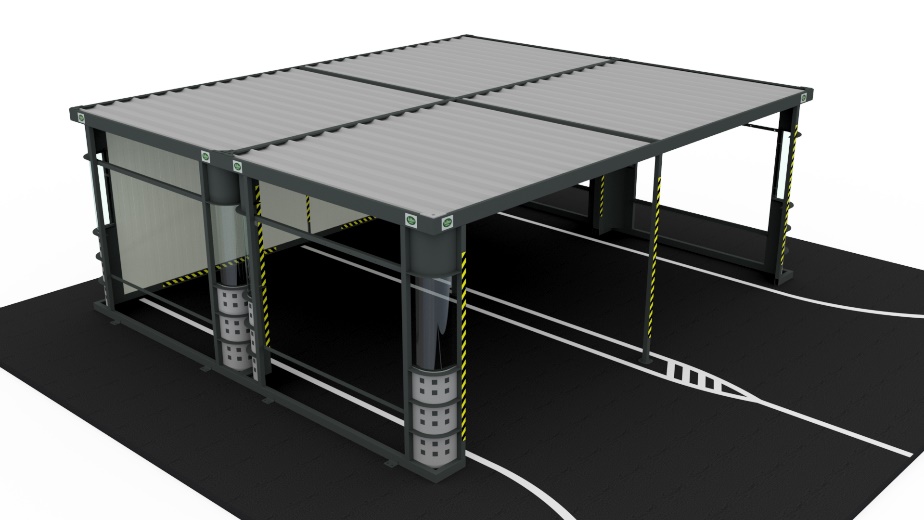
Image 3 The position of the charger

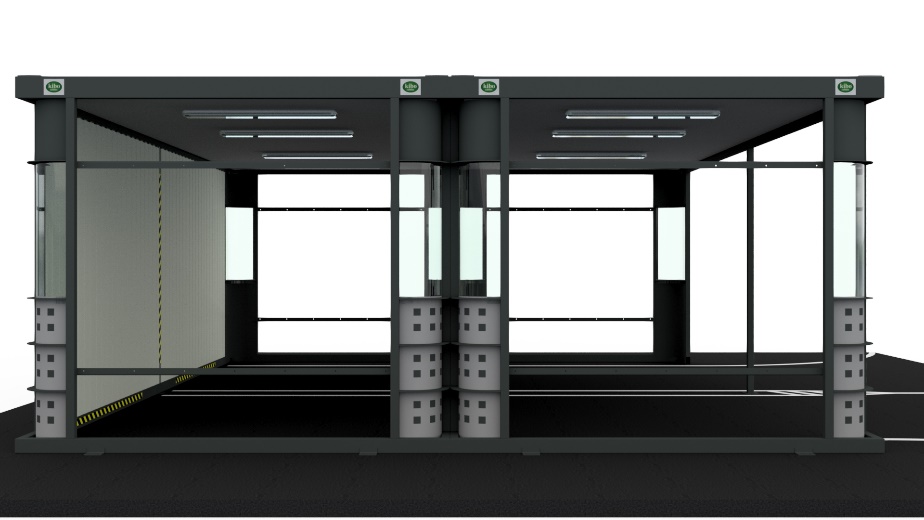
A kiosk will be placed at the area of the City hall, in order for the cars to park and be charged.

An indicative cars’ pavilion (kiosk) is shown below:











## Obligations of the participants (excluding penalties)

### Implementation Study

When submitting their technical offer, economic operators must submit a study of the implementation of the final proposed solution in accordance with the terms of the technical description, the calculations and the specifications. The study will include the parking kiosk, the photovoltaic power station, the electrical interconnection with the system, the modification of the internal electrical installation and the installation and connection of the charger for the two electric vehicles.

### Knowledge of the Specific Conditions of the Installation

Tenderers should be aware of the specific conditions of the facility and will therefore visit the Bitola Sports Hall to clarify all the technical details. At the time of the visit they must obtain a written confirmation from the technical service of the municipality.

### Project Team

Tenderers are required to submit the project team data as well as the relevant organization chart of the economic operator.

### Time Schedule

Tenderers are required to submit a detailed timetable with item deliveries and execution of works.

### Power Supply Increase

Tenderers must take the necessary steps to increase the power supply of the building, if necessary, for the proper operation of other electrical loads.

## Indicative Single-line Diagram of the Installation

