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Green Inter-e-Mobility

20kWp PHOTOVOLTAICS APPLICATION AND ELECTRIC CAR CHARGING STATION AT RESEN

TECHNICAL DESCRIPTIONS

FEBRUARY 2020

Programme co-funded by the European Union and national funds of the participating countries

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TECHNICAL DESCRIPTIONS

1 Introduction

This paper is the technical description issue of the study about 20kWp photovoltaics installation and charging station at the City Hall of Resen. 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.

2 Technical Description of the Project

2.1 General Information

In order to charge the two electric cars given to the municipality of Resen, 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 Resen 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, inverter, 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.

2.2 Building Topology

The photovoltaic panels will be installed in the municipality of Resen and specifically on the roof of the City Hall.

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 chosen after consultation with the municipality, will be installed DC-AC inverters to convert the alternating current (AC) to direct current (DC) and, also, sub-boards from which the outgoing cables will depart.

The following image shows the location of the selected building.

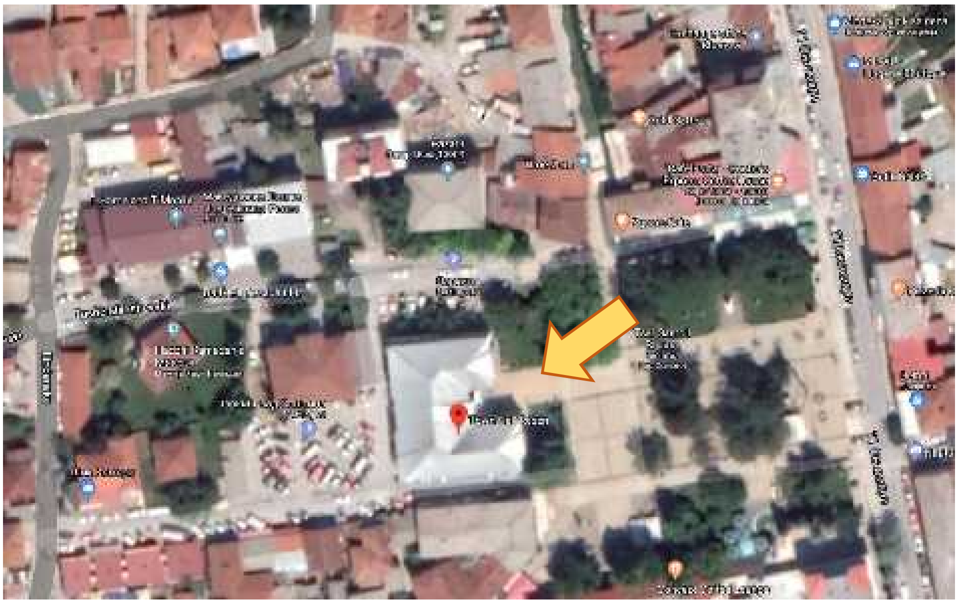

Image 1 The municipality of Resen

Image 2 The municipality of Resen

Image 3 The municipality of Resen

2.3 Installation Equipment

2.3.1 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 114m^2.

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 / m^2, 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.

2.3.2 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.

2.3.3 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.

2.3.4 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.

Image 4 Power Inverter

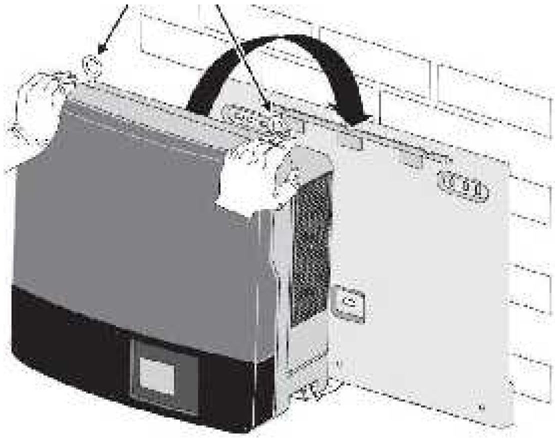

Image 5 Wall Mounted Inverter Installation

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:

$10\ p \leq n_s < 19\ p$

$N_p \leq 3\ s$

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).

2.3.5 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.

2.3.6 Cabling

2.3.6.1 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.

Image 6 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).

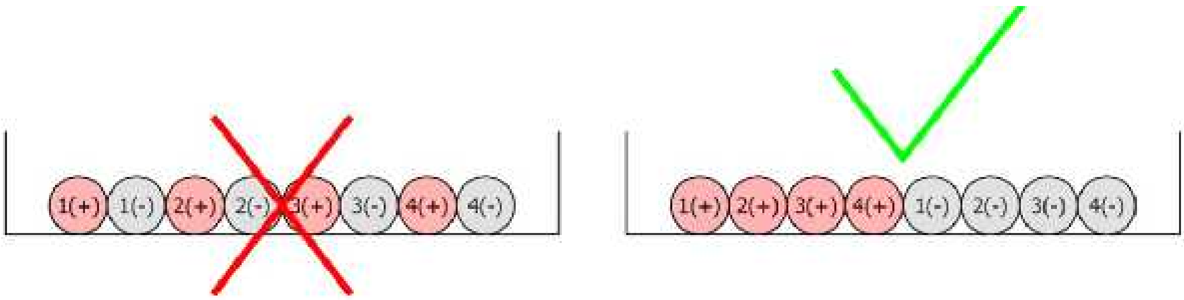

Image 7 Parallel wiring arrangement inside the grate of multiple strings

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2.3.6.2 AC cabling

The AC cabling will include the connection cable between the three-phase inverter and the LVB-PV, the LVB-PV and the New Low Voltage Board, the New Board with the existing LVB, as well as the charger with the LVB.

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 25mm^2 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.

2.3.7 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.

2.3.8 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.

2.3.9 Grounding System

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

2.3.10 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:

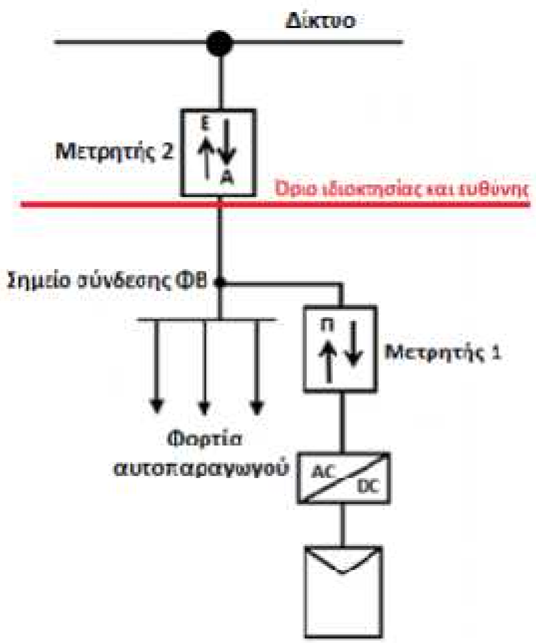

Image 8 PV system connection method

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2.3.11 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.

2.3.12 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.

2.3.13 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 form of switch

2.4 Other Installations

2.4.1 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 location of the charging station will be in the parking lot of the City Hall and is shown below.

Image 10 The area of the charging station

2.5 Obligations of the participants (excluding penalties)

2.5.1 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 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.

2.5.2 Knowledge of the Specific Conditions of the Installation

Tenderers should be aware of the specific conditions of the facility and will therefore visit the municipality of Resen 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.

2.5.3 Project Team

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

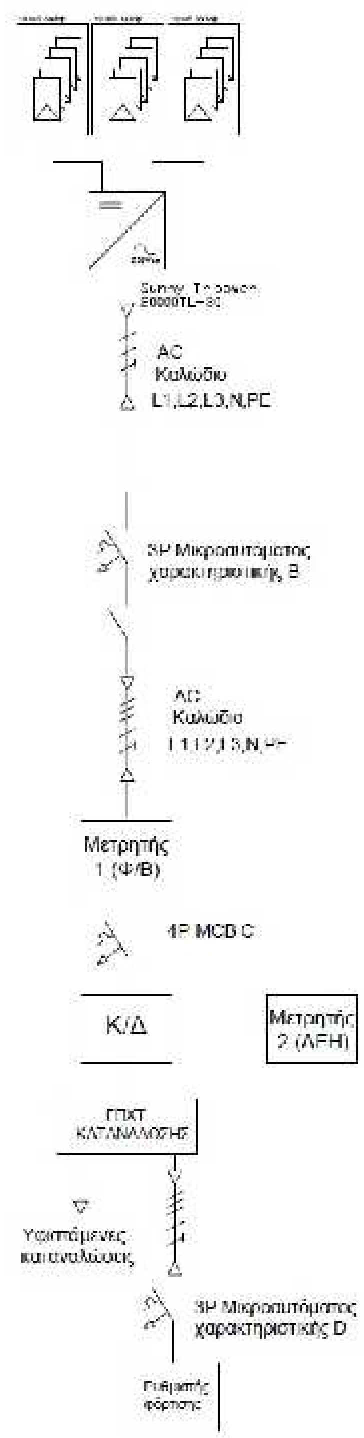
2.5.4 Time Schedule

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

2.5.5 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.

2.6 Indicative Single-line Diagram of the Installation



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20kWp PHOTOVOLTAICS APPLICATION AND ELECTRIC CAR CHARGING STATION AT RESEN

CALCULATIONS

FEBRUARY 2020

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CALCULATIONS

1 Introduction

This paper is the computational part for the study of the application of photovoltaic (PV) systems of 20 kWp and electric car charging station.

The calculations concern both the energy (power generation) and the electromechanical part (cables, boards, high current switching) of the Renewable Energy facility and the charging station.

The power generation was obtained using the tmy PVGIS database (https://ec.europa.eu/jrc/en/pvgis) and took into account the location of the installation, the type of the PV panels, the type of the inverters, the slope and the orientation, potential shading caused by nearby buildings and the losses of the cables.

In the E / M section the necessary cross sections and the voltage drop of the AC wiring were calculated, the switches were dimensioned and their selective protection was checked.

2 Strong Current Installation Calculations

2.1 General

This study refers to the electrical installations of the above project.

2.2 Regulations

The electrical installations were planned in accordance with the applying regulations.

2.3 Technical aids

In order to draft the study the following technical aids were used:

- Planning and Installing Photovoltaic Systems: A Guide for Installers, Architects and Engineers, German Solar Energy Society (DGS).
- P. Dokopoulos "Internal Electrical Installations".
- Siemens, "Electrical Installations Handbook", Wiley, 3rd Edition 2000.

2.4 Energy Calculation Parameters

2.4.1 Climatic Data

The climate data of the region as obtained from the tmy PVGIS database (https://re.jrc.ec.europa.eu/pvgis/) were used to calculate the energy consumption of the PV System.

The chart below shows the annual temperature in Resen. Its average value is 12.33˚C.

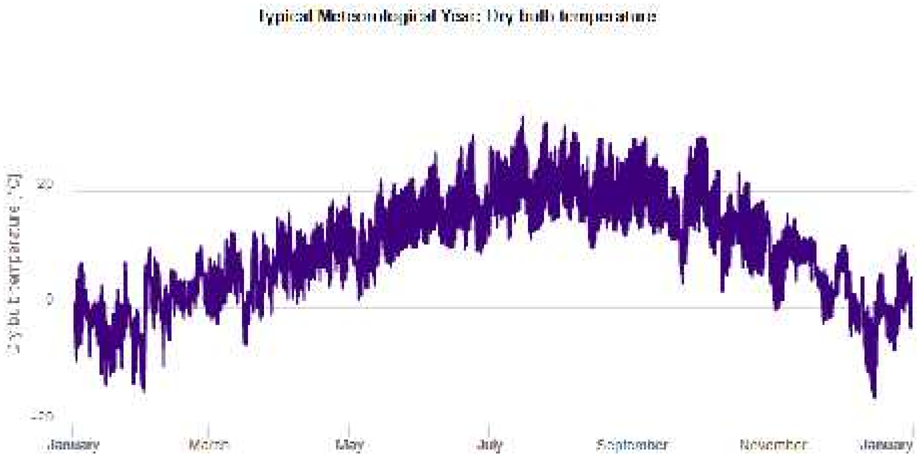

Image 2.1 Annual Temperature at Resen

The figures below show the annual global horizontal radiation and the diffuse horizontal radiation.

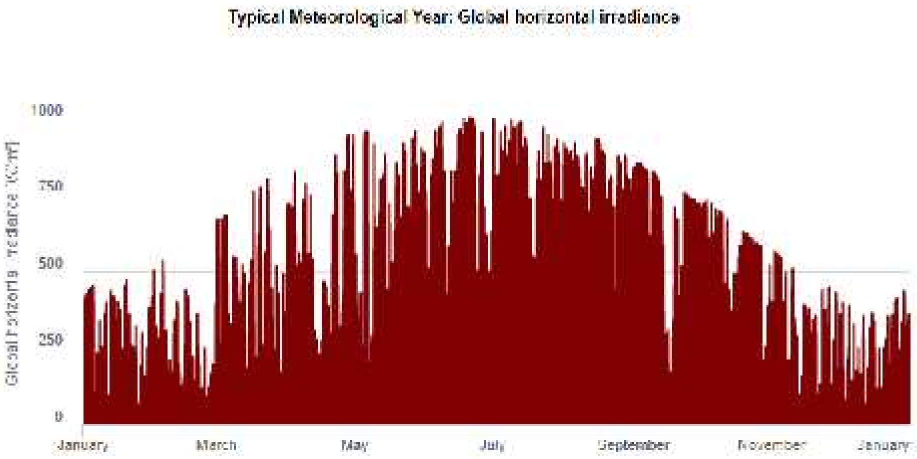

Image 2.2 Annual Global Horizontal Irradiance at Resen

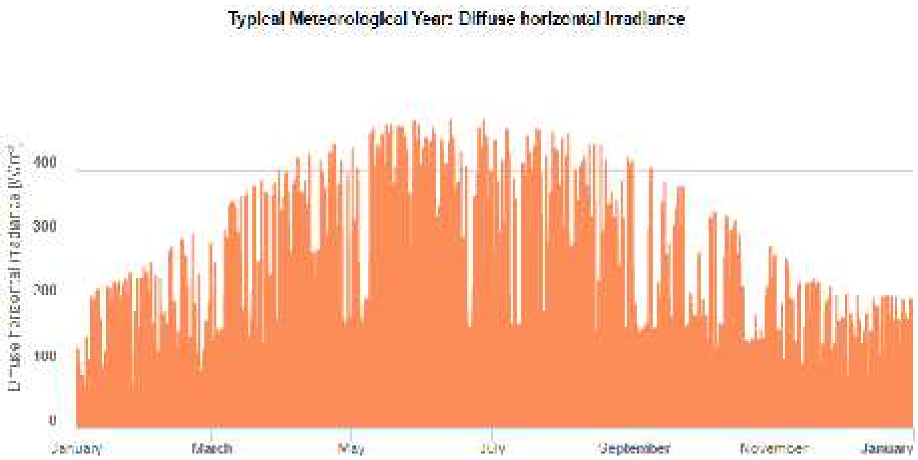

Image 2.3 Annual Diffuse Horizontal Irradiance at Resen

2.4.2 Electrical Energy Consumption

The initial design of the PV system was made on the assumption that each car (Nissan Leaf and Nissan e-NV200 EVALIA) would be fully charged once a day. The battery capacity of each vehicle is 40kWh. Therefore, the annual energy demand is 14600kWh for each vehicle and 29200kWh in total. According to the tmy PVGIS database, having frame slope of 25˚ and azimuth 45˚, the annual output will reach 25636.28 kWh. Therefore it is assumed that there will be 320 charges per year for each car.

2.5 Basic Calculation Rules

2.5.1 Number of Strings per Inverter

2.5.1.1 Temperature Parameters

The number of in-line and parallel frames in each inverter is determined by the inverter's maximum input voltage, the inverter's maximum input current, and the minimum possible detection voltage of the Maximum Power Point. As the electrical characteristics of the frames vary according to the climatic conditions (temperature, radiation) their extreme values are set for operating temperatures between -10 ° C and 70 ° C.

2.5.1.2 Correlation of the inverter voltage and the PV panels' voltage

The maximum permissible input voltage of the inverter selected for this study is $V_{maxinverter}$ = 1000V. Correspondingly, the detection range of the inverter maximum power point is between $V_{inverter\text{-}mpp}$ = 320-800Volt. The open circuit voltage (V_{oc}) of PV modules at -10 ° C (worst inverter temperature at winter) will be:

$$V_{o\,(-1^{\circ}\,C)} = V_{o\,(S\quad)} \cdot \left(1 + (-10-25)\cdot \Delta \;/_{100}\right) = V_{o\,(S\quad)} \cdot (1 - 35 \cdot \Delta \;/_{100})$$

$$V_{o\,(-1^{\circ}\,C)} = 46{,}29 \cdot (1 - 35 \cdot (-0{,}30)/100) = 46{,}29 \cdot 1{,}105 = 51{,}15\,V$$

The open circuit voltage of the panels at -10 ° C will be 51.15V.

The voltage at the MPP (maximum power point) of the PV panels at 70 ° C will be equal to:

$$V_{M\quad(7^{\circ}\,C)} = V_{M\quad(S\quad)} \cdot \left(1 + (70-25)\cdot \Delta \;/_{100}\right) = V_{M\quad(S\quad)} \cdot (1 + 45 \cdot \Delta \;/_{100})$$

$$V_{M\quad(7^{\circ}\,C)} = 37{,}66 \cdot (1 + 45 \cdot (-0{,}30)/100) = 37{,}66 \cdot 0{,}865 = 32{,}58\,V$$

The voltage at the MPP (maximum power point) of the PV panels at 70°C will be 32,58V.

Therefore, the maximum number of PV panels allowed to be connected in series to the inverter shall be:

$$n_{m\quad se} = \frac{V_{m\quad in}}{V_{o\,(-1^{\circ}\,C)}} = \frac{1000V}{51{,}15V} = 19{,}55 \cong 19 \text{ PV PANELS}$$

The minimum number of PV panels allowed to be connected in series to the inverter shall be:

$$n_{m \quad se \quad \_2 \quad T} = \frac{V_{m \quad in \quad -m}}{V_{M \quad (7° \; C)}} = \frac{3 \quad V}{3 \;,5 \; V} = 9{,}82 \cong 10 \text{ PV PANELS}$$

2.5.1.3 Correlation of the inverter current and the PV panels' current

The maximum current the inverter can receive at each input is equal to 33A. Given that the PV modules can develop the maximum current at high temperatures and at error state (short circuit current I_{sc}) the design should be such that the inverter operation is not compromised. Thus the true current of the frames in the worst case (Short circuit error in summer) will be equal to:

$$I_{S \; (7° \; C)} = I_{S \; (S \quad)} \cdot \left(1 + (70 - 25) \cdot {}^{\Delta}/_{100}\right) = I_{S \; (S \quad)} \cdot \left(1 + 45 \cdot {}^{\Delta}/_{100}\right)$$

$$I_{S \; (7° \; C)} = 9{,}27 \cdot (1 + 45 \cdot (+0{,}05)/100) = 9{,}27 \cdot 1{,}0225 = 9{,}48 \text{ Ampere}$$

Therefore, the maximum number of parallel PV strings for the inverter is:

For inverter input A:

$$N_{m \quad pa} = \frac{I_{m \quad in}}{I_{S \; (7° \; C)}} = \frac{33A}{9{,}48A} = 3{,}48 \cong 3 \; P \qquad S$$

For inverter input B:

$$N_{m \quad pa} = \frac{I_{m \quad in}}{I_{S \; (7° \; C)}} = \frac{33A}{9{,}48A} = 3{,}48 \cong 3 \; P \qquad S$$

2.5.1.4 Electrical Installation Connection

According to the analysis above the electrical connection of all PV modules should verify the mathematical inequalities:

$$10 \; p \quad \leq n_S \quad < 19 \; p$$

$$N_p \quad \leq 3 \; s$$

All circuit calculations were made taking into account the following:

2.5.2 Pipelines - Routes

2.5.2.1 Calculations of the Dimensions of metal rails

The ducts and cables as referred to in the technical specification are routed within metal galvanized cable grates. The dimensions of the grate are selected based on the number and diameter of the cables that will be installed. According to the diameter of the cables, the dimensions are chosen as follows:

$$D = 1.3 \cdot (100 + a) \cdot \frac{S}{100}$$

$$S = \sum_i \frac{\pi \cdot d_i^2}{4}$$

where:

D: the area of the required grate

α: the percentage (%) as a provision for empty space on the grate

S: the sum of the area of all cables

di: the diameter of each cable

The side height (H) and width (B) of the grate are calculated by the equation: B x H ≥ D

It should be noted that for these grates the provision for vacant space was 30% to ensure adequate ventilation of the cables and to cover future installation needs.

2.5.2.2 Cables

To reduce losses in DC circuits between inverters and PV panels, a fixed cross section of H1Z2Z2-K wiring equal to 6.0mm² was obtained to ensure voltage drop and energy loss below 1%. The table below summarizes the results for the various strings.

Table 1 DC Losses

String Operating Voltage	String Operating Current	Number of Strings	Average Current per String	Average Wiring Length (Single Run)	Voltage Drop	Energy Losses
Vmpp (Volt)	Impp (A)	n	Impp (A)	L (m)	(%)	(%)
437	147	16	9,19	55,00	0,72	0,67

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466	28	3	9,33	55,00	0,68	0,69
437	110	12	9,17	55,00	0,72	0,67
525	73	8	9,13	55,00	0,60	0,66
583	110	12	9,17	55,00	0,54	0,67

The AC cables are FG7OR-type ethylpropylene insulated flexible copper ducts for better resistance to high temperatures. The cross-section of the cables depends on the rated current flowing through them and on the total length.

The calculations were carried out with ambient temperature at 45 ° C and maximum permissible voltage drop of 1.2%.

The following parameters are taken into account when selecting the cross section:

The maximum continuous permissible current for off-ground cables shall be equal to:

$$I = I_0 \cdot f_\theta \cdot f_n$$

Io: is the reference current that flows continuously across the conductors, i.e. the charge coefficient is m = 1, given in Table A (1,2) below and applies to the following scenario

- ambient temperature 30 ° C
- PVC insulation
- single-phase or three-phase system

f_θ: Temperature dependent factor, given at Table B.

f_n: Factor dependent on the number of adjacent circuits, given at Table C

The following table A(1,2) gives the value Io, that is the maximum continuous current (in Ampere) of a low voltage cable installed on the ground. The cable insulation is made of PVC, the conductor from copper and the current is 50Hz frequency.

Table A.1: Cable charge limits for 1-phase or 3-phase systems inside or on walls

Cable Cross section (mm²)	Insulation		
	PVC		
	For XLPE or EPR insulation the values are multiplied by 1.19		
	Three-pole cable in tube in insulated wall	System of 3 insulated cables in tube or three-pole cable in insulated wall	Three-pole cable in tube on or in building materials
1,5	13	13,5	14,5
2,5	17,5	18	19,5
4	23	24	26
6	29	31	34
10	39	42	46
16	52	56	61
25	68	73	80
35	83	89	99
50	99	108	118
70	125	136	149
95	150	164	179
120	172	188	206
150	196	216	240
185	223	245	273
240	261	286	321
300	298	328	367

Table A.2: Charging limits for multipolar and single polar low voltage cables

Cable Cross section (mm²)	Insulation
	PVC
	For XLPE or EPR insulation the values are multiplied by 1.19

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	Multipolar cables		**Single polar cables**		
	3 ducts	2 ducts	In contact	< 0,3d	> 0,3d
1,5	18,5	22	-	-	-
2,5	25	30	-	-	-
4	34	40	-	-	-
6	43	51	-	-	-
10	60	70	-	-	-
16	80	94	-	-	-
25	101	119	110	130	141
35	126	148	137	162	176
50	153	180	167	196	216
70	196	232	216	251	279
95	238	282	264	304	341
120	276	328	308	352	396
150	319	379	356	406	456
185	364	434	409	463	521
240	430	514	485	546	615
300	497	593	561	629	709

Table B: Correction factor f_θ for ambient temperature other than 30 ° C.

Ground temperature (°C)	Insulation	
	PVC	**EPR or XLPE**
10	1,22	1,15
15	1,17	1,12
20	1,12	1,08
25	1,06	1,04
35	0,94	0,96
40	0,87	0,91
45	0,79	0,87
50	0,71	0,82
55	0,61	0,76
60	0,50	0,71
65	-	0,65
70	-	0,58
75	-	0,50

Table C: Correction factor fn for grouping more than one circuit or more than one multipolar cables in contact or short distance between them.

Number of Circuits	Free in the air or on the surface of construction material or on wall bare in a pipe or in a wall bare or in pipe	In a simple layer, in contact with wall or floor or on a solid cable carrier	In a simple layer mounted directly under the roof
1	**1,00**	**1,00**	**0,95**
2	**0,80**	**0,85**	**0,81**
3	**0,70**	**0,79**	**0,72**
4	**0,65**	**0,75**	**0,68**
5	**0,60**	**0,73**	**0,66**
6	**0,57**	**0,72**	**0,64**

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7	**0,54**	**0,71**	**0,63**
8	**0,52**	**0,70**	**0,62**
9	**0,50**	**0,70**	**0,61**
12	**0,45**	**0,70**	**0,61**
16	**0,41**	**0,70**	**0,61**
20	**0,38**	**0,70**	**0,61**

2.5.3 Voltage Drop

2.5.3.1 Voltage drop calculation on a simple line with a load and a supply

The voltage drop ΔU is usually calculated at the rated voltage based on the resistor R' and the reactance X' per length unit, the power Π and the power factor cosϕ.

For single-phase circuit is (U = phase voltage):

$$\frac{\Delta U}{U} = \frac{2 \cdot l \cdot \Psi' \cdot P}{U^2} = 2 \cdot l \cdot \Psi' \cdot I \cdot \frac{\cos\varphi}{U}$$

For three-phase circuit is (U = polar voltage):

$$\frac{\Delta U}{U} = \frac{l \cdot \Psi' \cdot P}{U^2} = \sqrt{3} \cdot l \cdot \Psi' \cdot I \cdot \frac{\cos\varphi}{U}$$

Ψ' is the equivalent resistance per unit of length, which is a function of the line and angle ϕ of the power factor. The following apply:

$$\Psi' = R' + X' \cdot \tan\varphi$$

$$R' = \frac{1}{\kappa \cdot A}$$

The symbol memo for this paragraph is:

l = length (m)

P = power (W)

U = voltage (V)

I = current (A)

cosϕ = power factor

R', X' = resistance, reactance per unit of length (Ω/m)

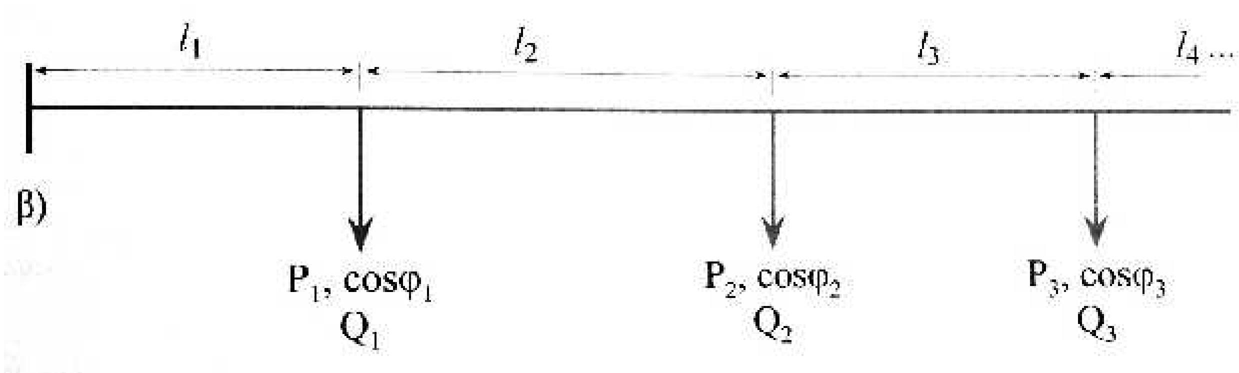
κ = conductivity ($\Omega^{-1} \cdot m \cdot mm^{-2}$), at operating temperature

A = cross section (mm^2)

For low voltage and cross sections $A \leq 16mm^2$ applies Ψ'=R'.

2.5.3.2 Voltage drop in line with multiple load

On distribution lines with loads P_1, P_2, P_3 with space l_1, l_2, l_3 between each other as in the following figure:



For single-phase circuit is (U = phase voltage):

$$\frac{\Delta}{U} = 2 \cdot \frac{\Psi'_1 \cdot P'_1 \cdot l_1 + \Psi'_2 \cdot P'_2 \cdot l_2 + \Psi'_3 \cdot P'_3 \cdot l_3 + \ldots}{U^2}$$

These calculations are made taking into account not the actual loads P_1, P_2, P_3 but total notional loads P_1', P_2', $P_3'$and Q_1', Q_2 ', Q_3' corresponding to the lengths l_1, l_2, l_3.

$P_1'= P_1+P_2+P_3+\ldots$, $Q_1'= Q_1+Q_2+Q_3+\ldots$

$P_2'= P_2+P_3+P_4+\ldots$, $Q_2'= Q_2+Q_3+Q_4+\ldots$

$P_3'= P_3+P_4+P_5+\ldots$, $Q_3'= Q_3+Q_4+Q_5+\ldots$

Ψ_1 ', Ψ_2', Ψ_3' are the resistances corresponding to the loads (P_1', Q_1'), (P_2', Q_2'), (P_3', Q_3') and the lengths l_1, l_2, l_3. If the line has a fixed cross-section it can be assumed to the above formulas that

Ψ_1 '= Ψ_2' = Ψ_3'= Ψ_m' , where Ψ_m' is the equivalent resistance.

The following also applies:

$$\Psi'_m = R' + X' \cdot \tan \varphi_m$$

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where ϕ_m is the angle of an average power factor.

For the angle ϕ_m applies:

$$\cos\varphi_m = \frac{P_1 \cdot \cos\varphi_1 + P_2 \cdot \cos\varphi_2 + P_3 \cdot \cos\varphi_3 + \ldots}{P_1 + P_2 + P_3}$$

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TECHNICAL SPECIFICATIONS

FEBRUARY 2020

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CONTENTS

Introduction

The installations of this study will be constructed in accordance with the applying laws, legislation and Technical Specifications.

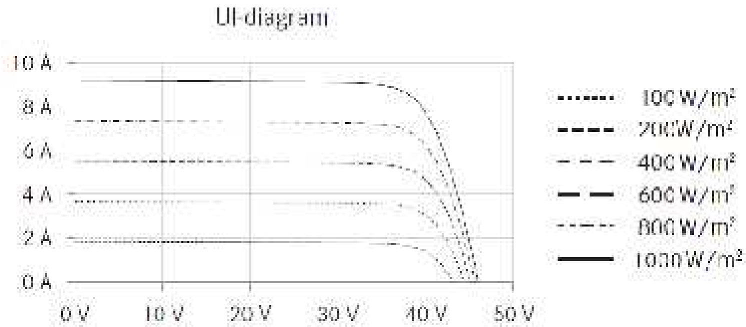
1. Installation of Strong Currents

1.1 Photovoltaic Panels

Photovoltaic panels of monocrystalline silicon at nominal power 330Wp (± 3% - @STC) and with an efficiency rate greater than or equal to 18.40%. The panel should have a maximum system voltage of 1000VDC, operating temperature from -40 ° C to + 85 ° C, static pressure resistance ≥5.400Pa and IP68 protection (junction box). It will consist of 72 silicon cells connected properly, encased in anodized aluminum profile frame, while the front will be covered with specially treated glass ≥3.2mm thick suitable for use in solar applications. It will have a junction box with at least 3 Schottky diodes and pre-installed cables with positive and negative poles, cross section of 4.00mm², 1.30m long and MC4 connectors for easy and waterproof connection. The framework will be IEC 61215, IEC 61730 certified as well as IEC 61701: 2011 and DIN EN 13501-5 categorized. The frames will have a linear efficiency reduction of up to 20% over 25 years. The frames should be of indicative dimensions of 1956x992x40mm (± 10%). The electrical characteristics of the frame will be:

Nominal current Impp [A]	:	8,77 (±10%)
Nominal Voltage Vmpp [V]	:	37,66 (±10%)
Short-circuit current Isc [A]	:	9,27 (±10%)
Open-circuit Voltage Voc [V]	:	46,29 (±10%)
Voltage temperature factor [%/°C]	:	-0,30
Current temperature factor [%/°C]	:	0,05
Power temperature factor [%/°C]	:	-0,41

Characteristic Curve U-I



Indicative frame type: LUXOR ECOLINE P72/330

1.2 Inverters

DC/AC inverter, that converts direct voltage/current to alternating voltage/current. The inverter input will be suitable for connecting photovoltaic frames, of maximum voltage ≥1000VDC, start voltage ≥188VDC and nominal input voltage ≥600VDC. The inverter will have at least two Maximum Power Point detectors. The inverter output will be three-phase, 400V voltage, 50Hz frequency, with adjustable power factor cosφ from 0.8 inductive to 0.8 capacitive. The inverter will have load switch at the input side (DC), and built-in protections against errors and earth leakages, short-circuit, DC polarity reversion. The inverter will be transformerless, have IP65 (or above) protection and operating temperatures of at least -25°C to +60°C. The external dimensions of the inverter will be 661x682x264mm (± 20%) for various nominal inverter power. Each inverter will have built-in surge protection (that will provide uninterrupted protection from damaging overvoltages) and a communication unit to record power generation data via RJ45 port and ethernet. At the same time, the inverter will have a screen to display the local electrical indications. Finally, the inverter will have built-in protection against islanding, according to VDE 0126-1 and a 10-year operation warranty.

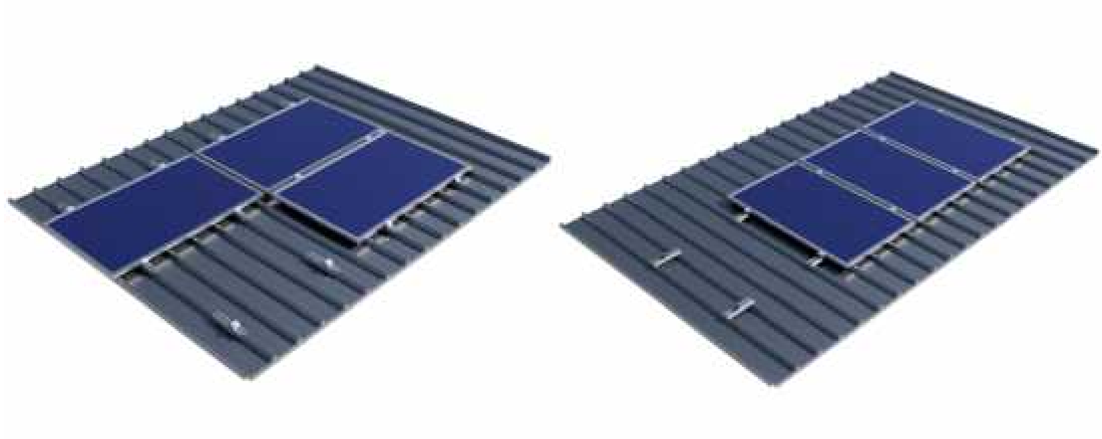
The electrical characteristics of the inverter are listed below:

		Inverter 20 kVA
Nominal Input Power DC [Wp]	:	20440 (±5%)
MPP detection voltage range [V]	:	320 - 800 (±5%)
Max Input Current DC [A]	:	≥33A ανά ανιχν. MPP
Number of inputs per detector MPP	:	≥3
Nominal Output Power AC [VA]	:	≥20000
Nominal Output Current [A]	:	29 (±5%)
Max Efficiency [%]	:	≥ 98,4
European Efficiency [%]	:	≥98,0
THD [%]	:	≤ 3,00

Indicative Inverter Type 20kVA: SMA Sunny Tripower 20000TL

1.3 PV Frame Mounts

The mounts will be made of aluminum, suitable for installation on industrial roof. The mounting system will allow the proper hold of the photovoltaic. It will be possible to mount the frames in both portrait and landscape mode.



They will be made from aluminum alloy 6005T6 and stainless steel screws.

The mounts should be certified by ISO 9001 and ISO 14001.

Indicative Mount Type: Alumil AS410L H2400 Helios Industrial Roof

1.4 Tubes - Grates – Branches' boxes - Plastic channels

1.4.1 Flexible Plastic Heavy Duty Electrical Spirals Ø16mm, Ø63mm

According to applying Technical Specification about plastic pipes for electrical installations.

1.4.2 Heavy Duty Metal Perforated Grates with Lid 100x60mm / 300x60mm / 400x60mm

According to applying Technical Specification about cable grates.

1.5 Strong Current Cables

1.5.1 DC Cables

Single-pole cable with polyclonal copper conductor (Cu) and elastic polymer insulation (XLPO or EM8) suitable for DC nominal voltage of at least 1000 VDC, solar radiation resistance and ambient temperatures from -40°C to +90°C. The cable should be suitable for operation at an outdoor, humid, acidic and alkaline environment. It should have CE certification, EN 60228. It should be halogen free. The cable should be suitable for PV frame applications.

Indicative Type: HIKRA SolarKabel H1Z2Z2-K or TOP Cable Solar ZZ-F

1.5.2 AC Cables - FG7OR type

Flexible power cable for alternating current and voltage applications. Suitable for permanent indoor and outdoor installations in humid or moist environment. The cable conductors will be polyclonal, made of flexible copper wires, according to DIN VDE 0295. The insulation will be made of G7-type ethylpropylene polymer. It will have an inner coating made of waterproof, fireproof material. The cable will have an outer cloak of Rz type thermoplastic PVC, it will be fireproof, CEI 20-22 / 1-5. The operating voltage shall be at least 0.6/1.0kV (Uo/U). The maximum operating temperature of the cable should be at least 90°C. The cable should have IEC 60502-1, EN 60332 and Directive 2014/35 / EU certifications.

Indicative Type: La Triveneta Cavi FG7OR.

1.5.3 Polyclonal Conductors Cu 25mm² (ground)

According to applying Technical Specification.

1.6 Low Voltage Electrical Boards

1.6.1 Waterproof thermoplastic boards IP66

Low voltage electrical equipment will be placed on boards suitable for outdoor installation with IP66 protection that comply with the requirements of the standards: IEC 62208, EN 60439-1, IEC 61439-1-2, IEC 60670 and EN 50298.

The boards will be made of thermoplastic material without glass fibers, that will be formed by the co-injection molding technique. This technique will form a two-layer "sandwich", one of which will be the compact integument and the other the expanded core, to ensure maximum mechanical impact resistance reaching grade IK 10. The boards should be 100% recyclable, highly resistant to UV, to corrosion by chemical and environmental factors and accompanied by a manufacturer's guarantee that their exterior surface will not change color or composition for at least 15 years. The nominal operating voltage of the equipment to be placed on the board shall be 690 V with a nominal current up to 400 A.

The thermoplastic boards to be used should have resistance to fire 750^{o}C (GWT-glow wire test according to IEC / EN 60695-2-1), resistance to external impacts IK 10 (according to IEC / EN 50102) and operating temperature: -25°C + 100°C. The insulation class of the boards should be 1000 V AC and 1500 V DC.

Tables with different exterior dimensions, up to one meter high, with a capacity of 24 to 216 elements, shall be available. The board doors are opaque and have an opening angle of 180^{o} to achieve easy access to the interior. In addition to rail materials within the board, industrial low-voltage materials should also be able to be placed using standard assembling kits. For complete compatibility between the board assembling kits and the industrial equipment (automatic power switches, load switches, etc.) as well as the guarantee of the good quality of the installation and operation of the board, the electrical equipment installed inside must be from the same manufacturer.

The boards to ensure maximum flexibility, scalability and quick recovery in the event of a component failure should be fully assembling (separate components: cabinet, door, assembly kits, etc.). Assembling all these components, as well as the assembly kits for the electrical equipment should be possible without the use of tools.

1.6.1.1 Components

The thermoplastic outside placed boards should be able to accept the following components: industrial material metal mounting bases, interior doors, standard horizontal perforated cable passages, wall mounting brackets, column mounting brackets, column mounting brackets, dehumidification kit that retains the degree of protection in IP 54, two-cabinet vertical joining kit for vertical extension of the utility area, thermoplastic base stand for floor placing, metal base stand for embedding in concrete, thermoplastic pedestal for embedding to the ground without the need to build a cement base, cover for protection from the rain.

1.6.1.2 Quality Certification

The supplier should maintain an acceptable quality assurance system for products and services and demonstrate compliance with ISO 9001 certification, provided by an independent certified body. Boards should be accompanied by a CE declaration of conformity, a RoHS environmental statement, and their compliance with the standards should be certified by a recognized organization (VDE, IMQ, etc.). In addition, they must have a manufacturer's written warranty stating a lifetime warranty of at least 15 years, stating that the board material is 100% recyclable as well as being resistant to chemical and environmental factors (temperature, humidity, water, acids, oils, etc.).

Indicative Type: ABB GEMINI or similar

1.6.2 Strong Current Metal Distribution Boards

Description	:	Assembled power distribution boards with metal base, back, ceiling and side sections. The board will have a metal opaque door to provide protection of IP43. It will be possible to install multiple front covers, in order to place DIN 35mm rail materials and, if required, front covers for installing measuring instruments. It will be possible to install an internal grate for the wiring path. The board will be ready, assembled with all its accessories, suitable for use. Depending on the number of materials it will have to host it will be placed on wall or on floor.
Rated Operation Voltage, Un	:	690V
Rated Insulation Voltage, U_i	:	1000V
Rated Frequency	:	50...60Hz
Rated Impulse Withstand Voltage, U_{imp}	:	6 kV (boards on wall) / 8 kV (boards on floor)
Rated Operating Current, I_n	:	400A (boards on wall) / 800A (boards on floor)
Short-time (1 s) withstand current, I_{cw}	:	25 kA (boards on wall) / 35 kA (boards on floor)

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Maximum peak current, I_{pk}	:	52,5 kA (boards on wall) / 74 kA (boards on floor)
Degree of Protection	:	IP43
Dimensions	:	690 (Π) x 650 (Y) x 204 (B) (boards on wall) 690 (Π) x 850 (Y) x 204 (B) (boards on wall) 690 (Π) x 1.050 (Y) x 204 (B) (boards on wall) 690 (Π) x 1.250 (Y) x 204 (B) (boards on wall) 690(Π) x 1.550(Y) x 240 (B) (boards on floor) 690(Π) x 1.750(Y) x 240 (B) (boards on floor) 690(Π) x 1.950(Y) x 240 (B) (boards on floor) 690(Π) x 2.150(Y) x 240 (B) (boards on floor)
Standards	:	CE, IEC 60439-1

Indicative Type: **ABB line ArTu L IP43/IK08**

1.7 Low Voltage Distribution Boards' Components

1.7.1 Miniature Circuit Breakers (MCB)

The MCBs will comply with European Standards IEC/EN 60898 and IEC/EN 60947-2 as well as with the German DIN VDE 0641 and DIN VDE 0660 Regulations. The MCBs will have type B characteristics. They will have a rated voltage of 400 V (AC), with a disconnection power of at least 6 kA and shall be equipped with thermal elements to protect from overcurrent and electromagnetic elements to protect from short circuit, which shall be induced by currents equal to 3 - 5 times over the rated for MCB type B. The width of their cover should not exceed 17,5 mm, while their attachment on the boards will be on special rails with a suitable latch.

MCBs are used to protect circuits of max current up to 125A

Their technical characteristics will be as follows:

- Manufactured according to standards: EN 60698, EN 60947-2
- Number of Poles: 1P, 2P, 3P, 4P, 1P+N, 3P+N
- Rated Voltage: 230-240V for (1P, 1P+N), and 230/400V for 2P, 3P, 4P, 3P+N
- Characteristic: B, C, D, K, Z
- Insulation Voltage: 500 V
- Max Operating Voltage: 440 Vac
- Min Operating Voltage: 12 V
- Frequency: 50-60 Hz
- Rated Short-circuit Capacity - EN60898: 4.5kA, 6kA, 10kA
- Rated Impulse Withstand Voltage: 4kV
- Dielectric test voltage: 2.5 kV
- Overvoltage Category: III

Indicative Type: ABB S200

1.7.2 Miniature Circuit Breaker PV indicative type ABB

Miniature circuit breaker PVs should be suitable for photovoltaic strings. They should be IEC / EN 60947-2 certified.

Their technical characteristics will be as follows:

- Manufactured according to standards: EN 60947-2
- Number of Poles: 2P, 4P
- Rated Operating Voltage: 1000 VDC
- Insulation Voltage: 1500 VDC

- Rated Short-circuit Capacity - EN60898: 5kA,
- Characteristic: B
- Rated Impulse Withstand Voltage: 8kV
- Overvoltage Category: III

Indicative Type: ABB S800PV

1.7.3 ABB indicative lamps

The indicative lamps on the panels will be low-power (<1.5W) LEDs and will be connected by inserting suitable fuses. The lamp cover will be red (unless otherwise noted in the drawings).

1.7.4 Network analyzer, placed on the door of the board

1.7.4.1 Description

The network analyzers are electronic devices that are used for the measurement of the main electrical parameters of the installation: voltage, current, frequency, power factor, active and reactive power, active and reactive energy. They should be placed on a board door and the depth inside the panel should be less than 58 mm, in order to save space at the total depth of the board. They should be complied to international standards IEC 61554, IEC 60529, IEC 60688, IEC 61326-1, IEC 62053-21, IEC 62053-23, IEC 62053-31 and IEC 61010-1. Their rated voltage is 24-240 V AC/DC.

Analyzers should have an illuminated LCD screen for easy and readable display of the measured electrical characteristics, control and programming buttons on their front side, and wiring to the back side of the instrument via removable terminals. The network analyzer should have a self-diagnostic function that will inform the user of any errors in the operation: check of voltages and currents sequence, check of consistency between wiring and set configuration, check of uniformity of current signs. In addition, for security reasons and to prevent any interference and change of the instrument's configured parameters, it should be possible to lock it with a safety password.

The analyzers shall be able to be placed in low and medium voltage electrical panels. The current will be measured indirectly using transformers (from 1 to 10000 A) and it will be possible to programme in the analyzer transform ratio (/ 1 or / 5 transform ratio). The voltage measurement for low voltage applications will be made directly for values up to 500 V AC while for medium voltage networks through voltage transformers (primary: 60 V to 60 kV, secondary: 60 to 190 V). They should also have 2 digital outputs programmed as an alarm or pulse output.

The electrical quantities to be measured shall be:

- Voltage
- Current
- Power factor (PF)
- Frequency
- Active, reactive power
- Maximum demand on active and reactive power

• Harmonic distortion factor (of voltage and current) expressed as a percentage (%) and absolute value

1.7.4.2 Technical characteristics

Measurement Type		Sampling TRMS
Measurement Accuracy		
Voltage		±0,5% F.S. ±1 digit
Current		±0,5% F.S. ±1 digit
Frequency		40,0 - 99,9 Hz: ± 0,2% ± 0,1 100 - 500 Hz: ± 0,2% ± 1
Power factor		± 1% ± 1 digit
Active power		± 1% ± 0,1% F.S (from cosϕ= 0,3 inductive to cosϕ= 0,3 capacitive)
Active energy		Class 1
Measurement Range		
Voltage	[V]	From 10 to 500 approx. TRMS VL-N.
Current		From 50 mA to 5 A TRMS approx.
Frequency	[Hz]	From 40 to 500 approx.
Power factor		2 decimal places displayed
Installation		Low and medium voltage. Single-phase connection Three-phase with neutral - Three-phase without neutral
Current inputs	[A]	Always use external CT
		Primary from 1 to 10,000 A AC approx.
		Secondary 5 A and 1 A AC approx. N.B.: in case of CT secondary at 1 A the accuracy class is reduced to 2.5% F.S. ±1 digit, in the range 5-100% F.S.
Voltage inputs	[V]	Direct insertion up to 500 AC approx..
		Indirect insertion with VT:
Climatic Conditions		
Operation	[°C]	from -5 to +55
Relative humidity		Max. 93% ((non-condensing) at 40°C
Protection Degree		
Frontal		IP 50
At terminals		IP 25

The supplier of network analyzers should maintain an acceptable quality assurance system for products and services and demonstrate compliance with ISO 9001 certification, provided by an independent certified body. Analysts should be accompanied by a CE declaration of conformity.

Network Analyzer Indicative Type: ABB M2M or similar

1.7.5 Surge Protective Devices SPD T2

1.7.5.1 General

SPDs are devices used to protect electrical equipment and in particular electronic devices and devices containing electronic components from short-term surges up to a few milliseconds and in the size of thousands of volts, in accordance with IEC 62305 international standard. They should be installed near the beginning of the installation or on the general low voltage board, with the shortest possible cable length. However, when the distance from the general lightning protection device to the next distribution panel is long (> 10 m), additional lightning protection equipment (SPDs) shall be used both at the beginning of the cable and at the end (distribution sub-panel). SPDs, for the sake of uniformity in the appearance of the panel, must be of a known manufacturer and look similar to the MCBs and other rail materials.

Class 2/Type T2 SPDs (8/20 μs) will be used to protect the equipment from indirect lightning strikes. Depending on the grounding system, they can be connected in a common way to a TNC system or in a common and differential way to a TNS and TT system.

The protection element for Class T2 SPDs is the metal-oxide varistor (MOV). 2 pcs are required for the protection of single phase (phase and neutral) and 4 pcs are required for the protection of three phase (3 phases + neutral).

The SPDs branch must be secured with a separate miniature circuit breaker of the same manufacturer to ensure safe isolation of the branch in the event of a short circuit due to the end of life of the lightning protection element. The coordination/co-operation of the SPD with the disconnector is certified by the manufacturer with a specific proposed type.

1.7.5.2 Operation Characteristics

SPDs should consist of detachable cartridges with a maximum discharge current of 15, 40 or 70 kA, depending on the application. They should also limit the voltage that will occur at the edges of the electrical equipment (voltage or protection threshold U_P) so as not to exceed 1, 1.4 and 1.5 kV respectively between phase and ground. The rated operating voltage should be 230/400 V and the maximum TOV-temporary overvoltage that may occur at the ends of the SPD is 334 V between phase and neutral. They must have a test certificate in accordance with international and European standards IEC 61643-1 and EN 61643-11.

The surge arrestors should be placed in such a way as to ensure that the length of the grounding cable from the SPD to the grounding spot is less than 15 cm.

Technical Characteristics

Number of Poles	1
Grounding system	TNS-TNC
Nominal Voltage, UN (L-N/L-L)	230/400 V, 50 Hz
Max operating voltage, Uc	275 V, 50 Hz
Max discharge current	15, 40 or 70 kA

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Imax, "class II" test, (8/20 μs), 1P	
Nominal discharge current In, "class II" test, (8/20 μs), 1P	5, 20 or 30 kA accordingly
Voltage protection level UP	1, 1,4 or 1,5 kV accordingly
Protection element	MOV
Reserve	Yes
Wire range	25 mm² and 16 mm²
Degree of protection	IP 20
Standards	EN 61643-11, IEC 64643-1

Indicative Type: ABB OVR T2 …(15/40/70) 275 s P or similar

1.7.6 Switch Disconnectors 0-1

1.7.6.1 General

Appropriate 0-1 load switches should be used to control and isolate DC loads. They will be sorted according to the Utilization Category required by the application. Their rated operating voltage should be 1000 VDC. They must also comply with the requirements of IEC/EN 60947-1 and IEC/EN 60947-3.

The operating mechanism of the load switches shall be quick make-quick break, they must have compact construction, tightly closed to prevent access to the detachment mechanism. The surface of the power contacts should be silver coated, both to minimize their impedance and to protect them from corrosion. The coating should be made of insulating plastic material, designed to withstand demanding use without the risk of cracking or permanent deformation and with high impact resistance, for protection against falls. Terminals and exposed bare parts should be protected against accidental contact and have a degree of IP 20 protection.

The load switches must operate with manual closing and opening, with locking capability and local control on their front. They should also have the capability of placing a controller and shaft to control the switch from the panel door (the panel door should only be opened if the load switch is OFF). All poles must be switched on and off at the same time. In the OFF position it should be ensured that all switch contacts are open and have a visual indication of the position of the contacts via the control (ON, OFF).

The switches shall have the following characteristics:

Rated Operating Voltage	1000 VDC
Rated Insulating Voltage	1500 VDC
Insulation Voltage (dielectric resistance)	12 kV
Short-circuit Current	10kA (for 0,1sec)
Number of Poles	4

1.7.6.2 Components

The switches shall be capable of receiving the following components: 4th pole for tripolar switches, auxiliary contacts, controls with locking, extension shafts and controls for control from panel board.

Indicative Type: ABB OTDC100E22 & ABB OESAZW1

1.7.7 PV Energy Metering Device

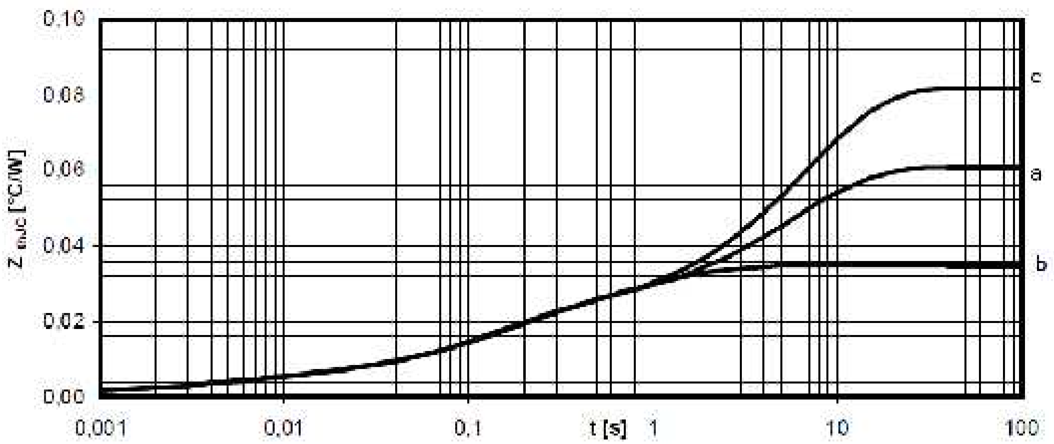
According to the approved materials and communication devices.

1.7.8 Rectifier diode

Rectifier diode with a repetitive peak reverse voltage (V_{RRM}) of at least 1000VDC. The diodes should be capable of carrying a current of at least 20A. They should be suitable for placement inside the electrical panel. Their full electrical characteristics are presented in the following table:

Max. values				
Repetitive peak reverse voltages	T_{vj} = -40°C... $T_{vj\,max}$	V_{RRM}	≥1000	V
Maximum RMS on-state current		I_{FRMSM}	≥20	A
Average on-state current	T_C = 130 °C	I_{FAVM}	≥20	A
Average on-state current	T_C = 55 °C, θ = 180°sin, t_P = 10 ms	I_{FAVM}	≥20	A
RMS on-state current		I_{FRMS}	≥32	A
Surge current	T_{vj} =25 °C, t_P = 10 ms T_{vj} = $T_{vj\,max}$ t_P = 10 ms	I_{FSM}	≥200	A
I^2t-value		I^2t	≥32	A
Typical values				
On-state voltage	T_{vj} = $T_{vj\,max}$, i_F = 5,0 kA T_{vj} = $T_{vj\,max}$, i_F = 1,0 kA	V_F	≤ 1,76 ≤ 1,00	V
Threshold voltage	T_{vj} = $T_{vj\,max}$	$V_{(TO)}$	≥ 0,81	V
Slope resistance	T_{vj} = $T_{vj\,max}$	r_T	0,17	mΩ
On-state characteristic	T_{vj} = $T_{vj\,max}$	A= B= C= D=	-6,685E-01 2,114E-04 2,752E-01 -1,385E-02	
Reverse current	T_{vj} = $T_{vj\,max}$, V_R = V_{RRM}	i_R	max. 60	mA
Thermal qualities				

Thermal resistance, junction to case	beidseitig / two-sided, θ = 180°sin beidseitig / two-sided, DC Anode / anode, θ = 180°sin Anode / anode, DC Kathode / cathode, θ = 180°sin Kathode / cathode, DC	R_{thJC}	≤ 0,038 ≤ 0,035 ≤ 0,064 ≤ 0,061 ≤ 0,085 ≤ 0,082	°C/W °C/W °C/W °C/W °C/W °C/W
Thermal resistance, case to heatsink	two-sided single-sided	R_{thCH}	≤ 0,005 ≤ 0,010	°C/W °C/W
Maximum junction temperature		$T_{vj\ max}$	180	°C
Operating temperature		$T_{c\ op}$	-40...+180	°C
Weight			≤ 280	g
Creepage distance			25	mm
Vibration resistance			50	m/s²

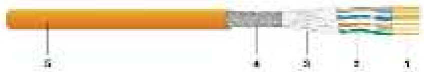


Indicative Type: INFINEON D1050N14T

2 Installation of weak currents

2.1 Cables

2.1.1 FTP cat6 data cables



Conductor material	:	Copper
Number of conductors	:	8 (4 pairs of 2)
Conductor cross-section	:	23 AWG (0,258mm^2)
Cable category under EIA/TIA 568	:	Category 6
Rated outer cross-section	:	7,0mm
Insulation diameter	:	1,36mm
Shielding	:	Yes
Outer sheath	:	LSZH
Operating capacity	:	45nF/km
Impedance	:	100 Ω
Max. transfer impedance (Ω/km)	:	120 Ω/km
Maximum conductor resistance in dc current	:	190 Ω/km
Signal depreciation (250MHz)	:	37,2dB/100m
Asymmetry	:	30ns/100m
Transmission speed	:	82%
Transmission delay, max 100 MHz	:	536ns/100m
Standards	:	CE, EIA/TIA 568 B ISO 11801

Indicative Type: **DATA CABLE S/FTP Cat.6 AWG23 CU 6002 4P Datwyler Cables**

2.2 Switch

The following table shows some indicative technical specifications of the router.

Technical Specifications	
Network protocol and standards compatibility	Data and routing protocols: TCP/IP, DHCP server and client, NAT (many to one).
Physical specifications	• Dimensions: 122 x 74 x 38 mm (4.8 x 2.91 x 1.5 in.) • Weight: 294 g (0.65 lb)
Environmental	• Operating temperature: 32° to 104°F (0° to 40°C) • Operating humidity: 90% maximum relative humidity, noncondensing
Interface	• Local: 10BASE-T, 100BASE-TX, 1000BASE-T, RJ-45 • 802.11ac, 802.11n, 802.11a, 802.11g, 802.11b
Electromagnetic emissions	Meets requirements of FCC Part 15 Class B.

Indicative Type: NETGEAR AC1200 WiF Range Extender Model EX6150

3 Other Installations

3.1 Charging Station

The charging station to be installed must allow two cars to be charged simultaneously. It will have a three-phase supply with a maximum current of 32A per phase and a maximum power of 2x22kW, or a single-phase supply of a maximum current of 32A and a maximum output of 2x7.4kW. The voltage will be alternating (AC) 400V (230V for single-phase supply) at a frequency of 50Hz.

It will have two IEC 62196-2 Type 2 Mode 3 Mennekes sockets with communication and security electronics IEC 61851. It will be possible to share the available power between the two sockets if two cars are simultaneously being charged.

It should have an LCD display screen for station status, charge evolution, power consumption etc., as well as charging cable protection system when the electric cars are being charged.

The station will be self-propelled with stainless steel Inox housing, anti-vandal protection and anti-graffiti coating. It will be accessible with an RFID card reader (ISO/IEC 14443A and ISO/IEC 15693) and will be free to access/connect and charge (plug & charge).

The station will have built-in MID power analyzers and a C5 remote control. There will be overvoltage protection on each socket (40A - Type C) and differential protection relay on each socket (RCD Type A 30mA, according to IEC 61008).

The installed charging station will be compliant with OCPP 1.6 communication protocol and with IEC 61851 standard. Direct communication with the power analyzers will be performed and, moreover, protection operation monitoring. It will also be possible to communicate either through a GSM network (with a SIM card) or via an Ethernet cable and an existing LAN / WAN network. Users will be identified by RFID cards or NFC smartphones.

Voltage monitoring and charging socket activation will be performed, as well as automatic restarting in the event of a power failure.

The operating temperature range is -30˚C to + 50˚C and the permissible ambient humidity is up to 99%. The station's waterproof degree is IP 54 and the external impact protection is IK 10.

In addition, the station will include the following add-ons:

- Integrated Teltonika RUT240 router for the communication of the station via GPRS mobile network with the back-office management and monitoring system
- Additional metal foundation base (for foundation on floors that cannot be attached to with screws)
- Station branding with two- or four-sided stickers
- Integrated Type B Protection - RCD, Type B 30mA, one per socket (optional instead of Type A RCDs)
- Extension of warranty per year (extension of warranty is provided up to three years in addition to the basic 2 + 3 warranty)

3.2 System installation

The electrical installation will be carried out in accordance with the following standards. Testing and commissioning will be carried out in accordance with IEC62446. In addition, system design and design and equipment installation work in accordance with IEC60364-7-712.

The contractor has to submit a project study for approval, including single-line diagrams and plans.

4 Detailed Documentation Statement

The Contractor undertakes to submit a detailed Documentation Statement, including the following:

• Data sheets of the basic equipment parts.

• Certificates of equipment offered.

• Flash Reports of the offered PV panels with serial number recognition and technical characteristics measurements per frame.

• Factory guarantees of the manufacturers of the equipment offered.

• Complete plans (As Build) of the PV station.

• Portal and Mobile Application Manual.

5 Reliability-Guarantee-Delivery

The supplier to whom the commission is awarded shall be required to guarantee the proper functioning of the products as follows:

- Photovoltaic modules 10 years for construction and 25 years for efficiency

-Electronic inverter 5 years

-Support base 25 years

-Installer warranty for the proper operation and performance of the systems, at least 3 years. This warranty will cover any other accessories and work not covered by any of the previous warranties.

The warranty period starts on the date of delivery of each material.

During the period of guaranteed operation, the contractor is responsible for the proper functioning of the object of supply. Also, during the guaranteed period of time the contractor is required to perform the required maintenance and to repair any defects in a manner and at a time specified in the Technical Specifications and the other issues of the contract.

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the participating countries

Greece - Republic of North Macedonia
Green Inter-e-Mobility

MUNICIPALITY OF RESEN

Green inter-e-mobility

Programme co-funded by the European Union and national funds of the participating countries

DESCRIPTION OF THE OBJECT OF THE CONTRACT

The object of the contract is the supply of two purely electric vehicles, a five-seat utility car and a seven-seat Mini bus in the Municipality of Resen.

In the next section the technical specifications for both vehicles are analyzed in detail.

The five-seat utility car

The five-seat utility car will feature air-conditioning with heat pump, intelligent cruise control, front and back electric windows, UV-protected crystals, remote control central lock, rain and light sensor, smart key and engine start button, air conditioning with dust filter and collector and e-Pedal function.

As far as safety is concerned, it will be equipped with front and rear disc brakes, immobilizer, speed limiter, ABS + EBD + Brake assist, height adjustable front belts with tensioners and load limiters, rear seat belts with tensioners and load limiters, as well as front and rear seat belt reminder system. It will include 6 airbags for accident support and stability control system, which helps maintain control. The vehicle will include systems for:

- Tire pressure check for each wheel
- Blind spot warning
- Active traction control
- Start-up assist

The highest speed of the car will reach 144km/h, while its maximum power will be 110kW/150 horsepower with a maximum torque of 320Nm.

The total length of the car will not exceed 4490mm, while the width of the car will not exceed 2030mm with the mirrors and 1788mm without them. Its height will reach 1530mm without load. The gross vehicle weight will be 1995kg.

The battery will be 40kWh lithium-ion.

The combined cycle autonomy will be 270km and for the city cycle 389km.

The seven-seat mini-bus

The seven-seat mini bus will have five doors and an automatic gearbox. The motion will be transmitted to the front wheels. Its gross weight will not exceed 2250kg, and the tare weight 1761kg. The maximum useful load will be at least 489kg. The maximum roof load will be 100kg.

The vehicle will have an AC synchronous electric motor. Maximum engine power will deliver 80kW/109 horsepower and a peak torque of 254Nm at 10500rpm. The highest speed reaches 123km/h and accelerates in 14sec. It will have mechanically sliding doors and a back door that is opening upwards.

It will also have air-conditioning and windshield wipers with intermittent operation. The vehicle will be equipped with an immobilizer, central door lock, battery overload protection, front and rear disc brakes, ABS + EBD, daytime lights and LED back lights, tire pressure control system. In addition, the vehicle will be able to fold its seats.

Its overall length will not exceed 4560mm, while the width will not exceed 2011mm with mirrors and 1755mm without them. Its height (without load) will reach 1850mm and the wheelbase will be 2725mm. The distance from the ground will be 153,4mm.

The type of the battery of the vehicle will be "Laminated lithium ion", rated voltage of 360V, capacity of 40KWh and 192 cells.

Mixed cycle autonomy will be 200km, while city cycle autonomy will exceed 300km.

ECONOMIC OBJECT OF THE CONTRACT

Financing.......

Τα προς προμήθεια είδη κατατάσσονται στους ακόλουθους κωδικούς του Κοινού Λεξιλογίου δημοσίων συμβάσεων (CPV) : 34144900-7 και συμπληρωματικού CPV 34144910-0

The estimated value of the contract amounts to 84.746,00€ including 18% VAT (budget excluding VAT: 71.818,64€, VAT: 12.927,36€).

Programme co-funded by the European Union and national funds of the participating countries