FINAL PROJECT

FOR THE CONSTRUCTION OF A

STAND ALONE PHOTOVOLTAIC SYSTEM

P0WER 2,25 kWp

NAMED

Countryside chalet

SITE IN THE CIY OF

Histon

Cottenham Road 152

CB24 9ET - Cambridgeshire

CUSTOMER:

Joe Black

Cambridge

Warkworth. 987D -

Attachments:

- *Single-line diagram of the plant;*
- *Planimetric scheme.*

DATE

25/10/2017

THE TECHNICAL

Cooper Michael

PLANT GENERAL INFORMATION

This project relates to the construction of a stand-alone plant producing electricity through photovoltaic conversion, with a peak power equal to 2,25 kWp.
The photovoltaic system will act as a generator to recharge the battery with nominal capacity equal to 81 Ah.
There's an auxiliary generator with a rated power of 5 kW that will intervene to supply energy in case of consumptions not covered by the photovoltaic system and the battery or to recharge the battery, if it is necessary.

CUSTOMER	
Customer:	Black Joe
Address:	Warkworth. 987D Cambridge
Tax code/VAT number:	
Phone number:	
Fax:	
E-mail:	

SITE OF INSTALLATION

The plant Countryside chalet has the following characteristics: Photovoltaic stand-alone plant.

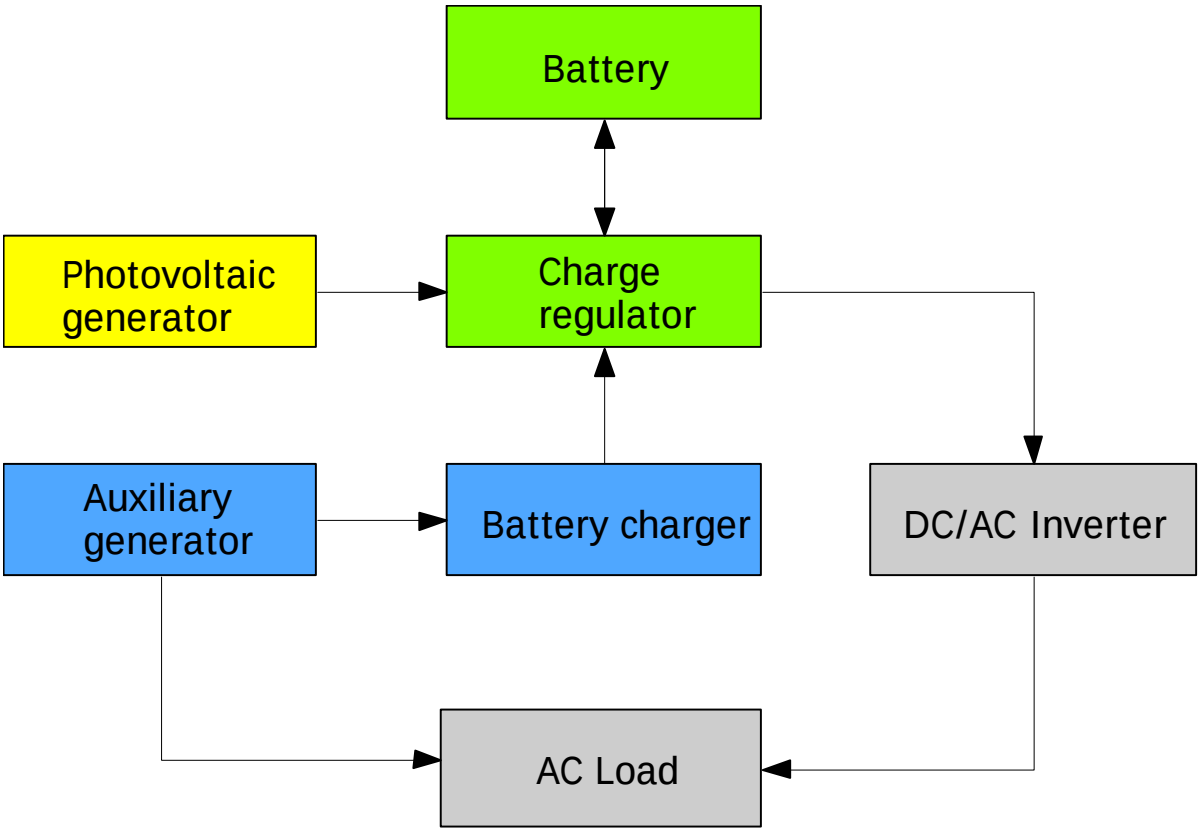
DATA ON THE LOCATION OF INSTALLATION	
Location:	Histon CB24 9ET Cottenham Road 152
Latitude:	052°16'06"
Longitude:	000°06'44"
Altitude:	16 m
Source climate data:	ElectroGraphics
Albedo:	51 % Snow or ice film, Green grass

DIMENSIONING OF THE PLANT

The amount of producible electricity will be calculated on the basis of radiometric data indicated in the standard ElectroGraphics.
It will not be admitted to the parallel strings that are not perfectly identical to each other for exposition, and/or brand, and/or model, and/or number of modules used. Each module, then, will be equipped with bypass diode.

The photovoltaic system consists of No. 1 photovoltaic generators composed of No. 9 photovoltaic modules and No. 1 charge controllers.
The total rated power is 2,25 kWp for an annual production of 2.064,3 kWh distributed over an area of 14,67 m².

BLOCK DIAGRAM



ACCUMULATION SYSTEM

The photovoltaic system will act as a generator to recharge the battery. The flow of energy between the production of electricity, the accumulation and the loads will be regulated by the appropriate charge controllers.
The sizing of the equivalent battery considers the following parameters:

Dimensioning	
System voltage	48 V
Dimensioning month	Month with higher consumption
Average daily consumption	7,8 kWh
Battery autonomy	1 days and 0 hours
Maximum battery discharge	40 %
Capacity of the equivalent battery	560,9 Ah
Energy of the equivalent battery	26,9 kWh

Battery	
Battery type	FIAMM 12FGL27
Rated capacity	27 Ah
Battery series	4
Battery parallel	3
Overall capacity	81 Ah

DC/AC INVERTER

The unit is composed of AC loads, connected to 1 DC/AC inverters.

Inverter DC/AC	
Type	STECA XTH 8000-48
Conversion efficiency AC/DC	0,96
Apparent power	7 kVA

AUXILIARY GENERATOR

Dimensioning	
Rated power	5 kW
Minimum power output	2 kW
Fuel consumption	0,3 l/kWh
Stand by fuel consumption	0,01 l/h

Battery charger	
Type	SOCOMEC EXCEL-CF 400/220 16A
AC/DC Efficiency	0,9
Generator activation level (SOC min)	60,0 %
Generator shutdown level (SOC max)	100,0 %

PHOTOVOLTAIC GENERATOR

The evaluation of the available solar resource was carried out according to standard ElectroGraphics, taking as reference the location that has historical data of solar radiation in close proximity of Histon.

TABLE OF SOLAR RADIATION ON HORIZONTAL

Month	Total per day [MJ/m^2]	Total per month [MJ/m^2]
January	2,3	71,3
February	4,43	124,04
March	8,21	254,51
April	11,74	352,2
May	16,49	511,19
June	18,11	543,3
July	16,6	514,6
August	13,5	418,5
September	10,58	317,4
October	6,16	190,96
November	3,35	100,5
Dicember	1,84	57,04

EXPOSURE

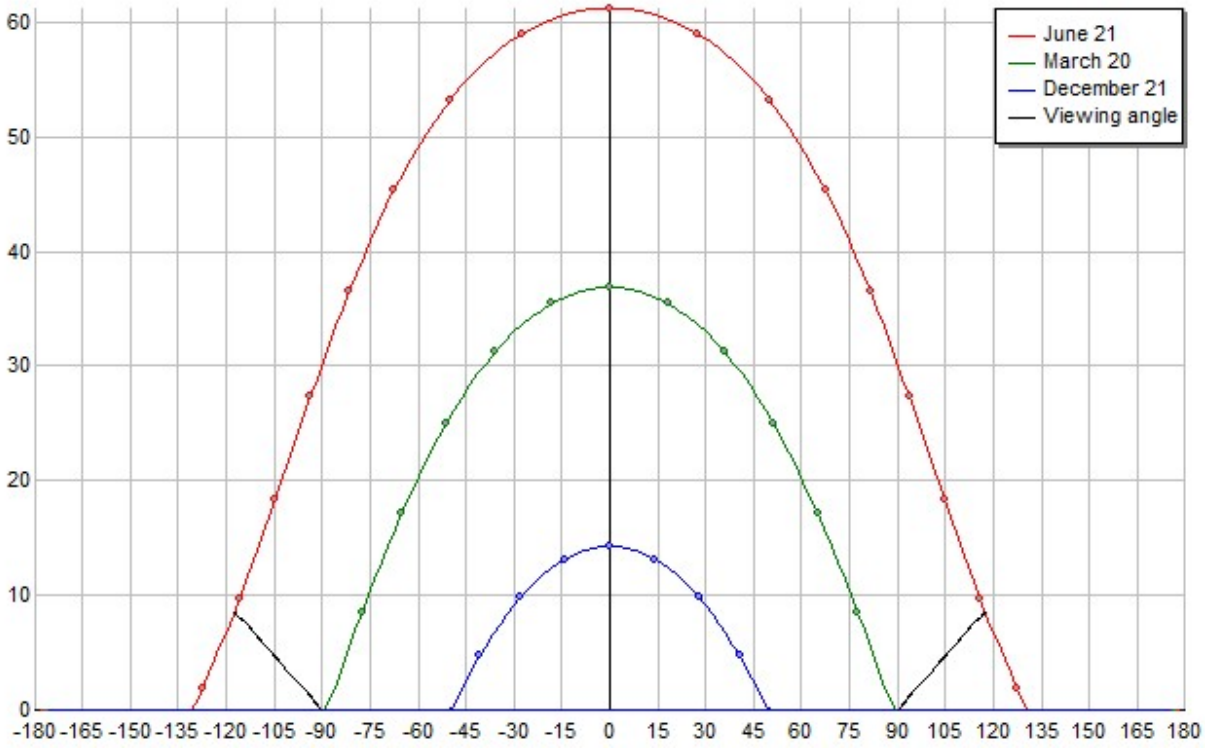
The photovoltaic system consists of 1 distributed generator on 1 exposures as defined below:

Description	Type of construction	Type of installation	Azimut	Tilt	Shad.
South Exposition	On roof	Fixed tilt	0°	18°	0 %

South Exposition

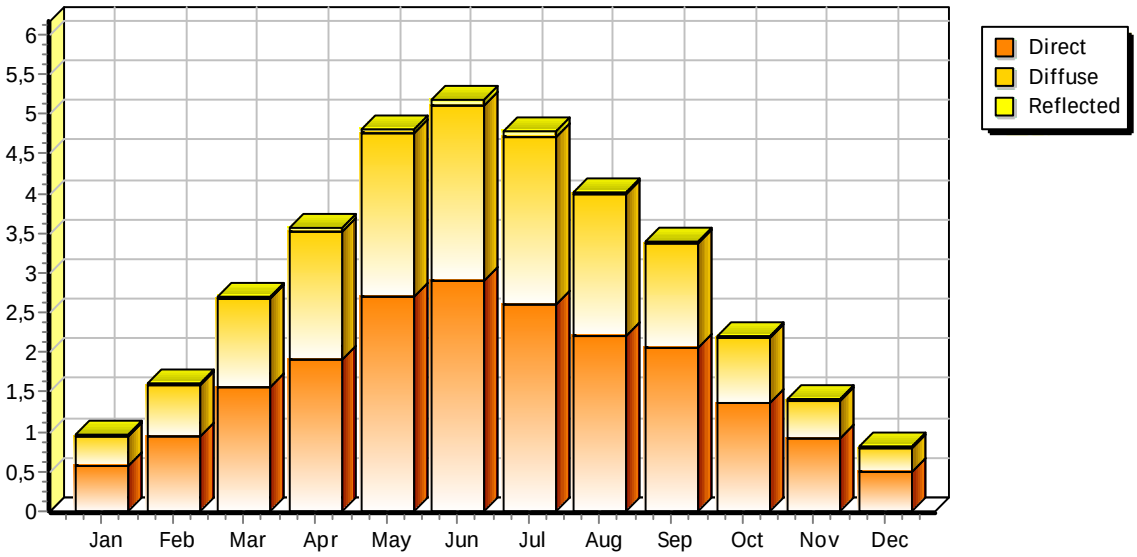
South Exposition will be exposed with a 0,00° orientation (azimuth) with respect to the south and will be exposed with a 18,00° tilt respect of the horizontal.
The energy production of the exposure South Exposition is conditioned by shading factors that determine a reduction of solar radiation as far 0 %.

SHADING DIAGRAM



SOLAR RADIATION DIAGRAM

Mediumdailysolarradiationonn



SOLAR RADIATION TABLE

Month	Direct Radiation [kWh/m^2]	Diffuse Radiation [kWh/m^2]	Reflected Radiation [kWh/m^2]	Total per day [kWh/m^2]	Total per month [kWh/m^2]
January	0,579	0,367	0,008	0,954	29,569
February	0,93	0,663	0,015	1,609	45,045
March	1,565	1,116	0,028	2,708	83,948
April	1,918	1,605	0,04	3,563	106,896
May	2,708	2,037	0,057	4,802	148,856
June	2,888	2,218	0,063	5,169	155,064
July	2,599	2,119	0,057	4,776	148,057
August	2,201	1,776	0,046	4,023	124,727
September	2,052	1,315	0,036	3,403	102,091
October	1,364	0,822	0,021	2,206	68,4
November	0,921	0,468	0,011	1,4	42,014
Dicember	0,503	0,298	0,006	0,807	25,014

SUPPORT STRUCTURES

The modules will be mounted on the galvanized steel supports with a tilt of 18°, will all have the same exposure. The anchors of the structure will need to withstand winds up to speeds of 120 km/h.

FV_South Generator

The generator consists of No. 9 type modules Policrystalline silicon with an estimated useful life of more than 20 years and degradation of production due to aging of 0,8 %% per annum.

CHARACTERISTICS OF PHOTOVOLTAIC GENERATOR	
Number of modules:	9
Number of charge regulators:	1
Rated power:	2250 W
Performance ratio:	85 %

CONSTRUCTION DATA OF MODULES	
Manufacturer:	YINGLI SOLAR
Ref-mark:	YGE 60 YGE 60 - YL250P-29b (2014)
Manufacturing technology:	Policrystalline silicon
Electrical characteristics	
Maximum power:	250 W
Efficiency:	15,3 %
Rated voltage:	29,8 V

No-load voltage:	37,6 V
Rated current:	8,4 A
Short-circuit current:	8,9 A
Dimensions	
Dimensions:	990 mm x 1650 mm
Weight:	18,5 kg

The voltage values at various operating temperatures (minimum, maximum and operating) fall within the acceptable range allowed by the inverter.

The electrical line that arrives from photovoltaic modules is grounding by appropriate Surge Protection Devices with "out of service" optical indicator, to guar.

CHARGE CONTROLLER

Construction details of the charge controllers	
Manufacturer	STECA
Ref-mark	MPPT 6000 parallel Tarom MPPT 6000
Input data	
Min MPPT voltage	17 V
Max MPPT voltage	170 V
Max input voltage	200 V
Max current	60 A
Max power	3,4 kW
With MPPT	Yes
Parallelable elements	0
Output data	
System voltage	48 Vcc
Max current	60 A
Consumption	2.000 mA
Working at 12 V	Yes

Adjuster 1	**MPPT 1**
Modules in series	3
Parallel strings	3
Exposures	South Exposition
MPP voltage (STC)	89,4 V
Number of modules	9

DIMENSIONING

The power rating of the generator is given by:

P = Pmodule * N°modules = 250 W * 9 = 2250 W

The total energy produced by the STC (radiation modules of 1000 W/m² at 25 °C of temperature) is calculated as:

Exposure	N° modules	Solar radiation [kWh/m²]	Energy [kWh]
South Exposition	9	1.079,68	2.429,29

E = En * (1-Disp) = 2064,3 kWh

where
Disp = Power losses obtained from:

Shading losses	0,0 %
Temperature increasing losses	2,5 %
Mismatching losses	5,0 %
DC current losses	1,5 %
Other losses (dirt, tolerances...)	5,0 %
Conversion losses	2,0 %
Total losses	15,0 %

SHADING OBSTACLES LOSSES TABLE

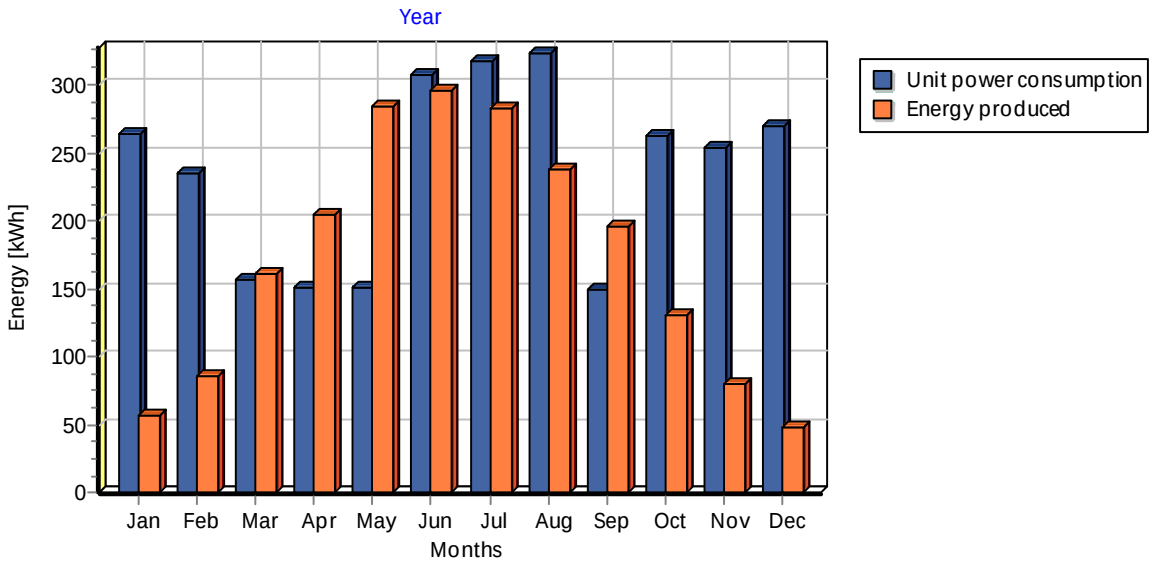
Month	Without obstacles [kWh]	Real production [kWh]	Losses [kWh]
January	56,5	56,5	0,0 %
February	86,1	86,1	0,0 %
March	160,5	160,5	0,0 %
April	204,4	204,4	0,0 %
May	284,6	284,6	0,0 %
June	296,5	296,5	0,0 %
July	283,1	283,1	0,0 %
August	238,5	238,5	0,0 %
September	195,2	195,2	0,0 %
October	130,8	130,8	0,0 %
November	80,3	80,3	0,0 %
Dicember	47,8	47,8	0,0 %
Year	2064,3	2064,3	0,0 %

UNIT POWER CONSUMPTION

Annual Unit power consumption:	2.842,1 kWh
Average daily consumption:	7,8 kWh

LOAD PROFILE

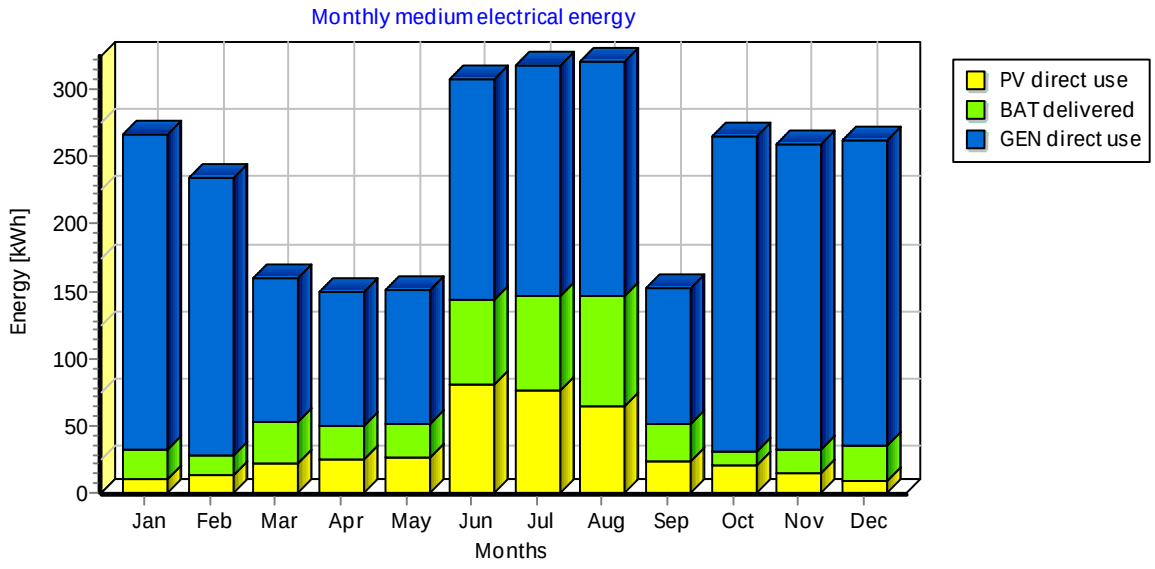
Description	Consumption [kWh]	Power [W]
Dryer	314	2.000
Dishwasher Class A	602,2	1.650
Washing Class A	219,8	1.400
Ceiling lights	133,2	150
Electric heater	490,5	1.500
Television	292	200
Conditioner fixed - 2.6kW	498,3	2.600
Electric oven Class A	292	800



ENERGETIC SIMULATION

Energetic simulation of consumptions and use of plant resources:

Initial charge of the battery		90 %
Minimum battery state of charge (SOC)		60 %
Time without electrical energy		0 %
Not covered consumption	0 kWh	0 %
Total photovoltaic energy produced	2.064,3 kWh	
Photovoltaic energy unused	1.033,5 kWh	50,1 %
Photovoltaic energy for battery charge	629,8 kWh	30,5 %
Total energy output auxiliary generator	2.248,9 kWh	
Auxiliary generator energy unused	93,1 kWh	4,1 %
Auxiliary generator energy for battery charge	114,5 kWh	5,1 %
Hours of energy production auxiliary generator	994 h	
Photovoltaic energy directly used	385 kWh	13,5 %
Energy supplied by the battery	415,8 kWh	14,6 %
Auxiliary generator energy directly used	2.041,3 kWh	71,9 %



ELECTRICAL CABLES AND WIRINGS

The electrical wiring will be done using cables with insulated copper conductors with the following requirements:

- Section cores of copper calculated in accordance with rules IEC
- Type FG21 if outdoors or FG7 if in underground conduits
- Type N07V-K if inside conduits within buildings

To ensure the safety of those working on the plant during the verification, or adjustment, or the maintenance, the conductors will have the following colors:

- Protection conductor: yellow-green (mandatory)
- Conductor for DC circuits: signed with a clear indication of the positive "+" and negative "-"

As it is possible to see from the above requirements, conductor cross-sections of the photovoltaic systems are certainly oversized for the current and the limited distances involved.

Wiring: **String - Field C.**

Description	Value
Identification:	N07V-K 450/750 V - 1X6 brown N07V-K 450/750 V - 1X6 black
Total length:	17,78 m
Dimensioning length:	7,49 m
Proximity circuits:	1
Ambient temperature:	30°
Table:	IEC 60364-5-52 Ed.3
Lay:	4(B1) - Insulated conductors or single-core cables in conduit on a wooden or masonry wall
Disposition:	Bunched in air, on a surface, embedded or enclosed
Type of cable:	Single-core
Material:	Copper
Designation:	N07V-K
Type of insulation:	PVC
Formation:	2x(1x6)
N° conductors positive:	1
Sect. positive:	6 mm²
N° conduttors negative:	1
Sect. negative:	6 mm²
N° conductors PE:	
Sect. PE:	
Rated voltage:	89,4 V
Working current:	8,4 A
Short-circuit current of modules:	17,8 A

Wiring: **Field C. - Charge controller C.**

Description	Value
Identification:	N07V-K 450/750 V - 1X16 brown N07V-K 450/750 V - 1X16 black
Total length:	2,39 m
Dimensioning length:	2,39 m
Proximity circuits:	1
Ambient temperature:	30°
Table:	IEC 60364-5-52 Ed.3
Lay:	4(B1) - Insulated conductors or single-core cables in conduit on a wooden or masonry wall
Disposition:	Bunched in air, on a surface, embedded or enclosed
Type of cable:	Single-core
Material:	Copper
Designation:	N07V-K
Type of insulation:	PVC
Formation:	2x(1x16)
N° conductors positive:	1
Sect. positive:	16 mm²
N° conduttors negative:	1
Sect. negative:	16 mm²
N° conductors PE:	
Sect. PE:	
Rated voltage:	89,4 V
Working current:	25,2 A
Short-circuit current of modules:	26,8 A

Wiring: **Charge controller C. - DC/AC Converter C.**

Description	Value
Identification:	N07V-K 450/750 V - 1X25 brown N07V-K 450/750 V - 1X25 black N07V-K 450/750 V - 1X25 yellow/green
Total length:	2 m
Dimensioning length:	2 m
Proximity circuits:	1
Ambient temperature:	30°
Table:	IEC 60364-5-52 Ed.3
Lay:	4(B1) - Insulated conductors or single-core cables in conduit on a wooden or masonry wall
Disposition:	Bunched in air, on a surface, embedded or enclosed
Type of cable:	Single-core
Material:	Copper
Designation:	N07V-K
Type of insulation:	PVC
Formation:	2x(1x25)+1G25
N° conductors positive:	1
Sect. positive:	25 mm²

N° conduttors negative:	1
Sect. negative:	25 mm²
N° conductors PE:	1
Sect. PE:	25 mm²
Rated voltage:	48 V
Working current:	60,0 A
Short-circuit current of modules:	60,0 A

Wiring: **Charge controller C. - Q. Battery**

Description	Value
Identification:	N07V-K 450/750 V - 1X25 brown N07V-K 450/750 V - 1X25 black
Total length:	2 m
Dimensioning length:	2 m
Proximity circuits:	1
Ambient temperature:	30°
Table:	IEC 60364-5-52 Ed.3
Lay:	4(B1) - Insulated conductors or single-core cables in conduit on a wooden or masonry wall
Disposition:	Bunched in air, on a surface, embedded or enclosed
Type of cable:	Single-core
Material:	Copper
Designation:	N07V-K
Type of insulation:	PVC
Formation:	2x(1x25)
N° conductors positive:	1
Sect. positive:	25 mm²
N° conduttors negative:	1
Sect. negative:	25 mm²
N° conductors PE:	
Sect. PE:	
Rated voltage:	48 V
Working current:	60,0 A
Short-circuit current of modules:	60,0 A

Table of cables							
Ref-mark	Description	Form.	Des.	Code	Origin	Dest.	Lc
W00	String cable 1-Q.1	2x(1x6)	N07V-K	CVPIR1450 CVPIR1443	String 1	Q.1	4,37 m
W01	String cable 2-Q.1	2x(1x6)	N07V-K	CVPIR1450 CVPIR1443	String 2	Q.1	5,92 m
W02	String cable 3-Q.1	2x(1x6)	N07V-K	CVPIR1450 CVPIR1443	String 3	Q.1	7,49 m
W03	Cable Q.1-inverter	2x(1x16)	N07V-K	CVPIR1461 CVPIR1458	Q.1	inverter	2,39 m

Summary Table of cables					
Code	Manufacturer	Form.	Des.	Description	Lc
CVPIR1450	PIRELLI CAVI e SISTEMI SPA	2x(1x6)	N07V-K	N07V-K 450/750 V - 1X6 brown	17,78 m
CVPIR1443	PIRELLI CAVI e SISTEMI SPA	2x(1x6)	N07V-K	N07V-K 450/750 V - 1X6 black	17,78 m
CVPIR1461	PIRELLI CAVI e SISTEMI SPA	2x(1x16)	N07V-K	N07V-K 450/750 V - 1X16 brown	2,39 m
CVPIR1458	PIRELLI CAVI e SISTEMI SPA	2x(1x16)	N07V-K	N07V-K 450/750 V - 1X16 black	2,39 m
CVPIR1464	PIRELLI CAVI e SISTEMI SPA	2x(1x25) +1G25	N07V-K	N07V-K 450/750 V - 1X25 brown	2 m
CVPIR1465	PIRELLI CAVI e SISTEMI SPA	2x(1x25) +1G25	N07V-K	N07V-K 450/750 V - 1X25 black	2 m
CVPIR1467	PIRELLI CAVI e SISTEMI SPA	2x(1x25) +1G25	N07V-K	N07V-K 450/750 V - 1X25 yellow/green	2 m
CVPIR1464	PIRELLI CAVI e SISTEMI SPA	2x(1x25)	N07V-K	N07V-K 450/750 V - 1X25 brown	2 m
CVPIR1465	PIRELLI CAVI e SISTEMI SPA	2x(1x25)	N07V-K	N07V-K 450/750 V - 1X25 black	2 m

ELECTRICAL PANELS

- **Field cabinet for direct current side**

It is planned to install an upstream cabinet for each converter to the parallel connection of strings, sectioning, measuring and controlling of the output data from the photovoltaic generator.

GROUNDING

The PV array will be operated as an IT system, or with no polarity connected to earth. The strings will be, formed by a series of individual photovoltaic modules and individually sectionable, equipped with a blocking diode and surge protectors.
For safety, if the user network or part of it is considered unfit to bear the greater intensity of current available (due to the contribution of the PV system), the network itself or the party concerned should be appropriately protected.
The support structure will be regularly connected to the existing earth.

VERIFICATION

Once complete, the installer of the system will check the following technical and functional areas:

- correct operation of the photovoltaic plant in different conditions of power generated (power, power failure, etc.).
- electrical continuity and connections between modules;
- grounding of the masses and drains;
- isolation of electric circuits from the masses;

The generator FV_South Generator satisfies the following conditions:

Voltage limits

Minimum voltage Vn to 70,00 °C (73,2 V) greater than Vmpp min. (17,0 V)

Maximum voltage Vn to -10,00 °C (102,0 V) lower than Vmpp max. (170,0 V)

No-load voltage Vo a -10,00 °C (125,4 V) less than max voltage of controller (200,0 V)

No-load voltage Vo to -10,00 °C (125,4 V) lower than maximum isolating voltage (1000,0 V)

Current limits

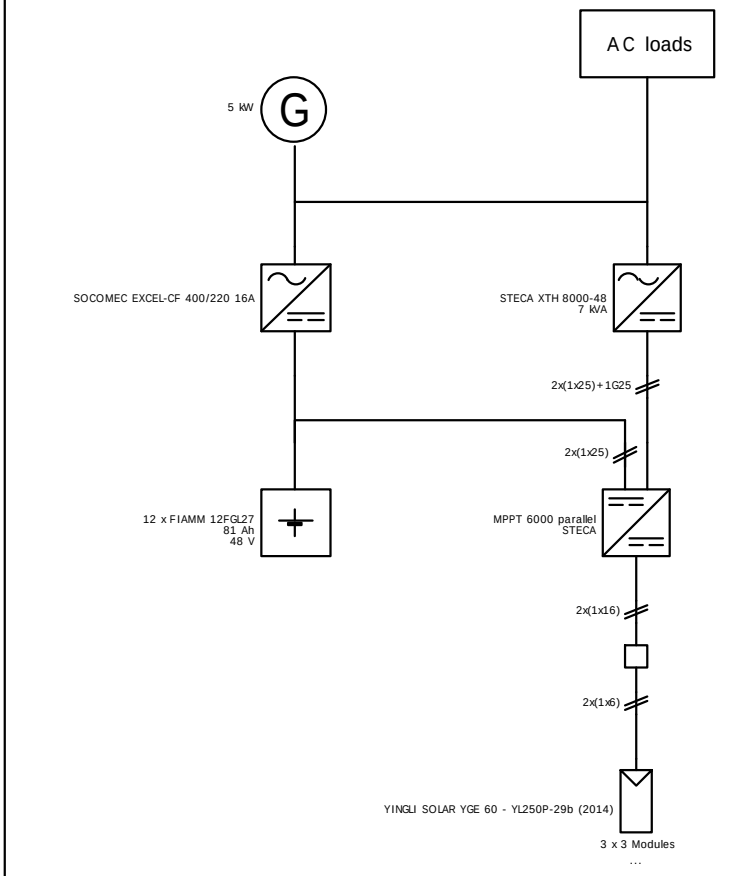
Maximum input current related to Isc (26,8 A) less than maximum current of controller (60,0 A)

Power limits

Power of photovoltaic field (2,25 kWp) less than maximum input power (3,20 kWp)

LAYOUT OF THE GENERATOR

SINGLE LINE DIAGRAM



Symbols legend	
	Inverter
	Photovoltaic field
G	Auxiliary generator
	Battery
	Charge controller

Plant single-line diagram	
Firm	
Responsable Michael Cooper	
Customer	
Rated power 2.25 kW	Date 10/25/2017

CONCLUSIONS

Must be issued and released by the installer the following documents:

- operating and maintenance guide, inclusive of the recommended schedule of maintenance;
- executive project in version "as built", accompanied by data sheets of installed material;
- statement of executed verifications and its outcome;
- certification issued by an accredited laboratory on the compliance with standard EN 61215 for crystalline silicon modules, and EN 61646 by thin film modules;
- certification issued by an accredited laboratory on the compliance of the dc/ac converter with current regulations;
- warranty statements relating to the equipment installed;
- warranty on entire system and its operating performance.

The installation company, as well as thoroughly build as described in this project, will perform all work in compliance with the rules of art.