

# IZEN ENERGY SYSTEMS NV

## 6.659 kW BUCUREȘTI PHOTOVOLTAIC PRODUCTION PLANT



## TECHNICAL BID FOR TURN KEY SOLUTION

For : Machiels nv, Philip Vercauteren  
October, 22 - 2012- STI

The present business proposal contains technical information that must be considered as confidential and therefore cannot be transmitted nor made available to any person other than its recipient and the staff members directly involved, without the previous consent of IZEN energy systems nv.



**YEARS**  
of experience



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# 1. INTRODUCTION

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Following previous contacts, the object of this document is to provide a technical proposal regarding the construction of one photovoltaic production plant in România, București, with an installed power of approximately 6,66 MWp.

Along the following sections of the present document all technical aspects which have an effect on the PV plant will be presented.

## 2. PV PLANTS IDENTIFICATION

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România, București, Strada Macului.



# 3. PRE-PROJECT CONSIDERATIONS



Without any data concerning geotechnical studies on rammed frames, it's not possible to realize an exact evaluation regarding the civil construction works to be done on site. However, we have considered that the ground composition allows the weight for the proposed structures and other required civil works.

We have considered that the terrain's topography and composition allows execution of foundations for the proposed structures, with the utilization of ramming, and other required civil works. These considerations do not avoid the requirement of geotechnical and topographical studies in a further stage of development. Based on the existing information, the available land will be enough for the project execution. Works related with water channeling renewal, passages over streams, runoff damages, drainage ditches or any other civil work related with water channeling, were not considered at this stage.

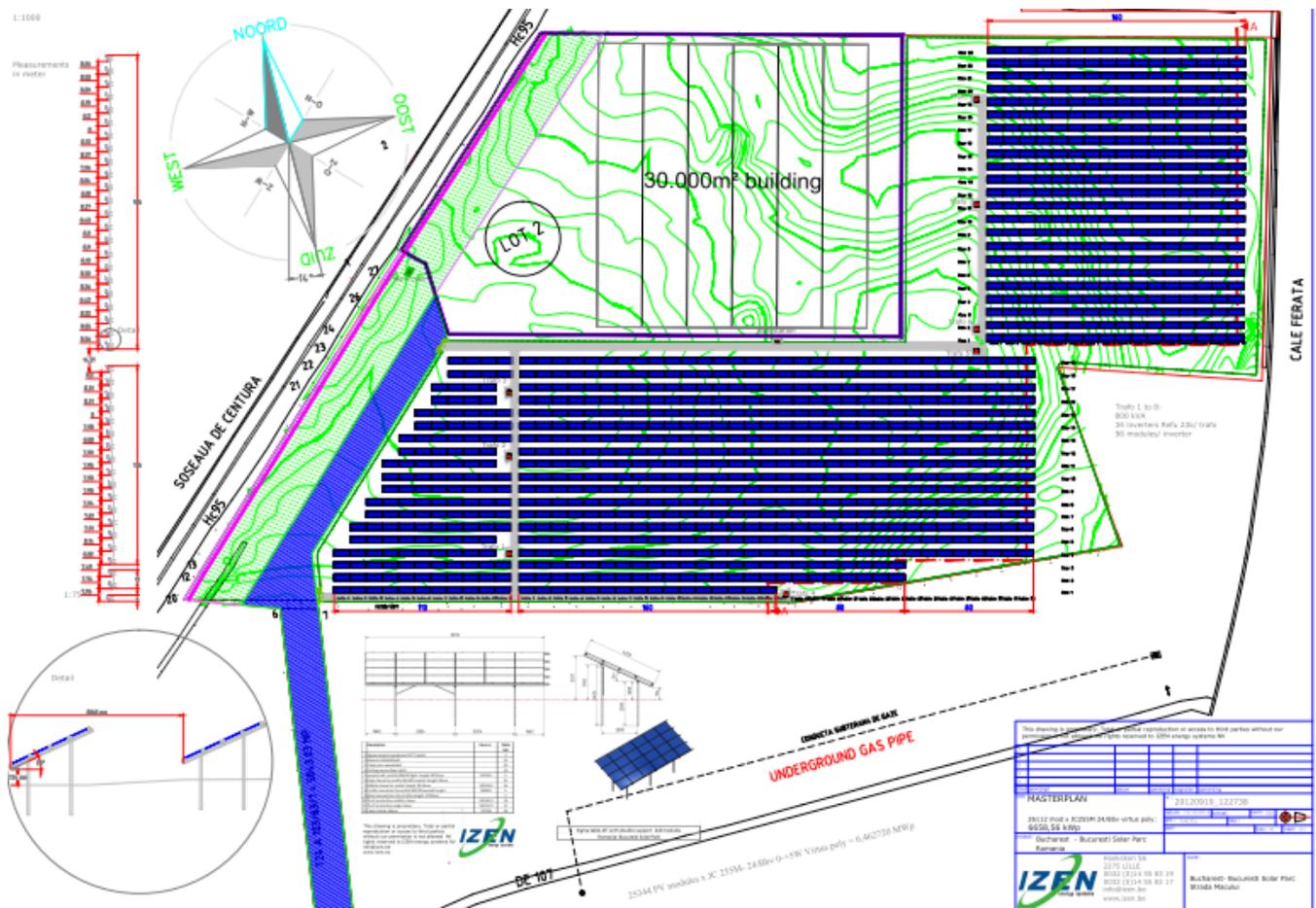
Regarding road accesses to this plant, we have considered that the existent accesses are able for the circulation of each single type of vehicle required for the correct plant execution.

This document refers to all the works, materials and necessary equipment for the construction of a ground PV plant until the connection cabin, in which are included PV modules and ground fixation structures, inverters, cabling, junction boxes, monitoring system, transformers, transformers stations and a substation.

The fencing and road works are described with the possibility to realize them by a local contractor. Surveillance system or cameras are not included in our study.

With the previous limitations and considerations we intend to present what we believe to be the best solution in terms of ease of use, optimization and efficiency.

# 4. PV PLANT



## 4.0 GENERAL DESCRIPTION

The presented plant will have its production from renewable source, specifically photovoltaic with peak power for 26112 panels of 255 Wp\* = 6659 kWp

\*In function of the availability of modules the wattage can be higher or lower with respect of the total output of the plant.

The main issues regarding the plant will be presented hereinafter.

Transformers are planned in a number of 8 with a capacity of 800 kVA. The work load of the transformers is calculated to be max.95%. The highest production is generated by three-phase string inverters with a peak efficiency of 98.3% even at low irradiation. With the panels mounted under 25° and a shadow angle of 21,35° the totality of the power plant will have an optimized performance and a yield production of 1377 kWh/kWp. (by PV Syst calculation)

<b>Main system parameters</b>		System type	<b>Grid-Connected</b>	
PV Field Orientation	Sheds disposition, tilt	25°	azimuth	14°
PV modules	Model	JC255M-24/Bb (-0/+5W) (vir	Pnom total	6659 kWp
PV Array	Nb. of modules	26112	Pnom	23.00 kW ac
Inverter	Model	RefuSol 23k	Pnom total	6256 kW ac
Inverter pack	Nb. of units	272.0		
User's needs	Unlimited load (grid)			

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<b>Main simulation results</b>		<b>Produced Energy</b>	<b>9167 MWh/year</b>	Specific prod.	1377 kWh/kWp/
System Production	Performance Ratio PR	84.3 %			

## 4.1 CIVIL WORKS

Some civil works that will take place during the plant execution are referred hereinafter for the technical description but not necessarily included in our offer:

- Fences & Gates: all materials galvanized and coated with polyester powder coating in a green color ex. Ral 6005

The fences will be realized with the following materials:

Fences Posts rectangular with a section of 60x40x2mm, placed every 3 meters

Underground depth of post : 400 to 600mm

Height : 1930 mm (finished height of 2000 mm) finished with a black synthetic recessed cap.

Against this posts will be placed a 3Dprofiled panel 5/5m, mesh size 50 x 200 mm in lengths of 3 meter.

The special 3D technique (from Van Merksteijn) ensures that in spite of its limited weight this profiled panel is still astoundingly stable.

Horizontal wires: 1 x Ø 5mm

Vertical wires: 1 x Ø 5 mm

Height: 2000 mm

Mesh size: 50 x 200 mm (in the 3D part 50 x 100mm)

Number of posts planned: 733P

Meters of Fences planned: 1832m

Gates:

Double-leaf swing gate: height 1930 x width 2500mm

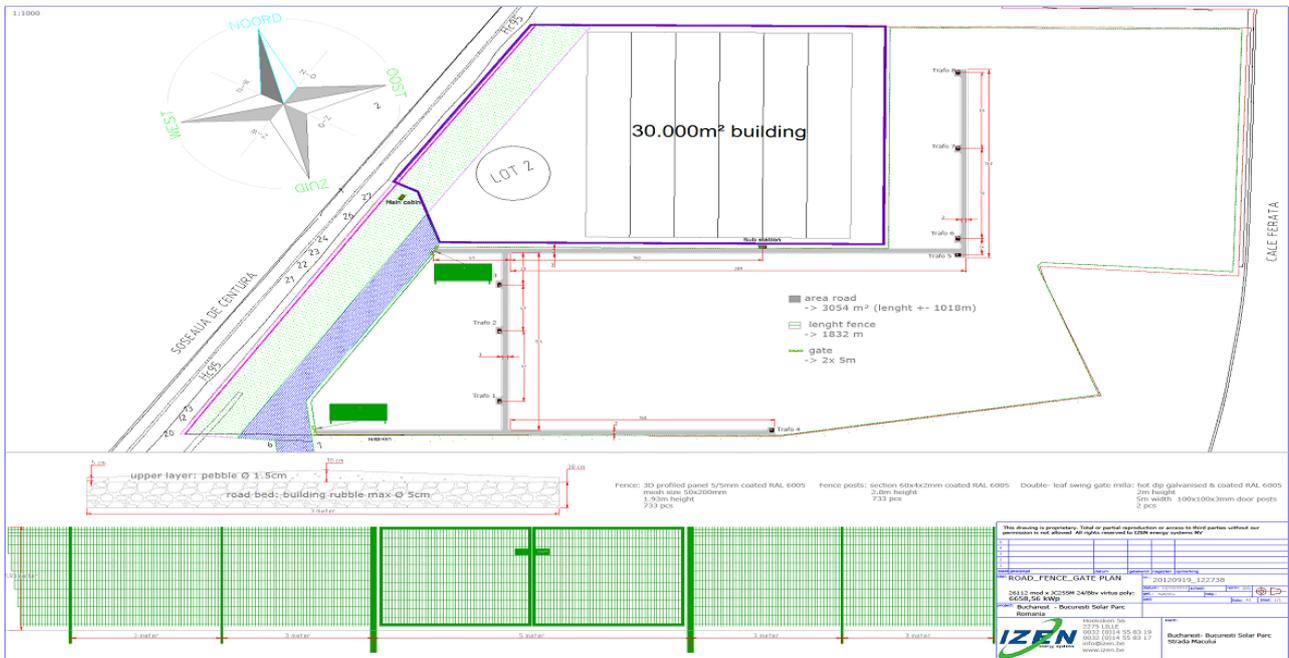
Gate panel: standard double wire panel 8/6/8, 50 x 200mm

Frame: tubular section in square bar steel 40 x 40 x 2mm

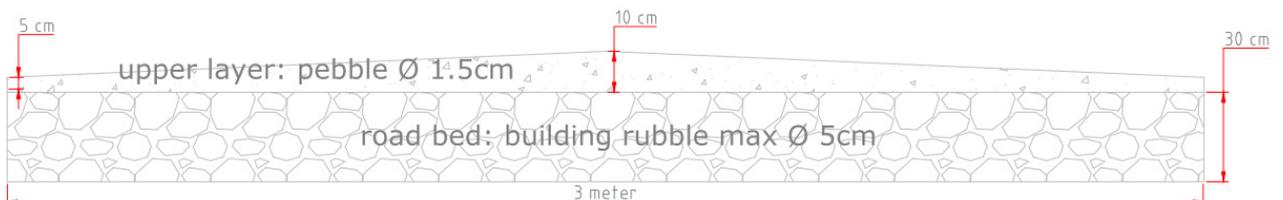
Lock: Locinox lock in stainless steel.

Number of gates planned: 2 gates

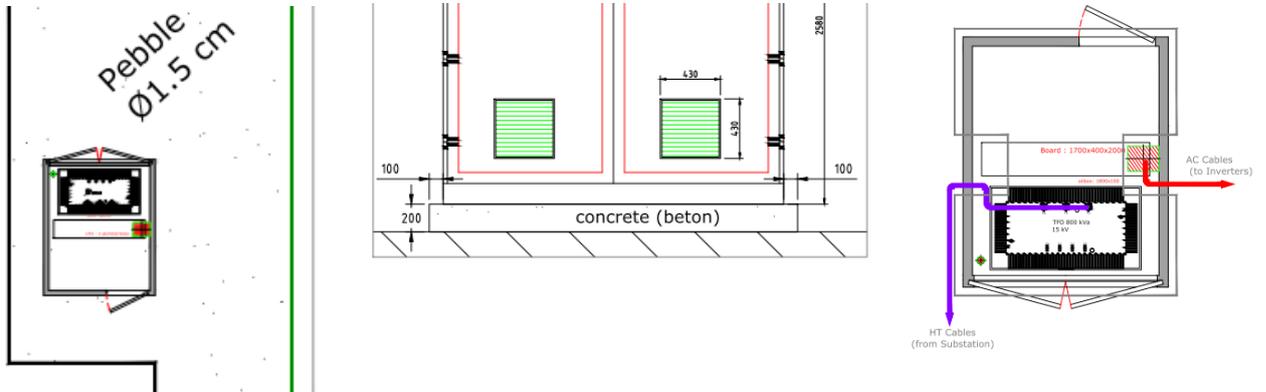
This works can be executed before the mounting works started and without the presence of any of our installing people.



- Execution of 3m wide internal roads with appropriate cover. The ground has to be removed over a depth of 30 cm and spread out over the field. In this bed there will be placed a geo cloth F2B with overlap. On this geo cloth will be placed 30 cm of building rubble with a maximum diameter of 5 cm and a thickness of 30 cm. This road base will be pressed and on top of it there will be placed pebble with a diameter of 1.5 cm in a drained way from 10 cm in the middle to 5 cm on the edges.

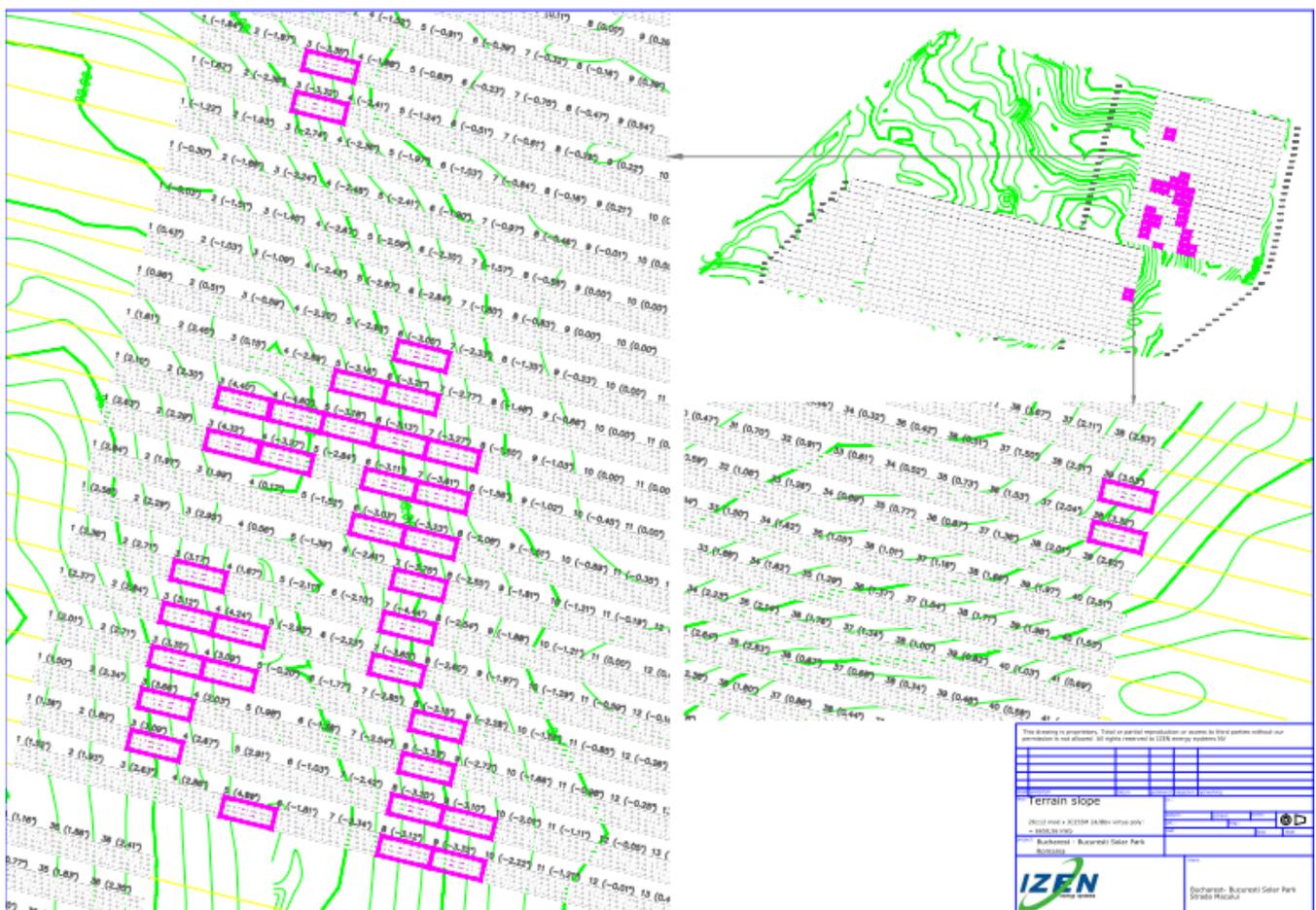


- Terrain preparation for Transformation Cabins. Around the Trafo stations the road structure is the same as all the roads. Under the Trafo stations there will be a concrete plate as foundation. This concrete plate has open spaces at both both sides for cable passages.



As some cables cross the roads through underground conduits, this empty pipes should be brought in place by our installing workers during the construction of the roads.

- Terrain preparation or leveling for structures where the difference between 2 tables is more than 3°. (only a few places)



## 4.2 FIXED STRUCTURE

Without enough knowledge about the kind of soil we have considered that the terrain's topography and composition allows execution foundations for the proposed structures and other required civil works. These considerations do avoid the requirement of geotechnical and topographical studies in a further stage of development.

The modules support structures allow us to place them with a defined inclination in order to optimize to relation between the production and the shadowing. The ramming posts structures were dimensioned in order to support a wind velocity of 120 Km/h and are made of steel witch is protected by hot dip galvanization.

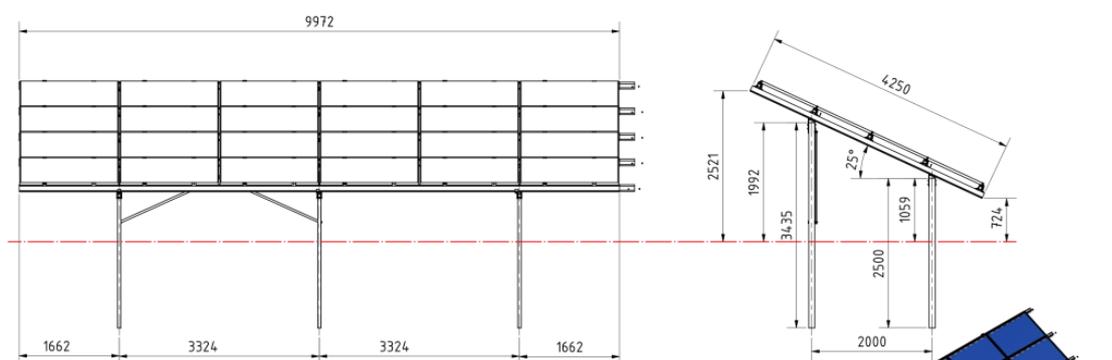
The profiles supporting the modules and all module clamps are made of aluminum. The fixation screws in contact with aluminum are of stainless steel with anti-theft clamps.

The selected structure is from a company that is a market reference fulfilling all the quality standards required for this type of installations.

This type of structure, with the usage of ramming will avoid the use of concrete in the soil, which besides environmental issues will be an advantage after the operation period, when dismantling shall be considered.

Regarding the layout, the placement of 4 modules in the vertical position and 6 modules in the horizontal position was the option selected, due to production optimization reasons. The following figure shows the details for this structure.

Calculations were made in order to define the correct distances between rank, in order to accept small shadowing during different periods of the year.



Description	Item nr.	Table
		4x6
1 Sigma support equipment 25° 2 posts		3
2 Module 1640x992x40		24
3 Clamp pre-assembled		30
4 Drilling screw diam. 6x25		10
5 support rail- profile 80x100 light- lenght 9972mm	145192 L	5
6 Edge clamp for profile 80x100 module height 40mm		24
7 Middle clamp for modul height 38-44mm	140142 K	36
8 Profile connector for profile 80/100 special lenght	999991	5
9 Wind connection: Alu-Profile lenght 3700mm		2
10 Theft protection middle clamp	140140 D	18
11 Theft protection edge clamp	140133 D	12
12 Cable holder 60mm	703110	28

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Sigma table 25° with double support 4x6 modules  
Romania- Bucuresti Solar Park

## 4.3 PV MODULES

The scale of this project and the present market conditions made us consider several solutions for the photovoltaic modules, for example in terms of power specifications, to ensure this project modules supply. Nevertheless all our choices would have to meet certain quality requirements previously established, always with the perspective of searching exclusively bankable modules.

Before choosing PV module some studies had been made in order to identify the suppliers which would guarantee certain levels of quality and delivery deadlines. As a result of these studies, the chosen photovoltaic module for the preliminary configuration of this project is ReneSola, Poly or Virtus 255 Wp

ReneSola modules benefits of

- Always till 5W +(PLUS) tolerances on peak power
- Linear warranty.
- Power Guard warranty

### Why ReneSola

Dear Sir or Madam:

Recently, we get the question why they should choose ReneSola as their panel supplier in their PV project. Here following is some points which you may agree:

As you know, ReneSola is published company in New York Stock Exchange with code of "SOL". In 2010, we have revenue about 1.2billion USD. For 2011, due to the market change, we still have about 1billion USD Revenue.

As a published company, we have the certificate of ISO9001, ISO14001 and OHSAS18001, TUV, UL, CEC, ISO, IEC, CE, MCS and so on. Attached are the certificates for your reference.

ReneSola start PV wafer production in 2005 and continuously growing up. We have customers like BP Solar, Gintech, SunTech Power, Motech, Q.CELLS, CSI, SCHOTT SOLAR, JA SOLAR, SOLARFUN, SUN EARTH, JETION SOLAR, TOPRAY SOLAR AND ETC. We are no. 1 supplier of Suntech Power for the high efficiency wafer for last 5 years

Attached is the update TDS for your reference about our main product for 2012. It includes 190/195Wp mono and 235/240/245Wp poly and 245/250Wp Virtus with plus tolerance. I hope we have more chance to work together in 2012.

In additional, our company has following advantages comparing to other players:

1, As we are no. 1 supplier for high efficiency wafer, you may know that we delivery high efficiency wafer to Suntech Power, CSI, Trina, Q-Cell and etc. So, we are confident about the quality of our wafer, solar cell and solar panels.

2, As you know, we have 10,000MT poly crystalline raw material production, we can keep a constant low price comparing to others; With the 2GWp wafer supply capacity, we are able to delivery highest efficiency and quality wafer to make sure that we can get highest quality cells and panels. With the building up of a service center in Frankfurt, a local service will be possible.

3, In additional, we have a R&D team(about 120 people) who is working to develop no degradation wafer, we hope to bring these product at second half of 2012. You know, once these products come out, the energy yield will be much better. I think your partner need to bring you not only a good product for today, your partner also need to bring competitive product for coming a few years.

Best regards

## Virtus Module

250W, 255W, 260W



High Module Conversion Efficiencies



Easy Installation and Handling



Mechanical Load Capability of up to 5400 Pa



Conforms with IEC 61215:2005,  
IEC 61730: 2004, UL 1703 PV Standards



ISO9001, OHSAS18001, ISO14001 Certified



- Linear Performance Warranty
- Traditional Warranty

**10-year**  
material & workmanship

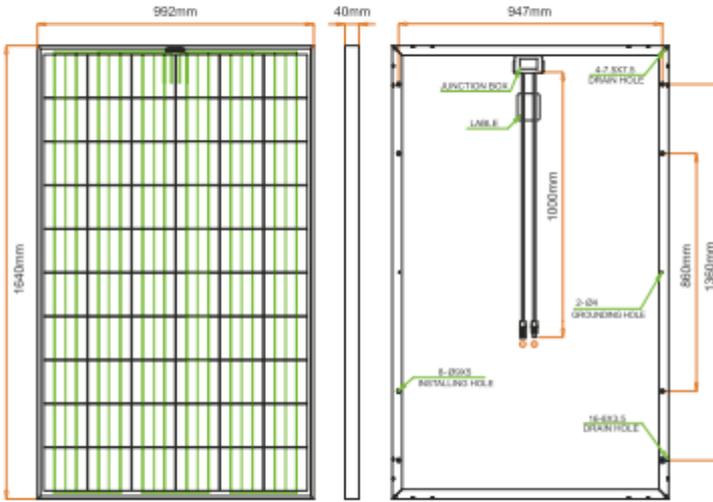
**25-year**  
linear power output



APPROVED PRODUCT

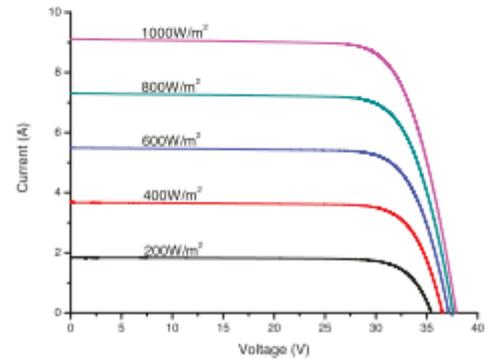


#### Dimensions



Drawing Only for Reference

#### I-V Curves



#### Varied Irradiation Efficiencies

Irradiance	200W/m <sup>2</sup>	400W/m <sup>2</sup>	600W/m <sup>2</sup>	800W/m <sup>2</sup>	1000W/m <sup>2</sup>
Efficiency	15.7%	16.0%	16.1%	16.1%	16.0%

#### Electrical Characteristics STC

	JC250M-24/Bbv	JC255M-24/Bbv	JC260M-24/Bbv
Maximum Power (Pmax)	250 W	255 W	260 W
Power Tolerance	0 ~ +5W	0 ~ +5W	0 ~ +5W
Module Efficiency	15.4%	15.7%	16.0%
Maximum Power Current (Imp)	8.29 A	8.43 A	8.56 A
Maximum Power Voltage (Vmp)	30.2 V	30.3 V	30.4 V
Short Circuit Current (Isc)	8.84 A	8.98 A	9.09 A
Open Circuit Voltage (Voc)	37.3 V	37.4 V	37.6 V

Values at Standard Test Conditions STC (Air Mass AM1.5, Irradiance 1000W/m<sup>2</sup>, Cell Temperature 25°C)



LEADERSHIP, KNC

# Renesola – PowerGuard Solar Power Quality Guarantee Insurance

12 AUGUST 2012

## Policy Structure

- Coverage provided by this insurance is based on the Warranty offered by Renesola to its clients, including
  - Product warranty
  - Performance warranty

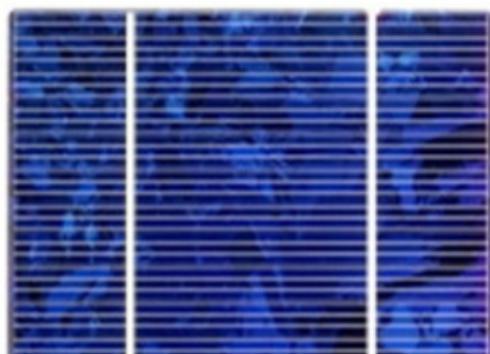


- Policy Period: From 12:00 am Aug 1st, 2012 to 12:00 am Aug 1st, 2013
- Covered Products: Photovoltaic module equipment sold by Renesola Solar that are selected to be declared into the policy
- Sales Exposure: Up to \$150,000,000, If sales exceed \$150,000,000 during the period, additional premium will be charged
- Warranty Period:
  - First Tranche: Year 1 ~ Year 10 (cover by Hannover)
  - Second Tranche: Year 11 ~ Year 25 (cover by RSUI)
- Territory: Worldwide
- Policy Form: Claim made and report basis during the Warranty Period

## What are Covered?

### Coverage 1

- “Loss”, “Damage”, or “Expenses” incurred: To repair, replace or furnish financial settlement for “Damage” arises from a “Product Defect”



### Coverage 2

- “Loss”, “Damage”, or “Expenses” incurred: To repair, replace or furnish financial settlement for undamaged “Covered Equipments” when a “Serial Product Defect” arises



## What are NOT Covered?

01	Direct physical "Damage" or "Destruction" to "Covered Solar Energy Collection Equipment"	07	"Loss" or "Damage" or "Expense" due to Renesola's liability for bodily injury, property damage, personal injury or advertising injury, including but not limited to strict liability
02	"Loss" arising from performance of Renesola, Renesola's agents, employees or any repair facility, its agents or employees	08	Breach of any implied warranties arising out of law
03	"Loss", "Damage" or "Expense" within the "Self-Insured Retention" amount	09	Willful act or gross negligence on Renesola's part
04	"Loss", "Damage" or "Expense" in excess of the Aggregate Limit of Insurance	10	Liability or duty to anyone other than Renesola
05	Expenses that is not a part of cost of the "Covered Solar Energy Equipment", such as receiving, handling, inspecting, testing or installing, etc.	11	Any liability for "Loss", "Damage" or "Expense" sustained as result of a tort, wrongful act or negligence by Renesola or any other party
06	"Loss" or "Damage" arising from those events specifically excluded from Warranty	12	Any loss of income or profit or any extra expense Renesola suffer due to "Loss" or "Damage"

## What are NOT Covered? – Cont.

13	"Loss" or "Damage" associated with or arising from the interruption of service	18	Any fines or penalties imposed on Renesola by any governmental entity or "Contract Holder", except that covered by Endorsement(s)
14	Any duty to defend or represent Renesola in a Suit or other judicial or administrative proceeding	19	Any "Loss" or "Damage" arising out of any "Product Defect" where the defect was known to Renesola prior to the sale
15	"Loss" of any nature / "Loss" in connection with any actual or alleged violation of any federal, state or local laws or regulations	20	Any "Loss" or "Damage" arising as a result of Warranty Terms that have not been accepted in writing by PowerGuard.
16	Any "Loss", "Damage" or "Expense" arising from a nuclear reaction, nuclear radiation or radioactive contamination	21	Building Integrated Photovoltaic
17	"Loss", "Damage" or "Expense" arising from war-like activities, except those authorized by Government or Law.	22	Damage to or arising from Microinverter

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## Duties in the Event of Loss

1. As soon as reasonably practicable notify our claims administrator by telephone, fax or email, and send written notice of "Claim" after the "Loss" or "Damage" comes to your attention.
2. During and after the event, take all reasonable steps within Renesola's power to preserve and salvage the property insured and to minimize the "Loss", observing any reasonable instructions as may be given by PowerGuard;
3. Report all criminal acts immediately to the police in a timely manner;
4. Expeditiously determine the extent of the "Loss" or "Damage", its cause, and recommend steps to remedy the "Loss" or "Damage".
5. Submit a written report to PowerGuard describing the extent of the "Damage" or "Loss", the causes thereof and measures which Renesola recommend are to be taken to remedy same;
6. Renesola and any person authorized by Renesola has the duty to control all necessary repairs, provided however that Renesola shall ensure that such repairs are performed in a proper, reasonable and economical manner;
7. Upon notification to PowerGuard under this condition, Renesola may carry out repairs of any minor "Loss" or "Damage" or replace items which have sustained any "Loss" or "Damage" of less than the "Self-Insured" Retention" shown in the Declarations of this policy; in all other cases PowerGuard's representative shall have the opportunity to inspect the "Loss" or "Damage" before any repairs or alterations are effected, and PowerGuard shall not unreasonably delay the performance of this right.

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## Notice of Claim

1. In the event of "Loss" or "Damage", Renesola shall give, as soon thereafter as practicable, notice of such "Loss" to PowerGuard and shall communicate to PowerGuard a detailed Proof of Loss in a form provided by PowerGuard containing the information PowerGuard may request to investigate the "Claim" within thirty (30) days from the date Renesola receive notification from Renesola's customer of a "Loss".
2. Renesola shall provide PowerGuard a description of the "Covered Solar Energy Collection Equipment" and the components involved and a description of how, when and where the "Loss" or "Damage" occurred.
3. Renesola shall perform a test of the "Covered Solar Energy Collection Equipment" carried in accordance with the "Standard Test Conditions" defined in the IEC standards 61215 (crystalline silicon terrestrial photovoltaic modules). A significant and meaningful proportion of photovoltaic modules for which "Loss" or "Damage" is claimed shall be submitted to the performance test in accordance with Renesola's quality procedures that Renesola have documented and that are recognized as a component of Renesola's ISO 9000-certified quality assurance standards.
4. At PowerGuard request, Renesola shall give PowerGuard complete inventories of the damaged and undamaged property including quantities, costs, values and the amount of "Loss" claimed.
5. Renesola shall permit PowerGuard to inspect the property proving the "Loss" or "Damage" and to examine Renesola's books and records and to make copies from Renesola's books and records, and Renesola shall permit PowerGuard to take samples of damaged and undamaged property for inspection, testing and analysis.
6. Renesola shall cooperate with PowerGuard in the investigation or settlement of the "Claim". Any and all of the information obtained by PowerGuard from access to Renesola books and records as well as other surveys and investigations will be maintained by PowerGuard in confidence and will only be used by PowerGuard in a manner consistent with the objectives herein.

## 4.4 DC CABLES

### TOP SOLAR PV ZZ-F (AS)

#### PV1-F 0,6/1 kV (1,8 kV c.c.)

Flexible cables suitable for mobile and fixed installation. Suitable for connection between photovoltaic panels, and photovoltaic panels to the AC inverter. High security cable (AS): no fire propagation, low smoke emissions and halogen-free. Suitable for indoor and outdoor use. These cables meet the HD 605/A1 weather-UV test.

The materials used in the construction of these cables exceed the thermal endurance test specified in the standard UNE-EN 60216 for +120 °C (temperature index). Compliance with this test provides that, with proper installation, operation and maintenance, the estimated life of the cable is 30 years at 90 °C.

**Nominal voltage:** AC: 0,6/1 kV; DC: 1,8 kV

**Ambient temperature range:** -40 °C to + 90 °C.

**Maximum conductor temperature:** 120 °C.

**Maximum short-circuit temperature:** 250 °C (maximum 5 s).

**Minimum bending radius (fixed):** 5 x cable Ø.

**No flame propagation:** EN 60332-1-2 / IEC 60332-1-2.

**No fire propagation:** EN 60332-3 / IEC 60332-3.

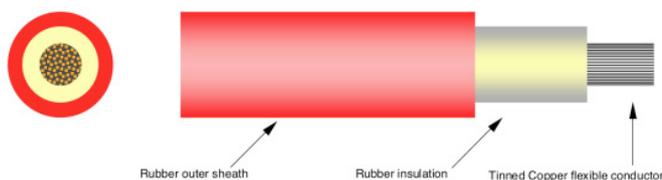
**Halogen free:** according to EN 50267 / IEC 60754

HCl content < 0,5%.

pH > 4,3 ;

conductivity < 10 µS/mm.

**Smoke density:** light transmittance > 60% (according to EN 61034 / IEC 61034).



### Connector system for photovoltaic

### MC4

PV-KST4...-UR



PV-KBT4...-UR



# 4.5 INVERTERS

The inverter is responsible for converting direct current (DC), generated from the photovoltaic modules, in alternated current (AC) to be injected in the public electrical grid.

Considering the terrain surface is not equally it is better to use decentralized inverters which can increase solar production in these circumstances.

All the inverter's specifications were taken into account when designing the PV plant and setting up the number of modules in series (fixing the value of tension) and the number of string in parallel (fixed power).

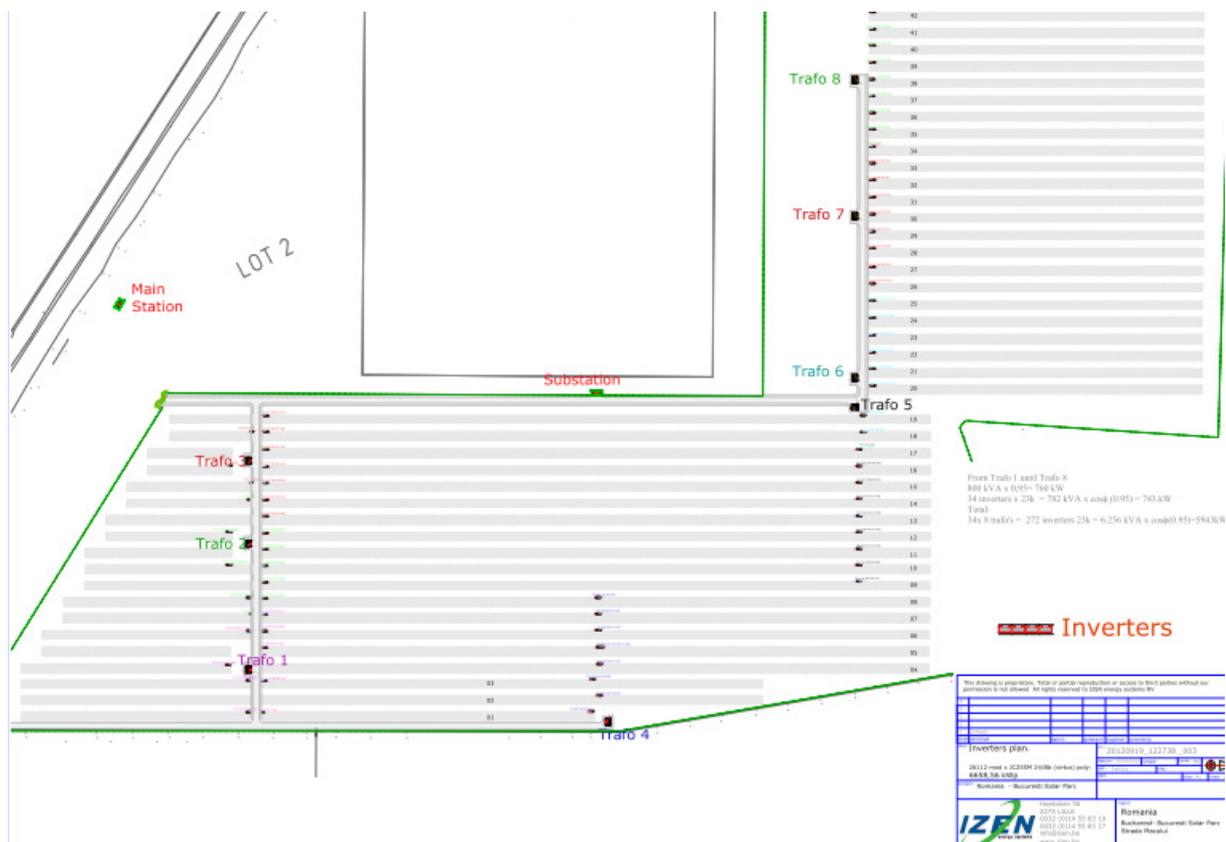
Another very important fact on the inverter is its nominal power. The closer it works with this value, the higher performance it will get.

The selected inverters are a market reference fulfilling all the quality standards required for this type of installations, regarding protections, electromagnetic compatibility, etc.

These system designs were enhanced with the installation of REFUSOL 23K TL inverters for the total of the PV plant.

Some of the features of this equipment are:

- Faults notification via modem
- Data acquisition and logging
- Isolation protection
- DC and AC over voltage protection



New

## REFU*sol*/ 023K - 460 VAC REFU*sol*/ 023K - 460 VAC



Thanks to its high output voltage, the new REFU*sol*/ 023K - 460 VAC three-phase string inverter is the ideal solution for medium voltage applications in large-scale PV systems. Thus, the device completes the existing series of REFU*sol*/ 008K – 020K string inverters with 400 VAC and the outdoor-compliant central inverter REFU*sol*/ 333K with 690 VAC.

The innovative MPP tracking and the wide input voltage range allows for a peak efficiency of 98.3% even at low irradiation. The easy day-and-night monitoring of yield is ensured by an integrated data logger – e.g. using the REFU*log* internet platform. The data logger is connected to the Ethernet and optionally to the wireless REFU*connect* module.

Its low weight and unique power density allow for easy handling when installing the transformerless inverter. Due to its „plug & play“ connectors and integrated interfaces such as RS485 or Ethernet, the new string inverter is future-proof and installed within a short time. Absolutely no maintenance is ensured as a result of the convection cooling concept of the three-phase REFU*sol*/ 023K. Thus it is a reliable component for your additional yield.

# REFU*sol*

### Highlights:

- 460 VAC for medium voltage applications
  - Highest efficiency (98.3%)
  - Easy installation
  - Suited for outdoor applications (IP65)
  - Maintenance-free
- 
- 460 VAC für Mittelspannungsapplikationen
  - Höchste Effizienz (98,3%)
  - Einfache Installation
  - Outdoorfähig (IP65)
  - Wartungsfrei

Der neue dreiphasige Stringwechselrichter REFU*sol*/ 023K - 460 VAC ist dank der hohen Ausgangsspannung die ideale Lösung für Mittelspannungsapplikationen im Bereich der PV-Großanlagen. Damit schließt das Gerät die Lücke zwischen der bestehenden Serie der Stringwechselrichter REFU*sol*/ 008K – 020K mit 400 VAC und dem outdoorfähigen Zentralwechselrichter REFU*sol*/ 333K mit 690 VAC.

Durch das innovative MPP-Tracking und den breiten Eingangsspannungsbereich wird schon bei geringer Einstrahlung der Spitzenwirkungsgrad von 98,3% erreicht. Dank des integrierten Datenloggers können die Erträge rund um die Uhr bequem überwacht werden – z. B. über die Internetplattform REFU*log*. Die Installation erfolgt über eine Ethernetanbindung und optional über das kabellose Funkmodul REFU*connect*.

Das geringe Gewicht und die einzigartige Leistungsdichte sorgen für einfaches Handling bei der Installation des traflosen Wechselrichters. Durch die „plug & play“ Steckverbindungen und die integrierten Schnittstellen, wie z. B. RS485 oder Ethernet, ist auch der neue Stringwechselrichter zukunftssicher und in kürzester Zeit installiert. Das Konzept der Konvektionskühlung macht den dreiphasigen REFU*sol*/ 023K absolut wartungsfrei und zu einer zuverlässigen Komponente für Ihren Mehrertrag.

## Technical data Technische Daten

		REFU <sup>sol</sup> 023K	
<b>DC data</b>	<b>DC Daten</b>		
Max. PV power	Max. PV-Leistung	25.3 kW P <sub>nom</sub> +10%	
MPPT range	MPPT-Bereich	575 ... 900 V	
Max. DC voltage	Max. DC Spannung	1000 V	
Max. DC current	Max. DC Strom	41 A	
MPP tracking	MPP Tracking	One fast, precise MPP tracker	Ein schneller, präziser MPP-Tracker
Number of DC connections	Anzahl DC-Anschlüsse	6 x MC4	
DC-disconnection switch	DC-Trennschalter	Yes	Ja
Internal overvoltage protection	Interner Überspannungsschutz	Type 3	Typ 3
<b>AC data</b>	<b>AC Daten</b>		
Rated AC power	AC-Bemessungsleistung	23 kVA	
Max. AC active power	AC max. Wirkleistung	23 kW	
AC grid connection	AC Netzanschluss	3 AC 460 V + N 50-60 Hz	
Rated power factor	Nenn-Leistungsfaktor	1	
Adjustable displacement factor	Verschiebungsfaktor einstellbar	0.9i ...1... 0.9c	
Max. AC current	Max. AC Strom	29.2 A	
Distortion factor THD	Klirrfaktor THD	< 1.8%	
Max. efficiency	Max. Wirkungsgrad	98.34%	
European efficiency	Europ. Wirkungsgrad	98.10%	
Infeed starting at	Einspeisung ab	20 W	
Internal consumption in night operation	Eigenverbrauch Nacht	< 0.5 W	
Internal overvoltage protection	Interner Überspannungsschutz	Type 3	Typ 3
<b>Cooling, ambient conditions, EMC</b>	<b>Kühlung, Umgebungsbedingungen, EMV</b>		
Cooling	Kühlung	Natural convection	Natürliche Konvektion
Ambient temperature	Umgebungstemperatur	-25 ... +55°C	
Elevation	Aufstellhöhe	Up to 2000 m above sea level	Bis 2000 m über NN
Noise	Geräusch	< 45 dBa	
Emitted interference	Störaussendung	EN 61000-6-4: 2007	
Interference immunity	Störfestigkeit	EN 61000-6-2: 2005	
Environmental classif.	Umweltklassen	4K4H acc. to DIN IEC 721-3-4	4K4H nach DIN IEC 721-3-4
Certification	Zertifikate	CE, VDE0126-1-1, VDEW compliance, Belgium C10/C11, Italy ENEL, Spain RD1663, RD661, Austria ONORM, EN 50438:2007: Cyprus, Portugal	
Grid code	Netzanschlussbedingungen	Complies with all of the German low and medium voltage grid regulations (VDEW, BDEW, VDE-AR-N 4105 <sup>1)</sup> , EEG2012) Erfüllt alle Bestimmungen für das Nieder- und Mittelspannungsnetz (VDEW, BDEW, VDE-AR-N 4105 <sup>1)</sup> , EEG2012)	
SZS or grid protection	selbsttätige Schaltstelle	Acc. to VDE 0126-1-1	Nach VDE 0126-1-1
Interfaces	Schnittstellen	Ethernet & RS485	
<b>Mechanical</b>	<b>Mechanik</b>		
Type of protection	Schutzart	IP65 as per EN 60529	IP65 nach EN 60529
Dimensions Width / Height / Depth	Abmessungen Breite / Höhe / Tiefe	535 mm / 601 mm / 277 mm	
Weight	Gewicht	41,5 kg	

<sup>1)</sup> In preparation

<sup>1)</sup> In Vorbereitung

# 4.6 MONITORING SYSTEM

The plant monitoring is vital for the plant well-functioning and for taking advantage of system efficiency. This system consists in capturing data regarding energy production through the inversion system using equipment that records, processes and transmits this data via internet (GSM or PSTN), internal plant server, etc.

Exploiting the equipment directly connected to the inverter, we have the advantage of besides the production data, getting several blocks of information regarding the inverter and plant status. This way there is the possibility to follow and present in real time several parameters regarding the plant status, such as creating its history.

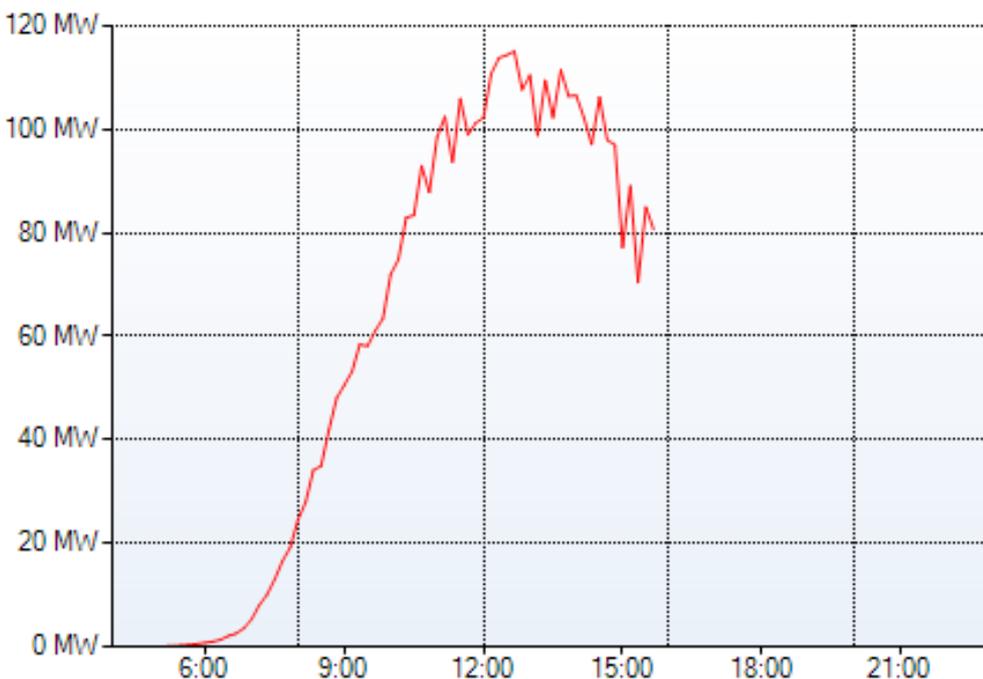
For the present project we selected Refulog proprietary monitoring system and control equipment which is presented hereinafter. This system allows having a time tracking of several PV plants' functioning parameters, such as production values. This system will also allow to keep historical data and to present it at any moment.

This system, among others, allows measuring:

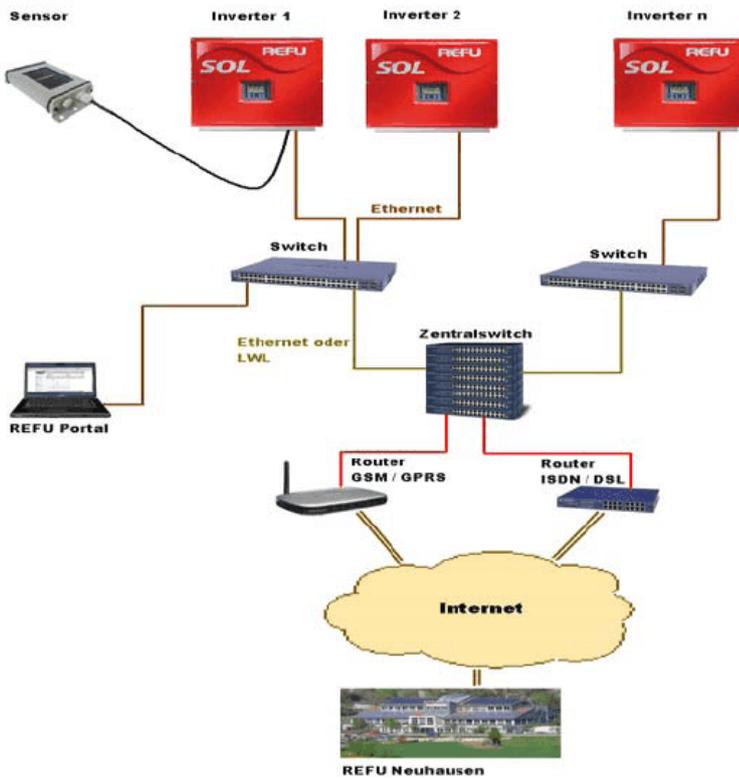
- Voltage and current values at the inverter input side.
- Grid phase voltage and inverter output power.
- Exterior temperature.
- Modules temperature.
- Hourly data.

In the following figure we can see a basic scheme of the monitoring system:

Produced energy: **9.169.443,- kWh** Reduced CO2: **4 969 ton**



# Monitoring system basic scheme



Willkommen REFU Elektronik GmbH (guest) | Abmelden

FAQ Kontakt

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**Anlage** Statistik

REFU Metzgingen / Neuhausen

Anlagenübersicht

- REFU Metzgingen / Neuhausen
- 301
- 302
- 303
- 304

## Anlage "REFU Metzgingen / Neuhausen"

Zurück Wechselrichter Karte

**Anlagendaten**

Beschreibung	Dies ist die Testanlage der REFU Elektronik GmbH
Expansionsnr.	REFU Elektronik GmbH
Installierte Leistung	47,5 kWp
Modultyp	72 Module SP2004-220, 108 Module SP130/10-130 Solar-Panels
Ausrichtung	-0°
Neigung	14,0°
Modulfläche	0,0 m²
Wechselrichter	4
Wechselrichtertypen	000003 (4)
Erzeugerart	0,40 €

**Aktuelle Daten**

Status	<span style="color: green;">✔</span>
Ertrag	69 €
Gesamtertrag	139 kWh
GG, Einsparung	74 kg
Aktuelle Leistung	3,4652 W
Tagesertrag	3,7 kWh
Tagesertrag normiert	5,08 kWh/m²
Einstrahlung	29 W/m²
Modultemperatur	-0 °C
Letzter Datenempfang	20.02.2009 11:00:00

**Statistik**

Tag: Monat Jahr Gesamt

09.12.2008

**Datenauswahl**

REFU Metzgingen / Neuhausen	AC Leistung
211	AC Leistung normiert
212	Tagesertrag
213	
214	

-<< Hinzufügen

**Legende**

REFU Metzgingen / Neuhausen AC Leistung W

# 4.7 AC CABLES

## Power cable NYY-J/- O acc. to VDE 0276-603



conductor material:	bare copper
conductor construction:	class 1, from 25 sqmm class 2
insulation:	PVC DIV 4
sheathing material:	PVC DMV 5
colour of outer sheath:	black
meter mark:	yes
flame retardant:	VDE 0482-332-1-2/IEC 60332-1
UV-resistant:	yes
maximum temperature at conductor:	70 °C
max. operating temperature, fixed:	70 °C
temperature, moved/during installation:	-5 - +70 °C

	NYY-J	NYY-O
nominal voltage U <sub>0</sub> :	600 V	600 V
nominal voltage U:	1 kV	1 kV
maximum permitted operating voltage in 3-phase systems:	1,2 kV	1,2 kV
test voltage:	4 kV	4 kV

**Application:** For fixed installation in buildings, in free air, in ground and in water.

Switzerland:	TT
Denmark:	PVILD
Austria:	E-YY
Russia:	BBГ



The products and information presented here are for technical calculation only. They are subject to technical progress and in no way represent the ability of shipment. Outer diameters are approximately.

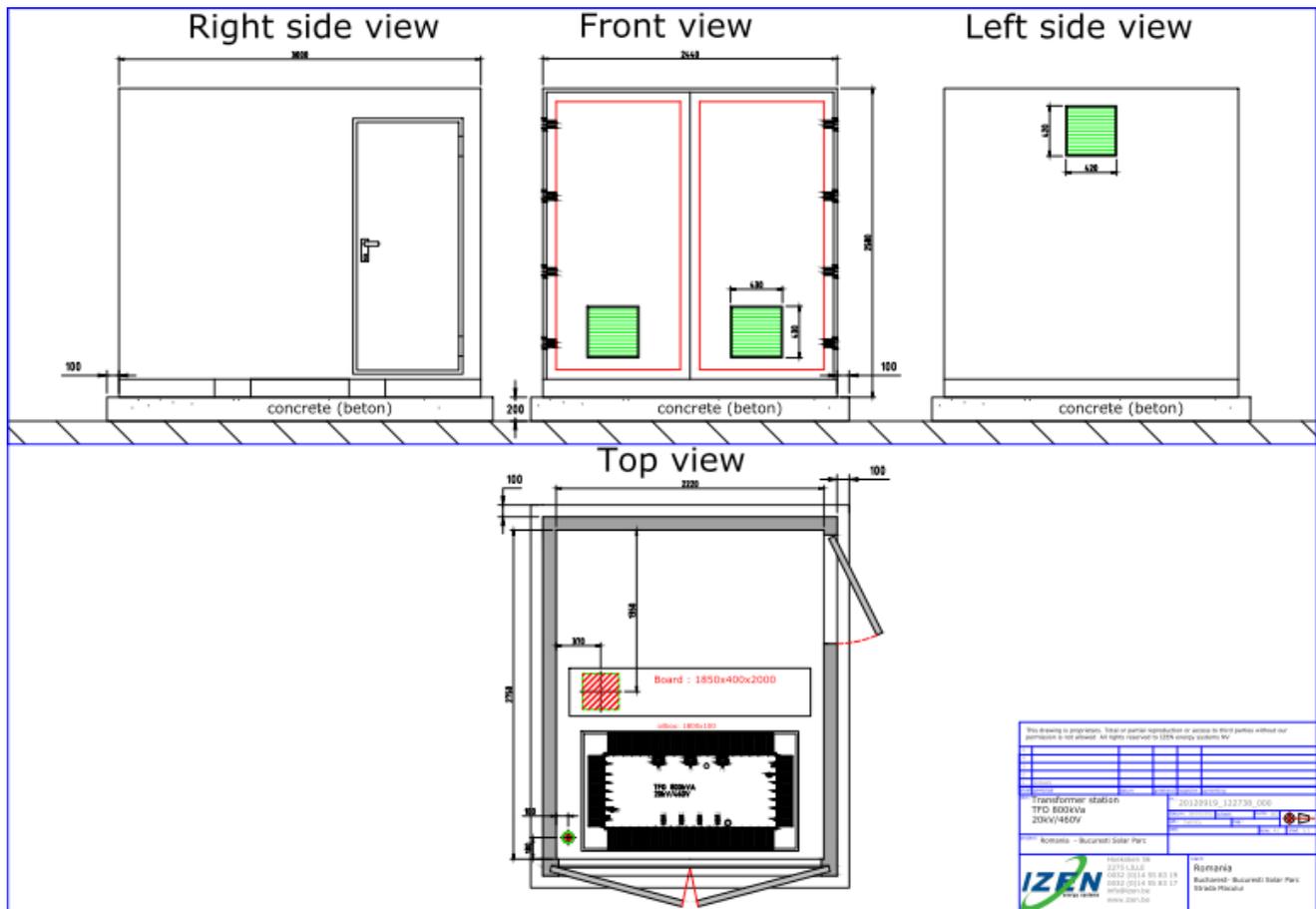
### Core identification

number of cores	with protective conductor	without protective conductor
1	green-yellow	black
2	-	blue, brown
3	green-yellow, blue, brown	brown, black, grey
4	green-yellow, brown, black, grey	blue, brown, black, grey
5	green-yellow, blue, brown, black, grey	blue, brown, black, grey, black

Table: Technical characteristics NYY-J

p/n	part name	R <sub>i</sub> [Ω/km]	W <sub>i</sub> [mm]	I <sub>bl</sub> [A]	I <sub>be</sub> [A]	I <sub>k</sub> [kA]	L <sub>b</sub> [mH/km]	R <sub>bv</sub> [mm]	W <sub>m</sub> [mm]	D <sub>A</sub> [mm]	F <sub>z</sub> [N]	Cu [kg/km]	G [kg]	
011840	NYY-J 01X4 SW	RE	4,61	1	37	50	0,46	0,459	136,5	1,8	9,1	200	38	110
011742	NYY-J 01X6 SW	RE	3,08	1	47	62	0,69	0,431	142,5	1,8	9,5	300	58	130
010133	NYY-J 01X10 SW	RE	1,83	1	64	83	1,15	0,399	153	1,8	10,2	500	96	180
010116	NYY-J 01X16 SW	RE	1,15	1	84	107	1,84	0,371	168	1,8	11,2	800	154	240

## 4.8 TRAF0 STATIONS & EQUIPMENT



### Specific description custom 10ft container:

#### **Insulation:**

- Structure of metal studs, welded in walls, doors and roof. This structure is used to fix the lining. This structure can be used to fix your equipment to the walls
- Insulation walls, doors and roof: PUR, thickness 50mm
- Lining walls, roof and doors: galvanized steel plate, thickness 0,8mm, riveted to the structure

#### **Single door:**

- 1 door
- Steel door, DIN 4102
- 1 wing, turning to the outside
- WxH: 900x2050mm
- Insulation: Styrofoam, thickness 50mm
- Steel profiles, thickness 2mm
- External door sheet, Steel plate, thickness 1,5mm
- Internal door sheet, galvanized steel plate, thickness 0,8mm
- 2-piece hinge plates with ball bearing
- Door handle and cylinder key lock on outside with 3 keys

#### **Lock case double door:**

- On the lock bar of the first opening leaf we place a lock case
- Steel case, thickness 3mm, hinged gripper pin that goes through the door leaf
- Lock on the inside of the container according your specifications

**Openings:**

- In the wooden floor we make a hole with dimensions 200x200mm
- In each leaf of the door we welded a framework, built from metal profiles, thickness 3mm. On these framework we mounted a grille Renson, type 425 (dimensions: 500x500mm)
- In the wall we welded 2 frameworks, built from metal profiles, thickness 3mm. On these frame we mounted a grille Renson, type 433 (dimension: 400x428mm). At the inner side we placed a steel sheet for mounted your ventilator

**Electricity:**

- 2x Lights 2x58W
- 1x Light switch
- 2x Power points 220V
- 1x safety lightning 8W with 1h autonomy
- Cables are incorporated in walls
- Attestation AIB Vinçotte

**Mounting points in floor:**

- 4x mounting points in floor
- Steel plate welded on the structure of the floor
- Mounting with vibration dampers of your inputted ventilators

**Painting:**

- Container is steel blasted outside (SA 2.5)
- Painting:
  - 2K Epoxy primer, thickness 60µm
  - 2K PU finishing, thickness 80µm in your choice of color

<b>Technical specification</b>		
<b>Project : Romania</b>		
<b>Brand : SCHNEIDER ELECTRIC</b>		
<b>Threephase oil immersed distribution transformer</b>		
<b>According to EN 50464-1 standard - losses E0Dk</b>		
Rated power :	800	KVA
Cooling :	ONAN (natural)	
Insulation class - Temperature rise :	A - 60/65	K
Maximum ambient temperature :	40	°C
Primary rated voltage :	20000	V
Primary connections :	Plug in	
Tapping range : off circuits tapping	± 2,5 ± 5	%
Insulation level (Um) :	17,5	KV
Secondary rated voltage at no-load :	460	V
Secondary connections :	Busbars	
Vector group :	Dyn11	
Rated frequency :	50	Hz
No load losses :	1400	W
Load losses at 75°C :	10500	W



## Masterpact NT 630-1600 A



MT630 A / 1600 A

La gamme Masterpact NT disjoncteurs de puissance assure la protection des circuits de forte puissance et des récepteurs :

- intensité nominale de 630 A à 1600 A
- volume unique de 630 A à 1600 A
- tri et tétrapolaire
- appareil fixe ou débrochant
- 4 types de protection électronique RMS en standard
- long retard réglable de 0,4 à 1 s par crans ou par cléset, en local ou à distance
- tension d'emploi jusqu'à 690 V CA
- pouvoir de coupure de 42 à 150 kA sous 230/415 V CA avec une nouvelle performance H2 (ou 50 kA/480 V)
- variantes interrupteur HA, HA10
- des fonctions électroniques dédiées à la gestion d'énergie et à l'analyse de réseau
- alimentation par le haut et par le bas
- mécanisme à accumulation d'énergie pour fermeture de l'appareil (synchro-couplage).

Une gamme d'accessoires et d'auxiliaires électriques complète :

- interverrouillage pour inverseur de source manuel ou automatique 2 Masterpact
- moteur de réarmement
- déclencheur à minimum de tension (MFI, MNR)
- déclencheur à émission de courant (MX)
- électro-aimant de fermeture (DF)
- contacts auxiliaires (DF, SDE, FF, etc.)
- bouton poussoir de fermeture électrique BFFE
- verrouillage par cadenas et/ou par clés.

## Protection Circuit protection

## iC60L circuit breakers (curve B, C, K, Z)



Country approval pictograms

IEC/EN 60947-2

IEC/EN 60898-1 up to 40 A

- iC60L circuit breakers are multi-standard circuit breakers which combine the following functions:
  - circuit protection against short-circuit currents,
  - circuit protection against overload currents,
  - suitable for industrial isolation according to IEC/EN 60947-2, standard,
  - fault tripping indication by a red mechanical indicator in circuit breaker front face.



Alternating current (AC) 50/60 Hz						
Breaking capacity (I <sub>cu</sub> ) according to IEC/EN 60947-2						Service breaking capacity (I <sub>cs</sub> )
	Voltage (U <sub>e</sub> )	230 to 240 V	380 to 415 V	440 V		
Pole(s)	12 to 133 V	230 to 240 V	380 to 415 V	440 V		
Pole(s) (IP)	12 to 80 V	180 to 133 V	230 to 240 V	-		
Rating	0,5 to 4 A	100 kA	100 kA	100 kA	75 kA	100 % of I <sub>cu</sub>
IP	6 to 25 A	75 kA	50 kA	25 kA	25 kA	60 % of I <sub>cu</sub>
	32 to 40 A	75 kA	38 kA	25 kA	15 kA	60 % of I <sub>cu</sub>
	50 to 63 A	75 kA	38 kA	15 kA	15 kA	50 % of I <sub>cu</sub>
Breaking capacity (I <sub>cn</sub> ) according to IEC/EN 60898-1						
	Voltage (U <sub>e</sub> )					
Pole(s)	480 V					
Pole(s)	230 V					
Rating	0,5 to 40 A	15000 A				
IP						

## **General LV switchboard (160 --> 4000 A)**

### **Use**

Construction of low-voltage switchboards for the tertiary sector or for industry with main devices of 160 to 4000 A.

### **Compliance with the standards**

All low-voltage devices **comply with the NBN EN60439-1 standard** and have been subjected to the required standard and individual tests.

To simplify matters, the description “all low-voltage devices” is replaced in the text below by “LV switchboard” (low-voltage switchboard).

The LV switchboard is equipped with devices that comply with the NBN EN60947-1 to 7 standard.

The safety devices comply with the NBN EN60947-2 standard.

The organisation that assembles the LV switchboard, including all internal mechanical and electrical connections and their construction elements, is the “panelbuilder”.

The organisation that installs and connects the LV switchboard at its destination, including all mechanical and electrical connections and their construction elements, is the “installer”.

### **Construction characteristics**

The switchboard consists of cubicles of steel frames and sections placed next to each other affixed with screws without nuts that can be reached from the outside.

Each cubicle can contain 3 separate areas:

- Area/compartment for devices
- Area/compartment for the vertical busbar
- Area/compartment for connecting the cables

All elements of the frame and the panelling are treated with epoxy polyester paint in RAL9001 colour and have been subjected to surface treatment in accordance with the tests of the IEC 60068-2- standard, with a minimum resistance of 400 hours in case of salt-mist tests.

A change in the degree of protection (IP30, 43 and 55) requires no change of frames, and thus not the position of the devices either, but only a change of the panelling. IP55 panels are equipped in the factory with **polyurethane** (PUR) gaskets to guarantee tried and tested tightness.

The design of the switchboard makes it possible to introduce prefabricated electrical busbar or cables both from below (cables, and from above, from the front and the back, without having

to change the height of the cells, nor the position of the main busbar.

All connecting points must be perfectly reachable.

The front-most and rear-most longitudinal girder of the cubicles and/or the ducts are removable to facilitate the introduction of the cables in the uppermost part of the columns.

The horizontal busbar is placed in the higher or lower part of the cubicles, and consists of rectangular copper rods of Cu-ETP quality with a constant section depending on the nominal current rating (5 or 10mm). The number and position of the insulating supports is determined on the basis of the short-circuit current and the length of the busbar.

The connecting pieces between the horizontal busbars are equipped with “breakable” heads that make possible the prescribed attracting torque, even without using a torque key. The switchboard can be extended on either end by adding extra cubicles.

#### The compartment for the vertical “busbar:”

The vertical distribution busbar is installed in a side compartment that is to the right or to the left of the device area. It consists of profiled aluminium up to 1600A, and makes it possible to make connections over the entire height, without drilling, on all phases, and via the front side of the switchboard. The contact area on the profile is made of copper to guarantee contacts of a high quality.

#### The device compartment:

The low voltage switchboards are equipped with standard dedicated mounting plates, with separate fastening, for the installation of one or more devices, up to 3200 A.

All functional units of the same type and the same rating are interchangeable from the front side. The mounting plates have markings for a rapid positioning of the device. The device and the mounting plate are fastened with screws without nuts.

Steel sheet front plates are installed on the front side of the devices as a standard, offering a completely safe access to the operating controls for the user. The electrical continuity of these front plates in regard to the electrical masses is provided in the attaching system as a standard and requires no separate earthing strip or wire.

A global hinging frame is also used systematically for the front plates to be able to access the internals of the switchboard rapidly for an intervention, without having to remove one by one all the front plates. If all the plates have to be removed nonetheless, the disassembly/assembly is carried out with unloseable screws.

All screws that are used for the electrical connections are bichromated and of class 8.8 with underlying washer. After turning to the prescribed tightening torque, each screw connection must be marked with coloured varnish.

For the power supply of several moulded-case circuit breakers up to 250 A (up to 4 three-pole or 3 four-pole devices) in the same functional unit, prefabricated insulated distribution blocks are used that make rapid changes or addition possible.

The power supply of modular devices is done by means of distribution blocks that are

protected against direct touching (IPxxB). Equipped with spring terminals, these distribution blocks make a rapid interchange of devices possible as well as a rapid re-distribution of the power. The nominal rating of the distribution blocks may amount to a maximum of 200A.

#### The low voltage switchboard has form 1, form 2b or form 3b partitioning

Cover plates are provided for the device in order to achieve a form 2b or form 3b partitioning, if necessary, according to the NBN EN60439-1 standard. Furthermore, the user is protected from any direct access when the door is open by a front plate that is placed over the entire height of the busbar.

#### The compartment for the “cable connection” or cable duct:

The wiring with a diameter  $< 10 \text{ mm}^2$  are connected on terminals that are in the device compartment or in the duct.

The connection of the power cables is made either directly on the terminals of the devices or, only when several are placed on parallel, on the standard extension pads, connected to the device and installed in the duct.

### **Electrical characteristics**

- Designated operating voltage  $U_n$ : 690 V,
- $I_{eff./s}$ : 85 kA/1s,
- $I_n$  max: 3200 A,
- Designated insulation voltage: 1000 V,
- IP30 in the basic version, IP43 with gaskets and IP55 in the waterproof version.
- Ambient temperature: 35° C.
- 

### **General**

The low voltage switchboard is made by a **panelbuilder** approved or designated (with written certificate) by the designer and manufacturer of the devices and installation systems of which the LV switchboard consists.

This functional switchboard and installation system is designed in conjunction with the devices and forms a common modular design so as to meet the requirements for the operation of the devices, electrodynamic forces, insulation distances, and leakage paths.

Every low voltage switchboard is delivered with a technical file containing the following documents:

- Single-wire diagram, “as built” plans and diagrams of the switchboard
- General technical data
- List of the material, used nomenclature, manuals for assembly, adjustment and start up
- Copies of calculation notes for the derived test provisions subjected thereto
- Copies of the calculation notes for the selectivity, filiation
- Report of quality control and individual tests
- Statement that shows that the switchboard complies with the NBN EN60439-1 standard
- Explanation of CE marking
- Installation and maintenance instructions

A separate numbered sticker is affixed on one of the sides of the switchboard, mentioning that the low voltage switchboard complies with the NBN EN60439-1 standard, and referring to the certificate of conformity in the technical file.

Depending on the legislation in force under the European directives, the technical file must be kept in archival storage by the switchboard constructor for 10 years.

The individual tests are carried out on all constituent columns / casing parts of the low voltage switchboard, where appropriate after delivery, and in the presence of our representative (end customer or engineering)

The end customer or an inspection body authorised by him, may carry out an additional inspection on the basis of an acceptance procedure, after the low voltage switchboard has been installed and connected.

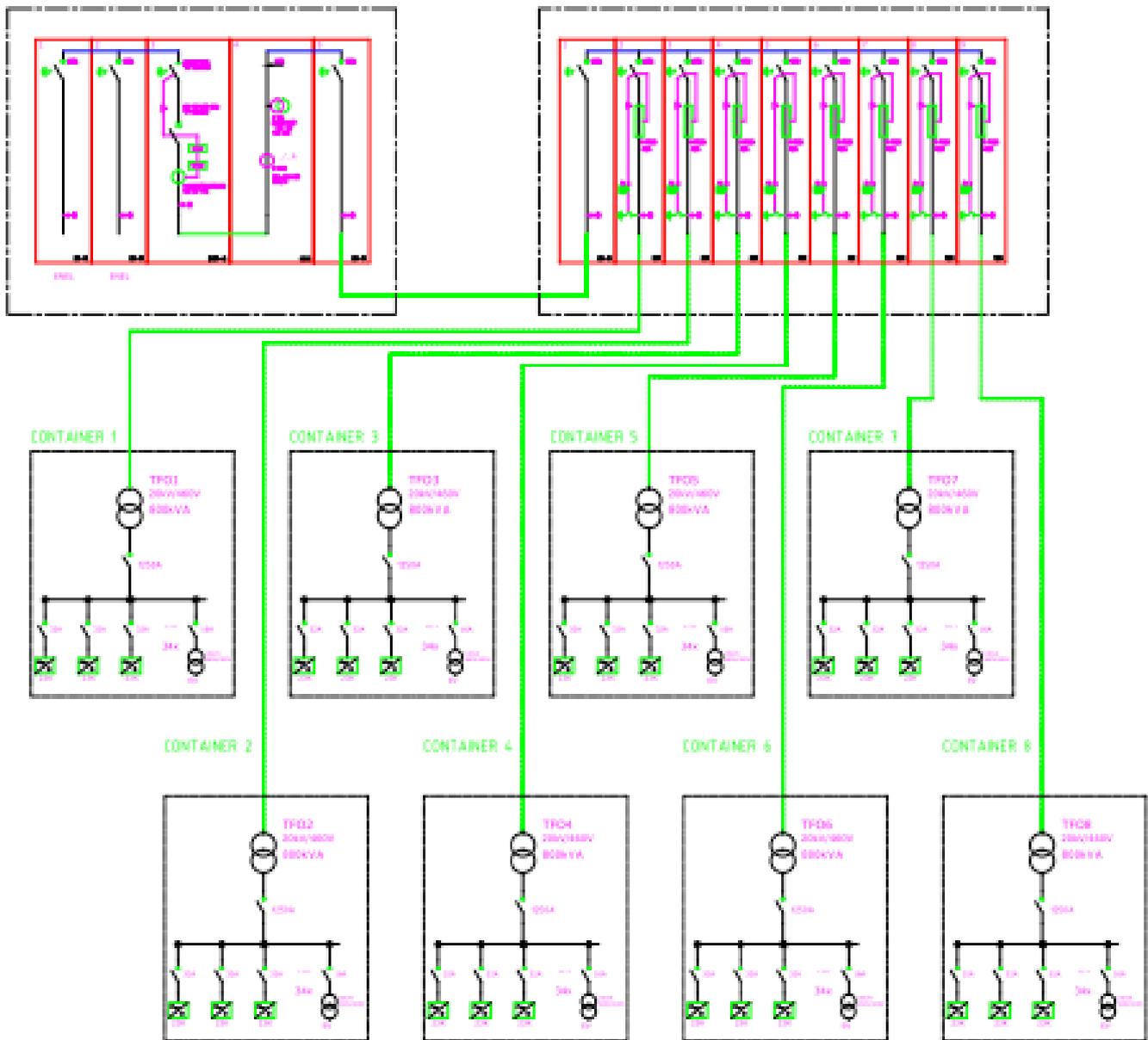
- Ditches for low and medium voltage. These ditches shall be implemented in accordance with the guidelines that are established by the owner of the land.

# Single-Wire Diagram

## CHITILA SOLAR PARC

### MAINSTATION

### SUBSTATION



# 5. ENERGY PRODUCTION

In the present chapter we present the method we used to estimate energy production for this PV plant.

The energy produced by a PV plant is directly related with the solar irradiation, temperature conditions, and equipment's efficiency. It is also related with its own design, equipment quality and implementation. The environmental conditions are non-predictable; however it is possible to be supported in existing meteorological databases to get meteorological references to our study.

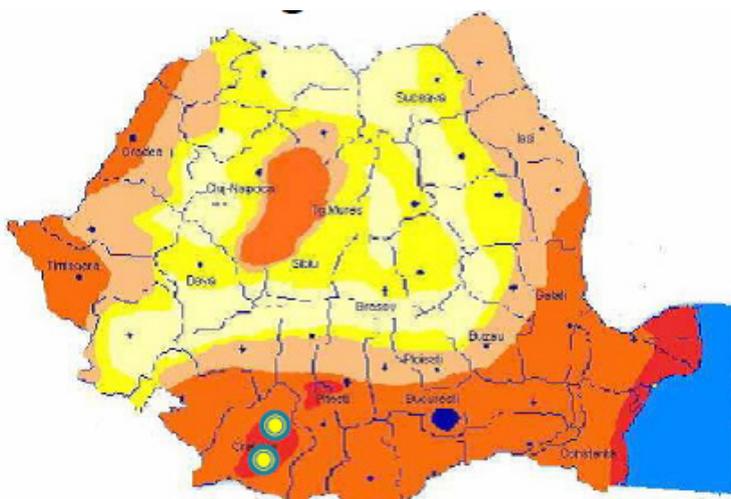
The plant final yield will be a consequence of its own component. Such yield will depend on used materials quality, their behavior under several operation conditions and other external factors such as dust and dirt.

## 5.1 CALCULATION OF PR

The solar irradiation and temperature data used in our study represent an average from 3 databases, which calculate this data using measurements taken from several meteorological stations using different interpolation data techniques. The databases used were the most referenced on the PV business, namely METEONORM, PVSYST.

Nearest stations are: Bucuresti, Otopeni, Ruse

Regarding its meteorological characterization, the project location, Bucuresti has by itself enough radiation conditions for this project development considering the existing knowledge about Romania territory, the region of south east Romania has characteristics to obtain a good efficiency in this PV system.



ZONA DE RADIATIE SOLARA	INTENSITATEA RADIATIEI SOLARE (kWh/m <sup>2</sup> /an)
I	>1350
II	1300-1350
III	1250-1300
IV	1200-1250
V	<1200

The plant should receive an global horizontal irradiation of 1427 kWh/m<sup>2</sup>/year which results in a yield production of **1377 kWh/kWp**.

In order to be able to compare different cells or even different photovoltaic modules, there are specified uniform test conditions, in which solar cells electrical data characteristic's curve is identified.

These "Standard Test Conditions" (STC) are in line with the standard IEC 60904/DIN EN 60904:

- E - 1.000W/m<sup>2</sup> irradiance;
- T - 25°C cell temperature, with 2°C tolerance;
- AM - 1,5 air mass;

To get the incident irradiation gain in PV generator plane, we use one of the most recognized software in this field of study (PVSYST produced by University of Genève) that allows us to simulate the solar irradiation and energy produced in each plant with treat accuracy.

IZEN energy systems NV has created a database with medium values for each of previously specified losses, based on reference values from several referenced sources and measurements taken from already existing plants.

Some of these values were introduced in PVSYST in order to obtain a PR value as near as possible to real value.

It should be taken in account that some of these loss factors, such as inverter yield, shadings, modules tolerance and temperature originated losses are calculated by PVSYST, since these values are calculated based on supplier data, for inverters and modules, and based on meteorological stations, for temperature and spectral/angular losses. For shadings, PVSYST has a shading design tool which allows us to calculate the losses originated by this factor.

Once all factor values are introduced in PVSYST, it will make a simulation calculating the PV plant PR.

Simulation for Yield calculation for Bucuresti PV plant with hor. irradiation 1427 kWh/m <sup>2</sup>		6659	kWp	
	Year	Expectedated Yield	Monitoring cost	+ inflation
1	2013	9169443 kWh	€ 16.648	"
2	2014	9114426 kWh	€ 16.648	"
3	2015	9059740 kWh	€ 16.648	"
4	2016	9005381 kWh	€ 16.648	"
5	2017	8951349 kWh	€ 16.648	"
6	2018	8897641 kWh	€ 16.648	"
7	2019	8844255 kWh	€ 16.648	"
8	2020	8791190 kWh	€ 16.648	"
9	2021	8738442 kWh	€ 16.648	"
10	2022	8686012 kWh	€ 16.648	"
11	2023	8633896 kWh	€ 16.648	"
12	2024	8582092 kWh	€ 16.648	"
13	2025	8530600 kWh	€ 16.648	"
14	2026	8479416 kWh	€ 16.648	"
15	2027	8428540 kWh	€ 16.648	"
16	2028	8377968 kWh	€ 16.648	"
17	2029	8327701 kWh	€ 16.648	"
18	2030	8277734 kWh	€ 16.648	"
19	2031	8228068 kWh	€ 16.648	"
20	2032	8178700 kWh	€ 16.648	"

## Grid-Connected System: Simulation parameters

**Project :** **Bucuresti Solar Park**

**Geographical Site** **Boekarest** **Country** **Romania**

**Situation** Latitude 44.5°N Longitude 26.0°E  
 Time defined as Legal Time Time zone UT+2 Altitude 92 m  
 Albedo 0.20

**Meteo data :** Boekarest , Meteonorm SYN File

**Simulation variant :** **simulation**

Simulation date 15/10/12 15h51

### Simulation parameters

**Collector Plane Orientation** Tilt 25° Azimuth 14°

**21Sheds** Pitch 8.11 m Collector width 4.08 m  
 Inactive band Top 0.00 m Bottom 0.00 m  
 Shading limit angle Gamma 21.35 ° Occupation Ratio 50.3 %  
 Shadings electrical effect Cell size 15.6cm Strings in width 12

**Horizon** Free Horizon

**Near Shadings** No Shadings

### PV Array Characteristics

**PV module** Si-poly Model **JC255M-24/Bb (-0/+5W) (virtus poly)**

Manufacturer ReneSola

Number of PV modules In series 24 modules In parallel 1088 strings

Total number of PV modules Nb. modules 26112 Unit Nom. Power 255 Wp

Array global power Nominal (STC) **6659 kWp** At operating cond. 6034 kWp (50°C)

Array operating characteristics (50°C) U mpp 666 V I mpp 9061 A

Total area Module area **42481 m²** Cell area 38134 m²

### Inverter

Model **RefuSol 23k**

Manufacturer Refu Elektronik GmbH

Characteristics Operating Voltage 575-900 V Unit Nom. Power 23.0 kW AC

Inverter pack Number of Inverter 272 units Total Power 6256.0 kW AC

### PV Array loss factors

Thermal Loss factor Uc (const) 29.0 W/m²K Uv (wind) 0.0 W/m²K / m/s  
 => Nominal Oper. Coll. Temp. (G=800 W/m², Tamb=20°C, Wind=1 m/s.) NOCT 45 °C

Wiring Ohmic Loss Global array res. 0.82 mOhm Loss Fraction 1.0 % at STC

Module Quality Loss Loss Fraction 1.0 %

Module Mismatch Losses Loss Fraction 1.5 % at MPP

Incidence effect, ASHRAE parametrization IAM = 1 - bo (1/cos i - 1) bo Parameter 0.05

### System loss factors

AC wire loss inverter to transfo Inverter voltage 460 Vac tri

Wires 439 m 3x30000 mm² Loss Fraction 1.0 % at STC

External transformer Iron loss 59197 W Loss Fraction 0.9 % at STC

Resistive/Inductive losses 0.3 mOhm Loss Fraction 0.8 % at STC

**User's needs :** Unlimited load (grid)

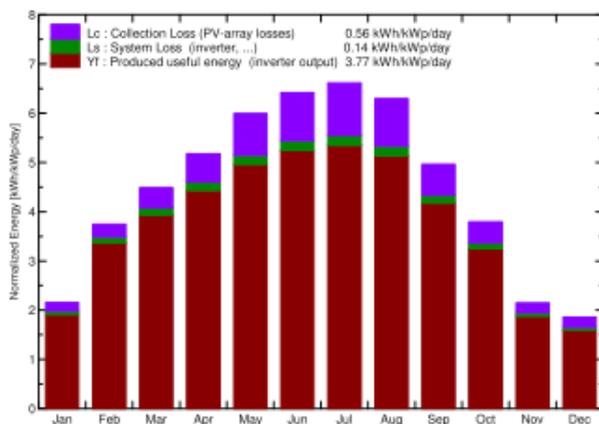
### Grid-Connected System: Main results

**Project :** **Bucuresti Solar Park**  
**Simulation variant :** **simulation**

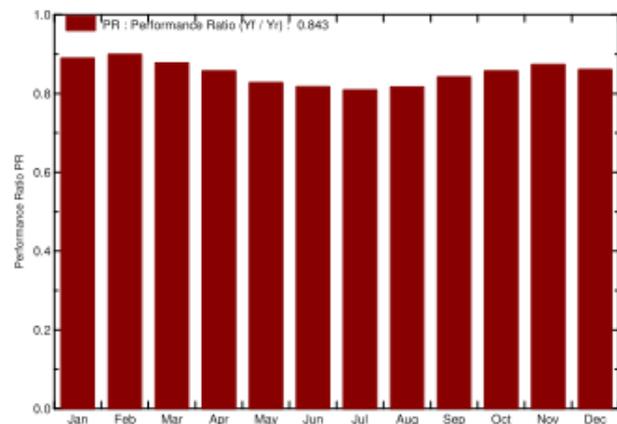
<b>Main system parameters</b>		<b>System type</b>	<b>Grid-Connected</b>
PV Field Orientation	Sheds disposition, tilt	25°	azimuth 14°
PV modules	Model	JC255M-24/Bb (-0/+5W) (vir	255 Wp
PV Array	Nb. of modules	26112	Pnom total <b>6659 kWp</b>
Inverter	Model	RefuSol 23k	Pnom 23.00 kW ac
Inverter pack	Nb. of units	272.0	Pnom total <b>6256 kW ac</b>
User's needs	Unlimited load (grid)		

**Main simulation results**  
 System Production **Produced Energy 9167 MWh/year** Specific prod. 1377 kWh/kWp/year  
 Performance Ratio PR **84.3 %**

**Normalized productions (per installed kWp): Nominal power 6659 kWp**



**Performance Ratio PR**



**simulation**  
**Balances and main results**

	<b>GlobHor</b>	<b>T Amb</b>	<b>GlobInc</b>	<b>GlobEff</b>	<b>EArray</b>	<b>E_Grid</b>	<b>EffArrR</b>	<b>EffSysR</b>
	kWh/m <sup>2</sup>	°C	kWh/m <sup>2</sup>	kWh/m <sup>2</sup>	MWh	MWh	%	%
<b>January</b>	44.6	-1.74	66.7	61.6	409	395	14.45	13.94
<b>February</b>	72.6	0.69	104.8	99.1	651	628	14.62	14.10
<b>March</b>	111.5	5.39	139.0	132.1	843	812	14.28	13.75
<b>April</b>	139.7	11.06	155.2	147.1	920	886	13.95	13.44
<b>May</b>	182.9	17.90	185.8	175.3	1063	1024	13.47	12.97
<b>June</b>	195.8	20.81	192.5	181.9	1088	1047	13.30	12.81
<b>July</b>	203.7	23.26	205.0	193.6	1146	1104	13.16	12.67
<b>August</b>	180.0	22.60	195.2	185.3	1101	1061	13.28	12.79
<b>September</b>	126.0	16.35	148.9	141.1	866	835	13.70	13.20
<b>October</b>	87.8	11.13	117.6	111.1	696	671	13.94	13.44
<b>November</b>	46.1	5.70	64.4	60.0	389	375	14.20	13.70
<b>December</b>	36.4	-0.42	57.5	51.7	341	329	13.98	13.49
<b>Year</b>	1427.1	11.12	1632.7	1539.8	9515	9167	13.72	13.22

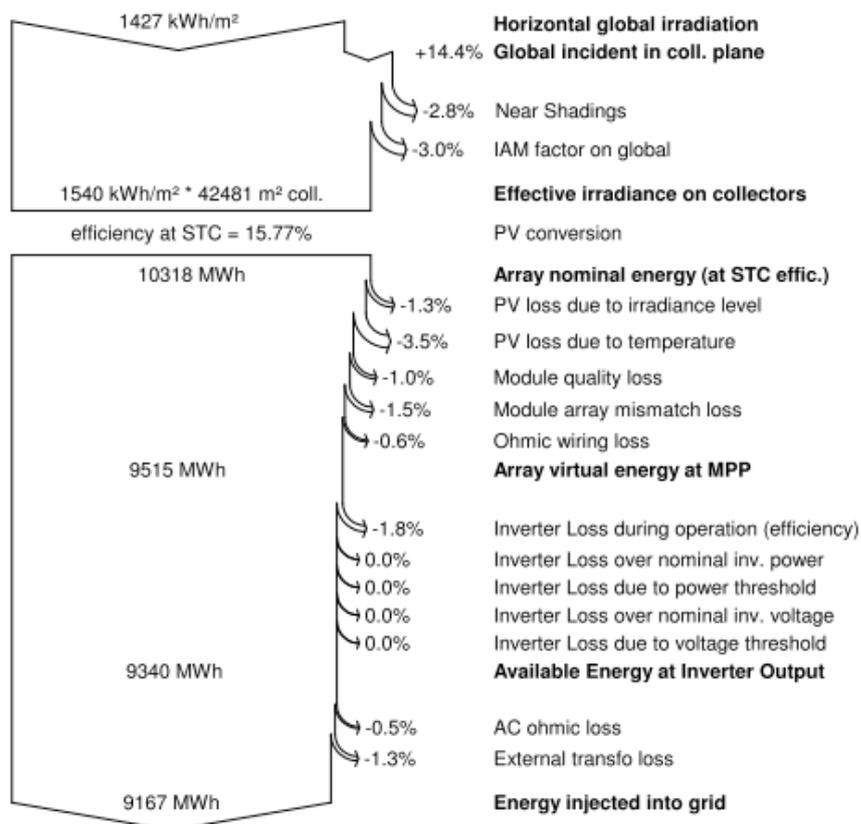
Legends: GlobHor Horizontal global irradiation EArray Effective energy at the output of the array  
 T Amb Ambient Temperature E\_Grid Energy injected into grid  
 GlobInc Global incident in coll. plane EffArrR Effic. Eout array / rough area  
 GlobEff Effective Global, corr. for IAM and shadings EffSysR Effic. Eout system / rough area

### Grid-Connected System: Loss diagram

**Project :** Bucuresti Solar Park  
**Simulation variant :** simulation

<b>Main system parameters</b>	System type	<b>Grid-Connected</b>	
PV Field Orientation	Sheds disposition, tilt	25°	azimuth 14°
PV modules	Model	JC255M-24/Bb (-0/+5W) (virtually)	255 Wp
PV Array	Nb. of modules	26112	Pnom total <b>6659 kWp</b>
Inverter	Model	RefuSol 23k	Pnom 23.00 kW ac
Inverter pack	Nb. of units	272.0	Pnom total <b>6256 kW ac</b>
User's needs	Unlimited load (grid)		

#### Loss diagram over the whole year



# 6. WARRANTIES

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## **Photovoltaic Module Warranty**

Guarantee will be given, by suppliers photoflash certificates, that the total peak power of the photovoltaic park will be equal or higher than the total peak power contracted.

Each module will have a power guarantee which will stretch for 25 years under the following conditions:

### **Limited warranty**

It is guaranteed for five years since sale date to end customer that modules are free of assembling and raw materials defects under normal use conditions. If any defect is detected on a module during this period, it will be repaired, replaced or the value of purchase is to be refunded. This guarantee is lost if an exchange of place for the module installation occurs.

### **Extension of limited warranty on power output to 10/25 years**

If any module presents an output power below 80% of minimum specified on datasheet in the period between the module sale to the end user and 25 years after, it will be repaired or replaced by a similar or equivalent module.

If any module presents an output power below 90% of minimum specified on datasheet in the period between the module sale to the end user and 10 years after, it will be repaired or replaced by a similar or equivalent module.

## **Inverter Warranty**

Guarantee will be given, by supplier of Inverter.

IZEN always buys the inverters with regular warranty of three years and extended till 5 years.

In this case the end customer has the possibility to extend this warranty until 20 years if extension has been ordered upon expiry of the regular warranty of 3 years.

More about the Refusol Warranties under: [http://europe.refusol.com/fileadmin/user\\_upload/pdf/certificate/Warranty\\_Certificate\\_EN\\_V06.pdf](http://europe.refusol.com/fileadmin/user_upload/pdf/certificate/Warranty_Certificate_EN_V06.pdf)

# 7. REFERENCES

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## IZEN PROJECT

Zonne-  
centrale  
Heusden Zolder  
4704 kWp



### Project 2008

Zonnecentrale Heusden-Zolder

### Location

Machiels - LRM Heusden

Terrillaan 14 - 3550 Heusden-Zolder

### Customer

Machiels nv

Ekkelgaarden 16

3500 Hasselt

**Installation size** 4704 kWp

**Modules** Upsolar 200 wp - 23 520 p

**Inverters** REFUsol 15 K - 245 p

**Frames** VME - aluminium



# IZEN PROJECT

Sibelco  
Lommel  
3076.80 kWp



## Project 2009

Zonnecentrale Lommel

## Location

Sibelco Lommel

Maatheide - 3920 Lommel

## Customer

Machiels nv

Ekkelgaarden 16

3500 Hasselt

**Installation size** 3076.80 kWp

**Modules** Upsolar 200 wp - 15384 p

**Inverters** REFUsol 15 K - 154 p

**Frames** VME - aluminium



# IZEN PROJECT

Sibelco  
Maasmechelen  
1152 kWp



## Project 2009

Zonnecentrale Maasmechelen

## Location

Sibelco - Mechelse Heide Zuid

Steenweg naar As - 3630 Maasmechelen



## Customer

Machiels nv

Ekkelgaarden 16

3500 Hasselt



**Installation size** 1152 kWp

**Modules** Upsolar 200 wp - 5 760 p

**Inverters** REFUsol 12 K - 80 p

**Frames** VME - aluminium

# IZEN PROJECT

Nyrstar  
Overpelt  
7600.32 kWp



## Project 2010

Zonnecentrale Overpelt

## Location

Nyrstar - Overpelt – Nyrstar OGS + GGS

Siberiëstraat - 3900 Overpelt

## Customer

Machiels nv

Ekkelgaarden 16

3500 Hasselt

**Installation size** 7600.32 kWp

**Modules** Trunsun 210 wp - 36 192 p

**Inverters** REFUsol 17 K - 377 p

**Frames** VME - aluminium



# IZEN PROJECT

NV de  
scheepvaart  
Genk  
499.2 kWp



## Project 2010

Zonnecentrale Genk

## Location

Genk – NV de scheepvaart  
Kanaalweg, 3600 Genk



## Customer

Machiels nv  
Ekkelgaarden 16  
3500 Hasselt

**Installation size** 499.2 kWp

**Modules** Upsolar 200 wp - 2 495 p

**Inverters** REFUsol 16 K - 25 p

**Frames** VME - aluminium

# IZEN PROJECT

NV de  
scheepvaart  
Hasselt  
537.6 kWp



## Project 2010

NV de scheepvaart

## Location

Hasselt – NV de scheepvaart

Boksbeemdenstraat, 3500 Hasselt



## Customer

Machiels nv

Ekkelgaarden 16

3500 Hasselt



**Installation size** 537.6kWp

**Modules** Upsolar 200wp - 2 688 p

**Inverters** REFUsol 16K - 28 p

**Frames** VME - aluminium

# IZEN PROJECT

Hödlmayr  
International  
Tongeren  
4536 kWp



## Project 2011

Zonnecentrale Tongeren

## Location

Hödlmayr International  
Prinsenweg 2, 3700 Tongeren



## Customer

Machiels nv  
Ekkelgaarden 16  
3500 Hasselt

**Installation size** 4536 kWp

**Modules** Upsolar 210 wp - 21 600 p

**Inverters** REFUsol 10 K - 152 p

**Frames** VME - aluminium

# IZEN PROJECT

Siponto  
Manfredonia  
Italy  
956.8 kWp



## Project 2011

Siponto

## Location

Siponto - SAS Di Tinasol SRL  
Sona Industriale D/46 - comparto2  
71043 Manfredonia (IT)

## Customer

Siponto - SAS Di Tinasol SRL

**Installation size** 956.8 kWp

**Modules** Renesola 230 wp - 4160 p

**Inverters** REFUsol 20 K - 52 p

**Frames** VME - aluminium



# IZEN PROJECT

**Boude-  
wijnsluis  
Antwerpen  
172.32 kWp**



## **Project 2012**

Boudewijnsluis

## **Location**

Havenbedrijf Antwerpen - GD255 Boudewijnsluis

Boudewijnweg, 2030 Antwerpen

## **Customer**

Havenbedrijf

Potpolderweg, Haven;

2040 Antwerpen

**Installation size** 172.32 kWp

**Modules** Yingli 240 wp - 718 p

**Inverters** REFUsol 20k - 7 p

**Frames** VME - aluminium

# IZEN PROJECT

Zand-  
vlietsluis  
Antwerpen  
299.52 kWp



## Project 2012

Zandvlietsluis

## Location

Havenbedrijf Antwerpen - GD255 Boudewijnsluis  
Boudewijnweg, 2030 Antwerpen

## Customer

Havenbedrijf  
Potpolderweg, Haven;  
2040 Antwerpen

**Installation size** 299.52 kWp

**Modules** Yingli 240 wp - 1248 p

**Inverters** REFUsol 20 K - 13 p

**Frames** VME - aluminium