CONTAINED ENERGY

PROPOSAL

266.7kWp OFF-GRID PHOTOVOLTAIC SYSTEM

Pulau Bawah & Elang Resort

Indonesia

STRICTLY PRIVATE & CONFIDENTIAL

Contents

1. Introduction

PT Contained Energy Indonesia (CE) is the leading solar system integrator in Indonesia, providing world-class engineering, installation, supply and support services to the private and government sector. Our company has a vision and mission to reduce carbon emission and sustain natural environment in the world, especially Indonesia.

As solar industry is growing significantly in Indonesia, it requires a trustable and highly-experienced companies to properly handle the project demands to ensure safety and efficiency of the solar energy system. Following that, Contained Energy has a long track record of more than 14 years and over 150 successful projects in Indonesia, the Pacific Islands and other tropical and remote areas. So, our standards of services have been proven to meet the expectation. Our Indonesia-based engineering and project management teams consist of highly trained and experienced engineers from the Netherlands, Spain and Indonesia. The pictures below are some of our successful projects.

Figure 1. Off-grid installation in Nikoi Island

Figure 2. On-grid Installation in

Figure 3. On-grid installation in Papua

Figure 4. AC-Coupling in Loola Eco Resort

2. Detailed Company Information

2.1. CEI Team

Simon Landsheer, Chief Executive Officer

Simon Landsheer's appointment as CEO has seen the restructuring of Contained Energy as a registered Singapore entity with a shift towards a solar leasing investment model. He is also the primary investor through his investment company Impiro. Simon, 35, is a global entrepreneur, setting up his first business aged 15 and establishing over 17 companies worldwide, including international telecom group Silverstreet.

Michael Brouwer, Chief Financial Officer

Michael has more than 25 years of experience in accounting and financial analysis. He has worked in Holland, USA and for the past eight years in Singapore, Malaysia and Indonesia

Miroslav Dijakovic, Director of Business Development

Miroslav has built his career in a variety of roles working for the Croatian Embassy in Indonesia covering the region and leading renewable energy companies in Indonesia. Miroslav has intimate knowledge of the Indonesian business environment, including in-depth knowledge of the renewable energy sector and its many regulations.

Stefan Jevremovic, Head of Residential Department

Stefan has 5 years of experience in engineering, design, project management and sales of solar PV projects and solar residential cooling. His interests are EV's and he is an active investor in stock markets.

Marc Ferra Aldea, Project Director

Marc specializes in PV Design, installation and maintenance, with six years' professional experience with construction, electricity and PV solar companies in Spain, India and Indonesia. Marc joined Contained Energy in 2013.

Fidel Castro, Junior Project Engineer

BSc in Electrical Engineering of State Islamic University of Sultan Syarif Kasim Riau (UIN Suska Riau). His focus of study was sustainable energy (energy efficiency and renewable energy). He specializes in PV system design, both on grid and off grid.

Dionysia Bema Nariswari, Solution Engineer

MSc degree in Energy and Sustainability from University of Southampton, UK. Prior to that, she received her BSc degree in Mechanical Engineering from Bandung Institute of Technology. Bema specializes in PV system design, both on grid and off grid.

Nisa Vathona Magetan, Solution Engineer

Nisa received her BSc degree in Electrical Engineering from State Islamic University of Sultan Syarif Kasim Riau (UIN Suska Riau). She focuses on sustainable energy system design, especially PV System.

2.2. Installation Reference

Contained Energy is dedicated to provide sustainable and renewable energy solutions to a variety of sectors including residential, commercial, public, government and communities. The company uses an integrated approach for the deployment of alternative energy solutions — including designing, supplying, installing and managing smart and robust energy systems with leading technology, equipment and innovations, backed by world-class services and support. Contained Energy's diverse range of energy systems is custom-engineered to fit the client's needs whether for a private villa, factory or entire community. CE is a market-leader in renewable and alternative energy solutions in Indonesia and Oceania; one of the fastest growing markets for secure, cost-efficient and eco-friendly energy solutions.

Indonesia's geographic location and tropical climate has seen Contained Energy become experts in using sustainable materials equipped to last the test of time in extreme heat and cyclone-prone areas.

Below are locations of some of our installations:

Figure 5. Locations of our Installations

1. PT Samator Surabaya 1MWp - Rooftop

System Specification:

- 1MWp On Grid Solar PV System
- 300Wp Polycrystalline panel
- ABB Trio 27.6 OUTD
- Aluminum Mounting Structure
- UV Protected DC Cable
- IP65 Distribution Boxes

2. PT Sampoerna Karawang Tbk 448kWp – Ground Mounted

System Specification:

- 448kWp On Grid Solar PV System
- REC 275Wp Polycrystalline panel
- ABB Trio 27.6 OUTD
- Pilling, Ground Mounted Structure
- UV Protected DC Cable
- IP65 Distribution Boxes

3. PT Sampoerna Rungkut Tbk 63kWp – Rooftop

System Specification:

- 63kWp On Grid Solar PV System
- REC 275Wp Polycrystalline panel
- ABB Trio 27.6 OUTD
- Aluminum Mounting Structure
- UV Protected DC Cable
- IP65 Distribution Boxes

4. Sidji Hotel Pekalongan 80kWp - Rooftop

System Specification:

- 80kWp On Grid Solar PV System
- 250Wp Polycrystalline panel
- ABB Trio 27.6 OUTD
- Aluminum Mounting Structure
- UV Protected DC Cable
- IP65 Distribution Boxes

5. Bodyshop Jakarta 65kWp – Rooftop

System Specification:

- 65kWp On Grid Solar PV System
- 300Wp Polycrystalline panel
- ABB Trio 27.6 OUTD
- Aluminum Mounting Structure
- UV Protected DC Cable
- IP65 Distribution Boxes

6. Bay Paradise Ciputat 31kWp – Ballasted Rooftop

System Specification:

- 31Wp On Grid Solar PV System
- REC 275Wp Polycrystalline panel
- ABB Trio 27.6 OUTD
- Ballasted Mounting Structure
- UV Protected DC Cable
- IP65 Distribution Boxes

3. Project Team Profile

3.1 Project Organization

3.2 Team Leader Identification

Function/Name	Nationality	Age	Education	Years of experience	Email
Project Manager / Marc Ferra Aldea	Spain	31	Bachelor of Construction Engineering, MSc in Energy Efficiency	7 years	marc.ferra@containedenergy.com
Project Engineer / Fidel Castro	Indonesia	22	Bachelor of Science (Electrical Engineering)	1 year	fidelcastro@containedenergy.com
Electro-Mechanical Engineer / Nova Darma Setia	Indonesia	35	Bachelor of Mechanical Engineering	8 years	nova@containedenergy.com

Technicians:

- **I Wayan Argatha,** Diploma 2 of Engineering, BPLE Tiara Course
- **Komang Budiasa,** Graduate of Negeri 1 Denpasar Vocational High School, Electrical Major
- **Saputra Winawa,** Graduate of Negeri 3 Singaraja Vocational High School, Electrical Major

With more than 7-year experience in the field, our technicians have been involved in, and completed many projects. See our project list attached.

4. Solar Photovoltaic System

4.1. Photovoltaic System Overview

A solar photovoltaic (PV) system or solar power system is a renewable energy system, which uses PV modules to convert sunlight into electricity. The electricity that is being generated can be stored or used directly, fed back into the grid line or combined with one or more other electricity generators or other renewable energy sources. A Solar PV system is a very reliable and clean source of electricity that can suit a wide range of applications such as residences, industry, warehousing, agriculture, etc. The main components of this system consist of:

1. Solar/PV panel: Converts solar energy to electricity (DC current)
2. Inverter/Charger: Converts DC/AC to AC/DC current
3. System Electrical Distribution Board: Distributes and protects the electrical power system

Figure 6. PV module

Figure 7. Solar inverter

On-grid solar power is by far the easiest and most economical way of using solar energy. Photovoltaic (PV) panels mounted on the roof generate DC electricity that is being sent to an inverter, which converts the DC electricity into standard 220V/50 Hz (or 380V 3-phase) AC electricity and 'synchronizes' it with the power grid (PLN).

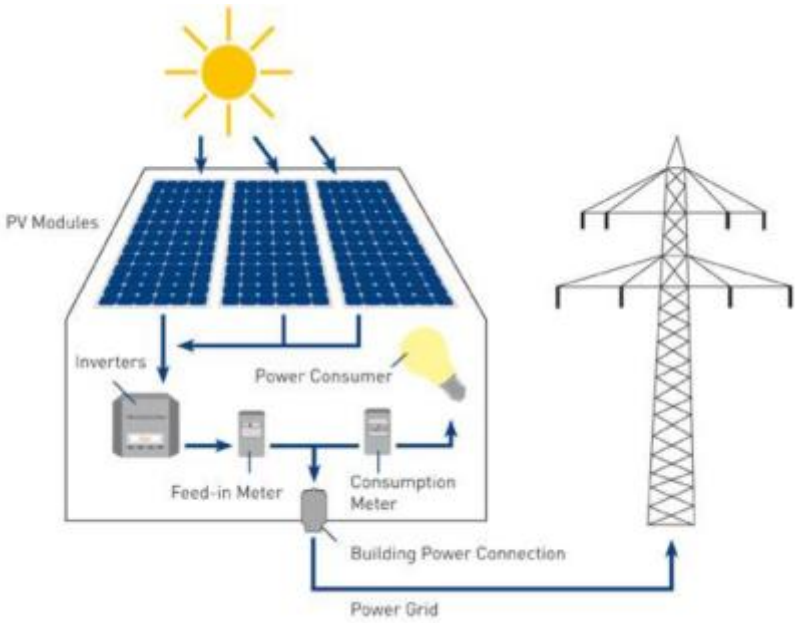


Figure 8. On-grid PV system schematic

Thus, the power/energy created by the solar modules is simply being deducted from the power/energy you purchase from the power grid (PLN).

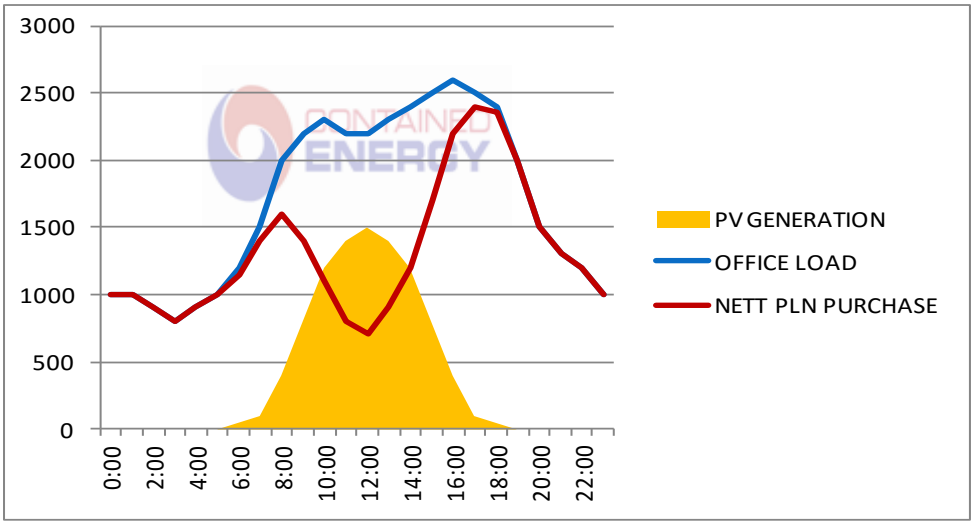


Figure 9. Electricity consumption and generation graph

4.2. Photovoltaic System Description

PT CEI proposes 266,680Wp of off-grid PV system in the rooftop of buildings in Pulau Bawah and Pulang Elang. The system consists of 904 modules of REC 295 TP2S and 12 SMA inverters in total, spreads between 15 buildings and villas on 2 islands.

The proposed system will be connected to the distribution panel at the genset room at Pulau Bawah. The 266.68 kWp of PV System is projected to produce 342 MWh of energy annually using Sunny Design simulation. The location is set to Singapore as it was the closest available location on Sunny Design. PVSyst is not used as there is limitation to use only one orientation per off grid system.

The mounting system used is an aluminum mounting with custom made O clamp for bamboo rooftop. Further inspection of rooftop's structure is needed to have clearer size and quotation.

PV Arrangement

Building	Tilt	No.Building	Azimuth	No. Of modules	Total Modules	Total kWp	Inverter	Total Inverter	Total Energy Yield (MWh
Water Villa N/S	45	2	0/180	64	128	37.76	SMA STP 15000TL-10	2	
Water Villa E/W	45	1	90/-90	64	64	18.88	SMA STP 15000TL-10	1	
Office, Clinic, Staff Bdg Type 2S & 6	20	4	-45/135	42	168	49.56	SMA STP 50-40	1	
Kitchen, Staff Bdg Type 1W & Type 2	20	3	45/-135	42	126	37.17	SMA STP 15000TL-10	2	
GM House	20	1	45/-135	56	56	16.52	SMA STP 15000TL-10	1	
Villa 1 & 2 Elang	20	2	45/-135	84	168	49.56	SMA STP 20000 TL-30	2	
Villa 3 Elang	20	1	-45/135	84	84	24.78	SMA STP 20000 TL-30	1	
Longhouse Elang	20	1	45/-135	110	110	32.45	SMA STP 15000TL-10	2	
Total		**15**			**904**	**266.68**		**12**	**341.98**

For this initial design, the interconnection point for both island is planned to be located in the genset room on Pulau Bawah. Because all the battery and inverters is going to take spaces, we will build a power house on available spaces on Pulau Bawah.

The main difference between Hybrid system and Offgrid system is the absence of battery. Hybrid system doesn't use battery bank and battery inverter, but it use SMA fuel save controller to control the power output of the genset.

4.3. System Component Summary

No	Components	Specification
1	**PV Module** • Units • Rated Power • Total Power • Solar Cell Type • Dimension • Efficiency	**REC 295 TP2S** 904 modules 295Wp/module 266.68 kWp Polycrystalline Silicon 1675 X 997 X 38 mm 17.7 %
2	**Inverter** • Units • Rated AC Power • Voltage / frequency • Dimension • Max Efficiency **Inverter** • Units • Rated AC Power • Voltage / frequency • Dimension • Max Efficiency **Inverter** • Units • Rated AC Power • Voltage / frequency • Dimension • Max Efficiency	**SMA STP 15000TL** 8 unit 15,000 W 230 V /50Hz 665 X 690 X 265 mm 98.2 % **SMA STP 20000TL** 3 unit 20,000 W 230 V /50Hz 665 X 690 X 265 mm 98.5 % **SMA STP Core1 50** 1 unit 50,000 W 230 V /50Hz 621 X 733 X 569 mm 98 %
4.	**Electrical Distribution**	• DC and AC protections • IP65 Connectors and enclosures • Solar PV cable UV resistant and flame retardant
5.	**Monitoring System**	• Monitoring Display: Sunny Portal • SMA Sensor Box

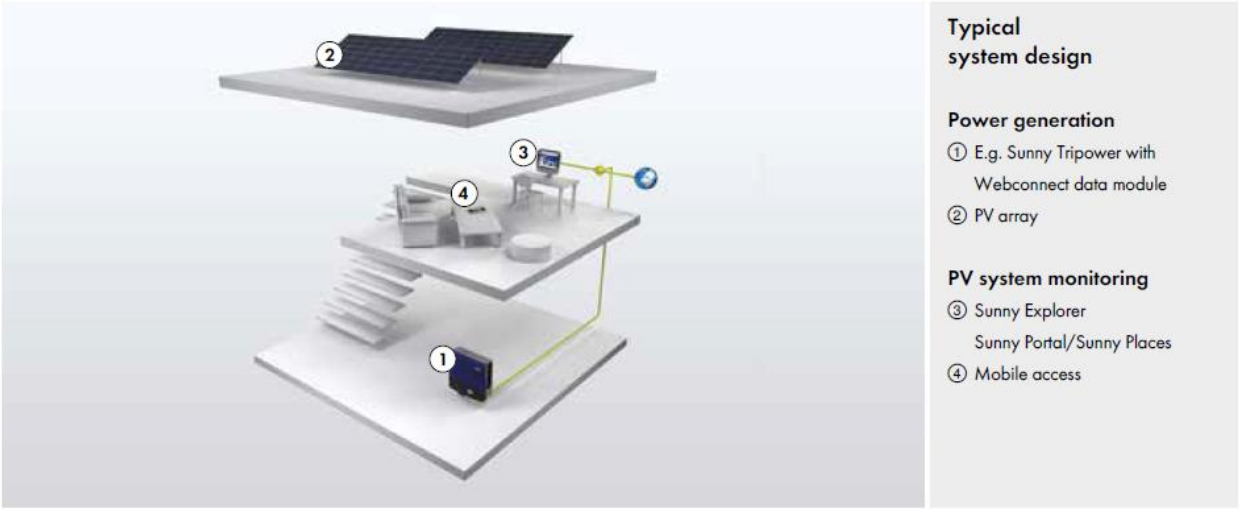
4.4. Monitoring System

Monitoring is installed to control and overview the solar system performance. The proposed control and monitoring system is SMA Webconnect and will be displayed on Sunny Portal.

SMA Webconnect

Ideally suited for online monitoring of small PV systems with up to four inverters, Webconnect provides free access to Sunny Portal and Sunny Places, the community portal. It's simple to use, requiring only Internet access and a DSL router. Following the simple installation of the factory-integrated inverter interface, Webconnect commissioning is plug-and-play. Once configured, key system data can be accessed and displayed in a clear format whenever needed. Furthermore, Sunny Places now offers PV system operators the opportunity to exchange ideas with other users and compare their systems to others in the community.

One of the great advantages of Webconnect is the direct transfer of data from the inverter to the Sunny Portal and Sunny Places—without any other SMA devices. In addition to the integrated Webconnect functionality, all it takes is Internet access and a DSL router. With system data clearly displayed in Sunny Places and the Sunny Portal, users can get an overview of their system, compare it with others and communicate with other system operators.



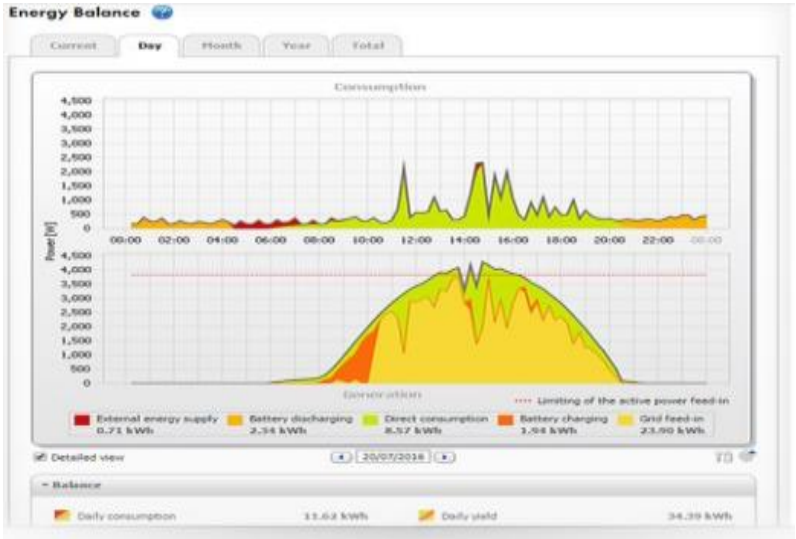
Sunny Portal

Sunny Portal is an Internet portal for the monitoring of systems as well as the visualization and presentation of system data. With Sunny Portal, PV system operators and installers can access key system data anytime, anywhere. They can also analyze measured values and visualize and compare yields, meaning that even minor deviations can be detected and resolved quickly. Sunny Portal is the biggest PV monitoring portal, * with over 250,000 registered systems world-wide and more than 14 GW of monitored PV power in over 160 countries.

Sunny Portal visualizes all yield data conveniently and concisely:

- Live system status data
- Information about current energy flow (purchased electricity, battery charging)
- Monitors communication to the portal
- Monitors inverter performance
- Weather information for location

Sunny Portal offers specialist views of the energy yields, taking into consideration the requirements of different system types. The Sunny Portal features optimal possibilities for analyzing measured values and visualizing yields, whether you need a data table or a diagram.



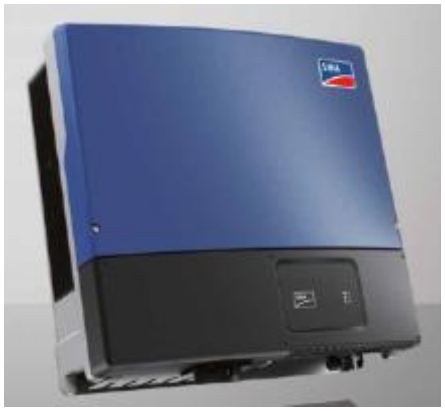
4.5. Major Equipment Features

A. REC 295TP2S

- Norwegian PV Manufacturer
- 17.4 % of Efficiency
- IP67 junction box for long-term weather endurance
- 10-year product warranty, 25-year linear power output warranty (max digression in performance of 0.7% p.a.)

B. Inverters: SMA STP 15000TL, 20000TL, CORE1 50

- German technology
- Flexible and dependable one-phase string inverter
- Independent dual MPPT input to maximize yield
- Warranty 5 years (extendable)



C. Weather Sensors

- German technology
- Rapid error detection via continuous target-actual comparison of plant performance
- Precise acquisition of irradiation intensity, module temperature and ambient temperature
- Easy installation on the solar generator

D. Cabling

- Solar cable (tinned copper, and XLPE insulated for the marine cable)
- 1000V rating
- Halogen free
- Flame Retardant
- UV and marine protection

4.6. Solar Photovoltaic System Quote

4.6.1 Total Quote for All Systems

	Amount	Unit	Quote
Solar module			$128,006.40
REC295TP2S	266,680.00	Wp	
Module amount	904	pcs	
Inverters			$96,900.00
SMA STP 15000TL-10	8	pcs	
SMA STP 20000TL-30	3	pcs	
SMA Core1 50-40	1	pcs	
Weather Station	2	pcs	
SMA Fuel Save Controller	1	pcs	
Mounting Systems			$24,004.60
Bamboo mounting system	56.64	Wp	
Galvalum roof mounted	266,623.36	Wp	
Cables & Conduits			$102,638.00
Solar Cable 1x4mm2	240	meter	
NYY 4x25 mm2 + PE 1x16mm2	400	meter	
NYY 4x35 mm2 + PE 1x16mm2	50	meter	
XLPE 4x300 mm2	2000	meter	
Conduit Pipe + Fittings for Outdoor	200	meter	
Cable Tray for Indoors	150	meter	
Grounding for Structure Commercial	1	set	
Labelling	1	set	
Switch Gear			$18,500.00
AC Combiner Box (Input 7 MCB 32A, MCB 100A / Output 1 MCCB 220A)	1	set	
AC Combiner Box (Input MCB MCB 32A, 3 MCB 40A / Output MCCB 190A)	1	set	
Interconnection Equipment (Power Meter and MCCB)	1	set	
Installation			$48,900.00
Site Supervisor	240	man.days	
Safety Officer	60	man.days	
Installers	480	man.days	
Local Labor	960	days	
Flight return (Bali-Riau)	6	set	
Civil Work			$14,000.00
Powerhouse	1	unit	
Engineering and test-commissioning			$19,500.00
Engineering design	20	eng.days	
Test and Commissioning	10	eng.days	
Project Management	60	eng.days	
Training and Documentation	1	set	
Flight return (Bali-Batam)	10	set	
Miscellaneous			$33,885.45
Mobilization and Demobilization	1	set	
Ladder	3	month	
Safety Equipment	1	set	
Sub Total			**$486,334.44**
Total/Wp (excl. 10% PPN)			**$1.824**

Solution	Price (USD)
266.7kWp On-Grid PVSystem	USD 486,335

5. Warranties, Notes, Delivery and Payment Terms:

Warranties:

- Solar modules : 10 years product warranty and 25 years performance warranty
- Inverter : 5 years
- Mounting System : 10 years material guarantee and 25 years product lifetime
- Installation : 1 year from Contained Energy (extendable to a total of 3[1] or 5[2] years)

Notes:

- Quote includes:
  - System engineering design
  - Supply and installation of equipment for PV system
  - Free SMA Sunny Portal access among inverter life time
  - Warranties
- Quote excludes:
  - Temporary facility (water, electrical power, etc), to be provided by owner
  - Internet connection and quota for the monitoring
  - Transportation of materals to and from site
  - Food and Accommodation during the project
  - Civil works
  - 10% PPN

Notes:

- Delivery terms: Equipment delivery to site 4-6 weeks from DP transfer proof[3]

Payment terms:

- 40 % down payment
- 20 % on proof of shipping solar modules
- 10% prior to equipment delivery to site
- 20% after competition
- 10% after commissioning

- **Commercial invoice will be made in Indonesian Rupiah, subjected to the CIMB clicks sell rate of the date when the invoice is issued (Faktur Pajak will be issued after receipt of the payment)**

[1] 2 years extra cost of 2% of the total cost
[2] 4 years extra cost of 4% of the total cost
[3] Apply terms & conditions

6. Conclusion

We hope and trust that this proposal, although preliminary and subject to further detailing after site inspections and discussions, is clear and attractive and we look forward to discussing it in more detail at your convenience.

Kind Regards,

Miroslav Dijakovic

Director of Business Development

7. Appendices

7.1. Sunny Design Simulation

PT Contained Energy Indonesia

Tractebel - Engie

PT Contained Energy Indonesia

GRAHA MOBILKOM LT.2
JALAN RADEN SALEH RAYA NO. 53, CIKINI
JAKARTA PUSAT 10330, DKI INDONESIA
+6221 39899863

Project name: Tractebel 60p offgrid v6
Project number: ---

Location: Singapore / Singapore

Grid voltage: 230V (230V / 400V)

System overview Water Villa E/W

32 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017) (PV array 1)
Azimuth angle: 90 °, Tilt angle: 45 °, Mounting type: Roof, Peak power: 9.44 kWp

32 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017) (PV array 2)
Azimuth angle: -90 °, Tilt angle: 45 °, Mounting type: Roof, Peak power: 9.44 kWp

1 x STP 15000TL-30

System overview Water Villa N/S

64 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017) (PV array 1)
Azimuth angle: 0 °, Tilt angle: 45 °, Mounting type: Roof, Peak power: 18.88 kWp

64 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017) (PV array 2)
Azimuth angle: 180 °, Tilt angle: 45 °, Mounting type: Roof, Peak power: 18.88 kWp

1 x STP 15000TL-30 **1 x STP 15000TL-30**

System overview 42panels building NE-SW

63 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017) (PV array 1)
Azimuth angle: 45 °, Tilt angle: 20 °, Mounting type: Roof, Peak power: 18.59 kWp

63 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017) (PV array 2)
Azimuth angle: -135 °, Tilt angle: 20 °, Mounting type: Roof, Peak power: 18.59 kWp

1 x STP 10000TL-20 **1 x STP 10000TL-20**
1 x STP 10000TL-20

System overview 42panels building NW-SE

84 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017) (PV array 1)
Azimuth angle: -45 °, Tilt angle: 20 °, Mounting type: Roof, Peak power: 24.78 kWp

84 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017) (PV array 2)
Azimuth angle: 135 °, Tilt angle: 20 °, Mounting type: Roof, Peak power: 24.78 kWp

2 x STP 10000TL-20 **2 x STP 10000TL-20**

1 / 25

Project overview

System overview GM House

28 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017) (PV array 1)
Azimuth angle: 45 °, Tilt angle: 20 °, Mounting type: Roof, Peak power: 8.26 kWp

28 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017) (PV array 2)
Azimuth angle: -135 °, Tilt angle: 20 °, Mounting type: Roof, Peak power: 8.26 kWp

1 x STP 15000TL-30

System overview Villa 3

42 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017) (PV array 1)
Azimuth angle: -45 °, Tilt angle: 20 °, Mounting type: Roof, Peak power: 12.39 kWp

42 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017) (PV array 2)
Azimuth angle: 135 °, Tilt angle: 20 °, Mounting type: Roof, Peak power: 12.39 kWp

1 x STP 20000TL-30

System overview Villa 1 and 2

84 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017) (PV array 1)
Azimuth angle: 45 °, Tilt angle: 20 °, Mounting type: Roof, Peak power: 24.78 kWp

84 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017) (PV array 2)
Azimuth angle: -135 °, Tilt angle: 20 °, Mounting type: Roof, Peak power: 24.78 kWp

2 x STP 20000TL-30

System overview Longhouse

55 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017) (PV array 1)
Azimuth angle: 45 °, Tilt angle: 20 °, Mounting type: Roof, Peak power: 16.23 kWp

55 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017) (PV array 2)
Azimuth angle: -135 °, Tilt angle: 20 °, Mounting type: Roof, Peak power: 16.23 kWp

1 x STP 15000TL-30 **1 x STP 15000TL-30**

System Components

Storage system

1 x MC-Box-36.3
Batteries: Lithium

36 x Sunny Island 8.0H
Total nominal capacity: 691.20 kWh (equates to 14400 Ah at C10)
Of which can be utilized: 552.96 kWh (equates to 11520 Ah at C10)

Genset

Active power: 298 kW
Average energy efficiency: 3.50 kWh/l

Project overview

PV design data

Total number of PV modules:	904	Spec. energy yield*:	1271 kWh/kWp
Peak power:	266.68 kWp	Line losses (in % of PV energy):	1.46 %
Number of PV inverters:	16	Unbalanced load:	0.00 VA
Nominal AC power of the PV inverters:	220.00 kW	Used PV energy:	338.94 MWh
AC active power:	220.00 kW	Used PV share:	100 %
Active power ratio:	82.5 %	PV share of the energy supply (during the day):	28.6 %
Max. available PV energy*:	338.94 MWh	Average annual solar fraction:	14.2 %
Energy usability factor:	99.9 %		

Signature

*Important: The yield values displayed are estimates. They are determined mathematically. SMA Solar Technology AG accepts no responsibility for the real yield value which can deviate from the yield values displayed here. Reasons for deviations are various external conditions, such as soiling of the PV modules or fluctuations in the efficiency of the PV modules.

Evaluation of design

Project name: Tractebel 60p offgrid v6
Project number:

Water Villa E/W

Location: Singapore / Singapore
Ambient temperature:
Annual extreme low temperature: 22 °C
Average high Temperature: 30 °C
Annual extreme high temperature: 35 °C

1 x STP 15000TL-30 (PV system section 1)

Peak power:	18.88 kWp
Total number of PV modules:	64
Number of PV inverters:	1
Max. DC power (cos φ = 1):	15.33 kW
Max. AC active power (cos φ = 1):	15.00 kW
Grid voltage:	230V (230V / 400V)
Nominal power ratio:	81 %
Dimensioning factor:	125.9 %
Displacement power factor cos φ:	1

STP 15000TL-30

PV design data

Input A: PV array 1
32 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: 90 °, Tilt angle: 45 °, Mounting type: Roof

Input B: PV array 2
32 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: -90 °, Tilt angle: 45 °, Mounting type: Roof

	Input A:	Input B:
Number of strings:	2	2
PV modules per string:	16	16
Peak power (input):	9.44 kWp	9.44 kWp
Typical PV voltage:	461 V	461 V
Min. PV voltage:	439 V	439 V
Min. DC voltage (Grid voltage 230 V):	150 V	150 V
Max. PV voltage:	630 V	630 V
Max. DC voltage:	1000 V	1000 V
Max. MPP current of PV array:	18.3 A	18.3 A
Max. operating input current per MPPT:	33 A	33 A

PV/Inverter compatible

Evaluation of design

Project name: Tractebel 60p offgrid v6
Project number:

Water Villa N/S

Location: Singapore / Singapore
Ambient temperature:
Annual extreme low temperature: 22 °C
Average high Temperature: 30 °C
Annual extreme high temperature: 35 °C

1 x STP 15000TL-30 (PV system section 1)

Peak power:	18.88 kWp
Total number of PV modules:	64
Number of PV inverters:	1
Max. DC power (cos φ = 1):	15.33 kW
Max. AC active power (cos φ = 1):	15.00 kW
Grid voltage:	230V (230V / 400V)
Nominal power ratio:	81 %
Dimensioning factor:	125.9 %
Displacement power factor cos φ:	1

STP 15000TL-30

PV design data

Input A: PV array 1
32 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: 0 °, Tilt angle: 45 °, Mounting type: Roof

Input B: PV array 1
32 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: 0 °, Tilt angle: 45 °, Mounting type: Roof

	Input A:	Input B:
Number of strings:	2	2
PV modules per string:	16	16
Peak power (input):	9.44 kWp	9.44 kWp
Typical PV voltage:	✓ 461 V	✓ 461 V
Min. PV voltage:	439 V	439 V
Min. DC voltage (Grid voltage 230 V):	150 V	150 V
Max. PV voltage:	✓ 630 V	✓ 630 V
Max. DC voltage:	1000 V	1000 V
Max. MPP current of PV array:	✓ 18.3 A	✓ 18.3 A
Max. operating input current per MPPT:	33 A	33 A

PV/Inverter compatible

Evaluation of design

Project name: Tractebel 60p offgrid v6
Project number:

Water Villa N/S

Location: Singapore / Singapore
Ambient temperature:
Annual extreme low temperature: 22 °C
Average high Temperature: 30 °C
Annual extreme high temperature: 35 °C

1 x STP 15000TL-30 (PV system section 2)

Peak power:	18.88 kWp
Total number of PV modules:	64
Number of PV inverters:	1
Max. DC power (cos φ = 1):	15.33 kW
Max. AC active power (cos φ = 1):	15.00 kW
Grid voltage:	230V (230V / 400V)
Nominal power ratio:	81 %
Dimensioning factor:	125.9 %
Displacement power factor cos φ:	1

STP 15000TL-30

PV design data

Input A: PV array 2
32 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: 180 °, Tilt angle: 45 °, Mounting type: Roof

Input B: PV array 2
32 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: 180 °, Tilt angle: 45 °, Mounting type: Roof

	Input A:	Input B:
Number of strings:	2	2
PV modules per string:	16	16
Peak power (input):	9.44 kWp	9.44 kWp
Typical PV voltage:	461 V	461 V
Min. PV voltage:	439 V	439 V
Min. DC voltage (Grid voltage 230 V):	150 V	150 V
Max. PV voltage:	630 V	630 V
Max. DC voltage:	1000 V	1000 V
Max. MPP current of PV array:	17.1 A	17.1 A
Max. operating input current per MPPT:	33 A	33 A

PV/Inverter compatible

Evaluation of design

Project name: Tractebel 60p offgrid v6
Project number:

42panels building NE-SW

Location: Singapore / Singapore
Ambient temperature:
Annual extreme low temperature: 22 °C
Average high Temperature: 30 °C
Annual extreme high temperature: 35 °C

1 x STP 10000TL-20 (PV system section 1)

Peak power:	12.39 kWp
Total number of PV modules:	42
Number of PV inverters:	1
Max. DC power (cos φ = 1):	10.25 kW
Max. AC active power (cos φ = 1):	10.00 kW
Grid voltage:	230V (230V / 400V)
Nominal power ratio:	83 %
Dimensioning factor:	123.9 %
Displacement power factor cos φ:	1

STP 10000TL-20

PV design data

Input A: PV array 1
21 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: 45 °, Tilt angle: 20 °, Mounting type: Roof

Input B: PV array 1
21 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: 45 °, Tilt angle: 20 °, Mounting type: Roof

	Input A:	Input B:
Number of strings:	1	1
PV modules per string:	21	21
Peak power (input):	6.20 kWp	6.20 kWp
Typical PV voltage:	✓ 605 V	✓ 605 V
Min. PV voltage:	577 V	577 V
Min. DC voltage (Grid voltage 230 V):	150 V	150 V
Max. PV voltage:	✓ 827 V	✓ 827 V
Max. DC voltage:	1000 V	1000 V
Max. MPP current of PV array:	✓ 9.1 A	✓ 9.1 A
Max. operating input current per MPPT:	18 A	10 A
Max. input short-circuit current per MPPT:	25 A	15 A
Photovoltaic Output Circuit Current:	✓ 9.7 A	✓ 9.7 A

PV/Inverter partly compatible

PV array and inverter type are only conditionally compatible, since the inverter is undersized in this combination (< 86 %).

Evaluation of design

Project name: Tractebel 60p offgrid v6
Project number:

42panels building NE-SW

Location: Singapore / Singapore
Ambient temperature:
Annual extreme low temperature: 22 °C
Average high Temperature: 30 °C
Annual extreme high temperature: 35 °C

1 x STP 10000TL-20 (PV system section 2)

Peak power:	12.39 kWp
Total number of PV modules:	42
Number of PV inverters:	1
Max. DC power (cos φ = 1):	10.25 kW
Max. AC active power (cos φ = 1):	10.00 kW
Grid voltage:	230V (230V / 400V)
Nominal power ratio:	83 %
Dimensioning factor:	123.9 %
Displacement power factor cos φ:	1

STP 10000TL-20

PV design data

Input A: PV array 1
21 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: 45 °, Tilt angle: 20 °, Mounting type: Roof

Input B: PV array 2
21 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: -135 °, Tilt angle: 20 °, Mounting type: Roof

	Input A:	Input B:
Number of strings:	1	1
PV modules per string:	21	21
Peak power (input):	6.20 kWp	6.20 kWp
Typical PV voltage:	✓ 605 V	✓ 605 V
Min. PV voltage:	577 V	577 V
Min. DC voltage (Grid voltage 230 V):	150 V	150 V
Max. PV voltage:	✓ 827 V	✓ 827 V
Max. DC voltage:	1000 V	1000 V
Max. MPP current of PV array:	✓ 9.1 A	✓ 9.1 A
Max. operating input current per MPPT:	18 A	10 A
Max. input short-circuit current per MPPT:	25 A	15 A
Photovoltaic Output Circuit Current:	✓ 9.7 A	✓ 9.7 A

PV/Inverter compatible

Evaluation of design

Project name: Tractebel 60p offgrid v6
Project number:

42panels building NE-SW

Location: Singapore / Singapore
Ambient temperature:
Annual extreme low temperature: 22 °C
Average high Temperature: 30 °C
Annual extreme high temperature: 35 °C

1 x STP 10000TL-20 (PV system section 3)

Peak power:	12.39 kWp
Total number of PV modules:	42
Number of PV inverters:	1
Max. DC power (cos φ = 1):	10.25 kW
Max. AC active power (cos φ = 1):	10.00 kW
Grid voltage:	230V (230V / 400V)
Nominal power ratio:	83 %
Dimensioning factor:	123.9 %
Displacement power factor cos φ:	1

STP 10000TL-20

PV design data

Input A: PV array 2
21 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: -135 °, Tilt angle: 20 °, Mounting type: Roof

Input B: PV array 2
21 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: -135 °, Tilt angle: 20 °, Mounting type: Roof

	Input A:	Input B:
Number of strings:	1	1
PV modules per string:	21	21
Peak power (input):	6.20 kWp	6.20 kWp
Typical PV voltage:	✓ 605 V	✓ 605 V
Min. PV voltage:	577 V	577 V
Min. DC voltage (Grid voltage 230 V):	150 V	150 V
Max. PV voltage:	✓ 827 V	✓ 827 V
Max. DC voltage:	1000 V	1000 V
Max. MPP current of PV array:	✓ 9.1 A	✓ 9.1 A
Max. operating input current per MPPT:	18 A	10 A
Max. input short-circuit current per MPPT:	25 A	15 A
Photovoltaic Output Circuit Current:	✓ 9.7 A	✓ 9.7 A

PV/Inverter compatible

Evaluation of design

Project name: Tractebel 60p offgrid v6
Project number:

42panels building NW-SE

Location: Singapore / Singapore
Ambient temperature:
Annual extreme low temperature: 22 °C
Average high Temperature: 30 °C
Annual extreme high temperature: 35 °C

2 x STP 10000TL-20 (PV system section 1)

Peak power:	24.78 kWp
Total number of PV modules:	84
Number of PV inverters:	2
Max. DC power (cos φ = 1):	10.25 kW
Max. AC active power (cos φ = 1):	10.00 kW
Grid voltage:	230V (230V / 400V)
Nominal power ratio:	83 %
Dimensioning factor:	123.9 %
Displacement power factor cos φ:	1

STP 10000TL-20

PV design data

Input A: PV array 2
42 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: 135 °, Tilt angle: 20 °, Mounting type: Roof

	Input A:	Input B:
Number of strings:	2	
PV modules per string:	21	
Peak power (input):	12.39 kWp	---
Typical PV voltage:	605 V	---
Min. PV voltage:	577 V	---
Min. DC voltage (Grid voltage 230 V):	150 V	150 V
Max. PV voltage:	827 V	---
Max. DC voltage:	1000 V	1000 V
Max. MPP current of PV array:	18.3 A	---
Max. operating input current per MPPT:	18 A	10 A
Max. input short-circuit current per MPPT:	25 A	15 A
Photovoltaic Output Circuit Current:	19.3 A	---

PV/Inverter compatible

Evaluation of design

Project name: Tractebel 60p offgrid v6
Project number:

42panels building NW-SE

Location: Singapore / Singapore
Ambient temperature:
Annual extreme low temperature: 22 °C
Average high Temperature: 30 °C
Annual extreme high temperature: 35 °C

2 x STP 10000TL-20 (PV system section 2)

Peak power:	24.78 kWp
Total number of PV modules:	84
Number of PV inverters:	2
Max. DC power (cos φ = 1):	10.25 kW
Max. AC active power (cos φ = 1):	10.00 kW
Grid voltage:	230V (230V / 400V)
Nominal power ratio:	83 %
Dimensioning factor:	123.9 %
Displacement power factor cos φ:	1

STP 10000TL-20

PV design data

Input A: PV array 1
42 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: -45 °, Tilt angle: 20 °, Mounting type: Roof

	Input A:	Input B:
Number of strings:	2	
PV modules per string:	21	
Peak power (input):	12.39 kWp	---
Typical PV voltage:	605 V	---
Min. PV voltage:	577 V	---
Min. DC voltage (Grid voltage 230 V):	150 V	150 V
Max. PV voltage:	827 V	---
Max. DC voltage:	1000 V	1000 V
Max. MPP current of PV array:	18.3 A	---
Max. operating input current per MPPT:	18 A	10 A
Max. input short-circuit current per MPPT:	25 A	15 A
Photovoltaic Output Circuit Current:	19.3 A	---

PV/Inverter partly compatible

PV array and inverter type are only conditionally compatible, since the inverter is undersized in this combination (< 88 %).

Evaluation of design

Project name: Tractebel 60p offgrid v6
Project number:

GM House

Location: Singapore / Singapore
Ambient temperature:
Annual extreme low temperature: 22 °C
Average high Temperature: 30 °C
Annual extreme high temperature: 35 °C

1 x STP 15000TL-30 (PV system section 1)

Peak power:	16.52 kWp
Total number of PV modules:	56
Number of PV inverters:	1
Max. DC power (cos φ = 1):	15.33 kW
Max. AC active power (cos φ = 1):	15.00 kW
Grid voltage:	230V (230V / 400V)
Nominal power ratio:	93 %
Dimensioning factor:	110.1 %
Displacement power factor cos φ:	1

STP 15000TL-30

PV design data

Input A: PV array 1
28 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: 45 °, Tilt angle: 20 °, Mounting type: Roof

Input B: PV array 2
28 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: -135 °, Tilt angle: 20 °, Mounting type: Roof

	Input A:	Input B:
Number of strings:	2	2
PV modules per string:	14	14
Peak power (input):	8.26 kWp	8.26 kWp
Typical PV voltage:	403 V	403 V
Min. PV voltage:	384 V	384 V
Min. DC voltage (Grid voltage 230 V):	150 V	150 V
Max. PV voltage:	552 V	552 V
Max. DC voltage:	1000 V	1000 V
Max. MPP current of PV array:	18.3 A	18.3 A
Max. operating input current per MPPT:	33 A	33 A

PV/Inverter compatible

Evaluation of design

Project name: Tractebel 60p offgrid v6
Project number:

Villa 3

Location: Singapore / Singapore
Ambient temperature:
Annual extreme low temperature: 22 °C
Average high Temperature: 30 °C
Annual extreme high temperature: 35 °C

1 x STP 20000TL-30 (PV system section 1)

Peak power:	24.78 kWp
Total number of PV modules:	84
Number of PV inverters:	1
Max. DC power (cos φ = 1):	20.44 kW
Max. AC active power (cos φ = 1):	20.00 kW
Grid voltage:	230V (230V / 400V)
Nominal power ratio:	82 %
Dimensioning factor:	123.9 %
Displacement power factor cos φ:	1

STP 20000TL-30

PV design data

Input A: PV array 1
42 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: -45 °, Tilt angle: 20 °, Mounting type: Roof

Input B: PV array 2
42 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: 135 °, Tilt angle: 20 °, Mounting type: Roof

	Input A:	Input B:
Number of strings:	2	2
PV modules per string:	21	21
Peak power (input):	12.39 kWp	12.39 kWp
Typical PV voltage:	605 V	605 V
Min. PV voltage:	577 V	577 V
Min. DC voltage (Grid voltage 230 V):	150 V	150 V
Max. PV voltage:	827 V	827 V
Max. DC voltage:	1000 V	1000 V
Max. MPP current of PV array:	18.3 A	18.3 A
Max. operating input current per MPPT:	33 A	33 A

PV/Inverter compatible

Evaluation of design

Project name: Tractebel 60p offgrid v6
Project number:

Villa 1 and 2

Location: Singapore / Singapore
Ambient temperature:
Annual extreme low temperature: 22 °C
Average high Temperature: 30 °C
Annual extreme high temperature: 35 °C

2 x STP 20000TL-30 (PV system section 1)

Peak power:	49.56 kWp
Total number of PV modules:	168
Number of PV inverters:	2
Max. DC power (cos φ = 1):	20.44 kW
Max. AC active power (cos φ = 1):	20.00 kW
Grid voltage:	230V (230V / 400V)
Nominal power ratio:	82 %
Dimensioning factor:	123.9 %
Displacement power factor cos φ:	1

STP 20000TL-30

PV design data

Input A: PV array 1
42 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: 45 °, Tilt angle: 20 °, Mounting type: Roof

Input B: PV array 2
42 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: -135 °, Tilt angle: 20 °, Mounting type: Roof

	Input A:	Input B:
Number of strings:	2	2
PV modules per string:	21	21
Peak power (input):	12.39 kWp	12.39 kWp
Typical PV voltage:	605 V	605 V
Min. PV voltage:	577 V	577 V
Min. DC voltage (Grid voltage 230 V):	150 V	150 V
Max. PV voltage:	827 V	827 V
Max. DC voltage:	1000 V	1000 V
Max. MPP current of PV array:	18.3 A	18.3 A
Max. operating input current per MPPT:	33 A	33 A

PV/Inverter compatible

Evaluation of design

Project name: Tractebel 60p offgrid v6
Project number:

Longhouse

Location: Singapore / Singapore
Ambient temperature:
Annual extreme low temperature: 22 °C
Average high Temperature: 30 °C
Annual extreme high temperature: 35 °C

1 x STP 15000TL-30 (PV system section 1)

Peak power:	14.75 kWp
Total number of PV modules:	50
Number of PV inverters:	1
Max. DC power (cos φ = 1):	15.33 kW
Max. AC active power (cos φ = 1):	15.00 kW
Grid voltage:	230V (230V / 400V)
Nominal power ratio:	104 %
Dimensioning factor:	98.3 %
Displacement power factor cos φ:	1

STP 15000TL-30

PV design data

Input A: PV array 1
25 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: 45 °, Tilt angle: 20 °, Mounting type: Roof

Input B: PV array 2
25 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: -135 °, Tilt angle: 20 °, Mounting type: Roof

	Input A:	Input B:
Number of strings:	1	1
PV modules per string:	25	25
Peak power (input):	7.38 kWp	7.38 kWp
Typical PV voltage:	720 V	720 V
Min. PV voltage:	687 V	687 V
Min. DC voltage (Grid voltage 230 V):	150 V	150 V
Max. PV voltage:	985 V	985 V
Max. DC voltage:	1000 V	1000 V
Max. MPP current of PV array:	9.1 A	9.1 A
Max. operating input current per MPPT:	33 A	33 A

PV/Inverter compatible

Evaluation of design

Project name: Tractebel 60p offgrid v6
Project number:

Longhouse

Location: Singapore / Singapore
Ambient temperature:
Annual extreme low temperature: 22 °C
Average high Temperature: 30 °C
Annual extreme high temperature: 35 °C

1 x STP 15000TL-30 (PV system section 2)

Peak power:	17.70 kWp
Total number of PV modules:	60
Number of PV inverters:	1
Max. DC power (cos φ = 1):	15.33 kW
Max. AC active power (cos φ = 1):	15.00 kW
Grid voltage:	230V (230V / 400V)
Nominal power ratio:	87 %
Dimensioning factor:	118 %
Displacement power factor cos φ:	1

STP 15000TL-30

PV design data

Input A: PV array 1
30 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: 45 °, Tilt angle: 20 °, Mounting type: Roof

Input B: PV array 2
30 x REC Solar AS REC 295 TP2 (TwinPeak 2) (02/2017), Azimuth angle: -135 °, Tilt angle: 20 °, Mounting type: Roof

	Input A:	Input B:
Number of strings:	2	2
PV modules per string:	15	15
Peak power (input):	8.85 kWp	8.85 kWp
Typical PV voltage:	✓ 432 V	✓ 432 V
Min. PV voltage:	412 V	412 V
Min. DC voltage (Grid voltage 230 V):	150 V	150 V
Max. PV voltage:	✓ 591 V	✓ 591 V
Max. DC voltage:	1000 V	1000 V
Max. MPP current of PV array:	✓ 18.3 A	✓ 18.3 A
Max. operating input current per MPPT:	33 A	33 A

PV/Inverter compatible

Wire sizing

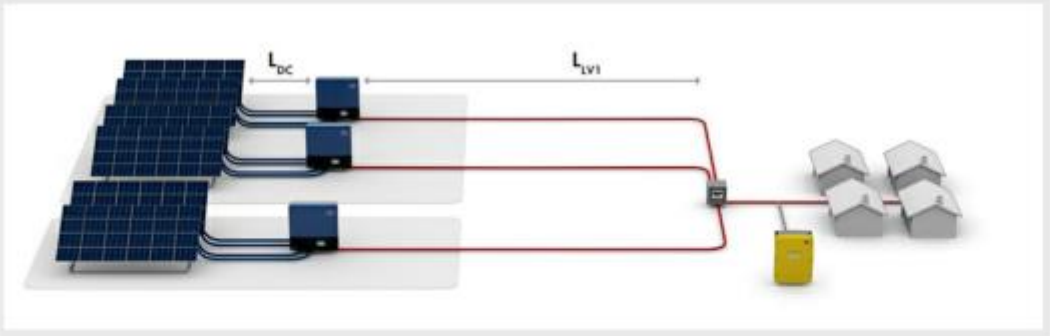
Project name: Tractebel 60p offgrid v6 **Location: Singapore / Singapore**

Project number:

Overview

	DC	LV	Total
Power loss at nominal operation	393.15 W	1.28 kW	1.68 kW
Rel. power loss at rated nominal operation	0.15 %	0.58 %	0.74 %
Total cable length	960.00 m	6100.00 m	7060.00 m
Cable cross-sections	4 mm^2	300 mm^2 25 mm^2	4 mm^2 300 mm^2 25 mm^2

Graphic



DC cables

		Cable material	Single length	Cross section	Voltage drop	Rel. power loss
Water Villa E/W						
1 x STP 15000TL-30 PV system section 1	A	Copper	10.00 m	4 mm²	999.7 mV	0.22 %
	B	Copper	10.00 m	4 mm²	1 V	0.22 %
Water Villa N/S						
1 x STP 15000TL-30 PV system section 1	A	Copper	10.00 m	4 mm²	804.5 mV	0.17 %
	B	Copper	10.00 m	4 mm²	804.5 mV	0.17 %
1 x STP 15000TL-30 PV system section 2	A	Copper	10.00 m	4 mm²	735.9 mV	0.16 %
	B	Copper	10.00 m	4 mm²	735.9 mV	0.16 %
42panels building NE-SW						
1 x STP 10000TL-20 PV system section 1	A	Copper	10.00 m	4 mm²	892.9 mV	0.15 %
	B	Copper	10.00 m	4 mm²	892.9 mV	0.15 %
1 x STP 10000TL-20 PV system section 2	A	Copper	10.00 m	4 mm²	892.9 mV	0.15 %
	B	Copper	10.00 m	4 mm²	835.4 mV	0.14 %
1 x STP 10000TL-20 PV system section 3	A	Copper	10.00 m	4 mm²	835.4 mV	0.14 %
	B	Copper	10.00 m	4 mm²	835.4 mV	0.14 %
42panels building NW-SE						
2 x STP 10000TL-20 PV system section 1	A	Copper	10.00 m	4 mm²	724.8 mV	0.12 %
	B	Copper	10.00 m	4 mm²	---	---
2 x STP 10000TL-20 PV system section 2	A	Copper	10.00 m	4 mm²	723.5 mV	0.12 %
	B	Copper	10.00 m	4 mm²	---	---
GM House						
1 x STP 15000TL-30 PV system section 1	A	Copper	10.00 m	4 mm²	892.9 mV	0.22 %
	B	Copper	10.00 m	4 mm²	835.4 mV	0.21 %
Villa 3						
1 x STP 20000TL-30 PV system section 1	A	Copper	10.00 m	4 mm²	890.8 mV	0.15 %
	B	Copper	10.00 m	4 mm²	808.1 mV	0.13 %
Villa 1 and 2						
2 x STP 20000TL-30 PV system section 1	A	Copper	10.00 m	4 mm²	892.9 mV	0.15 %
	B	Copper	10.00 m	4 mm²	835.4 mV	0.14 %
Longhouse						
1 x STP 15000TL-30 PV system section 1	A	Copper	10.00 m	4 mm²	892.9 mV	0.12 %
	B	Copper	10.00 m	4 mm²	835.4 mV	0.12 %
1 x STP 15000TL-30 PV system section 2	A	Copper	10.00 m	4 mm²	892.9 mV	0.20 %
	B	Copper	10.00 m	4 mm²	835.4 mV	0.19 %

Lines LV1

	Cable material	Single length	Cross section	Line resistance	Rel. power loss
Water Villa E/W					
1 x STP 15000TL-30 PV system section 1	Copper	100.00 m	25 mm²	R: 22.933 mΩ XL: 7.500 mΩ	0.65 %
Water Villa N/S					
1 x STP 15000TL-30 PV system section 1	Copper	100.00 m	25 mm²	R: 22.933 mΩ XL: 7.500 mΩ	0.65 %
1 x STP 15000TL-30 PV system section 2	Copper	100.00 m	25 mm²	R: 22.933 mΩ XL: 7.500 mΩ	0.65 %
42panels building NE-SW					
1 x STP 10000TL-20 PV system section 1	Copper	100.00 m	25 mm²	R: 22.933 mΩ XL: 7.500 mΩ	0.43 %
1 x STP 10000TL-20 PV system section 2	Copper	100.00 m	25 mm²	R: 22.933 mΩ XL: 7.500 mΩ	0.43 %
1 x STP 10000TL-20 PV system section 3	Copper	100.00 m	25 mm²	R: 22.933 mΩ XL: 7.500 mΩ	0.43 %
42panels building NW-SE					
2 x STP 10000TL-20 PV system section 1	Copper	100.00 m	25 mm²	R: 22.933 mΩ XL: 7.500 mΩ	0.43 %
2 x STP 10000TL-20 PV system section 2	Copper	100.00 m	25 mm²	R: 22.933 mΩ XL: 7.500 mΩ	0.43 %
GM House					
1 x STP 15000TL-30 PV system section 1	Copper	100.00 m	25 mm²	R: 22.933 mΩ XL: 7.500 mΩ	0.65 %
Villa 3					
1 x STP 20000TL-30 PV system section 1	Copper	1000.00 m	300 mm²	R: 19.111 mΩ XL: 75.000 mΩ	0.72 %
Villa 1 and 2					
2 x STP 20000TL-30 PV system section 1	Copper	1000.00 m	300 mm²	R: 19.111 mΩ XL: 75.000 mΩ	0.72 %
Longhouse					
1 x STP 15000TL-30 PV system section 1	Copper	1000.00 m	300 mm²	R: 19.111 mΩ XL: 75.000 mΩ	0.52 %
1 x STP 15000TL-30 PV system section 2	Copper	1000.00 m	300 mm²	R: 19.111 mΩ XL: 75.000 mΩ	0.54 %

The displayed results are approximate values to give a general indication to users of possible operating results. The results are determined mathematically based on standardized assumptions. The actual operating results will be dictated significantly by the actual irradiation conditions, the actual efficiency, the genset operating conditions and the individual consumption behavior and can deviate from the calculated results. SMA SOLAR TECHNOLOGY AG THEREFORE ASSUMES NO LIABILITY FOR YIELD SHORTFALLS IN THE EVENT OF DEVIATIONS BETWEEN THE CALCULATED- AND ACTUAL OPERATING RESULTS.

Information

Project name: Tractebel 60p offgrid v6 **Location: Singapore / Singapore**
Project number:

Tractebel 60p offgrid v6

The system has a low solar fraction. A larger PV system is recommended.

42panels building NE-SW

1 x STP 10000TL-20 (PV system section 1)

PV array and inverter type are only conditionally compatible, since the inverter is undersized in this combination (< 86 %).

42panels building NW-SE

2 x STP 10000TL-20 (PV system section 2)

PV array and inverter type are only conditionally compatible, since the inverter is undersized in this combination (< 88 %).

Storage system

Nominal capacity too low

Autonomous time not reached

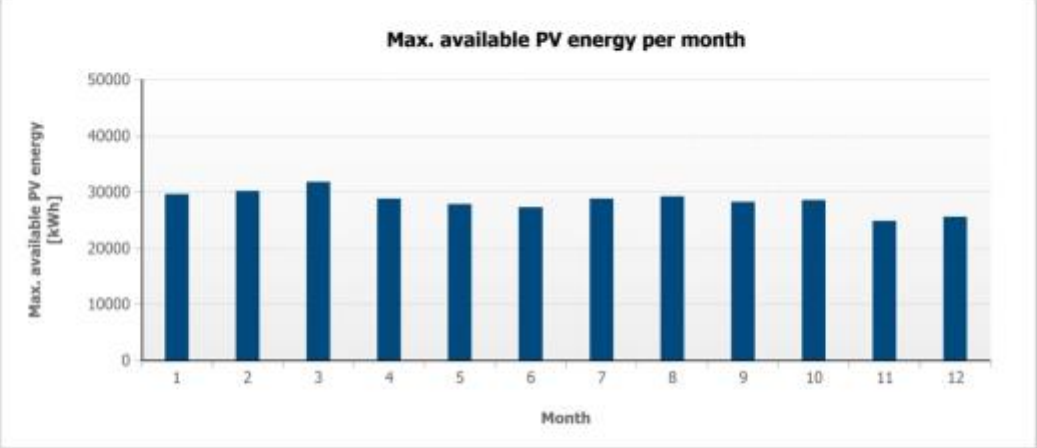
Ratio of the nominal AC powers genset / storage system less than 0.8 or greater than 1.2

Monthly values

Project name: Tractebel 60p offgrid v6 **Location: Singapore / Singapore**

Project number:

Diagram



Table

Month	Max. available PV energy [kWh]	Used PV energy [kWh]	Consumption [kWh]	Solar fraction
1	29451	29451	190517	15 %
2	30056	30056	172080	16 %
3	31628	31628	190517	16 %
4	28688	28688	184371	15 %
5	27658	27658	190517	14 %
6	27142	27142	184371	14 %
7	28660	28660	190517	14 %
8	29082	29082	190517	14 %
9	28071	28071	184371	14 %
10	28414	28414	190517	14 %
11	24667	24667	184371	13 %
12	25426	25426	190517	13 %

Analyses of the energy and power in the system

Project name: Tractebel 60p offgrid v6 **Location: Singapore / Singapore**

Project number:

Power

System stability jeopardized

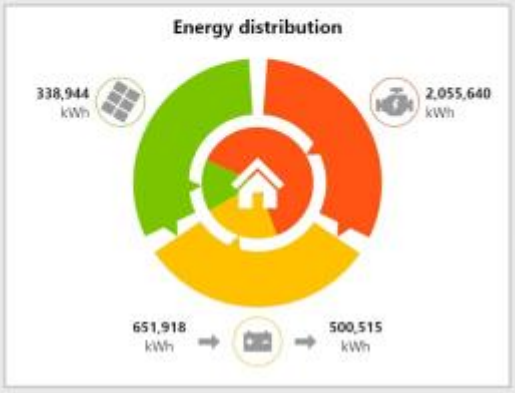
Nominal AC power PV inverters / storage system: 1.02

Nominal AC power genset / storage system: 1.72

Usable storage capacity: 553 kWh (1.9 h)

Total nominal AC power of the system:	808.5 kW
Nominal AC power PV inverters:	220 kW
Nominal AC power storage system:	216 kW
Nominal AC power genset:	372.5 kW
Power reserve:	0 kW
Energy deficit:	0 kWh
Nominal AC power PV inverters / storage system:	1.02
Nominal AC power genset / storage system:	1.72
Usable storage capacity:	553 kWh
Autonomous time:	1.9 h
Average annual solar fraction:	14.2 %

Energy



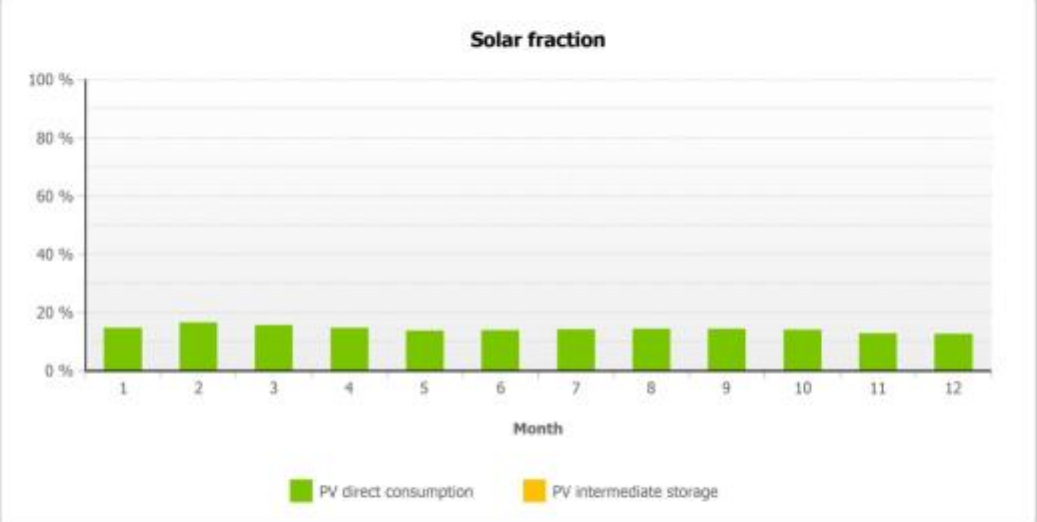
Annual energy consumption:	2,243 MWh
Max. available PV energy:	339 MWh
Used PV energy:	339 MWh
Directly consumed PV energy:	339 MWh
Intermediately stored PV energy:	0 kWh
Annual energy generation of the genset:	2,056 MWh
Annual nominal energy throughputs of the battery:	943
Annual fuel consumption:	569,772 l

The displayed results are approximate values to give a general indication to users of possible operating results. The results are determined mathematically based on standardized assumptions. The actual operating results will be dictated significantly by the actual irradiation conditions, the actual efficiency, the genset operating conditions and the individual consumption behavior and can deviate from the calculated results. SMA SOLAR TECHNOLOGY AG THEREFORE ASSUMES NO LIABILITY FOR YIELD SHORTFALLS IN THE EVENT OF DEVIATIONS BETWEEN THE CALCULATED- AND ACTUAL OPERATING RESULTS.

Analyses of the energy and power in the system

Project name: Tractebel 60p offgrid v6 **Location: Singapore / Singapore**
Project number:

Solar fraction



Month	Solar fraction [%]	Used PV share [%]	Fuel consumption [l]
1	15	100	47722
2	16	100	42752
3	16	100	47854
4	15	100	46467
5	14	100	48801
6	14	100	47099
7	14	100	48552
8	14	100	48698
9	14	100	47129
10	14	100	48379
11	13	100	47149
12	13	100	49168

The displayed results are approximate values to give a general indication to users of possible operating results. The results are determined mathematically based on standardized assumptions. The actual operating results will be dictated significantly by the actual irradiation conditions, the actual efficiency, the genset operating conditions and the individual consumption behavior and can deviate from the calculated results. SMA SOLAR TECHNOLOGY AG THEREFORE ASSUMES NO LIABILITY FOR YIELD SHORTFALLS IN THE EVENT OF DEVIATIONS BETWEEN THE CALCULATED- AND ACTUAL OPERATING RESULTS.

Storage system

Project name: Tractebel 60p offgrid v6 **Location: Singapore / Singapore**
Project number:

Power

AC power at 25 °C:	216 kW
AC power at 40 °C:	195.5 kW
AC power at 25 °C for 30 min:	288 kW

Battery

Batteries:	Lithium
Total nominal capacity:	691.20 kWh (equates to 14400 Ah at C10)
Of which can be utilized:	552.96 kWh (equates to 11520 Ah at C10)

System Components

	Device	Settings per cluster/device	
Multicluster Box	MC-Box-36.3		
Cluster 1	3 x Sunny Island 8.0H	Batteries:	Lithium
Cluster 2	3 x Sunny Island 8.0H	Capacity:	57.60 kWh (equates to 1200 Ah at C10)
Cluster 3	3 x Sunny Island 8.0H	Of which can be utilized:	80 % (equates to 960 Ah at C10)
Cluster 4	3 x Sunny Island 8.0H		
Cluster 5	3 x Sunny Island 8.0H		
Cluster 6	3 x Sunny Island 8.0H		
Cluster 7	3 x Sunny Island 8.0H		
Cluster 8	3 x Sunny Island 8.0H		
Cluster 9	3 x Sunny Island 8.0H		
Cluster 10	3 x Sunny Island 8.0H		
Cluster 11	3 x Sunny Island 8.0H		
Cluster 12	3 x Sunny Island 8.0H		

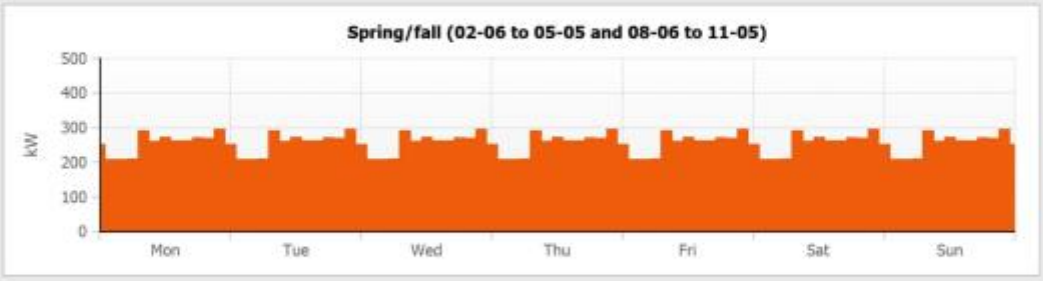
Load profile overview

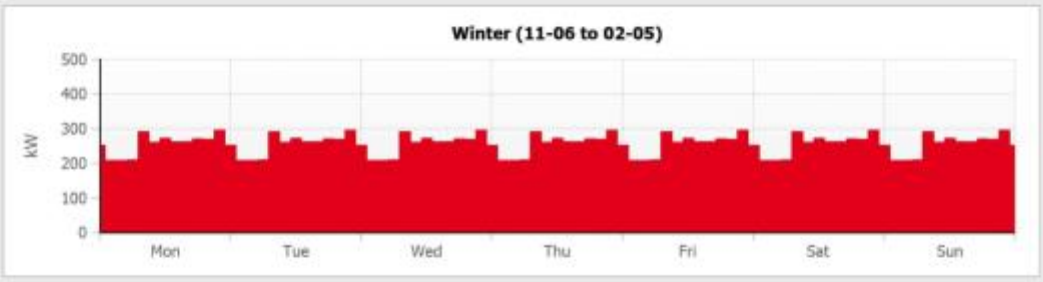
Project name: Tractebel 60p offgrid v6 **Location: Singapore / Singapore**
Project number:

Overview

Load profile	Annual energy consumption	30 minute power
Bawah and Elang Island	2243181 kWh	296.7 kW
Total	**2,243 MWh**	**296.7 kW**

Average weekly profile by seasons





The displayed results are approximate values to give a general indication to users of possible operating results. The results are determined mathematically based on standardized assumptions. The actual operating results will be dictated significantly by the actual irradiation conditions, the actual efficiency, the genset operating conditions and the individual consumption behavior and can deviate from the calculated results. SMA SOLAR TECHNOLOGY AG THEREFORE ASSUMES NO LIABILITY FOR YIELD SHORTFALLS IN THE EVENT OF DEVIATIONS BETWEEN THE CALCULATED- AND ACTUAL OPERATING RESULTS.

7.2 Resume of Personnel

- **Project Manager**

1. Surname : Aldea
2. Name : Marc Ferra
3. Date and place of birth : Barcelona, 19 May 1986
4. Nationality : Spain
5. Education :

Institutions:	*Sustainable Architecture & Energy Effeciency, La Salle, Universitat Ramon Llull, Barcelona*
Date: *From (months/year)* *To (months/year)*	 *2011*
Degree:	*Master, Energy Effeciency and Sustainable Architecture*

6. Language skills (Mark 1 to 5 for competence, where 5 is the highest):

Language	*Level*	*Passive*	*Spoken*	*Written*
Spanish	*Mother Tongue*	*5*	*5*	*5*
English	*Working Proficiency*	*5*	*5*	*5*
Bahasa		*4*	*4*	*4*

7. Membership of Professional Bodies : N/A
8. Other skills (e.g. computer literacy, etc.): AutoCAD, Sketchup Photosop, Designbuilder, Presto, PVSyst, Dialux, Transol
9. Present Position: Solar Project Director
10. Years of professional experience: 7 years
11. Key qualifications: Solar Project Engineer & Director, Building Engineer
12. Specific experience

Country	*Date: from (month/year) to (month/year)*	*Name and brief description of the project*
Indonesia	*2015*	*Samator – Surabaya* *1MWp On-Grid*
Indonesia	*2016*	*Sampoerna –Karawang* *448kWp On-Grid*
Indonesia	*2015*	*The Body Shop HQ – Jakarta* *60kWp On-Grid*

Indonesia	*2015*	*Woodenship –Bali* *20kWp On-Grid*

13. Professional experience (add more tables, if necessary)

Date: from (month/year) to (month/year)	September 2014 - Present
Location	Indonesia
Company / Organisation	Contained Energy
Position	Solar Project Director
Job Description	Design & prepare offers; cost planning, BoQ & contract admin, managing client & partners in Indonesia, Colombia, Mexico

- **Project Engineer**

1. Surname : Castro
2. Name : Fidel
3. Date and place of birth : Padang, 30 October 1994
4. Nationality : Indonesian
5. Education :

Institutions:	
Date: *From (months/year)* *To (months/year)*	*UIN Suska Riau* *September 2012* *November 2016*
Degree:	*Bachelor of Engineering (Electrical Engineering)*

6. Language skills (Mark 1 to 5 for competence, where 5 is the highest):

Language	*Level*	*Passive*	*Spoken*	*Written*
Indonesia	*Mother Tongue*	*5*	*5*	*5*
English	*Business Level*	*4*	*4*	*4*

7. Membership of Professional Bodies: -
8. Other skills (e.g. computer literacy, etc.): Autocad, Sketch Up, PVSyst
9. Present Position : Project Engineer
10. Years of professional experience : 1 years

11. Key qualifications : Electrical engineering, PV system design, project management

12. Professional experience (add more tables, if necessary)

Date: from (month/year) to (month/year)	January 2017 - Now
Location	Indonesia
Company / Organisation	Contained Energy
Position	Project Engineer
Job Description	Conduct site survey, design PV System (On-Grid, Off-Grid and Hybrid), and Working with PLN for Net Metering Application

- **Electro-Mechanical Engineer**

1. Surname : Nova Darma Satria
2. Name : Nova
3. Date and place of birth : 10 November 1981
4. Nationality : Indonesia
5. Education :

Institutions:	Universitas Udayana
Date: *From (months/year)* *To (months/year)*	 August 2000 May 2006
Degree:	Bachelor Degre of Mechanical Engineering

6 Language skills (Mark 1 to 5 for competence, where 5 is the highest):

Language	*Level*	*Passive*	*Spoken*	*Written*
Indonesia	*Mother Tongue*	*4*	*4*	*4*
English		*3*	*3*	*3*

7. Membership of Professional Bodies :
8. Other skills (e.g. computer literacy, etc.) : Microsoft Office - Good
9. Present Position : Solar Installation Coordinator
10. Years of professional experience : 8 years
11. Key qualifications : Solar Installer
12. Specific experience

Country	*Date: from (month/year) to (month/year)*	*Name and brief description of the project*
Indonesia	*April/2014 – May/2014*	*80 kWp on grid PV system in Pekalongan, Central of Java*
Indonesia	*July/2015 – July/2015*	*63 kWp on grid PV system in Bintaro, Banten*
Indonesia	*November/2015 – April/2016*	*887.7 kWp on grid PV system in Gresik, East Java*
Indonesia	*December/2016 – January/2017*	*448 kWp on grid PV system in Karawang, West Java*

13. Professional experience (add more tables, if necessary)

Date: from (month/year) to (month/year)	December/2008 to present
Location	Bali, Indonesia
Company / Organisation	PT Contained Energy Indonesia
Position	Solar Installation Coordinator
Job Description	Lead installer team at the project, Assist technician team on site, troubleshoot installation problem

7.3 Contractor Reference

No	Name of Project	Location	Installation Type	Date Installed	Customer Contact Information		PV System Installed	Project Cost
					Name	Phone Number		
	2017							
1	Sampoerna Karawang Factory	Karawang	Piling, Ground Mounted	26-Jan-17	Tauhid Adi N	+6281233233123	448kWp	~ 800.000 USD
2	Sampoerna Rungkut Factory	Rungkut, Surabaya	Tin Roof	26-Jan-17	I Made	+628123023432	63kWp	
	2016							
3	PT. The Bay Paradise	Ciputat	Ballasted, Roof top	15-Sep-16	Arista	+6281297428877	31 kWp	~ 50.000 USD
4	Cirendeu Residence	Jakarta	Flat Mounted, Rooftop	15-Oct-16	Arista	+6281297428877	9 kWp	~ 17.000 USD
5	Samator (PT. Aneka Gas)	Surabaya	Tin Roof	26-Apr-16	Wahyu	+6285707768799	1 MWp	~ 1.300.000 USD
6	Woodenship	Bali	Tin Roof	15-Jul-15	Wira	+628122354112	30 kWp	~ 50.000 USD
7	Micronesia	Federated States of Micronesia	2 x 16 Island System	2012-2016	JGH Denmark		500 kWp	~ 1.500.000 USD
	2015							
8	The Body Shop HQ	Bintaro, Jakarta	Tin Roof	15-Jul-15	Adriansyah	+6281281142418	63 kWp	~ 100.000 USD
9	Villa Bukit Sungai	Bali	Tiles Roof	13-Jul-15	Candra	+62811388518	20 kWp	~ 40.000 USD
10	The Sidji Hotel	Pekalongan	Tin Roof	13-Jan-15	Faozi	+6281542333600	80kWp	~ 160.000 USD

7.4 Job Safety Analysis

No.	Work situations	Potential Accidents or Hazards	Preventative Measures
1.	Using power tools & electric cords	• Electric shock from worn or frayed power cords & power lines • Objects thrown from equipment such as saw blades • Sharp tools	• Develop company personal protective equipment policy • Eliminate extension cord hazards by using battery operated tools • Develop procedures for using power tools & electric cords
2.	Working with ladders to access equipment & rooftops	• Lifting hazards from carrying ladders • Fall hazards from accidents on ladders • Electrical hazards from contact with electrical power lines	• Develop proper lifting & carrying procedures for ladders • Develop proper ladder use policies
3.	Working in very hot weather conditions	• Dehydration • Potential of passing out • Heat exhaustion • Heatstroke • Death	• Reduce heat exhaustion risk hazards by working during cooler hours of the day • Develop hydration & safe practices while working in hot weather conditions
4.	Working with solar hot water collector panels	• Injuries from lifting heavy & awkward flat plate collectors • Handling collectors that are hot from sitting in the sun (sun burn)	• Eliminate hot collector hazards by covering the collector area with an opaque object • Develop policies & procedures for working with solar hot water collectors
5.	Working with solar electric PV panels	• Handling solar electric PV panels in the sun resulting in electric shock	• Develop policies & procedures for working with solar electric PV panels
6.	Working with existing and new wiring & electrical circuits	• Electric shock cause by exposure to live electric circuits or energized equipment	• Always de-energize circuits before beginning working with them • Use a meter or circuit test device such as a current clamp to ensure the circuit is dead prior to working on it
7.	Working with batteries	• Batteries contain hazardous compounds which can cause reproductive harm, severe burns & environmental hazards • Electrical arc hazards	• Always open the main DC disconnect switch between the batteries & the inverter prior to working on the battery bank • Remove personal jewellery and use only appropriate tools when working on batteries • Dead batteries must be recycled properly

7.5 Material, Tools and Equipment List

No	Materials	Type/Brand
1	Solar Modules	REC 295TP2S
2	Array Mounting Racks	PLP
3	Grounding Equipment	Local Manufacturer
4	Combiner Box	Hager
5	Meter and Instrumentation	Schneider
6	Inverter	SMA
7	DC Cables	Helukabel
8	AC Cables	Supreme/Kabelindo/JienZhongGong

Hand and Power Tools

- Wire Stripper With Screw Cutter
- Clamp Meter
- Small Flashlight
- Tool Pouch And Belt
- Pliers
- Screwdriver
- Electrician Level (Water pass)
- Tape Measure
- Voltage detector (Test pen)
- Sheet Rock Saw
- Electric Drilling tools
- Head Lamp
- Electricians Hammer
- Labeling machine
- Wire Stripper

Personal Protective Equipment (PPE)

- Safety glasses
- Goggles
- Face Shields
- Helmets
- Earmuff/Earplugs
- Gloves
- Steel Toed Shoes

7.6 Health, Safety & Environment Protocol

General HSE Requirements

1.1 Contained Energy Indonesia (CEI) as EPC company for this solar photovoltaic plant installation shall observe and comply with safety regulations

- CEI shall comply with the HSE legal and project site requirements. The direct responsibility on HSE of the CEI's employees and its employed third party contractors (if any) lies with the CEI's management.
- CEI and its employees shall correct all unsafe acts and unsafe conditions and inform the respective project manager.
- CEI employees shall comply with all posted instructions such as caution, warning, and restricted area signs.
- CEI is responsible for maintaining a safe working environment. A significant part of this is daily housekeeping. CEI shall ensure that their areas are kept clean and free of any hazardous conditions caused by construction materials or debris, spilled liquids, etc.
- CEI is to ensure that only trained and authorized personnel in the proper operation of valves, breakers, disconnects, blast gates, or other similar control devices may tamper with or defect safety devices (such as guards, shields, interlocks, smoke or flame detectors, sprinklers, PA speakers, exhaust airflow monitors, etc) and/or operate valves, breakers, disconnects, blast gates, or other similar control devices.
- CEI shall not interrupt any life-safety systems, including exhaust, alarm systems or fire detection without proper control measures in place and approval from an authorized body through CEI.
- CEI shall ensure that the creation of temporary holes or openings shall be properly barricaded or guarded to protect persons from accidentally walking or falling into the hole.
- CEI shall ensure that all employees involved in site work are equipped with the appropriate personal protection equipment.
- CEI shall ensure that all its employees and third party contractors involved in the project work are competent for the specific job or task. They shall also be aware of the risk related to the job or task they carried out and the risk control mitigation measures.

Project Orientation

2.1 Project orientation shall be conducted prior to the commencement of installation activities. Attendance of the CEI's key personnel of the project shall be required. The CEI may also utilize this session to make any clarifications when necessary.

2.2 All personnel should familiarize with the evacuation routes from the area in which they are working, as well as the assembly point outside the respective building.

7.7 Quality Assurance Plan

Contained Energy Indonesia (CEI) strives to deliver high-quality solar photovoltaic systems throughout Indonesia. To ensure this, we conducted quality assessments on every stage of the solar photovoltaic project, starting from planning and design to long-term operation. Our approach is based on an integrated assessment of plant location, material and component properties, cost structure, operation, maintenance, and overall system performance.

Planning & Design

A successful project begins with the definition of specifications, the evaluation of the project site and the analysis of regional environmental conditions. Besides irradiation, this may include soiling risks, temperature, humidity, and salinity. Environmental and climate data from various geographic information systems (GIS) provide important information and set as the baseline for our solar photovoltaic plant simulation.

Yield Assessment

As part of our yield assessment services, we analyse different sources of solar irradiation data available for the region to give indications for design specifications. This supplies our customers with site specific input parameters for their own yield and profitability calculations, enabling high performance and maximum yield to be achieved. We obtain high-quality meteorological data of the plant location and construct a detailed performance model of the plant based on design documents. The resulting yield reports provide detailed information all parameters that affect energy yield as well as the associated losses.

Engineering & Procurement

During the project engineering and procurement phase, a technology screening helps our customers to find the components that fit best to the specific project. We conduct manufacturer quality benchmarking and ensure each component of the solar plants is of high-quality through our long-list of experiences in providing solar photovoltaic systems.

Commissioning

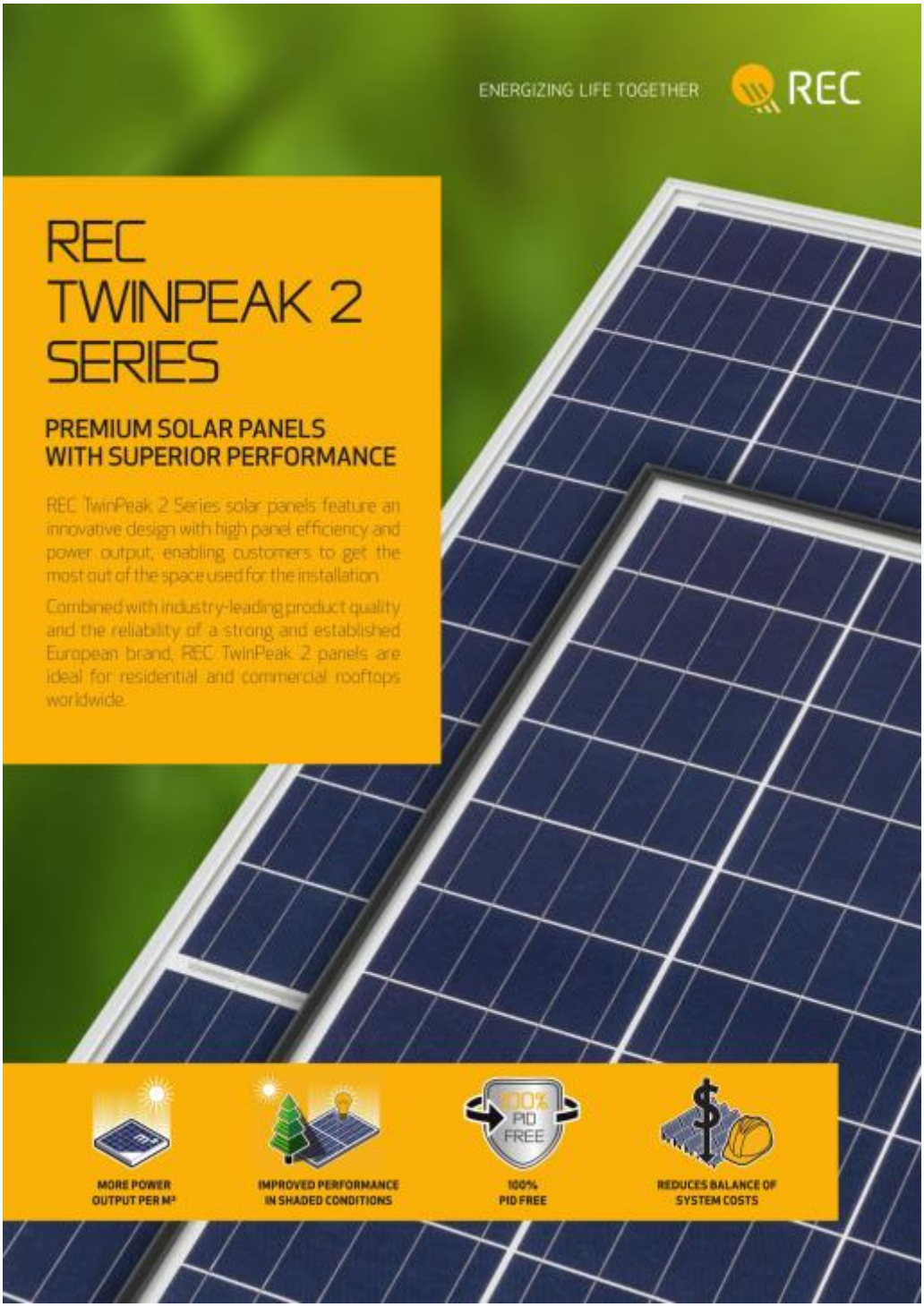
To ensure that solar plants are built to the highest standards and that they can reach the expected performance, we offer a comprehensive test program for solar energy systems. The range of services includes visual plant inspections, quality assurance of components, and evaluation of plant performance. These services help to identify defects and deficiencies in the installation. Early fault detection enables operators to react quickly for necessary repairs and potential warranty claims. Our tests are performed with approved state-of-the-art procedures.

System in Operation

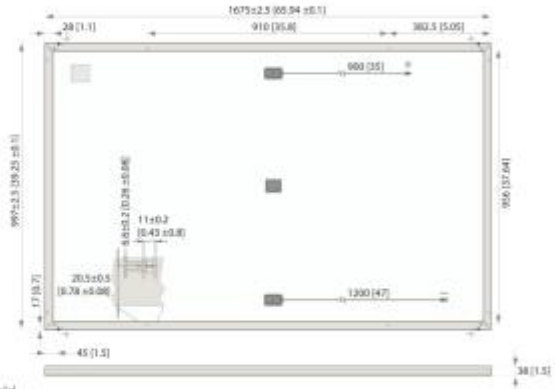
Independent confirmation of the quality and performance of components and complete plants is valuable to manufacturers, EPCs, banks and investors alike, irrespective of how long a plant has been operating. We offer independent performance reports that are reliable and accurate, for periods ranging from one day to many years. The reports include benchmarking as well as an analysis of measured versus expected performance ratios, based on our yield assessment. Moreover, a comprehensive plant inspection and failure analysis provides information about safety, optimization potential, and may serve as a basis for repowering projects.

7.8 Products Data Sheet

7.8.1 REC 295TP2S



REC TWINPEAK 2 SERIES



Measurements in mm [in]

ELECTRICAL DATA @ STC	Product Code*: RECxxxTP2				
Nominal Power - P_{MPP} (Wp)	275	280	285	290	295
Watt Class Sorting - (W)	0/+5	0/+5	0/+5	0/+5	0/+5
Nominal Power Voltage - V_{MPP} (V)	31.5	31.7	31.9	32.1	32.3
Nominal Power Current - I_{MPP} (A)	8.74	8.84	8.95	9.05	9.14
Open Circuit Voltage - V_{OC} (V)	38.2	38.4	38.6	38.8	39.0
Short Circuit Current - I_{SC} (A)	9.30	9.39	9.49	9.58	9.65
Panel Efficiency (%)	16.5	16.8	17.1	17.4	17.7

Values at standard test conditions STC (airmass AM 1.5, irradiance 1000 W/m², cell temperature 25°C).
At low irradiance of 200 W/m² (AM 1.5 and cell temperature 25°C) at least 95% of the STC module efficiency will be achieved.
*Where xxx indicates the nominal power class (P_{MPP}) at STC indicated above, and can be followed by the suffix BLK for black framed modules.

ELECTRICAL DATA @ NOCT*	Product Code*: RECxxxTP2				
Nominal Power - P_{MPP} (Wp)	206	210	214	218	223
Nominal Power Voltage - V_{MPP} (V)	29.2	29.4	29.6	29.8	30.0
Nominal Power Current - I_{MPP} (A)	7.07	7.15	7.24	7.32	7.43
Open Circuit Voltage - V_{OC} (V)	35.4	35.6	35.8	36.0	36.2
Short Circuit Current - I_{SC} (A)	7.52	7.59	7.68	7.75	7.85

Nominal operating cell temperature NOCT (800 W/m², AM 1.5, windspeed 1 m/s, ambient temperature 20°C).
*Where xxx indicates the nominal power class (P_{MPP}) at STC indicated above, and can be followed by the suffix BLK for black framed modules.

CERTIFICATIONS

IEC 61215, IEC 61730 & UL 1703, IEC 62804 (PID Free), IEC 61701 (Salt Mist Level 6), IEC 62716 (Ammonia Resistance), ISO 11925-2 (Ignitability Class E), UN 38.3, 91/74 (Class 1), ISO 9001:2015, ISO 14001, OHSAS 18001

take-e-way WEEE Compliant Recycling scheme

WARRANTY

10 year product warranty
25 year linear power output warranty
(max. degression in performance of 0.7% p.a. from 97% after the first year)

See warranty conditions for further details.

17.7% EFFICIENCY

10 YEAR PRODUCT WARRANTY

25 YEAR LINEAR POWER OUTPUT WARRANTY

TEMPERATURE RATINGS	
Nominal operating cell temperature (NOCT)	44.6°C (±2°C)
Temperature coefficient of P_{MPP}	-0.36 %/°C
Temperature coefficient of V_{OC}	-0.30 %/°C
Temperature coefficient of I_{SC}	0.066 %/°C

GENERAL DATA	
Cell type:	120 REC HC multicrystalline 6 strings of 20 cells
Glass:	3.2 mm solar glass with anti-reflective surface treatment
Back sheet:	Highly resistant polyester polyolefin construction
Frame:	Anodized aluminum (available in silver or black)
Junction box:	IP67 rated, 3-part with 3 bypass diodes 4 mm² solar cable, 0.9 m + 1.2 m
Connectors:	Stäubli MC4 PV-KBT4/PV-KST4 (4 mm²) Tonglin TL-Cable01SFR (4 mm²) Dependent on product type

MAXIMUM RATINGS	
Operational temperature:	-40...+85°C
Maximum system voltage:	1000 V
Maximum snow load:	550 kg/m² (5400 Pa)
Maximum wind load:	244 kg/m² (2400 Pa)
Max series fuse rating:	25 A
Max reverse current:	25 A

MECHANICAL DATA	
Dimensions:	1675 x 997 x 38 mm
Area:	1.67 m²
Weight:	18.5 kg

Note! Specifications subject to change without notice.

Founded in Norway in 1996, REC is a leading vertically integrated solar energy company. Through integrated manufacturing from silicon to wafers, cells, high-quality panels and extending to solar solutions, REC provides the world with a reliable source of clean energy. REC's renowned product quality is supported by the lowest warranty claims rate in the industry. REC is a Bluestar Elkem company with headquarters in Norway and operational headquarters in Singapore. REC employs more than 2,000 people worldwide, producing 1.4 GW of solar panels annually.

www.recgroup.com

7.8.2 SMA STP 15000TL

SUNNY TRIPOWER 15000TL

Efficient
- Maximum efficiency of 98.2 %
- SMA OptiTrac Global Peak MPP tracking for best MPP tracking efficiency

Reliable
- Triple protection with Optiprotect– electronic string fuse, self-learning string failure detection, integrable DC surge arrester (SPD Type II)

Flexible
- DC input voltage of up to 1000 V
- Tailor-made system design with Optiflex

Innovative
- Cutting-edge grid management functions
- Reactive power available 24/7 (Q on Demand)*

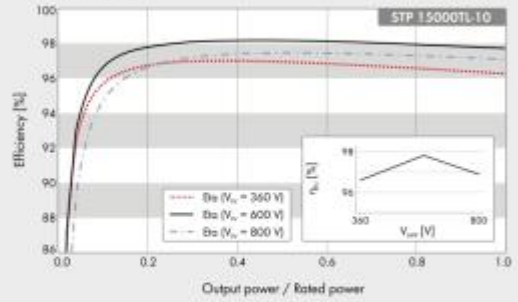
SUNNY TRIPOWER 15000TL

The Three-Phase Inverter for Easy PV System Design

The Sunny Tripower 15000TL has new, cutting-edge features: The integration of grid management functions, including Integrated Plant Control, allows the inverter to regulate reactive power at the grid-connection point. This means that upstream regulator units are no longer needed, and system costs are lowered. Another innovation is around-the-clock provision of reactive power (Q on Demand 24/7).

Optiflex technology and the Optiprotect safety concept remain proven standards: Optiflex provides enormous design flexibility with the two MPP inputs in connection with a broad input voltage range - and does it for almost all module configurations. The Optiprotect safety concept, with its self-learning string failure detection, electronic string fuse and integrable DC surge arrester type II, ensures maximum reliability.

Efficiency Curve



Accessory

● Standard features ○ Optional features –Not available
Data at nominal conditions
Status: January 2016

Technical Data	Sunny Tripower 15000TL
Input (DC)	
Max. DC power (at cos φ = 1) / DC rated power	15340 W / 15340 W
Max. input voltage	1000 V
MPP Voltage range / rated input voltage	360 V to 800 V / 600 V
Min. input voltage / initial input voltage	150 V / 188 V
Max. input current input A / input B	33 A / 11 A
Max. input current per string input A1 / input B1	40 A / 12.5 A
Max. DC short-circuit current input A / input B	50 A / 17 A
Number of independent MPP inputs/strings per MPP input	2 / A:5; B:1
Output (AC)	
Rated power (at 230 V, 50 Hz)	15000 W
Max. AC apparent power	15000 VA
Nominal AC voltage	3 / N / PE; 220 / 380 V 3 / N / PE; 230 / 400 V 3 / N / PE; 240 / 415 V
AC voltage range	160 V to 280 V
AC power frequency / range	50 Hz / 44 Hz to 55 Hz 60 Hz / 54 Hz to 65 Hz
Rated power frequency/rated grid voltage	50 Hz / 230 V
Max. output current / Rated output current	24 A / 24 A
Power factor at rated power / Adjustable displacement power factor	1 / 0 lagging to 0 leading
THD	≤ 3 %
Feed-in phases/connection phases	3 / 3
Efficiency	
Max. efficiency / European efficiency	98.2 % / 97.8 %
Protective devices	
Input-side disconnection point	●
Ground fault monitoring / grid monitoring	● / ●
DC surge arrester SPD type III / SPD type II	● / ○
DC reverse polarity protection / AC short-circuit current capability / galvanically isolated	● / ● / –
All-pole sensitive residual-current monitoring unit / Electronic string current monitoring	● / ●
Protection class (as per IEC 62109-1) / overvoltage category (as per IEC 62109-1)	I / AC: III; DC: II
General Data	
Dimensions (W / H / D)	665 / 690 / 265 mm (26.2 / 27.2 / 10.4 inches)
Weight	59 kg (130.07 lb)
Operating temperature range	–25 °C to +60 °C (–13 °F to +140 °F)
Noise emission, typical	51 dB(A)
Self-consumption (at night)	1 W
Topology / cooling concept	Transformerless / OptiCool
Degree of protection (as per IEC 60529)	IP65
Climatic category (according to IEC 60721-3-4)	4K4H
Max. permissible value for relative humidity (non-condensing)	100 %
Features / function	
DC connection / AC connection	SUNCLIX / spring-cage terminal
Display	Graphic
Interface: RS485, Bluetooth®, Speedwire / Webconnect	○ / ● / ○
Data interface: SMA Modbus / SunSpec Modbus	○ / ○
Multifunction relay / Power Control Module	○ / ○
OptiTrack Global Peak/Integrated Plant Control/Q on Demand 24/7	● / ● / ●
Off-Grid capable/SMA Fuel Save Controller compatible	● / ●
Warranty: 5/10/15/20/25 years	● / ○ / ○ / ○ / ○
Certificates and approvals (others available upon request)	AS 4777, BDEW 2008, C10/11:2012, CE, CEI 0-16, CEI 0-21, EN 50438[2], G59/3, IEC 60068-2, IEC 61727, MEA 2013, IEC 62109-1/2, NEN EN 50438, PPC, PPDS, RD 1699, RD 661/2007, SI4777, UTE C15-712-1, VDE 0126-1-1, VDE-ARN 4105, VFR 2013, VFR 2014
[1] To be observed in the event of short-circuit of the string fuse. [2] Does not apply to all national appendices of EN 50438	
Type designation	STP 15000TL-10

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7.8.3 SMA STP 20000TL

SUNNY TRIPOWER
20000TL / 25000TL

Efficient
- Maximum efficiency of 98.5 %

Safe
- DC surge arrester (SPD type II) can be integrated

Flexible
- DC input voltage of up to 1,000 V
- Multistring capability for optimum system design

Innovative
- Cutting-edge grid management functions with Integrated Plant Control*
- Reactive power available 24/7 (QonDemand24/7)*

SUNNY TRIPOWER 20000TL / 25000TL

The versatile specialist for large-scale commercial plants and solar power plants

The Sunny Tripower 20000TL/25000TL is the ideal inverter for large-scale commercial and industrial plants. Not only does it deliver extraordinary high yields with an efficiency of 98.5%, but it also offers enormous design flexibility and compatibility with many PV modules thanks to its multistring capabilities and wide input voltage range.
The future is now: the Sunny Tripower 20000TL/25000TL comes with cutting-edge grid management functions such as Integrated Plant Control*, which allows the inverter to regulate reactive power at the point of common coupling. Separate controllers are no longer needed, lowering system costs. Another new feature–reactive power provision on demand (QonDemand24/7).*

*In preparation

Accessories

– Does not apply to all national appendices of EN 50438
* Planned

● Standard features ○ Optional features – Not available
Data at nominal conditions
Preliminary information – last updated: May 2014

Technical Data	Sunny Tripower 20000TL	Sunny Tripower 25000TL
Input (DC) Input (DC)		
Max. DC power (@ cos ϕ = 1)	20440 W	25550 W
Max. input voltage	1000 V	1000 V
MPP voltage range / rated input voltage	320 V to 800 V / 600 V	390 V to 800 V / 600 V
Min. input voltage / start input voltage	150 V / 188 V	150 V / 188 V
Max. input current input A / input B	33 A / 33 A	33 A / 33 A
Number of independent MPP inputs / strings per MPP input	2 / A:3; B:3	2 / A:3; B:3
Output (AC)		
Rated power (@ 230 V, 50 Hz)	20000 W	25000 W
Max. AC apparent power	20000 VA	25000 VA
AC nominal voltage	3 / N / PE; 220 / 380 V 3 / N / PE; 230 / 400 V 3 / N / PE; 240 / 415 V	3 / N / PE; 220 / 380 V 3 / N / PE; 230 / 400 V 3 / N / PE; 240 / 415 V
Nominal AC voltage range	160 V to 280 V	160 V to 280 V
AC grid frequency / range	50 Hz, 60 Hz / -6 Hz to +5 Hz	50 Hz, 60 Hz / -6 Hz to +5 Hz
Rated power frequency / rated grid voltage	50 Hz / 230 V	50 Hz / 230 V
Max. output current	29 A	36.2 A
Power factor at rated power	1	1
Adjustable displacement power factor	0 overexcited to 0 underexcited	0 overexcited to 0 underexcited
Feed-in phases / connection phases	3 / 3	3 / 3
Efficiency		
Max. efficiency	98.5 %	98.5 %
Protective devices		
Input-side disconnection point	●	●
Ground fault monitoring / grid monitoring	● / ●	● / ●
DC surge arrester (type II) can be integrated	○	○
DC reverse polarity protection / AC short-circuit current capability / galvanically isolated	● / ● / –	● / ● / –
All-pole sensitive residual-current monitoring unit	●	●
Protection class (according to IEC 62103) / overvoltage category (according to IEC 60664-1)	I / III	I / III
General data		
Dimensions (W / H / D)	665 / 690 / 265 mm (26.2 / 27.2 / 10.4 inch)	665 / 690 / 265 mm (26.2 / 27.2 / 10.4 inch)
Weight	61 kg (134.48 lb)	61 kg (134.48 lb)
Operating temperature range	-25 °C to +60 °C (-13 °F to +140 °F)	-25 °C to +60 °C (-13 °F to +140 °F)
Noise emission (typical)	51 dB(A)	51 dB(A)
Self-consumption (at night)	1 W	1 W
Topology / cooling concept	Transformerless / Opticool	Transformerless / Opticool
Degree of protection (as per IEC 60529)	IP65	IP65
Climatic category (according to IEC 60721-3-4)	4K4H	4K4H
Maximum permissible value for relative humidity (non-condensing)	100 %	100 %
Features		
DC connection / AC connection	SUNCLIX / spring-cage terminal	SUNCLIX / spring-cage terminal
Display	–	–
Interface: RS485, Speedwire/Webconnect	○ / ○	○ / ○
Multifunction relay / Power Control Module	○ / ○	○ / ○
Guarantee: 5 / 10 / 15 / 20 / 25 years	● / ○ / ○ / ○ / ○	● / ○ / ○ / ○ / ○
Planned certificates and permits (more available on request)	AS 4777, BDEW 2008, C10/11, CE, CEI 0-16, CEI 0-21, EN 50438, G59/3, IEC61727, IEC 62109-1/2, NEN EN 50438, PPC, RD 1699, RD 661/2007, SI4777, UTE C15-712-1, VDE 0126-1-1, VDE-AR-N 4105	
Type designation	STP 20000TL-30	STP 25000TL-30

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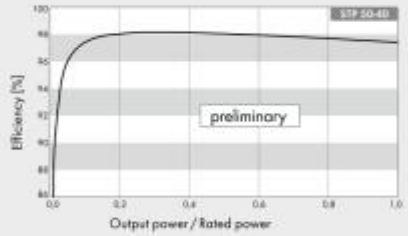
7.8.4 SMA STP CORE1 50

TECHNICAL DATA (PRELIMINARY*)	SUNNY TRIPOWER CORE1
Input (DC)	
Max. DC power (at cos φ = 1) / DC rated power	51000 W / 51000 W
Max. input voltage	1000 V
MPP voltage range / rated input voltage	150 V to 1000 V / 500 V to 800 V
Min. input voltage / start input voltage	150 V / 188 V
Max. operating input current / per MPPT	120 A / 20 A
Max. short circuit current per MPPT / per string input	30 A / 30 A
Number of independent MPPT inputs / strings per MPP input	6 / 2
Output (AC)	
Rated power (at 230 V, 50 Hz)	50000 W
Max. apparent AC power	50000 VA
AC nominal voltage	3 / N / PE; 220 V / 380 V 3 / N / PE; 230 V / 400 V 3 / N / PE; 240 V / 415 V
AC voltage range	180 V to 280 V
AC grid frequency / range	50 Hz / 44 Hz to 55 Hz 60 Hz / 54 Hz to 65 Hz
Rated power frequency / rated grid voltage	50 Hz / 230 V
Max. output current / Rated output current	72.5 A / 72.5 A
Output phases / line connections	3 / 3
Power factor at rated power / Adjustable displacement power factor	1 / 0.0 leading ... 0.0 lagging
THD	3%
Protective devices	
Input-side disconnection device	●
Ground fault monitoring / grid monitoring	● / ●
DC reverse polarity protection / AC short-circuit current capability / galvanically isolated	● / ● / -
All-pole sensitive residual-current monitoring unit	●
Protection class (according to IEC 62109-1) / overvoltage category (according to IEC 62109-1)	I / AC: III; DC: II
AC/DC surge arrester (Type II)	O / O

TECHNICAL DATA (PRELIMINARY*)	SUNNY TRIPOWER CORE1
Efficiency	
Max. efficiency / European efficiency	>98.0% / >98.0%
General data	
Dimensions (W / H / D)	621 mm / 733 mm / 369 mm (24.4 in / 28.8 in / 22.4 in)
Weight	82 kg (180 lb)
Operating temperature range	-25°C to +60°C (-13 °F to +140 °F)
Noise emission (typical)	<60 dB(A)
Self-consumption (at night)	<5 W
Topology / Cooling concept	Transformerless / OptiCool
Degree of protection (as per IEC 60529)	IP65
Climatic category (according to IEC 60721-3-4)	4K4H
Max. permissible value for relative humidity (non-condensing)	100%
Features / functions / accessories	
DC connection / AC connection	SUNCLIX / screw terminal
LED indicators (status / fault / communication)	●
Interface: Ethernet / WLAN / RS485	● (2 ports) / ● / O
Data interface: SMA Modbus / SunSpec Modbus / Speedwire, Webconnect	● / ● / ●
Multi-Function relay / Expansion Module Slots	● / ● (2 ports)
OptiTrac Global Peak / Integrated Plant Control / Q on Demand 24/7	● / ● / ●
Off-grid capable / SMA Fuel Save Controller compatible	● / ●
Guarantee: 5 / 10 / 15 / 20 years	● / O / O / O
Certificates and permits (more available on request) *Does not apply to all national appendices of EN50438	ANRE 30, AS 4777, BDEW 2008, C10/11:2012, CE, CEI 0-16, CEI 0-21, EN 50438:2013*, G59/3, IEC 60068-2-x, IEC 61727, IEC 62109-1/2, IEC 62116, MEA 2013, NBR 16149, NEN EN 50438, NRS 091:2-1, PEA 2013, PPC, RD 1699/413, RD 661/2007, Res. n°7:2013, SI4777, TOR D4, TR 3.2.2, UTE C15-712-1, VDE 0126-1-1, VDE-ARN 4105, VFR 2014, P.O.12.3, NTCO-NTCyS, GC 8.9H, PR20, DEWA
● Standard features O Optional - Not available Data at nominal conditions - preliminary version: 11/2016	
Type designation	STP 50-40

*December 2016

Efficiency Curve



Assessories

- SMA SensorModule MD.SEN-US-40
- SMA IO-Module MD.IO-40
- Antenna Extension Kit EXTANT-US-40
- SMA RS485 Module MD.RS485-US-40
- AC Surge Protection Module Kit AC_SPD_Kit1-10
- DC Surge Protection Module Kit DC_SPD_Kit4-10

7.8.5 SMA SENSOR BOX

SUNNY SENSORBOX

Reliable
- Rapid error detection via continuous target-actual comparison of plant performance

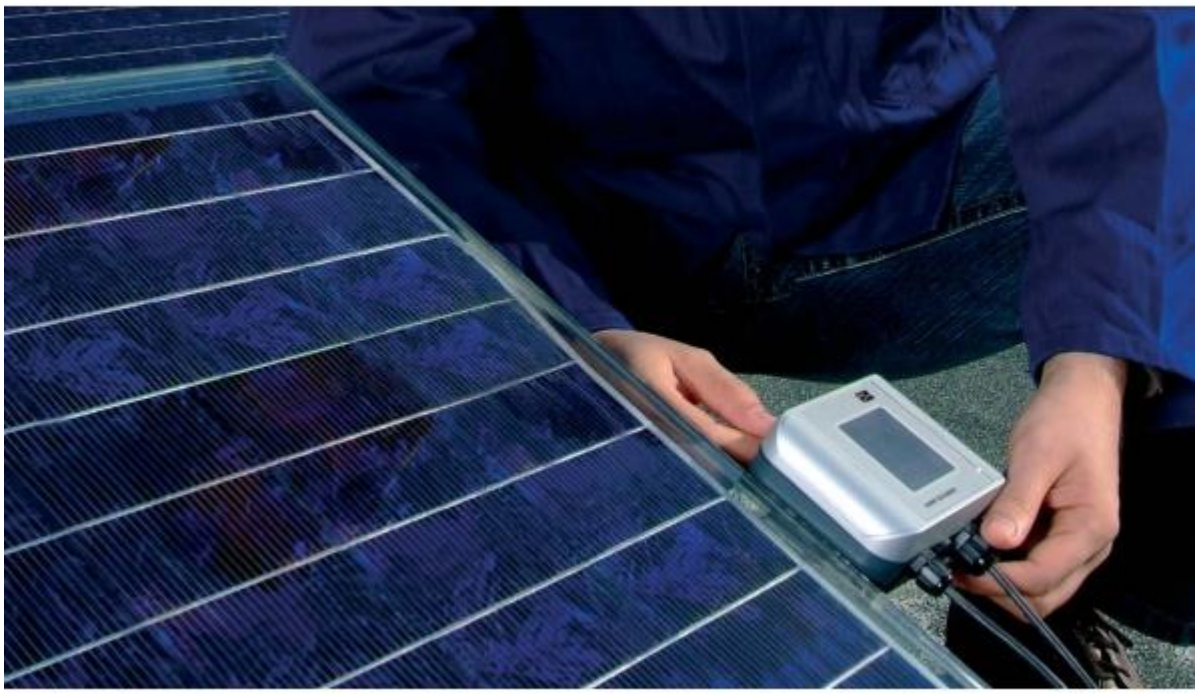
Informative
- Precise acquisition of irradiation intensity, module temperature, ambient temperature and wind speed values

Easy to install
- Easy installation on the solar generator
- Simple integration into existing PV plants via RS485
- Data analysis on any PC or in the Sunny Portal

SUNNY SENSORBOX

The weather station for PV plants

The Sunny SensorBox is installed directly onto the modules and measures the sun radiation and temperature. In combination with Sunny WebBox and Sunny Portal, it provides a continuous target-actual comparison of plant performance. This makes it possible to detect shade, dirt, and gradually declining performance in a generator and thus maximizes yield security. Additional sensors for optional measurement of ambient temperature or wind speed permit more precise calculations.



SUNNY SENSORBOX

Innovation and precision for your performance monitoring

Complete system monitoring easily installed

The Sunny SensorBox is installed outdoors at the solar generator, and comes with an integrated solar cell, which measures solar irradiation. The module temperature is measured by means of the temperature sensor which is included. From the present solar irradiation level and the module temperature, it is possible to calculate the expected output, and to compare it with the actual measured output of the inverters. Temporary or continuous yield losses caused by unknown failure sources are therefore a thing of the past.

... extendable

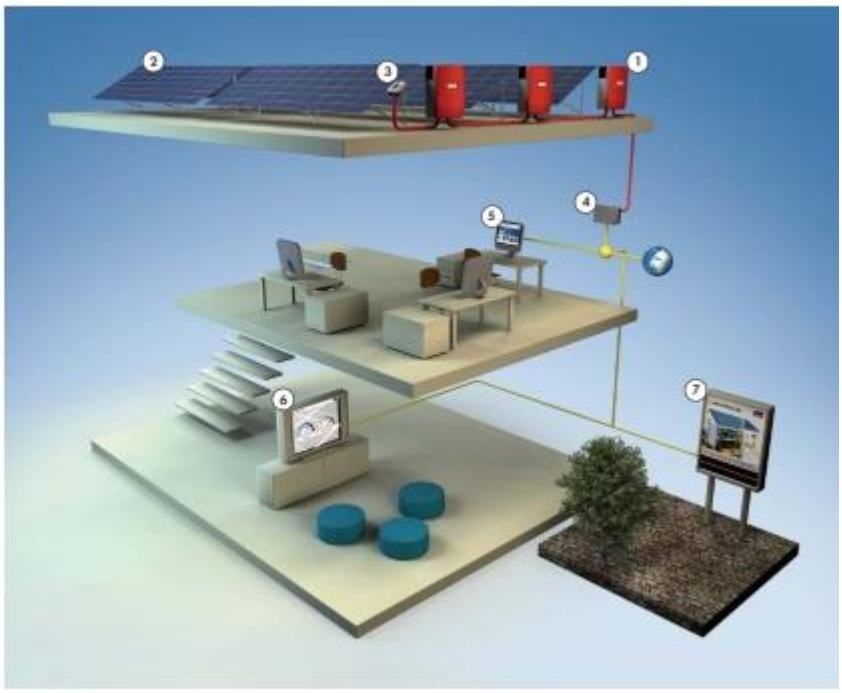
Once the Sunny SensorBox has been aligned to the modules, it is simply connected with the inverters to a Sunny WebBox with an RS485 data connection. From there, the data can be transferred to a PC for further processing, or to the Sunny Portal for automatic performance analysis. The Sunny SensorBox also enables the connection of additional sensors, e. g. to measure the ambient temperature or wind speed for calculations which are even more precise. This ensures reliable system monitoring for operators – and maximum yield security.

Typical system design – Cable Transmission

Electricity Generation
① SUNNY MINI CENTRAL
② Solar generator

System Monitoring
③ SUNNY SENSORBOX
④ SUNNY WEBBOX
⑤ SUNNY PORTAL
⑥ FLASHVIEW
⑦ SUNNY MATRIX

RS485
Local network / Internet



Performance ratio as a quality indicator

Shadowing, defects, surface contamination and gradual malfunctions such as deteriorating modules have a serious impact on the generator yield and the overall performance and are not to be underestimated. Particularly annoying for the operator is the fact that the losses in yield could have been avoided in most cases – if the error had been detected in time. The system efficiency of the PV-plant (performance ratio) is therefore an essential value. The performance ratio indicates the ratio of actual yield to the theoretically possible yield. Since the performance ratio indicates how the irradiated energy on the generator side is exploited, it is the decisive quality factor for the performance of the entire PV system. This is where the Sunny SensorBox comes into play.

How to determine the performance ratio

You simply divide the actual energy yield through the possible energy yield. While the inverter measures the actual energy, the possible energy yield is determined according to the efficiency of the modules, the module surface and the recorded insolation. Good grid connected PV systems reach performance ratios of between 60 % and 80 % – ratios under this value can indicate malfunctions of the system.

Technical data	Sunny SensorBox	
Communication		
Data logger communication	RS485 or SMA Power Injector with Bluetooth to Sunny WebBox	
Interfaces		
Sunny WebBox and Power Injector	1x SMACOM / spring terminals	
Max. communication range		
RS485	1.200 m	
SMA Power Injector with Bluetooth	100 m	
Power supply		
Power supply	RS485 Power Injector SMA Power Injector with Bluetooth	
Input voltage	100 V – 240 V AC, 50 / 60 Hz	
Power consumption	< 1 W	
Environmental conditions in operation		
Ambient temperature	–25 °C ... +70 °C	
Protection rating (as per EN 60529)	IP65	
General data		
Dimensions (W / H / D) in mm	120 / 50 / 90	
Weight	500 g	
Mounting location	Outdoor	
Deployment options	Mounting plate, roof bracket	
Language versions – manual	German, English, French, Italian, Spanish, Dutch, Czech, Portuguese, Greek, Korean	
Features		
Operation	via the Sunny WebBox interface	
Warranty	5 years	
Certificates and approvals	www.SMA-Solar.com	
Accessories		
Mounting plate	o	
Roof bracket	o	
Wind sensor	o	
Wall mounting bracket for wind sensor	o	
PT100 ambient temperature sensor	o	
PT100 module temperature sensor	●	
RS485 Power Injector	●	
SMA Power Injector with Bluetooth*	o	

● Standard features o Optional features – Not available

Communication with the Sunny WebBox via RS485

Continuous **monitoring** of generator performance in Sunny Portal

Measurement of radiation and module temperature (plus optional measurement of ambient temperature and wind speed)

Easy installation data transmission and energy supply via a common cable

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