The Roof Top Photo Voltaic

Solar Power Plant of capacity 20kWp

With partial financial support

&

100% technical support from

The Department of New and Renewable Energy, Government of India

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West Bengal Renewable Energy Development Corporation, Government of West Bengal

Dinabandhu Andrews College
P.O. Garia, Kolkata 700 084

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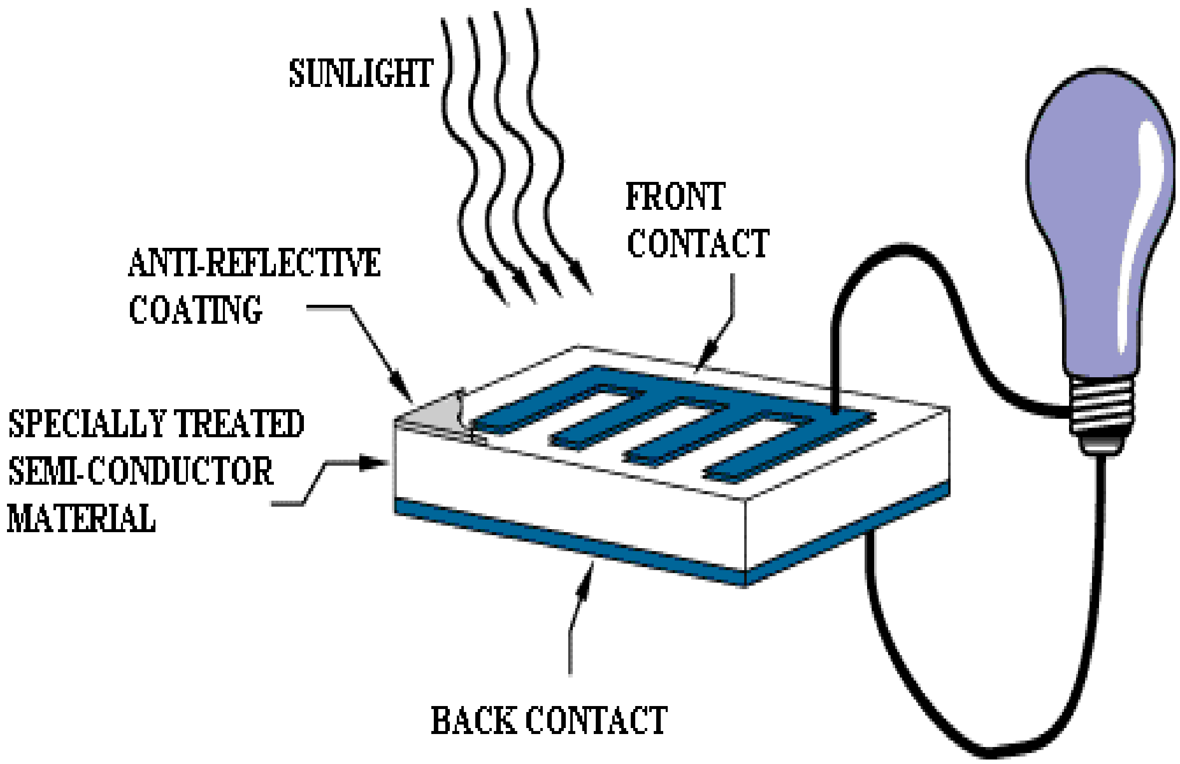
Introductory Technical notes

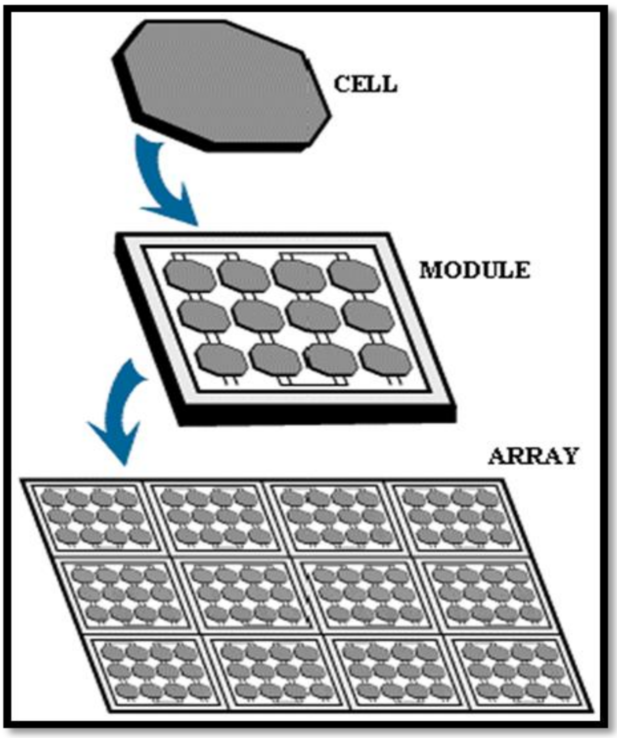
The work of establishment of Roof Top Photo Voltaic Solar Power Plant of capacity 20kWp was completed immediately after uploading the Self Study Report on the college website in December, 2015. This mega incidence of infrastructure development had had a cascade of events which slowly and progressively led to the foundation of what is popularly known as Solar Power Plant.

Photovoltaics involve the direct conversion of light energy into electricity through photon-electron interaction without involving any moving parts. So it is a method of emission free silent generation of electricity. Discovery of semiconductor p-n junction in 1950's has led to the development of electronics in one hand and in the other it is found to be used as light absorber. Since the solar radiation coming to earth has its peak near 1.5eV, semiconductor having band gap around this energy should be used to design solar cell. But at those days the Si technology being matured one Si was used to design the first generation solar cell though with much less conversion efficiency.

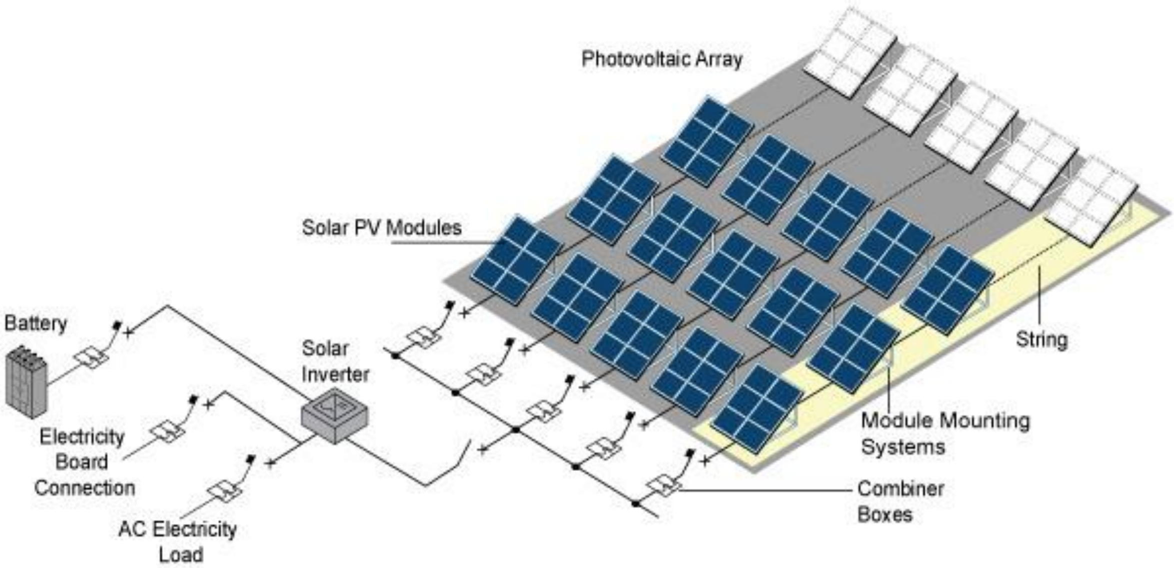
The first photovoltaic module was built at the Bell Laboratories in 1954. It was billed as a solar battery and was mostly just a curiosity as it was too expensive to achieve widespread use. In the 1960s, the space industry began to make the first serious use of the technology to provide power aboard spacecraft. Through the space programs, the technology advanced, its reliability was established, and the cost began to decline. During the energy crisis in the 1970s, photovoltaic technology gained recognition as a source of power for non-space applications also and the search for new materials began.



The diagram above shows how a Photovoltaic Cell generates electricity: Solar cells are basically p-n junction of semiconductors, such as Si. A thin Si wafer is doped differentially to form a p-n junction with a built-in electric field at the junction. When light energy falls on a solar cell, electron-hole pairs are generated and are carried away by the built-in electric field to establish current and voltage. The efficiency of the cell being dependent on rate of electron-hole pair generation the semiconductor band gap must be around the peak of solar radiation that reaches us. At present solar cells are not only made of Si, but high efficiency cells are designed with a-Si, CdS-CdTe, CdS-CuInSe and like semiconductors.



A number of solar cells electrically connected in a series-parallel combination to generate desired higher current and voltage and mounted in a support structure or frame is called a photovoltaic module. Modules are of different size as per the requirement of voltage and current. Multiple modules can be wired together to form an array. In general, the larger the area of a module or array, the greater is the electricity generation. Since power generation is directly proportional to the amount of incident light the array of solar cells must be installed at a region free of shadow and has to be mounted in a proper way to get maximum light throughout the day. The generated electric power is stored in battery bank to be used later on or it is converted to a.c. by an inverter to be fed to the grid.



The cascade of events that preceded the establishment of Roof Top Photo Voltaic Solar Power Plant of capacity 20kWp

1. The college was served a letter by West Bengal Renewable Energy Development Corporation, Government of West Bengal on 28th April, 2014 with a proposal of installing a roof-top Solar PV Power Plant of capacity 20kWp on partial fund sharing basis: Rs.15,00,000.00 jointly by the Department of New and Renewable Energy, Government of India & The West Bengal Renewable Energy Development Corporation, Government of West Bengal, and Rs.5,00,000.00 by Dinabandhu Andrews College

2. The Principal informed the authority of WBREDA that the college is ready to pay Rs.5,00,000.00 as and when the demand letter is raised

3. The authority of WEBREDA raised the demand letter for Rs.5,00,000.00 on 28th January, 2015 and advised the college authority to apply to the CESC Ltd. (the Electricity Distributing Co.) to complete the necessary formalities for availing the NET-METTERING benefit from the proposed Roof-Top PV Solar Power Plant

4. The college authority made a payment of Rs.5,00,000.00 to WBREDA on 16th February, 2015 through Cheque No. 320905, dated 10.02.2015 drawn on Axis Bank Ltd., Tollygunge Branch

5. The college authority approached the CESC Ltd. in congruence with the advice forwarded by WBREDA for availing the NET-METTERING benefit

6. The CESC Ltd. authority forwarded a copy of the proposed agreement to be signed by the college authority and that of the CESC Ltd. The college authority redirected the said draft agreement to the office of the WEBREDA for its valued opinion

7. The WEBREDA thoroughly examined the draft agreement and issued a letter on 16.06.2015 in favour of the college authority advising it to go ahead with the proposed agreement

8. The WEBREDA authority issued an work order in favour of M/s. Pulse Power Technologies Pvt. Ltd. having registered office at 156A, Lenin Sarani, Kolklata 700 013, and forwarded a copy of the said work order to the Principal of Dinabandhu Andrews College

9. The work was undertaken by M/s. Pulse Power Technologies Pvt. Ltd. under the administrative control of the office of the Chief Engineer, PIDD, WBSEDCL, 5th Floor, Bidyut Bhavan

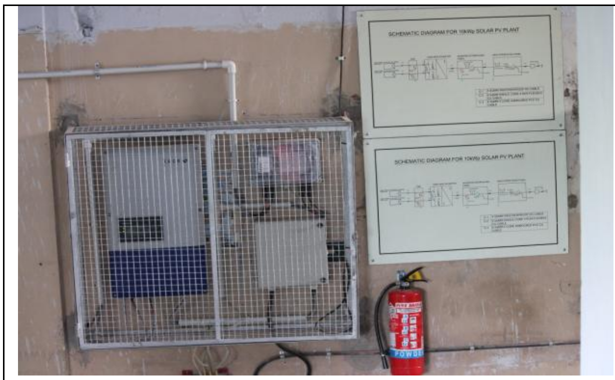
10. The Roof-top PV Solar Power Plant was formally inaugurated by the Hon'ble Power Minister of Government of West Bengal Sri Manish Gupta on 30th January, 2016

UGC Guideline regarding Establishment of Roof-top PV Solar Power Plant

The Inspector of Colleges of Calcutta University directed the authorities of its affiliated colleges for immediate implementation of the UGC Notification bearing No. D.O. No. F.14-21/2014(CPP-II), dated 04.03.2015 duly signed by the Secretary of the University Grants Commission, Ministry of Human Resource Development, Government of India.

Establishment of Roof-top PV Solar Power Plant of 20 kWp capacity in Dinabandhu Andrews College with partial financial support and 100% technical support from The Department of New and Renewable Energy, Government of India and West Bengal Renewable Energy Development Corporation, Government of West Bengal can therefore be considered as equivalent to the implementation of a project of the University Grants Commission.

The copy of the letter of the Inspector of Colleges of Calcutta University bearing No. C/482/Circular, dated 21.04.2015 and that of the Secretary of the University Grants Commission, Ministry of Human Resource Development, Government of India bearing No. D.O. No. F.14-21/2014(CPP-II), dated 04.03.2015 are presented here for ready reference of all concerned.




ROOF-TOP PV SOLAR POWER PROJECT OF 20K WP
CAPACITY IN
DINABANDHU ANDREWS COLLEGE
INAUGURATED BY
HON'BLE SRI MANISH GUPTA
MINISTER-IN-CHARGE
POWER & NES DEPARTMENT
GOVERNMENT OF WEST BENGAL
ON 30TH JANUARY, 2016
IN AUGUST PRESENCE OF
SRI BAPPADITYA DASGUPTA
AS CHIEF GUEST
AND
SRI ARUP CHAKRABARTY
AS SPECIAL GUEST

Solar energy is the radiant light and heat from the sun that has been harnessed by humans since ancient times using a range of ever-evolving technologies. Solar radiation along with secondary solar resources account for most of the available renewable energy on earth.

Solar Radiation at the Earth's Surface

While the solar radiation incident on the earth's atmosphere is relatively constant, the radiation at the earth's surface varies widely due to:

- Atmospheric effects, including absorption and scattering;
- Local variations in the atmosphere, such as water vapour, clouds, and pollution;
- Latitude of the location;
- Season of the year and the time of day.

The above effects have several impacts on the solar radiation received at the earth's surface. These changes include variations in the overall power received, the spectral content of the light and the angle from which light is incident on a surface. In addition, a key change is that the variability of the solar radiation at a particular location increases dramatically. The variability is due to both local effects such as clouds and seasonal variations, as well as other effects such as the length of the day at a particular latitude. Desert regions tend to have lower variations due to local atmospheric phenomena such as clouds. Equatorial regions have low variability between seasons.

Solar Technologies and Techniques

Solar energy technologies refer primarily to the use of solar radiation for practical ends. All other renewable energies other than geothermal derive their energy from energy received from the sun.

Solar technologies are broadly characterized as either passive solar or active solar depending on the way they capture, convert and distribute sunlight. Active solar techniques include the use of photovoltaic modules (also called photovoltaic panels) and solar thermal collectors (with electrical or mechanical equipment) to convert sunlight into useful outputs. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light dispersing properties, and designing spaces that naturally circulate air.

Active solar technologies increase the supply of energy and are considered supply side technologies, while passive solar technologies reduce the need for alternate resources and are generally considered demand side technologies.

Solar Electric Technologies

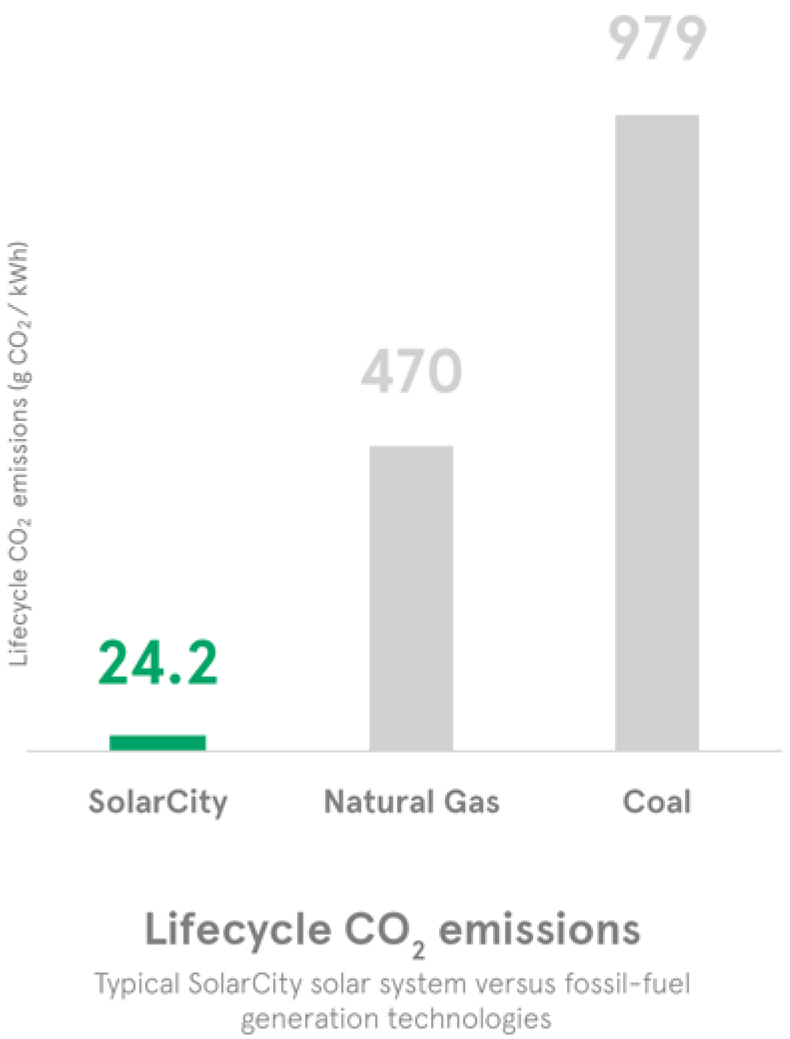
Sunlight can be directly converted into electricity using **photovoltaics (PV)** and various experimental technologies.

Power our Institute with clean energy.

Solar power systems derive clean, pure energy from the sun. Installing solar panels on your home helps combat greenhouse gas emissions and reduces our collective dependence on fossil fuel.

Traditional electricity is sourced from fossil fuels such as coal and natural gas. When fossil fuels are burned to produce electricity, they emit harmful gases that are the primary cause of air pollution and global warming. SolarCity's carbon footprint per unit of energy production is 95% lower than that of fossil fuel power plants.

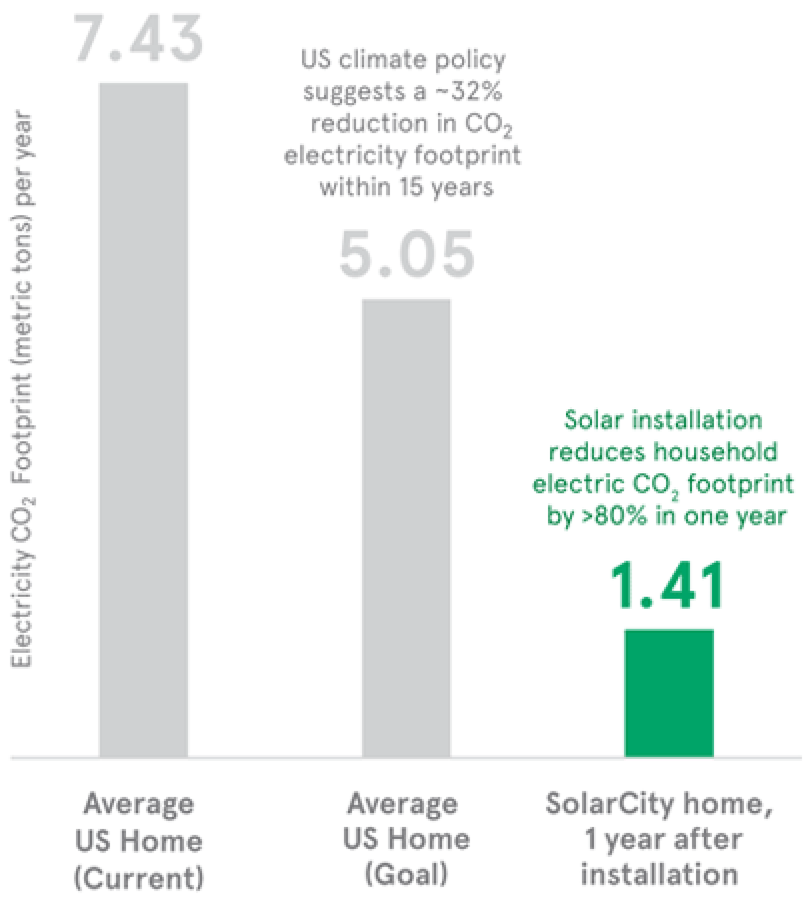
Not only are fossil fuels bad for the environment, they're a finite resource. Limited availability creates a volatile market in which energy prices can skyrocket in a short period of time.



A powerful way to be part of the solution.

Given the low greenhouse gas emissions from solar power, increasing its adoption is an essential strategy in efforts to combat climate change at an individual and national level.

SolarCity customers can reduce their electric-power carbon footprint at a scale and pace that is not only consistent with, but vastly accelerates America's attainment of Clean Power Plan goals. In fact, the typical SolarCity system starts delivering net carbon reductions in less than 1 year.



Solar installations vastly accelerate U.S. progress toward combating climate change

Solar power for our country

India is densely populated and has high solar insolation, an ideal combination for using solar power in India. Much of the country does not have an electrical grid, so one of the first applications of solar power has been for water pumping; to begin replacing India's four to five million diesel powered water pumps , each consuming about 3.5 kilowatts, and off-grid lighting. Some large projects have been proposed, and a 35,000 km² area of the Thar Desert has been set aside for solar power projects, sufficient to generate 700 to 2,100 giga watts

The Indian Solar Loan Programme, supported by the United Nations Environment Programme has won the prestigious Energy Globe World award for Sustainability for helping to establish a consumer financing program for solar home power systems. Over the span of three years more than 16,000 solar home systems have been financed through 2,000 bank branches, particularly in rural areas of South India where the electricity grid does not yet extend.

Announced in November 2009, the Government of India proposed to launch its Jawaharlal Nehru National Solar Mission under the National Action Plan on Climate Change with plans to generate 1,000 MW of power by 2013 and up to 20,000 MW grid-based solar power, 2,000 MW of off-grid solar power and cover 20 million sq meters with collectors by the end of the final phase of the mission in 2020.

Solar PV Potential

Solar Power, a clean renewable resource with zero emission, has got tremendous potential of energy which can be harnessed using a variety of devices. With recent developments, solar energy systems are easily available for industrial and domestic use with the added advantage of minimum maintenance. Solar energy could be made financially viable with government tax incentives and rebates.

With about 301 clear sunny days in a year, India's theoretical solar power reception, just on its land area, is about 5 Peta hour/year (i.e. = 5000 trillion kWh/yr ~ 600 Tera Watt). The daily average solar energy incident over India varies from 4 to 7 kWh/m2 with about 2300-3200 sunshine hours per year, depending upon location. This is far more than current total energy consumption. For example, even assuming 10% conversion efficiency for PV modules, it will still be thousand times greater than

the likely electricity demand in India by the year 2015.

Exploitation of the abundant solar energy resources available in our country is therefore, being accorded a high priority by the Ministry of New and Renewable Energy. The Ministry has come forward to support Solar PV based Power Plants in big way throughout the country with a host of fiscal incentives. For encouraging investment by the private sector in power generation through renewable energy, MNRE has formed nodal agencies in all the states, and has issued a set of guidelines for their consideration.

Considering the good potential available and also the thrust given by the Government of India and State Government to this national endeavor of exploiting renewable source of energy for power generation and with the availability of abundant Solar Power we have set up two 10,00 KWp Grid connected Roof Top Solar PV Power Plant in this college

KACO new energy.

Device name:	Type:	
Powador 12.0 TL3	**10,00 kW nominal power, three-phase**	
RS485 address:	Network address:	MAC address:
1	**192.168.1.191**	**00:1E:C0:F4:60:83**
Serial number:	Software version:	Data received:
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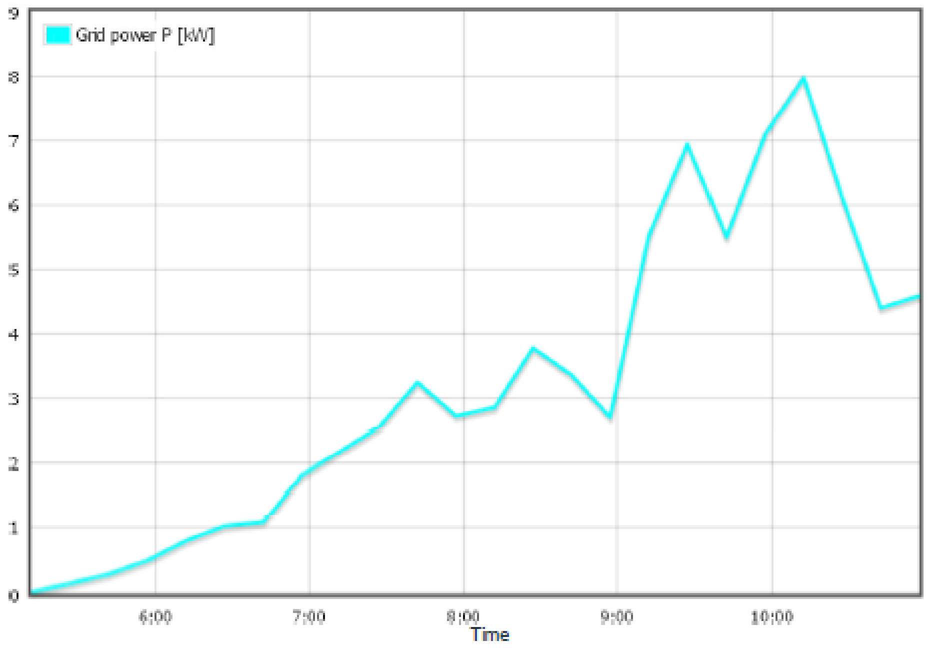
Daily view | **Monthly view** | **Yearly view** | **General view**

Daily view 1. September 2016



State

Feed-in mode

Live values

Generator power	2,26 kW 2,27 kW
Grid power	4,44 kW

Yields

Today	19,3 kWh

Choose view

- Grid power
- Generator powers
- Generator voltages
- Advanced options

Data export

Daily report of power generation (Grid power) (01/09/2016)

KACO new energy.

Device name:
Powador 12.0 TL3

Type:
10,00 kW nominal power, three-phase

RS485 address:
1

Network address:
192.168.1.191

MAC address:
00:1E:C0:F4:60:83

Serial number:
12.0TL01509692

Software version:
V3.00

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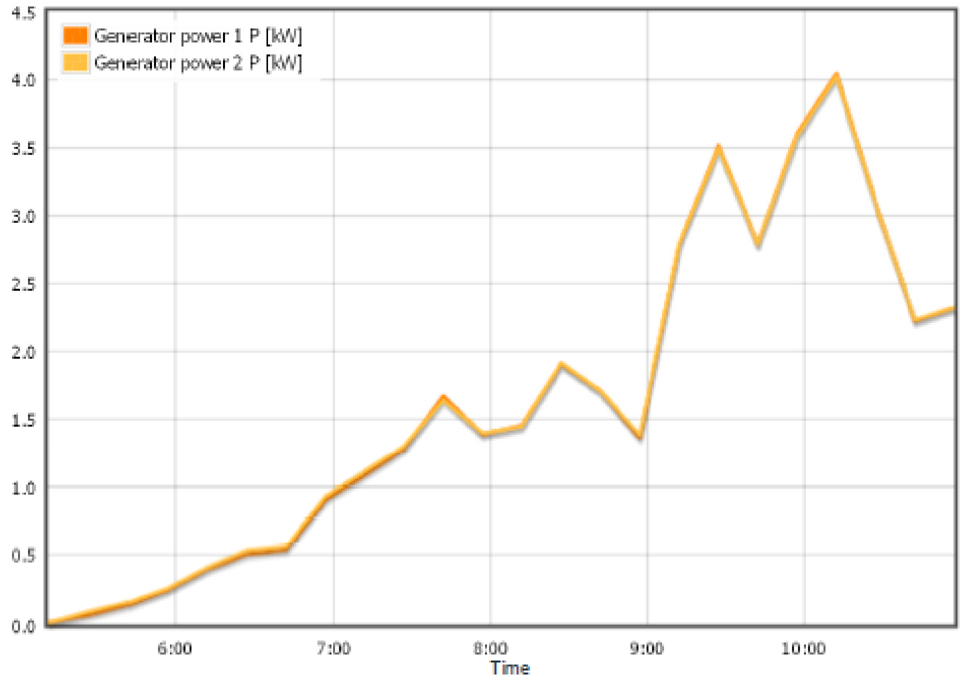
Daily view | **Monthly view** | **Yearly view** | **General view**

Daily view 1. September 2016



State

Feed-in mode

Live values

Generator power	2,15 kW 2,20 kW
Grid power	4,22 kW

Yields

Today	19,3 kWh

Choose view

- Grid power ○
- Generator powers ◉
- Generator voltages ○
- Advanced options

Data export

Daily report of power generation (Generated Power)

KACO new energy.

Device name:
Powador 12.0 TL3

Type:
10,00 kW nominal power, three-phase

RS485 address:
1

Network address:
192.168.1.191

MAC address:
00:1E:C0:F4:60:83

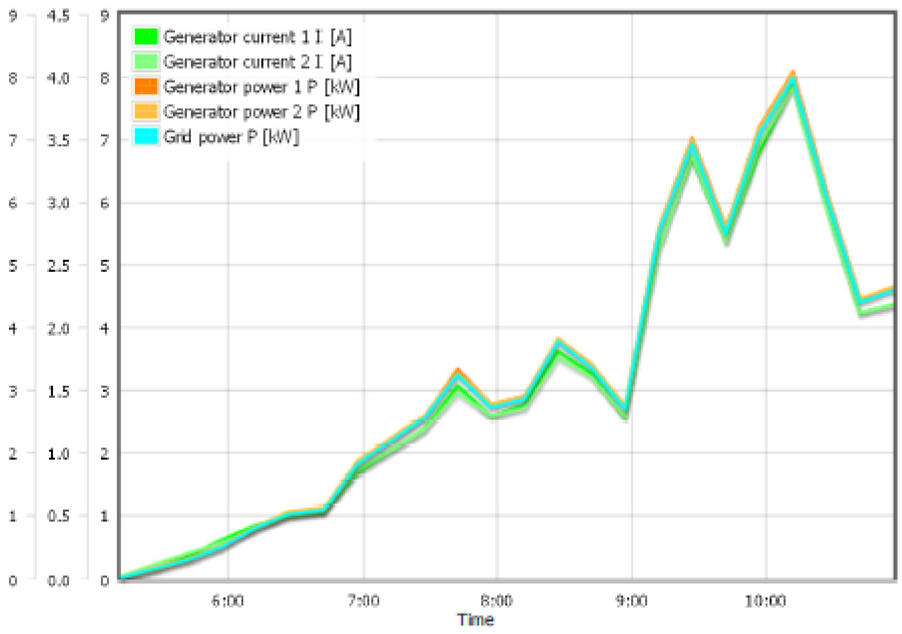
Serial number:
12.0TL01509692

Software version:
V3.00

Data received:
01.09.2016, 11:35:46

Daily view | **Monthly view** | **Yearly view** | **General view**

Daily view 1. September 2016



State

Feed-in mode

Live values

Generator power	3,13 kW 3,12 kW
Grid power	6,16 kW

Yields

Today	19,3 kWh

Choose view

- Grid power
- Generator powers
- Generator voltages
- Advanced options

	1	2	3
Generator voltage	☐	☐	
Generator current	☑	☑	
Generator power	☑	☑	
Grid voltage	☐	☐	☐
Grid current	☐	☐	☐
Grid power	☑		
Device temperature	☐		

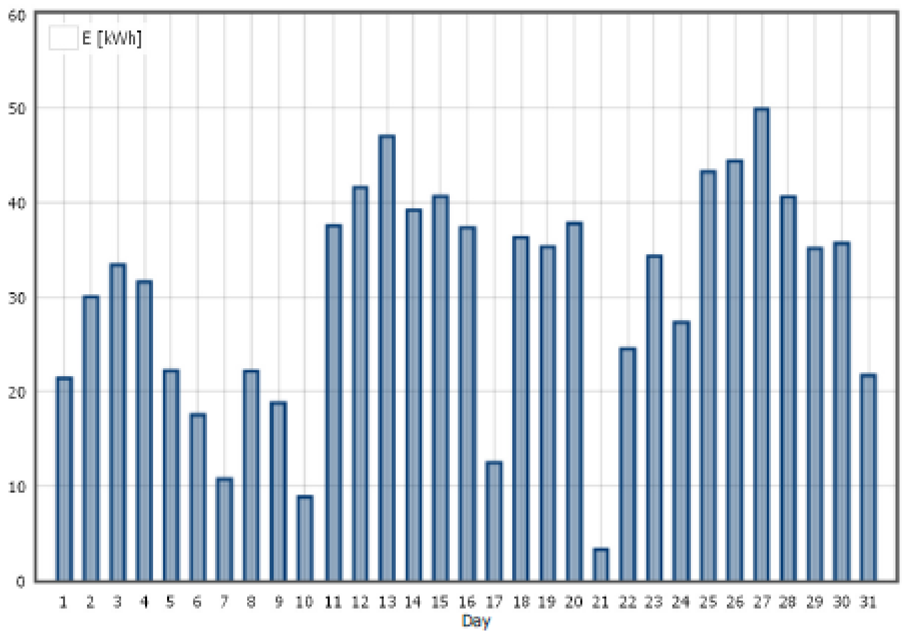
Daily report of power generation (Generated power, Grid power, Generated current) (01/09/2016)

KACO new energy.

Device name: **Powador 12.0 TL3**	Type: **10,00 kW nominal power, three-phase**	
RS485 address: **1**	Network address: **192.168.1.191**	MAC address: **00:1E:C0:F4:60:83**
Serial number: **12.0TL01509692**	Software version: **V3.00**	Data received: **01.09.2016, 11:36:46**

Daily view | **Monthly view** | **Yearly view** | **General view**

Monthly view August 2016



State

Feed-in mode

Live values

Generator power	2,53 kW 2,56 kW
Grid power	5,02 kW

Yields

August 2016	941,2 kWh

Monthly report of power generation (August, 2016)

Device name:
Powador 12.0 TL3

Type:
10,00 kW nominal power, three-phase

RS485 address:
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Network address:
192.168.1.191

MAC address:
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Serial number:
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Software version:
V3.00

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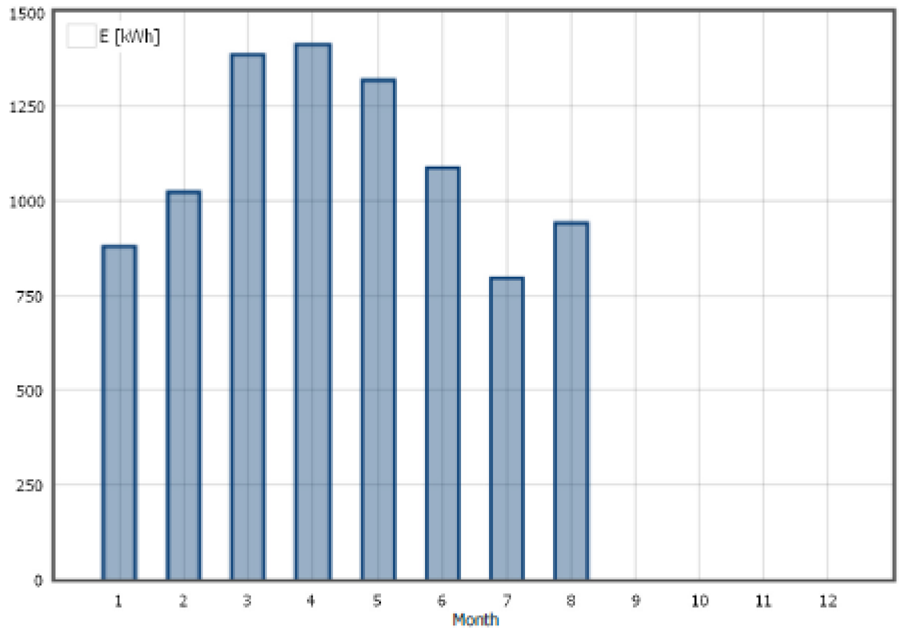
Daily view | **Monthly view** | **Yearly view** | **General view**

Yearly view 2016



State

Feed-in mode

Live values

Generator power	2,25 kW 2,28 kW
Grid power	4,48 kW

Yields

Current year	8845,4 kWh

Yearly report of power generation (2016)

Let us go green

Let us save petroleum products