# Energy Conservation Testimony of RK University after Deploying Renewable, Efficient & Sustainable Technologies

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## Abstract

The engineering education can play a significant role to promote and develop a clean, green, and sustainable environment around the world. Recently, COP26 (twenty-sixth session of the Conference of Parties) has showcased the global efforts to address climate change impacts on the Earth. In the same regard, this article is presenting the annual report of energy conservation in RK University through renewable, efficient, and sustainable technologies. This annual testimony concentrates on the energy saving efforts taken by the University through successful execution of roof-top solar power plant, biogas plants, rain-water harvesting system, solar water heater system, energy efficient sensor-based street lights and energy efficient fans. This article also includes various energy conservation computations to realize the important of clean and green energy. This annual report also fulfills the requirement of "Green Campus" as per the UGC and "Swachh Campus" as per the MHRD, Government of India.

***Keywords****: Sustainable environment; Climate change; Energy conservation; Annual report; Green campus; Swachh campus.*

## Introduction

For the past two decades, the energy demand from fossil fuels has increased enormously due to massive industrial growth and a steep rise in population [1]. Renewable energy sources have attracted attention as potential sources of energy. They are clean and cost-effective than conventional energy sources. Green energy is one of the 20 sustainable development goals emphasized by the United Nations. As of September 2021, India has 101.53 GW of renewable energy capacity and represents ~38% of the overall installed power capacity. The country is targeting about 450 GW of installed renewable energy capacity by 2030.

By the end of COP26, 151 countries had submitted new climate plans (known as nationally determined contributions, or NDCs) to slash their emissions by 2030 [2]. In engineering education, several universities have developed short-term courses to provide certificates in education for clean, green & environmental sustainability available to all disciplines. The role of universities and colleges are to take climate action by promoting and executing clean, renewable, and sustainable energy-based systems. With this same regard, RK University has taken the initiative to develop "Swachh campus" & "Sustainable

environment" by implementing renewable, efficient & sustainable technologies.

As per the 2019-2020 annual report of energy audit and energy conservation for RK University, more than 50% of the electricity consumed by RK University is produced from roof-top solar photo-voltaic (SPV) plants installed in the university campus. Moreover, solar water heaters are also installed in the university campus to boil the water.

A bio-gas plant is also installed in the university area and the output gas is used in the hostel kitchen area of the university. The university campus has the provision of rainwater harvesting to make maximum use of rainwater. And the water demand is fulfilled by 2 numbers of open wells in the campus.

The university is also having energy efficient technology like energy efficient BLDC (Brushless Direct Current) fans which save ~60% of electricity compared to conventional fans. Furthermore, the university campus has installed the latest LED tube lights which save ~50% of electricity compared to conventional tube lights. In the university campus, outside streetlights are worked by day-light sensors which reduces the wastage of electricity.

**Energy Conservation by Renewable Resources: RK University**

This article represents the energy conservation report of RK University, which includes renewable energy system-based implementation work as mentioned below.

**(A) Roof-top SPV Plant**

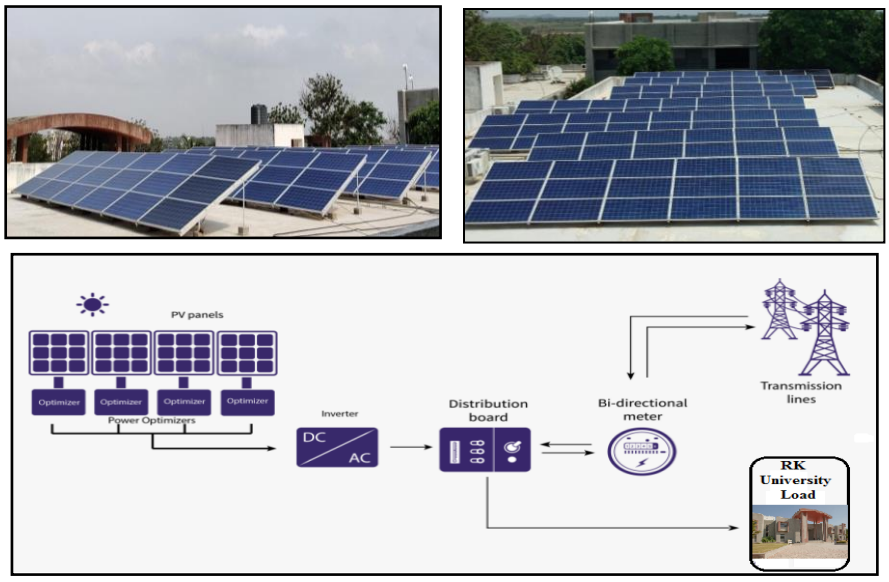


**Fig 1:** Photographs and layout of Roof-top Solar PV Plant

A Roof-top Solar PV Plant is installed in RK University since 2018. The total installed capacity of this plant is 157.5 kW. As per geographical location, the latitude and

longitude of this plant are 22.2406° N and 70.9017° E, respectively. In this plant SPV panels are installed at the angle of 26.5°. Moreover, the net area covered by SPV panels is 1,570 $m^2$. Total capital cost of this roof top SPV plant is Rs. 88.91 lakh and after receiving 30% subsidy by state and central government, net amount Rs. 63.15 lakh was paid by the University. This SPV plant has 3 numbers of "on-grid" inverters with the capacity of 50 kVA each. SPV panels are mounted on an aluminum fixed structure for supporting purpose.

In this plant, poly-crystalline cells are used, and each module has 72 numbers of poly-crystalline cells. The module rating is 320 $W_P$ and total numbers of SPV modules are 492. This plant has total 48 numbers of panels with a total rating of 157.5 kW. Let's see few historical analysis related to this plant as per below graphs.

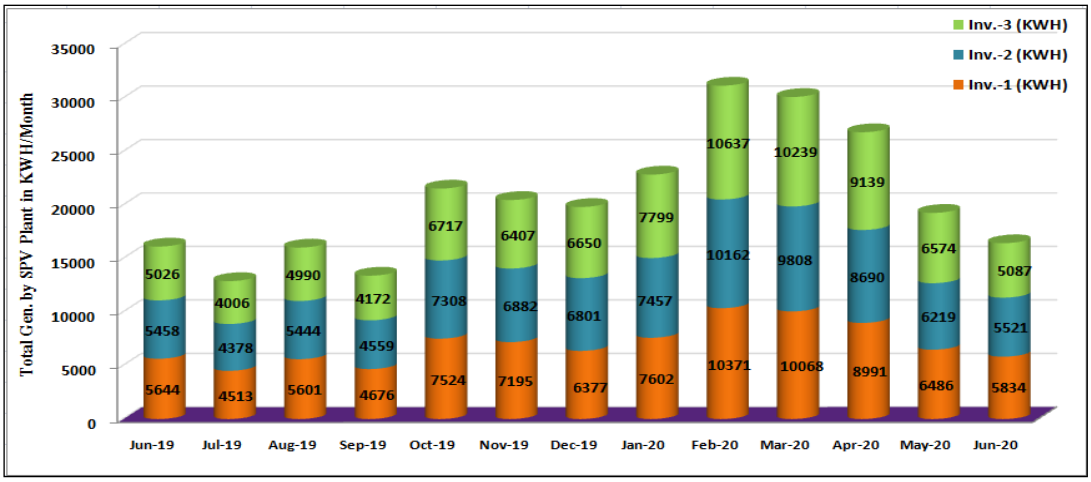


**Fig 2:** Month wise KWH generation of SPV plant

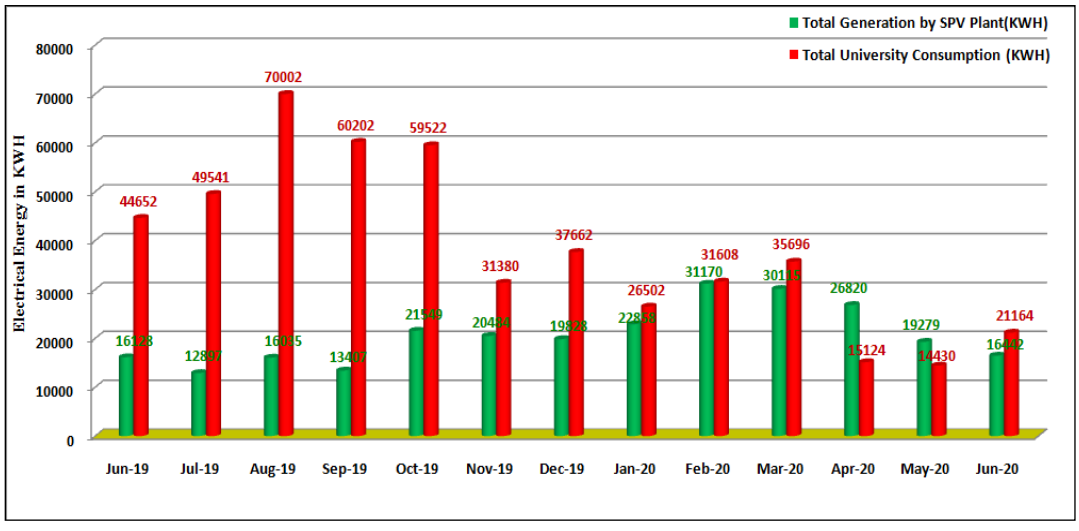


**Fig 3:** Month wise electricity generation by SPV plant Vs. month wise electricity consumption by the University

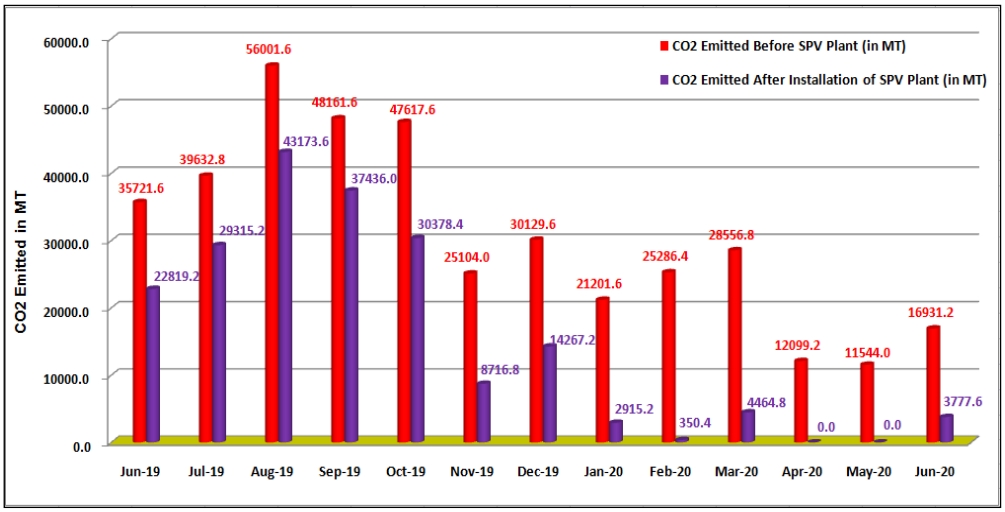


**Fig 4:** Month wise $CO_2$ emission by University with/without installation of SPV plant

As per the above graphs, it is understandable that, annually 53% of the electricity used in the University is drawn from Solar PV plant. Moreover, annually same percentage of $CO_2$ emitted from the University's electricity consumption is also reduced [3]. The overall the average efficiency of SPV plant is near to 15.32% and average utilization factor is around 44.5% [4]. If we estimate the payback period of this plant than ideally it should be around 3.5 years, but due to less per unit rate of SPV generation (~Rs.3 per unit) and higher per unit rate of grid electricity consumption (~Rs.8 per unit), the net payback period stands around 8.5 to 9 years includes maintenance cost. This SPV plant is installed by JJPV Pvt. Ltd., Rajkot.

### (B) Solar Water Heaters

One more usage of the same renewable resource in RK University is solar water heaters. In the University's hostel area and staff quarters having excellent solar water heater facility & total 52 numbers of solar water heaters are successfully installed since 2011. And the net cost of solar water heater is Rs.38,000 each.

**Table 1:** Building/area wise solar water heater list in RK University

| Sr. No. | RK University area | No. of Solar water heaters | Capacity of heating in Liter |
|---|---|---|---|
| **1.** | Hospital area | 3 + 4 = 7 | 500 Liters each |
| **2.** | Boy's Hostel - A | 4 + 4 + 4 = 12 | 500 Liters each |
| **3.** | Boy's Hostel - B | 4 + 4 + 4 = 12 | 500 Liters each |
| **4.** | Girl's Hostel - A | 2 + 1 = 3 | 500 Liters each |
| **5.** | Girl's Hostel - B | 2 + 1 = 3 | 500 Liters each |
| **6.** | Girl's Hostel - C | 2 + 2 = 4 | 500 Liters each |
| **7.** | 2 BHK Staff Quarters | 3 + 2 = 5 | 500 Liters each |
| **8.** | 3 BHK Staff Quarters | 1 + 1 = 2 | 500 Liters each |
| **9.** | North Star School | 2 + 2 = 4 | 500 Liters each |

If consider a conventional electric heater in the stand of solar water heater, then 3.5 KW power is required to boil 500 Liter water. Thus, the net power saving from solar water heater is 52*3.5 = 182 KW. Let's see the photo/layout of the solar water heater as below.


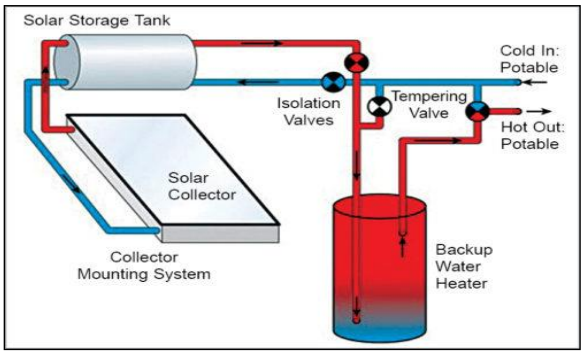


**Fig 5:** Photograph and layout of solar water heater

The solar collector tubes are mounted at 45°. And a backup water heater is also available [5] as a mention in the above figure. Moreover, the type of solar water heater is "Evacuated tube collector" which has good efficiency.

### (C) Bio-gas Plant

Biogas is a type of bio-fuel that is naturally produced from the decomposition of organic waste. Hence, it is a renewable or green source of energy. Bio-gas plant is a device for the conversion of fermentable organic matter in particular cattle dung/food waste into combustible gas [6]. Now, RK University has facilitated a bio-gas plant that is working by food waste of hostel mess & kitchen area. Moreover, the gas produced by the plant is used for the cooking purpose in same kitchen area.

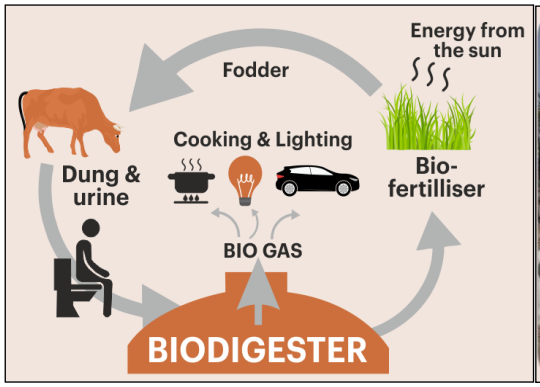


**Fig 6:** Process layout & photograph of bio-gas plant of RK University

The capacity of RK University's bio-gas plant is 85 $m^3$ & daily feed is 2125 kg. Daily water requirement is ~2000 liter. The model of this bio-gas plant is KVIC floating dome type, and the plant commissioning date is 3rd August 2018. The cost of plant is Rs.13.5 lakh. The output gas connection of this plant is at hostel kitchen area.

### (D) Rain-Water Harvesting System

Water is one of the most important elements in the daily routine life. The average annual rainfall of India is 119 cm and out of them India stores only 6% of rainfall [7]. The rain is only source of water & using the Rain-Water Harvesting System (RWHS), people can store the rainwater in the tank and recharging aquifer directly or indirectly [6]. The RK University is situated in Saurashtra agro-climatic zone. And the major part of the Saurashtra region falls under semi-arid type with varying climatic as well as soil.

RK University campus has the provision of RWHS & its plan is to make maximum use of rainwater. Let's see the figure of RWHS & few snap-shot of installed RWHS in the University.


**Fig 7:** Layout & Photographs of RWHS

In general, rooftop rain-water from the buildings is collected in the tank and excess water diverted into the well for recharge. In RK University, the capacity of underground tank is 2 lakh liters. The water demand is fulfilled by 2 open well & 3 bore wells in the campus; it is recharged by rooftop rainwater in rainy season. Moreover, harvested rainwater used in hostel & college building. The ground-water recharge is done from the surface runoff from the campus. Recharging water into the aquifers is assist in improving the quality of existing ground-water. The net cost of RWHS is Rs.2.5 lakh.

**Energy Conservation by Efficient & Sustainable Technologies: RK University**

Energy conservation report of RK University is also including few energy efficient & sustainable technological devices as mentioned below.

### (1) Energy Efficient BLDC Ceiling Fans

RK University campus has successfully installed energy efficient BLDC ceiling fans with the power rating of only 32 W.

**Fig 8:** Photograph of BLDC ceiling fan

The air delivery and fan diameter are same as the conventional fan but due to in-built BLDC motor; the total power consumption of this fan is reduced up to 60%. And the payback period of this BLDC ceiling fan is around 2 to 2.5 years only.

**Table 2:** Features of BLDC ceiling fan

| Sr. No. | Features of BLDC Ceiling Fan | |
|---|---|---|
| **1.** | Power Consumption | 32 Watt |
| **2.** | Voltage Range | 90 to 270 V |
| **3.** | Air Delivery | 220 $m^3$ / min. |
| **4.** | Net Weight | 4.2 kg |
| **5.** | Color | White |
| **6.** | Material | Aluminum |
| **7.** | Mfg. Company | Sinox Power Pvt. Ltd., Rajkot. |
| **8.** | Dimension (L*W*H) | 54 x 24 x 23 cm |
| **9.** | Max. Speed | 375 RPM |
| **10** | No. of Speeds | 6 |
| **11.** | Power Factor | 0.95 |

In RK University, total 840 numbers of BLDC ceiling fans are installed and working efficiently (as per June 2022 data). Now, compared to a conventional ceiling fan of 80 W, the monthly electricity saving from this BLDC ceiling fan is [(80W*30 days*6 hrs.) – (32W*30 days*6 hrs.)] 8.64 kWh per fan [8].

**(2) Energy Efficient LED Tube lights**

RK University campus has also effectively established LED tube lights with the power rating of 20 W. The light intensity & illuminance are the same as per conventional tube light but due to the used of LED; total power consumption of LED tube light is reduced up to 50 % [9]. And the payback period of this LED tube light is around 2.5 to 3 years only.

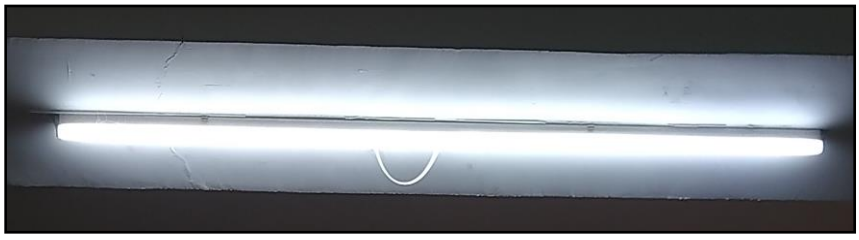

**Fig 9:** Photograph of LED tube light

In RK University, the total 450 numbers of LED tube lights are mounted and working successfully (as per July 2022 data). Now, compare to conventional tube light of 40 W, the monthly electricity saving from this LED tube light is [(40W*30 days*6 hrs.) – (20W*30 days*6 hrs.)] 3.6 kWh per tube light. The detailed features of LED tube light are mentioned below.

**Table 3:** Features of LED tube light

| Sr. No. | Features of LED tube light | |
|---|---|---|
| **1.** | Power Consumption | 20 Watt |
| **2.** | Voltage Range | 110 to 280 V |
| **3.** | Model; Type | 20 W LED; T5 |
| **4.** | Color Temp. | 6500 K |
| **5.** | Length | 120 cm |
| **6.** | Luminous Flux | 1800 Lumen |
| **7.** | Mfg. Company | Newbie Tech. Pvt. Ltd., Rajkot. |
| **8.** | Power Factor | 0.85 |

### (3) Energy Efficient Day-light Sensor based LED Street Lights

RK University campus has also effectively installed energy efficient day-light sensor-based LED streetlights with the power rating of just 22 W.

**Fig 10:** Photograph of LED Street light

The light intensity & illuminance are same as per conventional streetlight but due to the used of LED; total power consumption of LED Street light is reduced and due to day-light sensor the wastage of electric power is also diminished [10].

**Table 4:** Features of LED Street light

| Sr. No. | Features of day-light sensor based LED street light | |
|---|---|---|
| **1.** | Power Consumption | 22 Watt |
| **2.** | Voltage Range | 220 to 260 V |
| **3.** | Optics | Polycarbonate diffuser |
| **4.** | Height of the Pole | 3.75 Mtr. |
| **5.** | Type of Sensor | Photocell or Day-light |
| **6.** | Luminous Flux | 2100 Lumen |
| **7.** | Mfg. Company | Fornax LED Pvt. Ltd. |
| **8.** | Power Factor | 0.90 |

In RK University, total 130 numbers of day-light sensor based LED Street lights are installed and working powerfully (as per July 2022 data). Now, compared to conventional streetlight of 80 W, the monthly electricity saving from this day-light sensor based LED Street light is [(80W*30 days*6 hrs.) – (22W*30 days*6 hrs.)] 10.44 kWh per street light. And the payback period of LED Street light is 1.5 to 2 years only.

## Conclusion

By using renewable, efficient, and reliable technologies, RK University has conserved a high amount of electricity (~65%). Capital or initial costs of these technologies are high (2 to 2.5 times) but running or working costs are very less (30% to 50%). Thus, payback periods of all technologies are around 1.5 years to 3.5 years only. Moreover, by using these technologies, the total $CO_2$ emission from the University's electricity consumption is also reduced (65%).

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