**Poll Res. 39 (1) : 113-116 (2020)**

ISSN 0257–8050

# ECONOMIC ANALYSIS AND EMISSION ANALYSIS FOR GRID-CONNECTED 1KW SOLAR ROOF TOP PHOTOVOLTAIC POWER SYSTEM USING RETSCREEN EXPERT SOFTWARE: CASE STUDY ON TRIVANDRUM DISTRICT, INDIA

**LIJI SAMUEL**

*Department of Economics, Kariavattom Campus,*
*University of Kerala, Trivandrum, Kerala, India*
*Address for The Correspondence- Varuvil Veedu, Vallakadavu, Kalayapuram P.O, Kottarakkara,*
*Kollam 691 560, Kerala*

(Received 20 September, 2019; accepted 31 October, 2019)

**ABSTRACT**

**In this modern time due to absence of synchronism between the rise in the energy demand and rise in energy production. The monster of darkness and pollution had already started to imprison the whole of mankind. Growing dependency on conventional sources for filling intense hunger of electrical energy has raised a question mark over the existence of conventional energy sources after a few decades from now. Looking into this situation we are now bound to look for some alternative for slacking our force of using these sources like coal, natural gas, etc. Here in this paper analyses the feasibility and emission for grid connected 1kw solar rooftop photovoltaic power system using RETSCREEN expert software. We believe that this paper will were absolutely going to show a way to enhance the life of the conventional energy sources and conserve the beauty of our environment for our upcoming generation.**

**KEY WORDS :** Cost analysis, Emission analysis, RETSCREEN expert, Weather condition, Solar roof top PV.

## INTRODUCTION

Everyday life in the 21st century requires more and more energy. From more powerful computers to large televisions and latest gadgets as well as rapid population and economic growth across the various geographical location has led to the depletion of fossil fuel resources on a worldwide basis has necessitated an urgent search for the alternative sources. So it induces a strong urge to think upon some another alternative to reduce the pollution and exploitation of our surrounding and thus brings in a picture of harnessing different energy sources present in the nature to meet our ever awaited energy demand (Balachander and Vijayakumar, 2001).

The prime sources available for renewable energy are sun, wind and water, etc. In this renewable energy options, solar energy is clean, inexhaustible and environmental friendly potential resource (Ramachandra, 2000). Not only that for the production of solar energy, no carbon emission is present thereby reducing pollution and requires no fossil fuel. Therefore to satisfy the energy demand, grid-connected solar energy systems are now becoming a promising option to meet the future energy demand at reduced consumption of fossil fuel (Central Electricity Authority, 2010).

This study analyses the load flow of any building to use the 1 KW roof top solar energy power for load analysis with the simulation approach a more efficient way by using RET Screen software. The following study is a grid based on, one which is directly connected to the 1KW solar roof top to KSEB Grid for an eco-friendly and economically efficient power system (ARRERC, 2015-2016). The

aim of the analysis is that solar photovoltaic energy is rising and may perform an important role in reaching a high-energy demand in Kerala (Ramachandra *et al.*, 2011). To enlarge the participation of 1 KW solar photovoltaic energy in the renewable energy market eg: ANERT requires,

- To generate mass awareness of the solar photovoltaic energy and its multiple benefits;
- To disseminate information on technological and promotional developmental activities
- To implement public policies to build photovoltaic energy generation.

The main objective of this project is to study the economic feasibility and practical application of the of the 1 KW rooftop solar power systems in Kerala for which Thiruvananthapuram district is selected.

## METHODOLOGY OF THE STUDY

The all in one tool RET Screen clean energy project analysis software is used for analysing cost and revenue effectiveness, financial feasibility , emission and risk covered in setting up a renewable energy replacement for a conventional one. It was originally developed in 1996 by Natural Resources Canada [*www.retscreen.net*].

### RET Screen expert software

The RETScreen Clean Energy Management software system (usually shortened to RETScreen) could be a software system package developed by the govt. of North American nation. RETScreen knowledgeable was highlighted at the 2016 Clean Energy Ministerial control in point of entry. RETScreen knowledgeable is that the current version of the software system and was free to the general public on Sept nineteen, 2016. The software system permits for the excellent identification, assessment and optimization of the technical and financial viability of potential renewable energy and energy efficiency projects; as well as the measurement and verification of the actual performance of facilities and the identification of energy savings and production opportunities (Clean Energy, 2016).

## PROJECT INFORMATION

### Roof Top Solar Grid Power Plants Program with the Assistance of ANERT

### Location: Trivandrum

Selection of the weather zone

For project installation a suitable land large enough to accommodate all the equipment need to be marked out. The place in consideration for the project has to be tested upon various parameters such as solar radiation, wind speed, stability, etc (Archived – RET Screen International 2016).

The RET Screeng expert platform then gives all the required data related to the location based upon information from NASAt. The case studies result as displayed by the software is given below.

### Climate data

The RET Screen Climate information includes the meteorological information needed within the model. While running the software the user may obtain climate data from ground monitoring stations and or from NASA's global satellite or analysis data. If climate data is not available from a specific ground monitoring station, data is then provided from NASA's satellite or analysis data. The source of the data (i.e."Ground" or "NASA") is indicated next to the information within the climate information dialogue box. To access the climate database the user may click on the appropriate icon in the Location worksheet (NASA–POWER, 2016). As per the data Trivandrum is located in 8.50N and

**Table 1**. Installed Capacity: 1 KW of Roof Top SPV( Solar Photovoltaic)

| Depiction | Make and mode | Quantity |
|---|---|---|
| Solar PV module with RFID tag | Titan, m 6-60, 250Wp | 4 |
| Solar power conditioning unit | SU-KAM/power fronics 1KVA | 1 |
| solar low maintenance tabular battery | EXIDE, 6cms 150 L | 4 |
| Module Structures | Solaris, struct 050 | 1 set |
| Battery stend | Solaris, struct 050 | 1 set |
| DC junction box | Solaris, DCDB | 1 |
| AC metering and distribution box | Solaris, ACDB | 1 |
| Solar grade DC cables | Siechem/havells/poly cab | 10 m (as specified by ANERT) |

*Note:* They provide 5 years warranty for the entire system and 25 years output warranty for the module

77.00 E. The climate zone is extremely hot and humid. The elevation is 64. The Average Global Horizontal Irradiation for Trivandrum district comes out to be in the range of 4.64 kWh/$m^2$/d to 6.42 kWh /$m^2$/d. The monthly average irradiation on ground for the site is as follows:

## FEASIBILITY ANALYSIS

Feasibility analysis permits decision-makers to conduct a five step standard analysis, including energy analysis, cost analysis, emission analysis, financial analysis, and sensitivity or risk analysis. Fullyintegrated into this five-step analysis are benchmark, product, project, hydrology and climate databases, which are linked to worldwide energy resource maps.

## GHG EMISSIONANALYSIS

Under this section the advantage of using solar energy conversion system as an alternative to the conventional energy sources is explained by observing the amount of reduction of one of the major pollutant carbon dioxide (Carbon Finance at the World Bank, 2013).

Here it is shown that, this 1KW solar energy generation station did not produced any greenhouse gas emissions if compared with the place of conventional sources.

Based power plant showed the net annual $CO_2$ emission to 99%. In other words which can be stated as by implementing this project we can indirectly say that about 1.5 tones carbon dioxide is equivalent 0.3 to cars and light trucks contributing to emission of greenhouse gases is not used.

### Financial Viability

| | | |
|---|---|---|
| Pre-tax IRR – equity | % | 28.8% |
| Pre-tax IRR – assets | % | 14.7% |
| After-tax IRR – equity | % | 19.8% |
| After-tax IRR – assets | % | 10.2% |
| Simple payback | yr | 5.7 |
| Equity payback | yr | 7.6 |
| Net Present Value (NPV) | INR | 300,618 |
| Annual life cycle savings | INR/yr | 15,398 |
| Benefit-Cost (B-C) ratio | | 10.5 |
| Debt service coverage | | 1.1 |
| Energy production cost | INR/kWh | 0.09 |

## RESULTS OF THE ANALYSIS

From the above financial analysis we understood that the project period is 25 years, inflation rate and debt ratio is 4.9% and 2% annually in 1 KW roof top solar PV. It produced 1.7 MWh, the export rate is Rs. 6.58, the revenue is Rs. 10865. Some of the cost data requirements for the model, both initial installed costs and on-going operation and maintenance (O&M) costs, are provided in the RETScreeng Cost Database. To access the cost database specific to the type of system or measure being considered, the user may click on the appropriate icon in the Energy Model worksheet next to the cost data entry cell. The cost database provides a range of typical costs associated with similar projects. On this project cost is Rs.99329,total annual costs is Rs.11007, total annual savings and revenue is Rs.12000 the simple payback period is 5.7

**Table 2.** Financial Cost of The1 KW of Roof Top SPV (Solar Photovoltaic)

| | |
|---|---|
| Cost of 1 KW solar PV system (in INR) | 192,000/ |
| Central finance assistance –MNRE (in INR) | 53,262/ |
| State Finance Assistance –ANERT (in INR) | 39,000/ |
| Total subsidy (in INR) | 92,262/ |
| Customer contribution after subsidy (in INR) | 99,328/ |

*Source:* ANERT (Agency of Non – Conventional Energy And Rural Technology ),Tvm

**Table 3.** Location | Climate Data of Trivandrum

| | Unit | Climate data location | Facility location |
|---|---|---|---|
| Name | | India - Kerala - Thiruvananthapuram | India - KL - Kollam |
| Latitude | $^0$N | 8.5 | 8.9 |
| Longitude | $^0$E | 77.0 | 76.6 |
| Climate zone | | 0A - Extremely hot – Humid | 0A - Extremely hot - Humid |
| Elevation | M | 64 | 16 |

it means the investment payment is recovered within 5.7 years. The NPV is Rs .300, 618, this project is profitable (NPV > initial costs),cost –benefit ratio is 10.5 ,this is positive . All matters are positive this project is financially and economically viable.

## CONCLUSION

RET Screen offers a very reliable and easy to use platform for the effective analysis of all type of energy source replacements. This software tool keeps into account all the local climatic conditions and metrological data which further enhances the analytical efficiency. The breakeven point provided by RET Screeng based upon the cost analysis calculations gives an insight into the cash inflow and outflow in the project. The emission analysis gives a realistic advantage of setting up a renewable energy project. This tool is very much helpful for people trying to design hybrid systems for clean energy. This project can be taken as the foundation for the grid connected 1 KW solar roof top energy systems in Kerala.

## FUTURE RECOMMENDATIONS

After analysing the Solar Rooftop photovoltaic system of capacity 1 KW power, it has been found that the rooftop SPV system financially viable. All the above efforts will serve dual advantage to our Kerala state, one is cost saving and other is less sustainable use of fossil fuels. Thus, roof top PV systems have a high potential in form of annual power generation and low payback periods under 5.7 years for the districts like Trivandrum, which is blessed with enormous sunshine availability throughout the year. Also current electricity prices are very high in Kerala for consumer, which is not in residential category that also makes installing 1KW solar rooftop project financially viable in Trivandrum. Also, land availability in Trivandrum is a big problem, which makes the rooftop concept a great ideal to make Trivandrum a power sufficient and pollution free district. In addition, this will help in reducing Global warming by offsetting greenhouse gas emissions (GHGs). So let us all join hands for a better tomorrow.

## REFERENCES

"Archived - canada launchessh clean energy software - Canada News Centre". News.gc.ca. 2007-12-11. Retrieved 2016-07-15.

"Archived - RETScreenbInternational - RETScreene Software: Cumulative Growth of User Base. Web.archive.org. Archived from the original on 2015-09-20. Retrieved 2016-07-15.

"Cleanf Energy Project Analysis, RETScreen® Engineeringg & Cases Textbook: M154-13/2005E-PDF-Government of Canada Publications" (PDF). Publications.gc.ca. Retrieved 2016-02-24.

"NASA - POWER. Nasa.gov. Retrieved 2018-02-13. Carbon Finance at the World Bank: Prototype Carbon Fund. Wbcarbonfinance.org. Retrieved 2018-02-13.

"RETScreend adds energy performance analysis module". REEEP.org. Retrieved 2016-07-15.

"RETScreenf Clean Energy Project Analysis Software | Environmental software tools for accounting, carbon footprinting & sustainability performance. Environmenttools.co.uk. Retrieved.

Aggregate Revenue Requirement and Expected Revenue From Charges, 2015-2016. Kerala State Electricity Board, Vydyuthi Bhavanam, Pattomu, Thiruvananthapuram

Balachander, K. and Vijayakumar, P. 2012. Economic Analysis, Modeling and Simulation of Photovoltaic Fuel Cell Hybrid Renewable Electric System for Smart Grid Distributed Generation System. *International Journal of Mechanical Engineering & Technology*. (IJMET). 3 (1) : 179-186, ISSN Print: 0976 - 6340, ISSN Online: 0976-6359.

Central Electricity Authority, 2010. Report of Sub-Group II & III on Integration of Solar Systems with Thermal / Hydro Power Stations, New Delhi, India. Http:// Www.Cea.Nic.In/More_Upload/Solar_Sg2_3_ Report.Pdf.

Clean Energy Solutions Center. "Financial Analysis with RETScreen". Retrieved 2016-10-20.

NASA - NASAf Collaboration Benefits International Priorities of Energy Management. Nasa.gov. 2010-02-24. Retrieved 2016-07-15.

Ramachandra, T.V. 2000. Energy Alternatives: Renewable energy and energy conservation technologies, Karnataka Environment Research Foundation, Bangalore.

Ramachandra, T.V., Rishabh Jain, Gautham Krishnadas, 2011. Hotspots of Solar Potential In India, Renewable and Sustainable Energy Reviews 15 (2011) 3178-3186, Doi:10.1016/J.Rser.2011.04.08 www.retscreen.net.