Forecasting of Medium-Term Energy Output of On-Grid Rooftop Photovoltaic Arrays -Case Study for a Sri Lankan Solar Panel Installer

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***Abstract*—The world is shifting towards the higher utilization of renewable energy sources in the road to greener energy which conserves an environmentally friendly atmosphere. The generation of sustainable energy via adopting solar photovoltaic is common worldwide. The objectives of the research study are to identify the salient factors contributing to the energy generation of photovoltaic systems, to utilize a gamut of machine learning algorithms to build the predictive model and to identify the best machine learning algorithm to predict the energy generation based on accuracy and precision metrices. These objectives aid to achieve the aim of this study, which is to build a predictive model to determine the medium-term energy generated from on-grid rooftop solar systems. The study has unveiled a new piece of knowledge on how the photovoltaic system dynamics and location specific data has contributed to the prediction of the power output of the system. Further the findings are of paramount importance to the industry experts as well as the current and prospective solar panel users. The data of all solar panel sites of the installer was utilized and it was extracted from the source information systems. The necessary transformations and validations were applied and a detailed analysis was performed. The feature engineering, feature scaling, outlier-handling, multi-collinearity and feature selection was performed on data. The intended forecasting model based on fourteen supervised machine learning algorithms was built. The KNN Regression algorithm in the factor analysis of all features after principal component analysis has outperformed all other built models. Moreover, a strong positive co-relation was observed in the principal component analysis towards the solar panel energy output prediction. As part of future work, it's imperative to build models utilizing a wider sample of on-grid roof top solar plants.**

Keywords—photovoltaic, forecast, regression, machine learning algorithm, medium-term

I. INTRODUCTION

Energy is an integral part and parcel of human life. It can be produced via renewable and non-renewable energy sources. The non-renewable energy sources such as fossil fuel, emit harmful greenhouse gases when burnt. Further it consumes billions of years for the formation. In contrast renewable energy sources such as hydro, solar, wind and biomass are naturally available, and they are replenished very frequently unlike non-renewable energy sources. Moreover, due to the higher rate of depletion of non-renewable energy sources, higher energy demand and the unfavorable circumstances it causes the world is shifting towards utilization of natural energy sources.

It can be proven that the world is moving from the higher utilization of wind power in 2010, towards the higher utilization of solar energy when it comes to 2021(Fig. 1). Moreover, it's a source of abundant energy in most areas of the world and it possesses a higher productivity in contrast to other sustainable energy sources. Further studies reveal that solar energy has the capability of supplying thousand times more energy than the global energy demand and currently only 0.02% of solar energy is utilized worldwide [2].

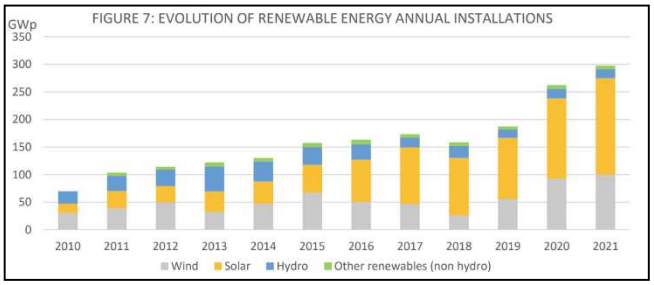

Fig. 1. The utilization of annual renewable energy [1]

The solar power can be converted to energy in two main methods namely via Concentrated Solar Power (CSP) and Solar Photovoltaic (PV). The most widely utilized method is the PV technology in which the sun light is converted to electricity utilizing the photovoltaic cells which exhibit semi-conductor properties [3]. Further, as per the findings of the International Energy Agency, approximately 1100 MT (Million Tons) of Carbon Dioxide emission has been blocked during the 2021 year period with the utilization of PV systems. Moreover worldwide, 175 GW of PV systems have been added onto the system in year 2021 and in a global view the Asia Pacific region dominates in PV installations [1].

The amount of energy produced by the solar panel is directly proportional to the amount of sun light, also known as solar irradiance it receives. The energy generated by the PV array is a direct current (DC). It's converted to an alternative current (AC) via an inverter for the domestic use of electricity [4].

There are three main configuration types of PV systems. Each type differs based on how it handles the electricity passed out from the inverter. Namely they are on-grid, off-grid and hybrid solar systems. In a grid tied, once the current is converted via the inverter, it's sent to the Main Distribution Panel (MDP). From the MDP, the energy is utilized for the domestic usage and the excess is routed to the grid [5].

The grid acts as a storage facility and it's the cheapest form of a solar system. However, during power blackouts, when the grid is inactive it's not capable of producing energy. Hence it is the main disadvantage of grid-tied configurations [6].

The solar panels can be mounted on the ground or rooftops. The roof mounting is the most popular method, as utilizing ground space could be more costly [7].

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