Statistical Machine Learning Models for PV Energy Yield Forecasting

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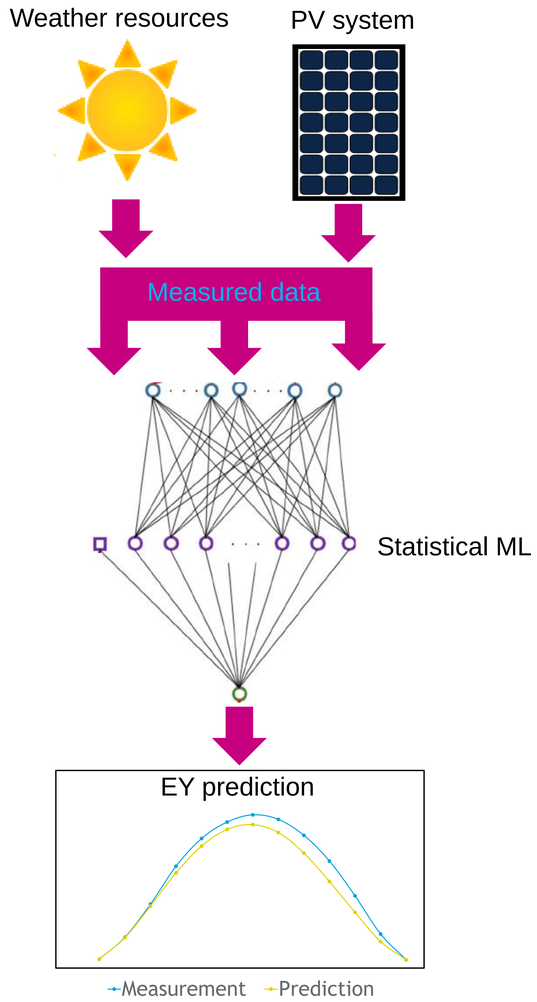
Introduction

PV system deployment in the Middle East is expected to increase at rapid pace in the coming years. Saudi Aramco's plan to invest in 12,000 MW of renewable energy by 2030 entails investing in the kingdom's national renewable energy program as well as through affiliate investments in renewables. The development of new PV technologies, adapted to such areas, and their energy yield (EY) forecasting, requires accurate device modeling for effective estimation of their power output. Towards this direction we have developed a mathematical - computational model that addresses these challenges. The model is a combination of PDE models and data driven statistical machine learning algorithms.

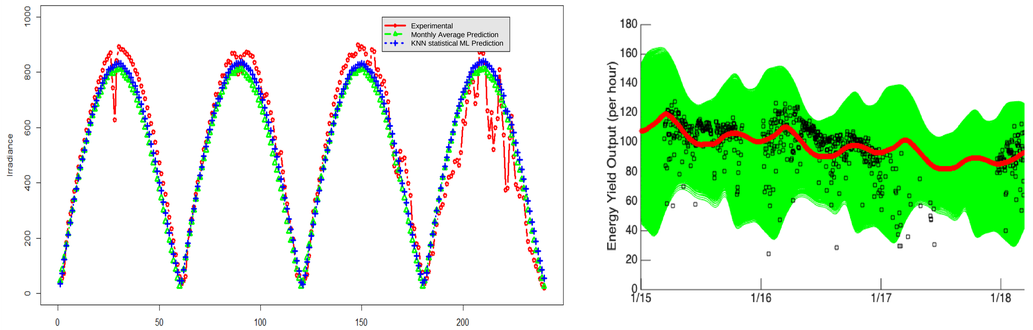
Objectives

- Implement a customized solar cell simulator incorporating various environmental parameters and local climate characteristics.
- Evaluate the performance of various solar technologies under local climate conditions.
- Develop machine learning techniques and algorithms for estimating outdoor field PV operating parameters.
- Develop statistical and machine learning algorithms for evaluating real time performance in terms of Energy Yield (EY) output of local PV installations.
- Develop and validate hourly and daily EY forecasting algorithms.
- Develop a web-based software platform incorporating the above methodologies for data observations,
- Perform EY forecasting and system monitoring of PV installations

Methodology



Results



EY prediction(forecasting) for AlBSF solar cell architecture (left) and irradiance day ahead forecasts (right) using advanced statistical and machine learning algorithms

Summary

- A fully customized model for the simulation of various solar cell structures has been developed incorporating local climate characteristics
- Machine learning techniques are implemented to estimate actual solar cell operational parameters
- Highly advanced statistical models have been developed to forecast solar irradiance and EY
- Very close agreement was observed between simulated and experimental energy yield results

Ongoing Work

- Web-based software interface tool has been developed
- Further model development will forecast EY output of large grid connected PV systems
- Software can be customized to monitor and predict performance off-grid PV-system with storage