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Feasibility study of Machine Learning based Renewable Energy Applications

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Abstract: Due to the recent fractuation in the world economy we have seen that there is a rapid interest in harvesting the energy from renewable sources rather from conventional degrading sources like coal and petroleum. Basically in the field of production of energy by the recent researches and environmentalists have focused on varying the resources and renewable sources like solar, wind, hydro, biomass. We can readily adopt the use of harvestment from the renewable sources by using the existing technologies , investing some capital on development of electricity system and make polices to use the green energy systems. Therefore, by power system planning we can easily enhance the power quality, renewable generation and power system efficiency. The advancements in Machine Learning techniques contribute significantly to solve problems related to energy systems. The techniques used in order to meet up the challenges are pattern recognition, Artificial neural network, fuzzy systems, hybrid combinations and programming based on evaluation. Especially advances in Machine Learning and recent web-based and mobile technologies provide new challenges in machine learning for energy applications.

Keywords: Renewable Energy, Machine Learning, Power Systems, Economic feasibility

I. INTRODUCTION

Energy plays a crucial factor in technological and economic development of present society. Renewable energy technologies have enormous potential but still it faces many challenges relating to its sustenance and security. There are various renewable energy resources like photo-voltaic, solar thermal, geothermal, tidal waves, wind power, and biomass which has been growing rapidly in energy sector. By increasing the part of renewable resources sectors, the modern era countries and companies have to variegate their energy. Renewable energy sources are highly variable because of which instability occurs in the generation capacity. The main reasons behind these fluctuations are wind speed, the intensity of solar radiation because the output energy from power plants depends on various environmental factors. The renewable energy power plants limitation is that constant observation has be recorded on a daily basis. Some renewable energy resources are expensive to store like wind and solar so its needs proper management for the energy generation. If the generation capacities of the natural resources are not enough to meet the demands then the conventional sources like gas power plants are used in particular to cover electricity shortfall.

In order to overcome these above mentioned challenges and limitations new paradigms are set up one of which is the utilization of machine learning system in order to manage the energy consumption and energy generation.

1.1 Machine Learning in Energy

Machine learning in energy is a reliable tool for monitoring and energy consumption regulation. When it comes to ensuring energy efficiency the data collectors and sensors present in the industries lead to bulk data collection regarding the energy consumption. The data mining and machine learning communities

have detected a great opportunity in various applications like big data for business of energy. There are various other standard models of weather that predict the strength of incoming of the storms and the weather variations of a given region. But, the amount of power generation lead to models which cannot predict wind strength near the hub of the turbine. Machine learning and big data can make power sources more grid friendly and it can operate more efficiently.

1.2 Usage of machine learning in wind and solar sectors:

1.2.1. Wind:

The wind turbine total power received by depends on the wind farm performance. Wind turbines optimize the results by comparing the operating data with weather data. Wind speed, hub height, air density, area swept by blades of turbine, roughness of terrain, generator efficiency, temperature are the factors affecting the output power generated by the wind turbines.

Relationship between wind speed and height:

$v_2/v_1 = (h_2/h_1)^{\alpha}$

Where, v_2, v_1 - Wind velocity

h_2, h_1 – Height at which turbine is located

α – ground friction coefficient

More the efficiency more is the generation of electric power

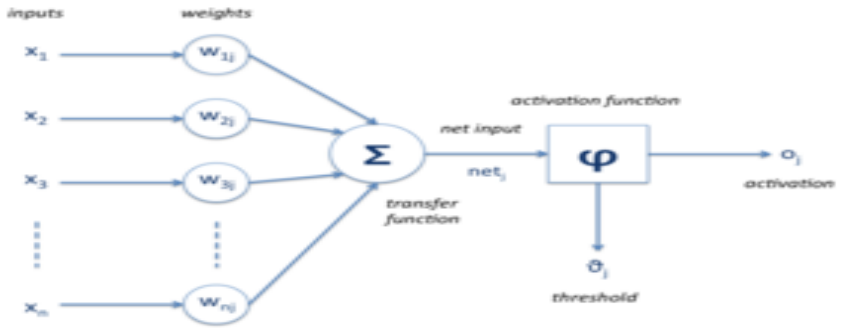

Figure 1: A j^{th} artificial neural network used in Machine Learning

In particular the Artificial Neural Networks, A. Marvuglia and A. Messineo created an equivalent model of a wind farm under normal operating conditions by using a data-driven approach. This model could be utilized in online monitoring of the power generation process for anomaly detections forecasts. This model also inspired by information scattering in the actual neural networks. The prediction was made by use an activation function. They consist of input data through a non-linear weighted sums of transfer functions Neural Networks have drawn a lot of attention in the renewable energy sector as because of high performance computing particularly in parallel computing which leads to an affordable computing results.

1.2.2 Solar:

To energy production optimize by solar power stations machine learning techniques are recently used in order to increase the accuracy of solar forecasts. IBM with many other collaborators urbanized a weather model based on self learning and renewable forecasting technology – SMT. It uses machine learning, big data and analytics so that the forecasting accuracy can be increased 30%. A machine learning based model blending is used by the researchers which take into account multiple meteorological models.

Figure 2: Solar Panel Installation site

Many solar forecasting systems take narrow location and time-frame views. Machine learning techniques are used to blend the historical data as the function of weather situation of a given region for various physics-related numerical weather models like NAM (North American Mesoscale Model), Rapid Refresh (RAP) and High-Resolution Rapid Refresh (HRRR) are used. Each model have various resolutions and accurate results for various weather situations and they even carry various manifestation of error dependence of the given input parameters which can be analyzed using FANOVA – functional analysis of variance.

II. CONCLUSION

The energy production and consumption optimization through the above illustrated examples, has proven that machine learning is a promising tools. With proper accuracy the Machine learning techniques can be used for planning and design of renewable energy plants on available data parameters. It would go ahead to larger energy savings than their conventional sources. Optimization of energy production at industrial level can be done using machine learning techniques. The advancements made massive amount of energy related data available easily and they carry statistical detailing about how the energy is distributed, produced and consumed.

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