FORECASTING OF RENEWABLE ENERGY RESOURCE IN INDIAUSING SPSS

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ABSTRACT: - Energy consumption is promptly increasing in most developing countries Since they foster their economic growth. Modern technological electrical devices in day-to-day activities require high consumption of energy. People's requirement for higher living standard and rapid population growth are among the determinants in the demand of energy generation. There is increasing demand for the use of alternate or renewable energy sources to achieve clean and low-cost electricity to meet requirements. The potential for onsite power generation also remains enormous in India with increasing in-vestment in small-scale solar, wind power, biomass and other renewable resources. Pro-motion of energy production from the combination of sources of energy known as hybrid system is represented by an important objective of meeting the energy demand and justified by environmental protection and increase of energy independence. This paper portrays the forecast of renewable hybrid energy generation of India by using statistical package for social sciences (SPSS) as dependent variable and independent variables are mini hydro, solar, wind, biomass and other sources (Power generation from waste). The findings are similar and correspond with the assumptions in the relationship between variables.

Keywords: Renewable energy generation forecasting, standby power system (SPS) statistical package for social sciences (SPSS), auto regressive integrated moving average (ARIMA), hybrid energy, energy scenario in India.

1. **INTRODUCTION: -** One-third of global greenhouse gases are emitting from fossils fuels such as coal, oil, and natural gas. It is important to make people's lives better, safer and there must be plentiful energy implemented programs in India. Energy also needs for implementing economic growth goals. As for the economic development of a country, demand of electric power is increased. Across the country with a ten-year timetable for the Ministry of Power (MoP) established an extensive long-term plan with the purpose of offering electricity to all at an affordable price and a specific goal

of minimizing power wastage and expense. India contributes approximately 6.65% of total global greenhouse gases emissions-stands fourth, after China (14.36%), The EU (9.63%) and The United States (6.85%), to an estimated 6.8% of total CO2 emissions (9.66 percent). With respect to global warming, the ecological equilibrium may also be altered. For the past twenty years, John Schellenauer has sought to restrict global warming to under two degrees Celsius. The World Energy Council predicts that global demand for electricity will top out in the year 2030. At the same time, it is one of the biggest users of energy and imports expensive fossil fuel just about a quarter of energy demand pro- vided by the combination of coal and oil, close to 74% of which is supplied by either of these. The process of adopting renewable energy would enable the country with rapidly transition to sustainable growth while protecting against potential climate disaster as well as sustainable energy sources of renewable energy. Renewable energy already meets the electricity needs and reduces greenhouse gas emissions, as described in. India has established a sustainable energy supply choice for its long-term goal. At present date awareness of renewable energy has increased resulting in an increase in citizens' usage of solar, wind and waste-powered. It's clear that renewable energy is both safer and cheaper than other options. An ambition of the Indian Government to-generate 175 GW of renewable energy, that includes 100 GW from solar, 60 GW from bioenergy, and 10 GW from hydro power plants by that year. The global investors have set out to meet the promises of over 270 GW of renewable energy capacity to be installed in 2020, which was a substantial increase from the projections. As it has been observed from these assurances, that guarantees are: 58 GW by international corporations and 131 GW by the private sector with a further 13 GW by Indian Railways. The Latest projections show that solar power will exceed 700 GW and renewable energy will account for over 400 GW in 2050. India will have to set ambitious renewable energy goals of 175 GW by the end of 2022, in order to achieve them, it will need to generate 175,000 new jobs and give rise to 15 million new energy-poor people. There needs to be an aggressive combination of push and pull policies alongside clear approaches to grow renewable energy sources. With the advancement in technology and proper environmental policy along with proper research and development will make the renewable resources more cost-effective and efficient manner. To assist with investment, opportunities for unskilled employees and vendors in the renewable sector are being explored. This study also expresses the technical and financial strategies, as well as government policies that support growth in renewable energy. There is a pressing need to learn more about all the challenges that renewable energy production has faced. Also, it is important to discover ways to resolve these obstacles for the growing renewable power

sector. Under normal circumstances, renewable and green energy has such an enormous advantage as compared with fossil fuel.

2. **Methodology:** The forecasting of energy generation is critical with misjudging abilities; one will underserve their customers and deficiencies that could not be justified for many years. It would be a difficult to find such an investment from government funds in a developing country like India, since the costs will greatly exceed government revenues. Since there is so much change in energy needs over time, it is absolutely essential to predict future energy use. Predictions say the government would prepare and build infrastructure to meet potential needs. Businesses also use projections on energy usage to assess the effect a new technology. The new information technology will enable them to understand and account for various approaches exist for projecting a variety of them, including simple extrapolation, simple time series analysis and complex models that employ a combination of these. Some of the notable works in connection with the present study includes ten models of FIS (Totally Integrated System Predictions) were developed to study the effects of two variables such as population and income (parameters: socioeconomic or demo- graphic) on the Municipal Solid Waste (MSW) generation for Kolhapur City, India. A study demonstrates, the grey theory uses of single and multi-hybrid load fore- casting techniques to estimate the increase in China and India's energy demand. Three quality-measurement standards (trend map, error measure and fit model) are applied to test the usefulness of these proposed methodologies. The results demonstrated that these proposed models can generate dependable energy demand, which forecasts in India and China, could be applied elsewhere. Metabolic Grey Model (MGM), Auto- regressive Moving Average (ARMA) and back propagation neural network (BP) have been reported to predict the energy demand in India that is the third-largest consumer in the world after China and The United States. To determine the Total Electricity Consumption (TEC) in industrial sectors, agricultural, commercial, traction and domes- tic electricity consumption of India by 2030, suitable approaches for forecasting the energy demand are used. Such as multiple linear regression (MLR), simple regression, exponential smoothing and the software's are used with the input data of Holt's and GDP are IBM's SPSS Statistics and Microsoft Excel, while output data is using GDP per capita. GDP, population of the country, and GDP-per-per-capita are considered in formulating the prediction. Energy pattern analysis was also conducted to find out the significant influencing variables.

2.1 Forecasting method: The time series is a sequence of one variable's data value over given period of time. Econometric models are time series models with a little more imagination. Using historical data to predict the future semi pertaining the prospective actions with anticipated misperceptions taken into account. Prerequisite data for a forecasting technique, there is a difference between econometric models and time series dependent

models' dynamic memory (over a very limited periods of time). Therefore, in addition to the timeseries analysis models, time series are completely simple. Since several variables are not required, the data is not likely to be useful and they don't define any cause -and-effective relationships. Even if changes to the variables are observed, it does not offer insights as to how and why they occurred. What typically happens when someone use econometric techniques or models on time series data, several variables are strongly correlated. To sum it up, this concept is called multi-linearity

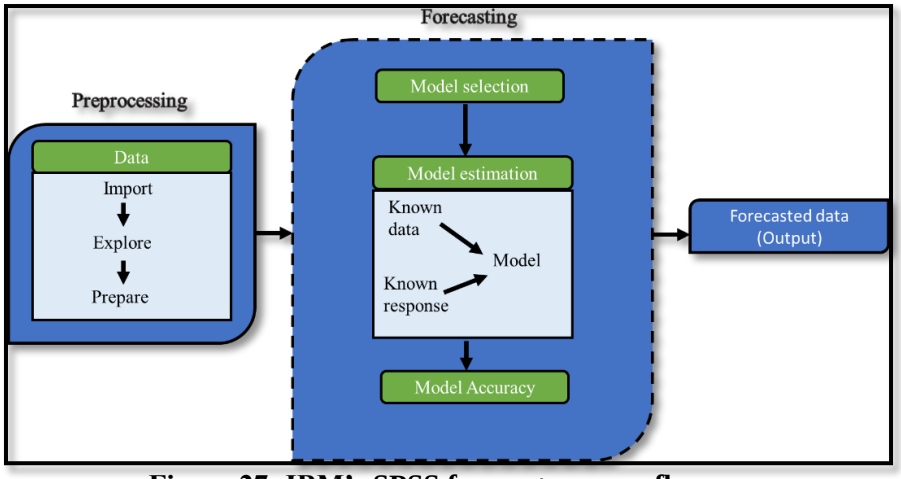

Figure 27: IBM's SPSS forecast process flow

Forecasting tool: Time series modeling is used by IBM Business Rules Forecasting. The time series is the same as a data series measured on a regular basis. With time series forecasting, future events are predicted based on what has already occurred and are tied to each other, as they share the same behavior over time. With this, time element, a forecaster is inherent in the process. It can be said to be described as, the time-line serves as a metaphor for the future to improve forecast accuracy of the time series analysis and additional factors are needed. For instance, energy required, population growth and energy demand that are called variables on their own. These have been properly utilized as predictions for future energy use. In the section energy required, supplied and the population of India is described below Instead of hardcoding the values like inputs and settings. The study employed the expert Mode here, so forecasting is an essential to the, standby power system (SPS). With the support of an auto regressive integrated moving average (ARIMA) or exponential smoothing model, it was able to find and use the best fitting set of ARIMA parameters.

3. Results and Discussions:

A country's population size has a huge impact on energy demand. India ranks as the second most populous country in the world for the month of January 2019 (second in terms of population), nearly 17.7% of the world's population. growth projections show that, the nation would have over 1.383 billion, 1.610 billion, 1.658 billion, and 1.704billion residents by the year 2020, respectively. Each year, India's population grows at a faster rate than any other country, as well as the states' populations of all over 30million. By the year 2040, India will be the world's most energy-hungry country. Renewables would become the second- or will soon overtake gas as-domestic power output by that year. The demand for renewable energy will rise by a total of 256 MW by theyear2016and increase by approximately 12% per year.

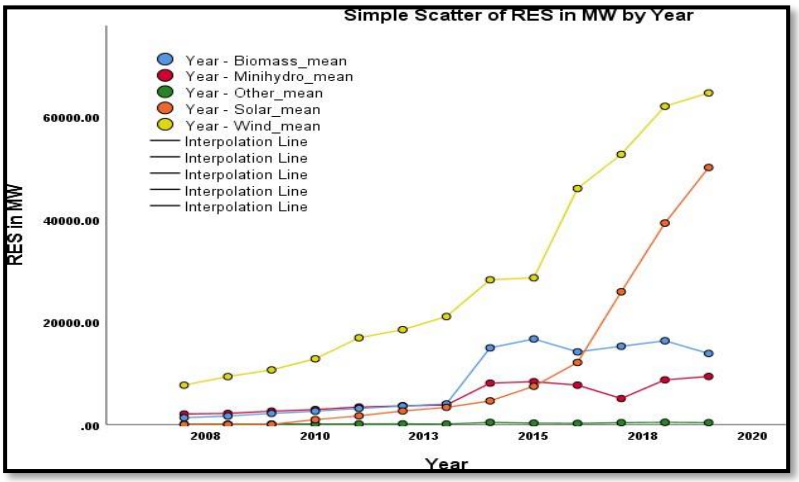

Figure 28: Sources of renewable energy generation in India between 2008-2020

*Source: Annua lCEA report of India 2019-2020

The primary sources energy consumption for the BRICS nations (Brazil, Russia, India, China and South Africa) over the next 20 years is around 17 million tonnes of renewable energy was consumed in 2016, and this will be approximately equal to that by 2040.It is believed that India's energy use will expand at the highest rate of all major economies by the year 2040, with a coal dependency occurring to the most and then declining to a near-complete extent, with respect to natural gas, renewables, and nuclear power at the tail end of the scale. In the year 2020, and to rise to 13 percent by 2040 Even with India's rapid economic growth, energy is still in short supply. The need for economic growth in India is increasing the supply of energy. Sustainable development faces increased population growth at the same time as population growth can no longer be maintained, and at the same time, the country is confronted with a looming problem of sustainability. It is projected that demand and supply will increase in the coming decades. The power supply forecast for the country is in the table from 2009–

2018 to 2018–19 (or till). In 2018, the energy demand was1,212,000 megajoules of 134 gigawatt per hour energy and the supply was 1,167 giga-joules of 567 megajoules, which is 0.7% deficient (correction). This study anticipates that by 2021–22, the overall electricity demand would be around 1925 Terawatt hours (TWh), with a peak demand of 297 GW. Possible causes an increase in electrical appliances, i.e., a rise in the residential sector with growing demand for construction materials, transportation services, increased demand for capital goods, and increased investment in infrastructure, the industrial sector is using more electricity. India's 25% of energy needs could be fulfilled with renewable sources of energy, will provide 33% of its electricity from renewable sources by that year. 175 GW of installed capacity, along with a rising percentage of renewable power, by 20.3% of the energy needs are met by renewable resources in 2022. MoP, aims to increase the contribution of renew-ableenergyinIndia'stotalenergyconsumption.2018oftheorderofrevisedRPO (the legislation of June 2018 specifies a target of 21% renewable energy by the year), that goal will be attained, the overall target was set at fifteen percent in 2014, and raised to twenty one percent in 2018.With a stated target of having 40% of the country's energy supplied by renewable sources in place by the year 2030, India intends to go as far as possible in that direction.

3.1 Mini Hydro Energy: Big hydropower developments are small hydropower, and micro-hydro (2 to 25 MW) and mini-hydro While it is expected that SHP will produce 20 GW of electricity, the actuality will be only 5 GW. As of December 31st, 2018 the country has reached an installed capacity of 4.5 GW and is capable of increasing by that number. The long- term target, which was designed by the new NITI Ayog (started on August 1, 2017 and finished in 2019–2020), was compiled into the 2017–2020 NITI Ayog's 3-year plan. MNREU is supplying funds to support for the installation of small/beginner-size micro- hydro projects in both public and private sectors. A number of surveys and financial studies are performed, accompanied by the identification of new possible sites, along with the preliminary preparation of new and/funding studies an integrated supervisory control and data acquisition (SCAD) system has been installed). As part of a joint venture, the cost was 400 million INR, or 95.62 million USD, for the facility was INR 40 crore. Standards that conform to laws and regulations applicable to hydro-mechanical devices are researched. Holt’s forecasting model were analyzed for the years be- tween 2014-2040 and were forecasted to be 15761 MW, 18921 MW and 22081 MW respectively for the years 2030, 2035 and 2040. When compared with independent variables as Population, required and supplied data, it is concluded that Population foresees RES better

3.2 Solar Energy: Under the solar mission, the target of 20,000 MW to 100,000 MW of solar energy bytheyear2021-22. In2008 2009, only six megawatts were required. An initiative of the “Made in India” campaign is to increase the country's solar capacity to help the progress of the country. Currently, India stands fifth in the world in terms of solar power generation. Tenders have been issued

for 25,212MW of installed solar energy, and 22.8GW of tendered out or active solar power are in process by the end of the year 31st of December 2018. The Ministry of New and Renewable Energy has earmarked 100GW of new solar power generation for the three years (2018–2019 and 2019–2020) which is expected to be supplied from next year. As a result, these programs will remain at least two years from fruition. Tar taxes will be handled by reverse e-auction to slash tariffs. In July 2018 that the lowest solar tariff was 2.44 Indian Rupees per kWh. Solar energy tariffs were INR 18 Indian Rupees per kWh in 2010. Of the over 10 million acres of available land, over 100,000,000 have been allocated to the solar power initiative, of which 75,000 has been secured. in total, solar parks have produced a 26,694MW of energy. A total of forty-one megawatts of solar projects have been put into service in the various solar parks (floating solar power). Brown's forecasting model were analyzed for the years between 2014-2040 and were forecasted to be1,69,295 MW, 2,23,473 MW and 2,77651 MW respectively for the years 2030, 2035and 2040. When compared with independent variables as Population, required and supplied data, it is concluded that Population foresees RES better.

3.3 Wind Energy: The installed capacity target of India as of was just over 40 GW as of December 31st,2018, but it expects to cross 60 GW by 2022. Following China, India stands in fourth place in the world when it comes to the total capacity of wind turbines built. Additionally, almost 9.4 GW capacity has been or is being added. MNRE will be offering a 10 GW of new wind power per year for 2018-2019 and 2019-2020. Overall, the country's total wind energy potential exceeds 302 megawatts at a height of 100meter above ground level. The previous tariff administration has been replaced with the feeding capacity system. On December 8, 2017, the Ministry of Energy announced guidelines for an energy procurement through tariff-based competitive bidding for wind power installations. The open method of bidding has achieved the lowest construction costs for wind power. Since the industrial revolution, the growth of the wind industry has continued through a vigorous, long-term ecosystem, resulting in robust projects as well as stable manufacturing capability. Winding turbines can now be generated with state-of-the-art technologies General Electric, Siemens, ABB, Mitsubishi, Vestas, Suzlon, GE Windstream, Vestas, the first is very strong in India. Firms generate more than 12 different types of wind turbines in India. To countries in addition to exporting them to the USA, Europe, Australia, and Brazil, the nation is a manufacturer of wind turbines and components approximately 70-80% of the domestic output was done with strong domestic. Brown's forecasting model were analyzed for the years between 2014-2040 and were forecasted to 1,39,098 MW, 1,72,488 MW and 2,05,878 MW for the years 2030, 2035 and 2040 respectively. When compared with independent variables as Population, required and supplied data, it is concluded that Population foresees RES better

Model Statistics	Pearson's Correlations

Source Variables	R-squared	RMSE	MAPE	MAE	p-value
Minihydro	0.776	1374.438	19.689	972.194	6.3637E-7
Wind	0.944	4800.206	10.384	2854.807	6.3637E-7
Biomass	0.731	3378.208	21.724	1776.832	6.3637E-7
Other	0.672	81.45	33.17	55.052	6.3637E-7
Solar	0.97	2848.366	21.289	1347.071	0.001

Table 8: Summary of forecasted results of time series modeler statistics(dataupto2040)

1.4 Biomass Energy: In today's world, modern technology has created a new way of doing business for bio- energy use in India. Following the vote in May 2018, the existing policies for biomass were modified. The policy shows industrial residues such as fossil fuels, wood created through energy plantations, wood obtained from crop-residue, agricultural waste, and industrial waste wood, along with bagasse, wood produced through energy plantations, and weed-generated. At 2.5 million (USD 35,477.7) per bagasse per year energy from products such as bio-waste, agricultural, forestry, poultry, agro-industrial, industrial, and municipal waste. The federal government declared the national biofuel policy in August 2018. The MNRE pursued expressions of interest in biomass energy and biogas potential. established in 2018, including the distribution of a biomass subsidy and the incentivization of co-generation in sugar mills and other industries to follow the new method. ARIMA forecasting model were analyzed for the years between 2014-2040 and were forecasted to be 25,317 MW, 30,532 MW and 35,748 MW respectively for the years 2030, 2035 and 2040. When compared with independent variables as Population, required and supplied data, it is concluded that Population fore- sees RES better

1.5 Other energy: Often known as waste-to-energy (WtE) or energy-from-waste (EfW), this method converts primary energy or process energy into waste through use of a waste reduction system. The term WtE is a form of energy reclamation. The majority of WT processes generate electricity or create a combustible fuel, such as methane or ethanol.

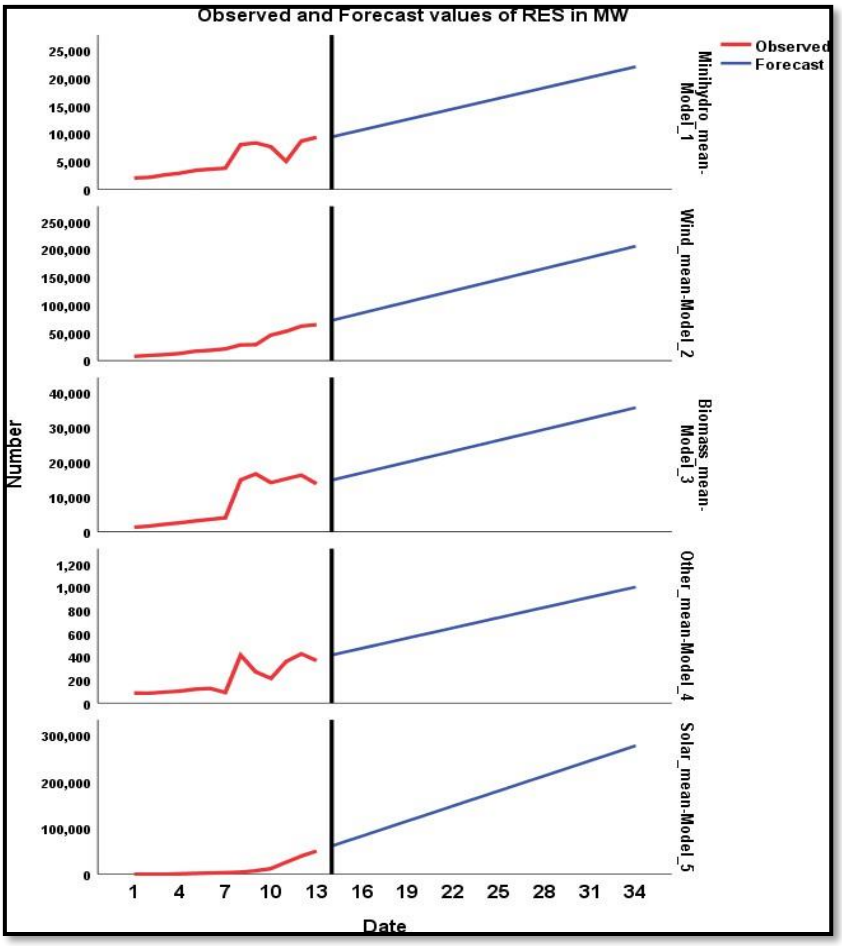

Figure 29: Forecasted sources of renewable energy generation

A capacity for turning waste into energy grew by about four million metric tonnes per year during the 2001-2007 period. Several waste-to-to-energy plants were installed in Japan and China, that used direct smelting or fluidized bed incineration instead. There are several modern breeders who have incorporated the new stoker technology, and others who have taken advantage of the oxygen enrichment. A variety of innovative treatment methods such as direct smelting, the Ebara fluidization and fluidization procedure, and the Thermos select Fluidization method exist worldwide. As of June 2014, India has 93.5 MW total waste-to-to-energy power, of which 373 MW is ready to be utilized. 2011 and 2012 data are shown, followed by projections for 2011 and 2012. Holt's forecasting model were analyzed for the years between 2014-2040 and were forecasted to be 708 MW, 855 MW and 1002 MW respectively for the years 2030, 2035 and 2040. When compared with independent variables as Population, required and supplied data. It is concluded that Population foresees RES better as given in Table 8.

CONCLUSION: The role of predicting power plant usage requires sophisticated long-term forecasting because it is associated with the economy, population and usage of Exponential

smoothing. Every year since 2014 to 2040 was accurately predicted by the method given. As it can be observed from the information provided in this project, renewable power production will increase rapidly in India. Indications for an articulate rise in re- new able power generation coupled with modest potential growth in Indian economy. In addition, increasing contribution of renewable energy in the faster pace of economic growth can be attributed to the shift in the overall Indian economy, as some industries with energy use are expected to expand. Power generation from renewable energy sources, especially mini hydro, wind, solar, and biomass, is expected to become increasingly important in light of the Government's goal to use more cleaner energy. Therefore, energy planning of a country depends heavily upon precise and proper demand forecasting. Precise forecasting is one of the major challenges to manage in the energy sector of any nation. Moreover, forecasts are important for the effective formulation of energy laws and policies in order to conserve the natural resources. It also protects the ecosystem, promote the nation’s economy as well as protect the health and safety of the society.

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