

An ANFIS powered Integrated System for Continuous Power for a Domestic Load by Harnessing Maximum Energy from the Solar and wind Source.

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Abstract— This paper intends in developing an integrated system to give energy for a domestic load continuously by extracting maximum energy from the renewable sources like wind and solar. This system can be designed according to the size of the domestic loads and the availability of the renewable sources. The applications of soft switching techniques like ANFIS in power semiconductor devices enable us to maximize the extraction of energy from the renewable sources. The system can be energized by the integrated power of solar and wind power or grid power. The difficulties related to the integration of renewable energy or grid energy with the domestic load are investigated by a simulation model of the entire system. The main focuses of this investigation on this work are in the extraction of maximum power from the solar and wind sources and make them to use for the domestic purposes and thereby reducing the utilization of power from the grid which are generally being powered by the non renewable sources.

Keywords— solar and wind power, bridge converter, utility grid, ANFIS, programmable relay

I.INTRODUCTION

One of the primary needs for socio economic development of any nation is in the provision of reliable supply. The basic purpose of this paper is based on providing such a reliable power to any domestic needs by harnessing maximum energy from the renewable energy sources like wind and solar ,which is readily available everywhere.

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The rapid growth in the development and usage of solar and wind powers is a part of the efforts to reduce the carbon dioxide, green house gases and other power plant pollutants. Also due to the effects of global warming, the limited availability of fossil fuels, increasing cost and the negative impact of fossil fuels on environment, the renewable energy sources are getting more value in the present scenario and made the urgency to improve and to increase the usage of renewable energy sources in different forms. When comparing with other renewable energy sources, the solar and wind sources are promising alternatives due to their inexhaustible and environment pollution free characters. Eventhough the solar and wind are inexhaustible in nature, one cannot fully depend on one source because of its topographical and atmospheric dependant. Therefore there is a need to develop a reliable system to access the both solar and wind sources whenever available.

The proposed system consists of a solar array, a windmill and a battery bank on the generation side, an inverter, a programmable relay and the utility grid on the consumer side for assuring the consumer a continuous power with a minimum utility bill. Programmable relay determines the type of power to the load whether from the renewable source through battery bank or from the utility grid, which means if the integrated output of the solar and wind goes below the rated power of the consumer load, the programmable relay will divert the energy from the utility grid to ensure the continuous power for the consumers. Also whenever the consumer is not in need of power, the relay will start to contribute to the utility grid. Therefore we can access the maximum energy from the renewable sources. Also this paper emphasize the control technology for controlling the power converters

to regulate the voltage, frequency and the power oscillations. Furthermore this paper encourages new vistas for expanding more research and experimental work on renewable sources to address the critical need of the industry in expanding the knowledge base in green energy systems, power electronics and control technology.

II. CONVENTIONAL SYSTEM

In order to give a continuous power one can able to use the Uninterrupted Power Supply in which the battery is charged by the utility grid supply only. It assures supply only for a limited period only. If there is no power for a long period, then charging of battery in the UPS will also get disturbed since there is no provision of charging battery from the renewable sources like wind and solar. Therefore the backup time for supplying power to the loads will be less because it purely depends on the availability of grid power

III. PROPOSED INTEGRATED SYSTEM

The block diagram of the proposed integrated system is shown in the Fig 1.

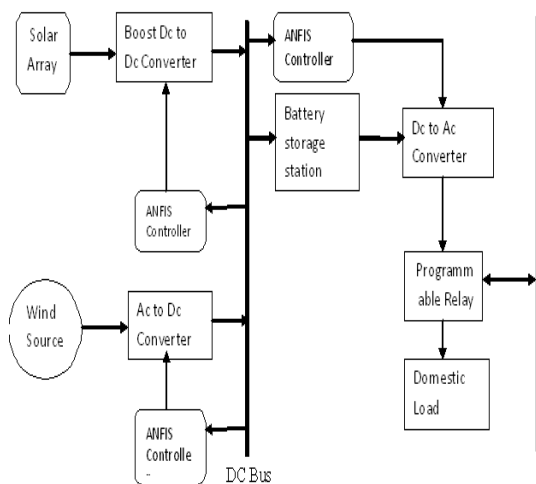


Figure.1. Block diagram of proposed integrated system

There are two kinds of power is available for the domestic load (i)one is from the integrated output of solar and wind sources and (ii) another from the utility grid. The proposed integrated system of solar and wind seems to be the more efficient way and more environment friendly of generating energy from the sun and wind sources. Since the efficiency and dependability on solar power is low when comparing with other sources, one cannot fully depend on solar power alone. So there is a timely need of searching for an innovative ideas like this proposed system to access more energy from the renewable sources.

Next to the solar power, wind energy is considered to be more efficient renewable energy.

The programmable relay has an important role in this system, because it decides the direction of power flow between domestic load and sources. When the integrated output of the renewable sources is equal or more than the rating of the domestic load, relay will divert the power to the load from the integrated output. If the integrated output is less than the rating of the domestic load, the relay will give the power supply from the utility. Hence the proposed systems ensure the continuous power. Another advantage is whenever the load is not in need of power, the relay will contribute the output of the renewable sources to the utility grid. Hence the available energy from the renewable sources can be utilized efficiently without wasting the power. Also the efficiency of the integrated output of both sources of energy is higher than the individual efficiencies of solar and wind energy.

IV. SOLAR POWER

The solar PV cell converts solar radiation into the DC current by using the principle of photovoltaic effect. A solar module is formed by connecting the solar cells in series. For getting required voltage and current some modules are connected in series and some modules are connected in parallel and this arrangement is called solar array.

Since the costs of solar modules are getting reduced in the recent years, solar energy is getting more important in small power

generation for residential purposes. All the power generated by the solar modules are injected to a common coupling point, where power generated by the wind also coupled after converting into DC. An efficient arrangement can be obtained simply by cascading a boost converter and a voltage source inverter, both operating at high frequencies. The PWM control is provided to regulate the output voltage of the boost converter. In order to get maximum power the perturbation and observation method is used, which measures the pv characteristics and then perturbs the operating of the of the pv generator to encounter the direction changes. The maximum power is reached at the condition $dP/dV = 0$, for any radiation or temperature, where power is given by

$$P = V [N_{pp} \{I_{pv} - I_D(e^{q(V/N_{ss}+R_s I/N_{pp})/AKT} (V/N_{ss}+R_s I/N_{pp})/R_p)\}] \quad (1)$$

where P is the power developed by the pv array, N_{pp} and N_{ss} represents the number of cells in parallel and in series respectively, R_p gives the parallel resistance associated with pv module, R_s is the series resistance associated with pv module, K is the Boltzman constant, A is the Ideal factor, Reverse saturation current and the Output current of solar array are given by I_D and I_{pv} is the current generated by the solar radiation and q is the charge on the electron.

V.WIND ENERGY

Wind power is more popular from olden days to nowadays, since high power can be achieved in an efficient way. Modelling of a wind power generation system mainly consists of designing a wind turbine, and an electrical machine, mostly a synchronous machine. Then this model is connected to power electronics circuit which consists of AC-DC converters. The efficiency of a wind mill is greatly influenced by the pitch of the rote blades. The equation of the output power of the wind turbine is given by

$$P_m = C_p (\alpha, \beta) 0.5\rho A V^3 \quad (2)$$

where P_m is the mechanical output power of the turbine (w), C_p is the Performance coefficient of the turbine, α represents tip speed ratio of the rotor blade tip speed to wind speed, β is the blade pitch angle (deg), ρ denotes air density (kg/m^3), A is the turbine swept area (m^2) and wind speed is given by V_{wind} (m/s).

VI. ANFIS

ANFIS architecture is depicted in the following Fig 2. In the architecture, circle box denotes a fixed node and square box indicates adaptive node. Since the sugeno fuzzy model has high interpretability and computational efficiency, it is used with a,b as inputs and c as output. For a sugeno fuzzy model, two fuzzy if-then rules are set, which can be expressed as

R_1 : if a is X_1 and b is Y_1 ; then

$$C_1 = p_1 a + q_1 b + r_1 \quad (3)$$

R_2 : if a is X_2 and b is Y_2 ; then

$$C_2 = p_2 a + q_2 b + r_2 \quad (4)$$

where

X_i, Y_i – fuzzy sets in antecedent

$p_i a, q_i b$ and r_i – designing parameters

that are determined during the training process.

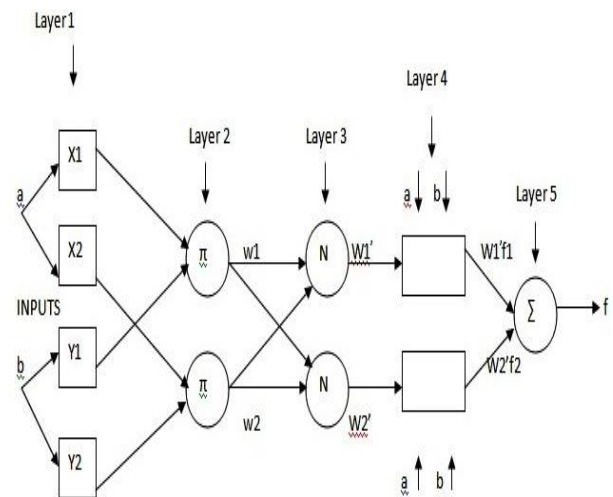


Figure.2. ANFIS architecture

Layer 1: Each node i in the first layer employ a node function given by

$$k_i^1 = \mu_{x_i}(a), \quad i = 1, 2 \quad (5)$$

$$k_i^1 = \mu_{y_{i=2}}(a), \quad i = 3, 4 \quad (6)$$

where

μ_{x_i} and $\mu_{y_{i=2}}$ can accept any fuzzy membership function.

Layer 2: firing strength of a rule in each node can be calculated as

$$k_i^2 = w_i = \mu_{x_i}(a) \mu_{y_i}(a), \quad i = 1, 2 \quad (7)$$

Layer 3: The i^{th} node in this layer calculates the ratio of i^{th} rules firing strength to the sum of all rules firing strength

$$k_i^3 = \overline{w_i} = \frac{w_i}{w_1 + w_2}, \quad i = 1, 2 \quad (8)$$

where

$\overline{w_i}$ = normalized firing strengths.

Layer 4: Each and every node i has the following function

$$k_i^4 = \overline{w_i} c_i = w_i (p_i a + q_i b + r_i), \quad i = 1, 2 \quad (9)$$

where

p_i , q_i and r_i are consequent parameters.

Layer 5: Overall output is calculated in this layer as the summation of all incoming signals and it is given by

$$k_i^5 = \sum_{i=1}^2 \overline{w_i} c_i = \frac{w_1 c_1 + w_2 c_2}{w_1 + w_2}, \quad i = 1, 2 \quad (10)$$

Training algorithm requires a training set, designed between inputs and outputs. The optimized membership function for 'E' and 'dE' is as shown in Fig.3 and Fig.4.

The members of epochs have 500 for training. The number of membership function for the input variables E and dE is 7 and 7 respectively. Therefore the number of rules is 49. These triangular membership functions are used

for the input variables. ANFIS used here contains 95 fitting parameters, which includes 28 premise parameters and 147 consequent parameters. The training error from the ANFIS is equal to 28×10^{-6} and the testing RMS error is equal to 15×10^{-6} .

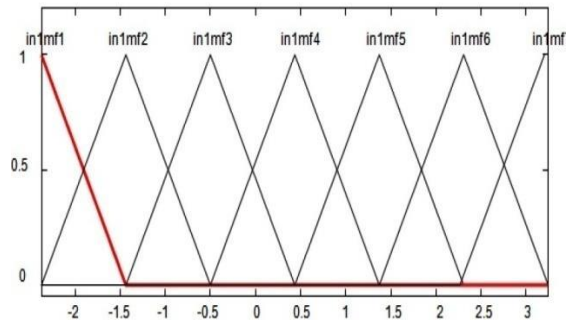


Figure.3. Membership functions of the 1st input variable 1st (E)

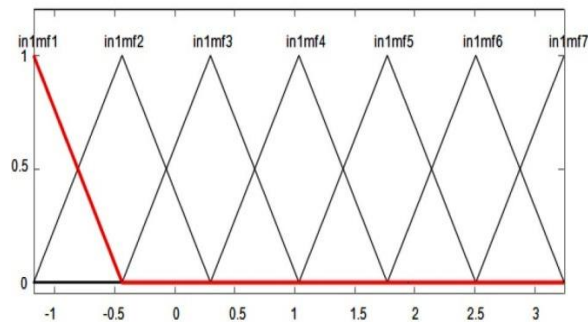


Figure 4. Membership functions of the 2nd input variable 2nd(dE)

VII.RESULTS OF SIMULATED MODEL

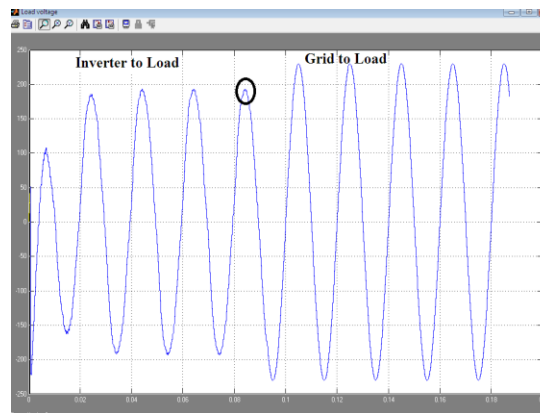


Figure.5.Output voltage from inverter and grid of the proposed model.

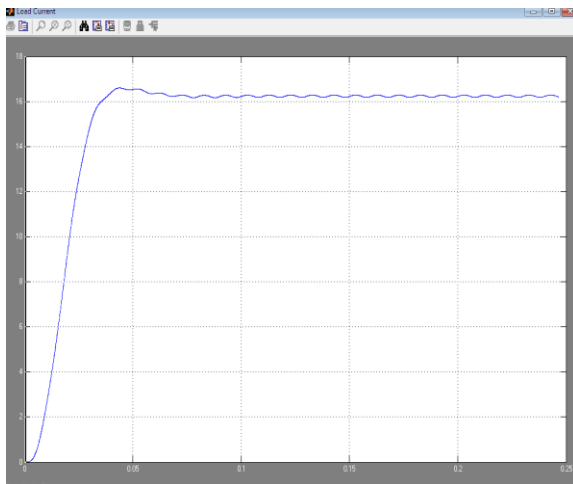


Figure.5.Output current of the proposed model.

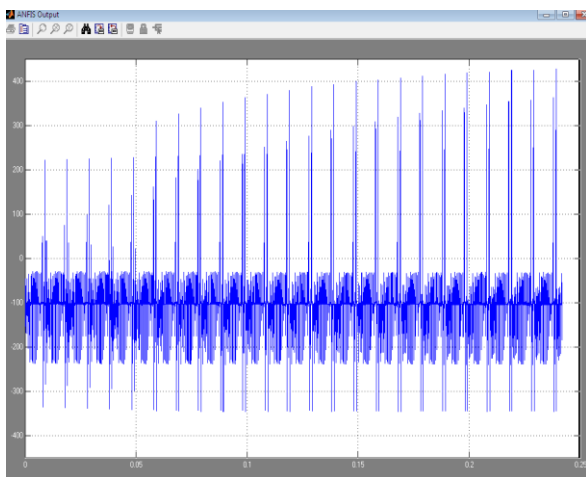


Figure.6.ANFIS controller output

low switching losses. The simulation of the entire integrated system is carried out by MATLAB/SIMULINK environment and results were presented in terms of output voltage and output current through resistive loads.

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VII. CONCLUSION

The work presented above seems to be more efficient for residential purposes and eco-friendly, since the system generates power from the renewable sources. A complete solar and wind generation system is modeled and simulated including detailed models for the solar cell, wind turbine, generator and power electronics. Due to the integration of two sources, availability of power for the residential load can be assured with constant voltage for the maximum time, when comparing with the power from one source. By using IGBT as switch with diode, it is possible to obtain the voltage with