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Energy Forecasting for efficient transitioning of Electricity Generation from Renewable Energy Source

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Abstract

In this world of global warming, where temperature is rising day by day and where every creature is getting tempted from the unwanted climatic change, humans have invented ways to generate electricity from renewable energy sources, which has given a sight of relief to this burning earth. With the arrival of these renewable energy sources such as hydro energy, solar energy, tidal energy, geothermal energy, biogas energy, nuclear energy using uranium obtained only from the sea water, the dependency on non-renewable energy sources such as fossil fuel, and natural gas has reduced a lot as compared to few years back. With the advent of continuous change in weather conditions as and arrival of various festival seasons, the demand of electricity in different zones of country varies from time to time. In this research paper we propose an algorithm to predict the amount of energy that should be most efficiently generated by a particular energy source at a particular time for a particular area.

Introduction

Electricity was invented in the year 1819-1820 by Michael Faraday and from that day till date there has been always a mandatory requirement of electricity in the life of human being. Work has been ongoing for it’s continuous development. Various ways have been developed to provide it’s need to present enormous population. Solar energy, tidal energy, geothermal energy, biogas energy are some of the renewable energy sources from which electricity has been generated without harming the mother nature and which is being used today to feed the needs of the present population.

Motivation

Today usage of renewable energy sources for electricity generation is becoming more and more prominent in almost all the countries across the globe. When the demand for electricity exceeds the amount of generated power available then there is power crisis. If the demand is low but more power is generated then there is surplus power. But excess power generated means excessive use of materials used for power generation as well as more capacity needed to store this power. Now, if we can limit this power generation as per the population requirement from time to time, then we can extend the life time of the materials used for power generation. Suppose the efficiency of wind turbine is 28.5% at the beginning, but it decreases to 21% after 19 years of usage if it is used continuously but if it is used as per the requirement, then the rate of decrease in efficiency of the wind turbine can be controlled to some extent and it’s lifetime can be increased. This research propose an algorithm which predicts the amount of power to be generated within a country during a period of time based on demand making most efficient use of available resources, and coming to conclusion whether the country is lacking power needs or excessing it’s power demand.

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Background

Amount of power produced is always a concern for the town authorities to meet the power demand for the town. Previously, researchers have worked on biogas calculator (in order to calculate amount of biogas formed). Apart from it tidal energy and solar energy calculations have also been made in order to calculate the total power generated from them.

Materials and Methods

In this research we have made an algorithm to give a complete overview of the energy generated from renewable energy sources and if it is not meeting the demands then the addition of power generated from non renewable energy sources is also been made into this algorithm.

So inputs taken are as follows:

C = Country Name

S = Number of States

UT = Number of Union Territory

I = Number of Island

Sm = Name of States

Utm = Name of Union Territory

Im = Name of Islands

WS = Is there any Wind Stations? (Y/N)

NS = Is there any Nuclear Stations? (Y/N)

HS = Is there any Hydel Stations? (Y/N)

SS = Is there any Solar Stations? (Y/N)

TS = Is there any Tidal Stations? (Y/N)

GS = Is there any Geothermal Stations? (Y/N)

BS = Is there any Biogas Stations? (Y/N)

Mn = Month Name

Nd = Number of Days in the given month

Ministry of Power :

(Predicted)

i. Average Power consumptions of the states/Union Territory/Islands (NP)
ii. Festivals present in the month (Y/N)
iii. Average power consumptions of the state during the festivals (ENP)

A. Wind Energy

1. Sectional Inputs

a. Meteorological Department:

(Predicted)

i. Air Density (pa)
ii. Wind velocity (V)

b. Wind Mill Power Stations:

i. Rotor Swept Area (Ar)

ii. Coefficient of Performance (Cp)

iii. Generator Efficiency (Ng)

iv. Gear box bearing efficiency (Nb)

c. Ministry:

i. Number of Weather Stations (i) = 1 to a

ii. Number of Wind mills at Weather Station “i” (j) = 1 to b

2. Formula Used:

WW = 0.5*pa*Ar*Cp*Ng*Nb

Ww = WW*nd

3. Sectional Calculations:

Total Wind power of all Wind Stations of the month (Calculated, Predicted) = Ww

B. NUCLEAR ENERGY

1. Sectional Inputs

a. Nuclear Power Station :

i. Is the Uranium used, is extracted from Sea water? (Y/N)

ii. Total mass of reactant to be used for the month (Mr)

iii. Predicted total mass of product for the month (Mp)

b. Ministry:

i. Number of Nuclear Stations (i) = 1 to c

2. Formula Used:

Ein = m*c^2

Win = Ein/(nd*86400)

3. Sectional Calculation:

Difference in mass of reactant and product (m) = Mr – Mp

Total Nuclear power of all Nuclear Stations of the month (Calculated, Predicted) = Win

C. HYDEL ENERGY

1. Sectional Inputs:

   a. Hydel Power Station:

      i. Efficiency of turbine (Nt)

      ii. Density of water (pw)

      iii. Volumetric Flow Rate (Qw)

      iv. Acceleration Due to gravity (g)

      v. Difference of Height between Inlet and Outlet (hw)

   b. Ministry:

      Number of Nuclear Stations (i) = 1 to d

2. Formula Used:

   WH = Nt*pw*Qw*g*hw

   Wh = WH*nd

3. Sectional Calculation:

   Total Hydel power of all Hydel Power Stations of the month (Calculated, Predicted) = Wh

D. SOLAR ENERGY

1. Sectional Inputs:

   a. Meteorological Department: (Predicted)

      i Latitude (Lat)

      ii. Magnetic declination (Md)

   b. Solar Panel Station:

      i. Solar elevation in degrees (a)

      ii. Panel tilt angle of the module measured from the horizontal in degrees (b)

      iii. Solar power density in W/m^2 incident on a horizontal surface according to solar elevation angle (sinc)

      iv. Electric power of one solar panel in W (Ep)

      v. Total solar panel area in m^2 (Ap)

      vi. Performance Ratio (PR)

      vii. Energy of 1 solar pannel/Area of 1 solar pannel (rs)

      viii. Monthly Solar irradiation on PV pannels with specific inclination and orientation (Hs) =Sincident * sin(a+b)

   c. Ministry:

      i. Number of Solar Panel Stations (i) = 1 to e

ii. Number of Solar Panels at Solar Panel Station “i” (j) = 1 to f

2. Formula Used:

Estot = Ap*rs*Hs*PR

Ws = Estot/(86400*nd)

3. Sectional Calculations:

Total Solar power of all Solar Panel Stations of the month (Calculated, Predicted) = Ws

E. TIDAL ENERGY

1. Sectional Inputs:

a. Tidal Power Station:

i. Power Conversion Efficiency (Ef)

ii. Density of water in kg/m^3 (D)

iii. Vertical tidal range (h)

iv. Horizontal area of barrage basin in m^2 (Ab)

v. Acceleration due to gravity (gt)

b. Ministry:

i. Number of Tidal Power Stations (i) = 1 to k

2. Formula Used:

Et = 0.5*Ab*(h^2)*gt*D

Wt = Et/(86400*nd)

3. Sectional Calculations:

Total Tidal power of all Tidal power stations of the month (Calculated, Predicted) = Wt

F. GEOTHERMAL ENERGY

1. Sectional Inputs:

a. Geothermal Power Station:

i. Pressure of geofluid in SI unit (P)

ii. Temperature of saturated geofluid in Kelvin (T)

iii. Specific enthalpy of saturated geofluid at state 1 in kJ/kg (h1)

iv. Specific enthalpy of saturated geofluid at state 2 in kJ/kg (h2)

v. Specific enthalpy of saturated geofluid at state 3 in kJ/kg (h3)

vi. Specific enthalpy of saturated geofluid at state 4 in kJ/kg (h4)

vii. Specific entropy of saturated geofluid at state 4 in kJ/kg K (s4)

vii. Specific entropy of saturated geofluid at state 5 in kJ/kg K (s5)

viii. Specific entropy of saturated geofluid at state 6 in kJ/kg K (s6)

ix. Specific entropy of saturated geofluid at state 7 in kJ/kg K (s7)

x. Specific enthalpy of geofluid at saturated liquid state in kJ/kg (hf)

xi. Specific enthalpy of geofluid at saturated vapour state in kJ/kg (hg)

xii. Generator efficiency (Efg)

xiii. Isentropic turbine efficiency (Ef1)

xiv. Reservoir temperature in K (Tres)

xv. Sink temperature at all states in K (Tsink)

b. Ministry:

i. Number of Geothermal Power Stations (i) = 1 to l

2. Formula Used:

Specific Gross Electric Power in a day (WG) = {[(h2-h3)/(h4-h3)]*(h4-h5)}

Wg = WG*nd

3. Sectional Calculations:

Total Geothermal power of all Geothermal Power Stations of the month (Calculated, Predicted) =Wg

G. BIOGAS

1. Sectional Inputs:

a. Digester Biogas Tank:

i. Annual methane production in m^3/year (Rmp)

ii. Substrate mass during a year in tonne/year (Ms)

iii. Content of dry mass in 1 tonne of substrate in % (Sm)

iv. Content of dry organic mass in dry mass in % (Dom)

v. Potential for methane production in m^3/t Dom (Pm)

vi. Biogas plant working time in a year in hours (Ty)

vii. Biogas plant working time in a month in hours (Tmo)

viii. Hourly methane production in m^3 (GMP)

ix. Calorific value of methane in kWh/m^3 (W)

x. Electric performance in cogeneration (Efel)

xi. Theoretical electrical power in W (Ptel)

xii. Gross electrical energy in MWh/month (Em)

xiii. The energy factor which determines the use of generated energy for own needs of the biogas plant (Ze)

xiv. Use of energy for process in MWh/month (Epr)

xv. Net electric energy in MWh/month (Enet)

b. Ministry:

i. Number of Biogas Power Stations (i) = 1 to m

2. Formula Used:

Rmp = Ms*Sm*Dom*Pm

GMP = Rmp/Ty

Ptel = GMP*Feel*W

Em=Ptel*Tmo

Epr = Em*Ze

Enet = Em-Epr

Wb = Enet/(86400*nd)

3. Sectional Calculations:

Total Biogas power of all Biogas power stations of the month (Calculated, Predicted) = Wb

II. Main Calculations:

Total Predicted Power from Renewable Resources for the month (W) = Ww+Win+Wh+Ws+Wt+Wg+Wb

Predicted Load Demand of the month = NP or ENP (Sum of all States/UT/Island for the given nation)

Power Needed from Non-Renewable Conventional Electric Industries, for the month, for the given Country (Dp) = | (Np or ENP) - W|

Percentage of Electricity given by Non-reneawble resource (PER) = [Dp/(NP or ENP)]*100

III. Main Output:

1. Case 1 : (NP or ENP > W)

“Country is lacking to meet the load demand of public through renewable resources by PER percentage”

2. Case 2 : (NP or ENP = W)

“Country is going neck to neck in meeting load demands through renewable resources”

3. Case 3 : (NP or ENP < W)

“Country is meeting the load demands and conserving through renewable resources”

Conclusion

This above algorithm will be helpful in determining whether the country is generating enough power efficiently from it’s renewable energy as well non renewable energy sources to meet the level of power consumption by it’s citizens within a year.