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Forecast Energy transition between Renewable and Non-Renewable Energy sources for efficient Electricity Generation

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Abstract

The Bulletin of Atomic Scientists on January 23, 2020 in Washington, D.C., USA, declared that human civilization is sitting on a ticking time bomb in view of the polar ice melting six times faster than in 1990s due to global warming, leading to global sea level rise, change in climate, extreme weather events and water scarcity. With recent earthquakes in Croatia, Bosnia and Herzegovina, Hungary, Slovenia, Austria and Russia, humanity is closing towards the doomsday. These horrifying events and numbers across the globe could be decreased by a significant amount if we switch to clean energy for electricity generation. But transition to clean energy is difficult due to capital costs, site selection, transmission, market entry, reliability misconceptions and misinformation. To deal with this challenge, a realistic model based on Java algorithm titled "SUDDHA SHE 1426" (renamed Suddha herein) has been developed. "Suddha" means "Pure", as per "Dharmashastra"- a genre of Sanskrit theological texts. Suddha is capable of forecasting conventional sources of energy, computing the potential of a nation to produce energy from renewable sources using realistic parametric estimates and in turn help in proper transition from Non-Renewable to Renewable source of energy for efficient electricity generation. It has been found out that by using Suddha model, the emission of carbon dioxide in India can be reduced by 41.84 %.

Keywords: Suddha, Energy forecasting, Non-Renewable source, Renewable source, Conventional source, Electricity generation.

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1. Introduction

According to WHO [1], 7 million people die every year across the world due to air pollution. Air pollution killed 1.2 million Indians in the year 2017 [2], as the third biggest cause of death. Recently the researchers of University of California, Irvine and NASA's Jet Propulsion Laboratory has found from-their assessment of Denman Glacier in East Antarctica that it has retreated almost 3 miles over the last 22 years. This giant glacier is melting so fast that the world could see a rise in sea level by 5 feet. If this trend continues, it could put 400 million people at risk from sea level rise by 2100 [3].

Switching completely to green energy is one of the few steps, humanity can take to try to evade disaster. This work focus on forecasting of energy transition. Forecasting of energy has been in use for several years now. It is the process of applying statistics to make predictions about consumption level. The model *SUDDHA SHE 1426* predicts the reduced CO2 emission level that is achievable by India after switching to renewable sources of power generation.

It takes input from various power distribution units of the country to predict the performance of the country towards the journey to clean energy. Renewable power model considered are wind, solar, hydel, tidal, biogas, geothermal, and biogas. Wind model of power station of Suddha works on the conversion of kinetic energy to electrical energy depending on wind speed, swept area of turbine , betz limit , tip speed ratio and blade efficiency. Solar model of power is based on panel tilt and solar elevation angle for direct solar radiation on a PV module. Hydel section operates on energy equations governing the conversion of kinetic energy of falling water into mechanical energy which in turn is converted to electrical energy using a generator. Tidal power section model is based on the phenomenon of the gravitational interaction of Earth with the Moon and Sun and Earth's rotation, thereby generating tides. Biogas section uses substrate selection, calorific value of 1 m^3 of biogas and the thermal and electrical efficiency of the co-generation generator in which the biogas is burned and turned into electrical energy. Geothermal power model uses the concept of specific enthalpies and entropies of the saturated geofluid at different thermodynamic states, quality of the geofluid, mass flow rate of the geofluid and generator efficiency. Nuclear Power section of Suddha models the principle of Einstein's mass energy equivalence equation. Suddha also has an inbuilt feedback or emergency section which comes into action at time of failures of renewable power stations and helps in computing and tackling the situation. To activate this section of Suddha, a unique password is present that will be made available only to the concerned authorities.

1.1 Background

Many research works have been taking place in recent years on energy forecasting. Earlier review has been done on trends in load forecasting for optimizing the operation of distributed systems [4]. Recently research work has been done to forecast India's electricity demand using probabilistic methods [5].

2. Materials and Method

Suddha has been subdivided into many subsections and computations have been done in International System of Units (SI). Each subsection has a unique task associated with it. Various abbreviations and symbols have been used in each of these subsections and during the explanation of Suddha Flowchart. It is as follows:-

2.1 Suddha Algorithm

The flowchart of Suddha has been explained in **Figure 1.**
The detailed flowchart of the power section has been given **Figure 2**.
The detailed flowchart of the emergency section has been given **Figure 3.**

Main Input Section Module

```
1 - Start
2- MainInputSection() From 3 to 29   /* Consists of all the necessary inputs , important calculations based on those inputs and the exceptions. */
3 - Enter name of country , enter number and names of the union territories , states and islands
4- Enter name of the month and the no. of days the month has (Nd)
5- Read the load demand (Lp) for the given month of each state , union territory and island
6- Determine renewable power resources the nation has.
7-If wind power is mentioned CALL WindPower()   Else GOTO   8
8-If nuclear power is mentioned CALL NuclearPower()   Else GOTO 9
9- If hydel power is mentioned CALL HydelPower() Else GOTO 10
10- If solar power is mentioned CALL SolarPower() Else GOTO 11
11- If tidal power is mentioned CALL TidalPower() Else GOTO 12
12- If geothermal power is mentioned CALL GeothermalPower() Else GOTO 13
13-If biogas power is mentioned CALL BiogasPower() Else GOTO 14
14- Total Power (W)= Ww+Wn+Wh+Ws+Wt+Wg+Wb
15- If Lp>W Then Display "Country is failing to meet load demand of the public through renewable energy sources" Else GOTO 16
16 - If Lp=W Then Display "Country is going neck-to-neck in meeting the load demand of the public through renewable energy sources" Else GOTO 17
17- If Lp<W Then Display "Country is successful in meeting the load demand of the public through renewable energy sources"
18-Read value of emergency indicator variable (e )
19- If e=1 Then GOTO 20 Else GOTO 30
20 -Read admin password.
21- If admin password is valid Then GOTO (22 to 29)   Else GOTO 20
22- Read type of emergency variable (St)
23- If St=1 CALL WindShutdown() Else GOTO 24
24- If St=2 CALL NuclearShutdown() Else GOTO 25
25- If St=3 CALL HydelShutdown() Else GOTO 26
26-If St=4 CALL SolarShutdown() Else GOTO 27
27- If St=5 CALL TidalShutdown() Else GOTO 28
28- If St=6 CALL GeothermalShutdown() Else GOTO 29
29- If St=7 CALL BiogasShutdown() Else GOTO 22
30- Stop
```

Figure 1: Main Flowchart of Suddha

Power calculating modules

```
1- Start
2- BiogasPower() From 3 to 5 /* Calculates predicted monthly Biogas power of the given country */
3-Accept parameter Ms,Sm,Dom,Pm,Tmo,Ty,W,Feel,Ze
4-Wb= ((Enet*Nd)/86400) kW
5-Display Wb
6-Stop
```

```
1- Start
2- WindPower() From 3 to 5 /* Calculates predicted monthly Wind power of the given country */
3-Accept parameters pa,Ar,Cp,Ng,Nb
4-Ww= ( 0.5*pa*Ar*Cp*Ng*Nb*Nd ) kW
5-Display Ww
6-Stop
```

```
1- Start
2- NuclearPower() From 3 to 5 /* Calculates predicted monthly Nuclear power of the given country */
3-Accept parameters Mr,Mp
4-Wn=   (((( Mr-Mp) *c*c)*Nd ) / 86400 ) kW
5-Display Wn
6-Stop
```

```
1- Start
2- HydelPower() From 3 to 5 /* Calculates predicted monthly Hydel power of the given country */
3-Accept parameters Nt,pw,Qw,hw
4-Wh= (Nt*pw*Qw*hw*Nd) kW
5-Display Wh
6-Stop
```

Figure 2: a), **b**), c), d): **Power section flowchart of Suddha pertaining to Biogas, Wind, Nuclear and Hydel energy sources respectively.**

```
1- Start
2- SolarPower() From 3 to 5 /* Calculates predicted monthly Solar power of the given country */
3-Accept parameters Ap,rs,Hs,PR
4-Ws= ((Ap*rs*Hs*Nd)/86400) kW
5-Display Ws
6-Stop
```

```
1- Start
2- TidalPower() From 3 to 5 /* Calculates predicted monthly Tidal power of the given country */
3-Accept parameters Ab,h,gt,D
4-Wt= ((0.5*Ab*h*h*gt*D*Nd)/86400) kW
5-Display Wt
6-Stop
```

```
1- Start
2- GeothermalPower() From 3 to 5 /* Calculates predicted monthly Geothermal power of the given country */
3-Accept parameters h2,h3,h4,h5
4-Wg= [[(h2-h3)/{(h4-h3)*(h4-h5)}] * Nd] kW
5-Display Wg
6-Stop
```

Figure 2 e), f), g): Power section flowchart of Suddha pertaing to Solar, Tidal and Geothermal energy sources respectively.

Emergency Modules

```
1- Start
2- SolarShutdown() From 3 to 6   /* Calculates the excess electric power to be generated using conventional energy sources in case of solar power station shutdown */
3- Read electricity generated by power station till shutdown (amtelec)
4- Wsp= SolarPower()
5- roam = Wsp-amtelec
6- Display "Excess power to be generated using conventional energy sources", roam
7-Stop
```

```
1- Start
2- TidalShutdown() From 3 to 6 /* Calculates the excess electric power to be generated using conventional energy sources in case of tidal power station shutdown */
3- Read electricity generated by power station till shutdown (amtelec)
4- Wtp= TidalPower()
5- roam = Wtp-amtelec
6- Display "Excess power to be generated using conventional energy sources", roam
7-Stop
```

```
1- Start
2- GeothermalShutdown() From 3 to 6   /* Calculates the excess electric power to be generated using conventional energy sources in case of geothermal power station shutdown */
3- Read electricity generated by power station till shutdown (amtelec)
4- Wgp= GeothermalPower()
5- roam = Wgp-amtelec
6- Display "Excess power to be generated using conventional energy sources", roam
7-Stop
```

Figure 3 a), b), c): **Emergency section flowchart of Suddha pertaining to Solar, Tidal and Geothermal energy sources respectively.**

```
1- Start
2- BiogasShutdown() From 3 to 6    /* Calculates the excess electric power
to be generated using conventional energy sources in case of biogas power
station shutdown */
3- Read electricity generated by power station till shutdown (amtelec)
4- Wbp= BiogasPower()
5- roam = Wbp-amtelec
6- Display "Excess power to be generated using conventional energy
sources", roam
7-Stop
```

Figure 3 d): **Emergency section flowchart of Suddha pertaining to Biogas energy source.**

```
1- Start
2- WindShutdown() From 3 to 6    /* Calculates the excess electric power to
be generated using conventional energy sources in case of wind power
station shutdown */
3- Read electricity generated by power station till shutdown (amtelec)
4- Wwp= WindPower()
5- roam = Wwp-amtelec
6- Display "Excess power to be generated using conventional energy
sources", roam
7-Stop
```

```
1- Start
2- NuclearShutdown() From 3 to 6    /* Calculates the excess electric power
to be generated using conventional energy sources in case of nuclear power
station shutdown */
3- Read electricity generated by power station till shutdown (amtelec)
4- Wnp= NuclearPower()
5- roam = Wnp-amtelec
6- Display "Excess power to be generated using conventional energy
sources", roam
7-Stop
```

```
1- Start
2- HydelShutdown() From 3 to 6    /* Calculates the excess electric power
to be generated using conventional energy sources in case of hydel power
station shutdown */
3- Read electricity generated by power station till shutdown (amtelec)
4- Whp= HydelPower()
5- roam = Whp-amtelec
6- Display "Excess power to be generated using conventional energy
sources", roam
7-Stop
```

Figure 3 e), f), g): Emergency section flowchart of Suddha pertaining to Wind, Nuclear and Hydel energy sources respectively.The detailed descriptions of each sections of the Suddha Algorithm are explained in the subsections below:-

2.1.1 Main Input Section

This section takes country name, number of states, Union Territory (UT), islands and their corresponding names, name of month we want to forecast energy and its Number of Days in the given month (nd). Finally Suddha checks whether the country has wind, nuclear, Hydel, solar, tidal, and geothermal and Biogas power stations. Refer to figure 1.

2.1.2 Predicted Load Demand

In this section Sudhha takes the average predicted power of the particular states, UT, islands from the concerned authorities depending on the presence of celebration, festivals or important events in the mentioned location for that month. Refer to figure 1.

2.1.3 Wind Power Generation Prediction

This section takes as parameters variables Air Density (pa), Wind Velocity (V) as inputs for each wind power stations, from the Meteorological Department for the mentioned month. Also, variables Rotor Swept Area at Wind Power Station (Ar), Coefficient of Performance at Wind Power Station (Cp), Efficiency of Generator at Wind Power Station (Ng) and Gear Box Bearing Efficiency at Wind Station (Nb) are taken as input parameter from each wind power station. Data about rotors has been taken from "Danish Wind Industry Association" [6]. The value of air density has been obtained from "Wikipedia" [7]. Similarly values of wind velocity, rotor swept area, coefficient of performance, generator efficiency and gear box efficiency has been taken from "Sciencing"[8], "Minnesota Municipal Power Agency"[9], "FT Exploring Science & Technology"[10] and "Green Living"[11] respectively. Finally, prediction of the production of each wind station is based on the mathematical equation: Predicted Wind Power(Ww)[12]:-

$$Ww = 0.5*pa*Ar*Cp*Ng*Nb*nd \quad \text{----(1)}$$

This model is shown in figure 2b.

2.1.4 Nuclear Power Generation Prediction

Suddha will first check whether the source of uranium used in electricity generation is coming from renewable resource or not. If yes, then it will proceed and take parameter variables Mass of reactants per month in nuclear reactions (Mr) to be used for the mentioned month and Predicted Mass of products per month in nuclear reactions (Mp) for the same, as inputs for each station under this category. The parametric values have been obtained from "Lumen Nuclear Chemistry". It will ultimately compute and predict the production based on the mathematical equation: Predicted Nuclear Power (Wn) [13]:-

Wn = ((Mr-Mp)*c*c*nd)/ (86400) ----(2)

Here c means speed of light and number of days nd has been multiplied with the factor 86400 to convert into total number of seconds in that month. The model is shown in figure 2c.

2.1.5 Hydel Power Generation Prediction

This section predicts Hydel energy generation by taking parametric variables Efficiency of turbine at Hydel Power Station (Nt), Density of water at Hydel Station (pw), Volumetric flow rate at Hydel Station (Qw), Acceleration due to gravity at Hydel Station (g) and Difference of height between inlet and outlet for each Hydel Stations (hw) as inputs for each station for the given month. Parametric values of this section have been taken from "Electropaedia" [14], "Water Science School" [15] and "Open Learning" [16]. It will ultimately compute and predict the production based on the mathematical equation: Predicted Hydel Power(Wh)[17]:-

Wh= Nt*pw*Qw*hw*nd ----(3)

This model is shown in figure 2d.

2.1.6 Solar Power Generation Prediction

Suddha takes parameters Latitude of Solar Station (Lat), Magnetic Declination at Solar Plant (Md), Solar Elevation (in degrees) (a), Panel tilt angle of module measured from horizontal (in degrees) (b), Solar power density incident on horizontal surface according to solar elevation angle (Sinc), Electric power of one solar panel (Ep), Total solar panel area(Ap), Performance Ratio (PR) and Energy of 1 solar panel to area of 1 solar panel (rs) as inputs. It then computes variable Monthly solar radiation on PV panels with specific inclination and orientation (Hs) based on mathematical equation: Hs = Sinc*sin(a+b). Tilt angle, Solar irradiance has been taken from earlier research works [18] and Wikipedia. Rest of the parametric values has been obtained from "Photovoltaic-software" [19]. Ultimately Suddha predicts the solar power production for the month by using the mathematical equation: Predicted Solar Power(Ws) [20]:-

Ws = (Ap*rs*Hs*PR*nd)/(86400) ----(4)

This model is shown in figure 2e.

2.1.7 Tidal Power Generation Prediction

The algorithm will take variables Power conversion efficiency of Tidal Station (Ef), Density of water at Tidal Power Plant (D), Vertical tidal range (h), Acceleration due to gravity at Tidal Station (gt) and Horizontal area of barrage basin at Tidal Station (Ab) as the inputs for each tidal station to compute and eventually predict the tidal energy for the input month. Realistic Parametric Values has been obtained from "Water Science School" [14], "Azo Cleantech" [21] and "SurgeWatch" [22].It will mainly use the mathematical equation: Predicted Tidal Power (Wt)[23]:-

Wt= (0.5*Ab*h*h*gt*D*nd)/ (86400) ----(5)

This model is shown in figure 2f.

2.1.8 Geothermal Power Generation Prediction

In this section Suddha will ask for the parametric variables Pressure of geofluid at Geothermal Power Plant (P), Temperature of geofluid (T), Specific enthalpy of saturated geofluid at state 1 (h1), state 2 (h2), state 3 (h3), state 4 (h4), state 5 (h5), state 6 (h6), state 7 (h7), liquid sate (hf), vapor state (hg), Generator efficiency at Geothermal Station (Efg), Isentropic turbine efficiency of Geothermal Station (Ef1) , Reservoir temperature of Geothermal Power Plant (Tres) and Sink temperature at all states (Tsink), from the users. This process will be repeated for every geothermal power station of the country. Parametric values have been taken from earlier research works [24]. Eventually the system will predict the geothermal energy for the given month by using the equation: Predicted Geothermal Power(Wg)[24]:-

Wg= [(h2-h3)/ {h4-h3)*(h4-h5)}]*nd ----(6)

This model is shown in figure 3g.

2.1.9 Biogas Power Generation Prediction

To compute the biogas energy for the month, Suddha will take into account the parameters Substrate mass during the month at Biogas Plant (Ms), Content of dry mass in 1 tonne of substrate (in percentage) (Sm), Content of dry organic mass in dry mass (in percentage) (Dom), Potential for methane production at Biogas Station (Pm), Biogas plant working time in month (in hours) (Tmo), Biogas plant working time in year (in hours) (Ty), Calorific value of methane (W), Electric performance in cogeneration at Biogas Station (Efel) and Energy factor determining the use of generated energy for own needs of biogas plant (Ze), for each of the biogas stations. After this, the system will calculate the variable Monthly methane production at Biogas Power Plant (Rmp), Hourly methane production at Biogas Power Plant (GMP), Energy in month at Biogas Station (Em), Theoretical electric power of Biogas Station (Ptel), Net electric energy in given month at Biogas Plant (Enet) and Use of energy in production (Epr) using Mathematical equations: Rmp = Ms*Sm*Dom*Pm, GMP = Rmp/Ty, Ptel = GMP*Efel*W, Em = Ptel*Tmo, Epr = Em*Ze and Enet = Em-Epr [25]. Parametric values have been obtained from past research works [26]. Eventually Suddha will predict the power produced from biogas energy using the mathematical equation: Predicted Biogas Power (Wb)[25]

$$Wb = (Enet*nd)/ (86400) \quad \text{----(7)}$$

This model is shown in figure 3a.

2.1.10 Main Calculation Section

This section will predict the total power that will be generated from Renewable resources for the given month in the nation. It will also compute the total predicted load demand of the nation for that month. Ultimately Suddha will compute the percentage of electricity that will be coming from non-renewable resources for that month of the mentioned nation as parameter "PER".

2.1.11 Main Output Section

In this section Suddha will check whether the total predicted power from renewable resources could meet the total load demand of the country for the month. Based on this it will show its output which will classify countries into three sections: "RED ZONE – Country is lacking to meet the load demand of public through renewable resources by PER", "YELLOW ZONE – Country is going neck and neck in meeting load demands through renewable resources" or "GREEN ZONE – Country is meeting the load demands and conserving through renewable resources". This section will help the nation to self assess, proper transition from use of non-renewable resources to renewable resources and eventually moving a step closer to the goal of green energy. Refer to figure 1.

2.1.12 Emergency Section

This has been exclusively developed to help Suddha take action in prediction of energy even at times of accidents, natural disasters and other extraordinary circumstances. This section could be used only by the administration that will have the unique password to activate this section. If this section gets activated by entry of proper passwords, it will then locate the area of failure, the renewable power stations which got affected and the percentage of power that these stations have failed to generate with respect to that they claimed. Eventually Suddha will instruct the higher level power stations to compensate for the affected power stations and to charge convenience fee accordingly depending on the cause behind failures. This model is shown in figures 3a, 3b, 3c, 3d, 3e, 3f and 3g.

3. EXPERIMENT PERFORMED

We have taken realistic values of each and every parameters mentioned under section 2 to see whether Suddha is able to give the desired results We have performed this step repeatedly using diverse set of values. To align the results close to realistic situation, we have used realistic set of values every time. We have found out that on average 80 % of power comes from fossil fuels for each states and UT of India [27]. Hence ultimately after forecasting green energies we have also found the decrease in percentage of use of fossil fuels due to the use of Suddha. We have considered the following Indian states/union territories for this model:- Ladakh, Maharashtra, Sikkim, Lakshadweep, Himachal Pradesh and Karnataka.

4. Calculation

To examine the accuracy of Suddha, we have used diverse set of realistic values for each and every parameters mentioned in the section 2. To be close to realistic situations we have taken values from various websites, power stations and other companies, present in the respective domains. One such set of values and their outputs has been given as follows:

4.1 Wind Power Station

The parametric equation for wind power calculation is given by Equation (1). The practical values needed for the calculation of wind power have been taken from [6-12].

Air density of the place (pa) = 1.225 kg/m^3
Average rotor swept area of the place (Ar)= 7853.98 m^2
Average coefficient of performance for the place (Cp)= 0.459
Average generator efficiency (Ng)= 0.45
Average gear box bearing efficiency (Nb) = 0.87

Model power generated, based on realistic estimates, by one Wind mill per month = (0.5*1.225*7853.98*0.459*0.45*0.87) * 30 = 25.93352 kW…. (1)

Statistic – Ladakh consumes 0.0384 GW of power monthly [28]. Using [27, 28], Ladakh gets 0.03072 GW from fossil. Taking the ratio of this number and the power in eq. 1, Suddha predicts that 0.07 % of total power is needed by Ladakh (monthly). This in turn saves 8467.126 Kg of coal from getting burnt monthly (using [29]) (pt. a). If the monthly production goes above eq. 1, the hydrogen fuel cells will be used to store the excess energy. The final value of 25.93352 kW from eq. 1 is taken to be the threshold value. The excess electrical power generated will either be carried over in the next month or utilized as and when deemed necessary.

4.2 Nuclear Power Station -

The parametric equation for nuclear power calculation is given by Equation (2). The practical values needed for the calculation of nuclear power have been taken from [13].

Total mass of reactants(Mr) = (92*(1.00728 amu) + 143*(1.00867 amu)) = 236.9096 amu
Total mass of products(Mp) = 235.04393 amu
Mass defect = 1.86564 amu
Speed of light in vacuum(c) = 3 * 10^8 m/s
Mass defect(Mr-Mp) = 1.86564* (1/ (6.022*10^26)) = 3.09797 * 10^-27 kg
Total energy = 3.09797*10^-27 * 3 * 10^8 * 3 * 10^8 = 2.7843 * 10^-10 J/atom
Total energy in kJ/mole = 2.7843 * 10^-10 * 6.023* 10^23 = 1.6762 * 10^11 kJ/mole

Model power generated, based on realistic estimates, by a single nuclear reactor per month = ((1.6762* 10^11) / 86400)* 30 = 58*10 ^6 kW/mole…. (2)

Statistic – On average Maharashtra uses 205.7 GW of power monthly [27]. Using [27, 28], Maharashtra receives 164.56 GW from fossil fuels. Taking this information and eq. 2, nuclear section of Suddha will contribute to 35.24 % of total monthly energy of the state. Hence it will help in saving 18.9*10^9 Kg of coal monthly in Maharashtra (using [29]) (pt. b). To deal with excess energy, heat storage will be coupled to nuclear reactors using steam cycles so that a reactor operating at full capacity would provide variable electricity to the grid. The final value of 58 GW/mole from eq. 2 is taken to be the threshold value. The excess electrical power generated will either be carried over in the next month or utilized as and when deemed necessary.

4.3 Hydel Power Station

The parametric equation for hydel power calculation is given by Equation (3). The practical values needed for the calculation of hydel power have been taken from [14-17].

Efficiency of turbine(Nt) = 0.85
Density of water(pw) = 997 kg/m^3
Volumetric flow rate(Qw) = 0.010 m^3/s
Acceleration due to gravity(g) = 9.8 m/s^2
Difference of height between inlet and outlet(hw) = 25m

Model power generated, based on realistic estimates, by one Hydel power station in one month = (0.85 * 997 * 0.010 * 9.8 * 25) * 30 = 62.2875 kW…. (3)

Statistic – This has been observed that average monthly power consumption of Sikkim 0.582 GW [28]. Taking [27] in account, we calculate 80 % of 0.582 GW (the energy that comes from coal), which comes as 0.466 GW. Considering this number and eq. 3, this section of Suddha will contribute 0.013% of Sikkim's total monthly power consumption. In turn we can save 20336.87 Kg of coal monthly (using [29]) (pt. c). If the energy exceeds eq. 3, then pumped hydroelectric storage facilities store energy in the form of water in an upper reservoir, pumped from another reservoir at lower elevation. The final value of 62.2875 kW from eq. 3 is taken to be the threshold value. The excess electrical power generated will either be carried over in the next month or utilized as and when deemed necessary.

4.4 Solar Power Station

The parametric equation for solar power calculation is given by Equation (4). The practical values needed for the calculation of solar power have been taken from [18-20].

Solar elevation(a) = 56.56 degrees

Panel tilt angle of the module measured from the horizontal(b) = 11.496 degrees

Solar power density incident on a horizontal surface (Hs) = 1120 W/m^2

Enter total solar panel area(Ap) = 18.5 m^2

Enter performance ratio(PR) = 0.18

Model power generated, based on realistic estimates, by one solar station in one month = (sin (56.56+11.496)*18.5 * 1120 *0.18) * 30 = 103.781 kW…. (4)

Statistic – Lakshadweep uses an estimate 0.058 GW of power monthly [28].Keeping [27] in consideration and using [28], we find that 0.046GW of power comes from fossil fuels in Lakshadweep. Taking this and eq. 4 into consideration, Solar section of this algorithm could help by contributing 0.226 % of Lakshadweep's total monthly power consumption. This will help Lakshadweep by avoiding burning of approximately 3384.497 Kg of coal monthly (using [29]) (pt. d). Classic heat exchange system to be used, for storing excess energy, where water is turned to steam for driving a steam or Tesla turbine. The final value of 103.781 kW from eq. 4 is taken to be the threshold value. The excess electrical power generated will either be carried over in the next month or utilized as and when deemed necessary.

4.5 Tidal Power Station

The parametric equation for tidal power calculation is given by Equation (5). The practical values needed for the calculation of tidal power have been taken from [15, 21-23].

Density of water(D) = 977 kg/m^3

Vertical tidal range(h) = 10 m

Horizontal area of barrage basin(Ab) = 9*10^6 m^2

Acceleration due to gravity(gt) = 9.8 m/s^2

Model power generated, based on realistic estimates, by one tidal power plant in one month= (((0.5*9*10^6*977*9.8*10*2)/86400)*0.80)*30 = 23.94 *10^3 kW…. (5)

Statistic – It has been observed that average monthly consumption of power for Himachal Pradesh is 12.43 GW [28]. Having [27] in consideration and using [28], we find that 9.944 GW of power comes from fossil fuels in Himachal Pradesh. Taking this and eq. 4 into account, tidal power station of Suddha will provide at least 0.24 % of the state's total monthly use. On doing further calculations, it has been found out that we can save 7.816*10^6 Kg of coal monthly (using [29]) (pt. e). If energy produced in excess as compare to eq. 5, then tidal barrage technique would be used to store tidal power. The final value of 23.94 MW from eq. 5 is taken to be the threshold value. The excess electrical power generated will either be carried over in the next month or utilized as and when deemed necessary.

4.6 Geothermal Power Station

The parametric equation for geothermal power calculation is given by Equation (6). The practical values needed for the calculation of geothermal power have been taken from [24].

Specific enthalpy of saturated geofluid at state 2 (h2) = 839900 J/kg

Specific enthalpy of saturated geofluid at state 3 (h3) = 482510 J/kg

Specific enthalpy of saturated geofluid at state 4(h4) = 2698900 J/kg

Specific enthalpy of geofluid at saturated liquid state(hf) = 188450 J/kgK
Specific enthalpy of geofluid at saturated vapor state(hg) = 2583200 J/kgK
Generator efficiency (Efg) = 0.9
Mass flow rate of geofluid =339 kg/s
Quality of geofluid at state 2= (839900-482510)/ (269890-482510) = 0.161
Quality of geofluid at state 5 = (7184.2-638.7)/ (8164.8-638.7) = 0.870
Specific enthalpy of geofluid at state 5 = 188450 + 0.870*(2583200-188450) = 2271160 J/kg
Model power generated, based on realistic estimates, by one Geothermal power plant in one month = (0.161*(2698900-2271160) *0.9*339)*30 = 630331.77942 = 0.630331 * 10^6 kW…. (6)

Statistic – Karnataka uses 96.7 GW of power, on average monthly [28]. Taking [29] in consideration and using [28], we find that 77.36 GW of power comes from fossil fuels in Karnataka. Using this section (from eq. 6) will help the state by producing 0.815 % of its total monthly consumptions which can help Karnataka to avoid 205.803*10^6 Kg of coal from getting burnt monthly (using [29]) (pt. f). To store excess power, if generated with respect to eq. 6, compressed air energy storage is used. It uses excess energy into underground salt caverns. According to energy demand, this energy will be released through turbines to provide electricity. The final value of 0.630331 GW from eq. 6 is taken to be the threshold value. The excess electrical power generated will either be carried over in the next month or utilized as and when deemed necessary.

4.7 Biogas Power Station

The parametric equation for biogas power calculation is given by Equation (7). The practical values needed for the calculation of biogas power have been taken from [25].

Substrate mass during a year = 8000 tonne/ year = 8*10^6 kg/ year
Content of dry mass in tonne of substrate(Sm) = 9.5 %
Content of dry organic mass in dry mass (d.o.m) = 78.5%
Potential for methane production(Pm) = 210*10^-3 m^3/kg d.o.m
Biogas plant working time in a year(Ty) = 8000 hrs/year
Biogas plant working time in a month(Tmo) = 667 hrs/month
Electrical performance in co-generation(Efel) = 0.37
Energy factor which determines the use of generated energy for own needs of biogas plant(Ze) = 0.09
Calorific value of methane(W) = 9167 Wh/m^3
Annual methane production per year =8*10^6*0.95*0.785*210*10^-3 = 1252860 m^3/year
Hourly methane production = 1252860/8000 = 156.6075 m^3/ hr
Theoretical electric energy(Em) = 156.6075 * 9167 * 0.37 = 531179.75 Wh
Gross electric energy per month(Epr) = 531179.75 * 667 = 354296893.25 Wh
Use of energy for process per month = 354296893.25 * 0.09 = 31886720.3925 Wh
Model electrical energy produced by one Biogas power plant per month(Enet) = 354296893.25-31886720.3925 = 322410172.8575 Wh = 1.1607 *10^9 kW…. (7)

Statistic – If India can use its raw materials like agricultural waste, manure, municipal wastes, plant sewage, food waste and green waste properly, then this section could prove to be the x-factor in India's dream to completely switch to green energy. It has been found out India's total average monthly consumption is 1.189992000000*10^6 GW [28]. Considering this value and eq. 7, Biogas section of Suddha will help India, by contributing 97.47% of India's monthly power consumptions. In turn we can avoid burning of 378.74*10^9 Kg of coal monthly (using [29]) (pt. g). If energy generated is more than eq. 7, then chemical secondary energy carriers such as hydrogen and carbon based fuels will be used to store the excess of biogas power for future use. The final value of 1.1607 TW from eq. 7 is taken to be the threshold value. The excess electrical power generated will either be carried over in the next month or utilized as and when deemed necessary.

5. Results and Discussion

Considering the statistics of section 4 (pt. a-g) and adding them up, we can see Suddha can save a whooping 3.98*10^11 Kg of coal monthly from getting burnt, which in turn equivalent to 1.17*10^13 MJ [29].

Table 1: Quantitative and Comparative Analysis of impact of Suddha model in India (using pt. a-g of Section 4 and [30])

Types of Renewable Energy Source	Names of States/ Union Territories considered	Total power generated per month (in W)	Weight of coal saved (in Kg)	Reduction in emission of CO_2 (in kg)
Wind Energy	Ladakh	25.93352 * 10^3	8467.126	20481.98
Nuclear Energy	Maharashtra	58 * 10^9	18.9 * 10^9	45.712 *10^9
Hydel Energy	Sikkim	62.2875 * 10^3	20336.87	49194.89
Solar Energy	Lakshadweep	103.781 * 10^3	3384.497	8187.09
Tidal Energy	Himachal Pradesh	23.94 * 10^6	7.816 * 10^6	18.91 * 10^6
Geothermal Energy	Karnataka	0.630331 * 10^9	205.803 * 10^6	497.84 * 10^6
Biogas Energy	All 28 States and 8 Union Territories have been considered	1.1607 * 10^12	378.74 * 10^9	916.17 * 10^9

6. Conclusion

Suddha have been developed with an ultimate aim of helping nations in their journey of getting free from shackles of Non-Renewable sources for electricity generation. Sudhha uses mathematical functions and equations to predict the potency of the country to produce electricity from renewable resources. India typically uses Bituminous coal. It has been seen that 2.419 Kg of CO2 is emitted on burning 1kg of bituminous coal [29]. Taking this numbers and section 5 in account, Suddha will help India to reduce the emission of CO2 by 1.034*10^11 Kg monthly or 1,240 million tonnes of CO2 annually [30]. In 2018 India emitted 2,299 million tonnes of CO2 [31]. Hence by using Suddha, the emission of carbon dioxide in India can be reduced by 41.84 %. The prediction would be much more accurate and precise with help of Machine Learning algorithms and Data Mining methodology. In case of emergency or accidents Suddha can only predict the residual unproduced energy, which is to be taken from other power stations. Future works can be done in modifying the emergency algorithm of Suddha so that it can even predict the compensation to be paid while buying the energy by training Suddha about the causes of failure so that in future Suddha can even predict accidental failures and emergency situation to tackle the failure of Power stations. This in turn will help in better distribution of electricity throughout the nation.

"SUDDHA SHE 1426" code is available at: https://github.com/rwito-1234/Renewable_Energy/blob/master/FinalCode.java

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Conflict of interest
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