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A Review on Self-Excited Induction Generator: It's Suitability for Renewable Energy and its Application in Rural Area "An India's Perspective"

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***Abstract*: The paper deals with the employment of the renewable energy by using the technique of Self Excited Induction Generator system so that economical and reliable power supply as per power demand can be generated effectively in rural areas. The paper has been prepared with India's perspective. The methodology uses a simple arrangement of induction machine and its associated components within which the first cause of the induction machine is rotated at a speed more than the synchronous speed by different means of mechanical energies like wind energy or that of hydro energy. The induction generator has to be provided with the reactive power. This system has an advantage over the other system as power can be generated abundantly with efficiency at a lower cost.**

Keywords: **Self Excited induction generator, Renewable Energy, Wind Energy, Hydro Energy.**

1. INTRODUCTION

The modern era is totally dependent on the conventional sources of energy. This fact has given rise to threat that once these sources of energy became scarce or vanishes then the human society will be challenged economically as well as all the work has to be done manually, however the time has arrived to look for the substitute of these energy resources. One may think of the ways that the sustainable use of non-renewable resources which has come to an extent of nearly impossible and to a certain extent this is true. However, in the case of energy resources, when the resource itself cannot be used sustain ably, there comes the need to invest in substitutes for the resource that provide an identical service.[1]

For a country like India with a population of above 1200 million it becomes difficult to supply power to each part of the country through a centralised network moreover the investment required to supply electrical power from the centralised power generating site, cost of transmission line and the risk of power loss is very high, however many small micro plants generating hydro, wind energy which are located at different parts of country can do a lot for electrification of rural areas.

The power generation at location where no grid power is supplied make use of self-excited induction generator in which the prime mover is rotated by the mechanical energy of moving water or wind. [2,3]

Electromechanical energy conversion is the working principle of SEIG; this machine can also work as motor for converting electrical input to mechanical output. [4-6]

A three-phase induction machine can be operated as a self-excited induction generator by connecting an appropriate capacitor bank across its terminal, and the rotor is driven by an external prime mover, voltage will be generated and it will rise until steady state condition is achieved due to magnetic saturation in the machine [7-9]. Though, low voltage regulations, reactive power consumption, under load and/or speed changes, are some of the drawbacks of the induction generator. Much studies and research has been done for trying to take SEIG as a viable option for electricity generation. [10, 11]

In this paper review has been done on Self Excited Induction Generator. Section II gives the description of the various induction generators; Section III gives the description of the various induction generators; section IV gives the availability of energy resources in India; section V gives the application of SEIG in rural area; section VI gives the Wind power generation in demand in developing countries like India; section VII discusses SEIG and hybrid system for Wind power Generation; section VIII gives the scope of Hydel Energy in India; section IX gives the SEIG for Hydro power Generation; section X gives the suggestions; section XI concludes the paper.

2. INDUCTION GENERATORS

Induction generators can be classified on the basis of excitement process as
1. Grid connected induction generator
2. Self-excited induction generator

Further induction generators are classified on the basis of rotor construction as
1. Wound rotor induction generator
2. Squirrel cage induction generator

On the basis of prime movers the induction generator can be classified as
1. Constant speed constant frequency [CSCF]
2. Variable speed constant frequency [VSCF]
3. Variable speed variable frequency [VSVF]

3. SELF EXCITED INDUCTION GENERATORS

There has always been aim of the researchers to extract more and more energy from the available resources. Many new methods are adopted by the researchers worldwide to make the use of the widely available nonconventional sources but the area of interest common among many of them is the wind power Generation through use of Self excited induction Generator. Traditionally, synchronous generators have been used for power generation but induction generators are increasingly being used these days because of their relative advantageous features over conventional synchronous generators. As a result of the major advantage of it, now we are able to gain continuous energy from this wide reservoir of energy at a very low cost.

Some of the features are, low maintenance cost, brush less and rugged construction and simplicity in operation, self-protection against faults, good dynamical response, and capability to generate power at varying speed. The later feature facilitates the induction generator operation in stand-alone/isolated mode to supply far flung and remote areas where extension of grid is not economically viable; in conjunction with the synchronous generator to fulfilled the increased local power requirement, and in grid-connected mode to supplement the real power demand of the grid by integrating power from resources located at different sites.

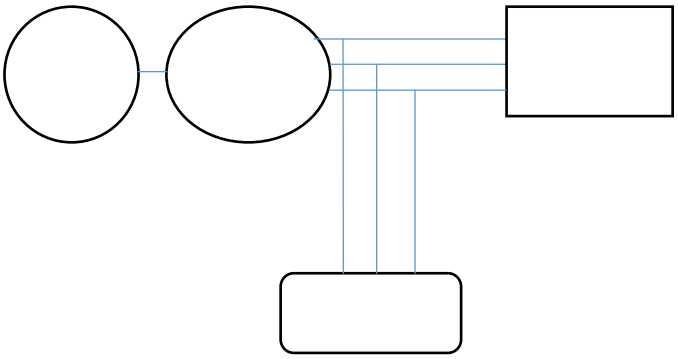

Fig. 1 Block diagram of SEIG

By SEIG we mean Cage Rotor model of Induction generator as Cage rotor has many advantages over Wound rotor

1- The conductor required in cage rotor type model of SEIG is relatively less than that of wound rotor type.
2- Consequently the I^2R losses are more in case of wound rotor type.
3- Wound rotor requires slip rings, Brushes etc. which increases its maintenance cost which is not with the Cage model of SEIG as it does not uses Brushes or Slip rings.

4. IV. AVAILABILITY OF ENERGY RESOURCES IN INDIA

According to International Energy Agency (IEA), about 1.3 billion people worldwide lack access to electricity services with nearly 2.7 billion without clean cooking facilities. 404 million people in India currently do not have access to electricity and the daily average per capita electricity use is about 2 kWh for connected population. [12-14]. Therefore the major challenges in electricity sector are twofold:
a) Expanding access to electricity for sections of populations not reached by the grid, and
b) Meeting increased demands from sections of populations within the reach of the grid

Increasing energy efficiency is also a major challenge for country's power sector which reports nearly 26 % losses in transmission and distribution. Renewable sources of energy such as hydro and wind are of major concern among the researchers and Scientists since decades.

The growth in power generation sector in some way determines the progress of that country. In spite of many rural electrification plans launched by central and many state governments we are still back in power generation, India has nearly 54000 un-electrified villages. In most of "Electrified villages" as on official records of government the supply of electricity is for only 4-6 hours per day. It is not acceptable if 'Electricity for all' is the basic motto with all ensured with 24x7 power supply.

Table 1: Different renewable energy sources and its potential and installed capacity.

Source	Potential (MW)	Installed Capacity (MW)
Wind	45000	12000
Biomass	17000	900
Small Hydro (<25MW)	15000	2700
Cogeneration-Bagasse	5000	1400
Waste	2700	72
Solar	>100000	12

However according to CEA report of June2009, the technical extraction of different resources is given in table 2 and 3 which shows that we are totally dependent on the conventional sources of energy.

5. APPLICATION OF SEIG IN RURAL AREAS

The SEIG system is of great importance in rural areas as power can be generated in those areas which suffer from rampant power cut-off and power shortage power can generated at a minimal cost ,As stated that on an average the per day power supply in our rural areas on an average is 4-6 hours daily which is of much concern.

The below information will give you a detail of some of the concerned areas of India where SEIG can find an extensive application for the exploration of energy.

6. WIND POWER GENERATION IN DEMAND IN DEVELOPING COUNTRIES LIKE INDIA

A recent report by the ministry of power, states that by the end of 2050 many great powers of the world are likely to utilise around 50 % of its energy from renewable sources, today Germany is the biggest producer of wind power, India ranks in fourth in the list. Our yearly generation of wind power accounts for 3500 MW approx. however the estimated wind resource is of around 45000MW which is much more than what we explored. In Bihar and Jharkhand, Wind power has emerged as the biggest renewable energy source in the world but still they are not given importance. The modern European technique is to make huge wind turbines and 2 MW wind turbine has become very common in Europe and soon they are about to produce 5 MW capacity wind turbine. Moving on the path followed by the Europeans Indian government also aimed for large and Giant turbines but unfortunately they forget the scope of the small turbines .However 100000MW can be prepared only from small turbines with capacity of 25-100KW ,our government has not recognised this bright and glittering industry.

The Wind Potential in India was first estimated by Centre for Wind Energy Technology (CWET) at 50m hub-height i.e. 49 GW but according to the new survey at 80m hub height, the potential grows as much as 102 GW. This figure was adopted by the government as the official estimate. However, Lawrence Berkley National Laboratory (LBNL) has stated the potential is over 300 to 400 GW.

The state Orissa which forms the coastal region of India has a potential of about 1400MW however only 2MW generation is possible.

Currently, the use of wind power for electricity production in developing countries is limited, the main area of growth being for very small battery charging wind turbines (50 - 150 Watts). Wind speed data can be obtained from wind maps or from the meteorology office. Unfortunately the general availability and reliability of wind speed data is extremely poor in many regions of the world. However, significant areas of the world have meant annual Wind speeds of above 4-5 m/s (metres per second) which makes small-scale wind powered electricity generation an attractive option.

7. SEIG AND HYBRID SYSTEM FOR WIND POWER GENERATION

Unlike the trend toward large-scale grid connected wind turbines seen in the West, the more Immediate demand for rural energy supply in developing countries like India is for smaller machines in the 5 - 100 kW range. These can be connected to small, localised micro systems and used in conjunction with power generating SEIG sets. Small wind energy systems, namely the water pumping windmills, the aero generators and solar-wind hybrid power systems can also be used for harnessing wind power potential all the listed systems uses Self excited induction generator model , in addition to the large capacity wind turbines. These SEIG systems have been found to be very useful for meeting water pumping and small power requirements in decentralized mode in rural and remote windy areas of the country, which are un-electrified or have intermittent electric supply. The Ministry has been implementing a Programme on “Small Wind Energy & Hybrid Systems” for promoting these Systems in the country through the programme.

8. SCOPE OF HYDEL ENERGY IN INDIA

Of the estimated potential of 15,000 MW of small hydro plants in the country, 4,400 sites with an aggregate capacity of 10,500 MW have been identified. The cumulative installed capacity of grid interactive small hydropower projects up to 31.3.2006 is 1826 MW. During 2006-07, 79 MW have been installed up to 31.12.2006 and as per trends it is likely that a total of 120 MW would be added during the year. With this, the capacity addition during the 10th plan is likely to be 510 MW. Apart from this, projects aggregating 394 MW are under implementation. State wise installed capacity and that are under implementation as on the date of 31.12.2006 are shown in the table below.

9. SEIG FOR HYDRO POWER GENERATION

The Ministry of Non-Conventional Energy Sources is assigned the business of small hydro power up to 25 MW station capacities. The Ministry’s aim is that out of the total grid interactive power generation capacity that is being installed, 2% should come from small hydro. The Programme is essentially private. Electricity generation from small hydro is becoming increasingly competitive with preferential tariffs and some other concessions. The challenge is to improve reliability, quality and costs. There is need to lower the cost of

equipment, increase its reliability and set up projects in areas that give the maximum advantage in terms of capacity utilization.

According to the Ministry of Power, the scope for investments in the Indian power sector stands at USD 300 billion.

10. SUGGESTIONS

For the development of India more emphasis should be over the decentralised electrical energy generation than the centralised generation of electricity ,SEIG possesses a bright future for rural development through SEIG system we will be able to overcome the shortage of electrical energy .Some of the states in India such as Orissa, Bihar ,Jharkhand ,Goa ,Madhya Pradesh ,Kerala Andhra-Pradesh ,West Bengal, Uttarakhand are rich in some or the other resources by implementation of proper generating system in rural areas of these states would make India rich in electrical power.

11. CONCLUSION

The non-conventional sources of energy are still not given importance. However to be in the list of the developed country ,Indian government should adopt this non-conventional energy and should implement small power generating station, as every place in India is rich in some or other resources. The only requirement is the vision to explore them and utilise it for the betterment of human beings concerned areas of India where SEIG can find an extensive application for the exploration of energy:

Region wise and State wise Installed Generating Capacity of Electricity (Utilities) in India as on 31.03.2011 and 31.03.2012

										(In GW)	
	Hydro		Thermal		Nuclear		New & Renewable**		Total		Growth* Rate(2010-11to 2011-12)
States/UTs	31.03.11	31.03.12	31.03.11	31.03.12	31.03.11	31.03.12	31.03.11	31.03.12	31.03.11	31.03.12	
Delhi	0.00	0.00	1.51	1.54	0.00	0.00	0.00	0.02	1.51	1.56	3.48
Haryana	0.88	0.88	3.44	3.85	0.00	0.00	0.11	0.12	4.43	4.86	9.64
Himachal Prd.	0.97	2.07	0.00	0.00	0.00	0.00	0.38	0.53	1.35	2.60	92.95
Jammu & Kashmir	0.78	0.78	0.18	0.18	0.00	0.00	0.13	0.13	1.09	1.09	0.11
Punjab	2.23	2.23	2.66	2.66	0.00	0.00	0.33	0.35	5.21	5.24	0.47
Rajasthan	0.99	0.99	4.33	4.60	0.00	0.00	1.47	2.37	6.78	7.95	17.21
Uttar Pradesh	0.52	0.52	4.67	7.12	0.00	0.00	0.61	0.69	5.81	8.33	43.44
Uttrakhand	1.65	1.65	0.00	0.00	0.00	0.00	0.15	0.19	1.80	1.84	2.21
Central Sector NR	5.79	5.99	11.59	12.84	1.62	1.62	0.00	0.00	19.01	20.46	7.63
Sub-Total (NR)	13.82	15.12	28.38	32.79	1.62	1.62	3.17	4.39	46.99	53.93	14.76
Chhatisgarh	0.12	0.12	3.66	3.89	0.00	0.00	0.25	0.27	4.03	4.29	6.36
D & N Haveli	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Daman & Diu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Goa	0.00	0.00	0.05	0.05	0.00	0.00	0.03	0.03	0.08	0.08	0.00
Gujarat	0.77	0.77	10.34	14.73	0.00	0.00	2.00	3.50	13.11	19.00	44.92
Madhya Pradesh	1.70	1.70	2.81	2.81	0.00	0.00	0.27	0.48	4.78	4.99	4.39

Maharashtra	3.33	3.33	11.05	13.39	0.00	0.00	2.81	3.63	17.19	20.35	18.36
Central Sector WR	1.52	1.52	11.01	12.33	1.84	1.84	0.00	0.00	14.37	15.69	9.18
Sub-Total (WR)	7.45	7.45	38.92	47.20	1.84	1.84	5.36	7.91	53.56	64.39	20.22
Andhra Pradesh	3.70	3.73	7.73	8.38	0.00	0.00	0.77	0.89	12.19	13.00	6.62
Karnataka	3.60	3.60	3.91	5.01	0.00	0.00	2.62	3.18	10.13	11.80	16.44
Kerala	1.88	1.88	0.43	0.43	0.00	0.00	0.15	0.16	2.46	2.47	0.68
Lakshadweep	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	-7.00
Puducherry	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.00	0.03	0.03	-0.08
Tamil Nadu	2.12	2.12	4.66	4.66	0.00	0.00	5.81	7.34	12.59	14.12	12.11
Central Sector SR	0.00	0.00	8.75	10.00	1.32	1.32	0.00	0.00	10.07	11.32	12.41
Sub-Total (SR)	11.30	11.34	25.52	28.52	1.32	1.32	9.34	11.57	47.48	52.75	11.09
A & N Island	0.00	0.00	0.06	0.06	0.00	0.00	0.01	0.01	0.07	0.07	0.00
Bihar	0.00	0.00	0.53	0.53	0.00	0.00	0.07	0.08	0.60	0.61	2.01
Jharkhand	0.13	0.13	1.55	2.60	0.00	0.00	0.00	0.00	1.68	2.73	62.11
Odisha	2.06	2.06	1.62	2.22	0.00	0.00	0.08	0.10	3.76	4.38	16.42
Sikkim	0.00	0.00	0.01	0.01	0.00	0.00	0.05	0.05	0.05	0.06	9.60
West Bengal	0.98	0.98	6.23	6.48	0.00	0.00	0.16	0.16	7.37	7.62	3.40
Central Sector ER	0.71	0.71	9.02	10.27	0.00	0.00	0.00	0.00	9.73	10.98	12.85
Sub-Total (ER)	3.88	3.88	19.02	22.17	0.00	0.00	0.36	0.40	23.26	26.44	13.67
Arunachal Prd.	0.00	0.00	0.02	0.02	0.00	0.00	0.08	0.08	0.09	0.09	0.00
Assam	0.10	0.10	0.34	0.38	0.00	0.00	0.03	0.03	0.47	0.51	7.89
Manipur	0.00	0.00	0.05	0.05	0.00	0.00	0.01	0.01	0.05	0.05	0.00
Meghalaya	0.16	0.24	0.00	0.00	0.00	0.00	0.03	0.03	0.19	0.27	43.34
Mizoram	0.00	0.00	0.05	0.05	0.00	0.00	0.04	0.04	0.09	0.09	0.00
Nagaland	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.03	-6.52
Tripura	0.00	0.00	0.15	0.15	0.00	0.00	0.02	0.02	0.17	0.17	0.00
Central Sector NER	0.86	0.86	0.38	0.38	0.00	0.00	0.00	0.00	1.24	1.24	0.00
Sub-Total (NER)	1.12	1.20	0.99	1.02	0.00	0.00	0.22	0.22	2.33	2.45	5.03
Total States	**28.68**	**29.90**	**72.08**	**85.88**	**0.00**	**0.00**	**18.45**	**24.49**	**119.21**	**140.27**	**17.67**
Total Central	**8.89**	**9.09**	**40.75**	**45.82**	**4.78**	**4.78**	**0.00**	**0.00**	**54.41**	**59.68**	**9.69**
Total All India	**37.57**	**38.99**	**112.82**	**131.70**	**4.78**	**4.78**	**18.45**	**24.49**	**173.63**	**199.96**	**15.17**

***:- Renewable Energy Sources includes Small Hydro Projects, Wind Power, Biomass Power Biomass Gesifier,Urban & Industrial Waste and Solar Power.*

** Growth rate of total installed electricity generating capacity of India Sub-totals/Totals may not tally due to conversion to GW and rounding off*

Source: Central Electricity Authority.

Sourcewise and Statewise Estimated Potential of Renewable Power in India as on 31.03.2012

							(in MW)
						Total	
States/ UTs	**Wind Power**	**Small Hydro Power**	**Biomass Power**	**Cogeneration-bagasse**	**Waste to Energy**	**Estimated Reverses**	**Distribution (%)**
1	2	3	4	5	6	7	8
Andhra Pradesh	5394	560	578	300	123	6955	7.75
Arunachal Pradesh	201	1334	8	0	0	1543	1.72
Assam	53	239	212	0	8	512	0.57
Bihar	0	213	619	300	73	1205	1.34
Chhattisgarh	23	993	236	0	24	1276	1.42
Goa	0	7	26	0	0	33	0.04
Gujarat	10609	197	1221	350	112	12489	13.91
Haryana	0	110	1333	350	24	1817	2.02
Himachal Pradesh	20	2268	142	0	2	2432	2.71
Jammu & Kashmir	5311	1418	43	0	0	6772	7.54
Jharkhand	0	209	90	0	10	309	0.34
Karnataka	8591	748	1131	450	151	11071	12.33
Kerala	790	704	1044	0	36	2574	2.87
Madhya Pradesh	920	804	1364	0	78	3166	3.53
Maharashtra	5439	733	1887	1250	287	9596	10.69
Manipur	7	109	13	0	2	131	0.15
Meghalaya	44	230	11	0	2	287	0.32
Mizoram	0	167	1	0	2	170	0.19
Nagaland	3	197	10	0	0	210	0.23
Odisha	910	295	246	0	22	1473	1.64
Punjab	0	393	3172	300	45	3910	4.36
Rajasthan	5005	57	1039	0	62	6163	6.87
Sikkim	98	266	2	0	0	366	0.41
Tamil Nadu	5374	660	1070	450	151	7705	8.58
Tripura	0	47	3	0	2	52	0.06
Uttar Pradesh	137	461	1617	1250	176	3641	4.06
Uttaranchal	161	1577	24	0	5	1767	1.97
West Bengal	22	396	396	0	148	962	1.07
Andaman & Nicobar	2	7	0	0	0	9	0.01
Chandigarh	0	0	0	0	6	6	0.01
Dadar & Nagar Have	0	0	0	0	0	0	0.00
Daman & Diu	0	0	0	0	0	0	0.00
Delhi	0	0	0	0	131	131	0.15
Lakshadweep	16	0	0	0	0	16	0.02
Puducherry	0	0	0	0	3	3	0.00
Others*	0	0	0	0	1022	1022	1.14
All India Total	**49130**	**15399**	**17538**	**5000**	**2707**	**89774**	**100.00**
Distribution (%)	**54.73**	**17.15**	**19.54**	**5.57**	**3.02**	**100.00**	

** Industrial waste*
Source: Ministry of New and Renewable Energy

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