Planning of MICROGRID in Makhla village Amravati District

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Abstract: *Remote areas, where renewable energy systems can make their greatest impact, for the most part will not have data on the available resources. This is especially true in developing countries. Often, the designer has to estimate the resources either based on data available at similar or nearby locations or rely on qualitative information, which may be of the form :highly windy, highly variable, calm, mostly cloudy, etc. But, such information is only a snapshot and does not represent long term averages that are needed for planning. In present paper Micro Grid is planned for Makhla village in Amravati district as a rural electrification.*

Keywords: Microgrid

INTRODUCTION

Depending on the geographic location , remote areas may be blessed with abundance of some resources and total lack of some others. Indian Renewable Energy Sources can handle all such cases as long as proper resource inputs are used.Estimation of needs is fairly straight – forward in the case of renewable energy systems dedicated to specific purposes .Rural energy needs in developing countries are quite difficult to estimate. Detailed discussions with local populace will be needed to arrive at realistic values. Also introduction of IRES will most likely alter the energy consumption patters and best estimates of the modified energy needs are the ones that are required as inputs .Where the available financial resources are limited, the planner must prioritize the needs as appropriate and try to satisfy as many of them as possible.Whether to supply energy to improve the basic living environment or to “ productive” uses such as agriculture and small scale industries is one of the many socio- economic issue that will have to be resolved.

Planning Of Micro Grid in Amravati District

Amravati is a district of Maharashtra state in central India.Total population is 2,607,160 peoples with 5,26,230 households. Makhla village is in chikhaldara taluka in Amravati district, State Maharashtra.

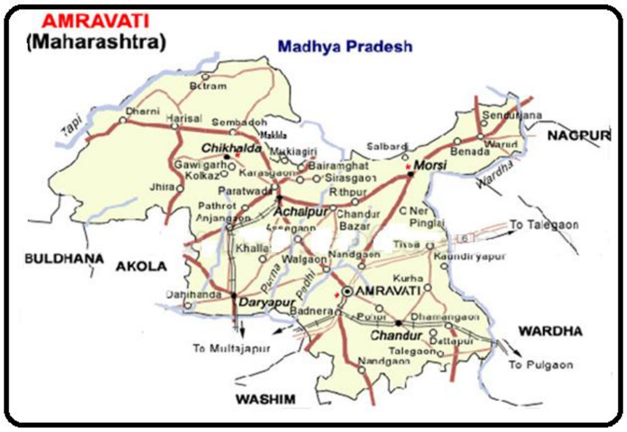


Fig . 1 Map of Amravati District

Week No.	load in p.u	Week No.	load in p.u	Week No.	load in p.u	Week No.	load in p.u
1	0.348	14	0.921	27	0.501	40	0.772
2	0. 346	15	. 875	28	0.526	41	0.78
3	0.410	16	0.87	29	0.5	42	0.79
4	0.346	17	0.81	30	0.5	43	0.772
5	0.348	18	0.911	31	0.501	44	0.7
6	0.48	19	0.981	32	0.584	45	0.584
7	0.584	20	1.0	33	0.584	46	0.5
8	0.56	21	0.981	34	0.584	47	0.5
9	0.584	22	0.99	35	0.584	48	0.50
10	0.737	23	0.812	36	0.628	49	0.348
11	0.77	24	. 88	37	0.6	50	0.346
12	0.8	25	0.869	38	0.62	51	0.34
13	0.76	26	0.8	39	0.629	52	0.348

Table 1 Load Model of Amravati District

Table 1. shows the load model of Amravati district where during the month of May peak load occurs because during this month summer is at peak so almost all the load are on large pumping of water is also required .The district is situated between 20°32' and 21°46' north latitudes and 76°37' and 78°27' east longitudes,has 12,235 km² area.Makhla is a village in Amravati with total area of 733.26 hectares. Latitude 21.697o N and longitude 77.365o .This village is rich in natural resources.There are around 190 families with a population of 970 persons.Water requirement for the Makhla Village is 37,345 lit. /day.

Table 1.1 Average Solar sunshine hours at Makhla village

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Avg.sunshine hours	9.3	10.1	9.2	9.4	9.3	7.1	1.2	1.8	4.7	8.1	9.2	9.2

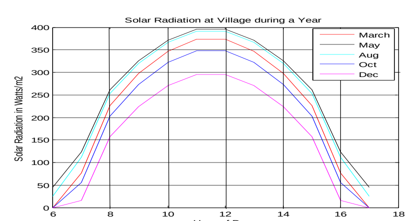


Fig 1.1 Solar radiation at village during an year.

Wind speed is available in good amount at this site. During the month from November to February it is in with good rated speed. The various months wind speed are plotted on graph shown in fig 1.3

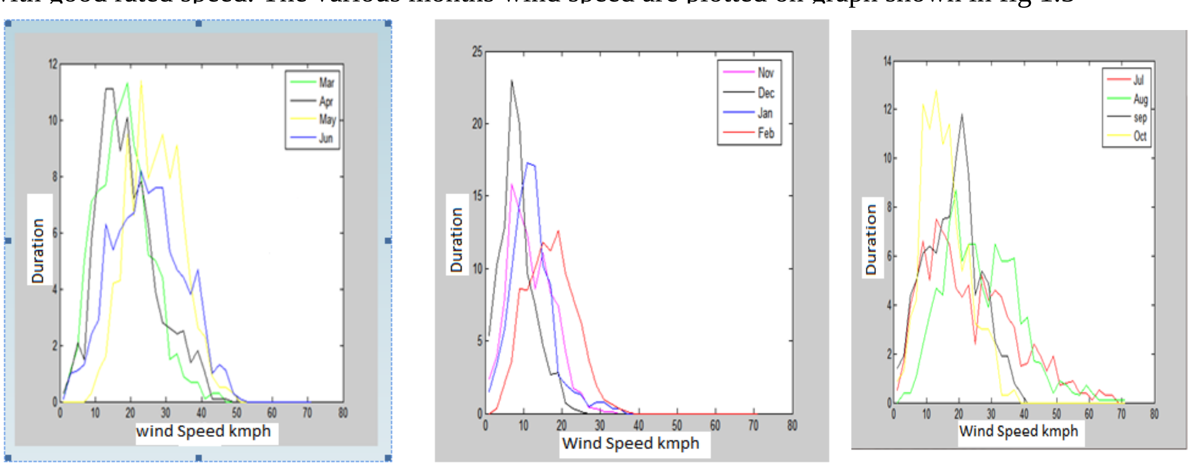


Fig 1.2 wind speed data at Makhla village

Table 1.2 Weighted rainfall data arranged yearwise

Sr. No.	Year	Bhaisdehi		Chandur Bazar		Atner		Total Weighted Rainfall in inches
		Rainfall in inches, R1	R1 X 0.791783 (Inches)	Rainfall in inches, R2	R2 X 0.14132 (Inches)	Rainfall in inches, R3	R3 X 0.066887 (Inches)	
1	1985	37.95	30.05	26.28	3.71	24.25	1.62	35.38
2	1986	39.03	30.90	26.53	3.75	41.97	2.81	37.46
3	1987	23.25	18.41	19.18	2.71	28.75	1.92	23.04
4	1988	39.12	30.97	45.09	6.37	31	2.07	39.42
5	1989	32.11	25.42	20.31	2.87	23.71	1.59	29.88
6	1990	60.81	48.15	27.92	3.95	28.54	1.91	54.00
7	1991	27.8	22.01	18.13	2.56	22.74	1.52	26.09
8	1992	32.7	25.89	29.82	4.21	25.54	1.71	31.81
9	1993	45.82	36.28	26.09	3.69	35.48	2.37	42.34
10	1994	53.41	42.29	41.27	5.83	45.81	3.06	51.19
11	1995	33.65	26.64	20.32	2.87	34.28	2.29	31.81
12	1996	45.29	35.86	30.78	4.35	33.39	2.23	42.44
13	1997	43.65	34.56	29.99	4.24	42.64	2.85	41.65
14	1998	47.61	37.70	32.49	4.59	34.08	2.28	44.57
15	1999	60.15	47.63	27.67	3.91	28.08	1.88	53.41
16	2000	16.6	13.14	17.24	2.44	13.29	0.89	16.47
17	2001	40.78	32.29	23.16	3.27	20.82	1.39	36.95
18	2002	40.79	32.30	19.6	2.77	24.44	1.63	36.70
19	2003	31.23	24.73	25.3	3.58	22.24	1.49	29.79

Table 1.3 Monthly data for year 1956 with the capacity and the rated head

Sr. No.	Operating Conditions of Reservior		Closing conditions of reservoir (Water), Mm3	Total water level (TWL)	Discharge, Q (m3 / sec)	Maximum water level (MWL)	Head, H (m) (MWL - TWL)
	Water Reservoir Level, m	Water, Mm3					
1	438.55	6.389	440.59	434.87	0.1961	439.91	5.04
2	440.59	9.148	444.24	434.758	0.0075	443.022	8.264
3	444.238	16.27	451.13	434.765	0.0151	448.834	14.069
4	451.133	38.03	452	435.68	3.7323	451.711	16.031
5	452	41.76	451.24	435.71	4.0088	451.746	16.036
6	451.24	38.49	448.51	435.86	5.1668	450.33	14.47
7	448.51	27.93	444.07	435.92	5.6953	447.029	11.109
8	444.067	15.86	440.59	435.59	3.199	442.908	7.318
9	440.592	9.151	440.42	434.75	0	440.533	5.783
10	440.416	8.857	439.98	434.75	0	440.269	5.519
11	439.977	8.135	439.26	434.75	0	439.738	4.988
12	439.262	7.26	438.57	434.75	0	439.03	4.28

It can be concluded that solar , hydro and wind resources are available in good amount so planning of Microgrid comprising of these sources can be done. A remote agricultural with no electrical Grid connection and a population of 190 families is used for planning.

Method: DESIGN OF LOAD AND MICROGRID

There are 190 families in Makhla village of Amravati district. So out of them 10% are rich that is 19 families , 20% are medium rich families that is 34 families and rest 137 families are poor. Rich people has 4 room house with 1 T.V,4 tube lights, 3 fans, refrigerator and mixer. Medium rich people has 3 room house with 3 tubelights, 2fan,1 T.V. Whereas poor people has 2 room house with 2 tubelights and 1 fan. There are 10 shops with power requirement of 13.675kw per month. Following table predicts the domestic electricity requirement of the 190 families. As per the solar,hydro,wind data availability first the individual sources are considered to satisfy the demand and accordingly capacity of generator is calculated. Then combination of two sources has to be done finally combination of three sources can be done and it can be seen that how much capacity of sources can satisfy the demand. Finally all the available sources that is solar , wind , hydro (Micro grid) are planned in such a optimum state that they satisfy the demand at low cost.

Table 1.4: Energy consumption of poor families (137 houses)

Local load	Specification	Power Watts	Quantity	Working time	Energy required per day Wh	Total
Lighting	Light bulb	9	2	5	90	45.210 kWh
Fan		40	1	6	240	

Table 1.5: Energy consumption of middle class families (34 houses)

Local load	Specification	Energy Watts	Quantity	Working time	Energy required per day Wh	Total
Lighting	Light bulb	9	3	5	135	32.810 kWh
Fan		40	2	6	480	
T.V		70	1	5	350	

Table 1.6: Power consumption of rich families (19 houses)

Local load	Specification	Energy Watts	Quantity	Working time	Energy required per day Wh	Total
Lighting	Light bulb	9	4	5	180	52.250 kWh
Fan		40	3	6	720	
T.V		70	1	5	350	
Fridge			1		800	
Mixer			1		700	

As per load model of Amravati district peak load occurs during May month so here peak load of 176 kW also is considered in the May month and correspondingly the other months demand is calculated from that load model (Example : from 10 to 13th week the average of load in P.U is 0.77 so 176x0.77 =135.5 kW likewise other months demand is calculated.)

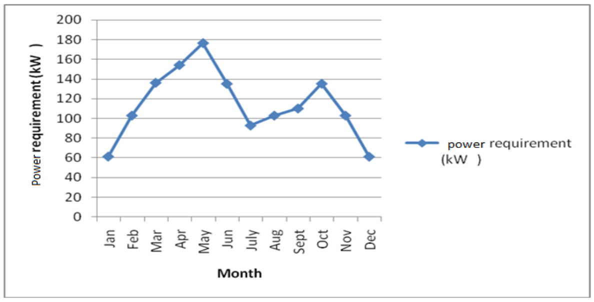


Fig 1.3: Graph showing load variation

Considering different season the load requirement table has been calculated like in the month of winter and rainy the requirement of fan is less while in the month of summer the load demand increases. From above table it can be concluded that peak load appears in the month of May . So now accordingly the different combination of sources has to be done to predict that the requirement can be very well satisfied by locally available sources.

Here 80 kW solar panel alone proves to be insufficient during the month March to October as shown in fig 1.4

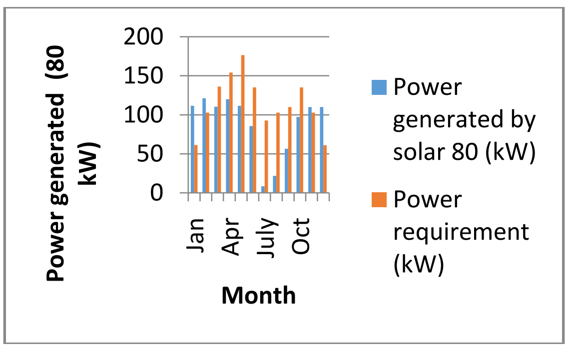


Fig 1.4: Power generation by 80 kW solar capacity

Here 100 kW solar panel alone again proves to be insufficient during the month May to October as shown in fig 1.5.

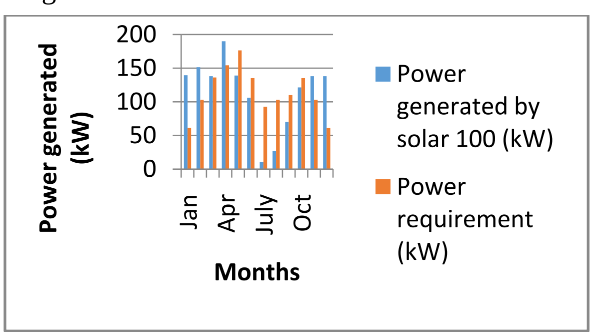
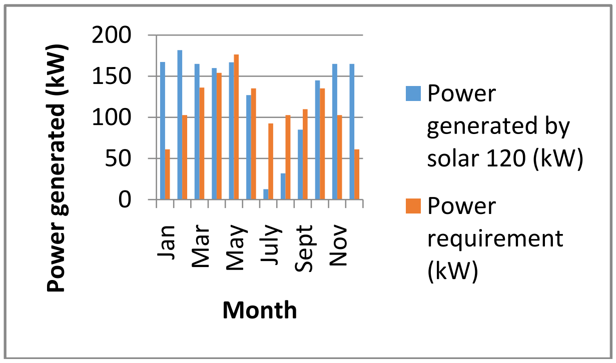


Fig 1.5: Power generation by 100 kW solar capacity

Here 120kW solar panel alone proves to be insufficient during the month May to september as shown in fig 1.6.



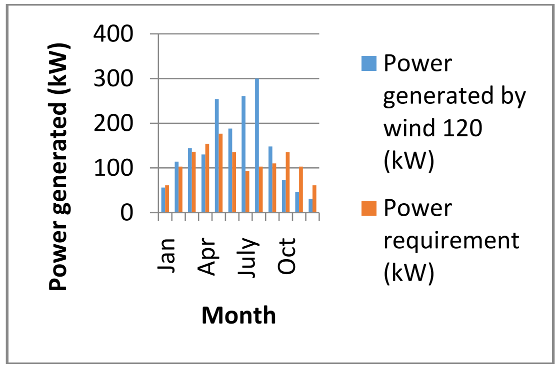
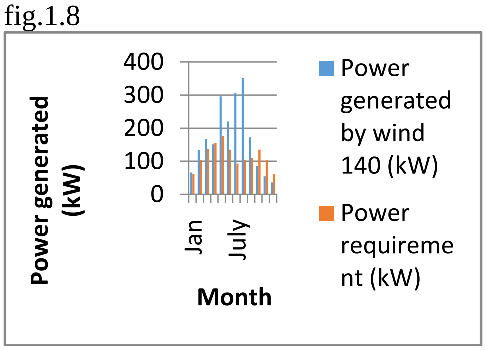


Fig 1.6: Power generation by 120 kW solar capacity

Fig 1.7: Power generation by wind of capacity 120 kW alone

As shown in fig 1.7 it can be seen that wind generator of 120 kW has load loss in January and from October to December.It can be concluded that weak wind speed months are during winter from October to January.

Again if capacity is increased by more 20 kW still there is load loss from October to December shown in fig.1.8



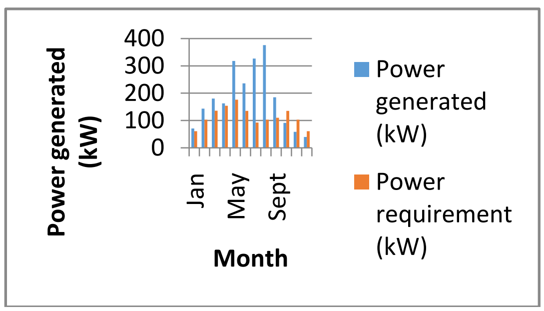
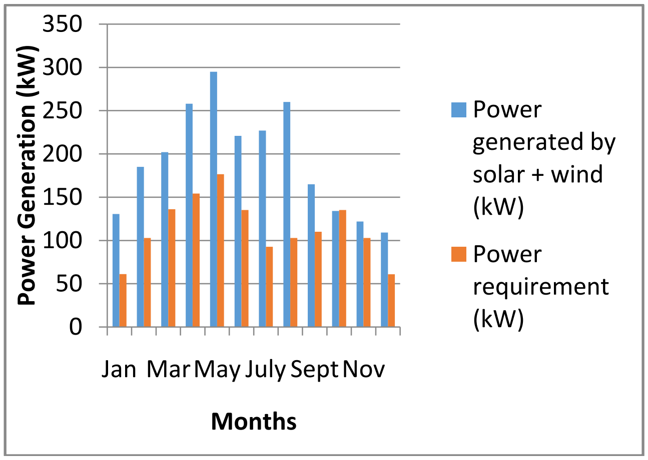


Fig 1.8: Power generation by wind of capacity 140 kW alone

Fig 1.9: Power generated by 150 kW wind power alone

With the wind generator of capacity 150 kW in fig 1.9 there is loss of load in the month of October, November and December. Rest of the month wind generator is able to satisfy the demand which is reliable than above discussed capacity.Also power generation from May to August is almost double the requirement so if storage is considered then it will prove beneficial during weak wind season.

Now when solar panel of 60kW capacity and wind of capacity100kW is combined then they are able to satisfy the load demand which is shown in the fig 4.14 below and these two hybrid capacity are not bringing about any loss of load.Fig 2 predicts the combination of 120kW wind capacity and 50 kW hydro capacity satisfying the demand only load loss occurs in October month.also in some month both hybrid combination has twice power generated than demanded which can be stored and supplied during deficient month.



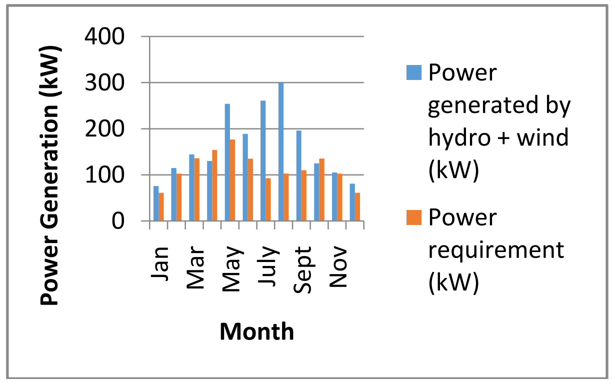
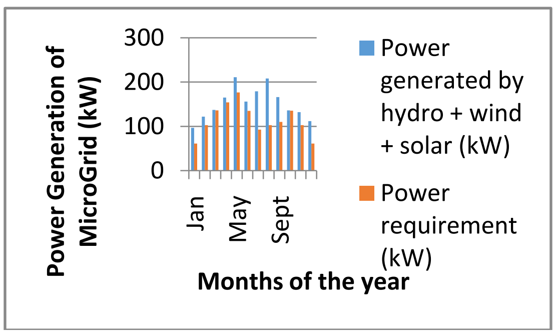


Fig 2: Power generated by solar and wind power

Fig 2.1: Power generated by hydro and wind power

In fig 2.2 Micro grid comprising of solar (30 kW) , wind (80 kW) and hydro (50 kW) is more promising than other combination as capacity of all the sources is reduced and no load loss is occurring.



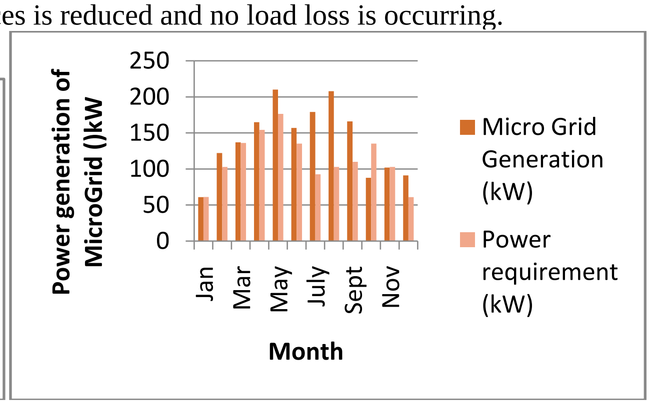
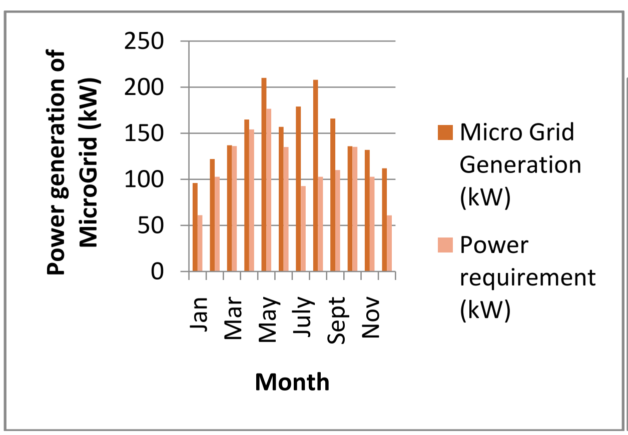


Fig 2.2: Power generated by Micro Grid

Fig 2.3: Power generated by Micro Grid during weak wind source



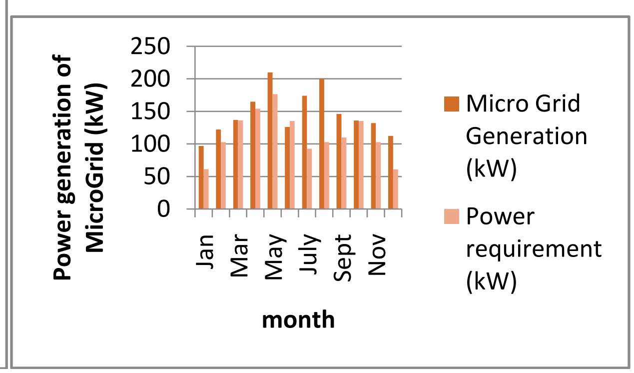


Fig 2.4: Power generated by Micro Grid during no rainfall month

Fig 2.5: Power generated by Micro Grid during weak solar rays

It can be concluded from fig 2.3that if wind velocity is weak during winter. So that wind capacity is kept off from September to January month . From figure it is seen that with all three sources included there is no load loss in any month and only if weak wind months are considered then there is load loss only in the month of October. It can also be seen that during month of July and August power generation is twice the requirement so if storage battery is used than load failure in the October month can also be overcome. Also keeping wind capacity off will also be economical during weak wind speed month.

In fig 2.4 no rainfall months are taken in to analysis that if hydro capacity is kept off during month of February to May no load loss occur .
In fig 2.5 weak month of solar radiation are considered that if solar capacity is off during month of June to September then load loss is occurring in the month of June. Rest of the months solar capacity is considered only when its weak month are considered then the loss in the month of June occurs which can be overcome by using suitable storage capacity as there is twice the production in the month of August and September.Again it is economical if during weak month capacity is kept off.

Integration of Sources:
Here a standalone type of Micro Grid is planned.It has three sources i) Micro hydro with 50 kw capacity ii) Micro wind with 80 kW capacity and iii) Micro solar with 30 kW capacity . These are interfaced with controllers and converter and inverter for proper operation and then are supplied to local load of Makhla village through a transformer.

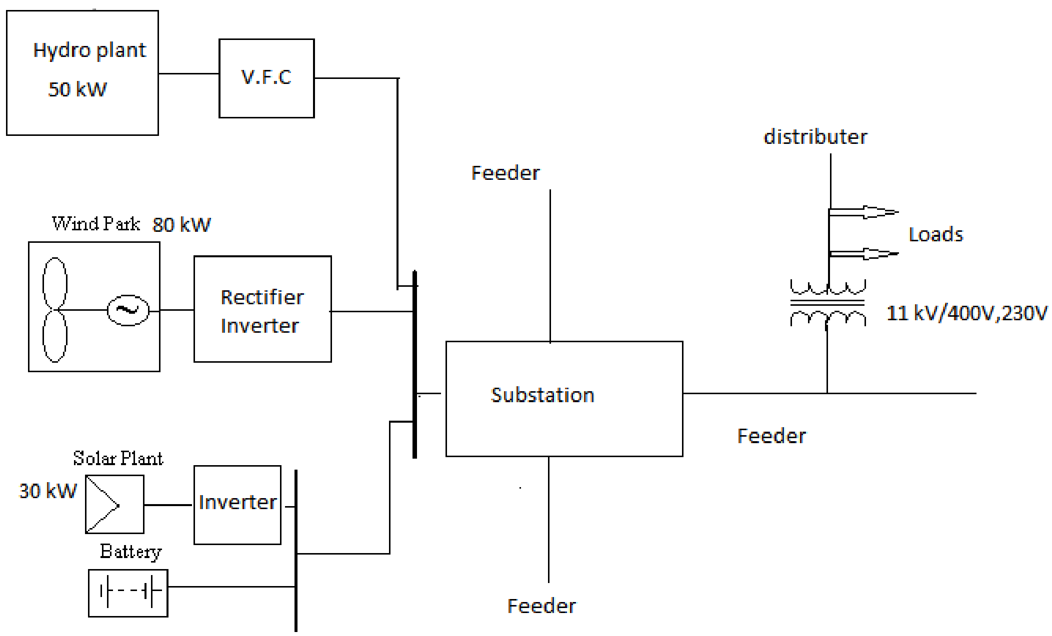


Fig 2.6 Distribution network of Microgrid

Conclusions:

Planning a Micro Grid in Makhla village is possible since natural resources are available in the village area itself that is solar, wind , hydro.Instead of using a single source with large capacity multiple sources with small capacity is analyzed or planned. So the people of Makhla with 190 families will get satisfied with Micro Grid in terms of domestic electricity since it is a village with no electricity.
The conclusion that can be drawn with this project is that

Micro Grid can be planned and is capable to supply the demand side with reduced capacity. If in some month one of the source is unable to cope the demand or it is less than other two sources play the role of supplying the demand. So this can be applied to any source. A MicroGrid consisting of 30 kW solar capacity,50 kW hydro capacity and 80 kW wind capacity seems to be more reliable and no load loss occurs than considering single or two sources together.

If single source is considered like 130 kW solar then load loss occur in month of July and August since it is weak in those month. Cost is also the main matter in case of solar panel. Second if wind source alone is considered then 150 kW wind capacity there is load loss in the month of October to December while there is excess production during July and August.

Combine two sources analysis is also fruitfull but capacity is high so MicroGrid with three sources with reduced capacity is planned.

Among MicroGrid capacity ,the capacity of wind is highest with 80 kW as the wind speed is available in almost all the month .If we compare 1kW solar PV capacity = 4kWh/day and 1kW wind turbine = 8 kWh /day at 6.3 m/s wind speed. Thus it can be concluded that wind turbine =half of solar price. So wind turbine is 4 times cost effective than solar PV.Sun rays are less during July to September month .Also in Purna river no sufficient head is available from January to May since there is no rainfall during these month. So because of above reason wind capacity is kept higher due to its continous availability and cost.

Also in Microgrid consideration of weak availability of sources month is also analyzed.

Economically MicroGrid (Rs.11,575,000) is preferable and it is reliable also. Alone 130 kW solar cost Rs.19,825,000 while alone considered wind cost Rs.3,750,000 while hybrid (solar and wind) cost Rs.11,650,000 and hybrid (wind and hydro) cost Rs.8,000,000.Single solar source is costly and during rainy season there is load loss , so cannot be preferred in terms of cost and reliability.Single wind source cost less so can be preferred but during winter season load loss occurs.Hybrid system also are costlyas compared to MicroGrid.

Future Scope

In present work Micro Grid is planned for Makhla village in Amravati district as a rural electrification .But if the standard of living is increased or some small scale industries are to be introduced then the capacity of Micro Grid has to be increased with large storage capacity. If the storage battery is used then it will reduce the capacity of MicroGrid and will supply whenever there is less generation from Grid.

References:

1. *Su Youli,Z.Litifu,K.Nagasaka" Efficiency of Micro Grid with storage battery in reliability , economy and envionmental assessments", International Journal of Electrical and Power Engineering 3 (3) :154-162,2009.*
2. *V.S.K Murthy Balijepalli , S.A.Khaparde, C.V.Dobariya, "Deployment of MicroGrids in India," IEEE,Vol.10,pp.1-4,2010.*
3. *Z.Litifu,K.Nagasaka"Planning of Micro Grid power supply based on the weak wind and hydro power generation",IEEE Power Engineering Society,pp no. 0-7803-9156, vol 2,2006.*
4. *R. H. Lasseter and P. Paigi, "Microgrid: a conceptual solution," in Power*
5. *Electronics Specialists Conference, 2004. PESC 04. 2004 IEEE*
6. *35th Annual, 2004, pp. 4285-4290 Vol.6.*
7. *5. Mir Nahidul Ambial, Md. Kafiul Islam, Md. Asaduzzaman Shoeb, Md. Nasimul Islam MaruF, A. S. M. Mohsin, "An Analysis & Design on Micro*
8. *Generation of a Domestic Solar-wind Hybrid Energy System for Rural &*
9. *Remote Areas- Perspective Bangladesh ," vol 4, pp No. 29-43,2010.*
10. *6. R.Rmakumar, "Renewable Energy sources and Developing Countries ,"IEEE Trans. On Power App. & Systems,vol.PAS-102,no.2 ,pp.502-510, 1983.*