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IMPACT OF FUEL CELL BASED HYBRID DISTRIBUTED GENERATION IN AN ELECTRICAL DISTRIBUTION SYSTEM

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ABSTRACT

Recent developments in distributed generation technologies have enabled new options for supplying electrical energy in remote and off-grid areas. The importance of fuel cells has increased during the past decade due to the extensive use of fossil fuels for electrical power has resulted in many negative consequences. Fuel cells are now closer to commercialization than past and they have the ability to fulfill all of the global power needs while meeting the economic and environmental expectations..The objective of this paper is to study the economic performance and operation of a fuel cell distributed generation and to provide an assessment of the economic issues associated in electrical network. In this study, with HOMER (Hybrid Optimization Model for Electric Renewables) software, NREL's micro power optimization model performed a range of equipment options over varying constraints and sensitivities to optimize small power distribution systems. Its flexibility makes it useful in the evaluation of design issues in the planning and early decision-making phase of rural electrification projects. This study concludes that fuel cell systems appear competitive today if is connected with proposed hybrid DG in an AC distribution grid. The overall energy management strategy for coordinating the power flows among the different energy sources is presented with cost-effective approach.

Keywords: *Distributed Generation, AC Distribution Grid, NREL, Micro Power Optimization, Fuel Cell, HOMER*

1. INTRODUCTION

Distributed generation deals with small power generation units being located near consumers and load centers providing benefits to customers and support for the economic operation of the existing power distribution system. DGs are usually under 10MW, modular electric generation and storage technologies that provide electrical energy when and where needed. They are connected to the grid at a distribution voltage level[1],[2].High efficient reciprocating engines and combustion turbines together with emerging technologies such as fuel cells, micro turbines, wind, and photovoltaic provide a variety of options for distributed power generation, and the rising public awareness for environmental protection have turned alternative energy and distributed generation as promising research areas. Due to natural intermittent properties of wind and solar irradiation, renewable energy systems normally require energy storage devices or some other generation sources to form a hybrid system. Because some of renewable energy sources can complement each other, multi-source alternative energy systems with proper control have great potential to provide higher quality and more reliable power to customers than a system based on a single resource [5].The same authors presented the economic impact of hybrid DG in an electrical distribution system with cost effective approach [3]. Azmy A. M. and Erich I [4] presented the most economic operation regarding the operating costs of Fuel cells and micro turbines with AC Grid using genetic algorithms and neural networks. Cotrell, W. Pratt proposed the approach of feasibility of fuel cell and hydrogen internal combustion engines with remote DG systems [6]. Milani, Neil Patrick presented the Performance Optimization of a Hybrid Wind Turbine-Diesel Micro grid Power System[9] .However, the issues on optimal system configuration, and power management using fuel cell among different energy sources with distribution system are not resolved yet. Therefore,

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more research work is needed on new alternative energy systems and their corresponding control strategies. Fuel cells are good energy sources to provide reliable power at steady state, but they cannot respond to electrical load transients as fast as desired and also costlier when compared with other DG sources. This problem is mainly due to their slow internal electrochemical and thermodynamic responses [5]. But in this paper different renewable energy sources with fuel cell can complement each other, forms hybrid alternative energy systems with proper control have great potential to provide higher quality and more reliable power with cost effective to customers than a system based on same hybrid alternative energy systems without fuel cell. There are many combinations of different alternative energy sources and storage devices to build a hybrid system. Among the list of some of the stand-alone or grid-connected hybrid systems that have been reported in paper [3] by the same authors, Wind-PV-Fuel cell DG with AC Grid model has been proposed in this study. In the proposed system, the different DG source is integrated through an AC link bus with and without fuel cell is presented.

This paper is set out as follows: Section II represents the distribution network connected with hybrid DG with fuel cell was simulated and optimized results are analyzed and Section III represents the distribution network connected with hybrid(Wind-PV)DG without fuel cell was analyzed. In Section IV results obtained with the simulation process using [10] in hybrid DG with fuel cell and hybrid without fuel cell are analyzed and compared with the optimized categorized results and the presence of fuel cell with DG proved to be a economical one with less operating cost.

2. PROPOSED SYSTEM CONFIGURATION

Figure 1 shows the system configuration for the proposed hybrid DG system with fuel cell connected with AC Grid. In the system, the renewable wind –PV-Fuel cell are considered as a complete “green” power generation system because the main energy sources all environmentally friendly.

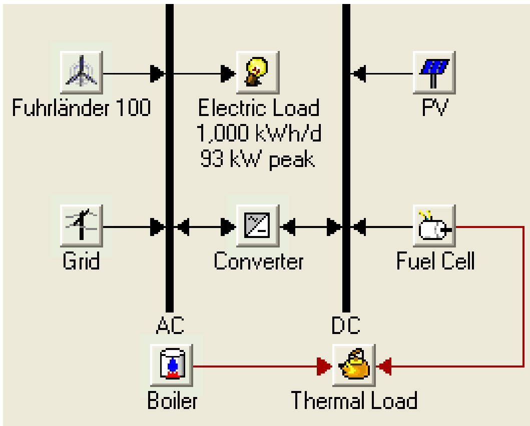

Fig. 1. Block diagram of the proposed hybrid Wind-PV-Fuel cell DG with AC Grid

With HOMER software, proposed DG System combination of photovoltaic (PV) modules, wind turbines and fuel cells was modeled with distribution systems serving electric and thermal loads. The analysis and design of distribution systems can be challenging, due to the large number of design options and the uncertainty in key parameters, such as load size and future fuel price. Renewable power sources add further complexity because their power output may be intermittent, seasonal, and non-dispatchable, and the availability of renewable resources may be uncertain. This software was designed to overcome these challenges. The Proposed System Configuration has been performed by three principal tasks namely simulation, optimization, and sensitivity analysis.

A. SIMULATION

The performance of the proposed hybrid Wind-PV-Fuel cell DG with AC Grid system configuration has been modeled and simulated for each hour of the year to determine its technical feasibility and life-cycle cost. Its higher-level capabilities, optimization and sensitivity analysis, rely on this simulation capability. The simulation process determines how a particular system configuration, a combination of system components of specific sizes, and an operating strategy that defines how those components work together, would behave in a given setting over a long period of time. In this process it was simulated a wide variety of DG configurations, that generates electricity, to serve a nearby load. Such a system may employ any combination of electrical generation and storage technologies and may be grid-connected or autonomous, meaning separate from any distribution grid. Using [10] determined

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whether the system satisfies the constraints imposed by the user on such quantities as the fraction of the total electrical demand served, the proportion of power generated by renewable sources, or the emissions of certain pollutants and also computed the quantities required to calculate the system's life-cycle cost, such as the annual fuel consumption, annual generator operating hours, operating cost and the quantity of power purchased annually from the grid. The total net present cost is the quantity uses to represent the life-cycle cost of the system. This single value includes all costs and revenues that occur within the project lifetime, with future cash flows discounted to the present. The total net present cost includes the initial capital cost of the system components, the cost of any component replacements that occur within the project lifetime, the cost of maintenance and fuel, and the cost of purchasing power from the grid. Any revenue from the sale of power to the grid reduces the total NPC.

A one-hour time step is necessary to model the behavior of the proposed hybrid DG system with acceptable accuracy particularly those involving intermittent distributed energy sources, but it is not enough to know the monthly average (or even daily average) wind power output, since the timing and the variability of that power output are as important as its average quantity. To predict accurately the flow of energy through fuel cell, PV cells, the battery, and the amount of surplus electrical production, it is necessary to know how closely the wind power output correlates to the electric load, and whether the wind power tends to come in long gusts followed by long lulls, or tends to fluctuate more rapidly. Hence one-hour time step is sufficiently small to capture the most important statistical aspects of the load and the intermittent renewable resources, but not so small as to slow computation to the extent that optimization and sensitivity analysis become impractical.

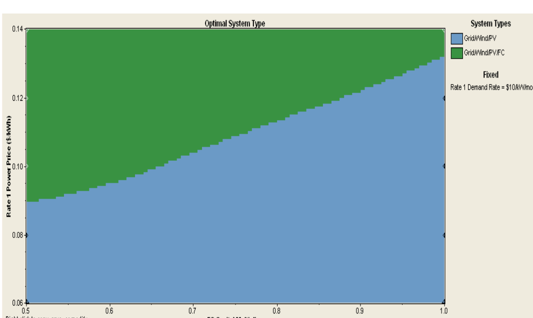

Fig2.portion of hourly simulation results for the proposed Wind-PV-Fuel cell hybrid DG system connected to AC grid system.

Figure 2 shows a portion of the hourly simulation results that when modeling a Wind-PV-Fuel cell DG system connected to AC grid. The proposed hybrid system models a wind turbine as a device that converts the kinetic energy of the wind into ac or dc electricity according to a particular power curve, which is a graph of power output versus wind speed at hub height. The power output of the wind turbine was calculated in a four-step process each hour,. First, it determines the average wind speed for the hour at the anemometer height by referring to the wind resource data. Second, it calculates the corresponding wind speed at the turbine's hub height using either the logarithmic law or the power law. Third, it refers to the turbine's power curve to calculate its power output at that wind speed assuming standard air density. Fourth, it multiplies that power output value by the air density ratio, which is the ratio of the actual air density to the standard air density. To calculate the air density ratio at the site elevation it is assumed that the air density ratio is constant throughout the year. In addition to the turbine's power curve and hub height, the user specifies the expected lifetime of the turbine in years, its initial capital cost in dollars, its replacement cost in dollars, and its annual O&M cost in dollars per year. The simulation process determines how a particular system configuration, a combination of system components of specific sizes, and an operating strategy that defines how those components work together, would behave in a given setting over a long period of time.

The simulation process serves two purposes. First, it determines whether the system is feasible and also considers the system can adequately serve the electric and thermal loads and satisfy any other constraints imposed by the user. Second, it estimates the life-cycle cost of the system, which is the total cost of installing and operating the system over its lifetime. The life-cycle cost is a convenient metric for comparing the economics of various system configurations.

B. OPTIMIZATION RESULTS

In the sensitivity analysis process, it was performed with multiple optimizations under a range of input assumptions to gauge the effects of uncertainty or changes in the model inputs. In the optimization process, the proposed system was simulated with many different system configurations in search of the one that satisfies the

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technical constraints at the lowest operating cost. Optimization determines the optimal value of the variables over which the system designer has control such as the mix of components that make up the system and the size or quantity of each. Sensitivity analysis helps assessing the effects of uncertainty or changes in the variables over which the designer has no control, such as the average wind speed or the future fuel price. It models a particular system configuration by performing an hourly time series simulation of its operation over one year. It steps through the year one hour at a time, calculating the available renewable power, comparing it to the electric load, and deciding what to do with surplus renewable power in times of excess, or how best to generate or purchase from the grid, additional power in times of deficit. When it has completed one year's worth of calculations, this model determines whether the system satisfies the constraints imposed by the user on such quantities as the fraction of the total electrical demand served, the proportion of power generated by renewable sources, or the emissions of certain pollutants. It also computes the quantities required to calculate the system's life-cycle cost, such as the annual fuel consumption, annual generator operating hours, expected battery life, or the quantity of power purchased annually from the grid.

Such comparisons are the basis of optimization process, described in the table1 displays a list of the system configurations that it found to be feasible. Important overall optimization results for the proposed hybrid system with fuel cell are listed in order (from top to bottom) of most cost-effective to least cost-effective in which fuel cell capital multiplier is taken 0.5 for power rate price 0.1$/KWH and demand price rate as10$/KW.

Table1: Important overall optimization results for the proposed hybrid system with fuel cell

PV (kW)	FL 100	FC (kW)	Converter (kW)	Grid (kW)	Initial capital	Operating cost ($/yr)	Total NPC	COE ($/kWh)	Renewable fraction	Natural gas (m3)	FC (hrs)
1	10	20	20	100	$342,000	36,771	$734,517	0.176	0.57	38,480	6,001
1	10	20	20	80	$342,000	36,771	$734,517	0.176	0.57	38,480	6,001
1	10	40	40	100	$387,000	34,008	$750,028	0.18	0.56	44,902	3,816
1	10	40	40	80	$387,000	34,008	$750,028	0.18	0.56	44,902	3,816
1	10	40	40	60	$387,000	34,009	$750,039	0.18	0.56	44,912	3,819
1	10	20	40	100	$357,000	36,918	$751,093	0.18	0.57	38,480	6,001
1	10	20	40	80	$357,000	36,918	$751,093	0.18	0.57	38,480	6,001
1	10	40	60	100	$402,000	34,156	$766,603	0.184	0.56	44,902	3,816
1	10	40	60	80	$402,000	34,156	$766,603	0.184	0.56	44,902	3,816
1	10	40	60	60	$402,000	34,157	$766,615	0.184	0.56	44,912	3,819
1	10	20	60	100	$372,000	37,066	$767,668	0.184	0.57	38,480	6,001
1	10	20	60	80	$372,000	37,066	$767,668	0.184	0.57	38,480	6,001
1	10	40	20	60	$372,000	38,289	$780,723	0.188	0.58	25,225	759
1	10	40	80	100	$417,000	34,303	$783,179	0.188	0.56	44,902	3,816
1	10	40	80	80	$417,000	34,303	$783,179	0.188	0.56	44,902	3,816
1	10	40	80	60	$417,000	34,304	$783,190	0.188	0.56	44,912	3,819
1	10	20	80	100	$387,000	37,213	$784,244	0.189	0.57	38,480	6,001
1	10	20	80	80	$387,000	37,213	$784,244	0.189	0.57	38,480	6,001
1	10	60	40	40	$417,000	35,287	$793,678	0.191	0.56	42,781	3,175
1	10	60	60	40	$432,000	34,117	$796,194	0.192	0.55	46,615	3,175
1	10	40	20	80	$372,000	39,948	$798,431	0.192	0.58	23,249	53
1	10	40	100	100	$432,000	34,451	$799,754	0.193	0.56	44,902	3,816
1	10	40	100	80	$432,000	34,451	$799,754	0.193	0.56	44,902	3,816
1	10	40	100	60	$432,000	34,452	$799,766	0.193	0.56	44,912	3,819
1	10	20	100	100	$402,000	37,361	$800,819	0.193	0.57	38,480	6,001
1	10	20	100	80	$402,000	37,361	$800,819	0.193	0.57	38,480	6,001
1	10	60	60	60	$432,000	35,532	$811,296	0.196	0.56	34,655	1,243
1	10	60	60	100	$432,000	35,591	$811,925	0.196	0.56	34,178	1,185
1	10	60	60	80	$432,000	35,591	$811,925	0.196	0.56	34,178	1,185
1	10	60	20	60	$402,000	38,412	$812,045	0.196	0.58	25,225	759
1	10	60	80	40	$447,000	34,265	$812,770	0.196	0.55	46,615	3,175
1	10	60	40	60	$417,000	37,146	$813,525	0.196	0.57	28,415	759
1	10	60	20	80	$402,000	39,638	$825,128	0.199	0.58	23,249	53
1	10	60	80	60	$447,000	35,680	$827,871	0.2	0.56	34,655	1,243
1	10	60	80	100	$447,000	35,738	$828,500	0.2	0.56	34,178	1,185
1	10	60	80	80	$447,000	35,738	$828,500	0.2	0.56	34,178	1,185
1	10	60	100	40	$462,000	34,412	$829,345	0.2	0.55	46,615	3,175
1	10	60	20	100	$402,000	40,827	$837,824	0.202	0.58	23,101	0
1	10	60	40	80	$417,000	39,724	$841,043	0.203	0.58	23,470	53
1	10	80	20	60	$432,000	38,536	$843,367	0.204	0.58	25,225	759
1	10	60	100	60	$462,000	35,827	$844,447	0.204	0.56	34,655	1,243
1	10	80	40	60	$447,000	37,270	$844,847	0.204	0.57	28,415	759
1	10	60	100	100	$462,000	35,886	$845,076	0.204	0.56	34,178	1,185
1	10	60	100	80	$462,000	35,886	$845,076	0.204	0.56	34,178	1,185
1	10	80	40	40	$447,000	37,440	$846,659	0.205	0.56	42,781	3,175
1	10	80	60	40	$462,000	36,153	$847,927	0.205	0.55	47,106	3,175
1	10	80	20	80	$432,000	39,329	$851,825	0.206	0.58	23,249	53
1	10	80	60	60	$462,000	36,716	$853,940	0.207	0.56	31,328	759
1	10	60	40	100	$417,000	40,975	$854,400	0.207	0.58	23,101	0
1	10	80	80	40	$477,000	36,186	$863,281	0.209	0.55	47,587	3,175
1	10	80	20	100	$432,000	40,494	$864,265	0.209	0.58	23,101	0
1	10	80	40	80	$447,000	39,414	$867,740	0.21	0.58	23,470	53
1	10	80	80	60	$477,000	36,750	$869,294	0.21	0.56	31,808	759
1	10	100	20	60	$462,000	38,660	$874,689	0.212	0.58	25,225	759
1	10	100	40	60	$477,000	37,394	$876,169	0.212	0.57	28,415	759
1	10	100	20	80	$462,000	39,019	$878,522	0.213	0.58	23,249	53
1	10	80	100	40	$492,000	36,334	$879,856	0.213	0.55	47,587	3,175
1	10	100	60	40	$492,000	38,306	$900,907	0.219	0.55	47,106	3,175
1	10	80	60	20	$462,000	42,503	$915,707	0.222	0.54	59,095	6,536
1	10	100	80	40	$507,000	38,331	$916,175	0.222	0.55	47,621	3,175
1	10	100	100	60	$522,000	37,011	$917,080	0.223	0.56	31,852	759
1	10	80	80	20	$477,000	42,127	$926,698	0.225	0.54	59,576	6,536
1	10	100	100	40	$522,000	38,476	$932,726	0.227	0.55	47,631	3,175
1	10	80	100	20	$492,000	42,275	$943,273	0.229	0.54	59,576	6,536
1	10	100	60	20	$492,000	48,106	$1,005,516	0.245	0.54	59,095	6,536
1	10	100	80	20	$507,000	47,722	$1,016,419	0.248	0.54	59,610	6,536
1	10	100	100	20	$522,000	47,867	$1,032,971	0.252	0.54	59,620	6,536

The Table2 below gives the categorized results of a proposed hybrid system with fuel cell. In the categorized optimization Results table, the result displays only the most cost effective configuration of each system design. In the optimization results using the proposed hybrid Wind-PV-Fuel cell DG with AC Grid results gives us economic details about each system configuration has been displayed in which the highlighted row indicates less operating cost of $34008 per year with 56% of utilization of renewable sources.

Table2: Categorized results of proposed hybrid DG system with fuel cell

PV (kW)	FL 100	FC (kW)	Converter (kW)	Grid (kW)	Initial capital	Operating cost ($/yr)	Total NPC	COE ($/kWh)	Renewable fraction	Natural gas (m3)	FC (hrs)
1	10	20	20	100	$342,000	36,771	$734,517	0.176	0.57	38,480	6,001
1	10	20	20	80	$342,000	36,771	$734,517	0.176	0.57	38,480	6,001
1	**10**	**40**	**40**	**100**	**$387,000**	**34,008**	**$750,028**	**0.18**	**0.56**	**44,902**	**3,816**
1	10	40	40	80	$387,000	34,008	$750,028	0.18	0.56	44,902	3,816
1	10	40	40	60	$387,000	34,009	$750,039	0.18	0.56	44,912	3,819
1	10	20	40	100	$357,000	36,918	$751,093	0.18	0.57	38,480	6,001
1	10	20	40	80	$357,000	36,918	$751,093	0.18	0.57	38,480	6,001
1	10	40	60	100	$402,000	34,156	$766,603	0.184	0.56	44,902	3,816
1	10	40	60	80	$402,000	34,156	$766,603	0.184	0.56	44,902	3,816
1	10	40	60	60	$402,000	34,157	$766,615	0.184	0.56	44,912	3,819
1	10	20	60	100	$372,000	37,066	$767,668	0.184	0.57	38,480	6,001
1	10	20	60	80	$372,000	37,066	$767,668	0.184	0.57	38,480	6,001

Fig 3 gives the variation of fuel cell power in KW versus the AC primary load in KW. Fig 4 shows the impact of Photo Voltaic power in KW

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versus the AC primary load in KW. Fig 5 shows the boiler output (KW) versus the AC primary load in KW.

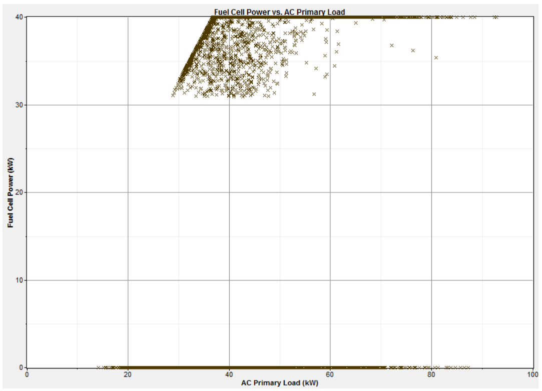

Fig 3 gives the variation of fuel cell power in KW versus the AC primary load in KWFig 4.

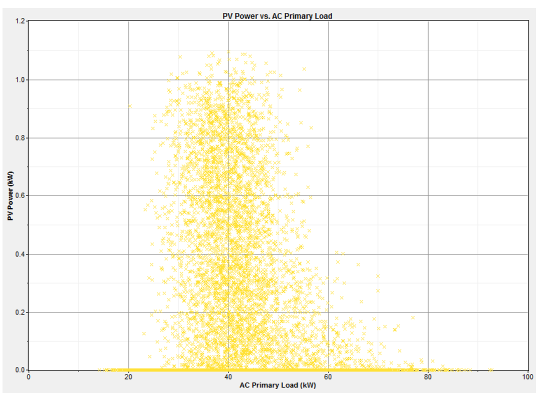

Fig 4. Photo Voltaic power in KW versus the AC primary load in KW

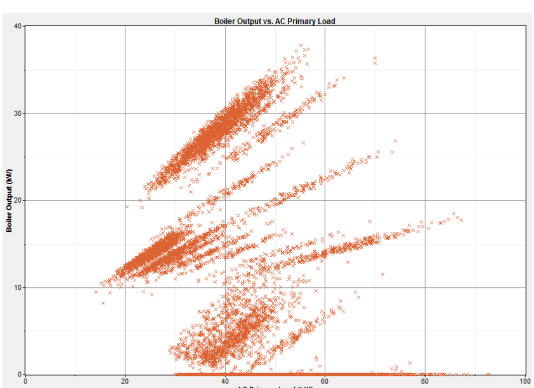

Fig 5. Boiler output (KW) versus the AC primary load in KW

3. SYSTEM CONFIGURATION WITHOUT FEUL CELL

Figure 6 shows the system configuration for the proposed hybrid DG system without fuel cell connected with AC Grid.

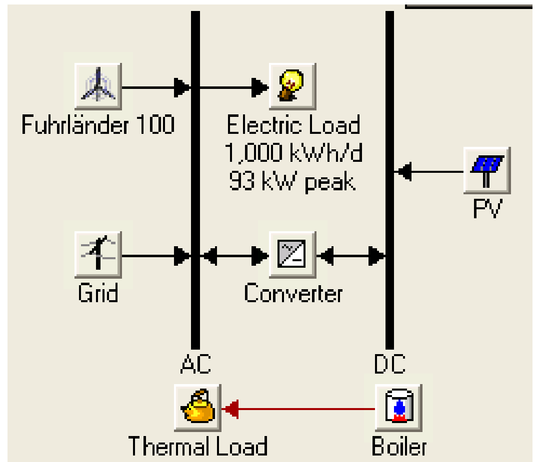

Fig.6.Block diagram of the hybrid (Wind-PV) with AC Grid (without fuel cell)

The same configuration without fuel cell has been simulated and optimized for the values for power rate price ($/KWH) 0.1and demand price rate as ($/KW) 10.

Table3: Categorized results of proposed hybrid DG system with fuel cell

PV (kW)	FL100	Converter (kW)	Grid (kW)	Initial	Operating cost ($/yr)	Total NPC	COE ($/kWh)	Renewable fraction	Natural gas (m3)
1	10	20	80	$312,000	41,480	$754,791	0.181	0.58	23,101
1	10	20	100	$312,000	41,828	$758,502	0.182	0.58	23,101
1	10	40	80	$327,000	41,628	$771,366	0.185	0.58	23,101
1	10	40	100	$327,000	41,975	$775,077	0.186	0.58	23,101
1	10	60	80	$342,000	41,775	$787,942	0.19	0.58	23,101
1	10	60	100	$342,000	42,123	$791,653	0.191	0.58	23,101
1	10	80	80	$357,000	41,923	$804,517	0.194	0.58	23,101
1	10	80	100	$357,000	42,271	$808,228	0.195	0.58	23,101
1	10	100	80	$372,000	42,070	$821,093	0.198	0.58	23,101
1	10	100	100	$372,000	42,418	$824,804	0.199	0.58	23,101

From the table3 the least operating cost of the hybrid DG (wind-PV) without fuel cell is $41480per year.

4. SIMULATION&OPTIMISATION RESULTS

The DG (Wind-PV) with AC Grid system configuration has been modeled and simulated for each hour of the year to determine its technical feasibility and life-cycle cost. From the Table2 and the Table3 when comparing the initial cost, the hybrid DG(Wind-PV)with AC Grid system with fuel cell is marginally high ($387000/year)

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with$312000/year for hybrid DG without fuel cell. but the operating cost of the system is considerably less .The table 2 clearly indicates that under certain combinations with cost effective constraints fuel cell is economical, that is the operating cost of the proposed hybrid DG (Wind-PV) with fuel cell is $34008/year compared with hybrid DG (Wind-PV) without fuel cell connected with AC Grid ($41480/year).The optimal system type graph shows the conditions under which it makes economic sense to invest in the fuel cell. If we set the 'FC Capital Multiplier' to 1 and set the other two variables to the x and y axis, we can see that the fuel cell makes economic sense only if both the power price and demand rate are very high. However, if we set the 'FC Capital Multiplier' to 0.5 (which cuts the cost of the fuel cell by 50%) the fuel cell makes sense at considerably lower power prices and demand rates.

The aim of this paper is that fuel cells may not competitive at today's prices based on capital cost, but their operating cost would be less under certain circumstances and combinations of the proposed hybrid DG connected to distribution grid.

5. CONCLUSIONS AND RECOMMENDATIONS

The results presented in this paper based on simulation and optimization suggest that the hybrid DG generation system with fuel cell is a reliable power source and the suitable for energy management studies with electrical distribution systems. In particular the ability of the fuel cell in picking up the load whenever wind is not available, and the ability of the PV in meeting the load demand whenever there is not sufficient wind, is demonstrated. Also, simulations results shows that the economic advantages of the studied combination of hybrid power systems gives less operating cost of $34008 per year with 56% of utilization of renewable sources. For economical reasons the technical challenges of interconnecting the distributed generation units with the distribution lines are ignored and the results are analysed based on cost factors.

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APPENDIX

The machine and controller parameters that have been used and obtained in this paper during the simulations are given below.

1. FUEL CELL

Quantity	Value	Units
Operation hours	3,816	hr/yr
Number of starts	730	starts/yr
electrical efficiency	48.2	%
Capacity factor	42.1	%
Fixed generation cost	2.05	$/hr
Marginal generation cost	0.0420	$/kWhyr
Electrical production	147,470	kWh/yr
Thermal production	95,010	kWh/yr
Mean thermal output	24.9	kW
Fuel consumption	30,969	m3/yr
total efficiency	79.3	%

2. PV

QUANTITY	VALUE	UNITS
Rated capacity	1.00	kW
Mean output	0.205	kW
Mean output	4.93	kWh/d
Capacity factor	20.5	%
Total Production	1,798	kWh/yr
Minimum output	0.00	kW
Maximum output	1.09	kW
PV penetration	0.493	%
Operation hours	4,375	hr/yr
Levelized cost	0.403	$/kWh

3. Wind Data

Description; Fuhrlander 100 (FL)

Rated Power: 100kW AC

S. No.	Wind Speed (m/s)	Power Output (kW)
1	0.00	0.000
2	1.00	0.000
3	2.00	0.000
4	3.00	1.000
5	4.00	2.000
6	5.00	8.000
7	6.00	17.000
8	7.00	30.000
9	8.00	45.000
10	9.00	63.000
11	10.00	79.000
12	11.00	94.000
13	12.00	108.000
14	13.00	119.000
15	14.00	125.000
16	15.00	122.000
17	16.00	120.000
18	17.00	112.000
19	18.00	107.000
20	19.00	101.000
21	20.00	97.000
22	21.00	96.000
23	22.00	95.000
24	23.00	94.000
25	24.00	97.000
26	25.00	101.000

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4. AC Primary Load

Hour	Load (kW)
00:00 - 01:00	10.000
01:00 - 02:00	6.000
02:00 - 03:00	6.000
03:00 - 04:00	6.000
04:00 - 05:00	6.000
05:00 - 06:00	12.500
06:00 - 07:00	20.000
07:00 - 08:00	22.500
08:00 - 09:00	18.750
09:00 - 10:00	12.000
10:00 - 11:00	12.000
11:00 - 12:00	17.500
12:00 - 13:00	17.500
13:00 - 14:00	11.000
14:00 - 15:00	11.000
15:00 - 16:00	11.000
16:00 - 17:00	11.000
17:00 - 18:00	17.500
18:00 - 19:00	27.000
19:00 - 20:00	29.000
20:00 - 21:00	40.000
21:00 - 22:00	29.750
22:00 - 23:00	22.750
23:00 - 00:00	12.750