Interconnected AC/DC grid systems and connecting renewable sources to form a utility grid.

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Abstract : In this paper, Ac/DC hybrid microgrid is connected with renewable sources like(Solar, Wind , Tidal) energy storages and loads. This hybrid system consists of both AC and DC microgrid system. A bidirectional system is used to link both the microgrid by regulating the power between them. The dc side of the PV array and fuel cell through the DC/DC converter connected to the dc bus. A battery act as energy storage device is connected to the dc bus through the bi-directional DC/DC converter. The PV array of ac side is connected to the ac bus through the DC/DC/AC converter. This system operates in grid-connected mode by the AC microgrid. The model and control strategy of each module Each control is analysed and simulation is simulated using MATLAB/Simulink. The influence of the system .This is simulated from steady state of the system and the transient process of switching of renewable sources the change of irradiance in both AC/DC side and their loads. The results of simulation analysis of operation characteristics and transient process underwent under different condition.

IndexTerms - **Solar, Tidal, Hybrid, AC/DC System, Grid Connection, Transient process.**

I. INTRODUCTION

In recent years due to increase in energy crisis and increase in environment pollution and the renewable energy has been widely accessed using microgrid. This can be widely divided into AC microgrid , DC microgrid and AC/DC microgrid from the structure and power suplly mode. With the development of society more DC devices such Phones, Television, Computer, LED, Audio System and so on consume DC looking into the trend of consumption of DC would be as much as that of AC. There would be trend of both AC equipment and DC equipment in order to reduce the losses , harmonic current and control difficult caused by AC/DC or DC/AC conversion, to increase reliability of the system widely across the world economy of the arrangement. Thus the hybrid AC/Dc microgrid has paid attention and studied.

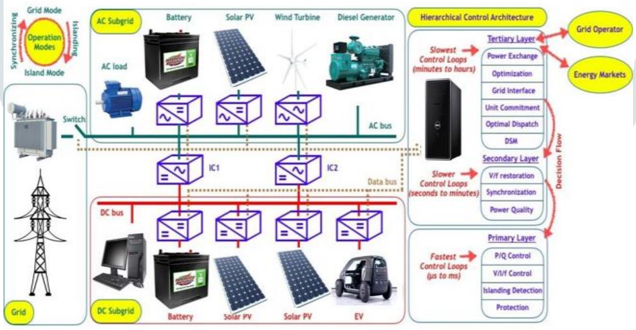

Figure 1 Block Diagram

Hybrid grids typically consist of AC sub-grids DC sub-grids and bi-directional DC/AC converters that build a bridge between AC sub-grids and DC sub-grids .The power can transfer smoothly between AC and DC grids in either direction. In comparison to individual AC grid or DC microgrid the hybrid microgrid can directly supply AC Loads an DC loads respectively and felicitate the connection between various renewable AC and DC sources using fewer converters to reduce the loss during power converstion from AC to DC or vice versa. Yes it is true this type of grid system are comparatively complex when compared to traditional grid.

This paper proposes a AC/DC hybrid microgrid system which includes Solar, wind and diesel generator and also AC and DC load. The presented microgrid connects to the utility grid via switch operating in grid connected mode and transient impact behaviour and operating characteristics and transient process of grid-connnected operation uder different condition.

II. System Configuration And Modelling

A. Hybrid AC/DC Microgrid System Strructure.

Figure 1 discribes the arrangement of both the AC and DC. AC microgrid system on left side , a dc microgrid on the right side and the power exchange system on the middle side. To achieve maximum power tracking (MPT) the SOLAR TIDAL and Wind are connected to AC bus through the DC/DC/AC converter also the unit power factor but in the case of AC loads it is directly connected to AC bus. In the DC side to achieve MPPT a battery as the storage through the bidirectional buck boost the fuel cell through DC/DC converter to achieve constaqtnt power output and to achieve variable DC load directly is connected to DC bus. The power exchenge system consist of a bi-directional AC/DC converter which can operate in inverter or rectification mode the rated voltages of AC and DC microgrid is 400V and 750V respectively.

B. Model of Photovoltaic Cell

Generally, PV system is an interconnection of modules which in turn made up of many PV cells in series or parallel. Fig 2 shows the equivalent circuit of photovoltaic cells, and the formulas relating current and voltage in the circuit as

$$J = J_0\left(\exp\left(\frac{qV}{nkT}\right) - 1\right) - J_{SC},\ J_{SC} \approx J_L$$

$$V_{OC} = \frac{nkT}{q}\ln\left(\frac{I_{SC}}{I_0} + 1\right) \qquad \eta = \frac{V_{OC}I_{SC}FF}{P_{in}} = \frac{V_{mpp}I_{mpp}}{P_{in}}$$

$$J_L = qG(L_n + L_p + W)$$ for constant G, wide base

$$J_L = q\int_0^W G(x)CP(x)dx = q\int_0^W [\alpha(\lambda)H_0\exp(-\alpha(\lambda)x)d\lambda]\,CP(x)dx$$

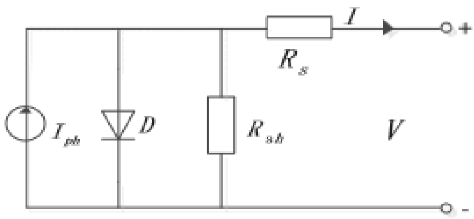

Fig2. Single-diode equivalent circuit for PV cell

C. Modelling Battery

The battery is modelled as a Non linear voltage source who's output depends upon the battery state of charge which is non linear function. The two important parameter to represent terminal voltage and SOC of battery are defined as

$$V_b = V_0 + R_b.i_b - K\frac{Q}{Q + \int i_b dt} + A.\exp(B\int i_b dt)$$

$$SOC = 100(1 + \frac{\int i_b dt}{Q})$$

Where R_b internl resistance of the battery i_b is battery charging current K is polarisation.They show to be great potential to be green power sources of the future because it continuously convert chemical energy into electrical energy.

$$Anode : H_2 \rightarrow 2H^+ + 2e^-$$

$$Cathode : \frac{1}{2}O_2 + 2H^+ + 2e^- \rightarrow H_2O$$

$$Battery\ Reaction : H_2 + \frac{1}{2}O_2 \rightarrow H_2O$$

D. Wind

Variable-speed wind turbines are designed to operate at a wide range of rotor speeds. Their rotor speed varies with the wind speed or other system variables, based on the design employed. Additional speed and power controls allow variable-speed turbines to extract more energy from a wind regime than would be possible with fixed-speed turbines. For Type-3 and Type-4 turbines, power converters are needed to interface the wind turbine and the grid. The advantage of converter-based systems is that they allow independent real and reactive power control.

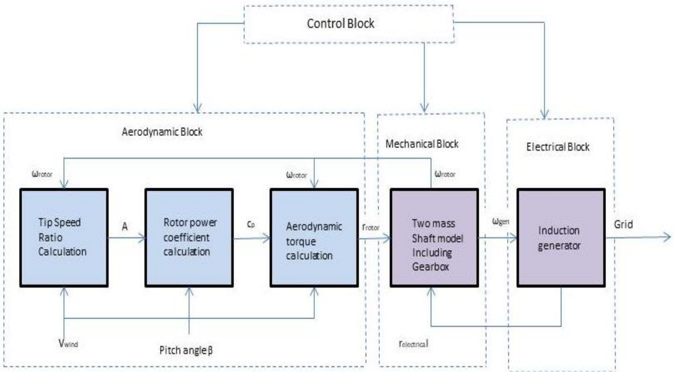

Figure 3. Control Block

E. Tidal

Tidal energy converters can have varying modes of operating and therefore varying power output. If the power coefficient of the device is known, the equation below can be used to determine the power output of the hydrodynamic subsystem of the machine. This available power cannot exceed that imposed by the Betz limit on the power coefficient, although this can be circumvented to some degree by placing a turbine in a shroud or duct. This works, in essence, by forcing water which would not have flowed through the turbine through the rotor disk. In these situations it is the frontal area of the duct, rather than the turbine, which is used in calculating the power coefficient and therefore the Betz limit still applies to the device as a whole.
The energy available from these kinetic systems can be expressed as:

$$P = \frac{\rho A V^3}{2} C_P$$

Where,

C_p= the turbine power coefficient
P = the power generated (in watts)
p= the density of the water (seawater is 1027 kg/m³)
A = the sweep area of the turbine (in m²)
V = the velocity of the flow

Relative to an open turbine in free stream, ducted turbines are capable of as much as 3 to 4 times the power of the same turbine rotor in open flow.

III. Control Strategy

A. Control Strategy of DC side PV array

To maximize the utilization of renewable energy from the PV array, and the boost converter should be operated in MPPT. As shown in Fig 3, the dc side PV array is connected to the dc bus through the boost converter, and the control strategy of boost converter is the voltage loop control method. First, the output voltage of PV array SY9 , is calculated by Incremental Conductance (IC) method to get the maximum power point voltage P9 , and then, the difference between SY9 and its reference P9 is sent to a PI controller to obtain the appropriate duty ratio for PWM signal, final, the output signal to drive the switch to achieve maximum power tracking.

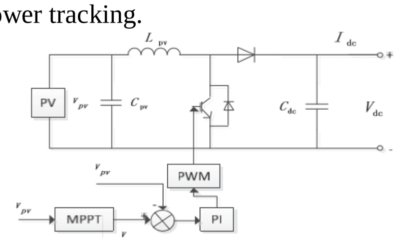

Figure 3 Control Stratergy

B. Control side of AC Strategy Array

The objective of control the ac side PV array is to achieve MPPT and unity power factor to the utility grid. The converter of ac side includes pre-stage DC/DC converter and the poststage DC/DC converter. In order to achieve MPPT, the prestage DC/DC converter adopts control strategy such as the previous section control strategy of dc side PV array. The poststage DC/AC converter connected to the ac bus and to achieve the maximum power factor to utility grid. The control strategy of post-stage DC/AC converter as the Fig 4 show, the outer loop is dc bus voltage and reactive power, and in order to operate in unit power factor, reference reactive TUHI L can be set as 0 in the inner current loop

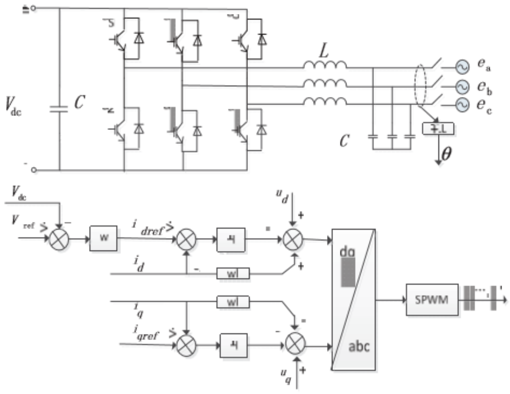

Figure 4. Converter Block

C. Control strategy of battery

The energy storage system is composed of the battery, a bidirection DC/DC converter and control system. Fig.5 represents the control system for the bi-directional converter, which can regulate the power flow in both directions. When IGBT S1 turn open and IGBT S2 turn off, the converter works as a boost circuit and the battery is discharging; When IGBT S2 turn open and IGBT S1 turn off, the converter works as a buck circuit and the battery is charging. The dual-loop control for the bi-directional DC/DC converter is used in this hybrid microgrid, the control objective is to provide a high quality dc bus voltage with good dynamic. In this scheme, the dc bus voltage GF 9 is compared with its reference voltage, UHI 9 and the difference is sent to a PI controller to get the battery current reference UHI , , which acts as the input signal of the inner loop, then the difference between UHI , and battery current EDW ,
is injected into another PI controller to obtain the signal for PWM generator to drive S1 and S2 turn open or turn off.

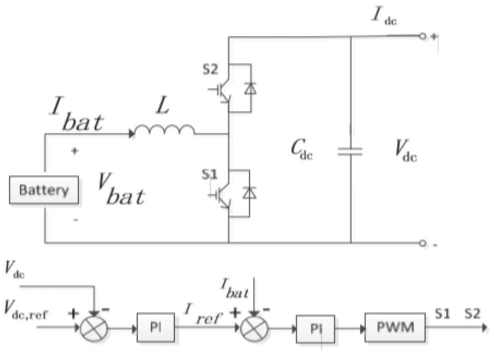

Figure 5 Bi Directional Converter

D. Control Strategy of fuel cell

Fuel cell is connected to the dc bus via a DC /DC converter, which works as a boost circuit. The control objective is to provide constant power to the dc microgrid. As shown in Fig 6, constant duty cycle is used to achieve constant power output of the fuel cell.

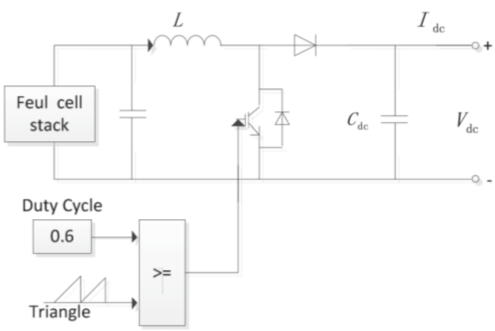

Figure 5. Fuel Cell

IV. Conclusion

Rapid increase in usage of DC devices such as mobiles, PC's, TV's and so on in the our daily life conversion of AC current to DC current does cause allot of wastage of current there's a huge loss of power in conversion instead it is better to ue a parallel system or Hybrid AC/DC microgrid. Which would decrease the wastage of power what we observe during conversion of AC to DC for each device.

Instead both the current should be supplied as proposed by the system. By which there would be minimal loss of the current and a lot of the energy would be saved and channelized for better usage. This will increase the efficiency of the system. Yes there's a huge initial costing of the setup and installation of the system with a lot of complexities.But once the system is once the system is installed successfully this setup will turn more efficient and profitable in long run. This would be the future of the current transmission

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