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Integrated Hybrid Standalone System With Bess And Power Converters For Renewable Energy Application

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Abstract: The Advancement in Industries and Requirement of Power has increased the Power Demand to a Large Extent. Depending only on Non Renewable Energy is not a Solution for Future Trends of Power Generation. Much the use of Renewable Energy is required to compensate the Demands. Powers Sources, such as photovoltaic and wind power generation, are playing a more and more important role in energy production. However, the output power of PV are usually strongly fluctuant due to the randomness and intermittence of solar and wind energy, which requires addition compensation tools to enhance the power transfer capacity and load factor. The key advantage of the proposed technique is to optimize the Hybrid Power system to supply using single transmission line so as to reduce the losses and cost. Boost Converter control System which has a PI controller that adjusts the Gain value such that the optimal power delivery from Boost Converter is matched with the AC Converter Output using direct duty cycle control method. The System is employed on a boost converter, Three Phase Rectifier with Single Arm Conversion and Battery supply tested experimentally for obtaining optimum results. This paper presents Improvement of Power Stability using Converters Reliability in Solar Wind hybrid Power systems.

Keywords: Buck- Boost Regulators, Control Switch Reduction, Multi Level inverters, Battery Storage, PI Controller.

I. INTRODUCTION

The developments in power electronics and semiconductor technology have triggered the improvements in power electronic systems. So, different circuit configurations, namely multilevel inverters have become popular and considerable interested by researcher are given to them. The output voltage the increasing interest in research to improve the performance of Photovoltaic (PV) systems, there is a little work done so far on fault diagnosis of PV arrays. Mismatch, shading and soiling are some of the disturbances that affect the normal operation of the PV panel and reduce its life. Many Maximum Power Point Tracking (MPPT) methods were developed to achieve a maximum power output in real-time. The “Perturb and Observe” (P&O) is a well-known method that is widely used in commercial controllers due to its good performance and simple implementation. The principal drawback of this method is the loss of power caused by the oscillations around the maximum power point (MPP) and its limitations at low irradiation. The presence of shading or soiling is another problem that faces the control strategy and can’t be solved by the classical MPPT algorithms. Hence to control the solar efficiency we are here applying the boost methodology to obtain a sustainable reliability.

The Optimal Sizing is used to deal with the different disturbances that can affect the normal operation of the PV panel. The performance of this optimization algorithm is further improved by the introduction of a Proportional Integrator (PI) regulator that accelerates the rising time and eliminates the steady state error. The Closed loop system is integrated with the hybrid power system so as to enhance the voltage of the system by conversion and stability systems. In the following Section we present the equivalent model of a PV panel and DFIG based Wind energy system united to supply the power to grid. The Power conversion and boost is done to match the stability current value. The Stabilized DC is now Stored in BESS and Inverted from Storage station to supply the Grid. The Total system is simulated and results are found using MATLAB Simulink.

II. PREVIOUS RESEARCH

Numerous related research works are already existed in literature which based on multilevel inverter circuit of the system. Some of them are reviewed here.

Vincent Roberge et al. [9] implemented Genetic algorithm based multilevel inverters to improve the high power inverters due to their high-voltage operation, high efficiency, low switching losses, and low electromagnetic interference. A parallel implementation of the GA on graphical processing units is proposed in order to accelerate the computation of the optimal switching angles for multilevel inverters with varying DC sources. GA is used to ignore solving the equation associated with higher

order harmonics. A reduction in the eliminated harmonics results in an increase in the degrees of freedom. As a result, the lower order harmonics are eliminated in more operating points. A 9-level inverter is chosen as a case study. The genetic algorithm (GA) for optimization purposes is used.
Pedram Sotoodeh et al. [10] presented the capability of a new single-phase wind energy inverter with the flexible AC transmission system. The proposed inverter is able to regulate active and reactive power transferred to the grid and which is placed between the wind turbine and the grid. The power factor can be controlled by using this inverter because of this inverter is equipped with distribution static synchronous compensator. The main objective of this his paper is to introduce new ways to increase the growth of renewable energy systems into the distribution systems. This will encourage the utilities and customers to use interactive supply of energy. Moreover, by using these types of converters will significantly reduce the total cost of the renewable energy application. In this paper, the modular multilevel converter is used as the desired topology to meet all the requirements of a single-phase system such as compatibility with IEEE standards, total harmonic distortion (THD), efficiency, and total cost of the system. This paper was implemented using 11- level inverter then the simulations have been done in MATLAB/Simulink.

Neelesh Kumar et al. [11] proposed three phase hybrid power control with a small number of switching devices. Large electrical drives and utility application require advanced power electronics converter to meet the high power demands. As a result, multilevel power converter structure has been introduced as an alternative in high power and medium voltage situations. A multilevel converter not only achieves high power rating but also improves the performance of the whole system in terms of harmonics. In this paper the proposed inverter can output more numbers of voltage levels with reduced number of switches as compared to cascade H-bridge inverter, which results in reduction of installation cost and have simplicity of control system. Finally, the simulation and experimental results validate the concept of this new topology.

Zhong Du et al. [13] implemented cascaded H-bridge multilevel inverter using only a single DC power source and capacitors. Generally, the Standard cascaded multilevel inverters require n DC sources for 2n + 1 level. Without requiring transformers, the scheme proposed here allows the use of a single DC power source with the remaining n-1 DC sources being capacitors, which is referred to as hybrid cascaded H-bridge multilevel inverter (HCMLI) in this paper. The proposed inverter can simultaneously maintain the DC voltage level of the capacitors and choose a fundamental frequency switching pattern to produce a nearly sinusoidal output. HCMLI using only a single DC source for each phase is promising for high-power motor drive applications as it significantly decreases the number of required DC power supplies, provides high-quality output power due to its high number of output levels, and results in high conversion efficiency and low thermal stress as it uses a fundamental frequency switching scheme. This paper was implemented for 7-level HCMLI with fundamental frequency switching control and how its modulation index range can be extended using triple harmonic compensation.

D. Kalyanakumar et al. [14] investigated Hybrid 7-Level H–bridge Inverter was used in a Distribution Static Compensator (DSTATCOM) in the Power System industry, so that the proposed system benefits of low harmonic distortion with reduced number of switches to achieve the output over the conventional cascaded 7-level inverter and reduced switching losses. The proposed system is used to obtain the improved power factor, compensate the reactive power and suppress the total harmonic distortion (THD) drawn from a Non-Liner Diode Rectifier Load (NLDRL) of DSTATCOM, by using Sub-Harmonics Pulse Width Modulation (SHPWM) technique is used as a control for the switches of HSL H – bridge Inverter. The proposed hybrid seven levels H – bridge implemented using MatLab/Simulink simulation software for shunt compensation of a 4.5 KV distribution system.

III. PROPOSED APPROACH

This Project has Wind and Solar Energy Systems. These two Energy stations are interlinked to Supply power to the load. The process is executed by storing the Energy in a battery Station and converting the DC to AC and transmitting to the Load. Solar power is drawn and Converted from DC to DC by adding Single Switch IGBT based closed loop DC to DC boost convertor and the Voltage is monitored such that a closed loop system follows the output voltage variation of solar power.

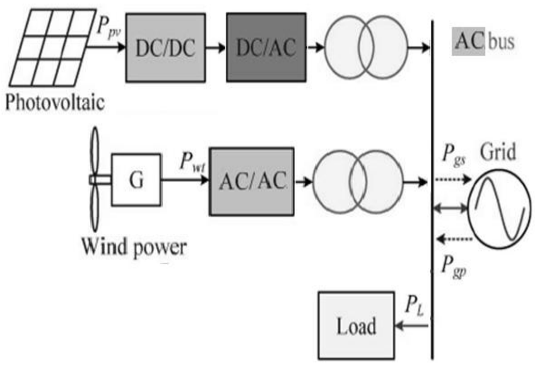

Figure 1: Single Line diagram of conventional system.

Grid would be realized with some minor errors expected. This slight sharing inaccuracy is no different from that experienced by reactive power sharing in the ac micro grid. The next concern is to introduce power sharing between the ac and dc micro grids, treated as two separate entities. The droop representation of each entity can be

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rightfully determined by summing the individual source characteristics in each micro grid, leading to an overall P − f droop for the ac Micro grid and an overall P − Vdc droop for the dc micro grid.

Information from these two droop characteristics should be properly merged, before using it to decide on the amount of power to transfer across the interfacing converter. For that, the recommendation written in the following equation is to normalize the frequency in the ac micro grid and the voltage in the dc micro grid, so that their respective ranges of variation commonly span from −1 to 1 [48], i.e.,

$$f_{pu} = \frac{f - 0.5(f_{max} + f_{min})}{0.5(f_{max} - f_{min})}$$

$$V_{dc,pu} = \frac{V_{dc} - 0.5(V_{dc,max} + V_{dc,min})}{0.5(V_{dc,max} - V_{dc,min})}$$

Where subscripts max and min represent the respective maximum and minimum limits of f and Vdc, and subscript pu represents their normalized per-unit values. These normalized variables should be next forced equal by feeding their error to a proportional-integral (PI) controller, followed by an inner current controller. Upon being equalized, the two micro grids would share active power based on their respective overall ratings. This thought is no different from enforcing a common frequency in the popularly discussed ac micro grid, upon which the ac sources would share power proportionally based on their respective ratings.

One simple method to keep fpu and Vdc,pu equal is to feed their error (fpu − Vdc,pu) to a PI controller, whose output is the active power reference PIk that must be transferred from the dc to ac micro grids through the interfacing converter when positive and vice versa.

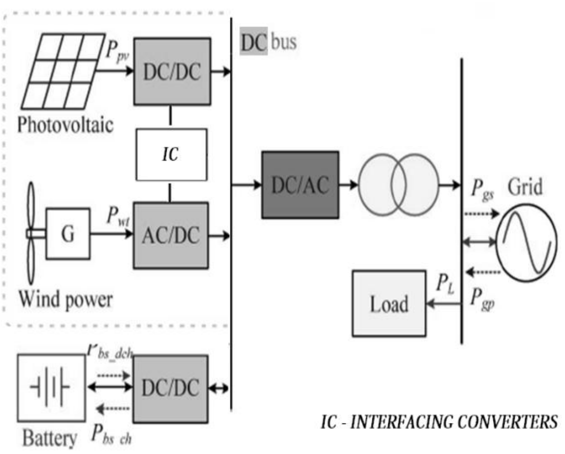

Figure 2: Single Line diagram of conventional system.

Renewable energy from Wind Energy station is obtained as an Alternating source. The Source voltage is converted to DC by rectification process and fed to Battery Station for Power Storage. This is done by a three phase full wave rectifier bridge. The storage energy is again converted to sinusoidal form and distributed top Load sides. The above Topology is studied and simulated and output results are obtained using MATLAB.

IV. MATHEMATICAL MODEL

By turning on controlled switches, T1, T5, T9 (remaining turn off) the output voltage +1Vdc (first level) is produced across the load. Similarly, turning on switches, T1, T2, T5, T6, T9, T10 (remaining turn off) +2Vdc (second level) output is produced across the load. Similarly, further levels can be achieved by further operation.

The S number of DC sources or stages and the associated number output level can be calculated by using the equation as follows,

$$N_{level} = 2S+1 \qquad (1)$$

For an example, if S=3, the output waveform will have seven levels (±3Vdc, ±2Vdc, ±1Vdc and 0). Similarly, voltage on each stage can be calculated by using the equation as given, simulation: DC inputs of dc3=25, dc2=75, and dc1=225 (for each H bridge with separate sources) at f=50Hz.

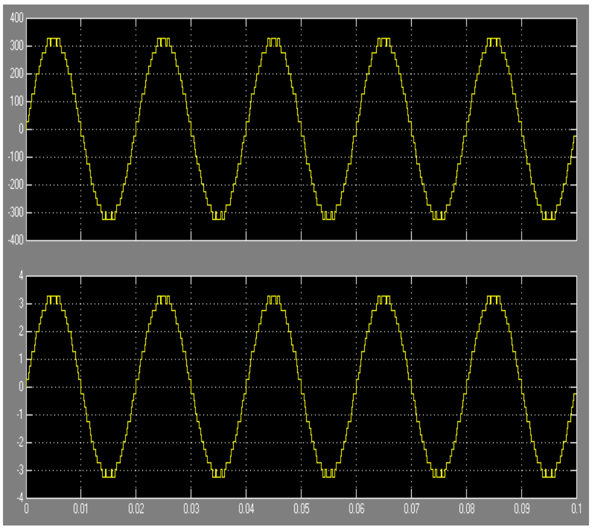

Figure 3: Simulation Wave form of Wind Energy

In this proposed system of a simulation result is the output voltage, output current and step level will be displayed with respect to time. The maximum step level steps with the time will be displayed. The range of voltage is up to ±300V and current value is option ±3A can be delivered.

The PWM generation output voltage of the proposed system is followed by, of 13-Level displayed. And the voltage level and current level for various steps displayed.

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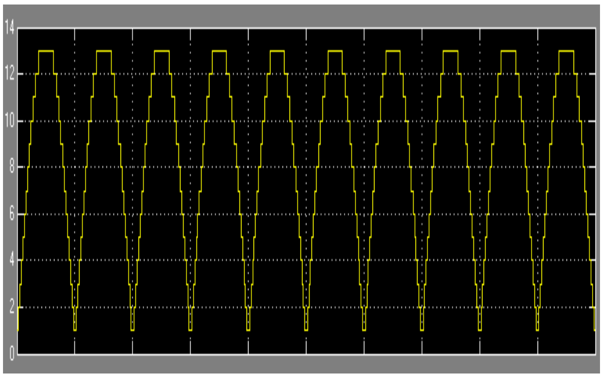

Figure 4: Simulation results for PWM of proposed system

The output voltage per the harmonic spectrum of output voltage and current is shown below. The reduction of THD is used to evaluate the performance of the multilevel inverter.

$$A_i = 1\, V_{dc}\ (1, 2, 3) \qquad (2)$$

The determined P Ik, upon being converted to a current command, can be tracked by any forms of closed loop current control ranging from classical PI control in the synchronous frame, state feedback control, to repetitive control, to name only a few. The commanded current can also include a reactive component for the ac micro grid, whose value is determined by first measuring the ac terminal voltage of the interfacing converter. The sensed voltage value, upon being passed through the same reactive droop characteristic discussed, would give the reactive power and hence reactive current references that the interfacing converter should inject.

V. SIMULATION RESULTS AND DISCUSSIONS

In this thesis, new single phase 13 levels H-Bridge inverter will be focused. Multilevel, i.e., positive, negative, and zero level waveform are synthesized using such an inverter. In the thesis, the total harmonic distortion (THD) methods are used to indicate the quantity of harmonic contents in the output waveforms.

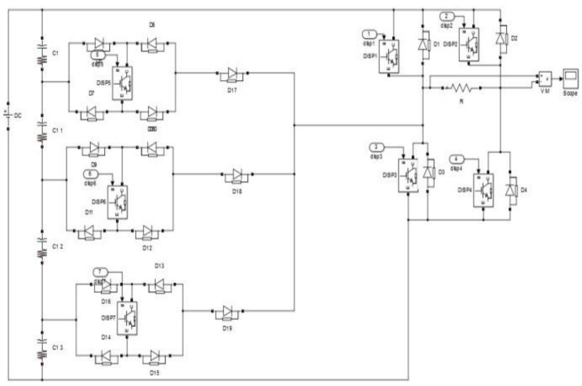

Figure 5: Simulation Circuit Diagram of Existing system

To reduce the THD in the output voltage, the lowest s-1 harmonics in each phase voltage need to be eliminated, where s is the number of the full-bridge inverter per phase.

Simulink model - of the PI-algorithm:

The content in the controller block is now - according to (5) - which we will use in this course If the error is negative ($t > t_{set}$) then u would be negative and the radiator heat negative! Which is not possible, therefore we have included a "Saturation" block in the actuator block, see figure 3. The settings of this block is Max = Q_R and Min = 0.

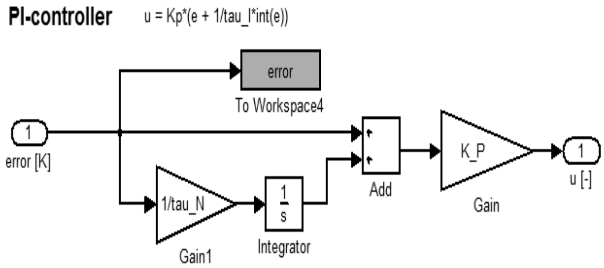

Fig 6: PI Controller System

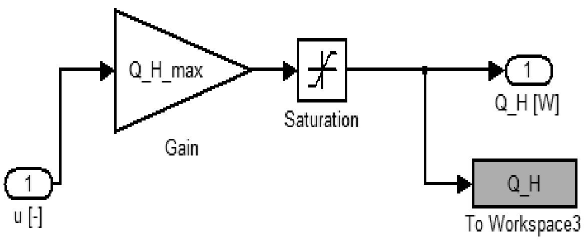

Figure 7: Saturation block to constrain the heat output

VI. PROPOSED SYSTEM IMPLEMENTATION

These two Energy stations are interlinked to Supply power to the load. The process is executed by storing the Energy in a battery Station and converting the DC to AC and transmitting to the Load. Solar power is drawn and converted from DC to DC by adding Single Switch IGBT based closed loop DC to DC boost convertor and the Voltage is monitored such that a closed loop system follows the output voltage variation of solar power because of variation in sun light intensity will cause power fluctuations from solar. This variation is controlled by boosting the output accordingly by monitoring with closed loop control system.

The renewable energy from Wind Energy station is obtained as an Alternating source. The Source voltage is converted to DC by rectification process and fed to Battery Station for Power Storage. This is done by a three phase full wave rectifier bridge. The storage energy is again converted to sinusoidal form and distributed top Load sides. The above Topology is studied and simulated and output results are obtained using MATLAB.

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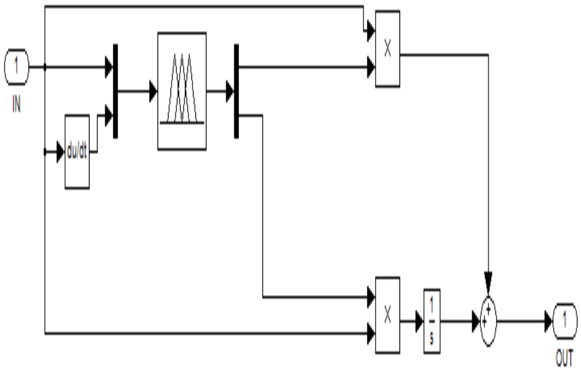

Fig 8: Block Diagram of Simulink System

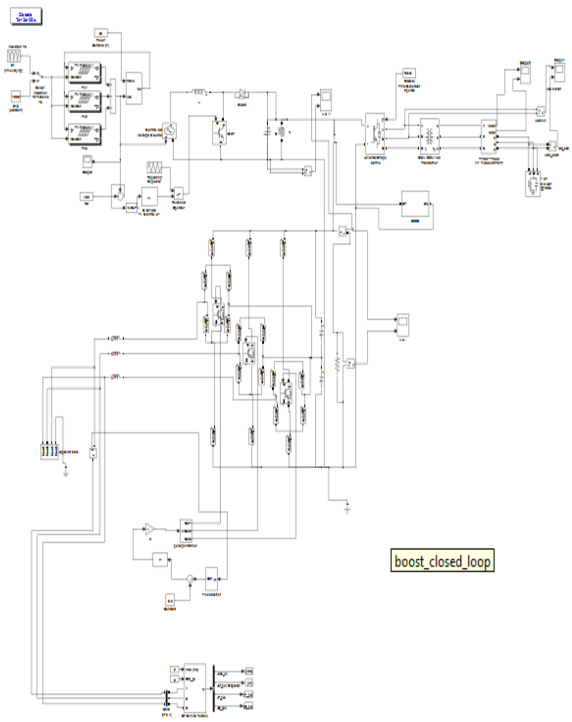

Fig 9: PI for Solar Power Boost Converter

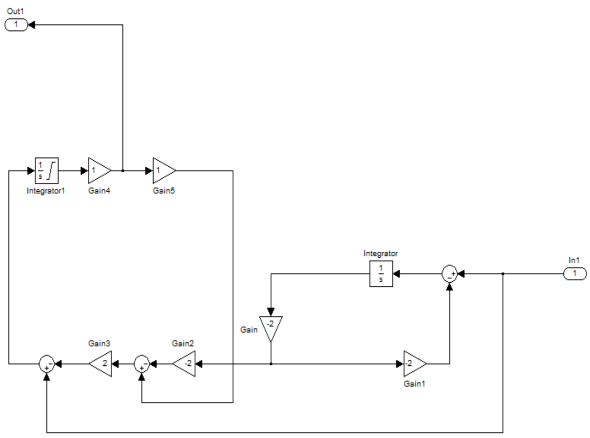

Fig 10: Flux Observe for Three Phase Converter

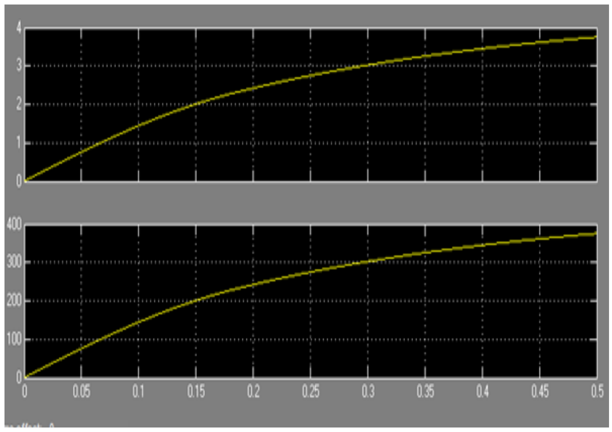

Fig 11: Output Voltage of Inverter and Load

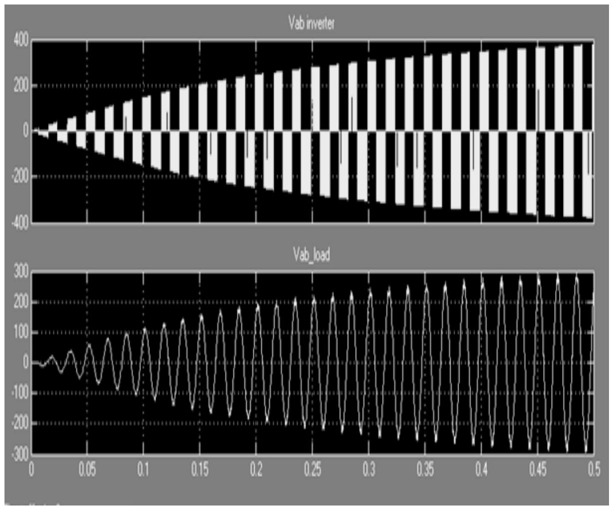

Fig 12: Voltage Optimizing of Solar and Wind Systems

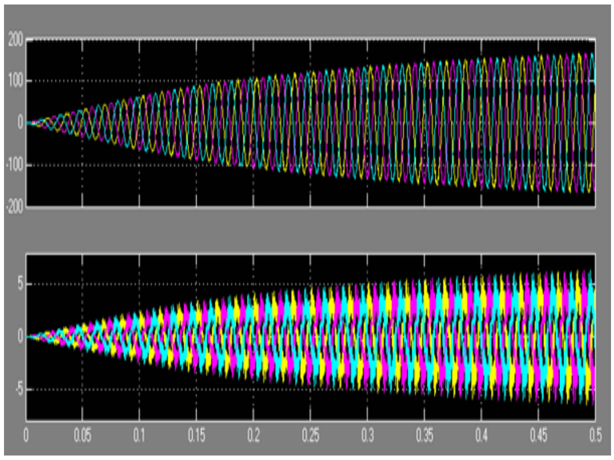

Fig 13. Inverter Output Voltage to Grid Connection

VII. CONCLUSION

The Solar and Wind is important tool for the study of the Hybrid power system and their efficient purpose during peak loads. In this study we proposed a method based Closed Loop PI controller method to sustain the voltage of Hybrid Power system with Stability and reliability on loading conditions. The PI controller is tuned to attain a constant phase matching current so as to charge the battery station and economize the power delivery. And eliminate the steady state error. The simulation results show the effectiveness of the closed loop PI boost control strategy in the case of the presence of the partial shading effect. The proposed method is useful in Stability and Reliability of the Power system

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