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Hybridization Of Wind With Solar Using Cuk And Sepic Converters

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Abstract

This project presents a hybrid model of solar and wind energy. This gives the hybridization of wind with solar using the CUK and SEPIC converters. In this model the solar PV panel source is connected to the CUK converter and correspondingly the wind turbine source is given to the SEPIC converter. Solar energy and wind energy are the two renewable energy sources most common in use. Hybridizing solar and wind power sources provide a realistic form of power generation. This Project is used to get maximum efficiency and complete utilization of renewable energy sources. Several hybrid wind/PV power systems with Maximum Power Point Tracking control have been proposed earlier. They used a separate DC/DC buck and buck boost converter connected in fusion in the rectifier stage to perform the MPPT control for each of the renewable energy power sources.However the renewable energy resources are not available continuously or constantly, here, a hybrid wind and solar energy system with a converter topology is proposed which makes use of Cuk and SEPIC converters in the design This system has lower operating cost and finds applications in remote area power generation. This topology allows the two sources to supply the load separately or simultaneously depending on the availability of the energy sources.

Keywords- MPPT (maximum power point tracking), cuk converters , sepic converters.

INTRODUCTION

Renewable energy is energy that comes from resources which are continually replenished such as sunlight, wind, rain, tides, waves and geothermal heat. About 16% of global final energy consumption comes from renewable resources, with 10% of all energy from traditional biomass, mainly used for heating, and 3.4% from hydroelectricity. New renewables (small hydro, modern biomass, wind, solar, geothermal, and biofuels) accounted for another 3% and are growing very rapidly. The share of renewables in electricity generation is around 19%, with 16% of electricity coming from hydroelectricity and 3% from new renewables.The use of wind power is increasing at an annual rate of 20%, with a worldwide installed capacity of 238,000 megawatts (MW) at the end of 2011, and is widely used in Europe, Asia, and the United States Since 2004, Photovoltaic passed wind as the fastest growing energy source, and since 2007 has more than doubled every two years. At the end of 2011 the photovoltaic (PV) capacity worldwide was 67,000 MW, and PV power stations are popular in Germany and Italy.Solar thermal power stations operate in the USA and Spain, and the largest of these is the 354 MW SEGS power plant in the Mojave Desert. The world's largest geothermal power installation is the Geysers in California, with a rated capacity of 750 MW. Brazil has one of the largest renewable energy programs in the world, involving production of ethanol fuel from sugarcane, and ethanol now provides 18% of the country's automotive fuel. Ethanol fuel is also widely available in the USA.

PHOTOVOLATIC CELL

The ability of certain materials to convert sunlight to electricity was first discovered by Becquerel in 1839, when he discovered the photo galvanic effect. This cell had a conversion efficiency of 6%. Within 4 years, solar cells were used on the Vanguard I orbiting satellite. Space applications eventually led to improved production efficiencies, higher conversion efficiencies, higher reliability, and lower cost for photovoltaic (PV) cells. Conversion efficiencies at the turn of the millennium for large-scale PV modules ranged from just under 10% for thin-film modules to over 30% for gallium arsenide (GA As) concentrating cells. Photovoltaic is the direct conversion of light into electricity at the atomic level. Some materials exhibit a property known as the photoelectric effect that causes them to absorb photons of light and release electrons. When these free electrons are captured, an electric current result that can be used as electricity.

WORKING PRINCIPLE

Sunlight is composed of photons, or particles of solar energy. These photons contain various amounts of energy corresponding to the different wavelengths of the solar spectrum. When photons strike a photovoltaic cell, they may be reflected, pass right through, or be absorbed. Only the absorbed photons provide energy to generate electricity. When enough Sunlight (energy) is absorbed by the material (a semiconductor), electrons are dislodged from the material's atoms. Special treatment of the material surface during manufacturing makes the front surface of the cell more receptive to free electrons, so the electrons naturally migrate to the surface. When the electrons leave their position, holes are formed. When many electrons, each carrying a negative charge, travel toward the front surface of the cell, the resulting imbalance of charge between the cell's front and back surfaces creates a voltage potential like the negative and positive terminals of a battery. When the two surfaces are connected through an external load, electricity flows. Most current technology photovoltaic modules are about 10 percent efficient in converting sunlight. Further research is being conducted to raise this efficiency to 20 percent.

BLOCK DIAGRAM

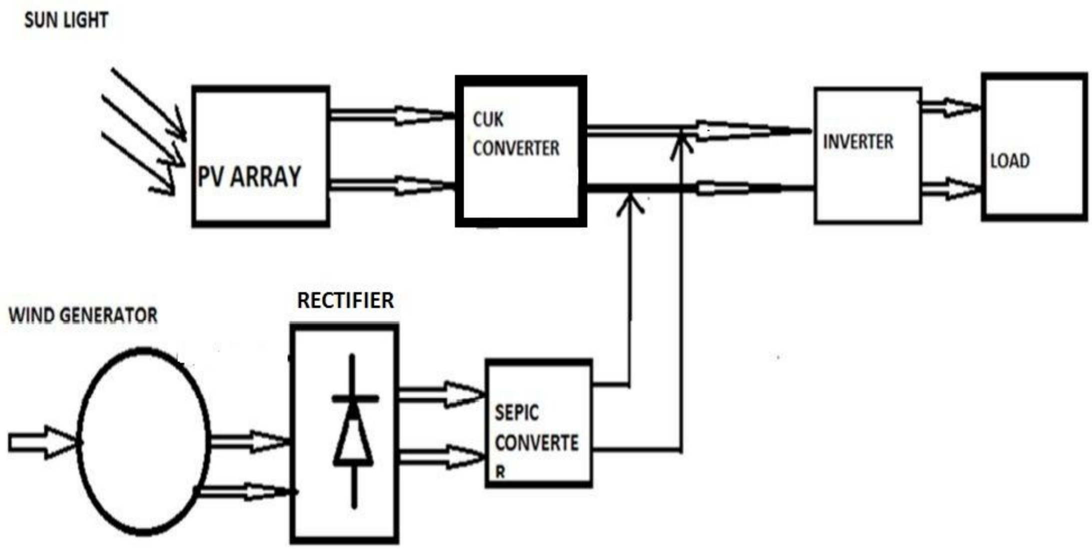

Fig.1 Block Diagram

HIGH EFFICIENCY SOLAR CELLS WITH CONCENTRATORS

Highest efficiency solar cells have been demonstrated using micro morph triple junction Ge/GA As/Ga in as P materials. Technology is quite intricate and cost of triple junction solar is quite high. Hence, these cells are primarily used for satellite applications. For terrestrial applications, these cells are used in high concentration mode to reduce usage of costlier cells. Using optical reflectors, light is concentrated from 200-500 times on 1 cm2 active area. The Sun is tracked daylong in two dimensions to keep the sun-spot on device area. Only few companies have mastered the cell and tracker technologies. There is need to know better and perfect the cell and tracker technologies. A six modules panel of 1.5KWp power with 2D tracker is installed at top of the boys hostel . A photograph 6 panel module is shown in Fig.2

Fig.2 Solar panel

WIND ENERGY

The first use of wind power was to sail ships in the Nile some 5000 years ago. The Europeans used it to grind grains and pump water in the 1700s and 1800s. The first windmill to Generate electricity in the rural U.S.A. was installed in 1890. The average turbine size of the wind installations has been 300 kW until the recent past. The newer machines of 500 to 1,000 kW capacities have been developed and are being installed.Prototypes of a few MW wind turbines are under test operations in several countries, including the U.S.A. A wind turbine is a rotating machine which converts the kinetic energy of wind into mechanical energy. If the mechanical energy is used directly by machinery, such as a pump or grinding stones, the machine is usually called a windmill. If the mechanical energy is instead converted to electricity, the machine is called a wind generator, wind turbine, wind power unit (WPU), wind energy converter (WEC), or aero generator.

HORIZONTAL AXIS WIND TURBINE

Horizontal-axis wind turbines (HAWT) have the main rotor shaft and electrical generator at the top of a tower, and must be pointed into the wind. Small turbines are pointed by a simple wind vane, while large turbines generally use a wind sensor coupled with a servo motor. Most have a gearbox, which turns the slow rotation of the blades into a quicker rotation that is more suitable to drive an electrical generator. Since a tower produces turbulence behind it, the turbine is usually pointed upwind of the tower. Turbine blades are made stiff to prevent the blades from being pushed into the tower by high winds. Additionally, the blades are placed a considerable distance in front of the tower and are sometimes tilted up a small amount. Downwind machines have been built, despite the problem of turbulence (mast wake), because they don't need an additional mechanism for keeping them in line with the wind, and because in high winds the blades can be allowed to bend which reduces their swept area and thus their wind resistance. Since cyclic (that is repetitive) turbulence may lead to fatigue failures most HAWTs are upwind machines.

SPEED AND POWER RELATIONS

The kinetic energy in air of mass "m" moving with speed V is given by the Following in SI units:

$$Kinetic\ energy = \frac{1}{2} m V^2$$

power in moving air is the flow rate of kinetic energy per second.Therefore:

$$Power = \frac{1}{2}(mass\ flow\ rate\ per\ second).V^2$$

If we let
P = mechanical power in the moving air
ρ = air density, kg/m3
A = area swept by the rotor blades, m2
V = velocity of the air, m/s

Then, the volumetric flow rate is A·V, the mass flow rate of the air in kilograms per second is ρ·A·V, and the power is given by the following:

$$P = \frac{1}{2}(\rho A V).V^2 = \frac{1}{2}(\rho A V^3)$$

CUK CONVERTER OPERATION

It has the capability for both steps up and step down operation. The output polarity of the converter is negative with respect to the common terminal. This converter always works in the continuous conduction mode. The Cuk converter operates via capacitive energy transfer. When M1 is turned On, the diode D1 is reverse biased, the current in both L1 and L2 increases, and the power is delivered to the load. When M1 is turned off, D1 becomes forward biased and the capacitor C1 is recharged.

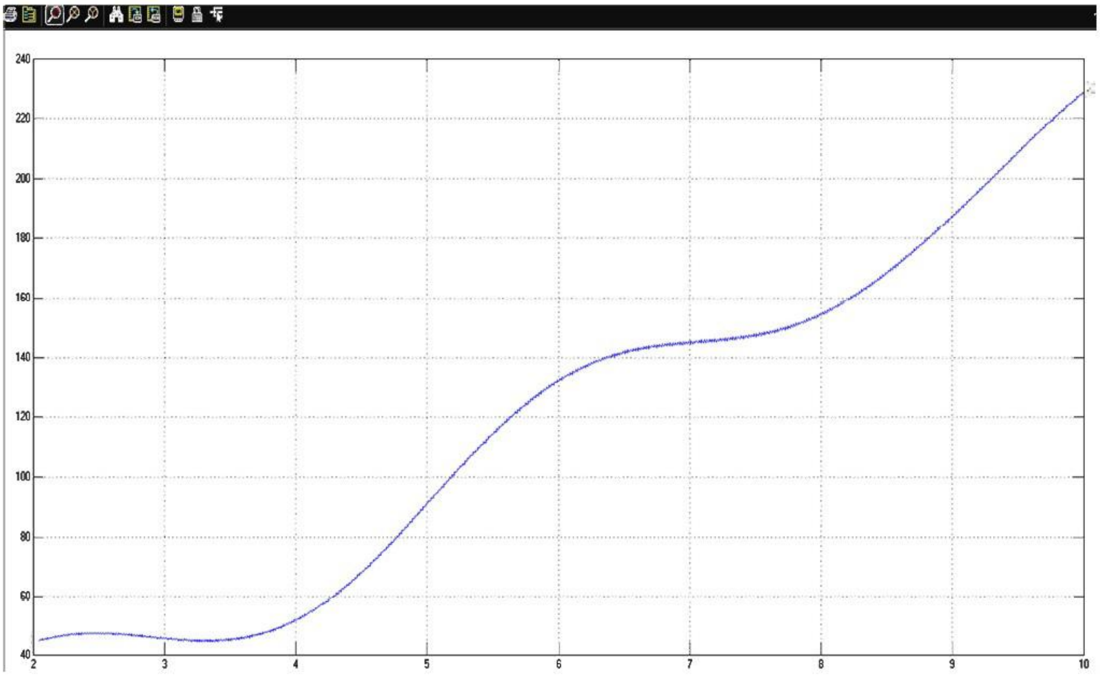

Fig 3.cuk operation

OPERATION OF SEPIC CONVERTER

The capacitor C1 blocks any DC current path between the input and the output. The anode of the diode D1 is connected to a defined potential. When the switch M1 is turned on, the input voltage, Vin appears across the inductor L1 and the current IL1 increases. Energy is also stored in the inductor L2 as soon as the voltage across the capacitor C1 appears across L2. The diode D1 is reverse biased during this period. But when M1 turns off, D1 conducts. The energy stored in L1 and L2 is delivered to the output, and C1 is recharged by L1 for the next period.

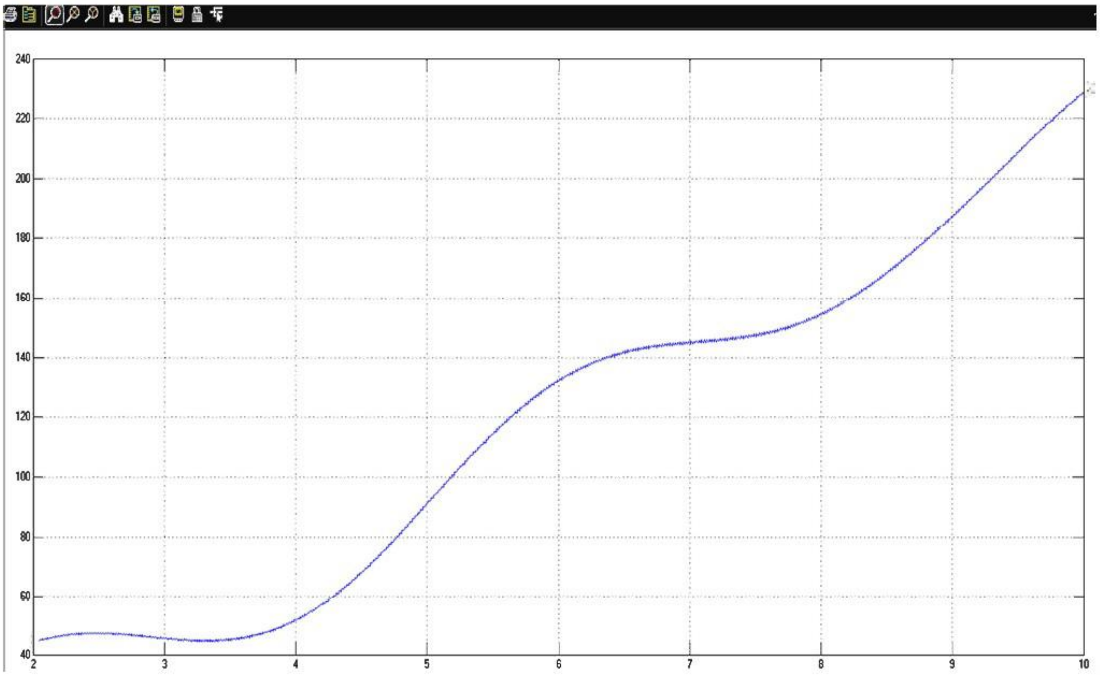

Fig 4.Sepic operation

PURPOSE OF MULTILEVEL INVERTER

The multilevel voltage source inverter is recently applied in many industrial applications such as ac power supplies, static VAR compensators, drive systems, etc. One of the significant advantages of multilevel configuration is the harmonic reduction in the output waveform without increasing switching frequency or decreasing the inverter power output. The output voltage waveform of a multilevel inverter is composed of the number of levels of voltages, typically obtained from capacitor voltage sources. This is called Multilevel. It Starts from three levels. The use of conventional two-level pulse width (PWM) modulation inverters Provide less distorted voltage and current but at the cost of high switching losses due to high switching frequencies.The use of multilevel inverters can overcome the disadvantages in the two level PWM inverters. As the number of levels reach infinity, the output is Total Harmonics Distortion (THD) approaches zero. The number of the achievable voltage levels, however, is limited by voltage unbalance problems, voltage clamping requirement, circuit layout, and packaging constraints.

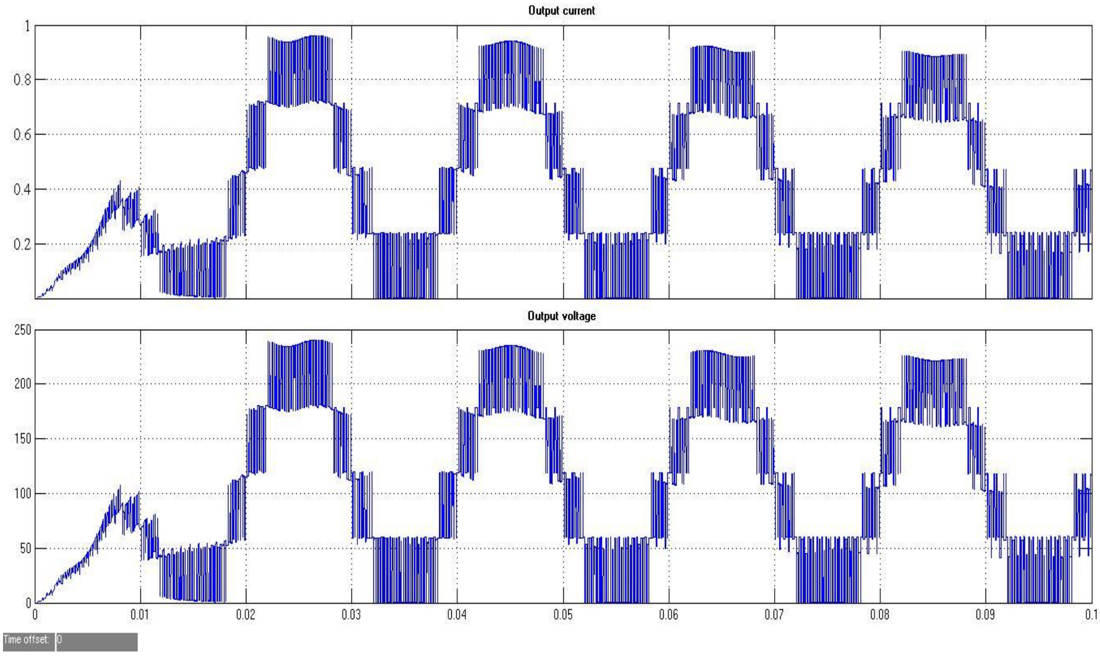

Fig 5.Multilevel inverter output

OPERATION OF CASCADE MULTILEVEL INVERTER

The multilevel inverter using the cascaded converters with separate DC sources is discussed here. The cascaded multilevel inverter synthesizes a desired voltage from several independent sources of DC voltages which may be obtained from batteries, fuel cells or solar cells. This configuration has recently become very popular in high-power AC supplies and adjustable-speed drive applications. This converter can avoid extra clamping diodes or voltage balancing capacitors. Each single DC sources is associated with a single H-bridge converter. The AC terminal voltages of different level converters are connected in series. Through different combinations of the four switches, S1-S4, each converter level can generate three different voltage outputs, +Vdc, -Vdc and zero. The AC outputs of different full-bridge converters in the same phase are connected in series such that the synthesized voltage waveform is the sum of the individual converter outputs .Note that the number of output waveform is the sum of the individual converter outputs .Note that the number of output-phase voltage levels is defined in a different way from those of the two previous converters .In this topology, the number of output phase voltage levels is defined by m=2N+1,where N is the number of DC sources .A five level cascaded converter ,For example ,consists of two DC sources and two full bridge converters. Minimum harmonic distortion can be obtained by controlling the conduction angles at different converter levels.

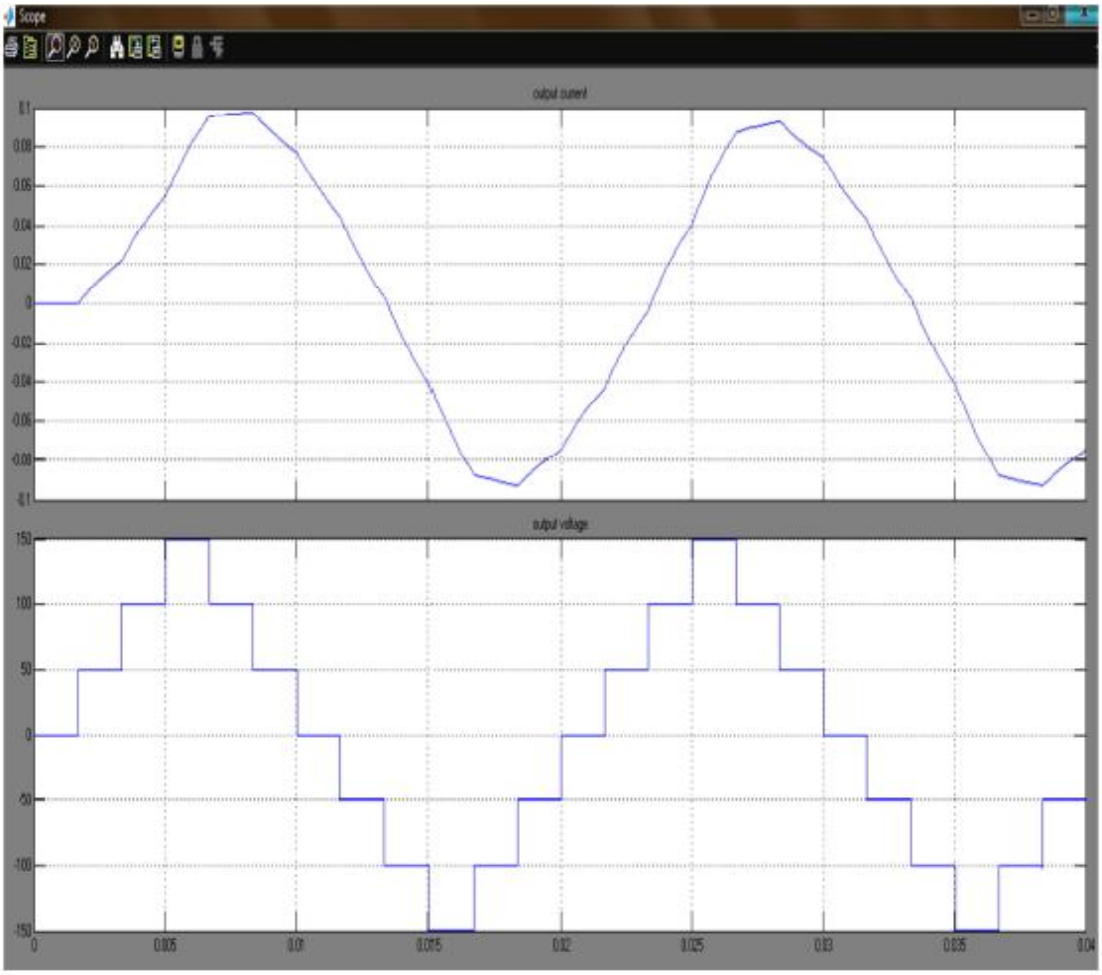

Fig 6.operation of multi level inverter

PARAMETER OF CUK AND SEPIC CONVERTER MODEL:

Table 7.Converter parameter

PARAMETERS	VALUES
Input voltage, Vd	24 volt
Output voltage, Vo	270 v0lt
Switching Frequency, Fs	25 KHz
Duty Cycle, D	0.8
Output Current, Io	1 A
Inductor	1.5mH
Capacitor	470mF
Resistance	100Ω

RESULT OF THE PROPOSED SYSTEM

The output current and voltage waveforms obtained from the simulation of complete hybrid system by using cuk, sepic converter, and inverter, the simulation result are shown in figure 5 and 6. In This Proposed Hybrid System We Are Giving Separate Input Supply To The Cuk 24 V And Sepic 46 V Converter, Where Converter Boosting The Voltage up to 220 In both cases. The Inverter are Used to Eliminates High Frequency Harmonics.

CONCLUSION

Renewable energy sources also called non-conventional type of energy are continuously developing by natural processes. Hybrid systems are the right solution for a clean energy production. Hybridizing solar and wind power sources provide a realistic form of power generation. Here, a hybrid wind and solar energy system with a converter topology is proposed which makes use of Cuk and SEPIC converters in the design? This topology allows the two sources to supply the load separately or simultaneously depending on the availability of the energy sources. The output voltage obtained from the hybrid system is the sum of the inputs of the Cuk and SEPIC converters. This system has lower operating cost and finds applications in remote area power generation, constant speed and variable speed energy conversion systems. MATLAB/ SIMULINK software is used to model the DC-DC converters, inverter and the proposed hybrid system.

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