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Design Of Mobile Electric Vehicle Charging Station With PV Array And Storage System

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Abstract:

In this paper we are going to present a conceptual mobile vehicle charging station to charge electric vehicles at the point where it is stopped or break down due to less battery. For this we used PV solar system and buck converter and lead acid battery. The total work is simulated on mat lab/Simulink 2018 and verified using prototype hardware. The results obtained are satisfactory.

Keywords:

PV cell,buckconverter,controller,SOS,lead acid battery,ElectricVechicles.

Introduction:

In the most recent decade two key issues rose in wording of energy all through the world. The first is coming up short on restricted oil sooner rather than later and the other one is carbon emanation bring about an unnatural weather change. Numerous nations at present depend intensely on coal, oil, and flammable gas for its energy. Fossil energizes are non-sustainable, that is, they draw on limited assets that will in the end sooner and getting excessively costly or as well naturally harming environment. Conversely, the numerous sorts of sustainable power source assets, for example, wind, and solar PV become energyand are continually renewed and will never run out. Sustainable power source [1] is for the most part called "clean energy" or "green power" since it doesn't contaminate the air or the water and does not result carbon emanation. Most sustainable power source comes either legitimately or in a roundabout way from the breeze or sun. Daylight, or sun based energy can be utilized legitimately for warming and lighting homes furthermore, different structures, for creating power, and for boiling water warming, sun based cooling, or charging vehicles in any charging station and an assortment of business and modern employments. So PV based framework is a powerful framework for utilizing in EV based charging station by using sun based energy. There can be seen so numerous logical examines regarding this matter covering dissect, discover arrangement, apply specialized strategies for defeating this issues as one looks into writing. Talking for the most part sustainable power source is proposed predominantly all around the globe because of its advantages and less mischief for the natural creatures. All things considered notable these assets are wind, sun powered energy, and so forth right now application as substitution of customary energy types like fuel, diesel and gaseous petrol. An itemized writing research has been done and under this edification of research a PV based EV/PHEV charging station attributes, particulars and necessities

are uncovered by utilizing genuine information for explicit region. The paper comprises of a framework portrayal, framework model, PC helped recreations

EV

Solar

Battery

A typical EV charging station consists of a solar panels of no of cell connected in series and parallel combination in order to get required output voltage. The solar panel is followed by a buck converter (stepdown) for converting the input dc voltage level battery level voltage (12.1 DC).The EV is charged by PV panel when there is good amount of irradiation otherwise it is charged through battery storage through a buck converter as shown in the block diagram representation.
Description of block diagram:
Solar panel:

and end with recommendations for the future attempts to be finished.
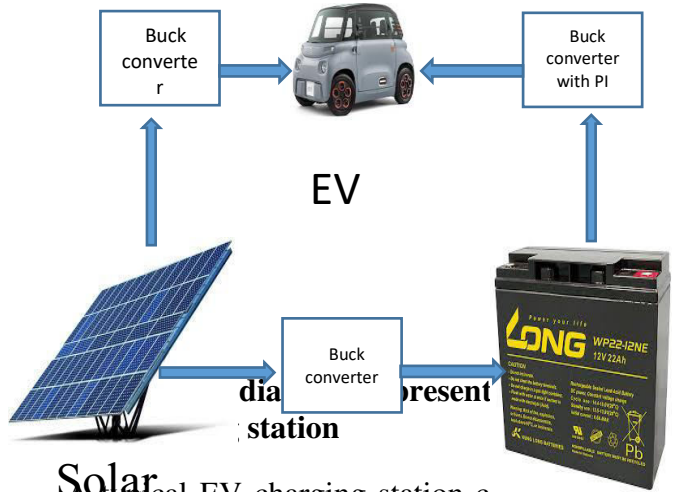**Representation of EV charging station:**

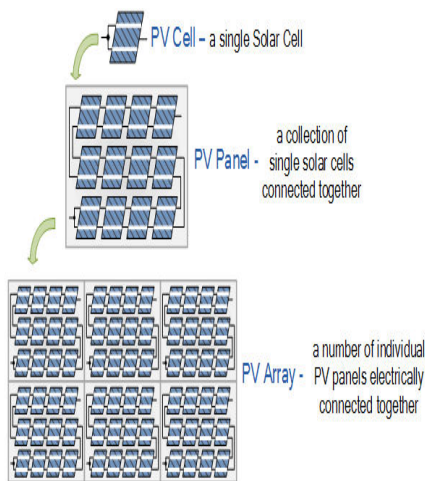**Fig 2 :Representing solar cell, solar paneland array**

If photovoltaic solar panels are made up of individual photovoltaic cells connected together, then the Solar Photovoltaic Array, also known simply as a Solar Array is a system made up of a group of solar panels connected together. A photovoltaic array is therefore multiple solar panels electrically wired together to form a much larger PV installation (PV system) called an array, and in general the larger the total surface area of the array, the more solar electricity it will produce.

A complete photovoltaic system uses a photovoltaic array as the main source for the generation of the electrical power supply. The amount of solar power produced by a single photovoltaic panel or module is not enough for general use. Most manufactures produce standard PV panels with an output voltage of 12V or 24V. By connecting many single PV panels in series (for a higher voltage requirement) and in parallel (for a higher current requirement) the PV array will produce the desired power output.

Equivalent representation of solar panel:
Equivalent circuit models define the entire I-V curve of a cell, module, or array as a continuous function for a given set of operating conditions. One basic equivalent circuit model in common use is the single diode model, which is derived from physical principles and represented by the Followingcircuit for a single solar cell
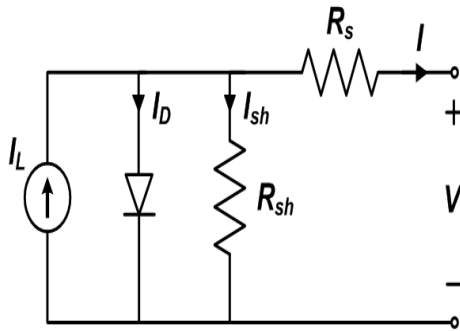
Fig 3: Electric equivalent of a solar cell

basic equation from the theory of semiconductors that mathematically describes the *I–V* characteristic of the ideal PV cell is --

$$I = I_{pv,cell} - I_{0,cell}\left[\exp\left(\frac{qV}{aKT}\right) - 1\right]$$

$$I_d = I_0\left[\exp\left(\frac{qV}{aKT}\right) - 1\right]$$

[1]

where *I*pv is the current generated by the incident light (it is directly proportional to the Sun irradiation), I_d is the Shockley diode equation, I_0 is the reverse saturation or leakage current of the diode, *q* is the electron charge (1.60217646 × 10−19 C),_is the Boltzmann constant (1.3806503 × 10−23 J/K), *T* (in Kelvin) is the temperature of the *p–n* junction, and *a* is the diode ideality constant. The below figure sown the Simulink reprresentaion of solar panel
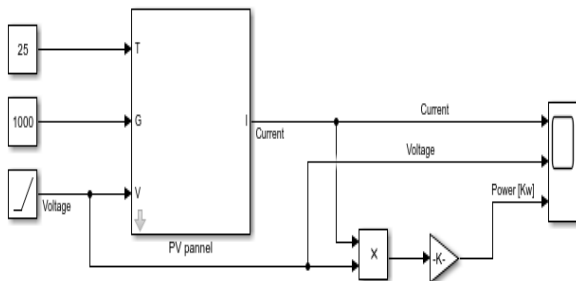

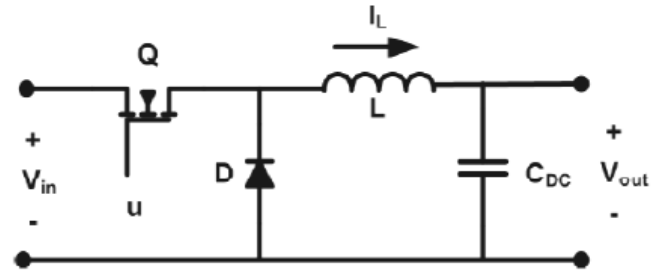**Fig4:Representation of PV cell in Simulink**

Buck Converter:

Fig 5: Representing buck converter

The dc-dc buck converter converts a higher dc input voltage to lower dc output voltage. The basic dc-dc buck converter topology is shown in Fig. 5. It consists of a controlled switchWS, an uncontrolled switch diode (D), an inductor L, an capacitance C and a load resistance R [14]. In the description of converter operation it is assumed that all the components are ideal and also the converter operates in Continuous conduction mode (CCM). In CCM operation the inductor current flows continuously over one switching period. The switch is either ON or OFF according to the switching position this results in two circuit states. The first sub-circuit state is when the switch is turned ON, the diode is reverse biased and inductor current flows through the switch,. The second sub-circuit state is when the switch is turned OFF and current freewheels through the diode

Power converter design:
Electric vehicles (EVs) are considered to be the future mode of transportation. EVs are much more energy efficient than gasoline/diesel powered vehicles and they do not produce any carbon emissions. They have a much simpler drive train, are much less noisy and require little maintenance. However, EVs are only sustainable if the electricity used to charge them comes from renewable sources and not from fossil fuel based power plants [1]–[3]. If EVs are

charged from a grid which is largely powered by renewable energy, then the net emissions are close to zero. The challenge, then, geothermal, biogas or tidal energy are excellent sources of renewable energy to power electric vehicles in the future. Amongst these, the use of solar photovoltaic panels to charge EVs is an attractive option due to several reasons:

- The cost of solar PV has been continuously falling over the past decades
- PV power has high accessibility to EV users as PV modules can be installed on the roofs and as solar car parks.
- The PV potential of rooftops or parking places is largely unutilized today, and this can be exploited in the future.
- There is both reduced energy and power demand on the grid due to EV charging as the charging power is locally generated in a _green'manner through solar panels [5]–[7]. This reduces/delays the need for grid reinforcement.
- Conventionally, PV systems use a battery to store the solar energy to manage the seasonal and diurnal variations in solar generation. In the case of charging EVs from PV, the EV battery can serve as an energy storage for the PV, and no additional battery will be required [8]–[11].
- The cost of charging the EV from solar is cheaper than charging it from the grid, and it reduces the impact of low PV feed-in tariffs [12], [13].
- PV systems have low noise, have no rotating parts and are practically maintenance free is to power EVs in the future using sustainable sources of energy. Wind, solar, hydropower,

- The power converter design investigates the power converter topology, semiconductor device technology, power density, efficiency, closed-loop control and EV charging standards to enable the solar charging of EVs. In simple words, it is the hardware that facilitates the possibility to charge EVs from PV. The existing solutions for charging EV using solar energy is to use a DC/AC solar inverter to extract power from a PV array and then use an AC/DC EV charger to charge the EVs. This is shown in Fig.1.3 where separate power converters are used for PV and EV. The AC grid is hence used as power exchange medium between EV and PV. However, this solution is not efficient and is inflexible due to several reasons:
- EV and PV are fundamentally direct current (DC) in nature, so exchanging power over AC requires more power conversion and is less efficient than DC power exchange. This is because high power inverters/rectifiers used for EV and PV
- typically have a two-step power conversion, a DC/DC stage, and a DC/AC stage. With DC power exchange between EV and PV, the DC/AC stage can be avoided.
- Two DC/AC inverters are needed in the existing solution, one in the PV converter and one in the EV converter, adding to the cost and complexity of the system.
- Solar inverters and EV chargers are currently designed as separate devices with no common control interface. This makes it challenging to practically implement charging

algorithms to control the EV charging based on PV generation.

- EV batteries can not only be charged from the grid but can also discharge power back to the grid. This phenomenon is called Vehicle-to-grid (V2G), and it requires a bidirectional EV charger (charge and discharge). With V2G, the EV can act as a controllable electrical generator for the grid. This would be even more beneficial if solar energy is stored in the EV during the day and can be extracted from the EV during the night. Currently, commercially available EV chargers are not bidirectional and hence do not offer the V2G technology.

- Finally, the current generation of power converters are built using traditional silicon semiconductor technology, due to which the switching frequency is limited to <30kHz. The lower switching frequency leads to larger passive components in the converters, thereby increasing the converter volume and decreasing the power density.
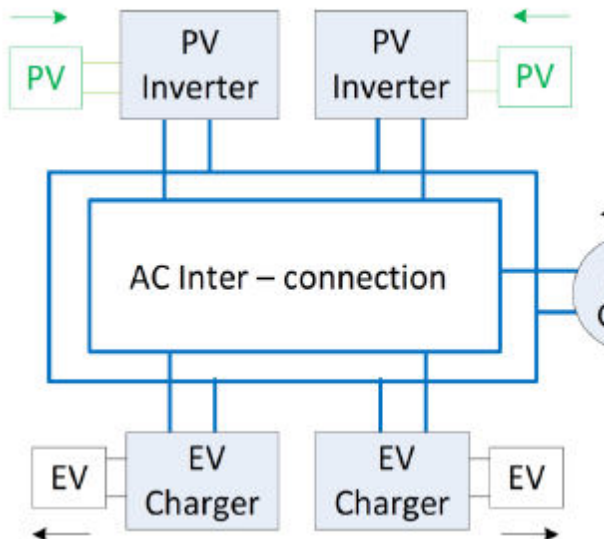
Fig 6: Existing solution for solar charging of EV is based on a DC/AC solar inverter

to extract PV power and then an AC/DC EV charger is used to charge the EV
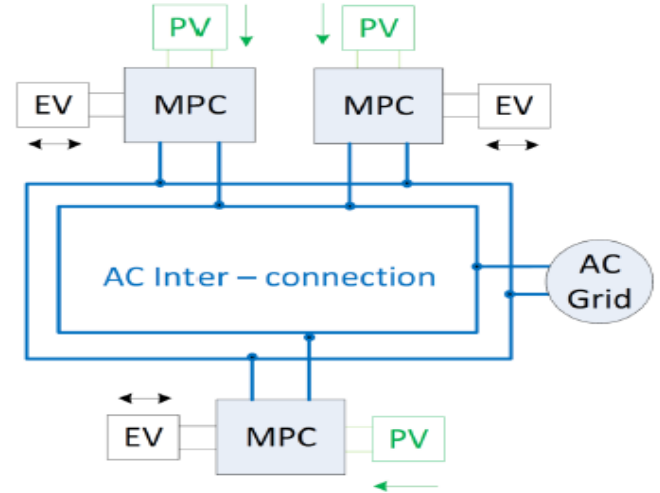

Figure 7: an integrated multi-port power converter (MPC) capable interconnecting PV and EV on DC and can connect to the AC grid
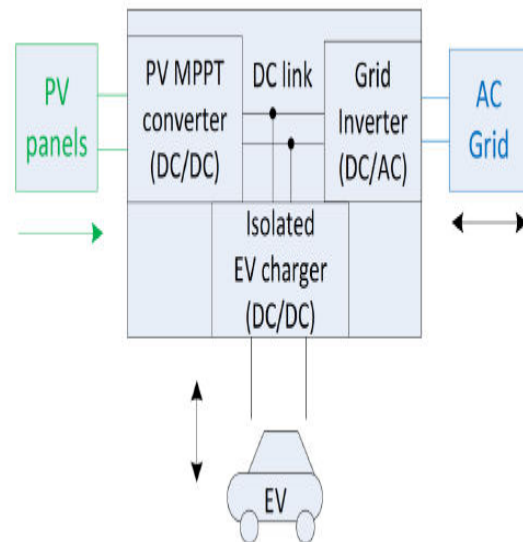

Figure8: Proposed Concept of Robotic Vehicle charging station

Figure 8 shows the schematic of Architecture 4 which is a combination of

Architecture 2 and 3. It uses a multi-port converter as shown in Fig. 7 to integrate the converters for the PV array and EV. Many MPCs are interconnected to each other using a DC interconnection. A high power, central inverter is used to connect to the AC grid. This central inverter is better than using several small inverters embedded within the MPC as in architecture

Operating modes of Proposed System

There are four possible power flows in an EV-PV charging system when using multiport or separate converters, named as EVPV Mode 1 to 4 as shown in Figure 8.

- **Mode 1 –** Mode 1 is the direct use of PV power for EV charging; which is the main objective of the charging system.
- **Mode 2 –** Mode 2 corresponds to the power flow from the grid to the EV for EV charging. Mode 2 is used when solar generation is insufficient to meet the EV charging requirements.
- **Mode 3 –** Mode 3 is the power exchange from EV to grid.
- **Mode 4 –** Mode 4 is used for feeding the PV power directly to the grid or to charge other vehicles. This mode is enabled under the condition that there is no EV for charging or the EV battery is full.

Simulations:
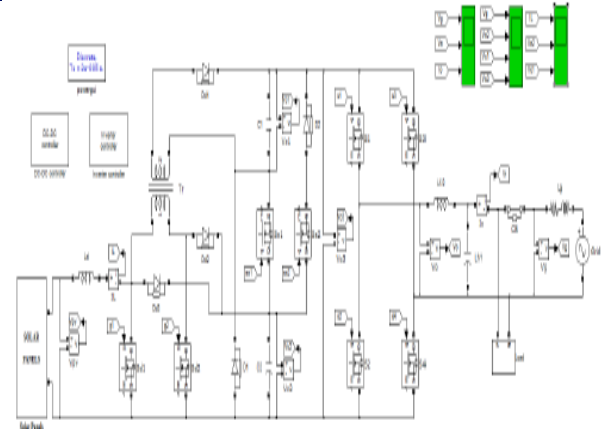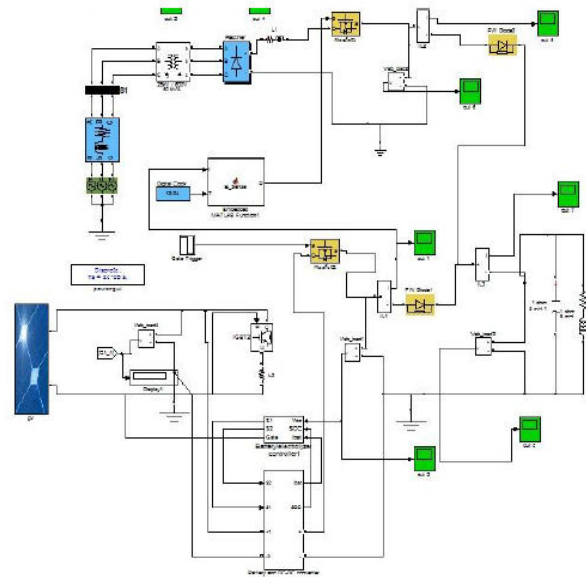
a) **Simulink diagram of PV generation unit with plant:**

Fig:Simulation diagram of PVgeneration

b) **Modelling of pv based EV charging station:**

Results:
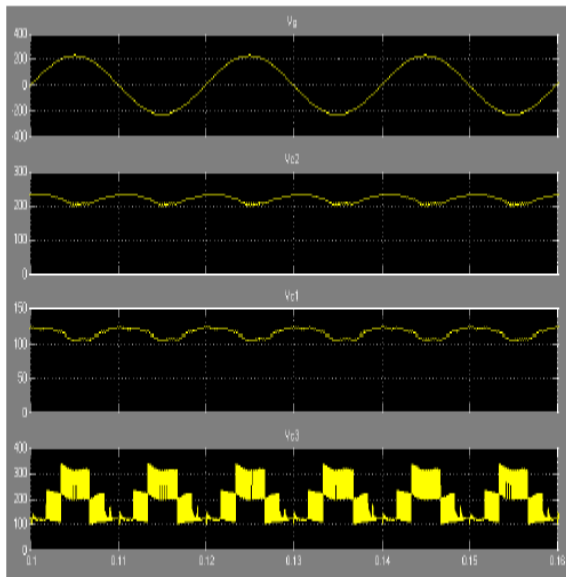
a) DC side of 7 level inverter:

Fig:waveforms on DC side of seven level inverter

b)Waveforms on AC side of 7 level inverter:
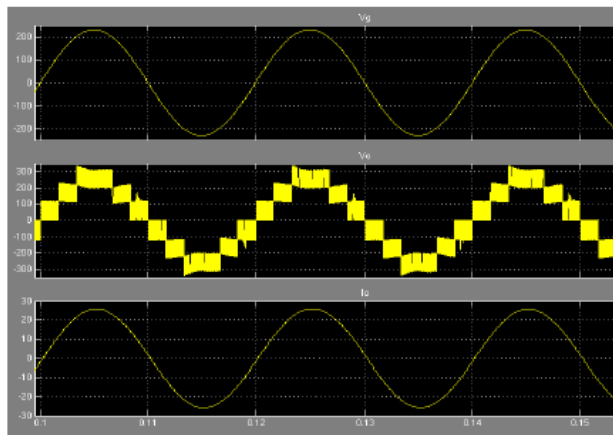

Fig :Waveforms on AC side of 7 level inverter
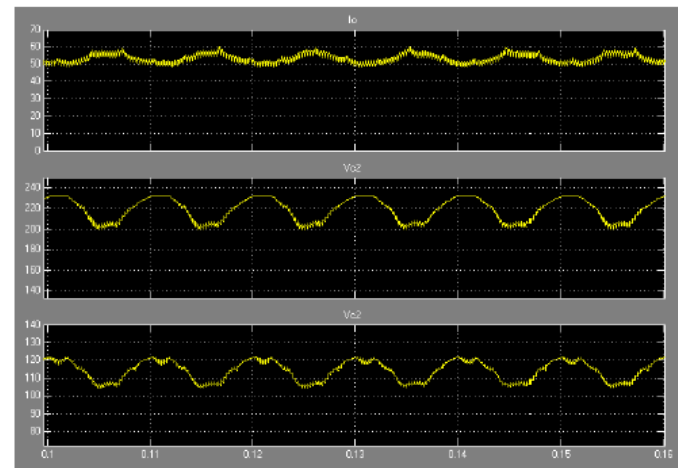
c) Waveform of dc-dc converter:

Fig: Waveform of dc-dc converter

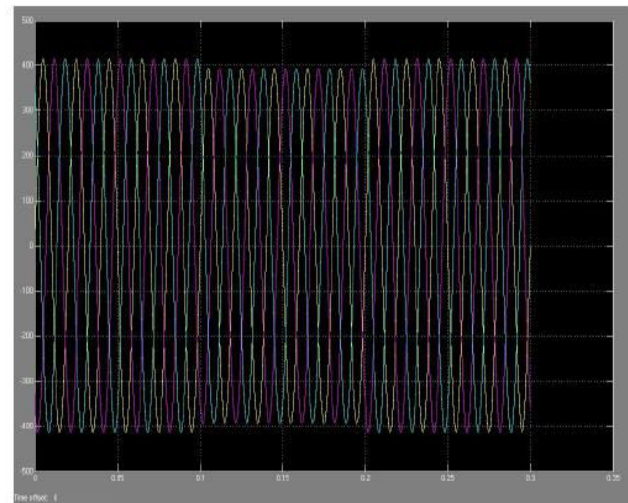d) Waveform on grid side voltage:

Fig: 3-ϕ voltage on grid side
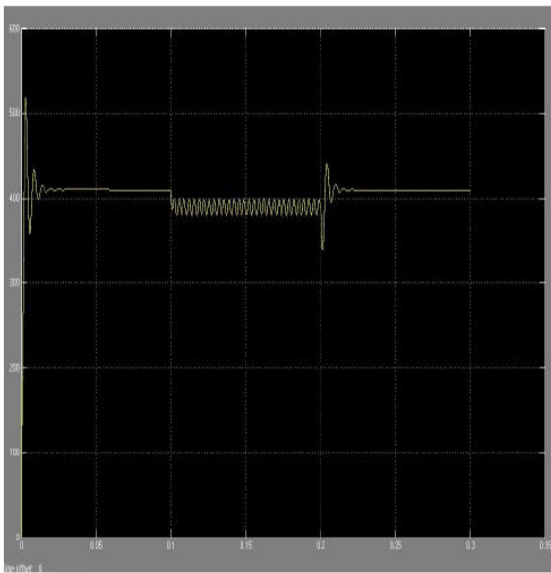
e) Battery and load voltage

Fig : Battery and load voltage

Conclusions

As a consequence of finite petroleum original resources, renewable energy sources became indispensable for our daily life energy demand. In this perspective this project is intended to give an efficient, applicable and cost effective model of PV based EV charging station. This study shows that it is possible to implement and market Solar PV based EV charging station without grid connection in Mode-1. In accordance available irradiance and temperature values, it can produce sufficient energy while battery used as a backup. Instead of using the grid power as backup source, energy storage system (ESS) batteries are chosen so that whenever solar power is inadequate to supply power for charging of EV, ESS takes the control and injects the necessary energy to the charging system. The presented model of solar power energy can be a good initiative for the future appliances and implementation to be carried out in this area.

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