ISSN :2455-0108 Impact Factor : 2015-3.462
IJO–Science
INTERNATIONAL JOURNAL ONLINE OF SCIENCE
Volume II, Issue VIII November 2016

Optimization of Small Scale Concentrated Solar Power Plant With Revolving Mechanical Arm

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ABSTRACT

Electrification ratio in India by the end of 2014 was about 70%. This means that 30% of people/of the group does not have electricity. So I am designing small scale (focused one's effort/increased/mainly studied) solar power plant with revolving mechanical arm which can be operated in small villages or in that areas were electrification is not possible. Some restrictions of electrification in these areas are the cost of (having different things working together as one unit) grid construction is (compared to other things) high, the limitation of energy useful things/valuable supplies and the population of the area is (compared to other things) small.

A small scale (focused one's effort/increased/mainly studied) solar power plant with revolving mechanical arm and (related to energy from plants) energy can be a good choice to solve the electricity problem in these areas. This option is based on the (compared to other things) good possible strength of solar energy in some areas of India which is daily average strength is about 3-5 kWh per day. This presents a series of activities in developing a (focused one's effort/increased/mainly studied) solar power plant which includes the idea-based design of the small-scale system with the ability (to hold or do something) of 10kW.

This project focused on the design & analysis of a small scale concentrated solar plant and revolving mechanical arm at solar receiver for integration into this planned solar unit. Mean irradiance levels at the focal spot of the solar receiver of 3 - 5 kWh per day and peak levels of 14 kWh per day were identified as major design challenges.

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Keywords: small scale concentrated solar power plant, receiver, absorber plate, heliostat, frame, and revolving mechanical arm.

1. INTRODUCTION

The late vitality emergency and natural weight are turning out to be progressively dire and attracting tremendous consideration regarding sun powered vitality use. Sun oriented innovation has made colossal mechanical and cost enhancements, however more innovative work stays to be done to make it cost and power focused with fossil fills. Expenses can be diminished by expanding interest for this innovation around the world, and in addition through enhanced part outline and propelled frameworks. Research is fundamentally centered around creating lower cost sunlight based concentrators, high-productivity motor/generators, and superior beneficiaries. The objective is to additionally build up the innovation to expand acknowledgment of the frameworks and help the frameworks infiltrate developing local and universal vitality markets.

India is situated in the (regions near the Equator) sun belt of the earth, by that/in that way getting ample gleaming vitality from the sun. The India (identified with the climate) Department (IMD) keeps up an across the nation system of radiation stations which measure sun oriented radiation furthermore the every day period of time of daylight. In many parts of India, clear sunny climate is experienced 250 to 300 days a year.

An intense renewable essentialness portfolio is inclined to fuse systems that engage imperativeness stockpiling with power era when there is obliged sunshine. Standard photovoltaic sheets change over prompt and diffuse sunlight into direct-current power, which can be adjusted into substituting current line voltages and frequencies (Fig. 1.1). Regardless, transient electrical yield is particularly related to the snappy sunlight, or sun arranged insolation, striking the photovoltaic board.

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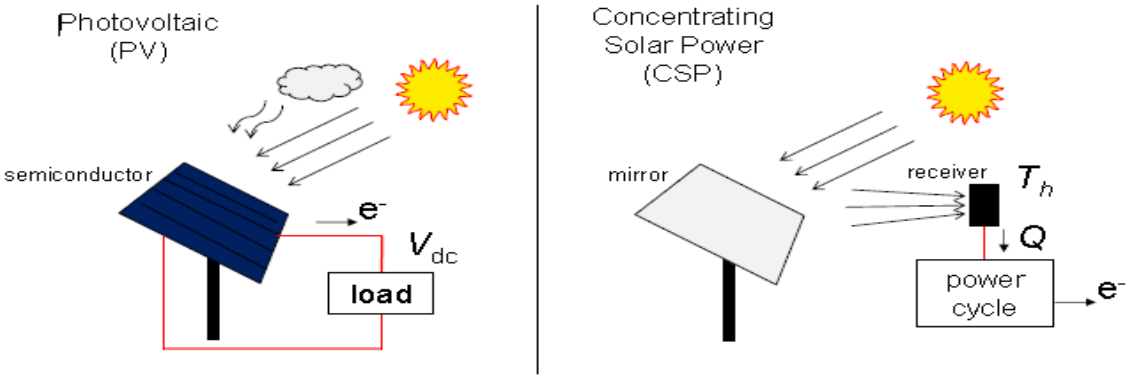

Fig. No.1.1: Solar power: PV vs. CSP

2. LITERATURE SURVEY

Sun based vitality is a wellspring of vitality that is never exhausted, subsequently, it is worth to be created. In the following future, sun oriented vitality can assume a principal part to supplant fossil fuel plants, and to move from a carbon innovation to a green innovation [1]. One of numerous approaches to use sun based vitality as a vitality source is building up a Concentrated Solar Power (CSP) framework. CSP is a framework that utilization coordinate sun based radiation concentrated to create warm onto a little region for delivering power [2]. This framework has been produced in a few nations, for example, Algeria, Egypt, Greece, India, Italy, Mexico, Morocco, Spain, and America [3].

At that point, destroy extent in Indonesia before the end of 2011 was around 74% [4]. This suggests 26% of Indonesia's masses does not have control. Most Indonesian who does not have permission to power lives in remote, isolated regions or little islands. By far most of Eastern Indonesia territory even have a zap extent underneath of 30% [5].

CSP plant offers a few advantages. It gives transformation effortlessness contrasted with different sorts of force plants. While others utilize diverse wellspring of vitality to deliver steam or gas to drive engine or turbine, CSP plant utilizes concentrated sun powered warmth. Moreover, fuel is not required for CSP plant. In addition, gathered in crossover with different wellsprings of vitality, CSP can keep running at evenings. CSP innovations basically utilize allegorical troughs, sun based towers, dish/motor frameworks, and straight Fresnel reflectors. Allegorical trough and

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straight Fresnel are frameworks that utilization line centering to catch sunlight based radiation, while sun based tower and dish motor framework utilizes point centering [6].

In this paper, the warm examination of the straight Fresnel point of convergence daylight based power with dim body cavity beneficiary was performed. It was shown that among the natural and the operational factors, the blueprint parameters also affect the power execution. With connection with the discharged CPC with a similar sort of recipient, a higher regard for the profitability of the Fresnel gatherer was viewed. Giorgio Cau, Daniele Cocco[21]. The most generally perceived used HTMs are fluids like air, water/steam, helium, fluid salt/metal and liquid sodium [22]. Each HTF has its own specific great conditions.

In a novel use of a Fresnel focal point for a sun oriented stove and sun powered warming has been appeared by US Researchers [23]. The idea introduced in this work could be connected from numerous points of view including: sun powered cooking for families in rural areas and rustic zones, for roadside nourishment cooking and merchant, or private scale sun powered warm accumulation and use for house warming. In the US researchers Guangdong Zhu, David Kearney, Mark Mehos [24], portrayed and measured the normal sun based field reflect reflectance in utility-scale concentrating sunlight based power plants.

A point by point experiment actualizing the general technique was connected to a most recent business explanatory trough plant and endorses the proposed reflect reflectance model and normal reflectance estimation method. Odeh and Morrison [25] built up a transient reproduction display for investigation of the execution of mechanical water warming frameworks utilizing allegorical trough sun oriented authorities. Tao et al. [26] introduced the operational standard and plan strategy for another trough sun oriented concentrator.

Endeavors to decrease this region are restricted by the most extreme working temperature of the safeguard and consequently by the warmth evacuation limit of the HTF. The better the warmth evacuation limit of the HTF, the lower the safeguard temperature, which implies collector size and warmth misfortunes can be decreased. For instance, the safeguard zone can be sliced down the middle if a HTF of water/steam is supplanted by sodium because of its unrivaled warmth exchange abilities [27].

Concerning radiative misfortunes the depression has unmistakable focal points over the outside recipient. Misfortunes because of impression of impinging concentrated sunlight based radiation can be fundamentally lessened and now and again they turn out to be low to the point that they are even irrelevant [29]. Beneficiary works up to 800°C, and high temperature collectors above 1000°C [31].

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3. OBJECTIVE AND METHODOLOGY

Objective:

- To enhance the performance of solar power plants in small villages in India.
- To recommend future work in the field of solar energy.
- To review existing radiation data sources and software's.
- To review design criteria for better performance of power plants.

Methodology:

Information and data from a wide variety of sources will be used, which includes theoretical knowledge of solar energy technology. Data for solar radiation has been analyzed from sources such as the Handbook of Solar Radiation for India. Methodology I am using for its Design is Autodesk Inventor V-2014, for Analysis I am using Ansys, Online Carnot cycle efficiency calculator and Govt. Approved Power Generation online software.

4. DESIGN PARAMETERS

For good performance, all the factors below should be taken into account:

1. Solar Collector System, Absorber and Thermal storage.
2. Setting of mirrors or lenses so that it will capture sunlight from a large area and concentrate it to a small area.
3. Selection of Molten fluid.
4. Selection Tube material.
5. Selection of good Turbine.
6. Positioning of Boiler, Turbine and Molten Fluid Tank.

5. Working of CSP

The sun oriented authority framework are concentrator, safeguard and warm stockpiling. Concentrator is a framework that utilizations mirrors surface or focal points to catching and think an extensive range of daylight, or sun based warm vitality, onto a little territory. The sunlight based radiation will be reflected to the safeguard situated at the concentration purpose of the straight allegorical. The warmth is then consumed and will warm the warm liquid inside the safeguard which thusly will stream into the warm stockpiling for use as a natural liquid radiator situated

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inside the evaporator. Natural liquid in the evaporator and after that warmed/dissipated by warm liquid from the safeguard, and the vanished natural liquid is extended in the turbine to drive a generator that produces power.

Point by point STUDY

In this fragment the gatherer diagram that was singled out commence of the essential review is analyzed and a model is made. In addition, the COMSOL model is checked using the Flow Modeling Simulation Software ANSYS FLUENT. The examination is done in three estimations so that the model can be used for a CFD examination of the whole beneficiary including inflow and surge from and to connecting portions in a future work.

PARAMETER STUDY

Along these lines, a keep going parameter focus on the pit significance is done. Meanwhile the cell expansiveness is moved additionally in light of the way that the standard focuses on exhibited no dependence of the analyzed criteria on the cell estimation. The essential section exhibits the material use. The examples are altogether practically identical for both SPU courses of action. For both setups and both cell separates over a sensible example is unmistakable.

Fig. 1. Old Model

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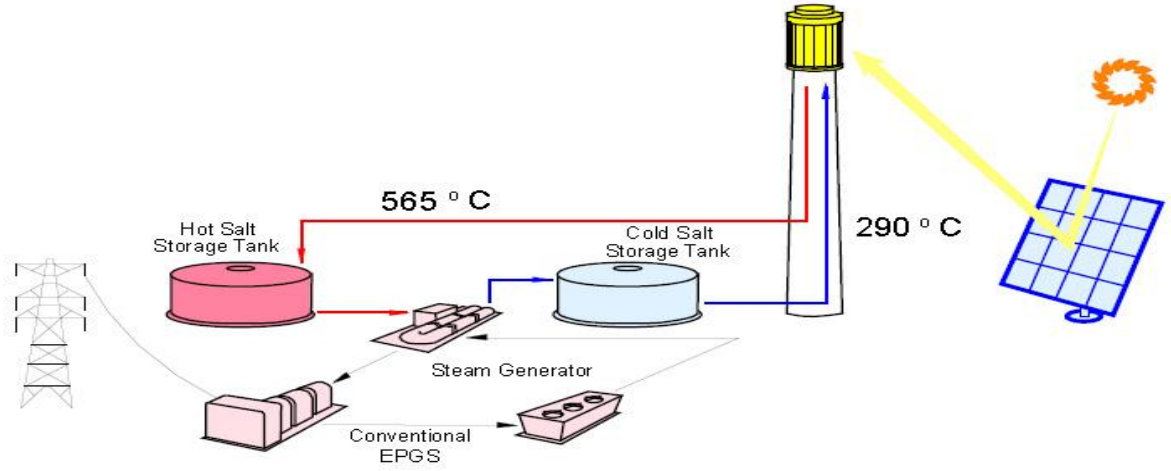

Fig. 2. Old Model Schematic Layout

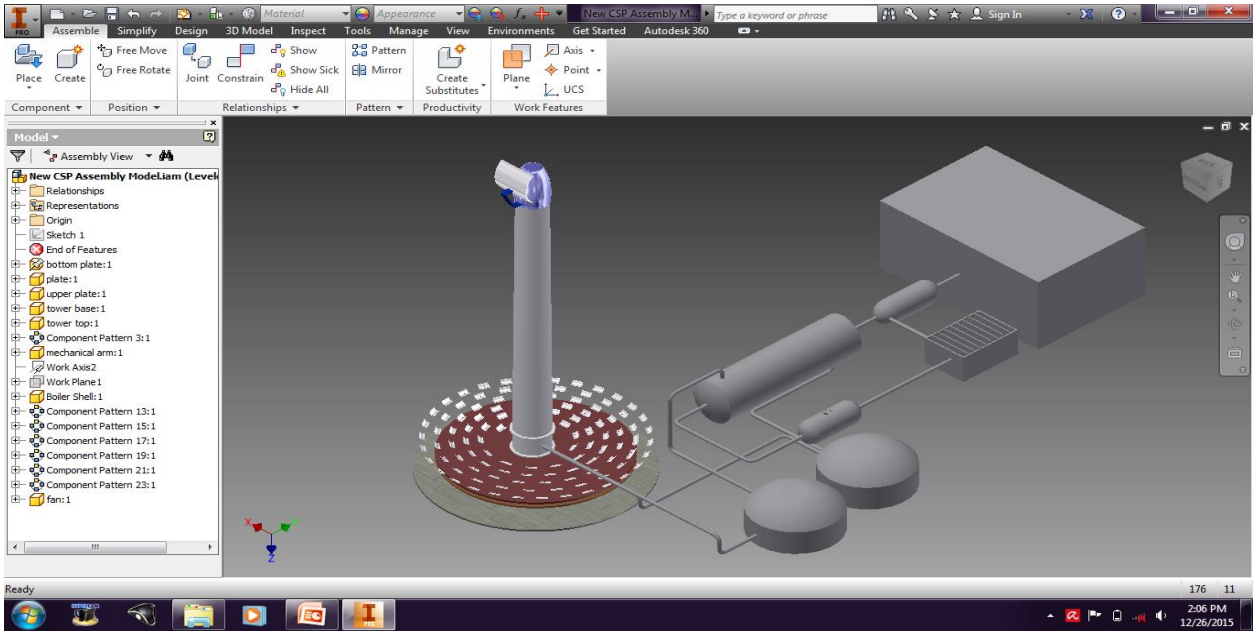

Fig. 3. Modified Model

7. RESULT AND DISCUSSION

EVALUATION AND DECISION:

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In order to evaluate the conflicting parameters the same value of benefit analysis as in the main study analysis is done. The pattern for both SPU arrangements is comparative. By and large the abatement in material usage exceeds the expansion of the window temperature. For the air setup and the pressurized design a pit profundity of X and Y mm gives the most astounding estimation of advantage. Because of the way that the pressurized setup is by and large best and because of straightforwardness reasons a depression profundity of Y mm for both designs is picked.

MODELING:

The liquid stream model depends on the same conditions as the COMSOL display in a marginally distinctive documentation. Nonetheless, it depends on the force condition portrayed in condition for the free stream and an amplified energy condition depicted in condition for the liquid stream inside the safeguard. In the COMSOL demonstrate it was not said how turbulence was displayed. In this model the turbulence demonstrating depends on the standard k-ε show.

The calculations were performed with the conservative assumption of no overlap between blocking and shading effects. The dynamic model is capable of simulating the dynamic behavior of the entire Concentrated Solar Plant .

MESHING

The lattice for the FLUENT model is done in ANSYS ICEM. Figure demonstrates the surface work for one fourth of the safeguard. As said before the motivation to demonstrate the collector in three measurements is that in future investigations the entire recipient including inflow and outpouring from and to neighboring segments must be examined. The surface work comprises of quadrangular components and the volume work of hexahedral components.

Since FLUENT is an immaculate CFD program strong mechanics estimations are impractical. In this manner the outcomes do neither incorporate material use of the window nor the safeguard. Nonetheless, the material temperature inside the strong of the safeguard was displayed. The distinction of the material temperature for both designs is under 2 percent.

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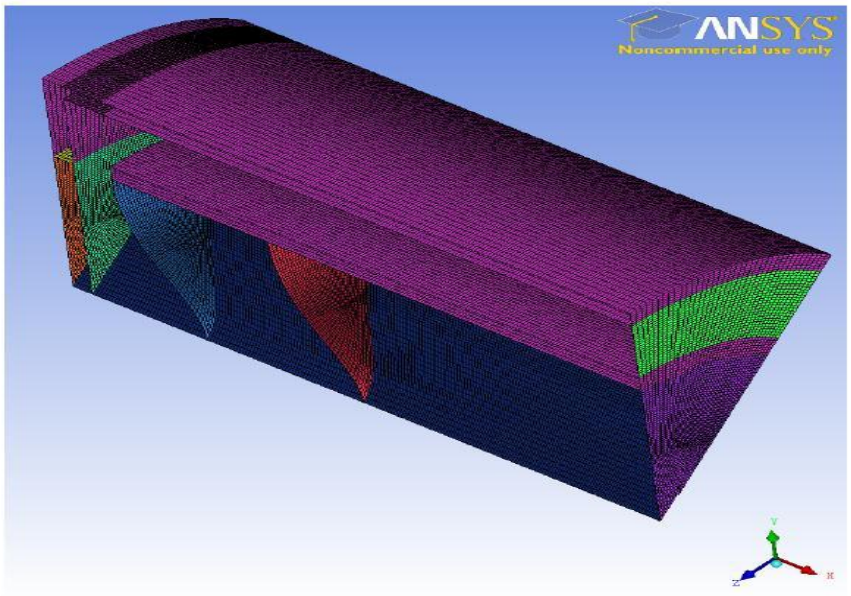

Fig. 4 . Meshed Model

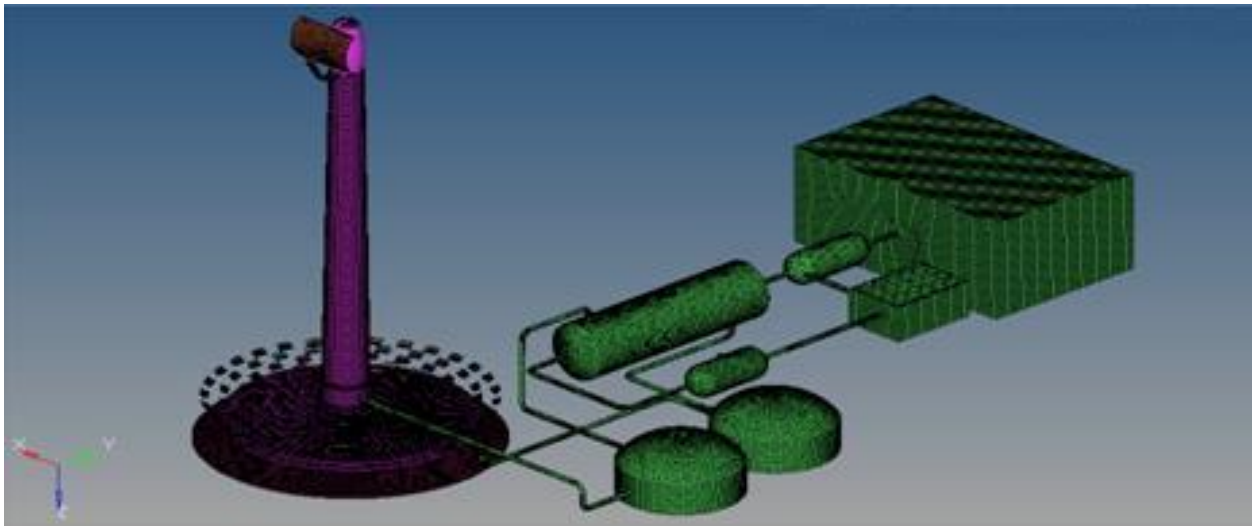

Fig. 5 . Meshed Model

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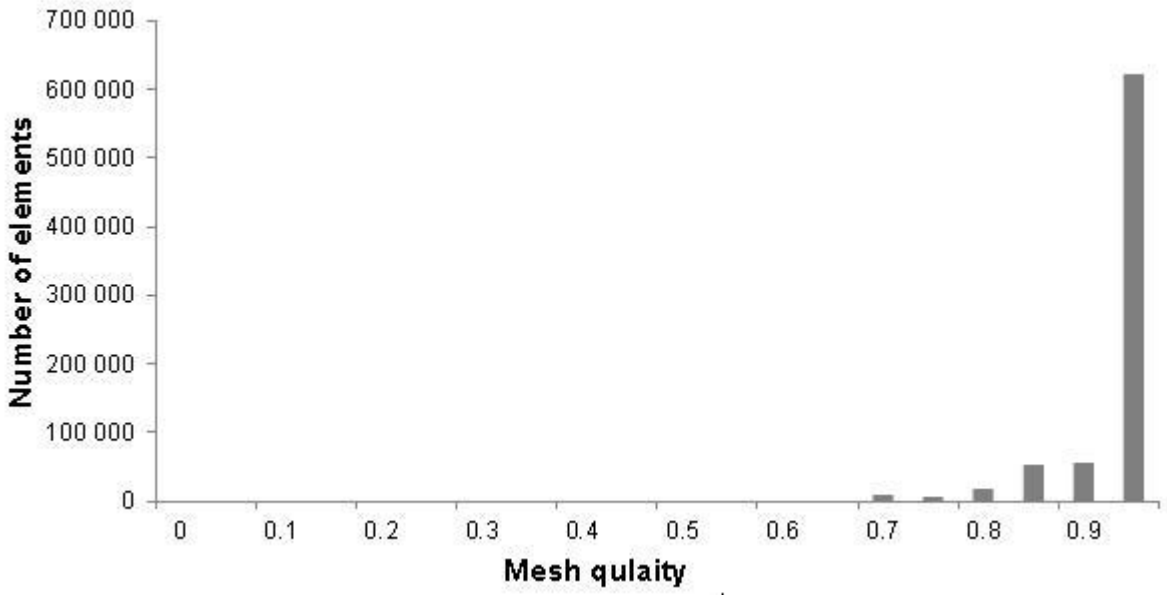
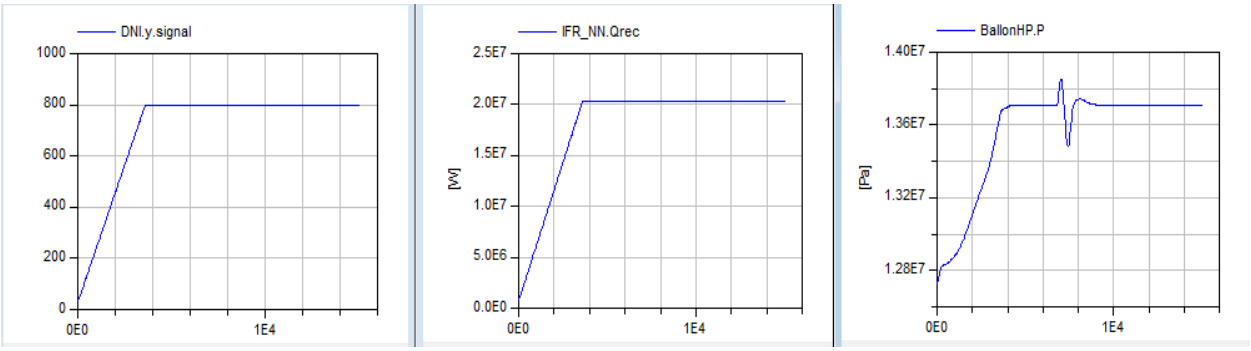


Fig.6. shows the overall mesh quality for the above shown mesh. Since the geometry is relatively simple the worst element quality is 0.6. Moreover, almost 90 percent of the elements have a quality above 0.9.

The dynamic model is capable of simulating the dynamic behavior of the combined cycle power plant with a Linear Fresnel field. The chosen simulation scenario represents the variation of solar energy. The results of the simulation are given in Fig. 7. The electric power produced by the system depends on the solar irradiation.



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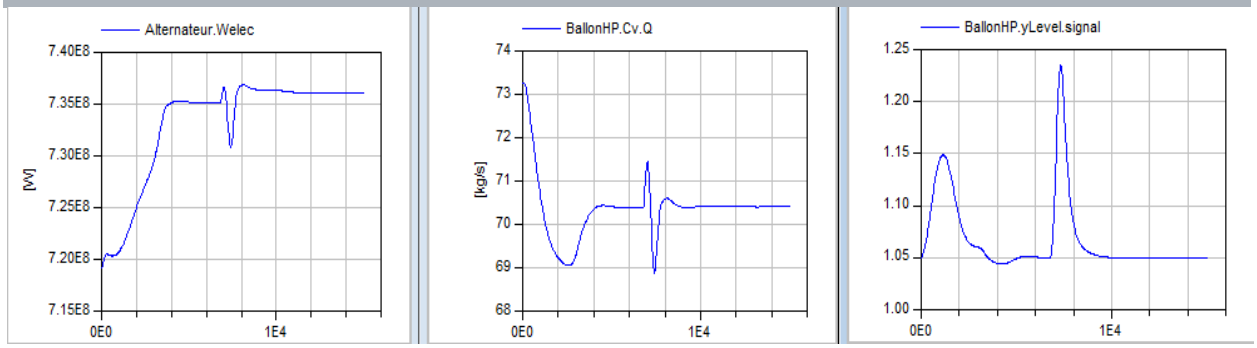

Fig. 7. Evolution of DNI, the power produced by LFR collector, the pressure in HP drum, the electric power produced, the steam mass flow rate outlet HP drum and the level in HP drum

8. CONCLUSION AND RECOMMENDATIONS

Conclusion:

From the past sections it is discovered plainly that a genuine lack of vitality is coming in not so distant future furthermore it is found there are numerous promising rotating alternatives to take care of that future demand. Out of that one of the promising choices is Concentrating Solar power (CSP) innovation on account of its similar lower cost and having high transformation effectiveness with sun based photovoltaic choice. In view of that in the present study it is attempted to build up a little scale Fresnel focal point and reflect field based sunlight based focusing power era framework where the approaching sun powered radiation is thought by Fresnel focal point and reflect field at the point of convergence of focal point. The course of action of attaching likewise gave so that the most extreme radiation can be focused on the surface of the beneficiary for the duration of the day. Presently, the creation of the entire framework is in advance. An ongoing investigation of the proposed plan is required for down to earth execution of this idea. This idea might be used additionally for vast scale execution in different mechanical parts.

Recommendations:

In the present study, the CSP based framework plan was proposed. A little scale small scale turbine framework in light of this plan can be introduced at research facility scale to examine the viable execution. Encourage a pilot size of this proposed plan might be executed to concentrate on the ongoing execution of the framework furthermore ponder its acknowledgment in the general public. Once more, the monetary examination of this outline at different scales can be done, that might be the road without bounds work.

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