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## An experiment of improvement in solar panel efficiency using solar concentration by number of mirrors

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### ABSTRACT

*Energy demand in India increasing as population growth increasing but it is difficult to fulfill energy demand as the resources are limited. India has a significant capacity for solar energy generation from renewable energy sources - solar photovoltaic, solar thermal, small water, wind, biomass, biofuels, and others. While proven technologies have emerged over the last few decades, the economic practicality of renewable energy is yet to be achieved and requires creation and adoption of innovative business and financial models. India's energy problems include: Over 40 per cent of the households in India still don't have electricity. One third of our total energy availability is from non-commercial sources (organic manure and fertilizer). Per capita energy consumption is one third of the world's average and per capita electricity consumption. India faces a supply gap of about 11% shortage and 14% of peak power shortage supply demand. Solar energy is at forefront of clean, renewable energy, and this pace is increasing due to the progress in solar panels production and efficiency as well as rapid unstable fuel costs. Photovoltaic (PV) solar cells are the most easily achievable solar technology, and they work best in bright days, in which the event does not have little or an obstacle in the sunlight. Photovoltaic (PV) technologies convert energy into electricity directly from the sunlight. Sunlight semiconductor strikes the substance and produces electrons, releasing electrons from their nuclear bonds. PV panels have no moving parts and usually live with less maintenance for twenty years or more. Landlords can set up PV panels to reduce or eliminate their monthly electricity bill, and utilities can create large "farms" of PV panels to provide pollution-free electricity to their customers. When the sun is at its highest point in the sky, then the power generation can offset the costly electricity generated when daily demand is greatest. Concentrated photovoltaic technology (CPV) uses optics such as mirrors and lenses to focus on sunlight on solar cells to generate electricity. CPV benefits on photovoltaic concentration because it is the number of solar cells required for the same power generation. With the duration and intensity of the sunlight, the temperature also puts a big impact on the performance of the PV module because high temperature reduces production efficiency. This experiment tells a practical approach to increase the efficiency of the solar panel by the number of uses of the mirror mechanism. These reflectors are cheap, easy to use, quite simple to use and no additional equipment or device is required to use. But experimental results show a remarkable increase in the overall production of solar panel. Experimental readings received from (a) without reflectors, (b) with one reflector, (c) with two reflectors and (d) with three reflectors) with numbers of reflectors are compared.*

**Keywords:** Efficiency improvement, number of mirrors, concentrated photovoltaic, four sun technology

### 1. INTRODUCTION

The 19th Century Industrial Revolution started in new technologies. The rise in inventions in that century was unprecedented in many ways. Some of these inventions included the Use of natural resources like coal and oil. The expenditure of these resources was never considered for the nature of the nature and use of these resources for environmental damage to the inventor or later generations. In relation to messing up the economic activity, dependence on coal and oil has increased at an extraordinary rate over the past few years. As a result of burning fuel, carbon dioxide and other gases are left in the atmosphere due to environmental damage. It has become mandatory to see energy technology with a new perspective. Apart from daily waste, there are generous renewable sources of energy such as air, sun, water, sea, and biomass. These sources are pollution-free and, therefore, being unlimited, clean energy.

Energy is an important input in the process of economic, social and industrial growth. Energy plays a vital role in our daily life. The degree of growth and civilization of a country measured by the utilization of energy by humans for my needs. Energy is Available in various forms like electrical energy, mechanical energy, chemical energy, heat energy and nuclear energy etc. Energy can be the removed from different resources i.e., solar energy bio-energy, human energy, mechanical energy, animal energy and kinetic energy.

Energy having many properties. At least of the energy conservation, "energy can not be made or cannot be ruined but it can be converted from one form to another. Energy can be transported from one place to another place". The energy requirement growing day by day because of the population growth, industrialization growing, and transportation growing etc.

### 1.1 Energy Crisis

An energy crisis is any significant EDDC bottleneck in the supply of energy resources to an economy. Infamous literature, it often refers to one of the energy sources used at a given time and place, especially those which are used as national fuel grids or vehicles in form of fuel.

The crisis of energy is a collective economic problem that is due to a limited supply of energy, which reduces the availability and consumers have increased costs.

India's energy consumption is increasing in one of the fastest rates of the world due to population growth and economic growth but it remains woefully constrained in terms of overall energy availability. Increasing resources and increasing the do not keep pace with energy supply the increasing demand; therefore, India is facing a shortage of serious energy. India faces an enormous requirement supply gap of about 11% energy shortage and 14% peak power shortages.

### 1.2 Energy Crisis in India

An energy crisis is also called "load shading", which is a significant hindrance in the supply of energy sets to the economy. In major writing, it often shows one of the energy sources used at a specific time and place, especially those which supply national power structures or are used in vehicles as fuels.

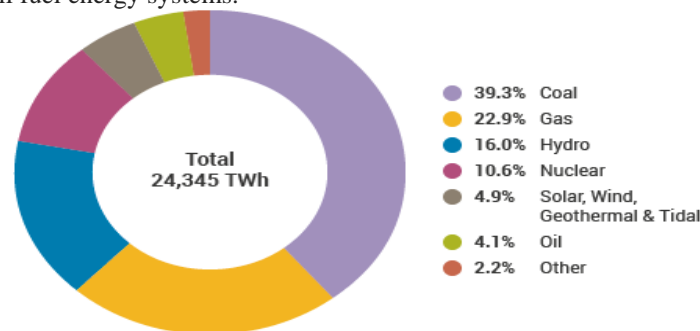
Electricity power is basic to fuel the financial development of India. The nation is on the quick direction of improvement yet to keep the force of development high; accessibility of continuous power supply is an unquestionable requirement. India needs the power to fuel the development of each industry, be it substantial scale or little scale, assembling, human services or training.

India is broadly dependent on energy imports to the meet its national energy needs. According to the evaluation of the Planning Commission, for the guarantee of 8% of the economy supported by the Government of India (GOT), 2031-32, India needs to expand its required energy supply in three to four circumstances and its power till the age of five Six conditions at the level of 2003-04 In order to limit dependence on energy imports and contribute to meeting this energy challenge, the legislature is laying in additional form.

### 1.3 The renewable energy space India

Energy is very important for the growth of any country. The energy requirement is continuously increasing with the population and demands of the population throughout the world. Due to limited availability of the conventional resources like coal, petroleum and natural gas etc, and extracted pollution caused by these resources like wind energy, solar energy, geothermal energy, bio-fuels ocean energy, magnetohydrodynamics energy etc. These energy sources will replace the fossil fuel based energy systems within some decades ahead and ultimately a durable energy system based on renewable sources will produce clean and pollution-free energy.

Most executive countries have abundant renewable energy resources, adding solar, wind, geothermal and biomass, as well as the qualification to create comparatively labor-intensive systems. By evaluating such sources of energy, developing countries can reduce dependence on oil and natural gas; Build a Weak Energy Portfolio for Price Growth In many situations, These investments may be less expensive than fossil fuel energy systems.



Source: IEA Electricity Information 2017

Fig. 1: IEA electricity information 2017

## 2. EXPERIMENTAL SETUP

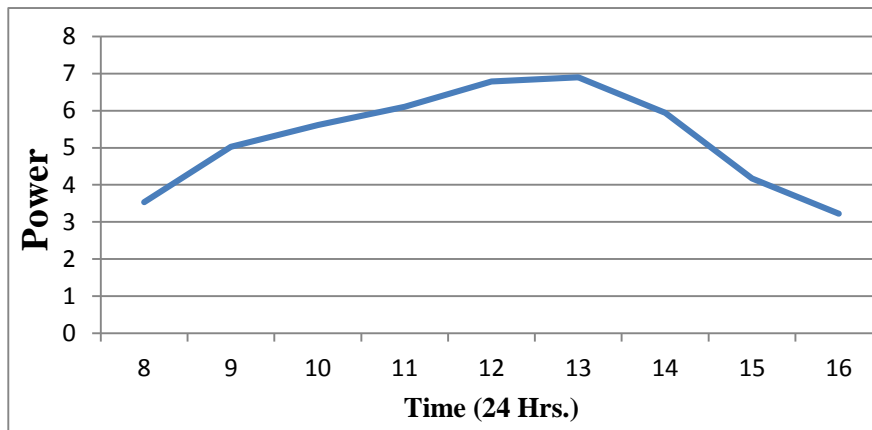
The introduced following viewpoint of improving solar panel efficiency is founded on experimental data (graph and readings) procured from four different viewpoints by using the number of mirrors. All these readings were recorded during four bright sunny days in May 2018. A monocrystalline solar panel made of silicon semiconductor was used for this experiment. An iron-made frame was built for solar panels and with space for three mirrors. One mirror from above and two from sides were reflecting solar radiation on the solar panel which was placed in the middle. This technique can be named as four sun technology also. In this experimental technique, active mirrors system was used for improving the efficiency of PV module. This analysis is based on following four methods i.e. a without mirrors, one mirror, two mirrors and three mirrors. The below table is giving information about how the performance measures of the solar cell are changing with respect to change in environmental conditions which in this case are changing concentration step by step. It can be clearly seen from the experimental readings that without concentration solar panel is even not generating its rated potency i.e. 10 watts. Only adding one mirror growing its output power approximately 1.05 watts. Similarly, output power goes on increasing by increasing concentration.

2.1 Changes in current, voltage, and power with respect to concentration

(A) Without mirror, Date: 05:05:2018

Table 1: Without mirror

Time	Voltage (V)	Current (Amp)	Power (W)
8:00 AM	10.1	0.35	3.535
8:30:AM	10.4	0.45	4.68
9:00 AM	10.7	0.47	5.029
9:30 AM	10.8	0.47	5.076
10:00 AM	11.0	0.51	5.61
10:30 AM	11.1	0.53	5.883
11:00 AM	11.3	0.54	6.102
11:30 AM	11.5	0.58	6.67
12:00 PM	11.5	0.59	6.785
12:30 PM	11.6	0.59	6.844
01:00 PM	11.7	0.59	6.903
01:30 PM	11.3	0.57	6.441
02:00 PM	10.8	0.55	5.94
02:30 PM	10.2	0.46	4.692
03:00 PM	9.7	0.43	4.171
03:30 PM	9.5	0.41	3.895
04:00 PM	9.2	0.35	3.22



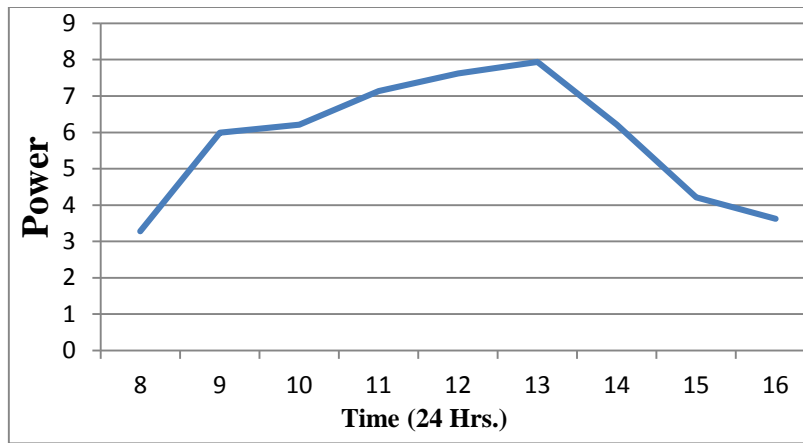
Graph 1: Changing the hourly power output of solar panel without the mirrors

Though this method was practiced by most of a few years ago people from all over the world, now one day this method is losing almost its value due to its less efficiency. In table 1 and graph 1 we find the power 6.903 watts at 1:00 pm.

(B) With one mirror; Date: 06:05:2018

Table 2: With one mirror

Time	Voltage (V)	Current (Amp)	Power (W)
8:00 AM	9.1	0.36	3.276
8:30:AM	10.1	0.43	4.343
9:00 AM	11.1	0.54	5.994
9:30 AM	11.2	0.55	6.16
10:00 AM	11.3	0.55	6.215
10:30 AM	11.5	0.56	6.44
11:00 AM	12.1	0.59	7.139
11:30 AM	12.3	0.60	7.38
12:00 PM	12.5	0.61	7.625
12:30 PM	12.6	0.61	7.686
01:00 PM	12.6	0.63	7.938
01:30 PM	12.1	0.60	7.26
02:00 PM	11.1	0.56	6.216
02:30 PM	10.2	0.48	4.896
03:00 PM	9.8	0.43	4.214
03:30 PM	9.6	0.41	3.936
04:00 PM	9.3	0.39	3.637



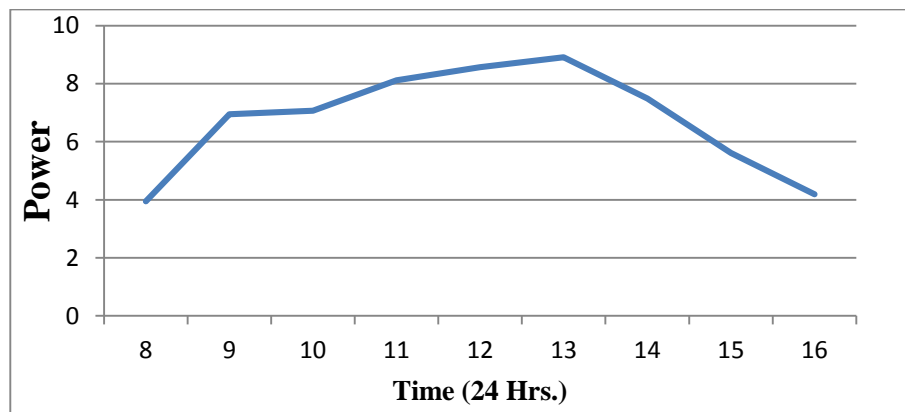
Graph 2: Changing hourly power output of the solar panel with one mirror

Since there is only one sun has the earth, therefore it can be named as the Sun to reflect the mirror. So in this matter, solar radiation is striking from two suns on the solar panel, and results are encouraging too. In graph: 2 from 8:00 am to 1:00 pm graph follows a growing trend but after the 1:00 pm following a decreasing trend. This is because when maximum immersion is achieved in these extreme hours, the maximum temperature effect dominates in these hours of the day and the potency output decreases. The collision between atoms and electrons impedes the flow of current and therefore increases the resistance, which ultimately causes temperature rise and causes a decrease in output power. It can be also checked that the solar panel's efficiency in these hours is less than the days of the rest of the day, but at the same time, this efficiency is better than using a solar panel without mirrors. In table 2 and on the graph 2 we find out the maximum potency is 7.938 watt and efficiency increases by with one mirror are 15 %.

(C) With two mirrors, Date: 07:05:2018

Table 3: With two mirrors

Time	Voltage (V)	Current (Amp)	Power (W)
8:00 AM	9.4	0.42	3.948
8:30:AM	10.0	0.47	4.7
9:00 AM	11.2	0.62	6.944
9:30 AM	11.3	0.62	7.006
10:00 AM	11.4	0.62	7.068
10:30 AM	11.6	0.63	7.308
11:00 AM	12.3	0.66	8.118
11:30 AM	12.5	0.66	8.25
12:00 PM	12.8	0.67	8.576
12:30 PM	12.9	0.67	8.643
01:00 PM	13.1	0.68	8.908
01:30 PM	12.7	0.65	8.225
02:00 PM	11.7	0.64	7.488
02:30 PM	11.0	0.55	6.05
03:00 PM	10.8	0.52	5.616
03:30 PM	10.4	0.48	4.992
04:00 PM	9.3	0.45	4.185



Graph 3: Changing hourly power output of the solar panel with two mirrors

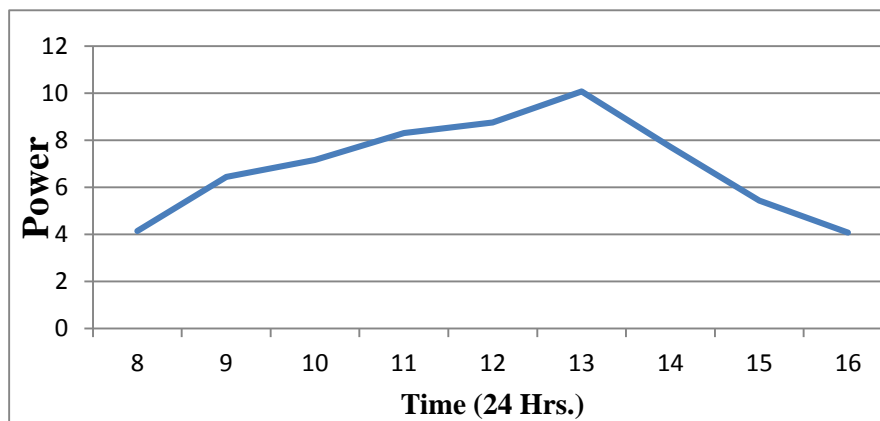
Since there is only one sun has the earth, hence the mirror can be named as the Sun to reflect. So in this matter solar radiation is striking three solar systems on solar panel and results are encouraging too. In the graph 3 at 8:00 am to 1:00 pm the graph adheres to the growing trend, but then follows the decreasing trend after 1:00 pm. This is because the maximum temperature effect in these hours is immense in these hours of the day when the immaturity is attained in these extreme hours and the power generation

decreases. Conflicts between atoms and electrons are obstructing the flow of current and thereby increasing resistance is ultimately causing a rise in temperature and decrease in production power. It can be also verified that the efficiency of the solar panel in this time these hours is less than the second hour of the day, but its capacity is better than using a solar panel without a mirror. In table 3 and on the graph 3 we find out the maximum power is 8.908 watt and efficiency increases by with two mirrors are 29.05 %.

**(D) With three mirrors, Date: 08:05:2018**

**Table 4: With three mirrors**

Time	Voltage (V)	Current (Amp)	Power (W)
8:00 AM	10.1	0.41	4.141
8:30:AM	10.7	0.50	5.992
9:00 AM	11.3	0.57	6.441
9:30 AM	12.2	0.57	6.954
10:00 AM	12.4	0.58	7.192
10:30 AM	12.6	0.58	7.308
11:00 AM	13.4	0.62	8.308
11:30 AM	13.8	0.63	8.694
12:00 PM	13.9	0.63	8.757
12:30 PM	14.1	0.67	9.444
01:00 PM	14.4	0.70	10.08
01:30 PM	14.0	0.66	9.24
02:00 PM	13.1	0.59	7.729
02:30 PM	11.8	0.57	6.726
03:00 PM	11.1	0.49	5.439
03:30 PM	10.6	0.45	4.77
04:00 PM	9.5	0.43	4.085



**Graph 4: Changing hourly power output of the solar panel with three mirrors**

Since there is only one sun has the earth, hence the mirror can be named as the Sun to reflect. So here in this matter, solar radiation has been striking on four solar panels and results are encouraging too. In graph: 4 from 8:00 am to 1:00 pm graph follows a growing trend but then after 1:00 pm follow a decreasing trend. This is because when maximum immersion is achieved in these extreme hours, the maximum temperature effect dominates in these hours of the day and the potency output decreases. Collisions between atoms and electrons are a flow of current flow and thus resistance is increasing which ultimately leads to extended in temperature and decrease in production power. It can be also verified that efficiency of the solar panel at this time these hours is less than the second hour of the day, but without it, the ability to use solar panels is better mirrored. In table 4 and on the graph 4 we find out the maximum power is 10.08 and efficiency increases by with three mirrors is 46.03 %.

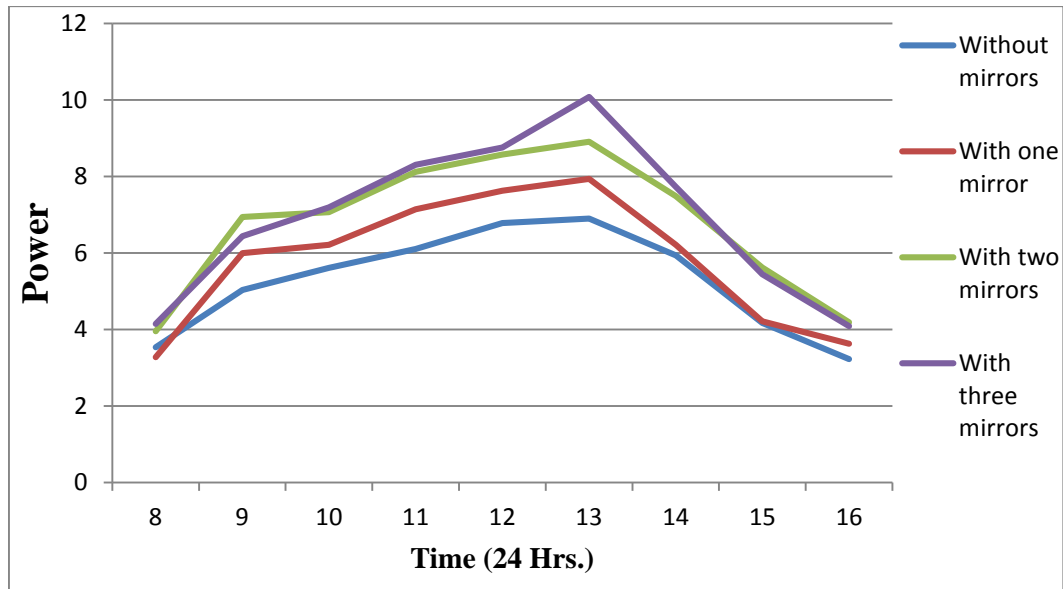
**3. RESULT**

Concentrated photovoltaic technology (CPV) uses optics such as mirrors and lenses to focus on solar cells. CPV benefits on photovoltaic concentration because it is a number of solar cells the need for the same power generation. With the duration and intensity of the sunlight, the temperature also puts a major effect on the performance of the PV module because high temperature reduces production efficiency.

**Table 5: Half hours comparison power (w) of four methods**

Time	Without mirror	One mirror	Two mirrors	Three mirrors
8:00 AM	3.535	3.276	3.948	4.141
8:30 AM	4.68	4.343	4.7	5.992
9:00 AM	5.029	5.994	6.944	6.441
9:30 AM	5.076	6.16	7.006	6.954
10:00 AM	5.61	6.215	7.068	7.192
10:30 AM	5.883	6.44	7.308	7.308
11:00 AM	6.102	7.139	8.118	8.308

11:30 AM	6.67	7.38	8.25	8.694
12:00 PM	6.785	7.625	8.576	8.757
12:30 PM	6.844	7.686	8.643	9.444
01:00 PM	6.903	7.938	8.908	10.08
01:30 PM	6.441	7.26	8.225	9.24
02:00 PM	5.94	6.216	7.488	7.729
02:30 PM	4.692	4.896	6.05	6.726
03:00 PM	4.171	4.214	5.616	5.439
03:30 PM	3.895	3.936	4.992	4.77
04:00 PM	3.22	3.627	4.185	4.085



Graph 5: Hourly power generation of solar panel is changing under four different conditions

This table is giving information about how to change the performance measures of solar cells in relation to changes in environmental conditions, which are changing the phase of phasing in this case. This experimental reading clearly shows that the solar panel is not even generating its rated power, that is, 10 watts. By adding just one mirror, its output power increases approximately 1.05 watt. Similarly, increasing the concentration, the output power is increasing.

Results obtained from this method were encouraging as for about 7 hours of the day its output power is far greater than the other explained three methods. It can be observed from the graph 5 that only for a single hour in the evening from 3:00 pm to 4:00 pm its output is below than the third method. The reason of this low power and low efficiency is that because for performing this method three mirrors was started at sharp ended at 3:00 pm to 4:00 pm as already discussed in previous sections that when electrons absorb adequate heat energy, they bump with each other and generate free electrons with other atoms. During these hours, however, the solar panel is getting solar power from the sun in the other three methods. The fourth curve of graph 5 greater than the other three curves. This method was approximately 17% more efficient than third method, 30% more efficient from the second method and efficiency increases by with three mirrors is 46.03 %.

#### 4. CONCLUSION

The results of the experiment for improving the capacity of solar panel using the number of mirrors were come out to be highly encouraging. Using three mirrors is better than the other three as efficiency is approximately 46.03% in this case. Production potency from the simple solar panel without using mirrors was maximum 6.903 watts and from solar panel with the one mirror was 7.938 watts, with two mirrors was 8.908 watts and three mirrors was 10.08 watts, this which means instead of purchasing new solar panel one can get 46.03 percent much power got from the same solar panel using this technique.

#### 5. FUTURE RECOMMENDATIONS

Of all the other four ways, the last one was efficient but it still Needs to improve. Someone can move their skills forward by following these recommendations, 46.03 percent. This will definitely increase further production power. Without the whole experiment, the following was the maximum Power Point Tracking Techniques (MPPT). So anybody can combine these three techniques to improve efficiency.

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