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Artificial Solar Tree

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Abstract

On an annual basis, yearly AQI of our environment is reducing and it is adversely affecting the human health. Along with this oxygen concentration in the atmosphere is also reducing. So, it is very important to maintain the oxygen concentration level for healthy environment.To achieve this, paper proposes the process of electrolysis of water and generate oxygen that is extracted from the water and then we can supply the extracted oxygen to a confined space. This will maintain the required oxygen level in the environment.With the exponentially incrementing pollution rates, prioritizing use of renewable energy sources with the focus that energy should not pose as a pollutant of the environment or cause natural hazards.Considering, the vision, solar energy constitutes as one of the promising alternatives.

Keywords: *Artificial Solar Tree, Solar Energy, Oxygen Concentration, Solar Panel.*

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I. INTRODUCTION

The advent of the Industrial Revolution allowed humanity to evolve into the 21st century. Science& Technology has developed rapidly, and the era of manufacturing has arrived. Industrial pollution is another impact that affects everyone. In the past, industry was primarily a small business producing smoke as a pollutant. However, since there were a certain number of factories operating at fixed hours each day, pollution did not increase much.But as these companies expanded into full-scaleoperations and manufacturing facilities, the issue of industrial pollution became more and more important. Smoke also contains gases that are bad for the atmosphere and man-made substances that destroy ecosystems. In addition, other substances thin the ozone layer and contribute to global warming. The main cause of air pollution is industrial pollutants. The World Health Organization lists lead as one of the top six air pollutants, along with particulate pollution, ground-level ozone, carbon monoxide, sulfur oxides and nitrogen oxides. Air pollution continues to affect us daily, leading to an exponential increase in many diseases.The environment and human health have suffered due to air pollution because of the proliferation of small, medium-sized, and large-scale companies. AQI isused by governments to report daily air quality. Informs about air cleanliness and pollution and potential health risks.[1] The AQI focuses on potential health effects that can occur hours or days after inhalingcontaminated air. The two pollutants that pose the greatest risk to human health are ground-level ozone and airborne particulate matter. Oxygen is used multiple times in the human body, so lack of oxygen will harm human health. This 90% of our biochemical and metabolic functions require oxygen.[2] Oxygen is necessary for the oxidation of food and releases the heat and energy needed for dailyactivities. Today there is less oxygen in the air. This is because burning fossil fuels uses up oxygen, and deforestation reduces oxygenproduction, but not enough to alter biological processes.It is an important source of energy in agriculture and other fields of modern technology, but it also contributes to the generation of pollution. Carbon dioxide, a greenhouse gas, is released into the atmosphere in large amounts when fossil fuels are burned.[3]The research method used in the project is Multiple Criteria Decision Making (MCDM).Solar energy has a significantly less negative impact on the environment than fossil fuels. Coal and natural gas are more effective in terms of application safety. The best option for electrolysis is solar energy as it is cheap, abundant, renewable and zero carbon.Furthermore, when generating electricity with solar panels, no greenhouse gases are emitted into the atmosphere.

II. MOTIVATION

2.1Effect of lack of O_2

Table 1: AQI table [2]

Daily AQI Color	Levels of Concern	Values of ex	Description of Air Quality
Green	Good	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk.
Yellow	Moderate	51 to 100	Air quality is acceptable. However, there may be a risk for some people, particularly those who are unusually sensitive to air pollution.
Orange	Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The public is less likely to be affected.
Red	Unhealthy	151 to 200	Some members of the public may experience health effects; members of sensitive groups may experience more serious health effects.
Purple	Very Unhealthy	201 to 300	Health alert: The risk of health effects is increased for everyone.
Maroon	Hazardous	301 and higher	Health warning of emergency conditions: everyone is more likely to be affected.

The table shows the air quality index ranges. As the AQI increases, the air becomes harmful to health at the same time. It may increase the risk of heart disease, respiratory disease, and lung cancer. Ozone is a major factor in causing asthma, and nitrogen dioxide and sulfur dioxide can also cause asthma, bronchial symptoms, pneumonia, and decreased lung function. Air quality must be kept within a precise range. Air purifiers are available in urban areas but are difficult or impossible to obtain in rural areas. Air purifiers are a city option, but they aren't affordable for everyone.In the Co-vid phase, people bought air purifiers as a precautionary measure to record their air quality. As an alternative to air purifiers, a more environmentally friendly and cost-effective way to oxygenate the air. [2]

2.2 Problem statement

The oxygen content in the air decreases day by day. Especially in rural areas, people's health is deteriorating due to the lack of advanced resources. People there cannot afford these advances. Also, there is no electricity.Solar energy is the most convenient way to find solutions to problems, as it is unlimited and free.

III. OVERALL WORKING

3.1 Working Principle

The conversion of one form of energy into another is one of the fundamental laws of energy conservation. A particular solar cell is made of crystalline silicon, a semiconductor material capable of producing both negatively and positively charged particles. The solar panels operate on this principle of photovoltaic effect.

To generate oxygen from water through electrolysis, a specific amount of current and voltage is required, which varies depending on the material used for the anode and cathode, among other factors. A solar panel is a device that converts available solar radiation into electrical energy. This conversion will take place by integrating the circuit with a buck and boost converter.[3] Knowing that solar energy is a highly unpredictable source of energy, a backup will be required during the night and on cloudy days. A charge controller is used to protect the battery from overcharging and undercharging.Multi Criteria Decision Making (MCDM) format is used to determine the uses of the selected components.MCDM is used to solve complex decision problems with multiple and competing objectives and criteria. It allows you to choose a single preferred alternative and create a short list of potential alternatives. The MCDM provides a framework for investigating the various components.[3]

3.2 Components

The components used in our model are Battery, Solar Panel, Charge Controller, Buck and Boost Converter, Graphite Electrodes, Copper Wires, Sulphuric Acid (H2SO4), Test Tubes, Dropper.

1] Battery

Table 2: Selection of the Battery with MCDM Method

	Weightage	25%	25%	25%	25%	
Battery	Types	Input power	Rated voltage	Life cycle	Price range	Total Efficiency
	Lead acid	180 W/KG 180/250=0.72 0.72×0.25=0.18	2.2V 2.2÷2.8=0.75 0.75×0.25=0.195	1000 1000÷2000=0.5 0.5×0.25=0.125	1500 1500÷1500=1 1×0.25=0.25	0.75= 75%
	NiCad cells	150 W/KG 150/250=0.6 0.6×0.25=0.15	1.2 V 1.2÷2.8=0.42 0.42×0.25=0.105	2000 2000÷2000=1 1×0.25=0.25	3000 1500÷3000=0.5 0.5×0.25=0.125	0.63=63%
	Lithium -ion	250W/KG 250/250=1 1×0.25=0.25	2.8 V 2.8÷2.8=1 1×0.25=0.25	400 400÷2000=0.2 0.2×0.25=0.05	2250 1500÷2250=0.66 0.66×0.25=0.165	0.71=71%

The battery stores the charge so that it can be used as a backup in the absence of sunlight or when the panel is unableto supply enough power.

There are several options available:

A. NiCad
B. Lithium Ion
C. lead acid.

NiCad cells cannot be used because their charge density is insufficient in terms of space. Furthermore, NiCad cells exhibit properties such as 'Memory effect,' in which the battery retains the smaller capacity if the NiCad cells are not fully charged and discharged. Lithium-Ion cells have a higher charge density and do not exhibit memory effects. They must be charged and discharged safely, which necessitates the use of a BMS (Battery Management System) to safely charge the individual cells while also maintaining a perfect balance between the different cells of the battery pack. However, lithium-ion cells are expensive and require maintenance.

As a result, lead acid batteries are the most practical and preferred option. They are the most used batteries in most appliances and even vehicles because the maintenance required is minimal and relatively inexpensive when compared to other types. Furthermore, because this model is mostly stationary, space would not be an issue. Lead acid batteries can also deliver large amounts of current in a short period of time. The battery used is a 12 V 7.2Ah battery that can provide 7 hours of backup under ideal conditions.

[2] Solar panel

Table 3: Selection of the Solar Panel with MCDM method

	Weightage	25%	25%	25%	25%	
Solar Panel	Types	Max power	Open circuit voltage	Short circuit current	Price range	Total efficiency
	Solar Panel KE 60	60 W 60÷60=1 1×0.25=0.25	22.10V 22.1÷22.5=0.98 0.98×0.25=0.25	3.60 A 3.60÷3.60=1 1×0.25=0.25	4000 4000÷4000=1 1×0.25=0.25	0.99=99%
	Loom Mono Crystalle SolarPanel	50 50÷60=0.83 0.83×0.25=0.20	22.5V 22.5÷22.5=1 1×0.25=0.25	2.51 A 2.51÷3.60=0.69 0.69×0.25=0.17	5538 4000÷5538=0.72 0.72×0.25=0.18	0.80=80%

There are two types of panels available:

A. Monocrystalline
B. Polycrystalline

Monocrystalline panels can provide more power and are more efficient, but also relatively expensive. Polycrystalline panels, on the other hand, produce less power but are more cost effective in small-scale applications. A 60W polycrystalline solar panel was used. The panel has the capacity to charge the lead acid battery in 6 hours. The open circuit voltage of the panel is 22.10V. The panel can provide a short circuit current of 3.60A and a maximum voltage of 18V under load conditions.

3] Solar charge controller

Table 4: Selection of the Solar Charge Controller with MCDM method

	Weightage	25%	25%	25%	25%	
Solar Charge Controller	Types	Input power	Output voltage	Output current	Price range	Total Efficiency
	10A amp Solar USBCharge Controller	480 W 480÷480=1 1×0.25=0.25	12 V 12÷12=1 1×0.25=0.25	10 A 10÷10=1 1×0.25=0.25	650 650÷650=1 1×0.25=0.25	1=100%
	6 Amp Solar Charge Controller	400 W 400÷480=0.83 0.83×0.25=0.20	12 V 12÷12=1 1×0.25=0.25	10 A 10÷10=1 1×0.25=0.2	900 650÷900=0.72 0.72×0.25=0.28	0.88=88%

The solar charge controller regulates the amount of power that enters and exits the battery. The controller has three terminal pairs.

A. The first pair, from left to right, is for the solar panel's input power.

B. The battery is connected to the second pair of terminals.

C. The third is for the load connection.

The 10A charge controller is much better the 6A charge controller as it has higher input power, and it is cost effective. On a sunny day, when the panel receives enough radiation and delivers maximum power, the controller will deliver power to the battery in a controlled manner to charge the battery. Once the battery is fully charged, the controller will bypass the battery and feed power directly from the panel to the load, using the battery only as a backup.

When the power from the panel is reduced, the controller will quickly and automatically draw power from the battery, allowing the load to continue to operate. The controller includes several safeguards to ensure that the battery is charged and discharged safely. The onboard lcd and navigation buttons can be used to set the overcharge and over discharge cutoff limits.

4] Buck and Boost Converter

Table 5: Selection of the Buck and Boost Converter with MCDM method

	Weightage	25%	25%	25%	25%	
Buck and boost converter	Types	Input voltage	Output voltage	Output current	Price range	Total efficiency
	XL 4015	4V 4÷4=1 1×0.25=0.25	1.25V 1.25÷1.25=1 1×0.25=0.25	5A 5÷5=1 1×0.25=0.25	100 100÷100=1 1×0.25=0.25	1=100%
	XL 6009	3.5V 3.5÷4=0.87 0.87×0.25=0.21	1.25V 1.25÷1.25=1 1×0.25=0.25	3A 3÷5=0.6 0.6×0.25=0.15	500 100÷500=0.2 0.2×0.25=0.05	0.66=66%

A buck boost module combines the buck and boost converters, with the input voltage first passing through the boost converter and being stepped up to the desired level.

There are several options available for buck and boost. The types that we have considered for this model are:

A. XL4015

B. XL0069

The XL4015 is superior since it is less expensive, has a higher input voltage, and a higher output current while XL0069 is costly. A specific value is then fed into the converter's buck conversion side, which lowers the voltage to the desired value. A XL4015 configuration is used to maintain higher efficiency and supported a wider output voltage range of 1.25V to 32V DC.The module will automatically switch between buck and boost modes based on the set value in order to maintain a constant DC output regardless of whether the input is higher or lower than the set value.

3.3Detailed System Working

Solar technologies carry out the conversion of energy from sunlight into electricity, either directly using photovoltaics (PV), or indirectly using concentrated solar thermal power or a combination. Photovoltaic cells convert light into an electric current using the photovoltaic effect. Solar panels (also known as "PV panels") are used to convert light from the sun, which is called "photons", into electricity that can be used to power electrical loads.

The circuit was connected in such a way that it prevented the reverse flow of energy.[4] The converted electrical energy is supplied to the charge controller, which is the brain of the entire system that will sense if there is a requirement of electrical energy at the load and supply the energy accordingly and the excess energy is supplied to the battery, where it is stored for further use in the absence of sunlight. This process of transferring the energy from the solar panel to the charge controller is carried out with the help of a buck and boost converter. It is a combination of both the buck as well as the boost converters with the input voltage first passing through the boost converter and being stepped up to a particular value and then being fed into the buck conversion side of the converter which willthen lower the voltage to the desired value. Such a configuration of first boost then buck is used to maintain a better efficiency and support a wider output range of voltage.The module will automatically shift between buck and boost modes depending on the set value to maintain a constant DC output regardless of the input being either higher or lower from the set value. Further it is supplied to conduct the process of electrolysis with the help of another buck and boost converter. During electrolysis an electrical power source is connected to two graphite electrodes, which are positioned in the water inside two test tubes. Electrolysis of pure water requires excess energy in the form of over potential to overcome various activation barriers. The inclusion of sulphuric acid, which is serving as a catalyst in this case, improves the efficiency of electrolysis. As a result, it was noticed that the graphite lead attached to the positive terminal began to corrode with time. Subsequently, Hydrogen appears at the cathode (the negatively charged electrode, where electrons enter the water), and oxygen appears at the anode (the positively charged electrode).

According to the ideal faradic efficiency, the amount of hydrogen generated is twice the number of moles of oxygen, andboth are proportional to the total electrical charge conducted by the solution and less than ideal faradic efficiency.[5] Consequently, oxygen was produced. So, to demonstrate the presence of oxygen, we measured the hydrogen content in the test tube by lighting a match at its mouth, which produced a pop sound, and the flame wasextinguished aftera ring was created in the test tube.

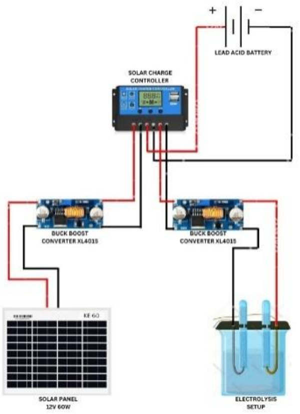

Figure 1: Pictorial representation of Solar Plant

Figure 2: Entire set up of the project

IV. MATHEMATICAL MODELLING

Table 6: Amount of Oxygen using efficiencies of different components

Intensity in watt/m^2	Efficiency of Solar Panel in %	Efficiency of Charge Controller in %	Efficiency of Battery in %	Efficiency of Chemical System (Electrolysis) in %	Amount of Oxygen produced in grams
800	13.6	80	70	14	0.24
700	13.6	80	70	14	0.21
600	13.6	80	70	14	0.18
500	13.6	80	70	14	0.15

The fig. represents the amount of oxygen produced theoretically using the efficiencies of all the components listed. The efficiencies of the components are as listed below:

I. Solar Panel – 13.6%
II. Charge Controller – 80%
III. Battery – 70%
IV. Chemical System (Electrolysis) – 14%

The efficiencies for all the components remain constant throughout. On the contrary, the intensity of the solar panel decreases with the change in time, i.e., from morning to evening.

The intensity of a solar panel ranges from 10% to 25%. The polycrystalline solar panel used here provides more power and current than the monocrystalline solar panel and it is cost effective, and it also has an efficiency of 13.6%.A solar charge controller used here has an efficiency of 80% and it has a higher input power than the other PWM type charge controllers.A lead acid battery is used here, it has an efficiency of 70% gives more power input as well as has a good life cycle and is cost effective.

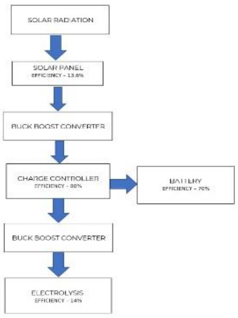

Figure 3: Block Diagram of current flow through components.

V. EXPERIMENTATION

This project used one of the basic laws of energy conservation to convert solar energy into electrical energy. Thus, oxygen was extracted.

To complete the whole project, we performed various tests and eventually came across many errors during the experiments. Initially, we used salt as a catalyst to increase the rate of electrolysis since pure water does not conduct electricity. The speed of electrolysis did increase, but the nature of salt and its reactivity during electrolysis intervened with the process. During electrolysis, the negative Cl ions reacted with the oxygen released on the anodeto form a yellow precipitate. This hindered the extraction of pure oxygen from the water. The copper wiresconnected with the negative and positiveelectrodes also corroded with time as the electrolytic cell was keptunder observation.

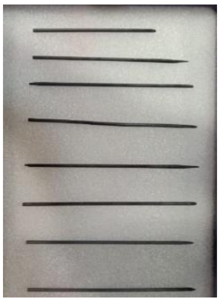

Figure 4: Graphite leads connectedto anode after electrolysis.

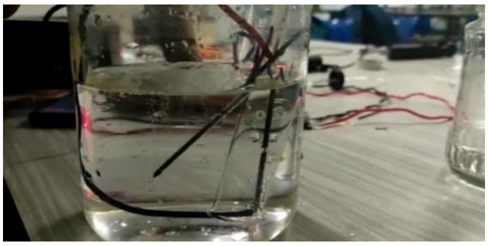

Figure 5: Formation of bubbles on the anode.

After some discussions and trial and errors, we concluded that we should consider changing the entire setup of the electrolytic cell. We used a large beaker as the container of the electrolyte, filled it with water and used two test tubes, also filled completely with water, to collect the gases. The two test tubes were inverted and placed inside the beaker filled with water and minimum invasion of air bubble was made sure during this process. The two electrodes were inserted inside each test tube along with the ends of the wires so that oxygen and hydrogen can get collected inside the test tubes. We used 10 ml of dilute sulphuric acid, which is considered one of the best catalysts for electrolysis of water. Since the acid was diluted, the process was inconveniently slow. The rate of corrosion as well as the rate of generation of gases was very prolonged. We made another setup like the previous one and added 30 ml of concentrated sulphuric acid to compare the rate of electrolysis in both the cases. To the contrary, the process in this case was extremely fast and the graphite lead corroded at a very fast rate. The speed of the reaction needed to be standard for it to be suitable to make a precise record of the readings and observations. To get a better control of the speed of the reaction, we decided to add the conc. sulphuric acid drop by drop with a definite number of drops for each reading. And successfully, the speed of reaction was improved and standardized to an impressive level which allowed us to take the readings with accuracy and provided us with more time to examine other factors such as corrosion of graphite lead, amount of gas collected in each of the two test tubes.
and the rate of collection of gases.

To generate electricity for electrolysis, we used a solar panel of 12V 60W which was connected to the buck boost converter and the charge controller. It was essential for the project to continue also during night times and cloudy days, so for that battery was mandatory as it stored energy and passed the signals further for the process of electrolysis. To prevent the backflow of the signals, the battery was connected to the charge controller. Further in the process, we performed electrolysis that gained the source from the battery which was controlled by another buck and boost converter. For electrolysis, we took a beaker filled with water at certain level and certain drops of sulphuric acid. Two test tubes filled with water were inverted inside the beaker. Next two graphite leads were attached to the anode wire as well as the cathode wire. The anode wire and the lead attached was carefully placed inside one of the test tubes so that both the anode and cathode would be separated. To complete the whole process of electrolysis we added certain number of drops of concentrated Sulphuric acid as a catalyst and noted down the readings. We changed the water after each reading for perfect results. Later, we collected oxygen in one test tube as well as hydrogen in another test tube. Later, to check the gas we emptied the test tube and carefully took out from the beaker by covering the mouth of the test tube and made sure that the gas inside it could not escape. We then burnt a matchstick and brought closer towards the mouth of the test tube which extinguished a flame forming a ring inside the test tube and resulted into a pop sound. This is how we extracted oxygen.Below shown is the observation table of the corrected readings:

Table 7: Observation Table

Catalyst used (Sulphuric acid)	SR. NO	Time Interval			Volume of Water			Length of Lead		Time interval of Hydrogen
		Electrolysis	Corrosion	Initial	Final	Difference	Initial	Final	Difference	
50 Drops	1	3 Seconds	7 Minute 23Seconds	656 mL	632 mL	24 mL	9 cm	8.2 cm	0.8 cm	16 Minutes 18 Seconds
	2	3 Seconds	3 Minutes 24 Seconds	648 mL	632 mL	16 mL	9 cm	8.8 cm	0.2 cm	15 Minutes 44 Seconds
	3	5 Seconds	7 Minutes 32 Seconds	648 mL	640 mL	8 mL	9 cm	8.8 cm	0.2 cm	16 Minutes 60 Seconds
60 Drops	1	34 Seconds	1 Minute 15 Seconds	632 mL	616 mL	16 mL	9 cm	8.8 cm	0.2 cm	10 Minutes 59 Seconds
	2	17 Seconds	1 Minute 2 Seconds	640 mL	616 mL	24 mL	9 cm	8.5 cm	0.5 cm	10 Minutes 59 Seconds
	3	12 Seconds	1 Minute 36 Seconds	640 mL	624 mL	16 mL	9 cm	8.8 cm	0.2 cm	10 Minutes 1 Second
70 Drops	1	8 Seconds	25 Seconds	648 mL	632 mL	16 mL	9 cm	8.5 cm	0.5 cm	10 Minutes 7 Seconds
	2	9 Seconds	30 Seconds	648 mL	640 mL	8 mL	9 cm	8.5 cm	0.5 cm	10 Minutes 2 Seconds
	3	12 Seconds	58 Seconds	640 mL	632 mL	16 mL	9 cm	8.7 cm	0.3 cm	10 Minutes 9 Seconds

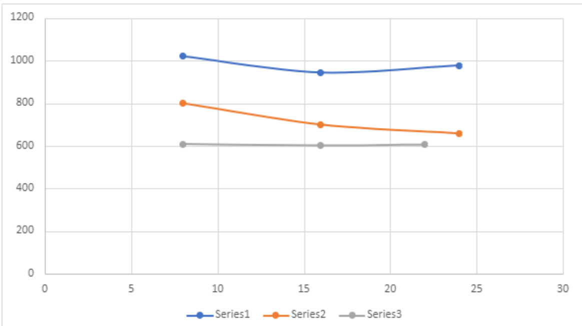

Figure 6: Shows a Volume of Water vs Time Interval Graph based on the readings acquired during the Experimentation process. The blue line depicts the curve created by adding 50 drops of catalyst in the electrolytic cell, the orange line shows the curve created by adding 60 drops of catalyst in the electrolytic cell and the grey line depicts the curve created by adding 70 drops of catalyst in the electrolytic cell.

VI. CONCLUSION

The paper suggests a methodical solution of oxygen deficiency in a room. It mentions the aspects of need of oxygen, motivation, components, and circuit design, along with the entire description of experimentation. The results of the experimentation included evolution of oxygen for supply in the room and release of hydrogen as a fuel.

REFERENCES

[1]. https://www.iqair.com/in-en/india/maharashtra/mumbai/
[2]. https://www.airnow.gov/aqi/aqi-basics/
[3]. Prof. Ishan Upadhyay, Soham Pal, Rohan Kolhe, Aabha Kadam, Nishant Choudhary, Jose Akkarapatty, Samay Shetty, Udbhav Kamath, Ved Gaikwad, "Solar Charger: A Green Way of Synthesizing & Using Energy", International Journal of Scientific & Engineering Research, https://www.ijser.org/researchpaper/Solar-Charger-A-Green-Way-of-Synthesizing-Using-Energy, Volume 12, Issue 11, November-2021.
[4]. B.Chaitra, M. Spoorthi, M. Sushmitha, H. S. Darshitha, S. Divya, "Artificial Solar Oxygen Tree", Journal of Emerging Technologies and Innovative Research (JETIR), https://www.jetir.org/view?paper=JETIREH06012, Volume 7, Issue 10, October 2020.
[5]. P.S. Deshmukh, P.P. Pawar, M.H. Chavan, S.B.Jadhav, Prof. P.D. Desai, Prof. V.V. Jadhav, "Artificial Solar Oxygen Tree", 13th International Conference on Recent Innovations in Science, Engineering and Management, http://data.conferenceworld.in/NMCOE18/71, 23 February 2018.
[6]. Deepak Sharma, Ravindra Kumar Jain, Mukesh Kumar Gupta, Hemant Sharma, "Performance Evaluation and Utilization on the Solar Steam Generation System for the Cooking Process in the Composite Climate", International Journal of Science and Research (IJSR), https://www.ijsr.net/search_index_results_paperid.php? id=SR201021153005, Volume 9 Issue 11, November 2020, 86 – 93
[7]. M. Srinivasan, A.Velu, B. Madhubabu, "Potential Environmental Impacts of Solar Energy Technologies", International Journal of Science and Research (IJSR), https://www.ijsr.net/search_index_results_paperid.php? id=ART20197856, Volume 8 Issue 5, May 2019, 792 – 795
[8]. George W. Crabtree and Nathan S. Lewis, "Solar energy conversion", Physics Today 60, 37-42 (2007) https://doi.org/10.1063/1.2718755
[9]. Keskar Vinaya N., 2013, Electricity Generation Using Solar Power, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) Volume 02, Issue 02, February 2013.
[10]. Monica Banik, Rajwant Kaur, Jyotsna Jacob, "An Explorative Study to Assess the Usage of Smart Phone and its Impact on the Health among Adolescents Attending Selected Colleges of Gurugram, Haryana", International Journal of Science and Research (IJSR), https://www.ijsr.net/search_index_results_paperid.php? id=SR20427140922, Volume 9 Issue 5, May 2020, 284 – 287
[11]. Nirma Kumari Sharma, "A Review Paper on Green Power Generation Using Renewable Energy Sources without Pollution", International Journal of Science and Research (IJSR), https://www.ijsr.net/search_index_results_paperid.php? id=ART20198767, Volume 8 Issue 6, June 2019, 1579 – 1582
[12]. Norton B, "Full-energy-chain analysis of greenhouse gas emissions for solar thermal electric power generation systems" Renewable Energy, pp.131-136, Vol. 15, 1998. [8] A Gekas, V., N. Frantzeskaki, and T. Tsoutsos. "Environmental impact assessment of solar energy systems. Results from a life cycle analysis." In Proceedings of the International Conference" Protection and Restoration of the Environment VI" Skiathos, July, pp. 1-5. 2002.
[13]. Iea, International Energy Agency. Renewable Energy Working Party. Benign energy?: the environmental implications of renewables. OECD Publishing; 1998. [10] Tsoutsos, Theocharis, Niki Frantzeskaki, and Vassilis Gekas. "Environmental impacts from the solar energy technologies."Energy policy 33.3, 289-296,2005.
[14]. Tsoutsos T. Environmental Impact Assessment Foe Energy Projects. educational notes, Environmental Department, Technical University of Crete, Chania. 2001.
[15]. Caves, Richard E., and Richard E. Caves. Multinational enterprise and economic analysis. Cambridge university press, 1996.
[16]. Johansson TB, Kelly H, Reddy AK, Burnham L, editors. Renewable energy: sources for fuels and electricity. Island press; 1993.
[17]. Glasson, John, and RikiTherivel. "Introduction to environmental impact assessment", Routledge, 2013.
[18]. Theodoratos PC, Karakasidis NG. Hygieneoccupational safety and environmental protection. Ion, Athens, 1997.
[19]. Rossa, Birgit, and Dieter J. von Willert. "Physiological characteristics of geophytes in semi-arid Namaqualand, South Africa." Plant Ecology vol.142, pp.121-132,1999.
[20]. Polit DJ, Maldonado D, Dávalos, "Solar might not always be a green source of energy" Procedia Engineering. vol.145, pp.611-21, 2016.
[21]. Roni George, Arun Ouseph Babu, "Environmental Impacts of Solar Energy Technologies", Imperial International Journal of Eco-Friendly Technologies, Vol.1-1, pp-75-79, 2016.
[22]. Wireless Power Transmission for Solar Power Satellite (SPS) (Second Draft by N. Shinohara), Space Solar Power Workshop, Georgia Institute of Technology.
[23]. LaportaLD.Cellular telephones: a new addiction .Journal of psychiatric Times 2006 Oct 1,23