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Sustanaibility: Green Water Processing Through Solar Energy in the Context of Indian Law: A Greener Way to Get Clean Water

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Abstract

Sustainability means using resources in such a way that lasts for a long time and guarantee that are available for generation and they get everything they want from the environment. Green water processing and solar energy combination is an important and strong step towards the sustainable future. It reduces depends on fossil fuels and has zero minimal negative impact on the environment. Solar energy is more sustainable. It is produced by nuclear fusion in the sun. It cuts the cost in treating water and helps communities succeed. If we adopt solar powered water treatment plant we treat the water in the planet with it deserves from us. Green water processing referes to different concepts including the use of microalgae in hydroponics to improve water efficiency and it does not use any chemical element in treating water. Using solar energy in water resources will reduce the dependency on conventional energy sources. It will help in solving the pure water crisis in remote areas. It also help in creating social justice. Green water processing contributes in a sustainable future by reducing waste water and treating waste and treating waste water and using resources more efficiency through methods like gray water recycling, rain water harvesting and bio-treatment. It is environment friendly process. India's efforts towards sustainability in green water processing and solar energy are driven by a comprehensive legal and regulatory frame work that includes central and state Acts, national mission and financial incentives.

Keywords: Environment, Sustainability, Green water processing, Solar energy, Fossil fuel

Laws Using solar energy in water treatment is helpful in sustainable development. Treating water through the Solar energy, cuts the cost and helps society thrive. By adopting Solar water treatment plants, we not just treat water, we treat whole earth with the care it deserves. Solar power is not going anywhere. If we mix solar energy with water treatment, we will have a Greener way to Get clean water.

Sustainability refers to society's ability to exist and develop without depleting the natural resources necessary to live in the future.[1]

Sustainability is the ability to maintain or support a process over time. Sustainability is often divided into three main concepts: economic, environmental, and social.

Sustainability means using natural resources in a way that doesn't deplete them and causes no long term environmental or social harm. Sustainability is the ability to maintain or support a process over time. Sustainability is often divided into three main concepts.

These three concepts are - Economic, Environmental, and Social.

The "5 C's of Sustainability" –

For sustainable future we have to think on a broad level that includes every aspect of our lives.

The **"5 C's** of Sustainability" are – Clean, Community, Culture, Care, and Corporate Governance [2]

1. CLEAN

The first "C" stands '**Clean**' – an acknowledgment of our responsibility to nurture and protect our planet. This promote clean energy, reduce waste, and minimize our carbon footprint. For a cleaner world, we must shift towards renewable energy sources like solar, hydroelectric power and wind. We should encourage practices like composting, recycling and conserving water can positively reduce environmental pollution. Ultimately, for sustainability a clean earth is the foundation.

2. COMMUNITY

The second "C" represents for 'Community'. Sustainability is not a solo concept; it needs a collective action. A sustainable community promotes shared values, inclusivity, and mutual support. By working together, communities can provide various local solutions to global challenges like food insecurity, climate change, and social inequality. Through community gardens, co-housing projects, or through local sustainability initiatives, the power of community cannot be underestimated towards a sustainable future.

3. CULTURE

Culture, the third "C", is about embracing diversity and fostering a culture of sustainability. Culture acts as a driver by influencing behaviours, it provides context for solutions and it supports all three pillars of Sustainability through creative economics, education, traditional knowledge, and social cohesion, making development more people- centered and resilient.

4. CARE

'Care', the fourth "C", is at the heart of sustainability. It includes care for the environment, care for each other, and care for future generations. It means being kind and responsible to people

and the planet. Conserve the natural resources and caring the earth for the future generations.

5. CORPORATE GOVERNANCE

The final "C" represents 'Corporate Governance. Businesses play a crucial role in sustainability. This system directs and controls companies, in this boards of directors, management, and shareholders are included. It ensures transparency & Accountability , stakeholder Interests and ethical Conduct that preventing corruption and unfair practices.

What are the '6 Rs' of sustainability?

The '6 Rs' are Reduce, Reuse, Recycle, Refuse, Rethink and Repair. These terms can lead a more sustainable life and may decrees our impact on the environment:[3]

- **Reduce** – Reduce refers to cutting down the amount of materials we consume.
- **Reuse** – Before buying new items to replace the old, ask yourself if they can be reused or repurposed before you discard them.
- **Recycle** – If we must discard of something, it can usually be recycled, and the materials can be reused to make something else.
- **Refuse** – 'Refuse' means refraining from buying and using things that you don't need.
- **Rethink** – Before you buy another product, rethink – do I really need it?
- **Repair** – It's easy to replace items when they break or wear away, but before we do, we need to consider if they can be repaired.

Sustainable development Goals

The world's 10 best and worst performing countries in the UN Sustainable Development Goals Index 2025. [4]

Europe dominates the SDG 2025 Index, with Europe dominating the top 10, and Nordic countries ranking the top, with Finland standing first this year, followed by Sweden and Denmark.

East and South Asian countries have made remarkable strides in achieving their socioeconomic goals, showcasing the most significant progress since 2015 in Nepal, which improved by 11.1 points; Cambodia, which gained 10 points; and the Philippines, which increased by 8.6 points, among others.

India has achieved a significant milestone by entering the top 100 for the first time in the history of the index. Ranking ***99th*** in 2025 with a score of ***67.0,*** India has improved steadily over the past four years, rising from 109th in 2024, 112th in 2023, 121st in 2022, and 120th in 2021.[5]

How does Solar energy help in Sustainable Development by treating water?

Renewable energy means energy that we get from a source that is not depleted when used, such as wind or solar power. Solar energy is a type of energy which is generated by the Sun. Solar energy is produced by nuclear fusion occurring in the Sun. Fossil fuels which take millions of years to form the sun's energy is constantly available. Solar energy is important for sustainable development. Solar energy improves social equity by providing access to affordable and clean energy specially in remote areas.

PROCESS OF TREATING WATER THROUGH SOLAR ENERGY

Various methods are used to treat water using solar energy, including solar distillation for purification and desalination, solar-powered filtration using PV panels to power reverse osmosis or other filters, solar disinfection (SODIS) which uses UV radiation to kill microbes, and solar pasteurization which uses heat

to kill pathogens. These methods range from simple, low-tech approaches like solar stills and SODIS bottles to more complex systems that combine solar electricity with mechanical filtration or UV disinfection.

PROCESS OF TREATING WATER THROUGH SOLAR ENERGY

The SODIS (Solar Water Disinfection) method uses sunlight and transparent plastic bottles to kill pathogens in contaminated water. It involves filling PET bottles with water and exposing them to direct sunlight for at least six hours, using a combination of UV radiation and heat to inactivate bacteria, viruses, and parasites. The process is simple, inexpensive, and effective for small volumes of low-turbidity water, making it a vital tool in developing countries, but it does not remove chemicals or physical particles. [6]

How to perform SODIS

- **Use the right bottles:** Use clear, transparent plastic PET bottles (ideally 2-liter size). Avoid bottles with high turbidity or those with a "#7" plastic code.
- **Clean the bottles:** Ensure the bottles are clean and free of any scratches or residue.
- **Fill and shake:** Fill the bottles about three-quarters full and cap them, then shake for about 20 seconds to saturate the water with oxygen, which aids the disinfection process.
- **Fill completely:** Fill the bottles completely and close them tightly.
- **Place in sunlight:** Lay the bottles horizontally in direct sunlight for at least six hours. A reflective surface like corrugated iron can help accelerate the process by increasing temperature.
- **Extend time if needed:** If the weather is cloudy, extend the exposure time to 48 hours.

SOLAR WATER DISTILLATION [7]

The method relies on sunlight, so its effectiveness is limited on very cloudy days. Solar water distillers or solar stills are usually used in remote areas where there is limited access to freshwater. The basic principles of solar water distillation are simple, yet effective, as distillation replicates the way nature makes rain. A solar still works on two **scientific principles**: evaporation and condensation. The salts and minerals do not evaporate with the water. For example, table salt does not turn into vapour until it gets to a temperature over 1400ºC. However, it still does take a certain amount of energy for water to turn into water vapour. While a certain amount of energy is needed to raise the temperature of a kilogram of water from 0ºC to 100ºC, it takes five and one-half times that much to change it from water at 100ºC to water vapour at 100ºC. Practically all this energy, however, is given back when the water vapour condenses.

Most stills are simple black bottomed vessels filled with water and topped with clear glass or plastic. Sunlight that is absorbed by the black material speeds the rate of evaporation. The evaporation is then trapped by the clear topping and funneled away. Most pollutants do not evaporate, so they are left behind. Most stills need to be about six square meters in size to produce enough water for a single person for a day. Multiple solar distillation systems are required to produce a large quantity of distilled water.

Solar Based Reverse osmosis water purification system [8]

Getting clean drinking water is a fundamental human right, but in many rural communities, particularly in areas with limited access to electricity yet it remains a significant challenge. Traditional water treatment methods such as boiling and chlorination can be ineffective and costly, leading to waterborne diseases and health problems. Solar-based RO water purification systems offer a sustainable and cost-effective solution to this challenge by utilizing solar energy to power the water treatment process. The solar-based RO water

purification system will consist of solar panels, a pre-treatment process, a reverse osmosis membrane, a post treatment process, and a storage tank for the purified water. The pre-treatment process will remove any large particles, sediment, and contaminants, while the reverse osmosis membrane will remove dissolved minerals and impurities. The post-treatment process will ensure that the water meets the required standards for drinking water.

Solar Photocatalytic wastewater treatment: In this method solar energy is used to activate a photo catalyst for example titanium dioxide that produces reactive oxygen species which break down organic pollutants and kill microorganisms in the water.

Photovoltaic-Solar Water Disinfection (SOLWAT)

In PV-solar water disinfection (SOLWAT), system, several conversion mechanisms occur for two final applications (PV to generate electricity and heat and UV to disinfect). As a result, this system has low energy consumption and good performance.

Legal frame work in India

On 28 July 2010, the United Nations (UN) General Assembly recognised the human right to water and sanitation, declaring that clean drinking water and sanitation are essential to fulfil all human rights. In September

(SDGs) in the 2030 Agenda action plan. There are 17 SDGs and all work towards "ending poverty in all its forms". They are the successors of the Millennium Development Goals (MDG) signed in 2000, but these new goals incorporate a specific sixth SDG on water. SDG6 aims to **"Ensure availability and sustainable management of water and sanitation for all"** and includes eight global targets related to management of natural water resources, wastewater, and the environment. The first target is to "Achieve access to safe and affordable drinking water" before 2030 since water accessibility is not guaranteed for a significant 29% of humanity. For example, 844 million people still lack access to safe drinking water, and approximately 1000 children die each day due to diseases related to unsafe drinking water or sanitation. Furthermore, availability of water is becoming more unreliable and problematic due to the effects of the climate crisis, the water demand of an ever-increasing population, the expansion of cities, and the developing economy.[9]

In India there is no any particular law related to it. There are legal frame works and Govt. policies that promotes the renewable energy. Legal and Policy Framework

The use of solar energy for water treatment falls under existing general laws and specific government schemes aimed at solar adoption and environmental protection:

- **Indian Constitution and Sustainable Development**:

Article 21 The judiciary has interpreted **sustainable development** as an integral part of the right to life. Article 21 of the Indian Constitution guarantees the right to life and personal liberty, stating that no person can be deprived of their life or personal liberty except according to a procedure established by law. This is a fundamental right available to both citizens and non-citizens and has been interpreted by the Supreme Court to include the right to live with dignity. The right to a healthy environment is considered a fundamental right derived from Article 21 of the Constitution, which protects life and personal liberty. Although not explicitly stated as a separate right in the original text, the Supreme Court of India has interpreted the "right to life" under Article 21 to include the right to a clean, healthy, and pollution-free environment essential for a life of human dignity. The Supreme Court has explicitly included the right to pollution-free water and air as part of the right to life. Cases like the M.C. Mehta litigation series

established principles such as absolute liability for hazardous industries to protect the public's right to life and health.[10]

In water treatment plant that uses solar energy helps in keeping environment healthy because it does not use any chemical to treat water.

Articles 48A and 51A(g) Through Articles these Articles Constitution directs the state to protect and improve the environment and requires citizens to do the same. The judiciary has interpreted **sustainable development** as an integral part of the right to life.[11]

India's E-Waste (Management) Rules, 2022, came into force on April 1, 2023. It establishes a comprehensive(EPR) Extended Producer Responsibility regime for over 100 types of electronic equipment. It also includes solar panels. This indirectly supports the long term viability of solar use in water treatment. These rules mandate producers to manage solar photovoltaic (PV) modules and cells until their end-of-life, establishing targets for recycling and responsible disposal.

- **Environmental Protection Acts**: The Water (Prevention and Control of Pollution) Act, 1974 and the Environment Protection Act, 1986 are general Acts that provide the legal basis for regulating water quality and pollution, and it is the core concern of water treatment through solar energy.

Govt. policies for Renewable:

- **Jal Jeevan a Mission** [12]
- Government of India in partnership with States/ UTs, is implementing Jal Jeevan Mission (JJM)–Har Ghar Jal to make provision of potable tap water supply to every rural household in the country by 2024. In the Operational Guidelines for the implementation of Jal Jeevan Mission, following provisions have been made regarding use of renewable energy for water supply in villages by States/ UTs:
- i.) explore for installation of solar energy powered standalone water supply system in scattered/ isolated/ tribal/ hilly villages;
- preferably use solar power pumping arrangements for single village water supply schemes; and
- explore for conjunctive use of solar power based pumping system in multi-village water supply schemes.
- Under Jal Jeevan Mission, to enable States/ UTs to test water samples for water quality, and for sample collection, reporting, monitoring and surveillance of drinking water sources, an online JJM – Water Quality Management Information System (WQMIS) has been launched, wherein States/ UTs also report information about water quality testing laboratories. The WQMIS is in public domain. All these laboratories have been opened to public to enable them to get their water samples tested. State-wise details of drinking water quality testing laboratories is at Annex.
- Drinking water supply is a State subject and powers to plan, approve, implement, operate and maintain rural water supply schemes including treatment plants, are vested with States. Further as provided under JJM, in-village water supply systems are to be managed by Gram Panchayats and/ or its sub-committee i.e. Village Water & Sanitation Committee (VWSC) or Pani Samiti. To enable rural local bodies/ Panchayati Raj Institutions to shoulder this responsibility, out of 15th Finance Commission grants to rural local bodies, 60% is earmarked as tied fund for water and sanitation for the period 2021-22 to 2025-26.

PM – Surya Ghar: Muft Bijli Yojana: It provides subsidies for residential solar panel and its installation, which can be used for various household needs. It includes water treatment systems.

Grid Connected Rooftop Solar Programme: This program promotes solar energy installation on a larger scale, which can be integrated with community water treatment infrastructure.
National and State-level Regulations: Various state and national policies exist that mandate Renewable Purchase Obligations (RPOs), which drive the demand for renewable energy generation, including solar.

Benefits

1. Good for the Environment and Long-Term Sustainability
2. Saves Money Over Time
3. Works Great in Remote Areas
4. Reliable and Needs Less Maintenance

Disadvantages

High Start-Up Cost

a. The Sun Doesn't Always Shine
b. Need for Some Know-How
c. Rate of distillation is usually very slow (6 litres of water per sunny day).
d. It is not suitable for larger consumptive needs.

Summary

Sustainability is today's need without compromising the future generation need. Indian laws promote sustainable development by reducing **carbon footprint** by shifting process of fossil fuels to solar. Water treatment processes have a lower environmental impact, contributing to climate change.
Solar-powered water purification and desalination technologies can provide clean water in remote or saline-prone areas, addressing water scarcity and contributing to SDG 6 (Clean Water and Sanitation). Using solar energy for water treatment reduces reliance on traditional energy sources, improving energy security and resilience. The E-Waste Management Rules encourage a circular economy for solar panels, which is a key aspect of sustainable development by focusing on reuse, recycling, and proper end-of-life management. It is Environment-friendly, low operation and maintenance cost.

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