



Introduction of Cleaner Production and Sustainable Development Goals

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Abstract: Cleaner production (CP) is a proactive strategy to reduce waste, emissions, and resource usage. This strategy seeks to boost output, save expenses, and enhance environmental performance, all supporting sustainable growth. Using cleaner production methods can assist in achieving United Nations Sustainable Development Goals (SDGs) of the United Nations, which include lowering poverty, promoting sustainable consumption and production, reducing sustainable consumption and production, and reducing climate change. This review discusses the concept of cleaner production, its benefits, and its role in achieving sustainable development goals.

Index Terms: Cleaner production, Sustainable development, Pollution management, Environmental protection

1 HISTORY OF CLEANER PRODUCTION

The idea first developed in the late 1970s and has since grown into a widespread movement that is changing how businesses and entire industries function. The need for sustainable production methods was first acknowledged at the 1972 Stockholm United Nations Conference on the Human Environment. This is where one of the earliest references to cleaner production can be found. The UNEP called as United Nations Environment Programme and the International Cleaner Production Network (ICPN) both helped to develop the idea's momentum in the 1980s and 1990s [1], [2].

The majority of the polluting businesses were founded at a time when raw materials were abundant, and sinks for waste disposal were similarly endless. Passive waste management techniques were widespread up to the 1960s and included:

1. "Foul and Flee" was a method of environmental migration that involved relocating from degraded places to the most practical and resourceful location. In the past, people would simply relocate if an area became uninhabitable due to environmental degradation.
2. Dilute and Disperse: This method was solely based on the idea that the environment was assimilative. Because of this, industries would discharge effluents into vast bodies of water, like seas, hoping that the ocean would somehow dilute the effluent.
3. Concentration and containment: The idea informs numerous widely used waste management strategies, including landfills. It has been determined, though, that the "contained" wastes frequently manage to leak into the environment.

As the human population increased, fewer materials were available, and the waste issue started to receive more attention. Thus, passive waste management techniques were not desired. Instead, methods that were proactive and reactive were preferred.

Reactive action examples include:

1. End-of-pipe approach: In the 1970s, this strategy was the most popular because it included cleaning pollutants and waste at the ends of emission pipes.
2. The onsite recycling method gained popularity in the 1970s since it involved gathering, processing, and reusing raw materials that would have otherwise been disposed of as waste. Fig. 1. Shows the Background of the cleaner production.

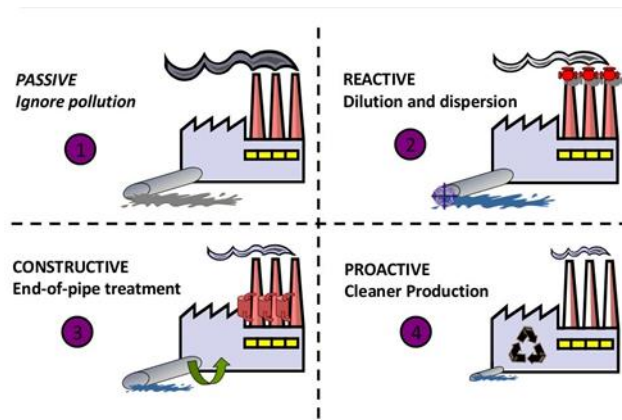


Fig. 1. Background of Cleaner Production [3]

Environmentalists were increasingly focused on a proactive approach after the 1990s, anticipating and preventing waste before production [4].

Both the United Nations Industrial Development Organization (UNIDO) and the United Nations Environment Programme (UNEP) set out to pilot preventive environmental measures in powerful developing nations after the 1992 United Nations Conference on Environment and Development (UNCED) in Rio. After their successful completion, UNIDO and UNEP initiated an initiative to create National Cleaner Production Centers (NCPCs). In 1994-1995, the first group of eight NCPCs was founded [5].

2 HISTORY OF SUSTAINABLE DEVELOPMENT GOALS

We need to reorient the global economy from one characterized by growing disparities, social exclusion, and severe environmental risks to one that promotes sustainable development.

1962, The Silent Spring- The world was made aware of the adverse effects of chemical pesticides on the environment by publishing Rachel Carson's book "Silent Spring" in 1962, which also inspired the emergence of a worldwide environmental movement. The most influential book on the environment of the 20th century is generally regarded as Silent Spring.

During the Santa Barbara Oil Spill, numerous animals were killed when more than 15 million liters of oil were spilled onto the California shore seven years later, in January 1969.

The world focused on this catastrophe because it was the worst oil spill. It served as a further reminder that humans are responsible for protecting the ecosystem. This prompted 20 million people to gather on April 22, 1970, for the first Earth Day.

1972, The Limits to Growth- Main purpose of event to bring up environmental issues that the media and policy had ignored. Environmentalists began to form "green" political movements in the form of activist non-governmental organizations and environmentalist political parties.

As a result, the "Conference on the Human Environment" was held in Stockholm in 1972. Being on a collision course with the economy and the environment was acknowledged for the first time at this assembly of UN member states. Environmental dangers were reaching previously unheard-of levels due to the growing impact of human activity on nature. The MIT (Massachusetts Institute of Technology) and the Club of Rome jointly published "The Limits to Growth" that year, shocking the entire world. Our civilization would likely collapse before 2100, according to the first research to question the viability of ongoing development in the human ecological footprint.

From International organizations to “normal” People - Since more people became aware of environmental issues, the modern green movement promoted environmental and social principles and altered government policies.

Many people worldwide joined the movement and started calling for policy reforms, particularly in opposition to the expansion of nuclear power. The devastating catastrophe at Three Mile Island, followed by the one in Chernobyl, and the fight against deforestation in the Amazon and Indonesia were milestones.

1983, The Brundtland Commission - The "Brundtland Commission" was established by the UN in 1983, under the direction of Dr. Gro Harlem Brundtland, in response to concerns about unsustainable economic growth. "Our Common Future" This commission's 1987 report defined the phrase "sustainable development. "During the "Earth Summit" in 1992, sustainable development was accepted as a universal ideal. At the time of the Rio+20 meeting, the United Nations member nations were implementing the Millennium Development Goals (MDGs). As such, it became widely accepted that the Millennium Development Goals (MDG) era would be succeeded by the Sustainable Development Goals (SDG) era, which would run from 2015 to 2030. These goals have been the subject of negotiations [6].

3 WHAT IS CLEANER PRODUCTION

The continual application of an integrated preventive environmental strategy to processes, products, and services is known as cleaner production (CP). Fig. 2. Shows the cleaner production definition. It aims to improve overall effectiveness while lowering human and environmental hazards [7].



Fig. 2. Cleaner production definition [8]

Cleaner production (CP), initially aimed at producing less waste, has developed into a notion of enhancing resource efficiency in manufacturing. A collection of precautionary management guidelines that aim to safeguard the environment from the adverse effects of goods and production methods might be called the cleaner production idea. Additionally, the idea of CP may be seen as something that can be used throughout a product or service's whole lifecycle, expanding the idea of well-being to include future generations of people. The idea is sufficiently broad to cover a variety of instruments, ranging from eco-design to lean production techniques. Hence, it is feasible to say that this idea is connected to preserving resources and the environment by adopting strategies, styles, and technologies to reduce or completely eradicate the environmental aggression of specific corporate processes and products. The idea is primarily focused on manufacturing systems. Still, it is considered broad enough to encompass people's consumption habits because everyone can reduce waste production, increase material recycling, and, most importantly, choose products with consideration for their environmental impact and awareness of how different companies operate [9].

4 WHY CLEANER PRODUCTION

Although environmental technologies have considerably reduced emissions (at least per product), cleaner production (CP) starts with the understanding that these technologies are expensive and require additional inputs of materials, energy, and labor. Hence, environmental technologies do not provide the industry with any financial incentives. On the other hand, they frequently result in higher manufacturing costs and a regulated approach. Investments made by the sector in nations with laxer legislation may help it avoid using environmental technologies.

On the other hand, cleaner production attempts to lessen both the adverse effects on the environment and the operational costs. In place of end-of-pipe solutions, Cleaner Production employs process-integrated, preventive measures.

To reduce or minimize dangers to people and the environment, "cleaner production" is a conceptual and procedural approach to production that mandates that all stages of a product's or a process' life cycle be handled.

Although some basic approaches to adopting CP in businesses exist, each has unique challenges.

5 FIVE BASIC PRINCIPLES OF CLEANER PRODUCTION

The proper use of resources is necessary for cleaner production. This includes careful resource efficiency, controlling the flow of materials, and resource replacement.

Five broad principles of cleaner production can be outlined:

- Input-Substitution - utilizing less hazardous operating, auxiliary, or raw resources. Use of equipment with a longer lifespan.
- Good Housekeeping- Maximize the process's material and energy efficiency, Reduce leakage-related losses as an example of "low-hanging fruit" to try to capture first. It is crucial to train staff.
- Internal recycling - closed the material and energy loops for substances like water and solvents, The cascading of energy and material streams.
- Technological Optimization/Change - the application of new technology, better control over the process, remodeling of operations, Modification or replacement of potentially hazardous processes.
- Optimization of the Product - extending the lifespan, easier to fix, more accessible recycling, deposition, or de-manufacturing, utilization of non-hazardous materials.

Recycling – For effective resource management, cyclic material flows must be set up and running smoothly. External recycling refers to actions after production (an open loop), where the material may be supplied into various processes. In contrast, internal recycling refers to actions within a process (a closed loop). Reduced material purchases result from internal Recycling. Materials acquired in quantity are unaffected by external recycling. Lastly, even if it occurs at the exact industrial location, using waste or emissions in another operation is not considered recycling.

Internal recycling includes:

- Use resources again for the same purpose, such as solvents.
- Reusing materials for new uses (for example, paper or solvents for pre-cleaning).
- Completing loops (with water).
- Numerous-way systems (packaging materials)
- Reclaiming precious materials.

6 HOW TO IMPLEMENT CP MEASURES IN COMPANIES

Learn the procedure first, then go on. Essential tasks include:

- Specify the process components, such as cleaning, etching, bonding, and rinsing in the case of electroplating.
- Recognize the linkages between the process's chemical and physical components.
- Create a flowchart showing all (!) the input, output, and interaction streams (quantitative).
- Examine the most crucial material streams in further detail.
- Look at the cross-media effects already in place.

Determine the process' weak areas:

It is easier to persuade businesses to act if the financial rewards are apparent immediately; therefore,

pinpoint the opportunities for process improvement.

Longer term, cleaner production will transform from a continuous improvement process to a process of production redesign. The objective is to achieve zero emissions, in which all raw materials are converted into finished goods sold or used in other methods [10], [11].

7 WHAT ARE THE SUSTAINABLE DEVELOPMENT GOALS?

According to a broad definition, sustainable development is "development that satisfies present needs without adversely affecting the power of future generations to satisfy their own needs." [12]. The Sustainable Development Goals (SDGs), sometimes called the Global Goals, were enacted by the United Nations in 2015 as a global call to action to eliminate safeguard the environment, poverty, and guarantee that by the year 2030, prosperity and peace will be experienced by all. The 17 SDGs understand that development must balance all the social, economic, and environmental sustainability aspects that actions in one area will impact results in others. Governments have agreed to give those who are falling behind the most priority while making progress. The SDGs aim to eradicate AIDS, hunger, poverty, and prejudice against women and girls. The SDGs must be achieved in every context, requiring the entire population's creativity, knowledge, technology, and financial resources [13]. Fig. 3. Shows the sustainable development goals.



Fig. 3. Sustainable Development Goals [14]

The 17 SDGs are as follows:

1. No Poverty
2. Zero Hunger
3. Good Health and Well-being
4. Quality Education
5. Gender Equality
6. Clean Water and Sanitation
7. Affordable and Clean Energy

8. Decent Work and Economic Growth
9. Industry, Innovation, and Infrastructure
10. Reduced Inequalities
11. Sustainable Cities and Communities
12. Responsible Consumption and Production
13. Climate Action
14. Life Below Water
15. Life On Land
16. Peace, Justice, and Strong Institutions
17. Partnerships for the Goals

Goal 1

NO POVERTY - One of humanity's biggest challenges is eliminating poverty in all forms. Too many people still struggle to meet even the most basic survival needs, despite the fact that the number of human living in extreme poverty decreased by more than half between 1990 and 2015. Over 736 million people, many of whom lack food, clean drinking water, and sanitary facilities, continued to live on less than USD 1.90 per day as of 2015. Although millions of people have been lifted out of poverty by rapid growth in nations like China and India, development has been uneven. Because females have less paid employment, less education, and less property ownership than men, women are more likely to be impoverished. The SDGs represent a strong promise to complete what we began and eradicate poverty in all of its forms and manifestations by 2030. Targeting the most disadvantaged, expanding access to fundamental resources and services, and assisting communities hit by natural and man-made disasters are all part of this [13], [15].

Goal 2

ZERO HUNGER - Due to accelerated economic growth and increasing agricultural output, the number of individuals who lack adequate nutrition has decreased by approximately half over the past two decades. The nutritional demands of many emerging nations that once experienced famine and starvation can now be met. Extreme hunger is now a thing of the past in Central and East Asia, Latin America, and the Caribbean. By 2030, the SDGs hope to eradicate all types of hunger and malnutrition, ensuring that everyone, especially children, has enough food throughout the year. This entails encouraging sustainable farming, helping small-scale farmers, and ensuring that everyone has access to markets, technology, and land. International collaboration is also necessary to ensure that money is invested in technology and infrastructure to increase agricultural output.

Goal 3

GOOD HEALTH AND WELL-BEING - The 2030 Agenda acknowledges the complexity and interdependence of both good health and sustainable development. It accounts for growing economic and social disparities, increased urbanization, climatic and environmental risks, the ongoing impact of HIV and other infectious diseases, as well as new problems, including non-communicable diseases. In order to achieve SDG 3, which calls for eradicating poverty and decreasing inequality, universal health care is essential. Action is also required to address new global health problems, such as antibiotic resistance, that the SDGs do not expressly address.

Goal 4

QUALITY EDUCATION - The goal of universal elementary education has advanced significantly since 2000. In 2015, the global percentage of children not in school decreased by nearly half, while in developing countries the total enrolment rate reached 91 percent. In addition, the number of girls enrolled in school is at an all-time high, and literacy rates have also increased. Each of these accomplishments is noteworthy. Realizing inclusive and high-quality education for everyone confirms the notion that it is one of the most potent and effective engines of sustainable development. By 2030, this objective will guarantee that all boys and girls have received free elementary and secondary education. In addition, it seeks to achieve gender and wealth equality, equal access to affordable vocational training, and universal access to top-notch higher education.

Goal 5

GENDER EQUALITY - Additionally being a fundamental human right, stopping all forms of discrimination against girls and women is essential for a sustainable future. It has been demonstrated that empowering women and girls promotes economic growth and development. Throughout the past 20 years, due to UNDP's commitment to gender equality, there has been a notable advancement in this area. Compared to 15 years ago, there are more girls attending school now, and gender parity in elementary education has been achieved in the majority of regions.

Goal 6

CLEAN WATER AND SANITATION - Around 40% of people experience water scarcity, and this worrying number is expected to increase as temperatures rise. The availability of drinking water is decreasing across all continents, despite the fact that 2.1 billion people have improved their sanitation since 1990. Water stress is a problem in a growing number of nations, and the drought and desertification problems are already getting worse. It is anticipated that by 2050, at least one in four individuals will experience ongoing water shortages. By 2030, we must invest in suitable infrastructure, offer sanitization services, and promote good hygiene practices to deliver safe and inexpensive drinking water to everybody. Ecosystems involving water must be preserved and restored.

Goal 7

AFFORDABLE AND CLEAN ENERGY - The percentage of individuals with access to electricity rose from 78 to 90 percent between 2000 and 2018, while the number of those without it fell to 789 million. Yet, as the population increases, so will the need for inexpensive energy, and a fossil fuel-based economy is causing significant alterations to our environment.

If we want to reach SDG 7 by 2030, we must invest in thermal, wind, and solar power, increase energy productivity, and ensure that everyone has access to energy.

Infrastructure development and technological advancements that deliver cleaner, more efficient energy in all nations will promote economic development and benefit the environment.

Goal 8

DECENT WORK AND ECONOMIC GROWTH - The SDGs support increased productivity, technological innovation, and steady economic growth. Effective strategies to end forced labor, slavery, and human trafficking are essential to this, as are encouraging entrepreneurship and job creation. The objective is to, by 2030 achieve decent work for all women and men and achieve full and productive employment.

Goal 9

INDUSTRY, INNOVATION, AND INFRASTRUCTURE - Infrastructure and innovation spending are essential factors for economic expansion and progress. Since cities now hold more than half of the world's population, the importance of mass transit, renewable energy, the development of new industries, and information and communication technologies is only increasing. In order to create new jobs and encourage energy efficiency, for example, technological advancement is essential to addressing both economic and environmental problems in a long-term manner. Investing in scientific research and innovation, as well as promoting sustainable industries, are all crucial ways to support sustainable development. 90% of those who currently lack Internet connections are from the developing world, where there are more than 4 billion people. For there to be equitable access to information and knowledge, as well as to encourage innovation and entrepreneurship, this digital divide must be closed.

Goal 10

REDUCED INEQUALITIES - Income inequality is increasing; the top 10% earn up to 40% of the world's income, while the bottom 10% only make between 2 and 7%. When population growth is taken into account, inequality has risen by 11% in developing nations. Global responses are required to address income disparity. This entails strengthening the oversight and regulation of financial markets and institutions, promoting development aid, and promoting foreign direct investment in areas with the highest need. Another crucial factor in closing the gap between groups is to make it safer for people to move around and migrate.

Goal 11

SUSTAINABLE CITIES AND COMMUNITIES - Most of people reside in urban areas. Two-thirds of the entire human population—6.5 billion people—will live in cities by 2050. Sustainable development cannot be accomplished without fundamentally altering how we design and maintain our urban environments. Mega-cities are on the rise, especially in the developing world, as a result of the fast urbanization brought on by rising populations and increased migration. Slums are also playing a bigger role in urban life. Creating business and employment opportunities, safe and affordable housing, and resilient societies and economies are all necessary for sustainable city development. It entails funding investments in public transportation, developing green public areas, and enhancing urban planning and management in inclusive and participatory ways.

Goal 12

RESPONSIBLE CONSUMPTION AND PRODUCTION - To accomplish this goal, it's crucial to focus on managing our common natural resources effectively, as well as how we get rid of toxic waste and pollutants. Equally critical is encouraging businesses, industries, and consumers to recycle and minimize waste, as well as helping emerging nations shift by 2030 to more sustainable consumption patterns. Yet, a significant percentage of the world's population consumes too little to cover their most basic needs. For more effective manufacturing and supply chains, reducing global food waste per person at the store and consumer levels is crucial. This can improve food security and move us toward an economy that is more resource-efficient.

Goal 13

CLIMATE ACTION - Providing assistance to vulnerable areas will directly support both Goal 13 and the

other SDGs. Efforts to include disaster risk reduction measures, sustainable resource management, and human security in national development strategies must coexist with these actions. With strong political will, greater investment, and the use of current technology, it is still conceivable to keep the rise in the global mean temperature to 2°C above pre-industrial levels, with the goal of 1.5°C, but this calls for swift and aggressive group action.

Goal 14

LIFE BELOW WATER - Around 30% of the carbon dioxide created by humans is absorbed by the oceans, and since the start of the industrial revolution, ocean acidification has increased by 26%. Marine pollution is at alarmingly high levels, with 13,000 pieces of plastic garbage on every square kilometer of water, the majority of which originates from land-based sources. The SDGs seek to manage marine and coastal ecosystems sustainably, safeguard them against pollution, and deal with the effects of ocean acidification. International law can aid in improving ocean conservation and sustainable resource use, which will lessen some of the problems that our seas are facing.

Goal 15

LIFE ON LAND - Both the land and the ocean are essential to human life for sustenance and subsistence. Humans depend on agriculture as a significant source of economic resources and consume 80% of their food from plants. A 3rd of the Earth's surface is covered by forests, which are key for preventing climate change, as well as being home to millions of species and important sources of clean air and water. In order to ensure climate change mitigation and adaptation, global food and water security, and peace and security, it is imperative that immediate action be taken to limit the loss of natural habitats and biodiversity, which are a part of our shared legacy.

Goal 16

PEACE, JUSTICE, AND STRONG INSTITUTIONS - The SDGs seek to drastically cut down on all types of violence and engage with communities, governments, and other organizations to put an end to conflict and insecurity. Supporting the rule of law and human rights, as well as stopping the supply of illegal armaments, is essential to this process, as is enhancing the participation of developing nations in the global governance institutions.

Goal 17

PARTNERSHIPS FOR THE GOALS - The globe is more interconnected than ever. Increasing information and technological availability is a crucial step in encouraging innovation. For sustainable growth and development, it is essential to coordinate policies that support debt management in developing nations and encourage investment in the least developed regions. By assisting national initiatives to meet all targets, the goals seek to improve North-South and South-South cooperation. Promoting international commerce and assisting developing nations in growing their exports is important. To achieve a global, rules-based, and equitable trading system that is just and open to all [13], [16].

8 SUSTAINABLE DEVELOPMENT AND CLEANER PRODUCTION

Cleaner production, pollution avoidance, etc. are all parts of the idea of sustainable development, which identifies the fundamental issue that the other ideas aim to solve: The ecosystem can only take so much

abuse before it starts to deteriorate, so society must take precautions to make sure that today's progress doesn't stop future development from happening. The function of industry and industrial pollution is clear, despite the fact that there are other concerns at hand. To prevent future generations from being unable to meet their demands, industrial systems and individual businesses will need to alter. Hence, rather than being a tactic for doing business, sustainable development is the long-term objective of each company [10].

Sustainable development and cleaner production are linked ideas that are increasingly acknowledged as being essential elements of international efforts to address environmental and social issues. Through lowering waste, pollutants, and resource use, cleaner production seeks to reduce the negative effects of industrial processes, goods, and services on the environment. While meeting the demands of the present generation without compromising the capacity of future generations to satisfy their own needs, sustainable development is a bigger notion. There are numerous ways that cleaner production advances sustainable development objectives (SDGs). Its contribution to the cause of environmental sustainability the one that stands out the most. Cleaner production can lessen the effects of industrial activities on the air and water quality, biodiversity, and other ecosystem services that are essential for human well-being and economic development. This is done by lowering waste and emissions. Moreover, more sustainable development can be achieved through the conservation of natural resources, including energy, water, and raw materials. Cleaner production can also aid in reducing poverty and promoting economic growth, which is another way it helps advance the SDGs. Cleaner manufacturing can help firms become more competitive, which can result in the creation of jobs and economic growth by decreasing expenses connected with waste disposal and pollution control. Less exposure to harmful substances and pollutants can also improve the health and well-being of workers and communities as a result of cleaner production. In terms of specific SDGs, Goals 12 (Responsible Consumption and Production) and 9 (Industry, Innovation, and Infrastructure) and in the 2030 Agenda for Sustainable Development of the United Nations are particularly applicable to cleaner production. While Goal 12 calls for sustainable patterns of consumption and production, Goal 9 emphasizes the necessity of sustainable industrialization and innovation. Cleaner production is a crucial method. To accomplish both of these objectives [17], [18].

9 CONCLUSION

In conclusion, fulfilling the Sustainable Development Goals (SDGs) and advancing sustainable development depend greatly on cleaner production. Cleaner production emphasizes maximizing resource efficiency, eliminating waste, and lowering emissions in manufacturing processes, which can assist companies in decreasing their environmental impact and enhancing their financial performance. The SDGs offer a framework for accomplishing these objectives. In contrast, sustainable development is a larger term that includes economic, social, and environmental sustainability. Businesses may help achieve various SDGs, such as those pertaining to, climate action, clean water and sanitation, cheap and clean energy and responsible consumption and production, by using cleaner production techniques. Governments may encourage cleaner manufacturing through incentives and legislation, and consumers can help by purchasing goods that are made responsibly. Fostering a more just, equitable, and sustainable future for all depends on cleaner production and sustainable development. By pursuing these objectives, we may improve the present and the future for the current and upcoming generations.

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