MODULE 2

ENVIRONMENTAL MANAGEMENT OBJECTIVES

2.1 ENVIRONMENTAL QUALITY OBJECTIVE

This includes a good living environment, good standards of public health, the safeguarding of biological diversity and long-term ecosystem productivity, and conservation of the natural and cultural landscape.

There are 16 environmental quality objectives.

- **i.** Reduced Climate Impact
- **ii.** Clean Air
- **iii.** Natural Acidification only
- **iv.** A Non-Toxic Environment
- **v.** A Protective Ozone Layer
- **vi.** A Safe Radiation Environment
- **vii.** Zero Eutrophication
- **viii.** Flourishing Lakes and Streams
- **ix.** Good-Quality Groundwater
- **x.** A Balanced Marine Environment, Flourishing Coastal Areas
- **xi.** Thriving Wetlands
- **xii.** Sustainable Forests
- **xiii.** A Varied Agricultural Landscape
- **xiv.** A Magnificent Mountain Landscape
- **xv.** A Good Built Environment
- **xvi.** A Rich Diversity of Plant and Animal Life

i. Reduced Climate Impact

- The UN Framework Convention on Climate Change - stabilization of concentrations of greenhouse gases in the atmosphere at level - ensure that human activities do not have a harmful impact on the climate system
- Goal achieved - biological diversity is preserved, food production is assured and other goals of sustainable development
- All countries, must have responsibility for achieving global objective

ii. **Clean Air**
The air must be clean enough not to represent a risk to health or to animals, plants or cultural assets.

iii. **Natural Acidification Only**

- Acidifying effects of deposition and land use must not exceed the limits that can be tolerated by soil and water.
- Deposition of acidifying substances must not increase the rate of corrosion of materials or cultural artefacts and buildings

iv. **A Non-Toxic Environment**
The environment must be free from man-made or extracted compounds and metals that represent a threat to human health or biological diversity

v. **A Protective Ozone Layer**
The ozone layer must be replenished so as to provide long-term protection against harmful UV radiation

vi. **A Safe Radiation Environment**
Human health and biological diversity must be protected against the harmful effects of radiation in the external environment.

vii. **Zero Eutrophication**
Eutrophication is caused by excessive levels of nitrogen and phosphorus, it increases algal blooms that block light from getting into water and harm plants and animals. It also prevents oxygen from getting into water, making it hypoxic and creates dead zone where no organisms survive. Therefore, environmental quality objective is aimed at zero eutrophication.

viii. **Flourishing Lakes and Streams**

- Lakes and watercourses must be ecologically sustainable and its variety of habitats must be preserved
- Natural productive capacity, biological diversity, cultural heritage assets and the ecological and water-conserving function of the landscape must be preserved, at the same time as recreational assets are safeguarded

ix. **Good-Quality Groundwater**
Groundwater must provide a safe and sustainable supply of drinking water

x. **A Balanced Marine Environment and Flourishing Coastal Areas**

- The sustainable productive capacity, and biological diversity must be preserved

- Coasts must be characterized by a high degree of biological diversity and a wealth of recreational, natural and cultural assets
- Industry, recreation and other utilization of the seas, coasts must be compatible with the promotion of sustainable development
- Particularly valuable areas must be protected against encroachment and other disturbance.

xi. Thriving Wetlands

The ecological and water-conserving function of wetlands in the landscape must be maintained and valuable wetlands preserved for the future

xii. Sustainable Forests

The value of forests and forest land for biological production must be protected, at the same time as biological diversity and cultural heritage and recreational assets are safeguarded

xiii. A Varied Agricultural Landscape

The value of the farmed landscape and agricultural land for biological production and food production must be protected, at the same time as biological diversity and cultural heritage assets are preserved and strengthened

xiv. A Magnificent Mountain Landscape

- The pristine character of the mountain environment must be largely preserved, in terms of biological diversity, recreational value, and natural and cultural assets
- Activities in mountain areas must respect these values and assets, with a view to promoting sustainable development
- Particularly valuable areas must be protected from encroachment and other disturbance

xv. A Good Built Environment

- Cities, towns and other built-up areas must provide a good, healthy living environment and contribute to a good regional and global environment
- Natural and cultural assets must be protected and developed
- Buildings and amenities must be located and designed in accordance with sound environmental principles and in such a way as to promote sustainable management of land, water and other resources

xvi. A Rich Diversity of Plant and Animal Life

- Biological diversity must be preserved and used sustainably for the benefit of present and future generations
- Species habitats and ecosystems and their functions and processes must be safeguarded

- Species must be able to survive in long-term viable populations with sufficient genetic variation
- People must have access to a good natural and cultural environment rich in biological diversity, as a basis for health, quality of life and wellbeing

2.2 RATIONALE OF ENVIRONMENTAL STANDARDS

- Environmental standards are administrative regulations or civil law rules implemented for the treatment and maintenance of the environment.
- Environmental standards should preserve nature and the environment, protect against damage, and repair past damage caused by human activity.
- Environmental standards are typically set by government and can include prohibition of specific activities, mandating the frequency and methods of monitoring, and requiring permits for the use of land or water.
- Standards differ depending on the type of environmental activity.
- Historically, the development of environmental standards was influenced by two competing ideologies: eco-centrism and anthropocentrism.
- Eco-centrism frames the environment as having an intrinsic value divorced from the human utility, while anthropocentrism frames the environment as only having value if it helps humanity survive. This has led to problems in establishing standards

  - In recent decades, the popularity and awareness of environmentalism has increased with the threat of global warming becoming more alarming than ever since the Intergovernmental Panel on Climate Change (IPCC) released their report in 2018.
  - The report asserts that based on scientific evidence “if human activities continue to at this rate it is predicted to increase in-between 1.5-2 °C over pre industrial levels in-between 2030 and 2052”.

- Busby argues that Climate change will define this century and that it is no longer a faraway threat. In turn, the demand for protecting the environment has risen.
- Developments in science have been fundamental for the setting of environmental standards. Improved measurements and techniques have allowed scientists to better understand the impact of human-caused environmental damage on human health and the biodiversity which composes the natural environment
- Therefore, environmental standards in modern times are set with the view that humans do have obligations toward the environment, but they can be justified in terms of obligations toward other humans. This means it is possible to value the environment without discarding anthropocentrism. Sometimes called prudential or enlightened anthropocentrism.
- This is evident as environmental standards often characterize the desired state (e.g. the pH of a lake should be between 6.5 and 7.5) or limit alterations (e.g., no more than 50% of the natural forest may be damaged). Statistical methods are used to determine the specific states and limits the enforceable environmental standard.
- Penalties and other procedures for dealing with regions out of compliance with the standard may be part of the legislation

2.3 CONCENTRATION AND MASS STANDARDS

Concentration

- Concentration is the mass of a pollutant in a defined volume of water.

Mass

- Mass is the amount of a pollutant that is discharged into a water body during a time (i.e. tons of sediment per year)

Both concentration and mass standards provide information of environmental significance.

2.4 EFFLUENT AND STREAM STANDARDS

2.4.1 EFFLUENT STANDARDS

- They are generally established for the effluent from industry and municipality wastewater treatment plants to be discharged into streams, land, sewers, ocean, etc.

- Effluent standard system is carried out to control the following stream standard system.
- No detail stream analysis is required to determine exact amount of waste treatment; effluent standard can serve as a guide to establish the stream classification or during organization of any pollution abatement program.
- Unless the effluent standards are upgraded, this system does not provide any effective protection for an over loaded stream.
- The main disadvantage of this standard type is that there is no control over the total volumeof polluting substances added to the stream daily.

parameter	**Unit**	**Effluent discharge standards**						
		Africa				**Asia**		
		Nigeria	Tanzania	Ghana	Uganda	Thailand	Malaysia	India
Temp.	C	40	NA	NA	35	40	40	NA
pH	-	6-9	6.5-8.5	6-9	6-8	5.5-9	5.5-9	6.5-8.5
BOD	mg O2/L	30-50	30	50	50	20-60	50	30
COD	mg O2/L	60-90	60	250	100	120-400	100	250
Oil and grease	mg/L	10	5	5	10	5-15	10	10
DS	mg/L	200	3000	1000	1200	3000	NA	NA
SS	mg/L	25	100	50	100	50	100	50-100
Total N	mg/L	10	10	NA	10	NA	NA	10

2.4.2 STREAM STANDARDS

- The system is based on establishing classification or standard quality for a stream & regulating any discharge to the extent, necessary to maintain the established stream classification or quality
- The primary objective of stream standards is to protect and preserve each stream for its best usage on a equitable basis for both upstream & downstream uses.
- The stream standard system is the prevention of excessive pollution regardless of type of industry or other factors such as location of industry or municipality.
- Pollution abutment should be considered in the decisions concerning location of a plant just as carefully as the labors, transportation, market & other conditions.

- It also allows the public to establish goals for maintaining quality of water for present as well for future needs.

S.NO.	Parameter	Requirement desirable Limit	Remarks
1.	Colour	5	May be extended up to 50 if toxic substances are suspected
2.	Turbidity	10	May be relaxed up to 25 in the absence of alternate
3.	pH	6.5 to 8.5	May be relaxed up to 9.2 in the absence
4.	Total Hardness	300	May be extended up to 600
5.	Calcium as Ca	75	May be extended up to 200
6.	Magnesium as Mg	30	May be extended up to 100
7.	Copper as Cu	0.05	May be relaxed up to 1.5
8.	Iron	0.3	May be extended up to 1
9.	Manganese	0.1	May be extended up to 0.5
10.	Chlorides	250	May be extended up to 1000
11.	Sulphates	150	May be extended up to 400
12.	Nitrates	45	No relaxation
13.	Fluoride	0.6 to 1.2	If the limit is below 0.6 water should be rejected, Max. Limit is extended to 1.5
14.	Phenols	0.001	May be relaxed up to 0.002
15.	Mercury	0.001	No relaxation

Emission Standards

- **Emission standards** are never-exceed levels applied directly to the quantities of emissions coming from pollution sources.
- Emission standards can be set on a wide variety of different bases. For example:
- Emission rate (e.g., kilograms per hour),
- Emission concentration (e.g., parts per million of biochemical oxygen demand, or BOD, in wastewater),
- Percentage removal of pollutant (e.g., 60-percent removal of waste material before discharge).
- In the language of regulation, emission standards are a type of performance standard, because they refer to end results that polluters who are regulated must achieve.

Ambient Standards

- An **ambient standard** is a never-exceed level for a pollutant in the ambient environment.
- For example, an ambient standard for dissolved oxygen in a particular river may be set at 3 parts per million (ppm), meaning that this is the lowest level of dissolved oxygen that is to be allowed in the river.

Ambient vs. Emission Standards

- Setting emission standards at a certain level does not necessarily entail meeting a set of ambient standards. This is due to naturally occurring processes.
- Sometimes the environment will convert a certain type of pollutant into something more damaging. As a result, ambient environmental quality depends on emissions and natural degradation. This is often the case with organic pollutants.
- Researching the link between emission levels and ambient quality levels is a major part of environmental science.

Pollutant	Time weighted average	Concentration of Ambient Air		
		Industrial area	Residential rural & other area	Sensitive area
Sulphur dioxide (SO_2)	Annual[a]	80 μg/m^3	60 μg/m^3	15 μg/m^3
	24 h[b]	120 μg/m^3	80 μg/m^3	30 μg/m^3
Oxides of nitrogen (NO_2)	Annual[a]	80 μg/m^3	60 μg/m^3	15 μg/m^3
	24 h[b]	120 μg/m^3	80 μg/m^3	30 μg/m^3
Suspended Particulate Matter (SPM)	Annual[a]	360 μg/m^3	140 μg/m^3	70 μg/m^3
	24 h[b]	500 μg/m^3	200 μg/m^3	100 μg/m^3
Respirable Particulate Matter (size Less than 10 μm) RPM	Annual[a]	120 μg/m^3	60 μg/m^3	50 μg/m^3
	24 h[b]	150 μg/m^3	100 μg/m^3	75 μg/m^3
Lead as Pb	Annual[a]	1.0 μg/m^3	0.75 μg/m^3	0.50 μg/m^3
	24 h[b]	1.5 μg/m^3	1.0 μg/m^3	0.75 μg/m^3
Carbon monoxide	8 h[b]	5.0 mg/m^3	2.0 mg/m^3	1.0 mg/m^3
	1 h	10.0 mg/m^3	4.0 mg/m^3	2.0 mg/m^3

2.5 MINIMUM NATIONAL STANDARDS (MINAS)

1976 – CPCB developed the concept of evolving industry-specific effluent standardsBased on a comprehensive study of the problems of the industry.

An attempt was made

- o To identify relevant pollution parameters
- o Its pollution potential
- o Best pollution control technologies available in India

MINAS contemplated a minimum level of treatment for specific industrial wastewater – based on

- Annual turnover of the industry.
- Techno-economic feasibility of the control objective.
- Initially textile and man-made fibers were studied and standards were set
- Later included oil refineries, chloroalkali etc.,
- Disposal specificity was not a part of MINAS.
- Standards were considered to be minimum standards that a specific industry should achieve irrespective of the mode of disposal.
- In Environmental Protection Act 1986, some of these standards were incorporated
- Since these were minimal standards – SPCB were permitted to make them only stringent and in no case relax them.

2.6.1 Advantages of MINAS

- Appear to be simple and direct.
- Apparently set clearly specified targets.
- Appeal to people's sense of getting environmental pollution reduced immediately.
- Are consistent with our ethical sense that pollution is bad and ought to be declared illegal.
- Conform to an operation of the legal system, which is to define and stop illegal behaviour.

2.6 ENVIRONMENTAL PERFORMANCE EVALUATION

Environmental Performance Evaluation (EPE) is "an internal process and management tool designed to provide management with reliable and verifiable information on an ongoing basis to determine whether an organization's environmental performance is meeting the criteria set by the management of the organization".

EPE, as detailed in International Standard, follows a "Plan-Do-Check-Act" management model.

2.7.1 The steps of this ongoing process are the following:

1. Plan

- Planning EPE;
- Selecting indicators for EPE

Using data and information that includes:

- collecting data relevant to the selected indicators;
- analyzing and converting data into information describing the organization's environmental performance;
- assessing information describing the organization's environmental performance in comparison with the organization's environmental performance criteria;
- Report and communicate information describing environmental performance.

2. Check and Act

Reviewing and improving EPE.

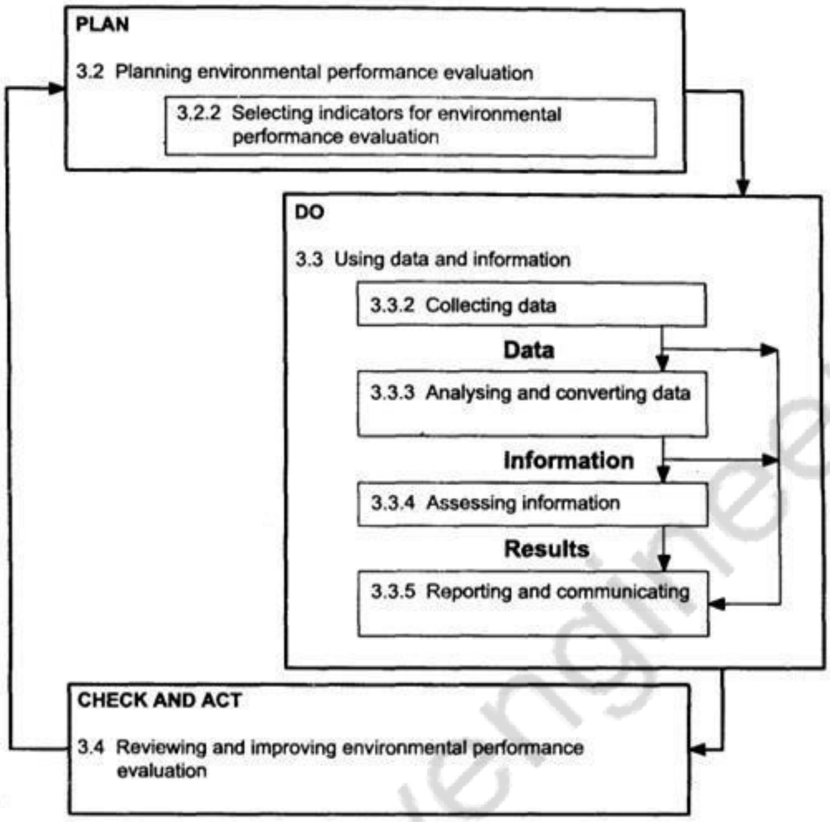


Figure 1 — Environmental performance evaluation

2.7.2 ENVIRONMENTAL PERFORMANCE INDICATORS

EPI provides information that helps evaluation and decision-making within organizations that engage in environmental efforts.

2.7.2.1 OBJECTIVES OF EPI

- To measure and evaluate environmental burdens, environmental problems that need to be solved and outcomes of environmental efforts comprehensively in order to promote environmental activities of organizations and to obtain information that helps decision making regarding these activities.
- To provide a common foundation of information between an organization and interested parties in order to facilitate that interested parties, such as consumers, business partners, residents in local communities, shareholders, and financial institutions, understand environmental activities of the organization

- To provide a common foundation of information for macro-level environmental policies of the national and local governments

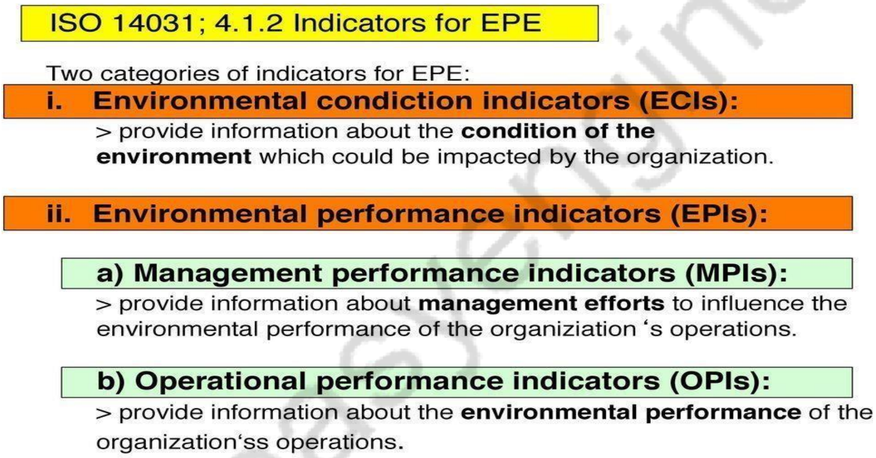
2.7.2.2 TYPES OF ENVIRONMENTAL PERFORMANCE INDICATORS

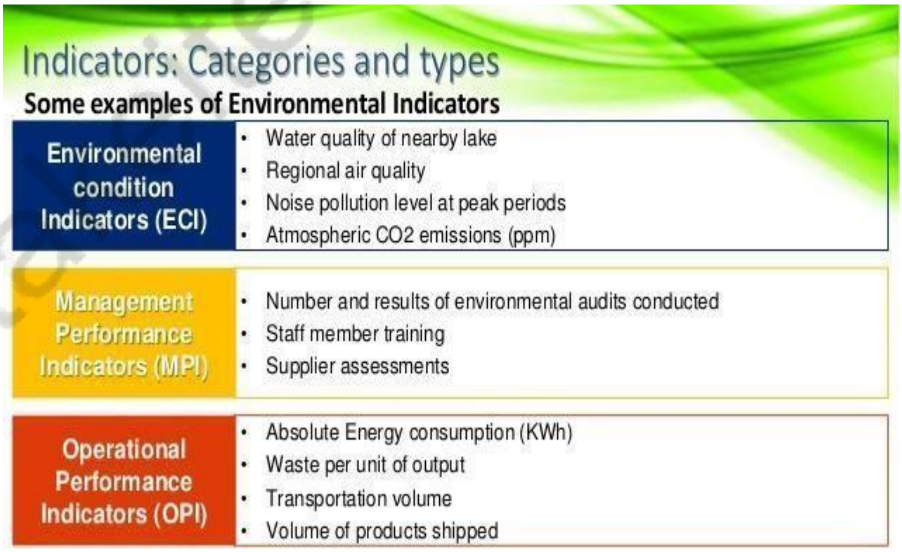
ISO standard describes two general categories of indicators for EPE:

i. Environmental Performance Indicators (EPIs); and
ii. Environmental Condition Indicators (ECIs).

There are two types of Environmental Performance Indicators:

i. Management Performance Indicators (MPIs)
ii. Operational Performance Indicators (OPIs)





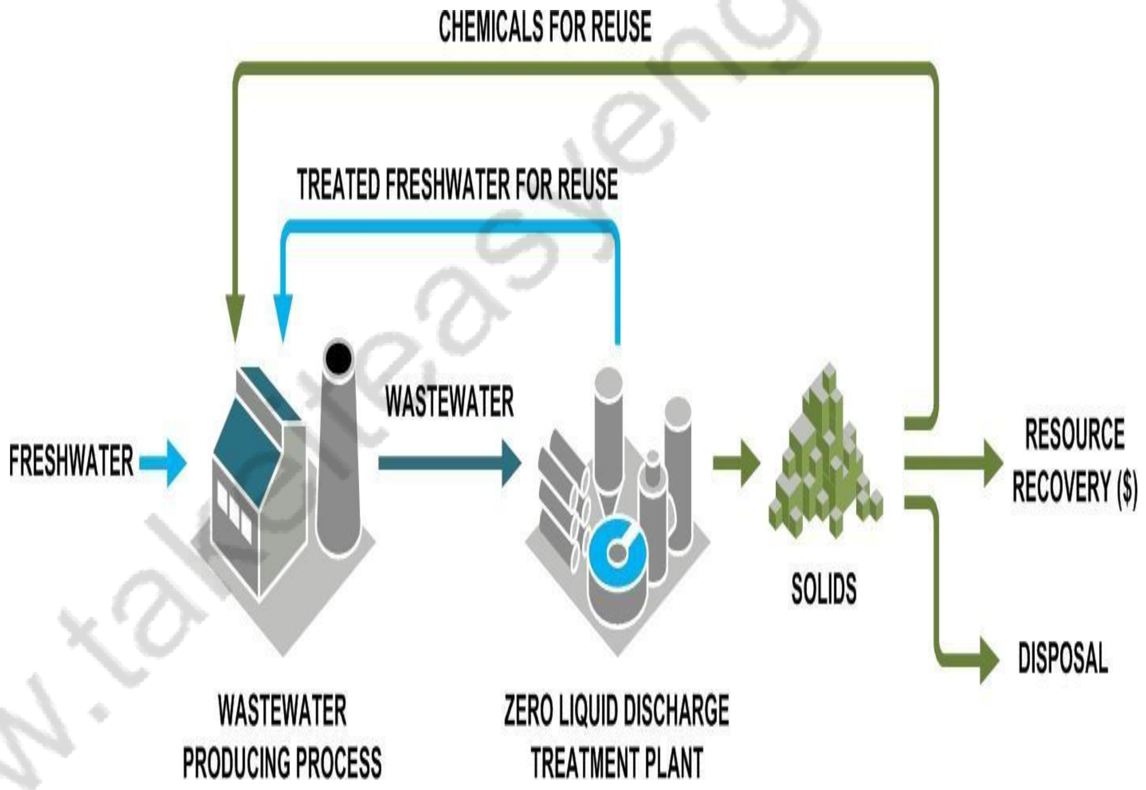
2.7 ZERO DISCHARGE TECHNOLOGY

In a world where freshwater is an increasingly valuable resource, industrial processes threaten its availability on two fronts, unless the water is treated.

Many industrial processes require water, and then reduce the availability of water for the environment or other processes, or alternately contaminate and release water that damages the local environment.

Another important reason to consider zero liquid discharge is the potential for recovering resources that are present in wastewater. Some organizations target ZLD for their waste because they can sell the solids that are produced or reuse them as a part of their industrial process.

Regardless of an organization's motivations to target zero liquid discharge, achieving it demonstrates good economics, corporate responsibility and environmental stewardship. By operating an in- house ZLD plant, disposal costs can be reduced, more water is re- used, and fewer greenhouse gases are produced by off-site trucking, which minimizes impact on local ecosystems and the climate



Zero liquid discharge (ZLD) is an engineering approach to water treatment where all water is recovered and contaminants are reduced to solid waste.

While many water treatment processes attempt to maximize recovery of freshwater and minimize waste, ZLD is the most demanding target since the cost and challenges of recovery increase as the wastewater gets more concentrated.

Salinity, scaling compounds, and organics all increase in concentration, which adds costs associated with managing these increases. ZLD is achieved by stringing together water treatment technology that can treat wastewater as the contaminants are concentrated.

2.8.1 BENEFITS OF ZERO DISCHARGE TECHNOLOGY

- There are a number of benefits to targeting zero liquid discharge for an industrial process or facility:
- Lowered waste volumes decrease the cost associated with waste management.
- Recycle water on site, lowering water acquisition costs and risk. Recycling on-site can also result in less treatment needs, versus treating to meet stringent environmental discharge standards.
- Reduce trucks associated with off-site waste water disposal, and their associated greenhouse gas impact and community road incident risk.
- Improved environmental performance, and regulatory risk profile for future permitting.
- Some processes may recover valuable resources, for example ammonium sulfate fertilizer or sodium chloride salt for ice melting.
- Several methods of waste management are classified as zero liquid discharge, despite using different boundaries to define the point where discharge occurs.
- Usually, a facility or site property line that houses the industrial process is considered the border or 'boundary condition' where wastewater must be treated, recycled, and converted to solids for disposal to achieve zero liquid discharge.
- Certain facilities send their liquid waste off-site for treatment, deep well disposal, or incineration and they consider this to qualify as zero liquid discharge. This approach to zero liquid discharge eliminates continuous discharge of liquids to surface waters or sewers, but can significantly increase cost.
- Some engineers describe their designs as near-zero liquid discharge or minimal liquid discharge to highlight that they discharge low levels of wastewater, but do

not eliminate liquid in their waste. For some facilities, it may be more economic to approach but not achieve complete ZLD by concentrating brine to lower volumes.

- Furthermore, it may be possible to avoid the creation of liquid waste on-site through careful water conservation or by treating contaminants at their source before they can enter the main flow of water.

2.8 CLOSING THE LOOPS

Production system in which the waste or by-product of one process or product is used in market for another product.

Closed-loop recycling is the process by which a product or material can be used and then turned into a new product (or converted back to raw material) indefinitely without losing its properties during the recycling process.

By reducing the production and use of raw materials, closed-loop recycling minimizes harm to the environment and discourages resource depletion. In contrast, open-loop recycling is the process by which a product is recycled but has to be mixed with raw materials to become a new product, typically leading to down cycling.

Ideal closed-loop systems produce no waste. They are called "closed" because products have a circular life cycle, beginning as raw materials and either being recycled into replacement products, returning to the original raw materials, or being returned to the environment as biodegradable waste.

This reduces the amount of (non-biodegradable) waste disposed, as recyclables are recovered and reused, rather than ending up in a landfill or as a pollutant.

It is a stable and sustainable system in which natural resources are renewed and waste never builds up. A closed loop

Closed-loop recycling involves: collecting and sorting recycled materials, extracting resources from the materials, and using those resources as inputs in the manufacturing of products practically identical to the original. Recycled materials are collected from homes, businesses, and recycling banks.

The most suitable materials for closed-loop recycling are aluminium, glass, and plastic. These are known to maintain their quality throughout many cycles of extraction, production, use, and recycling. For example, aluminium cans can be recycled and turned into new cans with practically no material degradation or waste.

• Under a closed-loop system, businesses reuse the same materials over and over again to create new products for purchase. It's a way to conserve natural resources and divert waste from the landfill, and increasingly, more companies are adopting it.

• Moving from a traditional linear system to a circular system, otherwise known as closing the loop, is a growing idea in the world of sustainable design and manufacturing.

• Closing the loop means moving from traditional design, which looked at the linear model for design and production – make, use and dispose – to how the disposal stage could be fed back into the creation of a new product.

Example:

- Buying recycled products is part of Closing the Loop
- Step is critical because it maintains the market demand for recyclables.
- Without a demand for recycled products, there is no economy to support recycling
- Creating stable markets for recycling ensures the continuation and expansion of recycling programs everywhere.
- Recycling waste newspaper to make paper-board or other type of paper.

2.9 CLEANER PRODUCTION

Cleaner production aims to minimize or avoid practices such as waste treatment (including stabilization, encapsulation, and detoxification), waste dilution to comply with regulations (e.g., releasing contaminated water into rivers or streams during high flow periods, blending arsenic containing fumes with flotation Cleaner production (CP) is a preventative approach to managing the environmental impacts of business processes and products. CP uses changes in technology, processes, resources or practices to reduce waste, environmental and health risks; minimize environmental damage; use energy and resources more efficiently; increase business profitability and competitiveness; and increase the efficiency of production processes. Cleaner production is applicable to all businesses, regardless of size or type.

Cleaner production is a preventive, company-specific environmental protection initiative. It is intended to minimize waste and emissions and maximize product output.

By analyzing the flow of materials and energy in a company, one tries to identify options to minimize waste and emissions out of industrial processes through source reduction strategies.

Improvements of organization and technology help to reduce or suggest better choices in use of materials and energy, and to avoid waste, waste water generation, and gaseous emissions, and also waste heat and noise.

2.10.1 BENEFITS OF CLEANER PRODUCTION

1. Improving environmental situation
2. Continuous environmental improvement
3. Gaining competitive advantage
4. Increasing productivity
5. Increasing economic benefits

2.10.2 CLEANER PRODUCTION PRACTICES

- Good housekeeping- Take appropriate managerial and operational actions to prevent: Leaks, spills, to enforce existing operational instructions
- Input substitution- substitute input materials By less toxic, or by renewable materials, or by adjunct materials which have a longer service lifetime in production.
- Better process control- Modify: Operational procedures, equipment instructions, and process record keeping in order to run the processes more efficiently and at lower waste and emission generation rates.
- Equipment modification- modify the existing production equipment and utilities in order: Run the processes at higher efficiency, lower waste and emission generation rates.
- Technology change- replace of The technology, processing sequence, synthesis pathway. In order to minimize waste and emission generation during production.
- On- site Recovery/Reuse- Reuse of the wasted materials in the same process for another useful application within the company.
- On- site Recovery/Reuse- Reuse of the wasted materials in the same process for another useful application within the company.

2.10.3 ENVIRONMENTAL STRATEGIES

<u>Passive environmental strategies</u>

- **Dilute and disperse**: It involves the attenuation of pollutants by permitting them to become physically spread out, thereby reducing their effective point concentration. The dispersal and the consequent dilution of a given substance depends on its nature and the characteristics of the specific pathway used to achieve this. It may take place, with varying degrees of effectiveness, in air, water or soil.

Reactive environmental strategies

- **End- of- pipe approaches:** From the 1960s onwards, it became obvious that the dilute and disperse strategy was no longer effective for important point-source pollutions. A complete technology and business was developed to install purification units at the end of the emission pipes of various production processes. This approach is called 'end-of-pipe' because they usually represent the last stage of a process before the stream is disposed or released to the environment. Although effective to a certain extent the end-of pipe approach is not "the solution".

- **On – site recycling**: End of pipe methods often resulted in increased costs with no appreciable benefits to industries in terms of enhanced materials or energy uses, as a result, recycling wastes and resource recovery methods were evolved in 1980s; which were actually better mechanisms of resource use and waste minimization tactics over the end-of pipe strategy.

Proactive environmental strategies

- Cleaner Production: After 1990s, new ideas have emerged to reduce emissions to the environment at the source i.e. proactive environmental strategy. It is a dynamic capability that allows organizations to evolve and align their strategy with the changing and uncertain environment. It has been argued that, the transition from reactive to proactive approaches involves complex organizational changes that do not always result in business success. This pollution prevention and waste minimization strategy appeared to be necessary to reduce the enormous costs of clean-up actions, certainly from the moment that the polluter pays principle was brought into legislation. This new approach of cleaner production seems very promising because it combines an environmental and a business concern.

2.10 CLEANER TECHNOLOGY

Clean technology, is any process, product, or service that reduces negative environmental impacts through significant energy efficiency improvements, the sustainable use of resources, or environmental protection activities. Clean technology includes a broad range of technology related to recycling, renewable energy, information technology, green transportation, electric motors, green chemistry, lighting, grey water, and more.

The current key sectors in the clean technology industry are:

- Sustainable energy and energy optimization to reduce dependence on fossil fuels
- The provision of clean water to all who need it
- Pollution reduction
- Recycling and waste management

i. **Sustainable Energy and Energy Optimization**: Many technologies use sustainable sources of energy, or optimize energy usage to reduce dependence on carbon fuels.

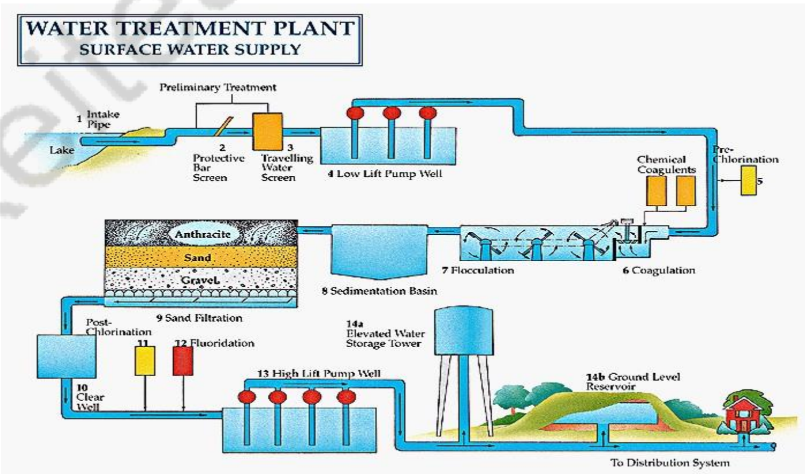
- Wind power – This sustainable resource is typically exploited in the form of vast wind farms, often found offshore. A wind farm contains a large group of individual wind turbines connected up which generate electricity without producing any greenhouse gas emissions after construction.
- Hydroelectric power – This refers to the use of the gravitational force of water falling

or flowing to produce electricity. Once constructed, a hydroelectric power plant will produce extremely low levels of greenhouse gases when compared to fossil fuel-based techniques.

- Solar energy – Two techniques are used to generate electricity from solar energy; photovoltaics (PV) or concentrated solar power systems (CSPs). The former uses the photovoltaic effect to directly convert light into an electrical current, whilst the latter uses lenses or mirrors to focus a beam of light directly onto a small area. This is converted into heat which subsequently drives a heat engine to generate electricity.
- Geothermal energy – This is simply the heat from the earth itself. This heat can be used similarly to the directed light beams for CSPs to heat up water to drive heat engines and generate electricity, or systems in buildings can capture the earth's naturally occurring thermal energy for space heating.
- Smart energy – This refers to the numerous ways that energy usage can be optimized with the introduction of connected energy consumption, automated energy distribution, and responsive energy supply – all made possible with the advent the Internet of Things (IoT).
- Energy reduction – This encompasses all of the ways that energy usage is reduced from the demand side, including automated systems, human behavior management, sustainable development, and sustainable building management.

ii. Clean Water

- Water treatment – This refers to the treatment of raw water to ensure that it is safe for human consumption.
- Wastewater treatment – The conversion of wastewater into water that can then be entered into the water cycle or reused is referred to as wastewater treatment.



iii. Pollution Reduction

- Emission control – There are several methods to reduce global emissions. The adoption of clean technologies, such as the sustainable energy sources listed above, as well as a transition from conventional gasoline-powered vehicles to biofuel and electric vehicles, are just a few of the suggested ways to control emissions.

- Pollutant monitoring – Air monitoring stations which provides annual reports on the volume of pollutants. Similar techniques of monitoring the levels of air pollutants are employed around the world, including the use of satellites and drones to create impartial, accurate monitoring reports.
- Remediation of polluted sites – When a request for environmental remediation of a location is made by government or other land remediation authorities, immediate action must be taken by the landowners to ensure the location is made safe for humans and animals. This can involve cleaning soil, groundwater, surface water, or sediment by removing pollutants and contaminants.

iv. Recycling and Waste Treatment

- Recycling of consumer products – The majority of consumer products in today's market have many parts or components which can be recycled. Once a product reaches its "post-consumer" stage, it should be sorted correctly to ensure it does not end up in landfills.
- Reduction and treatment of toxic waste – Often in the form of dangerous chemicals or materials, toxic or hazardous waste should be treated very carefully. Most governments have plans in place for the reduction, collection, treatment, and regulation of toxic and hazardous waste.

2.11 POLLUTION CONTROL VS POLLUTION PREVENTION - OPPORTUNITIES

2.12.1 Pollution prevention

EPA defines pollution prevention as:

• Source reduction

• Use of nontoxic or less-toxic alternatives.

• Re-using materials rather than putting them into the waste stream.

Pollution prevention opportunities

➢ Reducing or eliminating toxic materials

- Replacing a material in the production line.
- Reformulating the product.

- Installing new or modifying existing process equipment.
- Closed loop (on site) recycling
- Developing new technology that helps others implement
- Involves holistic approach.

2.12.2 Pollution control

Pollution control is the process of reducing or eliminating the release of pollutants into the environment. It is regulated by various environmental agencies which establish pollutant discharge limits for air, water, and land.

Pollution Control Opportunities

- End of pipe treatment
- Open loop (off site) recycling
- Incineration or disposal
- Burning waste for energy recovery
- Transferring waste from one medium to other.
- Incorporation waste from one medium to other.

2.12 POLLUTION PREVENTION BARRIERS

i. **End-of-Pipe Focus**
   - In most instances, the end-of-pipe focus of existing regulations does not create a direct barrier to pollution prevention.
   - Potential negative effect of focusing industrial and public resources on controlling pollutants after it has been created rather than on product, process, or raw material changes

ii. **Media-Specific Focus**
   - Current regulations address one environmental medium at a time.
   - The result can be transfer of pollutants from one environmental medium to another and concentration on media-specific solutions rather than multi-media preventive approaches.
   - Media-specific focus does not always encourage multi-media preventive approaches

iii. **Regulatory Program Evaluation Criteria**
   - Current benchmarks for measuring the success of

programs do not include consideration of pollution prevention progress

- The focus is on more easily quantified performance measures such as the number of permits issued or the number of inspections performed.

iv. Regulatory Inflexibility

- Lack of flexibility can sometimes create a barrier to pollution prevention.
- Pollution prevention is a customized process, varying facility by facility.
- May require flexibility and short-term variances in compliance schedules for emission standards or permits

v. Regulatory Uncertainty

- Industry personnel working to implement pollution prevention strategies may be required to consult with several agencies and with decision-making authority.
- Innovative project or a pollution prevention proposal may require multiple approvals for different aspects of that project, which may be difficult to obtain. This can discourage facilities from undertaking pollution prevention practices.

vi. Pollution Fees

- If structured on a multi-media basis with a significant correlation to quantities of pollutants created and set at sufficient levels, fees can provide incentives for pollution prevention
- Current fees are for the most part media-specific, set at levels determined by the costs of regulatory services, and in some cases are not closely correlated with quantities of pollutants released.
- Although fees set up in this manner do not present direct barriers to pollution prevention, it provides little incentive to go beyond standards and prevent pollution at the source.