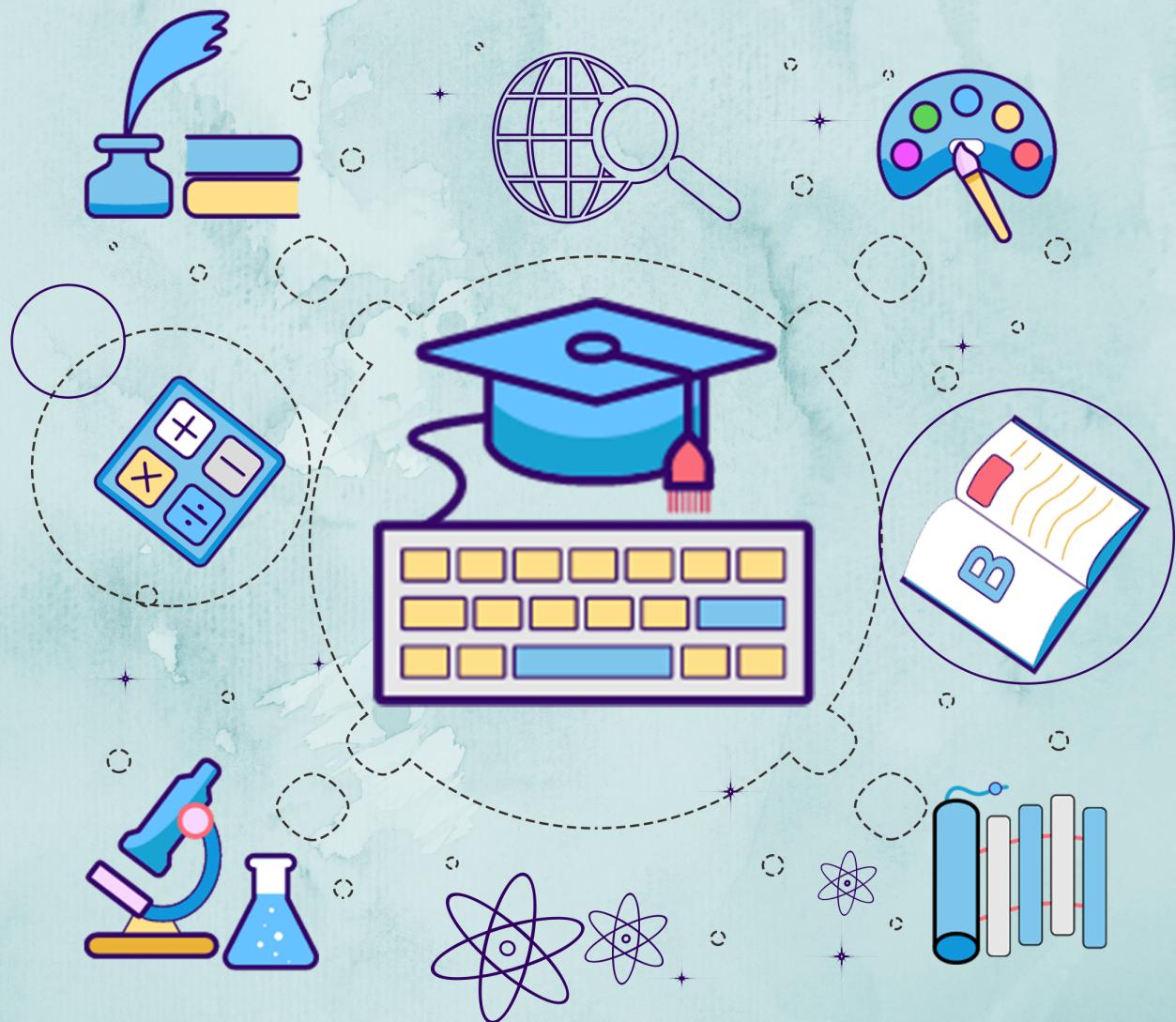


# Kerala Notes



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## KTU STUDY MATERIALS

# SUSTAINABLE ENGINEERING

## MNC 202

# Module 1

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# Sustainable Engineering

## Module 1

### SUSTAINABILITY- INTRODUCTION

The concept of sustainability become so important nowadays, because of the irreparable damage caused to the environment by industrial civilization & consumerism, which originated about 3 centuries ago. They were based on the following wrong assumptions:

- The earth belongs to humans only
- Ignore the fact that humans are part of the Earth's biosphere
- Earth's stock of resources are infinite
- The environment can bear any amount of damage that is caused by human activity.

The advantages & disadvantages of industrial civilization & consumerism are listed below:-

#### **Advantages**

1. Flourished the economy
2. Improved the living quality of the society

#### **Disadvantages**

1. Caused irreparable damage to the environment
2. Pose a threat to the life support systems of the earth.
3. E.g.1.The hole in the ozone layer surrounding our planet as a shield against the dangerous ultraviolet radiation from the sun
4. E.g.2. Increased carbon dioxide content and greenhouse gases in the atmosphere that causes global warming

Several warnings concerning the instability of Earth's life support systems have been raised in recent times. In 1992, some of the world's senior scientists from 70 countries, signed and sent an urgent warning "The environment is suffering critical stress..." to the government leaders of all nations as part of the United Nations Conference on Environment and Development (the "Earth Summit") held in Rio de Janeiro, Brazil. This marked the beginning of the concept of sustainability.

Sustainability is based on a simple principle: Everything that we need for our survival and well-being depends, either directly or indirectly, on our natural environment. Sustainability creates and maintains the conditions under which humans and nature can exist in productive harmony, that permits fulfilling the requirements of present and future generations. Sustainability is important to make sure that we have and will continue to have, the water, materials, and resources to protect

human health and our environment.

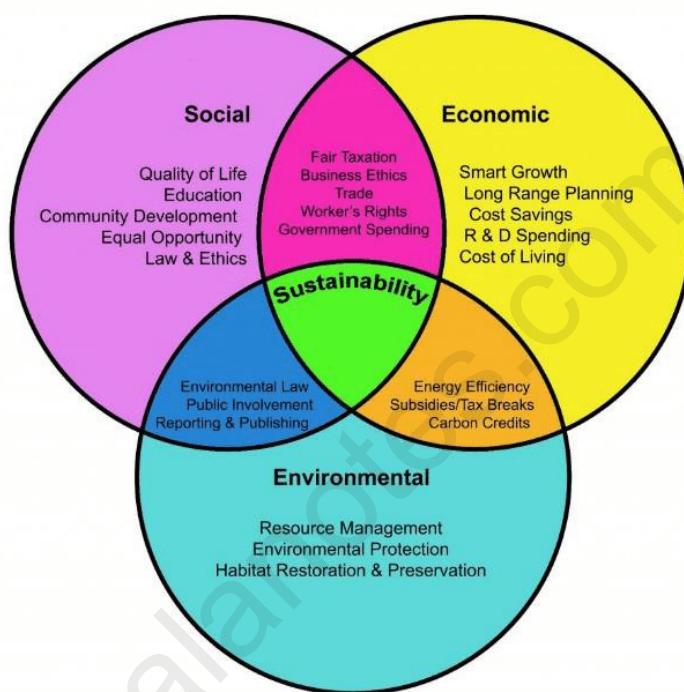
## SUSTAINABILITY- DEFINITION

Sustainability is the ability to achieve continuing economic prosperity while protecting the natural systems of the planet and providing a high quality of life for its people.

## SUSTAINABILITY- NEED & CONCEPT

Sustainability has three components, which are inter-related, as shown in Fig.1:

1. Environment
2. Society
3. Economy



The environment gives resources, raw materials to the Economy for production activities.

The economy creates products and sells them to society for use. Production by EconomyConsumption by Society leads to the following environmental impacts.

- 1. Exhaustion of Resources** – Water, Petroleum, Forests
- 2. Loss of Biodiversity** - Extinction of Animal/Plant Species due to Water, Soil, Air Pollution
- 3. Deforestation** - conversion of forestland to farms, urban use, etc.
- 4. Ozone Depletion** - reduction of the amount of ozone in the stratosphere due to the emission of chlorofluorocarbons (CFCs). CFC/s emitted from the industries, rises to the Stratosphere. Sunlight breaks CFCs to release Chlorine. Chlorine reacts with Ozone and destroys it.
- 5. Acid Deposition** – results in acid rain, acid fog, and acid mist.
- 6. Desertification** - a type of land degradation in which a land region becomes dry, typically

losing its water bodies, vegetation, and wildlife.

**7. Eutrophication** - a form of water pollution that occurs when excessive fertilizers run into lakes

and rivers. This encourages the overgrowth of algae and other aquatic plants.

**8. Global Warming** - a gradual increase in the average temperature of the Earth's atmosphere and

its oceans, caused by increasing concentrations of greenhouse gases – Carbon oxides,

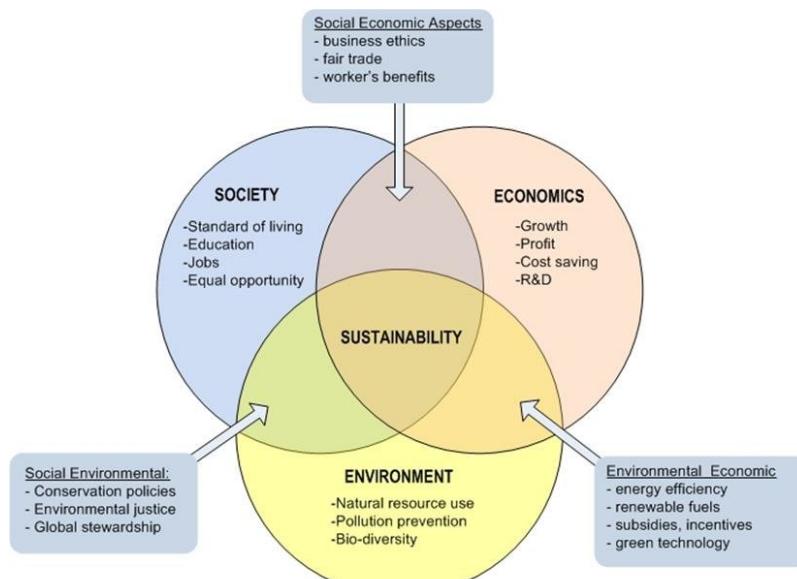
Nitrous oxides, sulfur oxides, Fluorocarbons

The environmental impact, caused by the economy on production and society on consumption, leads to the following damages to human life.

1. Freshwater scarcity
2. Climate change
3. Exposure to toxins in food, air, water, and soil
4. Emerging diseases
5. Food insecurity resulting in poverty
6. Energy scarcity due to depletion of non-renewable resources
7. Ecosystem damage and habitat loss due to pollutant discharges
8. Sea level rise

The need for sustainability is to reduce these damages and create livable planet earth for future generations. For this, United Nations presented the following key sustainability concepts:-

Intergenerational equity – Expects the present generation to hand over a safe, healthy, and resourceful environment to the future generation. Intra-generational equity – Emphasize the technological development should support the economic growth of the poorer section, so as to reduce the gap between nations. Sustainability means balancing the environment, society, and economy.



## SOCIAL- ENVIRONMENTAL AND ECONOMIC SUSTAINABILITY CONCEPTS

The concept of sustainability is based on the basis that people and their communities are made up of social, economic, and environmental systems that are in constant interaction and that must be kept in harmony.



### SOCIAL SUSTAINABILITY

There are six principles of sustainability that can help a community ensure that its social, economic, and environmental systems are well integrated and will endure. A community or society that wants to pursue sustainability will try to:

#### 1. Maintain residents' quality of life.

Quality of life has many components: income, education, health care, housing, employment, legal rights. Each locality must define and plan for the quality of life it wants and believes it can achieve, for now, and for future generations.

#### 2. Enhance local economic vitality.

A viable local economy is essential to sustainability. This includes job opportunities, a sufficient tax base and revenue to support the government and the provision of infrastructure and services, and a suitable business climate.

#### 3. Promote social and intergenerational equity.

A sustainable community's resources and opportunities are available to everyone, regardless of ethnicity, age, gender, cultural background, religion, or other characteristics. Further, a sustainable community does not deplete its resources and destroy natural systems.

#### **4. Maintain the quality of the environment.**

A sustainable community tries to find ways to co-exist with the natural environment and ecosystem. It avoids unnecessary degradation of the air, oceans, freshwater, and other natural systems.

#### **5. Incorporate disaster resilience and mitigation into its decisions and actions.**

A community is resilient in the face of inevitable natural disasters like tornadoes, hurricanes, earthquakes, floods, and drought if it takes steps to ensure that such events cause as little damage as possible.

#### **6. Use a consensus-building, participatory process when making decisions.**

Participatory processes are vital to community sustainability... It encourages the identification of concerns and issues, promotes the wide generation of ideas for dealing with those concerns, and helps those involved find a way to reach an agreement about solutions.

### **ENVIRONMENTAL SUSTAINABILITY**

Environmental sustainability requires:

1. Maintenance of biodiversity (genes, species, and ecosystems)
2. Protection of natural capital (air, water, soils, etc)
3. Maintenance of the energy and material cycles of the planet
4. Health and resilience of all life support systems.

This can be achieved by:

1. Reduce dependence upon finite, virgin resources like Fossil fuels, minerals, and metals
2. Nature must not be subjected to increased concentrations of substances produced by society. This requires that consideration be given to the biodegradability of substances and the length of time it takes the earth to reabsorb them.
3. The physical basis for the productivity and biodiversity of nature must be not systematically degraded. This requires that we protect diverse and special habitats.
4. There must be efficient use and fair distribution of resources to enable humans to meet their needs. This requires a reduction in consumerism, especially among wealthy nations.

### **ECONOMIC SUSTAINABILITY**

Economic sustainability ensures that the industry or business is making a profit without creating much damage to the environment/ecology. Economic growth is expressed in terms of Gross Domestic Product (GDP). This is the total amount of products produced within a nation, within one year. Economic growth has to be sustainable if it improves the quality of human life. Thus population factors must be included to ensure fair resource consumption.

### **ECONOMIC-SOCIAL AND ENVIRONMENTAL MATRIX**

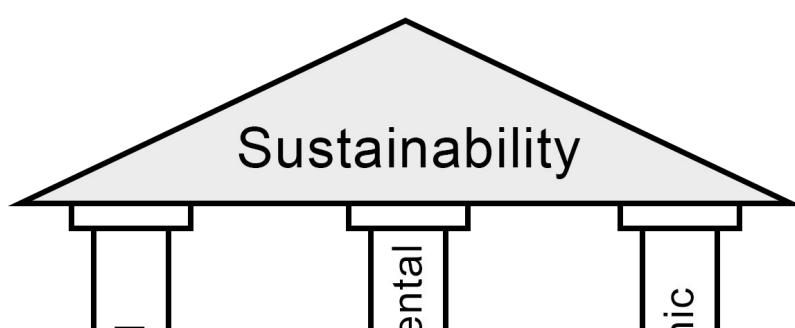
Quality of Life Concerns	Economic Issue		Social Issue		Environmental Issue	
	Unsustainable	Sustainable	Unsustainable	Sustainable	Unsustainable	Sustainable
Water	High cost of drinking water	Drinking water availability at low cost	Access to drinking water denied to weaker section	Adequate water supply to all sections	High-level of pollution in lakes and rivers	Conservation of existing fresh water bodies
Food	High cost of food and use of fertilizers and pesticides in farming	Good food available at low cost	Access to good food denied to weaker section	Adequate access to good food to all sections	Overuse of fertilizers and pesticides pollute the environment. Deforestation - conversion of forestland to farms	Food is of nutritious quality and related diseases are lowered.
Energy	High cost and intermittent power supply	Electricity available at low cost	Overuse of energy by the rich society and inadequate energy distribution	Adequate energy available to all sections	Use of fossil fuels and pollution	Use of renewable resources (solar, wind, biomass)

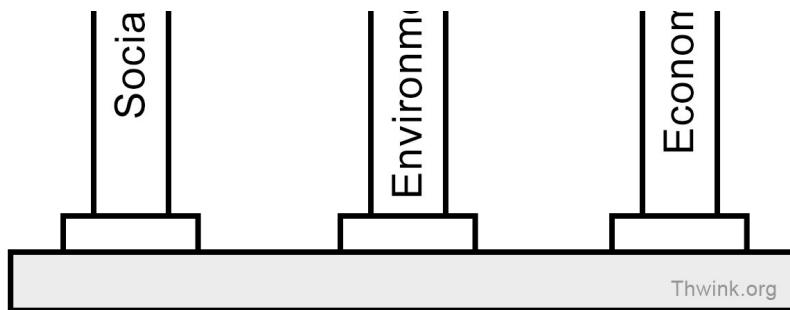
## SUSTAINABLE DEVELOPMENT

The concept of sustainable development has received much recognition after the Stockholm declaration in the year 1972.

Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. (Definition proposed by the Brundtland Commission in 1987 in their report "Our Common Future").

The three pillars of sustainable development are environment, society, and economy





Sustainable development should have the following features:-

1. Satisfying human needs
2. Favouring a good quality of life through decent standards of living
3. Sharing resources between rich and poor
4. Acting with concern for future generations
5. Looking at the 'cradle-to-grave' impact when consuming
6. Minimizing resource use, waste, and pollution

## **MEASURES OF SUSTAINABLE DEVELOPMENT**

The following are the measures of sustainability development:-

### **(i) Technology:**

Using appropriate technology is one that is locally adaptable, eco-friendly, cost-effective, resource-efficient, and culturally suitable. Nature is often taken as a model, using the natural conditions of that region as its components. This concept is known as "design with nature".

### **(ii) Reduce, Reuse, and Recycle Approach:**

The 3-R approach advocating minimization of resource use, using them again, and recycling the materials. It reduces pressure on our resources as well as reduces waste generation and pollution.

### **(iii) Promoting Environmental Education and Awareness:**

Making environmental education the center of all learning processes will greatly help in changing the thinking pattern and attitude of people towards our earth and the environment.

### **(iv) Resource Utilization as Per Carrying Capacity:**

Any system can sustain a limited number of organisms on a long-term basis which is known as its carrying capacity. If the carrying capacity of a system is crossed (say, by overexploitation of a resource), environmental degradation starts.

### **(v) Improving Quality of Life Including Social, Cultural and Economic Dimensions:**

Development should not focus just on one section of already affluent people. Rather it should include sharing of benefits between the rich and the poor. The tribal, ethnic people and their cultural heritage should also be conserved.

## NEXUS BETWEEN TECHNOLOGY AND SUSTAINABLE DEVELOPMENT

Technology is the offspring of science. Technological innovation can be seen as a 'double-edged sword, with respect to sustainable development.

1. Technology improves the quality of life, eliminate diseases, and increase life expectancy
2. On the other hand, technology creates irreparable environmental damage due to resource extraction and pollution of air, water, soil.

As technology advances, environmental degradation accelerates exponentially. Also, the benefits of technological innovations are mostly enjoyed by the developed countries. Technology remains a dream for underdeveloped countries which still face poverty, inadequate sanitation facilities, etc. Hence it is essential to integrate technology, society into sustainability.

Technology can support sustainability by

1. Conserving natural capital (renewable and nonrenewable resources)
2. Reducing waste and pollution
3. Raising efficiency standards
4. Finding substitutes for toxic/hazardous materials

Pollution prevention and cleaner production technologies are more cost-effective than the end of pipe waste treatment technology. Some of the technological applications towards sustainable development in various sectors are given below.

### 1. SUSTAINABLE AGRICULTURAL TECHNOLOGY

Sustainable agriculture integrates three main goals-environmental health, economic profitability, and social and economic equity. Some of the common ways towards sustainable agriculture are:

- a) Integrated Pest Management (IPM)
- b) Rotational Grazing
- c) Soil conservation
- d) Water quality/wetlands
- e) Cover crops
- f) Crop/ landscape diversity
- g) Nutrient management
- h) Agro-forestry

### 2. SUSTAINABLE ENERGY

Sustainable energy is the energy that, in its production or consumption, has minimal negative impacts on human health and the healthy functioning of vital ecological systems, including the global environment. This can be achieved by using the following:

a. Renewable energy sources

- Solar
- Biomass (It is a renewable energy resource derived from the carbonaceous waste of various human and natural activities. It is derived from numerous sources, including the by-products from the timber industry, agricultural crops, raw material from the forest, major parts of household waste, and wood.)
- Wind
- Tide
- geothermal Heat

b. Energy-efficient systems - upgrading the efficiency of the existing equipment, reduction of energy loss, saving of fuel, and optimization of its operating conditions and service life provide an ecologically safe strategy.

### MILLENNIUM DEVELOPMENT GOALS (MDGs)

The United Nations Millennium Development Goals are eight goals that all 191 UN member states have agreed to try to achieve by the year 2015. The United Nations Millennium Declaration, signed in September 2000 commits world leaders to combat poverty, hunger, disease, illiteracy, environmental degradation, and discrimination against women. The MDGs are derived from this Declaration, and all have specific targets and indicators.

 “ The Eight Millennium Development Goals are : ”

- 4.1. To eradicate extreme poverty and hunger;
- 4.2. To achieve universal primary education;
- 4.3. To promote gender equality and empower women;
- 4.4. To reduce child mortality;
- 4.5. To improve maternal health;
- 4.6. To combat HIV/AIDS, malaria, and other diseases;
- 4.7. To ensure environmental sustainability; and
- 4.8. To develop a global partnership for the development

The MDGs are interdependent; all the MDG influence health, and health influences all the MDGs. For example, better health enables children to learn and adults to earn. Gender equality is essential to the achievement of better health. Reducing poverty, hunger and environmental degradation positively influences, but also depends on, better health.

### SUSTAINABLE DEVELOPMENT GOALS (SDGs)

Recently, the international community decided to adopt a new set of development goals focusing on improving the sustainability of nation-states. The need for a new set of targets was developed

at the Rio +20 Conference, held in Rio de Janeiro, in June 2012. The Sustainable Development Goals (SDGs) build on the achievements of the Millennium Development Goals. As mentioned, in a press release, by Wu Hongbo, the UN Under-Secretary-General for Economic and Social Affairs.

Sustainable development goals that build on the successes of the Millennium Development Goals, and that apply to all countries, can provide a tremendous boost to efforts to implement sustainable development and help us address issues ranging from reducing poverty and creating jobs to the pressing issues of meeting economic, social and environmental aspirations of all people.

“ *The 17 sustainable development goals (SDGs) to transform our world:* ”

GOAL 1: No Poverty

GOAL 2: Zero Hunger

GOAL 3: Good Health and Well-being

GOAL 4: Quality Education

GOAL 5: Gender Equality

GOAL 6: Clean Water and Sanitation

GOAL 7: Affordable and Clean Energy

GOAL 8: Decent Work and Economic Growth

GOAL 9: Industry, Innovation, and Infrastructure

GOAL 10: Reduced Inequality

GOAL 11: Sustainable Cities and Communities

GOAL 12: Responsible Consumption and Production

GOAL 13: Climate Action

GOAL 14: Life Below Water

GOAL 15: Life on Land

GOAL 16: Peace and Justice Strong Institutions

GOAL 17: Partnerships to Achieve the Goal

## CLEAN DEVELOPMENT MECHANISM (CDM)

The Clean Development Mechanism is regarded as one of the most important internationally implemented market-based mechanisms to reduce carbon emissions. Created under the Kyoto Protocol, the CDM was designed to help developed nations meet domestic greenhouse gas (GHG) reduction commitments by investing in low-cost emission reduction projects in developing countries.

The Clean Development Mechanism (CDM), established under the Kyoto Protocol, is the primary international offset program in existence today. It generates offset through investments in GHG reduction and avoidance projects in developing countries. These offset credits, called Certified Emission Reduction credits (CERs), represent a reduction in one metric ton of carbon dioxide (CO<sub>2</sub>) emitted to the atmosphere. Developed countries can use CERs to more cost-effectively achieve their Kyoto Protocol GHG emission reduction targets.

The stated purpose of the Clean Development Mechanism is to help developing countries achieve sustainable development, and assist industrialized countries in complying with their emission reduction commitments.

### PURPOSE OF CLEAN DEVELOPMENT MECHANISM

Private companies fund projects in developing countries that reduce greenhouse gas emissions. They must also meet sustainable development criteria and the “additionality” requirement, which means the emission reductions made, must be “additional” to what would have been possible without CDM funding. Upon verification, the CDM awards these projects certified emission reductions (CERs), each equivalent to one ton of carbon dioxide. CERs are then sold to developed countries, which use them to meet a part of their reduction commitments under the Kyoto Protocol. CERs are also called “offset credits” because they “offset” the developed countries’ emissions with reductions in developing countries.

CDM allows countries to continue emitting greenhouse gases, so long as they pay for reductions made elsewhere. The justification for this is based on the premise that it would be far more expensive to implement emission reduction in industrialized countries than in developing countries. It would help developing countries to gain sustainable development benefits from the entry of “clean” and more energy-efficient technologies.

