Green and Sustainable Technologies
2 Credits
Introduction

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Content

- Introduction to sustainability
- Sustainable Development Goals: A Brief Introduction
- The Blue-Green Economic Policy: The Creator of New Prospects in the Economy
- What is green technology?
- Importance of green technology
- Evolution of green technology
- Emerging green technologies
- Why is Green Technology Necessary?

Local and global environmental issues

The world is facing increasing environmental threats which are posing severe scientific, social, and economic challenges to humans.

- the depletion of natural resources,
- the loss of diversity and
- Sectors of impact include soil, air, water, and food in both rural and urban landscapes.

The need to develop new forms of energy generation whilst efficiently utilizing existing energy sources.

Causes and Effects of Climate Change | National Geographic

https://www.youtube.com/watch?v=G4H1N_yXBiA

Air Pollution 101 | National Geographic

https://www.youtube.com/watch?v=e6rglsLy1Ys

There's An Island Made of PLASTIC: Twice the Size of Texas!

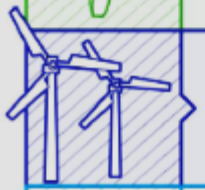
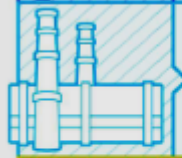
https://www.youtube.com/watch?v=cEeKerZ7iU4

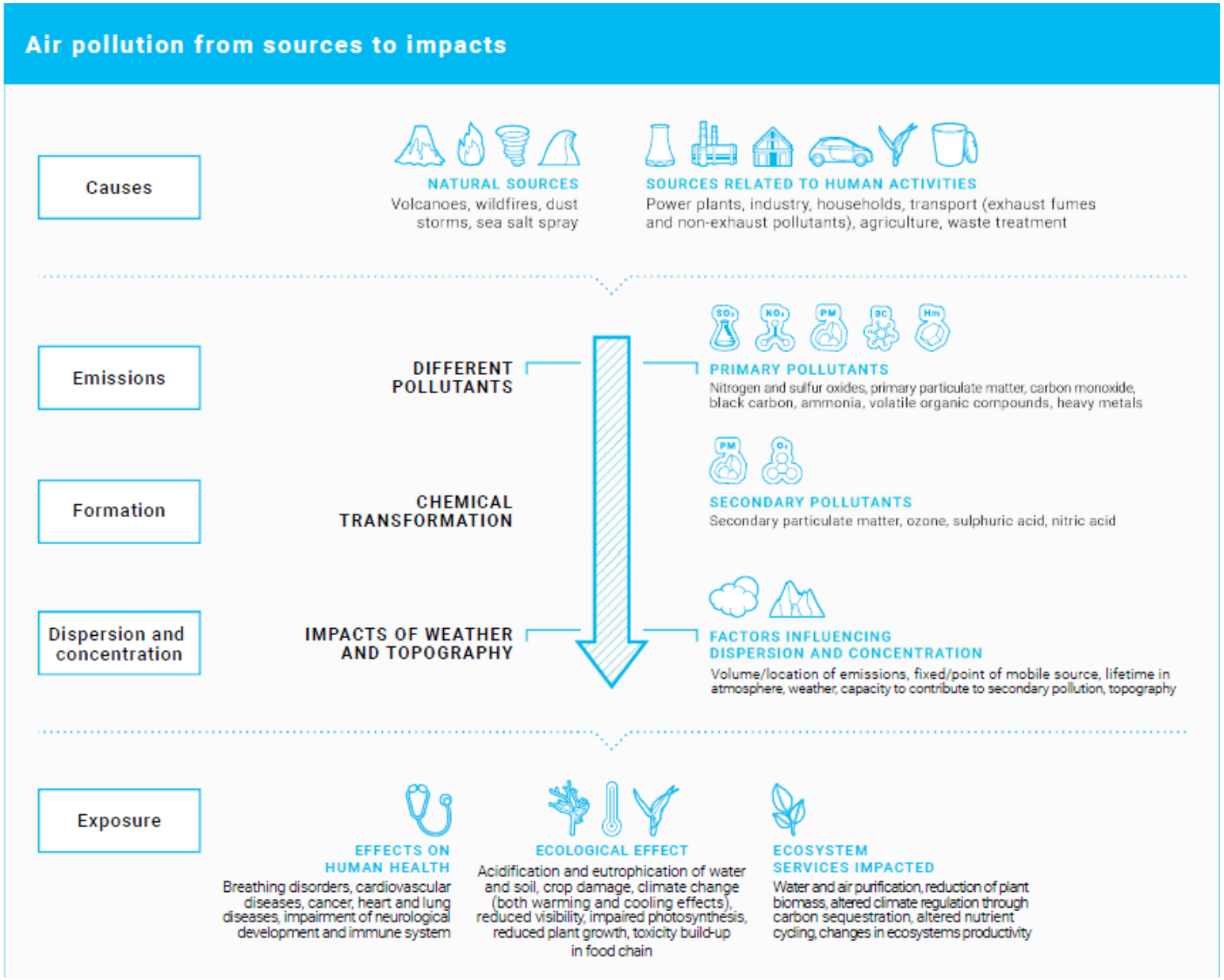
Global Carbon Budget 2023 https://www.youtube.com/watch?v=zkXF7OS0a0o

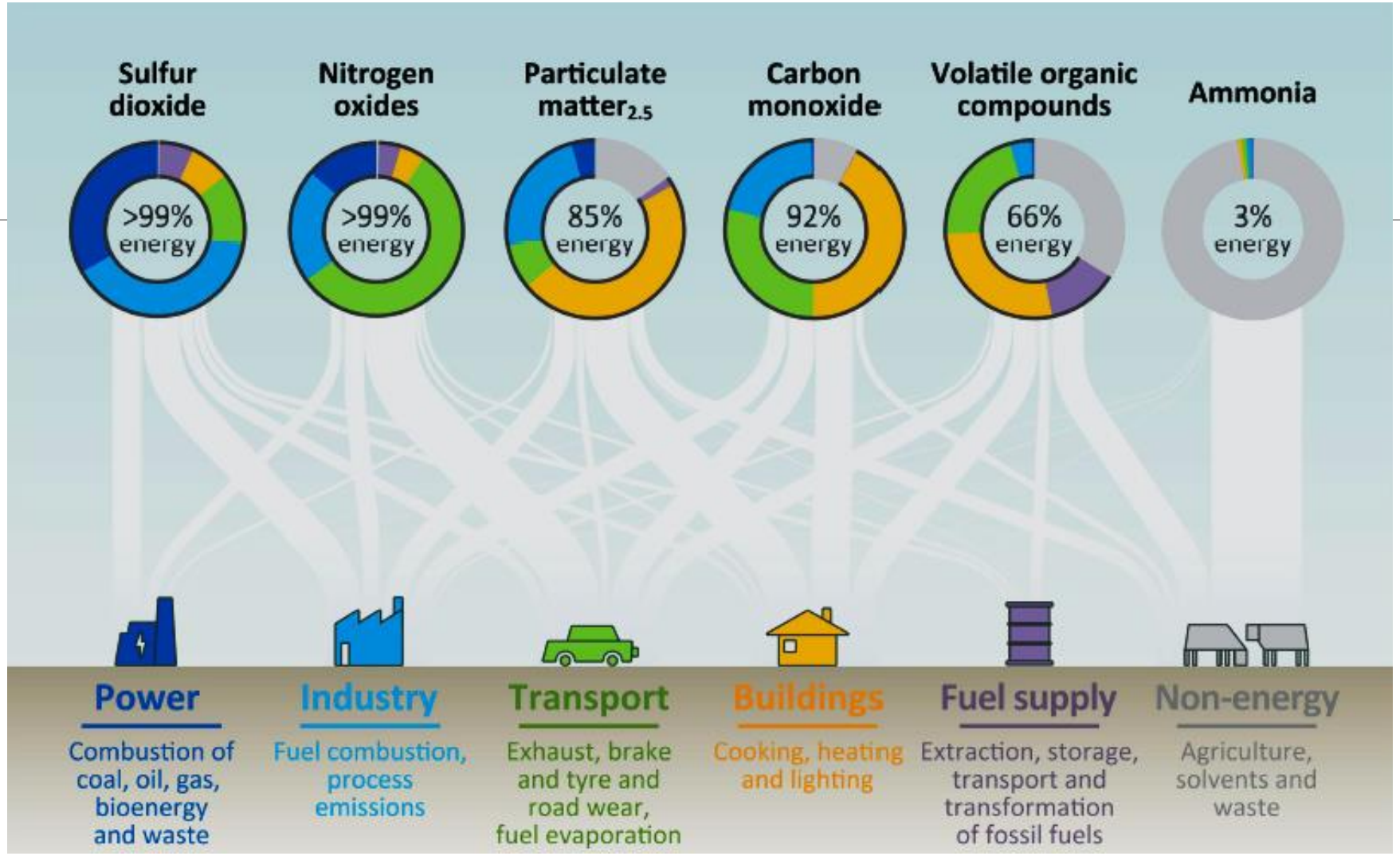
Carbon Emissions Report: 57 entities responsible for 80% of carbon emissions | WION Climate Tracker https://www.youtube.com/watch?v=DUWbelj57gg

- Pollution touches all parts of the planet.
- It is affecting our health through the food we eat, the water we drink and the air we breathe.
- Approximately 19 million premature deaths are estimated to occur annually as a result of the way we use natural resources and impact the environment to support global production and consumption
- Even in the most remote areas of the polar ice caps, the deep abyssal ocean and high mountains, pollutants such as heavy metals and persistent organic pollutants can be found in plants and animals
- https://ourworldindata.org/waste-management

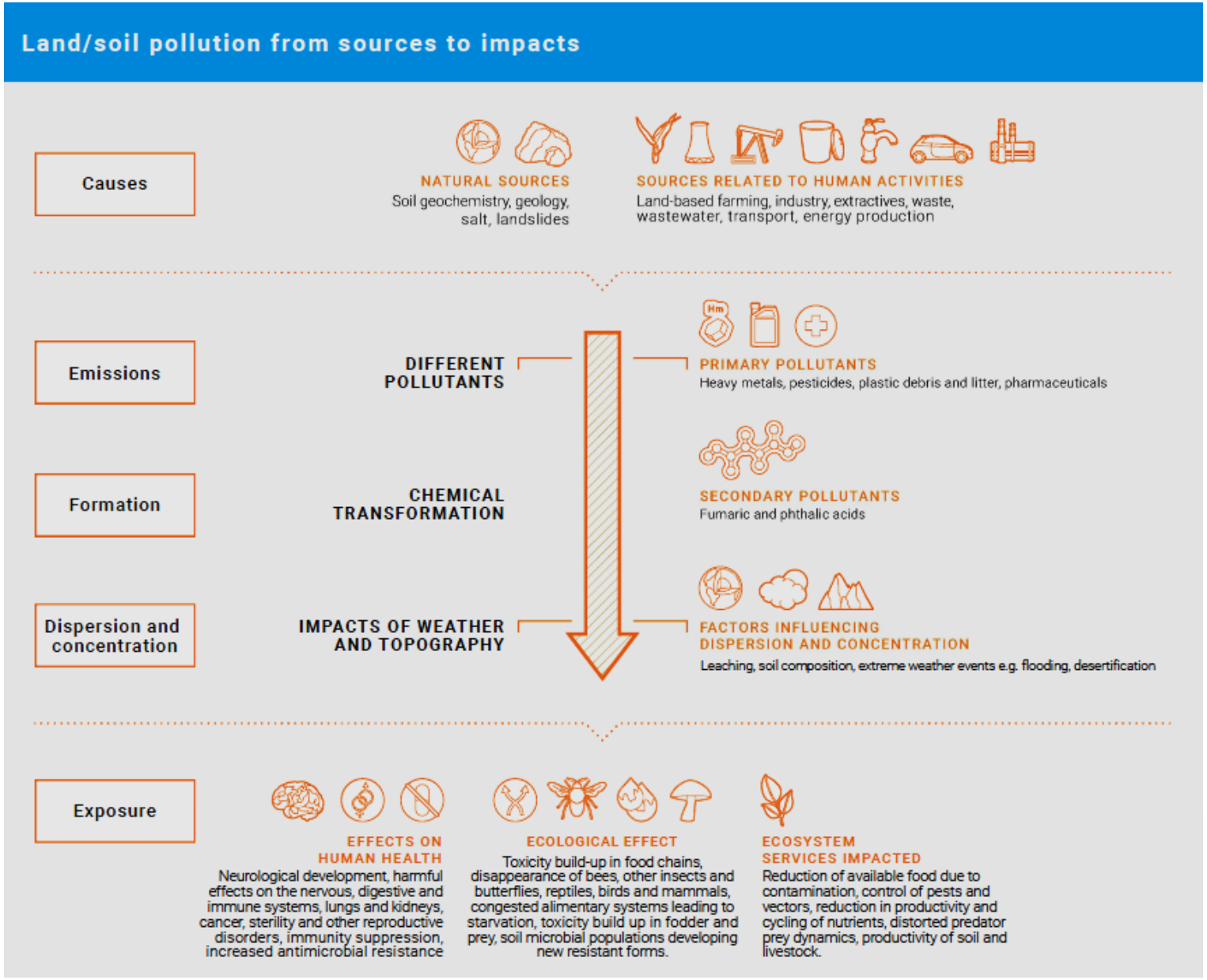
Major sources of today's pollution

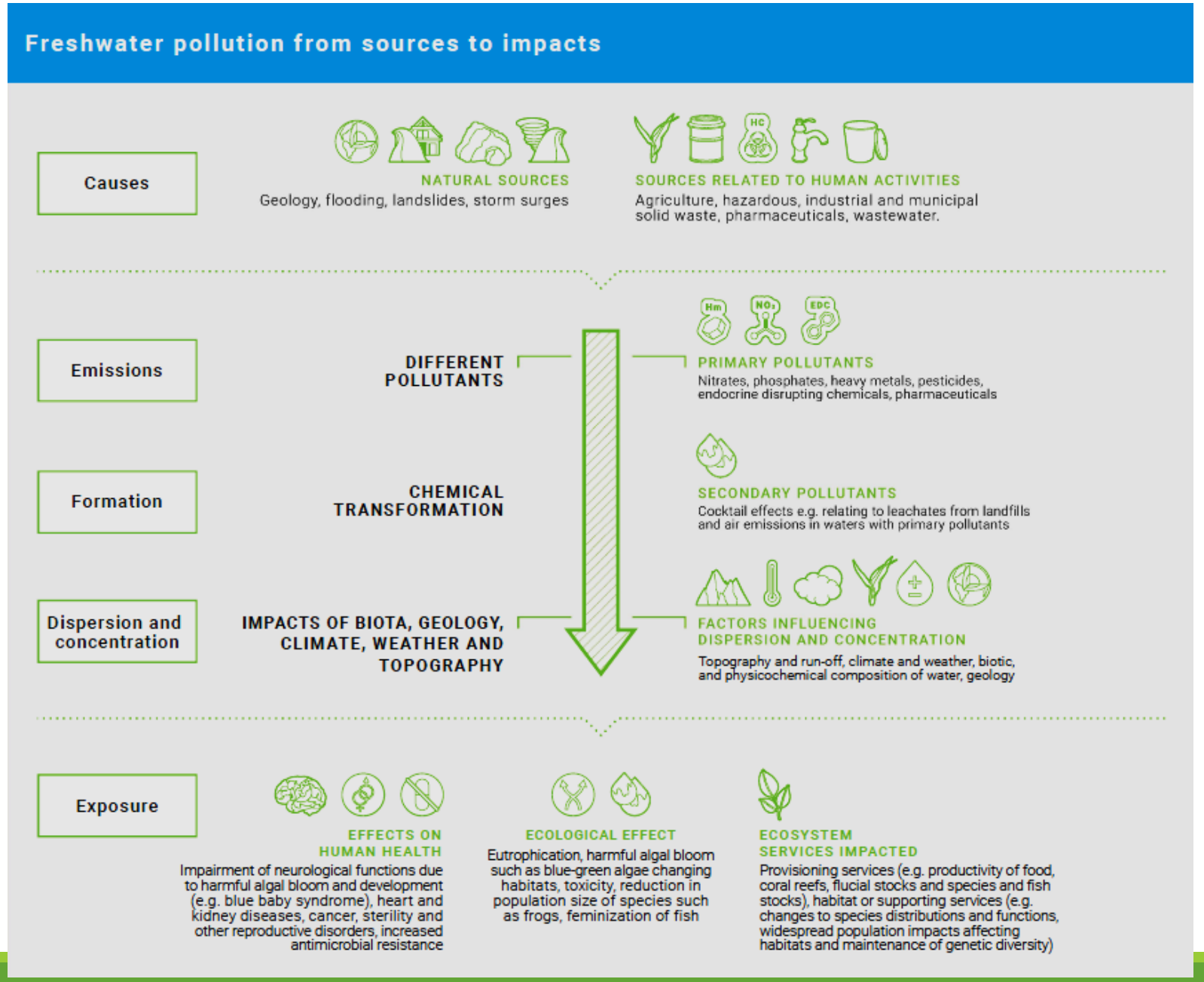
 **Agriculture and food**	Land-based farming, food and agro-industry, fisheries and aquaculture
 **Energy**	Combustion plants, fossil fuels, biomass, nuclear, domestic solid fuel heating
 **Industrial**	Chemicals, mineral extractives, forestry and paper products, cement
 **Manufacturing**	Information technology, home electronics, construction and home-building products, batteries, textiles, apparel, footwear, and luxury goods, pharmaceuticals (for example antibiotics)
 **Services**	Retail, hospitality and tourism, hospitals and health-care services
 **Transport**	Automobiles, fuel use and supply, engine emissions, road (tyres, surface), shipping, aviation, urban
 **Waste**	Improper management of municipal solid waste (which includes e-waste, plastics, food waste, organic waste and open burning), industrial waste (which includes e-waste, construction and demolition waste), hazardous waste (which includes e-waste), sewerage effluents, landfills (leachates)


Air pollution from sources to impacts
Causes
NATURAL SOURCES
Volcanoes, wildfires, dust storms, sea salt spray
SOURCES RELATED TO HUMAN ACTIVITIES
Power plants, industry, households, transport (exhaust fumes and non-exhaust pollutants), agriculture, waste treatment
Emissions
DIFFERENT POLLUTANTS
PRIMARY POLLUTANTS
Nitrogen and sulfur oxides, primary particulate matter, carbon monoxide, black carbon, ammonia, volatile organic compounds, heavy metals
Formation
CHEMICAL TRANSFORMATION
SECONDARY POLLUTANTS
Secondary particulate matter, ozone, sulphuric acid, nitric acid
Dispersion and concentration
IMPACTS OF WEATHER AND TOPOGRAPHY
FACTORS INFLUENCING DISPERSION AND CONCENTRATION
Volume/location of emissions, fixed/point of mobile source, lifetime in atmosphere, weather, capacity to contribute to secondary pollution, topography
Exposure
EFFECTS ON HUMAN HEALTH
Breathing disorders, cardiovascular diseases, cancer, heart and lung diseases, impairment of neurological development and immune system
ECOLOGICAL EFFECT
Acidification and eutrophication of water and soil, crop damage, climate change (both warming and cooling effects), reduced visibility, impaired photosynthesis, reduced plant growth, toxicity build-up in food chain
ECOSYSTEM SERVICES IMPACTED
Water and air purification, reduction of plant biomass, altered climate regulation through carbon sequestration, altered nutrient cycling, changes in ecosystems productivity

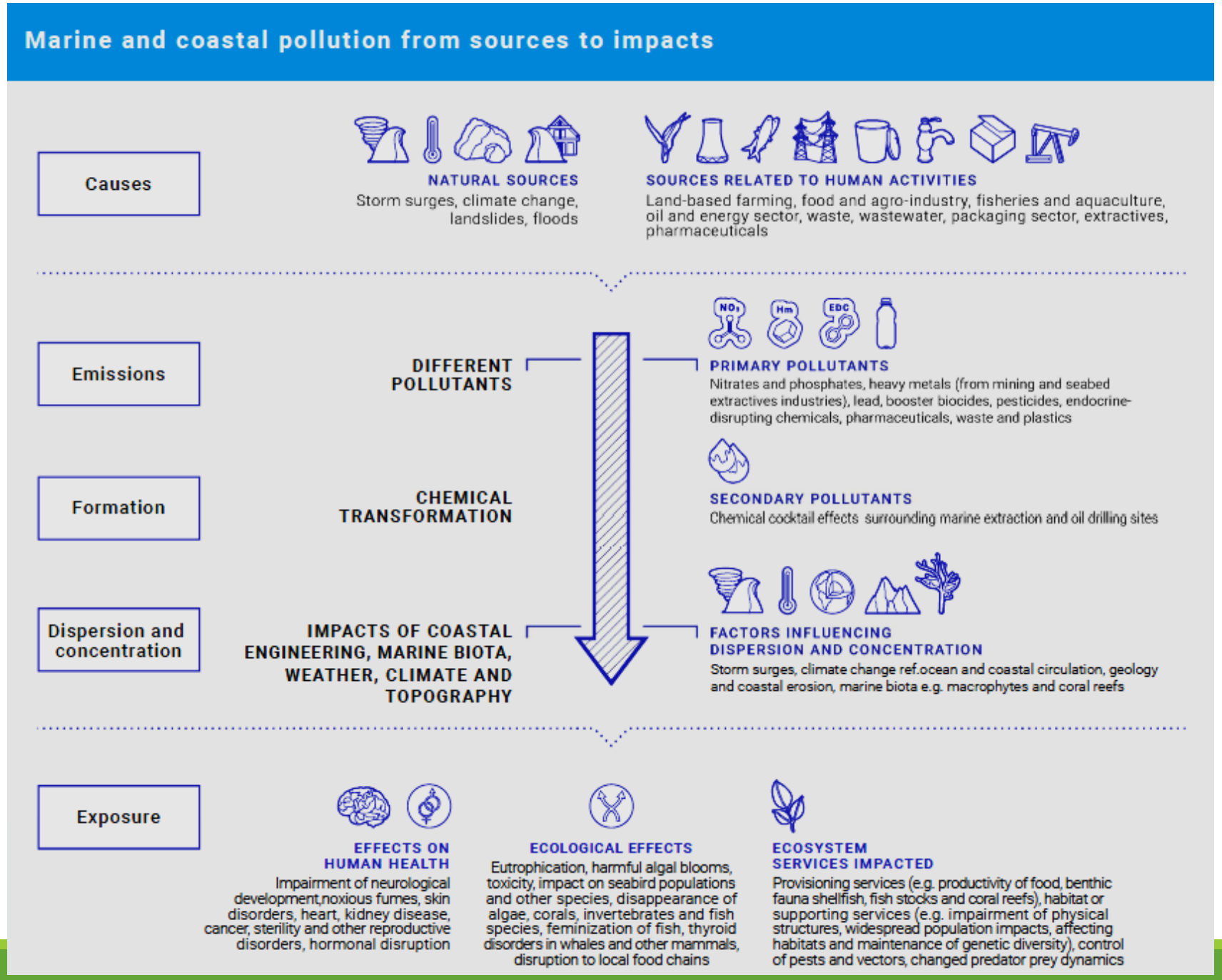


Sources of some key air pollutants


Land/soil pollution from sources to impacts
Causes
NATURAL SOURCES
Soil geochemistry, geology, salt, landslides
SOURCES RELATED TO HUMAN ACTIVITIES
Land-based farming, industry, extractives, waste, wastewater, transport, energy production
Emissions
DIFFERENT POLLUTANTS
PRIMARY POLLUTANTS
Heavy metals, pesticides, plastic debris and litter, pharmaceuticals
Formation
CHEMICAL TRANSFORMATION
SECONDARY POLLUTANTS
Fumaric and phthalic acids
Dispersion and concentration
IMPACTS OF WEATHER AND TOPOGRAPHY
FACTORS INFLUENCING DISPERSION AND CONCENTRATION
Leaching, soil composition, extreme weather events e.g. flooding, desertification
Exposure
EFFECTS ON HUMAN HEALTH
Neurological development, harmful effects on the nervous, digestive and immune systems, lungs and kidneys, cancer, sterility and other reproductive disorders, immunity suppression, increased antimicrobial resistance
ECOLOGICAL EFFECT
Toxicity build-up in food chains, disappearance of bees, other insects and butterflies, reptiles, birds and mammals, congested alimentary systems leading to starvation, toxicity build up in fodder and prey, soil microbial populations developing new resistant forms.
ECOSYSTEM SERVICES IMPACTED
Reduction of available food due to contamination, control of pests and vectors, reduction in productivity and cycling of nutrients, distorted predator prey dynamics, productivity of soil and livestock.


Freshwater pollution from sources to impacts
Causes
NATURAL SOURCES
Geology, flooding, landslides, storm surges
SOURCES RELATED TO HUMAN ACTIVITIES
Agriculture, hazardous, industrial and municipal solid waste, pharmaceuticals, wastewater.
Emissions
DIFFERENT POLLUTANTS
PRIMARY POLLUTANTS
Nitrates, phosphates, heavy metals, pesticides, endocrine disrupting chemicals, pharmaceuticals
Formation
CHEMICAL TRANSFORMATION
SECONDARY POLLUTANTS
Cocktail effects e.g. relating to leachates from landfills and air emissions in waters with primary pollutants
Dispersion and concentration
IMPACTS OF BIOTA, GEOLOGY, CLIMATE, WEATHER AND TOPOGRAPHY
FACTORS INFLUENCING DISPERSION AND CONCENTRATION
Topography and run-off, climate and weather, biotic, and physicochemical composition of water, geology
Exposure
EFFECTS ON HUMAN HEALTH
Impairment of neurological functions due to harmful algal bloom and development (e.g. blue baby syndrome), heart and kidney diseases, cancer, sterility and other reproductive disorders, increased antimicrobial resistance
ECOLOGICAL EFFECT
Eutrophication, harmful algal bloom such as blue-green algae changing habitats, toxicity, reduction in population size of species such as frogs, feminization of fish
ECOSYSTEM SERVICES IMPACTED
Provisioning services (e.g. productivity of food, coral reefs, flucial stocks and species and fish stocks), habitat or supporting services (e.g. changes to species distributions and functions, widespread population impacts affecting habitats and maintenance of genetic diversity)

Marine and coastal pollution from sources to impacts

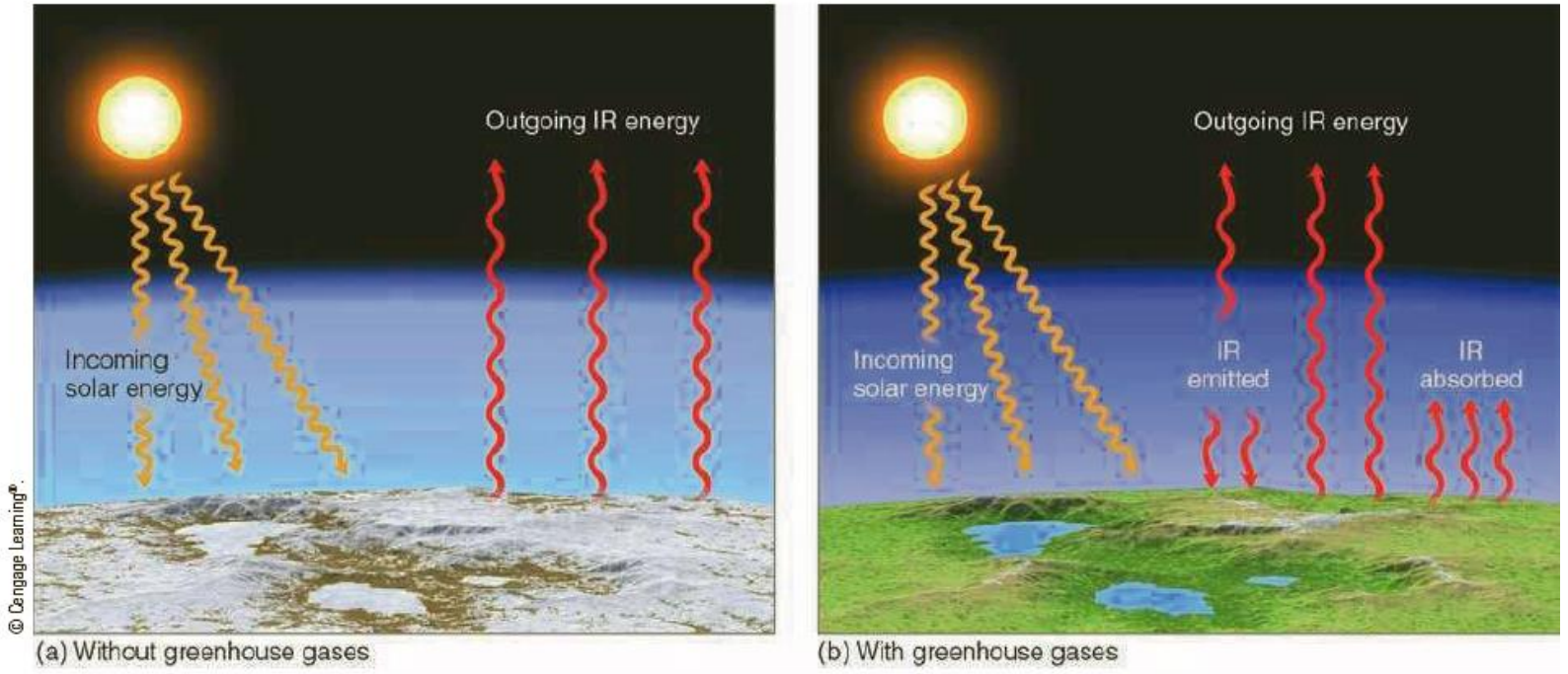


- Environmental pollution is a major problem of the world due to increasing industrialization.
- Industries play important roles in the national economy of every country, but they can also be the main sources for environmental pollution.
- Industrial wastes carry a variety of potentially toxic pollutants that can cause severe impacts on the environment and human health.
- Therefore, the adequate treatment and management of such hazardous wastes to protect the environment and public health.

https://www.assignmentpoint.com/other/environmental-pollution-in-present-world.html

Greenhouse effect

- In a greenhouse, the glass allows visible radiation to come in, but inhibits to some degree the passage of outgoing infrared radiation.
- For this reason, the absorption of infrared radiation from Earth by water vapor and CO_2 is popularly called the **greenhouse effect.**
- Earth's mean radiative equilibrium temperature without CO_2 and water vapor would be around -18°C (0°F), or about 33°C (59°F), lower than at present.



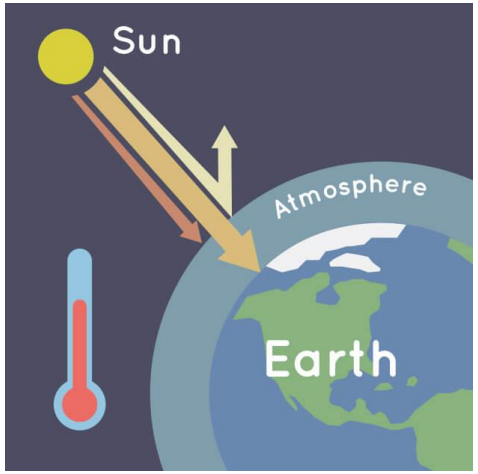
a) Near the surface in an atmosphere with little or no greenhouse gases, Earth's surface would constantly emit infrared (IR) radiation upward, both during the day and at night. Incoming energy from the sun would equal outgoing energy from the surface, but the surface would receive virtually no IR radiation from its lower atmosphere. (i.e., there would be no atmospheric greenhouse effect.) Earth's surface air temperature would be quite low, and small amounts of water found on the planet would be in the form of ice. (b) In an atmosphere with greenhouse gases, Earth's surface not only receives energy from the sun but also infrared energy from the atmosphere. Incoming energy still equals outgoing energy, but the added IR energy from the greenhouse gases raises Earth's average surface temperature to a more habitable level.

Greenhouse effect

- The greenhouse effect is a process that occurs when gases in Earth's atmosphere trap the Sun's heat.
- This process makes Earth much warmer than it would be without an atmosphere.
- That's what keeps our Earth a warm and comfortable 58 degrees Fahrenheit (14 degrees Celsius), on average.
- The greenhouse effect is one of the things that makes Earth a comfortable place to live.

How are humans impacting the greenhouse effect?

- Human activities are changing Earth's natural greenhouse effect.
- Burning fossil fuels like coal and oil puts more carbon dioxide into our atmosphere.
- NASA has observed increases in the amount of carbon dioxide and some other greenhouse gases in our atmosphere
- Too much of these greenhouse gases can cause Earth's atmosphere to trap more and more heat.
- This causes Earth to warm up.



Earth's atmosphere traps some of the Sun's heat, preventing it from escaping back into space at night. Credit: NASA/JPL-Caltech

Global warming: the phenomenon of increasing average air temperatures near the surface of Earth over the past one to two centuries.

Causes and Effects of Climate Change | National Geographic

https://www.youtube.com/watch?v=G4H1N_yXBiA

Air Pollution 101 | National Geographic

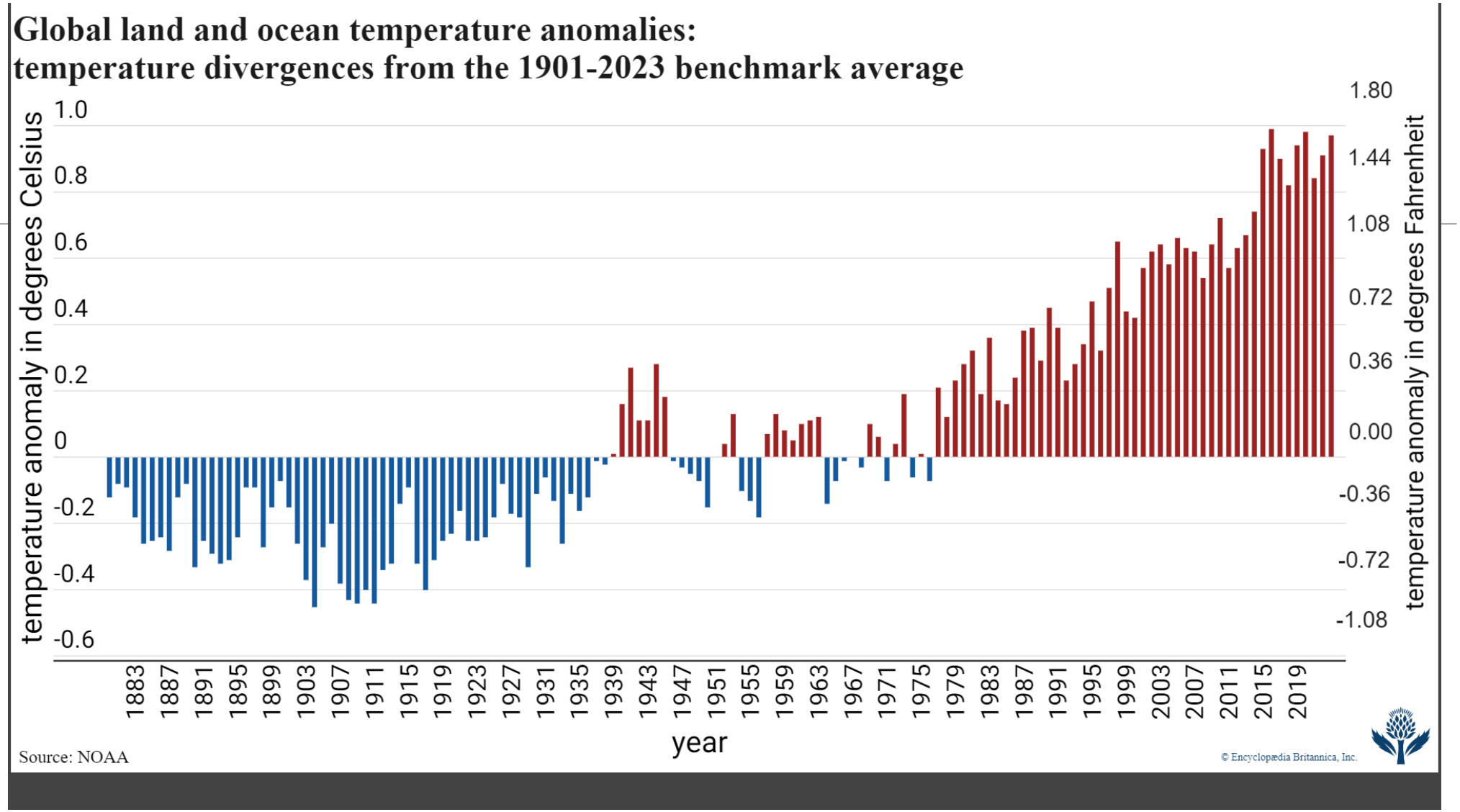
https://www.youtube.com/watch?v=e6rglsLy1Ys

There's An Island Made of PLASTIC: Twice the Size of Texas!

https://www.youtube.com/watch?v=cEeKerZ7iU4

Global Carbon Budget 2023 https://www.youtube.com/watch?v=zkXF7OS0a0o

Carbon Emissions Report: 57 entities responsible for 80% of carbon emissions | WION Climate Tracker
https://www.youtube.com/watch?v=DUWbelj57gg


Global land and ocean temperature anomalies:
temperature divergences from the 1901-2023 benchmark average
temperature anomaly in degrees Celsius
1.0
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
temperature anomaly in degrees Fahrenheit
1.80
1.44
1.08
0.72
0.36
0.00
-0.36
-0.72
-1.08
1883
1887
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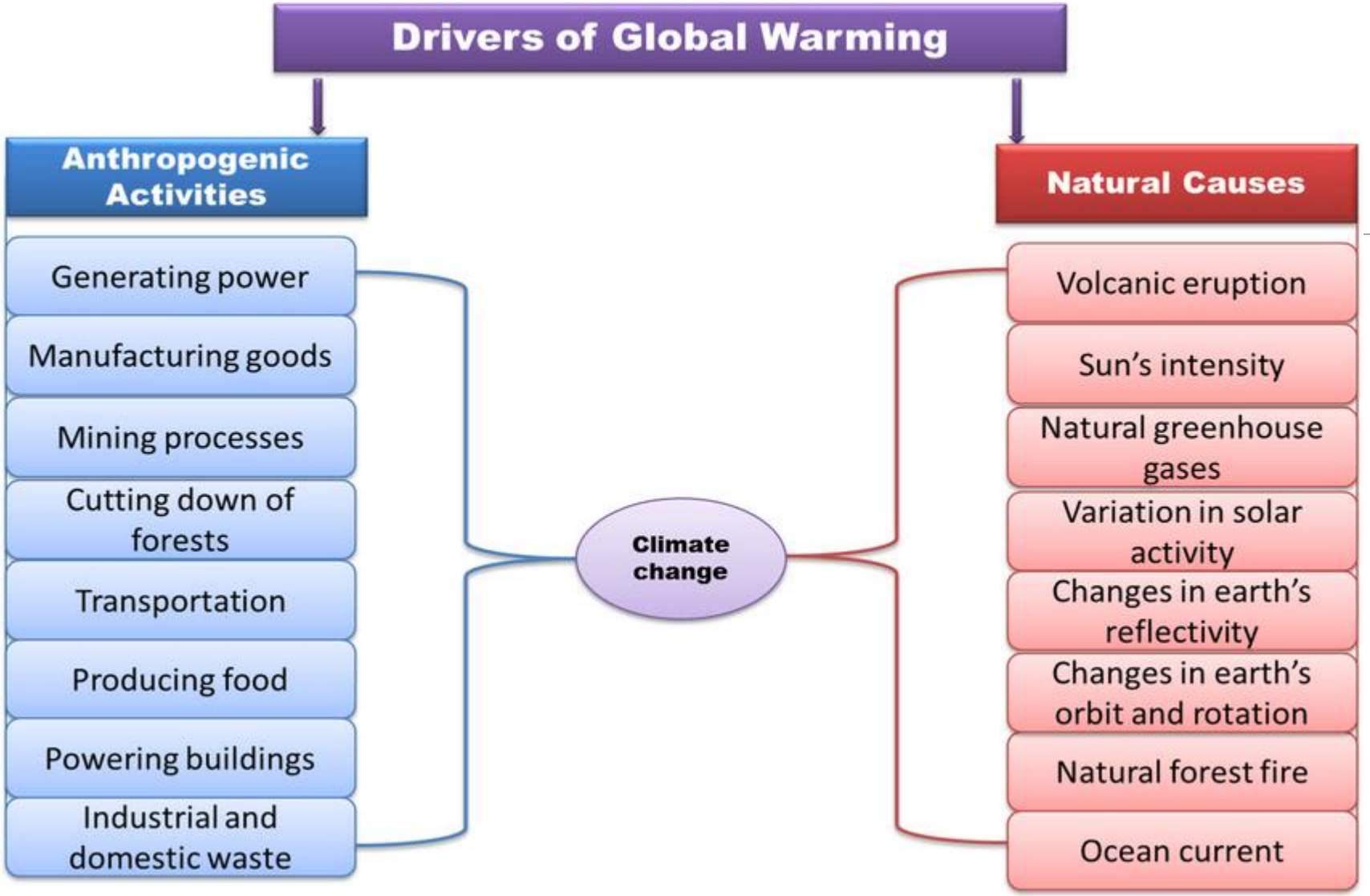
year
Source: NOAA
© Encyclopædia Britannica, Inc.


Drivers of Global Warming
Anthropogenic Activities
Generating power
Manufacturing goods
Mining processes
Cutting down of forests
Transportation
Producing food
Powering buildings
Industrial and domestic waste
Climate change
Natural Causes
Volcanic eruption
Sun's intensity
Natural greenhouse gases
Variation in solar activity
Changes in earth's reflectivity
Changes in earth's orbit and rotation
Natural forest fire
Ocean current

Causes and Effects of Climate Change

Causes

- Rapid industrialization
- Energy use
- Agricultural practices
- Deforestation
- Consumer practices
- Livestock
- Transport
- Resource extraction
- Pollution

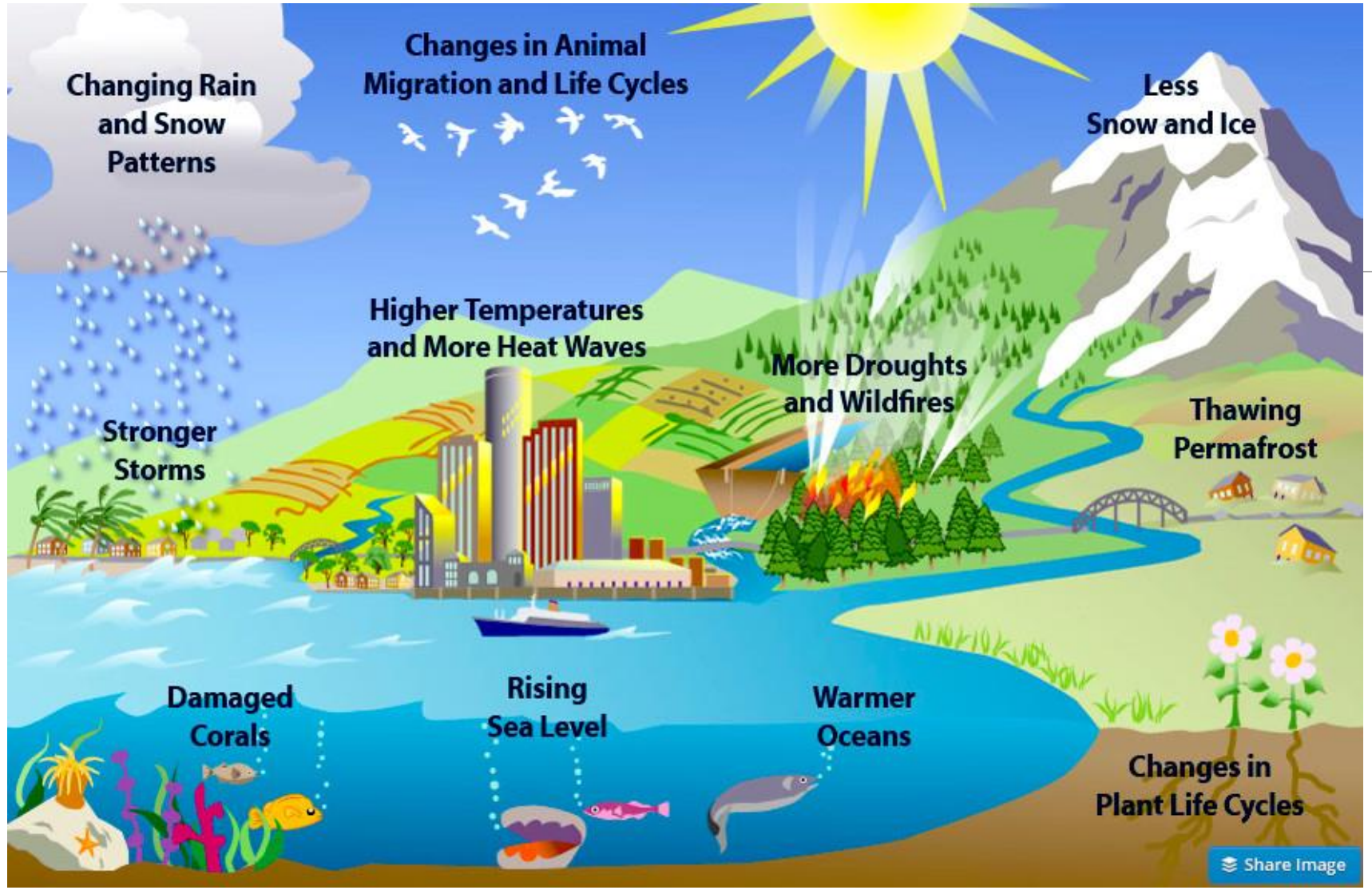
Effects

- Rising temperatures
- Rising sea levels
- Unpredictable weather patterns
- Increase in extreme weather events
- Land degradation
- Loss of wildlife and biodiversity

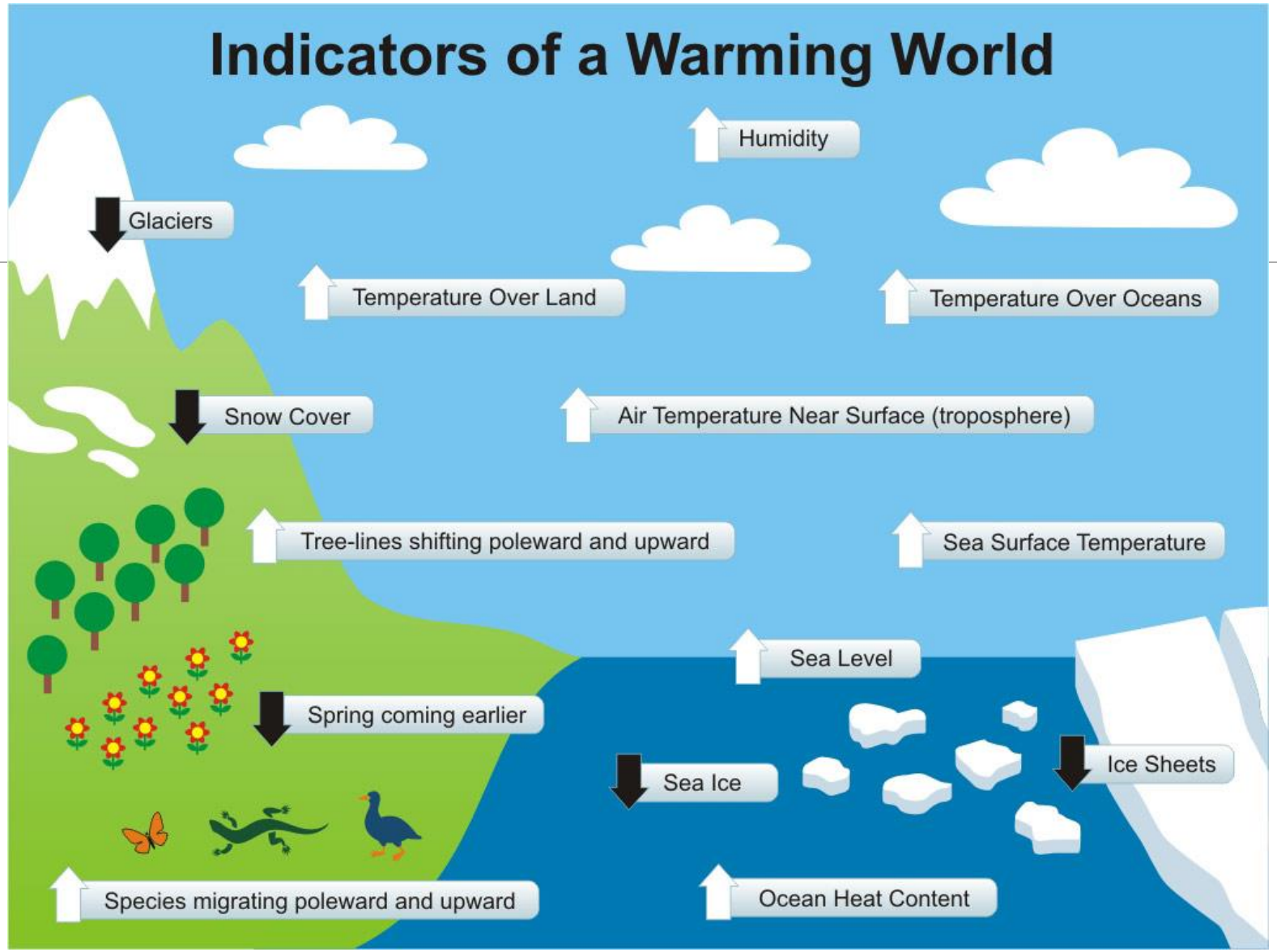
What are the social impacts of climate change?

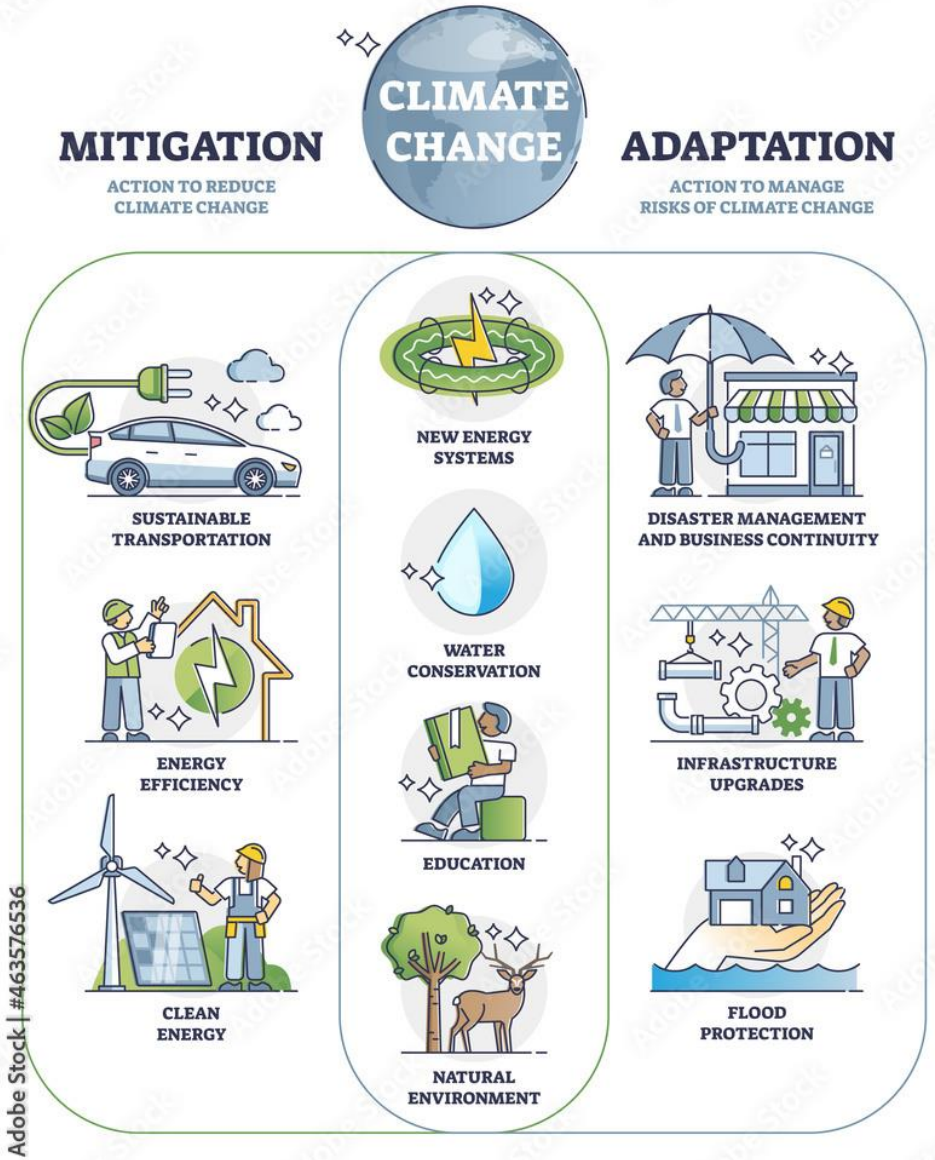
Displaced people. Poverty. Loss of livelihood. Hunger. Malnutrition.
Increased risk of diseases. Global food and water shortages.

GlobalGiving



Effects of Global warming and Climate Change on our immediate environments


Indicators of a Warming World
Humidity
Glaciers
Temperature Over Land
Temperature Over Oceans
Snow Cover
Air Temperature Near Surface (troposphere)
Tree-lines shifting poleward and upward
Sea Surface Temperature
Sea Level
Spring coming earlier
Sea Ice
Ice Sheets
Species migrating poleward and upward
Ocean Heat Content


CLIMATE CHANGE
MITIGATION
ACTION TO REDUCE CLIMATE CHANGE
ADAPTATION
ACTION TO MANAGE RISKS OF CLIMATE CHANGE
SUSTAINABLE TRANSPORTATION
ENERGY EFFICIENCY
CLEAN ENERGY
NEW ENERGY SYSTEMS
WATER CONSERVATION
EDUCATION
NATURAL ENVIRONMENT
DISASTER MANAGEMENT AND BUSINESS CONTINUITY
INFRASTRUCTURE UPGRADES
FLOOD PROTECTION
Adobe Stock | #463576536

Introduction to Sustainability

"Earth provides enough to satisfy every man's need but not his greed"
Mahathma Gandhi

- The environment is the place where we live.
- However, what we do in our own environment affects other people in the world.
  - For example: Global warming' - the process by which the burning of fossil fuels is changing the climate.
  - This is just one of the ways our actions are affecting the world.
- If people use too many resources now there just won't be enough for the future.

What is Sustainable Living?

- We have to live in a way that will allow our children and their children to carry on forever.
- They should have the same type of life that we have now.
- If we do not live in a more sustainable way then 9 billion people CANNOT live on the earth.
  - In some countries half the food is thrown away.
  - However in some countries a child dies from hunger every 5 seconds.

What is Sustainability https://www.youtube.com/watch?v=zx04Kl8y4dE

Sustainability: Balancing environmental protection and social responsibility with a healthy economy over time

Sustainable Materials vs Unsustainable Materials

Sustainable materials:

These are things that can be farmed and managed in a way that means they grow or breed again, such as: Plants; Trees; Animals

Unsustainable materials:

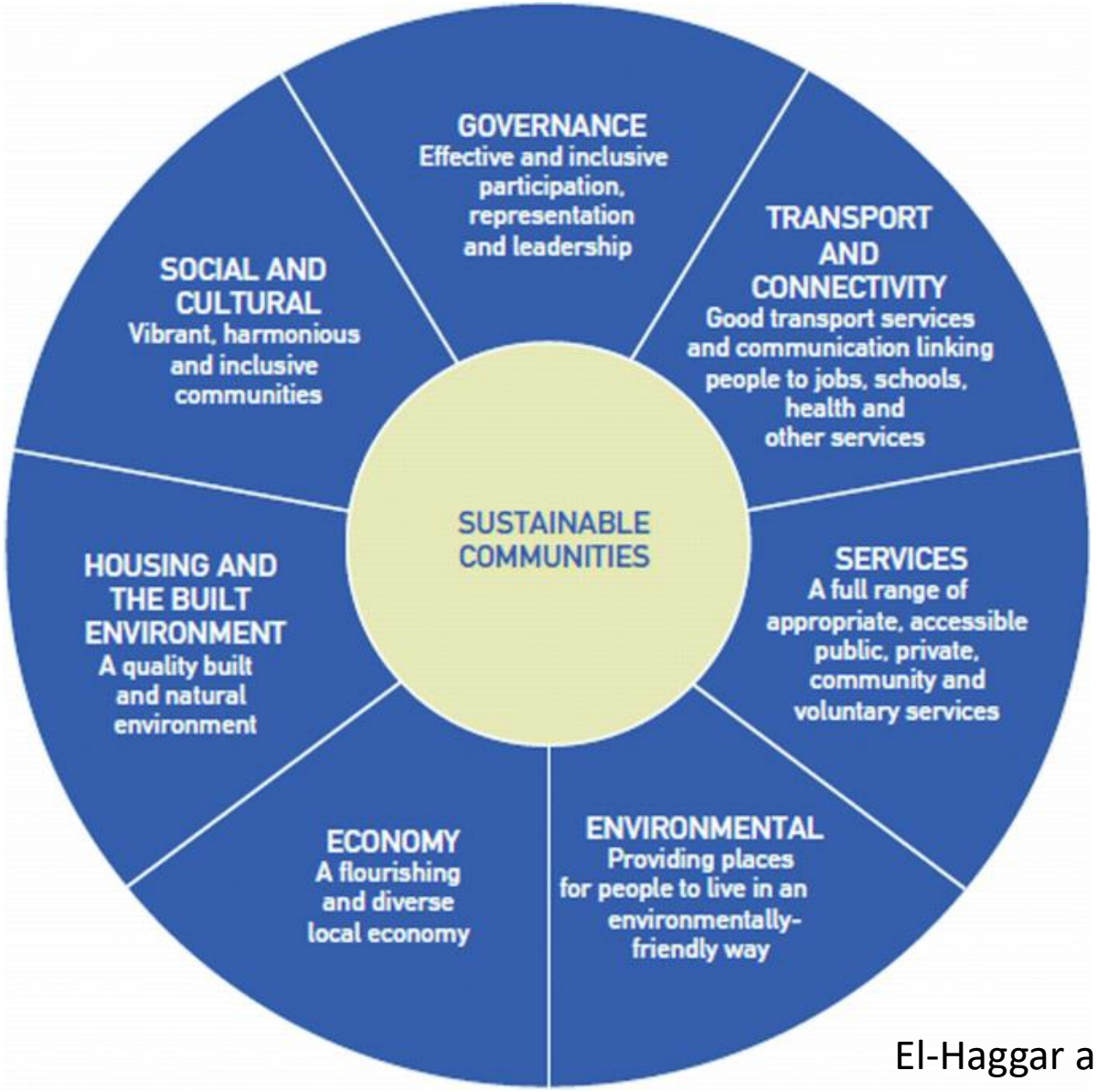
There is only a limited amount of these. So we need to use them carefully and not waste them. These are things like: Coal; Oil; Gas; Iron; Aluminium

What is a sustainable community?

- A sustainable community provides everything that people need to live, work and thrive.
- It meets the current needs of people, while making sure there are adequate resources for future generations to come.

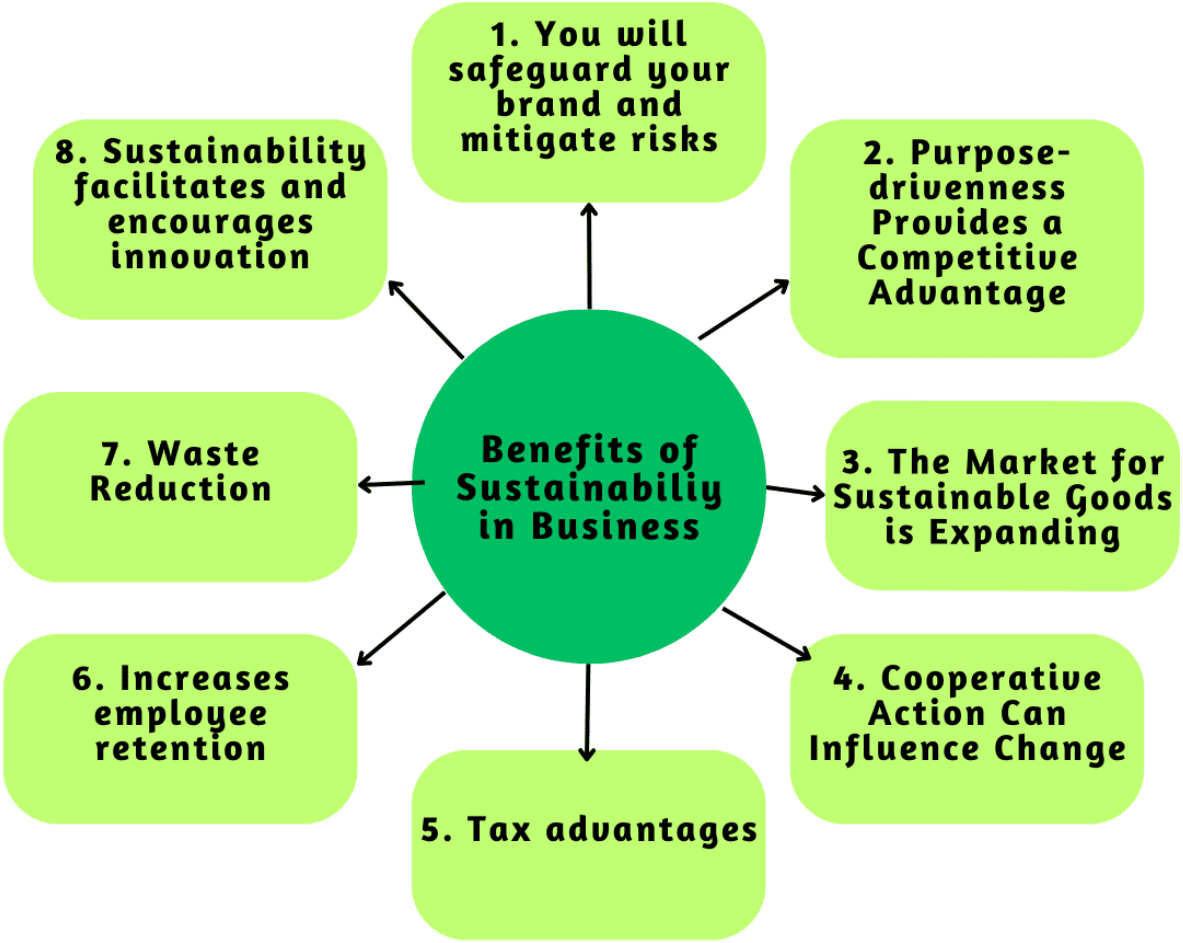
Three parts of a sustainable community

- Economic sustainability
- Social sustainability
- Environmental sustainability

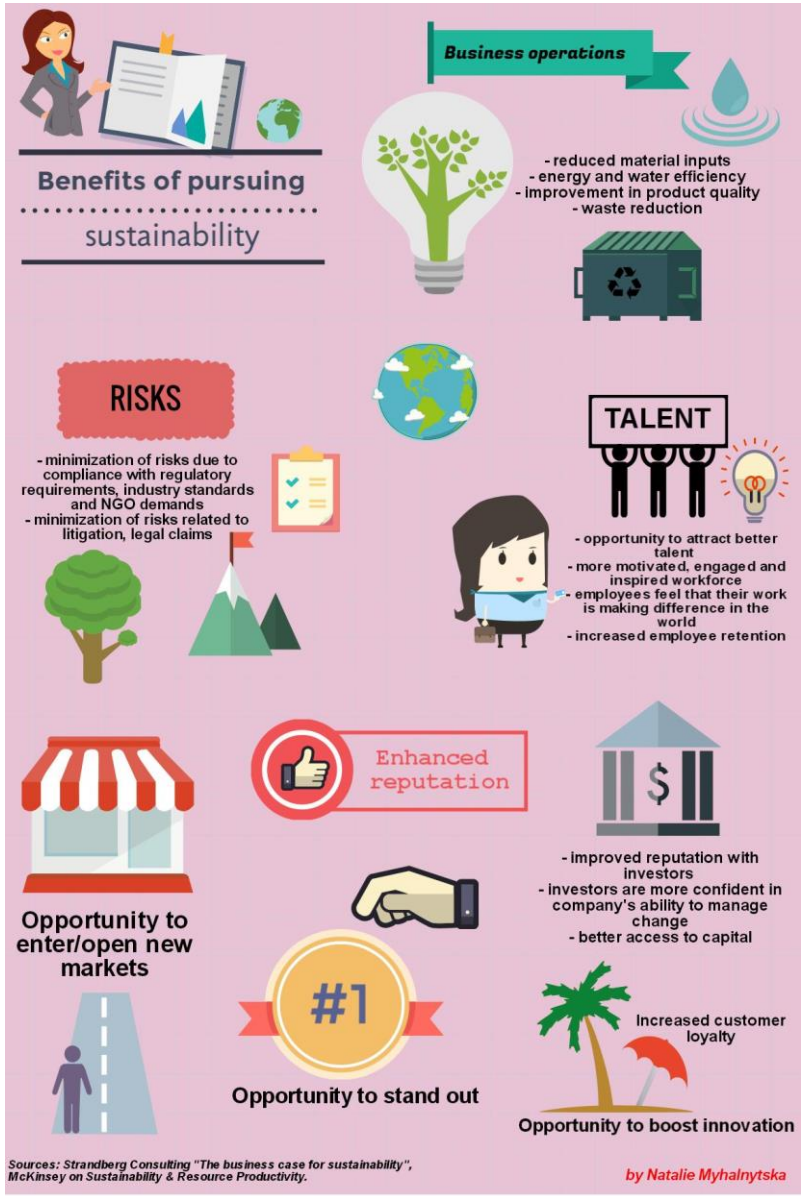


El-Haggar and Samaha, 2019

https://evolveea.com/district-pgh-resources-for-sustainable-communities/



https://sigmaearth.com/what-are-the-benefits-of-sustainability-in-business/


Benefits of pursuing
sustainability
Business operations
- reduced material inputs
- energy and water efficiency
- improvement in product quality
- waste reduction
RISKS
- minimization of risks due to compliance with regulatory requirements, industry standards and NGO demands
- minimization of risks related to litigation, legal claims
TALENT
- opportunity to attract better talent
- more motivated, engaged and inspired workforce
- employees feel that their work is making difference in the world
- increased employee retention
Enhanced reputation
- improved reputation with investors
- investors are more confident in company's ability to manage change
- better access to capital
Opportunity to enter/open new markets
#1
Opportunity to stand out
Increased customer loyalty
Opportunity to boost innovation
Sources: Strandberg Consulting "The business case for sustainability", McKinsey on Sustainability & Resource Productivity.
by Natalie Myhalnytska
powered by
Piktochart
make information beautiful

Resource Efficiency and Sustainability

Sustainable Development

Sustainability thus emerges as a crucial component of any successful paradigm to guide development in the new Millennium.

Requires a new emphasis on the nature and size of inputs to development, especially energy, resource, chemical and other material input.

Resource efficiency is one of the key issues in sustainable development.

Resource Efficiency

Related terms and concepts that are emerging include:

- **Eco-efficiency**
- **Eco-sustainability**
- **Eco-design**
- **Product Life-Cycle**
- **Green Productivity**

Sustainable Development Goals: A Brief Introduction

- Sustainable Development (SD) is defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland Report 1987).

- According to Mensah (2019), sustainable development is a multi-facet concept with many different definitions, meanings and interpretations.

- Comporek et al. (2021) have identified three elements of sustainable development as economic growth, social equity for fulfilling the requirements of the present generation, and environmental protection to ensure the potential of meeting the needs of present and future generations.

In 2015, the UNDP introduced the agenda of SDGs with a set of 17 aspirational 'Global Goals' with 169 targets and 244 indicators between them to be achieved by 2030 (United Nations, 2015).

https://www.youtube.com/watch?v=0XTBYMfZyrM&t=5s

- The Paris Agreement has set an ambitious goal of limiting the global mean temperature increase to below 2 degrees Celsius, and, if possible, under 1.5 degrees Celsius.
- Achieving this goal requires an unprecedented transformation of the way energy is supplied and used throughout the world, including
  - a rapid deployment of low carbon electricity generation technologies on the supply side, an acceleration of energy efficiency improvements on the demand side.

The SDG Report 2023: Special Edition

https://www.youtube.com/watch?v=zF361a019zA

Asia and the Pacific SDG Progress Report 2023

https://www.youtube.com/watch?v=rcd3CkZZFRU

The Blue-Green Economic Policy: The Creator of New Prospects in the Economy

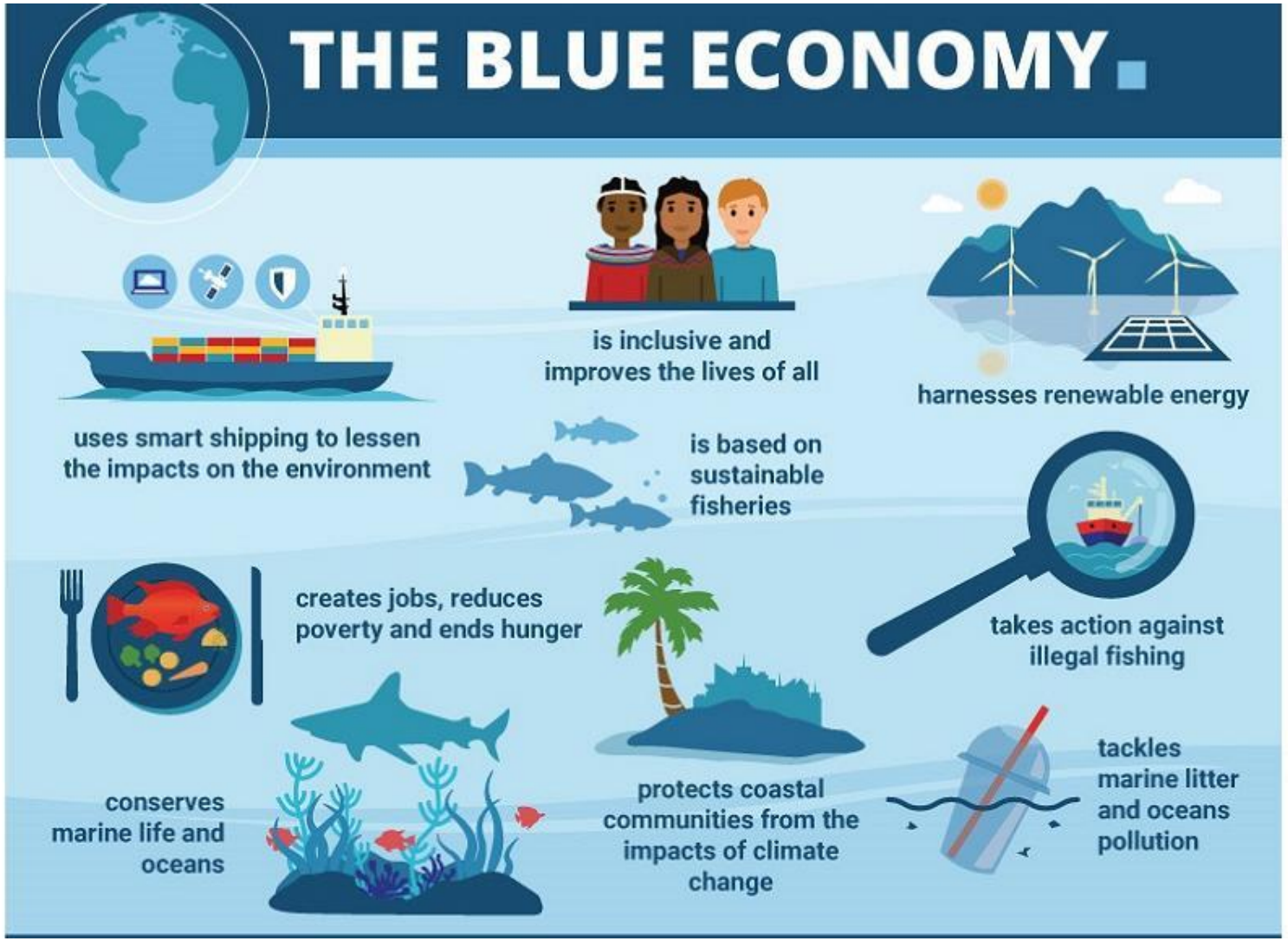
- The Blue-Green Economy is a modern development approach that has been formulated concerning ecological preservation and obtaining optimal benefits from the green environment and oceans without harming or exploiting them.
- Blue-Green Economy can be divided into two fields as the

  Blue Economy and the Green Economy

What is a ‘Green’ Product?

A ‘Green’ Product:

- **Can be recycled**
- **Have a recycled content**
- **Be energy efficient**
- **Emission reducing**
- **Re-usable**
- **Biodegradable**
- **Organic**



https://www.africanews.com/2018/11/26/importance-of-a-sustainable-blue-economy-statistics-and-facts/

Green Economy

There are several major concerns in the Green Economy.

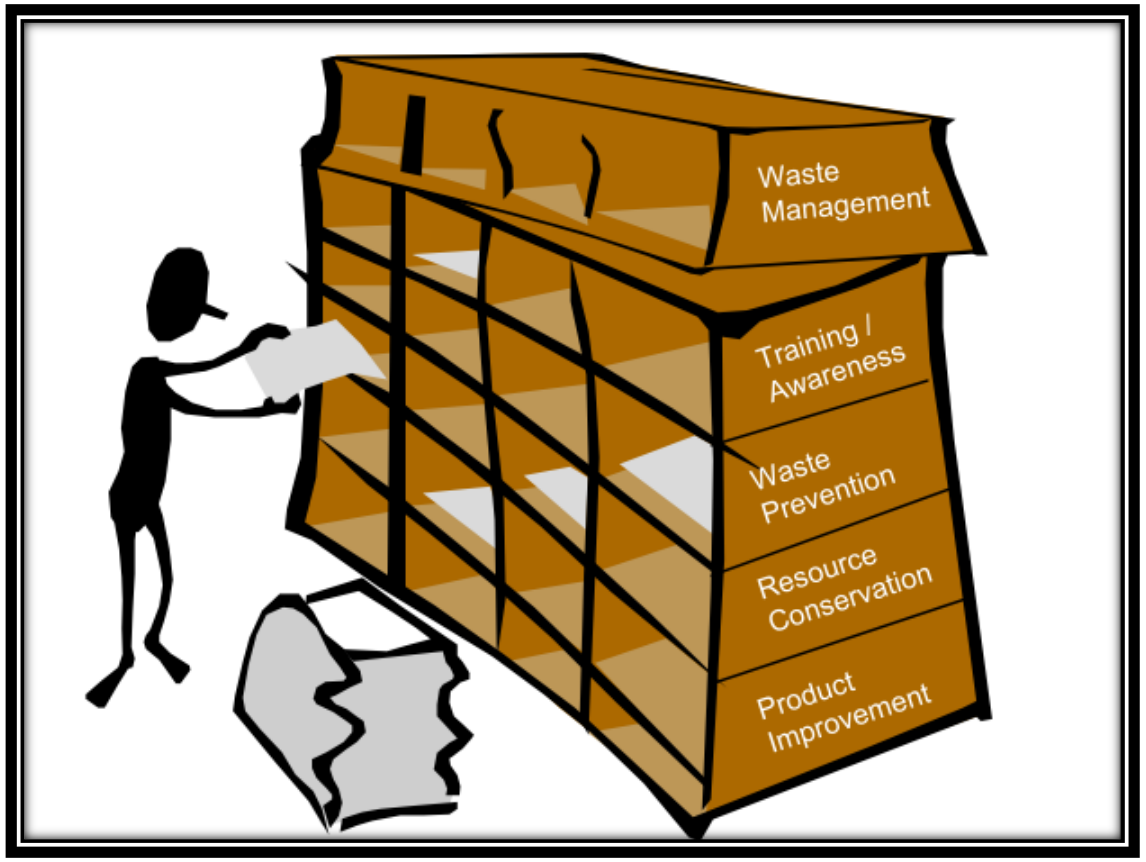
- Given priority to **energy efficiency practices.**
  - The Green Economic approach depends a lot on renewable energy sources like wind and solar, instead of nonrenewable petroleum-based resources.
- Introducing **'green construction methods**' to massive city and urban development projects and also to small scale constructions is another aspect of the Green Economy.
- **Clean transportation** has an important place in Green Economy.
  - In there, using more non-carbon and low-carbon emission methods of transportation, such as cycling and switching into public transportation, than using private motor vehicles are among suggestions of clean transportation.
- The **Environmental Management** aspect which plays a major role in Green Economy explains getting optimal benefits from the ecosystem without damaging it
- the priority given to **clean and safe agriculture, forestry and land management practices**.
  - Green Economy thoroughly advocates organic food production, fair trade, and reforestation. The strategies of Green Economy include the areas such as eco-friendly and cruelty-free food manufacturing industries.
- **Green tourism** which is also popular as eco-tourism around the world today, is also an important provision of the Green Economy.

Green economy and linkage with various factors

https://pdfs.semanticscholar.org/6a38/69dbd9c475e0d53f2e88c2bc1abe8c53554c.pdf?_ga=2.16960953.169534088.1645087735-219503377.1644163895

https://www.greenesa.com/article/renewable-energy-sources-types

Organization of the GP Techniques



Organization of the Techniques

1. Waste Prevention

- Improved Operating Procedures
- Waste Segregation
- Good Housekeeping
- 5S Program
- 7 Wastes

2. Resource Conservation

- Recycle , Reuse & Recovery
- Off-site Recycling
- On-site Recycling
- Energy Conservation
- Process Modification
- Input Material Changes
- Process / Equipment Changes

3. Pollution Control

- Air Emission Control
- Effluent Pollution Control
- Solid Waste Management

4. Product Improvement

- Design for Environment

5. Productivity & Quality Improvement

Objective of the module

The aim of this course is to enrich students with knowledge of green technology and the sustainability of environmental technology.

(https://www.greentechnologyinfo.com/environmental-technology/green-technology/)

Course content & Intended Learning Outcomes (ILOs)

No	Content	ILO
1	**Introduction to Green Technology** Basic definitions, basic principles, an overview of green technologies	**LO#1:** Explain and elaborate green technology concepts, approaches, tools, methods, technologies, and their importance
2	**Renewable Energy** Concept of Energy, Units and Measurement, Types of energy, Energy and power, Energy demand, History of fossil fuels, Sources of energy, solar, wind, tidal, geothermal, biomass, animal, human, hydrogen and fuel cells.	**LO#2:** Describe, evaluate, and develop different renewable energy technologies
3	**Biomass Energy Technology** Biomass classification, Biomass characteristics, Biomass production techniques, Harvesting of biomass, Gasifier and its process, Bio-ethanol production, bio-diesel production, Electricity generation from biomass Importance of biogas production, Biological process involved in Anaerobic digestion, Uses of biogas, Designing of small biogas digesters, Construction of a digester	**LO#3:** Describe and evaluate techniques of converting biomass to energy
4	**Industrial Green Technology** Bioplastics, green catalysis, green technology development challenges, opportunities for green technology markets	**LO#4:** Conduct case studies for analyzing and evaluating industrial applications of green technology **LO#5:** Describe green technology development challenges, opportunities for green technology markets
5	**Design approaches in green technology** Introduction to green building design	**LO#6:** Describe guiding principles fundamental to design approaches in green technology

Recommended Texts

1. Dahlquist, E. (2013). Technologies for Converting Biomass to Useful Energy, 1st edition. CRC Press

2. Mulvaney, D.R. (2011). Green Technology, 1st edition. London, UK: SAGE Publications Ltd

3. Dustin Mulvaney (2011) Green technology: an A-to-Z guide, Thousand Oaks, Calif: Sage Publications

Online Resources Related to Green Technology

1. Green technology: https://www.green-technology.org/
2. US green technology: https://usgreentechnology.com/
3. The Green Building Council of Sri Lanka (GBCSL) - the Sri Lanka's leading authority on implementing green concept and green building practices: https://srilankagbc.org/
4. World Green Building Council - a non-profit organization and global network of national Green Building Councils: https://www.worldgbc.org/

Sectors Using Green Tech

1. Energy Sector
2. Transportation Sector
3. Waste Management Sector
4. Water Filtration
5. Air Purification

Green Chemistry and Chemical Engineering

Principles of Green Chemistry proposed by Anastas and Warner

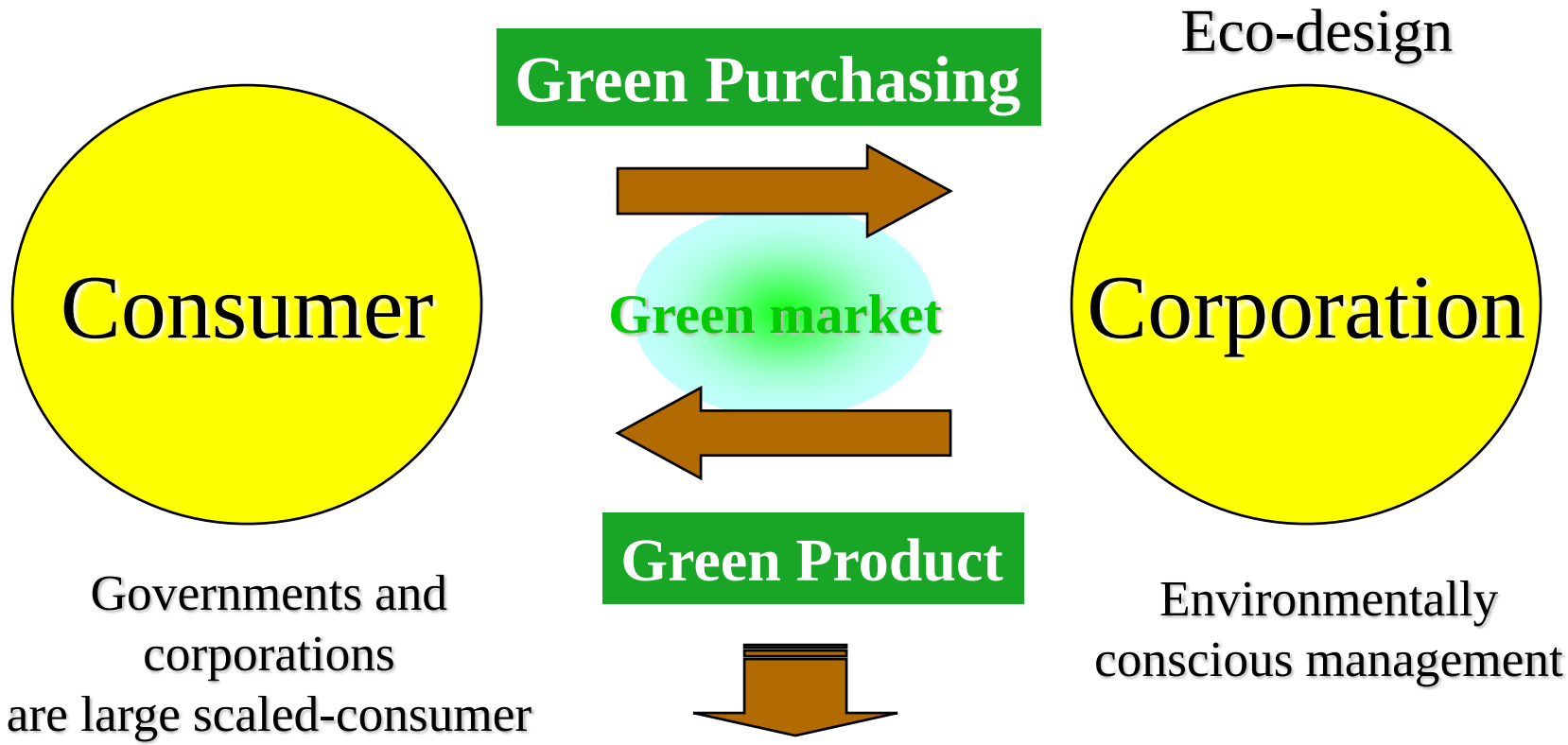
(https://www.researchgate.net/publication/326537035_Evolution_Of_Green_Chemistry_And_Its_Multidimensional_Impacts_A_Review/figures?lo=1)

- “Green products” refers to the promotion of safe, sustainable, and waste-minimizing chemical processes.

https://guides.loc.gov/green-business

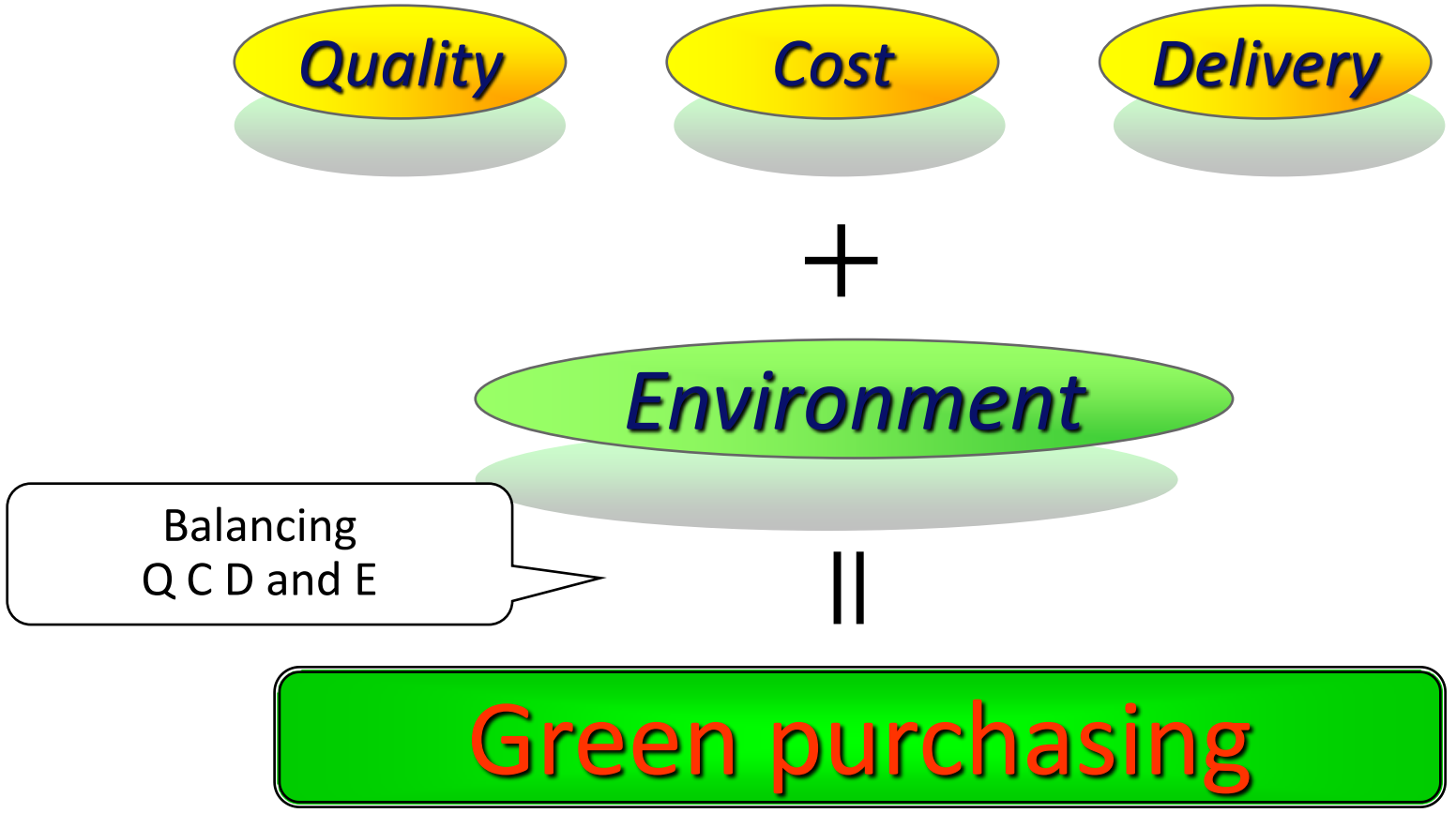
Green Purchasing changes a corporation

Encouraging environmentally conscious management and product development through the market

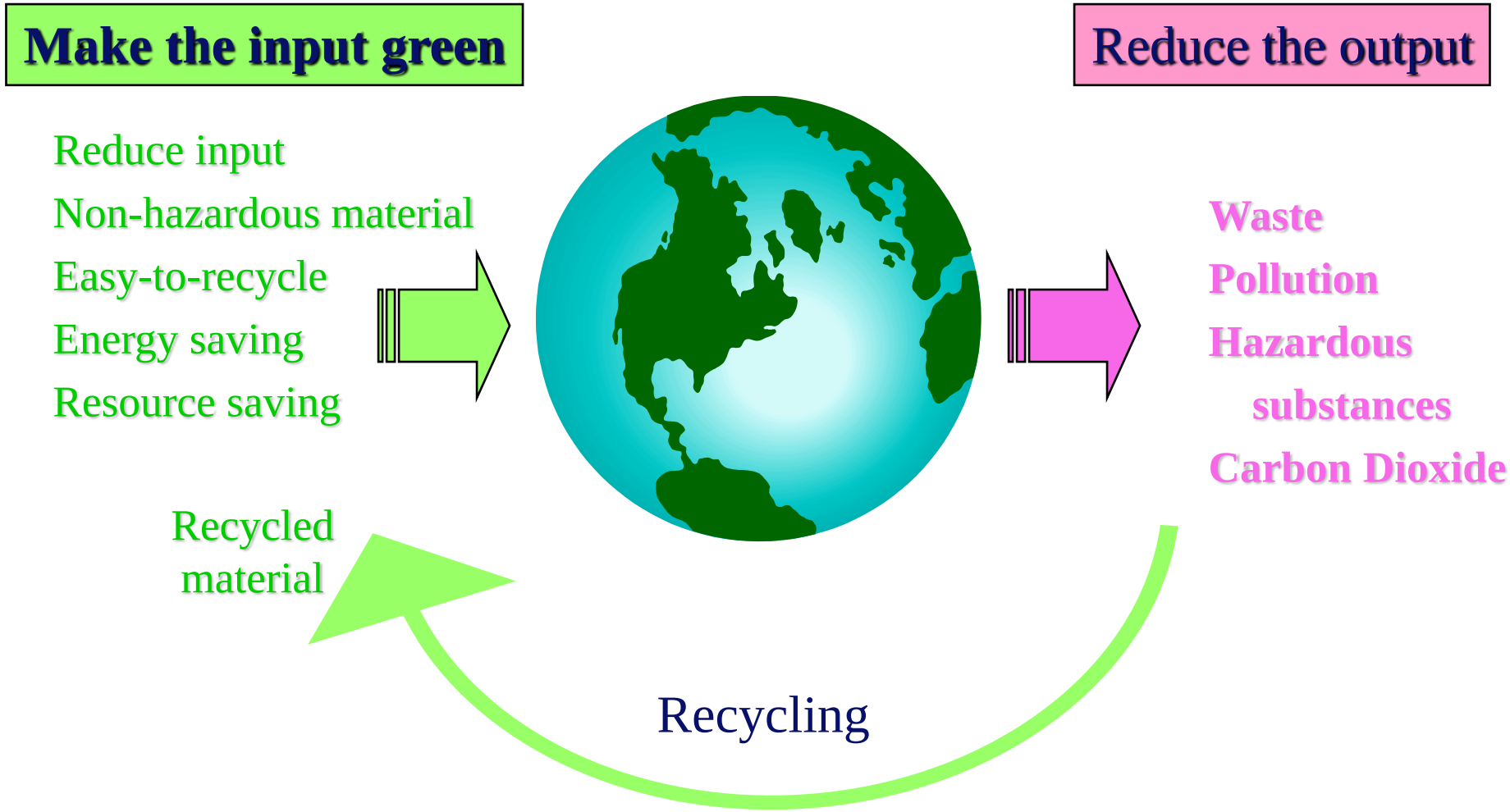


Establish a sustainable society

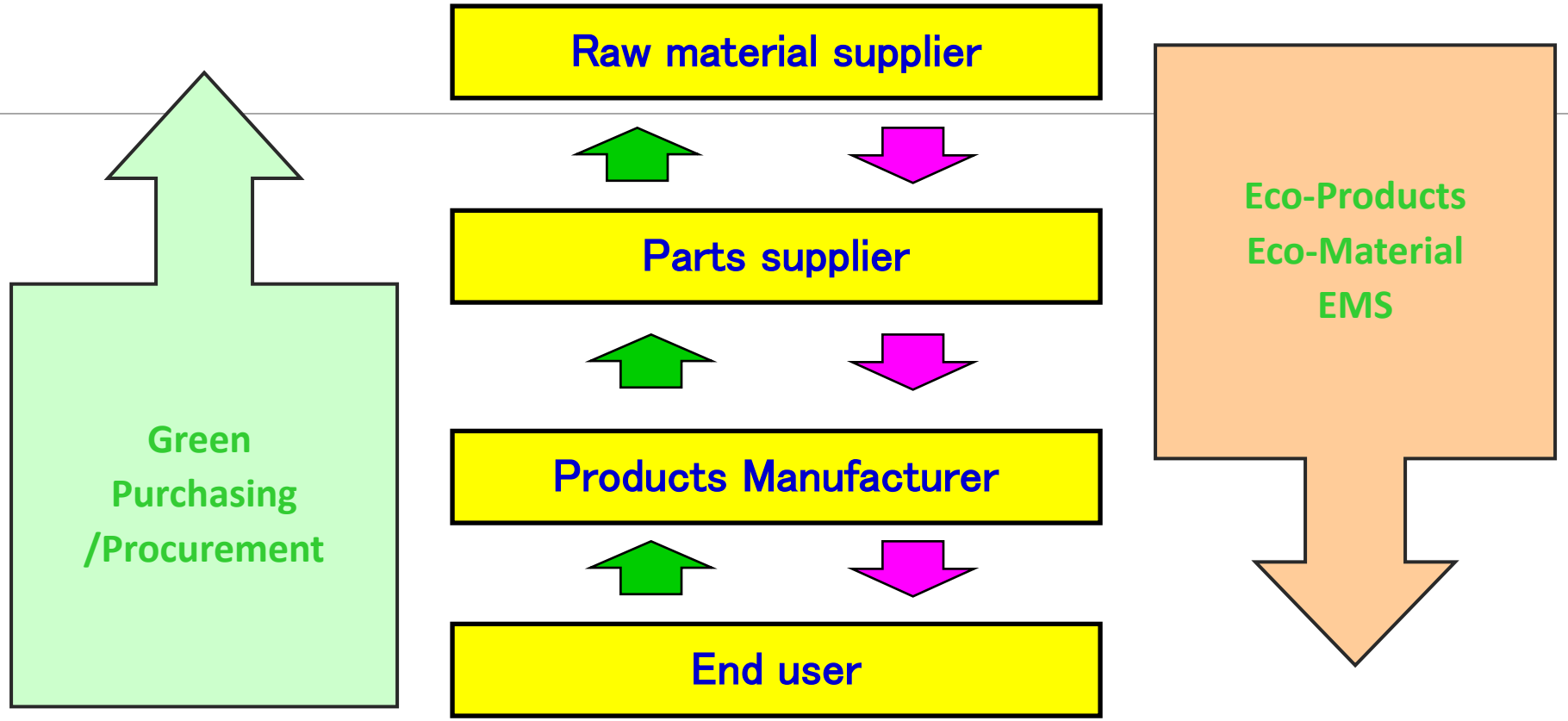
What is "Green Purchasing"?



Cope with Environmental Problems Focusing on "Input": Green Purchasing



Greening Supply Chain(GSC) & Green Purchasing



To be competitive in the global market, all the businesses "must" enhance green manufacturing.

Current Tool and Concepts with Regard to Sustainability

- Resource Circular economy is a concept drawn from the ideas of industrial ecology and industrial metabolism formulated during the 1970s and 1980s through a rethinking of the industrial processes

- For a resource circular economy to be successful, it should contribute to all three sustainable development dimensions: economic, environmental, and social.

Institutional Pressures and Barriers in the Path to Sustainability

1. Organization: Within the context of the organization, higher cost and unseen financial benefits are still seen as barriers when it comes to sustainability measures.

Main barriers to sustainable facility management:

A lack of

- steering mechanisms,
- financial skills,
- clients' understanding,
- process knowledge and underpinning knowledge, and
- lack of the availability of methods and tools and competencies related to the innovation process

2. Technological advancements: The rise in technological advancements, such as Building Information Model (BIM) and smart house technology, makes it difficult for the facility practitioner to make the viable decisions of choosing the right technology to help reduce energy consumption.

3. End User: Despite the end user's awareness of sustainability concept

4. Policies – Green Certifications: Whether the existing models and tools to measure sustainability are equipped enough to cater and match the needs of a Green certification?

5. Barriers in Emerging Economies: Although the three pillars of sustainability: environment, social, and economic are presumed to work in harmony, in reality, there are often conflicts among the three.

example: managers wonder whether it pays to be green.

Benefits - Sustainability

- Sustainability is one of the key requirements for any business, and continuously changing business requirements and the environment are the main drivers of sustainable business practices.
- Current advanced technology helps to promote green and clean modern societies.
- The Internet of Things (IoT) will play an important role in the upcoming years in environment protection, remote health monitoring, and sustainable development.
- Over time, technological innovation has altered the overall efficiency regarding sustainability.

Benefits - Sustainability

- To achieve goals of sustainable development, innovations are needed.
- The processes of green knowledge management play a special role in sustainable development, more specifically the creation, acquisition, exchange, and use of knowledge, as well as its impact on green technologies, eco-innovations, and the socio-economic dimension of sustainable development.
- Sustainable innovation allows the company to keep up with technology.
- The sustainable green innovations are aimed at the generation of high-quality innovative products that can reduce environmental footprint.
- As long as environmental issues arise, the importance of sustainable green innovations will be widely recognized.
- The compliance with environmental standards is the strongest predictor in the structural model, representing the impact of variable environmental factors, i.e., innovations, on the environmental situation.
- The eco-innovation values enable companies to confront challenges inflicted by competitors in the market

1. Sustainability reduces the risks

- Climate change will affect the ability of humans to work in regions or climates under stress caused by severe heat and draught or even floods brought on by excessive rain or rising water levels.
- That type of volatility would affect the food systems that nourish people, plants and animals in a profound way
- Continuity of operations: You could be shut down because of spills/releases/ incidents.
- Fines and litigation costs: The figures routinely run into the tens of millions of dollars and potentially the billions for significant incidents. That's just the one-time costs. The ongoing cost of increased scrutiny is of the same order of magnitude.
- Reputational risk from poor environmental record: Following an incident, companies often lose suppliers, partners and market access just from the bad press; it also can lead to turnover and difficulty attracting new talent.
- Climate crisis: Mark Carney, the governor of the Bank of England, recently told The Guardian that ignoring the risks posed by climate change is a nonstarter. "Companies that don't adapt will go bankrupt without question," he said.

2. Sustainability increases revenue

- When done properly, a focus on sustainability is also a profitable endeavor for the organization.
- According on the World Economic Forum website, “companies with a focus on eco-innovation are growing at an annual rate of 15%” while Challenge Advisory found that 37% of businesses report a profit from sustainability, and companies that actively plan with climate change in mind secure an 18% higher return on investment than companies that don’t.
- As more organizations realize higher performance, sustainability strategies will gain traction.

3. Sustainability improves brand and reputation

- It is **green technology that stimulates sustainable development**, which means identifying environmentally-friendly sources of growth, developing new environmentally-friendly industries, and creating jobs and technologies .
- To achieve green growth, **it is necessary to intensify investments and innovations** that represent a foundation of sustainable development and open new economic opportunities.
- Thus, the promotion of green economy requires thorough research on the conditions of its formation, system-forming factors, and its impact on national sustainable development.
- Parties that are interested in green economic development include business (which focuses on economic benefits), the authorities (which set environmental goals of sustainable development), and the public (which represents the interests of a social community)

Green vs. sustainability: A typology differences

Dimensions	Green	Sustainable
Relation to sustainable tripod	Only one leg (environmental improvement)	All three legs (environment health, economy vitality, social justice)
Focus	Individual components	Interplay of individual components and whole system
Tactics/strategy	Tactical application of activities that involve 'picking low-hanging fruit'; promoting individual changes and reforms to make world less unsustainable	Strategic discovery of the proper scale that will make successive policy steps and actions easier and less costly by designing and implementing a sustainable, self-balancing system
Political orientation	Conventional, pragmatic realist, reformist	Innovative, visionary, revolutionary (going to the roots)
Scale	Individual devices, products, indicators, practices, buildings as most tractable level for greening	City region as the level at which human and social disequilibriums and ecological insults can be dynamically rebalanced
Definition of success	Infinite progress of incremental improvements	Reduction of ecological footprint to a city region's fair earth share

What is Green Technology?

- The words ‘green technology’ consists of two different words that have a major impact to the world these days.

- It is worth to get a basic overview of the definition of these two words before we dig more into this field.

- The term ‘**technology**’ refers to the branch or application of scientific knowledge for practical purposes, which deals with the creation and usage of technical means in engineering, applied sciences, pure sciences, industrial arts and their interconnection with life, society and the environment.

- ‘**Green**’ is a common word which indicates colour of nature (plants) in general, and nowadays it has become a popular term which **represents something positive and beneficial to the environment or less harmful to the environment than others.**

- So, the combination of these two words ‘green technology’ refers to **a continuously evolving group of materials and methods from scientific techniques or knowledge to generate energy-efficient to non-toxic products**.

- In other words, this **technology encompasses innovation or invention that has features, functionality and cost savings elements which would give advantages to the environment and society**.

- It is also called as **clean technology** or **environmentally friendly technology**.

- The term technology usually refers to the application of various techniques, skills, methods and processes for any and all practical purposes or to achieve certain objectives such as scientific investigation or research.
- A technology that is environmentally friendly in its production, supply chain or usage is referred to as Green Technology or Green Tech for short.
- Green tech is an umbrella term that continuously develops products, system or equipment which are less taxing to the natural environment and its resources which limit and diminishes the negative effect of human exercises.

What is Green Technology?

- Green technology is the development and use of products, equipment and systems used to preserve the environment and resources, which reduces the negative impact of human activities.
- Green Technology also includes groups with methods and materials obtained from techniques to generate energy for non-toxic products
- Green technology is one of the alternatives to boost the national economy without affecting nature
- Green technology is known as the clean technology is one of the elements of environmental science to preserve nature surrounding and natural resources to minimize the negative effects of human activities

- Green technology is also said as **environmental technology**, helps us to conserve our natural energy and does not affect environment in anyway.

- It is used to develop environment friendly products to reuse, renew, and recycle natural resources.

- Different branches of green technology are
  - **green energy,**
  - **green chemistry,**
  - **green IT,**
  - **green building, etc.**

- **Green education** is about educating people for skill and knowledge development of green technology sustainability in environment.

- Paperless learning is the transformation from physical exchange of material to virtual exchange of materials. Students can learn, do research, and submit assignment with electronic resources.

- **Green job** will be created for which it is required to generate skilled green graduates and experts.
- Going green is not an easy task.

Importance of green technology

- Green technology can be seen as one of the elements that can minimize environmental quality degradation and provide a healthier environment.
- Green technology play an important role in creating the options that enable sustainability by developing materials, processes, value-added products, and systems that are environmentally preferable, more energy and resource-efficient, and often more cost-effective.
- In addition, green technology is also important to be applied in the field of education to inculcate student's interest in appreciating the environment.
- Students can also practice the knowledge learned and disseminated to the community towards a more sustainable country.
- This is due to the lack of awareness of environmental conservation and conservation among the community.
- The application of green technology as a sustainable development education driver (ESD) is expected to help address environmental issues (Jasmi and Kamis, 2019)

Importance of green technology

- Decoupling environmental degradation and resource consumption from economic and social development is an enduring challenge and requires a paradigm shift in our approach.
- Presently, green technologies are playing a significant role in
  - changing the course of the world's economic growth towards sustainability and
  - providing an alternative socio-economic model that will enable our present and future generations to live in a clean, healthy environment and in harmony with nature.
- The concepts of green technologies, if endorsed and disseminated into the lives of all people, will facilitate the aim of the Millennium Development Goals of keeping the environment intact and improving it for civilization to survive.

- In isolation period of Covid-19, it is realized that sustainable development is necessary for green environment.
- Green technology with IoT together makes society as green society in every perspective like healthcare.
- Cloud-based approaches are required to store big data, and machine-learning tools are applied to analyze big data.

Evolution of Green Technology

- People usually think that this concept is new and has just started to drive attention in the twentieth century.
- The truth is, the concept of green technology is not new and has been around for centuries.
- The earliest known application of green technology in the form of passive energy source from solar arose during the fifteenth century B.C. by the Egyptian ruler Amenhotep III with regard to the operation of his ‘sounding statues’.
- In the fifth century A.D., Socrates noticed that buildings should face towards the south so that the sun could penetrate them during winter and provide light and warmth.
- Solar architecture was then employed by the Greeks and Chinese about two and a half millennia.

- While it is true that green tech has gotten progressively mainstream in the modern age, components of these business policies have been being used since the 18th and 19th century when the Industrial Revolution was at its peak.
- Manufacturers were trying to minimize their negative environmental externalities in the early 19th century by modifying manufacturing practices to create less soot or waste by-products.
- In any case, green innovation as a perceived business division didn't generally create until the 1990s.
  - The global cumulative investment in renewable forms of energy and green technology processes exceeded $200 billion in the year 2017, according to a United Nations study published in 2018.
  - $2.9 trillion has also been invested in sources such as solar and wind power since 2004. The UN also reported that China was the world's largest investor in the field, with about $126 billion invested in 2017.

- In this new era, in the attempts to pave the way for a low-carbon future as a feature of modern times, people nowadays took more seriously on green technologies.

- With the target to boosting energy from renewable sources, together with combating climate change and environmental issues, green technologies have now become the main component of governments' agenda of most countries around the globe.

- As part of this, investment is growing in green technologies in order to fulfil the demand of green economy.

- In this regard, most of the countries have now rapidly shifted towards sustainable solutions with burgeoning innovations that have a clear environmental and social attention including renewable and energy-efficient technologies, water purification, carbon dioxide (CO_2) conversion, nanoscale bio-based engineering, passive buildings, and molecular nutrition.

- As green technologies continue to arise as a growing dynamism, several strong industry clusters have emerged such as water and wastewater, advanced materials, energy, agriculture, transportation, waste management, buildings, and manufacturing.

- The major goal of green technology is to help control climate change, protect the natural environment, reduce our dependence on Non-Renewable resources such as fossil fuel, and heal the damage done to the environment
- The market for Green Tech is relatively in its starting stage but the investment capital is already blooming.

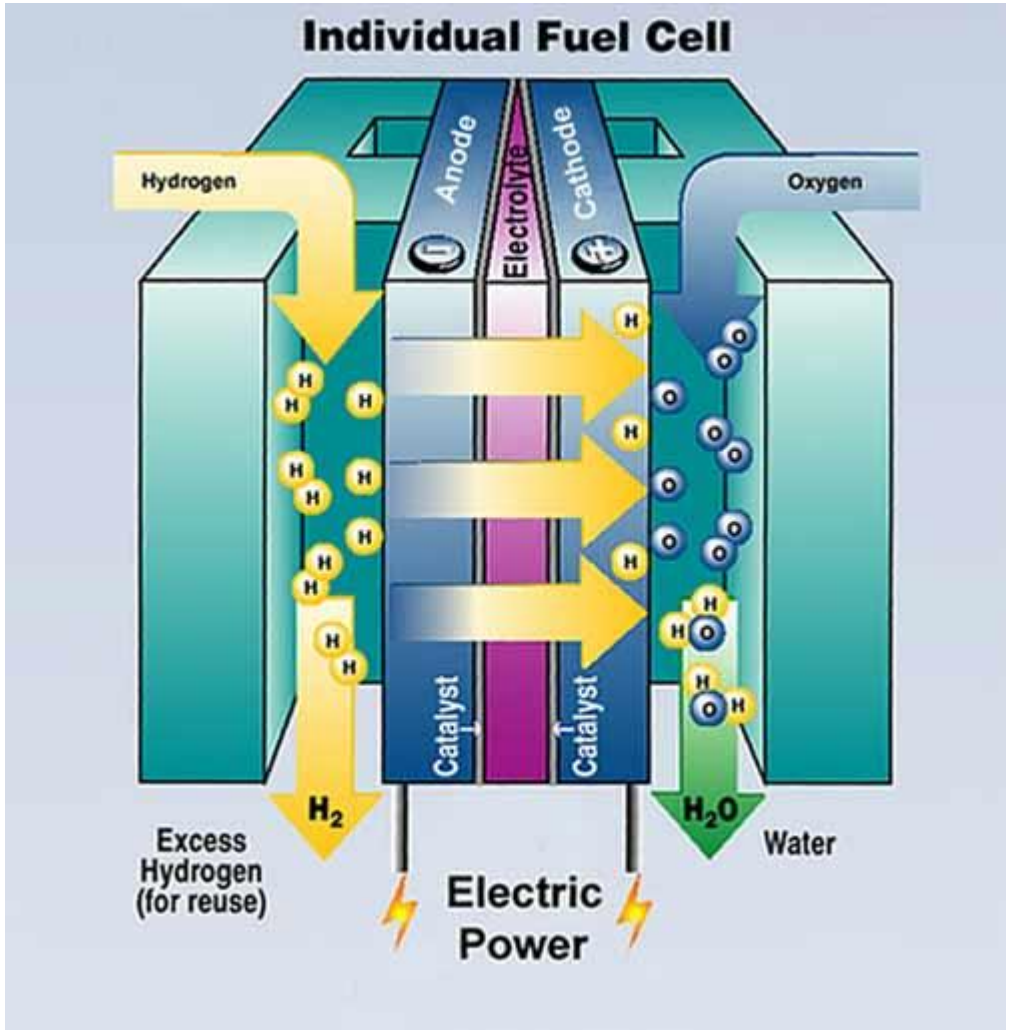
Conventional Green Technologies

Conventional green technologies have been applied in the fields of

- water and wastewater treatment,
- air pollution control,
- environmental remediation,
- waste treatment and management, and
- energy conservation.

Emerging green technologies

- Hydrogen and fuel cells
- Renewable energy
- Battery storage technologies
- Green buildings
- Sustainable urban planning
- Cleaner conventional energy
- Electric power infrastructure
- Cleaner transportation
- Cleaner industry
- Cleaner water
- Carbon capture and storage



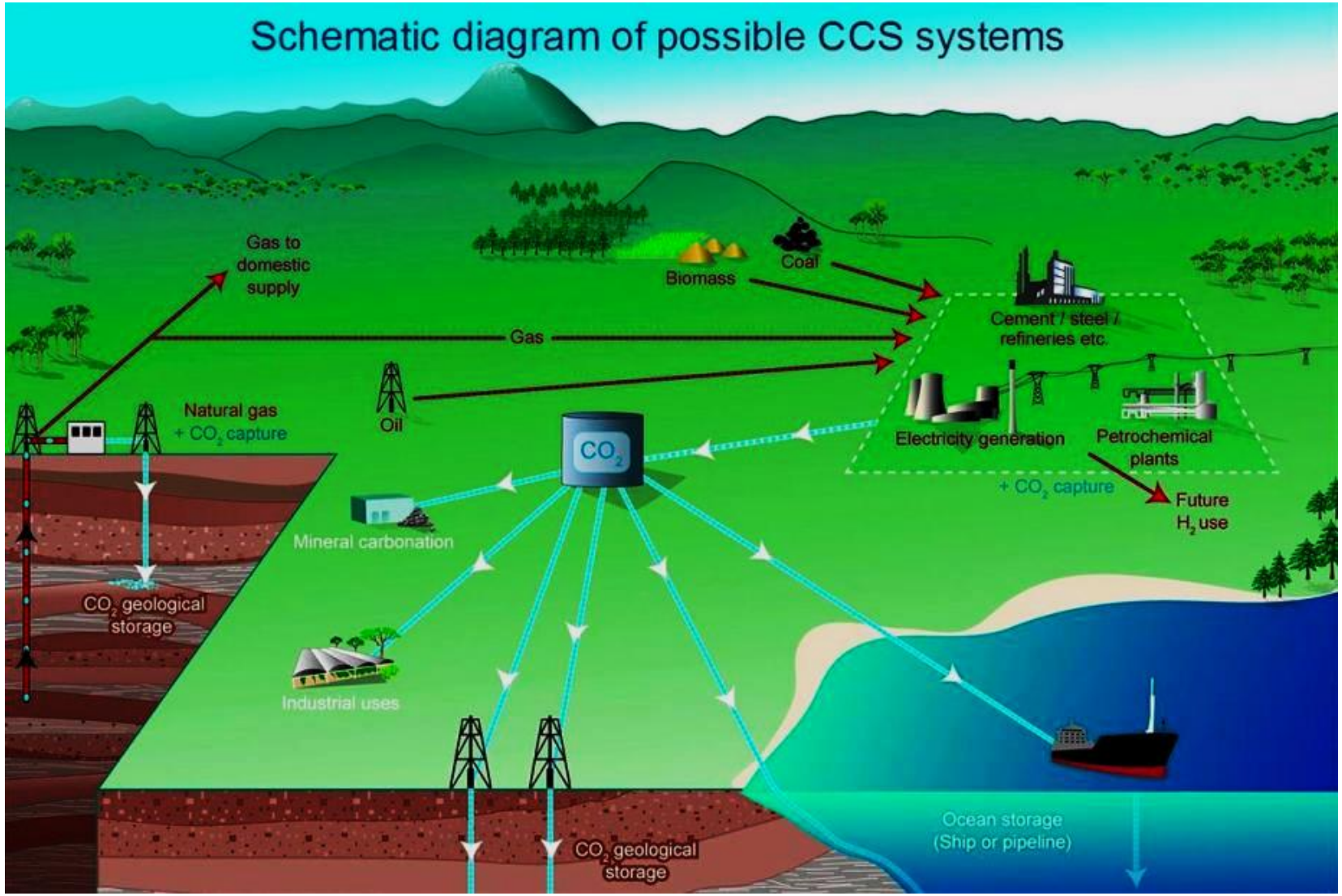
http://butane.chem.uiuc.edu/pshapley/Environmental/L11/2.html

Dimensions of sustainability of green buildings

https://www.researchgate.net/publication/333784260_Green_Smart_Building_Requisites_Architecture_Challenges_and_Use_Cases/figures?lo=1

https://www.greenesa.com/article/renewable-energy-sources-types

https://www.nrcm.org/programs/climate/cleaner-transportation/



If we take carbon dioxide out of the atmosphere, where do we put it? Researchers are investigating many different options for carbon capture and storage (CCS) systems. *IPCC*

https://scied.ucar.edu/learning-zone/climate-solutions/carbon-capture-storage

Green Technology Development Challenges

- Market challenges
- Technology challenges
- Financing challenges
- Regulatory challenges
- Opportunities for green technology markets

Sectors Using Green Tech

1. Energy Sector: can be used to build alternative, more environmentally sustainable fuel sources than fossil fuels

Usually fossil fuels produce waste as a by-product of their production. Instead of fossil fuels; solar, wind, and hydroelectric dams can be used, since they are environmentally cleaner and do not produce any harmful by-products.

2. Transportation Sector: One of the biggest contributors of global GHG emission are conventional fuel based vehicles. Therefore, many companies are incorporating Green Tech in transportation infrastructure and vehicles in the form of electric vehicles and compressed natural gas (CNG) buses.

3. Waste Management Sector: Green Tech is also being used in waste management sector for transporting, storing and recycling of wastes.

4. Water Filtration: Around the world, green tech is being widely used for water purification. Countries around the world where water supply is limited, green tech may be used for purifying polluted water or extracting salt from seawater to improve the supply of safe drinking water.

5. Air Purification: Green tech is also being used to clean the polluted air by decreasing the carbon emissions and gases released from the industrial sectors.

Green Chemistry and Chemical Engineering

- The goal of Green Chemistry and Chemical Engineering is to minimize waste, totally eliminate the toxicity of waste, minimize energy use, and utilize green energy (solar thermal, solar electric, wind, geothermal, etc.) – that is, non fossil fuel.
- Clearly, fossil fuels have their own waste and toxicity problems even though usually remote from the site of chemical production.

Principles of Green Chemistry proposed by Anastas and Warner

(https://www.researchgate.net/publication/326537035_Evolution_Of_Green_Chemistry_And_Its_Multidimensional_Impacts_A_Review/figures?lo=1)

- “Green products” refers to the promotion of safe, sustainable, and waste-minimizing chemical processes.
- Green chemistry is a scientific concept that seeks to improve the efficiency with which natural resources are used to meet human needs for chemical products and services.
- It encompasses the design, manufacture, and use of efficient, effective, safe, and more environmentally benign chemical products and processes.
- It can ensure eco-efficiency in everything we do, both individually and as a society.
- Green products also mean protecting and extending employment, expertise, and quality of life.

https://guides.loc.gov/green-business

1. Gas Expanded Liquids for Sustainable Catalysis –

A gas-expanded liquid (GXL) phase is generated by dissolving a compressible gas such as CO_2 or a light olefin into the traditional liquid phase at mild pressures (tens of bar) .

When CO_2 is used as the expansion gas, the resulting liquid phase is termed a CO_2-expanded liquid or CXL. GXLs combine the advantages of compressed gases such as CO_2 and of traditional solvents in an optimal manner.

Environmental advantages include substantial replacement of organic solvents with environmentally benign CO_2.

Process advantages include reduced flammability due to CO_2 presence in the vapor phase and milder process pressures (tens of bar) compared to $scCO_2$ (hundreds of bar).

2. Green Catalytic Transformations

- A heterogeneous catalyst is a catalytically active species that is in a different phase to the reagents within a reaction system, more often than not a solid in either liquid or vapor phase synthesis.
- There are a number of green chemistry related advantages of using heterogeneous catalysts as opposed to the homogeneous equivalents: Safety – An important consideration in the practice of green chemistry. Heterogeneous catalysts often tend to be environmentally benign and easy/safe to handle.
- This is due to the active specie being adhered to a support, (often forming a powder) essentially reducing its reactivity with the surrounding environment; Reusability – Due to the difference in phases, the catalyst is simply filtered off (through centrifugation on industrial scales) and reactivated for reuse many times over; Activity – In many cases increased activity is observed when supporting an active homogeneous species on a support, due to the complex but unique surface characteristics found with a variety of different supports; and Selectivity – heterogeneous catalysts can give an increased degree of selectivity in reaction pathway.
- This can simply be a consequence of adsorption of substrates and the consequential restricted freedom of movement of the reacting molecules. However, there are a handful of disadvantages.
- The quantity of solid catalyst required is often higher than that of the homogeneous equivalent, due to the lower concentration on the support surface, (reusability makes this less of an issue though).
- Blocking of the pores/ support channels can occur with narrow pores sizes and reduce efficiency over time in some liquid phase reactions; nevertheless, this is often twinned with high Stereo selectivity.

3. Green Chemistry Metrics: Material Efficiency and Strategic Synthesis Design

- Application of green metrics forces the precise itemization of what constitutes waste so that targeted reductions of these components can be made.
- The mass of waste of any chemical reaction is the sum of the masses of unreacted starting materials, byproducts produced as a mechanistic consequence of making the desired target product, side products produced from competing side reactions other than the intended reaction, reaction solvent, all work-up materials, and all purification materials used.
- Simple first generation waste reduction strategies target the last three items in the list since they contributed the bulk of the overall mass of waste.
- Waste reduction strategies targeting the first three items are based on synthesis design and are necessarily more challenging to implement.
- The connecting green metrics are atom economy (AE), environmental E-factor (E), and reaction mass efficiency (RME).
- These metrics and applications are described in detail in this entry.

4. Green Chemistry with Microwave Energy

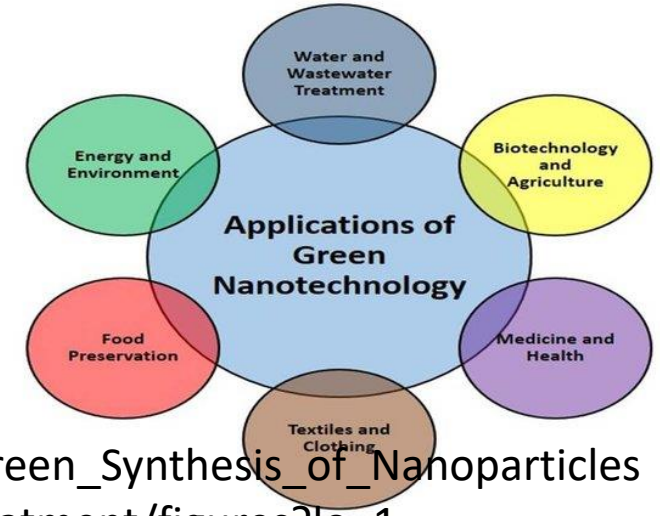
- An alternative heating technique using microwaves is useful for targeted energy introduction directly into polar reactants in chemical syntheses and transformations.
- This entry summarizes noteworthy greener methods that use microwaves that have resulted in the development of sustainable synthetic protocols for drugs and fine chemicals.
- Microwave assisted organic transformations are presented such as: solid-supported reagents based
- processes; greener reaction media including aqueous, ionic liquid, and solvent free for the synthesis of various heterocycles; and oxidation-reduction and also coupling reactions

5. Nanotoxicology in Green Nanoscience

- The unique properties that make nanomaterials an attractive technology (surface chemistry, surface area, size, shape, core material functionalization, aggregation, etc.) may also contribute to novel biological effects as a result of nanomaterial exposure.
- Toxicology will play an important role in elucidating the mechanisms of those interactions.
- This entry contains an exploration of the role of toxicology in implementing green nanoscience, the methodology of incorporating nanotoxicology in order to directly and indirectly address the principles of green chemistry in green nanoscience, and the importance of utilizing robust models for nanotoxicity testing.

Green nanotechnology

- Green nanotechnology is the use of nanotechnology to improve environmental sustainability of processes which produce negative externalities.
- It involves processing green nano-products and making use of nano-products to promote sustainability.
- Developments are on the use of nanomaterials for purposes including more efficient solar cells, practical fuel cells and environmentally friendly batteries.
- The most advanced energy-related nanotechnology initiatives are: storage, conversion, manufacturing changes by reduction of materials and process speeds, energy conservation and increased renewable energy sources.



https://www.researchgate.net/publication/328051538_Green_Synthesis_of_Nanoparticles_and_Their_Applications_in_Water_and_Wastewater_Treatment/figures?lo=1

6. Organic Batteries

- Development of sustainable processes for energy storage and supply is one of the most important worldwide concerns today.
- Primary batteries, such as alkaline manganese and silver oxide batteries produce electric current by a one-way chemical reaction and are not rechargeable and hence useless for reversible electricity storage.
- Portable electronic equipment, electric vehicles, and robots require rechargeable secondary batteries.
- Li-ion, lead acid, and nickel-metal hydride batteries are generally used at the present to power them.
- Solar cells and wind-power generators expect a parallel use of rechargeable batteries for leveling and preserving their generated electricity.
- Ubiquitous electronic devices such as integrated circuit smart cards and active radio-frequency identification tags need rechargeable batteries that are bendable or flexible and environmentally benign for durability in daily use.
- Designing of soft portable electronic equipment, such as rollup displays and wearable devices, also require the development of flexible batteries.
- It is essential to find new, low-cost, and environmentally benign electroactive materials based on less-limited resource for electric energy storage and supply.
- Reversible storage materials of electric energy or charge that are currently under use in electrodes of rechargeable batteries are entirely inorganic materials, such as Li ion-containing cobalt oxide, lead acid, and nickel-metal hydride

7. Oxidation Catalysts for Green Chemistry

- Catalysis is at the heart of Green Chemistry as it is the means to increase efficiency and efficacy of chemical and energy resources while promoting environmental friendliness and intensifying time and cost savings in chemical synthesis.
- A catalyst's function simply is to provide a pathway for chemicals (reactants) to combine in a more effective manner than in its absence.
- In the absence of a catalyst, heat is usually the way to overcome the energy barrier but this increases energy consumption and often results in unwanted side reactions.
- A catalyst cannot make an energetically unfavorable reaction occur or change the chemical equilibrium of a reaction because the catalyzed rate of both the forward and the reverse reactions are equally affected.
- Oxidation processes are used for odor control, bleaching of pulp for paper production, wastewater treatment, disinfection, bulk and specialty chemical production, aquatics and pools, food and beverage processing, cooling towers, agriculture/farming, and many others.
- There are a great many oxidation reactions that are catalytically driven.
- Such reactions are presented in this entry with emphasis on implementation of green strategies.

9. New Polymers, Renewables as Raw Materials

- Recent advances in genetic engineering, composite science, and natural fiber development offer significant opportunities for developing new, improved materials from renewable resources that can biodegrade or be recycled, enhancing global sustainability.
- A wide range of high-performance, low-cost materials can be made using plant oils, natural fibers, and lignin.
- These materials have economic and environmental advantages that make them attractive alternatives to petroleum-based materials.

10. Supercritical Carbon Dioxide (CO_2) as Green Solvent

- A supercritical fluid (SCF) is created when the temperature and pressure are higher than its critical values.
- Therefore, CO_2 becomes supercritical when its temperature and pressure are higher than 31.1C (critical temperature, Tc) and pressure 7.38 MPa (critical pressure, Pc).
- SCFs have many unique properties, such as strong solvation power for different solutes, large diffusion coefficient comparing with liquids, zero surface tension, and their physical properties can be turned continuously by varying the pressure and temperature because the isothermal compressibility of SCFs is very large, especially in the critical region.
- These unique properties of SCFs lead to great potential for the development of innovative technologies. Besides these common advantages of SCFs, supercritical CO_2 ($scCO_2$) has some other advantages, such as nontoxic, nonflammable, chemically stable, readily available, cheap, and easily recyclable, and it has easily accessible critical parameters.
- Therefore, $scCO_2$ can be used as green solvent in different fields.
- The basic properties of $scCO_2$ and its applications in extraction and fractionation, chemical reactions, polymeric synthesis, material science, supercritical chromatography, painting, dyeing and cleaning, and emulsions related with CO_2, are discussed in this entry.

Advantages of Green Technology

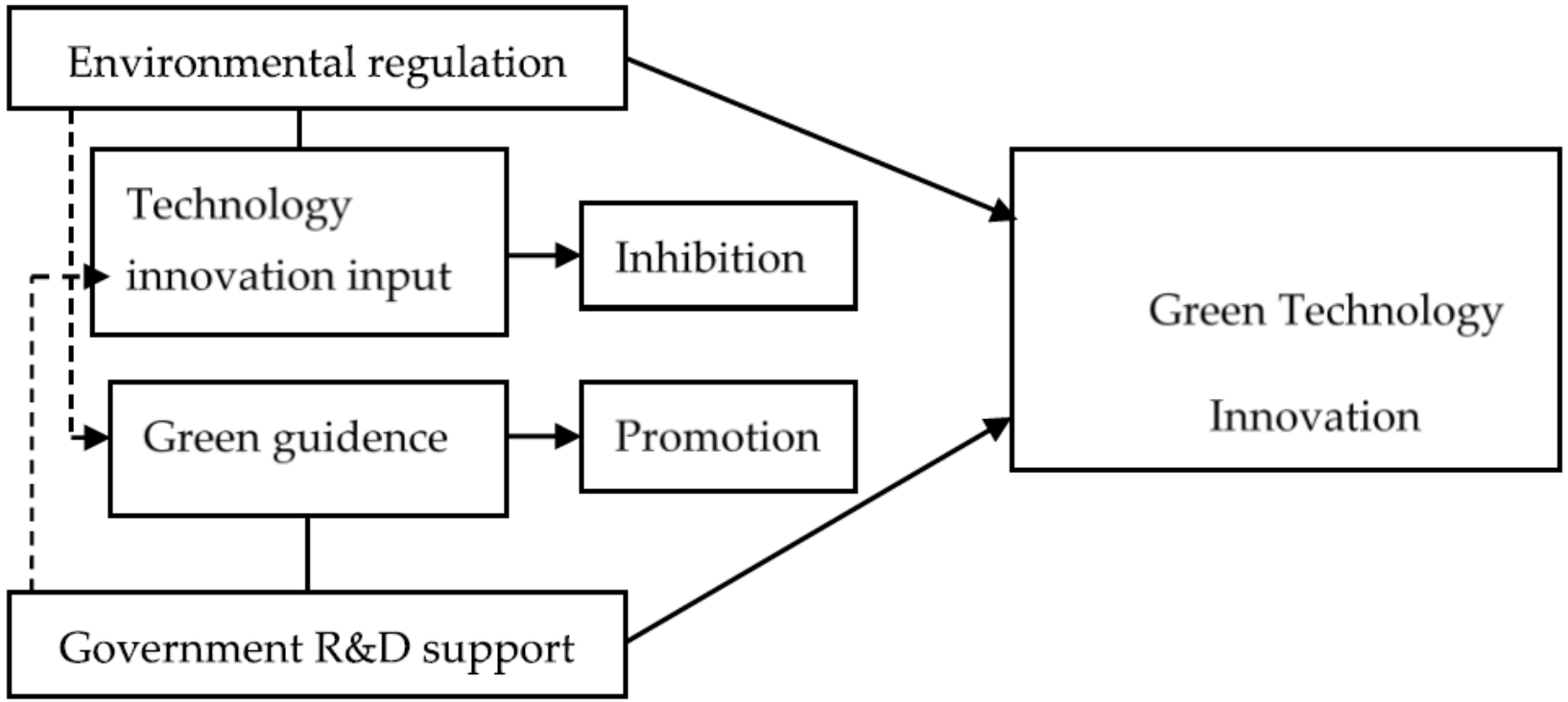
- Helps in recycling and managing waste materials.
- It is environmentally friendly as a result emit zero or less harmful materials in the environment
- Maintaining the Green Tech is very cost efficient.
- Green Tech helps conserve energy
- It is also helping in rejuvenating the health of our ecosystem
- Environmentally friendly technology has a positive and significant impact on the company's competitive advantage so that it can be said that the better environmentally friendly technology applied to the company, the more competitive advantage they will increase.
- Consumer investment in choosing energy-efficient vehicle products not only helps save money in fuel consumption, but also saves the environment.

Hurdles to Cross

- Statistics show that around 90% of our energy needs is fulfilled by burning fossil fuels.
- The shift from using cheap, energy dense and abundantly available fossil fuel towards environmentally friendly green tech will surely prove to be a major hurdle to cross.
- Widespread usage of wind and sun energy would surely help us to move away from relying on fossil fuels, but the expansion of wind and solar technologies will prove to be a difficult task because of the fact that the sun does not always shine and wind does not always blow
- This unreliability can be solved by storing the energy generated and using when it is needed.
- Few of these green technologies also cannot be anywhere such as tidal energy can only be utilised during high tides, geothermal energy can only be utilised in a geologically unstable place.
- We will also require new transmission lines to shuttle existing energy around the electricity grid and to bring wind and solar energy generated in the prairies and deserts to cities and towns where it's needed.
- Although there exist few hurdles in the way of Green technology but in the long run the usage of green tech will be worth the extra mile, we will put in it.

Why is Green Technology Necessary?

- Green technology's primary aim is to control global warming and reduce the greenhouse effect.
- The principal concept is to develop innovative inventions that do not affect the natural resources.
- It will result in less damage to humans, animals and our planet's overall health.
- Now it is obvious that our world is beginning to suffocate from all the waste that we produce. But if there's a will, then there's a way to make this problem much smaller.
- Simply put, green technology is proving to be crucial for our future survival.
- An ugly picture that is painted by the consequences of pollution and climate change give rise to the need and importance for such clean technologies.
- Green technology also provides alternative sources of energy, supports biologically degradable goods, encourages recycling, and promotes sustainable building growth.
- This also leads greatly to emissions reduction, decline in global warming and natural resources conservation This is why many developed and some developing countries are now transitioning towards this form of technology to help protect them from harmful impacts on the climate (Qamar et al., 2020)



Analysis of the role of environmental regulation and government research and development funding in technology innovation

The theoretical mechanism of interaction between environmental regulation and government R&D funding.

- Government R&D funding will regulate the role of environmental regulation on green technology innovation by changing the investment in technology innovation of enterprises.
- In addition, environmental regulation can provide green guidance for technology innovation of government R&D supported enterprises through the standards and targets of energy saving and emission reduction.
- In general, the matching of environmental regulation and government R&D funding policy is very important attention to “energy saving” of green product innovation constraints.
- The green guidance regulation of environmental regulation and the increase of government R&D investment can alleviate the inhibition of environmental regulation to a certain extent, thus the interaction can significantly promote green product innovation.
- Secondly, there are relatively many restriction standards of green process innovation which focus on “emission reduction”. The green guidance regulation of environmental regulation and the increase of government R&D investment can hardly counteract the restraining effect of environmental regulation.
- So, the final performance of interaction is significantly averse to the development of green process innovation.
- Under the joint action of environmental regulation and government R&D funding, green product innovation can be promoted significantly.

Summary

- Our Planet is on the verge of being collapsed under the pollution and our negative environmental externalities.
- We must cross every barrier and must continue to innovate in green technology.
- The market of green technology is on the all-time high as we are getting more and more aware of the environmental destruction we are causing.
- Because of the Paris Agreement many governments are also buying the green tech increasingly.
- For businesses being green is becoming a major opportunity in appeasing the crowd therefore they are buying green technology so that they can be perceived as the supporter of environmental sustainability.
- Green technology innovations are being increasingly implemented and getting more and more improved and environmentally friendly
- This course aims to provide comprehensive coverage on emerging dimensions on green technology.