The Green economy for sustainability

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Contents

Background of Green Economy (GE)

" Green economy" was first used in 1989 "Blueprint for a Green Economy" named report from United kingdom

In 1991 and 1994 appeared as a sequel, the reports "Blueprint 2: Greening the world economy" and "Blueprint 3:

Then come the term "sustainable development" Rio Summit or Earth Summit in 1992 by (UNCED)

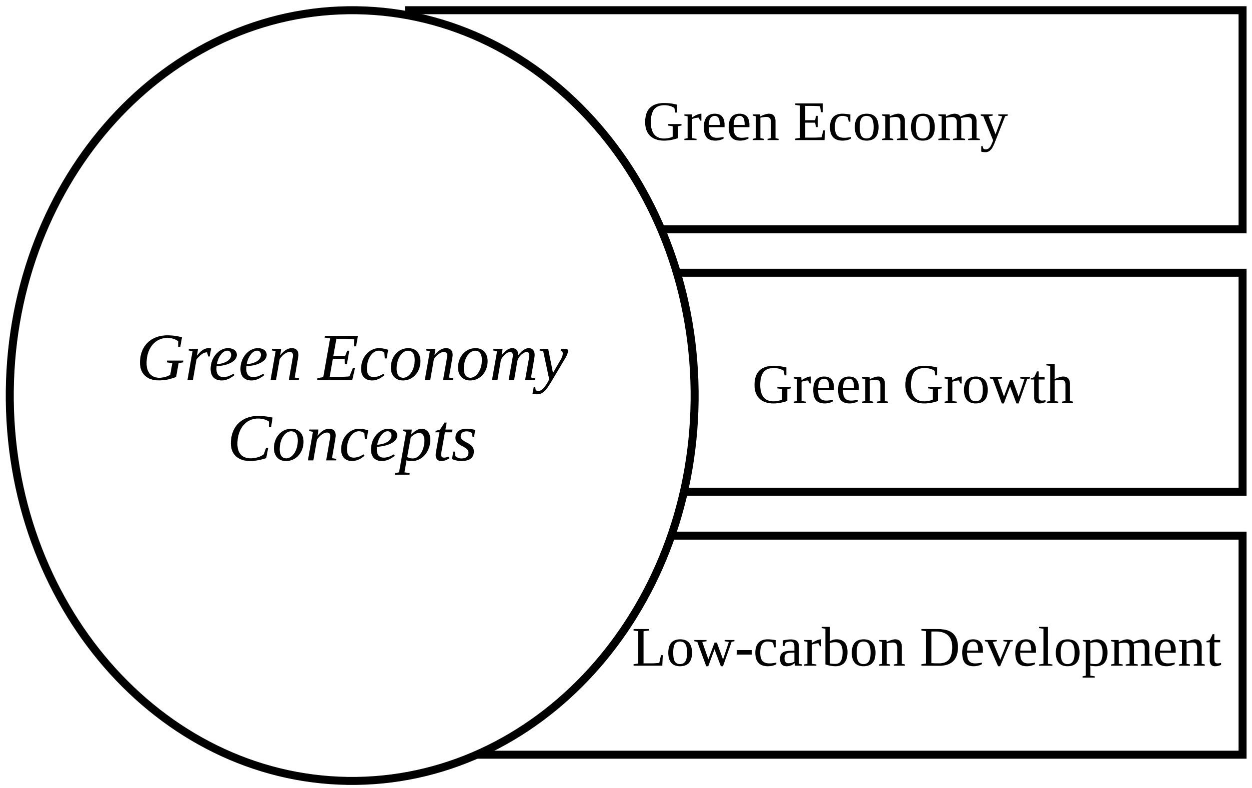
Revived during the global financial crisis of 2008 as rebooting the economy in a more sustainable way

green stimulus" programs as public sector incentive packages for private investment in "green" energy sources and technologies.

Finally, UNEP launched its GE Initiative in October 2008

Resounded in climate change mitigation discussions and become an important theme in UNFCCC negotiations

Concepts of GE



A transition towards an economic model based on the sustainable generation of equitable social, environmental and economic benefits

The potential of green sectors and industries as engines of growth

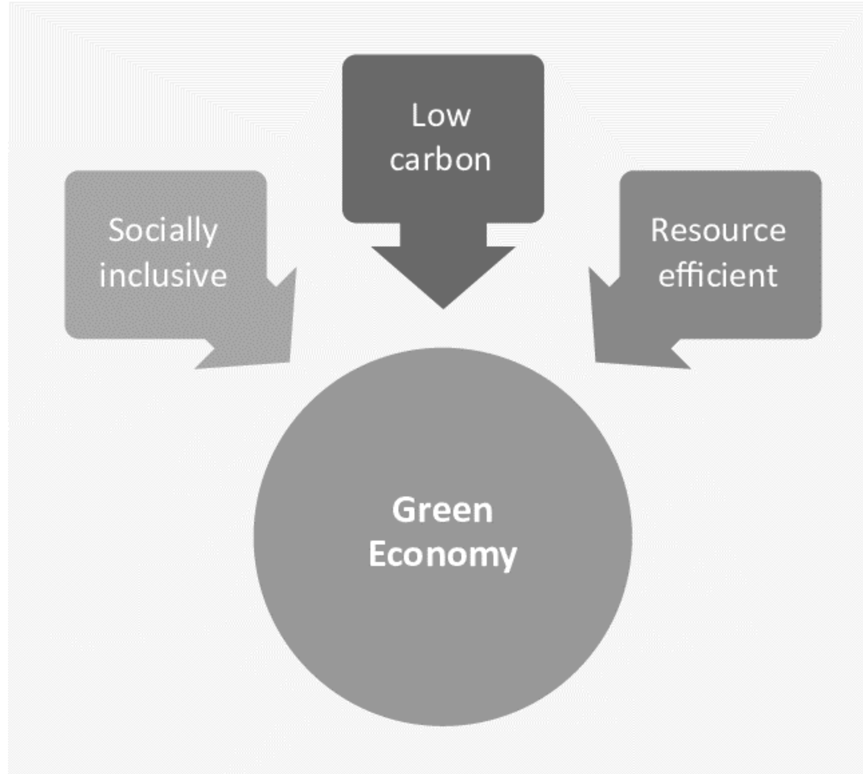
Development emphasizing reduction in use of fossil fuels as the engine for development (also referred to as climate-resilient development)

Definition of Green Economy (GE*)*

In 2011, the International Chamber of Commerce (**ICC**) stated in its "10 Conditions for a Transition Toward a Green Economy" that a green economy is one "in which economic growth and environmental responsibility work together in a mutually reinforcing fashion while supporting progress and social development."

The most acceptable definition from United Nations Environment Programme (**UNEP**) A green economy as one that results in “improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities”.

In simple words, "low carbon, resource-efficient, and socially inclusive.

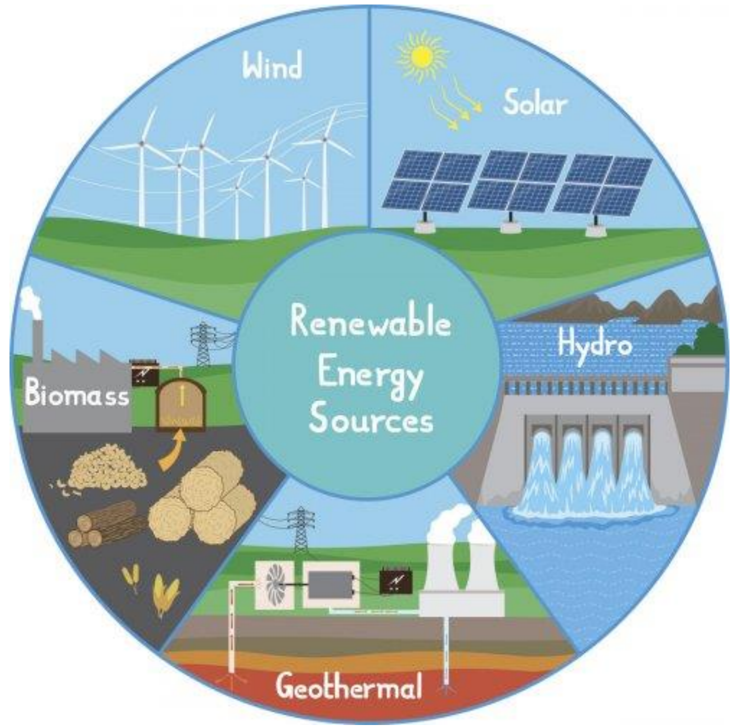


Karl Burkart defined a green economy as based on six main sectors

- Renewable energy
- Green buildings
- Sustainable transport
- Water management
- Waste management
- Land management

Renewable Energy

- Renewable energy can be generated continuously practically without decay of source. E.g.-
- Solar Energy
- Wind Energy
- Geothermal Energy
- Hydro Energy



According to data released by the International Renewable Energy Agency (IRENA) the world added more than 260 gigawatts (GW) of renewable energy capacity last year (2020) which was more than 176 GW, compare to 2019.

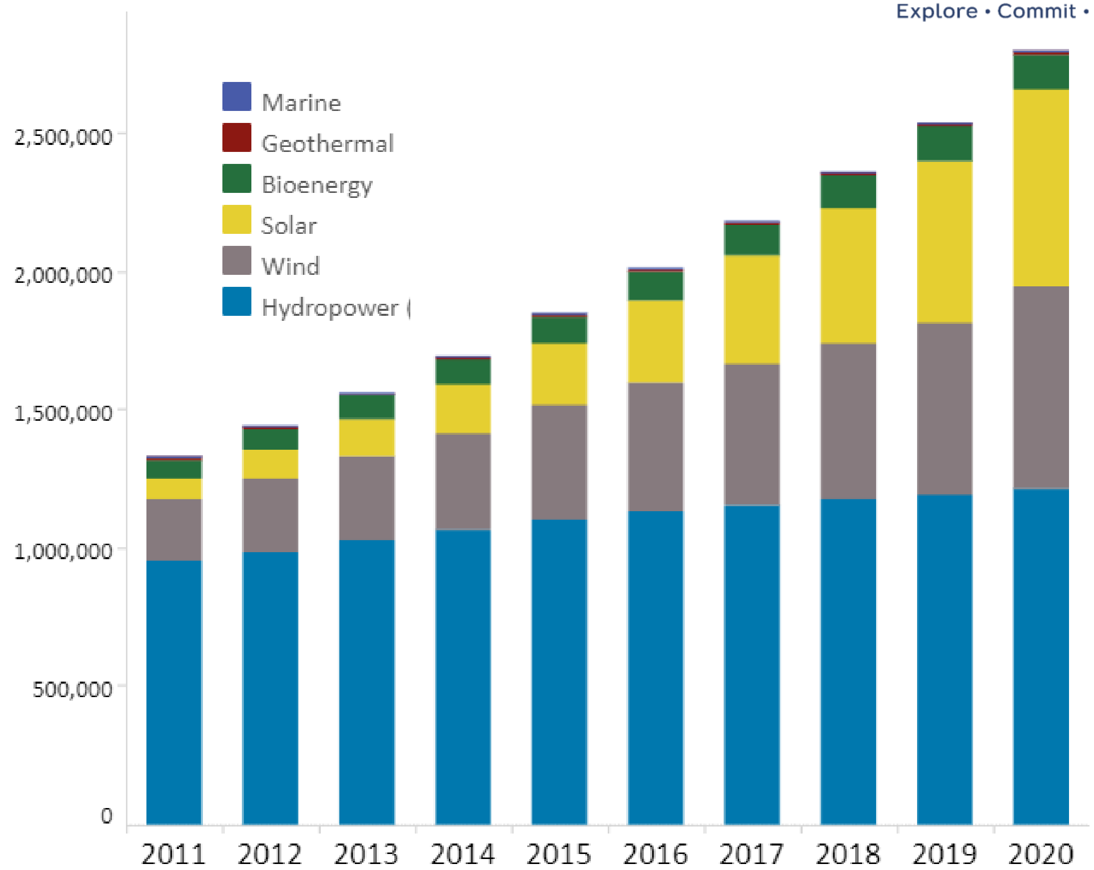


Fig. All Renewal energy sources installed capacity trend during 2011 to 2020

Building code changes to improve energy efficiency

Urban planning: use urban planning policies to enable reduced energy demand. increased renewable energy capacity and improved infrastructure resilience.
New buildings: Increase uptake of new buildings with net-zero operating emissions.
Building retrofits: Increase the rate of building energy renovation and increase the level of sustainability in existing buildings.
Building operations: Reduce the operating energy and emissions through improved energy management toots and operational capacity building.
Systems: Reduce the energy and emissions needed for equipment, appliances, lighting and cooking.
Materials: Reduce the environmental impact of materials and products in buildings and construction by taking a life-cycle and circular economy approach.
Resilience: Reduce building risks related to climate change through building design, selection of materials and improving resilience to structural, water and heat risks.
Clean energy: Increase secure, affordable and sustainable energy and reduce the carbon footprint of energy demand in buildings.

Sustainable Transportation

A more sustainable transportation system is one that:

•Allows the basic access and development needs of people to be met safely and promotes equity within and between successive generations. (Social dimension)

•Is affordable within the limits imposed by internalization of external costs, operates fairly and efficiently, and fosters a balanced regional development. (Economic dimension)

•Limits emissions of air pollution and **greenhouse gases (GHG)** as well as waste and minimizes the impact on the use of land and the generation of noise.

In conclusion, low-carbon, sustainable transport reduces short and long term negative impacts on the local and global environments, has economically viable infrastructure and operation, and provides safe and secure access for both persons and goods.

AVOID/REDUCE	SHIFT	IMPROVE
Reduce or avoid travel or the need to travel	Shift to more environmentally friendly modes	Improve the energy efficiency of transport modes and vehicle technology
• Integration of transport and land-use planning • Smart logistics concepts	• Transport Demand Management • Mode shift to Non-Motorised Transport • Mode shift to Public Transport	• Low-friction lubricants • Optimal tire pressure • Low Rolling Resistance Tires • Speed limits Eco-Driving (Raising Awareness) • Shift to alternative fuels

Hydrogen-Powered Tram

Prototype Solar Power-Assist for Buses

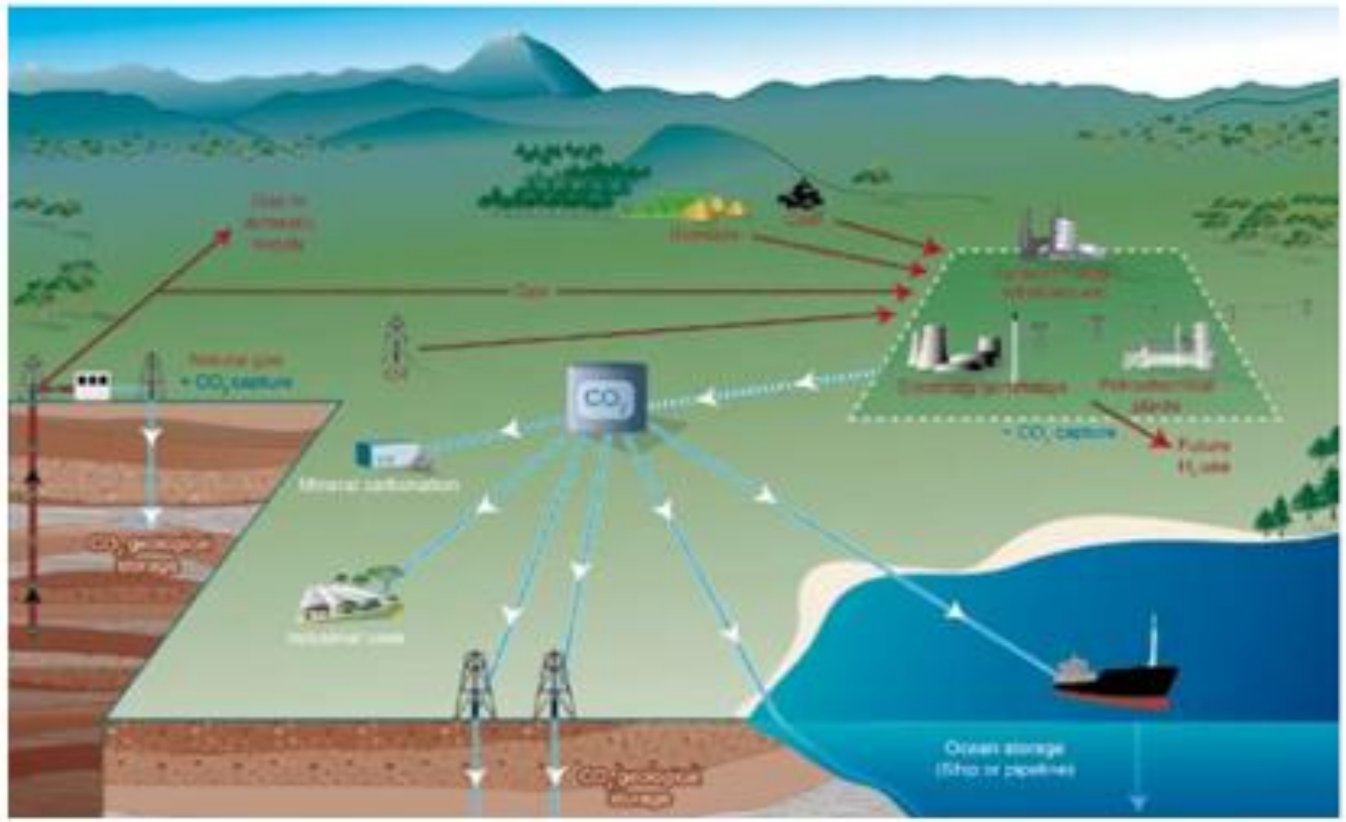
Capture and use landfill and digester gas

Capturing landfill gas to prevent methane from entering the atmosphere and contributing to smog and climate change. While reducing and diverting waste addresses many landfill challenges, these practices do not prevent landfills from generating methane, a greenhouse gas 21 times more powerful than carbon dioxide (over a 100-year time horizon) and a precursor to ozone pollution

Carbon Capture and Storage (CCS)

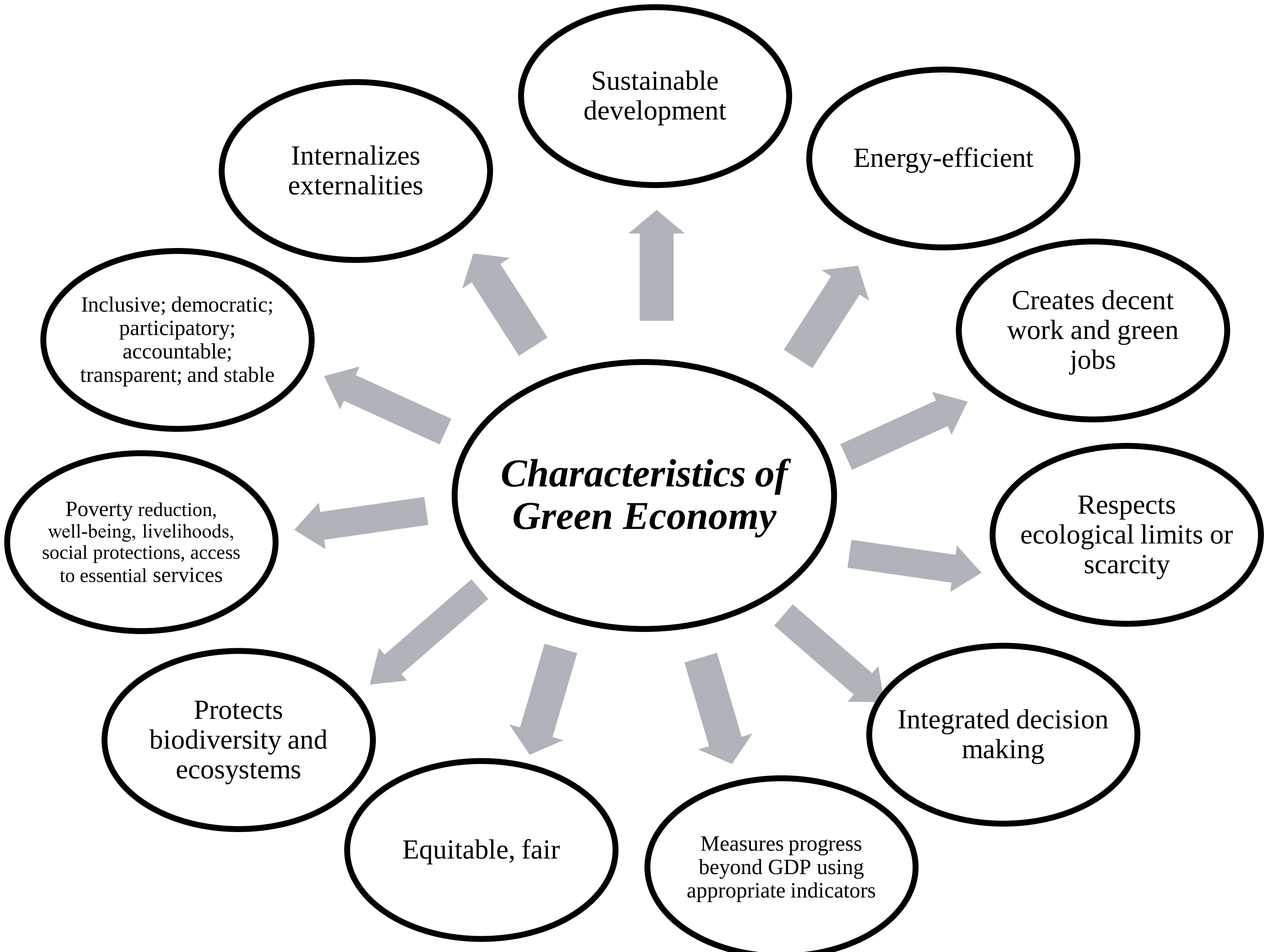
Carbon capture and storage (CCS) is a technological process that "scrubs" CO_2 from the emission stream, transports it and permanently and safely stores it underground, reducing emissions from energy-intensive industries.

Carbon capture helped capture 40 million tonnes of CO_2 from 26 operating power and industrial facilities globally in 2020.



Schematic diagram of possible CCS systems showing the sources for which CCS might be relevant, transport of CO_2 and storage options

Characteristics of Green Economy



Principles of Green Economy

1. The Wellbeing Principle	A green economy enables all people to create and enjoy prosperity.
2. The Justice Principle	The green economy promotes equity within and between generations.
3. The Planetary Boundaries Principle	The green economy safeguards, restores and invests in nature.
4. The Efficiency and Sufficiency Principle	The green economy is geared to support sustainable consumption and production.
5. The Good Governance Principle	The green economy is guided by integrated, accountable and resilient institutions.

The Vision of Green Economy

A fair, green economic future

Theories of green economy

1. GE in the context of free market theory

2. GE in the context of classical theories

1. GE in the context of free market theory

According to UNEP – the market will decide. No democracy, no debate, no discussion, just dollars (Patel & Crook 2012).

GE is a new public discourse and based on the following key strategies (Lievens, 2013) –

a) The market as central governance mechanism
b) A focus on technology
c) Sustainable entrepreneurship
d) Sustainable consumption.

These four strategies support the expansion of the market and enforce competition. All these strategies indicates that they are also fall under Neo-liberal paradigm.

Green economy is based on –

a. Neo-liberalism theory and functionally this green economy is based on –

a. free market environmentalism

b. eco-modernization theory.

2. Green economy in the context of classical theories

The classical economists 'belief is that the market as a mechanism for maximizing efficient resource use and wellbeing. One of the key classical theorists Adam Smith’s theory refined the idea of free market, free economy and the three natural laws- the law of self interest, the law of competition, the law of supply and demand. So in this sense, this can be seen easily that the privatization and market competition can lead the efficient use of resource

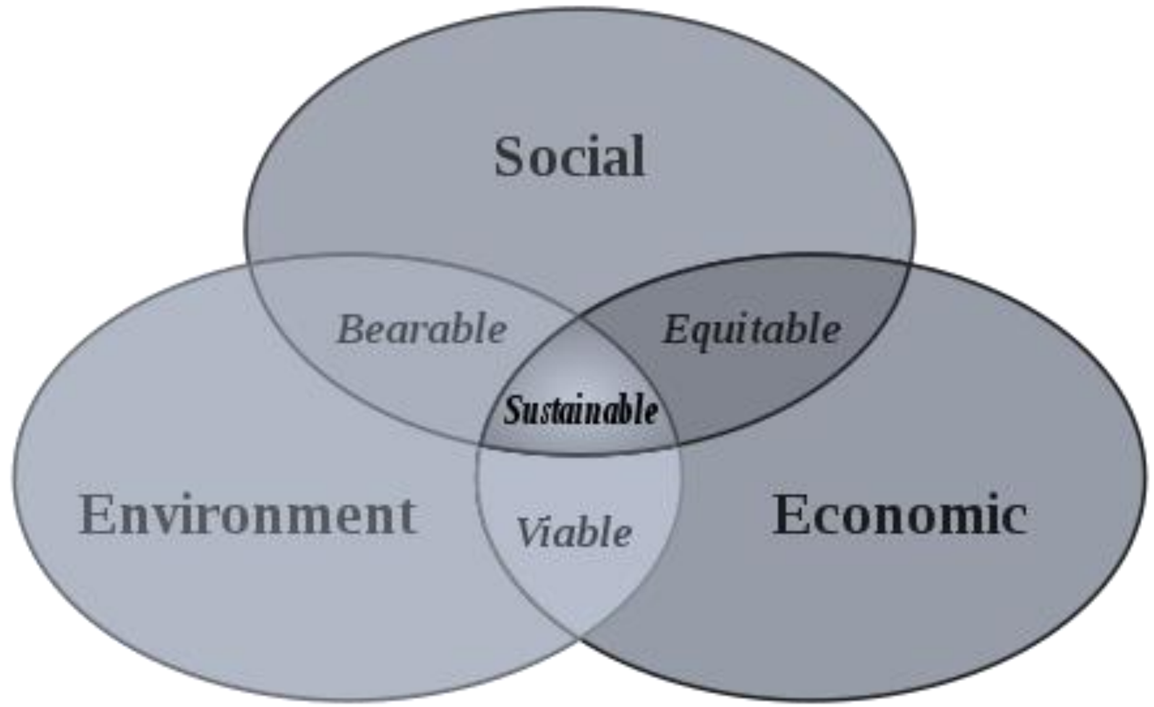
Proposals in Green Economy

Green economy includes a wide range of proposals that can be summarized in two ways (UNEP, 2011).

1. Green economy promotes the development of a 'post-fossil fuel' bio-economy based on exploitation of biomass through the employment of hazardous new technology.
2. The green economy embraces the protection of ecosystems and biodiversity through the commodification and privatization of natural and the use of new financial market. The privet sector must act as a major driver for the green economy. Actual transformation can only be achieved through private investments and innovations.

Sustainability

Sustainability is most often defined as meeting the needs of the present without compromising the ability of future generations to meet theirs. It has three main pillars: economic, environmental, and social. These three pillars are informally referred to as people, planet and profits.



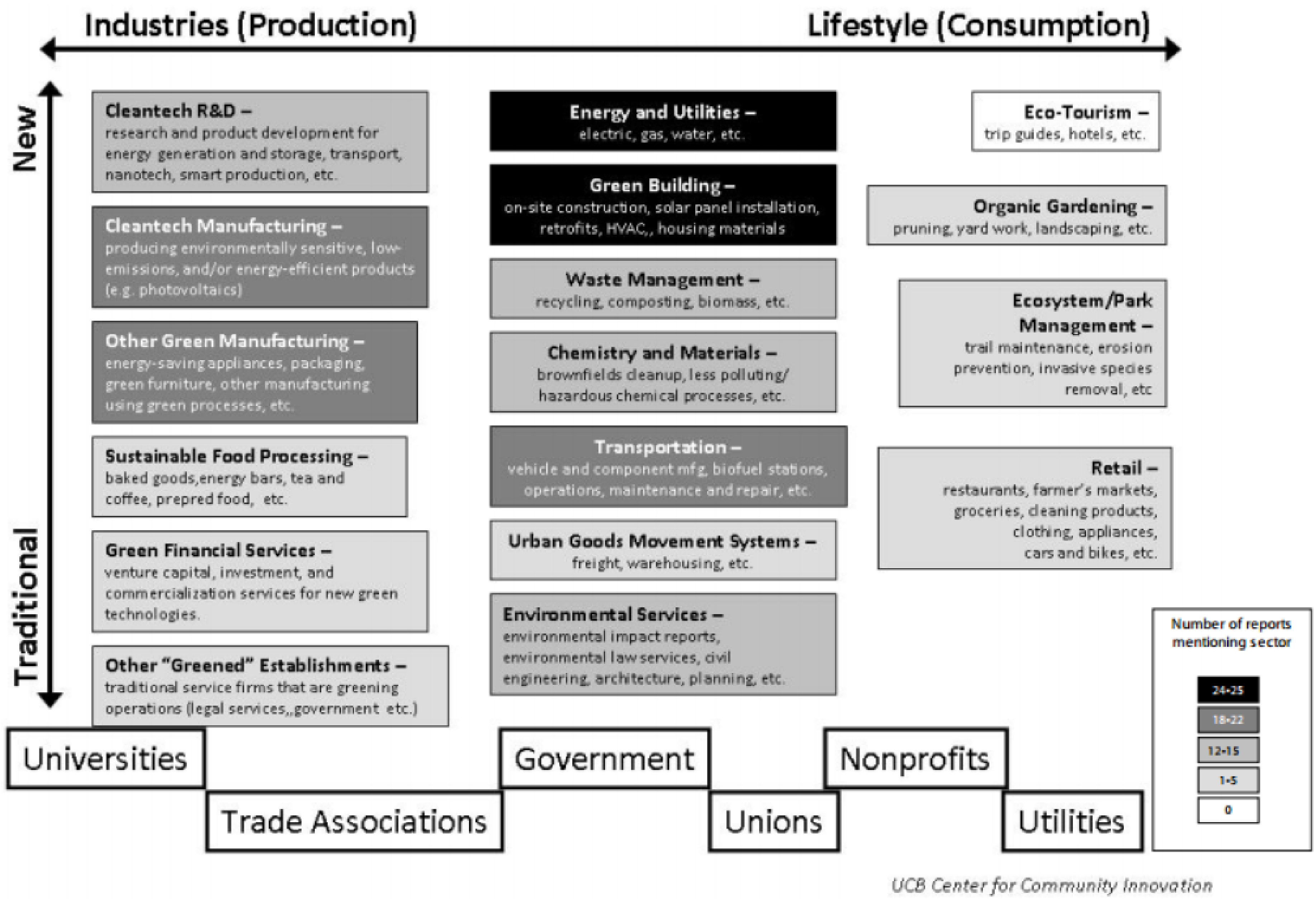
The role of green economy for sustainability

The role of Green Economy, Sustainable Consumption and Production and Resource Efficiency for Sustainable Development: Sustainable Consumption and Production aims to improve production processes and consumption practices to reduce resource consumption, waste generation and emissions across the full life cycle of processes and products – while Resource Efficiency refers to the ways in which resources are used to deliver value to society and aims to reduce the amount of resources needed, and emissions and waste generated, per unit of product or service. The Green Economy provides a macro-economic approach to sustainable economic growth with a central focus on investments, employment and skills.

Why green development is so important

- Over the last 20 years, economic growth has helped to lift almost a billion people out of extreme poverty. But 1 billion people are still extremely poor. 1.1 billion live without electricity and 2.5 billion people without access to sanitation. For them, growth has not been inclusive enough.
- In addition, growth has come at the expense of the environment. While environmental degradation affects everyone, the poor are more vulnerable to violent weather, floods, and a changing climate.
- Development experts, policymakers, and institutions like the World Bank have learned a major lesson: If we want to succeed in ending poverty, growth needs to be inclusive and sustainable. Three areas are critical to achieve

Sectors of the Green Economy



Source: http://communityinnovation.berkeley.edu/

Indicators for measuring the green economy

Economic Indicators

- Investment share,
- Labor productivity,
- Employment in sectors that meet a standard of
- Sustainability
- For example green GDP

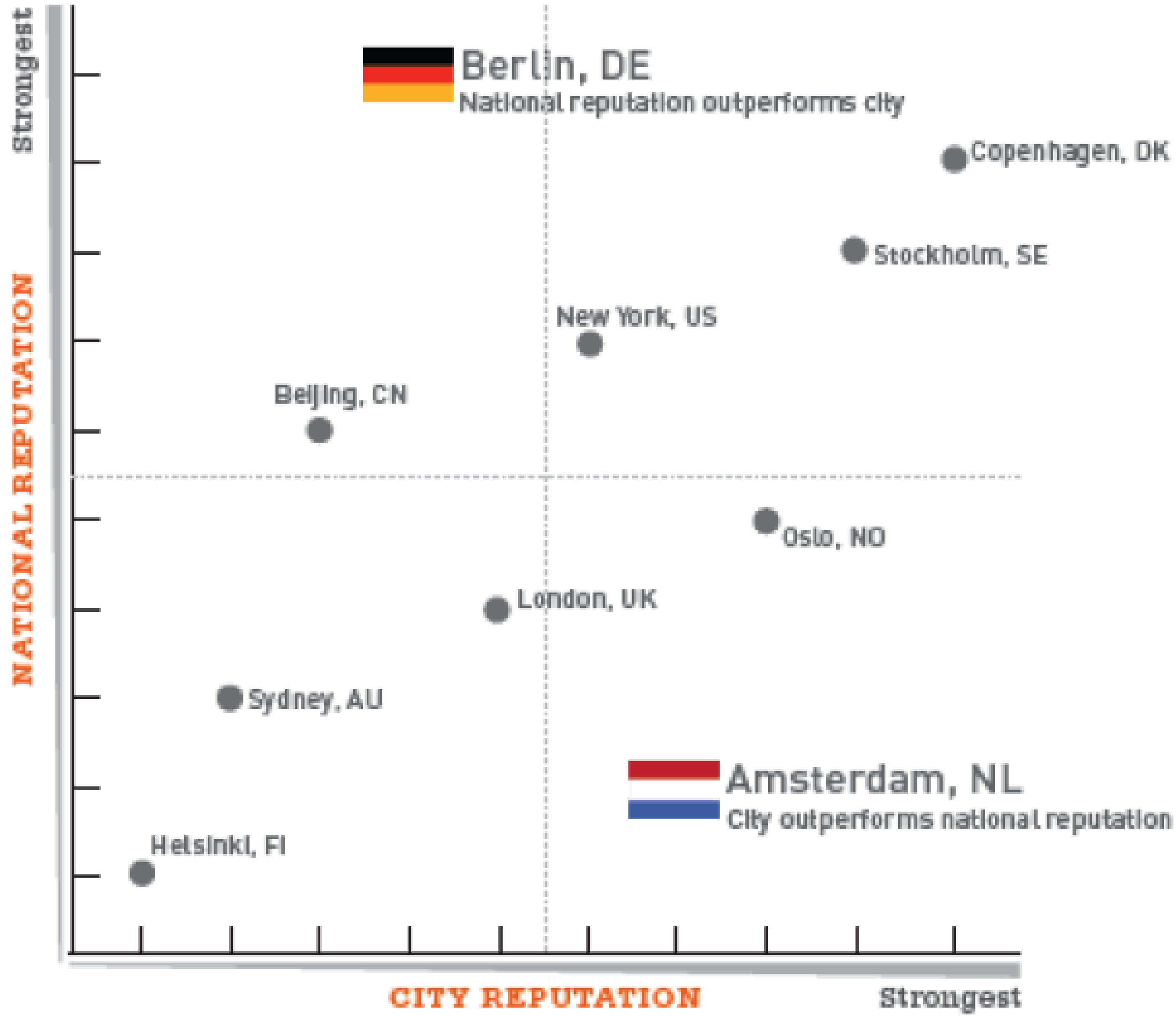
Environmental indicators

- Resource efficiency
- Pollution intensity level
- For example energy consumption / GDP

Progress and prosperity indicators

- Macroeconomic aggregates reflecting the depreciation of natural capital
- For example GDP / capita

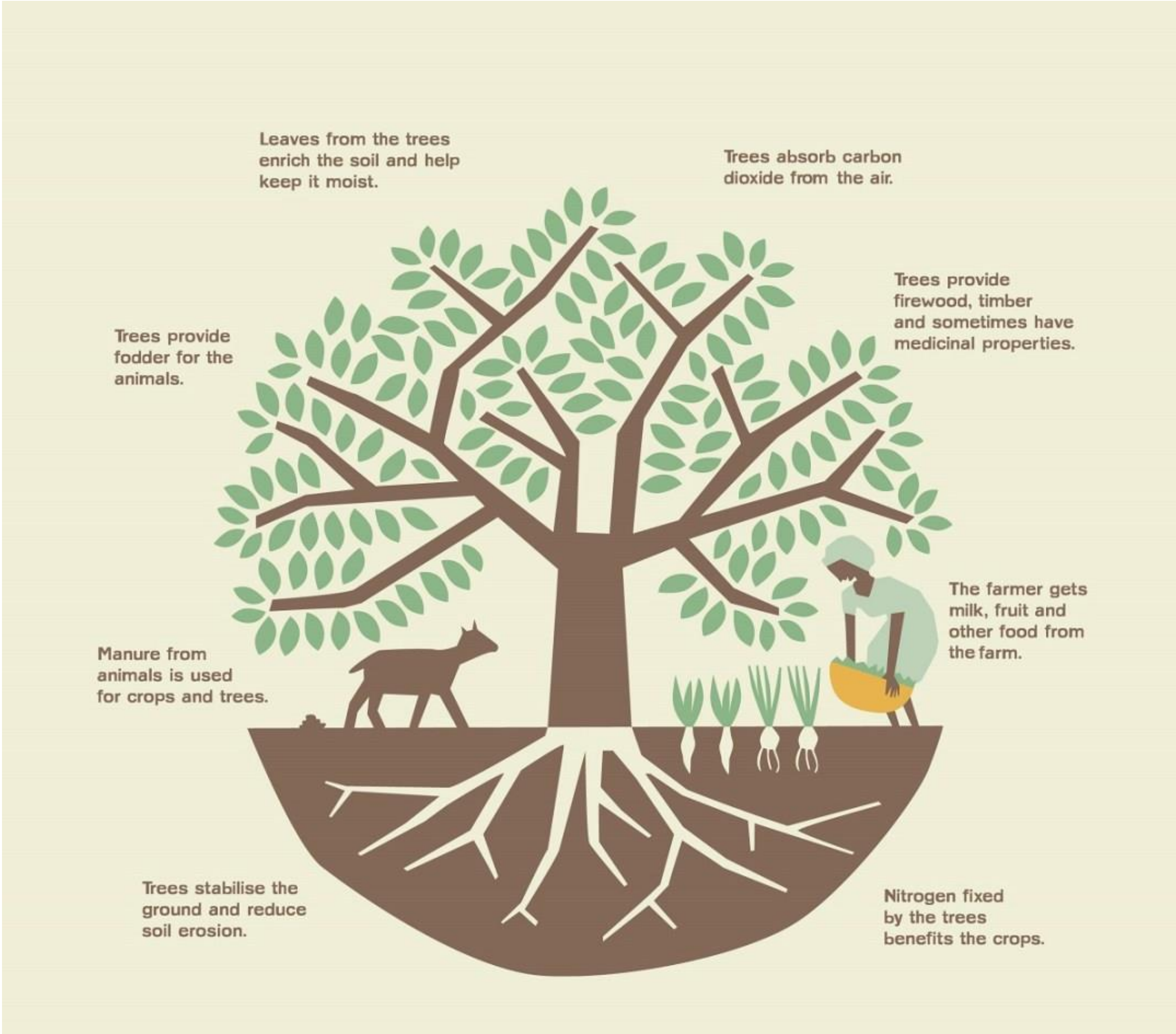
Top green cities in the World



Source: http://www.dualcitizeninc.com/ggei2012.pdf

Concept of Agroforestry

Agroforestry = Woody perennials + Crops and/or Animals



Definitions

- "Agroforestry is the art and science of growing woody and non-woody plants together on the same unit of land for range of benefits".
- "Agroforestry refers to those land use practices in which woody perennials (trees, shrubs, woody vines, bamboo, palms) are grown in association with agricultural crops or pastures, sometimes with livestock or other animals (e.g. insects such as bees, fish), and in which there are both ecological and economic interactions between the woody plants and other components".

- “Agroforestry is a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. In agroforestry systems there are both ecological and economical interactions between the different components” (Lundgren and Raintree, 1982).

- An intensive land management system that optimizes the benefits (physical, biological, ecological, economic, social) arising from biophysical interactions created when trees and/or shrubs are deliberately combined with crops and/or livestock (Garrett *et al.* 1994).

- **Recently ICRAF defined "Agroforestry as a dynamic, ecologically based, natural resources management system that, through the integration of trees on farmland and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels".**

- **"The 4 I's"**: it must be **intentional**, **intensive**, **integrative**, and **interactive.**

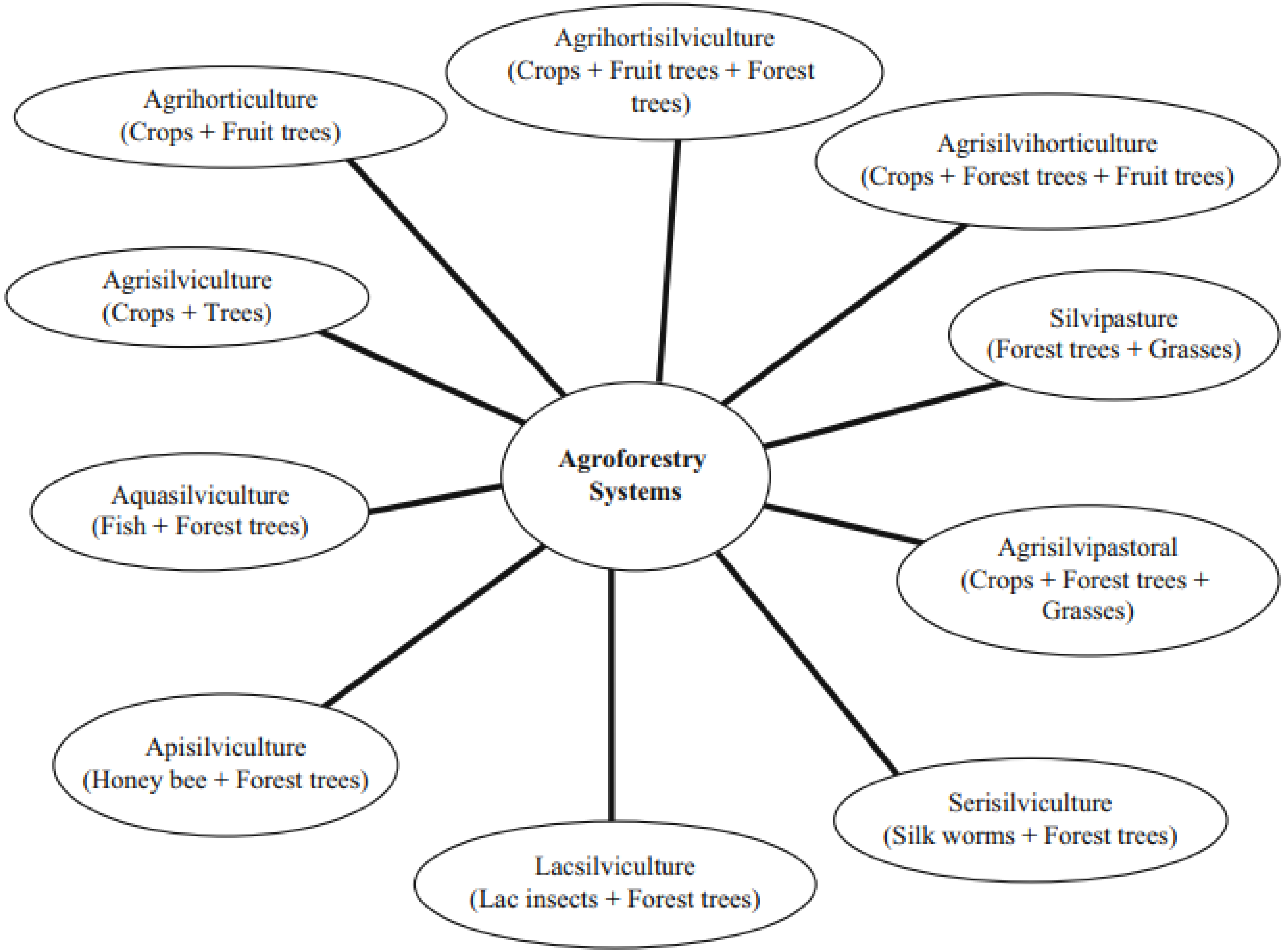
Components of Agroforestry

1. Trees / Silvicultural Components

2. Crops / Agricultural Components

3. Livestock / Pastoral Components

Types of Agroforestry

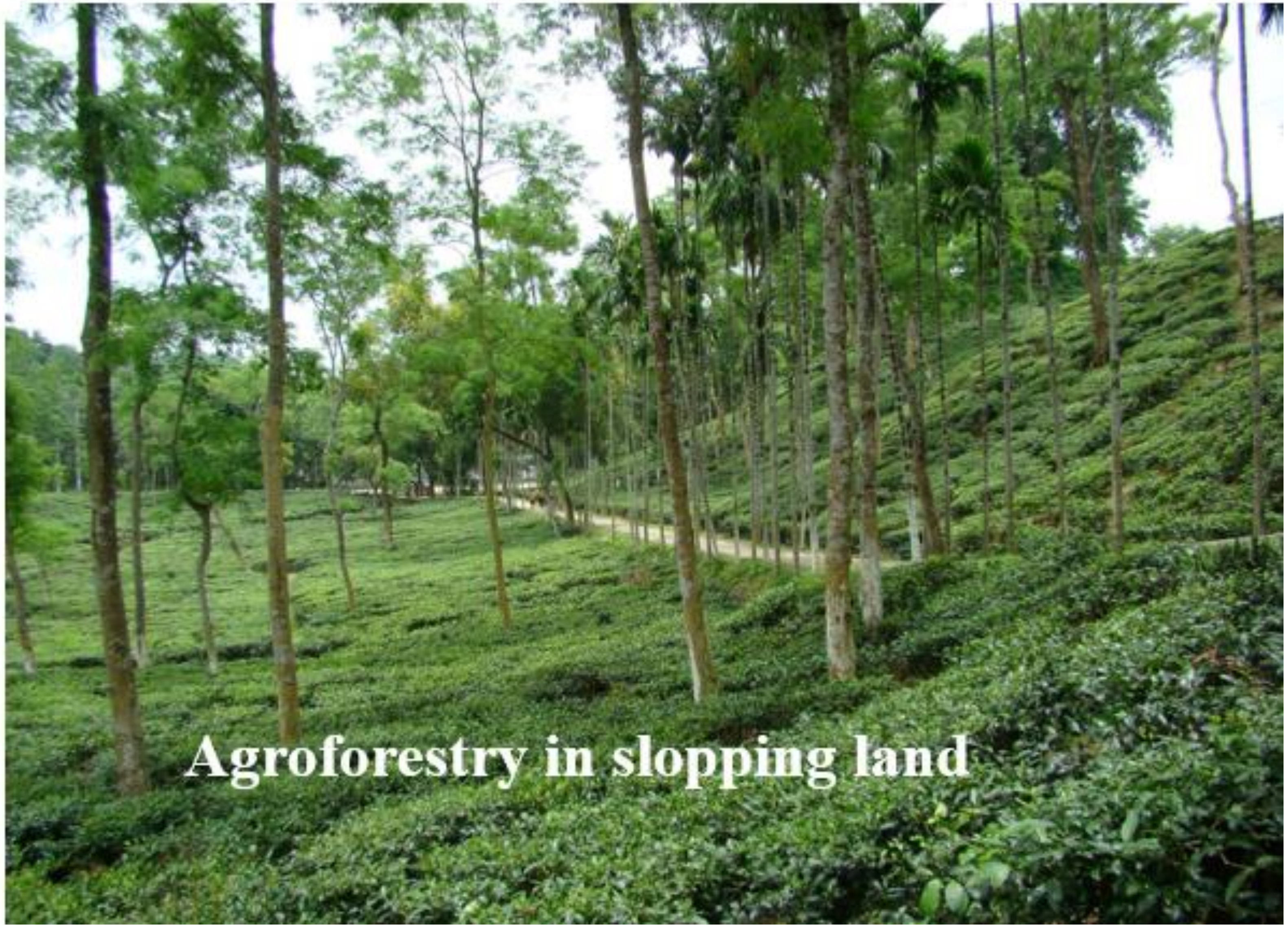


Hafiz

Cropland Agroforestry


Homestead Agroforestry


Silvipasture


Agroforestry in slopping land

Characteristics of Agroforestry

Board Characteristics

- The deliberate growing of woody perennial on the same unit of land as agricultural crops and/or animals, either in some form of special mixture or in temporal sequences.
- There must be significant interaction (positive and/or negative) between woody and non-woody components of the system, either ecological and / or economical.

Specific Characteristics

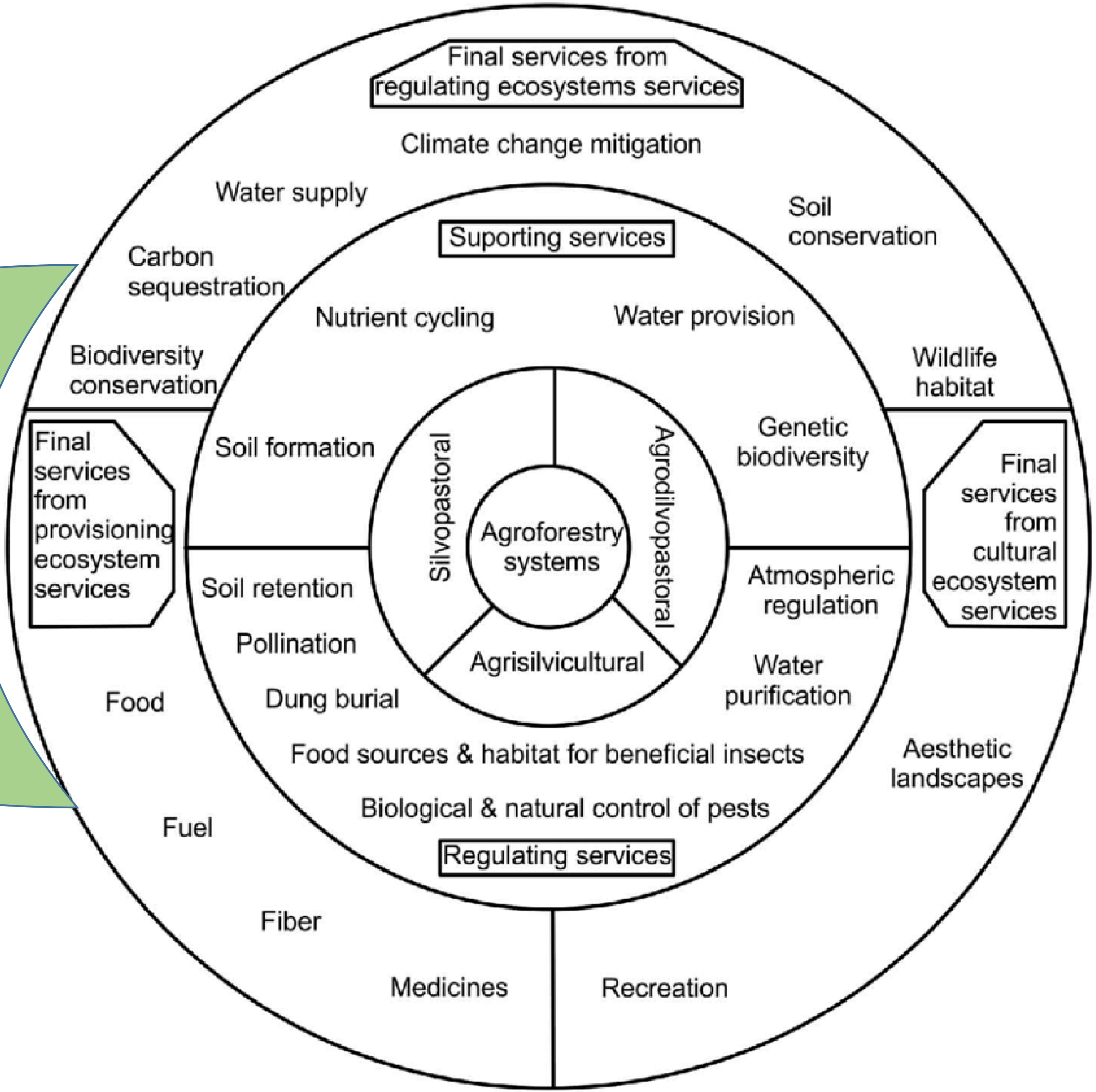
1. multiple plant components, at least one of which must be a woody perennial.
2. multiple plant components are managed in the same unit of land.
3. usually multiple products, often of different categories (e.g. food, fodder, fuelwood), at least one service function (shelter, shade, soil amelioration, etc.).
4. the cycle of an Agroforestry system is always more than one year.
5. the most simple Agroforestry system is more complex, ecological and economically than a mono-cropping system.
6. a dependence on the use and manipulation of plant biomass, especially by optimizing the use of plant residues.
7. a high level of interaction (economic and biophysical) between the woody and non-woody components of the system, either ecological and / or economical.

Attributes of Agroforestry

1. **Productivity** = **Fertility + Proper management**
2. **Sustainability** = **Productivity + Conservation of Natural Resources**
3. **Adoptability**

The word ‘adopt’ here means ‘accept’, and it may be distinguished from another commonly-used word adapt, which implies ‘modify’ or ‘change’. The fact that Agroforestry is a relatively new word for an old set of practices means that, in some cases, Agroforestry has already been accepted by the farming community. However, the implication here is that improved or new Agroforestry technologies that are introduced into new areas should also conform to local farming practices.

Outline of agroforestry system and its overall services



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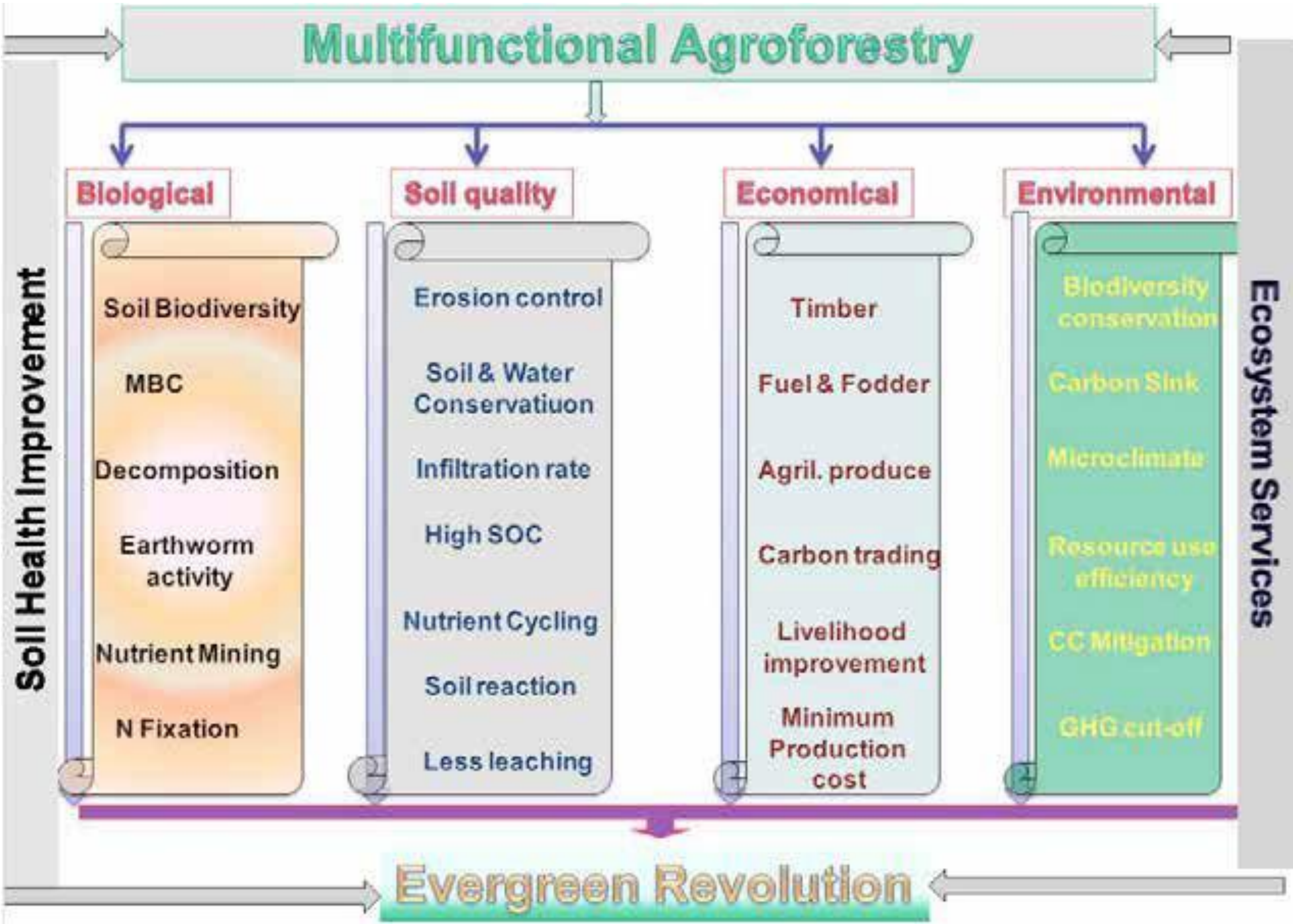


Innovative for green economy

Agroforestry as a green economy approach

Production of wheat-mung bean-rice under multipurpose tree based agroforestry

Wheat production under *Albizia lebbeck* (Black siris) based agroforestry

Agroforestry as a green economy approach

Wheat production under *Psidium guajava* (Guava) based agroforestry

Agroforestry as a green economy approach

Mung bean production under *Albizia lebbeck* (Black siris) based agroforestry

Agroforestry as a green economy approach

Mung bean production under *Psidium guajava* (Guava) based agroforestry

Agroforestry as a green economy approach

Mung bean production under *Mangifera indica* (Mango) based agroforestry

Agroforestry as a green economy approach

Rice production under *Albizia lebbeck* (Black siris) based agroforestry

Agroforestry as a green economy approach

Rice production under *Psidium guajava* (Guava) based agroforestry

Agroforestry as a green economy approach

Rice production under *Mangifera indica* (Mango) based agroforestry

Agroforestry as a green economy approach

Onion-banana production under *Leucaena leucocephala* (Ipil-ipil) based agroforestry

Agroforestry as a green economy approach

Onion-banana production under *Melia azedarach* (Ghora neem) based agroforestry

Agroforestry as a green economy approach

Vegetables production under *Mangifera indica* (Mango) based agroforestry

Agroforestry as a green economy approach

Vegetables production under *Psidium guajava* (Guava) based agroforestry

Agroforestry as a green economy approach

Multilayer vegetables production under *Albizia lebbeck* (Black siris) based agroforestry

Agroforestry as a green economy approach

Pineapple, Indian spinach and turmeric production under *Litchi chinensis* (Litchi) based agroforestry

Agroforestry as a green economy approach

Okra, egg plant and cane production under *Swietenia macrophylla* (Mahogany) based agroforestry

Agroforestry contributes to bio-economy for low-carbon society

Economic feasibility of potato production influenced by intra-row plant spacing under mango-based agroforestry system

Treatments	Outcome (US$/ha)		Gross Return ($./ha)	Total cost of Production ($./ha)	Net Return ($./ha)	BCR
	Potato tuber	Mango fruit tree				
Open field/sole-crop potatoes	2858.00	-	2858.00	1600.00	1258.00	1.78
Potatoes under mango trees	2618.00	890.00	3508.00	1642.00	1866.00	2.14

Agroforestry contributes to bio-economy for low-carbon society

The potentiality of Potato based Agrisilvicultural Land Use System in the Northern Part of Bangladesh

Treatments	Return ($\$ha^{-1}$)				Gross Return ($\$ha^{-1}$)	Total cost of Production ($\$ha^{-1}$)	Net Return ($\$ha^{-1}$)	BCR
	Potato	Ipil-Ipil	Ghora Neem	Kala Koroi				
T_1	2035	3840	-------	-------	5748	1737	4012	3.31
T_2	3620	-------	2880	------	6500	1734	4766	3.75
T_3	1095	------	--------	3413	4508	1747	2764	2.58
T_4	3553	------	-------	--------	3553	1658	1894	2.14

Agroforestry contributes to bio-economy for low-carbon society

Bio-economic production potentiality of *Solanum lycopersicum* under smart agroforestry practice

Production system	Outcome (Tk/ha)		Gross Return (Tk/ha)	Total cost of Production (Tk/ha)	Net Return (Tk/ha)	BCR
	Tomato	*Albizia lebbeck*				
Tomato sole-cropping (T_0)	519000	………	519000	130500	388500	3.98
Tomato-*Albizia lebbeck* agroforestry (T_1)	588200	204800	793000	160500	632500	4.94

Agroforestry contributes to bio-economy for low-carbon society

Economic performance of onion under *Albizia lebbeck, Melia azedarach* and *Leucaena leucocephala* based agroforestry systems

Treatments	Return (Tk/ha)				Gross return (Tk/ha)	Total cost of production (Tk/ha)	Net Return (Tk/ha)	BCR
	Onion	*Albizia lebbeck*	*Melia azedarach*	*Leucaena leucocephala*				
T_0	405600		-------	-------	405600	158526.5	247073.5	2.56
T_1	397600	307200	-----	------	704800	196720.5	508079.5	3.58
T_2	382800	------	230400	-----	613200	192313.5	420886.5	3.19
T_3	364400	-----	-------	273067	637467	194771.25	442695.75	3.27

Agroforestry contributes to bio-economy for low-carbon society

Bio-economic performance of bottle gourd under different shade of MPTs as agroforestry system

Treatment	Return (Tk./ha)				Gross Return (Tk./ha)	Total cost of Production (Tk./ha)	Net Return (Tk./ha)	BCR
	Bottle gourd	Ghora neem	Mango	Black siris				
T_1	1073200	300000			1373200	194517.85	1178682.15	7.06
T_2	1043600		380000		1423600	198924.85	1224675.15	7.16
T_3	1275600			500000	1775600	196975.60	1578624.40	9.01
T_4	1444400			………..	1444400	160730.85	1283669.15	8.98

Agroforestry contributes to bio-economy for low-carbon society

Bio-economic performance of organic cucumber (*CUCUMIS SATIVUS* L.) under woodlots-based agroforestry systems

Treatment	Return (US$/ha)				Gross return ($/ha)	Total cost of production ($/ha	Net return ($/ha	BCR
	Cucumber	*Albizia lebbeck*	*Melia azedarach*	*Leucaena leucocephala*				
T_1	2095.00	………	………	………	2095.00	1892.00	203	1.11
T_2	2345.00	4412.00	………	………	6757.00	2342.00	4415	2.89
T_3	1100.00	………	4471.00		5571.00	2289.00	3282	2.43
T_4	1950.00	………	………	3529.00	5479.00	2318.00	3161	2.36

Agroforestry contributes to bio-economy for low-carbon society

Economic potentiality of *Colocasia esculenta* L. under multipurpose tree-based agroforestry systems

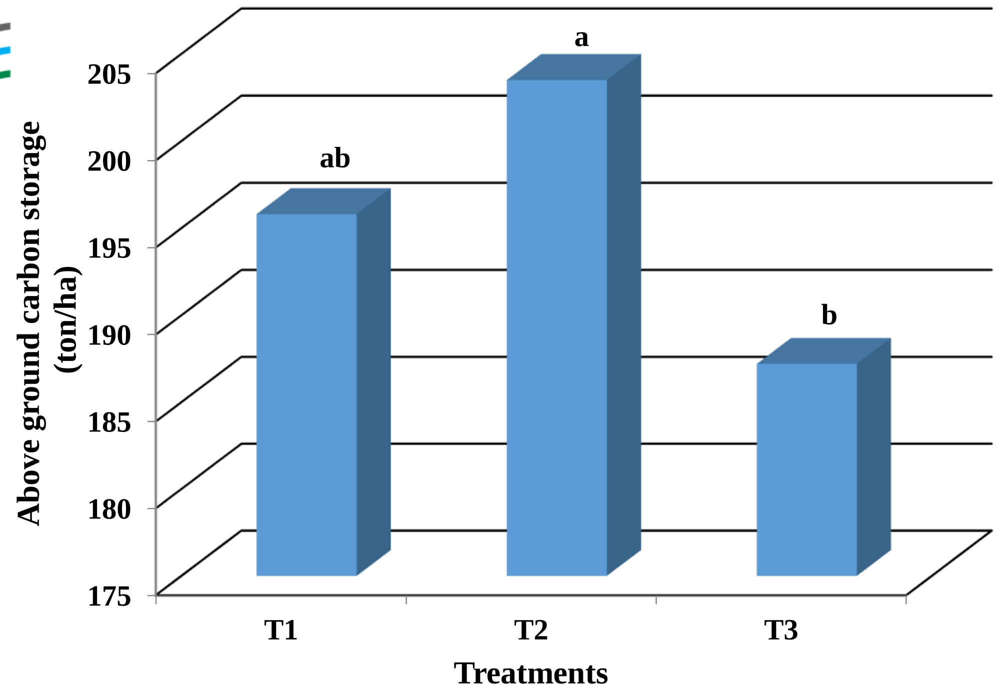
Treatment	Return (US$/ha)				Gross return ($/ha)	Total cost of production ($/ha)	Net return ($/ha)	BCR
	Taro	*Melia azedarach*	*Albizia lebbeck*	*Leucaena leucocephala*				
T_1	3476.47	……..	……..	……..	3476.47	960.35	2516.12	3.62
T_2	1912.94	1764.71	……..	……..	3677.65	1592.06	2085.59	2.31
T_3	3557.65	……..	2588.24	……..	6145.89	1285.75	4860.14	4.78
T_4	1231.76	……..	……..	2117.65	3349.41	1924.95	1424.46	1.74

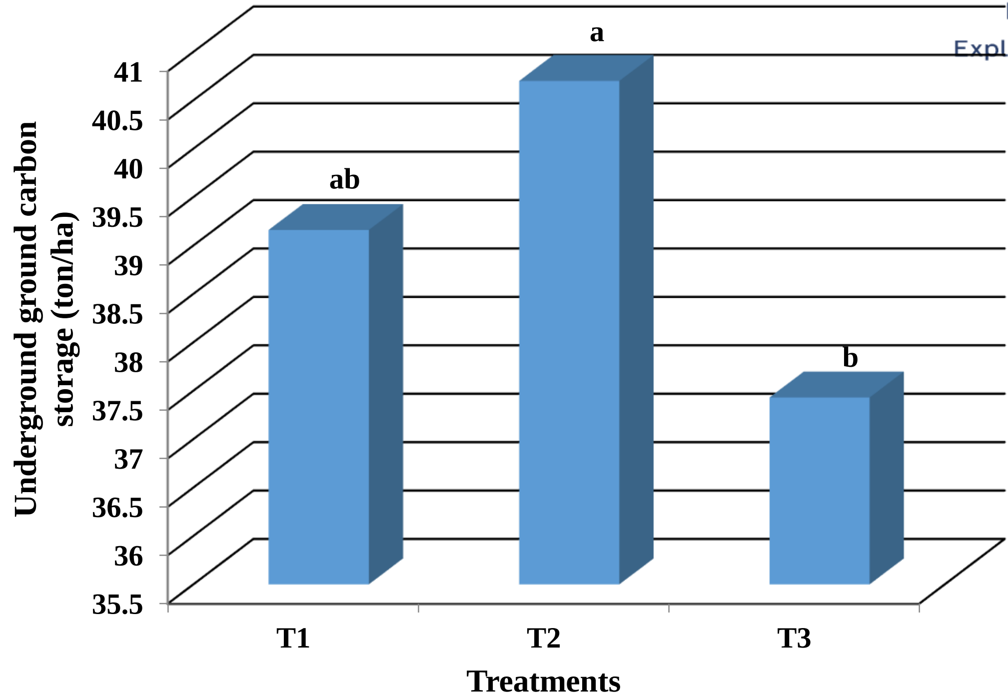
Agroforestry contributes to bio-economy for low-carbon society

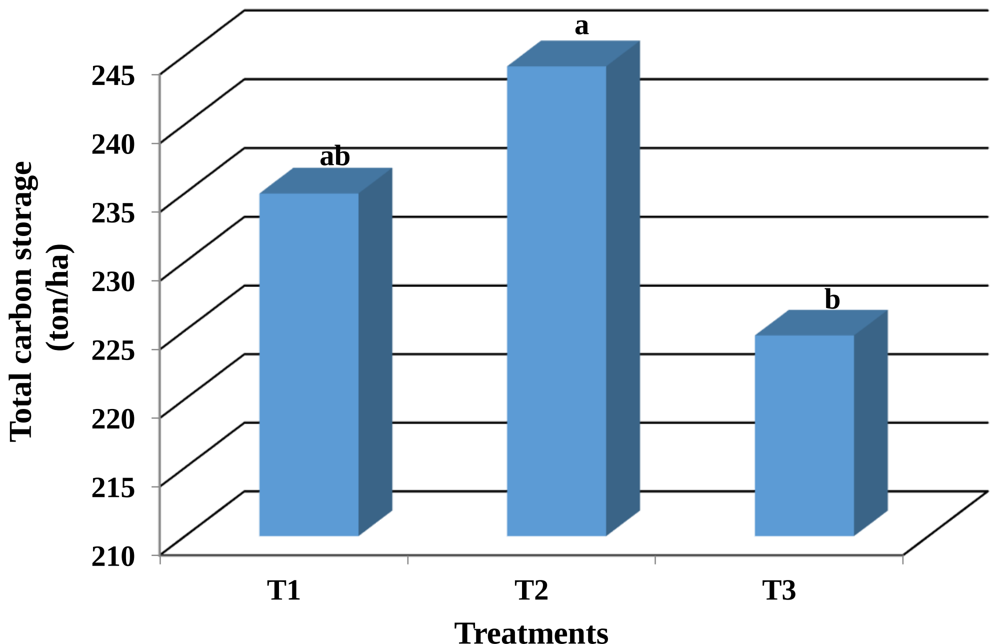
Okra-forest tree agroforestry model: potential for economic and environmental sustainability

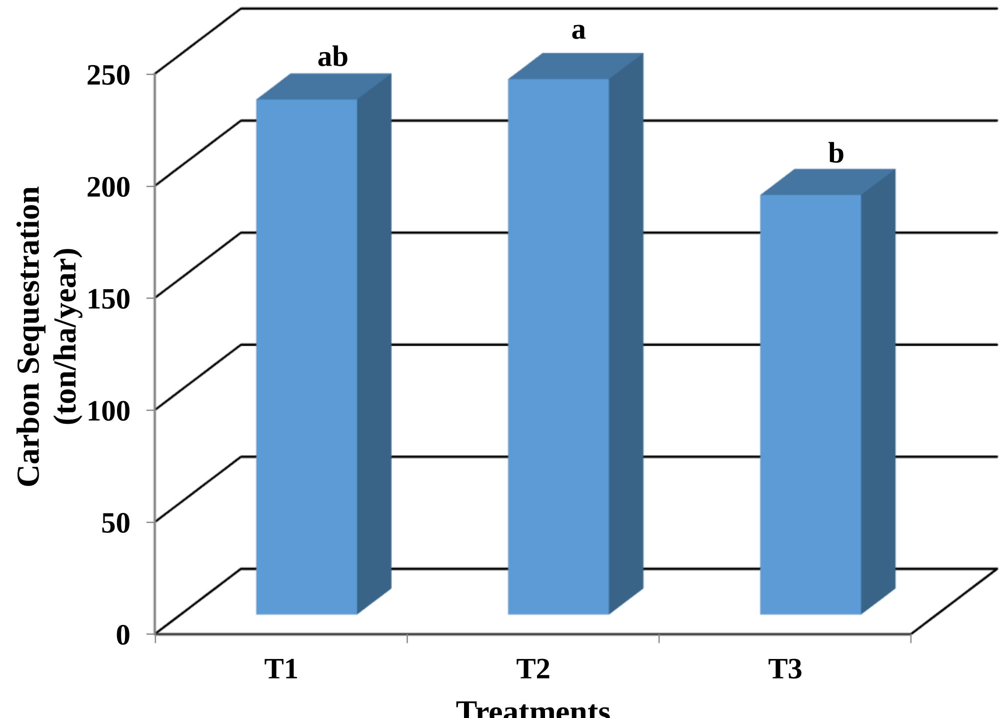
Treatments	Outcome ($./ha)				Gross Return ($./ha)	Total cost of Production ($./ha)	Net Return ($./ha)	BCR
	Okra	*Albizia lebbeck*	*Melia azedarach*	*Leucaena leucocephala*				
T_1	3570	3980	……..	……..	7550	1902	5648	3.97
T_2	3115	……..	2711	……..	5826	1858	3968	3.14
T_3	3185	……..	……..	3213	6398	1879	4519	3.41

Agroforestry contributes to bio-economy for low-carbon society









Thanks

Climate change and Global warming mitigation & adaptation

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Outlines

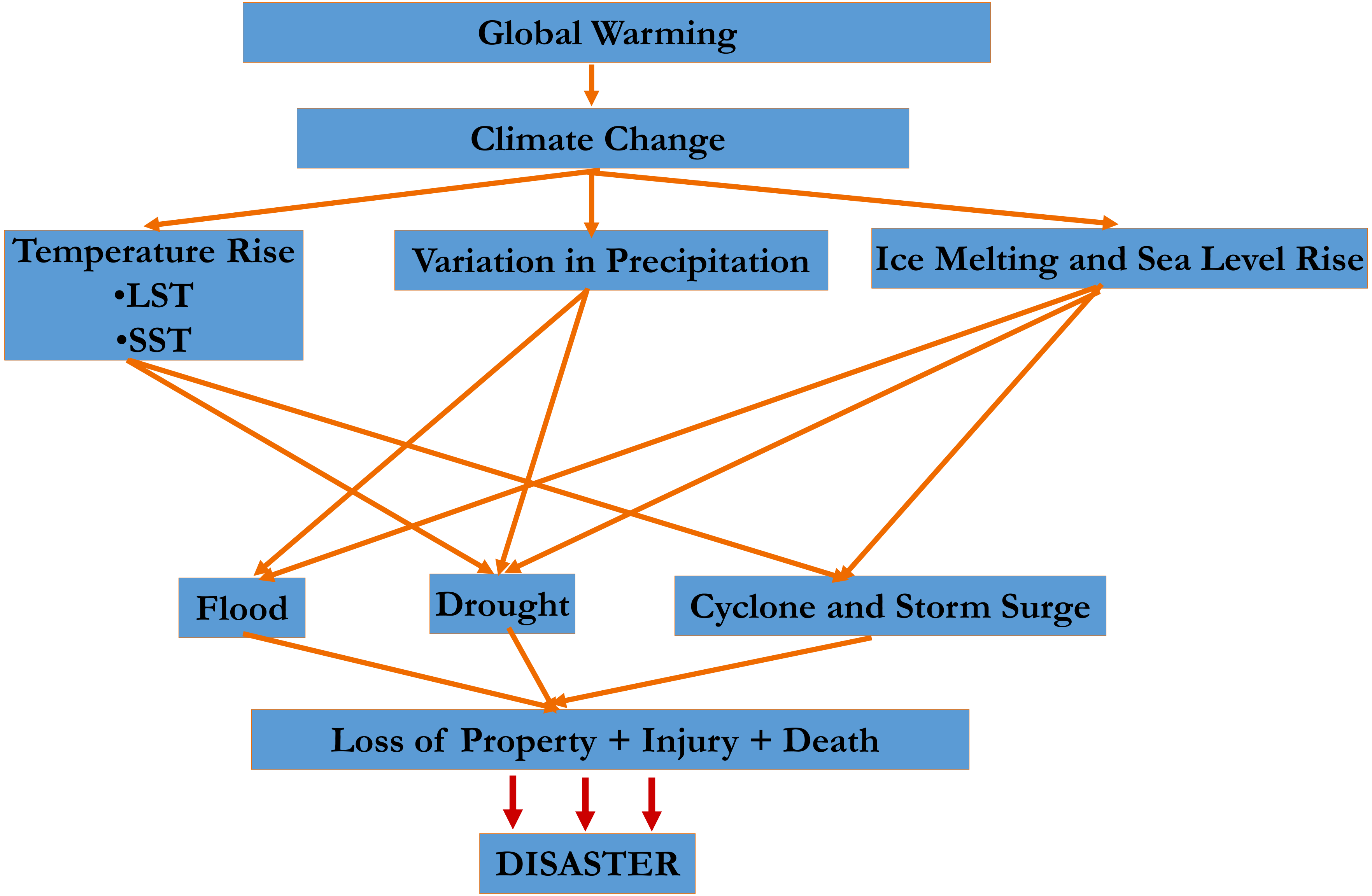
- Concept of climate change
- The Linkage of Climate change
- Why climate change?
- Global warming
- Green house gases effects
- Ozone layer Depletion
- Deforestation

- Mitigation
- Adaptation

Climate Change

- The average weather at a certain place and time of year over a lengthy period of time is referred to as climate (typically 30 years).
- The weather is expected to shift dramatically from day to day, but the climate is expected to stay reasonably stable.
- Climate change occurs when the climate does not remain constant.

The Linkage of Climate change



Why climate change?

Forest Fire

Extreme Temperature

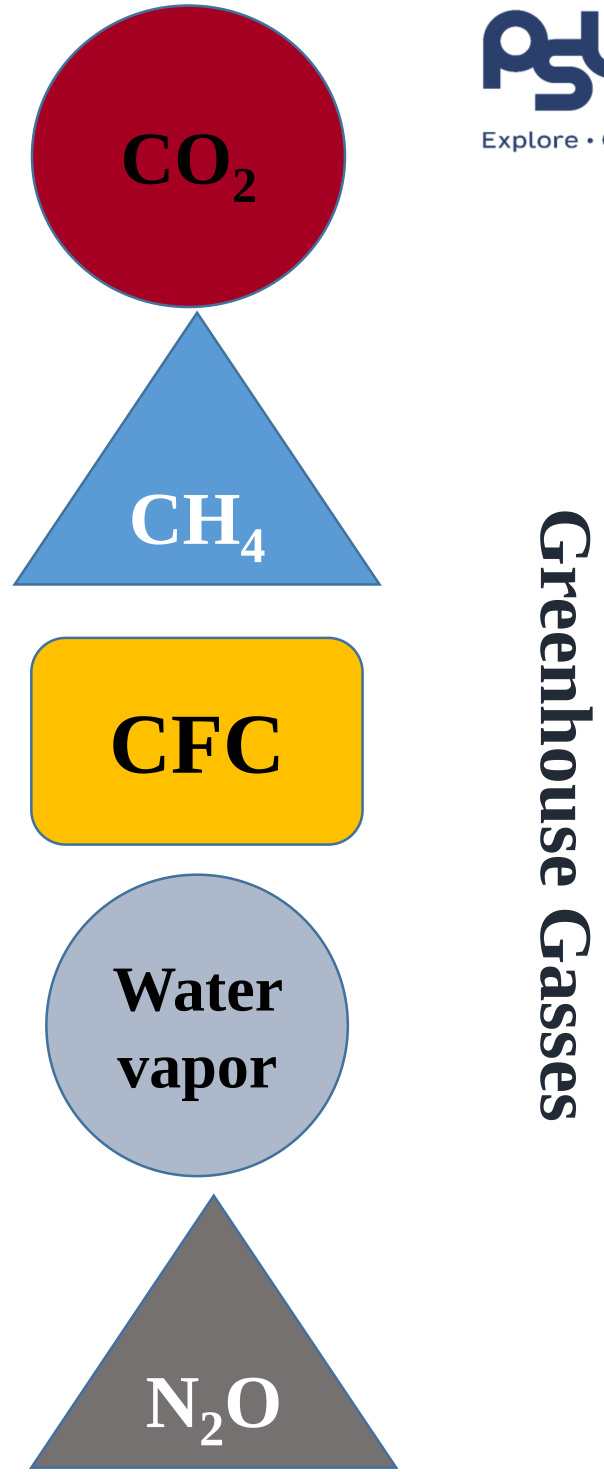
GLOBAL WARMING

Global warming refers to the unusually rapid increase in the average surface temperature of the Earth caused by human activities such as the burning of fossil fuels (coal, oil, and gas), large-scale deforestation, and other activities that release large amounts of greenhouse gases into the atmosphere over a long period of time.

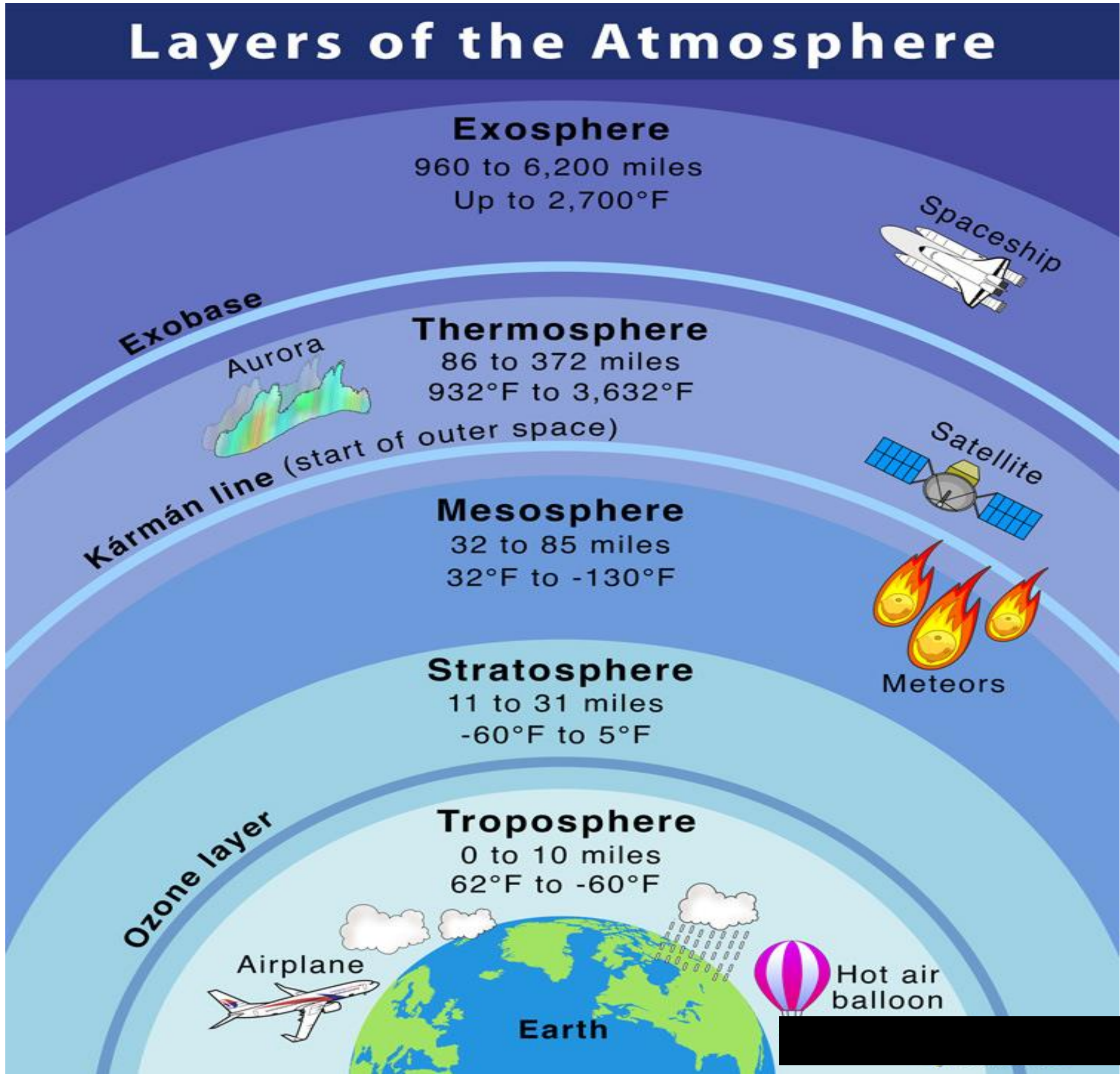
The Daily Guardian April, 2021

Global warming occurs due to the following reasons-

- Increase in the amount of greenhouse gases(carbon dioxide , Methane , Chlorofluoro Carbons, Nitrous Oxide , Ozone , water vapor)
- Depletion of ozone layer
- Deforestation etc.



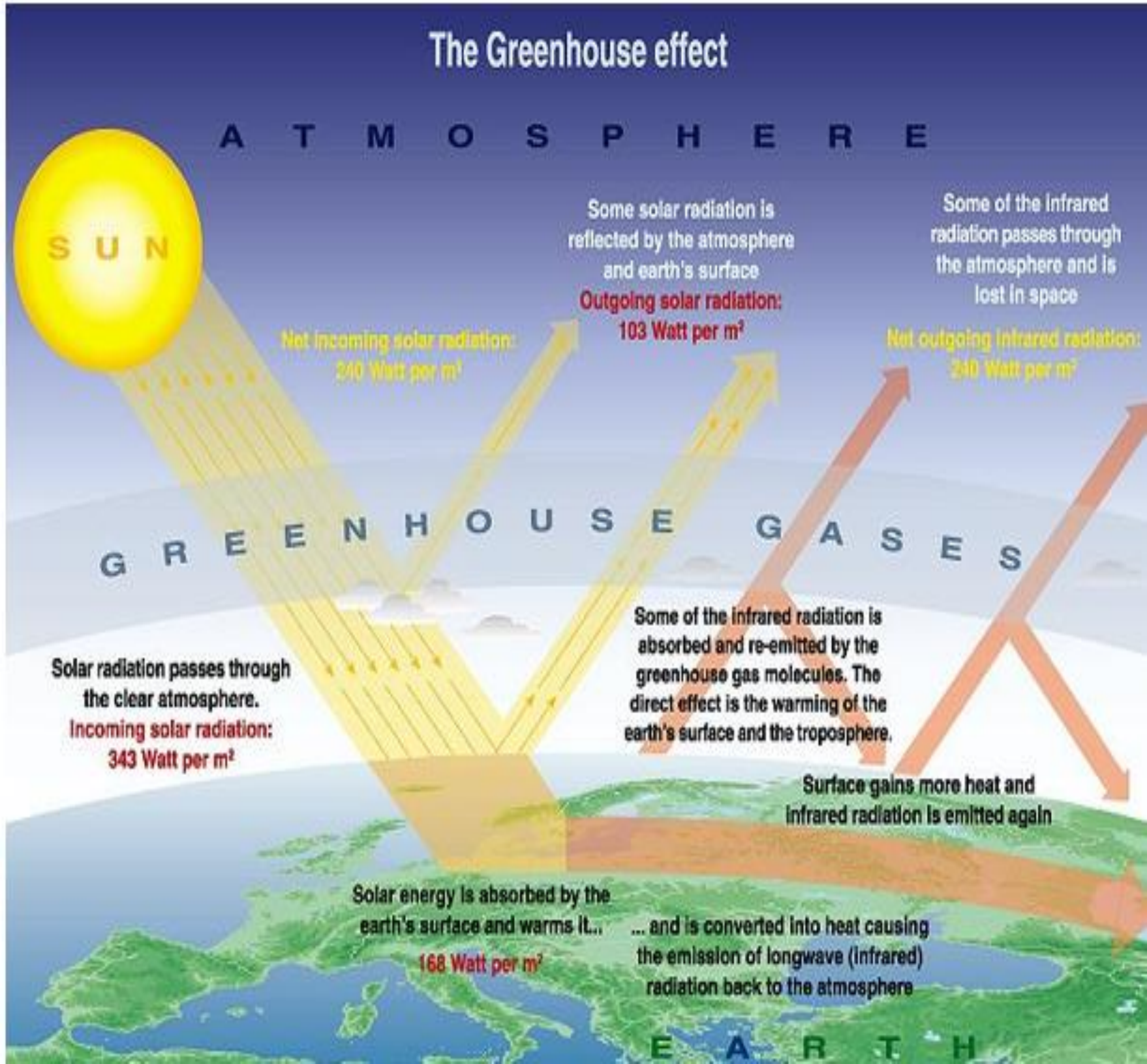
Earth's atmosphere



Constituent	Formula	Percentage by volume
Nitrogen	N_2	78.084
Oxygen	O_2	20.946
*Water	H_2O	0-4
Argon	Ar	0.934
*Carbon dioxide	CO_2	0.036 increasing gradually 0.0038
Neon	Ne	0.00182
Helium	He	0.000524
*Methane	CH_4	0.00017
Krypton	Kr	0.000114
Xenon	Xe	0.00009
Hydrogen	H_2	0.00005
*Nitrous Oxide	N_2O	0.00003
*Ozone	O_3	0.000004

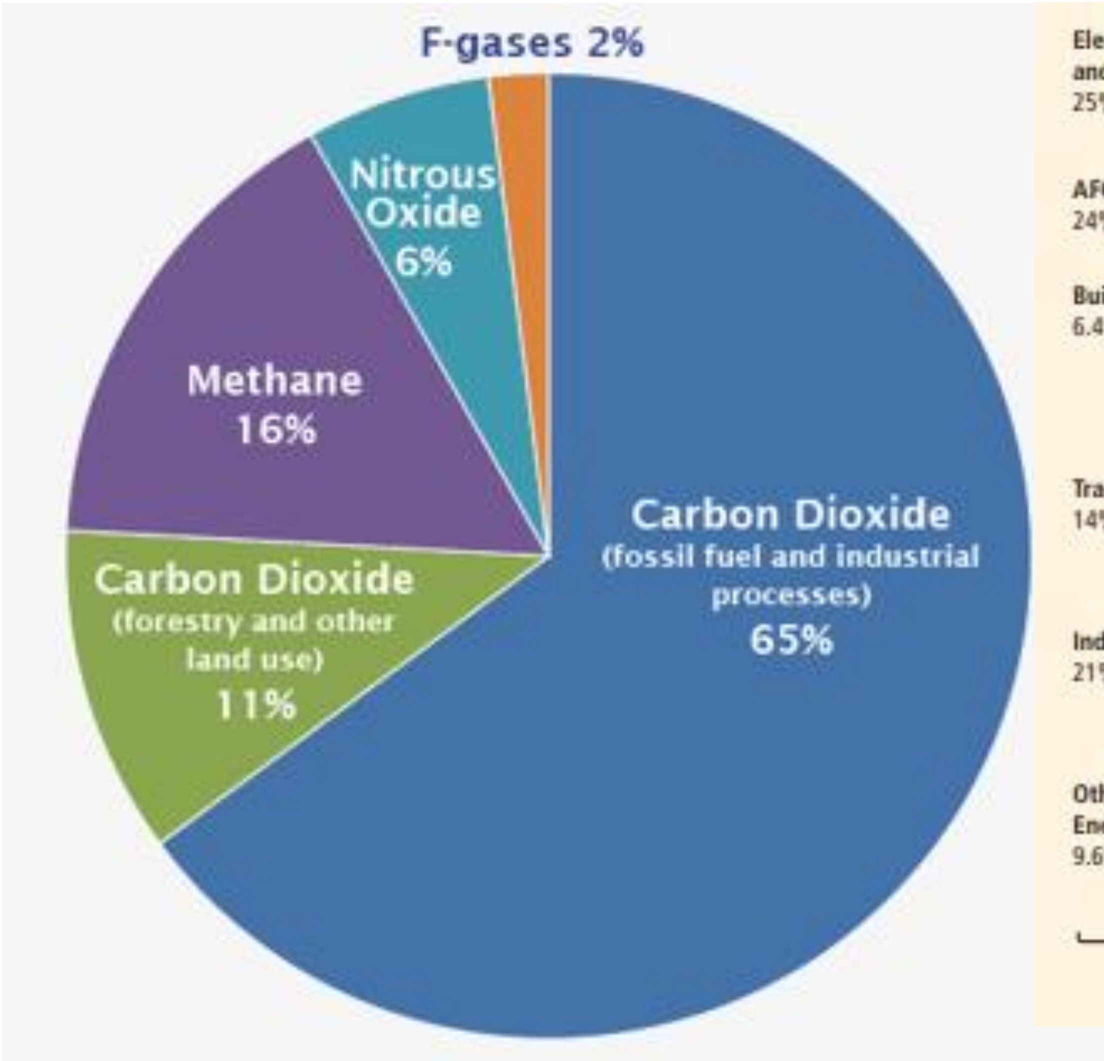
How the heat trap in earth atmosphere?

Step 1: Solar radiation reaches the Earth's atmosphere - some of this is reflected back into space.
Step 2: The rest of the sun's energy is absorbed by the land and the oceans, heating the Earth.
Step 3: Heat radiates from Earth towards space.
Step 4: Some of this heat is trapped by greenhouse gases in the atmosphere, keeping the Earth warm enough to sustain life.
Step 5: Human activities such as burning fossil fuels, agriculture and land clearing are increasing the amount of greenhouse gases released into the atmosphere.
Step 6: This is trapping extra heat, and causing the Earth's temperature to rise.



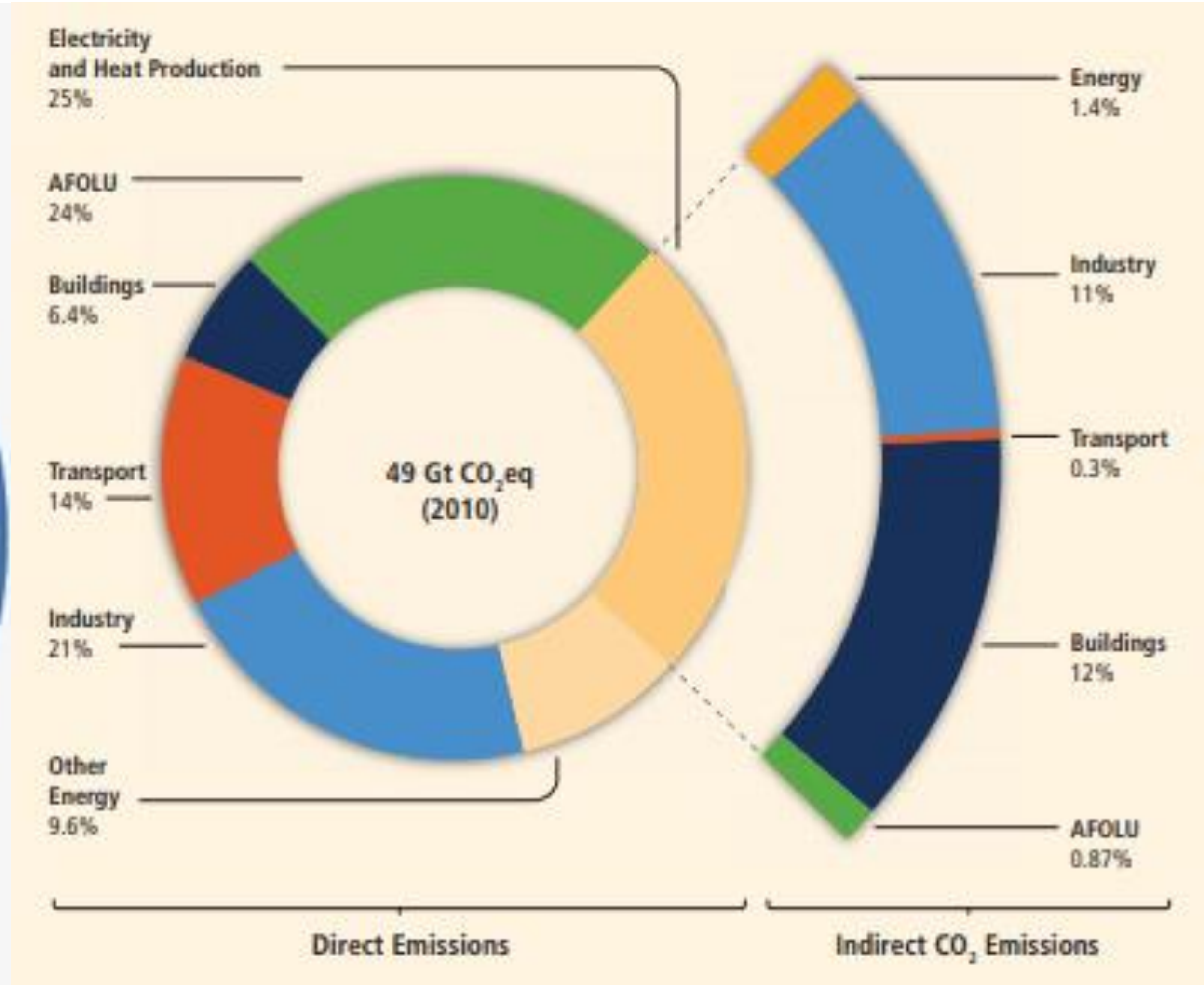
Greenhouse Gasses

Global Emissions by Gas



Source: IPCC (2014).

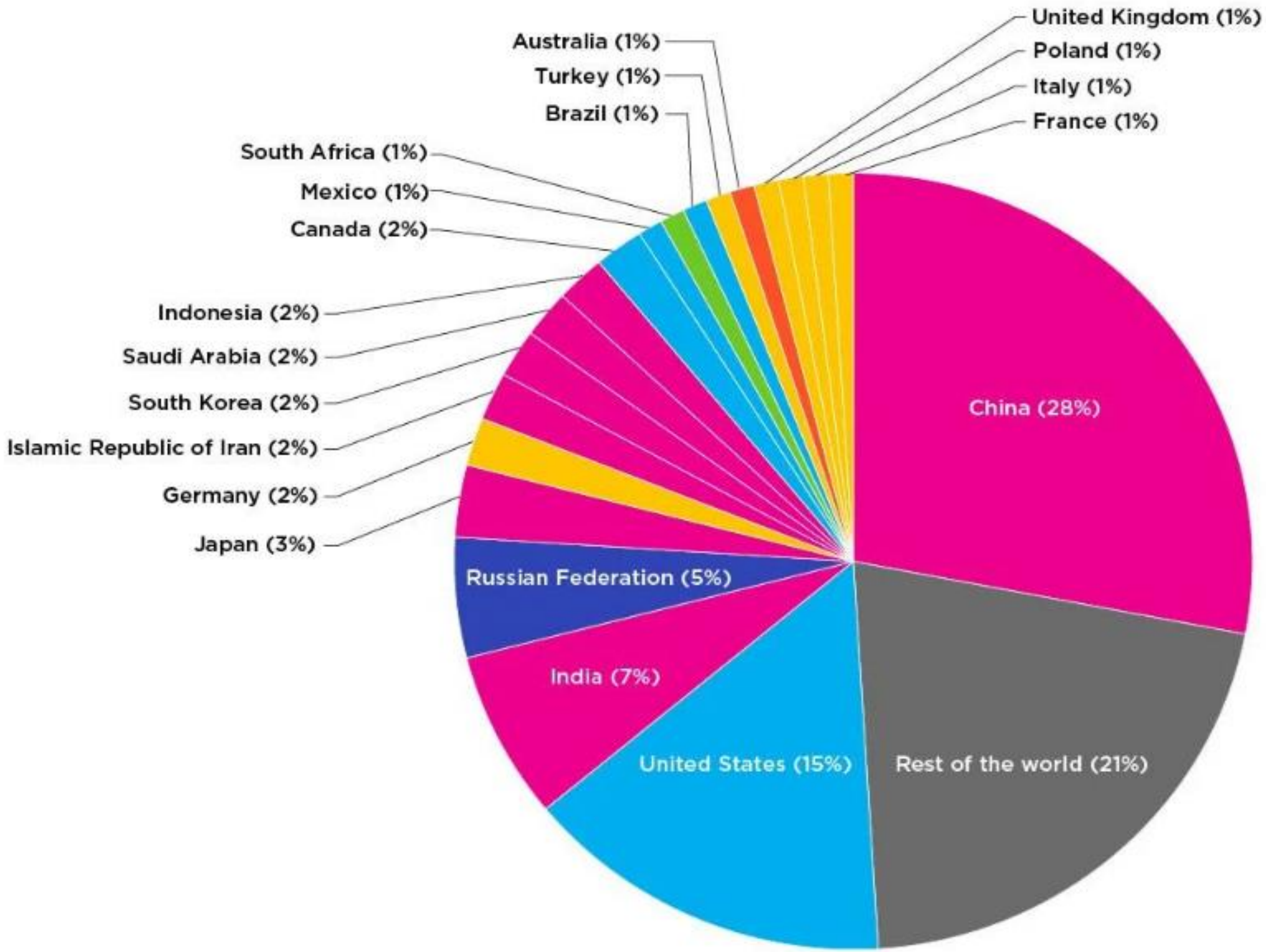
Global Emissions by Sector



Source: IPCC (2014).

CO_2 emission from different countries

Country	CO_2 emissions (total)
China	10.06GT
United States	5.41GT
India	2.65GT
Russian Federation	1.71GT
Japan	1.16GT
Germany	0.75GT
Islamic Republic of Iran	0.72GT
South Korea	0.65GT
Saudi Arabia	0.62GT
Indonesia	0.61GT
Canada	0.56GT
Mexico	0.47GT
South Africa	0.46GT
Brazil	0.45GT
Turkey	0.42GT
Australia	0.42GT
United Kingdom	0.37GT
Poland	0.34GT
France	0.33GT
Italy	0.33GT



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Data: Earth Systems Science Data 11, 1783-1838, 2019

Effects of Global Warming

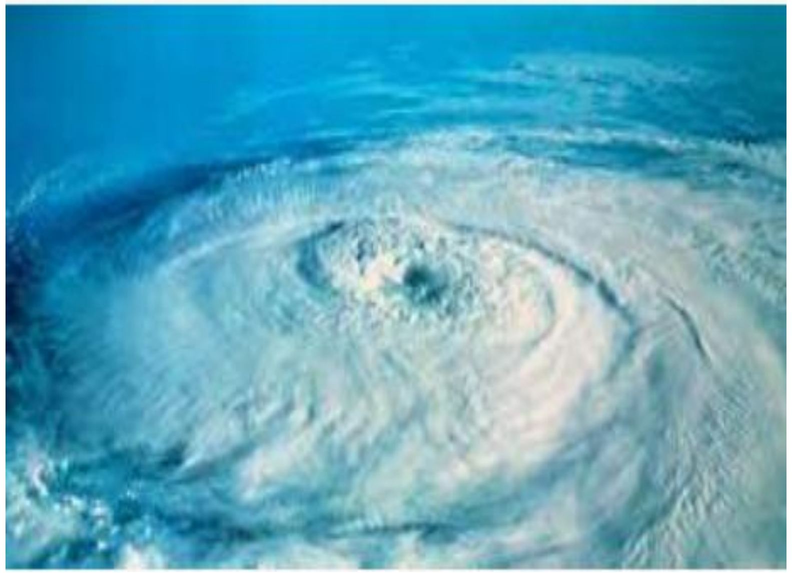
Melting of Glaciers

Natural Disasters

Rise in Droughts

Effects of Global Warming

The rise of Sea Levels



Hurricanes Frequency

Diseases

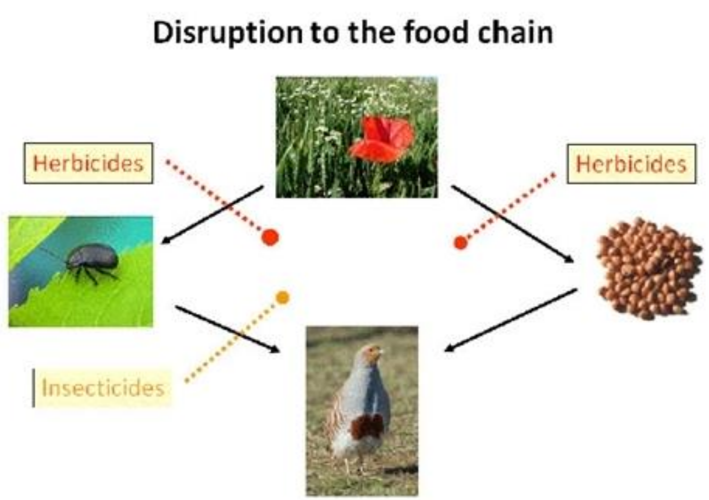
Effects of Global Warming

Frequent Wildfires

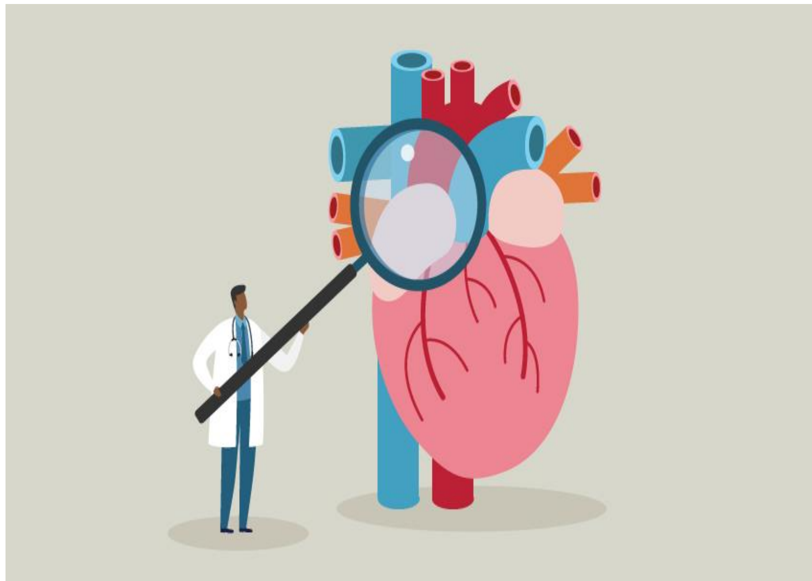
Severe Precipitation

Unexpected Heat Waves

Effects of Global Warming



Disruption to Food Chain



Health Risks

Animal Extinction

Effects of Global Warming

Economic Collapse

Diminishing Fresh Water Supply

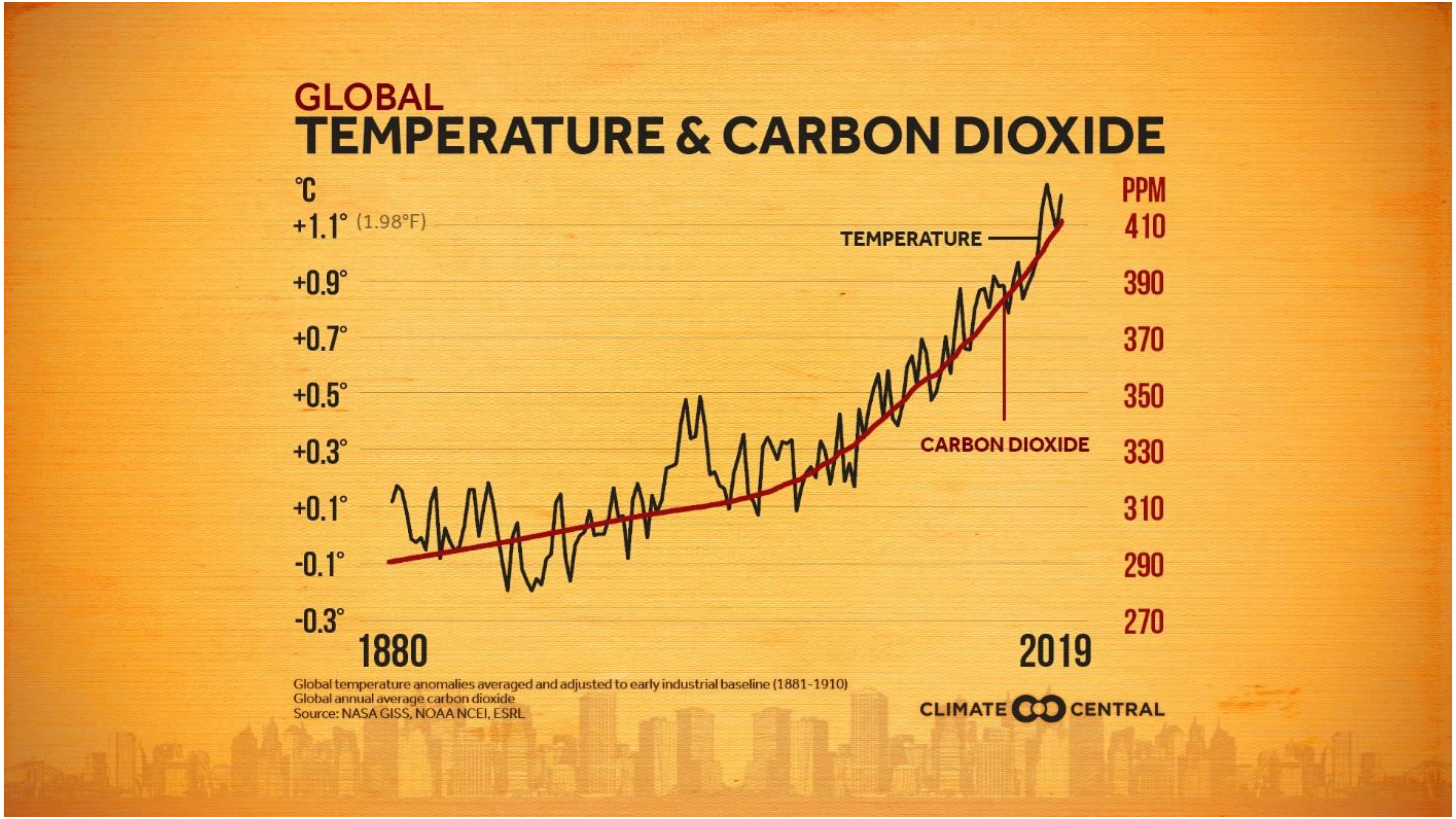
Poor Air Quality

The global mean temperature increased during the year 2010 to 2020 with rank

Year	Rank	Warming in °C	Warming in °F
2020	2	1.27 ± 0.04	2.29 ± 0.08
2019	3	1.25 ± 0.05	2.24 ± 0.08
2018	6	1.11 ± 0.04	2.00 ± 0.08
2017	4	1.18 ± 0.05	2.12 ± 0.08
2016	1	1.29 ± 0.05	2.33 ± 0.08
2015	5	1.15 ± 0.04	2.08 ± 0.08
2014	8	1.01 ± 0.05	1.82 ± 0.08
2013	13	0.95 ± 0.05	1.70 ± 0.08
2012	16	0.92 ± 0.04	1.65 ± 0.08
2011	18	0.91 ± 0.04	1.64 ± 0.08
2010	7	1.03 ± 0.04	1.85 ± 0.08

http://berkeleyearth.org/2019-temperatures/

CO_2 vs Temperature



OZONE

- Allotrope of oxygen
- Triatomic oxygen molecules(O_3)

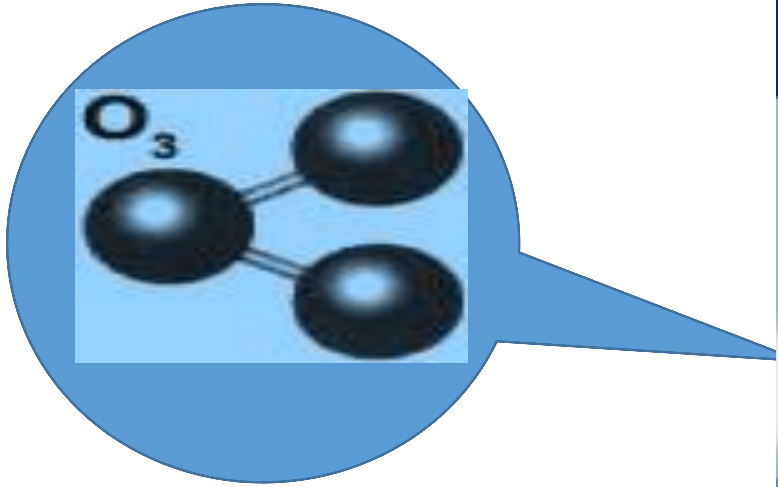
OZONE LAYER

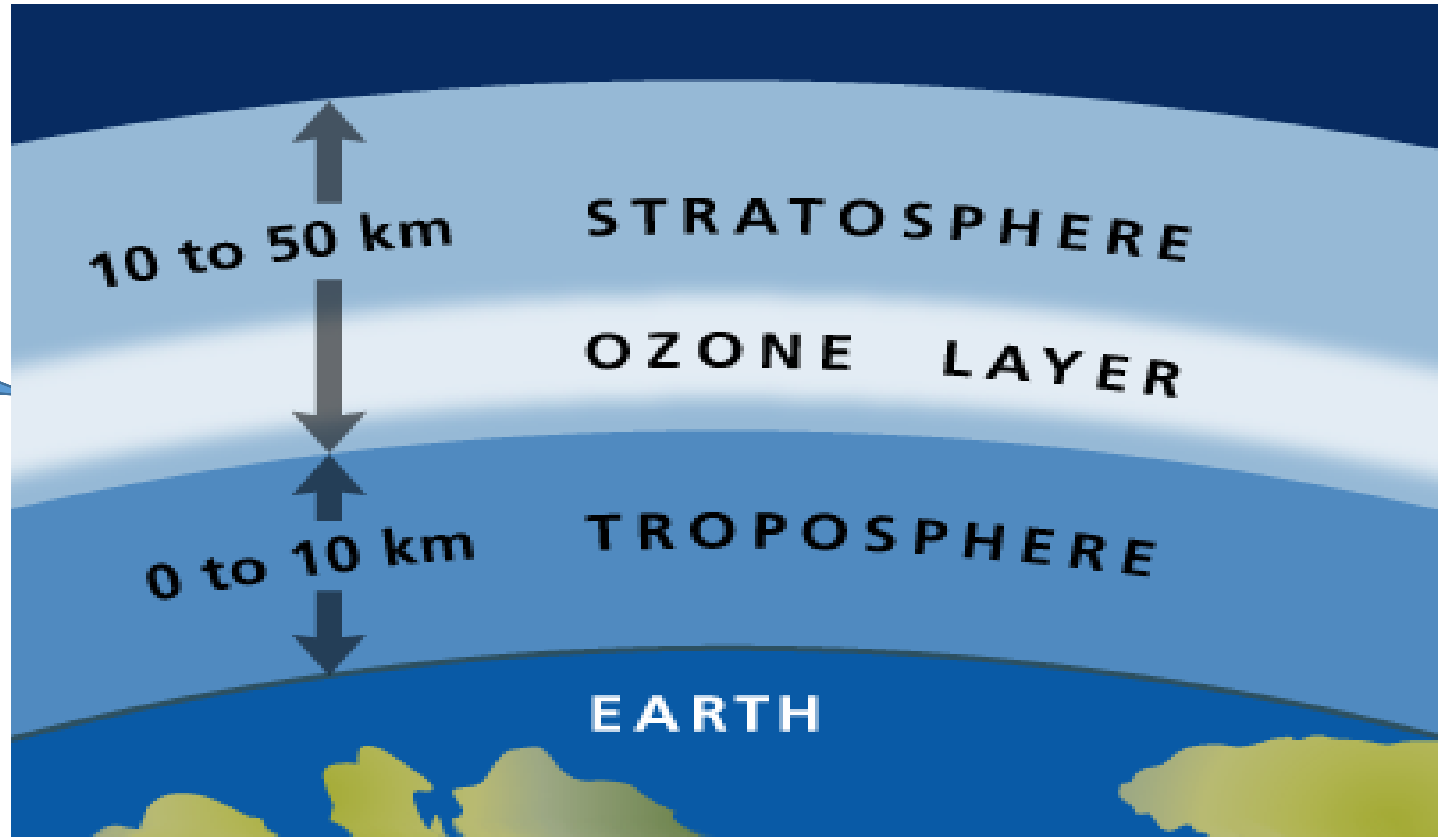
- Layer in earth atmosphere contains large concentration of ozone
- Located in lower portion of stratosphere (13-20KM above earth surface)

OZONE LAYER DEPLETION

- Large hole in the protection of the earth (ozone)
- Observed loss of ozone (over 50 years)
- Mainly above the northern and southern poles

Ozone and Ozone Layer





- Ozone gas layer exists in between troposphere and stratosphere

Formation of Ozone

Formation of free radical oxygen.

- $O_2 \longrightarrow 2\,O^*$
- Short UV wavelength broke the oxygen bond forming radicals

Formation of ozone

- $O_2 + O^* \longrightarrow O_3$
- Free radicals react with oxygen to form ozone.

Bad: Ozone near the Earth's surface in the troposphere is an air pollutant with harmful effects on animals and their respiratory systems.

Good: Ozone in the stratosphere protects living organisms by preventing harmful UV from reaching the Earth's surface, by converting it into heat.

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Ozone layer Depletion

Removal of ozone from stratosphere

- Cause by natural and man made ozone pollutants

Large holes on the ozone layer

- Usually on north and south pole region

Gradual loss of ozone gas from ozone layer

- Over 50 years

Destruction of Ozone

The breakdown of ozone takes place in 2 propagation steps

Step 1:

$Cl\bullet + O_3 \rightarrow ClO\bullet + O_2$

Step 2:

$ClO\bullet + O \rightarrow Cl\bullet + O_2$

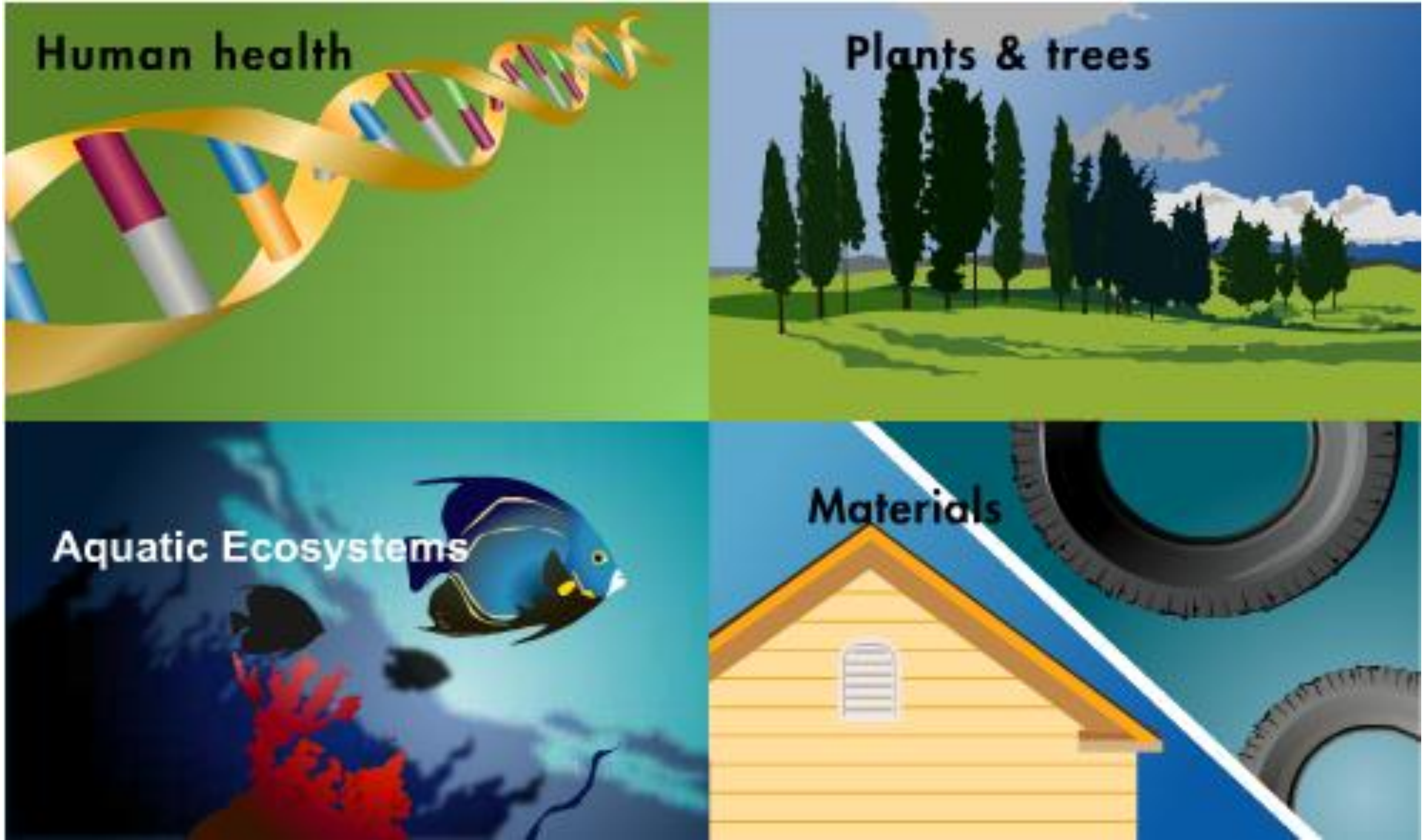
The propagation steps repeat in a cycle

Overall:

$O_3 + O \rightarrow 2O_2$

A single CFC molecule can destroy 100,000 ozone molecules

Effects of Ozone layer Depletion



Human Health

- Damages DNA
- Skin cancer
- Eye cataracts

Plants and Trees

- Reduces crop production, damage to seeds
- Reduces quality of crops

Aquatic Ecosystems

- Damage to plankton, aquatic plants, fish larvae, shrimp, crabs
- Affects marine food chain, damage to fisheries

Materials

- Paints, rubber, wood and plastic are degraded faster, especially in tropical regions
- Damages could be in billions of dollars

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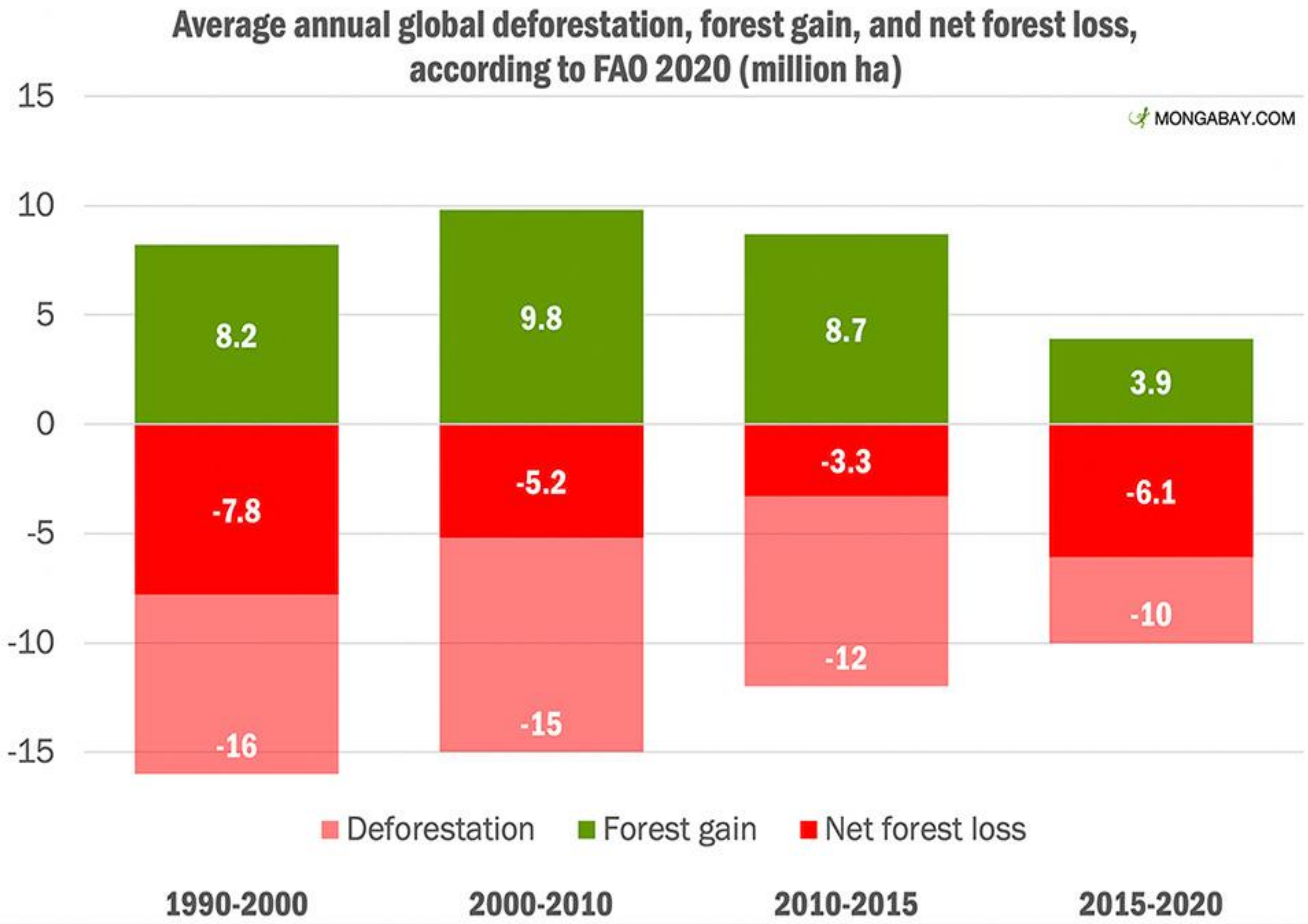
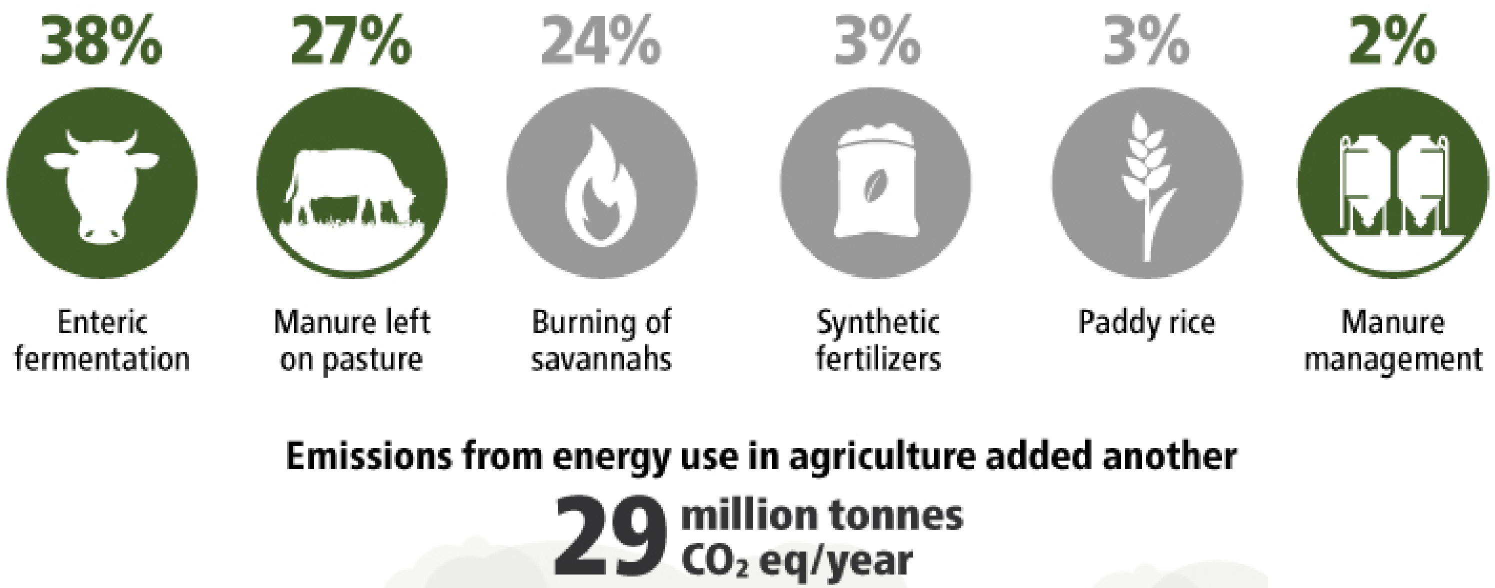
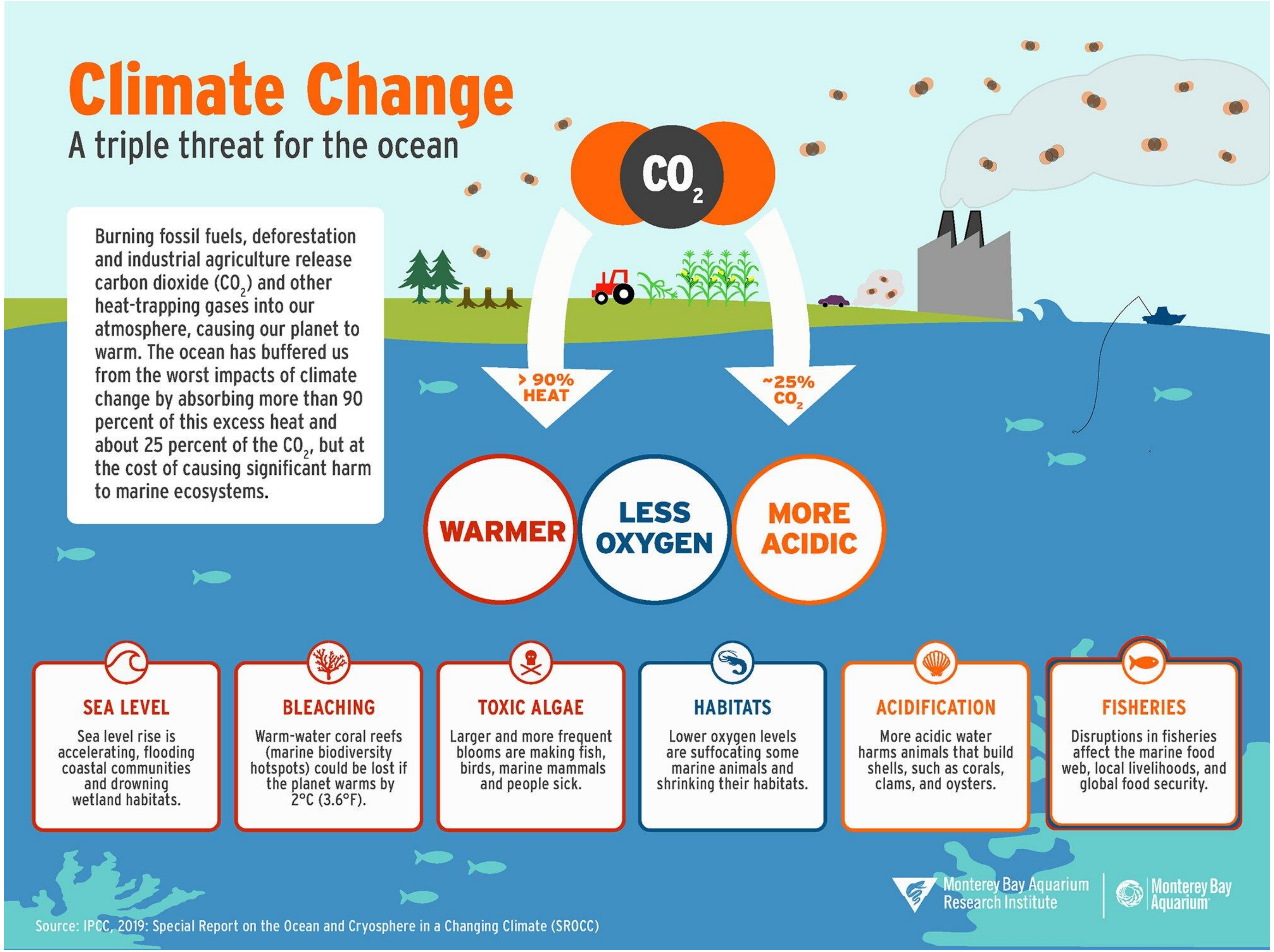
Deforestation



Agriculture and Greenhouse Gas Emissions

- ❑ 5 billion tonnes CO_2 eq/yr from crop and livestock production
- ❑ 4 billion tonnes CO_2 eq/yr due to net forest conversion to other
- ❑ 1 billion tonnes CO_2 eq/yr from degraded peatlands
- ❑ 0.2 billion tonnes CO_2 eq/yr by biomass fires





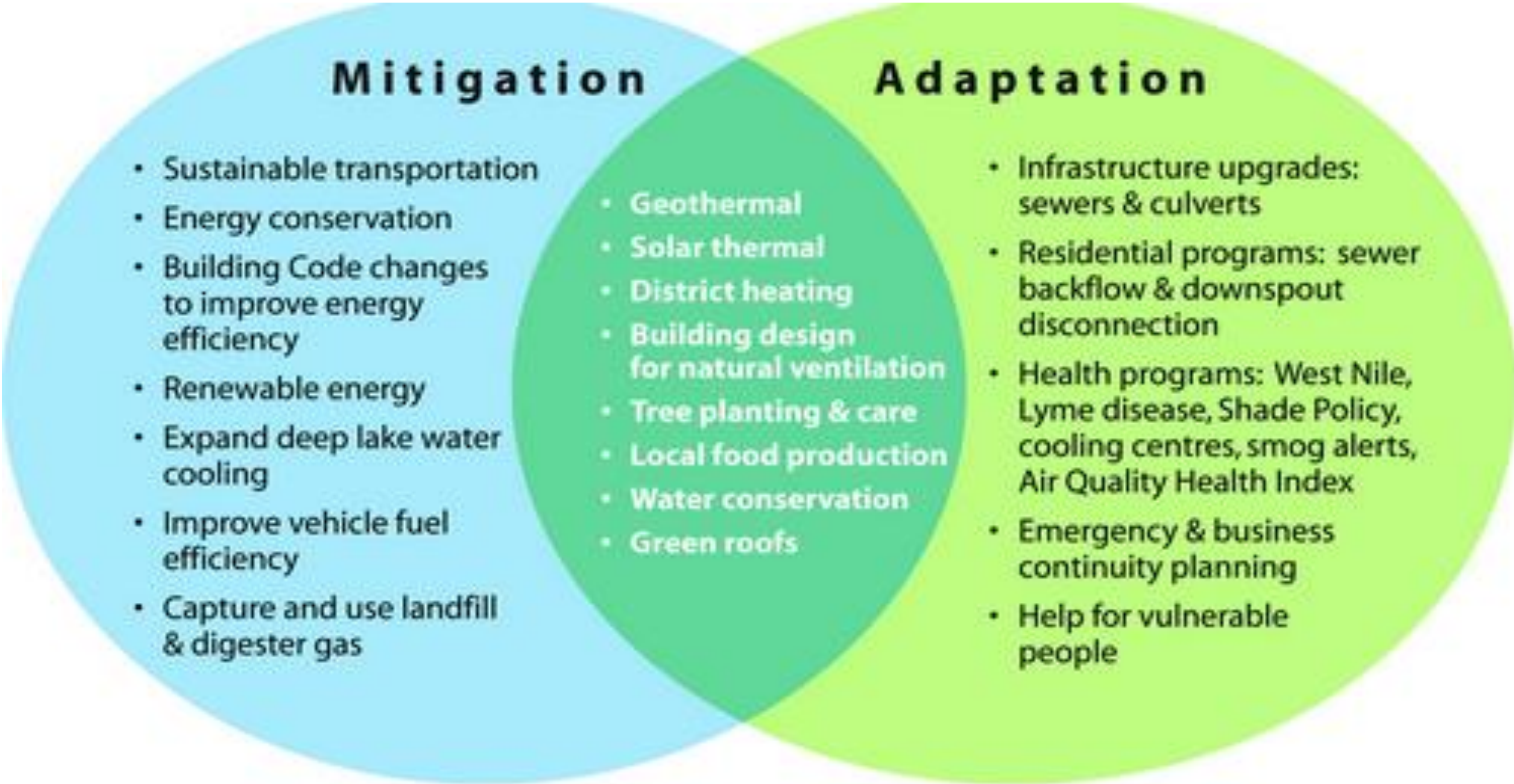
Climate Change
A triple threat for the ocean
Burning fossil fuels, deforestation and industrial agriculture release carbon dioxide (CO_2) and other heat-trapping gases into our atmosphere, causing our planet to warm. The ocean has buffered us from the worst impacts of climate change by absorbing more than 90 percent of this excess heat and about 25 percent of the CO_2, but at the cost of causing significant harm to marine ecosystems.
CO_2
> 90% HEAT
~25% CO_2
WARMER
LESS OXYGEN
MORE ACIDIC
SEA LEVEL
Sea level rise is accelerating, flooding coastal communities and drowning wetland habitats.
BLEACHING
Warm-water coral reefs (marine biodiversity hotspots) could be lost if the planet warms by 2°C (3.6°F).
TOXIC ALGAE
Larger and more frequent blooms are making fish, birds, marine mammals and people sick.
HABITATS
Lower oxygen levels are suffocating some marine animals and shrinking their habitats.
ACIDIFICATION
More acidic water harms animals that build shells, such as corals, clams, and oysters.
FISHERIES
Disruptions in fisheries affect the marine food web, local livelihoods, and global food security.
Monterey Bay Aquarium Research Institute
Monterey Bay Aquarium
Source: IPCC, 2019: Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC)

Consequences of climate change






Consequences of climate change



Mitigation: the globally responsible thing to do

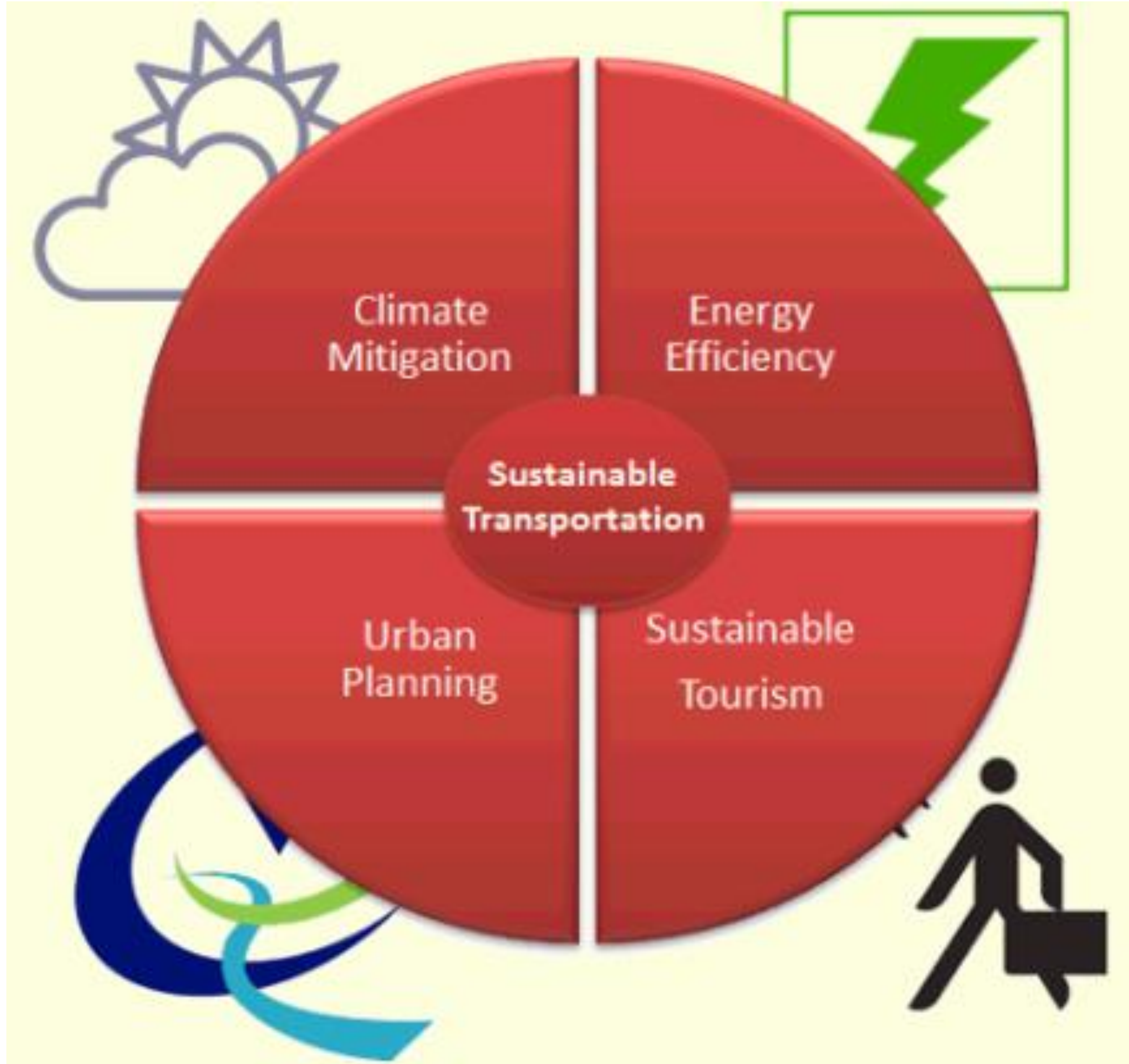
Actions that reduce the emissions that contribute to climate change.

Adaptation: the locally responsible thing to do

Actions that minimize or prevent the negative impacts of climate change.

Sustainable Transportation

Sustainable transportation concerns systems, policies, and technologies. It aims for the efficient transit of goods and services, and sustainable freight and delivery systems. The design of vehicle-free city planning, along with pedestrian and bicycle friendly design of neighbourhoods is a critical aspect for grassroots activities, as are telework and teleconferencing.



AVOID/REDUCE

Reduce or avoid travel or the need to travel

- Integration of transport and land-use planning
- Smart logistics concepts

SHIFT

Shift to more environmentally friendly modes

- Transport Demand Management
- Mode shift to Non-Motorised Transport
- Mode shift to Public Transport

IMPROVE

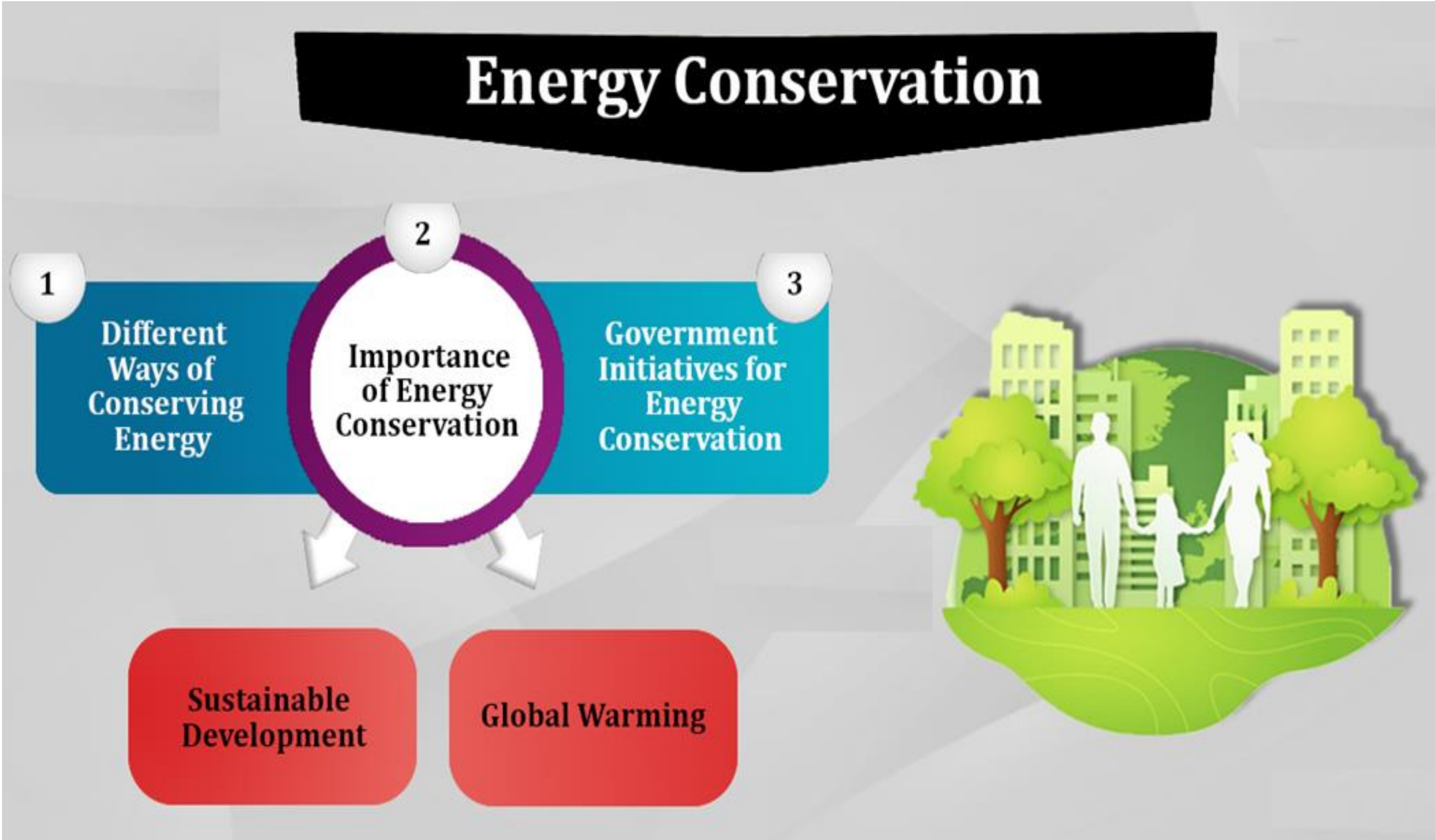
Improve the energy efficiency of transport modes and vehicle technology

- Low-friction lubricants
- Optimal tire pressure
- Low Rolling Resistance Tires
- Speed limits Eco-Driving (Raising Awareness)
- Shift to alternative fuels

Policies **Sustainable Transportation**	**Basic Package** *(implemented in all countries also in least developed countries)*	**Advanced** *(for advanced countries that face rapid development of car-ownership)*	**Deluxe Package** *(for most developed countries with high levels of motorisation)*
1. Removal of fuel subsidies Remove incentives for non-sustainable transport modes.			
2. Fuel taxation above European minimum taxation level. Give incentives to travel less, use low carbon modes and purchase fuel efficient vehicles.			
3. Low carbon long distance infrastructure Earmark a considerable share of the transport investments in low carbon modes.			
4. Efficiency standards Regulate car producers and correct market failures.			
5. Removal of further car-oriented subsidies *e.g.* for business cars in order to remove barriers for sustainable transport modes; replace with job-tickets.			
6. Incentive Programme for municipalities to set up TDM, public transport and NMT investments and integrated land-use and transport plans.			
7. Vehicle registration tax/ license auctioning *e.g.* taxing fuel inefficiency or weight.			
8. Low-carbon fuel standards Incentivizing low carbon fuels, *e.g.* electric cars.			
9. Research, Development and Demonstration For fuel efficient cars, electric bikes, busses and smart public transit.			

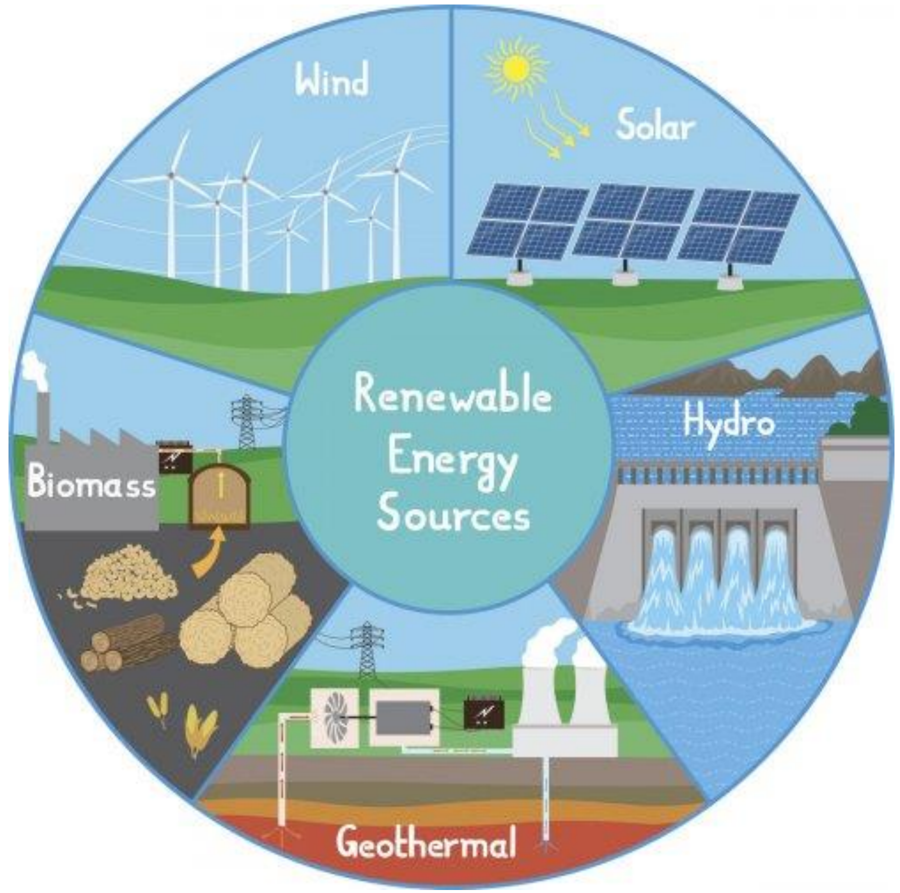
Energy Conservation

- Energy conservation refers to efforts made to reduce energy consumption.
- Energy conservation can be achieved through increased efficient energy use or reduced consumption from non-renewable energy sources.
- Energy conservation is often the most economical solution to energy shortages.


Energy Conservation
1
Different Ways of Conserving Energy
2
Importance of Energy Conservation
3
Government Initiatives for Energy Conservation
Sustainable Development
Global Warming

Renewable Energy

- Renewable energy can be generated continuously practically without decay of source. E.g.-
- Solar Energy
- Wind Energy
- Geothermal Energy
- Hydro Energy



According to data released by the International Renewable Energy Agency (IRENA) the world added more than 260 gigawatts (GW) of renewable energy capacity last year (2020) which was more than 176 GW, compare to 2019.

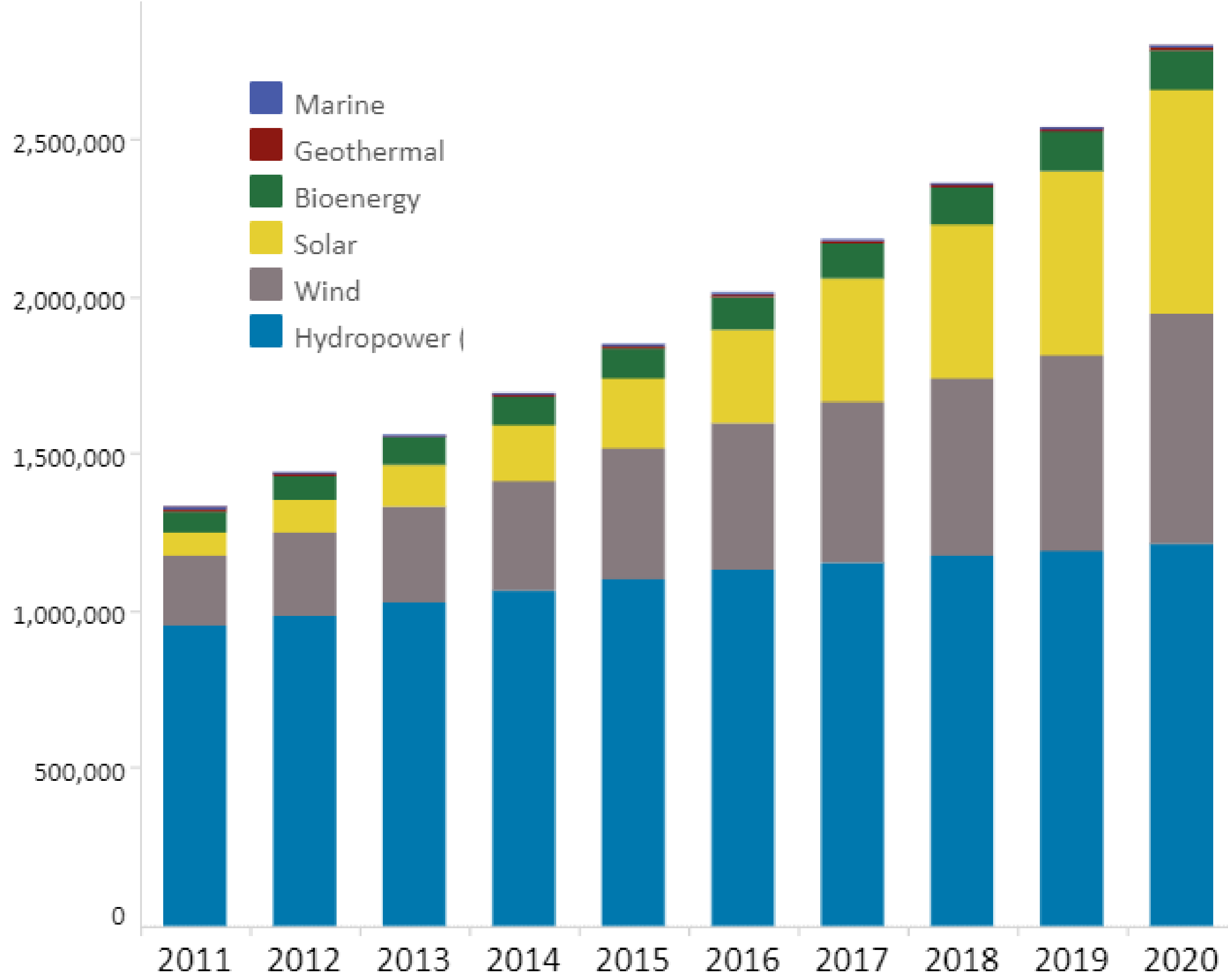


Fig. All Renewal energy sources installed capacity trend during 2011 to 2020

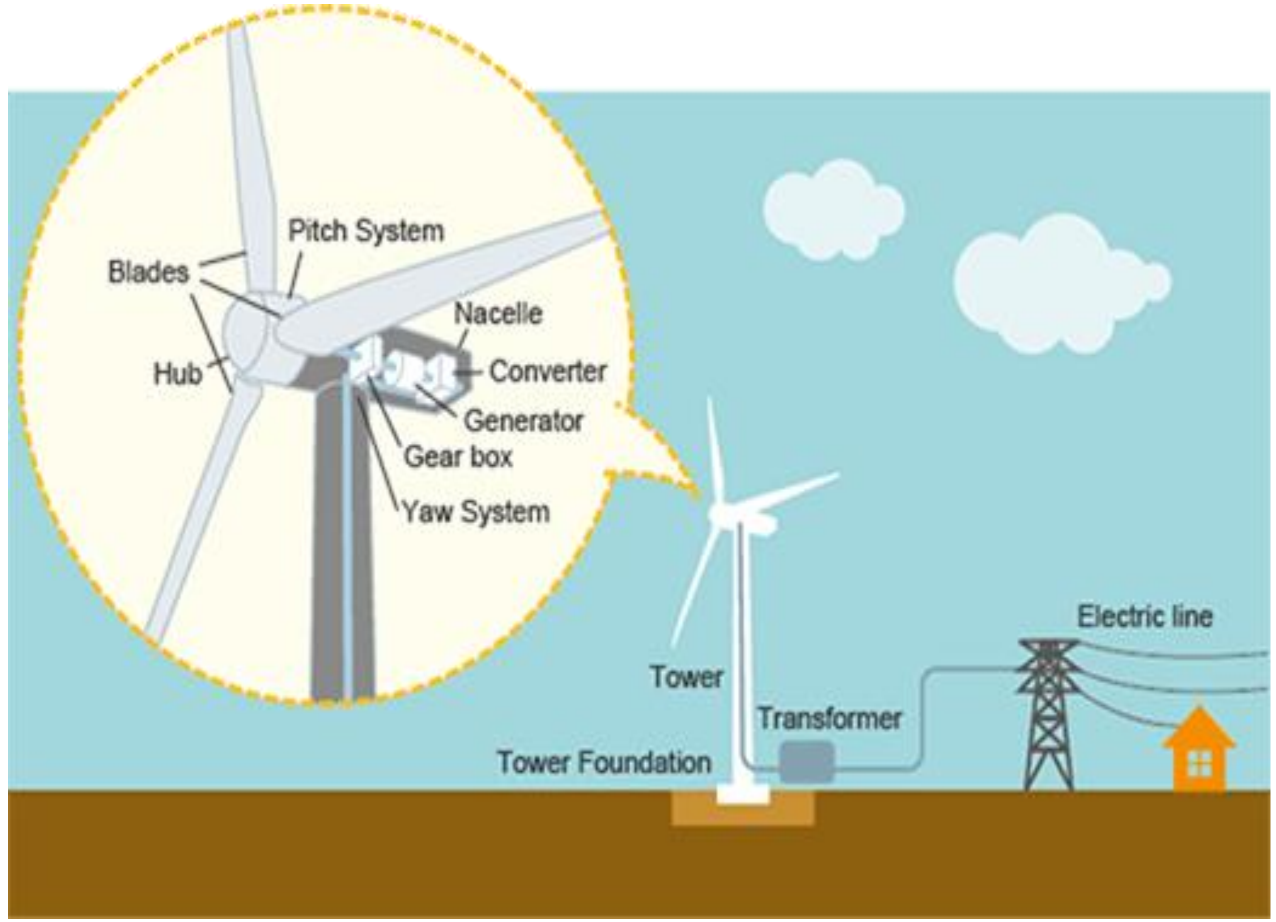
Renewal energy (Solar)

Over the entire year, on average for the whole city, the thermal solar panels would produce approximately 265 MJ/year/m^2 of building and the PV panels 113 MJ/year/m^2 of building.

Solar power is energy from the sun that is converted into thermal or electrical energy. Solar energy is the cleanest and most abundant renewable energy source available. Solar technologies can harness this energy for a variety of uses, including generating electricity, providing light or a comfortable interior environment, and heating water for domestic, commercial, or industrial use.

Wind energy

Wind power generation means getting the electrical energy by converting wind energy into rotating energy of the blades and converting that rotating energy into electrical energy by the generator. Wind energy increases with the cube of the wind speed, therefore Wind Turbine Generation System (WTGs) should be installed in the higher wind speed area.



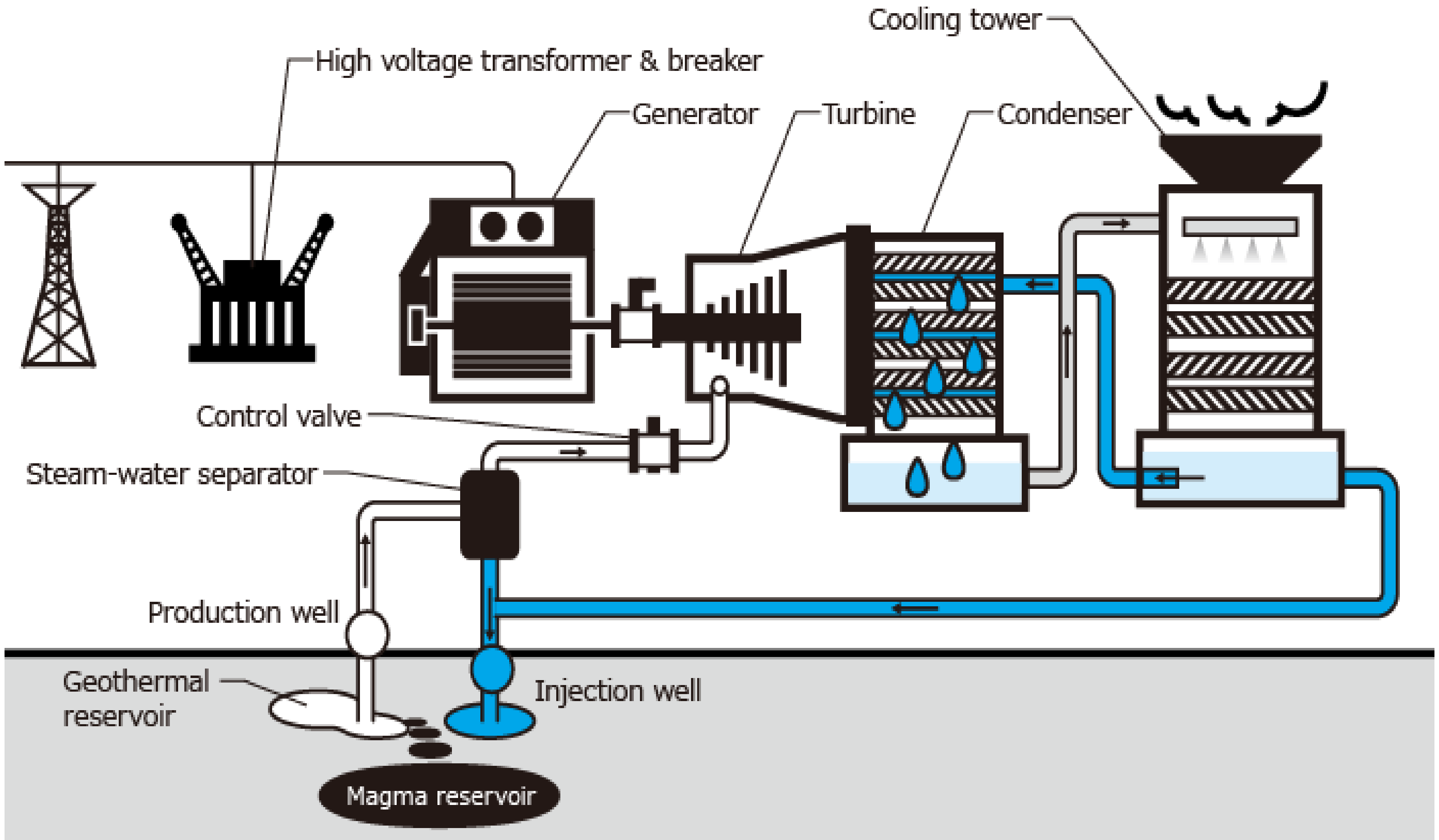
Benefits of Wind Power

- It is estimated by the American Wind Energy Association that the use of U. S. wind turbines may reduce the amount of carbon dioxide in the air by one-third.
- Homeowners by law can sell excess wind energy back to the utility companies.
- Wind energy replaces electricity from coal-fired power plants and thus reduces greenhouse gases that produce global warming.
- Farmers can still use the land to graze cattle, and receive land use royalties that have increased their land value.

Renewable energy — Geothermal power

Geothermal power is an independent and stable power generation system that utilizes the thermal energy of the Earth's magma.

Different from generation by solar power or wind power which is affected by seasonal and weather factors, geothermal power utilizing the stable thermal energy of the magma is free from seasonal and weather factors and offers stable and sustainable power generation.



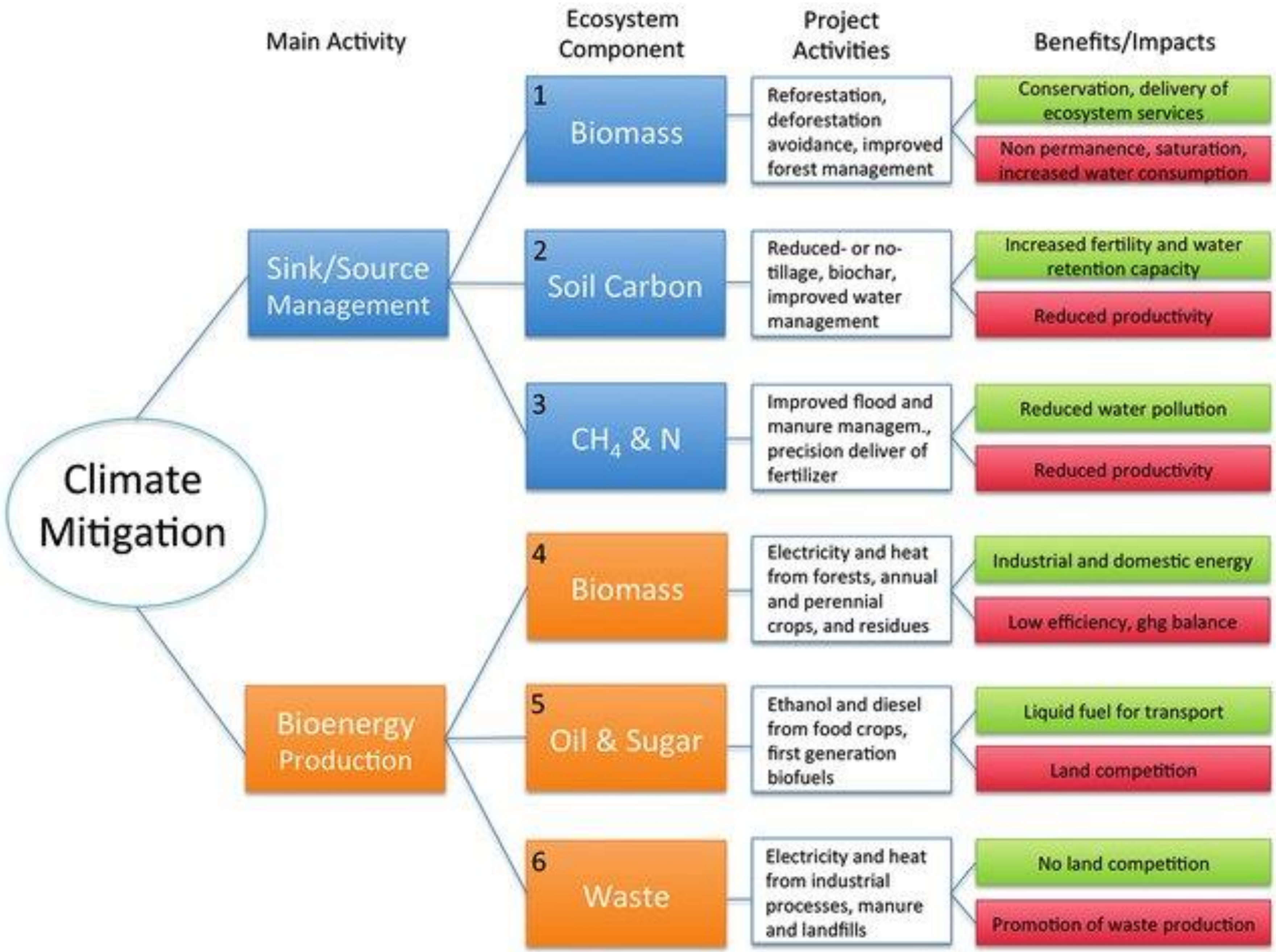
Renewable energy — Hydro power

Hydro power generates power by utilizing the energy of water falling from a higher position to a lower position. One of these hydro power generation systems is a "pumped-storage system" , which pumps up water from a lower reservoir to a higher reservoir during off-peak hours and generates power by dropping water from the higher reservoir to the lower reservoir during peak hours.

Advantages— Hydro power

- ❑ Extremely high operation efficiency in hydro-turbines and hydro-generators (about 90% in total at the maximum efficiency)
- ❑ Short start-up and shut-down time (3-5 minutes from starting to reaching the rated output)
- ❑ Able to accommodate rapid fluctuations in power load (able to change from no load to the rated output in about 1 minute)
- ❑ Simple and easy operation & maintenance compared to other power generation systems
- ❑ Low operation cost

Land-based biological climate mitigation activities



Capture and use landfill and digester gas

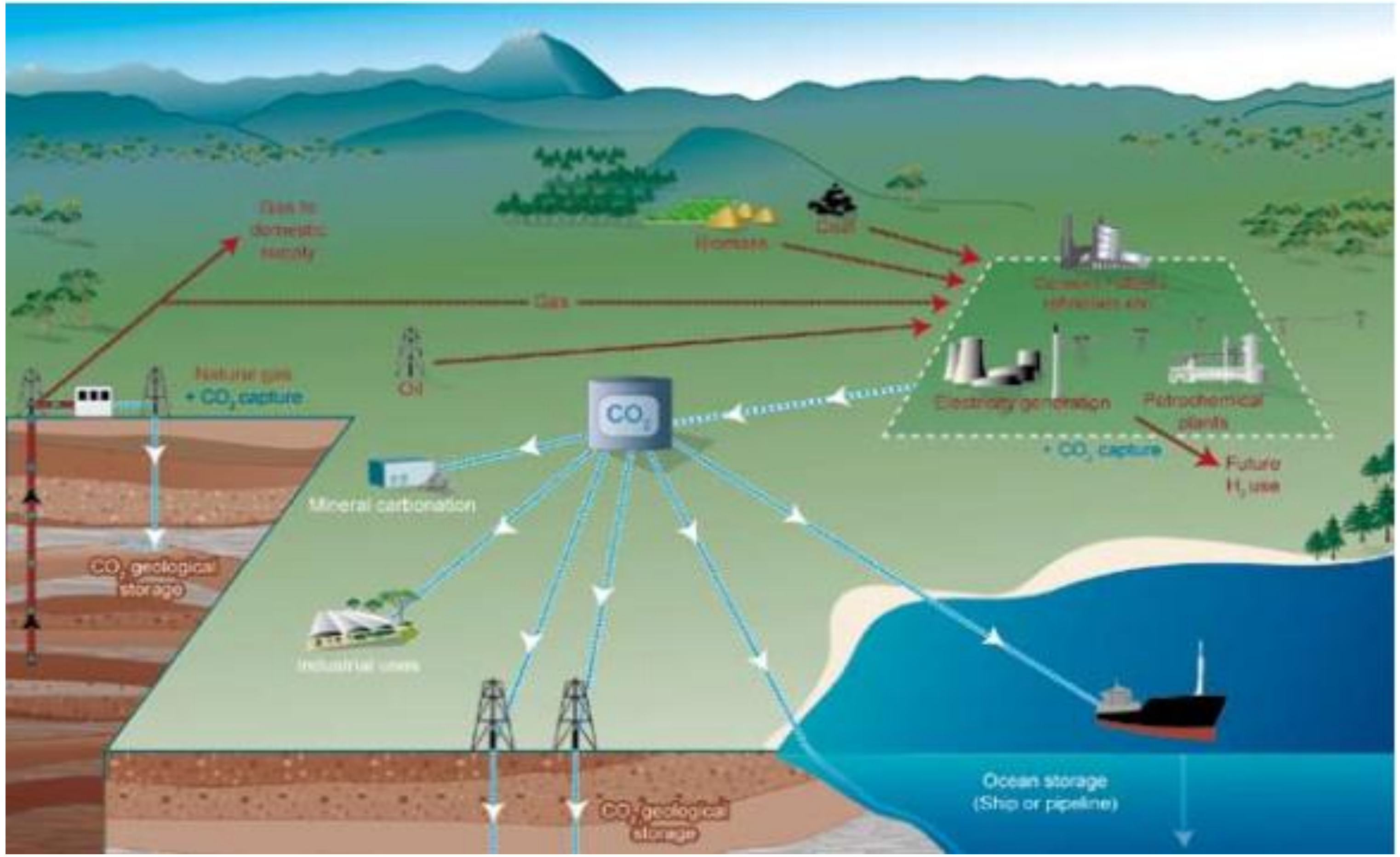
Capturing landfill gas to prevent methane from entering the atmosphere and contributing to smog and climate change.

While reducing and diverting waste addresses many landfill challenges, these practices do not prevent landfills from generating methane, a greenhouse gas 21 times more powerful than carbon dioxide (over a 100-year time horizon) and a precursor to ozone pollution

Carbon Capture and Storage (CCS)

Carbon capture and storage (CCS) is a technological process that "scrubs" CO_2 from the emission stream, transports it and permanently and safely stores it underground, reducing emissions from energy-intensive industries.

Carbon capture helped capture 40 million tonnes of CO_2 from 26 operating power and industrial facilities globally in 2020.



Schematic diagram of possible CCS systems showing the sources for which CCS might be relevant, transport of CO_2 and storage options

- **Aims to strengthen the global response to the threat of climate change**, in the context of sustainable development and efforts to eradicate poverty, **including by:**

(a) **Holding the increase in the global average temperature to well below 2°C** above pre-industrial levels and to **pursue efforts** to **limit the temperature increase to 1.5 °C** above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;

(b) **Increasing the ability to adapt to the adverse impacts of climate change** and **foster climate resilience** and **low greenhouse gas emissions development**, in a manner that does not threaten food production;

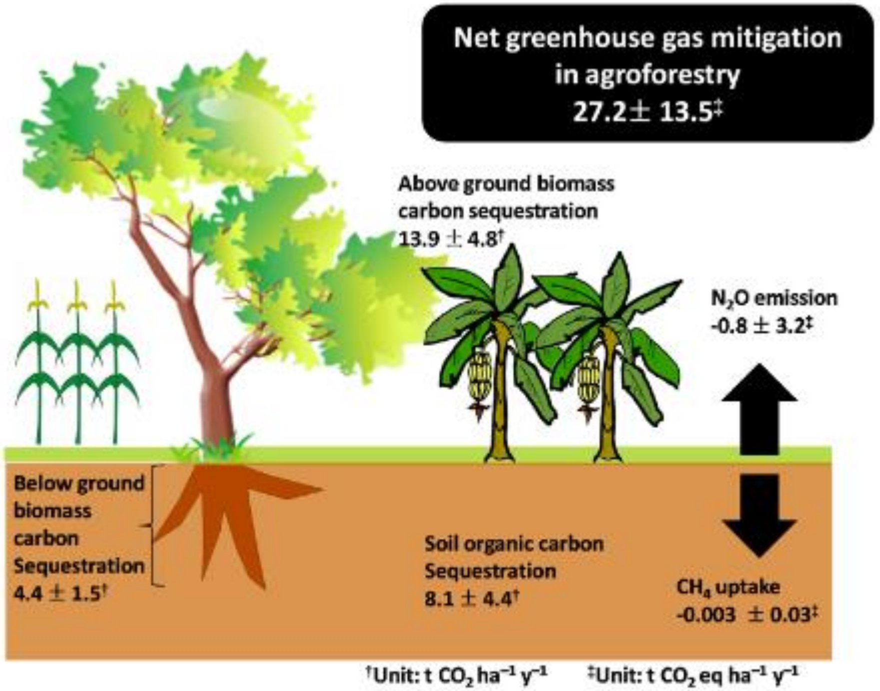
(c) **Making finance flows consistent with a pathway towards low GHG emissions and climate resilient development.**

Climate change through agroforestry

Climate change activity	Major climate change functions	Agroforestry functions supported climate change mitigation and adaptation
Adaptation	Reduce threats and enhance resilience.	• Change microclimate to reduce impact of extreme weather events on crop production. • Alter microclimate to maintain quality and quantity of forage yield. • Alter microclimate to reduce livestock stress • provide greater habitat diversity to support organisms (e.g., native pollinators, beneficial insects). • Provide greater structural and functional diversity to maintain and protect natural resource services. • Create diversified production opportunities to reduce risk under fluctuating climate
Actions that reduce or eliminate the negative effects of climate change or take advantage of the positive effects		
	Facilitate species movement to more favorable conditions	• Assist in plant species movement through planting decisions. • Provide travel corridors for species migration.
Mitigation	Sequester C.	• Accumulate C in woody biomass • Accumulate C in soil.
Activities that reduce GHGs in the atmosphere or enhance the storage of GHGs stored in ecosystems	Reduce GHG emissions.	• Reduce fossil fuel consumption, equipment runs in areas with trees, farmstead heating and cooling. • Decrease N_2O emissions, Greater nutrient uptake through plant diversity, N fertilizer application in tree component. • Enhance forage quality, thereby reducing CH_4

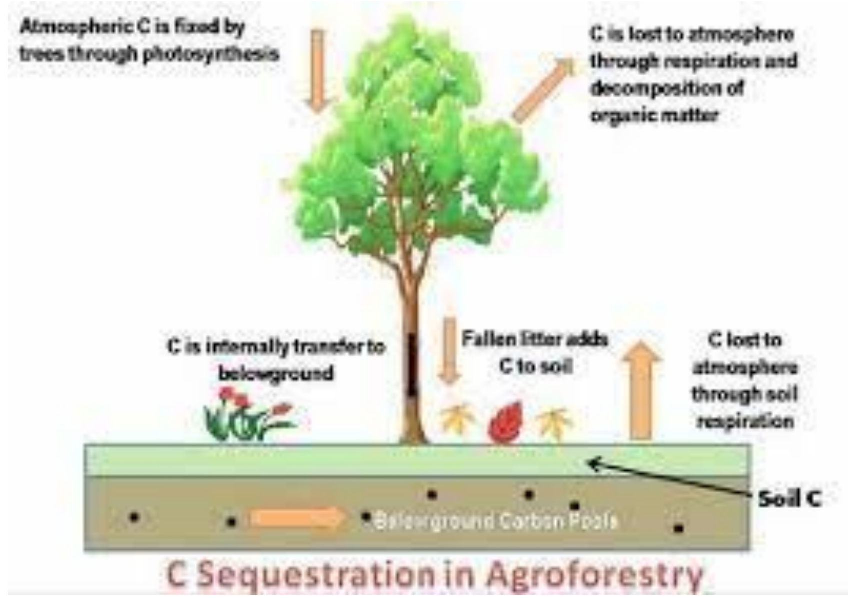
Agroforestry and Carbon storage

Carbon sequestration



Afforestation and reforestation, restoration of degraded lands- Vegetation and soil

Carbon Conservation



Conservation of Biomass and soil carbon in existing forests 1 ha offsets 5-10 ha of deforestation (Dixon, 1995)

Carbon Substitution

Materials	Primary energy input for production (kWh)	Resulting CO_2 emissions (Kg)
Wood	60	15
Steel	561	126
Concrete	221	54
Brick	108	26

Comparison of different pillars of 3 m length designed for the same load of 20 kN

The economic potential of agroforestry systems to sequester carbon

Carbon sequestration rate × Carbon price = Carbon value

Direct profit from carbon = Carbon value − Sequestration cost

Total profit = Direct profit from carbon + Higher yield, additional products

Thanks