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Environmental Assessments of Biofuels

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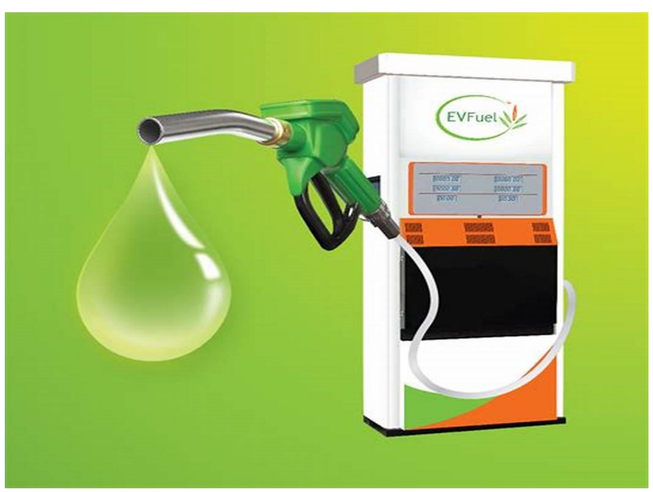

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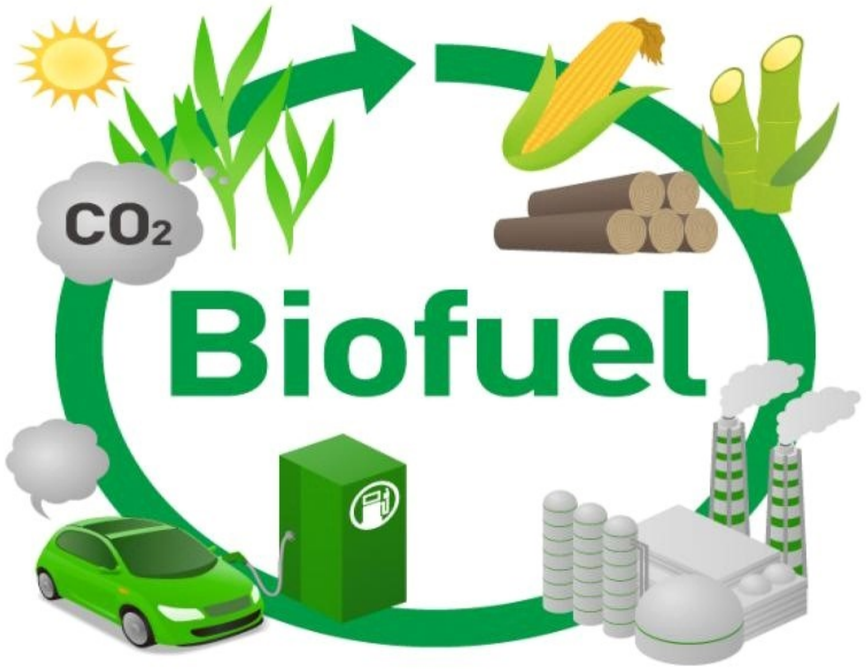
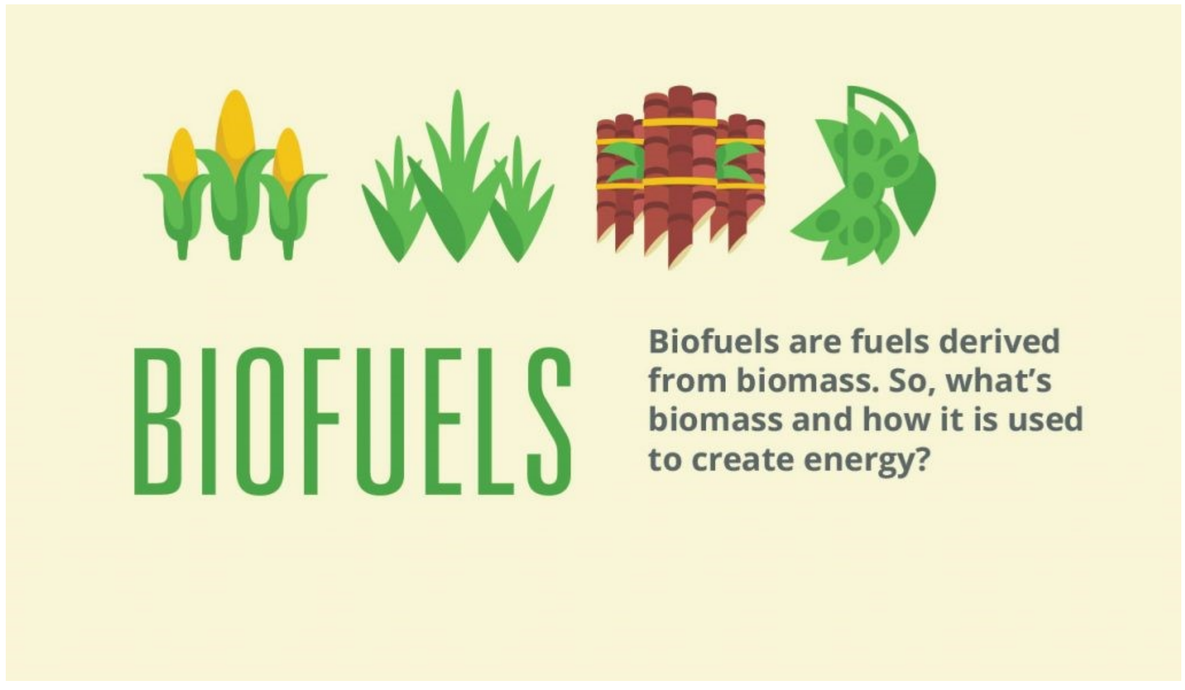
BIOFUELS

BIOFUEL

- Biofuel is a fuel that is produced through **<u>contemporary processes</u>** from biomass, rather than by the very slow geological processes involved in the formation of fossil fuels, such as oil.





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BIOFUELS

- Bioethanol
- Biodiesel
- Bio-jet/ aviation fuel
- Biogas
- Biohydrogen, bio-syngas
- Solid biofuel (wood, energy crops)
- Algae

BIOFUELS

Bioethanol

- Fermentation of sugar and starches produces **bio alcohols** like ethanol and in small quantities propanol and butanol. Ethanol contains almost **one-third** of the energy density of gasoline.
- But mostly they are used as an **additive in the vehicles.**
- Ethanol belongs to the type of **liquid biofuels** and is a renewable source of energy. It affects the production of food and can result in an increase in food prices. More energy is required to produce it in large quantities than it produces.

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BIOFUELS

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Biodiesel

- Biodiesel is another biofuel type which is a renewable source of energy.
- They are prepared from **plant oil and animal fats**. The primary sources of vegetable oils are rapeseed, palm, or soybean.
- They used the process called **transesterification** for their production.
- The process involves the exposure of plant oil with alcohol in the presence of a catalyst.

BIOFUELS

- The main product is then distilled from any byproduct. They can be used as biodiesel in place of petroleum diesel.
- It is a green biofuel example, as green biodiesel is produced during the process of refining.
- It does not contain sulfur.
- It reduces the emission of gases as well as odor.

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Biogas

- This biofuel type of first-generation is **gaseous** in nature. It can be produced from any kind of biomass.
- Its composition is just like natural gas. **Its main component is methane**, and it is produced by the **anaerobic decomposition of biomass**.
- It is the main reason this gas is gaining popularity and is slowly replacing natural gas. It is used as a fuel by households in gas cylinders. Some agricultural firms are also using it.
- It is the most common biofuel which is obtained from both plant and animals.

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Biohydrogen, Bio-syngas

- It is a type of gaseous biofuel. It is produced with a mixture of other gases include carbon monoxide, carbon dioxide. They are collectively called syngas or more commonly synthesis gas.
- Same like biogas, it is produced by the process of **pyrolysis, gasification or biological fermentation**.
- Hydrogen is produced by heating biomass in the process of pyrolysis and gasification.
- Whereas in the fermentation process it uses either dark fermentation or photo fermentation.

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BIOFUELS

- Dark fermentation breaks down biomass using bacteria, as it in the anaerobic process. Whereas photo fermentation is just like dark fermentation, the only difference is that it involves light.
- But despite all this method, is not preferable because of its low throughput; it means it takes a long time to complete.

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Wood

- It belongs to the type of solid biofuels.
- **It is one of the most common biofuels which is derived from organic matter.**
- **It can be obtained from trees as well as from plants and is used for fuel in the form of firewood, sawdust, chips, charcoal, and pellets.**
- People used wood to warm their houses, cook food, and to power small appliances at the house.
-

BIOFUELS

- The energy density of hardwood is around **14-15 MJ/Kg** if it is burned with 100 % efficiency. Wood is actually the most efficient among all the fuels, and they have **70 %** of the energy content recoverable.
- Its major drawback is pollution. It produces the **highest amount** of CO_2 when burned than fuels like methane.

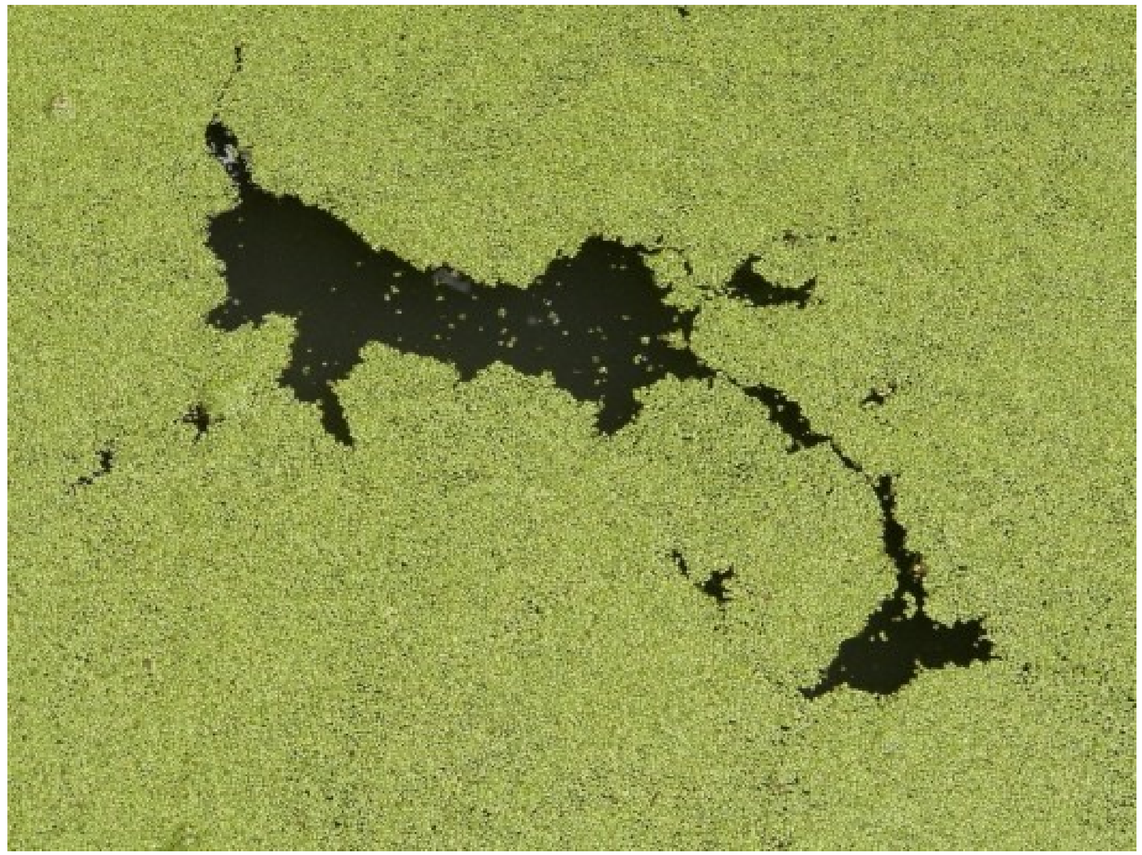
BIOFUELS

Algae Based Biofuels

- Algae are the highest source of energy in the class of **biofuels**. Because of the food problems, algae gain the most attention to use as a fuel.
- Algae has **20 to 80%** oil content which can be converted into different fuels.
- Production of diesel from algae is the **easiest way**. Scientists used gene technology to increase the production of oil and biodiesel content from algae.

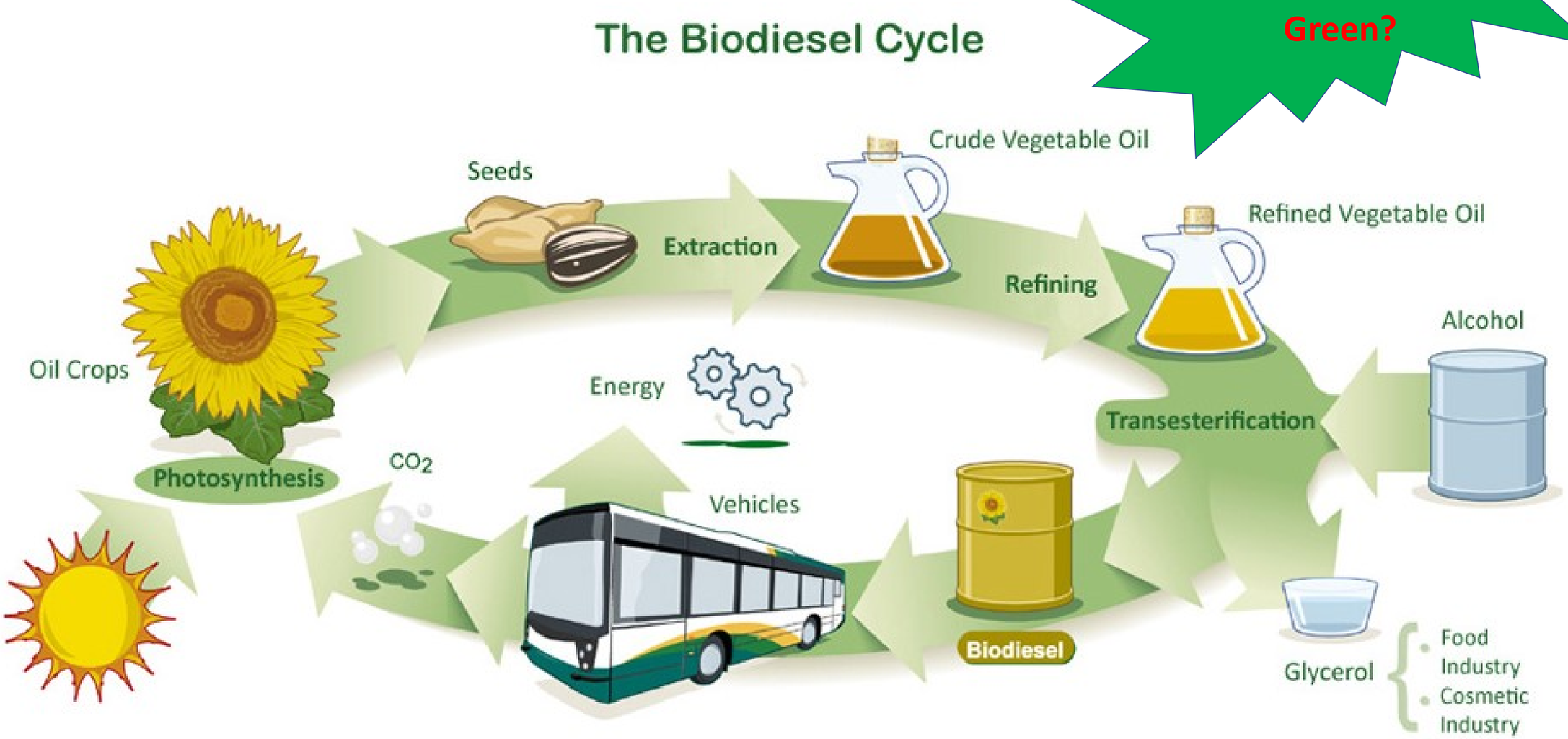
BIOFUELS

- They are the most **advanced form of biofuels.** Because of their high energy density, they can produce up to 300 % more oil per acre than other biofuels.
- Algae do not have any impact on food production.



BIODIESEL CYCLE : Example

Impact to Environment
Sustainable?
Green?



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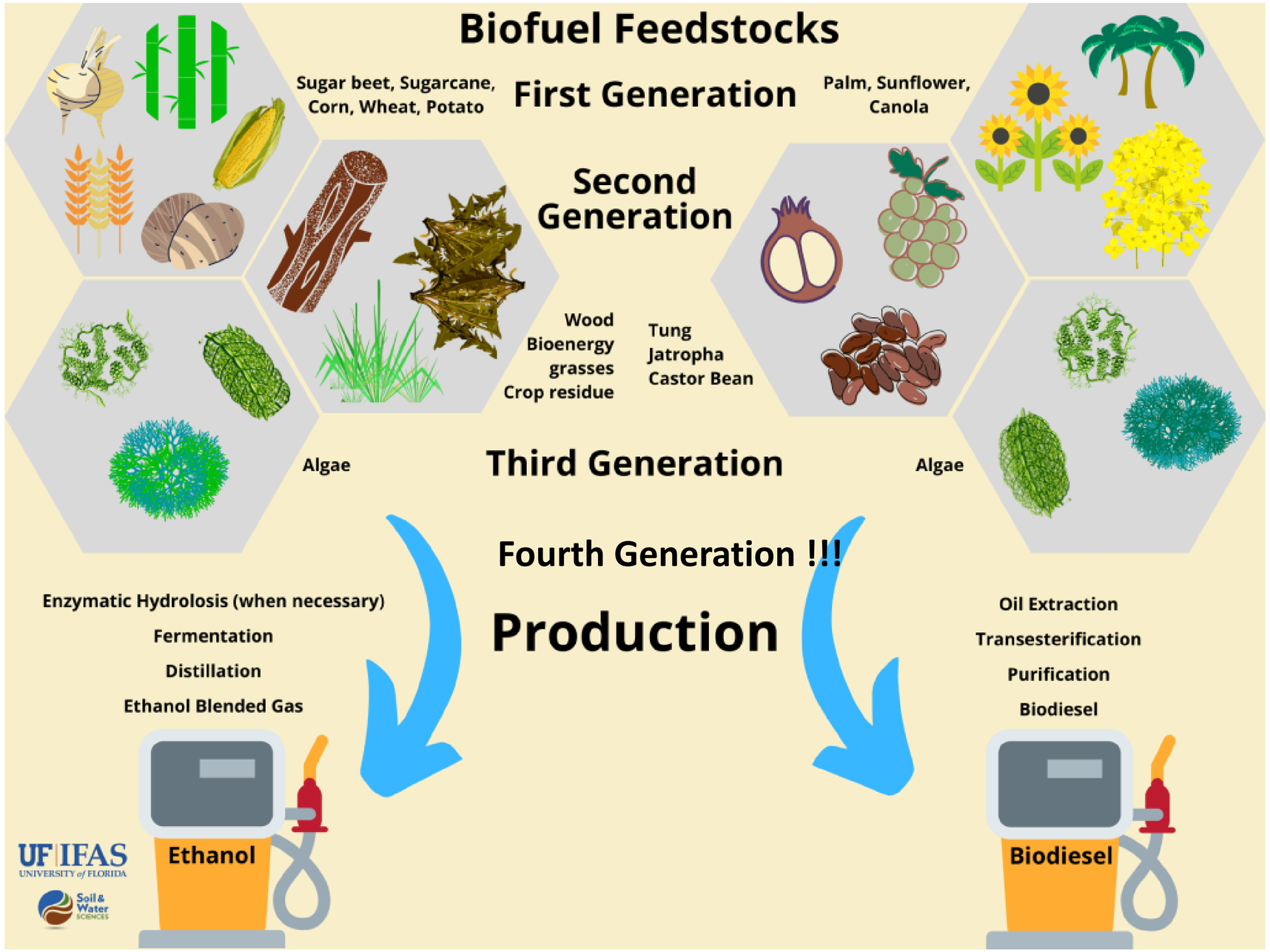
Biofuel Classification



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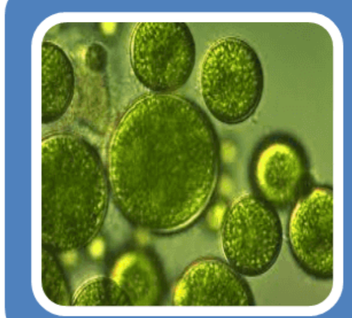
Biofuel

1st Generation Biofuel

- It has **High Carbon Content.**
- Made from Edible Items. Eg- **Sugar, Corn. Starch** etc.

2nd Generation Biofuel

- **Greeenhouse Gas content less than 1st Generation Biofuel**
- Made from leftover of Food Crops. Eg- **Rice Husk, Wood Chips** etc.



3rd Generation Biofuel

- It is **Carbon Neutral** in. (CO_2 Emitted = CO_2 Sequestrated)
- Produced using Microorganisms. Eg**. Algae**

4th Generation Biofuel

- Made from **'Genetically Engineered Crops**'.
- They are **Carbon Negative.**

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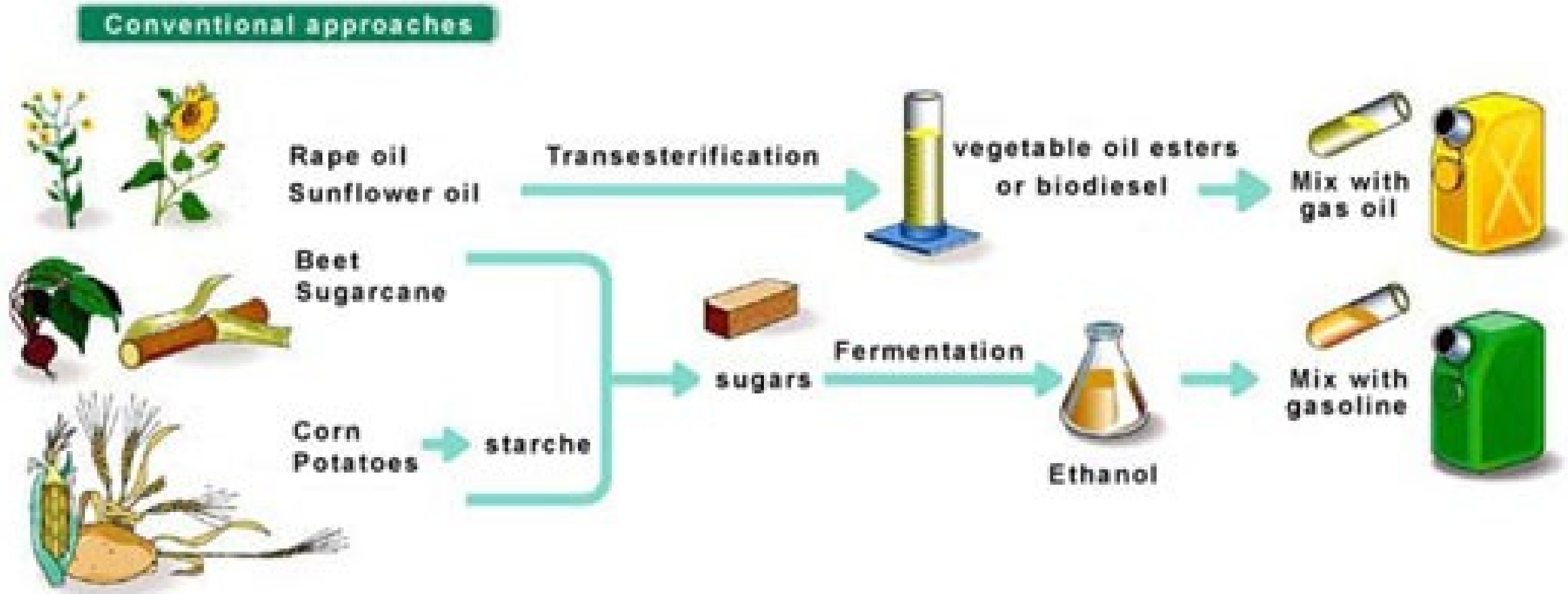
Biofuel Processing

First Generation Biofuel



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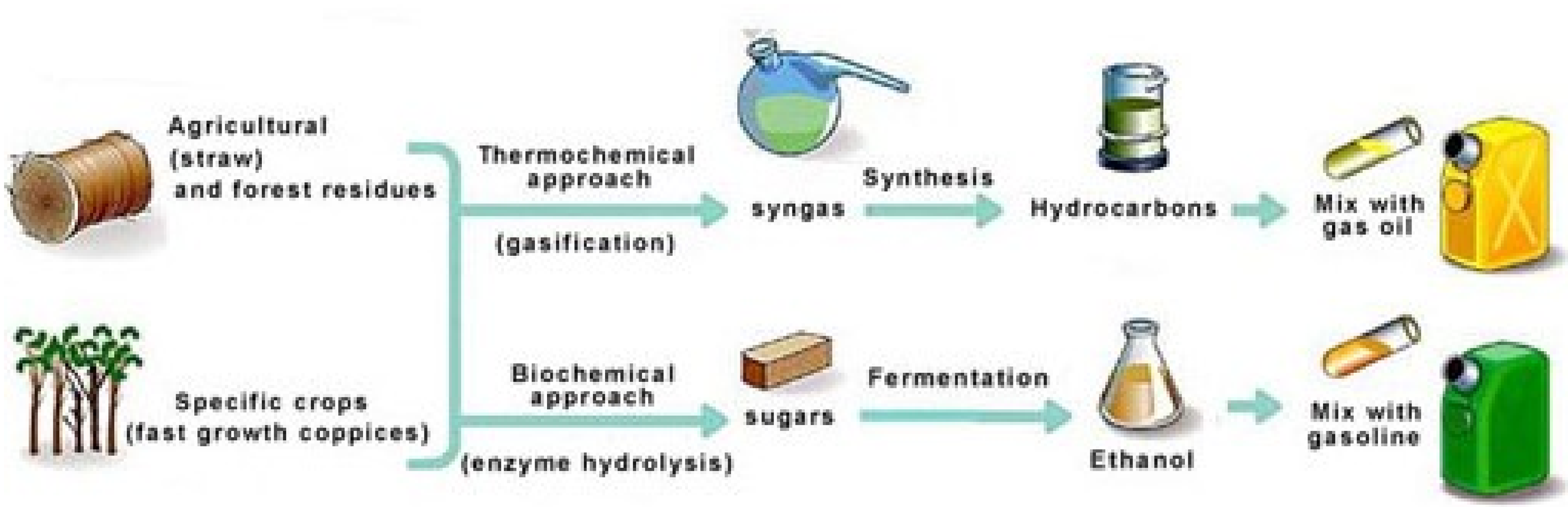
Biofuel Processing

Second Generation Biofuel



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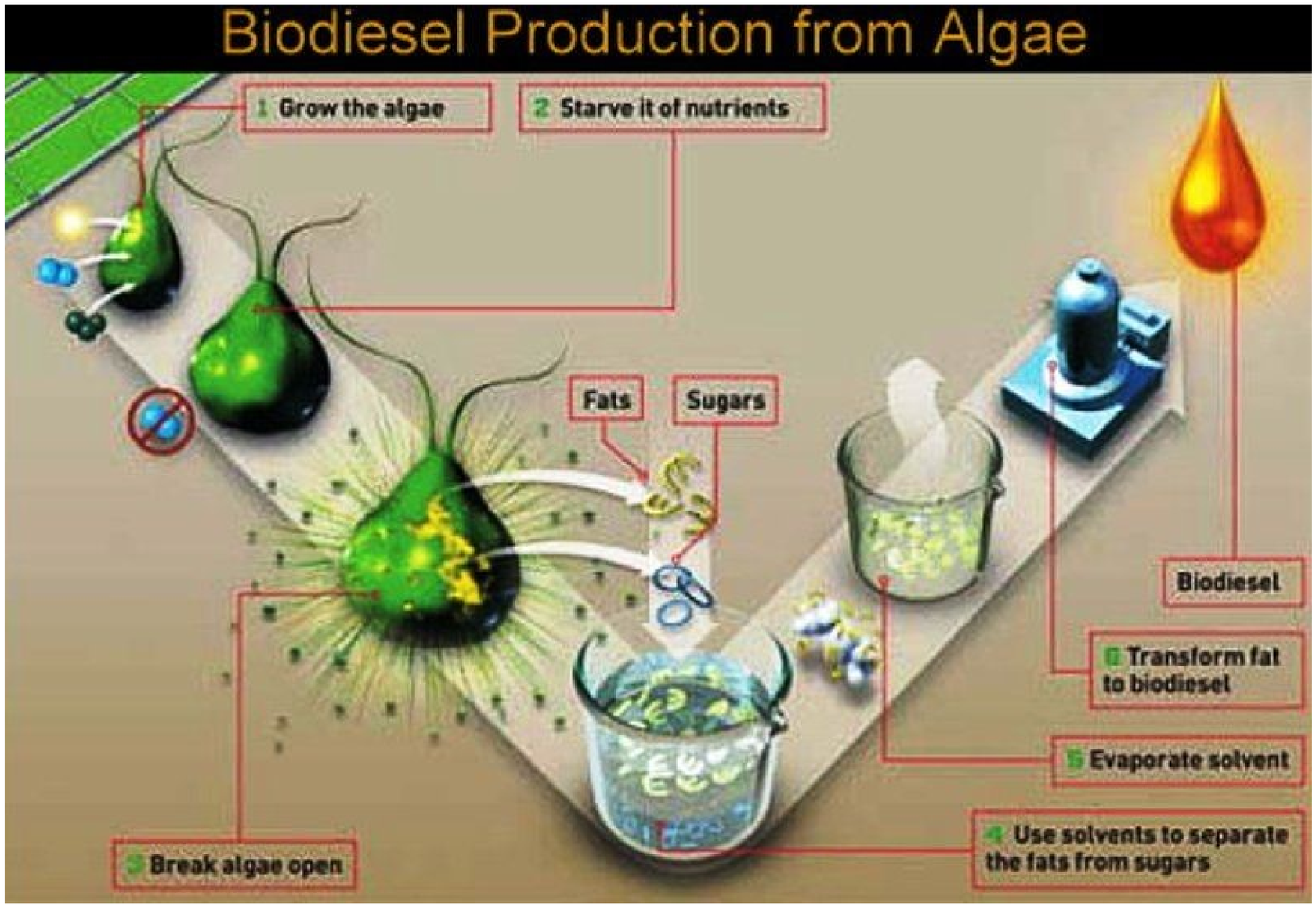
Biofuel Processing

Third Generation Biofuel



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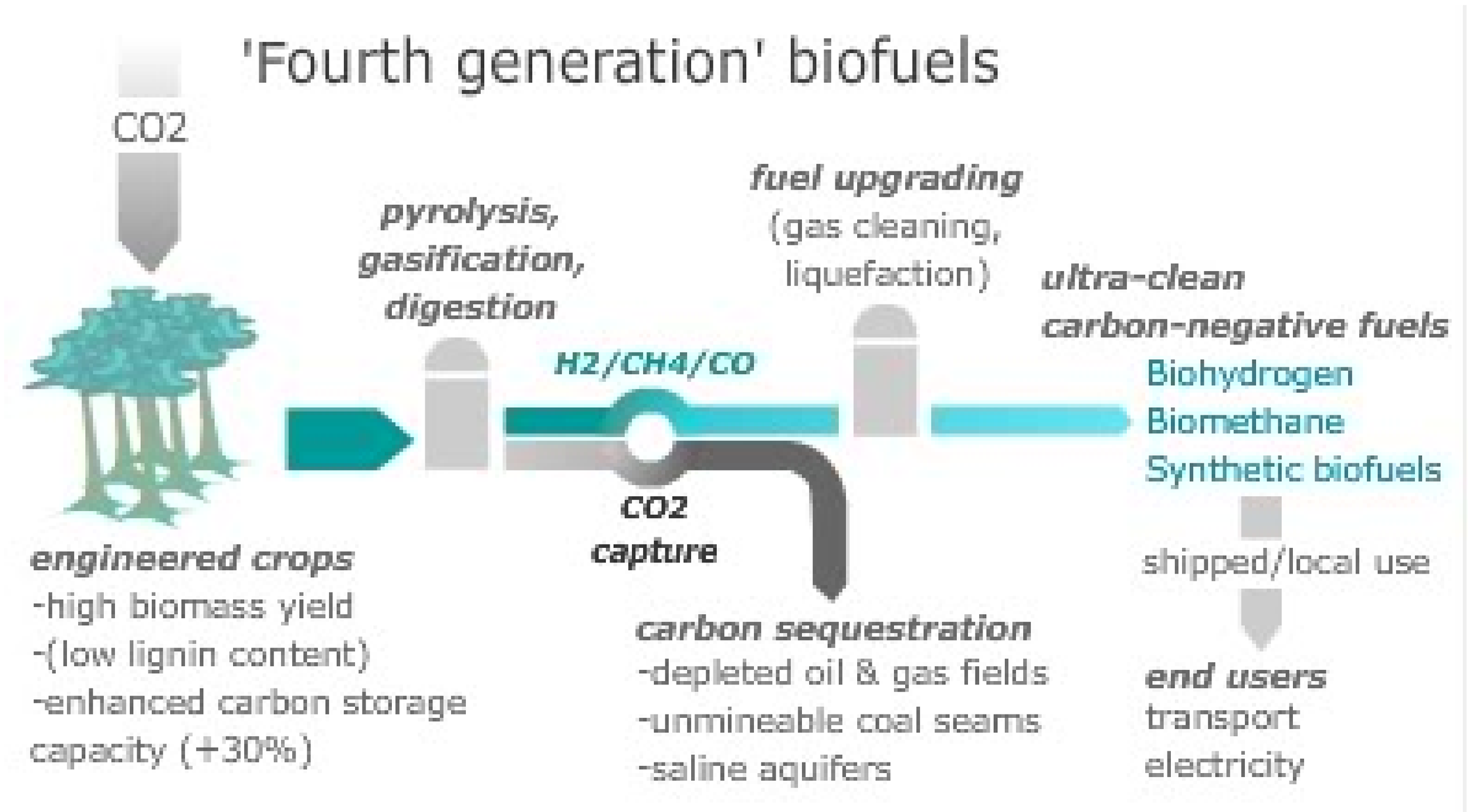
Biofuel Processing



Continent-based vegetable oil : Source for Biofuel

Vegetable oil availability in different parts of the world

Continent	Common available vegetable oil
Asia	Palm, corn, soybean, karanja, rubber seed, peanut, and coconut
America	Canola, soybean, sunflower, jojoba, castor, olive, safflower, corn, and peanut
Australia	Sunflower, canola, almond, soybean, palm, linseed, and olive
Africa	Palm, silk cotton (*Ceiba pentandra*), elais olenfera, and castor
Europe	Canola, sunflower, olive, soybean, sesame, corn, and peanut

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Continent-based vegetable oil : Source for Biofuel

- Regional preference toward a particular feedstock is an important parameter for the successful development and commercialization of biomass-based bioenergy-production process.

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Biofuel versus Fossil Oil: Sustainability

- Biofuel is more sustainable compared to Fossil Fuel?
- Biofuel is greener compared to Fossil Fuel?
- Biofuel is environmentally more friendly?
- Impact to global warming?
- Impact to land?
- Impact to health?

Reduce CO_2 emission means that it carries similar beneficial to the land/ health??

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Biofuel versus Fossil Oil: Sustainability

- Agriculture land needs expansion to meet bioefuel demand. This directly leads to changing the land use, consequently affecting the environment.
- Freshwater depletion is also an important issue of concern because biofuel feedstock production requires 8810, 6105 and 1764 Mm^3 freshwater per year for oil palm, sugarcane and cassava plantations. “Water-stress” problem……
- Studies also have revealed the risk of pesticide contamination in the areas with intensive agriculture.

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ENVIRONMENTAL ASSESSMENTS

Life Cycle Assessments: General

- A life cycle analysis is the act of measuring the environmental impact of a product or service throughout its life cycle, from the resources used to create the product or service, across its use by the user, to it's final end of life destination.
- There is a broad agreement in the scientific community that LCA is one of the best methodologies for the evaluation of the environmental burdens associated with biofuel production, by identifying **energy and materials used** as well as **waste and emissions released to the environment**.

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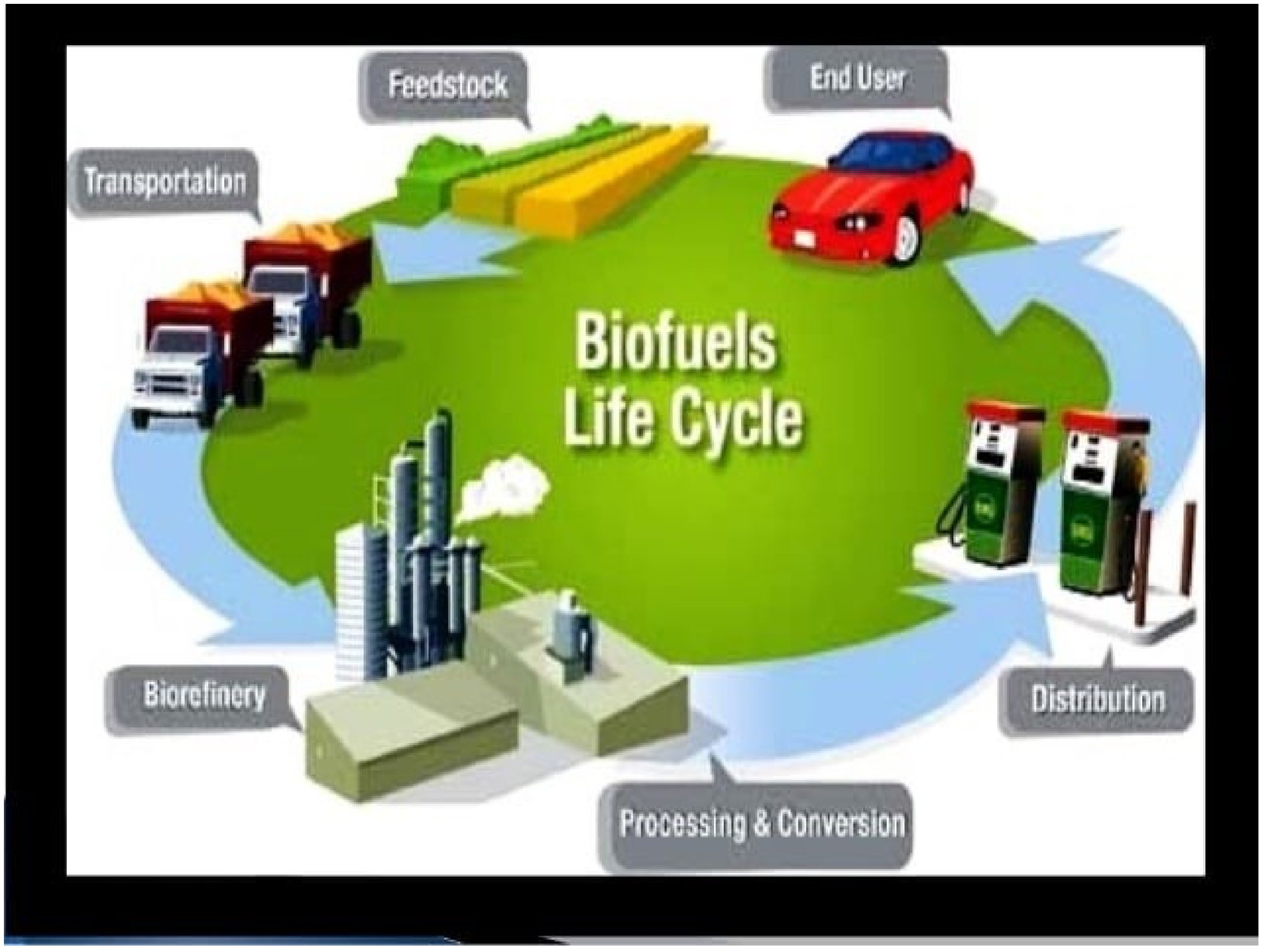
Life Cycle Assessments: General



Life Cycle Assessments: General

- LCA is a methodology for evaluating the environmental load of processes and products (goods and services) during their life cycle from cradle-to-grave.
- LCA studies have been used to examine life cycle impacts on other environmental aspects, including aspects such as (for example):

(i) local air pollution,

(ii) acidification,

(iii) ozone depletion,

(iv) land use, etc.

Life Cycle Assessments: General

- For example, most, but not all, biofuels substituting fossil fuels will lead to increased negative impacts. This applies particularly to **bioenergy crops** where, among others, the intensive use of fertilizers (compounds based on N and P) and pesticides can cause contamination of water and soil resources.
- Bioenergy crops: Sweet Sorghum, jatropha, Camelina
- Mostly are non-edible and planted purposely for biofuel.

Life Cycle Assessments: General

- Life cycle assessment comprises an **inventory phase** and an **impact assessment phase**.
- In the inventory phase, information is gathered about input and emissions for all processes in the studied system.
- The impact assessment phase follows the inventory phase and performs an assessment of all relevant environmental impacts associated with the input and emissions mapped in the inventory phase.

Life Cycle Assessments: General

- The impact assessment phase thus also covers other chemical-related impacts like global warming and tropospheric ozone formation, as well as physical impacts on land and input-related impacts on the availability of resources.

Conceptual basis of LCA

- According to the **ISO 14000 series (14041-43)**, the technical framework for the LCA methodology as it is defined in ISO 14040 consists of **four phases**:
- (1) goal and scope definition;
- (2) inventory analysis;
- (3) impact assessment; and
- (4) interpretation

Conceptual basis of LCA

- **<u>Firstly</u>**, defining the goal and scope involves defining purpose, audiences and system boundaries.
- **<u>Secondly</u>**, the life cycle inventory involves collecting data for each unit process regarding all relevant inputs and outputs of energy and mass flow, as well as data on emissions to air, water and land.
- This phase includes calculating both the material and the energy input and output of a building system.

Conceptual basis of LCA

- **Thirdly**, the life cycle impact assessment phase evaluates potential environmental impacts and estimates the resources used in the modeled system.
- This phase consists of **three mandatory elements**:
- (i) selection of impact categories,
- (ii) assignment of life cycle inventory results (classifications), and
- (iii) modeling category indicators (characterization)

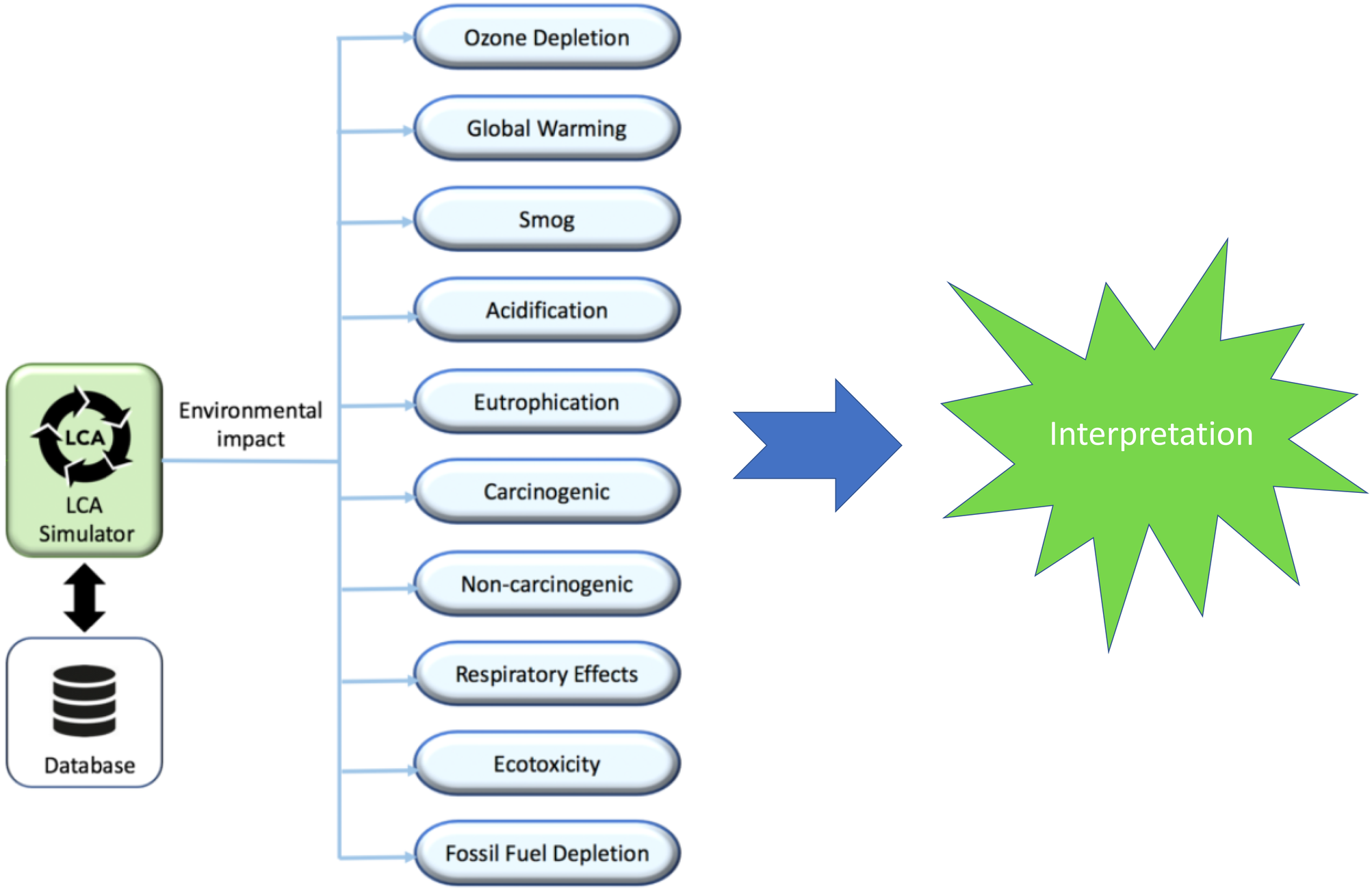
Conceptual basis of LCA

- Classification of the life cycle inventory results involves assigning the emissions, wastes and resources used; to the impact categories chosen.
- The converted life cycle inventory results are aggregated into an indicator result, which is the final result of the mandatory part of a life cycle impact assessment.
- Normalization, grouping, weighting and additional life cycle impact assessment data quality analysis are optional steps.

Conceptual basis of LCA

- Finally, the last stage of ISO 14040 is the **interpretation**. This stage identifies significant issues, evaluates findings to reach conclusions and formulate recommendations. The final report is the last element to complete the phases of LCA according to ISO 14040

Conceptual basis of LCA



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Sample Study: BIODIESEL

Biodiesel Production Process from oil seeds

Sample Study: BIODIESEL

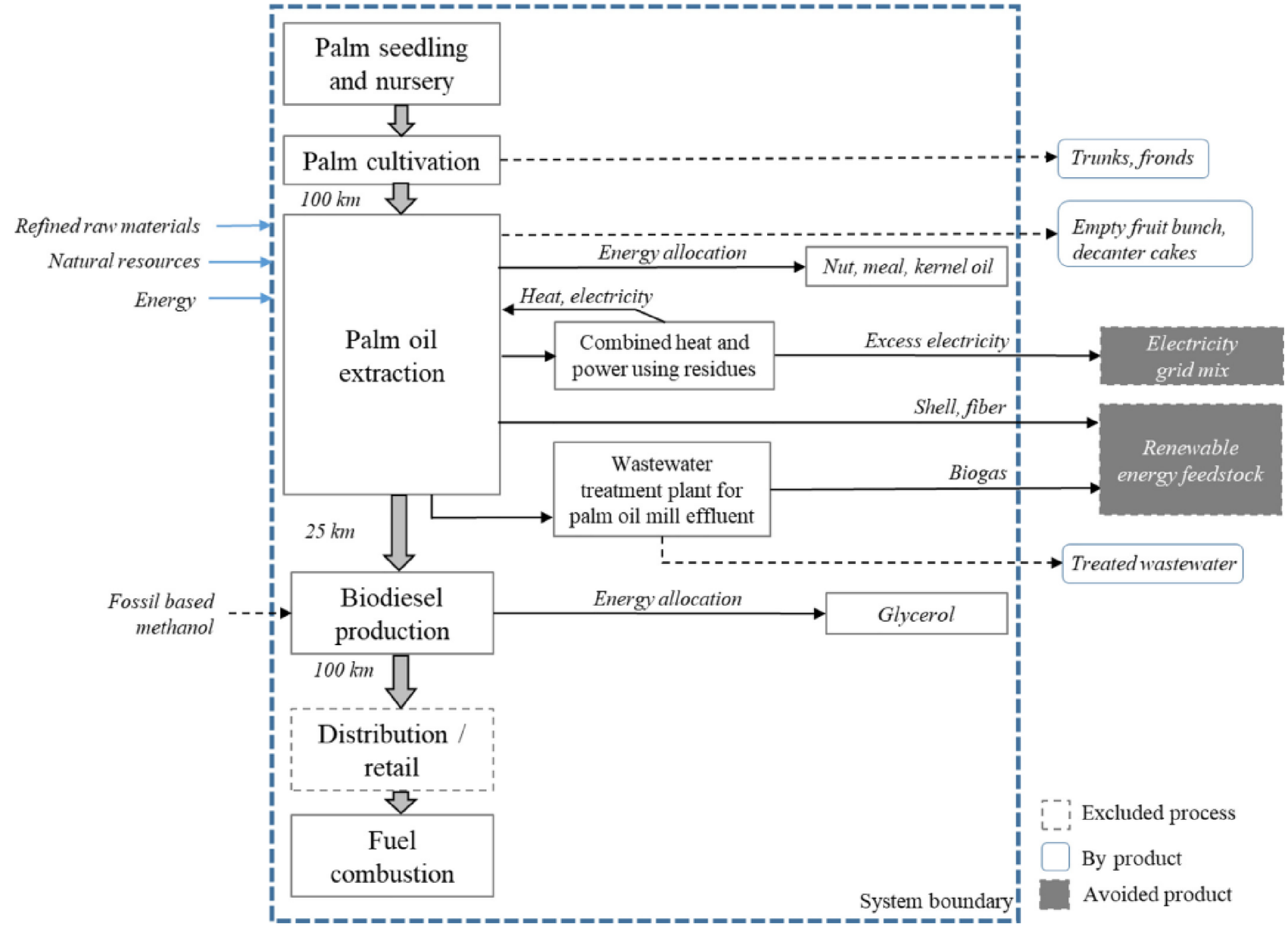

Fig. 1. System boundary of biodiesel for LCA study.

BIODIESEL

Preparation and extraction of oil pressure

- Rapeseed, sunflower and soybean seeds arrive at the plant production of biodiesel from agricultural fields to be treated and processed.
- The period provided for the collection of seeds, is performed for a maximum of 90 to 100 days, which estimates the collection period.
- The processes of drying and cleaning are done continuously at a rate of 100 t/h. In the dryer, the moisture of the seed is reduced from 12% to 8%, through a stream of air with a temperature of 150 °C and a relative humidity of 70%.

BIODIESEL

- The dryer is equipped with cyclones of 98% efficiency for recirculating drying air. Once clean, dry seed is then transported to storage silos for processing in the preparation plant.
- The seed previously cleaned and laminated is sent to a conditioner, to obtain the best temperature and humidity conditions for juicing. The conditioning of the seed is carried out in a vertical boiler floor, in which the seed is conditioned at a temperature of 100 °C and humidity of 4 to 4.5% before entering the press.

BIODIESEL

- Extraction is carried out throughout the year and planned its continuous operation, with an availability of 8000 h annually. The processing capacity in this first scenario is 500 t/day of seeds to obtain 220 t of crude oil and 290 t of protein meal for animal feed daily.
- Mechanical pressing gets 75% of the oil content in the seeds and a press cake that goes to the next chemical extraction process.

BIODIESEL

- The extraction of oil remaining in the pressed cake is made by solvent (hexane). It is estimated that the oil content in the pressed cake is 19 wt.%. In a soybean-processing plant, the soy protein is separated from the oil and the crude soybean oil is then purified by degumming to remove lecithin, by refining to remove fatty acids

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BIODIESEL

Distillation of the mixture and oil finish

- The mixture enriched with oil undergoes a process of evaporation that takes place in three stages.
- In the first stage, heating of the mixture by the vapors from the desolventizer, the mixture comes to a concentration of around 70– 80% in oil.
- In the second stage, an evaporation and separation operating under vacuum takes place. The miscella is concentrated up to 95% oil.

BIODIESEL

- In the third stage, evaporation takes place through a finishing evaporator.
- In the first stage, working temperature is at 60 °C, in the second at 100 °C and in the third phase, at 120 °C with steam injection to drag the last traces of hexane. All stages under a vacuum of 320 Torr.
- After removing the solvent from the mixture, the oil passes to a dryer, under a vacuum of 70 Torr, to reduce the humidity of the oil before storage

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BIODIESEL

Pre-treatment and filtration

- The mixture of oil/caustic soda is introduced into the activated carbon reactor located at the top of the column. The reactor has a residence time suitable for reaction with activated carbon. After the filtering operation, it retrieves the oil retained in the filter cake by blowing steam and the exhausted cake is discharged and evacuated

BIODIESEL

Deaerator/lung tank

- The bleached oil is normally at a temperature of 85–95 °C, it is first deaerated in the deaeration section, which is an integral part of the deodorization tower and works in the same vacuum than deodorization (steam distillation).
- The oil is sent from the aerator through the heat exchange floor to be preheated between 180 and 220 °C with the deodorized oil.

BIODIESEL

- Heat exchange occurs as a result of the bleaching oil circulation within the coils of the trading floor, operating under vacuum, cooling the deodorized oil to a temperature of approximately 125–135 °C.
- After the final cooling, the oil is cleaned by polishing through airtight filters. It is in this filtering in which the oil is given the final polishing.

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BIODIESEL

Goal and scope definition

BIODIESEL

- The first phase of LCA is to define goal and scope, which are equivalent to objective and the boundary of work to be performed.
- **<u>The objectives of this study are</u>**:
- (i) analyze the different processes that comprise biofuel production;
- (ii) determine the flow of matter and energy, as well as emissions that occur over this; and
- (iii) establish and quantify the environmental impacts caused by different emissions throughout the production process

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BIODIESEL

Functional unit (FU)

BIODIESEL

- The functional LCA unit could be chosen as 1 kg of biofuel synthesis.
- The functional unit for the assessment could be also set as 100 MJ of fuel used for a standard passenger car under similar driving condition.

Examples of FU/ Basis of estimation

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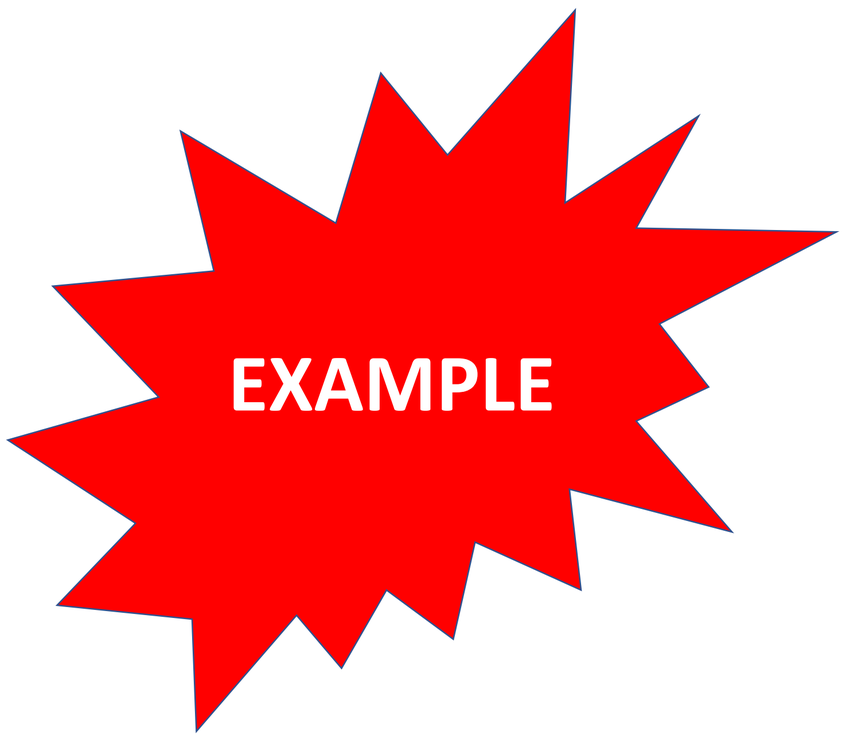
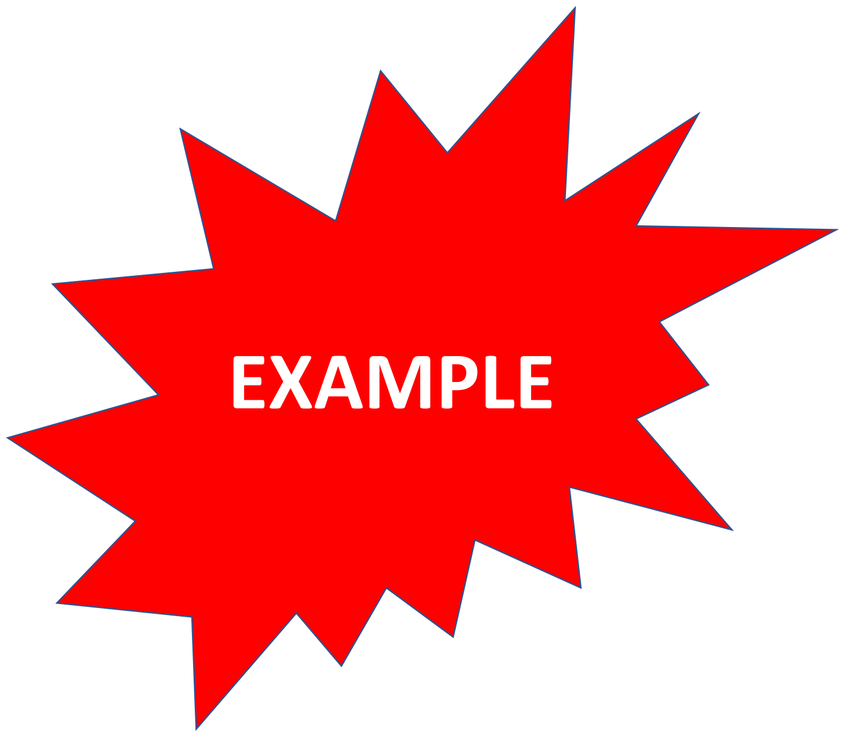
System boundary

- The system has been divided into 12 processes, which are those that make the process of **producing 1 kg of biofuel**:
- 1) rapeseed production
- 2) sunflower seed production
- 3) soybean seed production
- 4) drying and preparation of seed
- 5) rapeseed crude oil extraction



- 6) sunflower crude oil extraction
- 7) soybean oil extraction
- 8) refined rapeseed oil
- 9) refined sunflower oil
- 10) refined soybean oil
- 11) transesterification, and
- 12) glycerol collection



Inventory Analysis – From Database or from literature

Soybean, sunflower and rapeseed production

- This process encompasses the entire production process associated with soybean, sunflower and commercial rapeseed.
- It includes the entire life cycle of the plant: planting, fertilizing, treatment with different pesticides and plant collection. Taken into account also, the processes of operating with machines, including energy to use, and the different impacts derived of its use.

Drying and preparation of the seeds

- Once the seeds are carried to the plant (the transport process until the plant is outside the studio system) they are subjected to a process of washing, peeling, drying by air blown at base pressure and bleaching using calcium bentonite.

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Extraction of crude oil

- The prepared seeds pass through a series of rotating screws, where they are crushed and pressed.
- This milling process does not get all the oil in the seed, so the resulting paste is treated with a solvent, this solvent is hexane, so the paste is mixed with hexane.
- Once all the oil is obtained the hexane is condensed and separated from the water to be reused in the process, while the oil obtained is decanted and centrifuged to remove impurities and move to the next phase of production.

Refining of Crude Oil

- Refining process: Oil neutralization and degumming, bleaching and dewaxing of crude oils are performed. At this stage fatty acids, phosphatides and waxes contained in the oil are removed until obtaining the refined oil. In this process soaps are obtained as a byproduct that we will consider further.
- The main processes for refining crude oil when it will be used to manufacture biofuel are: neutralization and bleaching. calcium bentonite. It also eliminates the impurities not withdrawn in the neutralization.

- Neutralization: The fatty acids are removed neutralizing them with a strong base in this case caustic soda, formed a water-soluble soap paste.
- Bleaching: The pigments are removed by the addition of an adsorbent, in this case

Transesterification to biofuel

- The esterification reaction converts the oil into biofuel by reacting the triglyceride with an alcohol (alcoholysis) in the presence of a catalyst, producing a mixture of fatty acid alkyl esters (biofuel) and glycerol.
- Refined oil is added to methanol in the presence of sodium methoxide catalyst, it is transformed into methyl ester. Glycerol, a byproduct of the process, is obtained. The crude methyl ester is washed to remove traces of methanol, glycerol, catalyst, etc. Then, it is dried to obtain biofuel.

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Obtaining glycerin

- The glycerol water is introduced into a distillation column, where through evaporation, methanol is recovered, which is fed back to the beginning of the process.
- The byproduct of this reaction is glycerin, a hygroscopic triol. Glycerin can be converted into higher-value products by catalysis or biocatalysis processes

Transportation & Exhaust Emission

Distance of biomass feedstock transportation

Product	Origin/source	Destination	Distance (km)
Fresh fruit bunches	Oil palm farm	Palm oil mill	100
Crude palm oil	Palm oil mill	Biodiesel plant	25
Biodiesel (B100)	Biodiesel plant	Distribution site	100
Cassava root	Cassava farm	Ethanol conversion plant	100
Rice husk	Rice mill factory	Ethanol conversion plant	50
Ethanol	Ethanol conversion plant	Distribution site	100

The parameter of fuels for calculating the pollutants in exhaust emissions.

Parameter	Unit	Diesel	B100	Gasoline	Ethanol
Biofuel	%v	0	100	0	100
Biofuel	%wt	0	100	0	100
NCV	MJ /kg	43.4	39.0	42.5	26.8
NCV	kg /100 MJ	2.31	2.57	2.35	3.73
Density	kg /L	0.840	0.860	0.740	0.790

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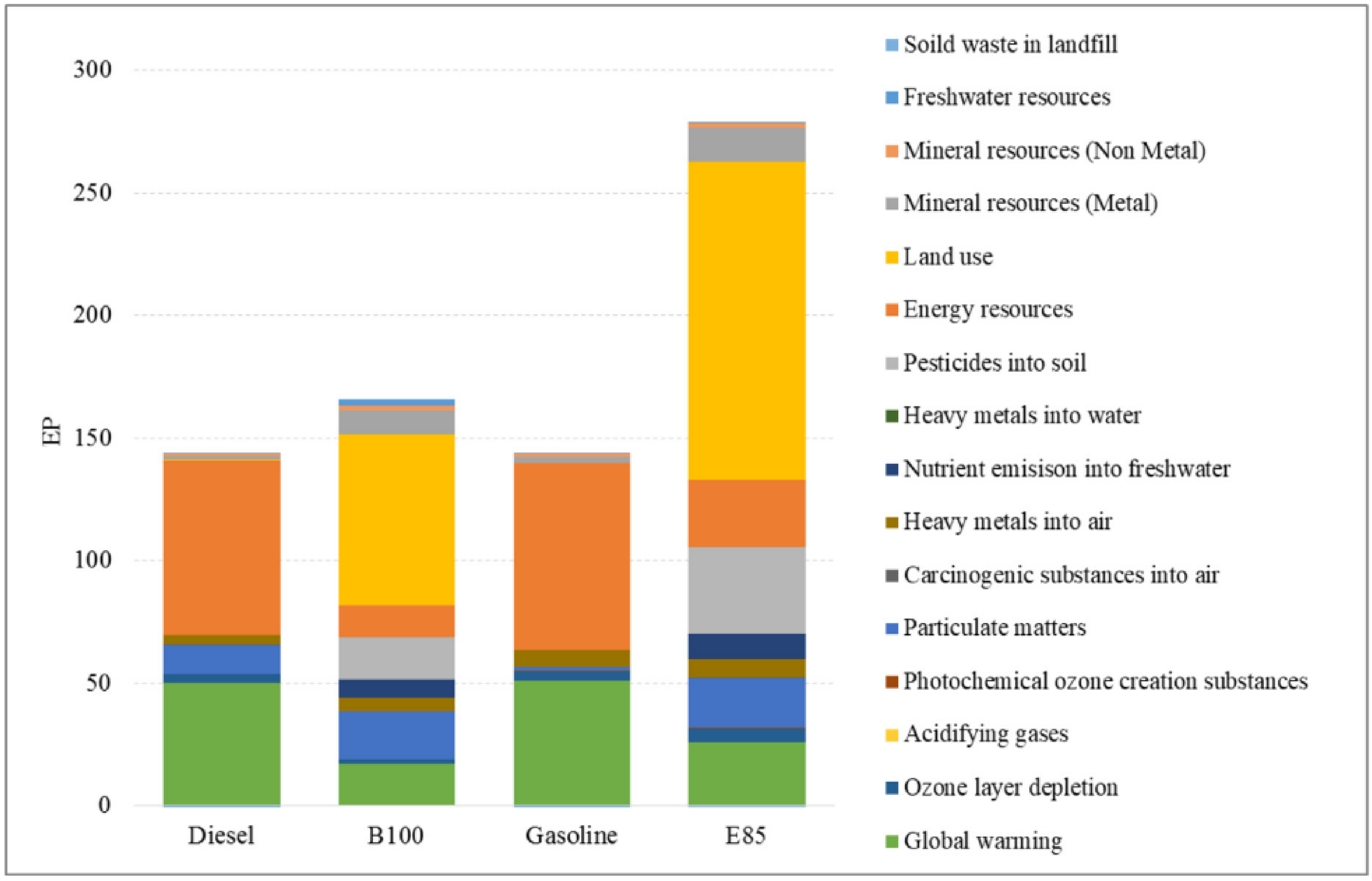
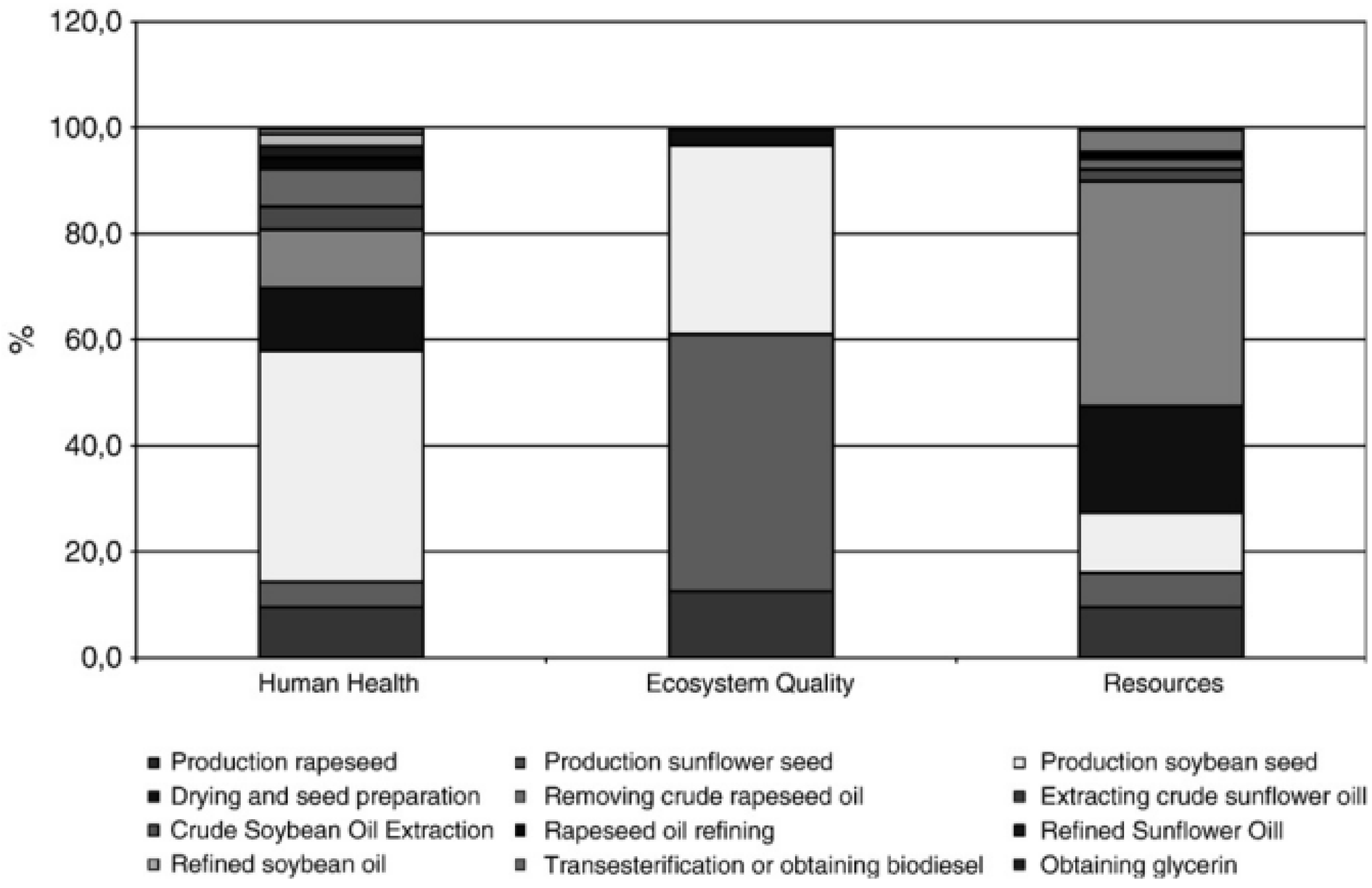
Impact Assessment/ Impact Mapping



LCA comparison of selected biofuels based on the functional unit (100 MJ)


120,0
100,0
80,0
60,0
40,0
20,0
0,0
%
Human Health
Ecosystem Quality
Resources
Production rapeseed
Drying and seed preparation
Crude Soybean Oil Extraction
Refined soybean oil
Production sunflower seed
Removing crude rapeseed oil
Rapeseed oil refining
Transesterification or obtaining biodiesel
Production soybean seed
Extracting crude sunflower oill
Refined Sunflower Oill
Obtaining glycerin

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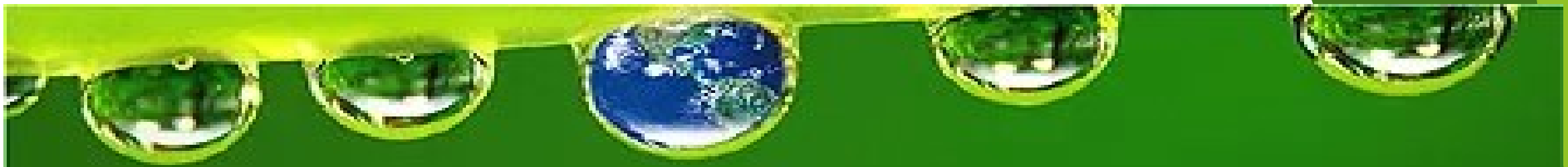
Global warming, climate change & Climate change mitigation

Chin Kui CHENG (PhD)
Khalifa University of Science & Technology
Abu Dhabi, UAE

CONTENTS

- Global warming
- Carbon dioxide emission
- Climate change
- Climate change mitigation
- UAE as a case study
- Current world trend



Ecology

Conservation

Pollution

Environment

Global Warmings

Renewable Resources

Eco Friendly

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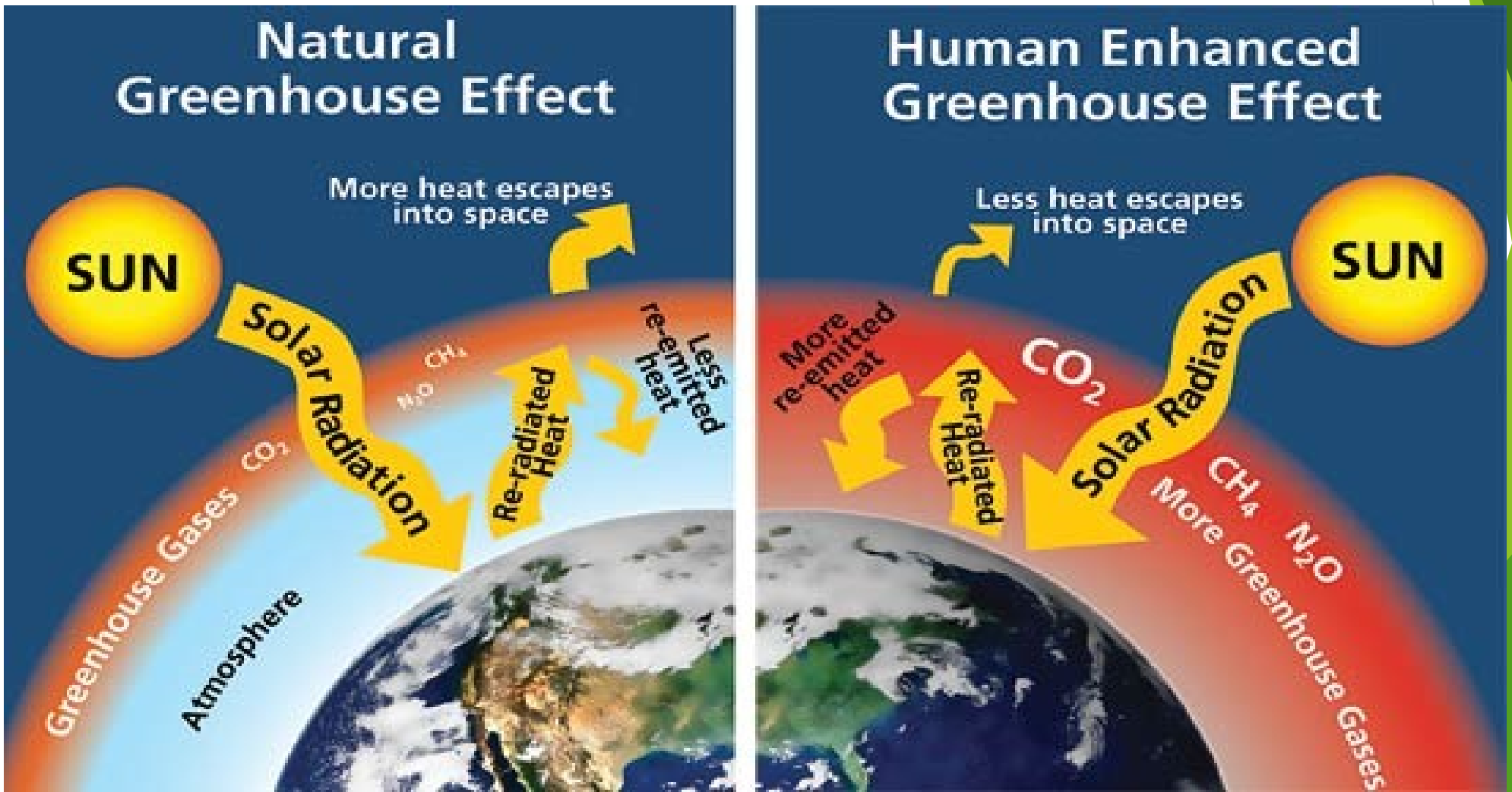
Global warming

- A gradual increase in the overall temperature of the earth's atmosphere generally attributed to the greenhouse effect caused by increased levels of carbon dioxide, CFCs, and other pollutants.
- The history of the greenhouse effect and global warming. First of all, predicted by Svante Arrhenius was a Swedish scientist that was the first to claim in 1896 that fossil fuel combustion may eventually result in enhanced global warming.
- We are living in an era of unprecedented technological innovation during last 2 decades that caused a dramatic increase in carbonaceous emissions into the atmosphere.

Green house effects

- When we burn organic materials (i.e. carbon-containing) fuels, or organic matter decomposes, carbon dioxide is released into the air.
- It is transparent to incoming solar radiation, but opaque to some wavelengths of heat radiated from the warmed surface of the Earth, and so traps heat, leading eventually to a warming of the lower atmosphere" This is known as the greenhouse effect.
- As in principle, the atmosphere behaves in a similar manner to a garden greenhouse, it allows sunlight to penetrate, but heat is trapped within the atmosphere in the same way that it is trapped within the glass walls of a greenhouse

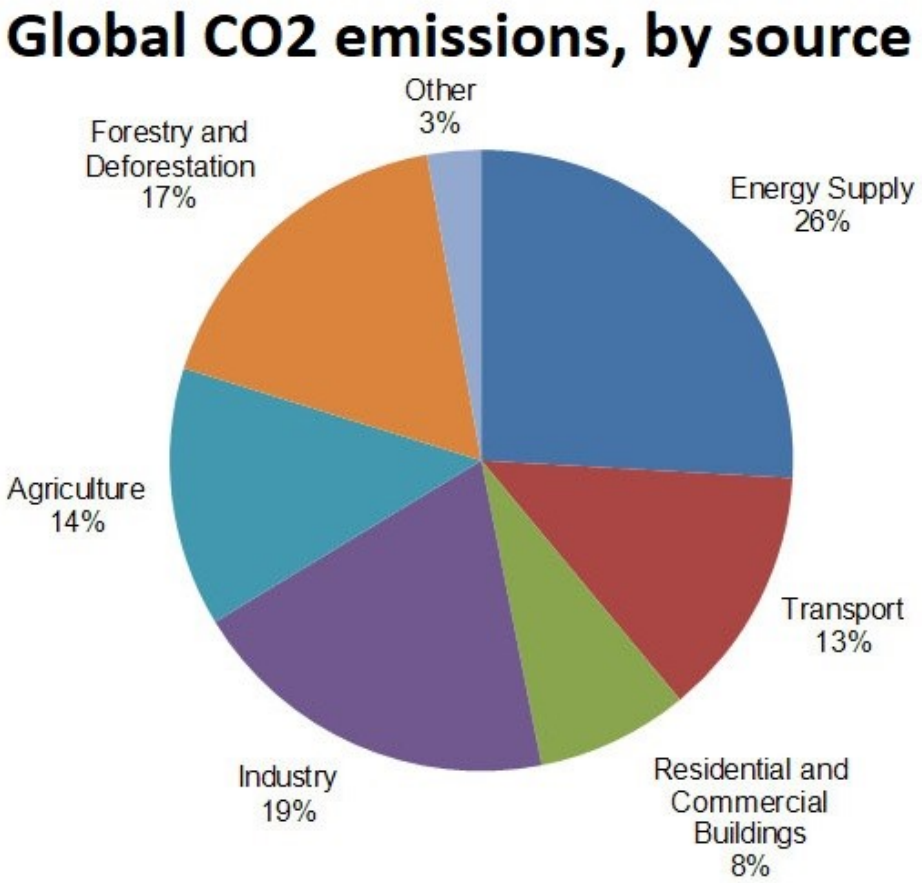
Natural and human enhanced green house effect



Various sources of CO_2 emissions.

Sources are mainly classified into three;

- Stationary
- Mobile
- Natural



Stationary

- Fossil fuel based electric power plants.
- Independent power producers.
- Manufacturing plants in industry (cement, limestone, hydrogen, ammonia, soda, fermentation, chemical oxidation).
- Commercial and residential buildings
- Flares of gas at fields.
- Military and government facilities.

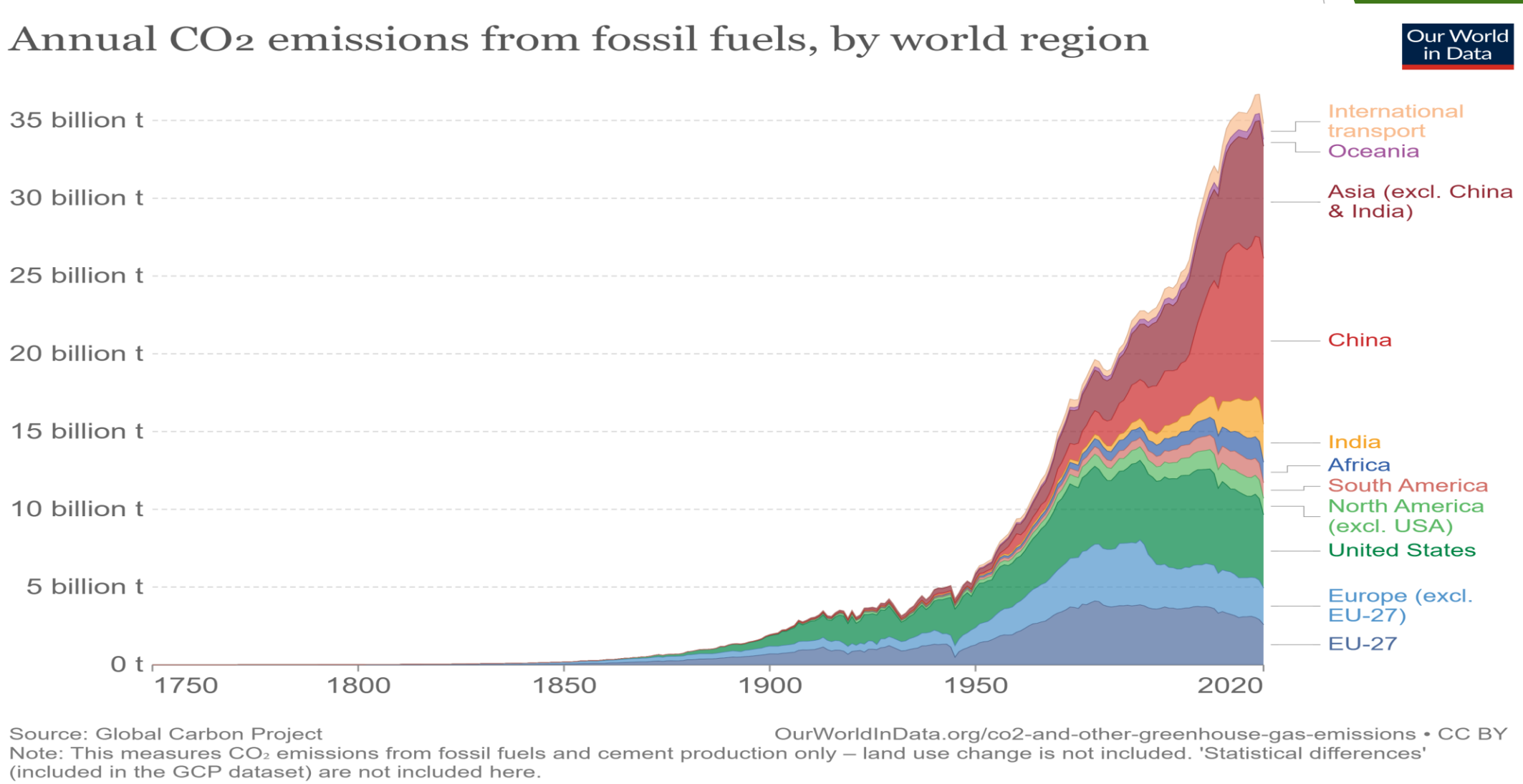
Mobile.

- Cars and sports utility vehicles
- Trucks and buses
- Aircrafts
- Trains and ships
- Construction vehicles
- Military vehicles and devises

Natural.

- Humans
- Animals
- Plant and animal decay
- Land emission
- Volcano
- Earth quake

Worlds top emitters of carbon dioxide



UN explanation for each individual have responsibility to control warming in different sectors;

- Energy
- Transport
- Water
- Food
- Dress
- Waste

Energy

- Although some 790 million people in the world still lack access to electricity, mankind doen't have to give up on our appliances — but we can use them in a way that doesn't waste energy.
- If people worldwide switched to energy-efficient light bulbs, the world would save US$120 billion annually.
- The energy supply sector (electricity, heat, and other energy) is the largest contributor to global greenhouse gas emissions, responsible for approx. 35% of total emissions and consume 29% global energy.

Transport

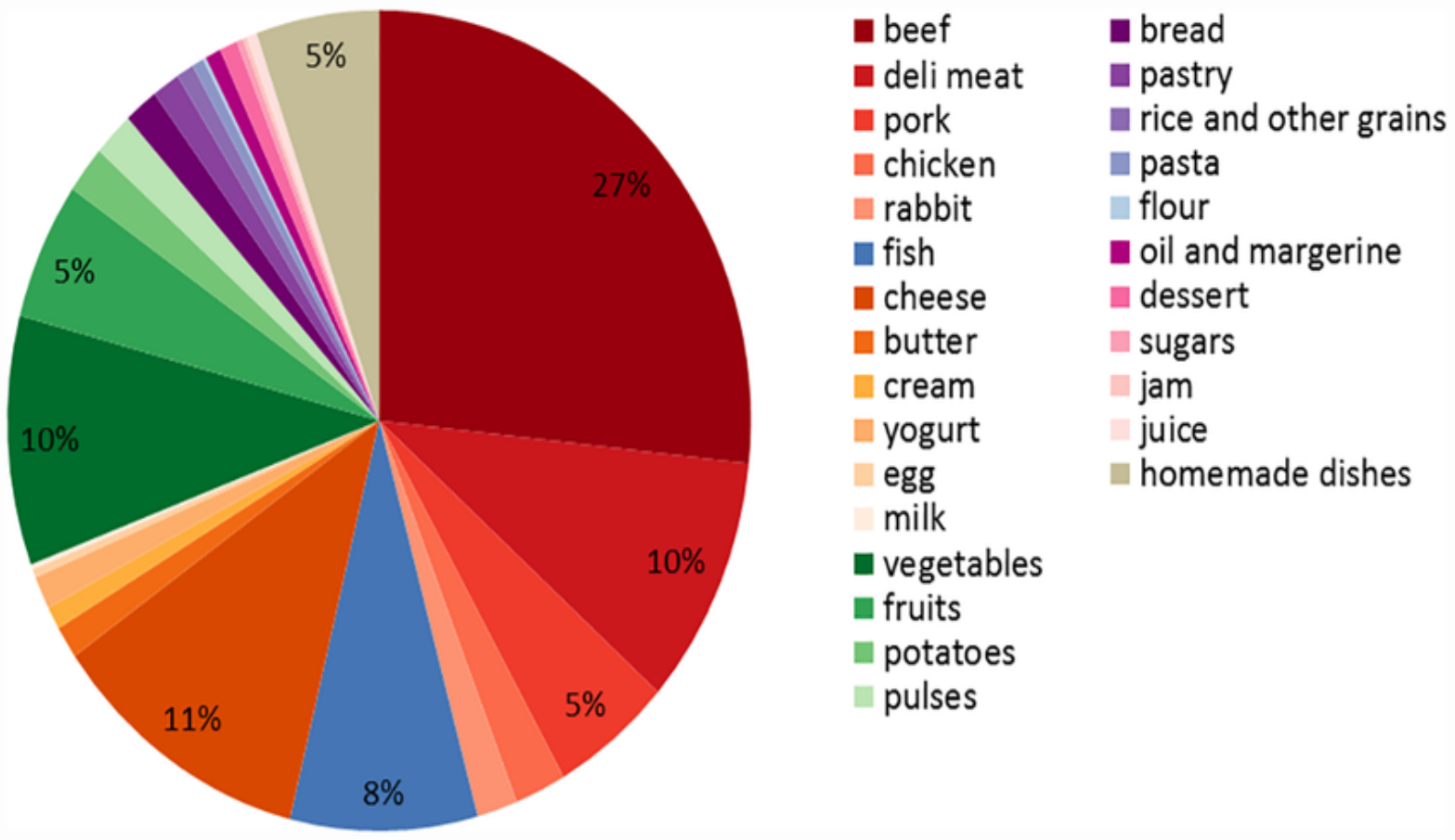
- Currently, the transport sector is almost completely dependent on fossil fuels. It contributes approximately one quarter of all energy-related carbon dioxide emissions.
- Among transportation road transport constitutes 45.1% (Buses, cars, motocycles etc)
- The transportation sector is one of the largest contributors to anthropogenic greenhouse gas (GHG) emissions.
- Since 1990, transportation greenhouse gas emissions have increased by 30 percent to more than eight billion metric tons of carbon dioxide equivalent.

Water

- Water is a precious resource: Less than 3% of the world's water is fresh (drinkable), of which 2.5% is frozen in the Antarctica, Arctic and glaciers.
- Humans are misusing and polluting water faster than nature can recycle and purify water in rivers and lakes.
- Climate change impacts the water cycle by influencing when, where, and how much precipitation falls.
- Increasing global temperatures causes water to evaporate in larger amounts, which will lead to higher levels of atmospheric water vapor and more frequent.

Food

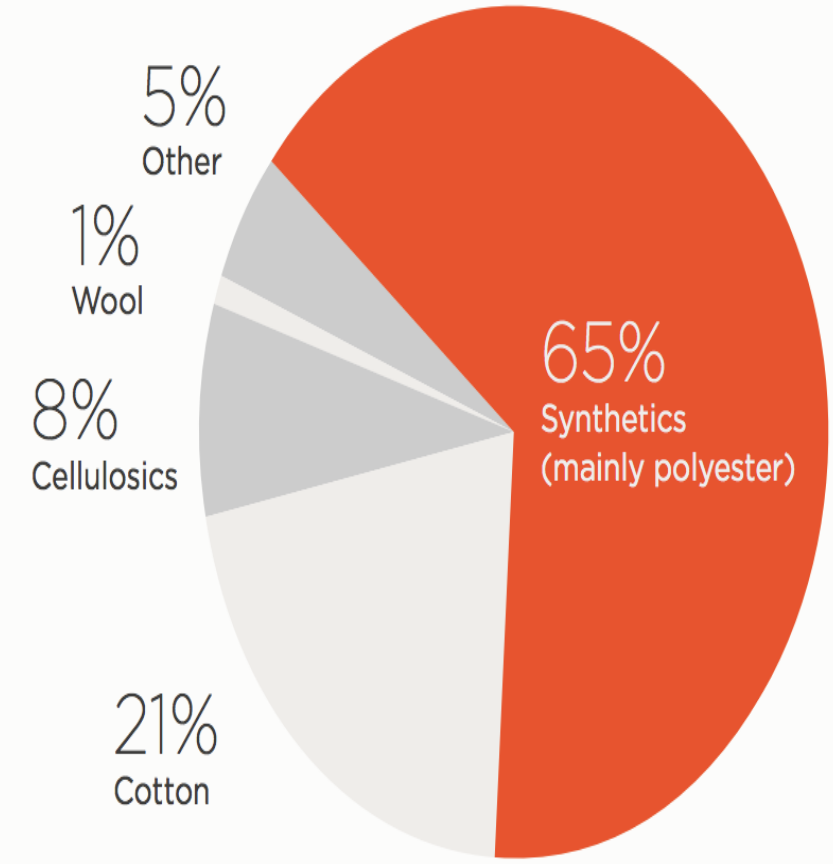
- 17% of all food available at consumer levels is wasted. This amounts to a big waste of resources used in production:
- i.e. land, water, energy and other inputs, and unnecessary greenhouse gas emissions.
- By reducing food waste, we can save money, reduce emissions, and help preserve resources for future generations.



Dress

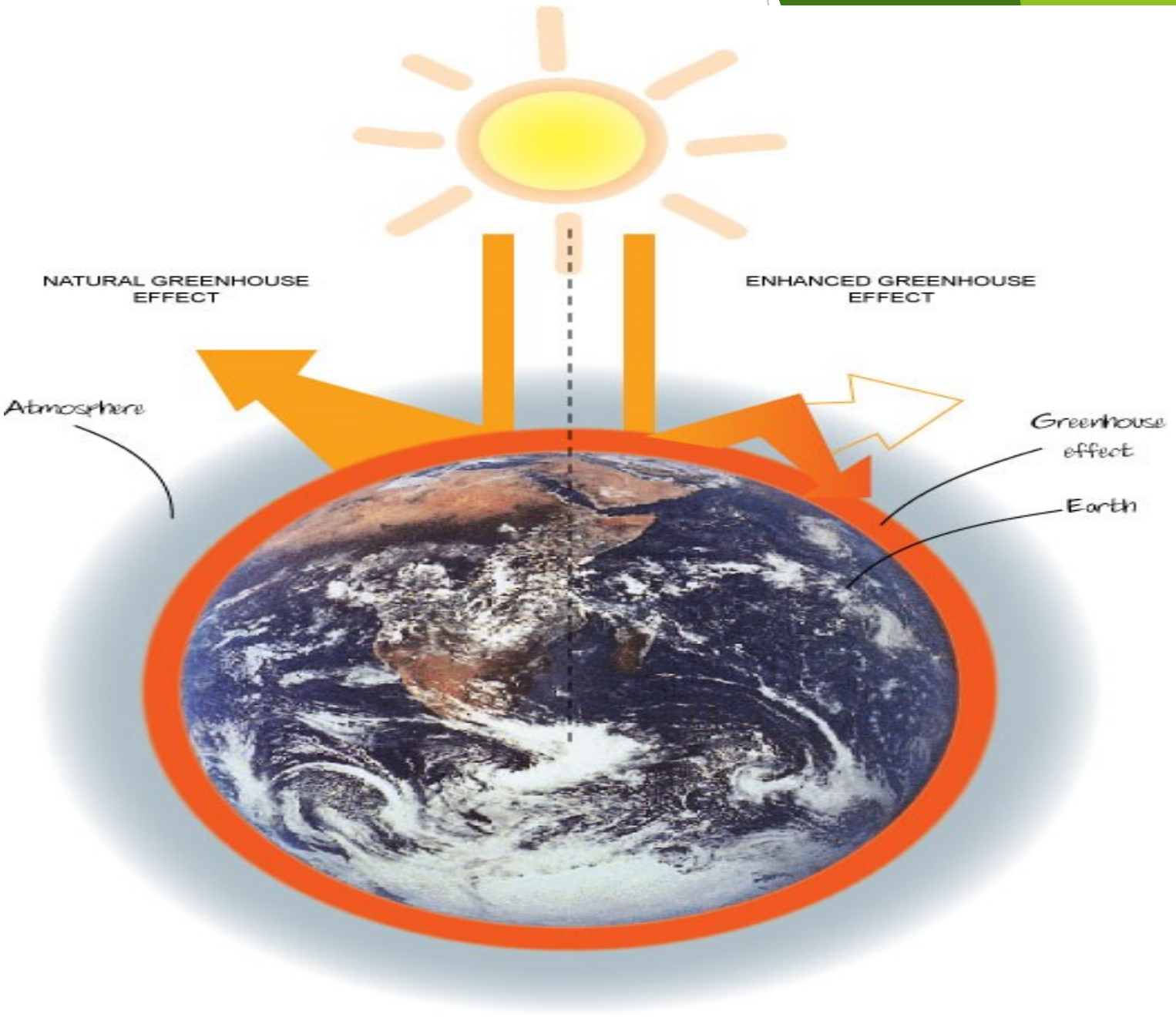
- Being stylish does not mean being wasteful. Buying fewer clothes, shopping second-hand, or upcycling, i.e. creating new clothes out of old ones, helps save water and reduce waste.
- 85% of textiles end up in landfills or are incinerated although most of these materials could be reused.

FIGURE 1
Market share of main fibres, 2016

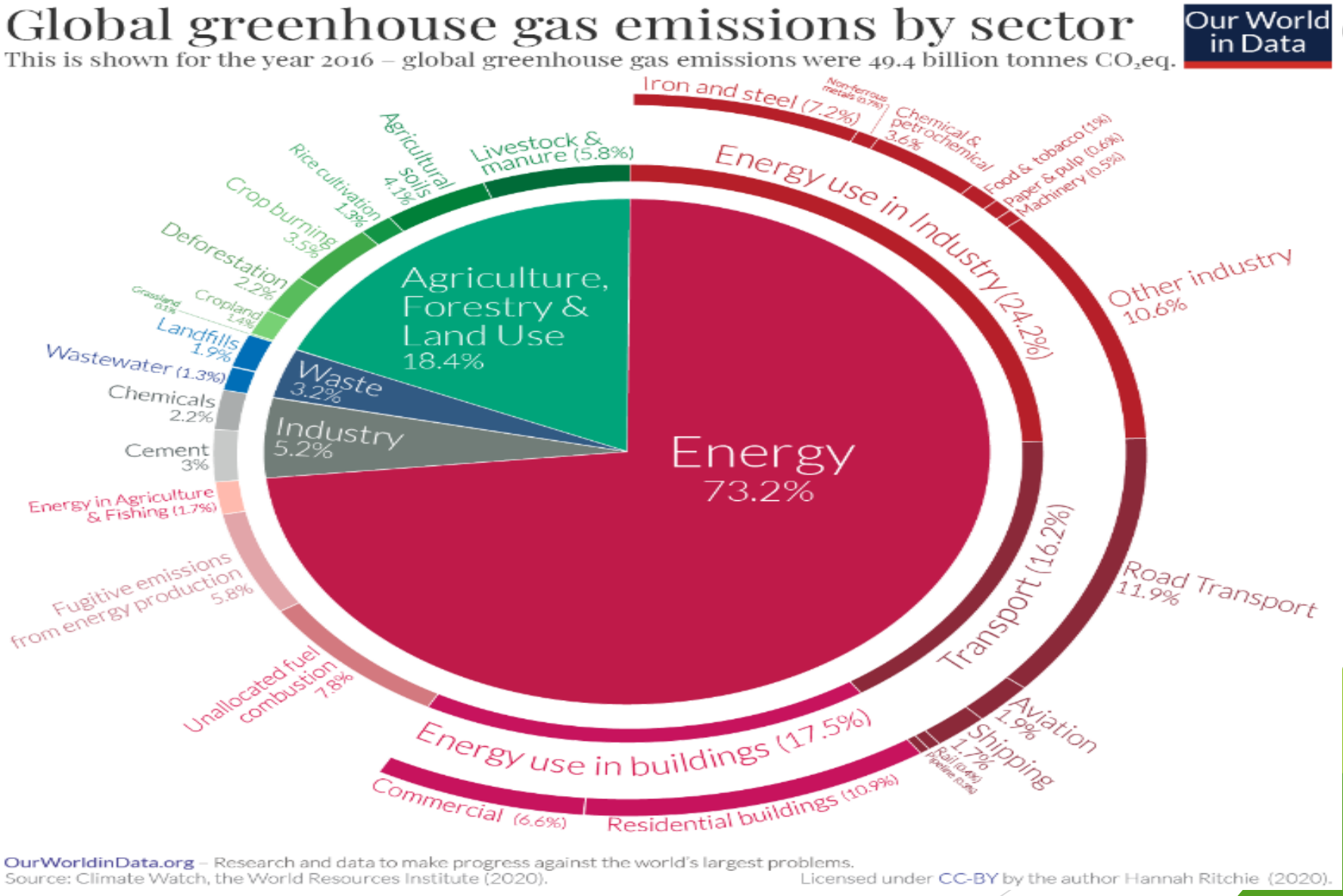


Waste

- Every year, an estimated 11.2 billion tonnes of solid waste is collected worldwide
- A decay of the organic proportion of solid waste is contributing about 5% of global greenhouse gas emissions.

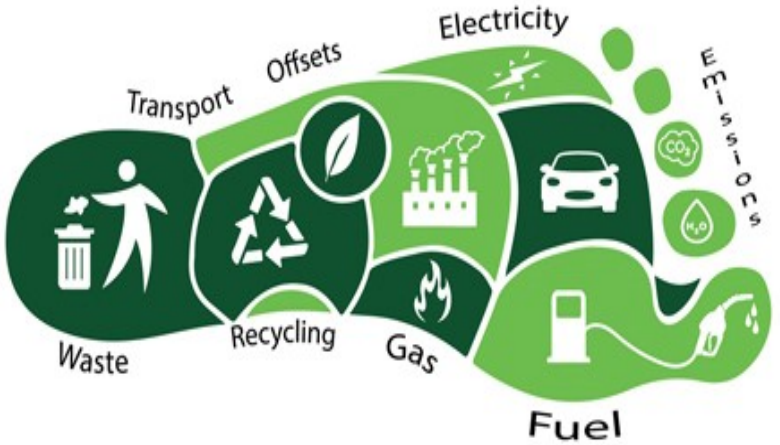


Global green house emission by sector.



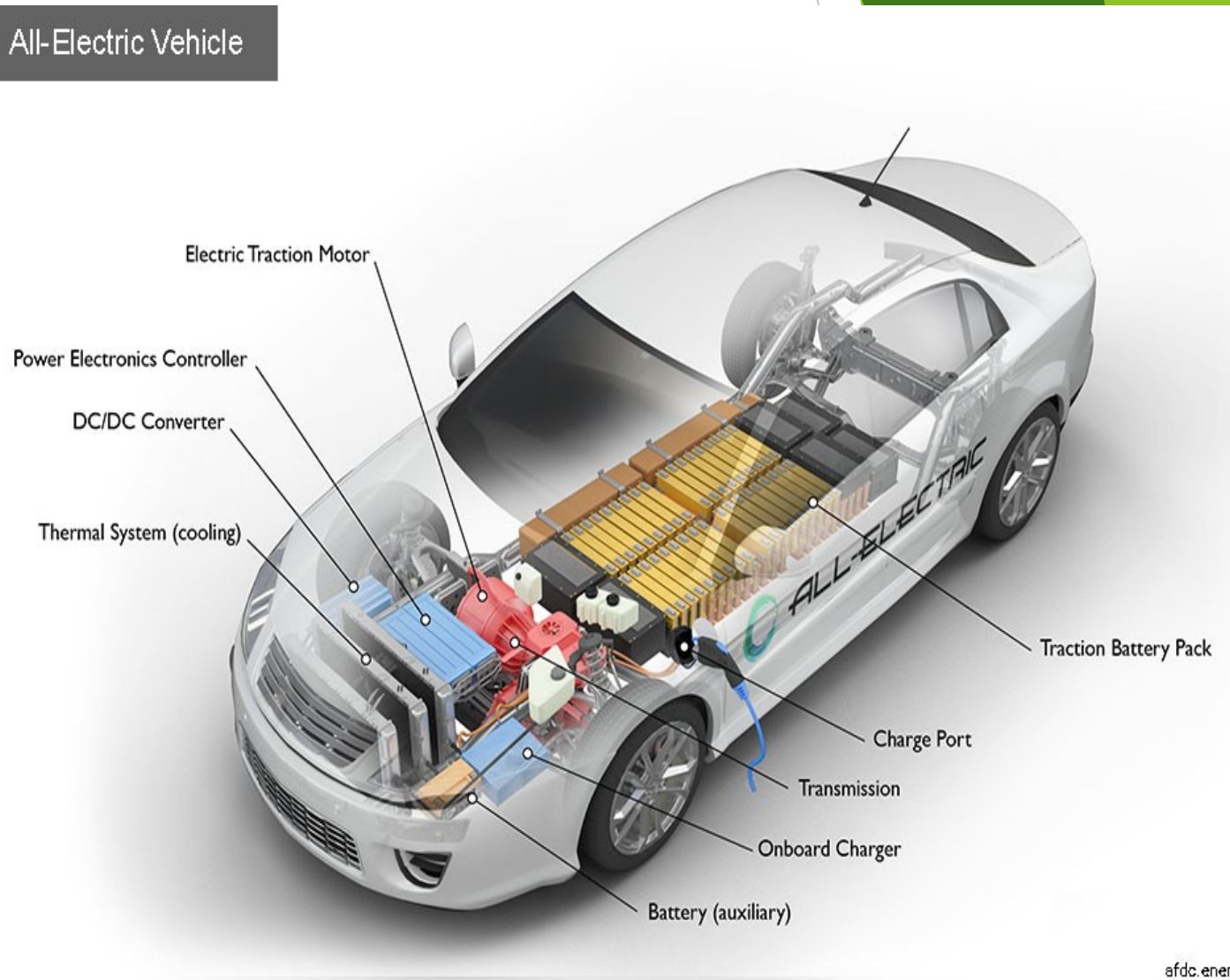
Prevention of global warming

- There are a variety of measures that need to be taken to curb global warming, starting from private homes to large industry scale.
- The "carbon footprint" (the amount of CO_2 a person is responsible for putting into the atmosphere) can be controlled at a personal level by various activities such as driving and flying less, recycling, using less energy consuming appliances, etc. To fully address the threat of global warming on a larger scale, governments are taking measures to limit emissions of CO_2 and other greenhouse gases.
- Another method is to put taxes on carbon emissions or higher taxes on gasoline, so that individuals and companies will have greater incentives to conserve energy and pollute less.

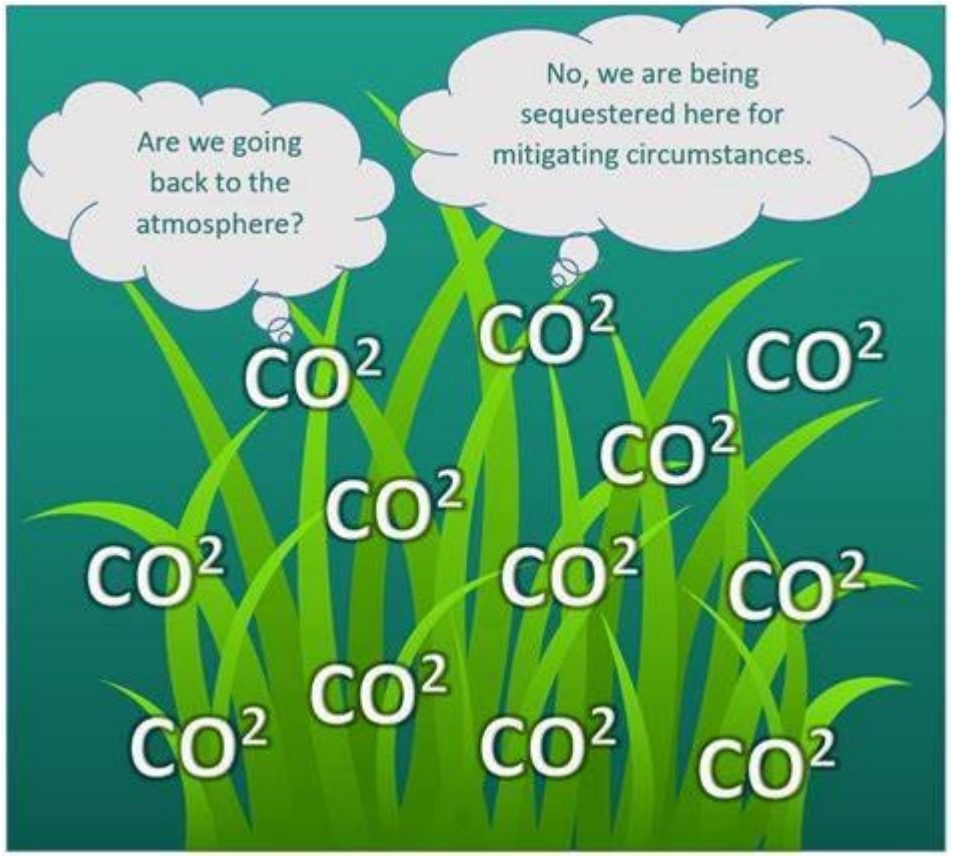


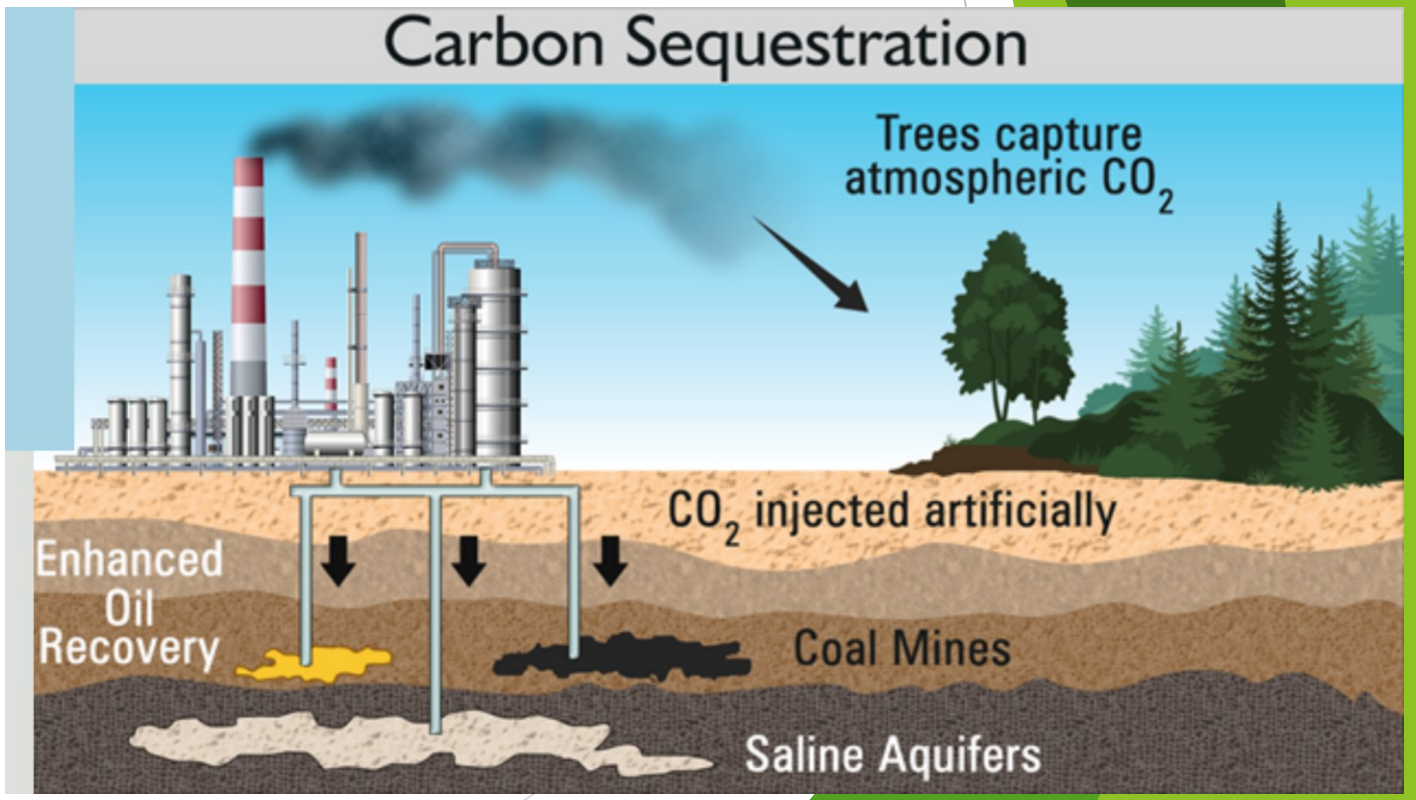
Scientific world contribution.

- Capturing.
- Sequestration.
- which is to efficiently convert it into fuels, chemical feedstock, concrete, household items, and anything that can be consumed in our routine life.
- Developing low carbon emission vehicles.



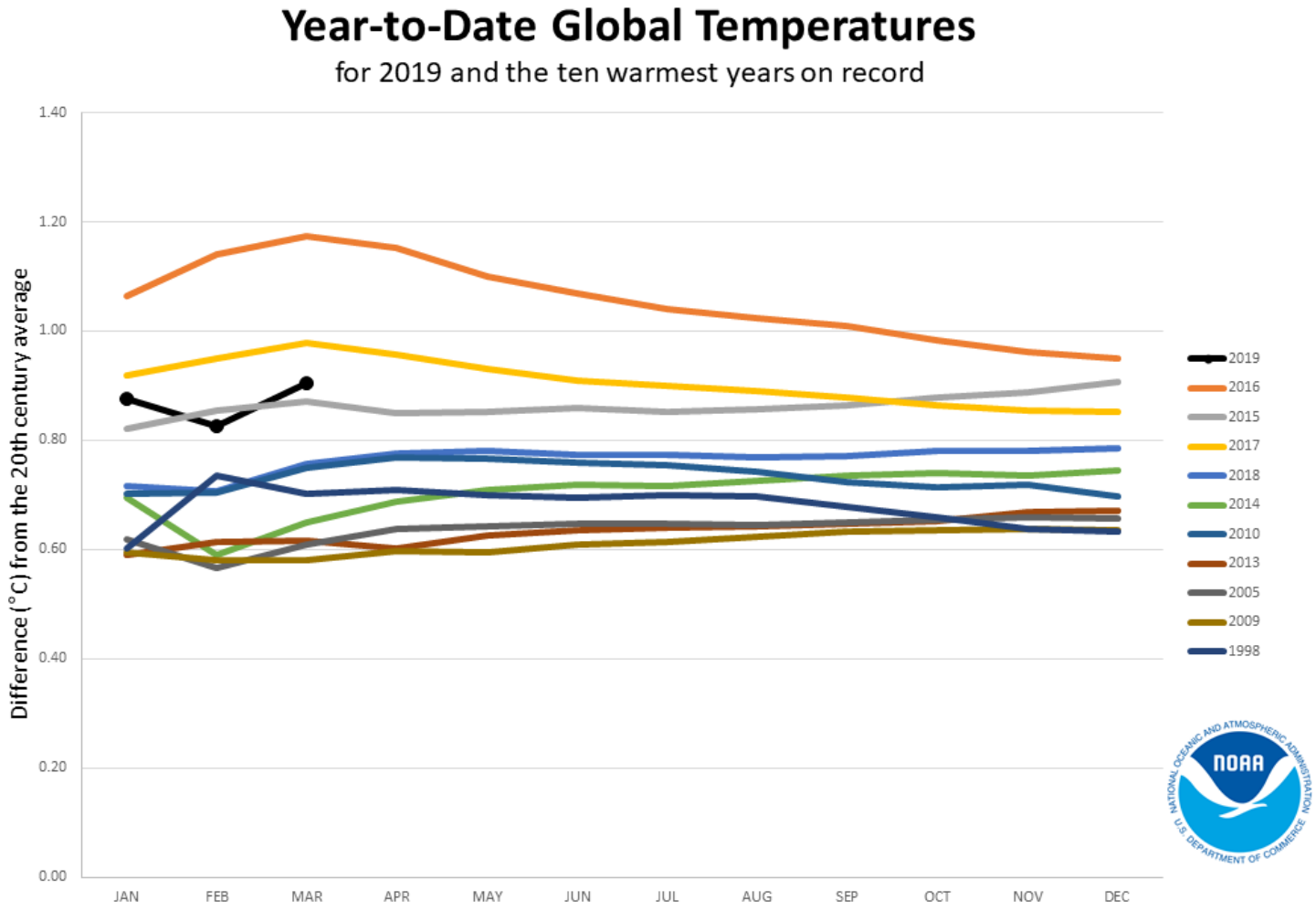
Carbon Capture & Sequestration



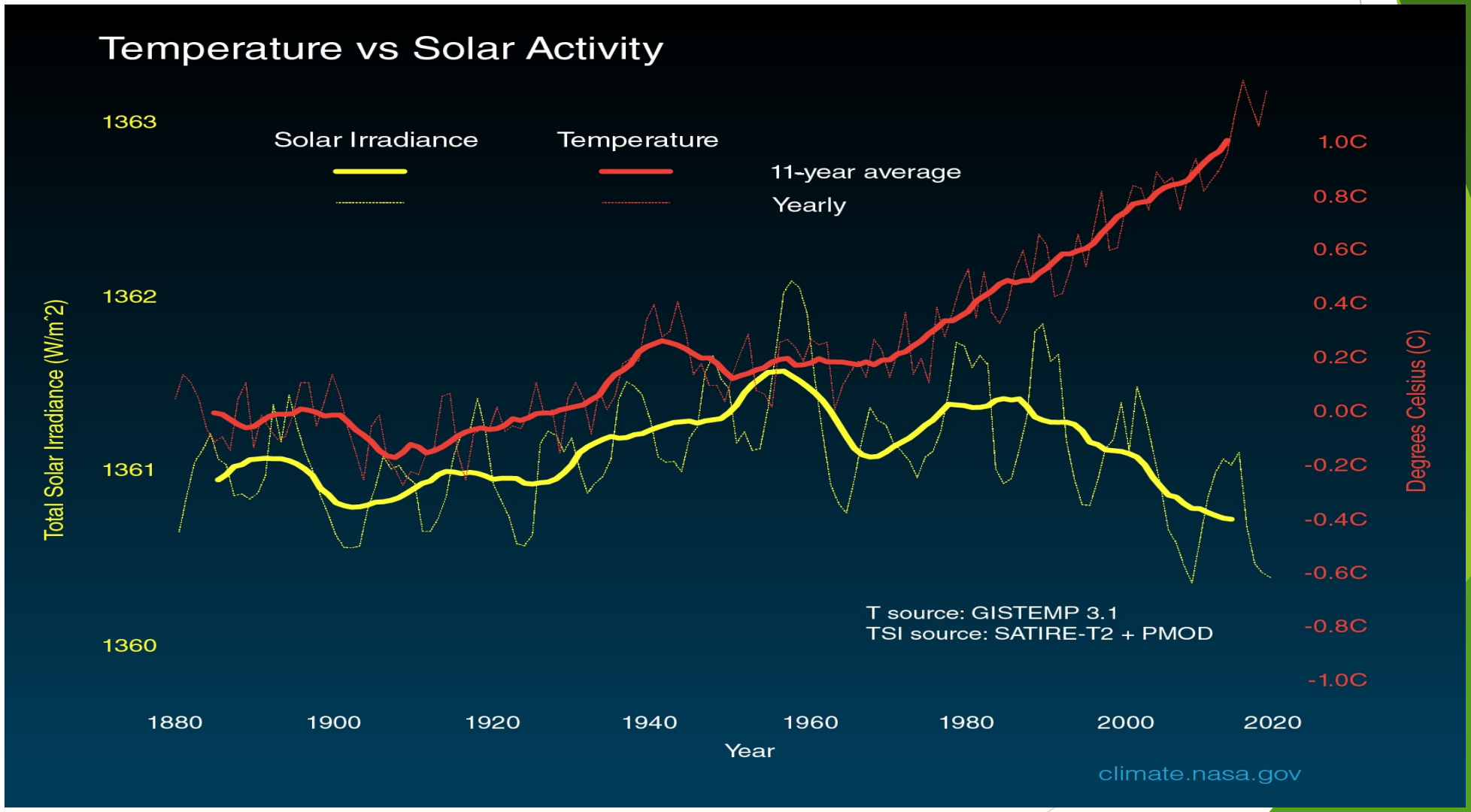


Climate change.

- Climate change refers to long-term shifts in temperatures and weather patterns. These shifts may be natural as argued (sun activity).
- However, since the 1800s, human activities have been the main driver of climate change, primarily due to the burning of fossil fuels (like coal, oil and gas), which produces heat-trapping gases.

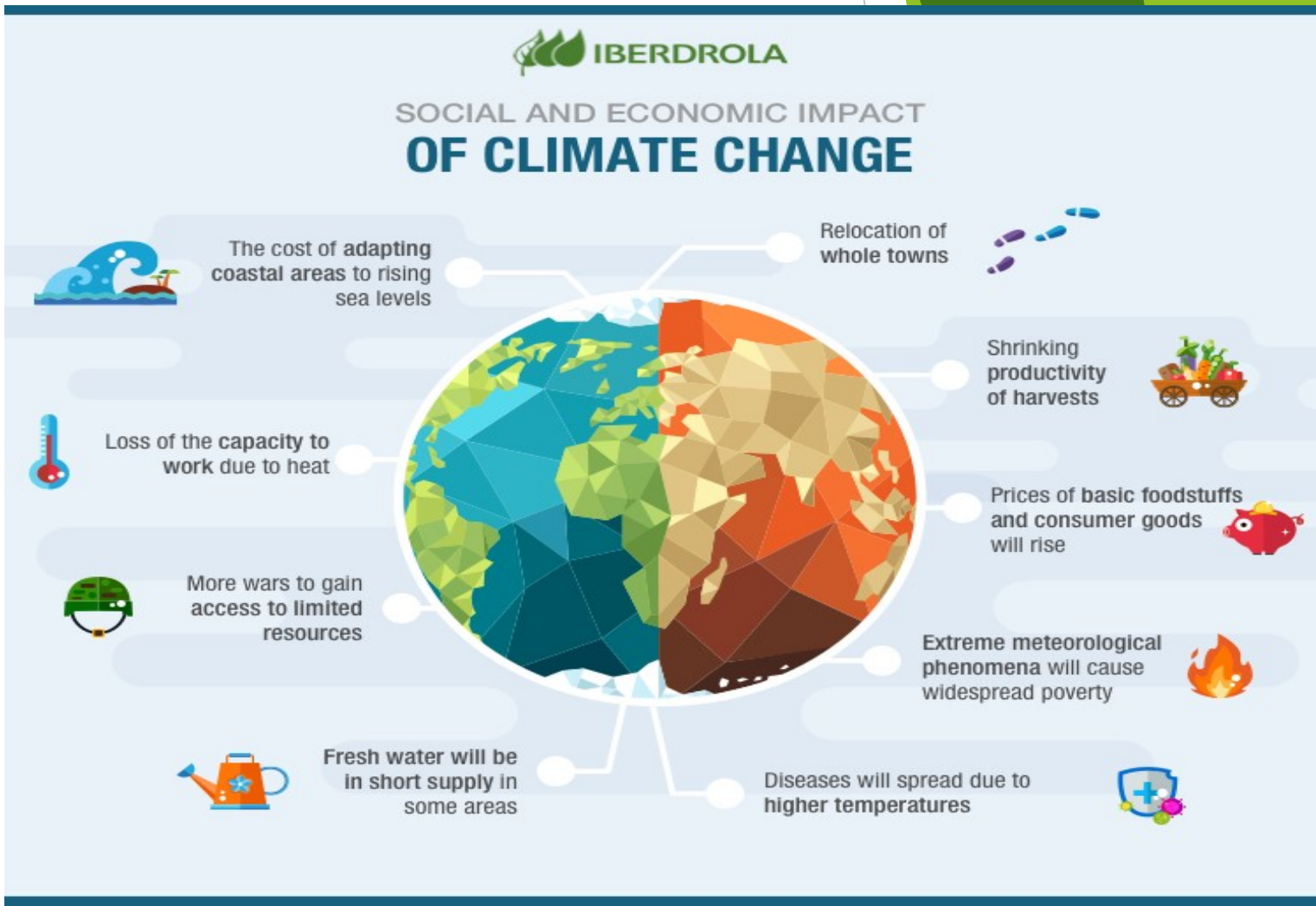


Temperature vs solar activity (NASA)



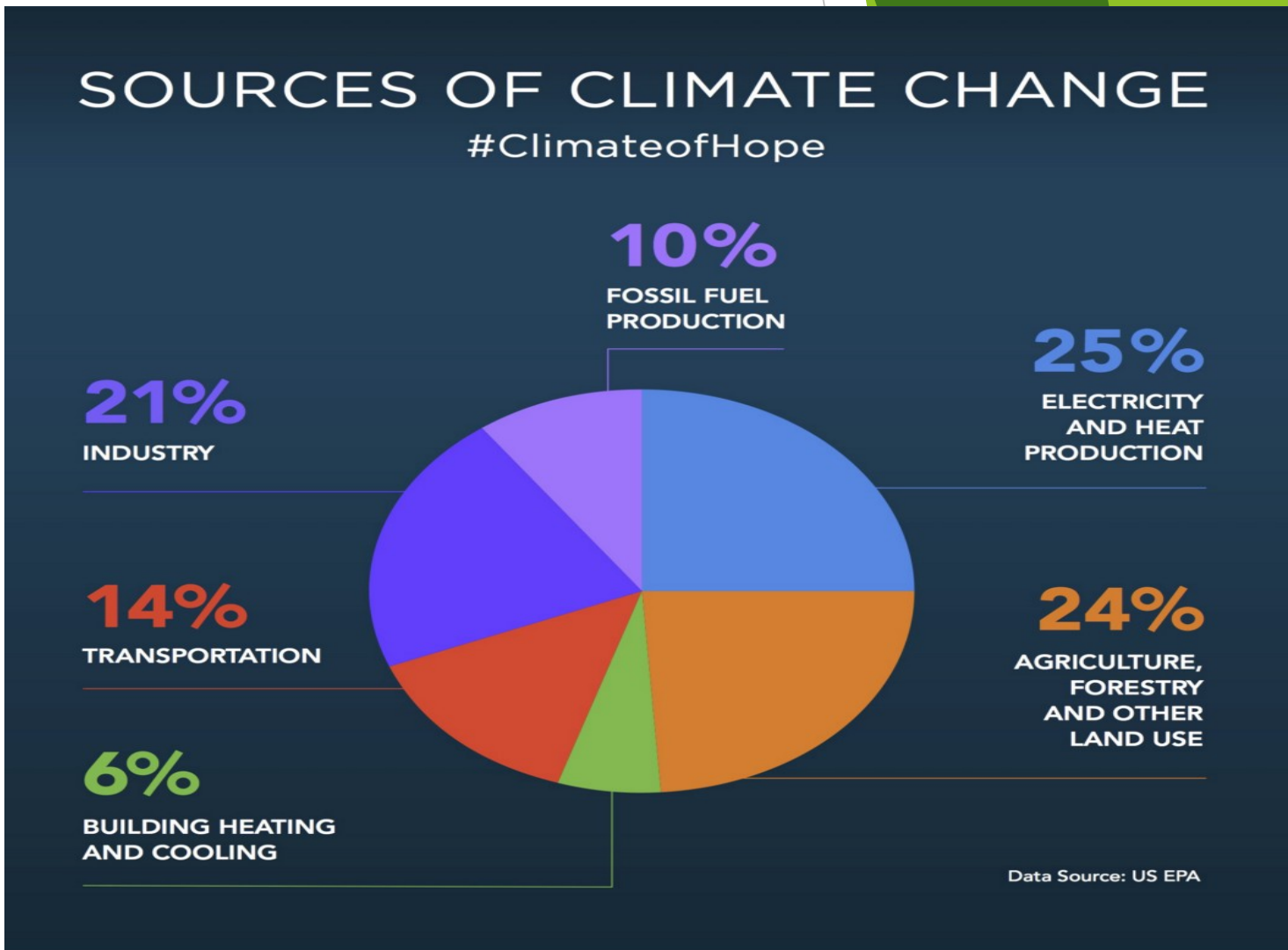
Impact of climate change

- Damage to your home. ...
- More expensive home insurance. ...
- Outdoor work could become unbearable. ...
- Higher electric bills and more blackouts. ...
- Rising taxes. ...
- More allergies and other health risks. ...
- Food will be more expensive and variety may suffer. ...
- Water quality could suffer.



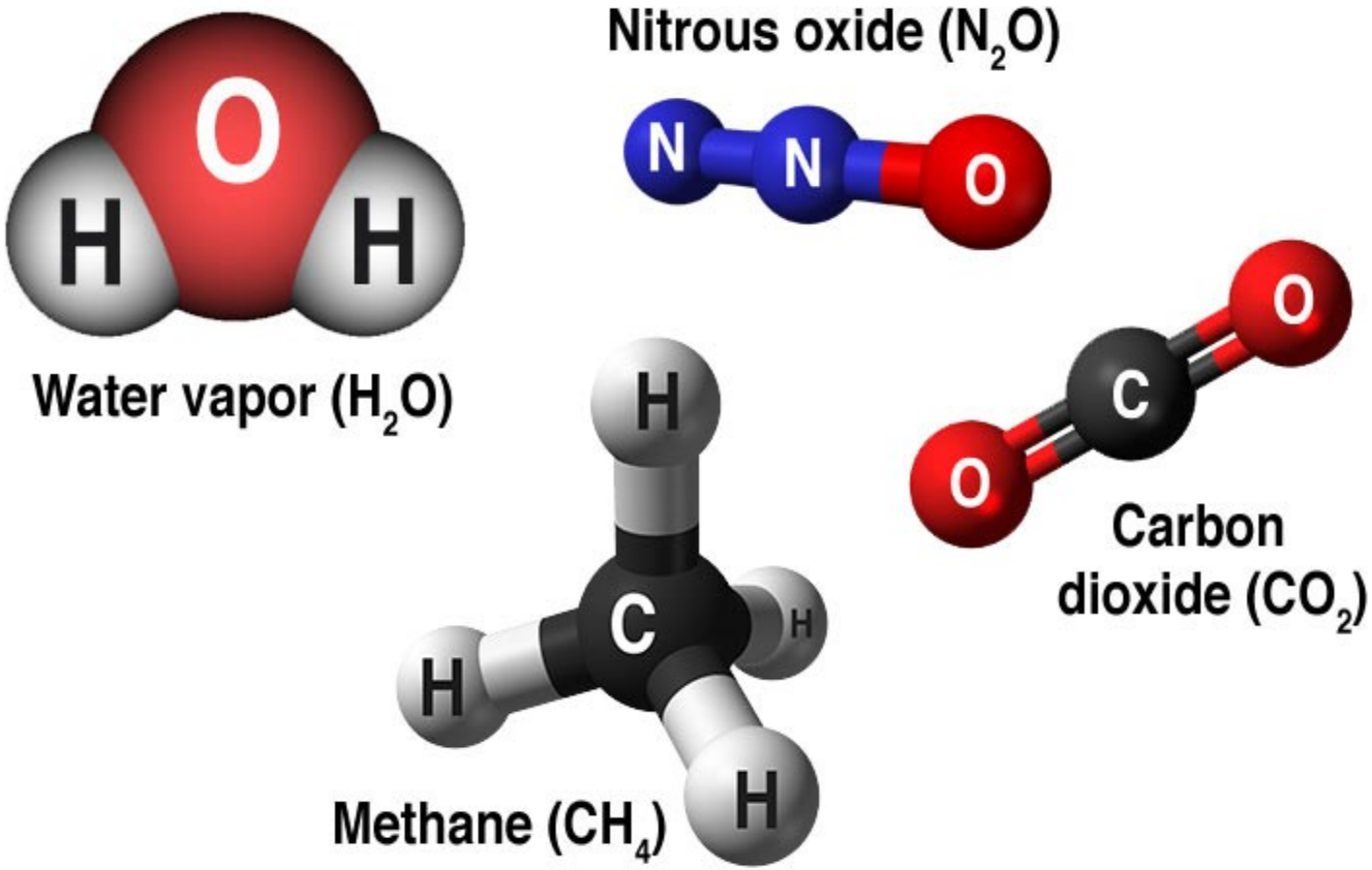
Reasons for climate change.

- Fossil fuels
- Deforestation
- Increasing livestock farming
- Fertilizers containing nitrogen
- Flourinated gases



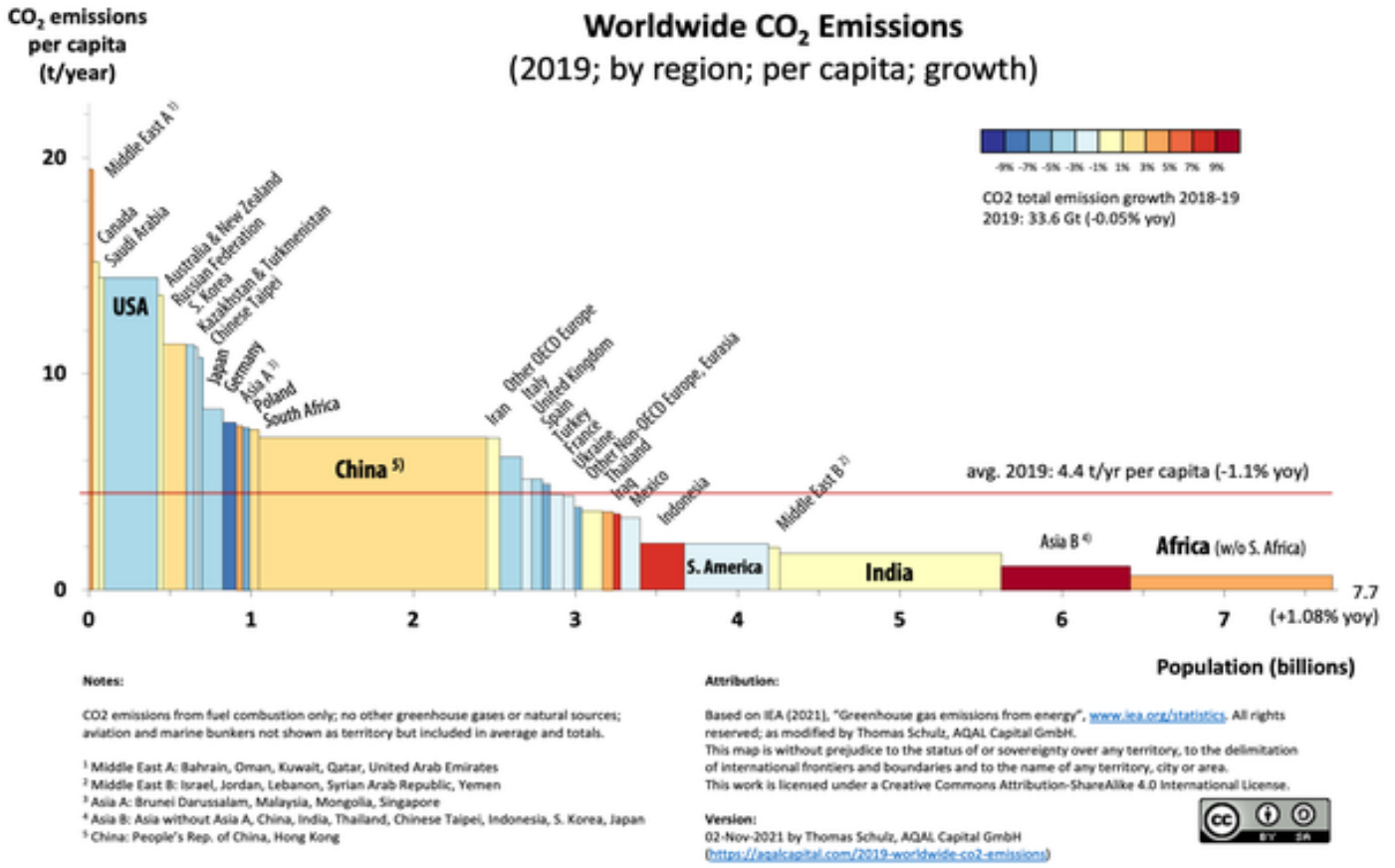
Gases that contribute to the greenhouse effect include

- Carbon dioxide
- Methane
- Nitrous Oxide
- Water vapour



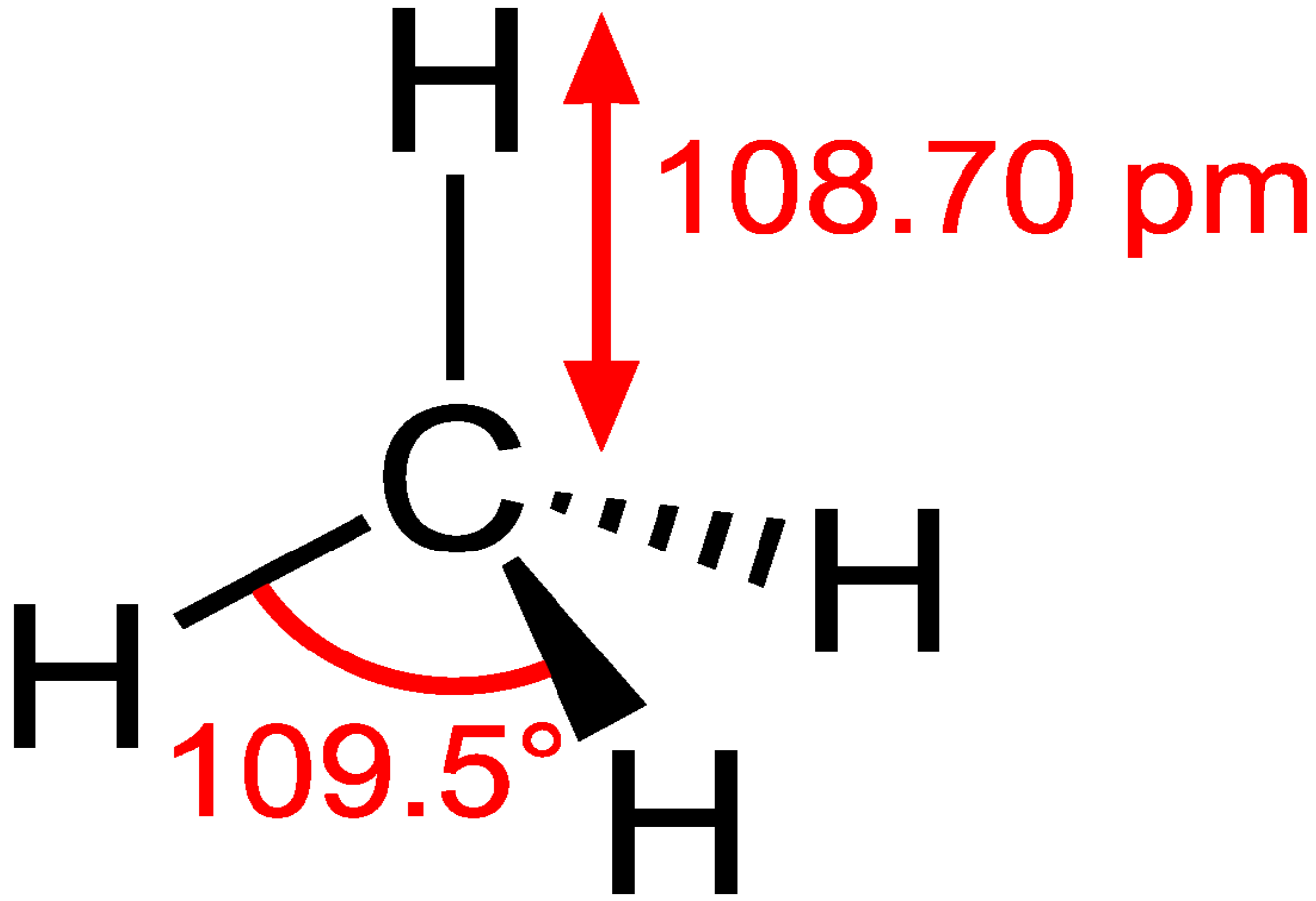
Carbon dioxide

- A minor but very important componer of the atmosphere.
- CO_2 is released through natural processes such as respiration and volcano eruptions and through human activities such as deforestation, land u changes, and burning fossil fuels.
- Humans have increased atmospheric CO_2 concentration by 48% since the Industrial Revolution began. This is th most important long-lived "forcing" o climate change.



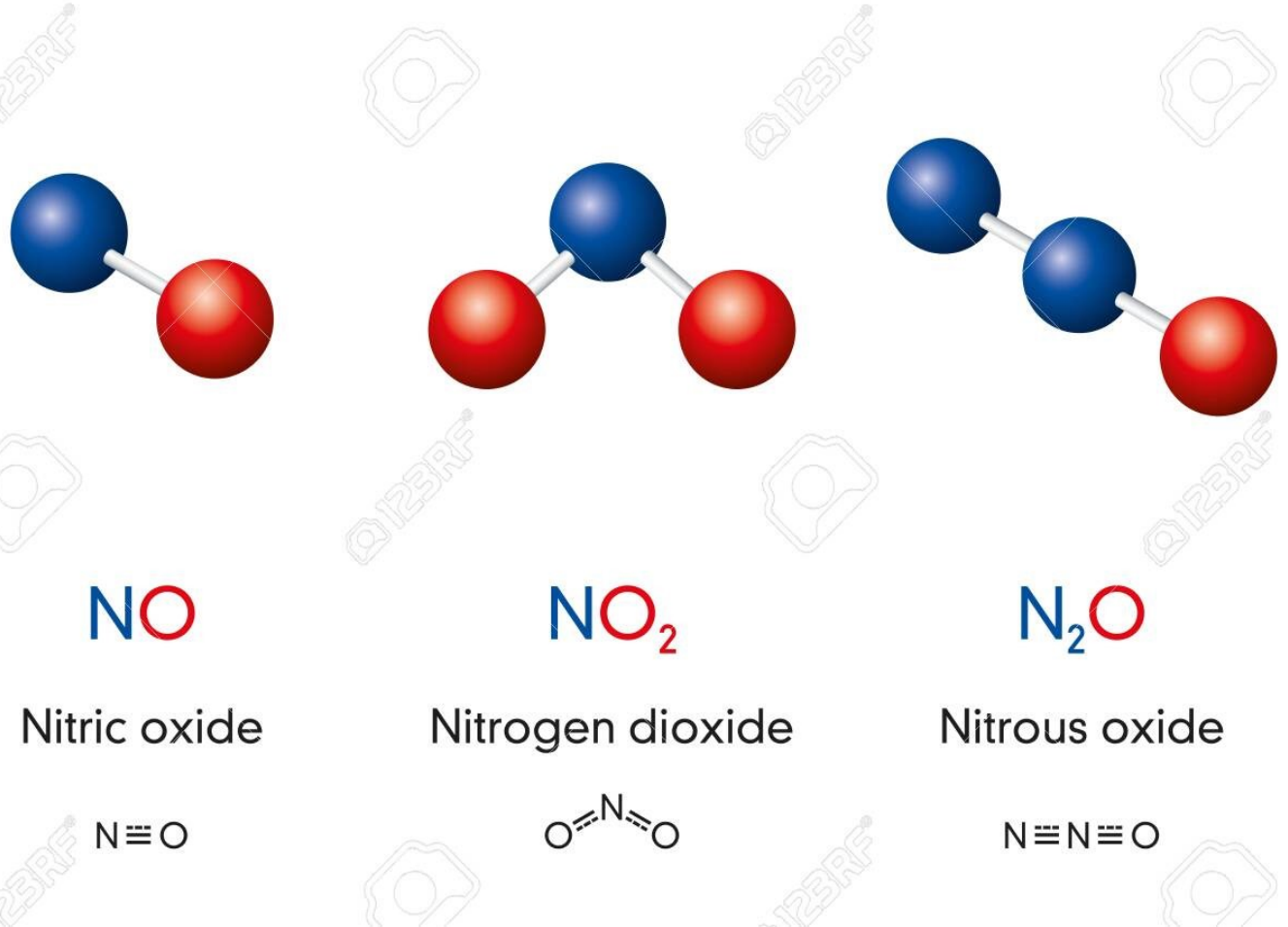
Methane

- A hydrocarbon gas produced both through natural sources and human activities, including the decomposition of wastes in landfills, agriculture, and especially rice cultivation, as well as ruminant digestion and manure management associated with domestic livestock.
- On a molecule-for-molecule basis, methane is a far more active greenhouse gas than carbon dioxide, but also one which is much less abundant in the atmosphere.



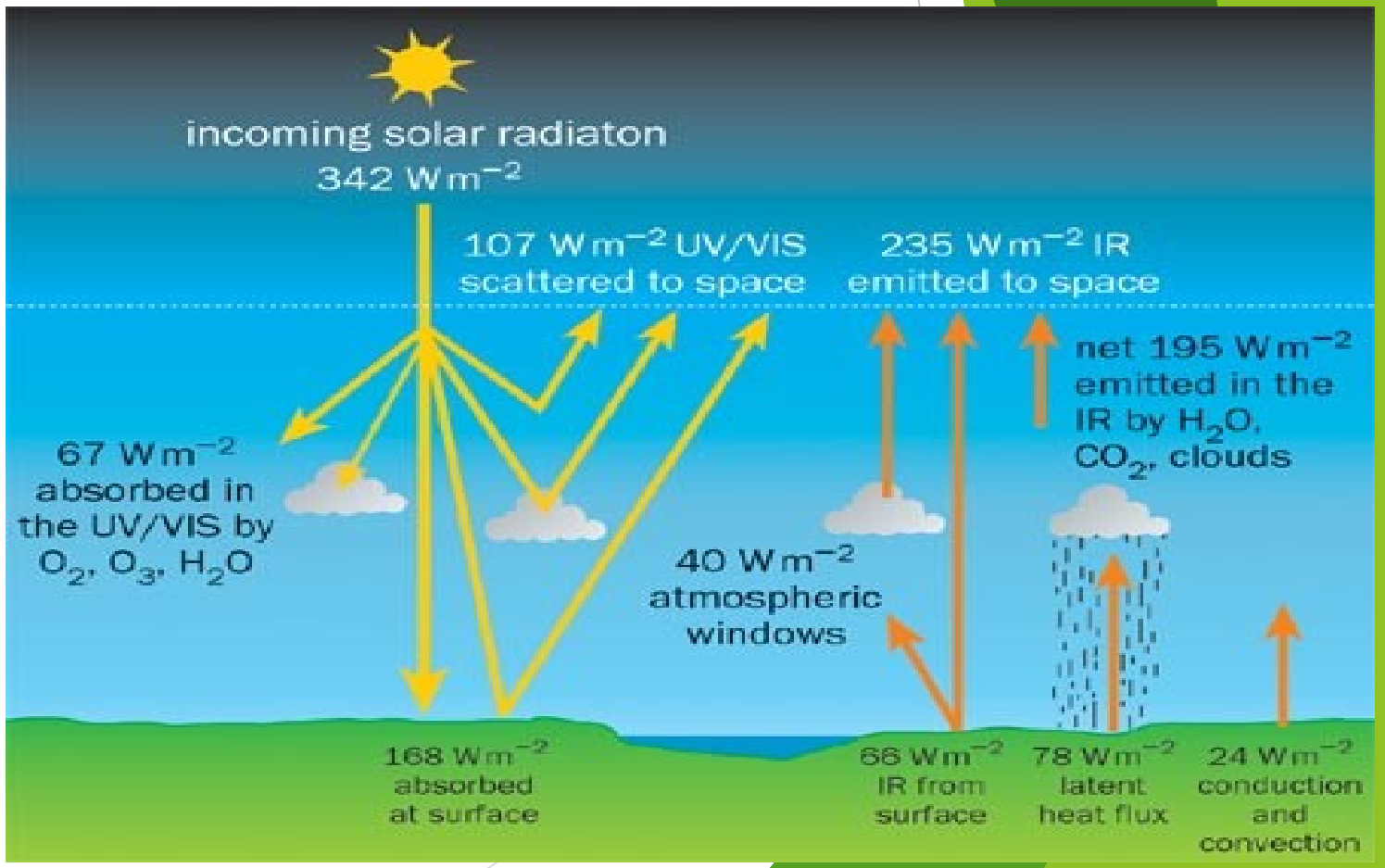
Nitrous oxide

- Nitrous oxide. A powerful greenhouse gas produced by soil cultivation practices, especially the use of commercial and organic fertilizers.
- Fossil fuel combustion
- Nitric acid production
- Biomass burning

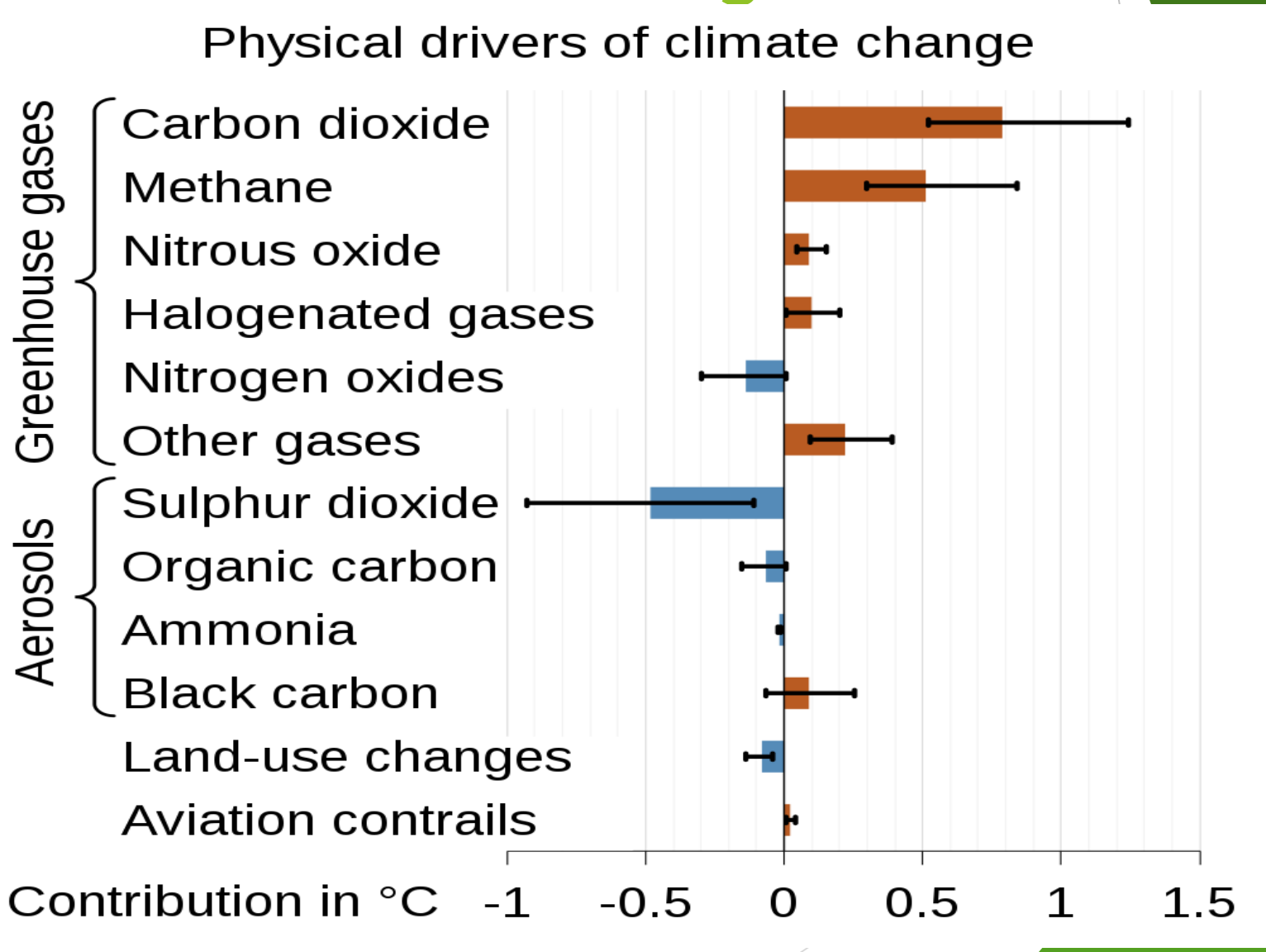


Water vapour.

- The most abundant greenhouse gas, but importantly, it acts as a feedback to the climate.
- Water vapor increases as the Earth's atmosphere warms, but so does the possibility of clouds and precipitation, making these some of the most important feedback mechanisms to the greenhouse effect



Physical drivers of climate change.



Climate change gas mitigation:

- The First Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) was released in 1990 and stressed the dangers of climate change.
- Global fossil fuel energy use and energy-related car-bon dioxide (CO_2) emissions have continued to rise, and in 2016 emissions were 55%above the 1990 value.
- The 2015 Paris Climate Conference set 2.0^{o}C temperature rise above preindustrial values as a safe limit with aspirational target of 1.5^{o}C.

Mitigation - reducing climate change - involves reducing the flow of heat-trapping greenhouse gases into the atmosphere

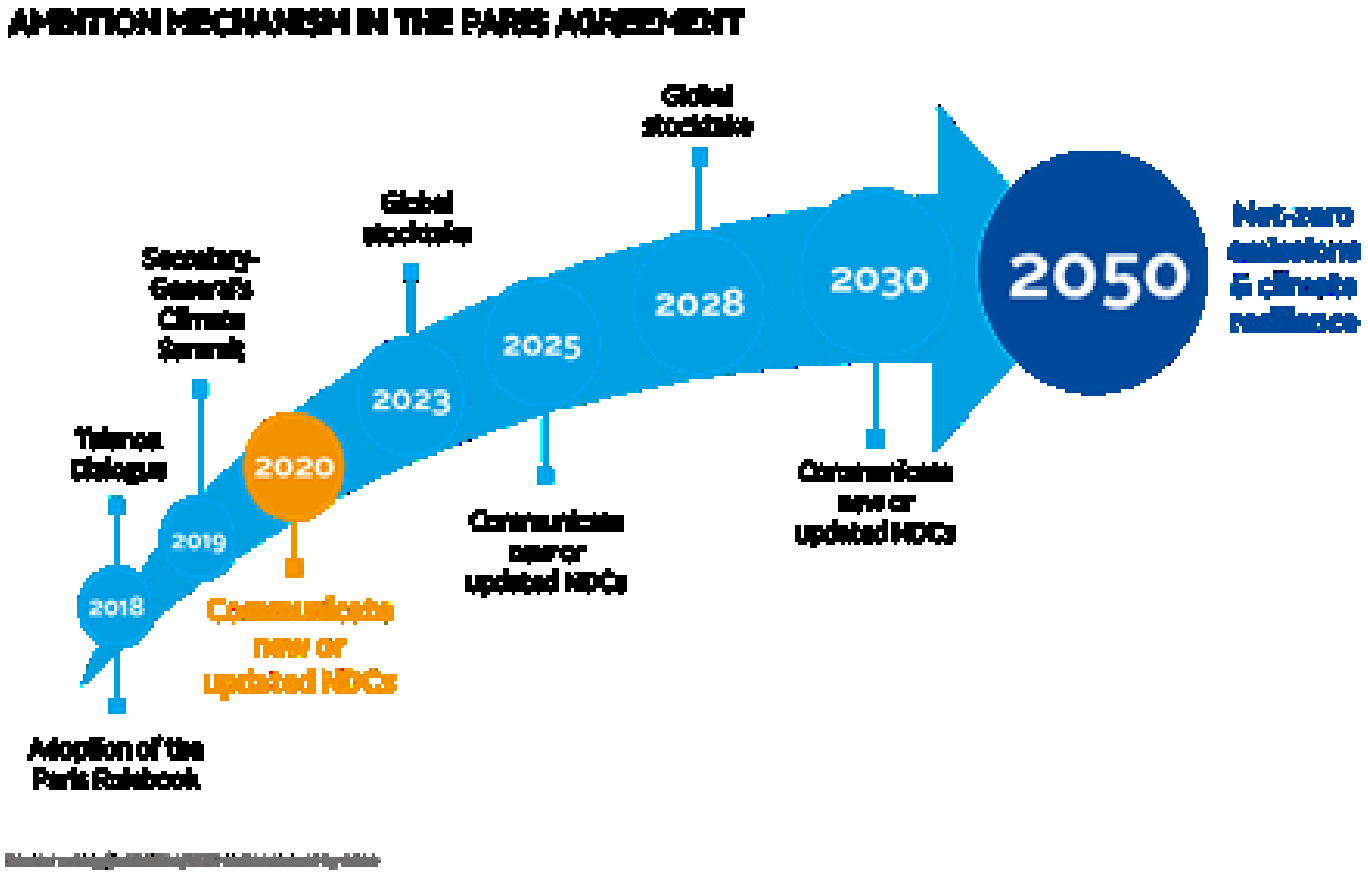
- Reducing sources of these gases.
- Enhancing the "sinks" accumulate and storage of these gases.
- Avoid significant human interference with the climate system.
- Stabilize greenhouse gas levels in a timeframe sufficient to allow ecosystems to adapt naturally to climate change.
- Ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner (source from the NASA 2014 report on Mitigation of Climate Change from the United Nations Intergovernmental Panel on Climate Change, page 4).

Paris climate agreement

- Legally binding international UN treaty under the UNFCCC
- Aim to keep global warming: well below **2ºC.**
- Preferably to **1.5ºC** compared to pre-industrial levels.

How does Paris agreement work?

- Nationally determined contributions.
- Long term strategies.
- Technology transfer.
- Financial support each other.
- Emphasis on climate related capacity building.



Role of renewable energy

- The good news is that this transition is taking place, with a third of global power capacity in 2018 based on renewable energy, according to the International Renewable Energy Agency.
- ✓ Solar energy
- ✓ Wind energy
- ✓ Hydropower
- ✓ Bioenergy
- ✓ Geothermal energy & Marine energy

Role of hydrogen

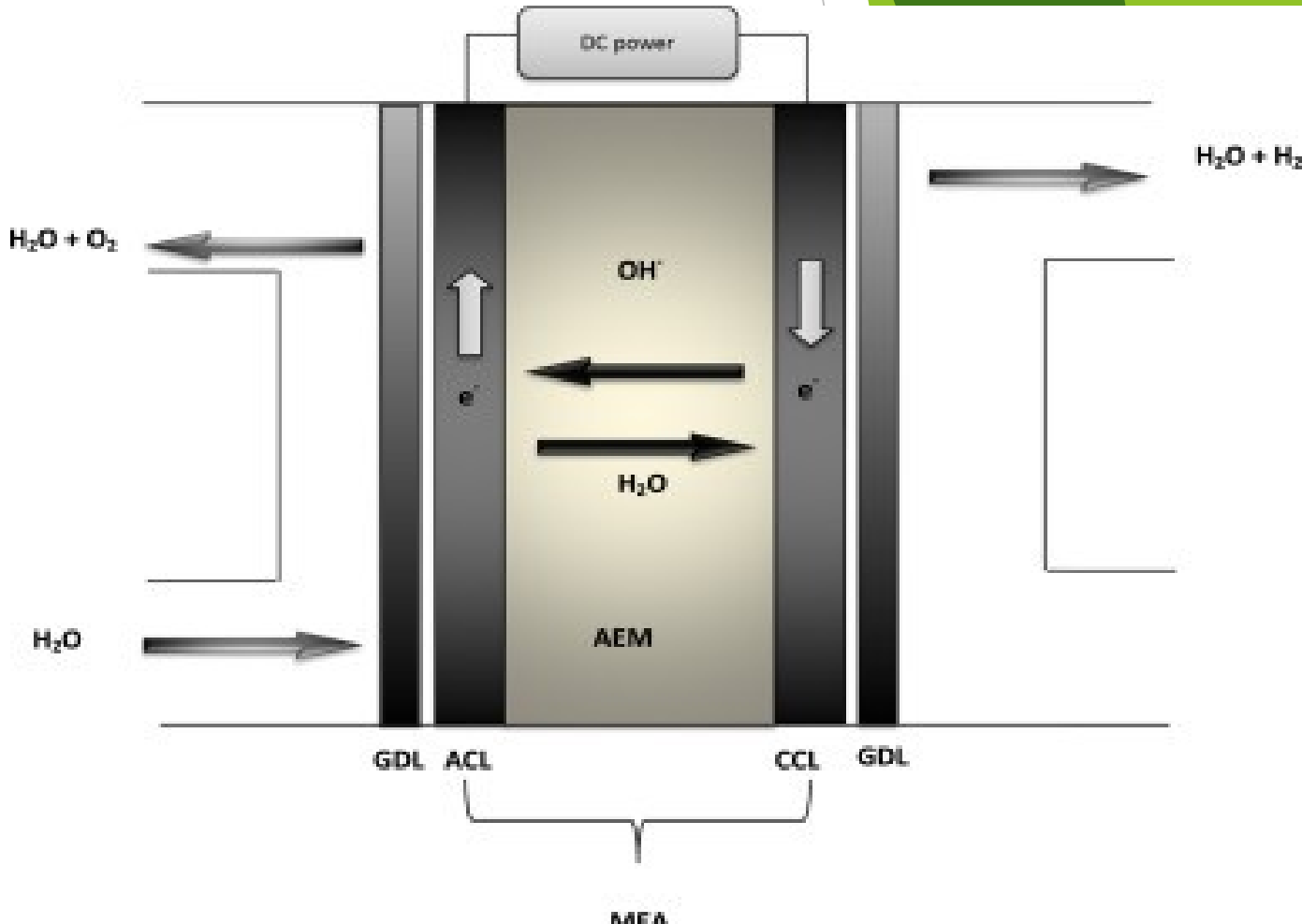
- 60 million tons of hydrogen produced annually.
- Today, 80% of the hydrogen we produce is for three main industries: refineries, ammonia production or metal processing.
- Hydrogen also has the potential to be used as fuel for power and transportation.
- Green hydrogen is net zero carbondioxide emission.
- Hydrogen production should increase 60 million tons a year to 500-700 million tons by mid-century, without considering rapid uptake of Fuel cell electric vehicles (FCEV).

Economic Case for Production of H_2.

- Producing low-carbon hydrogen cost-effectively remains one of the key barriers.
- Green hydrogen accounts 4% of global hydrogen production.
- Alkaline and PEM (proton exchange membrane) electrolysis for green hydrogen production.
- Alkaline technology is mature and lower-cost.
- PEM technology is newer and characterized by higher efficiencies, a smaller footprint and a better capacity to operate under flexible, decentralized operations.

Emerging new technology H_2

- Anion Exchange Membrane (AEM) electrolysis
- It combines benefits of both Alkaline and PEM, while simultaneously overcoming drawbacks



Role of electric vehicles

- One study found that emissions from EVs have emissions up to 43% lower than diesel vehicles.
- In the UK in 2019, the lifetime emissions per kilometer of driving a Nissan Leaf EV were about three times lower than for the average conventional car.
- While there are still challenges that EVs need to overcome, regarding battery production, proper disposal of used battery etc.

UAE: A case study

- United Arab Emirates is located in the Middle East.
- In the last years, the impact of global warming on the UAE has intensified the already existing environmental issues, including water scarcity and limited agricultural land.
- UAE is listed as having the 29th highest carbon dioxide emissions.

UAE: Challenges….

- World's seventh largest natural resource of oil and 17th-largest natural gas reserve.
- United Arab Emirates ranked in the position of the 9th wealthiest country in the world in terms of GDP per capita.
- These financial resources support their adaptation capacity to "climate change-induced challenges
- NASA satellites show sea levels rising at a rate of 3.22 millimeters per year.
- Specifically in the UAE, reports expect a land loss of 1–6% (1,555–5,000 km^2) by 2100.

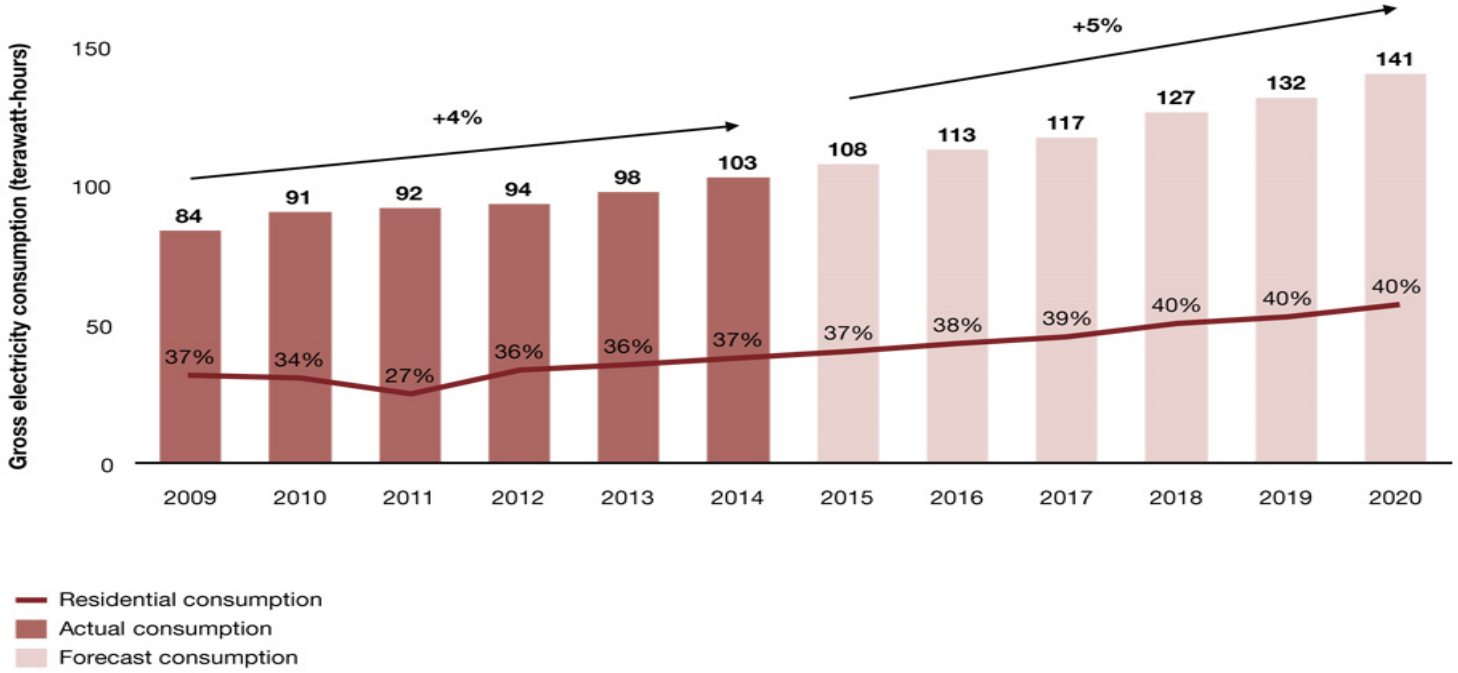
UAE electricity consumption

- Since the boom of the oil industry occurred in the early 21st century, the population and its consumption of energy have sharply increased.

Exhibit 1

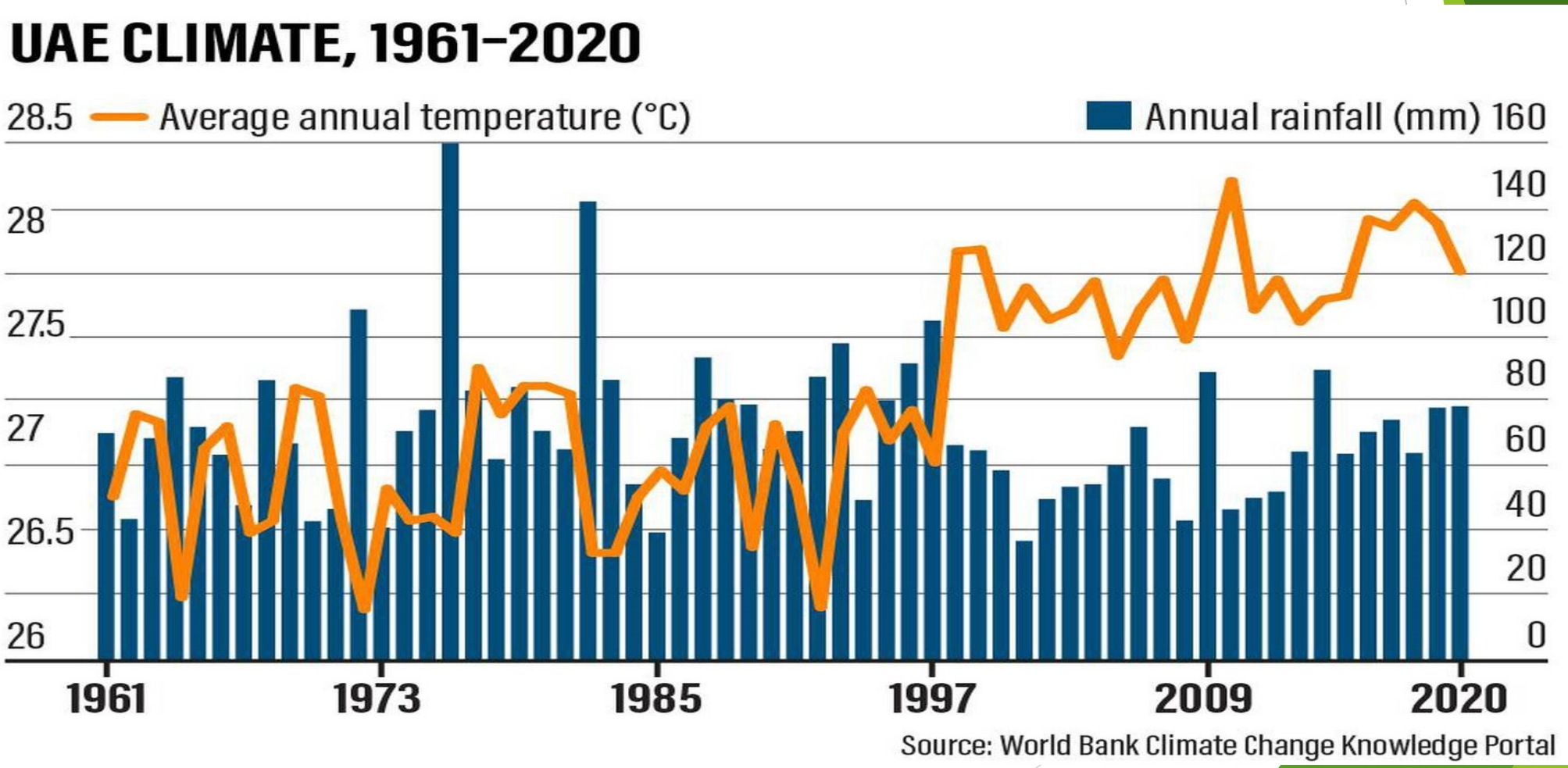
The UAE's gross domestic electricity consumption will grow rapidly over the next five years

Total Electricity Consumption and Residential Percentage of Total



Source: The Economist Intelligence Unit, 2015; International Energy Agency (IEA)

UAE climate change

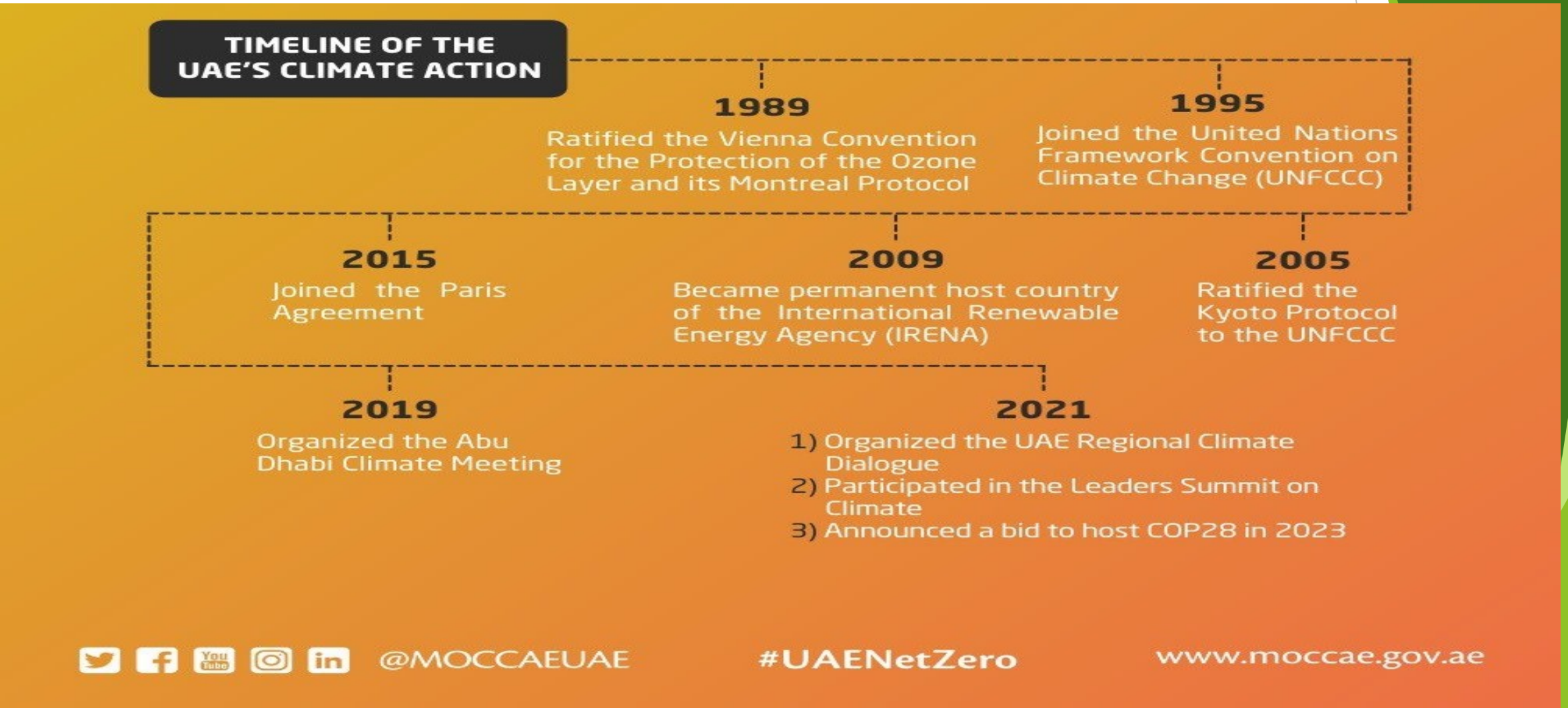


UAE Net Zero 2050 Target

The UAE Net Zero by 2050 strategic initiative is a national drive to achieve net-zero emissions by 2050, making the Emirates the first Middle East and North Africa (MENA) nation to do so.

- Strategic alignment(Paris agreement)
- Coordination efforts.
- Renewable energy.

UAE's history of climate action.



National Climate Change Plan of the United Arab Emirates 2017-2050.

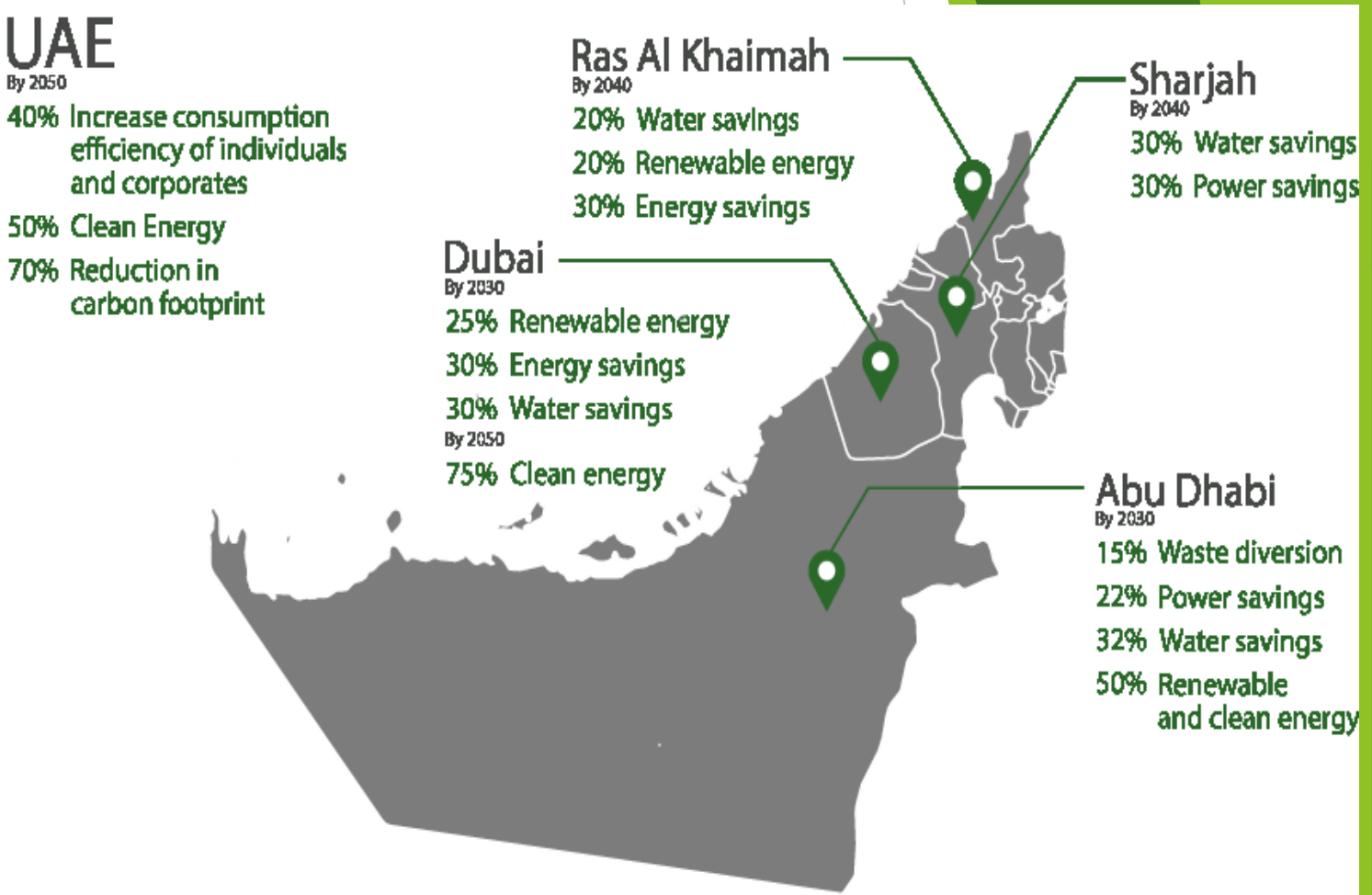
- This Climate Plan was developed by the Ministry of Climate Change, in partnership with the Global Green Growth Institute (GGGI). The document also benefited from the technical inputs from the Emirates Wildlife Society in association with WWF (EWS-WWF).
- It was developed based on detailed situation and gaps analysis, international benchmarking, and series of group and bilateral consultation meetings with various experts and representatives from the government, private sector, and academic institutes

Means of implementation.

- Innovative Green Finance.
- Capacity Building.
- Governance, and Monitoring and Evaluation.
- Awareness Raising and Communications
- International Cooperation.

Government measures for sustainability

- In line with Vision 2021 and National Agenda, the UAE needs to generate **27 percent of the energy requirements from clean energy sources**, reduce its per capita greenhouse gas emissions and achieve average oil consumption of 5 tonnes per person by 2021.



Hydrogen production

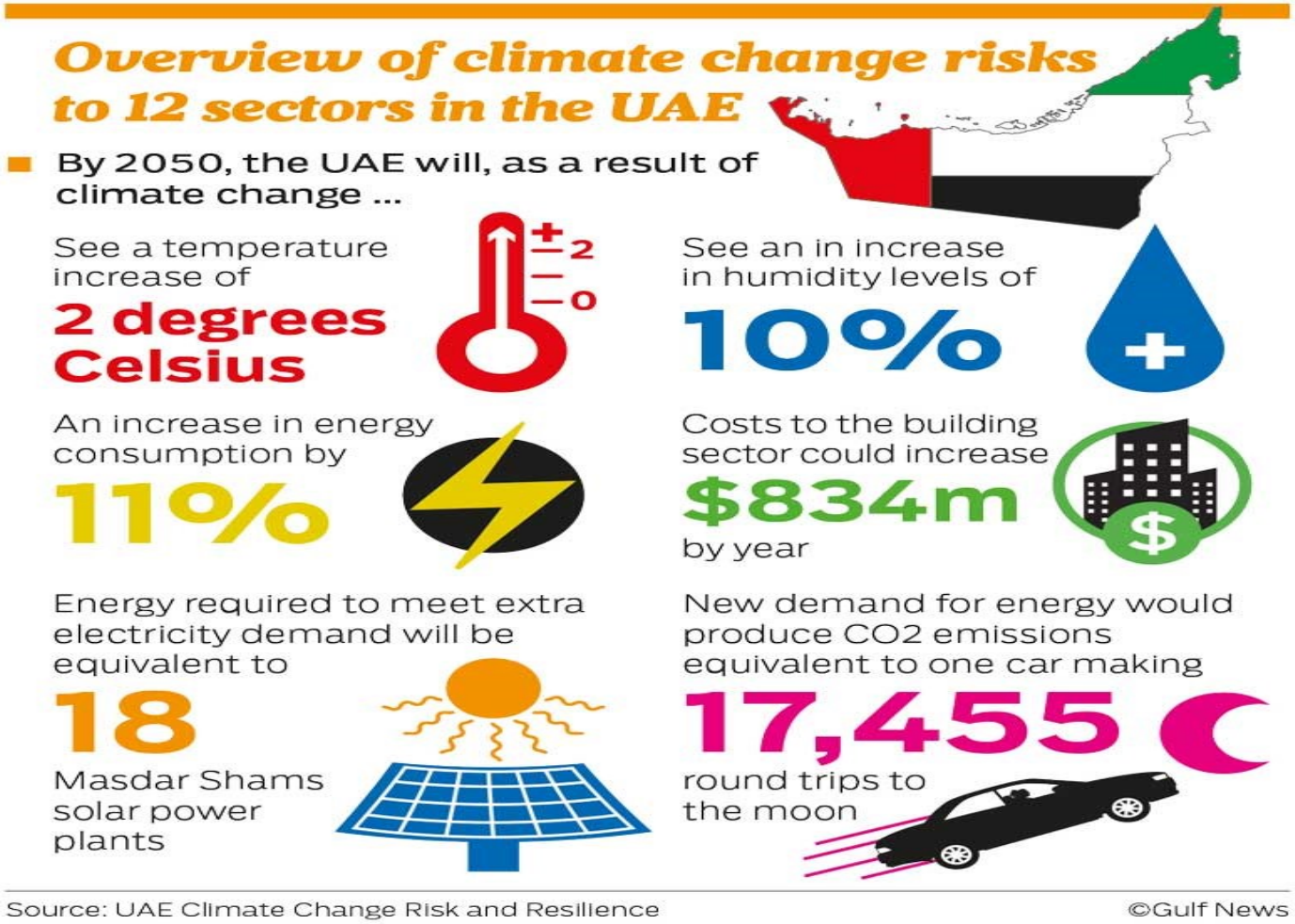
- Abu Dhabi's $1 billion initative to build a solar-powered hydrogen and ammonia plant.
- The project will initially include 100 megawatts of solar capacity.
- It will rise to 800 Megawatts in the future.
- ADNOC-BP collaboration including the potential development of clean hydrogen hubs in both the UK and UAE at a scale of at least 2 Gigawatts (GW).

Electric vehicles

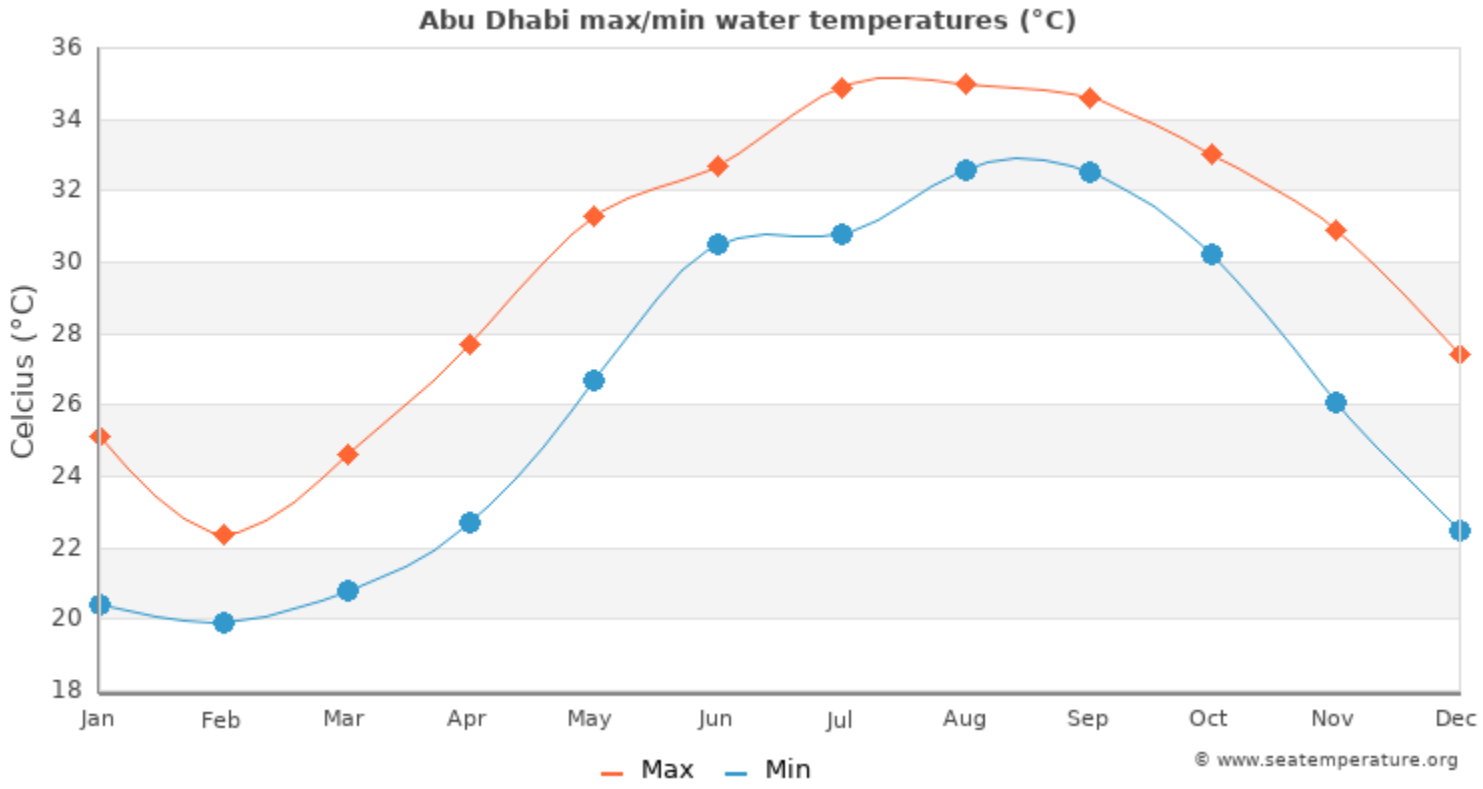
- Increasing governmental push to encourage individuals to buy electric cars over a conventional petrol model.
- DoE has given owners of private charging units a grace period until December 31st 2021 to have a sub-meter installed.
- There are around **650 charging points** in the UAE.

UAE state of climate report 2021

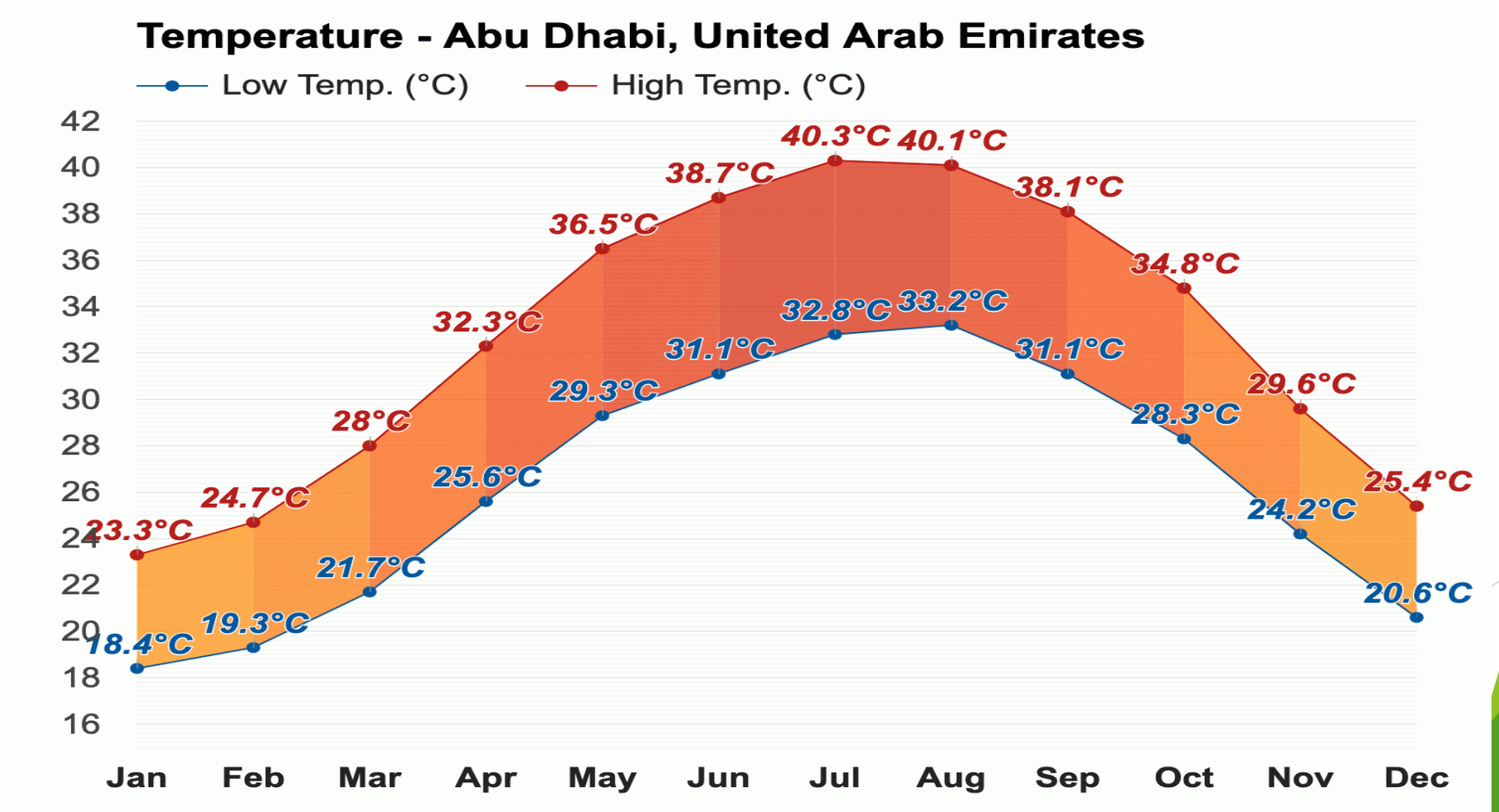
- Purpose of research and modelling studies.
- Understanding Arab world climate change and their impacts.
- Understand critical sectoral impact on climate change.



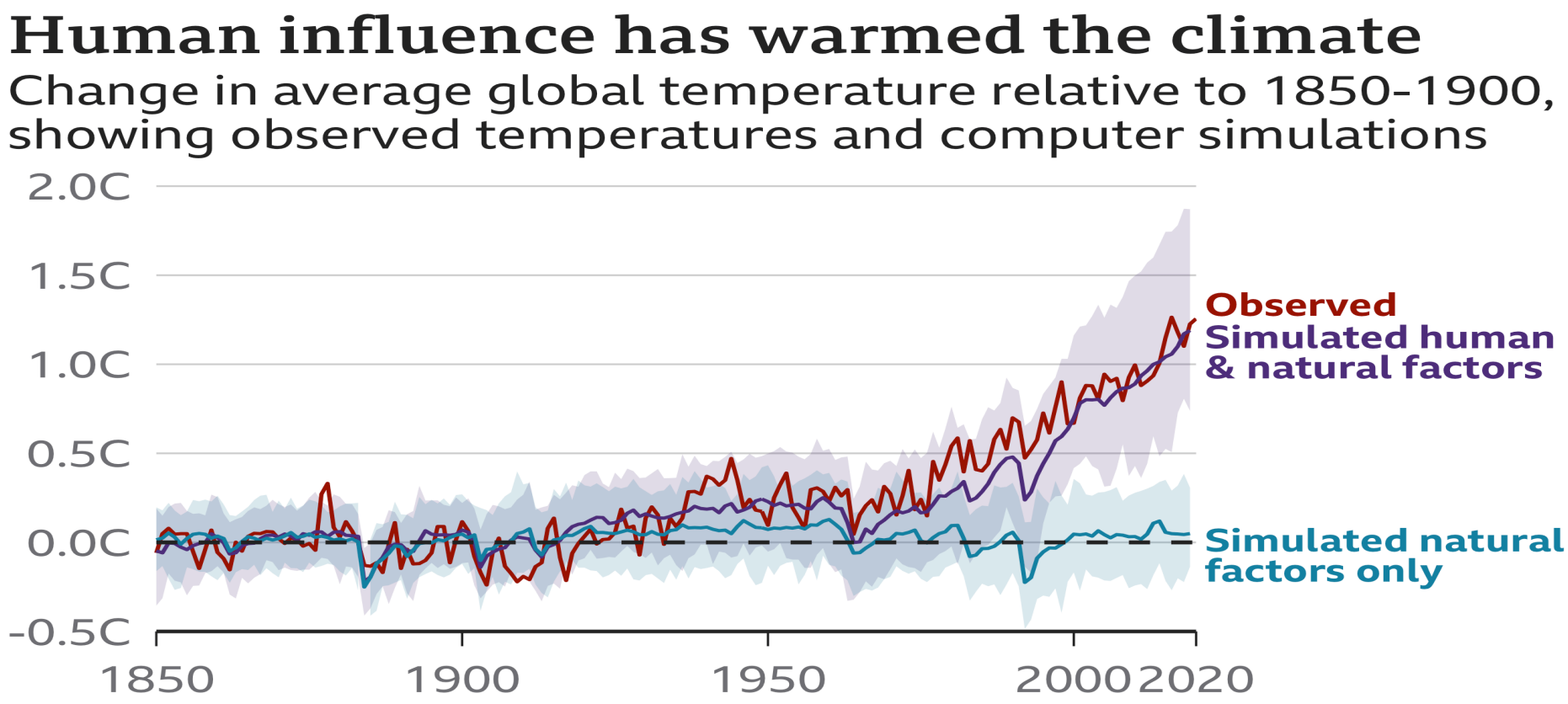
UAE sea water temperature.



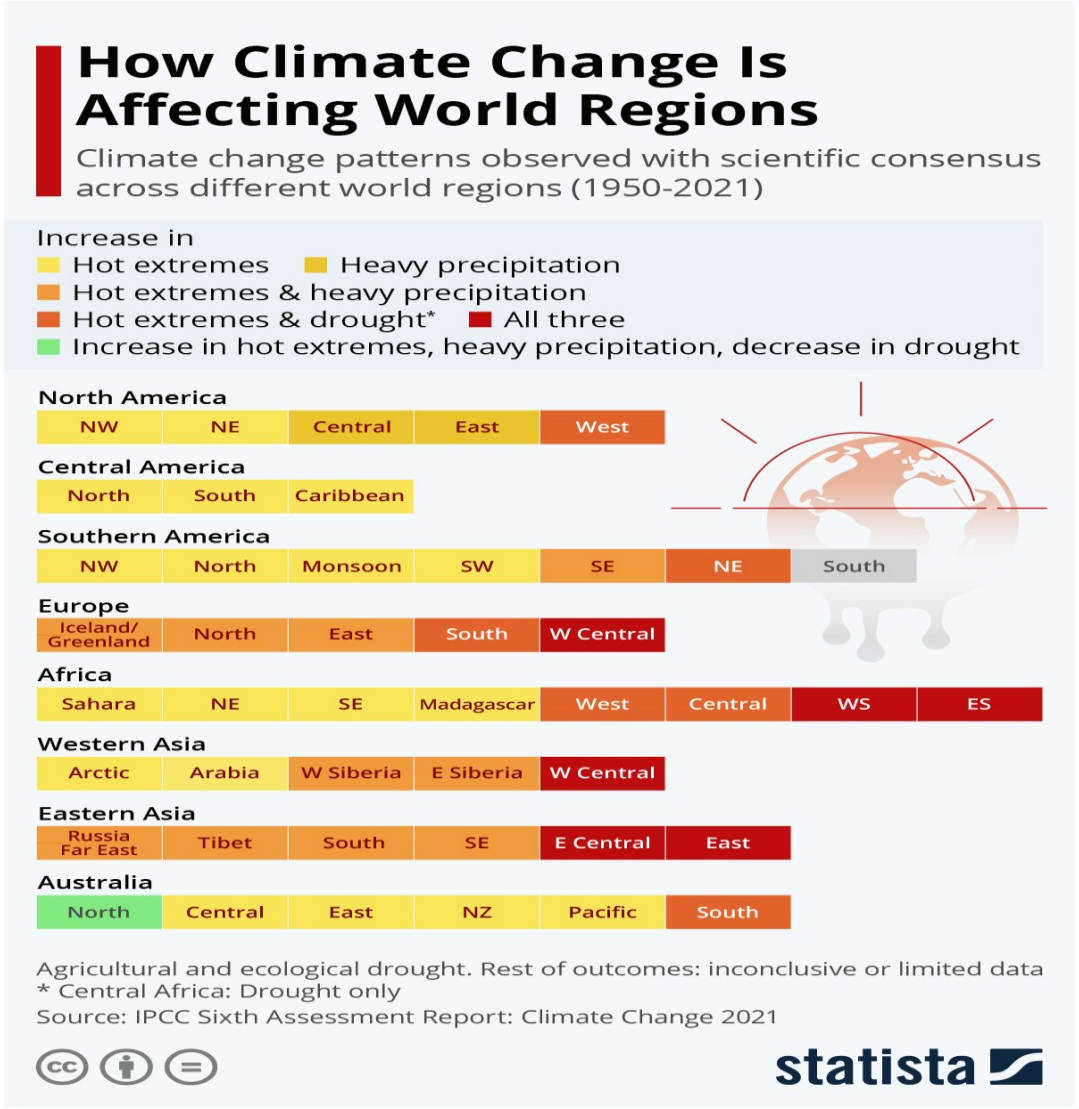
UAE-Abu Dhabi temperature.



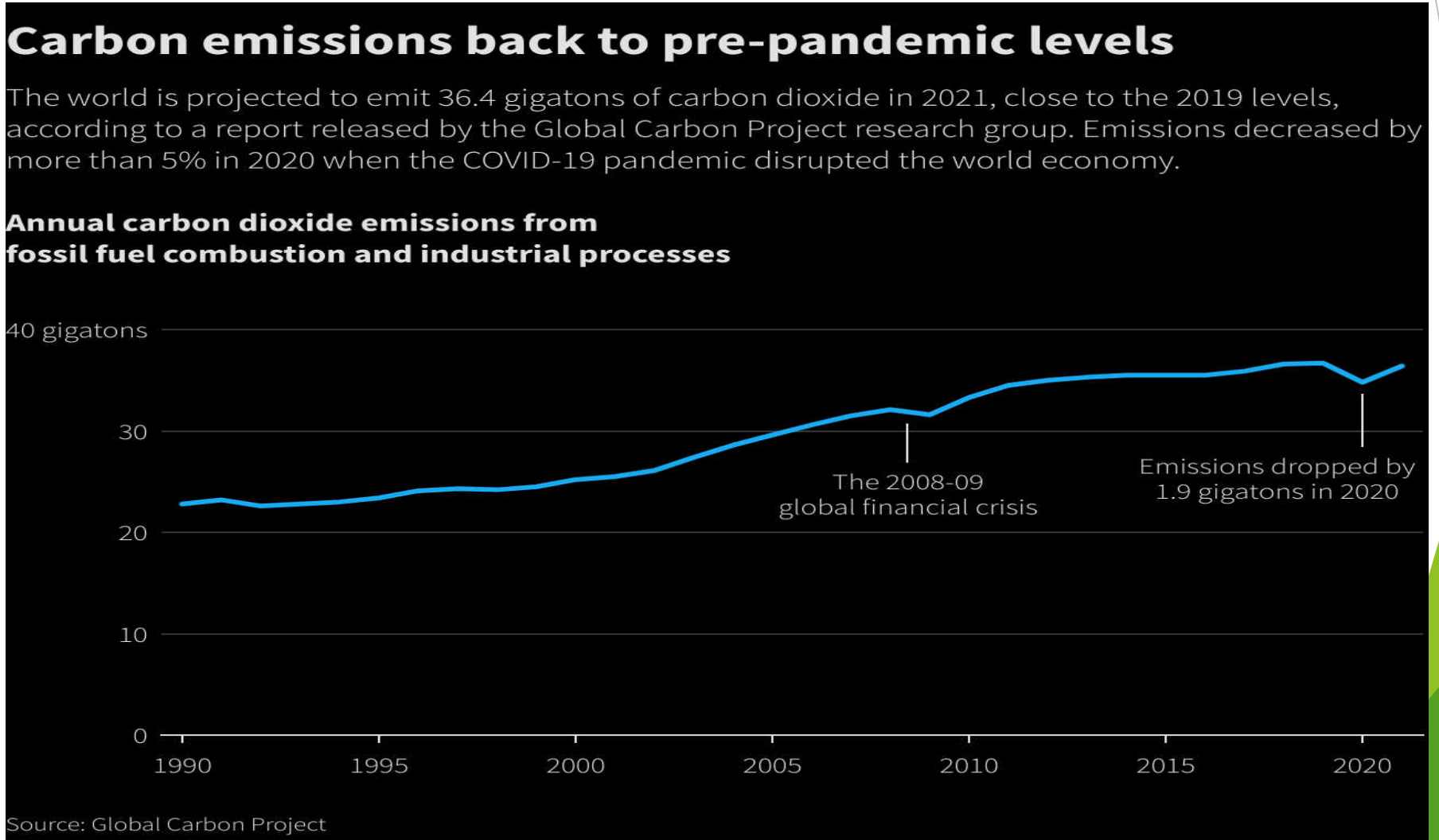
World annual report 2021.(Human influence report)



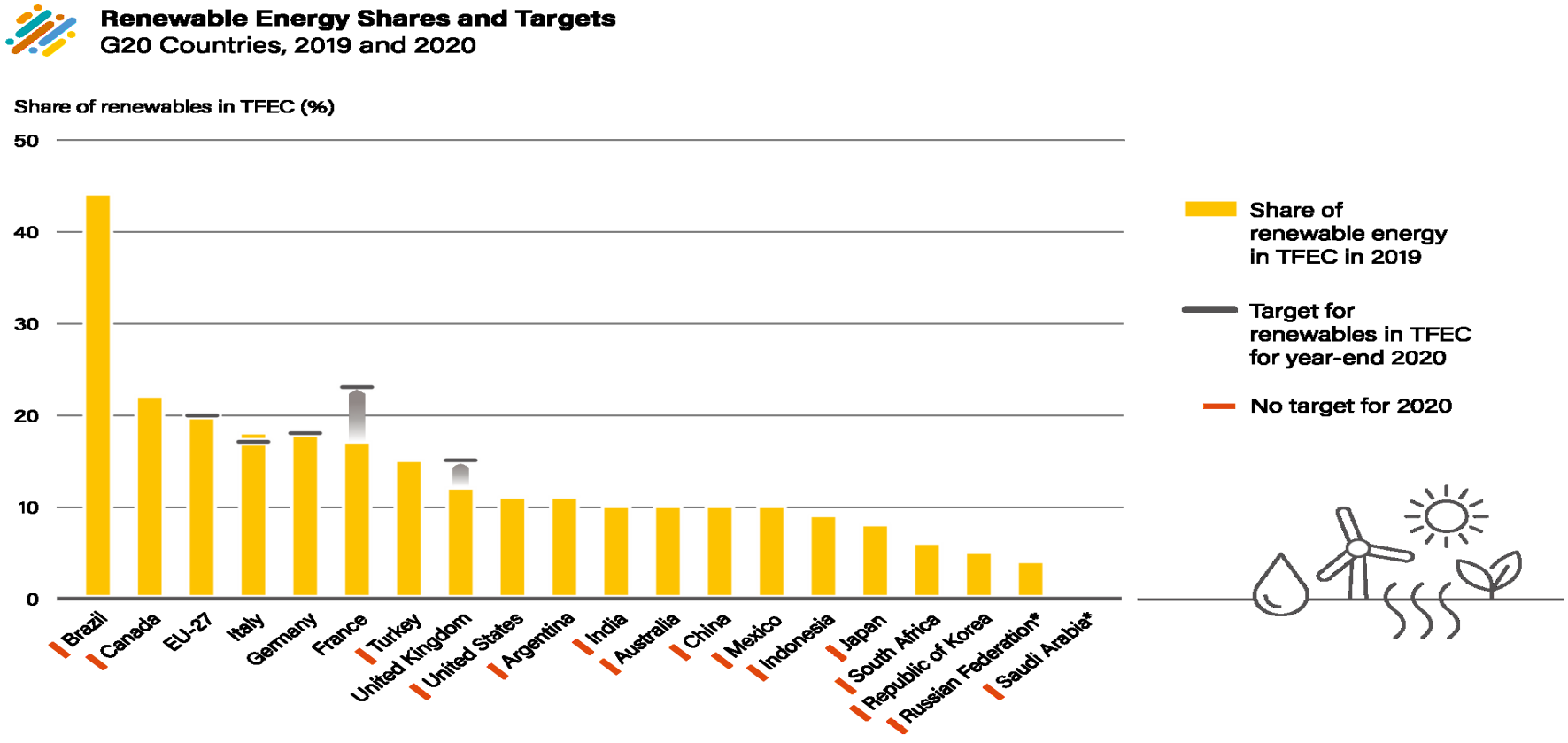
Effect of Global climate change in 2021



Effect of Covid-19 pandemic in carbon dioxide emission.



Share of G20 countries in renewable energy



Note: TFEC = Total final energy consumption.
Data for Russian Federation and Saudi Arabia are for 2018 and 2017 respectively.

Future of renewable energy.

- Renewable energy in the future is predicted that **by 2024**, solar capacity in the world will grow by 600 Gigawatts (GW), almost double the installed total electricity capacity of Japan.
- Overall, renewable electricity is predicted to grow by 1,200 GW by 2024, the equivalent of the total electricity capacity of the US.
- International Energy Agency's (IEA) conclusion in its World Energy Outlook 2020 that solar power is now the cheapest electricity in history.
- Another IEA study, Net Zero by 2050, reports that carbon neutrality is possible by 2050 – but only with big changes.

THANK YOU……