CLIMATE BOX

Module 1. Basic course on climate change.

Topic 1.2.3. How to prevent dangerous climate change?

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Empowered lives. Resilient nations.

United Nations Development Program
2020

How to prevent dangerous climate change?

3. How to prevent dangerous climate change?

3.1. 'Green' energy sources

3.1.1. What is energy?

3.1.2. The main sources of energy

3.1.3. Fossil fuels

3.1.4. Nuclear energy

3.1.5. Renewable energy sources

3.1.6. Advantages and disadvantages of different energy sources

3.2. Energy efficiency and energy saving

3.2.1. Environmentally friendly transport

3.2.2. Household appliances and electrical devices

3.2.3. Green construction. Passive and active buildings

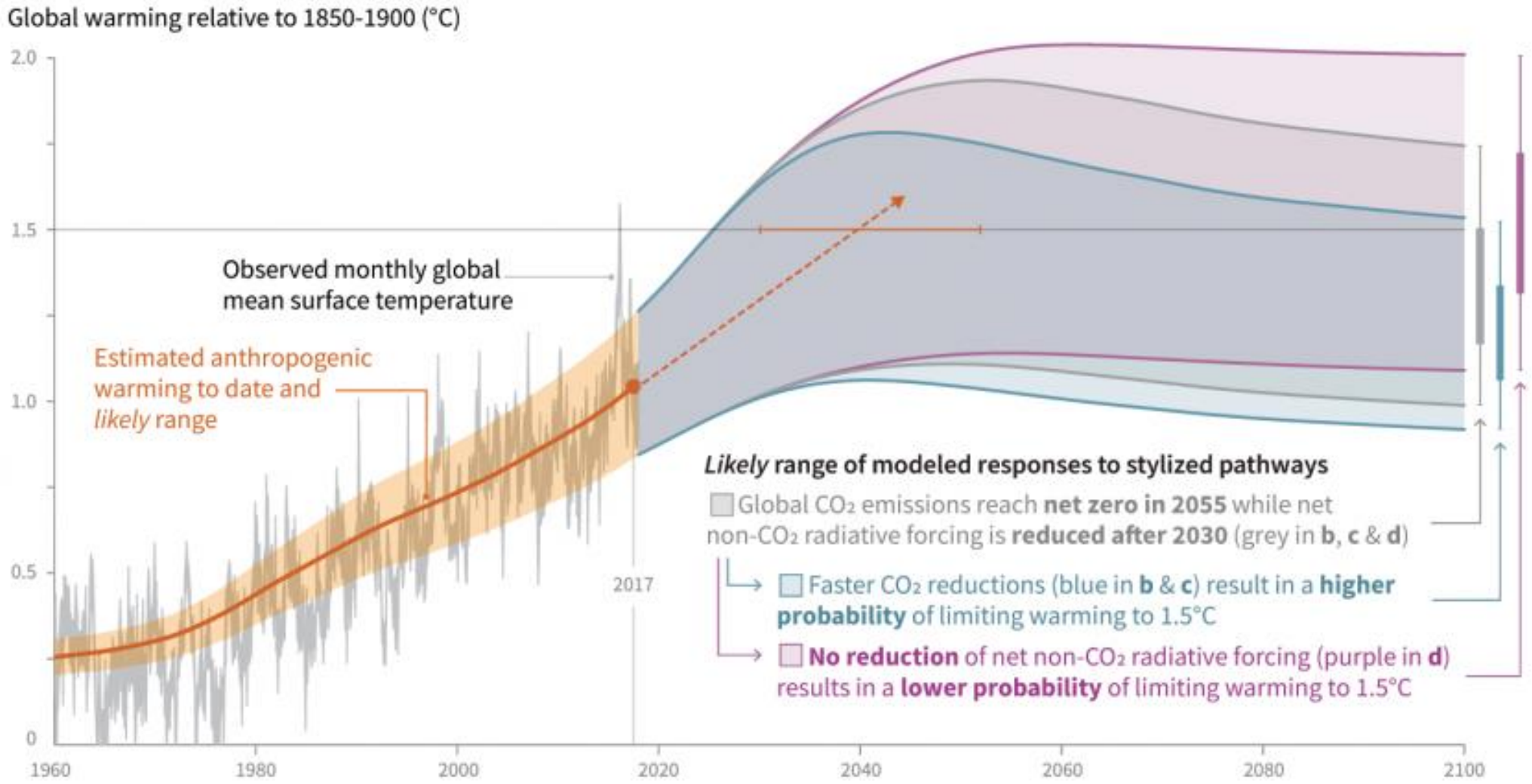
3.2.4. Green cities

3.3. Carbon footprint

3.4. How can I help the planet? Reducing your carbon footprint

3.5. Global cooperation on climate change and sustainable development

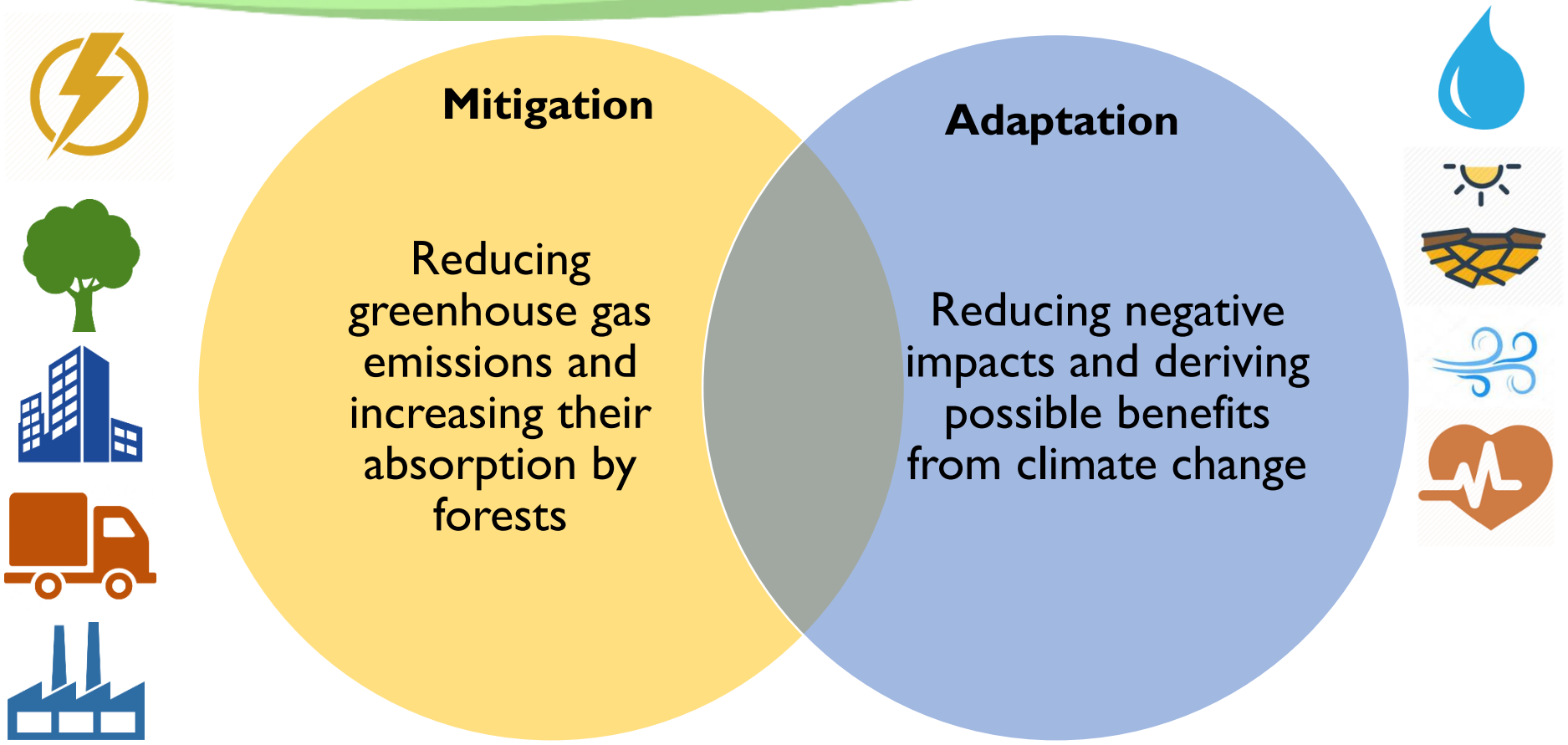
Temperature will continue to rise if nothing is done



IPCC, 2018

What can be done to avoid irreversible consequences of climate change?

There are two main directions of action to solve the problem:



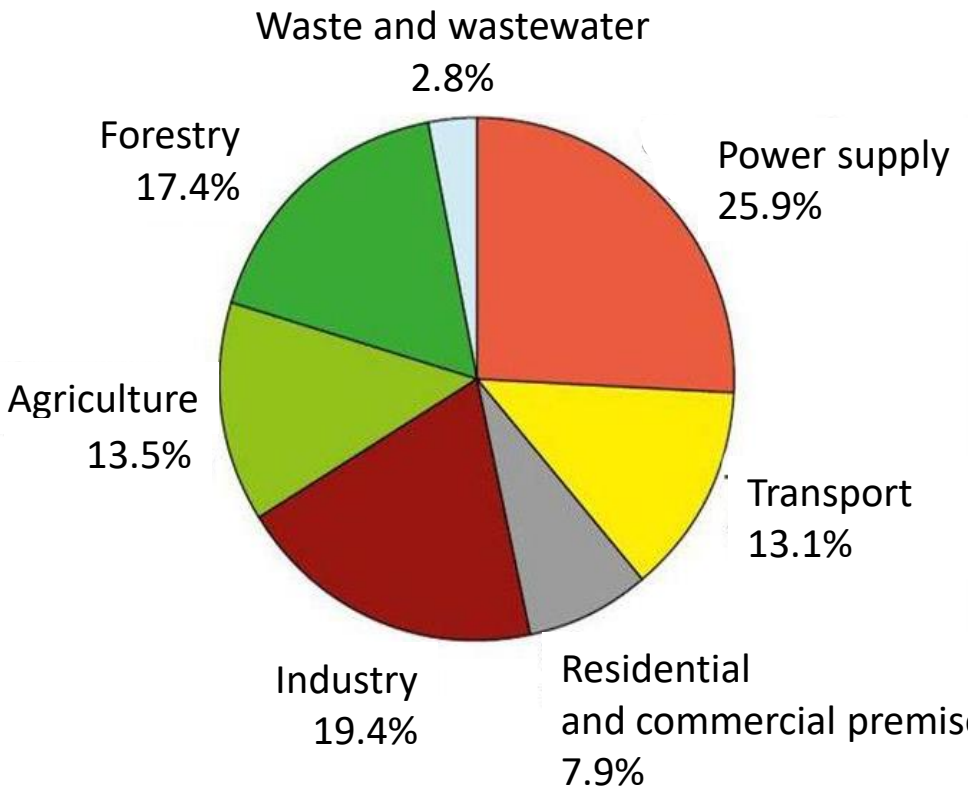
Mitigation of consequences – we reduce greenhouse gas emissions

Mitigation of consequences

Mitigation

Reducing greenhouse gas emissions and increasing their absorption by forests

Main sources of greenhouse gases (our carbon footprint)



About 75% of these emissions are directly or indirectly related to the production or consumption of energy from hydrocarbon sources.

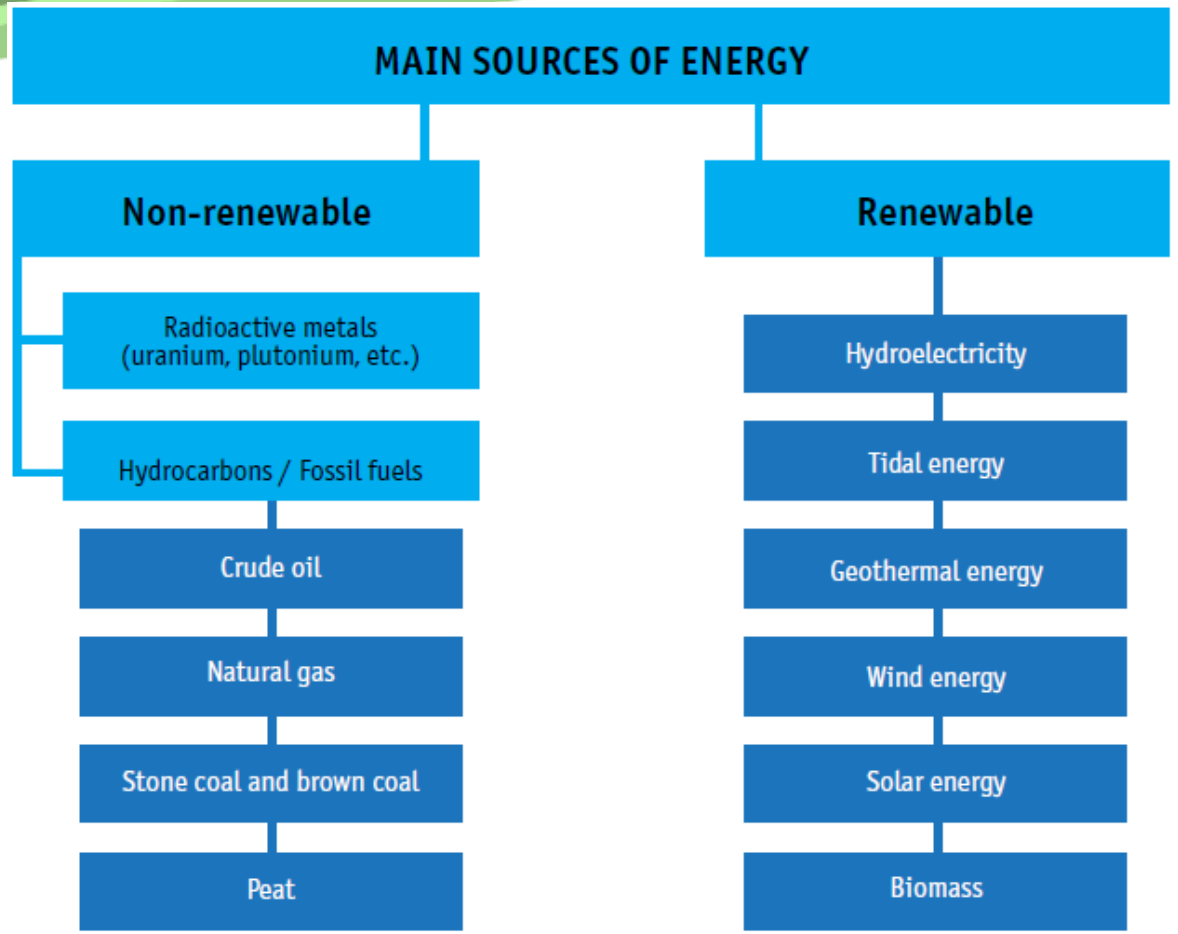
Source: IPCC 2014

Green Energy

Main sources of energy

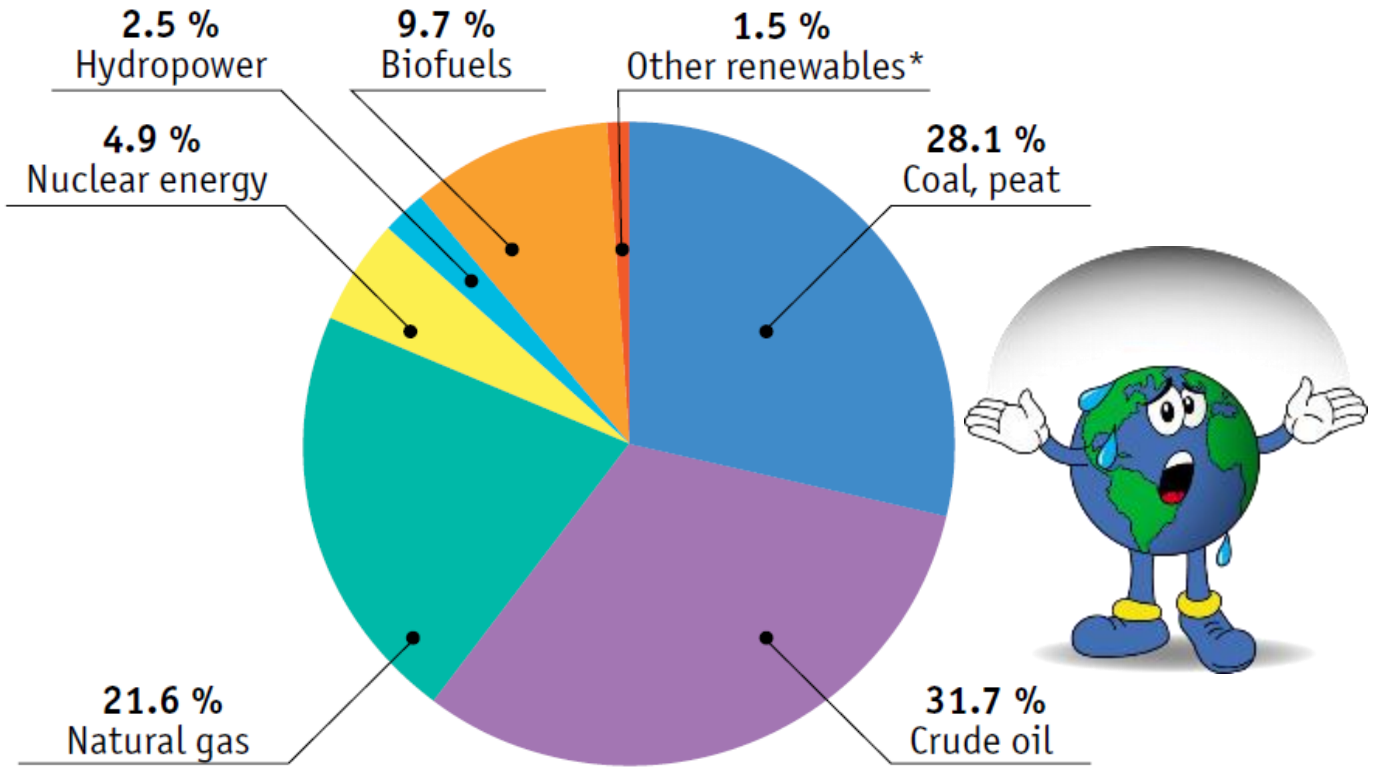
Natural sources of energy on our planet are usually subdivided into two major groups: non-renewable (or traditional) and renewable (or alternative)

- **Non-renewable sources of energy** are produced or replaced in nature much more slowly than they are consumed by mankind.
- **Renewable energy sources** draw energy from processes that occur continuously in nature. Sunlight, wind, flowing water, rain, tides and heat rising from the earth can provide huge amounts of energy. What is more, these resources are practically inexhaustible: they will only run out in the unthinkably distant future when our solar system itself completes its life cycle. Biomass (plant fibre, animal waste, and charcoal derived from wood, which was widely used in the past) is also a renewable source of energy, as it is quickly replaced in nature.



Main sources of energy

World consumption of various types of energy

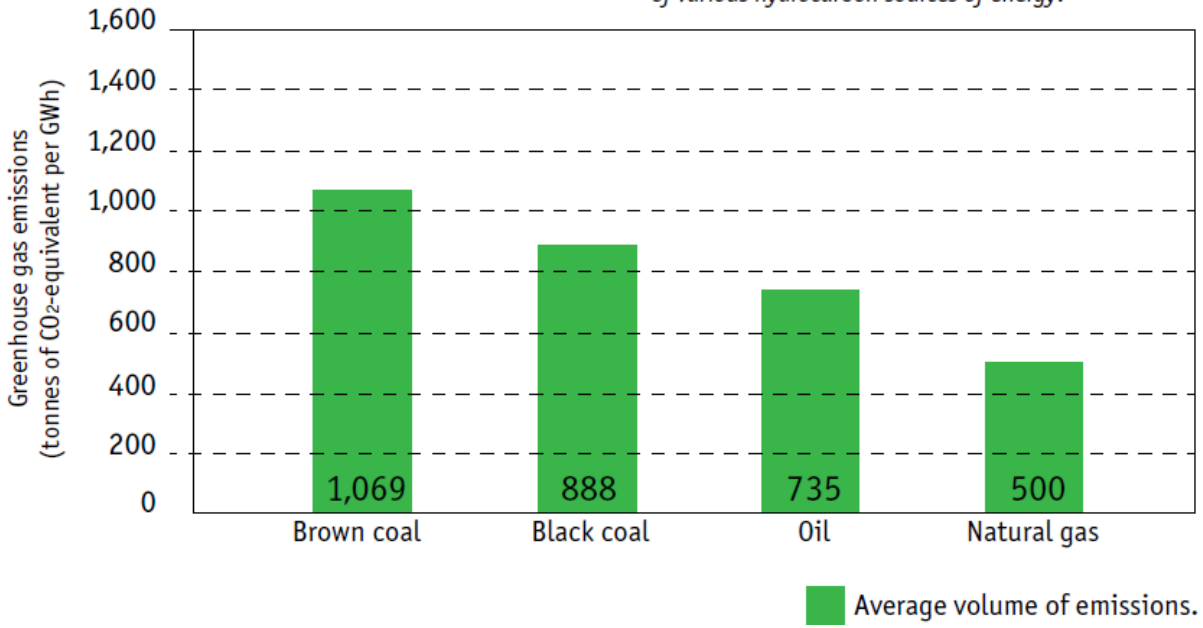


** Other renewable sources: wind, solar, geothermal, low-grade heat, etc.

Source: IEA 2018

Main sources of energy

Fig. 3.1.5. Emission of greenhouse gases from the use of various hydrocarbon sources of energy.



Pollutant emissions into the atmosphere from power plants using various fossil fuels in the European Union (grammes/gigajoule)				
Fossil fuel type	**Dust**	**Carbon monoxide (CO)**	**Nitrous oxide (NOx)**	**Sulphur dioxide (SO_2)**
Brown coal	3,254	89	183	1,361
Black coal	1,203	89	292	765
Oil	16	16	195	1,350
Natural gas	0.1	15	93	1

There are two major downsides to using hydrocarbon fuels:

- **Firstly**, they are not inexhaustible; and as they are depleted, the cost of their extraction and production of energy increases.
- **Secondly**, the combustion of natural gas, oil, and especially of coal emits large quantities of pollutants and greenhouse gases**,** that increase the temperature of the planet; and a number of pollutants (especially in coal production).

Solution 1. Renewable energy sources

The first way is to switch to the use of renewable energy sources, the harm to the climate from the receipt of which will be minimal.

These types of energy are often referred to as alternative, or green, because they provide an environmentally and climate-friendly source of energy as opposed to hydrocarbon fuels.

According to the International Energy Agency, **by 2050, up to 60% of all electricity in the world** can be obtained from climate-friendly renewable sources (now about 20%).

Solar energy: hot water and electricity

Solar collectors capture the heat of the sun. Water flows along tubes inside the collector and becomes warm (air or antifreeze is sometimes used instead of water). Such collectors can be used for heating buildings and to provide hot water.

Photovoltaic cells are another common way of collecting and storing solar energy and solar energy storage. Photovoltaic cells can be used on roofs and facades of buildings, for various vehicles or for large power plants - 'solar farms'.

Solution 1. Renewable energy sources

Wind energy

Windmills have been known since ancient times. They were used mainly for grinding grain, processing wood, or irrigating fields. In the Netherlands, windmills pumped water from land reclaimed from the sea, which was then used for agriculture.

Wind turbines are built not only on land, but also in the sea - the so-called **offshore wind farms.**

A new technological development is the construction of floating wind turbines that are installed on floating platforms.

Modern wind turbines use a principle analogous to that of windmills. Most often they are placed in coastal areas where strong winds constantly blow. A large wind farm can consist of several hundred windmills spread over a vast area - up to several hundred square kilometers.

Wind energy already has an important role in some European countries.

In Denmark, for example, wind turbines produce more than 40% of all electricity.

Solution 1. Renewable energy sources

Energy of water

The energy of moving water can be used in many ways.

The most common are **powerful hydroelectric power plants**, during the construction of which a **dam** is built, and all the power of the river is directed to the rotation of the generator blades. The construction of such a dam upsets the natural life of the river: it may alter the river's microclimate, destroying or harming the animals and plants that live there. Therefore, the construction of a hydroelectric power plant must be approached very carefully, paying due attention to environmental balance.

Damless hydroelectric generators are called **mini-hydroelectric** power plants and **micro-hydroelectric** power plants. They are installed on small rivers and collect the energy of the flow into the battery. Their capacity is small, they are suitable for providing energy to small farms.

Wave power stations use the energy of waves in the ocean.

Tidal power plants use the extraordinary phenomenon of tides.

Solution 1. Renewable energy sources

Geothermal energy

Geothermal energy uses heat produced by the earth. Evidence of the heat contained in the earth is visible in areas of volcanic activity, where hot underground water sometimes rises through cracks in the earth's surface and occasionally bursts upwards in the form of jets of water and steam. A borehole can be drilled to hot underwater lakes and their water can be used for heating or electricity generation, and also as a supply of hot water (if the chemical composition of the water is suitable).

Another possibility is to pump ordinary water from the surface via a borehole into hot zones under the ground, where it is heated by a 'natural boiler' to boiling point and returns to the surface through an adjacent borehole in the form of steam. This is called **petrothermal energy.**

Biomass

The simplest and most common way to produce energy from biomass is by burning it.

Not only can plant fiber be burnt, but it can also produce a universal fuel, biofuel, which is easier to transport and use in devices.

If industrial waste is used as fuel, for example, carpentry (wood shavings), then this is an example of the successful use of biomass, but if healthy forests are cut down for firewood, this is an example of wastefulness.

Solution 2: Energy efficiency and energy saving

The second way is to reduce our overall energy consumption.

In most cases, you don't need to invent anything to save energy, you just need to change your habits and stop wasting energy!

Fig. 3.2.1. Comparison between the energy efficiency of different lamp bulbs.

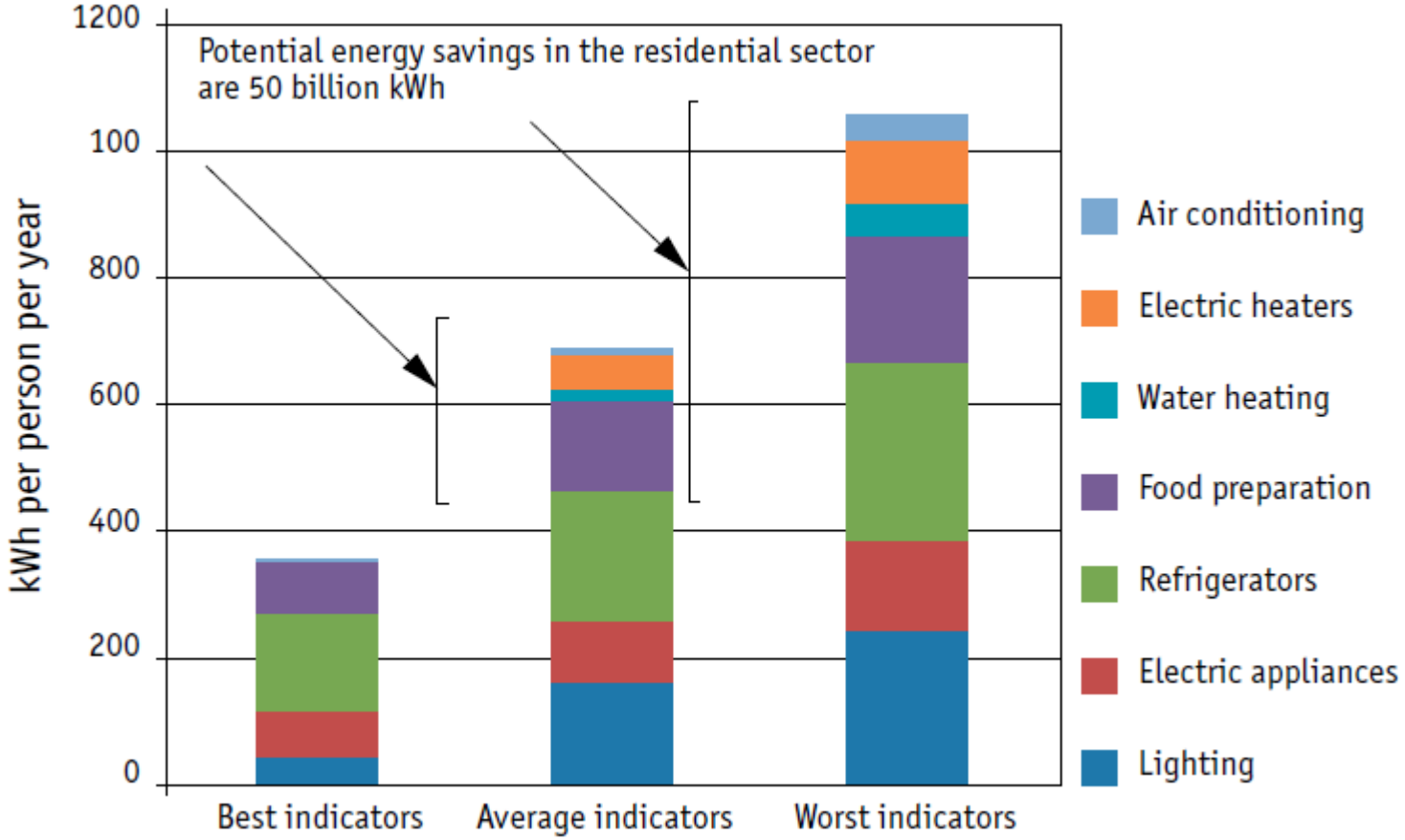
Energy efficiency *is the ratio between the amount of energy consumed and the useful result that is obtained from its consumption.*

Energy saving *is all of the measures, which are taken in order to reduce the amount of energy that is consumed and to increase the use of renewable energy.*

It has been estimated that charging a mobile phone emits 0.3 kg of CO_2 in a year and if a mobile phone charger is plugged in all the time (without being used), then 2.4 kg of CO_2 are emitted.

Solution 2: Energy efficiency and energy saving

Potential energy savings in residential buildings (example of Russia) .



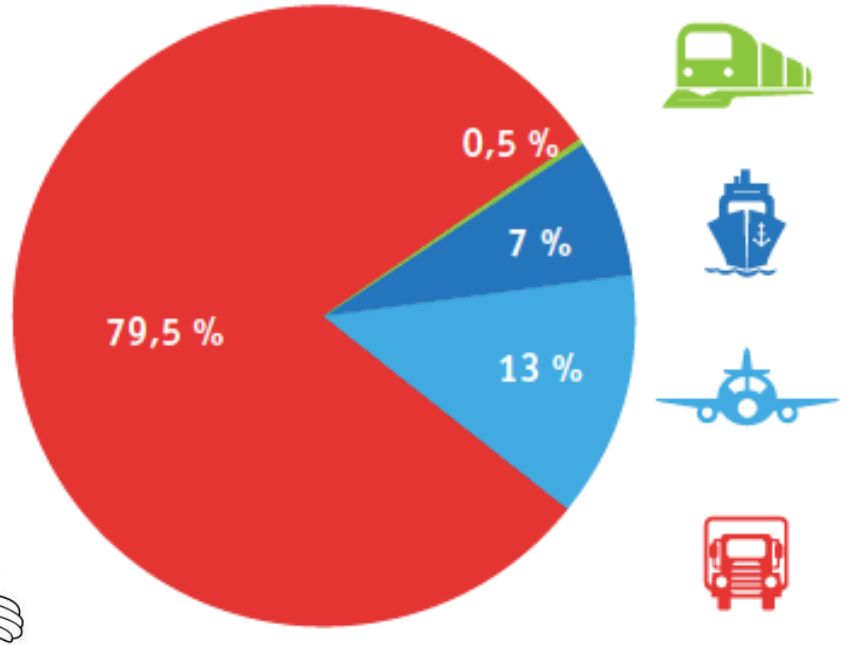
Energy efficiency and energy saving are very important.

- **For families** they mean savings on gas and electricity bills.
- **For electricity companies** they mean reduction of fuel costs, giving cheaper electricity.
- **For the country** they mean spending less on resources, and making industry more productive and competitive.
- **For the climate** they mean a reduction of greenhouse gas emissions into the atmosphere.

Environmentally friendly transport

Solution 3: Environmentally friendly transport

Breakdown of greenhouse gas emissions by different modes of transport



The impact of transport on climate change is huge, as most forms of transport use fossil fuels,
the combustion of which releases carbon dioxide into the atmosphere.

In total, transport accounts for about 13.5% of global greenhouse gas emissions, including 10% contribution by cars.

Solution 3: Environmentally friendly transport

What can be done to reduce the climate impact of transport?

- Avoid some trips by replacing them with telephone or Internet communication.
- For long distances, prefer the train. Trains are a more environmentally friendly way to travel long distances than aircraft.
- If you fly somewhere by plane, then choose airlines that use up-to-date aircraft: modern aircraft do less damage to the environment than older ones.
- Greenhouse gas emissions in a city can be reduced by encouraging people to use public transport instead of cars, riding bicycles, scooters, or simply walking more often.
- For personal transport, choose electric vehicles, biofuel vehicles, or the most energy efficient models if they run on traditional hydrocarbon fuels.

Waste Management

Waste management

Greenhouse gas emissions from waste

Not properly managed landfills with municipal solid waste (MSW) are one of the main sources of greenhouse gases, especially methane.

Due to the lack of oxygen, the bacteria in the waste produce methane. Methane is a powerful greenhouse gas, which is about 21 to 86 times stronger in terms of its global warming potential than carbon dioxide.

Global warming potential of greenhouse gas compared to CO_2	
Carbon dioxide(CO_2)	1
Methane(CH_4)	21 – 86
Nitrous oxide (N_2O)	265 – 310
Hydrofluorocarbons (HFC)	4 – 12400
Perfluorocarbon (PFC)	6500 – 11100
Sulfur hexafluoride(SF_6)	22800 – 23900

Reducing waste is important for the climate!

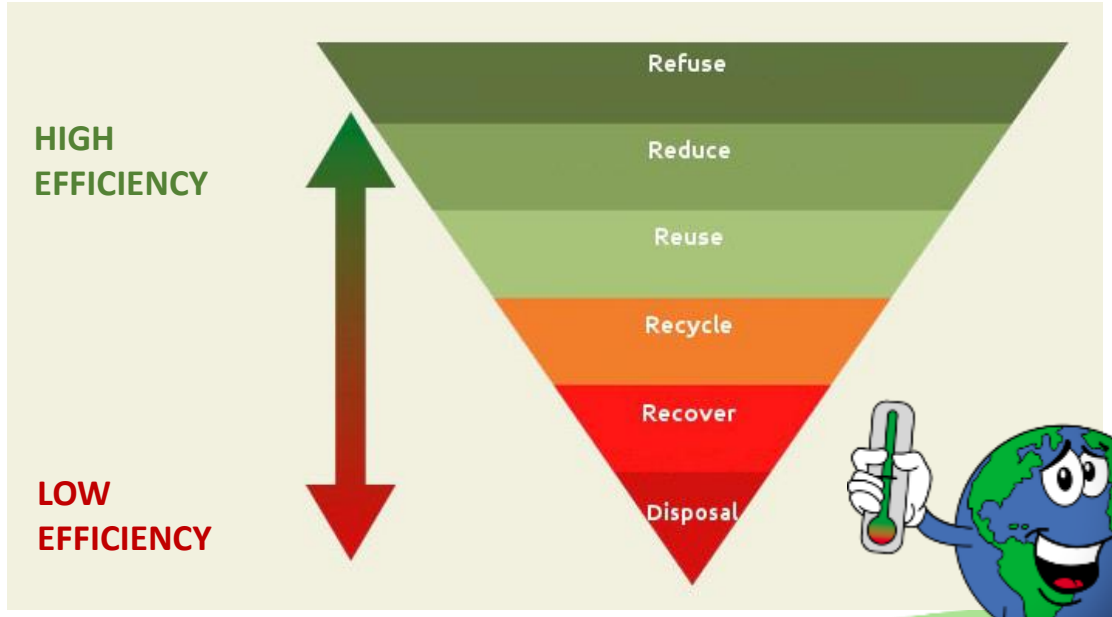
Source: IPCC 1995-2014 and GHG Protocol

Waste management

Waste management hierarchy

The pyramid in the figure is a generally accepted waste management hierarchy - from prevention (high priority) to disposal without further use.

THE EFFECTIVENESS OF THE METHODS OF REDUCING WASTE



Source: EcoBeing

Recycling not only avoids landfill gas emissions, but also saves energy for production compared to using primary raw materials.

Energy savings in production using recycled materials

Aluminum – 95%
Zinc – 60–70%
Paper – 64%
Copper – 70–85%
Magnesium – 95%
Plastic – 80–88%
Lead – 60–80%
Steel – 70%
Glass – 68%

Green Cities

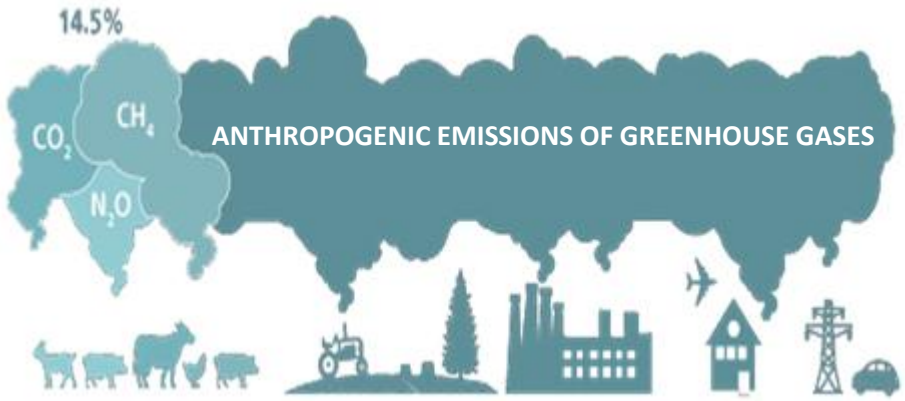
Green cities

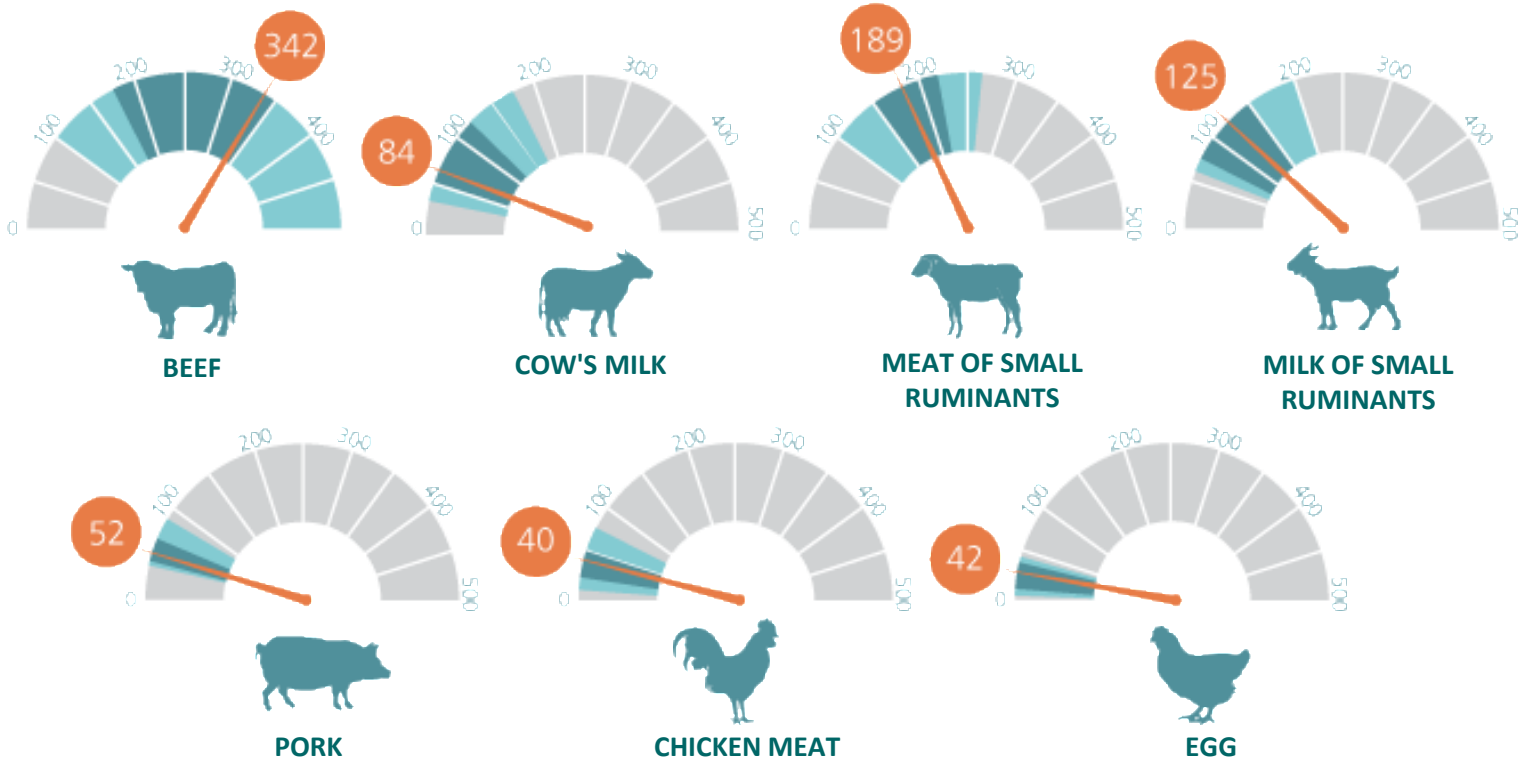
What can be done to reduce the city's climate impact?

Agriculture and Forestry

Low carbon diet

Greenhouse gas emissions from food production





Source: FAO 2018

Increased carbon sequestration in forests

How to manage the carbon balance of forests ?

The carbon balance of forests depends on many factors, the most important of which **are human impact, disasters** (forest fires, plagues of pests, etc.) and **climate change**.

If the felling of forests for timber and other purposes **is reduced**, forests will absorb more carbon from the atmosphere.

It is also important **to reduce the risks of occurrence and damage from forest fires.**

The World Wide Fund for Nature (WWF) in the Russian Far East implemented a project to manage the carbon balance of forests. The idea of the project is to abandon industrial felling of cedar-deciduous forests in the Bikin River basin. Only the procurement of firewood by the indigenous population is allowed. The project is encouraging local residents to develop traditional forms of forest management such as the collection of pine nuts, berries, mushrooms, ferns and herbs.

Reducing our Carbon Footprint

Carbon footprint

The carbon footprint of a city or country is the total amount of all greenhouse gases that all individuals and organizations within that city or country produce by what they do, events they participate in and products they consume directly or indirectly.

Direct emissions are amounts of carbon dioxide created by the use of fossil fuels. For example, the amount of greenhouse gases emitted during operation of a factory or a vehicle engine.

Indirect emissions are the amount of CO_2 released into the atmosphere when energy is produced and transported in order to make the products we buy and the services we need. It is indirect emissions that we, as consumers of goods and services, can influence to a greater extent.

Carbon footprint

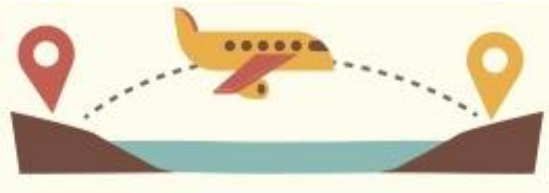
An example of a human carbon footprint

Comparing the carbon footprint of different modes of transport

0 tons CO_2

1000 km
0.25 tons CO_2

1000 km
0.75 tons CO_2



5000 km
1 tons CO_2

Source: Onetreeplanted.org

Carbon footprint

How do you calculate your carbon footprint?

- Calculating our carbon footprint (especially indirect emissions) is difficult as there are many different factors to consider and a wealth of information to be found.

- For ease of calculation and perception, all greenhouse gases are converted to CO_2 equivalent.

- In total, the formula for calculating greenhouse gas emissions looks like this:

Carbon footprint example

- E-mail-message – 4 g. – CO_2 eq.
- The same message with a large attachment – 50 g. – CO_2 eq.
- A plastic bag from a shop – 10 g. – CO_2 eq.
- A 0.5-litre bottle of water (local production) – 110 g. – CO_2 eq.
- An average bottle – 160 g. – CO_2 eq.
- An ice cream – 500 g. – CO_2 eq.
- A pair of jeans – 6 kg. – CO_2 eq.

Activity * Emission factor = Total emissions from activity

- ***By activity,*** *we mean the amount of resources needed (mainly energy) for the production, transportation and / or consumption of goods and services, or restored forest resources that absorb CO_2 from the atmosphere over a certain period of time (for example, a year).*
- ***The emission factor*** *depends on many aspects and, first of all, on the predominant type of energy in the national grid. Thus, in countries with a large share of renewable energy, the emission factor will be lower than in countries where the share of coal or oil is high. Countries periodically publish official data on the average emission factor (specific amount of CO2-eq.) of their national energy system.*

Carbon footprint

Task

Calculate how much greenhouse gas emissions **from a building can be reduced on average per year** if you replace electricity from the network with electricity from your own solar panel, which allows you to receive **50 kWh of electricity daily** if the building is located:

1. in Kazakhstan,
2. in Russia,
3. in Tajikistan.

Table: *Specific amount of CO2 emissions (emission factor) nat. energy systems of different countries and installations using renewable energy sources.*

№	Type of energy consumed	Country	Emission factors of the national grid (kgCO2/kWh)
1	Electricity from the grid	Kazakhstan	0.923
		Russia	0.513
		Tajikistan	0.023
2	Renewable sources (solar panel)	All countries	0

Source : https://ecometrica.com/assets/Electricity-specific-emission-factors-for-grid-electricity.pdf

Let's assume the 25% capacity factor (productivity) of a solar panel is the same in all countries.

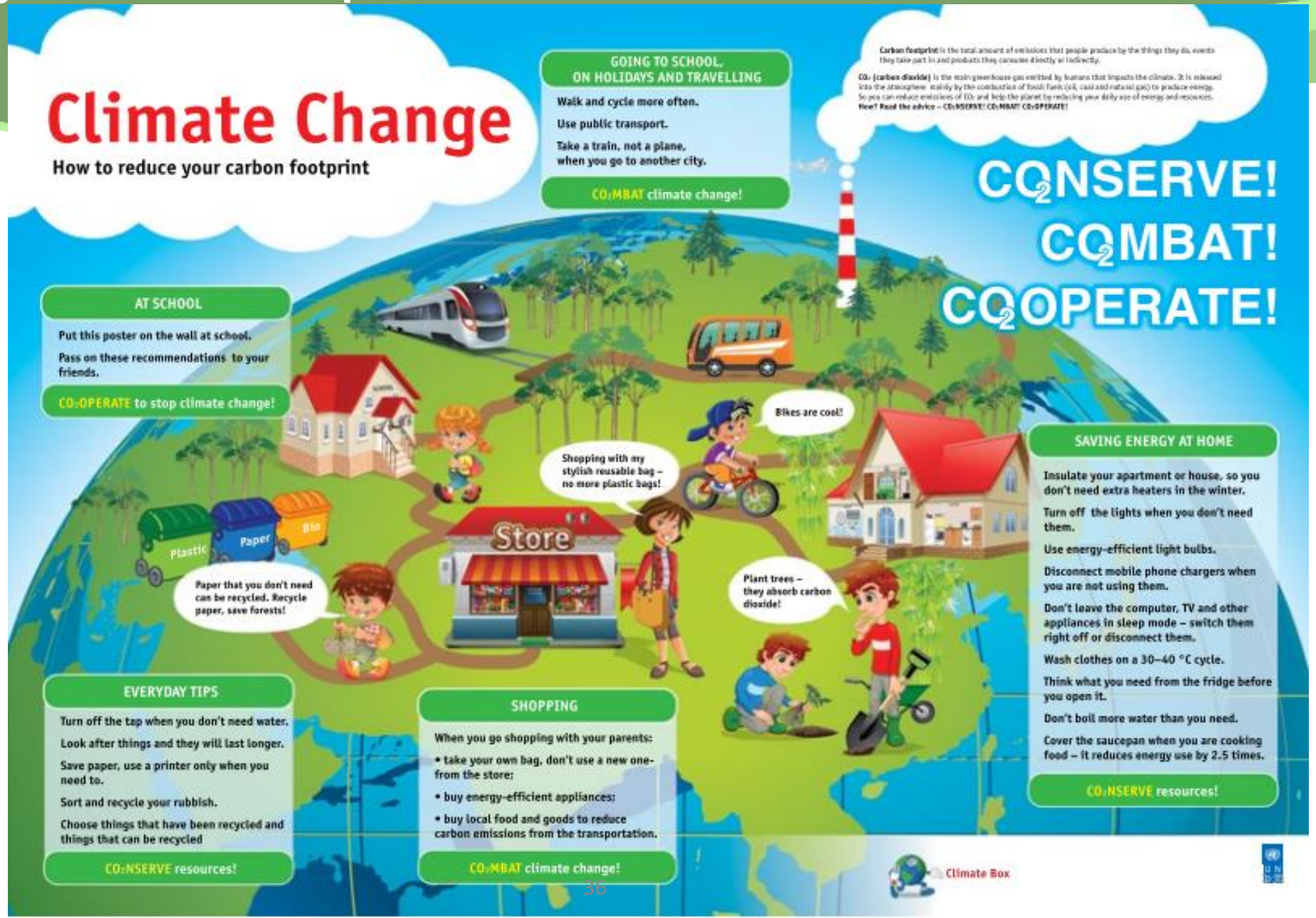
Activity * Emission factor = Total emissions from activity

Climate projects for schoolchildren

How to calculate the positive effect of a project on the climate in terms of reducing greenhouse gas emissions?

Result	Indicator	Index	Information collection method
Reducing greenhouse gas emissions or increasing their absorption	The effect of the project of schoolchildren on energy and resource conservation The effect of energy saving measures at home, at school, at the community level	Energy saving, kW * h / year	Calculations made by schoolchildren with teachers
		Decrease in emissions or increase in their absorption, CO2-eq / year relative to the baseline	Survey of children and their parents Summary reports of teachers

Reducing your carbon footprint



Test ‘My carbon footprint’

A. When you buy fruits and vegetables in a shop, what do you usually choose:
– local, unpackaged produce (1 point);
– unpackaged produce from the southern regions of your country (2 points);
– unpackaged produce from France, the Netherlands, Argentina and other countries (3 points);
– imported produce, individually pre-packed (4 points)?

B. The bag you use for shopping is:
– linen or cotton (1 point);
– paper (2 points);
– a plastic bag that I take from home (3 points);
– a plastic bag that I take or buy when I pay for goods in the shop (4 points).

C. When you buy drinks, what sort of container are they usually in?
– paper (1 point);
– glass (2 points);
– aluminum (3 points);
– plastic (4 points)?

D. What book do you prefer to read:
– a new one, bought in a shop (4 points);
– an electronic one (3 points);
– one that has already been read (2 points);
– one from the library (1 point)?

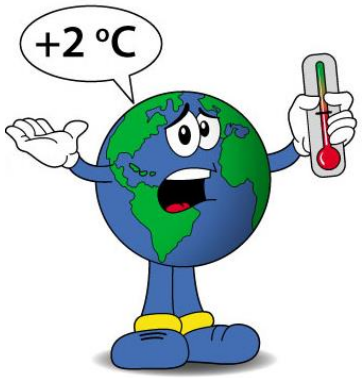
E. When you give someone a present, do you prefer:
– bright and attractive wrapping paper, whatever it is made of (4 points);
– paper with an environmental label to show that it is recyclable (2 points);
– a used box or bag that I specially decorate (2 points);
– to give the present without packaging (1 point)?

Answers to the test ‘My carbon footprint’:
From 5 to 7 points: Great! You have the carbon footprint of a mouse! You can be proud of yourself – all you need to do now is persuade others to be like you.
From 8 to 10 points: You have the carbon footprint of a cat’s paw! But don’t sit purring – you could do even better.
From 11 to 13 points: The carbon footprint of a horse’s hoof! Put on your harness and get down to some energy saving.
From 14 to 16 points: An elephant’s carbon footprint! Better put all that weight into saving energy.

Adapting to Climate Change

The damage from climate change can be great but at the 'local' level it is catastrophic

Key challenges: Fresh water and food in Africa and Asia, flooding of islands and lowlands



0 °C | 1 °C | 2 °C | 3 °C | 4 °C | 5 °C

Lower yields especially in developing countries in Africa, Asia and America

Some increase in yields in the northern countries

Decline in yields in many developed countries, including Russia

Growing shortage of fresh water in a number of arid regions, disappearance of small mountain glaciers

Rapidly growing freshwater problems in vast areas in Africa, Asia, Europe, America and Australia, particularly in the Mediterranean, Central Asia and southern Russia

The threat of gradual flooding of many of the world's largest cities, as well as densely populated coastal areas, especially in Asia

Current level

Relatively safe level. The goal of the UN countries at the end of the 21st century

Forecast for the end of the XXI century with the current goals of the largest countries for 2030

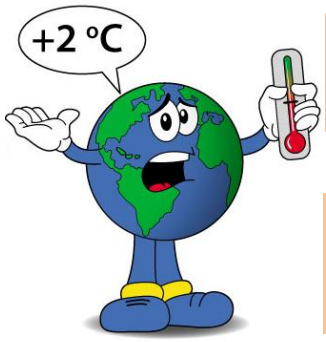
Scenarios for future climate change

The main problems: an increase in costs for combating dangerous phenomena, adaptation to new conditions is needed

0 °C | 1 °C | 2 °C | 3 °C | 4 °C

Extensive destruction of coral reefs

A rapid increase in the number of species on the verge of extinction



Problems of survival of northern species of animals and plants, gradual melting and reduction of permafrost, increasing costs of rebuilding the economy and infrastructure

The growing intensity of storm winds, droughts, floods, heat waves, forest fires, etc., the rapid growth of costs for dealing with emergencies, problems of economic development, maintaining the welfare and health of the population

An increasing risk of feedbacks that amplify negative effects; the risk of abrupt and large-scale changes in the climate system

Current level

Relatively safe level. The goal of the UN countries at the end of the 21st century

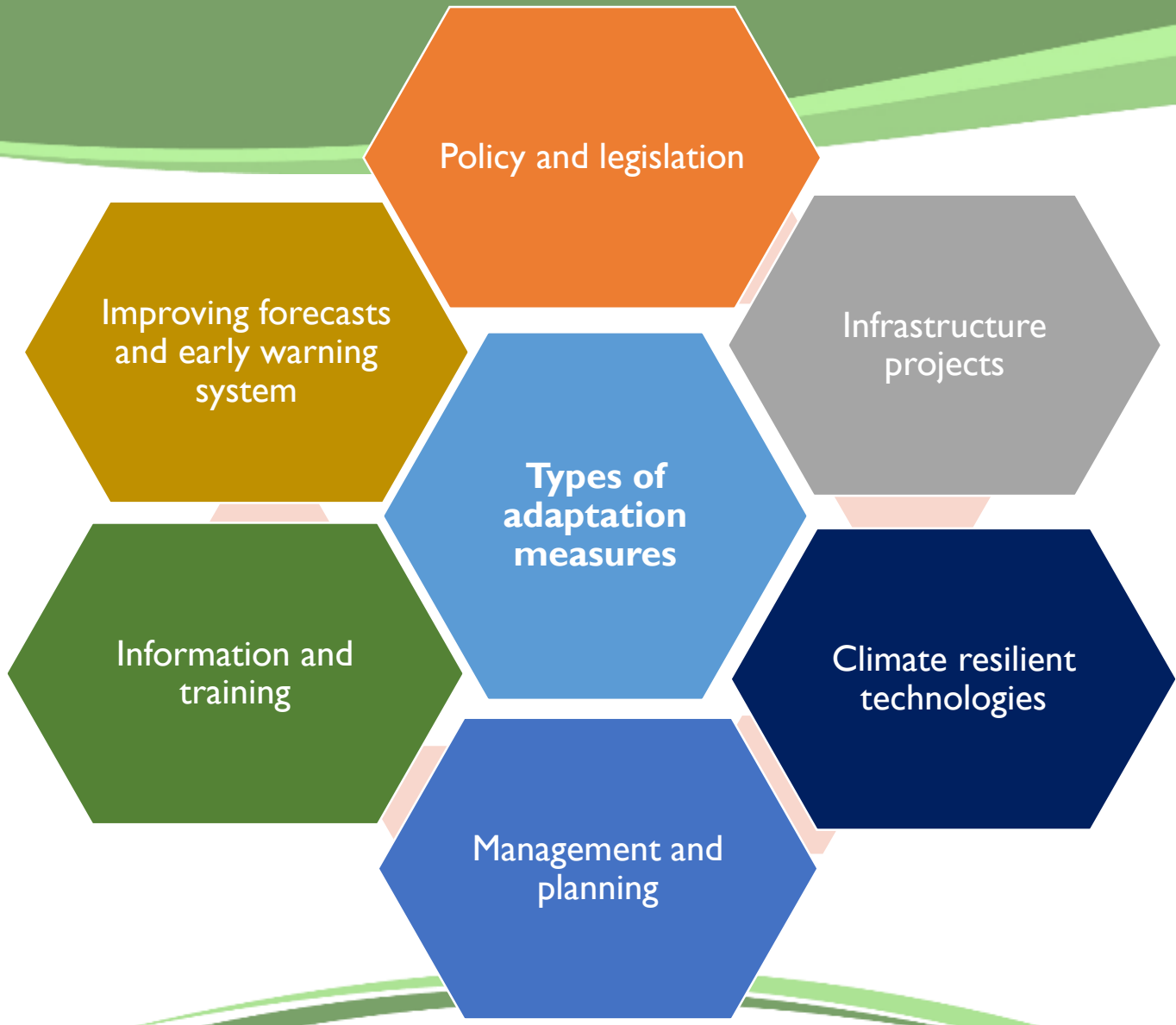
Forecast for the end of the XXI century with the current goals of the largest countries for 2030

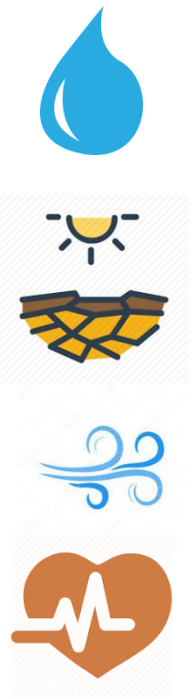
Risk reduction and adaptation

Adaptation *means altering natural or manmade systems to take account of the actual or expected impact of climate change in a way that will make it possible to moderate the harm or take advantage of any benefits brought by climate change. For example, adaptation measures might include the construction of buildings that are more resistant to extreme weather events, building dams to combat floods, developing new, drought-resistant crop varieties, etc.*

Risk reduction and adaptation

Types of adaptation measures



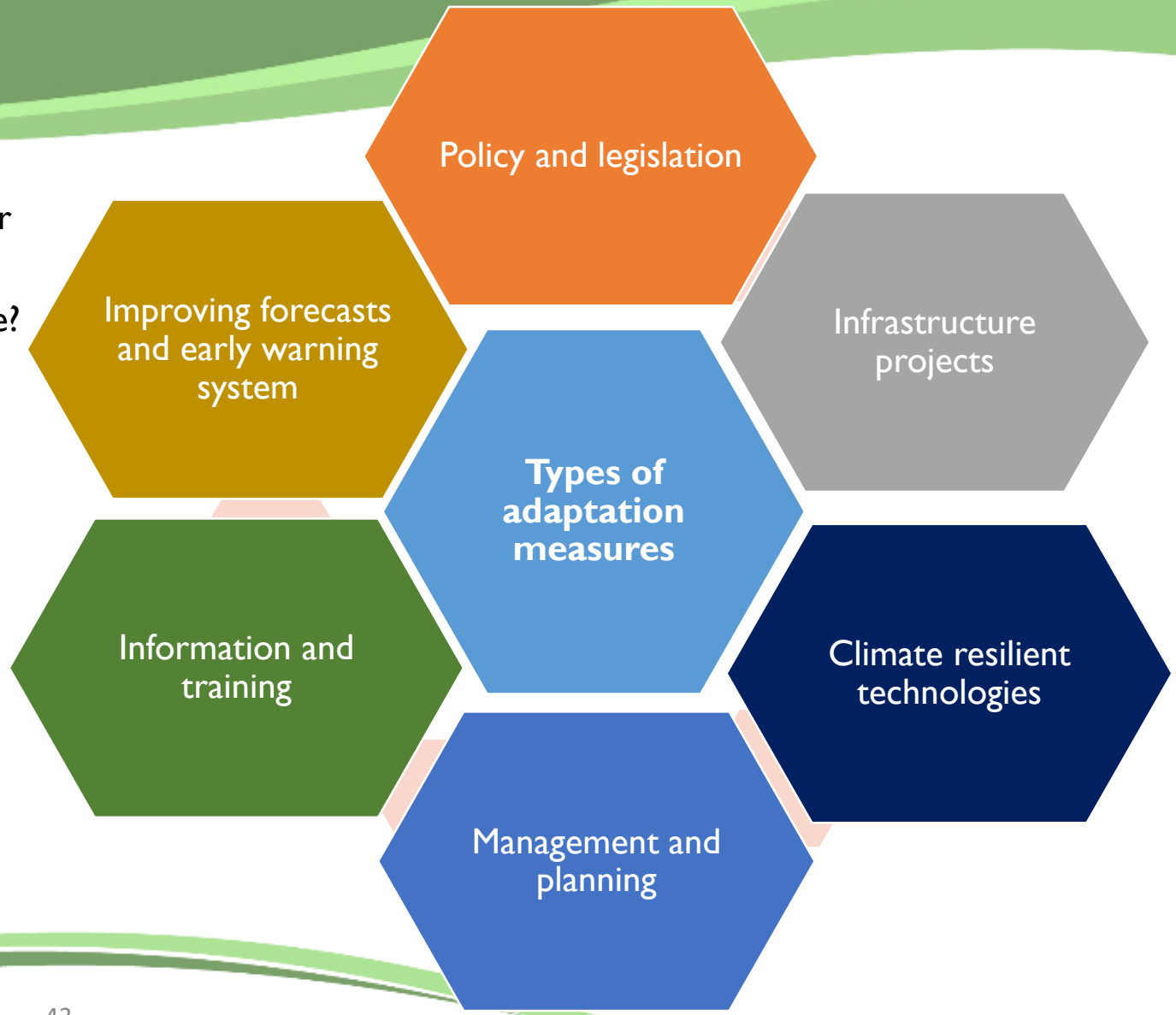


Examples of adaptation measures

Task

1. Match examples of adaptation measures (bottom) with their different types (right).
2. Which adaptation measures could schoolchildren undertake? Think of other examples besides the ones below.

Rooftop and wall gardens	Green areas for protection from heat waves
Improving the climate change forecasting system	Early warning system for extreme events
Medical Staff training	Construction of roads with a more resistant surface to climate change
New drought tolerant plants	Conservation of traditional activities of indigenous peoples
Rainwater harvesting	Anti-wave protection



Schoolchildren's climate projects

How to calculate the positive effect of a climate project in terms of adaptation?

Result	Indicator	Index	Information collection method
Reducing the vulnerability of communities (especially rural) to climate risks (adaptation)	Improved resilience / adaptive capacity to climate change impacts due to a youth project The positive effect of measures at home, at school, at the community level	Number of people who received knowledge about adaptation measures	Questionnaires for target audience in the project location Questionnaires for children and their parents Summary reports of teachers
		Number of people who took adaptation measures thanks to the project	

Risk reduction and adaptation

Task

Break down into several groups. Each group should think about what climate change risks may occur in its field of activity and come up with various adaptation measures to reduce such risks:

- **Group 1:** Management of a farm
- **Group 2:** Management of a city hospital
- **Group 3:** Department of housing and communal services of a city
- **Group 4:** Management of an international airport

Examples of adaptation projects from different countries

Armenia: reducing disaster risks

Armenia is among the 60 most vulnerable countries to natural disasters.

Over the past decade, UNDP has been assisting the Ministry of Emergency Situations of the Republic of Armenia in developing and implementing the national strategy and action plan for disaster risk reduction.

Project results:

- National Observation Center established to collect and process data and information on natural disasters
- National Crisis Management Center and rapid response teams in each region of the country established
- Drainage systems for water during floods were installed, riverbanks were fortified, protective nets against hail were installed, and others measures in different regions of the country were taken
- Public education and extensive information campaign

Examples of adaptation projects from different countries

Uzbekistan: climate resilient agriculture in drought prone regions

The Aral Sea region is highly prone to droughts, which only exacerbates water scarcity for agriculture in this area.

UNDP and Adaptation Fund project helps government agencies at national and local levels and local communities to adapt to climate change.

Project results :

- upgraded climate observation system and staff training
- drought early warning system developed and implemented
- three farmer assistance centers created
- modern water-saving technologies have been introduced
- farmers' associations (more than 12 thousand people) were created to restore degraded agricultural lands
- Internet information portal launched, etc.

The project has already helped 48 thousand people in Uzbekistan.

Action by the international community to solve the climate change problem

United Nations Framework Convention on Climate Change (1992)

In 1992, the countries of the world agreed at a special international UN conference in Rio de Janeiro on the need to cooperate on climate issues.

The agreement was compiled into an international document, the **United Nations Framework Convention on Climate Change (UNFCCC).**

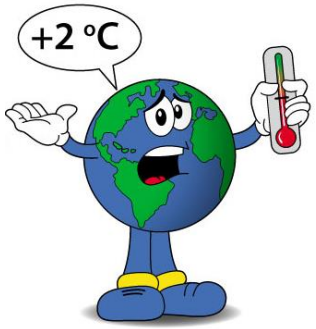
United Nations
Framework Convention on
Climate Change

International efforts to solve the climate change problem

- **1992 – United Nations Framework Convention on Climate Change**.
- **2008-2012 – the first commitment period of the Kyoto Protocol.** 37 developed countries and the European Community have pledged to reduce their greenhouse gas emissions by an average of 5% from 1990 levels.
- **2013-2020 – the second commitment period of the Kyoto Protocol.** Developed countries have decided to reduce their emissions by 18% from 1990 levels.
- **2015 – Paris Agreement adopted** with nationally determined contributions of all countries to global efforts to reduce greenhouse gas emissions.
- **2021 –** entry into force of the Paris Agreement.

United Nations
Framework Convention on
Climate Change

Paris Agreement(2015)



The main goal of the Paris Agreement is **to limit the rise in global air temperature within 1.5-2 degrees Celsius relative to pre-industrial levels**.

To this end, countries have adopted long-term targets to reduce greenhouse gas emissions (‘**nationally determined contributions**’ or **NDCs**) by 2030 and are developing long-term strategies and plans for low-carbon development and adaptation to climate change..

by August 2020, **189 countries have ratified the Paris Agreement**.

Paris Agreement is effective from 2021.

Climate change is closely linked to other UN Sustainable Development Goals

International efforts to solve the climate change problem

Task

Select one of the Sustainable Development Goals (except Goal 13 ‘Climate Action’).

Give examples:

- how climate change issues can relate to the chosen SDG?
- what climate projects (to reduce greenhouse gas emissions and / or adaptation) can help achieve this goal?

Questions to recap

1. The main source of greenhouse gas emissions associated with human activities:

A. deforestation;
B. automobile transport;
C. energy production and consumption;
D. agriculture.

2. What source of energy accounts for the most energy consumed in the world?

A. natural gas;
B. oil;
C. firewood;
D. wind energy.

3. Which energy source gives the most greenhouse gas emissions per unit of energy produced?

A. coal;
B. solar energy;
C. oil;
D. natural gas.

4. Which mode of transport accounts for the most greenhouse gas emissions?

A. rail transport;
B. sea transport;
C. air transport;
D. road transport.

Questions

The photos and illustrations used in the module, where sources are not specified, are either taken from the Climate Box toolkit (see the List of illustrations at the end of the textbook) or provided by the program participants.

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