



Climate change and economics

IMPACT OF ECONOMICS ON CLIMATE CHANGE

Human induced impacts mainly are related to use of fossil fuels (coal, natural gas and oil) for the production of energy – electricity or heat – which is one of the important preconditions for economic development

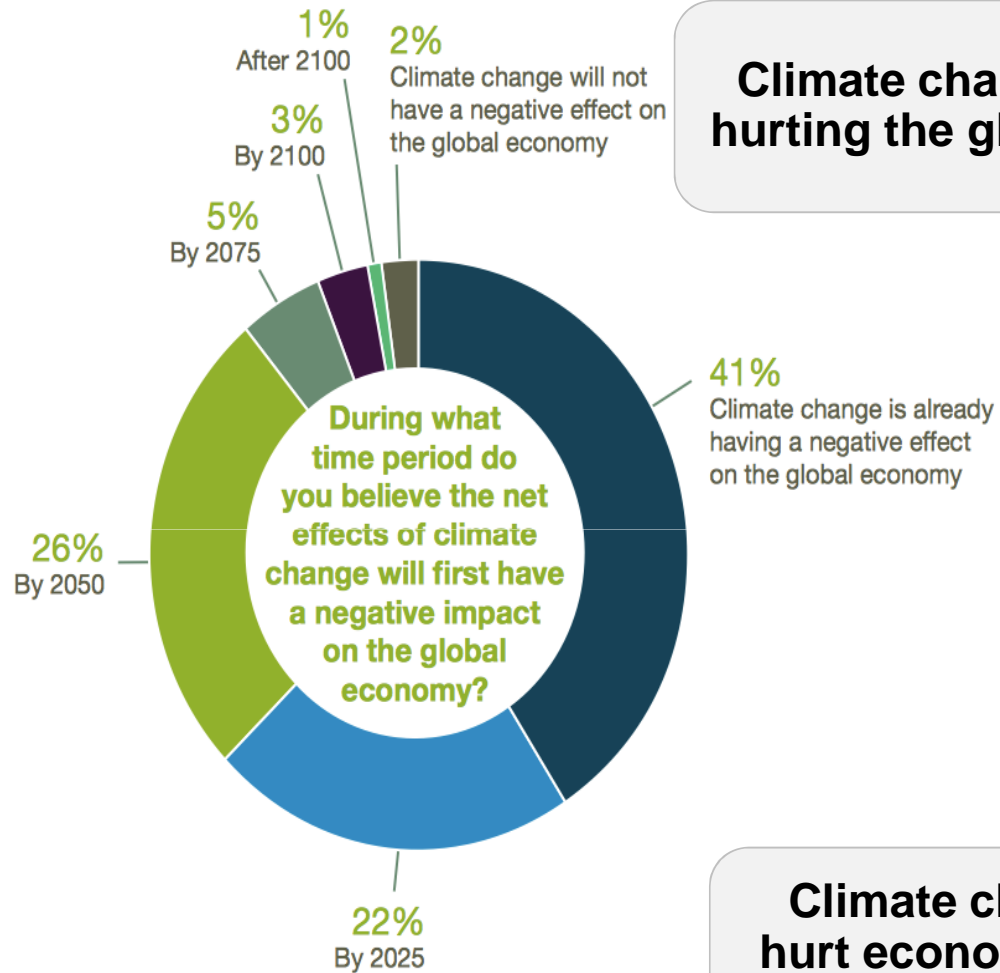
When you are in doubt to reach your destination with a private car, public transport or using your own muscle power, imagine also the impact of your decision on climate change

Consequences of a decision of single, indeed, may be relatively small, but a society of people all together have the opportunity to influence global decisions and consequences

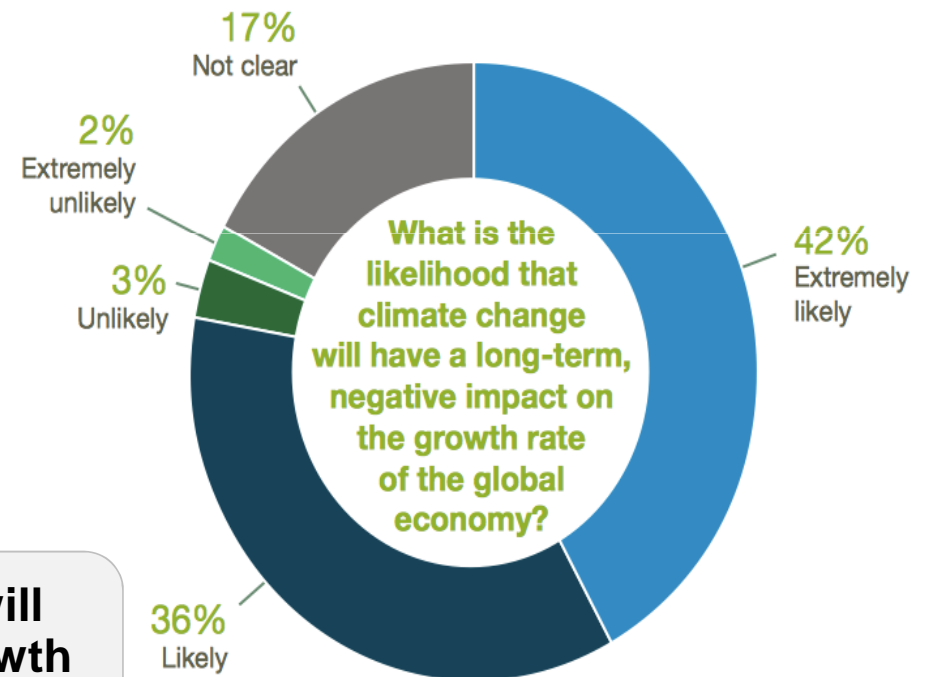
If only a few people are using bicycles instead of cars, streets do not get rid of cars, but if a city residents massively are using bicycles, traffic can be significantly relieved, less fuel consumed, air quality improved, and also health of citizens will be better



Climate change is already hurting the global economic



Climate change will hurt economic growth in future too



Potential economic costs in Washington (USA) under a business-as-usual approach to climate change in 2020, 2040 and 2080 (dollars per year)

Potential Cost	2020	2040	2080
Costs of Climate Change			
Increased Energy-Related Costs	\$222 million	\$623 million	\$1.5 billion
Reduced Salmon Populations	\$531 million	\$1.4 billion	\$3.0 billion
Increased Coastal and Storm Damage	\$72 million	\$150 million	\$352 million
Reduced Food Production	\$35 million	\$64 million	\$364 million
Increased Wildland Fire Costs	\$102 million	\$208 million	\$462 million
Increased Health-Related Costs	\$1.3 billion	\$2.2 billion	\$4.4 billion
Lost Recreation Opportunities	\$75 million	\$210 million	\$612 million
<i>Subtotal for Costs of Climate Change</i>	<i>\$2.3 billion</i>	<i>\$4.9 billion</i>	<i>\$10.7 billion</i>
Additional Costs from Business-as-Usual (BAU) Activities that Contribute to Climate Change			
Inefficient Consumption of Energy	\$1.4 billion	\$1.6 billion	\$2.2 billion
Increased Health Costs from Coal-Fired Emissions	\$19 million	\$23 million	\$31 million
<i>Subtotal for Costs from BAU Activities</i>	<i>\$1.4 billion</i>	<i>\$1.6 billion</i>	<i>\$2.2 billion</i>
TOTAL	\$3.8 billion	\$6.5 billion	\$12.9 billion
Average Cost per Household per Year	\$1,250	\$1,800	\$2,750

Source: ECONorthwest. *An Overview of Potential Economic Costs to Washington of a Business-As-Usual Approach to Climate Change*

Climate change has global consequences, thus the solution is necessary by involvement and actions of local people and by international cooperation



The most significant economic-related causes of climate change are:

- Exponential population growth
- Rapid industrial development, which demands consumption of more and more energy
- Globalization which requires increasingly higher fuel consumption due to transportation of raw material and final products over long distances

Various economic sectors contribute to the greenhouse effect, mainly by consuming energy, and many of technological processes are emitting greenhouse gases (GHG)

Under the Kyoto Protocol, signed in 1997 and entered into force in 2005, as the main GHG are set CO_2 , CH_4 , N_2O , as well as several fluoride containing gases (HFC, PFC), and others – SF_6 , NF_3 ; GHG emissions have to be limited globally

The largest contribution to greenhouse effect is attributed to CO₂ emissions, accounting for about 3/4 of the total GHG emissions – the main source is burning of fossil fuels, which is necessary for production of electricity and heat, transport and use of various sectors of the national economics

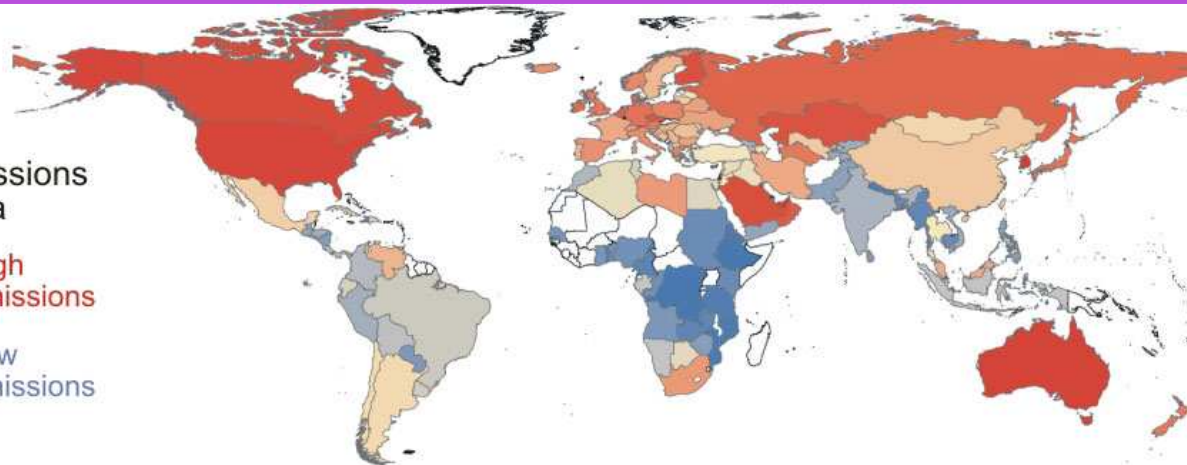
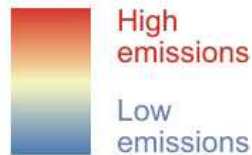
Can you imagine nowadays a sector of economics in which energy is not used? – Probably not ...

Also within a number of production processes that are not associated with the combustion of fuels CO₂ is emitted during chemical reactions, e.g., production of cement, metal and steel

Important role in reducing carbon dioxide emissions is to improve energy efficiency and use of renewable energy sources – biomass, hydropower, solar, wind and geothermal energy

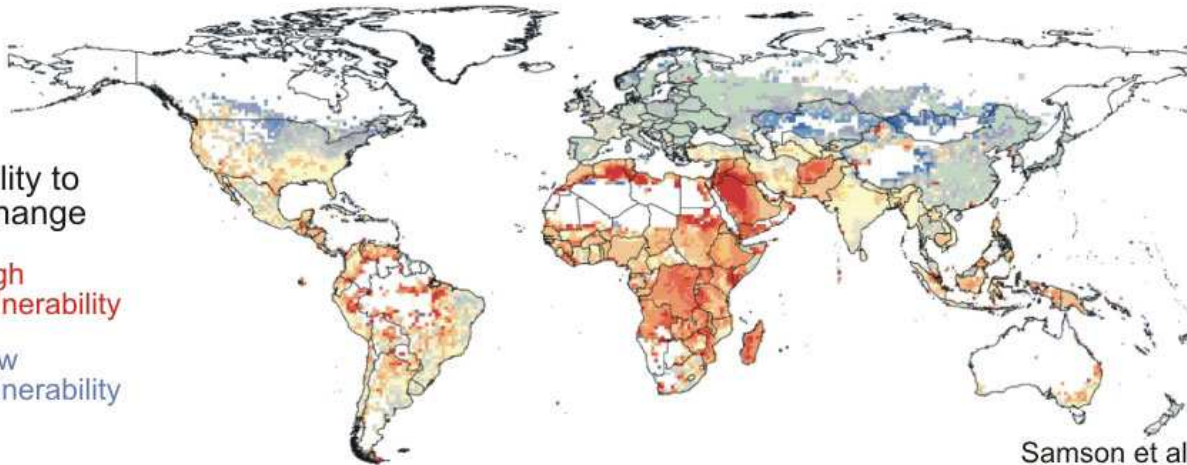


CO2 emissions
per capita



Those who contribute the least greenhouse gases
will be most impacted by climate change

Vulnerability to
climate change



Samson et al 2011

«Poorer regions are expected to have far less income to cope with damages than are wealthier regions, a problem compounded by the fact that they are also expected to bear more of the damages while having contributed the least to the problem»

Use of renewable energy is not completely free of GHG emissions - they are occurring, e.g., during production and transportation of wind turbines or solar panels, constructing dams, hydroelectric power plants etc.



In order to prevent CO₂ emissions into atmosphere, it is important to work on technologies that allow to attract and safely store carbon dioxide in underground storage, e.g., in depleted oil and gas deposit beds or deep saline aquifers

Agriculture and waste disposal are the main emitters of another GHG – methane CH₄

Methane appears from a variety of decomposition processes of organic substances - in agriculture (especially during livestock breeding and rice cultivation), forestry, waste disposal etc.

Methane is released also by many natural processes in swamps (bogs) and melting tundra

Life cycle of methane is considerably shorter than that for CO₂, but its impact on the greenhouse effect is 23 times greater – meaning that 1 ton of methane emissions corresponds to 23 tons of carbon dioxide emissions

Since methane is the main component of natural gas, a variety of economic sectors release methane emissions caused by leaching, processing, transportation and storage of gas and crude oil

Also use of renewable energy releases methane emissions – due to dams built for hydropower plants:

- by flooding the dam, a huge quantity of plants and trees are decomposed and methane accumulates in mud,
- after the water drainage, when mud is no longer covered by water, methane in large quantity is released into the atmosphere



Methane emissions can be reduced by collecting and processing decomposing material or methane gas in landfills, by applying animal feeding diets that reduce natural occurrence of methane in the digestive process, by improving production, processing and transport technologies and equipment quality of crude oil and gas

Nitrogen oxide also is a gas released in many natural processes and its impact on the greenhouse effect is 296 times greater than impact of CO₂



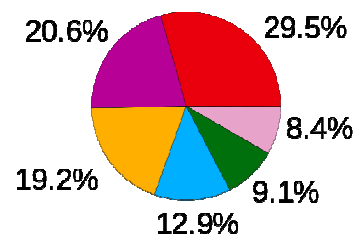
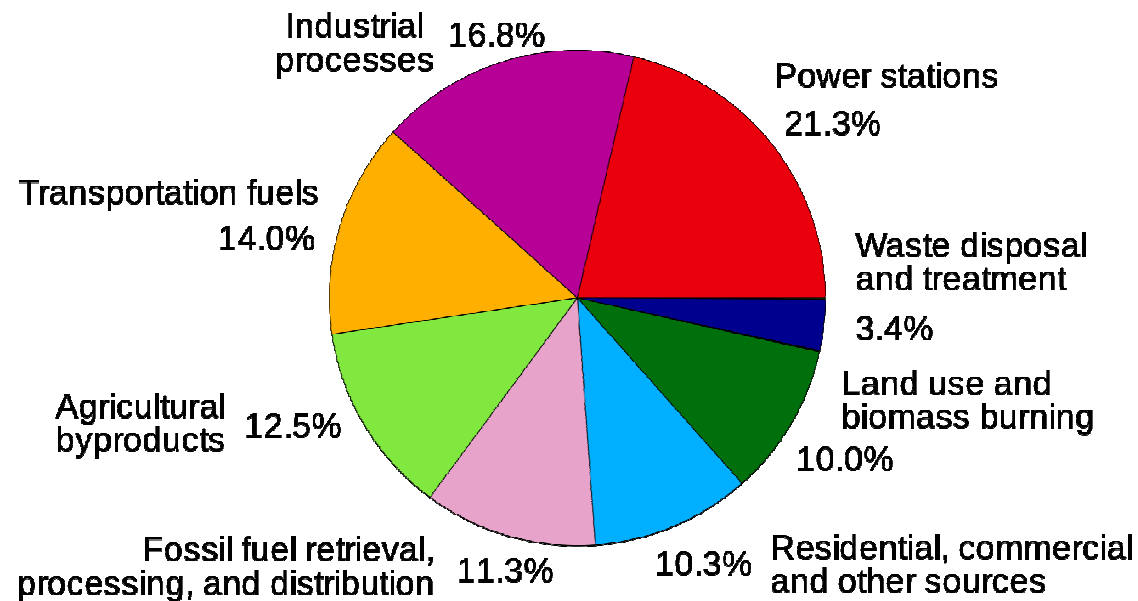
The main economic activities that generate nitrogen oxide is agriculture, fossil fuel combustion, wastewater treatment and industrial processes

In agriculture, the main emissions occur by enriching the soil with nitrogen fertilizers and during decomposition of manure

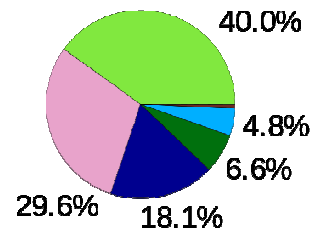
Nitrogen oxide is emitted also from the transport sector, by combusting fuels and during production of some synthetic materials

The main reduction potential of N₂O emissions demands more efficient use of fertilizers and manure management to reduce fuel consumption in transport and improvement of technological processes

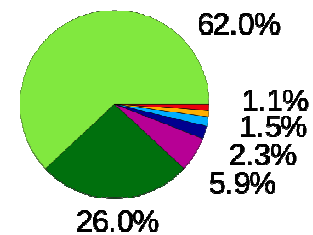
Annual GHG emissions by sector



Carbon Dioxide
(72% of total)



Methane
(18% of total)



Nitrous Oxide
(9% of total)

Fluorinated gases do not have natural sources and they are released only by human economic activities - they are emitted in a variety of industrial processes such as production of aluminum and semiconductors

Many fluorinated gases have very high global warming potential, even more than 22 thousands of times greater than carbon dioxide

Therefore, even small concentrations in the atmosphere can have a big impact on the greenhouse effect; in addition, for some of them the life cycle in the atmosphere is measured in thousands of years

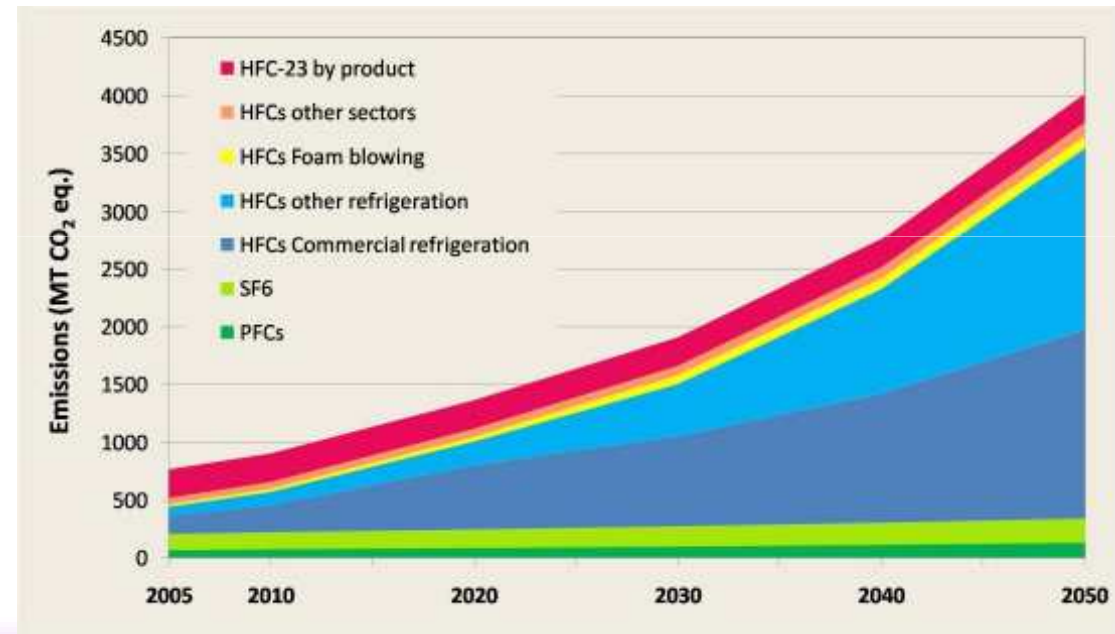
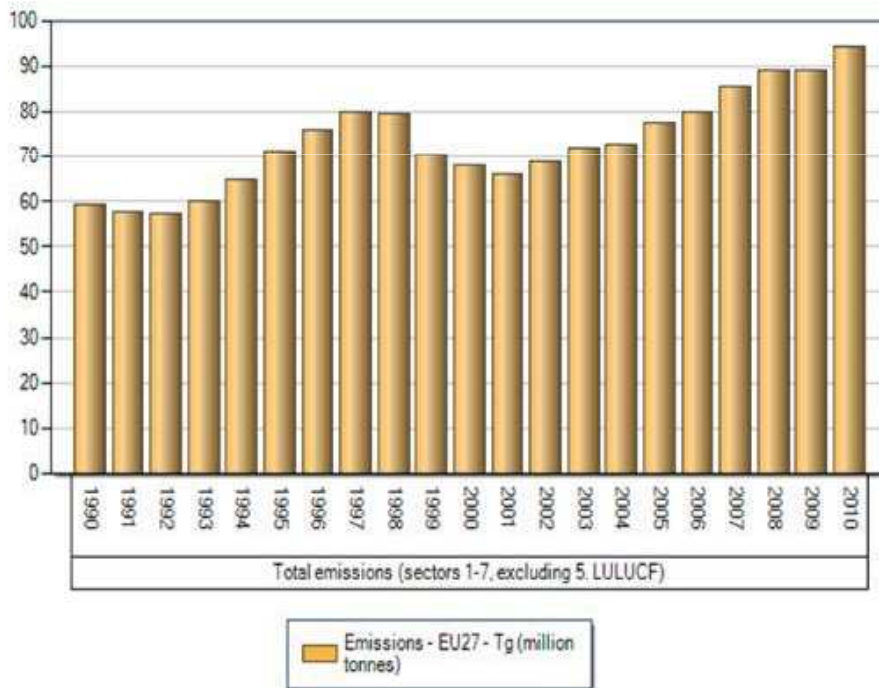
Hydrofluorocarbons are used as refrigerants, aerosol propellants, solvents and flame retardants (protective agent against burning) - these chemicals were developed to replace ozone depleting substances such as chlorofluorocarbons (CFCs) and hydrochlorofluocarbons (HCFCs)

By contrast, the ozone-depleting substances are gradually being banned by the Montreal Protocol, which entered into force in 1989



Fluorinated gases: good for the ozone layer, bad for the climate

Emissions of fluorinated gases in the EU27 (1990-2010) in million tons CO₂e



Projections for global fluorinated gases emissions 2005-2050

The average annual GHG emissions in the time period 2000-2010 has increased to 2.2 % a year, compared with an average annual increase (1.3 %) during 1970-2000



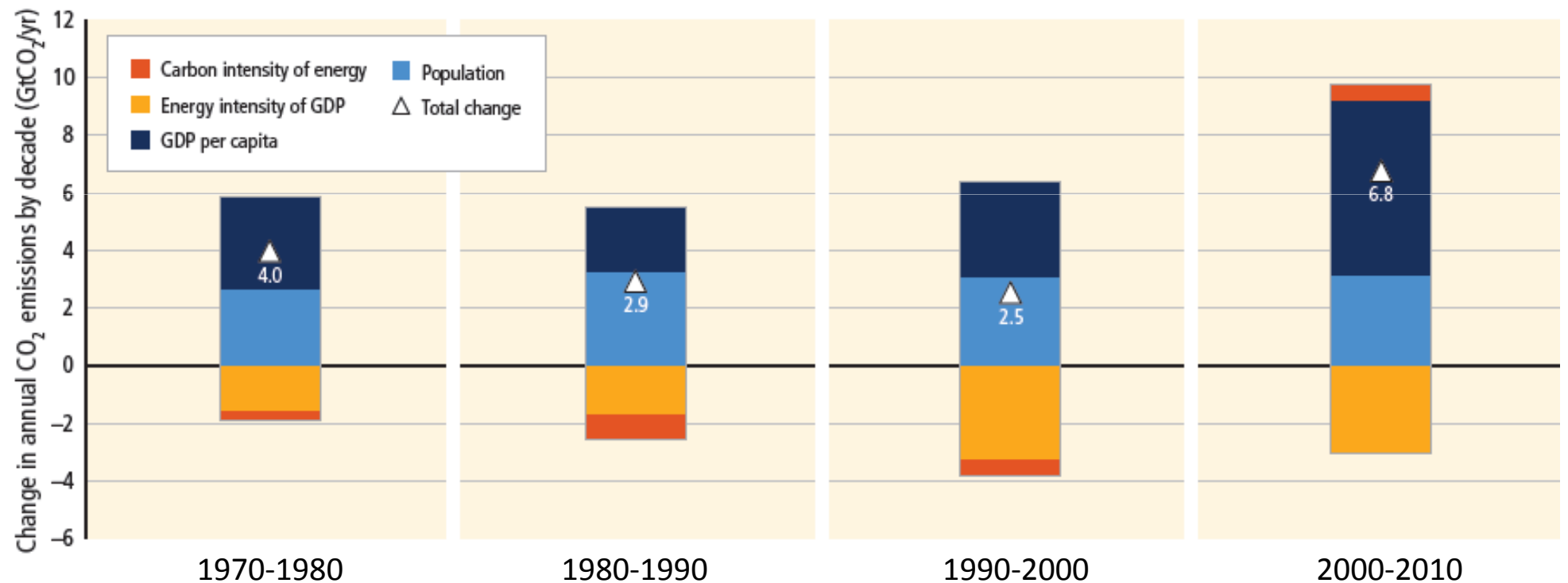
It can be related to very fast development of the national economic growth which has led to high energy consumption and subsequently to increase of GHG emissions

The total population of the developing countries during 1990-2009 increased by about 33 %, while the total CO₂ emissions from fuel combustion increased by approximately 139 %

IPCC (Intergovernmental Panel for Climate Change) 5th report, published in 2014 stated that about 3/4 of GHG emissions are CO₂ from fossil fuels, forestry and land use, but emissions of fluorinated gases are only about 2 %

In distribution of emissions by industrial sectors worldwide the direct emissions are resulting from agriculture, forestry and other land use, so called AFOLU, (24 %), production generates 21 %, transport – 14 %

Changes of the total annual CO₂ emissions from fossil fuel combustion in four groups of causes



In order to limit global warming by 2 °C in comparison with pre-industrial age, it is necessary to stabilize CO₂ concentration in the atmosphere below 400 ppm

It means that global CO₂ emissions until 2050 should be reduced by 40-70% compared to emissions in 2010, but until 2100 zero or negative level of emissions should be achieved

In addition at man-made GHG emissions should be mentioned fires, e.g., in the USA and Alaska forest fires are responsible for approximately 290 million tons of CO₂ emissions per year, which is around 4-6% of total GHG emissions that is emitted by the USA burning fossil fuels

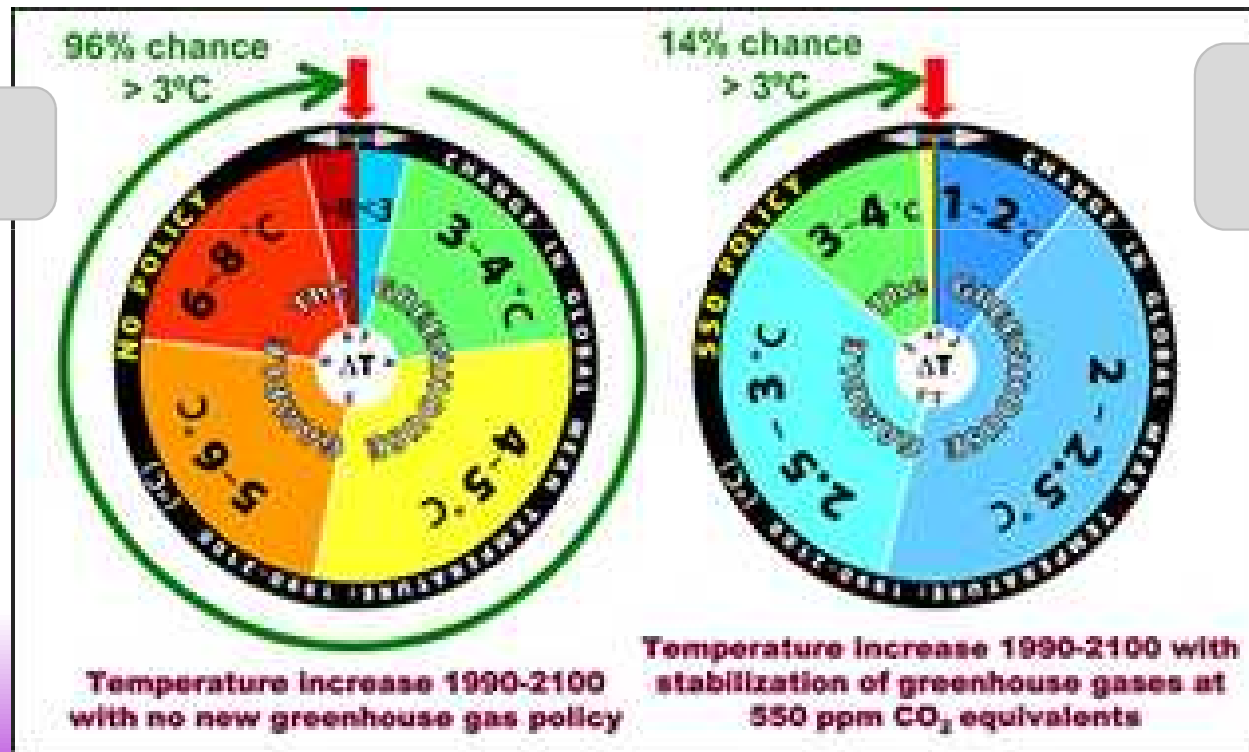
GHG and various harmful emissions resulting from use of weapons, as well as from firing fireworks should be mentioned as well

Research reveals that during national holidays in Zurich which are usually celebrated with fireworks, concentration of several harmful gases is ten times higher than the background level of a one week before and two weeks after the celebration



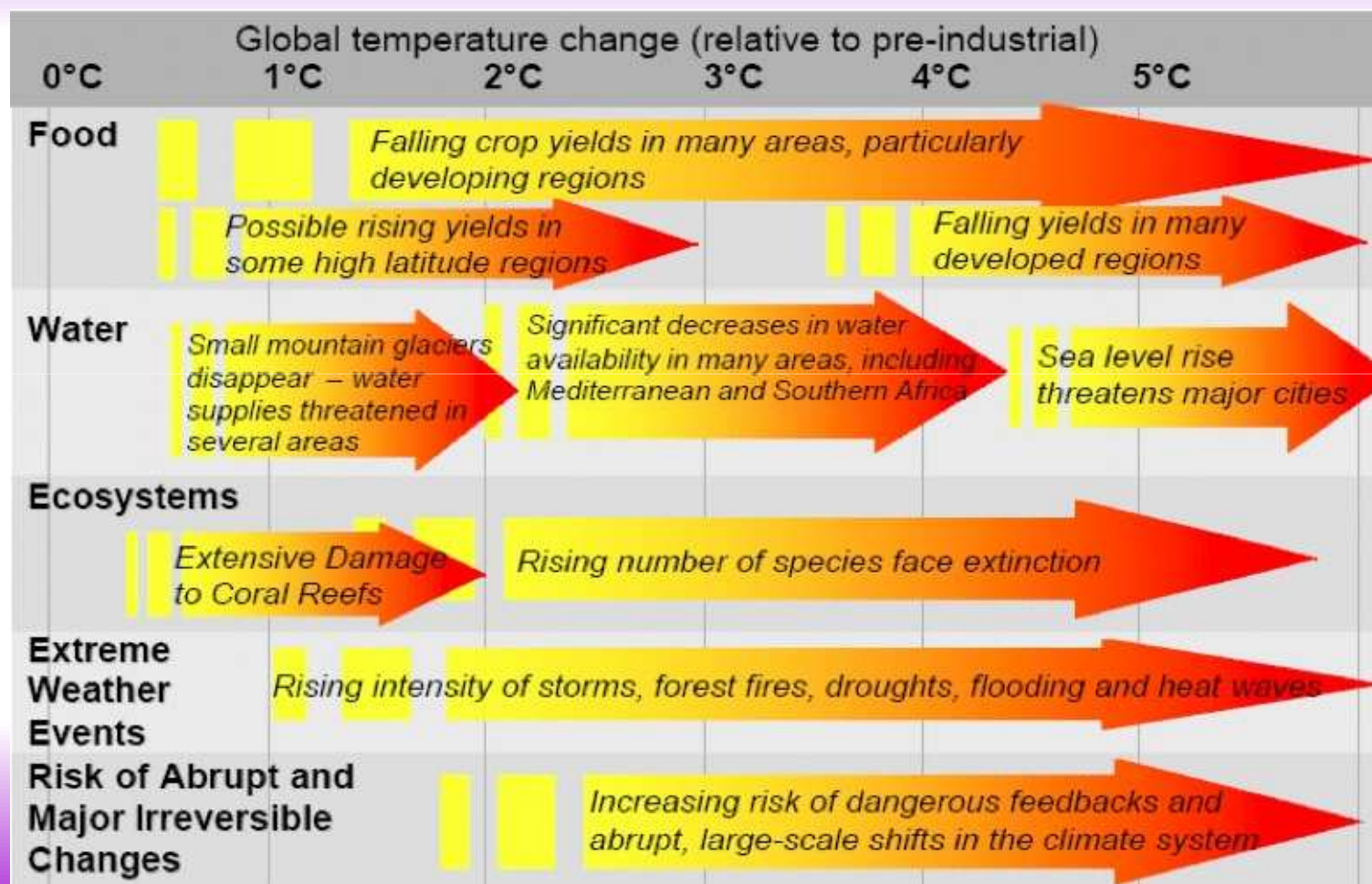
Comparison of likely temperature increases over 1990-2100, in great extent influenced by development of economics

With no policy



With stabilization of greenhouse gases at 550 ppm CO₂e

Projected impacts of climate change



In parallel with the increase of GHG concentration in the atmosphere, causing global warming, air pollution also caused by national economy **leads to opposite effect – dimming** – which means decrease of sunlight admittance into the atmosphere

NATIONAL ECONOMY

- Combustion of fossil fuels
- Industry
 - Production of cement, metals, steels, aluminium, semiconductors etc.
- Agriculture
 - Cattle breeding
 - Cereal cultivation etc.
- Forestry
 - Forest fires
 - Forestry waste burining
 - CO₂ binding and release
- Fireproofing and coolant solutions
- Waste management

CLIMATE CHANGE

- Increase of temperature
- Rise of sea level
- Melting of glaciers
- Increased precipitation
- Heat waves
- Frequent and stronger storms
- Desertification

GLOBAL DIMMING

- Decrease of temperature

Reduction of effect

Dimming appears due to the concentration of fine particles or dust released by various combustion processes and the effect is quite opposite – climate cooling

The most important anthropogenic factors influencing climate change

In the fight against climate change is affected by considerable obstacles to a variety of adverse effects arising from efforts to improve human health and quality of life, such as:

- increase of methane emissions due to exploitation of hydropower plants,
- loss of biodiversity and increase in food prices due to the cultivation of energy crops,
- death of birds due to the wind generators,
- reduction of dimming, improving air quality by removing the fine particles.

Addressing issues of climate change and adaptation, special attention should be paid to **the systemic thinking which analyzes causes, consequences and feedbacks in a whole system** in such way that dealing with one problem is not causing further damage in another sphere



IMPACT OF CLIMATE CHANGE ON ECONOMICS

No one can predict the effects of climate change with complete certainty, but it is known enough to understand the risks - the main risks and potential losses associated with:

- **Floods**
- **Strong storms**
- **Heat waves**
- **Shortage of food and water**

In 2013 more than 600 natural disasters occurred, in 37 of which forced displacement of 100 thousand to 4.5 million people was needed

If climate change mitigation measures are not performed immediately, it can lead to very high expenses during the coming decades due to the different climate-related disasters



Climate change mitigation through strict measures should be considered not as expensive expenditures, but as an investment for the future – if these investments are made wisely, it opens wide opportunities for local economic growth and development, as well as for increase of employment



Many effects of climate change are measurable in terms of money – such as damage caused by floods to the real estate and infrastructure, losses of agricultural crop yields due to extreme weather conditions etc.

Large part of the consequences of climate change can not be evaluated in monetary terms – loss of human lives or health, loss of historical monuments and natural treasures which can be destroyed by natural disasters

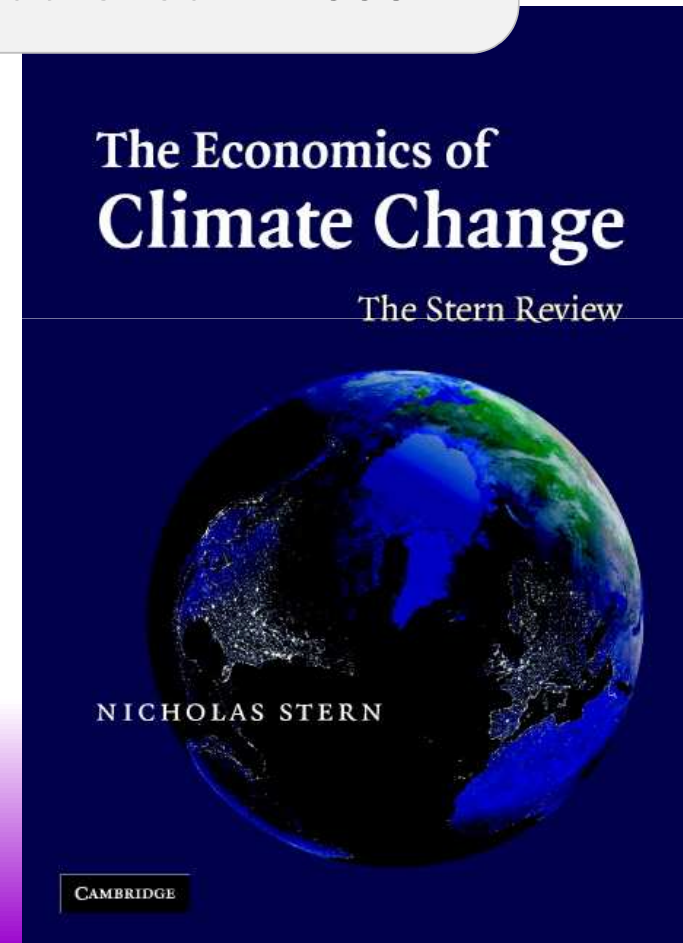
One of the most important reports prepared on the issue of **climate change impacts on economics** is the report «**Economics of Climate Change**» developed by Sir Nicholas Stern and published in 2006

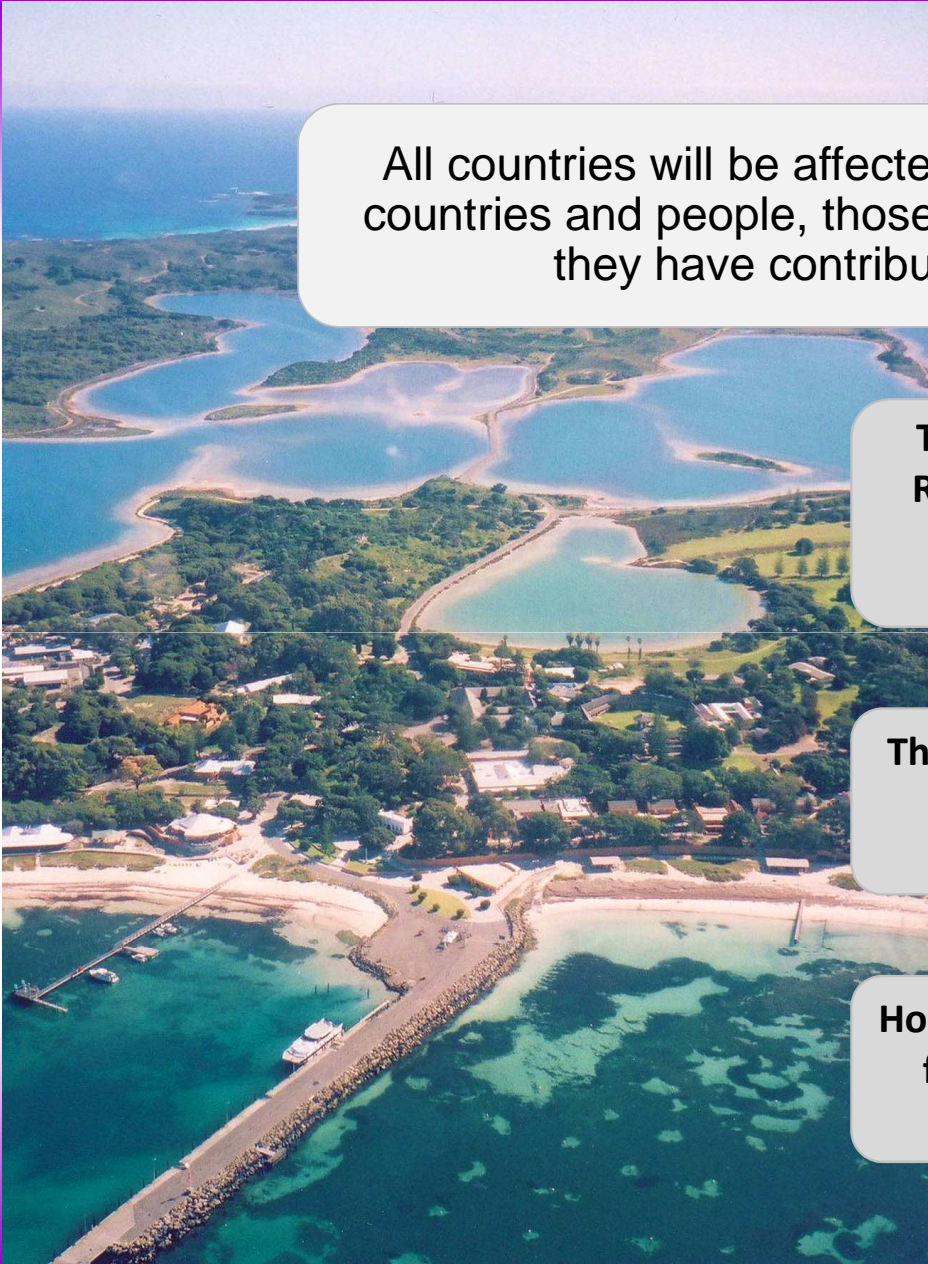
The report stresses that ignoring climate change can significantly harm economic growth and undermine the social activities – changes will be difficult or even impossible to prevent – as faster the effective measures to mitigate climate change will be implemented as cheaper they will be

The report warns that the effects of climate change could reduce global GDP by up to 20 % each year until the end of the century, and that the world would have to spend around 1-2 % of global GDP per year in order to reduce these risks

The main impact of climate change will be manifested as access to water resources, food production, health and environmental quality

Due to the warming of the worlds' climate, hundreds of millions of people could suffer from hunger, water shortages and coastal flooding





All countries will be affected, but the most vulnerable groups are the poorest countries and people, those who will suffer earliest and the most, even though they have contributed least to the causes of climate change

The island countries such as the Republic of Maldives, Philippines, Republic of the Fiji Islands, the Republic of Kiribati, the Republic of Nauru, the Solomon Islands and many others may lose all of their territories because of rising sea levels

Therefore, climate change is also an ethical and moral problem as the greater are the losses in those countries and for those people who has relatively small impact on climate change

However, the costs associated with extreme weather events, including floods, droughts and storms caused heavy losses in rich countries such as the USA, Japan, the Netherlands, the Great Britain etc.

The global assessment report of the Internal Displacement Monitor Centre reveals that **in 2013 22 million people were displaced from their places of residence due to natural disasters**

As in previous years, the most affected region is Asia, where 19 million people were displaced during the year

Although both, affluent and poor, countries are affected by natural disasters, however, developing countries bear the brunt as more than 85 % of people have been displaced

In Philippines, only due to the typhoon “Haiyang” were displaced 4.1 million people, about 1 million or more in Africa, America, Europe and Oceania together



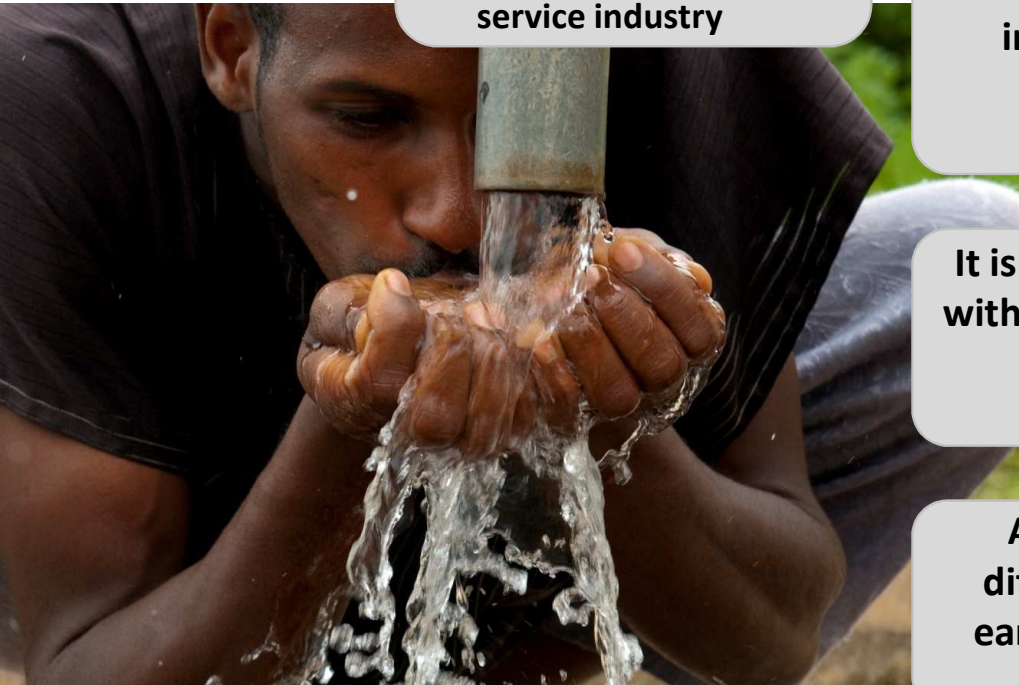
- Agriculture
- Forestry
- Fishery
- Power supply
- Water supply
- Transport
- Construction
- Health care
- Tourism and hospitality service industry

In overall, **direct or indirect affects of climate change will apply to all sectors of the economic** – the major direct impact is already ongoing and worsening is expected

In agriculture and forestry due to the climate change the need to introduce new crop varieties is needed that are better suited to extreme temperature and humidity changes as well as are resistant to new pests

It is estimated that the movement of species to the poles takes place with an average speed of 17.6 km per decade and to higher altitude in the mountains at a speed of 12.2 meters per decade that change the composition of species in certain areas

As there are significant differences among movement speed of different species, it is possible that some of the pests arrive much earlier than their natural enemies, therefore, timely studies on the effects on crops are required



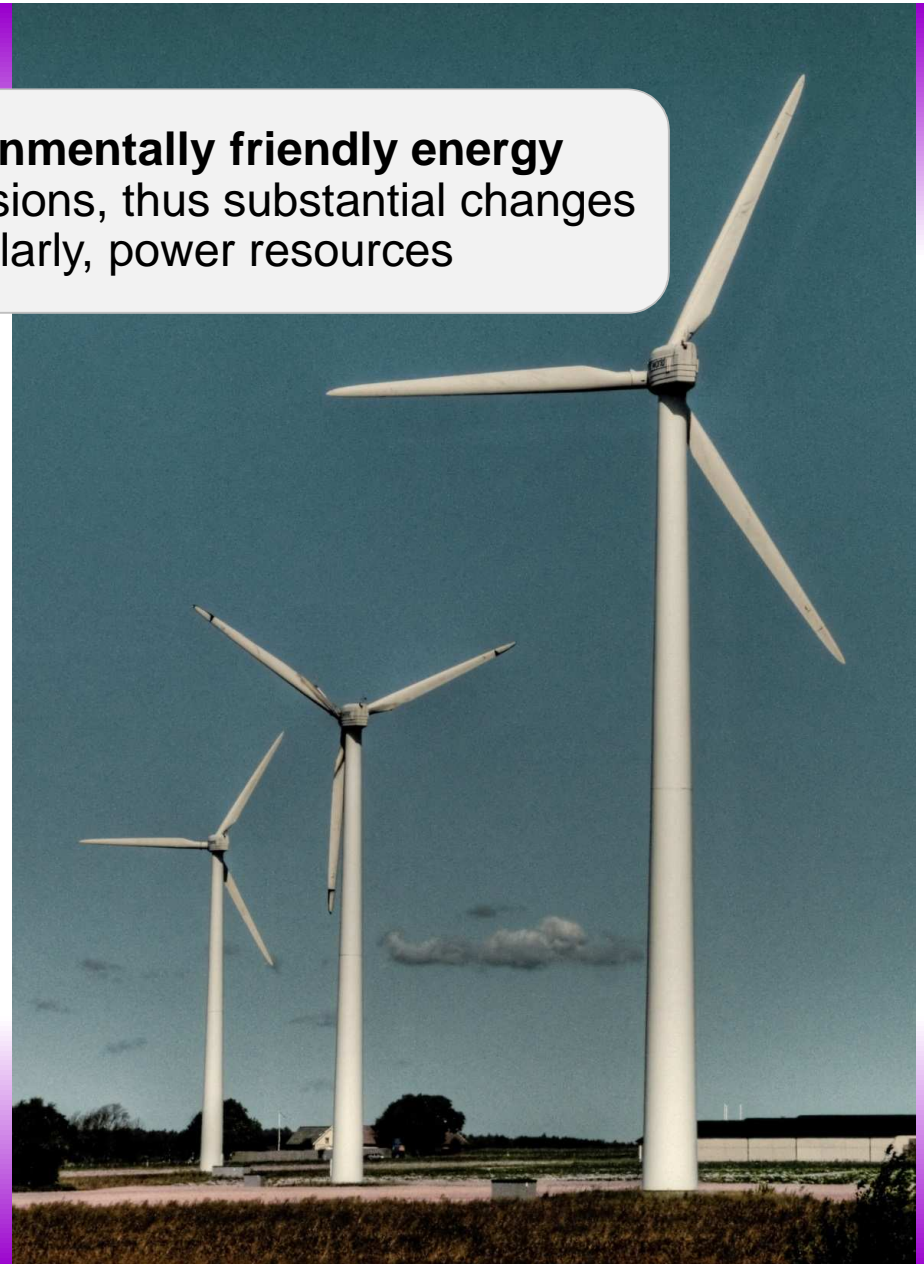
In order to mitigate climate change, **a shift to environmentally friendly energy sources is required**, with significantly lower GHG emissions, thus substantial changes are to be expected in yield of resources, particularly, power resources

It is estimated that in order to stay within the relatively safe 2 degrees of global warming, tolerable CO₂ emissions are 900 Gt

Taking into account the potential of carbon capture and disposal technologies, allowed carbon budget to 2050 may increase by 125 Gt CO₂

It would be emitted if only about 20-40 % of the already known fossil fuel reserves are burned

This creates enormous risks for investors who should be aware that 60-80 % of the already identified reserves of fossil fuels can not be burned, due to need not to exceed a global temperature rise



Interruption of investment in fossil fuel extraction companies will cause more opportunities for investment in alternative energy producers

Power supply companies have to take into account that more and more economic instruments will be used resulting in higher expenses of GHG emitting energy sources

In Latvia as one of the major alternatives to fossil energy electricity generation in hydropower plants is considered

Climate change has a major impact on the hydropower production types – whereas higher temperature accelerates the evaporation of water and hydrological circulation thus adversely affecting seasonality and volume of river runoff

Consequently, the hydropower generation capacity can be endangered and to become economically disadvantageous, therefore, significant attention should be paid to the development of technologies that allows the most effective power production even from small water flows



Significant changes are expected in the tourism sector, for example, in currently popular Mediterranean resorts the top season is expected in spring and autumn, but in summer due to extreme heat and drought the tourism will decline

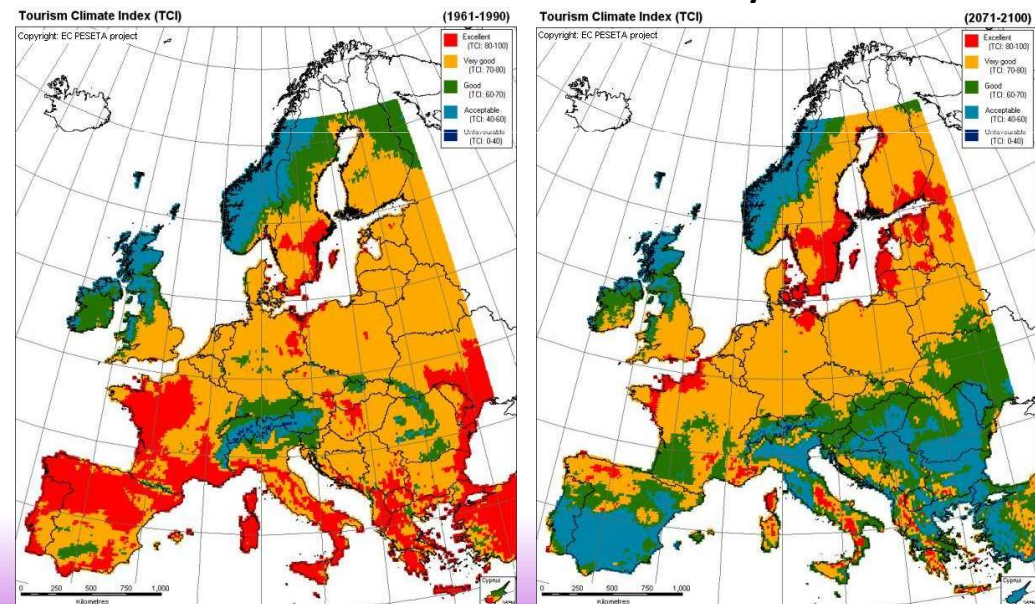
Perhaps the greatest flow of tourists can be expected in the Baltic Sea resorts, which has to be prepared to reduce the impact of tourism on the environment

More and longer blue-green algae appearing risk is expected and due to that natural waters may become unsuitable for safe swimming

Furthermore, greater demand for electricity in hot summer periods is expected in order to ensure cooling of indoor air

At the same time in winters the demand for heat energy for indoor heating could decrease

Comparison of the tourism climate index in 20th century and the end of the 21st century



Great losses in the national economy can be induced by the consequences of climate change **impacts on infrastructure** – energy and water supply, transport systems

In its turn, damage to infrastructure will affect all industries that are using these services

Especially dangerous is the loss of quality of drinking water and damage to the infrastructure caused by flooding

Due to sea level rise economic losses will occur in coastal areas

Huge flows of climate refugees from regions of flooded or desertification affected territories no longer suitable for living are expected – the number of climate refugees is estimated at about 50 million people until 2050



Potential impact of climate change on the economy of Latvia

- Increase of temperature
- Changes in intensity of precipitation
- Rise of sea level

Forestry

- A larger proportion of foliage (lapkoku) trees
- Increased amount of pests
- Emergence of new pests
- Higher fire risk in dry periods



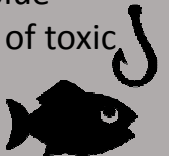
Agriculture

- New crop introduction, more resistant to higher precipitation
- Longer growing season, certain crops possibly can have more harvests per year
- Greater need for rural drainage



Fishery

- Intense appearance of blue-green algae and release of toxic substances into the fish organisms
- Changes in fish species due to higher water temperature



Energetics

- More expensive energy costs due to carbon price
- Change of river run-off in the production of electricity by hydropower plants
- Higher energy demand in summer for cooling and less in winter for heating



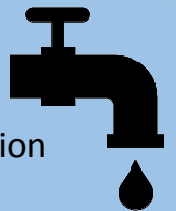
Construction

- Higher requirements for thermal insulation of buildings
- Higher requirements of buildings and structures for resistance to storms and floods
- Greater need for dams and sea-fastening structures



Water supply

- Higher amount and intensity of precipitation
- Higher flood risk
- Water demand at drought-affected regions
- Decrease of water quality



Potential impact of climate change on the economy of Latvia

- Increase of temperature
- Changes in intensity of precipitation
- Rise of sea level

Transport

- Higher requirements for vehicle efficiency and permitted levels of emissions
- Greater need for public transport services



Turism

- Greater flows of tourists
- Greater need for artificially established bathing areas, due to possibly unsafe natural water bodies
- Snowless winters more likely



Health care

- Injuries and deaths as a result of natural disasters
- Increase of infectious diseases
- Increase of respiratory infections
- Malnutrition-related illnesses



Infrastructure

- Higher requirements for the durability of infrastructure against storms and floods
- Alternative services for disaster situations



As the significance of impacts and potential risks at the various sectors of the economy are different, each company and organization should carefully assess the impact of climate change that can affect their activities and the potential to be prepared for the risks timely

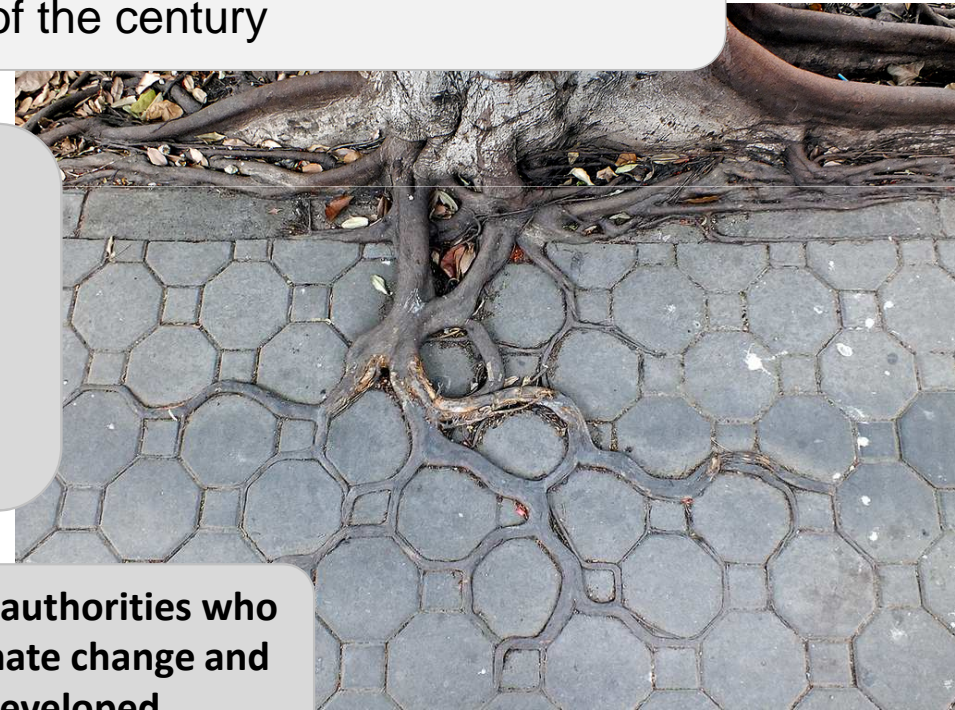
ADAPTATION MEASURES IN DIFFERENT BUSINESS SPHERES

Climate change has a large inertia – even if in 2000 GHG emissions would be interrupted, climate change and global temperature would continue to increase by more as 0.5 °C until the end of the century

The main adaptation measures:

- Timely and accurate information dissemination
- Advanced planning
- Climate change resilient crop formation
- Improvement of infrastructure

Important role in adapting to climate change is attributed to the local authorities who within their territorial plans must take into account the effects of climate change and timely adapt to them – strategies and action plans have to be developed



Studies related to the **climate change adaptation policies of farmers in Europe** reveal that following measures for different adaptation needs can be performed:

1) To react on changes of water supply –

- Efficiency of water use
- Improved soil ability to retain moisture
- Creation of small water reservoirs and increase of capacity

2) To react on flood and drought –

- Creation or restoration of wetlands
- Improvement of floodplain management
- Improvement of drainage systems
- Construction of dams
- Advanced rainwater detention
- Introduction of drought-resistant crop varieties
- Insurance against floods and drought

3) To respond to the increased need for irrigation –

- Changes in the choice of crops
- Introduction of climate resilient crop varieties

4) Changes in agricultural land use –

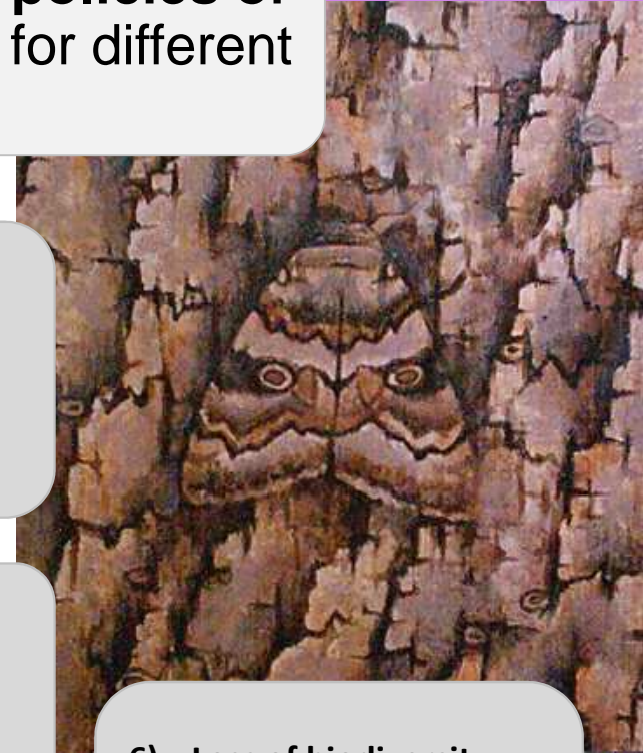
- Transformation of agricultural production and processing companies
- Supplementing of soil with organic substances

5) Changes in water and soil quality –

- Improved efficiency of nitrogen fertilizers
- Soil carbon management, protection against soil erosion

6) Loss of biodiversity –

- Increase the use of water in ecosystems
- Maintain corridors to increase crop diversity



RISK &
CHANGE

Alyson Warhurst

Previous studies have revealed that in overall relatively few companies have developed **adequate risk assessment of measures** – only 55 % of the 300 largest European companies have long-term goal of climate change management

Also, a large part of entrepreneurs in Latvia do not apply any concrete adaptation measures yet

Those entrepreneurs are anxious whose business depends on the presence of snow and ice in winter, and is affected by fluctuations of air temperature

Companies which are affected indirectly by climate change have to assess how their profitability can be affected by the rising cost of carbon in comparison with competitors

Approximately 80 % of emissions are caused by the supply chain - which means that a large part of the carbon cost will be included in the price of the products supplied

Business sectors most affected by the cost of carbon are chemical industry, production of food and beverages as well as production of industrial goods

2012
PopTech
Iceland

Peter Durand



ECONOMIC INSTRUMENTS FOR CLIMATE CHANGE MITIGATION

Climate change is considered to be the biggest **market failure** in the world's history

Market failure is a market condition when it is not able to provide the necessary relationship between demand and supply ensuring effective use of public resources available

It is caused by the so-called externalities – costs that arise around the world and for future generations due to climate change, which are not covered in any way by those who caused the climate change – GHG emitters

Thus, the emitters are not of economic interest to reduce these emissions

Moreover, climate is a public benefit - it is not possible to restrict its use to those who do not pay for the preservation in an appropriate condition for the people



To increase the interest of reducing emissions for the entrepreneurs whose by-product of business activities are GHG emissions, the governments are using **a variety of economic instruments:**

- Restrictions on use of certain substances
- Limits of emissions
- Prohibitions
- Instruments of economic interests

Such tools ensure that the entrepreneur's behavior is becoming more environmentally friendly as well as economically advantageous

This is achieved by a variety of taxes, charges and emissions trading systems

However, if such instruments are used only in some countries, it reduces their competitiveness due to the increased production costs

Similarly as in the field of sustainable development, also in climate change, economic analysis should be global and should take into account the very long periods of significant attention to risk and uncertainty assessment



As one of the most effective economic instruments of climate change mitigation **pricing of carbon emissions** is considered

This can be implemented either in the form of emissions trading schemes or carbon taxes

The aim is to include in the price of a product public costs resulting from the carbon emissions

For example, reduced crop productivity, health care costs due to heat and drought, or damage to properties and rising sea levels due to floods

Calculations reveal that in electricity production carbon emissions caused by external costs counts from 1.6 to 5.8 eurocents/kWh depending on the energy source, where the lower limit is attributed to the production of electricity from gas, but the higher – to coal-consuming technologies

The carbon price helps to shift the burden of losses to those who are responsible for it and who have real potential to reduce impacts



Within the **Emissions Trading Scheme (ETS)** total allowable level of GHG emissions is set - those industries or companies that are able to reduce their emissions, have a chance to sell the excess of emissions for larger emitters



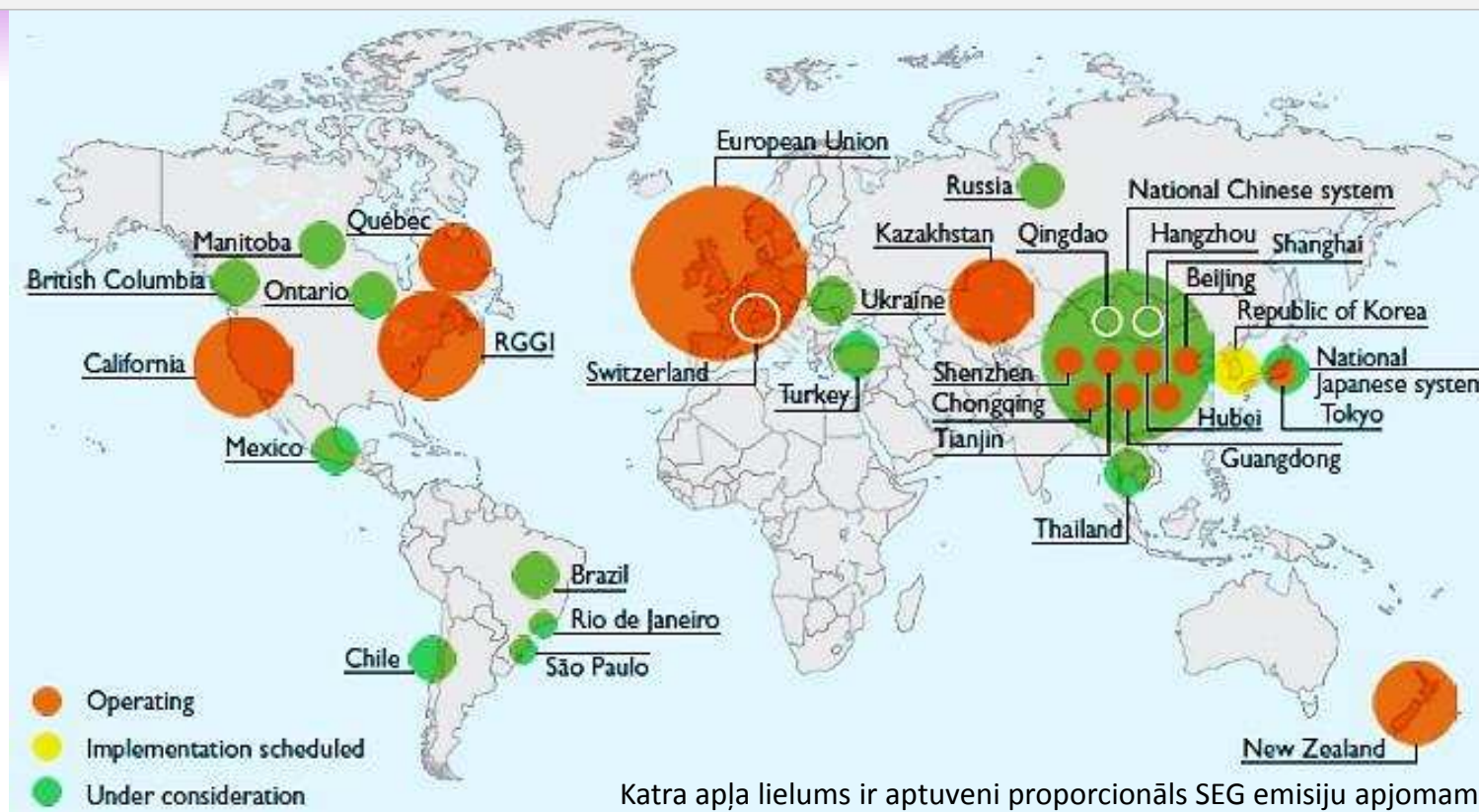
Thus a supply and demand is created for emissions permits, which enable the ETS to determine the market price of GHG emissions

Prices vary with supply and demand fluctuations

The total limit of the allowable emissions helps to ensure that the necessary reductions of emissions will be implemented, because all the pollutants are embedded together into previously allocated carbon emission permits within the budget

The ETS mostly operates within the European Union and during the 3rd period of its activities (2013-2020) it covers 11 000 power plants and industrial plants in 31 countries, as well as airline companies (covering approximately 45 % of total GHG emissions)

Situation in development of emissions trading system in the world, in 2014



During the 3rd period of the EU ETS activities 67 facilities from Latvia participated – mainly heat and electricity production plants, several industrial plants of glass fiber, building materials, metal production etc.

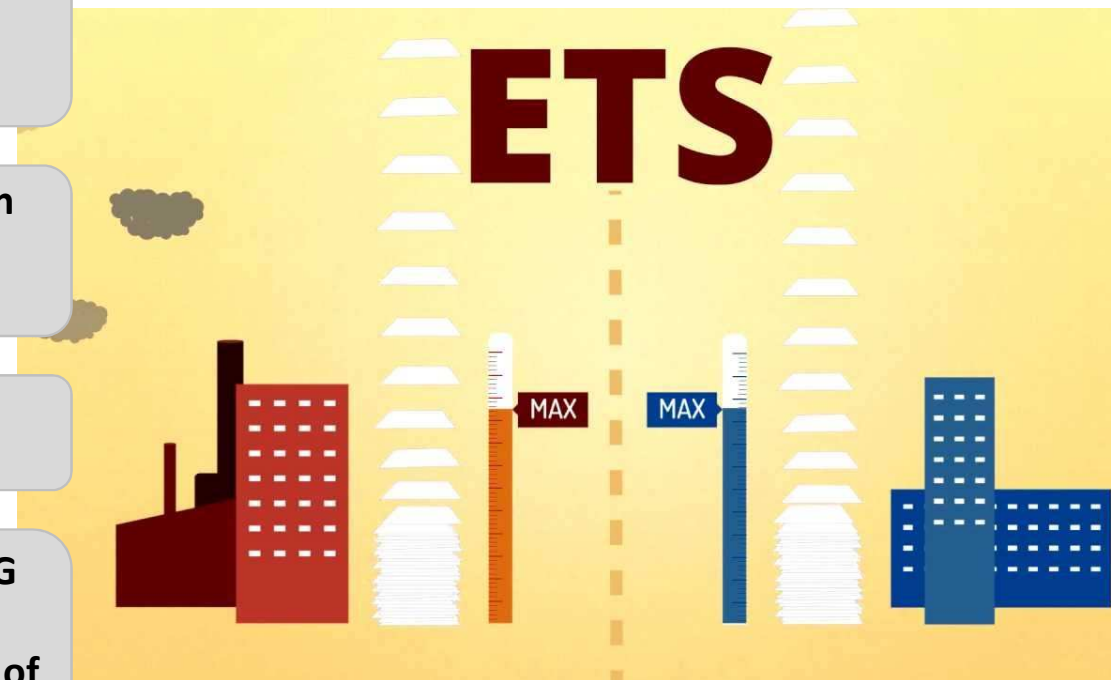
The EU ETS in the first two periods had significant shortcomings, because establishing allowable emission limits in advance for the emission trading period, it is impossible to predict accurately other influencing factors on amount of emissions

Thus, due to the economic crisis in the world during 2008-2010, the intensity of industry was significantly reduced leading to decrease of GHG emissions

This greatly reduced the demand for emissions permits, in addition, the initial allowable emissions standards were set too high

As a result, price of emissions permit decreased from about 30 EUR/t to 8 EUR/t

This price is too low to motivate investors to invest in GHG emission reducing technologies – to address these shortcomings, emission allowances should be granted free of charge, but already initially they must be sold at auctions



The goal of all EU countries, including Latvia, was reduction of total emissions by 8 % until 2012 – this was achieved **with an overplus** (pārpalikums) **(decrease by 19 %)** largely due to significant emission reductions in transition economies induced by changes of national economy structures



Two the largest GHG emitting countries are China and the United States of America accounts for about 45 % of global GHG emissions

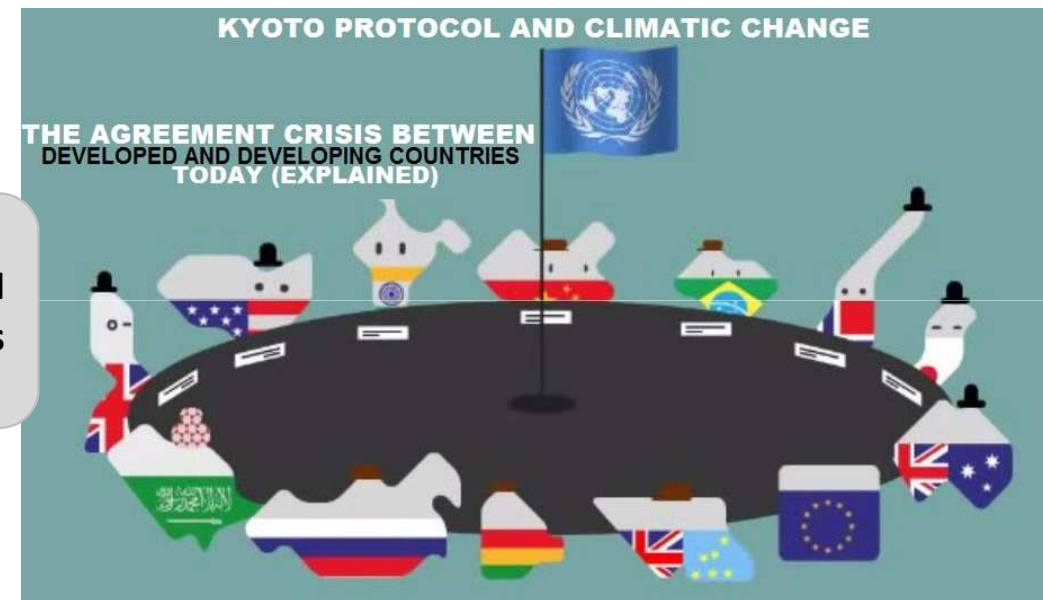
The USA has not ratified the Kyoto Protocol, hence its commitment to reduce emissions is voluntary

By contrast, currently the largest emitter China is among the developing countries for which in the first commitment period until 2012 the Kyoto Protocol did not impose specific emissions reduction commitments

China in 2005, when the Kyoto Protocol entered into force, emitted 7.527 thousand CO₂e t/year, but already in 2006 it became the largest GHG emitter, and in 2011 the emissions exceeded 10 Mt CO₂e /year, while in 2014 GHG emissions in China decreased by 2 % (the first time since 2001)

In the world as a whole as an important incentive to reduce emissions are the emission reduction targets set by **the Kyoto Protocol** and provided emission reduction mechanisms including emissions trading system

The Kyoto Protocol anticipated that during the 1st period (2008-2012) 37 industrialized countries (so-called Annex I countries) made a commitment to reduce GHG emissions on average by 5 % in comparison to 1990



For other member states specific emission reduction targets were not mandatory, but they were able to get foreign investments for GHG emissions reducing technologies applying the Clean Development Mechanism and Joint Implementation projects proposed by the Kyoto Protocol, which provided the developed countries with the so-called certified emission reduction units

During the 2nd period (2013-2020) of the Kyoto Protocol all contracting parties have **a common goal of reducing emissions by 18 %** in comparison to emission levels in 1990



During this period, the EU has committed to reduce its GHG emissions by 20 % in comparison with 1990

In 2015, negotiations on specific emission reduction targets continued for the period 2021-2030

It was announced that the EU countries are ready to reduce total GHG emissions by 40 % until 2030 in comparison with 1990 levels

Also the USA, which has not ratified the Kyoto Protocol, is planning to reduce emissions by 26-28 % until 2025 in comparison with 2005 levels

By contrast, China is committed to reduce GHG emissions by 40-45 % in comparison with levels of 2005, increasing the proportion of non-fossil fuel energy resources up to 15 % and increasing the forest area by 40 million ha

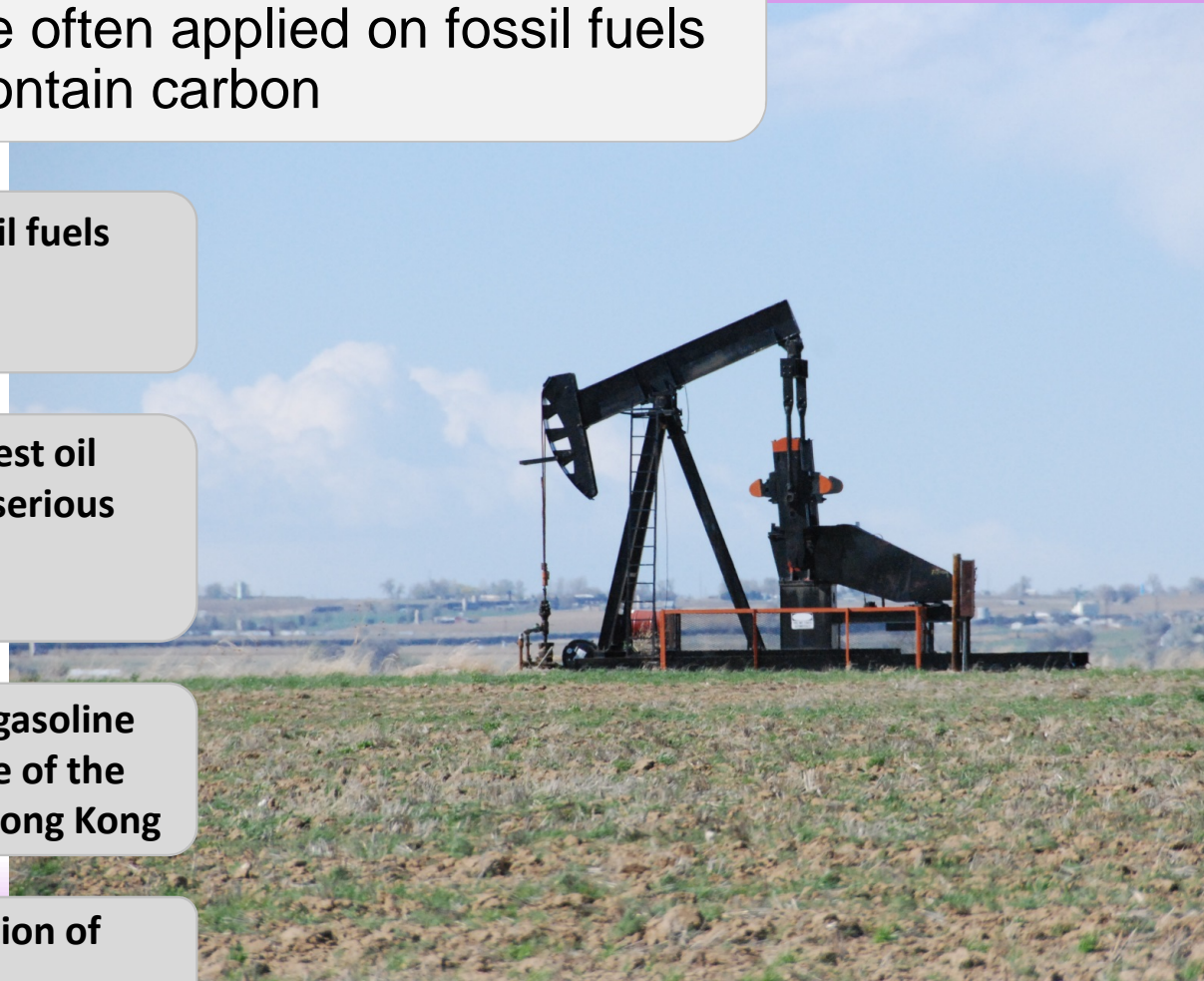
Applying a carbon tax, a specific price on carbon emissions is set, more often applied on fossil fuels that contain carbon

But in many countries of the world still not only fossil fuels are not taxed, but on the contrary – subsidies are paid

For example, Venezuela which owns one of the largest oil reserves and which in recent years is experiencing a serious financial crisis, still subsidizes fuel for domestic consumption

In Venezuela, in the 2nd quarter of 2015, the price of gasoline was only 2 USD cents per liter, while the average price of the world was 1.09 USD reaching maximum (1.93 USD) in Hong Kong

Consequently, an important step would be cancellation of subsidies to fossil fuels



One of the important ways that investments can help in the fight against climate change, is **improvement of infrastructure**



Infrastructure that is being built to meet the public's basic needs such as water and energy supply system, as well as mobility system is often very expensive, but it is used for decades

It is therefore important for creating and reconstructing of infrastructure to create real opportunities to change the way how to meet the needs of the climate change

In addition, the infrastructure must be resistant to extreme weather conditions

By contrast, developing the infrastructure according to the previous business practice that has led to climate change, we turn ourselves into unsustainable practice for many decades

Transition from fossil fuels to renewable energy sources is very complicated – it requires changes throughout the energy system from production and storage to distribution and final consumption

For example, electricity produced by solar panels or wind turbines should be available for use later or in another way – it can be achieved if there is a well-established connected to smart power grids

Also the transport system requires a radical change: wider use of electric vehicles creating and improving the network of public transport that can resolve the demand for mobility by offering alternatives to travel in private cars

Investments required to implement these changes could be huge

The European Commission estimated that the transfer of the energy and transport system in the EU to a low-carbon system will need about 270 billion EUR from state and private investments every year during the next 40 years



Investments in transport, water and energy transmission systems are being made all the time, so they targeted should be invested **towards more sustainable solutions**

The report of the Global Commission in 2015 identified the main directions in order to **ensure a low-carbon and climate-resilient economic growth and development:**

1. To accelerate the development of low-tech carbon cities of the world
2. To restore and protect the agricultural landscape and forests and to increase agricultural productivity
3. To invest at least 1 trillion USD a year in clean energy production and energy efficiency improvement
4. To increase energy efficiency standards to the world's best level
5. To implement an effective carbon price and to decline out subsidies for fossil fuels
6. To provide a new, climate smart infrastructure
7. To promote low-carbon innovations
8. To drive low-carbon economic growth through the business and investor behavior
9. To raise targets for reducing international aviation and maritime transport emissions
10. To reduce gradually use of hydrofluorocarbons (HFCs)

Various economic instruments are needed, not just to mitigate climate change in general, but also to achieve **the objectives of the European Union's climate targets by 2020**

Another economic instrument which can significantly affect the transition to cleaner technologies is a change in the intellectual property protection

Reducing the duration time of patents or facilitating licensing opportunities to ensure spread of technological improvements faster and wider

Governments may switch a part of the financing for the purchase of licenses to redirect and improve compliance with the law that the use of patent-protected inventions is mandatory

- To reduce GHG emissions by 20 % (or 30% if agreed upon the world)
- To increase the energy efficiency by 20%
- To obtain energy from renewable energy sources up to 20 %



Another important tool which can be used to reduce greenhouse gas emissions and promote adaptation is **public information and environmental awareness**



This would ensure consumer behaviour change - consumers with their wallets «vote» for a lower carbon products, choose climate-friendly transport modes, participate in climate adaptation activities, invest in climate-friendly businesses etc.

Here a major contribution is provided by non-governmental organizations, formal and informal education institutions as well as religious organizations

The climate is common benefit that belongs to everyone, therefore, the humanity must recognize the need for change in lifestyle, production and consumption

It must be realized that there exist a real «ecological debt» among the world's developed north and developing south, which suffer most of all from climate change

Climate change mitigation instruments

Goals of GHG emissions' reduction

- Carbon pricing
- Support measures to reduce emissions (reduce of taxes, subsidies)
- Emissions trading systems

Investments

- Renewable energy resources
- Safer power supply systems
- Smart power supply grid creation
- Smart transport systems
- Development of clean technologies

Support of infrastructure

- Development of public transport
- Bicycle paths
- High parking rates
- Low emission zones in cities
- Charging facilities for electromobiles

Environmental awareness

- Public information
- Direct sell-purchase communities
- Sharing and sharing economic development
- Voluntary reduction of consumption of material goods



Taking into account the complexity of climate change causes and consequences, it is clear that only a single instrument can not solve the problem – synergy of economic instruments and change of behavior is required

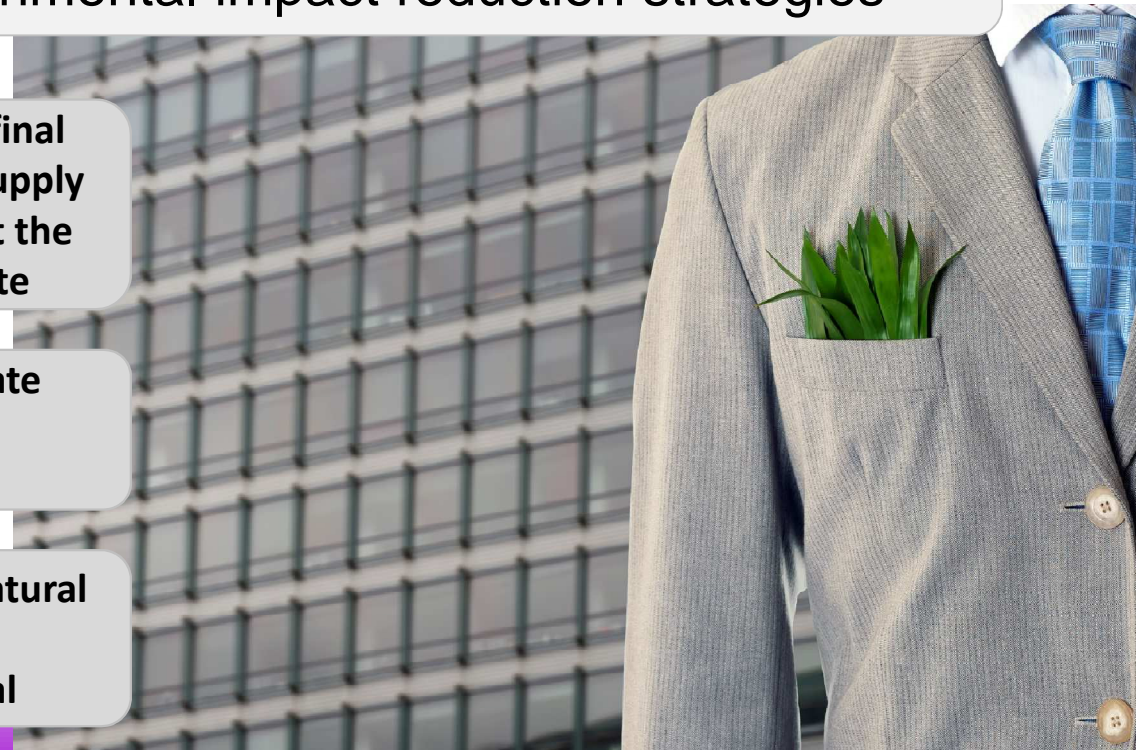
CLIMATE CHANGE MITIGATION MEASURES IN BUSINESS

In business the climate impact reduction is tightly associated with the whole resource-saving and overall environmental impact reduction strategies

In order to reduce the total GHG emissions of produced final product it is important to co-operate throughout all the supply chain – from raw material producers to customers who at the end of the life cycle will get rid of the product and waste

One of the general solutions in complex impact of climate change and the environment is so-called recycling-based economy or circular economy

The main principle of circular economy is to imitate the natural food chain, where there is no waste - production and consumption is balanced using waste as a raw material

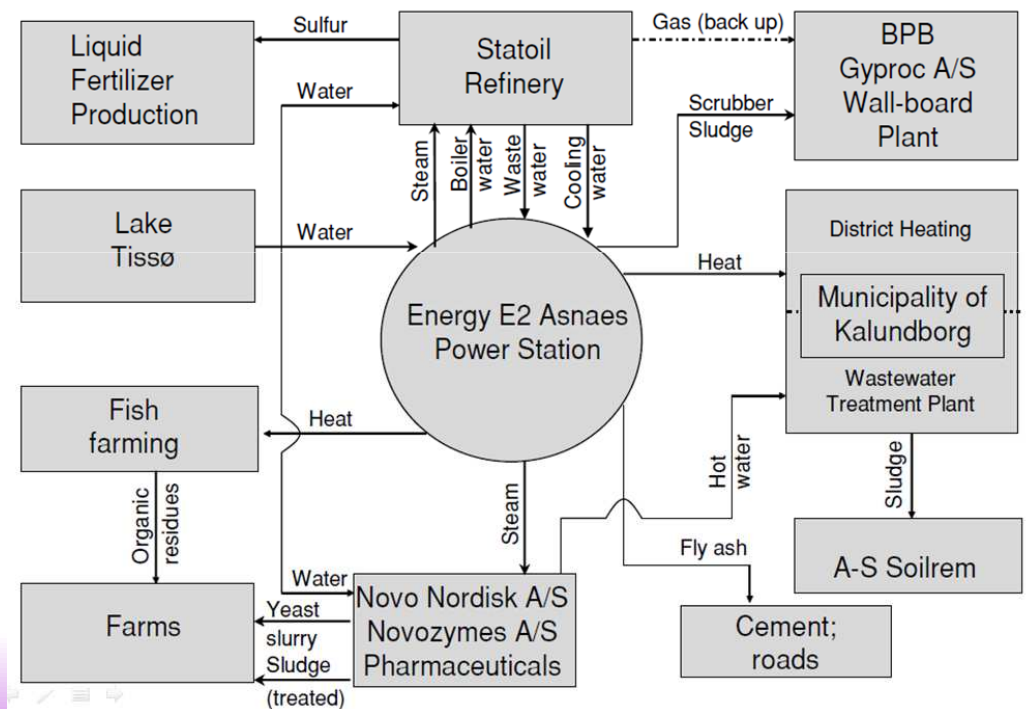


Five major **business models** used by the circular economy:

1) **Closed supply chain** – manufacturers use completely renewable, recyclable or biological raw materials which are basic for the circular production and consumption systems

- Such closed system ensures that all production and consumption is balanced by use of by-products and waste as raw material reduce inefficiencies
- For example, in Denmark, the industrial area of the Kalundborg city has developed as an eco-industrial park

Kalundborg Symbiosis Eco-Industrial Park, Denmark





View from around the Asnæs power station

KALUNDBORG ECO-INDUSTRIAL PARK



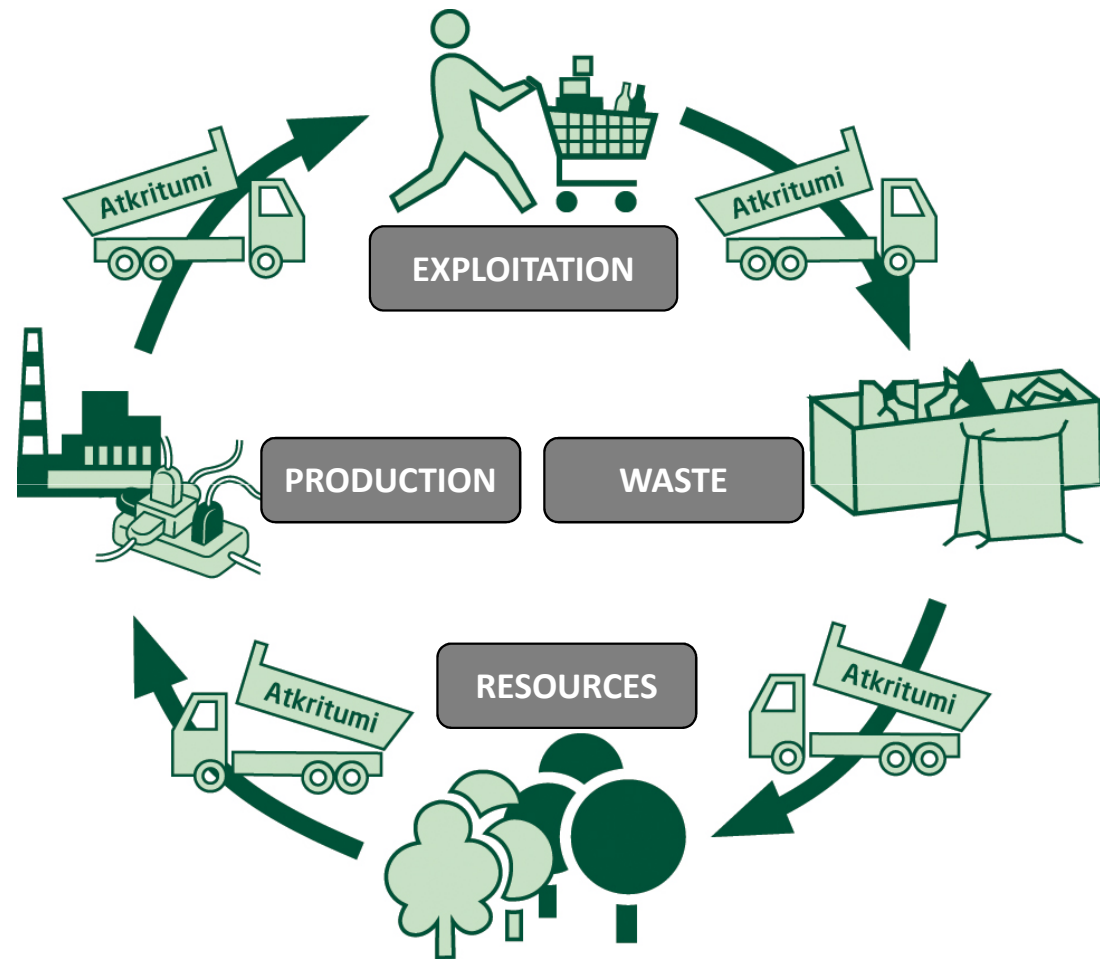


2) **Recovery of resources** – using technological solutions it is possible not only to recycle waste products for lower value products, but the processing can be tended to produce as valuable or more valuable products

- During this process, an important role should be given to product design and composition - already in the design of the product, provision of components should be made to ensure of their reuse after the end of the life cycle and how easy it will be to recover and sort the materials
- For example:
 - Clean up and reuse of waste water within the company
 - Newspapers printed with environmentally friendly ink that can be used for composting later
 - Used PET bottles can be used to produce solar cells

3) Extension of product's selflife – enables high-quality and long-term usability of products used in a long time, ensuring replacing only the outworn or damaged components and do not spending resources and energy for production of more and more new products

- For such goods as washing machines, refrigerators and other household appliances long-term used after the necessary restoration can be reused again by new owners among lower-income people
- It must be possible to transfer goods, to restore and to sell or donate them





4) **Sharing economy** – already the product design provides that the product can be used by many mutually independent users, significantly reducing the demand for new products and thus reducing environmental impact

- Products for sharing
- Rent
- Transfer or sale of a product from one user to another etc.

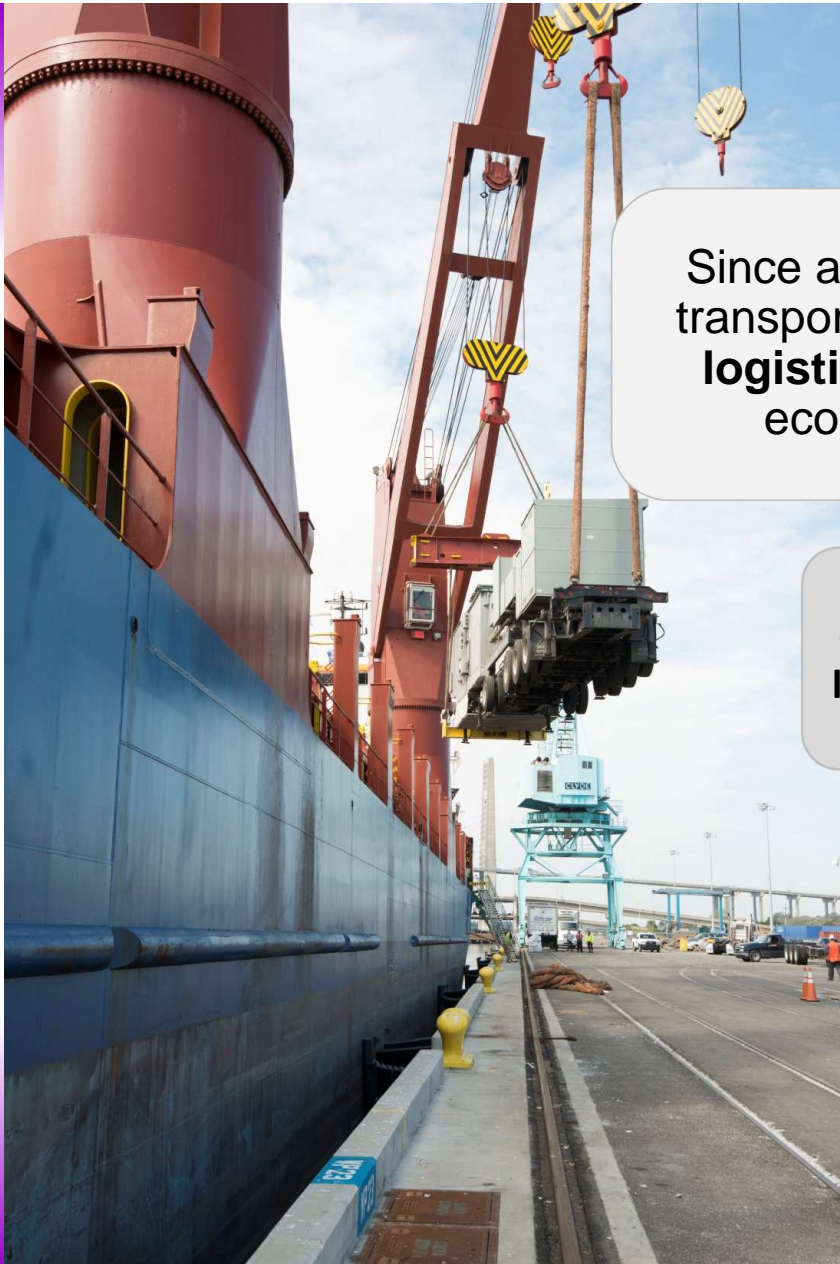
5) **Product replacement by service** – motivates the company to produce long-term usability and more energy-efficient products, as well as gaining the access to product's waste at the end of the life cycle

- For example, the American company «Interface» rents flooring services rather than sold floor coverings - the company is known for its ambitious plan which aims achieve zero waste levels until 2020
- Similar business model is implemented the Dutch company «Bundles» which rents a laundry option thus providing monitoring, maintenance and life management of invested materials
 - Customers in whose homes the washing machines are installed are charged only for the used times of washing cycles and its inventory is implemented by the internet technologies



The image displays the Bundles logo, which consists of a red square icon with white circular nodes and connecting lines, followed by the word "Bundles" in a white sans-serif font on a blue background. Below the logo, there are three smaller images: a close-up of a washing machine's drum, a black rectangular device with the Bundles logo and the text "Buddy Bridge", and a white handheld device with the Bundles logo. To the right of these images is a photograph of a man in a blue shirt standing on a stage, presenting to an audience. Behind him is a large screen displaying the text "Creating a sustainable world by making quality household appliances accessible to everyone". At the bottom of the entire image, there is a blue banner with white text in Dutch.

Wasbundles: Zorgeloos wassen
Betalen voor gebruik in plaats van bezit



Since a large proportion of GHG emissions are released from the transport sector, an important role is attributed in **improvement of logistics** – if the cost of CO₂ emissions will be compensated by economic instruments, then it will also be a cost-effective

Currently, for business owners more often it is profitable to purchase cheaper products or raw materials from China, India or other remote locations with relatively cheap workforce, because they do not need to cover direct costs of transport induced impact

If the carbon emissions will have to be paid, it will be more efficient to implement much shorter transport chains

Since water transport and railway transport has the lowest carbon emissions, there is a possibility to shift to these transport sectors

Significant savings in transportation can also be achieved by reducing the amount of packaging and changes in products' design

Worldwide known Swedish furniture and household manufacturer «IKEA» manages to maintain low prices largely due to the fact that they do not transport air

For example, replacing tea candle packaging of free packaging bags to the dense packing of regular square-shaped packages «IKEA» has managed to save processing time of 30-45 minutes a day, a place for 108 more packages on each pallet, as well as 400 truck trips that resulted in reduce of the selling price by 10%



By proper use of economic instruments and educating more demanding consumers with regard to the effects on the environment, these business models will be inevitably more profitable than the traditional business-as-usual

Thank you
for the attention!

