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- of the Czech Academy of Science
- Recetox Masaryk University MUNI RECETOX

# CLIMATE CHANGE AND CRISIS: MYTH OR FACT?

https://pollev.com/lindan443

December 7, 1972, from a distance of about 29,000 kilometers

<u>Apollo 17</u> spacecraft on its way to the <u>Moon</u>

# What comes to your mind when I say "Climate Change"?

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### II. Climate Change (CC)

Earth System Control variable process	Threshold avoided or influenced by slow variable	Planetary Boundary (zone of uncertainty)	State of knowledge*
Climate Atmospheric CO <sub>2</sub> change concentration, ppm; Energy imbalance at Earth's surface W m <sup>-2</sup>	Regional climate disruptions. Loss of glacial freshwater supplies.	concentration: 350	1. Ample scientific evidence. 2. Multiple sub-system thresholds. 3. Debate on position of boundary.

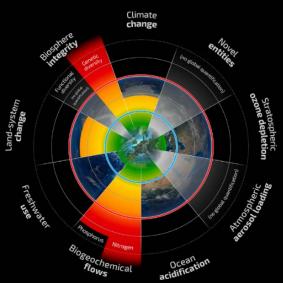
**Boundary:** Atmospheric  $CO_2$  concentration no higher than 350 ppm

Pre-industrial level: 280 ppm

Current level :	September 2022:	415.57 ppm
Mauna Loa	September 2021:	413.32 ppm
	September 2012:	391.02 ppm

(Weekly average value)

**Diagnosis:** Boundary exceeded



History of climate change and research





The earliest interest in "climate" was of a rather pragmatic nature

Greek klinein – "to incline, at an angle"

Aristoteles (384-322 BC) – Meterologica - VALID FOR ROUGHTLY 2000 YEARS

# Can you guess the year when the greenhouse effect was DISCOVERED?

Тор

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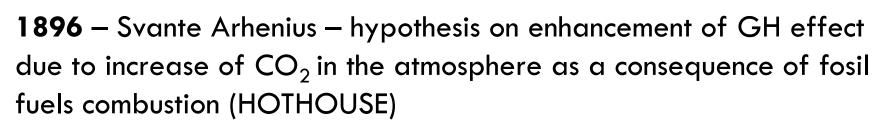
# CC - history

 $1753 - discovery of CO_2$ 

1824 – Joseph Fourier - greenhouse effect in the atmosphere

### **TEMPERATURE RELATED!**

**1861** – John Tyndall - water vapour other gases are **GREEN HOUSE GASSES** 



Tyndall<sup>°</sup>Centre<sup>®</sup>

for Climate Change Research

- the prognosis on increase of the temperature by several °C when GHG concentration doubles is still valid

### 1901 – term "GREENHOUSE EFFECT" (Ekholm)

# <u>CC - history</u>

1957 – oceanographer Roger Revelle and chemist Hans Suess shown that oceans can not absorb entire CO<sub>2</sub> produced by people

"Human beings are now carrying out a large scale geophysical experiment.,,





- The international body for assessing the science related to climate change.
- Created in 1988
- To provide governments at all levels with scientific information that they can use to develop climate policies
- Thousands of people from all over the world contribute to the work of the IPCC. For the assessment reports, experts volunteer their time as IPCC authors to assess the thousands of scientific papers published each year to provide a comprehensive summary of what is known about the drivers of climate change, its impacts and future risks, and how adaptation and mitigation can reduce those risks.
- The IPCC does not conduct its own research.
- Working Group I: the Physical Science Basis;
- Working Group II: Impacts, Adaptation and Vulnerability;
- Working Group III: Mitigation of Climate Change



## **CC... and politics**

**1972 – UNCHE (The United Nations Conference on the Human Environment )**, Stockholm. CC becomes one of the global priorities

• Creation of <u>United Nations Environment Programme (UNEP)</u>

**1990** – 1<sup>st</sup> IPCC report – <u>"Temperature increase by 0.3-0.6 °C is caused also by the</u> <u>human activities"</u>

**1992 –** Earth summit – United Nations Framework Convention on CC,

Rio de Janeiro

2005 - Kyoto Protocol (1997)
CHINA - developing country, USA - did not sign
2013 - 5<sup>th</sup> IPCC report <u>"Scientists are 95% certain that humans are the "dominant</u>"

<u>cause" of global warming since the 1950s"</u>

2016 – Paris Treaty came into force

**2021-2022 -** 6<sup>th</sup> IPCC report

2021 – United Nations Climate Change Conference, Glasgow

### **Greenhouse Effect and Global Climate Change**

- Greenhouse effect (GE) – natural atmospheric effect essential for life on the Earth

- GE dampens temperature fluctuation between day and night and thus provides favorable conditions for life



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# What is an average temperature on the Earth?





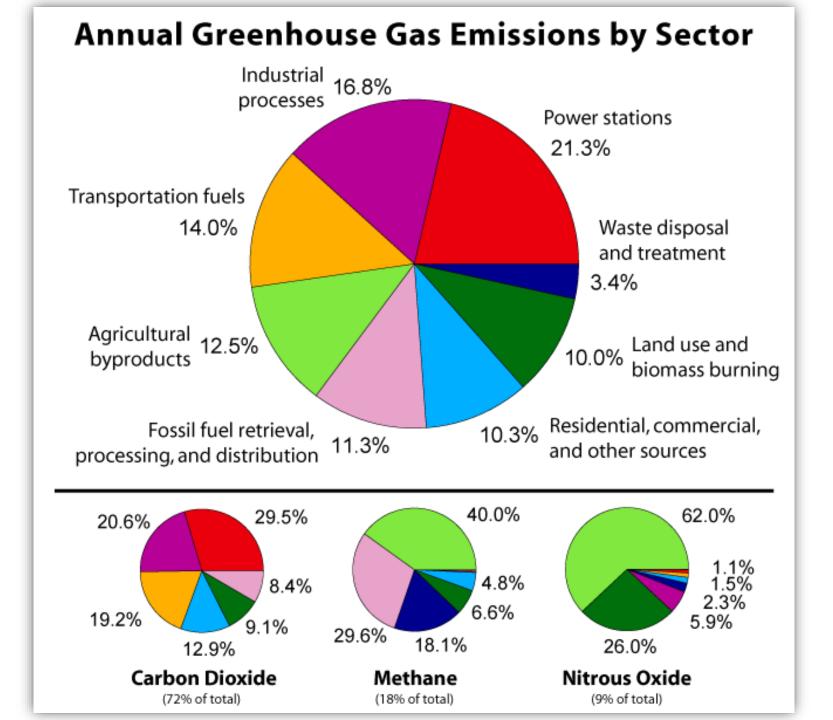
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### <u>Greenhouse Gasses (GH) in the atmosphere</u>

- the most important GHG is water vapour  $H_2O(g)$  that creates 2/3 of greenhouse effect
- however H<sub>2</sub>O(g) concentration in the atmosphere is not significantly influenced by human activities
- second most important GHG is **CO<sub>2</sub>** (~ 20 % GH effect)
- last 13 % of GH effect mainly gases like  $CH_4$ ,  $N_2O$ , CFC

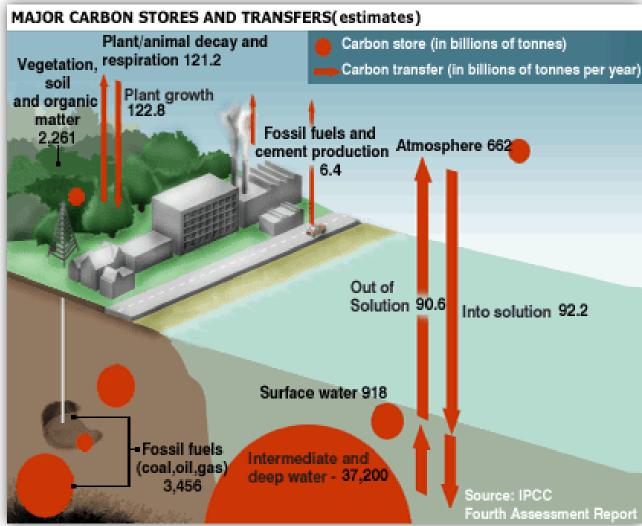
	Water	Carbon Dioxide	Methane	Nitrous Oxide
		COO		<b>~~</b>
Atmospheric Concentration	0.01-4%*	385 ppm	1797 ppb	322 ppb
Rate of Increase	n/a	1.5 ppm/yr	7.0 ppb/yr	0.8 ppb/yr
Atmospheric Lifetime	Very short 1–5 days	Variable 5–200 yr	12 yr	120 yr
Global Warming Potential (GWP)	n/a†	1	21	310

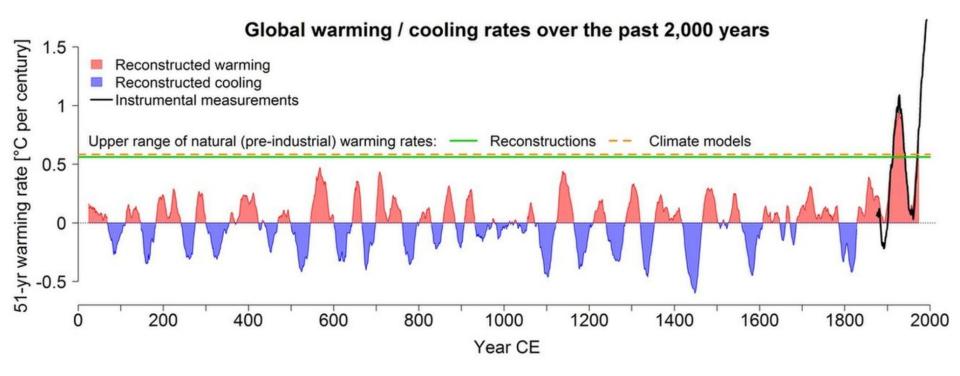
\* The amount of water vapor in the air varies according to temperature and density of air (usually ~1–3% of troposphere)
 † Water vapor levels vary strongly according to region, so rates of change and warming potential cannot be assessed



### ..... Problem?

increase of CO<sub>2</sub> level in the atmosphere due to the antropogenic action - disruption of the balance between release and absorption of **CO**<sub>2</sub> in the carbon geochemical cycle





### **GLACIAL/INTERGLACIAL PERIOD**

# INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC) AR6 CLIMATE CHANGE 2021: THE PHYSICAL SCIENCE BASIS

July 2021

Changing by the artist Alisa Singer

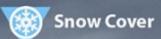
# **CC** indicators

### **Climate Change Indicators**





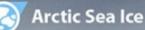
Temperature: Air & Ocean







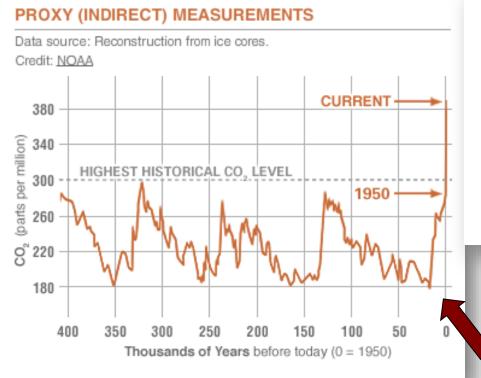
**Glaciers and Ice Sheets** 





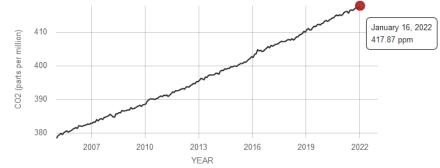


- $CO_2$  level increased more than >40 % since pre-industrial level
- level of other greenhouse gases increases as well
- main source of this increase is fosil fuels combustion + deforestation



#### DIRECT MEASUREMENTS: 2005-PRESENT

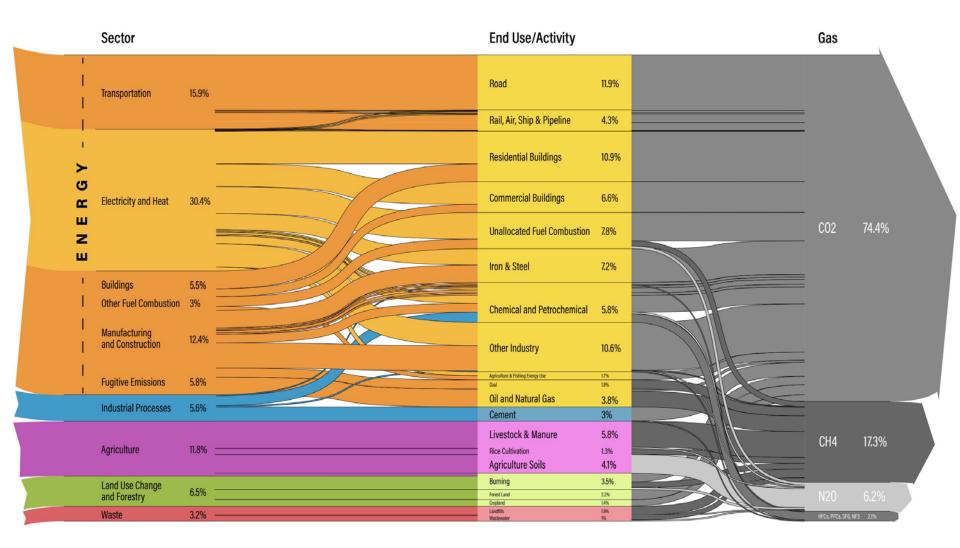
Data source: Monthly measurements (average seasonal cycle removed). Credit: <u>NOAA</u>



#### PROXY

Historical: memos, newspaper, diaries Biological: tree rings, corals, ice cores Geological: ocean sediments, ice sheets, past glaciers, stalactites

#### World Greenhouse Gas Emissions in 2016 Total: 49.4 MtCO<sub>2</sub>



Source: Greenhouse gas emissions on Climate Watch. Available at: https://www.climatewatchdata.org



WORLD RESOURCES INSTITUTE

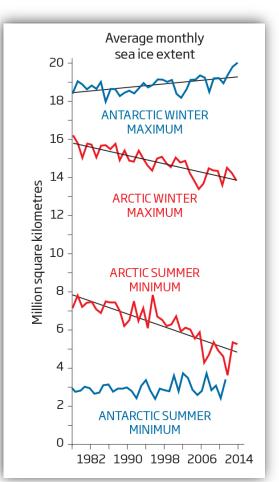
### Other indicators (variables) of CC

- changes in temperature (land/ocean)
- changes in ice cover in Arctic ocean
- changes in ice cover in North and South pole
- <u>sea level rise</u>
- humidity rise

The annual mean global near-surface temperature for each year between 2022 and 2026 is predicted to be between 1.1 °C and 1.7 °C higher than preindustrial levels (the average over the years 1850-1900). 2021

Temperature Anomaly (°C compared to the 1951-1980 average)





### Less ice in

## the Arctic ocean

#### new naval routes from Europe to Asia

Global Agenda Arctic Future of the Environment Geo-economics

Japan from Rotterdam - Suez Canal - **30 days** - Northern Sea Route - **18 days** 



### The final frontier: how Arctic ice melting is opening up trade opportunities

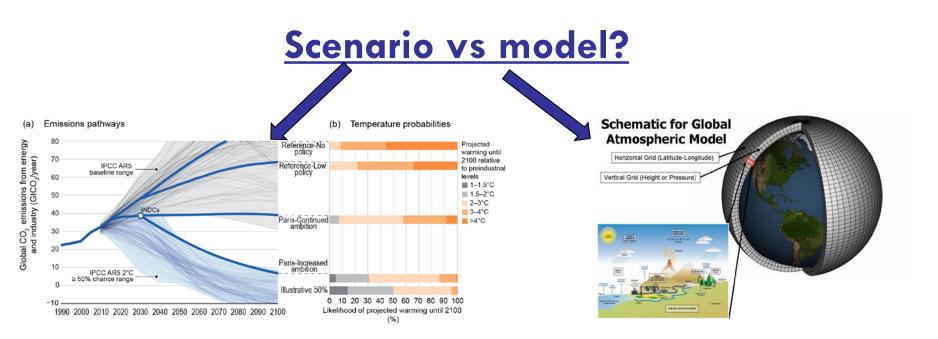


"The United States Geological Survey <u>estimates</u> that the Arctic contains approximately 13% of the world's **undiscovered oil resources** and about 30% of its **undiscovered natural gas resources.**"



### **Glacier calving in Arctic ocean**



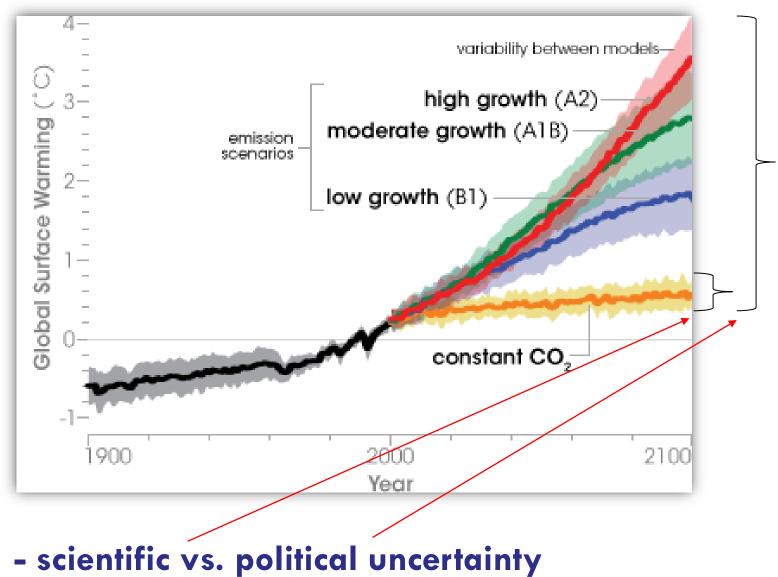


- plausible and often simplified description of how the future may develop, based on a coherent and internally consistent set of assumptions about driving forces and key relationships
- the impact of humans on the environment

- the climate models describe how the earth's **climate functions**
- based on physical laws and equations, approximation needed!

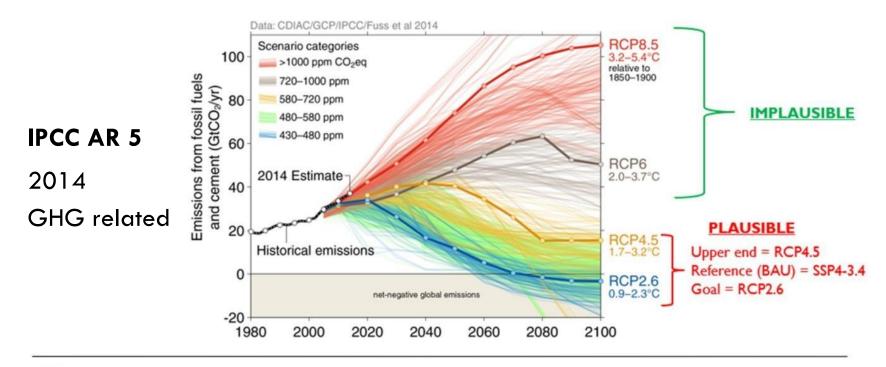
If the climate **models** are combined with the **emission scenarios**, it is possible to predict with a certain amount of **probability** how the climate will **be in the future**.

### **Temperature rise scenarios to 2100**



#### **Representative Concentration Pathway Scenarios**

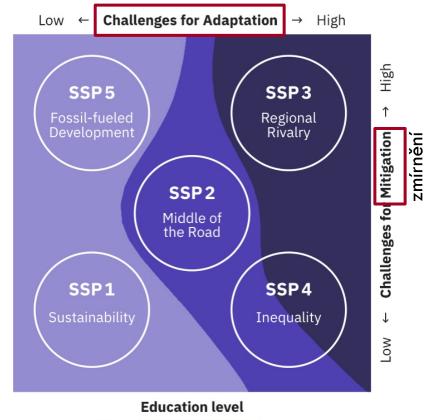
#### 4 of the 1,184 AR5 Scenarios





- a) **RCP2.6** 2,6 W.m<sup>-2</sup> significant lowered concentration of CO<sub>2</sub> in atmosphere(421 ppm-2100)
- **b) RCP4.5** 4,5 W.m<sup>-2</sup> stabilization of  $CO_2$  levels on lower level (538 ppm)
- c) **RCP6.0** 6,0 W.m<sup>-2</sup> stabilization of  $CO_2$  levels on higher level (670 ppm)
- d) RCP8.5 8,5 W.m<sup>-2</sup> "bussiness as usual" (936 ppm)

### Shared Socioeconomic Pathways (SSPs)



Socioeconomic challenges to mitigate vary, e.g., with the resource and carbon intensity of consumption.

Socioeconomic challenges to adapt vary, e.g., with the level of education, health care, poverty and inequality in societies around the world.

Shared Socioeconomic Pathways in the IPCC Sixth Assessment Report [14].SPM-14 v-t-E

SSP	Scenario	Estimated warming (2041–2060)	Estimated warming (2081–2100)	Very likely range in °C (2081–2100)
SSP1-1.9	very low GHG emissions: $\mathrm{CO}_2$ emissions cut to net zero around 2050	1.6 °C	1.4 °C	1.0 - 1.8
SSP1-2.6	low GHG emissions: CO <sub>2</sub> emissions cut to net zero around 2075	1.7 °C	1.8 °C	1.3 - 2.4
SSP2-4.5	intermediate GHG emissions: CO <sub>2</sub> emissions around current levels until 2050, then failing but not reaching net zero by 2100	2.0 °C	2.7 °C	2.1 - 3.5
SSP3-7.0	high GHG emissions CO <sub>2</sub> emissions double by 2100	2.1 %	3.6 °C	2.8 - 4.6
SSP5-8.5	very high GHG emissions. CO <sub>2</sub> emissions tripte by 2075	2.4 °C	4.4 °C	3.3 – 5.7

The IPCC Sixth report did not estimate the likelihoods of the scenarios<sup>[14]</sup> SP8-12 but a 2020 commentary described SSP5-8.5 as highly unlikely, SSP3-7 0 as unlikely, and SSP2-4 5 as likely<sup>[15]</sup>

Low

However, a report citing the above commentary shows that RCP8.5 is the best match to the cumulative emissions from 2005 to 2020. [16]

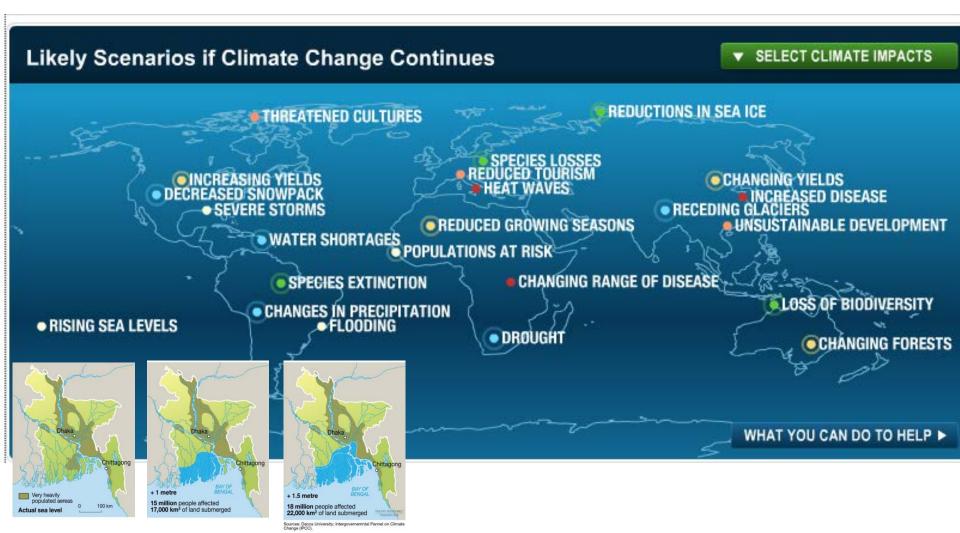
High

# **CC** consequences



### **Consequences of CC**

- regionally specific
- e.g. increasing vs. decreasing yields in some regions



# **Consequences of CC**

(2019)

- Heat waves, floods, drought, storm intensity
- DESERTIFICATION

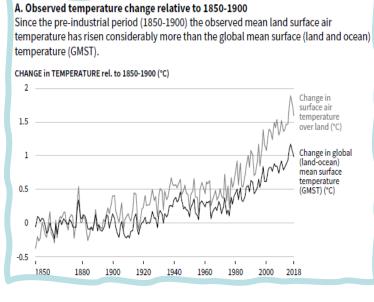


#### CHANGES OF BIODIVERSITY



#### higher vegetation cover (Asia, Europe, S Am, SE Australia)

drying of vegetation (N Eurasia, Central Asia, Congo Basin)



#### Summary for Policymakers

#### 6th IPCC Assessment Report

Impacts of climate change are observed in many ecosystems and human systems worldwide

(a) Observed impacts of climate change on ecosystems Changes in timing Changes in Species range shifts ecosystem structure (phenology) Ecosystems Terrestrial Freshwater Ocean Terrestrial Freshwater Ocean Terrestrial Freshwater Ocean SPM Confidence in attribution Global to climate change High or very high Africa Medium Asia Low Australasia Evidence limited, Central and insufficient South America na Not applicable Europe North America Small Islands Arctic Impacts Antarctic to human systems in panel (b) Mediterranean region Increasing \_ **Tropical forests** na na na adverse impacts Mountain regions na na na Increasing ± Deserts na na na adverse na na na and positive not impacts **Biodiversity hotspots** assessed

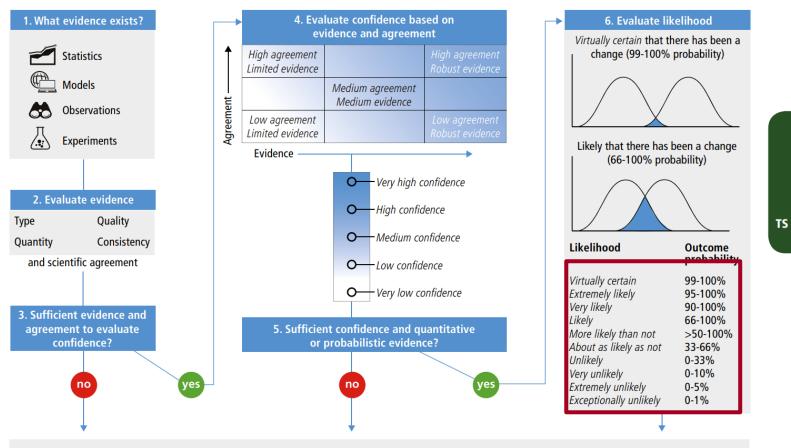
#### (b) Observed impacts of climate change on human systems

Impacts on water scarcity and food production Animal and Fisheries				Impacts on health and wellbeing			Impacts on cities, settlements and infrastructure Inland Flood/storm Damages					
Human systems	Water scarcity	Agriculture/ crop production		yields and aquaculture production	Infectious diseases	Heat, malnutrition and other	Mental health	Displacement	flooding and associated damages	damages in	Damages to infrastructure	to key economic sectors
			Ų	-	鎌		<b></b>	<b>∜</b> ★	<b>.</b>		e de la	Ш
Global	Θ	0		0	0	0	0	0	0	0	0	0
Africa	•	•	0	0	•	•	Θ	•	0	0	•	0
Asia	Θ	Θ	0	0	0	0	0	•	0	0	0	0
Australasia	Θ	0	Θ	0	0	0	0	not assessed	0	0	0	0
Central and South America	Θ	0	Θ	0	0	0	not assessed	•	0	0	0	0
Europe	Θ	Đ	0	Đ	•	0	0	0	0	0	•	0
North America	Θ	Đ	0	Θ	•	0	0	•	0	0	•	0
Small Islands	0	0	0	0	0	•		•	0	0	•	0
Arctic	Θ	Θ	•	0	•	0	0	0	0	0	•	Θ
Cities by the sea				0		0	not assessed	0		0	•	0
Mediterranean region	0	0	0	0	0	0	not assessed	0	•	0		0
Mountain regions	Ð	e	0		0	0	$\overline{}$	•	0	na	•	0

Figure SPM.2 | Observed global and regional impacts on ecosystems and human systems attributed to climate change. Confidence levels reflect uncertainty in attribution of the observed impact to climate change. Global assessments focus on large studies, multi-species, meta-analyses and large reviews. For that reason they can be assessed with higher confidence than regional studies, which may often rely on smaller studies that have more limited data. Regional assessments consider evidence on impacts across an entire region and do not focus on any country in particular.

(a) Climate change has already altered terrestrial, freshwater and ocean ecosystems at global scale, with multiple impacts evident at regional and local scales where there is sufficient literature to make an assessment. Impacts are evident on ecosystem structure, species geographic ranges and timing of seasonal life cycles (phenology) (for methodology and detailed references to chapters and cross-chapter papers see SMTS.1 and SMTS.1.1).

#### Evaluation and communication of degree of certainty in AR5 and AR6 findings



#### Present evidence and agreement

Behaviour, lifestyle, and culture have a considerable influence on energy use and associated emissions, with high mitigation potential in some sectors, in particular when complementing technological and structural change (*medium evidence, medium agreement*).

#### Present confidence

In many regions, changing precipitation or melting snow and ice are altering hydrological systems, affecting water resources in terms of quantity and quality (*medium confidence*).

#### **Present likelihood**

It is very *likely* that the number of cold days and nights has decreased and the number of warm days and nights has increased on the global scale.

# Main consequences of CC - summary

Phenomena Present trends	Confidence level	Phenomena Future trends	Confidence level	
The rise in weather and climate extremes has led to some irreversible impacts as natural and human systems are pushed beyond their ability to adapt. (increases in the frequency and intensity of climate and weather extremes, including hot extremes on land and in the ocean, heavy precipitation events, drought and fire weather)	High confidence	Biodiversity loss and degradation, damages to and transformation of ecosystems are already key risks for every region due to past global warming and will continue to escalate with every increment of global warming	Very high confidence!!!	
Warm-water coral bleaching and mortality and increased drought- related tree mortality	High confidence	Risks in physical water availability and water- related hazards will continue to increase by the mid- to long-term in all assessed regions, with	High confidence High confidence	
Increased heat-related human mortality	Medium confidence	greater risk at higher global warming levels		
Impacts in natural and human systems from ocean acidification, sea level rise or regional decreases in precipitation have also been	High confidence	Increases in frequency, intensity and severity of droughts, floods and heatwaves, and continued sea level rise will increase risks to food security		
attributed to human induced climate change		Climate change and related extreme events	High confidence	
Roughly half of the world's population currently experience severe water scarcity for at least some part of the year due to climatic and	Medium cofidence	will significantly increase ill health and premature deaths		
non-climatic drivers		In the mid- to long-term, displacement will	Medium confidence	
Climate change including increases in frequency and intensity of extremes have reduced food and water security, hindering efforts to meet Sustainable Development Goals	High confidence	increase with intensification of heavy precipitation and associated flooding, tropical cyclones, drought and, increasingly, sea level rise		
Climate change has adversely affected physical health of people globally and mental health of people in the assessed regions	Very high confidence!!!	1126		
Hot extremes including heatwaves have intensified in cities	High confidence			

# Scientific language is very **brief** and talking in the words of **probability and confidence**





54 588 zhliadnutí • 10. 3. 2021

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"How much do we want to spend on the climate compare to other problems?" "...more heat will damage crop growth in many warmer climates, but it means better agricultural production in cold countries. And,  $CO_2$  is a fertiliser — commercial greenhouses pump in extra  $CO_2$  to grow bigger tomatoes. So overall, we can expect agriculture to gain from global warming in the short and medium term..." B. Lomborg

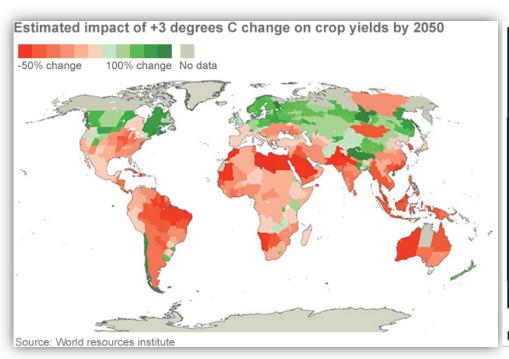
### Let's discuss!

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## Moral dimension of CC

"...more heat will damage crop growth in many warmer climates, but it means better agricultural production in cold countries. And,  $CO_2$  is a fertiliser — commercial greenhouses pump in extra  $CO_2$  to grow bigger tomatoes. So overall, we can expect agriculture to gain from global warming in the short and medium term..." B. Lomborg

yes, increasing yields, but mainly in countries with the actual overproduction, while the agrarian countries in developing world (with significant hunger) will experience even drop in the production





Interactive Map: Tracking World Hunger and Food Insecurity

# Climate change: The great civilisation destroyer?

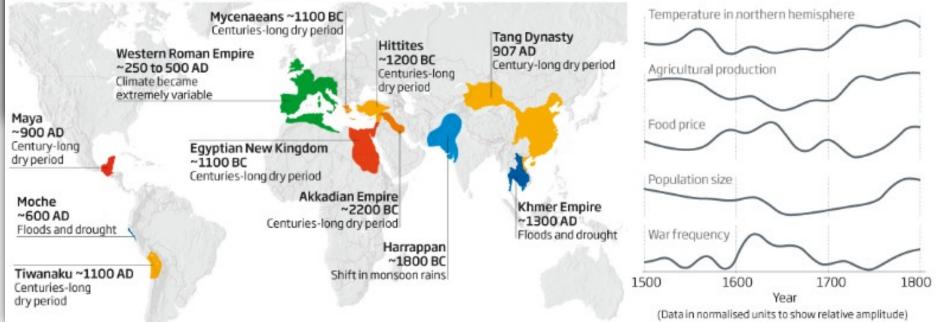
War and unrest, and the collapse of many mighty empires, often followed changes in local climes. Is this more than a coincidence?



#### More than coincidence?

#### © NewScientist

The decline and fall of many civilisations coincided with periods of climate change, and there are also correlations between climate change, population size and the frequency of wars, as data from Europe shows (right)





Al water

### **Solutions?**

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Democratic polititian Ex-vicepresident USA Environmentalist

Gore held the "first congressional hearings on the climate change, and co-sponsor[ed] hearings on toxic waste and global warming".



The Nobel Peace Prize 2007 Intergovernmental Panel on Climate Change , Al Gore

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# The Nobel Peace Prize 2007

IPCC INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE



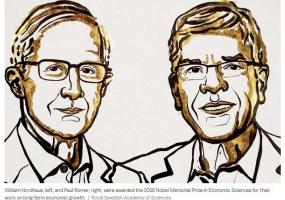
Intergovernmental Panel on Climate Change (IPCC) Prize share: 1/2 Photo: Ken Opprann Albert Arnold (Al) Gore Jr. Prize share: 1/2 "...was one of the first politicians to grasp the seriousness of climate change and to call for a reduction in emissions of carbon dioxide and other greenhouse gases."

The Nobel Peace Prize 2007 was awarded jointly to Intergovernmental Panel on Climate Change (IPCC) and Albert Arnold (Al) Gore Jr. *"for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change"* 

#### A 2018 Economics Nobel winner created an invaluable tool for understanding climate change

Prize winners William Nordhaus and Paul Romer studied long-term economic growth. Nordhaus calculated the impacts of climate change. By Umair Irfan | Oct 8, 2018, 12:10pm EDT

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- **9** A GOP insider on the Republicans who knew Trump was dangerous - and went MAGA anyway
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- Herschel Walker is an epically flawed candidate. He could still win.

The Weeds

Understand how policy impacts people

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#### SMART NEWS

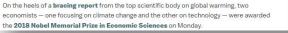
Nobel Prize in Physics Awarded to Scientists Who Warned the World of Climate Change

Their groundbreaking research answered fundamental questions about our universe and Earth's complex climate



October 5, 2021

2021







Early Tuesday morning, three scientists received the Nobel Prize in Physics for their decades of work

#### MOST POPULAR



Stunning Facial Reconstructions Resurrect a Trio of Medieval Scots

The True History Behind Netflix's 'Blonde'



Salem Witch Trials



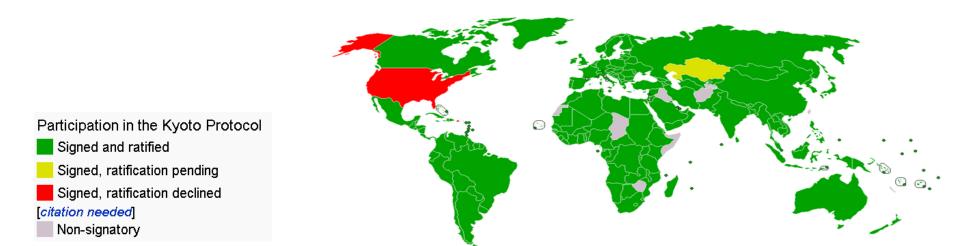
This 10-Year-Old Boy Makes Art That Sells for Over \$100,000

The Real History Behind 'The Woman King'

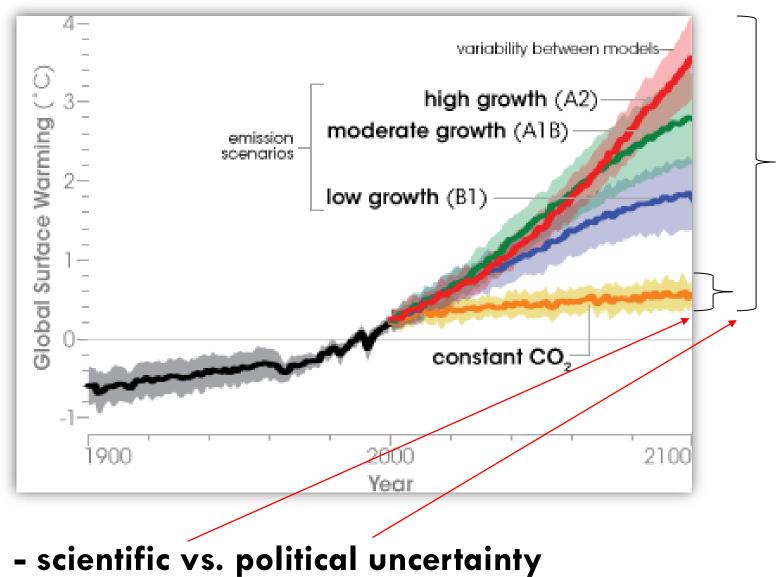
## Politics on CC

- main aim decrease the GHG emissions, mainly  $CO_2$
- 1992: UN Framework Convention on Climate Change
- 1997: Kyoto protocol (in force from 2005)
- industrial countries should decrease their GHG emissions until the year
   2012 for 5.2 % compared to the year 1990
- different threshold for different countries (e.g. EU 8%)

- however, industrial countries (Annex I countries with Kyoto targets) contributed "only" with 24 % of global  $CO_2$  emission (2010)

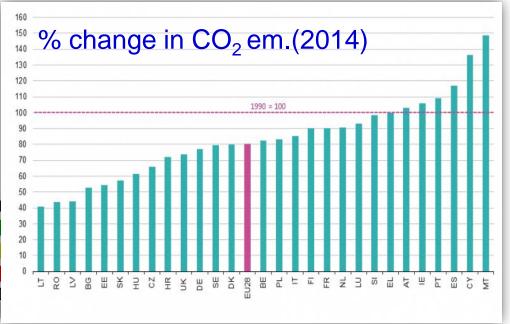


### **Temperature rise scenarios to 2100**



### Kyoto protocol – result (2012)

- industrial countries (Annex I countries with Kyoto targets) reduced their emissions for 24.2 % ! (much more than promissed target 5.2 %)
- however, emission in other countries have risen so fast, that global CO<sub>2</sub> emissions
   increased by 32 % from 1990 to 2010 <sup>(2)</sup>
- extension of the Kyoto Protocol until 2020
- certain countries (the EU and a few other countries) have committed themselves to further reducing CO<sub>2</sub> emissions.
- EU e.g. by 20-30% compared to 1990
- Average 18% generally achieved



### Paris treaty (2015)

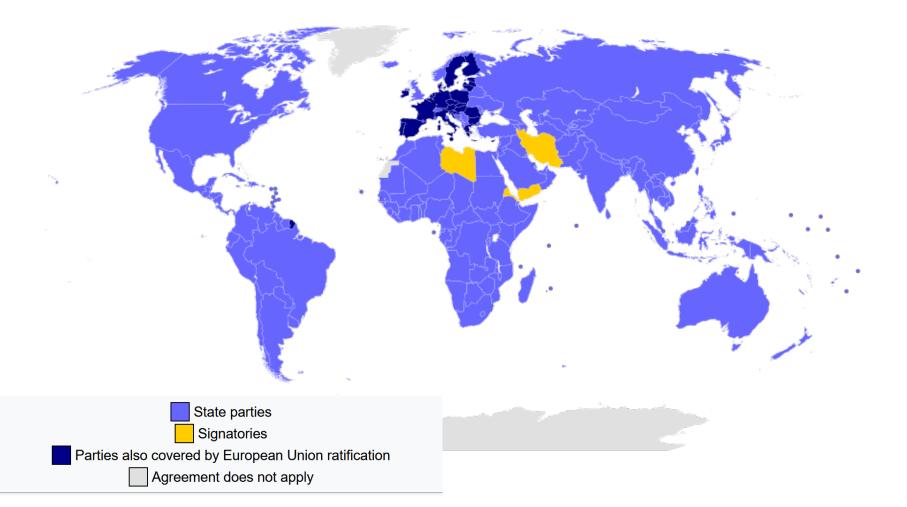
- continuation of the prolonged Kyoto protocol (2020)
- aim: Limit the temperature rise not more than 2 °C compared to pre-industrial era, ideally below 1.5 °C
- came into force in November 4th 2016

Shift in the rhetoric!



The Paris Agreement works on a **5**year cycle of increasingly ambitious climate action carried out by countries To stay below 1.5 °C of global warming, emissions need to be cut by roughly **50% by 2030**  "The 1.5°C figure is not some random statistic. It is rather an indicator of the point at which climate impacts will become increasingly harmful for people and indeed the entire planet," said WMO Secretary-General Prof. Petteri Taalas.

The annual mean global near-surface temperature for each year between 2022 and 2026 is predicted to be between 1.1 °C and 1.7 °C higher than preindustrial levels (the average over the years 1850-1900). In contrast to the 1997 <u>Kyoto Protocol</u>, the distinction between developed and developing countries is blurred, so that the latter also have to submit plans for emission reductions.



## **Solution**

# Adaptation and mitigation

#### **Summary for Policymakers**

SPN

Many options available now in all sectors are estimated to offer substantial potential to reduce net emissions by 2030. Relative potentials and costs will vary across countries and in the longer term compared to 2030.

	Mitigation options		on to net	emission reduction,	2030 (GtCO <sub>2</sub> -eq yr <sup>-1</sup> )	
	Mitigation options	0	2		4 (	5
Г	Wind energy		-			
	Solar energy			_		
	Bioelectricity					
	Hydropower					
2	Geothermal energy					
Energy	Nuclear energy					
<u>ا</u> ۳						
	Carbon capture and storage (CCS)					
	Bioelectricity with CCS					
	Reduce CH <sub>4</sub> emission from coal mining					
L	Reduce CH <sub>4</sub> emission from oil and gas		1			
Γ	Carbon sequestration in agriculture					
	Reduce CH <sub>4</sub> and N <sub>2</sub> O emission in agriculture					
_	Reduced conversion of forests and other ecosystems			-		
AFOLU	Ecosystem restoration, afforestation, reforestation	-				
<	Improved sustainable forest management					
	Reduce food loss and food waste	-				
L	Shift to balanced, sustainable healthy diets					
г	Avoid demand for energy services					
	Efficient lighting, appliances and equipment					
ß	New buildings with high energy performance					
Buildings	Onsite renewable production and use		- I			
B						
	Improvement of existing building stock					
L	Enhanced use of wood products	-				
Γ	Fuel-efficient light-duty vehicles					
	Electric light-duty vehicles					
	Shift to public transportation					
۲İ	Shift to bikes and e-bikes	<b>F</b> -1				
Transport	Fuel-efficient heavy-duty vehicles					
	Electric heavy-duty vehicles, incl. buses	<b>F</b> -1				
	Shipping – efficiency and optimisation	<b>H</b>				
	Aviation – energy efficiency					
L	Biofuels				Net lifetime cost of optio	ns:
					Costs are lower the	han the reference
Γ	Energy efficiency				0-20 (USD tCO2-6	2q <sup>-1</sup> )
	Material efficiency	H			20-50 (USD tCO2	
	Enhanced recycling	-			50-100 (USD tCO	
Ef.	Fuel switching (electr, nat. gas, bio-energy, H <sub>2</sub> )		-		100-200 (USD tC	
Industry	Feedstock decarbonisation, process change	E-4			Cost not allocated	
	Carbon capture with utilisation (CCU) and CCS				variability or lack	
	Cementitious material substitution	-				
L	Reduction of non-CO <sub>2</sub> emissions	H			Uncertainty range	
					the total potentia	
- [	Reduce emission of fluorinated gas				to emission reduc	
Other	Reduce CH <sub>4</sub> emissions from solid waste	<b></b>			individual cost ra associated with u	
٦[	Reduce CH <sub>4</sub> emissions from wastewater	-			associated With u	neertainty
		Ó	2	GtCO <sub>2</sub> -eq yr <sup>-1</sup>	4 6	5

Mitigation options have synergies with many Sustainable Development Goals, but some options can also have trade-offs. The synergies and trade-offs vary dependent on context and scale.

	Sectoral and system mitig	ation options	Re 1	atio	n wit	_	istai	_	_	evelo 9	<u> </u>	_	ioal		16	17	Chapter source
				2		4		, ,	•	9	10		2 1	4 13	10		
[	<ul> <li>Wind energy</li> </ul>		+					_		+		+		•			Sections 6.4.2, 6.7.7
ĩ	Solar energy		+					• •	+	+		+	•	•			Sections 6.4.2, 6.7.7
Energy systems	Bioenergy		•	•	•			•	+	+	- 1	+	+	÷			Sections 6.4.2, 12.5, Box 6.1
y sy	Hydropower				+			+						•			Section 6.4.2
erg	Geothermal energy		+		•		18	+		+		+					Section 6.4.2
E	Nuclear power				•				+	+			•	•			Section 6.4.2, Figure 6.18
l	Carbon capture and storage	(CCS)			+			-	+	+			•				Section 6.4.2, 6.7.7
- (	Carbon sequestration in agric	culture <sup>1</sup>	+	+					+					+			Sections 7.3, 7.4, 7.6
ŭ 🗋	Reduce CH <sub>4</sub> and N <sub>2</sub> O emission				_		- 7										Section 7.4
<b>F</b> G	Reduced conversion of forest						Ē			_		•				101	Section 7.4
e (	Ecosystem restoration, refore		+	_	_		- 2					+			_		Section 7.4
Agriculture, forestry and other land use (AFOLU)	Improved sustainable forest r		+	_			- 2		_	+	_		17				Section 7.4
lan	Reduce food loss and food w		÷	_	-						= 1	0.0	•				Section 7.5
her	Shift to balanced, sustainable			121			- 2				÷.				_		Section 7.4
Ag	Renewables supply <sup>3</sup>		÷	•	_		- 2			+			_				Section 7.6
					Ξ.					_	_	_					
۲ ۲	Urban land use and spatial pl		+	Ŀ	-	_	•	_			_	+			+		Sections 8.2, 8.4, 8.6
Urban systems	Electrification of the urban er		+	_	+	+	+ +	1	+	_	_	+	_				Sections 8.2, 8.4, 8.6
s	District heating and cooling r		+		÷.,				•	+		•		*			Sections 8.2, 8.4, 8.6
bar	Urban green and blue infrast		+	_	+	+			+		_	+	_	_	_		Sections 8.2, 8.4, 8.6
5	Waste prevention, minimisati		+	_	÷.,	_	_	_	•	_		_	•	_	_	_	Sections 8.2, 8.4, 8.6
l	Integrating sectors, strategies	and innovations	+	+	+	+	+ +		+	+	+	+	+	+	+	+	Sections 8.2, 8.4, 8.6
[	Demand-side management		+	+	+			+	•	٠		+	+				Section 9.8, Table 9.5
	Highly energy efficient building		•	+	•	+		+	•	٠	•	+	+		+	+	Section 9.8, Table 9.5
~	Efficient heating, ventilation	and air conditioning (HVAC)	•	+	+			+	•	•	•	+	+				Section 9.8, Table 9.5
Buildings	Efficient appliances		•	+	+	+	+ 4	+	•	-	•	+	•	+			Section 9.8, Table 9.5
nilo	Building design and performa	ince	+	+	+			+	•	-		+	+	+	+		Section 9.8, Table 9.5
	On-site and nearby productio	n and use of renewables	•	•	+	+	+ •	1	•	٠	•	+	+	+	+	+	Section 9.8, Table 9.5
	Change in construction methods and circular economy				+		1	+	•	+	- 1	+	+			+	Sections 9.4, 9.5
l	Change in construction mate	rials			٠		1	+	•	+	- 1	+	+	-		+	Section 9.4
ſ	Fuel efficiency – light-duty ve	hicle	+		+				+			+		+			Sections 10.3, 10.4, 10.8
	Electric light-duty vehicles		-							+							Sections 10.3, 10.4, 10.8
	Shift to public transport		+		_	+ -			_	_	+	_					Sections 10.2, 10.8, Table 10.3
+	Shift to bikes, e-bikes and no	a motorized transport	÷		_	+	_		_	_			_	+			Sections 10.2, 10.8, Table 10.3
Iransport	Fuel efficiency – heavy-duty		÷					-						+			
ans	Fuel shift (including electricit		-														Sections 10.3, 10.4, 10.8
r -					+			1	_	_			•				Sections 10.3, 10.4, 10.8
	Shipping efficiency, logistics of							+	+	_							Sections 10.6, 10.8
	Aviation – energy efficiency,	new tuels		_	_			+				_					Sections 10.5, 10.8
l	_ Biofuels			•	•			+	+	+		+		•			Sections 10.3, 10.4, 10.5, 10.6, 10.8
[	Energy efficiency				+			+	+	+							Section 11.5.3
È	Material efficiency and dema	nd reduction					18			+			+				Section 11.5.3
Industry	Circular material flows				+			•	+			+	+ +	•		+	Section 11.5.3
Ĕ	Electrification		+	•	+		+	+	+					-			Sections 11.5.3, 6.7.7
l	CCS and carbon capture and	utilisation (CCU)			٠			•	+	+	1	+		-			Section 11.5.3
Type of	relations:	Related Sustainable Devel	onm	ent G	ioals:												1 Soil carbon management
	Synergies     I No poverty     Trade-offs     Z Zero hunger		10 Reduced inequalities									in cropland and grasslands.					
			11 Sustainable cities and communities								agroforestry, biochar <sup>2</sup> Deforestation, loss and						
	Both synergies and trade-offs <sup>4</sup> 3 Good health and well		eing								nsum					ion	degradation of peatlands
Blanks r	Blanks represent no assessment <sup>5</sup> 4 Quality education					1	13 (	lima	ate a	tion							and coastal wetlands
Confide	Confidence level: 5 Gender equality								elow		er						<sup>3</sup> Timber, biomass, agri. feedstock
	n confidence	6 Clean water and sanita					15 Life on land								<sup>4</sup> Lower of the two confidence levels has been reported		
	Medium confidence 7 Attordable and clean e											<sup>5</sup> Not assessed due					
	I ow confidence 8 Decent work and econ						17 P	artn	ershi	p for	the g	joals					to limited literature
		9 Industry, innovation and	dini	rastr	uctur	e											
Figuro S	DM 8   Supergios and tra	de-offe between secto	ral	and	evet	tom	mit	iaa	tion	on	tion	c	d ti	0.0			

#### Figure SPM.8 | Synergies and trade-offs between sectoral and system mitigation options and the SDGs.

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## How to decrease CO<sub>2</sub> emmisions?

- decrease the fossil fuels consumption
  - increase efficiency of the industr. production
  - end the non-effective industr. production
  - save the energy and material



- economic tools to decrease CO<sub>2</sub> EU Emissions Trading System (EU ETS)
- <u>bio-fuels</u>? Probably not...

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### - Geo-engineering?

N<sub>2</sub>O release from agro-biofuel production negates global warming reduction by replacing fossil fuels

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### Geo-egineering - types and opportunities

#### Transforming Earth (т) PLANT TREES B BIOCHAR **IF IRON FERTILISATION** Plant forests and regularly harvest them. Burn plant material without oxygen to Trigger photosynthetic plankton blooms It is now possible to identify the Trees are a carbon sink as long as they are make charcoal-like "biochar". This carbon in the ocean by dumping iron into areas methods and locations where growing, and not allowed to rot. store can then be buried in soil, where it that don't have much. If the plankton planetary geoengineering will acts as a fertiliser. sinks, carbon is stored. Location: unused farmland have to take place Location: anywhere with rich plant growth Location: iron-depleted regions of the **BECCS** (Bioenergy with carbon ocean (DA) DAC (Direct air capture) capture and storage) **OCEAN LIMING** Build shipping-container-sized boxes full OL Suck out atmospheric CO2 by growing Throw lime into the ocean. It reacts with biofuel crops like sugar cane, burn them of a chemical "sponge" that sucks CO2 dissolved CO2 to form carbonates. This for energy, capture the resulting CO2, out of the air, ready for burial. You may may also help corals by reducing ocean need 100 million of them. and bury it. acidification. Location: windy and dry areas. More wind Location: the tropics, where growth is Location: coral habitats means more air is driven through the fastest boxes, increasing uptake B (IF)

(IF)

DA

(BE)

(BE

B

(IF)

(В

(T)

#### EW ENHANCED WEATHERING

Crush common minerals like olivine to powder to increase surface area for reacting with CO2 and water.

Location: proceeds fastest in warm, wet conditions, so areas such as humid coasts and rivers are best

(IF)

DA

(IF)

DA

(DA)

(IF)

#### Annual carbon savings by 2100

Bars show maximum		e for each technology 🦗
	Cost	per tonne of CO <sub>2</sub> captured
Plant tree	s	\$20-100
BECC	S	\$50-250
Biocha	r	\$10-300
Direct air capture	e	\$40-600
Iron fertilisatio	n	\$30-300
Ocean liming	g	\$50-180
Enhanced weathering	g 📃	\$80-2000

0 2 4 6 8 Gigatonnes of carbon per year (2010 annual emissions were 10 Gt)

BT

B DA DA

(IF)

DA

(IF)

DA

(IF)



# Tree growth? (Christian Korner, 2022)

- More productive forest more trees....
- BUT!
- Lower carbon storage

CO<sub>2</sub> stimulate growth Higher growth rate More dynamic system Reduced resistence!!! No higher carbon sequestration

Tree longevity rather than growth rate controls carbon capital of the forest = Carbon pool size maximum

### **European Green Deal (December 2019)**

### Striving to be the first climate-neutral continent



The European Commission adopted a set of proposals to make the EU's climate, energy, transport and taxation **policies fit for reducing net greenhouse gas emissions by at least 55% by 2030**, compared to 1990 levels.

# <u>What</u> about CR?

#### 

#### Politika ochrany klimatu v České republice

klimatu v ČR z roku 2004. Definuje hlavni cile a opatření v oblasti ochrany klimatu na národní úrovní tak, aby zajišťovala spihelní cilů snižovalní emisí sklenikových plynů v návaznosti na povinnosti vypřivající z mezinárodních dohodť (Rámcovú árniuva OSN o změné klimatu a jelí Kjotský protokol, Pařížská dohoda a závazky vypřývající z legislativy Evropské unie). Tato strategie v oblasti ochrany klimatu se zaměřuje na období 2017 až 2030, s výhledem do roku 2050, a měla by tak přispět k dlouhodoběmu přechodu na udřítelné nízko-emisín hospodřátrví ČŘ.

Vyhodnocení Politiky ochrany klimatu v Čit bylo zpracováno a předloženo vládé v roce 2021 a aktualizace Politiky ochrany klimatu v Čit je v návaznosti na přezkum závazků v rámci Pařížské dohody napláhována do konce roku 2023.

Vyhodnocení ukazuje, že el pro rok 2020. odpovidající sinžení emisí o 20 % oproti roku 2005, se s největší pravděpodobnosti podařilo naplnit. Cile Politiky ochrany klimatu pro rok 2030 (snižení o 30 % oproti roku 2005) je možné die aktuálních scenářů dosáhnout jen při naplnéhi scénáře s dodatečnými opatřeními. Ve scénáři se současnými politikami a opatřeními chybi k jeho naplnění zhruba 0 25 %. Rovněž dosažemí indikativního cile k roku 2040 předpoklád pouze scénář s dodatečnými opatřeními. Trajektorie snižování emisí však není v souladu s dosažením indikativního cile snižení emisí do roku 2050 o 80 % oport roku 1990 a CR dosud nemá k dispozicí scénáře, které by počíhaj s dosažením klimatičke neutrality.

Politika ochrany klimatu obsahuje celkem 41 opatreni, od průřezových témat a politik, přes opatření v jednotitých sektorech až po výzkum a vývoj, monitorování a opatření v oblasti mezinárdení ochrany klimatu a rozvojové spolupráce. 73 % opatření se podle vyhodnocení podařilo naplinit, 22 % opatření býlo pliněno částecha a 5 % nebýlo plinéno vůbec.



Adaptace na změnu klimatu je na národní úrovní řešena <u>Strategil přizoůsobení se změně klimatu v</u> podmíkách ČR (dále též "adaptační strategie"). Dokument byl přípraven v rámci mezirezortní spolupráce, koordinátorem přípravy celkového materiálu bylo Ministerstvo životního prostředí. Adaptační strategie a její obsah vychází z Bíle knihy Evropské Komise "Přizpůsobení se změně klimatu: směřování k evropskému akčnímu rámci" (2009) a je v souladu s <u>Adaptační strategií EU</u> přičemž reflěktuje měřítko a podmínky ČR. Vytvoření a implementace adaptačních plánů a opatření je nedilnou součásti závazků přijatých v rámci <u>Rámcové úmluvy OSN o změně klimatu (UNFCCC)</u> a <u>Pařížské dohody</u>.

Implementačním dokumentem adaptační strategie je <u>Národní akční plán adaptace na změnu</u> <u>klimatu</u> (dále též "akční plán"). Akční plán obsahuje seznam adaptačních opatření a úkolů, a to včetně odpovědnosti za plnění, termínů, určení relevantních zdrojů financování a odhad nákladů na realizaci opatření.

13. září 2021 byla Vládou ČR schválena první aktualizace adaptační strategie a akčniho plánu. Na aktualizaci obou dokumentů se podlelo více než 170 odborníků z veřejných, vědeckých a neziskových instituci. Materiály se opírají zejména o odborné podklady zpracované rezortními organizacemi MŽP (ČHMÚ a CENIA) s podporou Akademie věd ČR (zejm. CZECHGLOBE - Ústav výžkumu globální změny AV ČR, v.t.) a řady dalších výzkumných organizaci.

#### ČESKÁ REPUBLIKA 2030

SPOLEČNĚ – UDRŽITELNĚ

UDRŽITELNÝ ROZVOJ JE KLÍČEM K BUDOUCNOSTI ČESKÉ REPUBLIKY! KLÍČEM K UDRŽITELNÉMU ROZVOJI JE STRATEGICKÝ RÁMEC ČESKÁ REPUBLIKA 2030. NA TÉTO WEBOVÉ STRÁNCE MÁTE K DISPOZICI AKTUÁLNÍ INFORMACE, STRATEGICKÉ PLÁNY A ZAPOJENÍ VŠECH. ZAJÍMÁ VÁS, JAK NA TOM JSME? V TOM PŘÍPADĚ PRO VÁS MÁME PŘIPRAVENOU ZPRÁVU O KVALITĚ ŽIVOTA A JEJÍ ZITELNOSTI STRATEGICKÝ RÁMEC ŽIJEME UDRŽITELNĚ Plečtěle si strategický rámec pro udržitelný rozvoj ČR re suite additioning movies a scalty incla pokračovat pokračovat DOBROVOLNÉ ZÁVAZKY pokračovat

### Adaptation

# **Right choice?**

	REUTERS* World - Business - Legal - Markets - Breakingviews Technology - Investigations More -	D My View ~ Q, Sign In Register
Tellowing	<ul> <li>Climate Change Environment Energy</li> <li>Immute read - July 6, 2022 10:03 PM CMT+2 - Last Updated 3 months ago</li> <li>EU parliament backs labelling gas and pucker investments as green</li> <li>By Kate Abnett</li> <li>Summary</li> <li>Lawmakers back 'green' EU Investment label for the fuels</li> <li>Likely to become law unless super-majority of states veto</li> <li>Gas, nuclear rules have split EU countries and lawmakers</li> <li>Luxembourg, Austria to challenge law in court</li> </ul>	"This is a poor signal to the rest of the world that may undermine the EU's leadership position on climate action," said Anders Schelde, chief investment officer at Danish pension fund Akademiker
G Saved	BRUSSELS, July 6 (Reuters) - The European Parliament on Wednesday backed EU rules labelling investments in gas and nuclear power plants as climate-friendly, throwing out an attempt to block the law that has exposed deep rifts between countries over how to fight climate change. The vote paves the way for the European Union proposal to pass into law, unless 20 of the bloc's 27 member states decide to oppose the move, which is seen as very unlikely. The new rules will add gas and nuclear power plants to the EU "taxonomy" rulebook from 2023, enabling investors to label and market investments in them as green. Out of 639 lawmakers present, 328 opposed a motion that sought to block the EU gas and nuclear proposals.	Pension. If approved, the gas and nuclear rules would apply from Jan. 2023.
	The European Commission welcomed the result. It proposed the rules in February after more than a year of delay and intense lobbying from governments and industries.	

- Gas plants must switch to run on low-carbon gases by 2035
- New nuclear plants must receive construction permits before 2045 to get a green investment label, and be located in a country with a plan and funds to safely dispose of radioactive waste by 2050.

# SYSTEM CHANGE NOT CLIMATE CHANGE

"CHANGE OUR OWN PRACTICES OF HOW WE WORK WITH KNOWLEDGE"