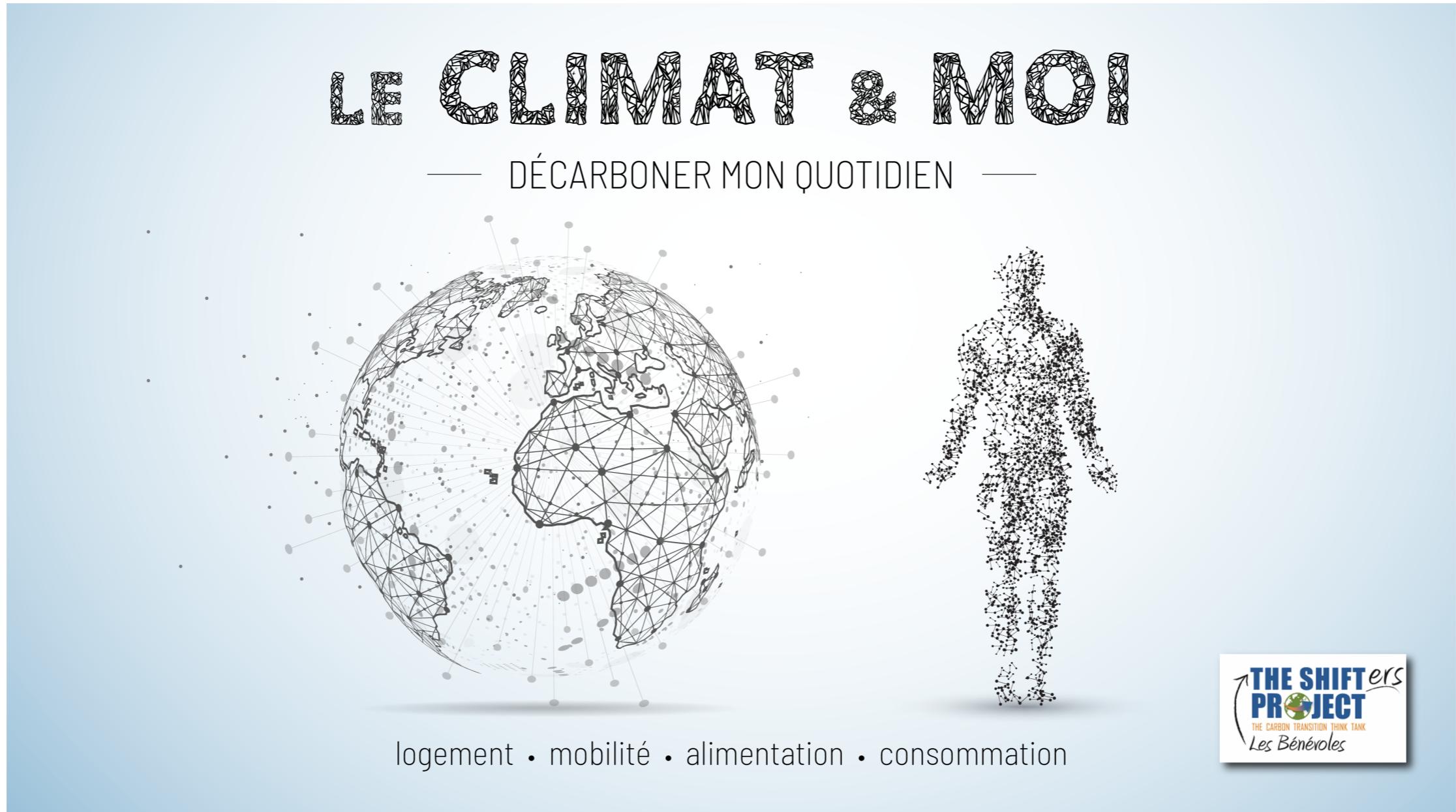


# ENVT3065 Sustainability challenges

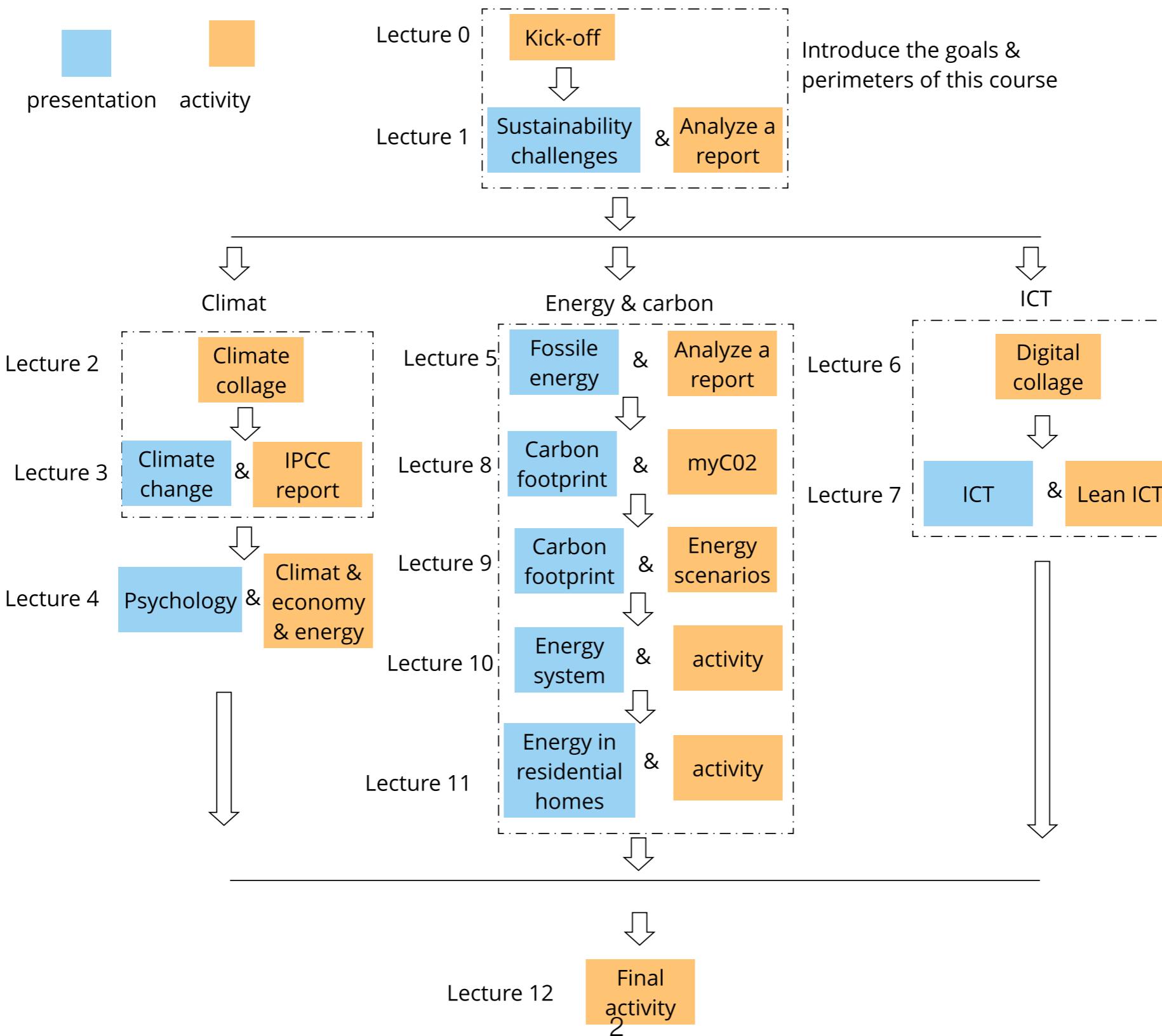
## Lecture 1



Credits: <https://theshiftproject.org/equipe/#benevoles>

# Lecture 1

## Course map



# Lecture 1

## Credits

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This lecture is mainly based on:

- Sustainable development & Transition given at the Catholic University of Louvain (UCL LEPL 1804). Professors: Bol David; Jeanmart Hervé; Luis Alconero Patricia; Marichal Xavier; Raskin Jean-Pierre;
- Sustainability development bachelor & lecture of Liège University. Professor: Aurore Degré.
- Jean-Marc Jancovici blog

# Lecture 1

## Goals

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### **Sustainable development**

Sustainable development goals

ENVT 3065 Sustainability Challenges's perimeter

Energy

Rebound effect

Challenges

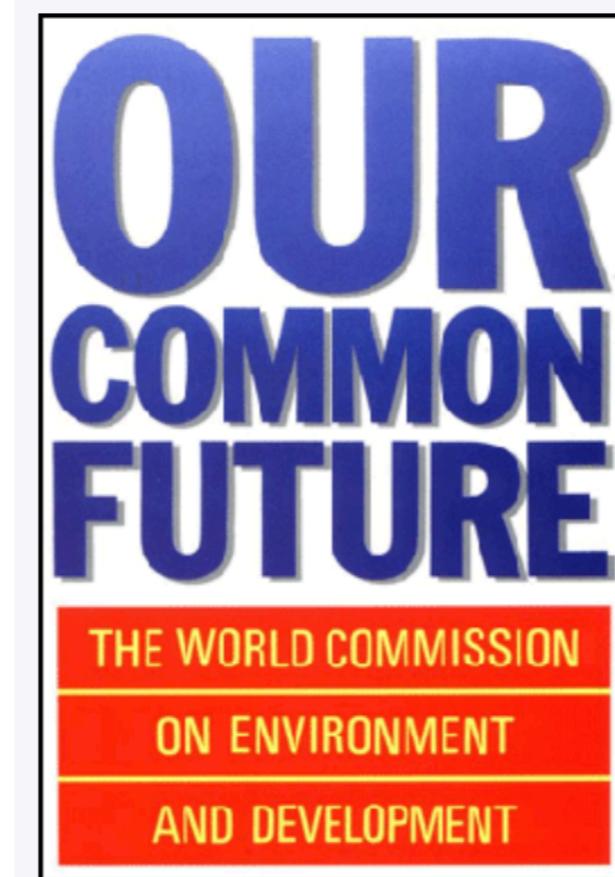
# Lecture 1

## Sustainable development

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Our Common Future also known as the Brundtland Report, was published on October 1987 by the United Nations through the Oxford University Press.

The report defined '**sustainable development**' as "*Development that meets the needs of the present without compromising the ability of future generations to meet their own needs*".



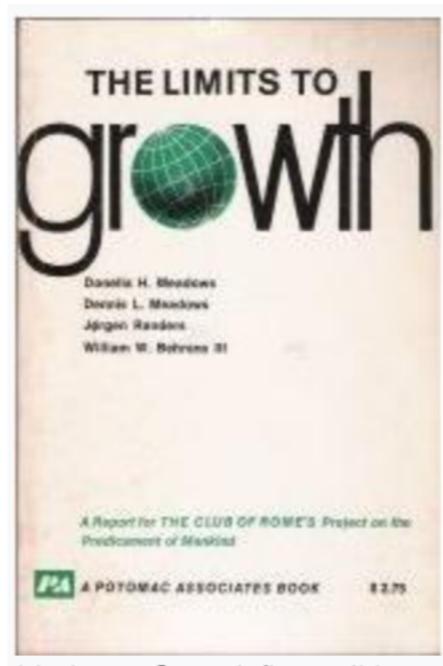
# Lecture 1

## Sustainable development

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The limits to growth is a 1972 report on the exponential economic and population growth with a finite supply of resources, **studied by computer simulation.**

Commissioned by the Club of Rome, the findings of the study were first presented at international gatherings in Moscow and Rio de Janeiro in the summer of 1971. The report's authors are *Donella H. Meadows, Dennis L. Meadows, Jørgen Randers, and William W. Behrens III, representing a team of 17 researchers.*



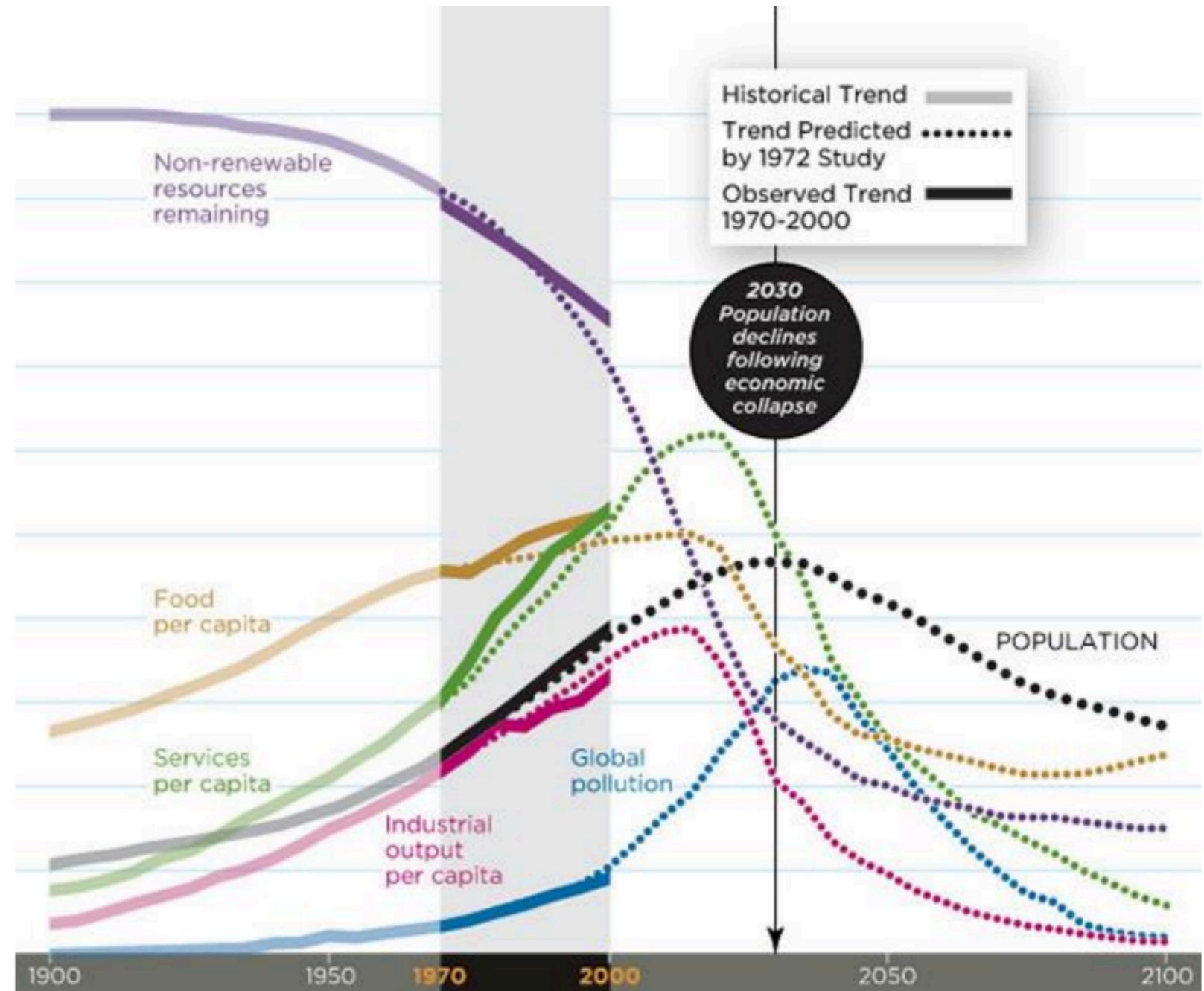
# Lecture 1

## Sustainable development

1970 - 2000: the data are in line with the model!

Major trends:

- depletion of non-renewable resources
- malnutrition
- increase in the quality of services
- rapid population growth
- accelerated industrialization
- deteriorated environment



# Lecture 1

## Sustainable development: planetary boundaries

The planetary boundaries concept presents a set of **nine planetary boundaries** within which humanity can continue to develop and thrive for generations to come.



<https://www.stockholmresilience.org/research/planetary-boundaries.html>

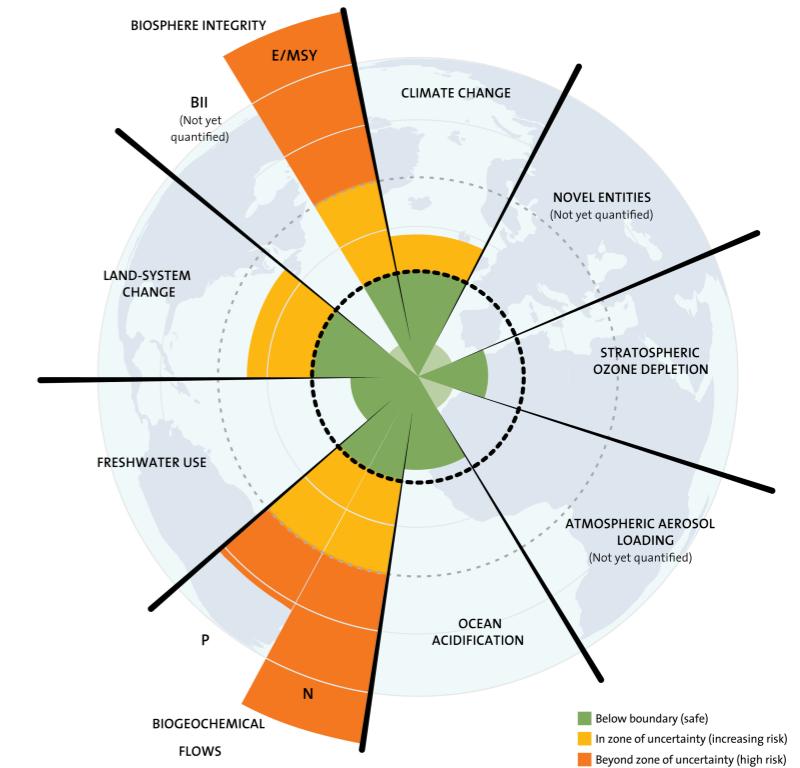
Credits: J. Lokrantz/Azote based on Steffen et al. 2015.

# Lecture 1

## Sustainable development: planetary boundaries

To go further:

Johan Rockström introduces the Planetary Boundaries framework at TED Global 2010.  
<https://youtu.be/RgqtrlixYR4>

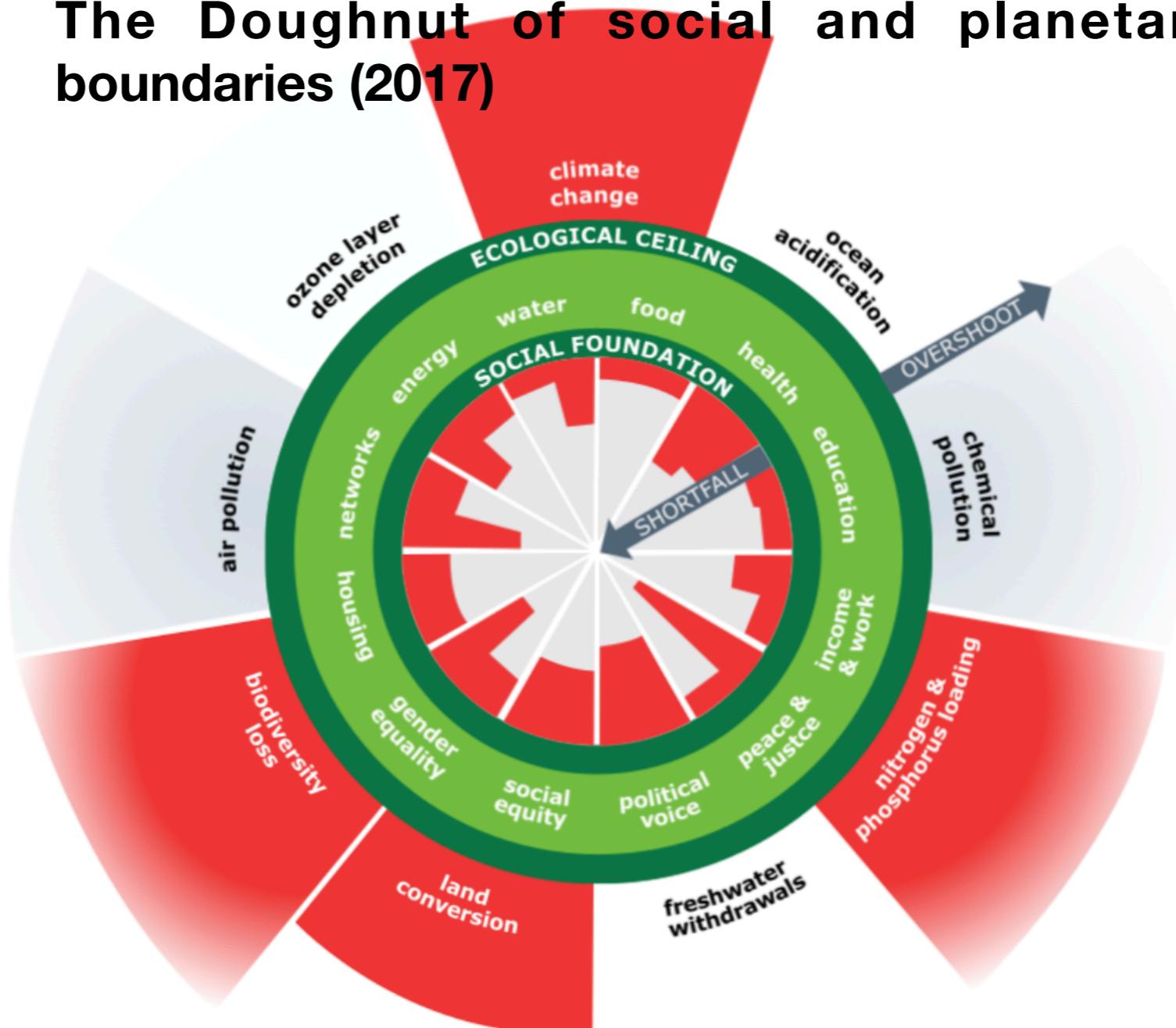


*Steffen, Will, et al. "Planetary boundaries: Guiding human development on a changing planet." Science 347.6223 (2015).*  
<https://science.sciencemag.org/content/347/6223/1259855>

# Lecture 1

## Sustainable development: DONUT !

### The Doughnut of social and planetary boundaries (2017)



**TED: A healthy economy should be designed to thrive, not grow**

<https://www.kateraworth.com/doughnut/>

# Lecture 1

## Sustainable development: DONUT !

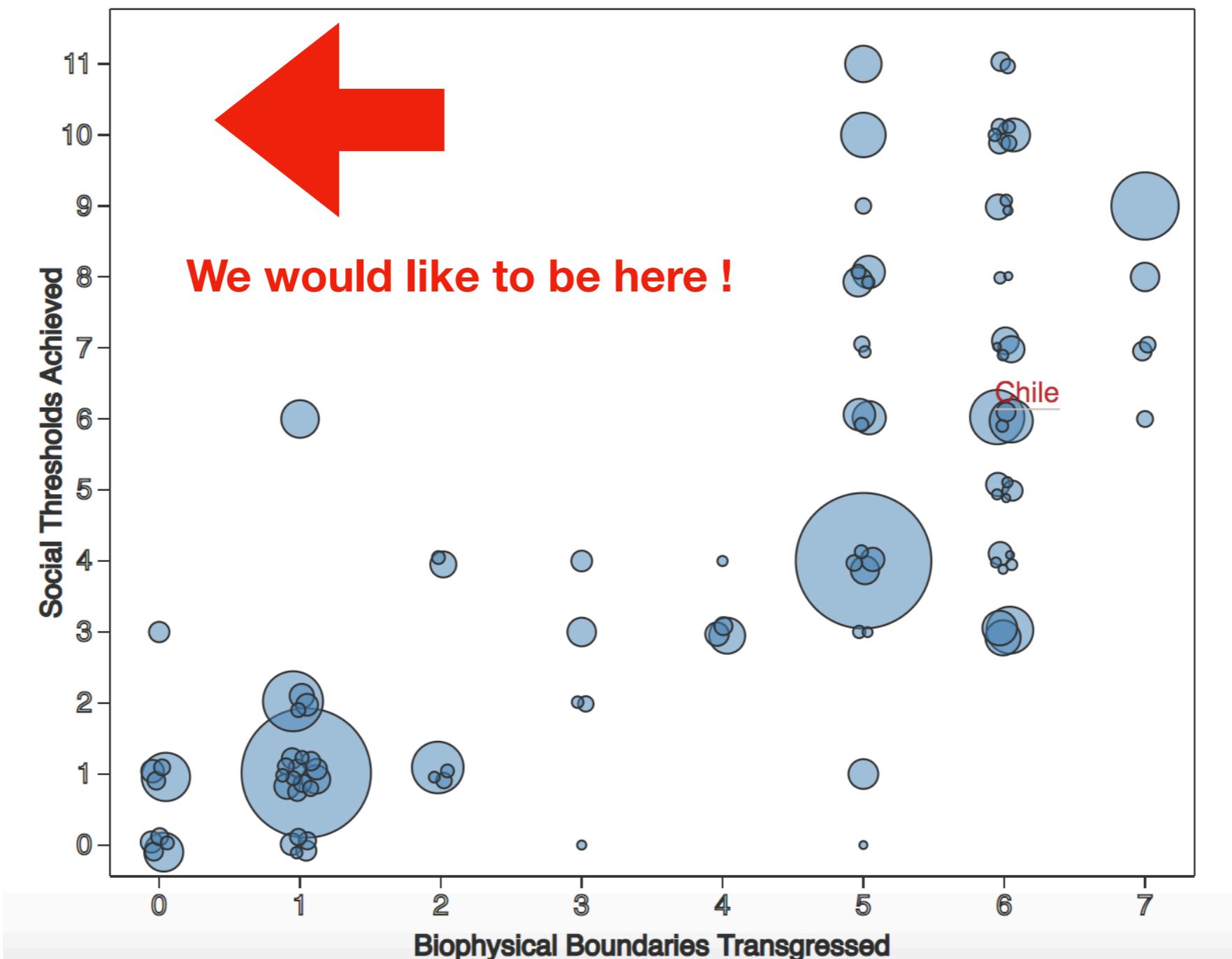


**A Good Life For All Within Planetary Boundaries**

<https://goodlife.leeds.ac.uk/>

# Lecture 1

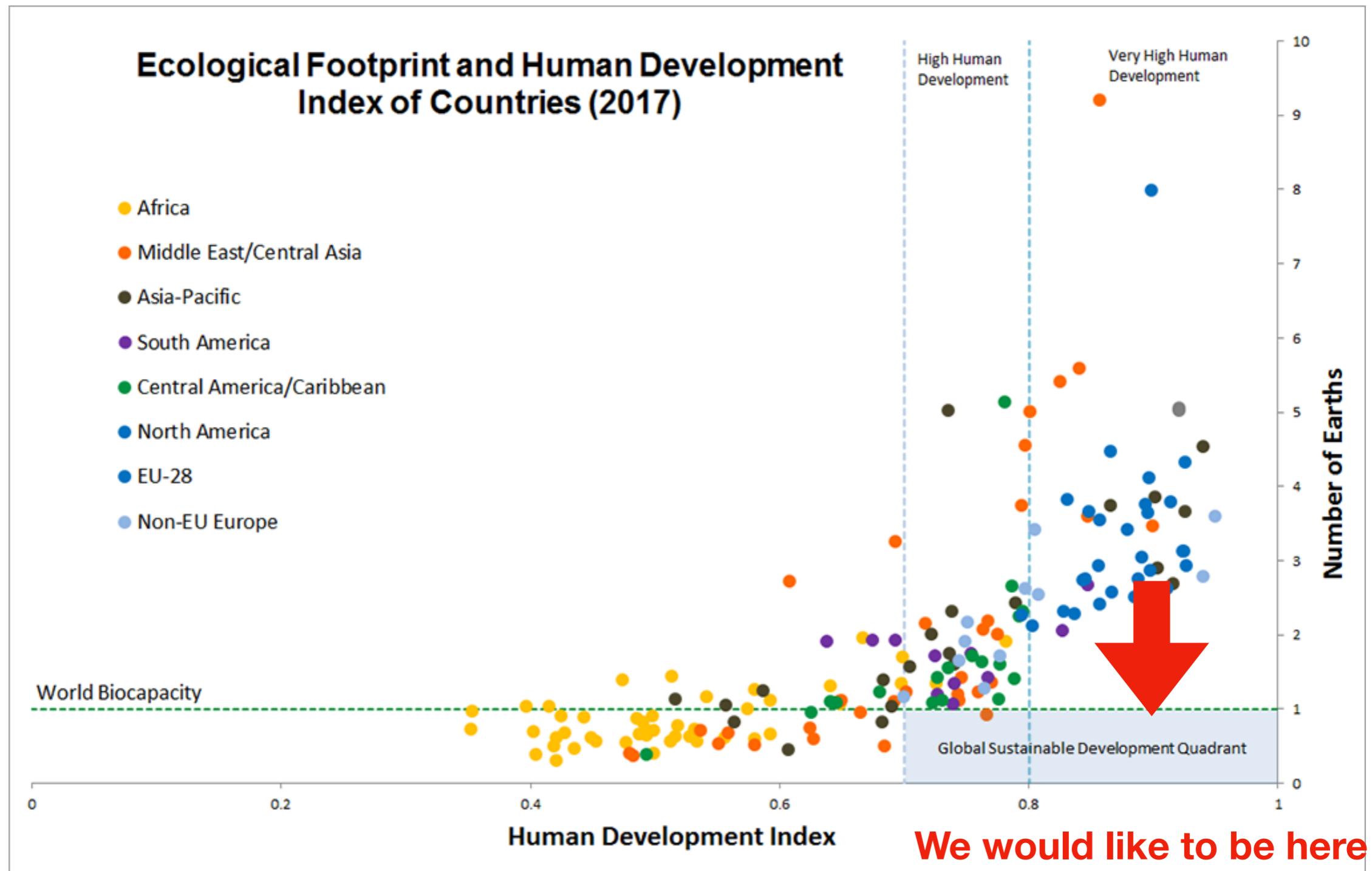
## Sustainable development: boundaries vs social thresholds



**Biophysical Boundaries Transgressed versus Social Thresholds Achieved by Nation**  
<https://goodlife.leeds.ac.uk/>

# Lecture 1

## Sustainable development: ecological footprint vs HDI



# Lecture 1

## Sustainable development: country overshoot day

### Country Overshoot Days 2021

When would Earth Overshoot Day land if the world's population lived like...



Source: National Footprint and Biocapacity Accounts, 2021 Edition  
data.footprintnetwork.org



A **country's overshoot day** is the date on which Earth Overshoot Day would fall if all of humanity consumed like the people in this country.  
<https://www.overshootday.org/newsroom/country-overshoot-days/>

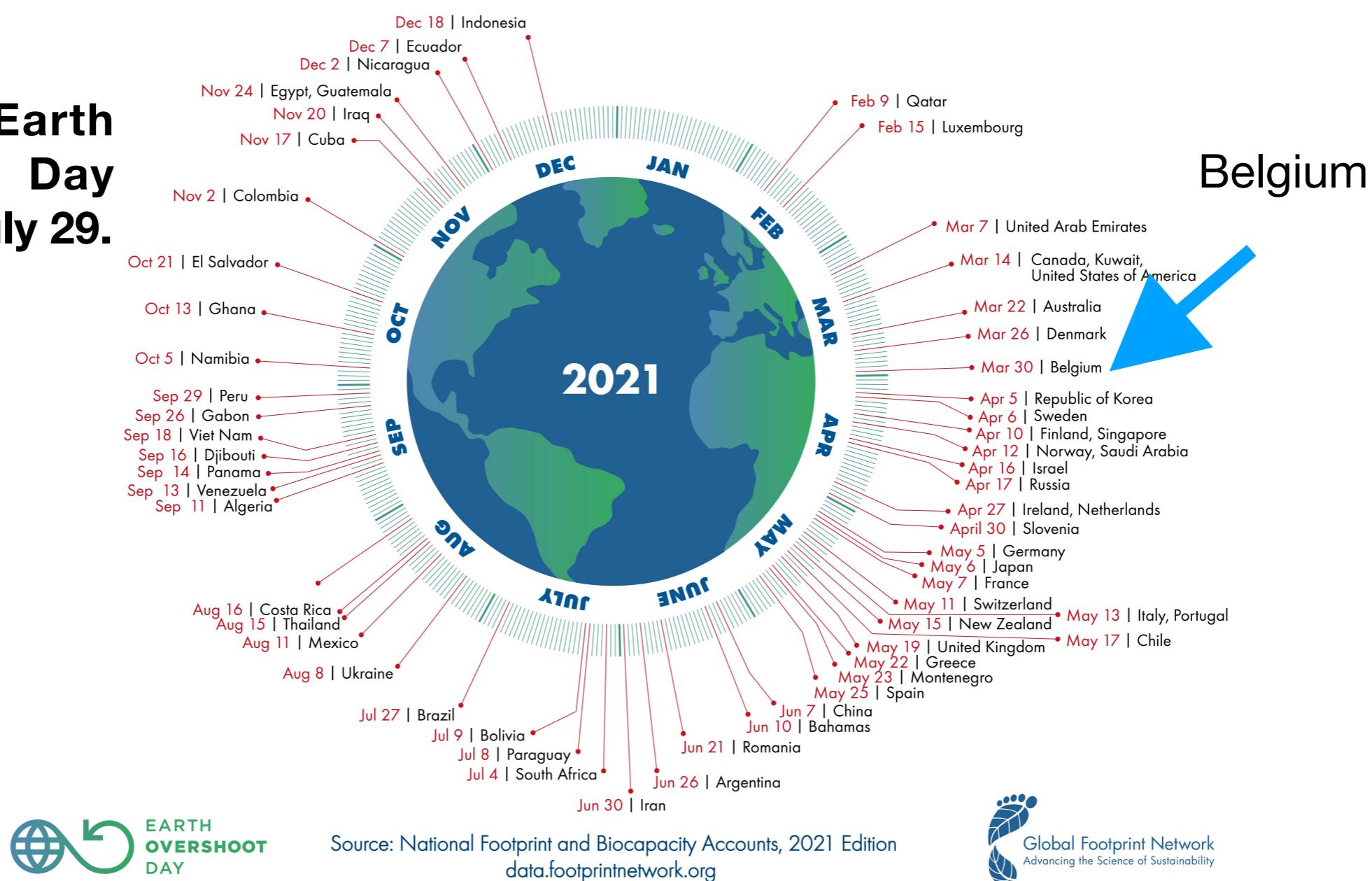
# Lecture 1

## Sustainable development: country overshoot day

In 2021, Earth  
Overshoot Day  
lands on July 29.

### Country Overshoot Days 2021

When would Earth Overshoot Day land if the world's population lived like...



# Lecture 1

## Goals

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Sustainable development

**Sustainable development goals**

ENVT 3065 Sustainability Challenges's perimeter

Energy

Rebound effect

Challenges

# Lecture 1

## Sustainable Development Goals

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UN Sustainable Development Goals SDGs

Do you know the **15 SDGs** ?  
<https://youtu.be/0XTBYMfZyrM>

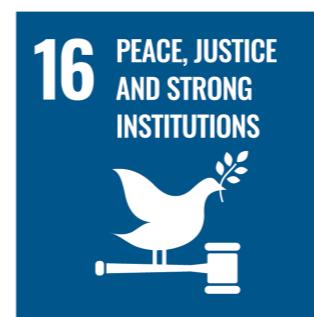


# Lecture 1

## Sustainable Development Goals



## SUSTAINABLE DEVELOPMENT GOALS



<https://www.un.org/sustainabledevelopment/news/communications-material/>

# Lecture 1

## Goals

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Sustainable development

Sustainable development goals

**ENVT 3065 Sustainability Challenges's perimeter**

Energy

Rebound effect

Challenges

# Lecture 1

## Course perimeter



## SUSTAINABLE DEVELOPMENT GOALS



<https://www.un.org/sustainabledevelopment/news/communications-material/>

# Lecture 1

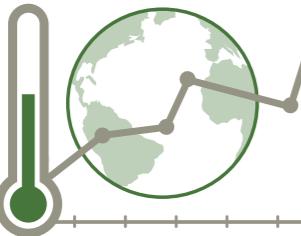
## Climate Change

**13 CLIMATE ACTION**

**TAKE URGENT ACTION TO COMBAT CLIMATE CHANGE AND ITS IMPACTS**

**BEFORE COVID-19**

**GLOBAL COMMUNITY SHIES AWAY FROM COMMITMENTS REQUIRED TO REVERSE THE CLIMATE CRISIS**



2019 WAS THE SECOND WARMEST YEAR ON RECORD

GLOBAL TEMPERATURES ARE PROJECTED TO RISE BY UP TO 3.2°C BY 2100

**COVID-19 IMPLICATIONS**

**COVID-19 MAY RESULT IN A 6% DROP IN GREENHOUSE GAS EMISSIONS FOR 2020**

**STILL SHORT OF 7.6% ANNUAL REDUCTION REQUIRED TO LIMIT GLOBAL WARMING TO 1.5°C**

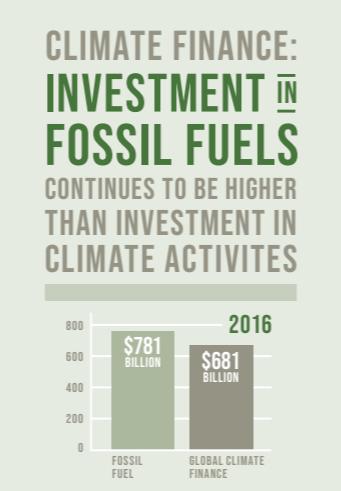
**CLIMATE CHANGE CONTINUES TO EXACERBATE THE FREQUENCY AND SEVERITY OF NATURAL DISASTERS**

MASSIVE WILDFIRES   DROUGHTS   HURRICANES   FLOODS

AFFECTING MORE THAN 39 MILLION PEOPLE IN 2018

**ONLY 85 COUNTRIES HAVE NATIONAL DISASTER RISK REDUCTION STRATEGIES ALIGNED TO THE SENDAI FRAMEWORK**

**CLIMATE FINANCE: INVESTMENT IN FOSSIL FUELS CONTINUES TO BE HIGHER THAN INVESTMENT IN CLIMATE ACTIVITIES**



Category	Value
Fossil Fuel	\$781 BILLION
Global Climate Finance	\$681 BILLION



## CLIMATE ACTION: WHY IT MATTERS

### What's the goal here?

Taking urgent action to tackle climate change and its impacts.

### Why?

The climate crisis continues unabated as the global community shies away from the full commitment required for its reversal. 2010-2019 was warmest decade ever recorded, bringing with it massive wildfires, hurricanes, droughts, floods

and other climate disasters across continents.

### How are people being affected by climate change?

Climate change is affecting every country in the world. It is disrupting national economies and affecting lives and livelihoods, especially for the most vulnerable.

Weather patterns are changing, sea levels are rising, and weather events are becoming more extreme,

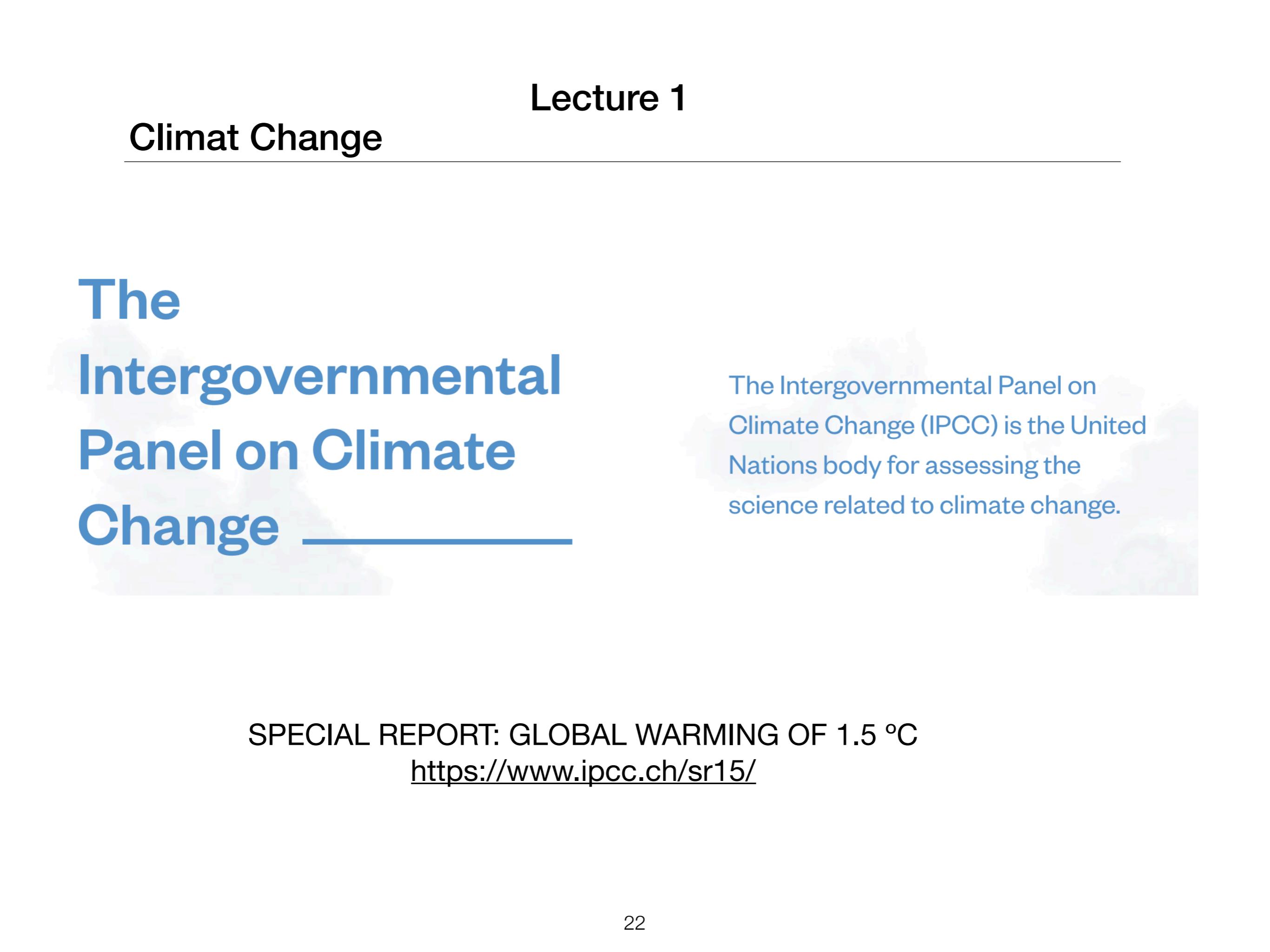
**13 CLIMATE ACTION**



To limit global warming to 1.5°C, as called for in the Paris Agreement, greenhouse gas emissions must begin falling by **7.6%** each year starting in 2020

# The Intergovernmental Panel on Climate Change

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The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change.

SPECIAL REPORT: GLOBAL WARMING OF 1.5 °C  
<https://www.ipcc.ch/sr15/>

# Climat Change

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## Lecture 1

**A.2. Warming from anthropogenic emissions from the pre-industrial period to the present will persist for centuries to millennia and will continue to cause further long-term changes in the climate system, such as sea level rise, with associated impacts (*high confidence*), but these emissions alone are *unlikely* to cause global warming of 1.5°C (*medium confidence*). (Figure SPM.1) {1.2, 3.3, Figure 1.5}**

Summary for Policymakers

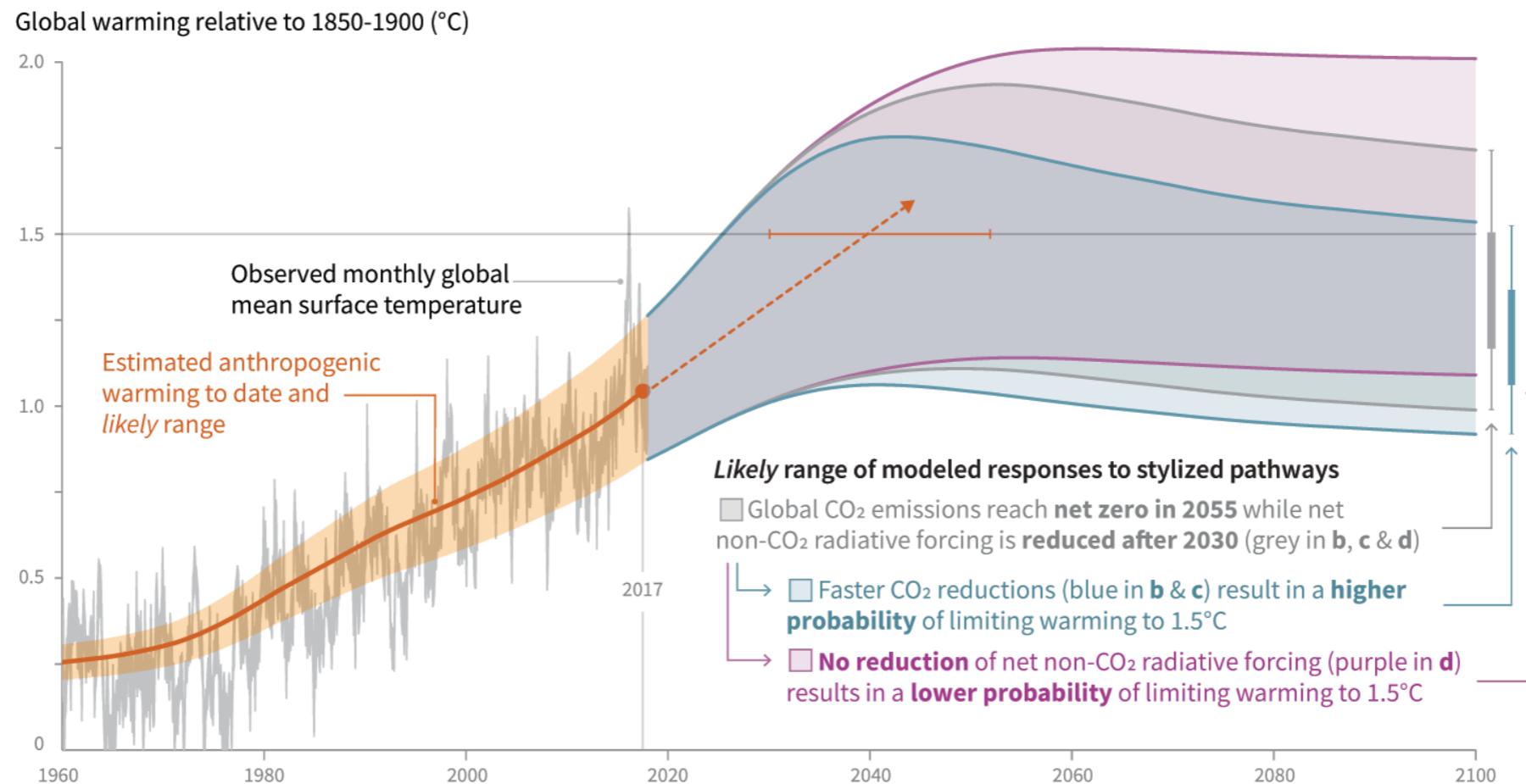
<https://www.ipcc.ch/sr15/chapter/spm/>

# Lecture 1

## Climat Change

**Cumulative emissions of CO<sub>2</sub> and future non-CO<sub>2</sub> radiative forcing determine the probability of limiting warming to 1.5°C**

a) Observed global temperature change and modeled responses to stylized anthropogenic emission and forcing pathways

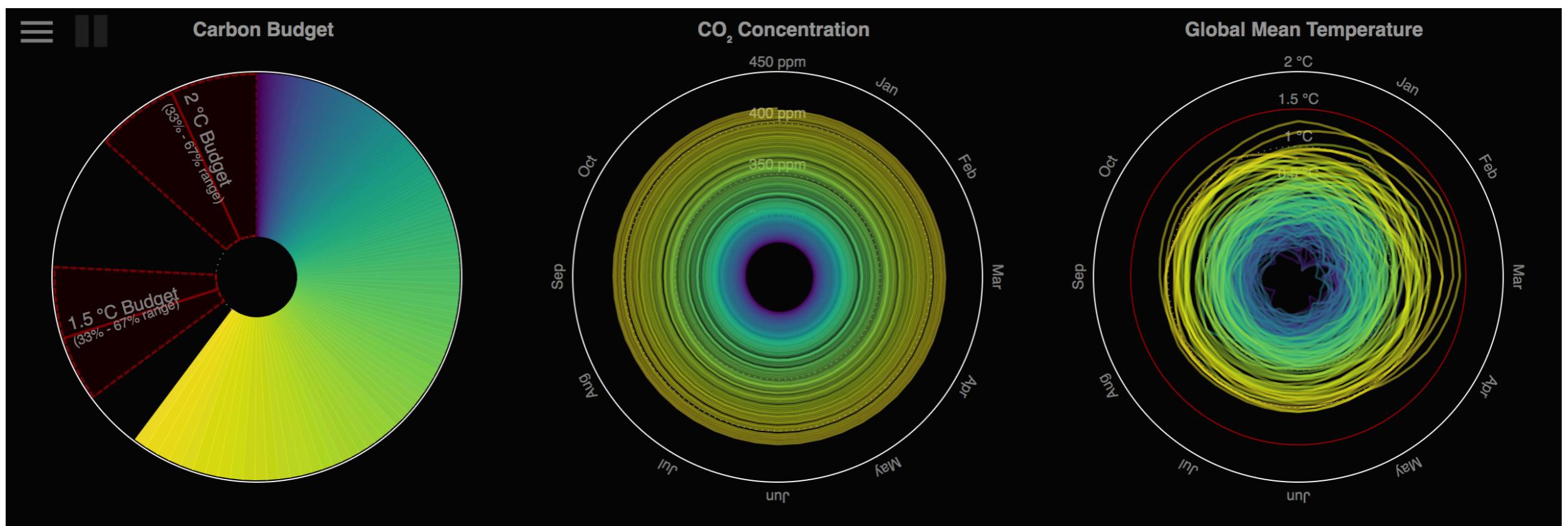


Summary for Policymakers  
<https://www.ipcc.ch/sr15/chapter/spm/>

# Lecture 1

## Climat Change

**Combined animations for temperature, CO<sub>2</sub> and carbon budgets**



[openclimatedata.net](http://openclimatedata.net)

# Lecture 1

## Climat Change

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C.1. In model pathways with no or limited overshoot of 1.5°C, global net anthropogenic CO<sub>2</sub> emissions decline by about 45% from 2010 levels by 2030 (40–60% interquartile range), reaching net zero around 2050 (2045–2055 interquartile range). For limiting global warming to below 2°C FN12 CO<sub>2</sub> emissions are projected to decline by about 25% by 2030 in most pathways (10–30% interquartile range) and reach net zero around 2070 (2065–2080 interquartile range). Non-CO<sub>2</sub> emissions in pathways that limit global warming to 1.5°C show deep reductions that are similar to those in pathways limiting warming to 2°C. (*high confidence*) (Figure SPM.3a) {2.1, 2.3, Table 2.4}

Summary for Policymakers  
<https://www.ipcc.ch/sr15/chapter/spm/>

# Lecture 1

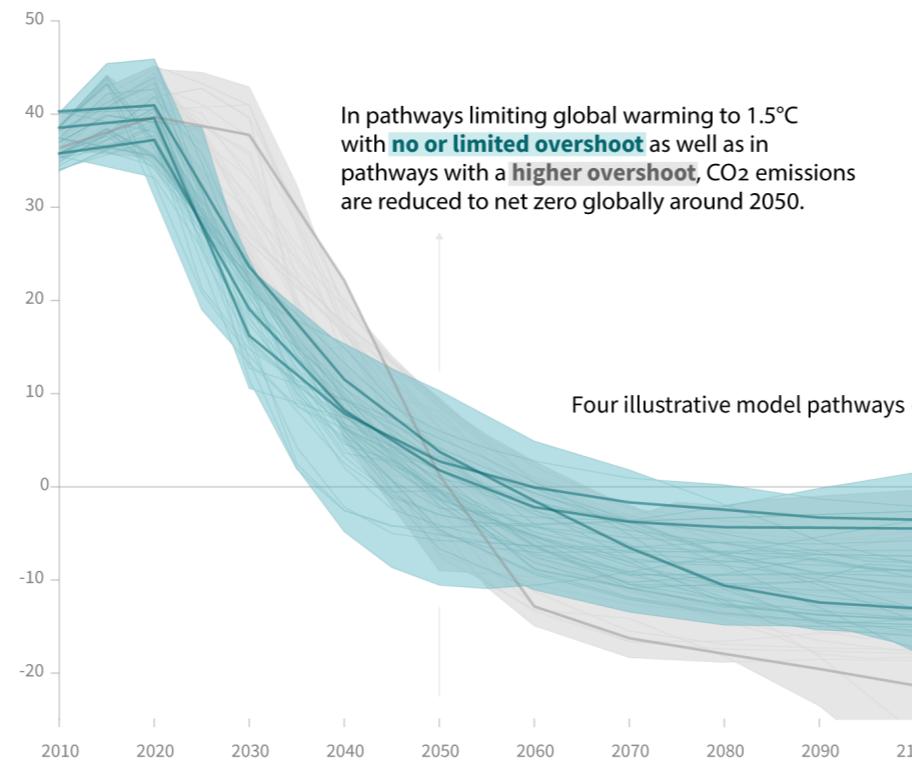
## Climat Change

### Global emissions pathway characteristics

General characteristics of the evolution of anthropogenic net emissions of CO<sub>2</sub>, and total emissions of methane, black carbon, and nitrous oxide in model pathways that limit global warming to 1.5°C with no or limited overshoot. Net emissions are defined as anthropogenic emissions reduced by anthropogenic removals. Reductions in net emissions can be achieved through different portfolios of mitigation measures illustrated in Figure SPM.3b.

Global total net CO<sub>2</sub> emissions

Billion tonnes of CO<sub>2</sub>/yr

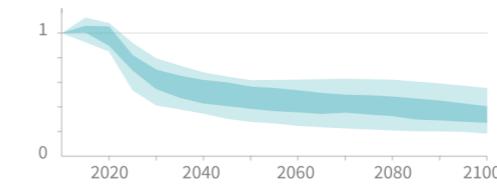


Timing of net zero CO<sub>2</sub>  
Line widths depict the 5-95th percentile and the 25-75th percentile of scenarios

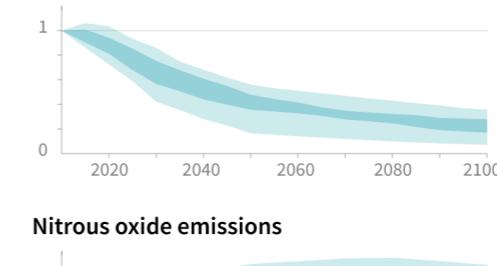
### Non-CO<sub>2</sub> emissions relative to 2010

Emissions of non-CO<sub>2</sub> forcers are also reduced or limited in pathways limiting global warming to 1.5°C with **no or limited overshoot**, but they do not reach zero globally.

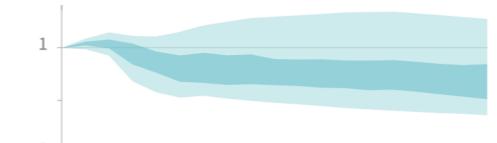
Methane emissions



Black carbon emissions



Nitrous oxide emissions

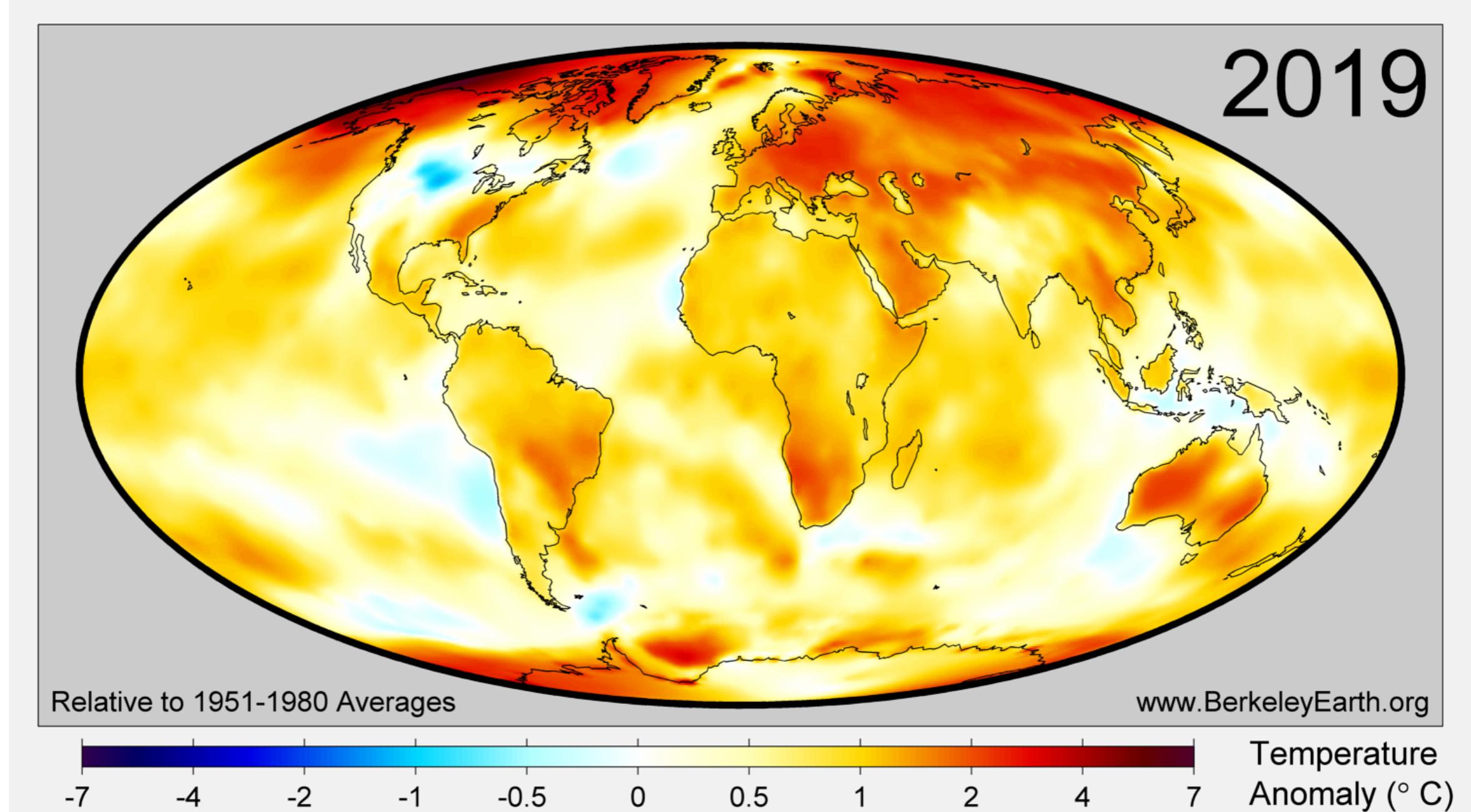


### Summary for Policymakers

<https://www.ipcc.ch/sr15/chapter/spm/>

# Lecture 1

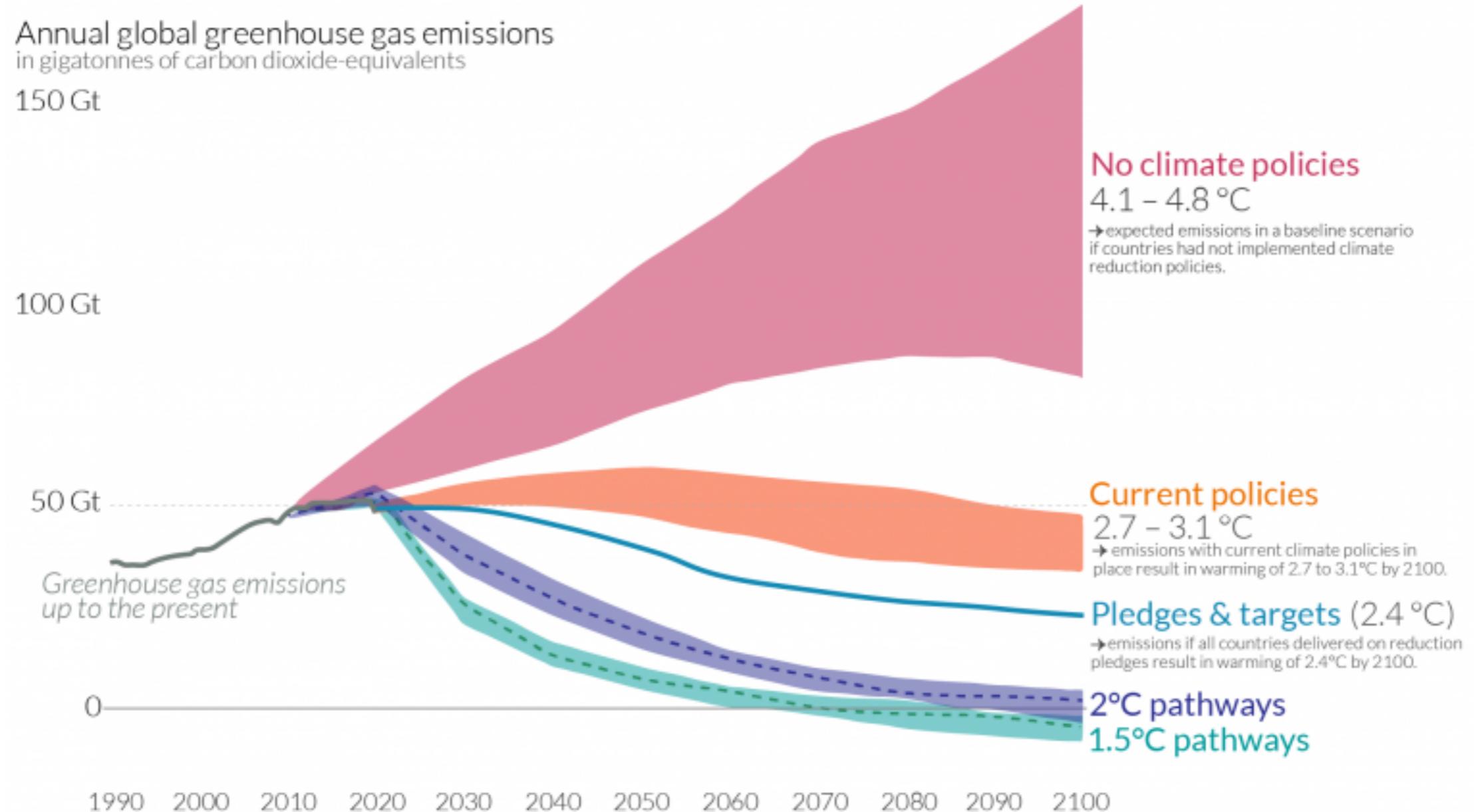
## Climat Change



from the Berkeley Earth global  
temperature reports

# Lecture 1

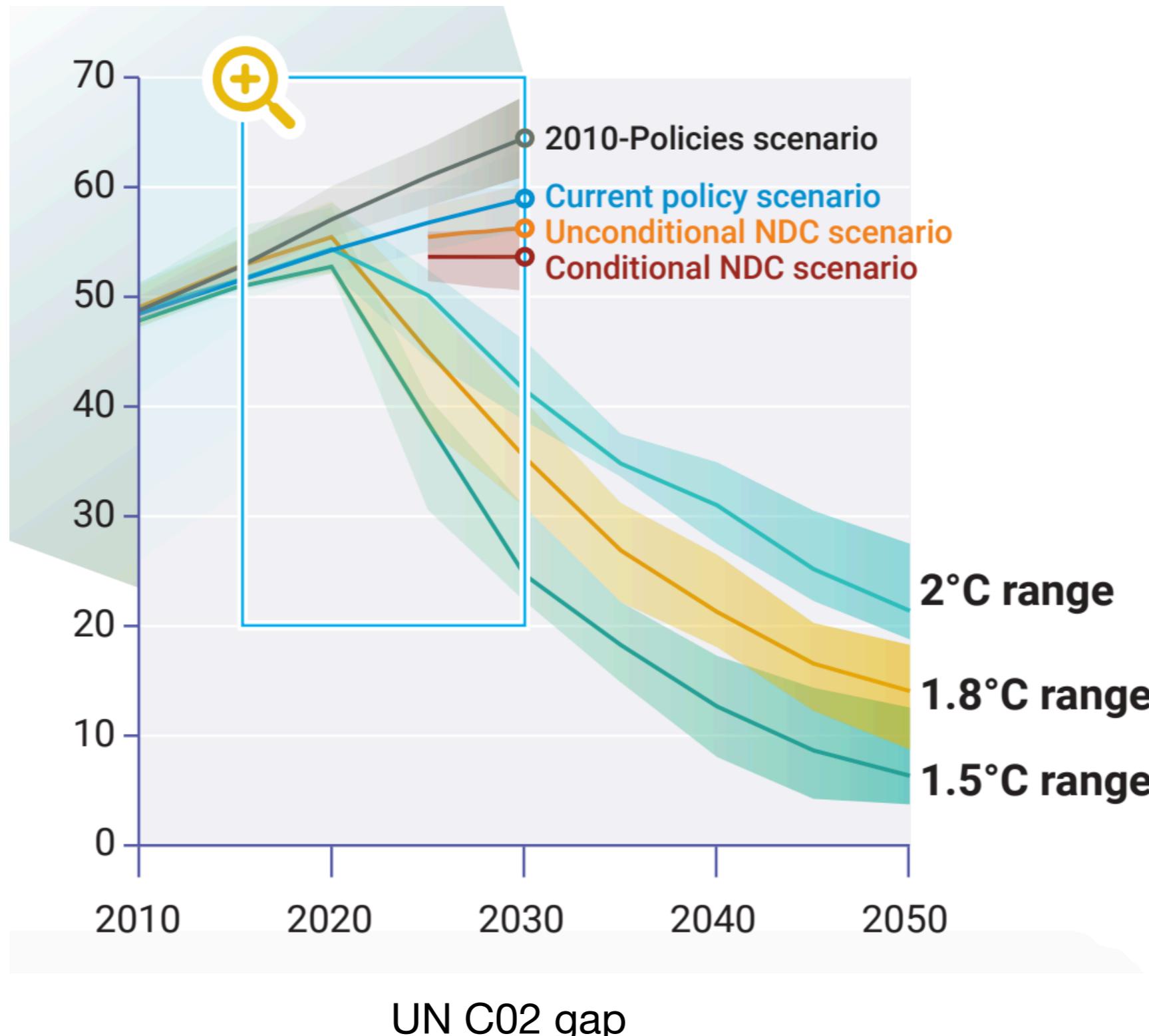
## Climat Change & C02 & gaps



our world in data

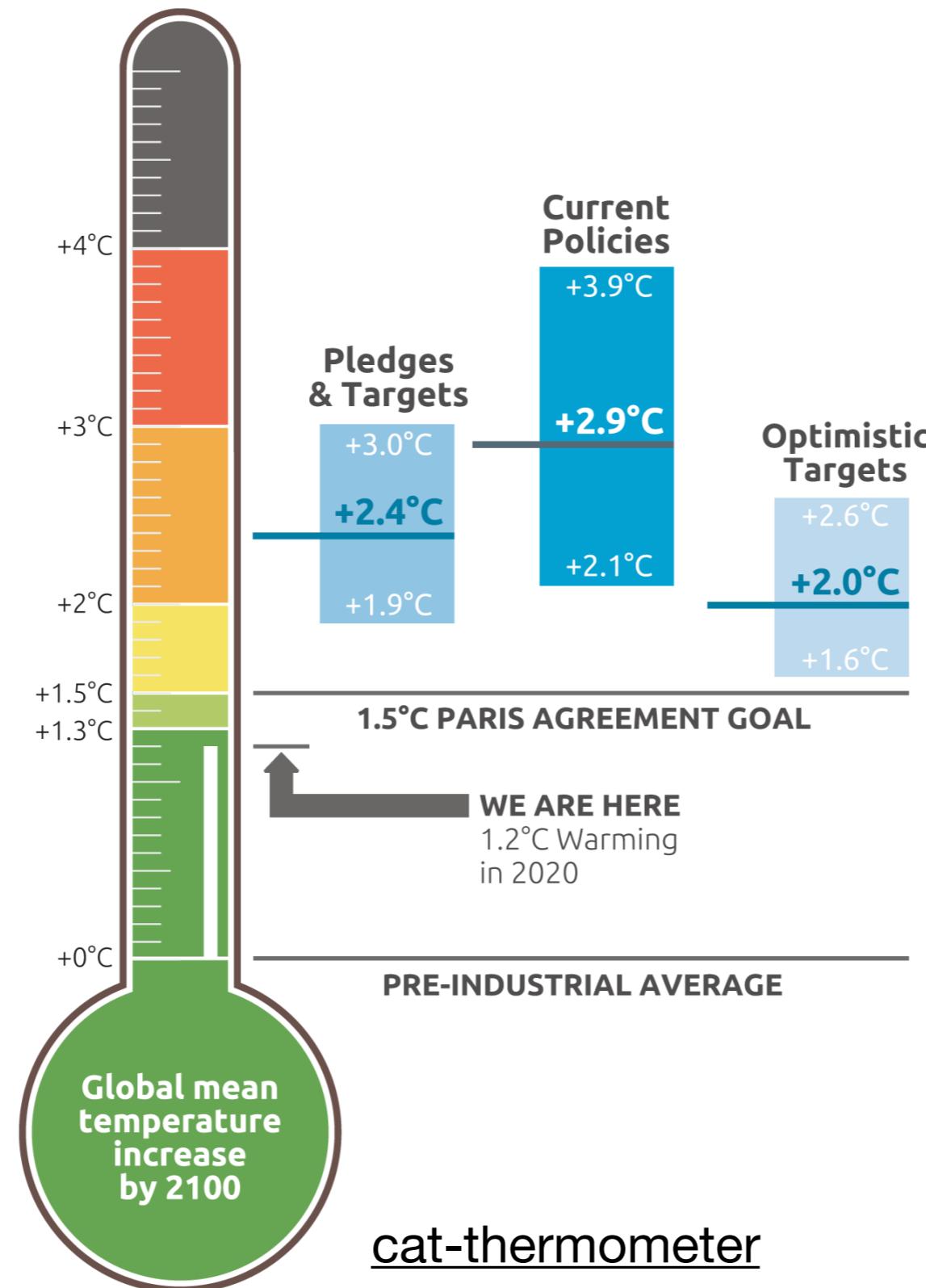
# Lecture 1

## Climat Change & C02 & gaps



# Lecture 1

## Climat Change & C02 & gaps

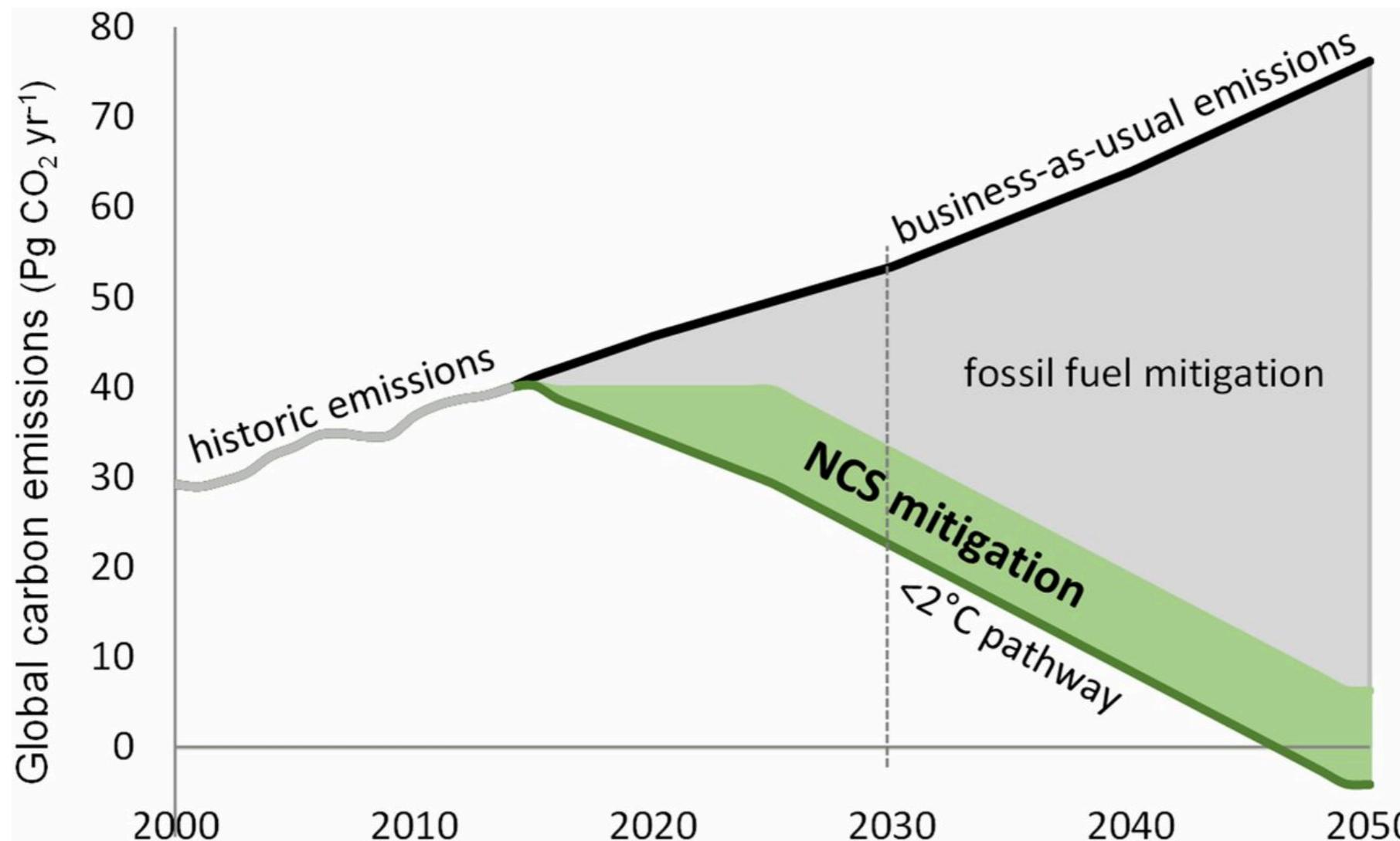


CAT warming projections  
**Global temperature increase by 2100**

May 2021 Update

# Lecture 1

## Climat Change & C02 & Natural Climate Solutions (NCS)



**NCS cannot do  
job alone !**

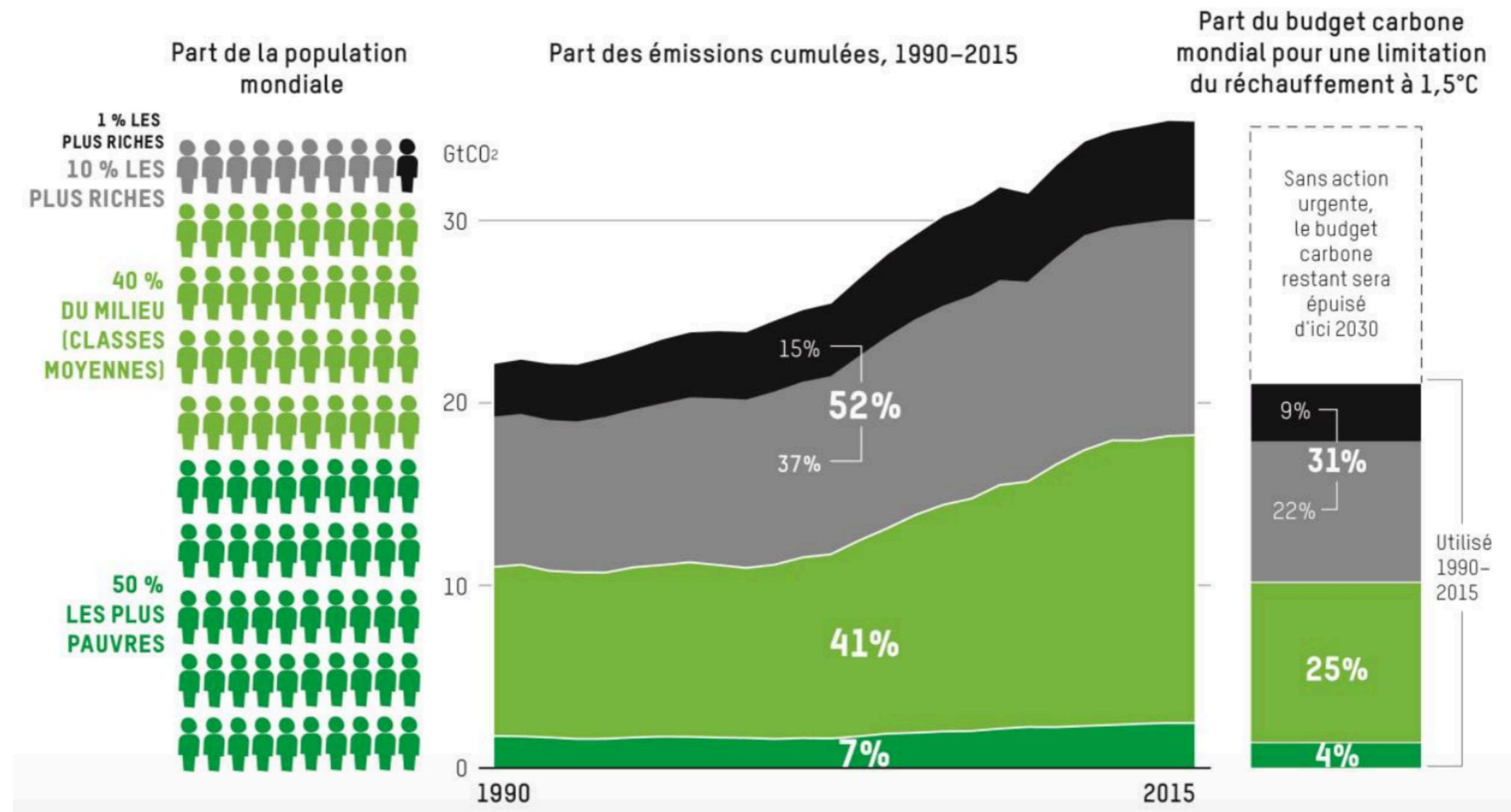
NCS cannot do  
job alone !  
Reforestation is  
the main NCS.

Griscom, Bronson W., et al. "Natural climate solutions." Proceedings of the National Academy of Sciences 114.44 (2017): 11645-11650.

article

# Lecture 1

## Climat Change & CO<sub>2</sub> & inequalities

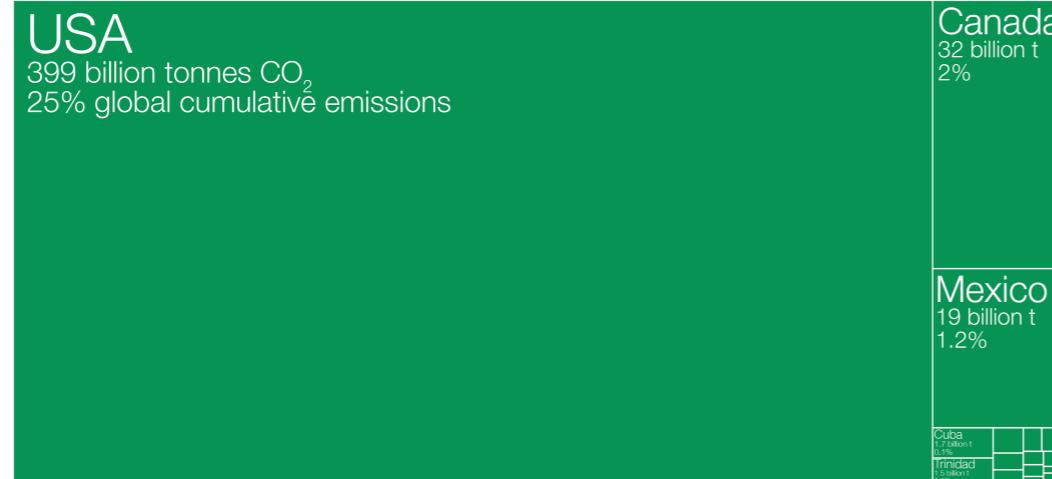


# Lecture 1

## Climat Change & CO<sub>2</sub> & inequalities

### North America

457 billion tonnes CO<sub>2</sub>  
29% global cumulative emissions



### EU-28

353 billion tonnes CO<sub>2</sub>  
22% global cumulative emissions

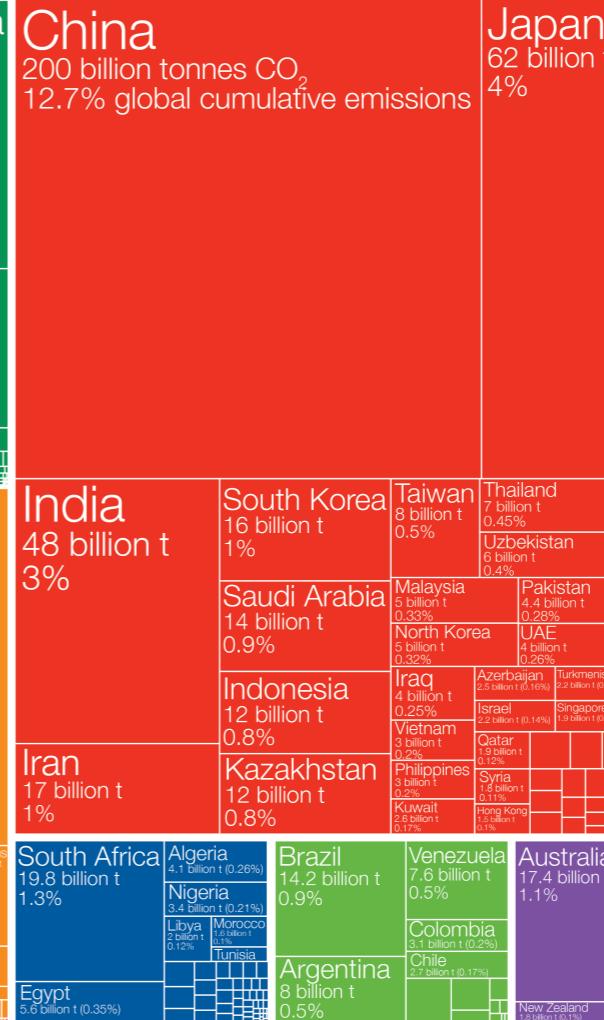


### Europe

514 billion tonnes CO<sub>2</sub>  
33% global cumulative emissions

### Asia

457 billion tonnes CO<sub>2</sub>  
29% global cumulative emissions



### Africa

43 billion tonnes CO<sub>2</sub>  
3% global emissions

### South America

40 billion tonnes CO<sub>2</sub>  
3% global emissions

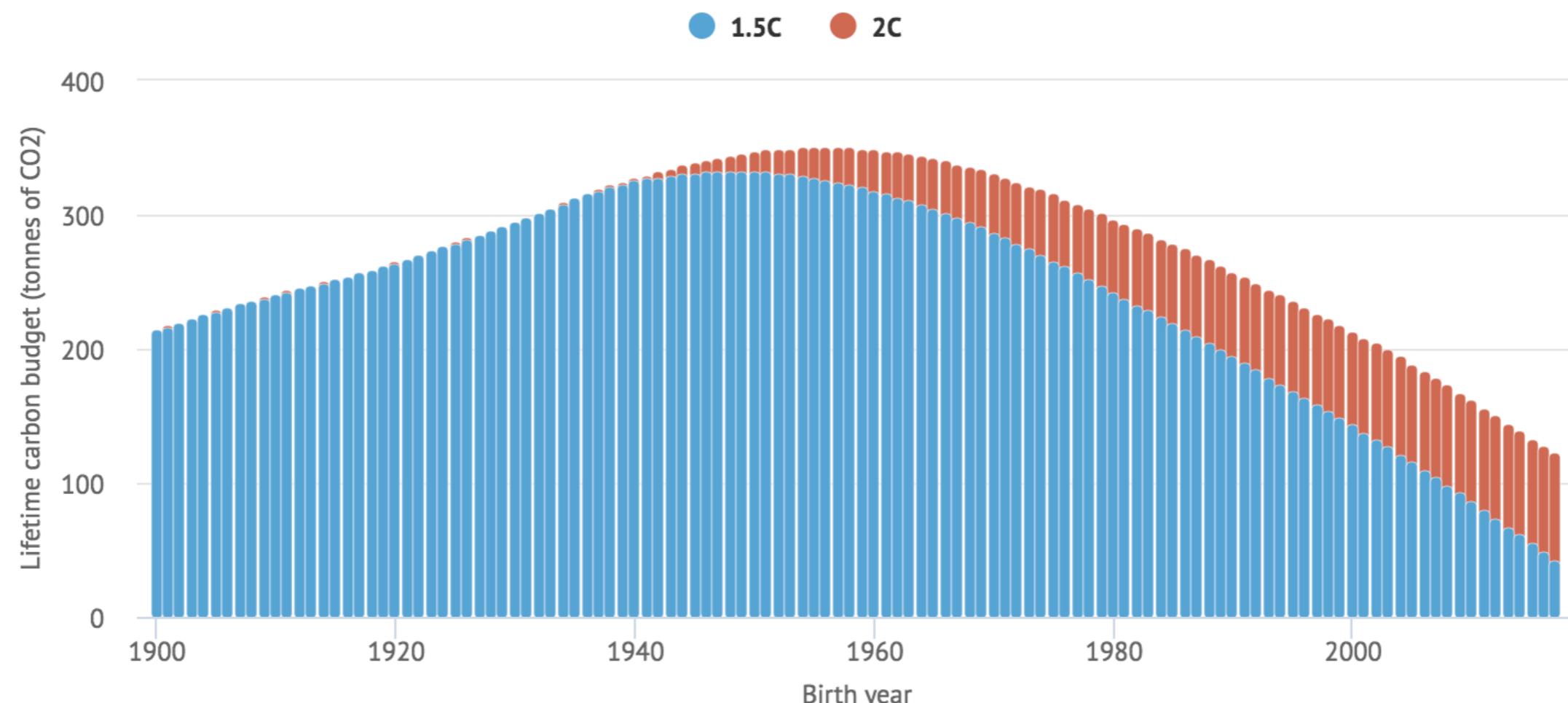
our world in data

# Lecture 1

## Climat Change & C02 & inequalities

Younger generations will have much lower lifetime carbon budgets

Overall emissions must fall rapidly to limit warming to 1.5 or 2C by 2100



Pre-Boomers

Boomers

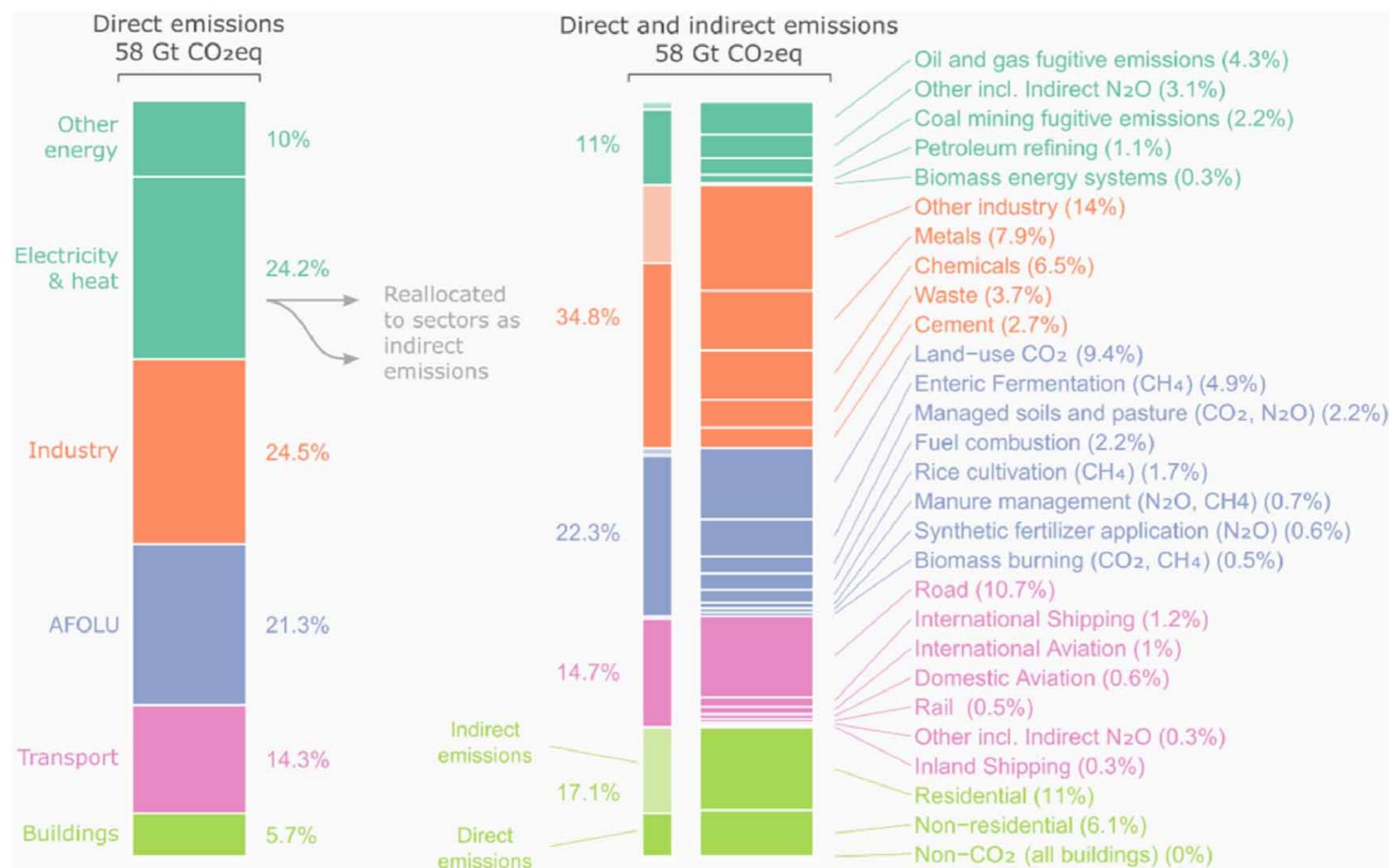
Gen X

Millenials

Gen Z

# Lecture 1

## Climat Change & C02 & sectors



Lamb, William F., et al. "A review of trends and drivers of greenhouse gas emissions by sector from 1990 to 2018." *Environmental Research Letters* (2021).

# Lecture 1

## Climat Change

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**D.4. Mitigation options consistent with 1.5°C pathways are associated with multiple synergies and trade-offs across the Sustainable Development Goals (SDGs). While the total number of possible synergies exceeds the number of trade-offs, their net effect will depend on the pace and magnitude of changes, the composition of the mitigation portfolio and the management of the transition. (*high confidence*) (Figure SPM.4) {2.5, 4.5, 5.4}**

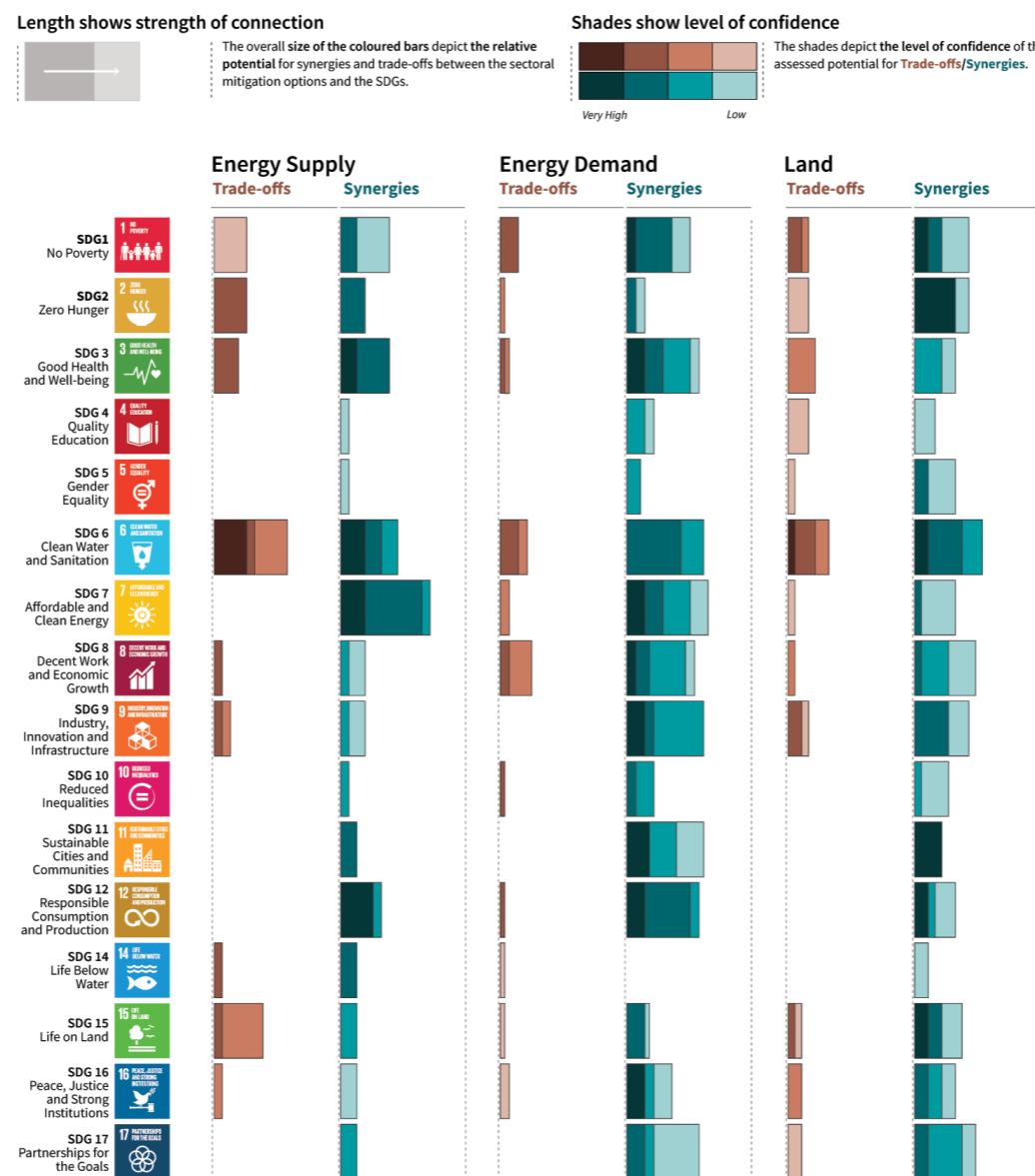
Summary for Policymakers  
<https://www.ipcc.ch/sr15/chapter/spm/>

# Lecture 1

## Climate Change & others SDGs

### Indicative linkages between mitigation options and sustainable development using SDGs (The linkages do not show costs and benefits)

Mitigation options deployed in each sector can be associated with potential positive effects (synergies) or negative effects (trade-offs) with the Sustainable Development Goals (SDGs). The degree to which this potential is realized will depend on the selected portfolio of mitigation options, mitigation policy design, and local circumstances and context. Particularly in the energy-demand sector, the potential for synergies is larger than for trade-offs. The bars group individually assessed options by level of confidence and take into account the relative strength of the assessed mitigation-SDG connections.



### Summary for Policymakers

# Lecture 1

## Course perimeter

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### WARNING!

We focus on climate change & energy but it does not solve the other issues (cf SDGs):

- Bio-diversity;
- Clean water
- Pollution;
- Inequalities;
- Etc

Everything must be addressed!

# Lecture 1

## Goals

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Sustainable development

Sustainable development goals

ENVT 3065 Sustainability Challenges's perimeter

**Energy**

Rebound effect

Challenges

# Lecture 1

## What is 1kWh?



<https://youtu.be/S4O5voOCqAQ>

<https://jancovici.com/en/energy-transition/energy-and-us/how-much-of-a-slave-master-am-i/>

# Lecture 1

## Energetic slaves

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**1 human being = 2 000 calories / day = 2,3 kWh / day**  
-> 800 kWh / year

**1 liter of oil = 10 kWh of thermal energy**

**30 MWh / year = 400 energetic slaves**  
(by taking into account the efficiencies  
see the assumptions in the article)

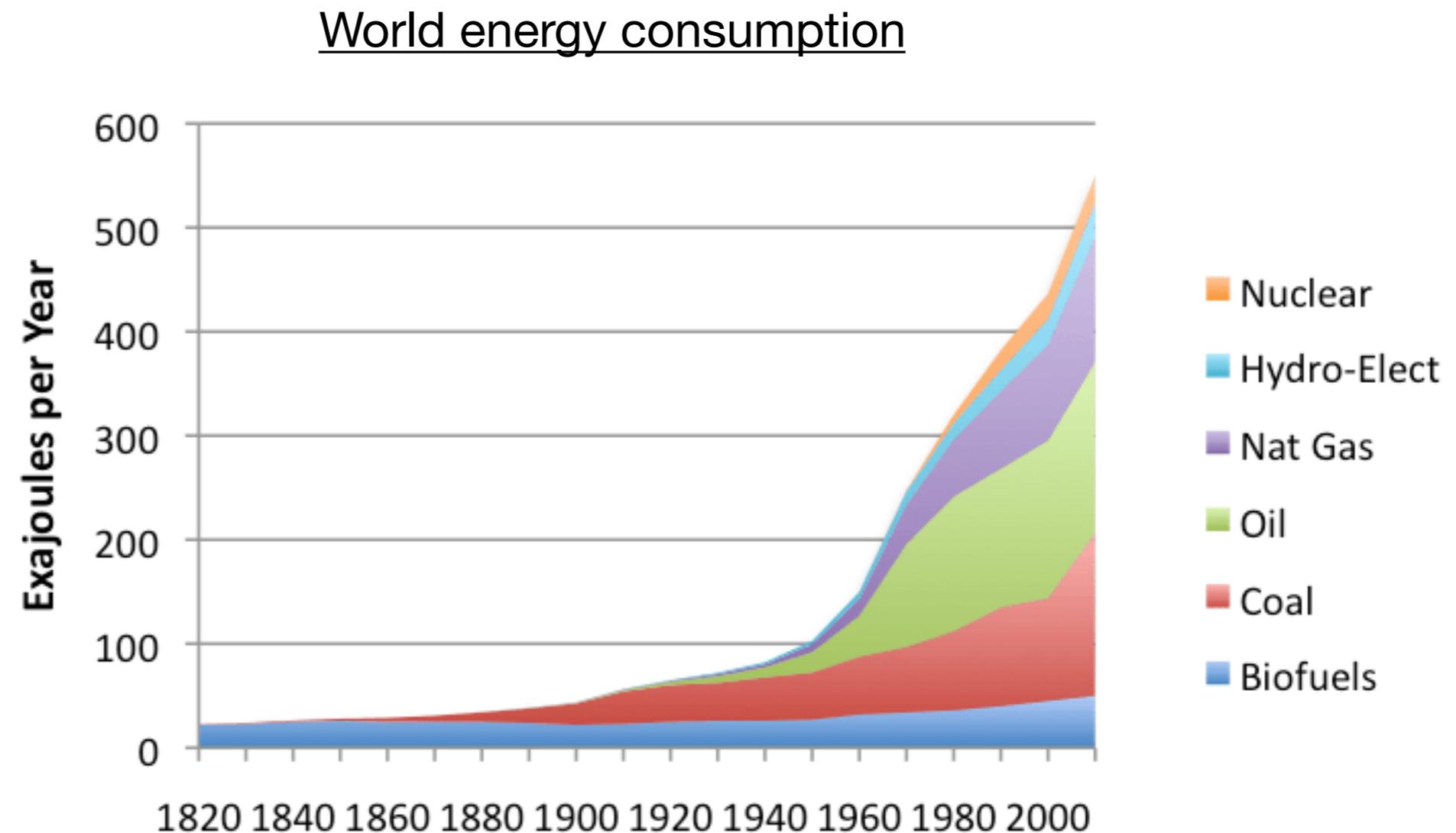
<https://jancovici.com/en/energy-transition/energy-and-us/how-much-of-a-slave-master-am-i/>

# Energy

## Lecture 1

What do you think ?

**Is there an energy transition ?**

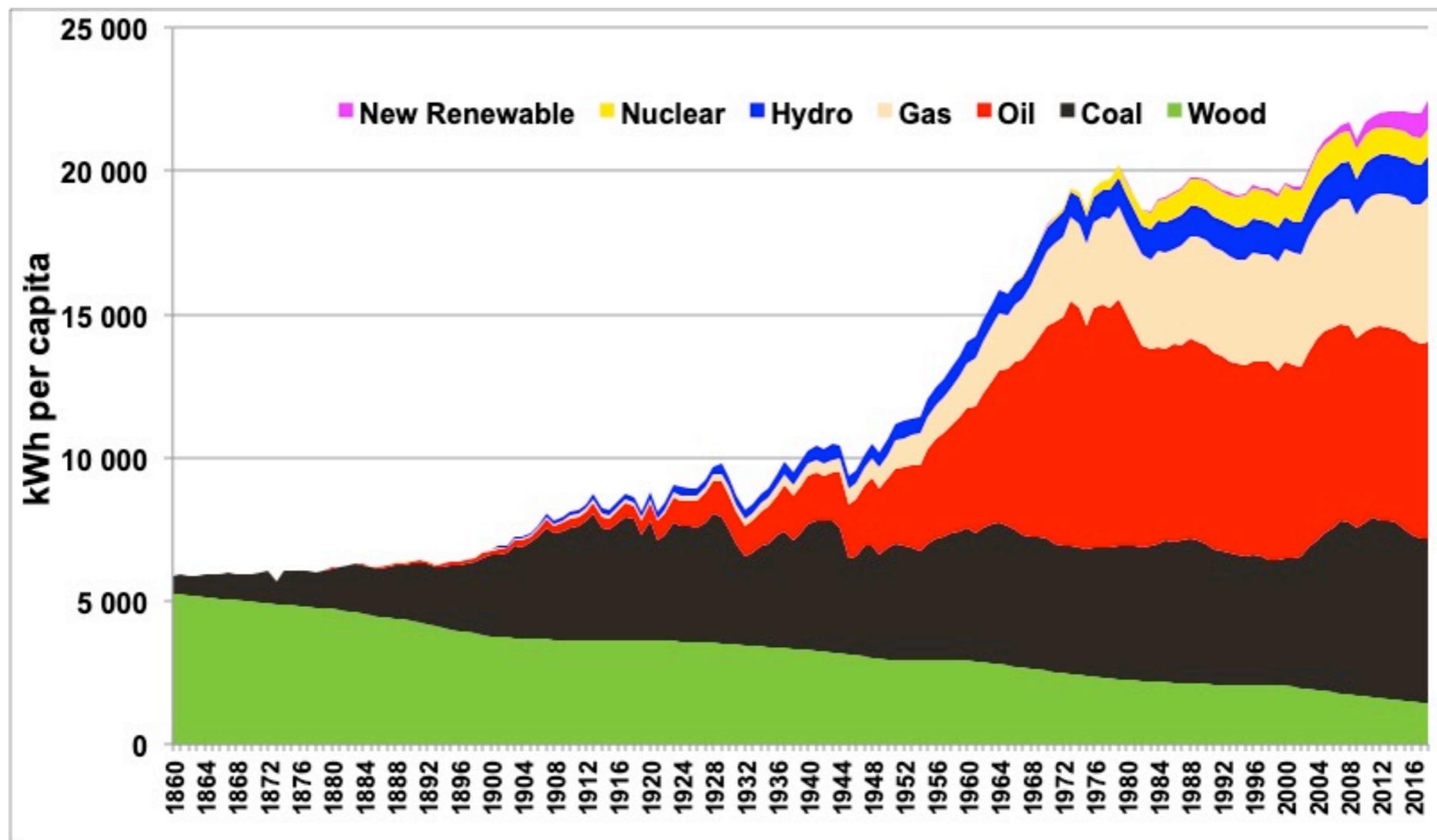


*World Energy Consumption by Source, Based on Vaclav Smil estimates from Energy Transitions: History, Requirements and Prospects together with BP Statistical Data for 1965 and subsequent*

# Energy

## Lecture 1

### World per capita energy consumption

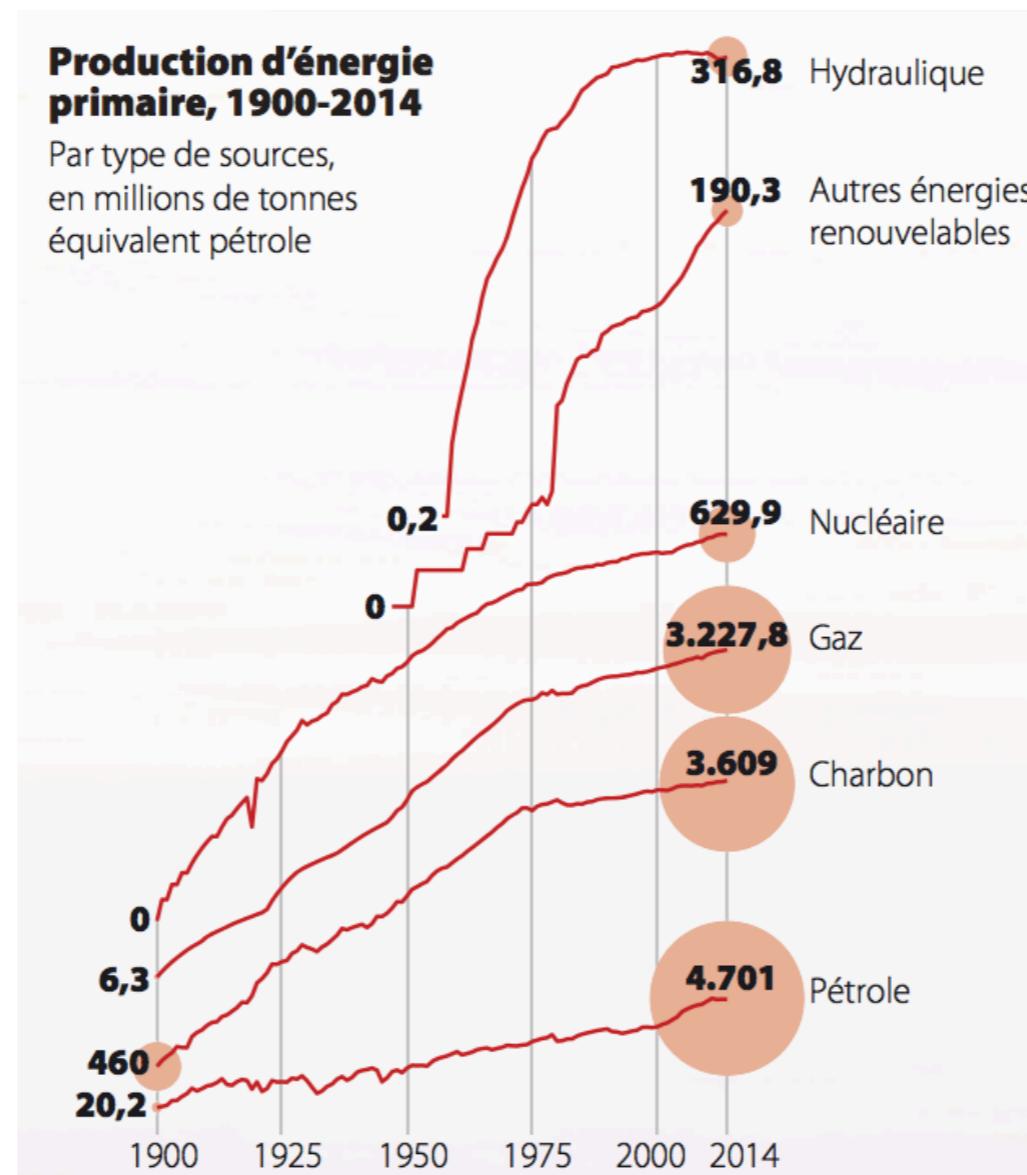


*Author's compilation of the following primary sources: Shilling et al., BP statistical review, Energy Information Agency, United Nations.*

<https://jancovici.com/en/energy-transition/energy-and-us/what-is-energy-actually/>

# Energy

## Lecture 1

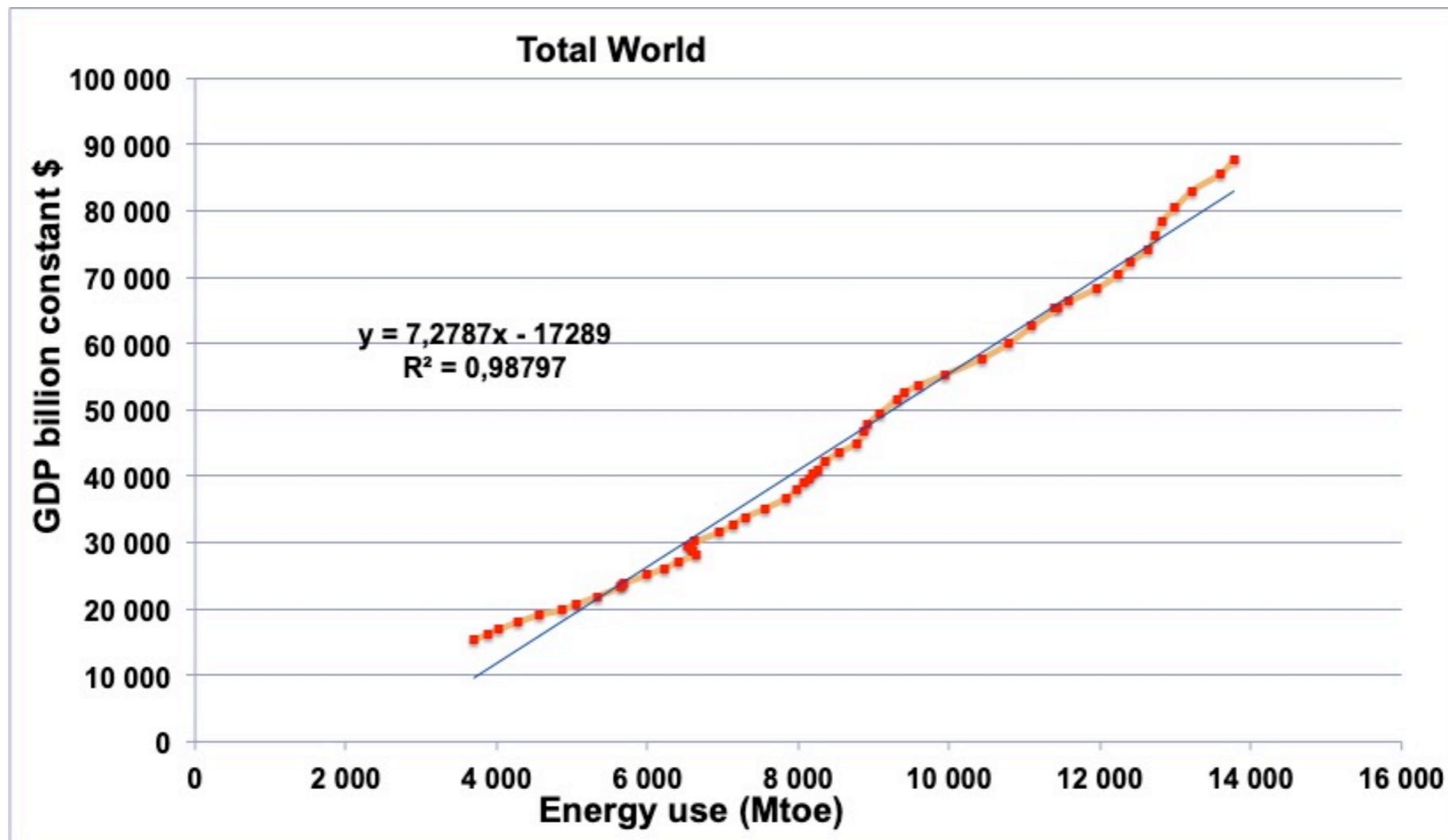


Credits: Source : *The Shift Project Data Portal*, d'après B. Etemad, J. Luciani (1900 - 1980) et US EIA Historical Statistics (1981-2014), [www.tsp-data-portal.org](http://www.tsp-data-portal.org)

# Lecture 1

## Energy & GDP

World Gross Domestic Product GDP in constant dollars plotted against the world energy consumption in million tonnes oil equivalent, from 1965 to 2014.



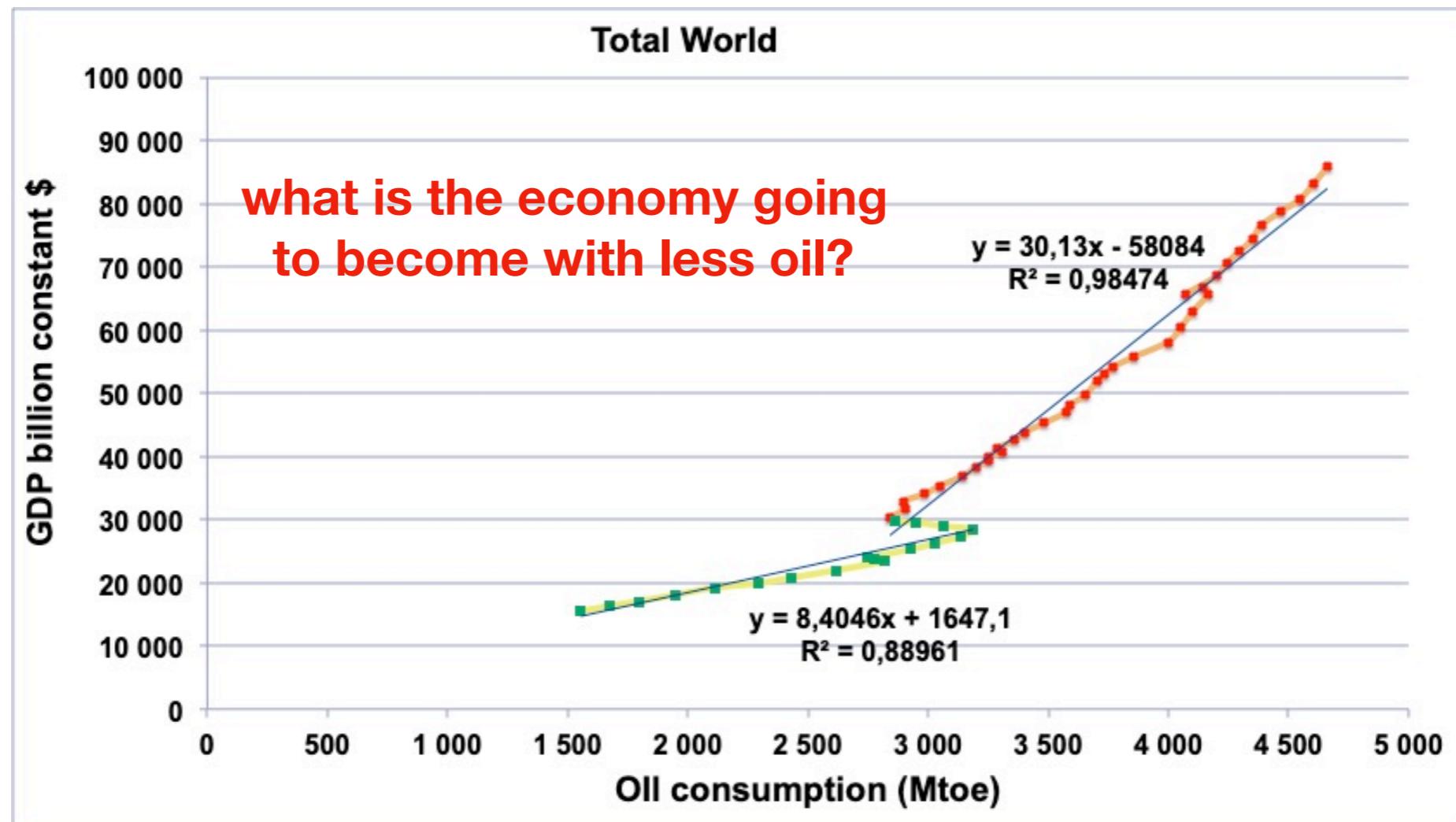
*Author's calculation on primary information coming from BP Statistical Review, 2015, and World Bank 2015 (GDP).*

<https://jancovici.com/en/energy-transition/energy-and-us/what-is-energy-actually/>

# Lecture 1

## Energy & oil & GDP

GDP per capita – world average – in constant 2012 dollars plotted against the world oil consumption in million tonnes oil equivalent, from 1965 to 2014.



*Author's calculation on primary information coming from BP statistical review & Shilling et al. (energy) and World Bank (GDP).*

<https://jancovici.com/en/energy-transition/energy-and-us/what-is-energy-actually/>

# Lecture 1

## Goals

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Sustainable development

Sustainable development goals

ENVT 3065 Sustainability Challenges's perimeter

Energy

**Rebound effect**

Challenges

# Lecture 1

## Rebound effect

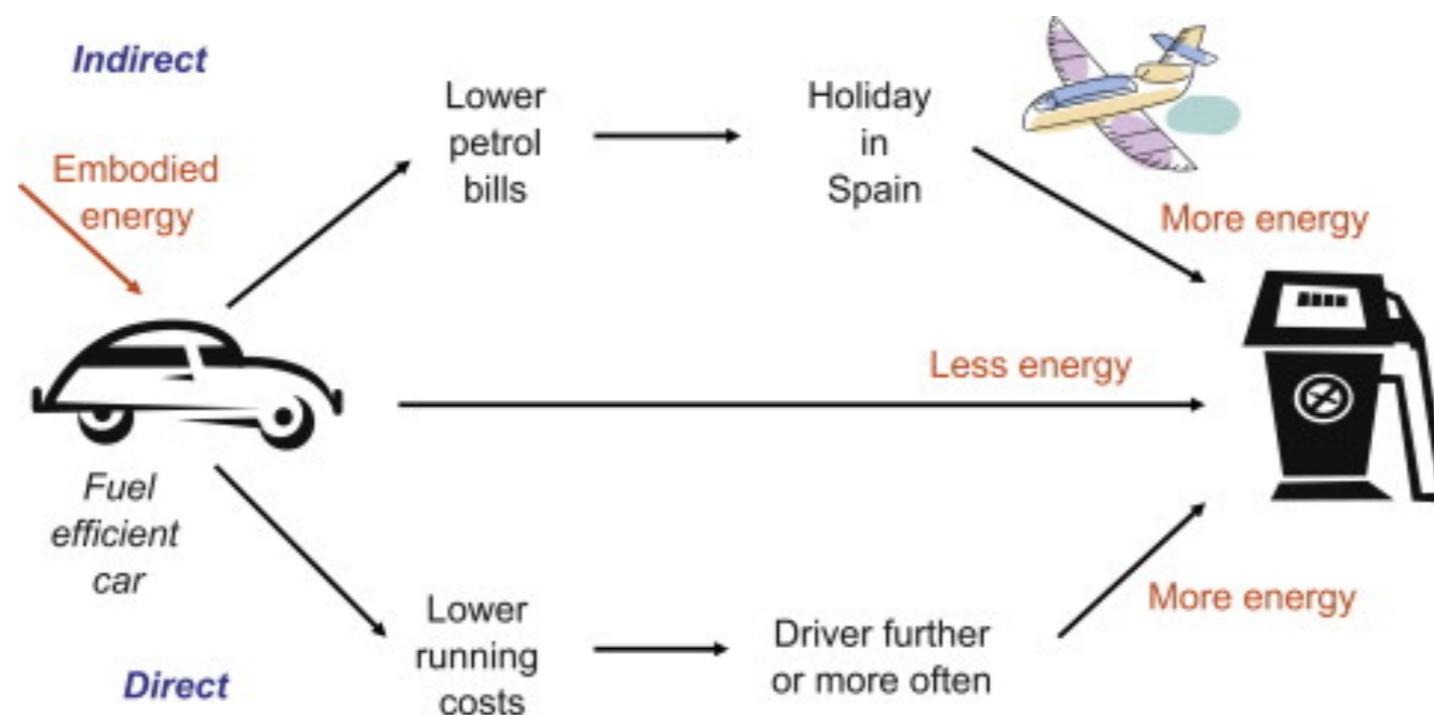
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Do you know what it is ?

# Lecture 1

## Rebound effect

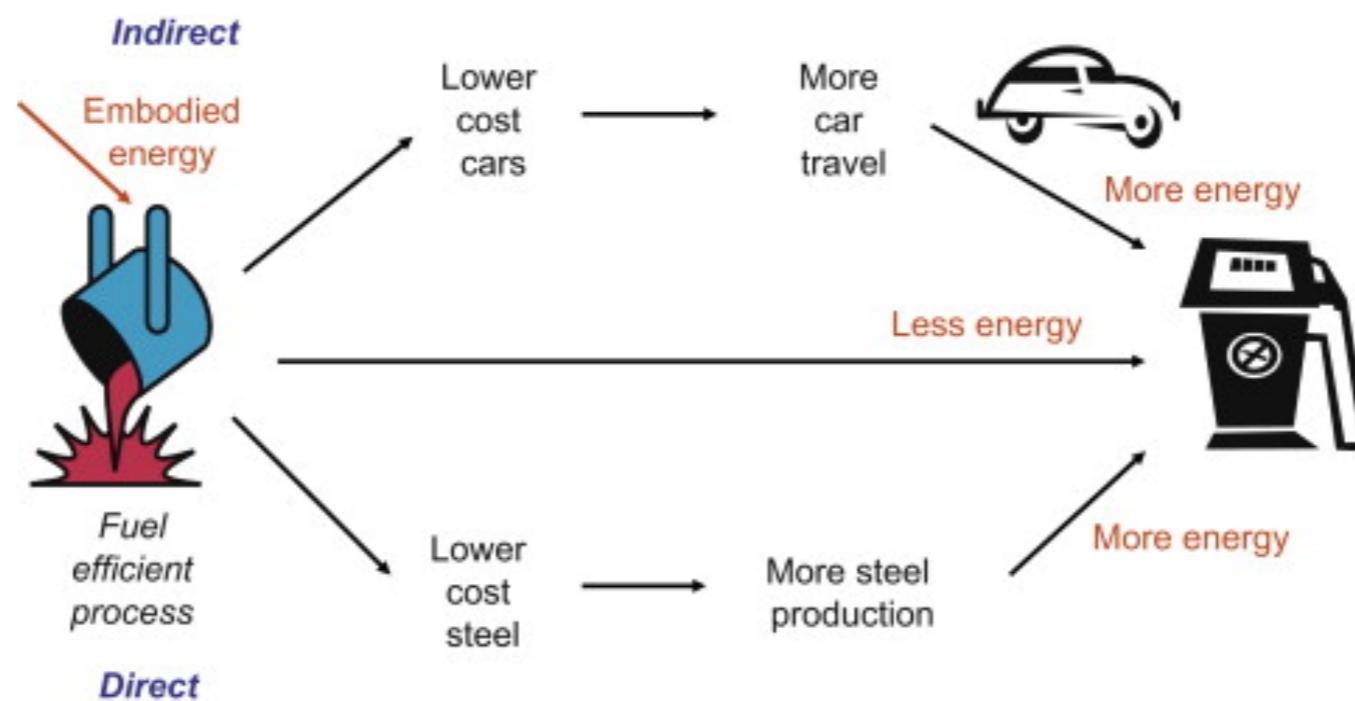
« While the evidence in favour of ‘Jevons Paradox’ is far from conclusive, it does suggest that **economy-wide rebound effects are larger than is conventionally assumed** and that energy plays a more important role in driving productivity improvements and economic growth than is conventionally assumed. »



Sorrell, Steve. "Jevons' Paradox revisited: The evidence for backfire from improved energy efficiency." *Energy policy* 37.4 (2009): 1456-1469.

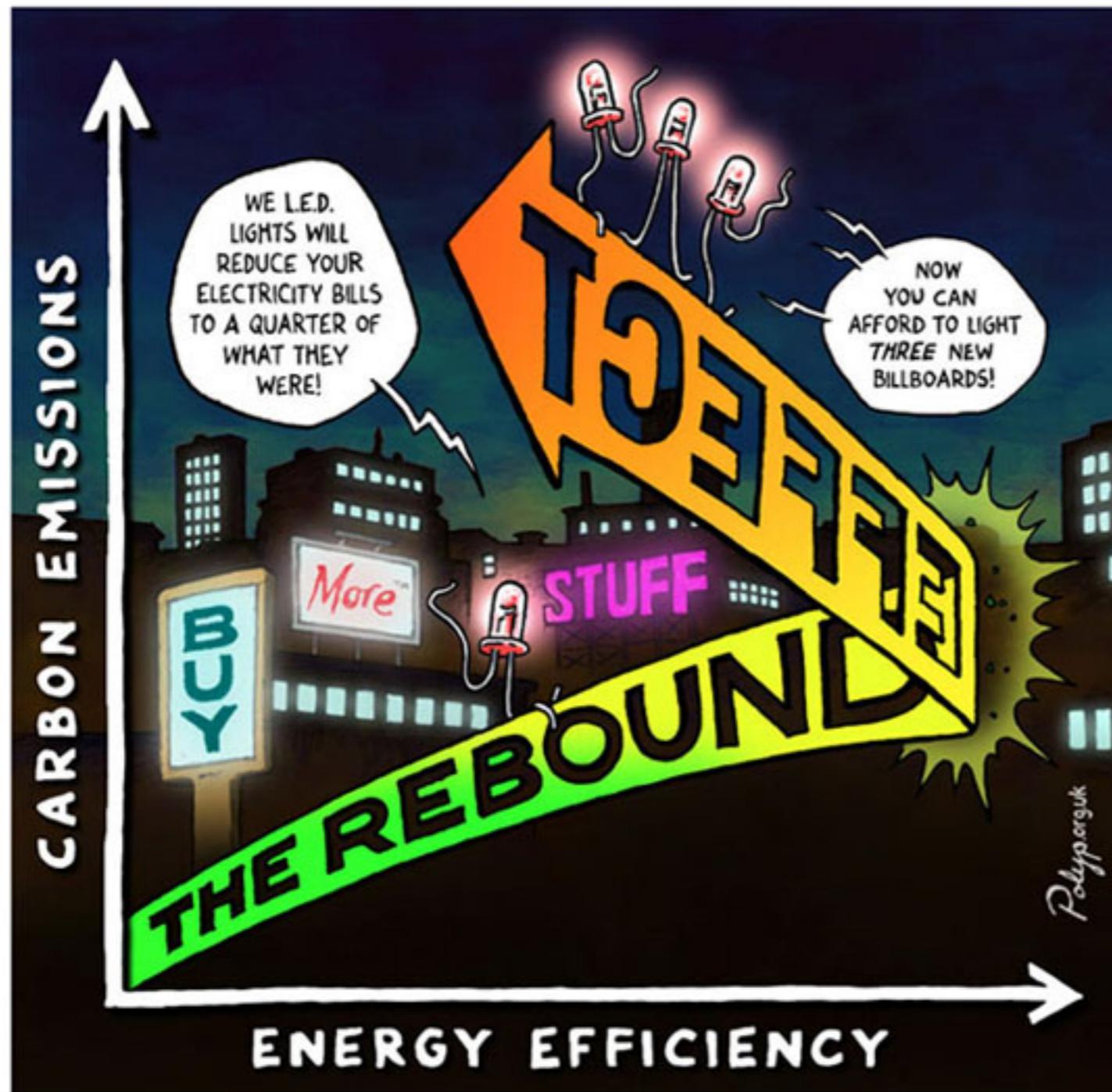
# Lecture 1

## Rebound effect



# Lecture 1

## Rebound effect



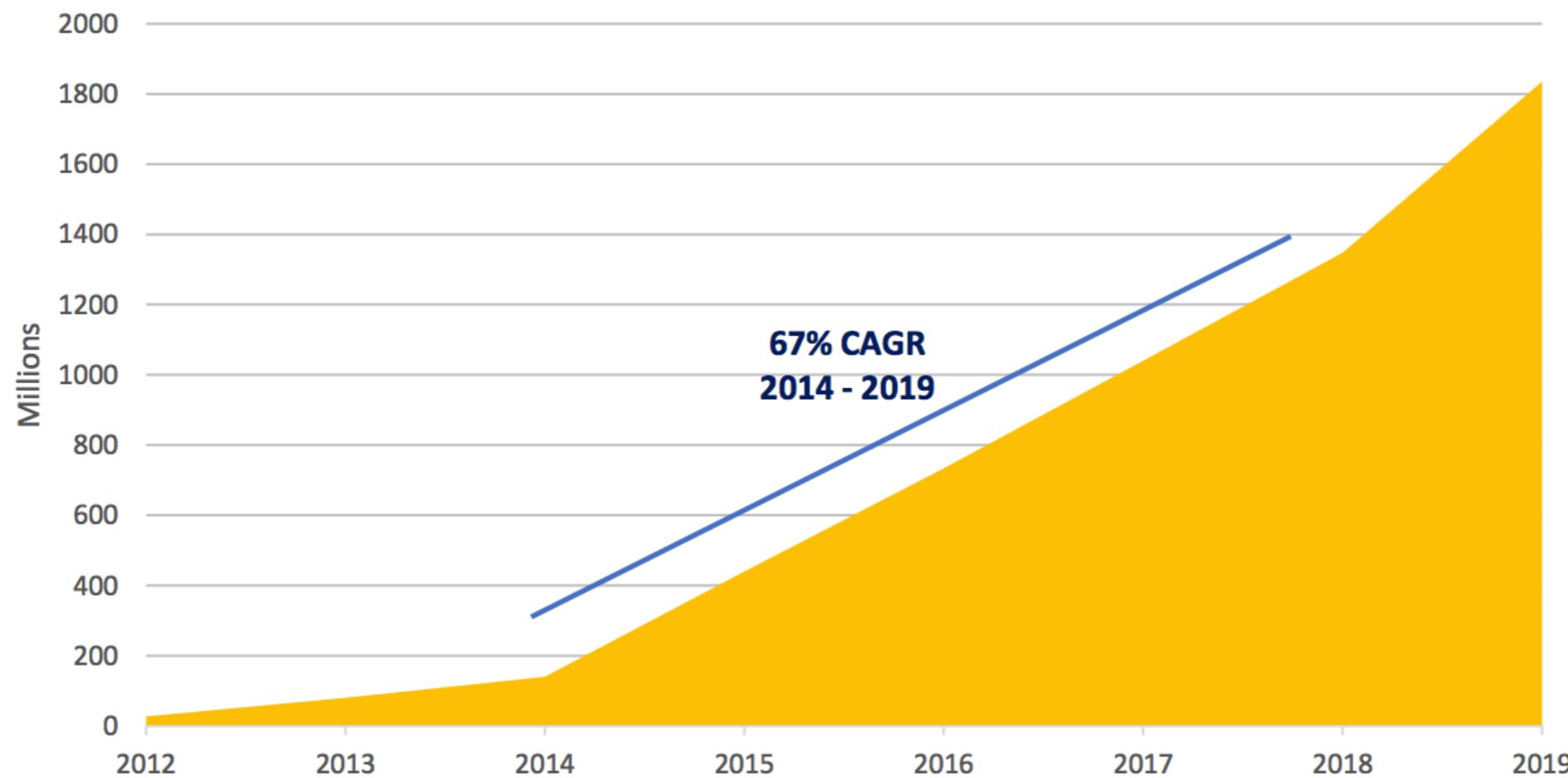
<https://www.thegwpf.com/green-madness-energy-efficient-led-lighting-increases-energy-consumption-light-pollution/>

# Lecture 1

## Rebound effect

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The multiplication of peripherals of daily life (or "**connected living**")



« New peripherals are appearing (bracelets measuring physical activity, portable Bluetooth speakers, etc.) and existing equipment in all households is becoming capable of communicating (televisions, refrigerators, coffee machines, alarm and monitoring systems, thermostats, lighting, etc.). »

<https://theshiftproject.org/en/article/lean-ict-our-new-report/>

# Lecture 1

## Rebound effect

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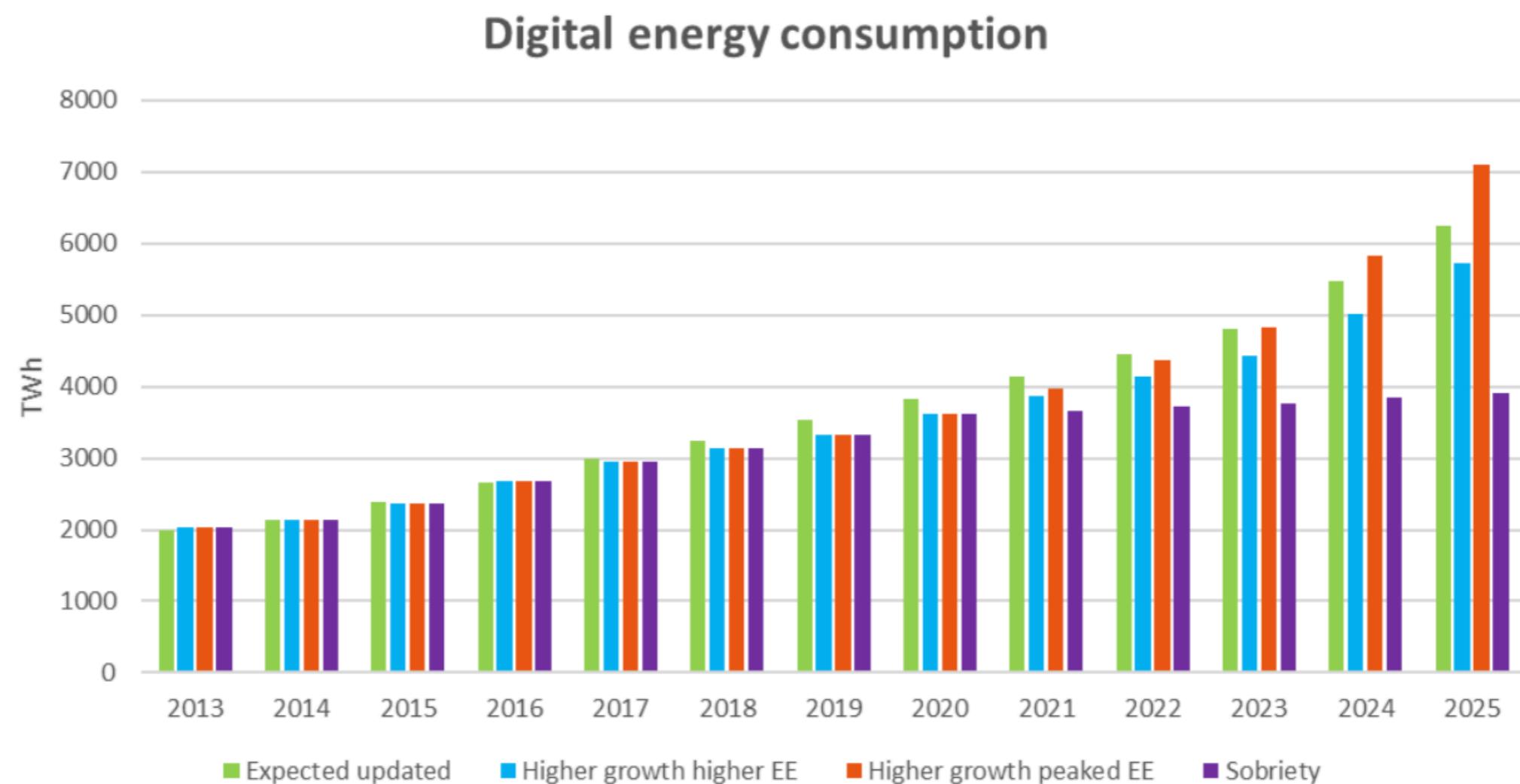
Digital devices in a household of 4 persons in an OECD country.

2012	2017	2022
2 smartphones	4 smartphones	4 smartphones
2 laptops/computers	2 laptops	2 laptops
1 tablet	2 tablets	2 tablets
1 DSL/Cable/Fibre/Wifi Modem	1 connected television	3 connected television
1 printer/scanner	2 connected set-top boxes	3 connected set-top boxes
1 game console	1 network attached storage	2 eReaders
	2 eReaders	1 printer/scanner
	1 printer/scanner	1 smart metre
	1 game console	3 connected stereo systems
	1 smart metre	1 digital camera
	2 connected stereo systems	1 energy consumption display
	1 energy consumption display	2 connected cars
	1 Internet connected car	7 smart light bulbs
	1 pair of connected sport shoes	3 connected sport devices
	1 pay as you drive device	5 internet connected power sockets
	1 network attached storage	1 weight scale
		1 eHealth device
		2 pay as you drive devices
		1 intelligent thermostat
		1 network attached storage
		4 home automation sensors

# Lecture 1

## Rebound effect

The share of digital technology in final energy consumption (growing by 1.5% per year) will have increased by **almost 70%** between 2013 and 2020.



<https://theshiftproject.org/en/article/lean-ict-our-new-report/>

# Lecture 1

## Rebound effect

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The gain of energy efficiency is not capable of compensating the exponential increase of numbers of digital devices.

<https://theshiftproject.org/en/article/lean-ict-our-new-report/>

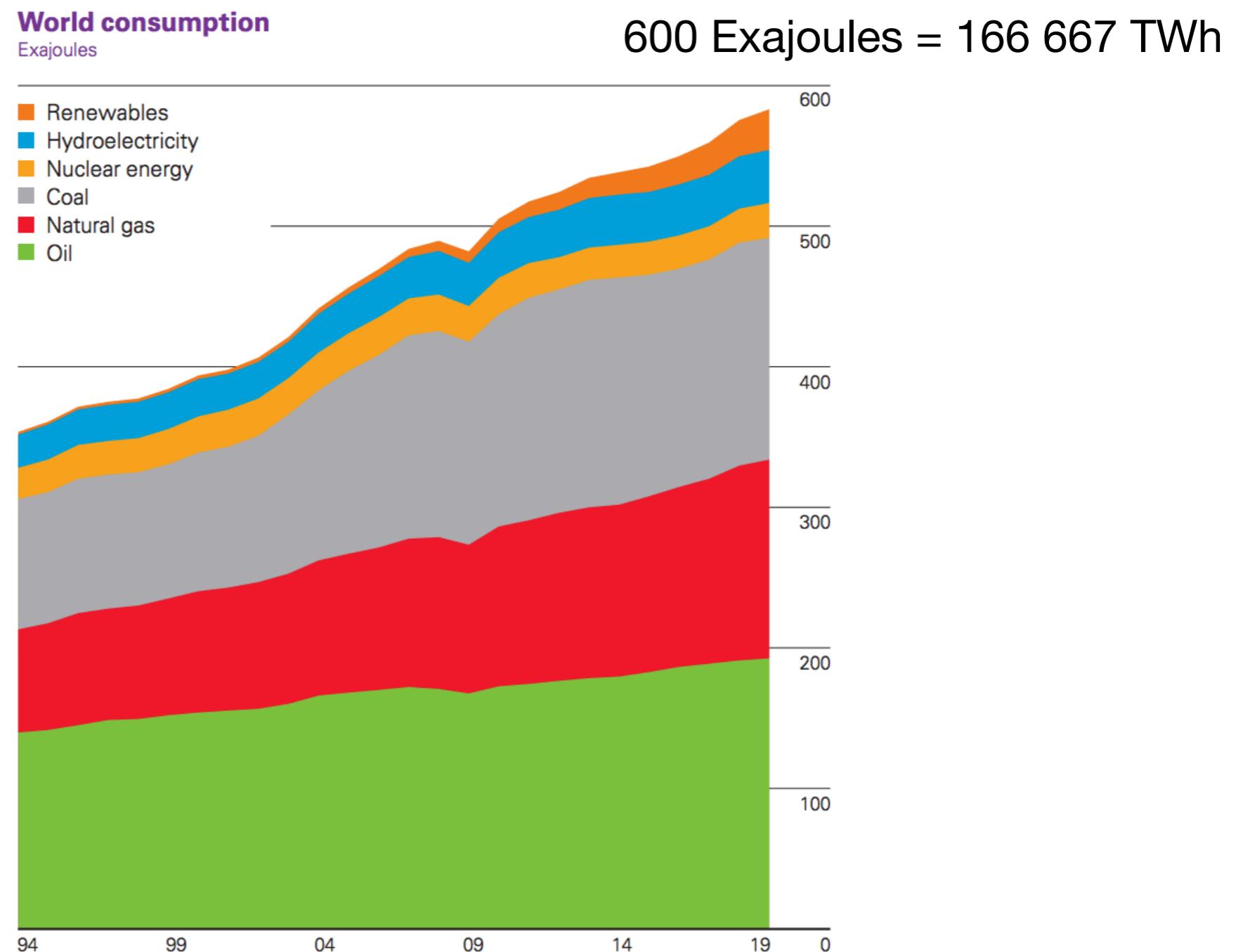
Same phenomenon for cars, etc.

# Lecture 1

## Rebound effect & energy

The energy consumption at the world scale keeps on increasing.

And **fossil fuels** are not decreasing ...



Credits: [bp Statistical Review of World Energy 2020](#)

# Lecture 1

## Rebound effect & 5G

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What do you think of 5G ?

TSP 5G report

# Lecture 1

## Goals

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Sustainable development

Sustainable development goals

ENVT 3065 Sustainability Challenges's perimeter

Energy

Rebound effect

**Challenges**

# Lecture 1

## Sustainability challenges

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**How to live x times better by using x times lesser resources?**

**How to get x times more meaning with x times less things?**

# Lecture 1

## Sustainability challenges

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**Will technology save us ?**

**Can technology save us ?**

**What do you think ?**

# Lecture 1

## Sustainability challenges

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**Let's question our imagination, our relationship to the world?**

Anthropocentrism



Biocentrism

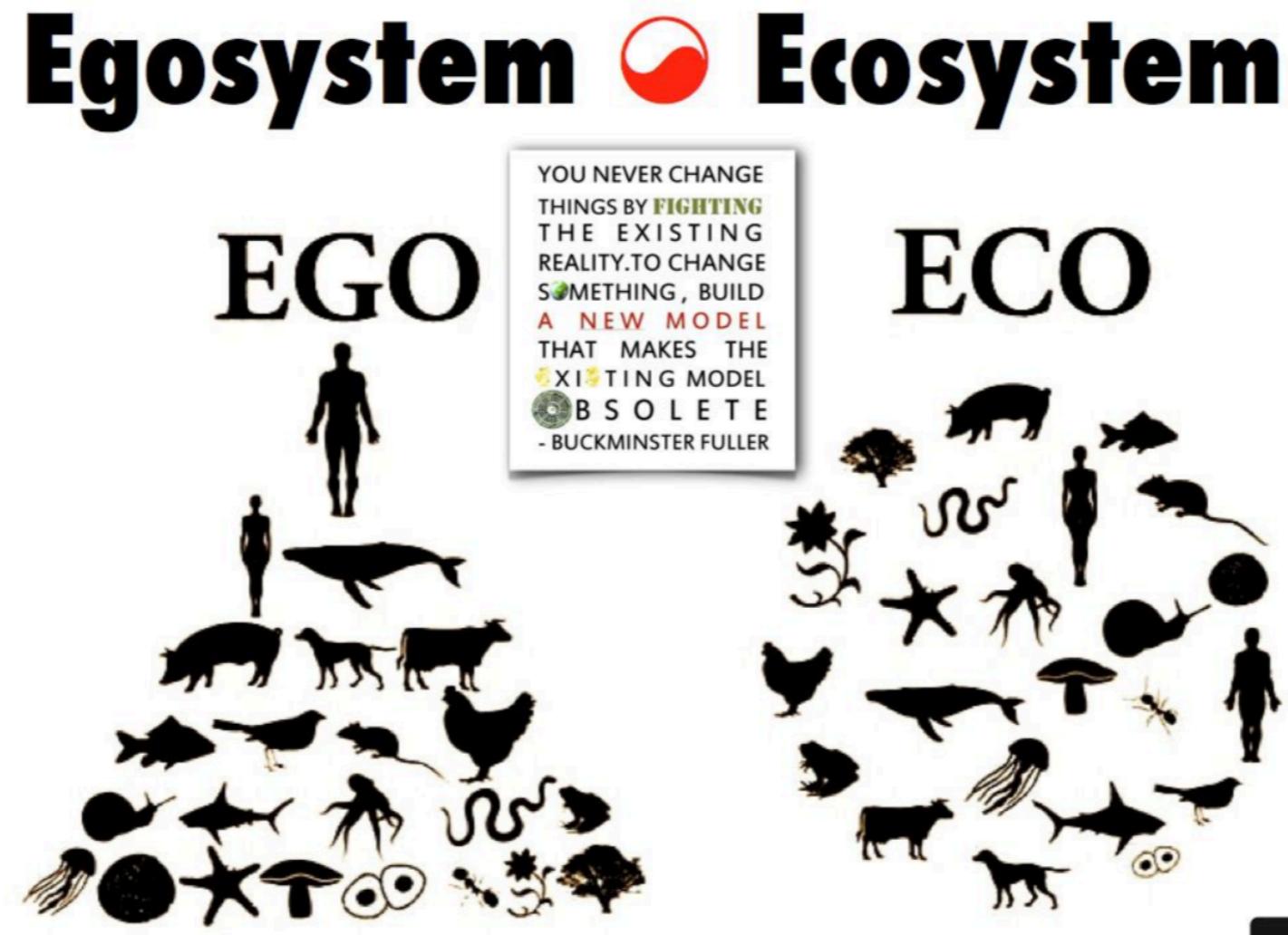


Credits: Sustainable development & Transition UCL LEPL 1804

# Lecture 1

## Sustainability challenges

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Credits: Sustainable development & Transition UCL LEPL 1804

# Lecture 1

## Sustainability challenges

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### The need to re-invent ourselves

- Global, holistic, systemic approach
- Thinking at the same time: technical, economic, responsibility, consequences (environmental, social),... Think with limits!
- Evaluate all the costs of innovation!
- Where are the winners, where are the losers?
- Importance of the collective, working together
- Collaboration vs Competition
- New instruments, new units, new criteria of success, of excellence, of well-being
- Transition to appropriate technologies - responding to needs, responding to a common vision of society - Human-centered innovations

# Lecture 1

## Sustainability challenges

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### Transition to appropriate technologies

- Need for decision support tools - Life Cycle Assessment (LCA) Granta, GaBI, SimaPro, Umberto, OpenLCA,...
- Circular economy with recycling as a last resort
- Eco-design, modular design,... with a view to repair, re-use,... (the 11 Rs)
- Fight against programmed obsolescence
- Anticipate the rebound effects (3-level environment impacts concept framework)
- The economy of functionality
- Legislation as a lever for change

# Lecture 1

## Conclusions

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Sustainable development

Sustainable development goals

ENVT 3065 Sustainability Challenges's perimeter

Energy

Rebound effect

Challenges

# Lecture 1

## Course perimeter



## SUSTAINABLE DEVELOPMENT GOALS



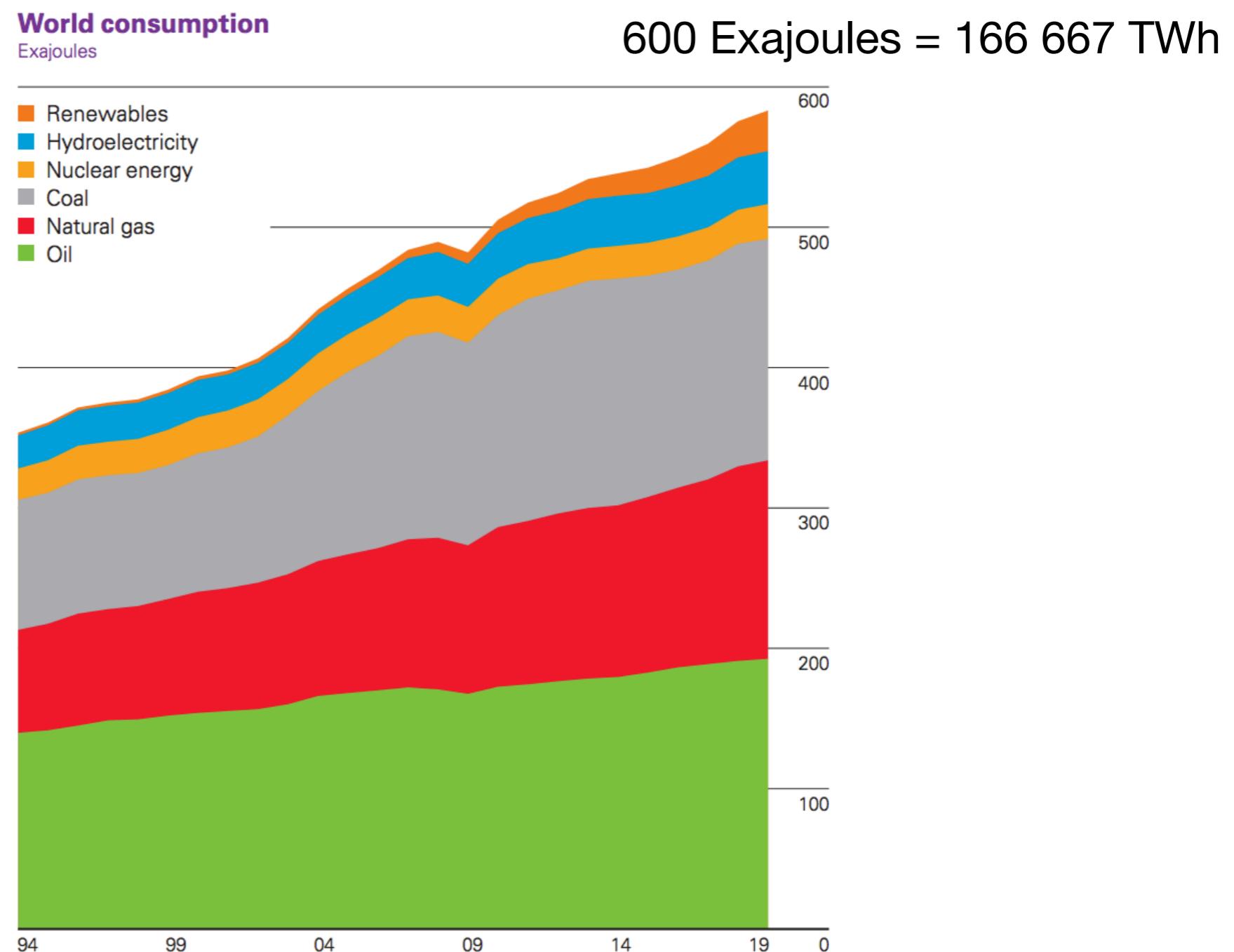
<https://www.un.org/sustainabledevelopment/news/communications-material/>

# Lecture 1

## Rebound effect & energy

The energy consumption at the world scale keeps on increasing.

And **fossil fuels** are not decreasing ...



Credits: [bp Statistical Review of World Energy 2020](#)

# Lecture 1

## Course map

