

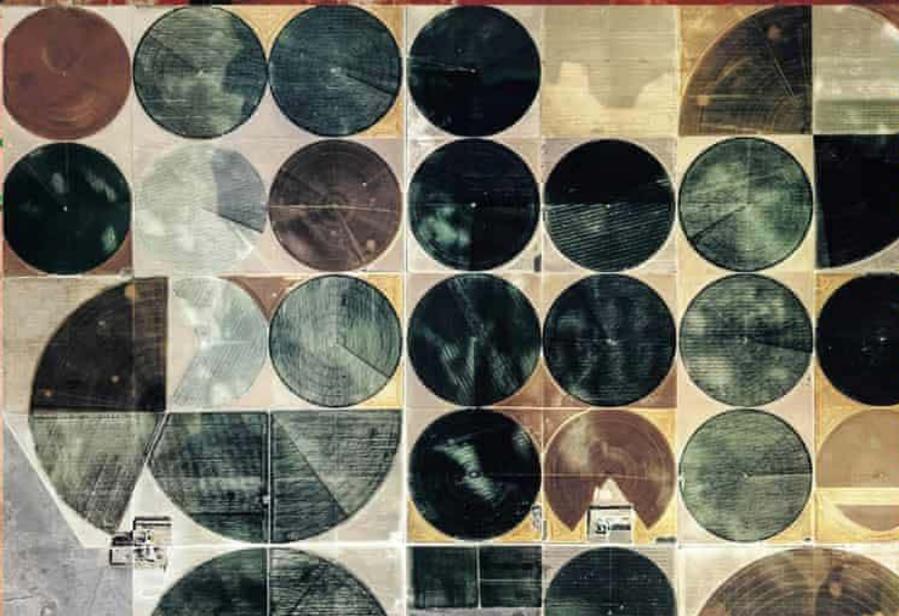
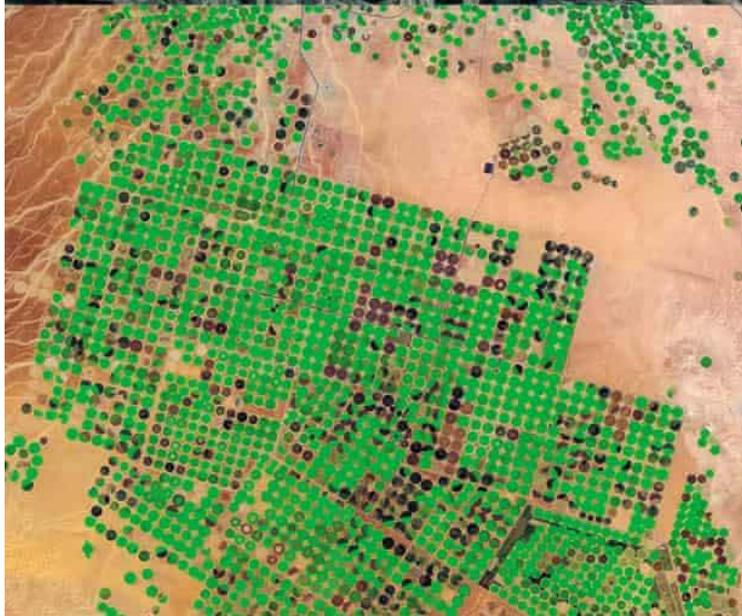
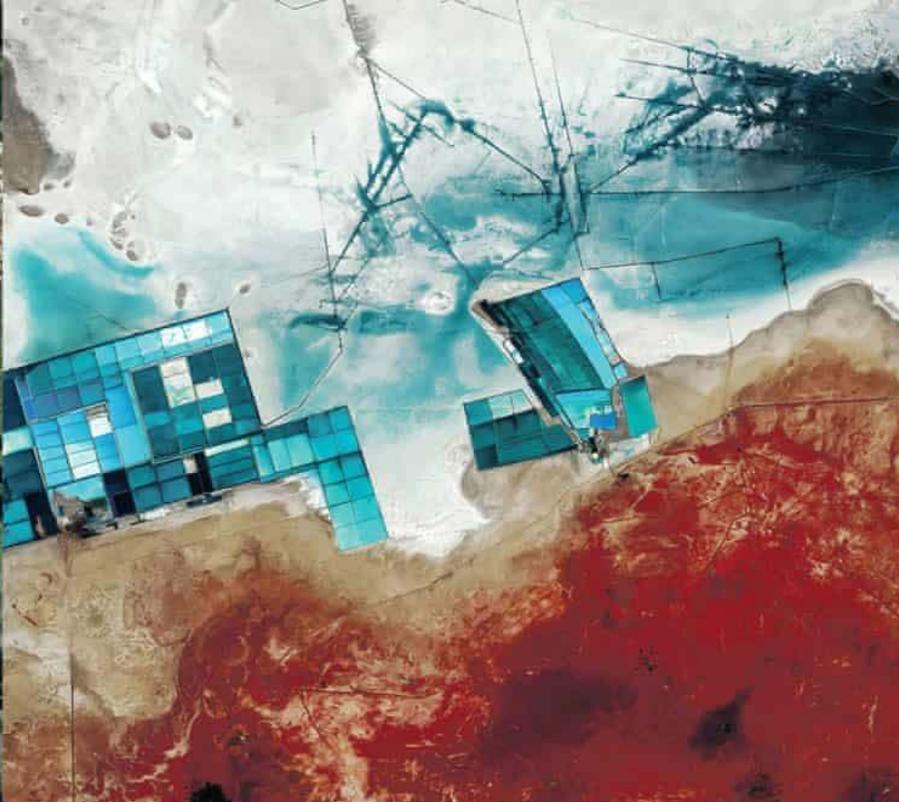
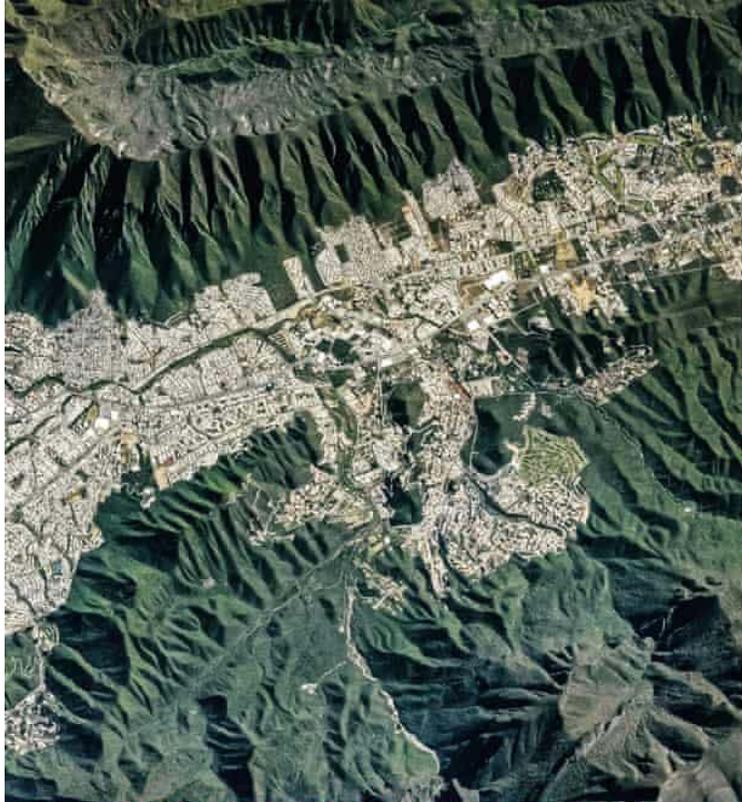
# **Ecological economics and sustainable growth**

Sigrid Stagl

3 June 2019, OeNB

Session 2 - Green growth in CESEE – opportunities and obstacles

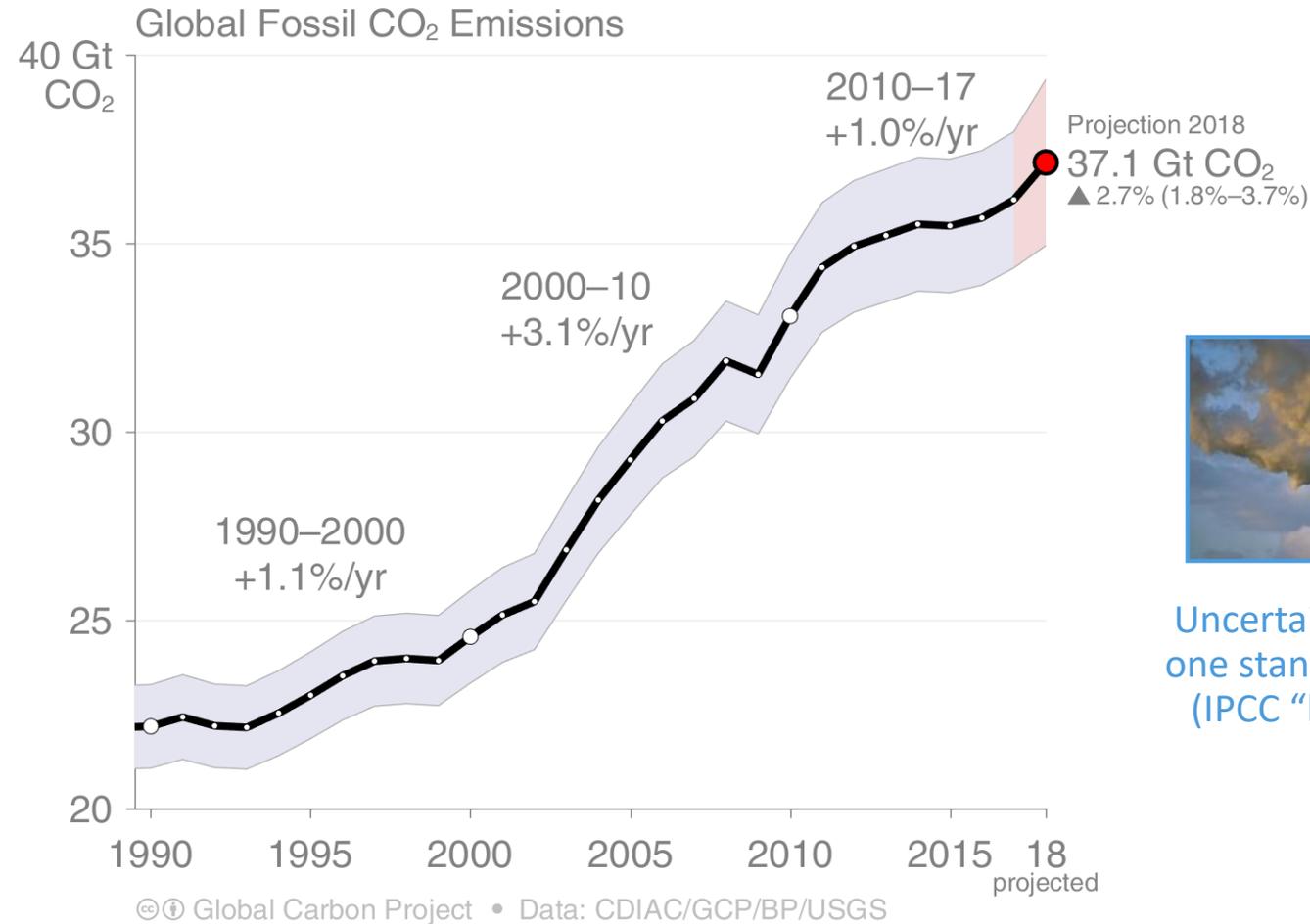
The 84th East Jour Fixe focuses on “Long-run economic growth and development in Central, Eastern and Southeastern Europe (CESEE)”, a very timely topic, given that a lot of uncertainty surrounds the medium- to long-term growth outlook for the CESEE region.



# Global Fossil CO<sub>2</sub> Emissions

Global fossil CO<sub>2</sub> emissions: 36.2 ± 2 GtCO<sub>2</sub> in 2017, 63% over 1990

- Projection for 2018: 37.1 ± 2 GtCO<sub>2</sub>, 2.7% higher than 2017 (range 1.8% to 3.7%)



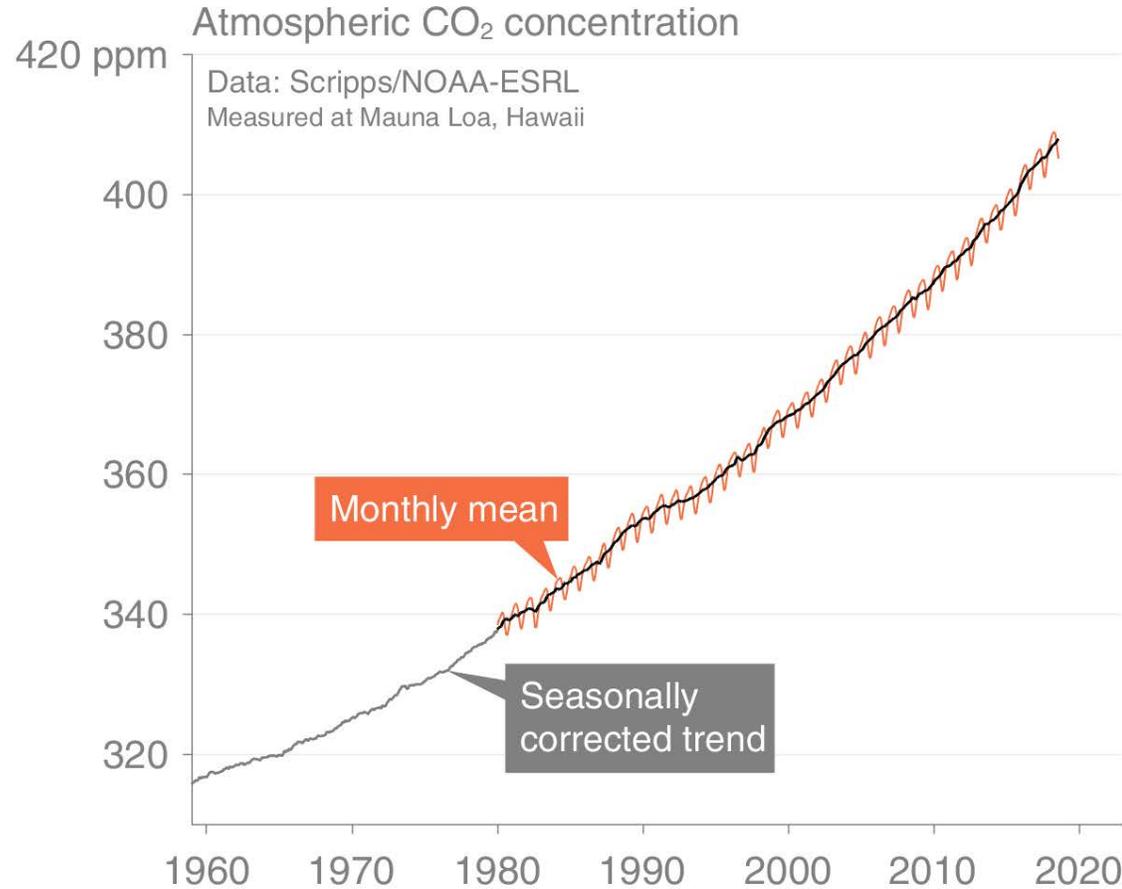
Uncertainty is ±5% for one standard deviation (IPCC “likely” range)

Estimates for 2015, 2016 and 2017 are preliminary; 2018 is a projection based on partial data.

Source: [CDIAC](#); [Le Quéré et al 2018](#); [Global Carbon Budget 2018](#)

# Atmospheric concentration

The global CO<sub>2</sub> concentration increased from ~277ppm in 1750 to 405ppm in 2017 (up 46%)  
 2016 was the first full year with concentration above 400ppm

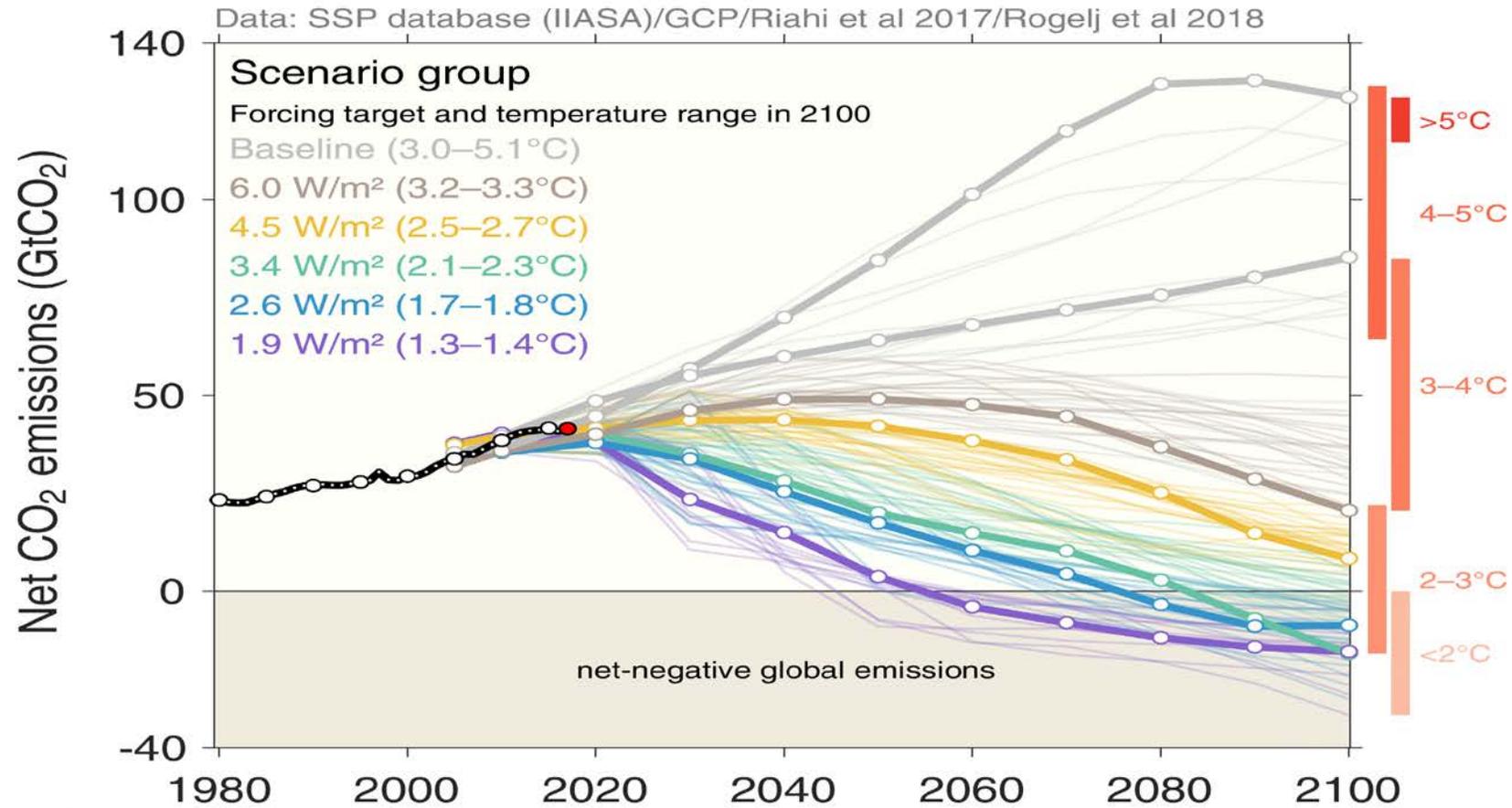


© Global Carbon Project

Globally averaged surface atmospheric CO<sub>2</sub> concentration. Data from: NOAA-ESRL after 1980; the Scripps Institution of Oceanography before 1980 (harmonised to recent data by adding 0.542ppm)  
 Source: [NOAA-ESRL](#); [Scripps Institution of Oceanography](#); [Le Quéré et al 2018](#); [Global Carbon Budget 2018](#)

# Shared Socioeconomic Pathways (SSPs)

The Shared Socioeconomic Pathways (SSPs) lead to a broad range in baselines (grey), with more aggressive mitigation leading to lower temperature outcomes (grouped by colours)

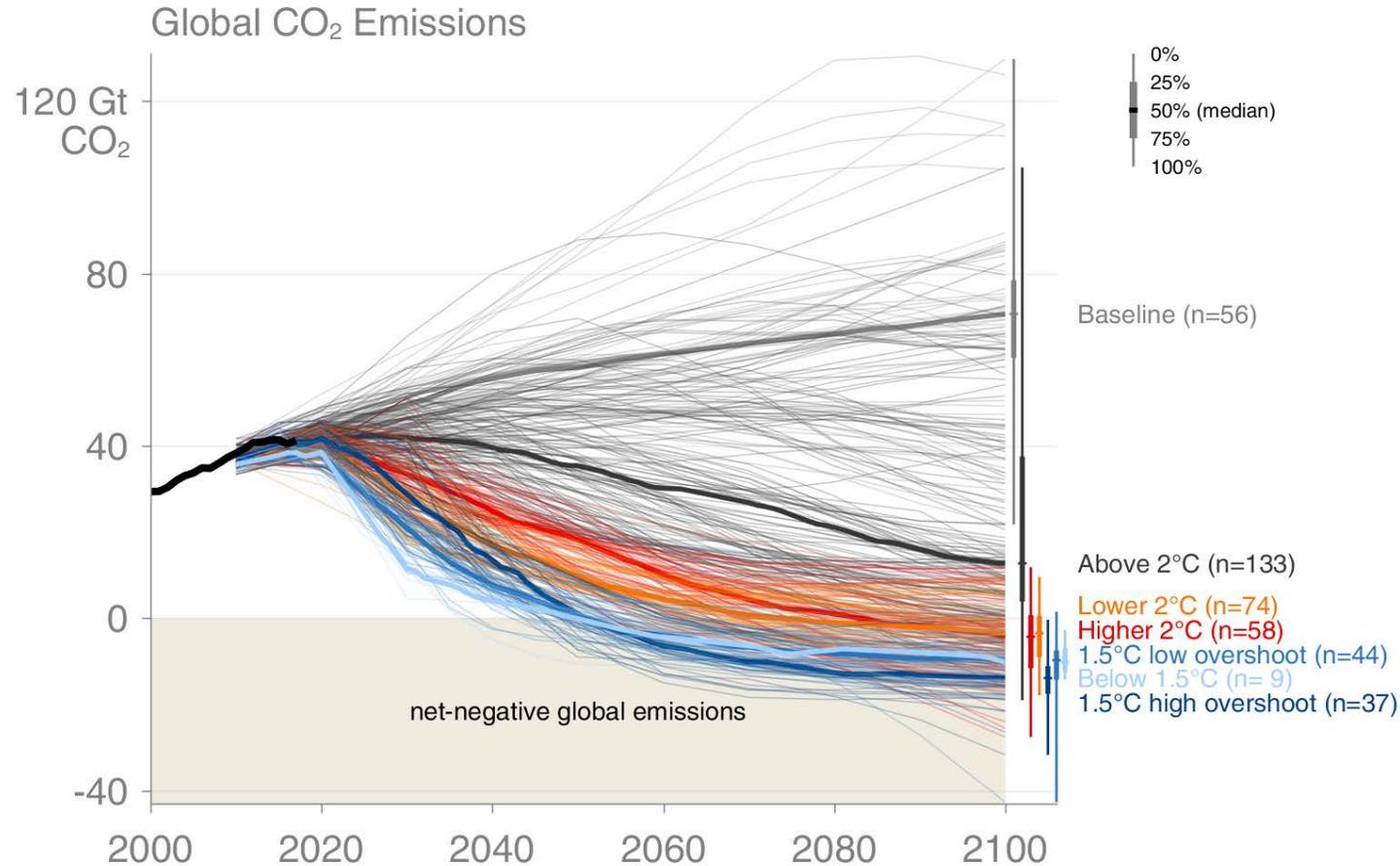


This set of quantified SSPs are based on the output of six Integrated Assessment Models (AIM/CGE, GCAM, IMAGE, MESSAGE, REMIND, WITCH). Net emissions include those from land-use change and bioenergy with CCS.

Source: [Riahi et al. 2016](#); [Rogelj et al. 2018](#); [IIASA SSP Database](#); [IAMC](#); [Global Carbon Budget 2018](#)

# The IPCC Special Report on “Global Warming of 1.5°C”

The IPCC Special Report on “Global Warming of 1.5°C” presented new scenarios: 1.5°C scenarios require halving emissions by ~2030, net-zero by ~2050, and negative thereafter



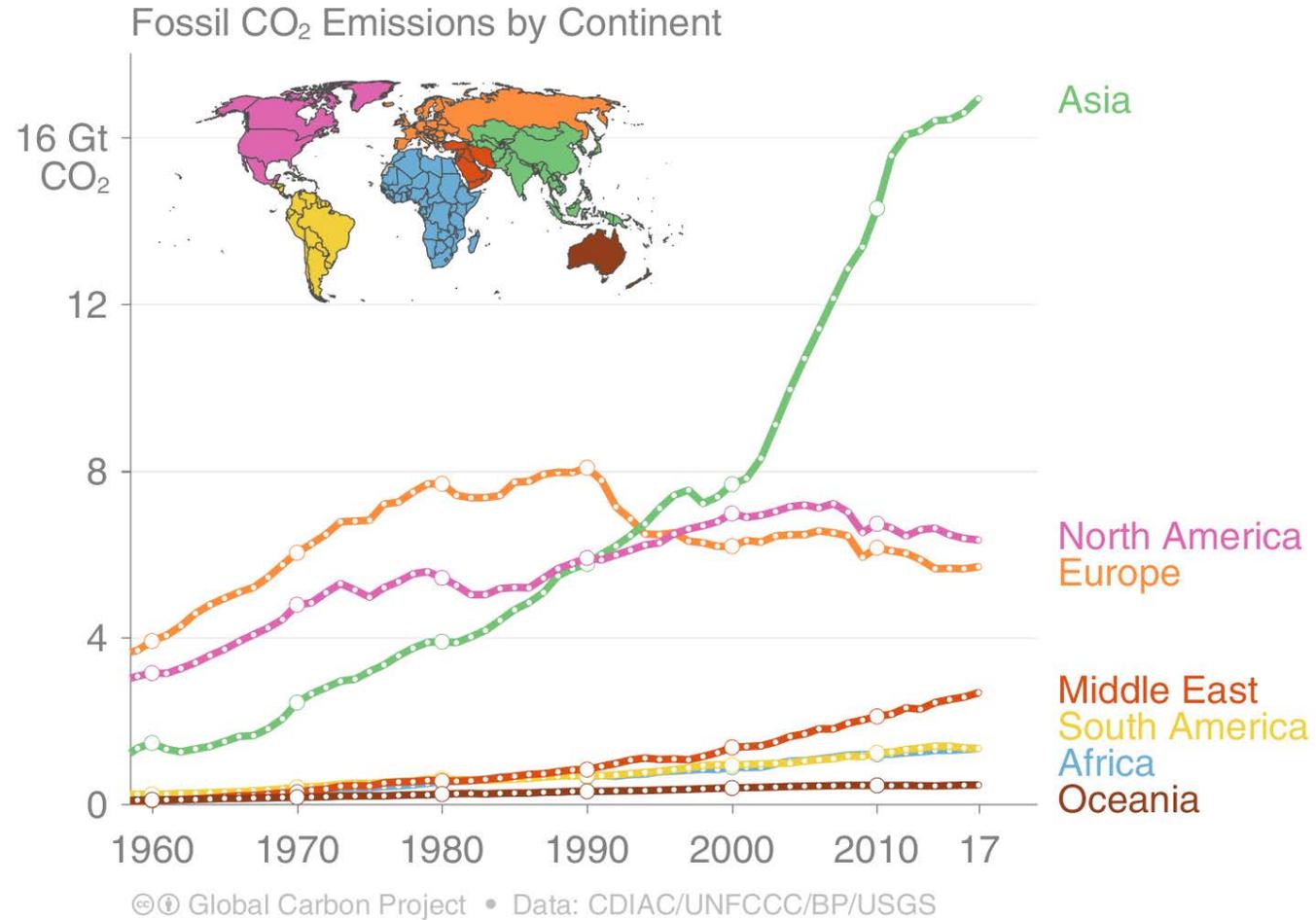
© Global Carbon Project • Data: IAMC 1.5°C Scenario Explorer (hosted by IIASA)

Net emissions include those from land-use change and bioenergy with CCS.

Source: [Huppmann et al 2018](#); [IAMC 1.5C Scenario Database](#); [IPCC SR15](#); [Global Carbon Budget 2018](#)

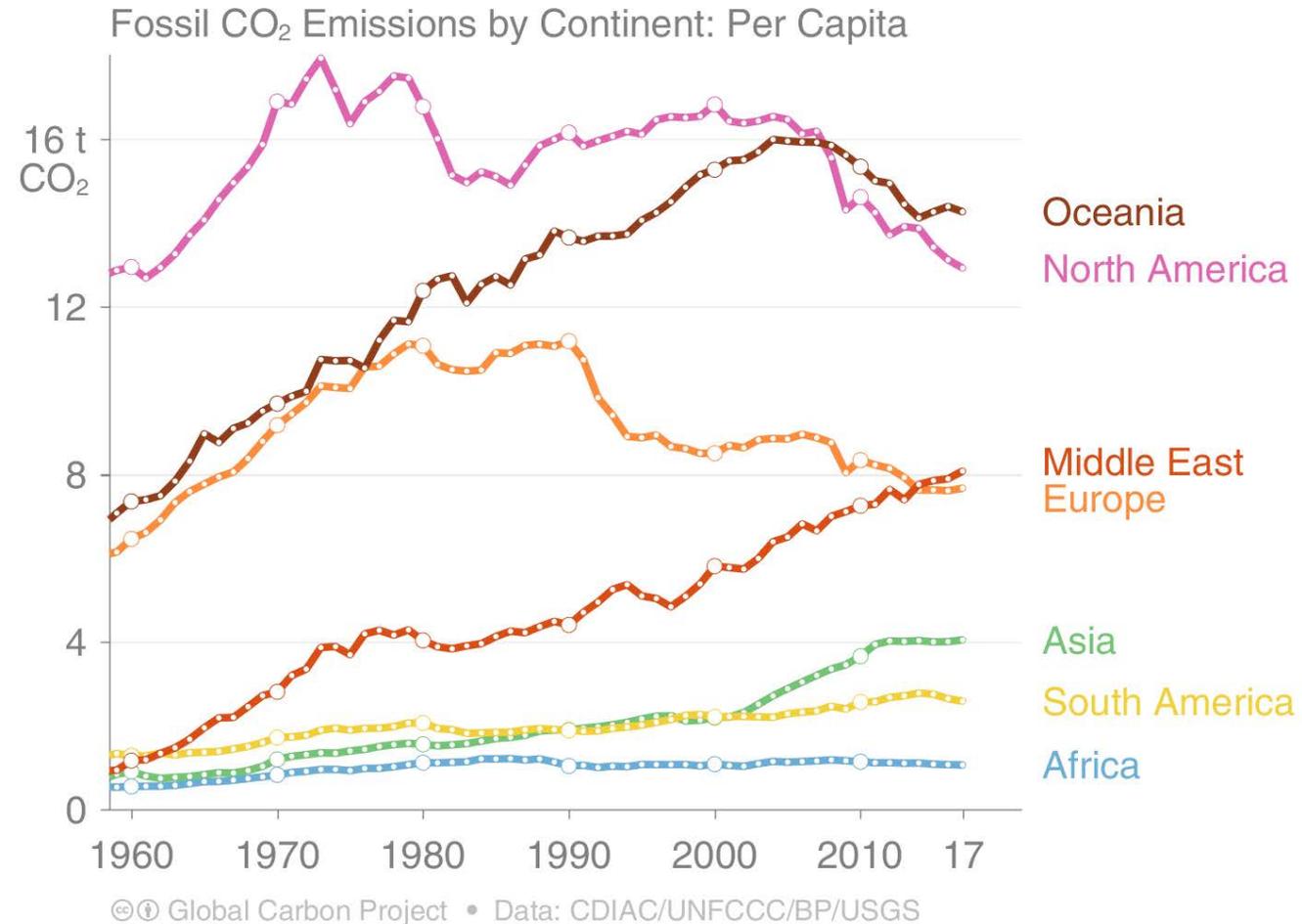
# Fossil CO<sub>2</sub> emissions by continent

Asia dominates global fossil CO<sub>2</sub> emissions, while emissions in North America are of similar size to those in Europe, and the Middle East is growing rapidly.



# Fossil CO<sub>2</sub> emissions by continent: per capita

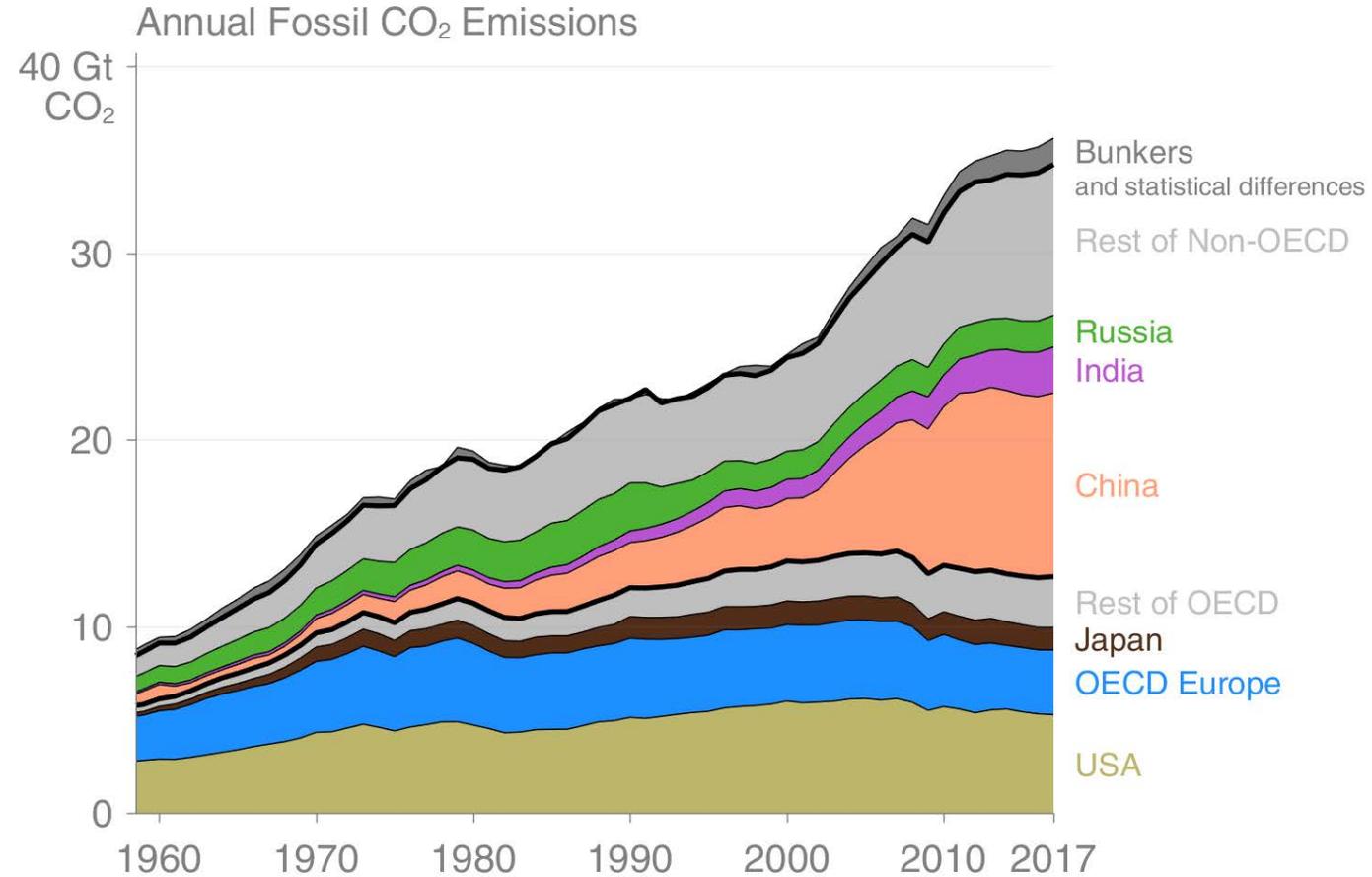
Oceania and North America have the highest per capita emissions, while the Middle East has recently overtaken Europe. Africa has by far the lowest emissions per capita.



The global average was 4.8 tonnes per capita in 2017.  
 Source: [CDIAC](#); [Le Quéré et al 2018](#); [Global Carbon Budget 2018](#)

# Breakdown of global fossil CO<sub>2</sub> emissions by country

Emissions in OECD countries have increased by 5% since 1990, while those in non-OECD countries have more than doubled

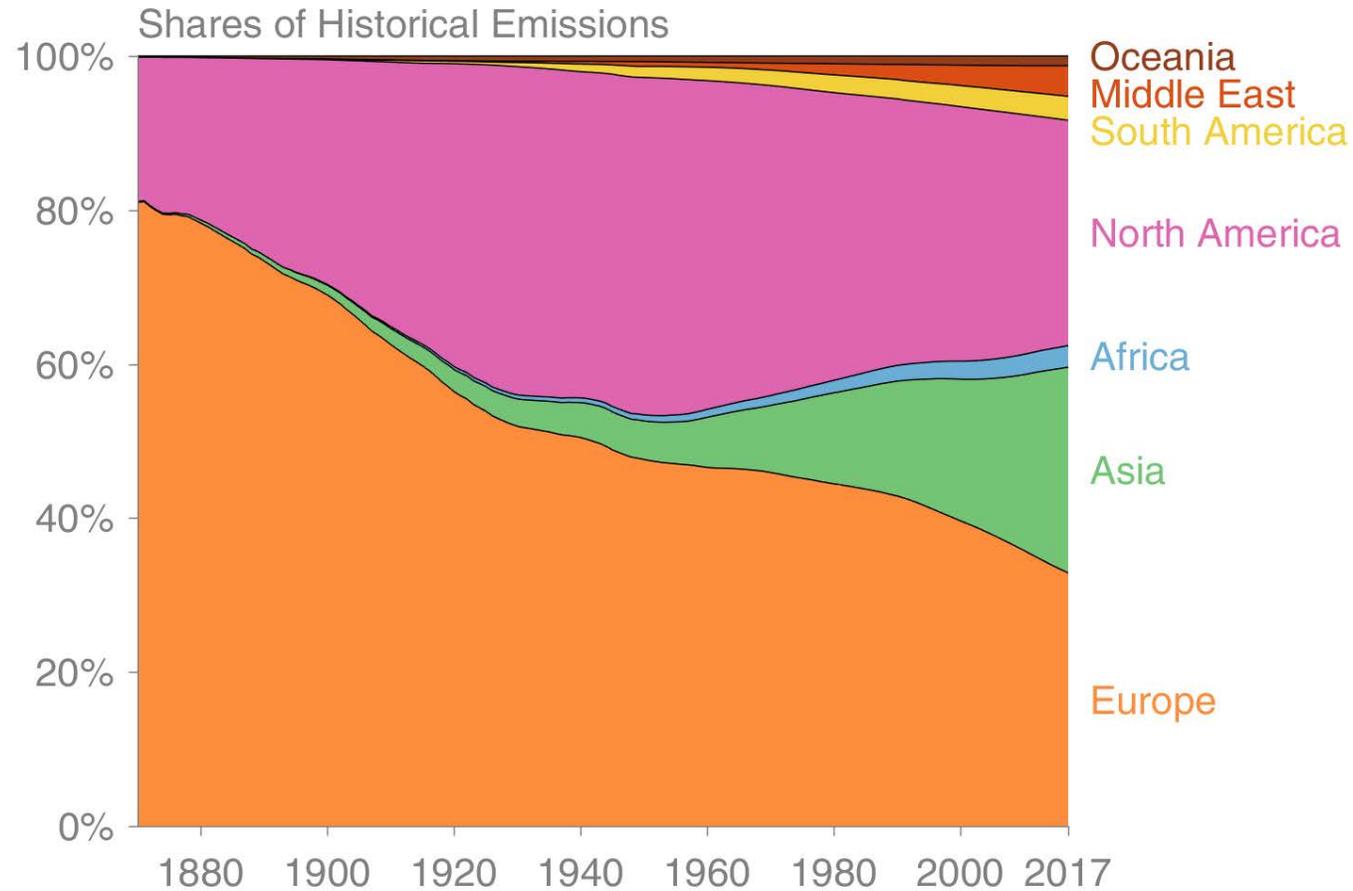


© Global Carbon Project • Data: CDIAC/UNFCCC/BP/USGS

Source: [CDIAC](#); [Le Quéré et al 2018](#); [Global Carbon Budget 2018](#)

# Historical cumulative emissions by continent

Cumulative fossil CO<sub>2</sub> emissions (1870–2017). North America and Europe have contributed the most cumulative emissions, but Asia is growing fast

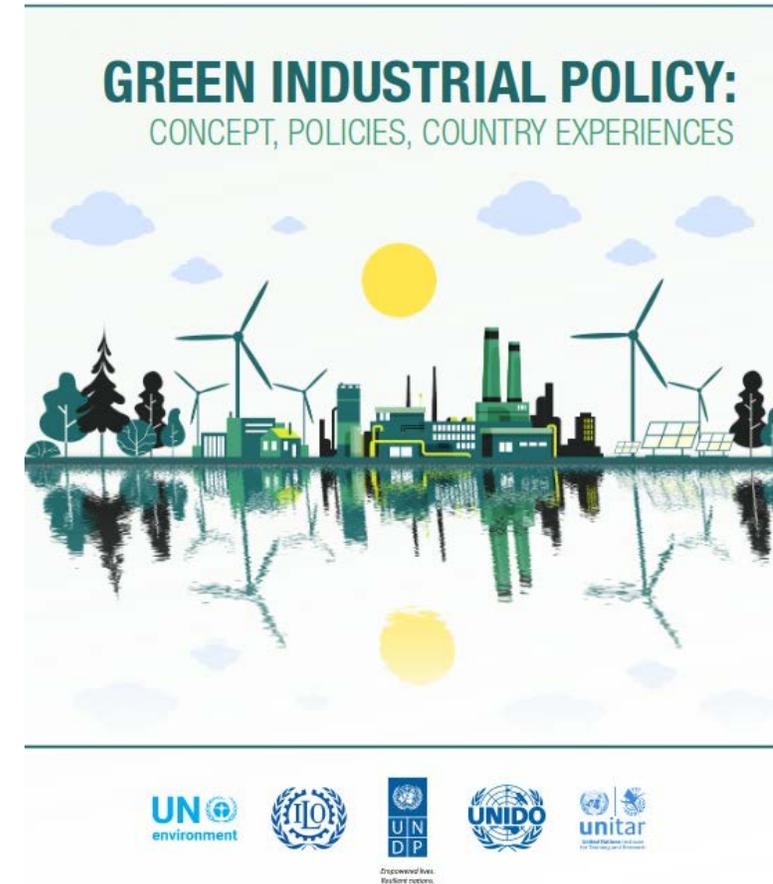


© Global Carbon Project • Data: CDIAC/UNFCCC/BP/USGS

The figure excludes bunker fuels and statistical differences  
 Source: [CDIAC](#); [Le Quéré et al 2018](#); [Global Carbon Budget 2018](#)

# Green Growth

- OECD: Green Growth Strategy & Indicators
- IEA: Ensuring Green Growth in a Time of Economic Crisis
- UNEP: accelerating structural change toward a green economy
- WEF-BCG study: some of the best emerging-world companies are combining profits with greenery

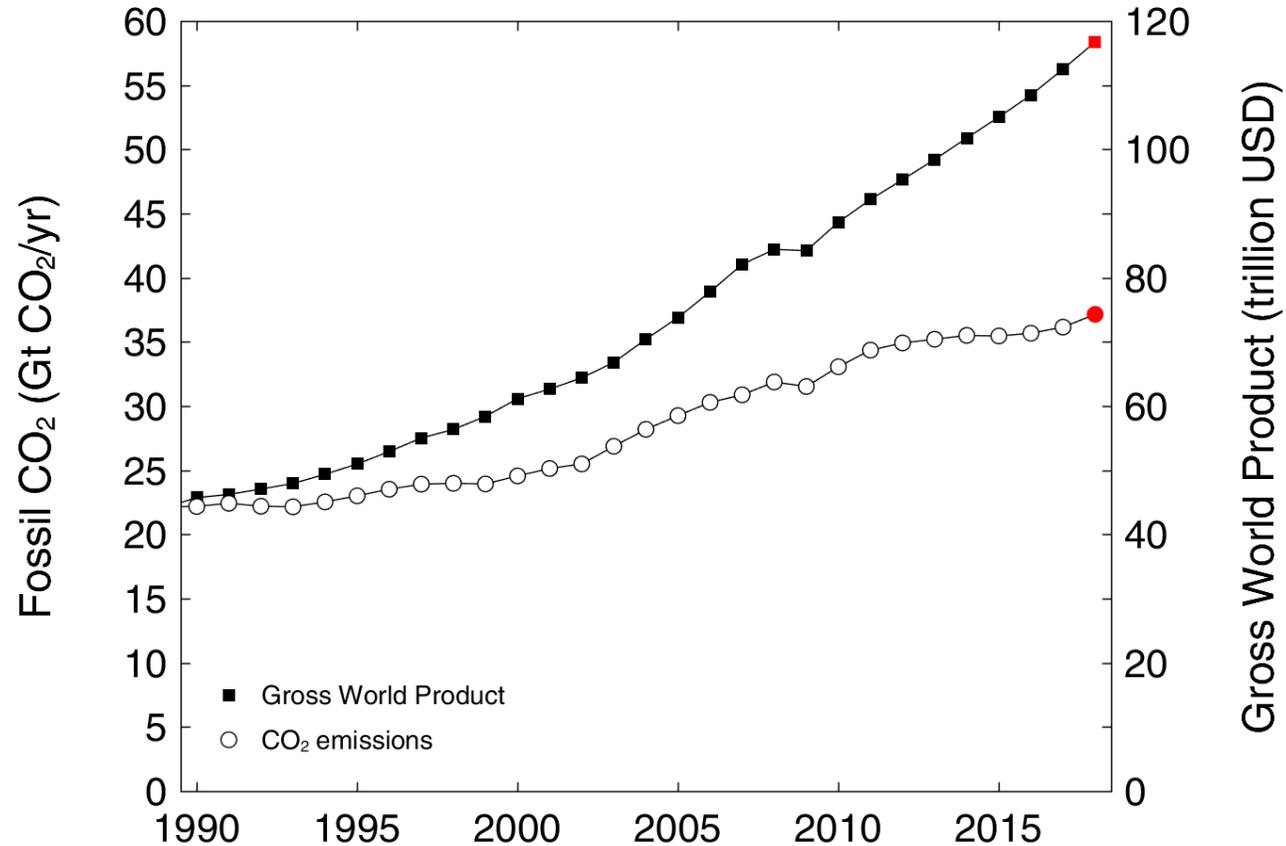


# UNEP: Green Economy

- Increase in **green investment**
- Increase in quantity & quality of jobs in **green sectors**
- Increase in share of **green sectors** in GDP
- Decrease in energy/resource use per unit of production
- Decrease in CO<sub>2</sub> and pollution level/GDP
- Decrease in wasteful consumption

# CO<sub>2</sub> emissions and economic activity

The global economy continues to grow faster than emissions. A step change is needed in emission intensity improvements to drive emissions down.



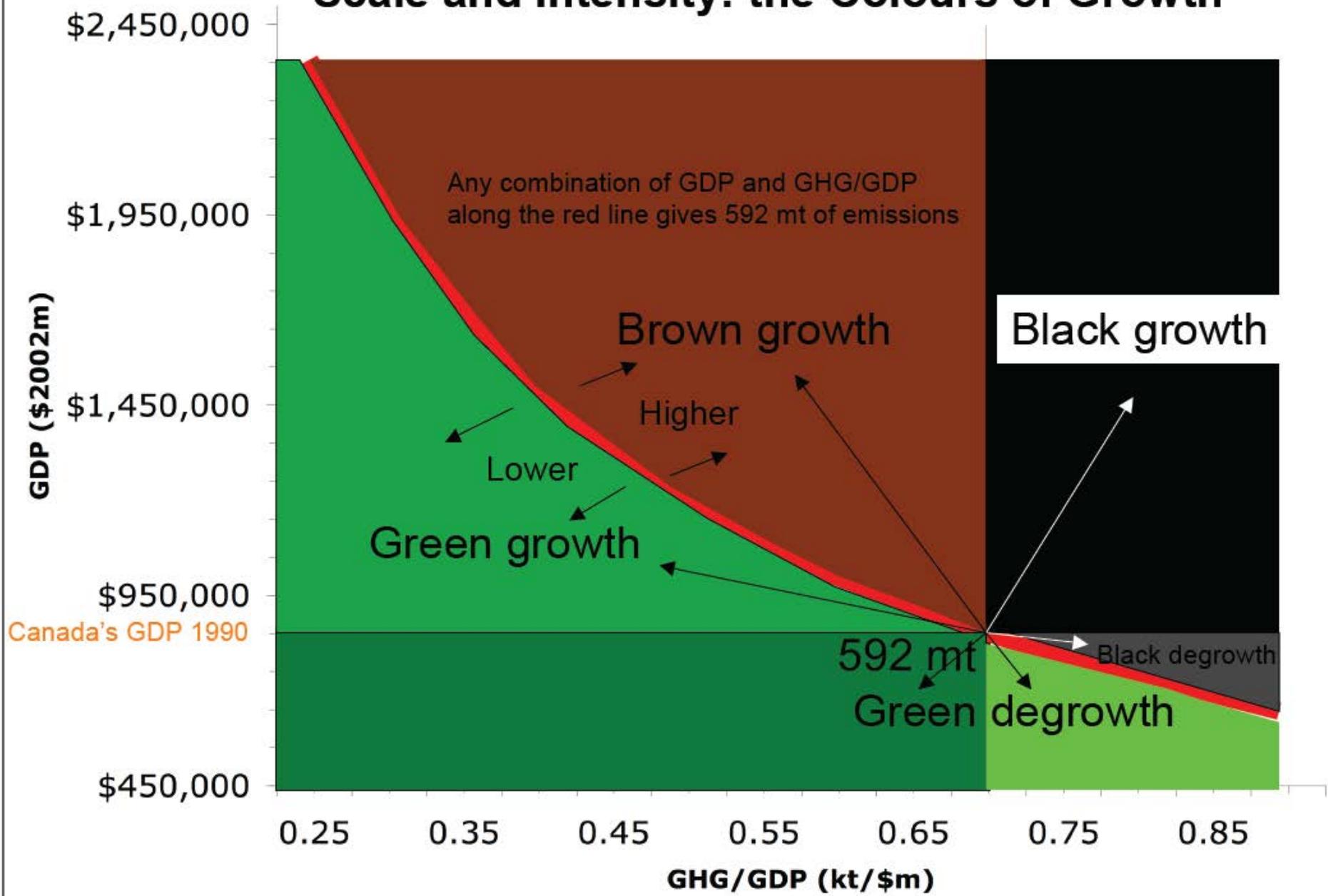
$$\text{CO}_2 = \text{CO}_2 \text{ intensity} \times \text{GDP}$$

Source: [Jackson et al 2018](#); [Global Carbon Budget 2018](#)

# Green growth = Selective growth

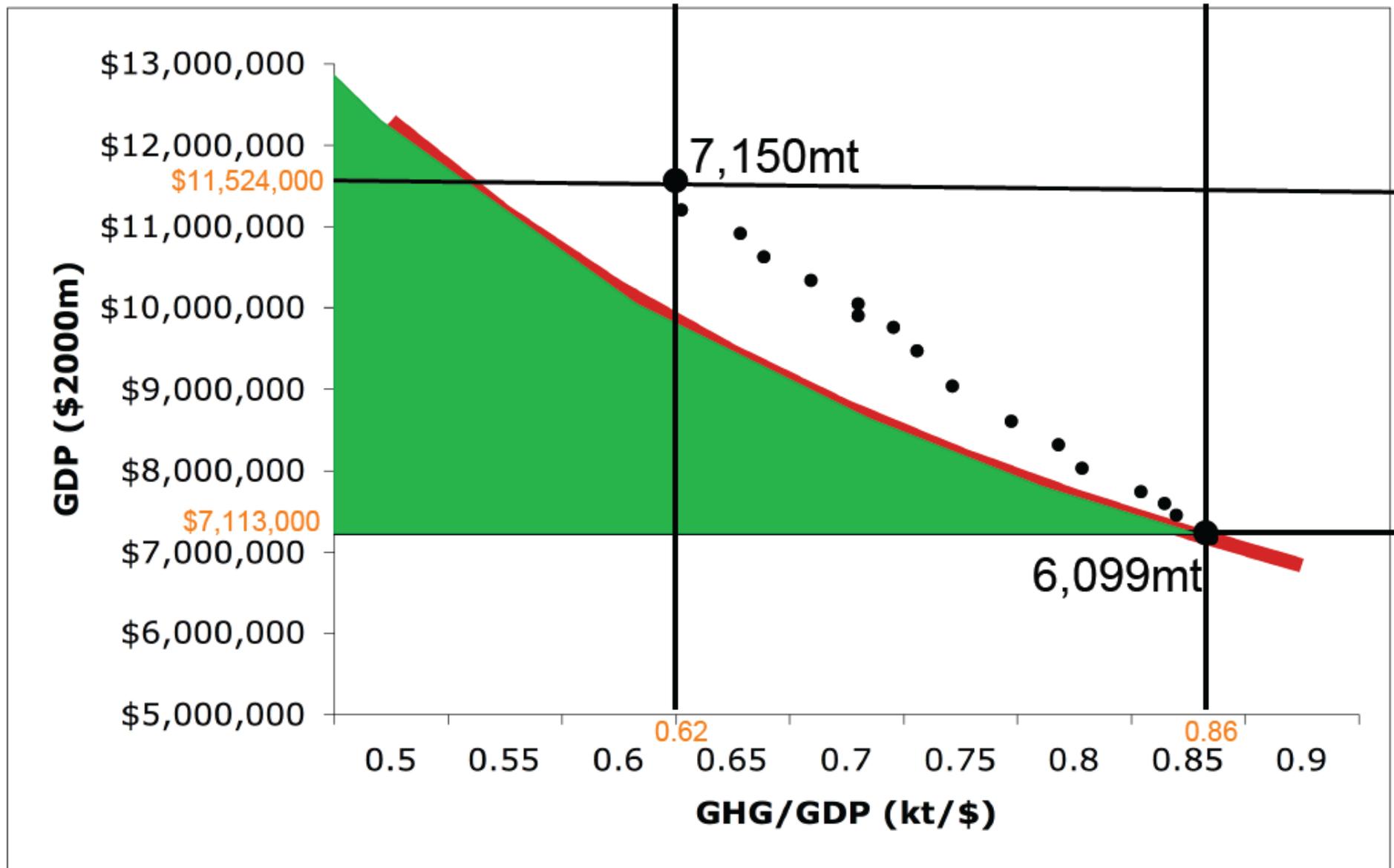
- Limited expenditure: 50% GDP; relative intensity: 10; limited expenditure target: 10% in 2020; -47% GHG
- Limited expenditure: 22% GDP; relative intensity: 10; limited expenditure target: 10% in 2020; +/- 0% GHG
- Limited expenditure: 22% GDP relative intensity: 4; limited expenditure target: 0% in 2020; +15% GHG
- Selective growth requires: limited expenditure to be large % of GDP; high relative intensity

# Scale and Intensity: the Colours of Growth

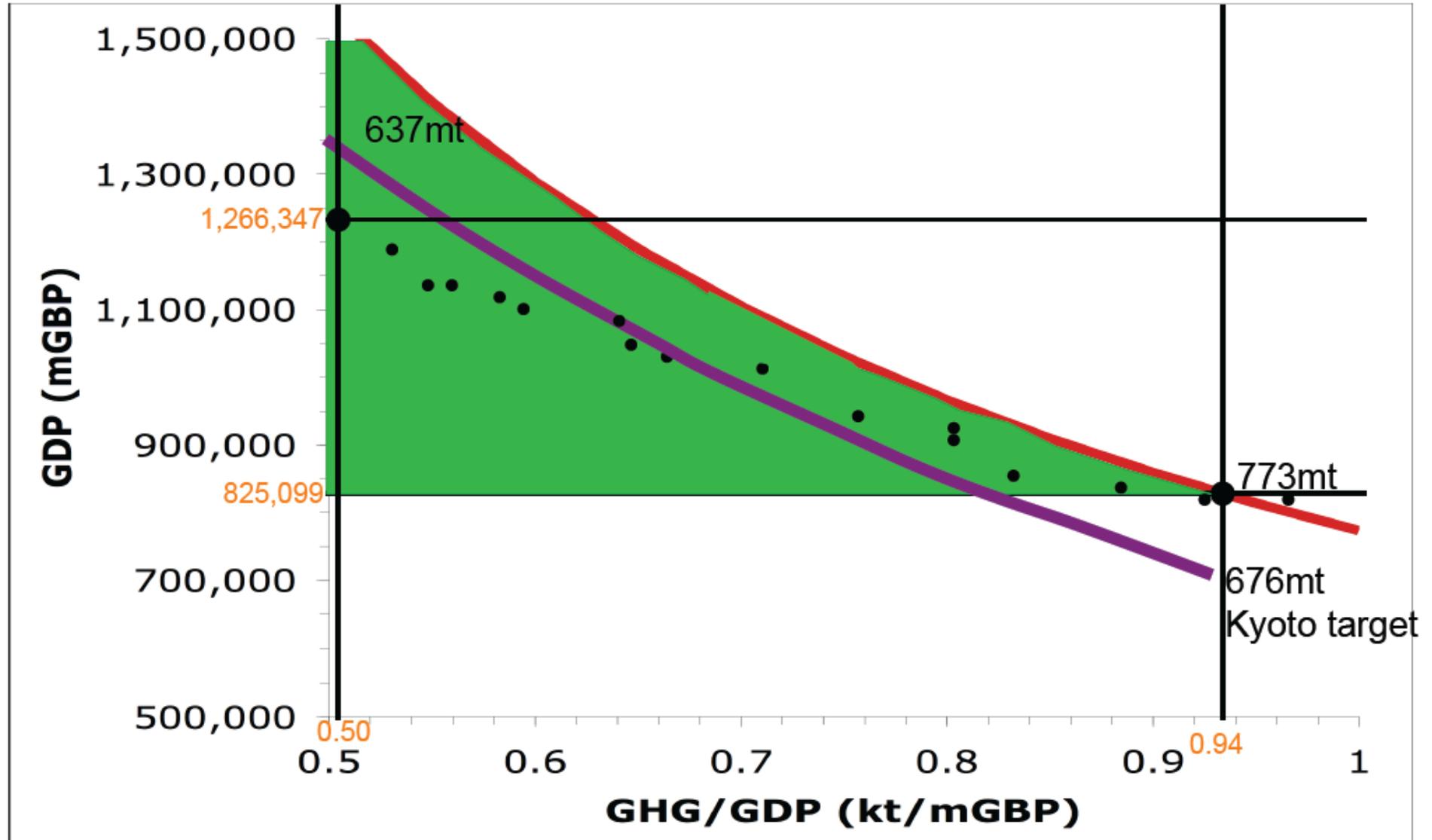


Canada's GHG Intensity 1990

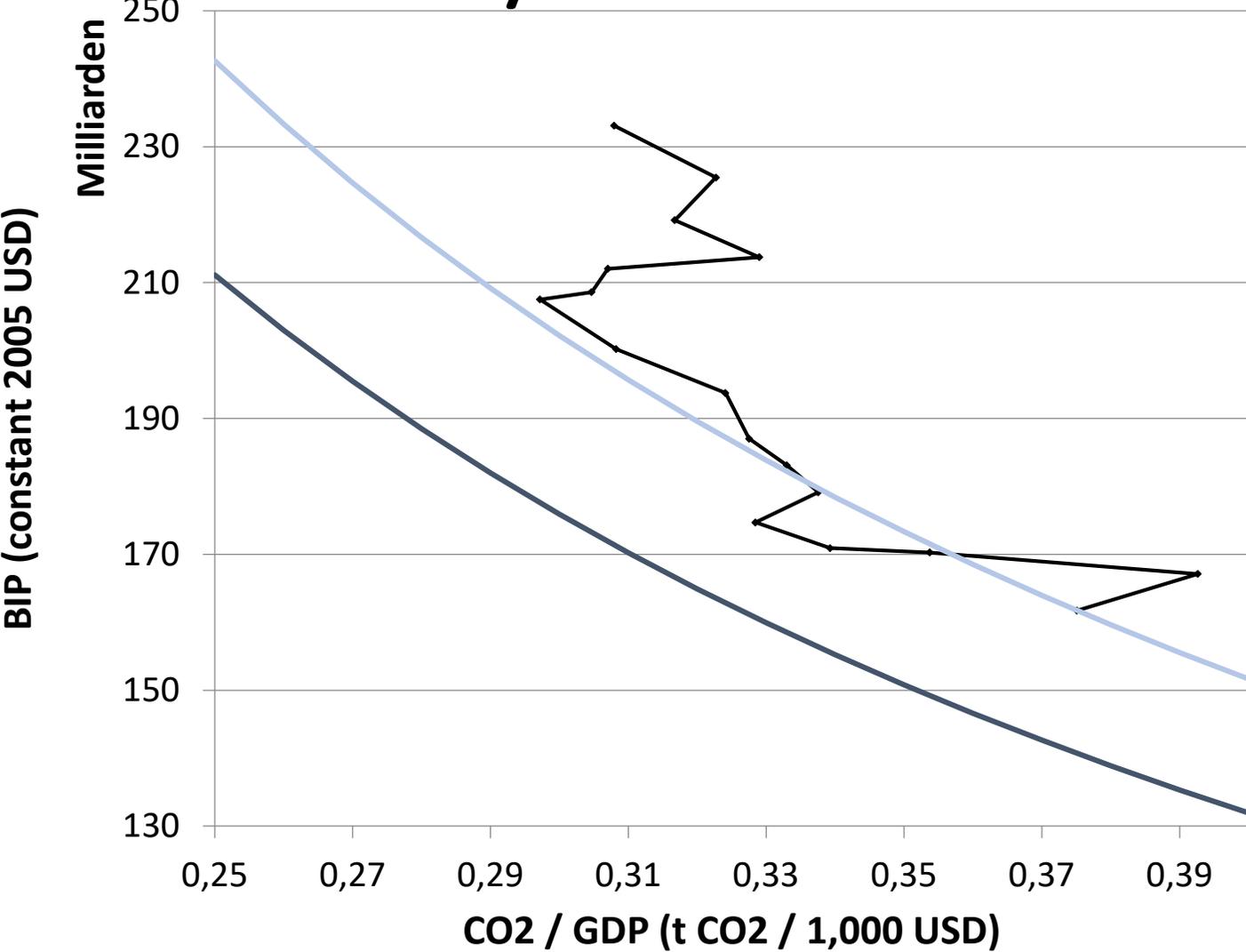
# USA's Economic Growth Scale and Intensity 1990-2007



# Britain's Economic Growth Scale and Intensity 1990-2007

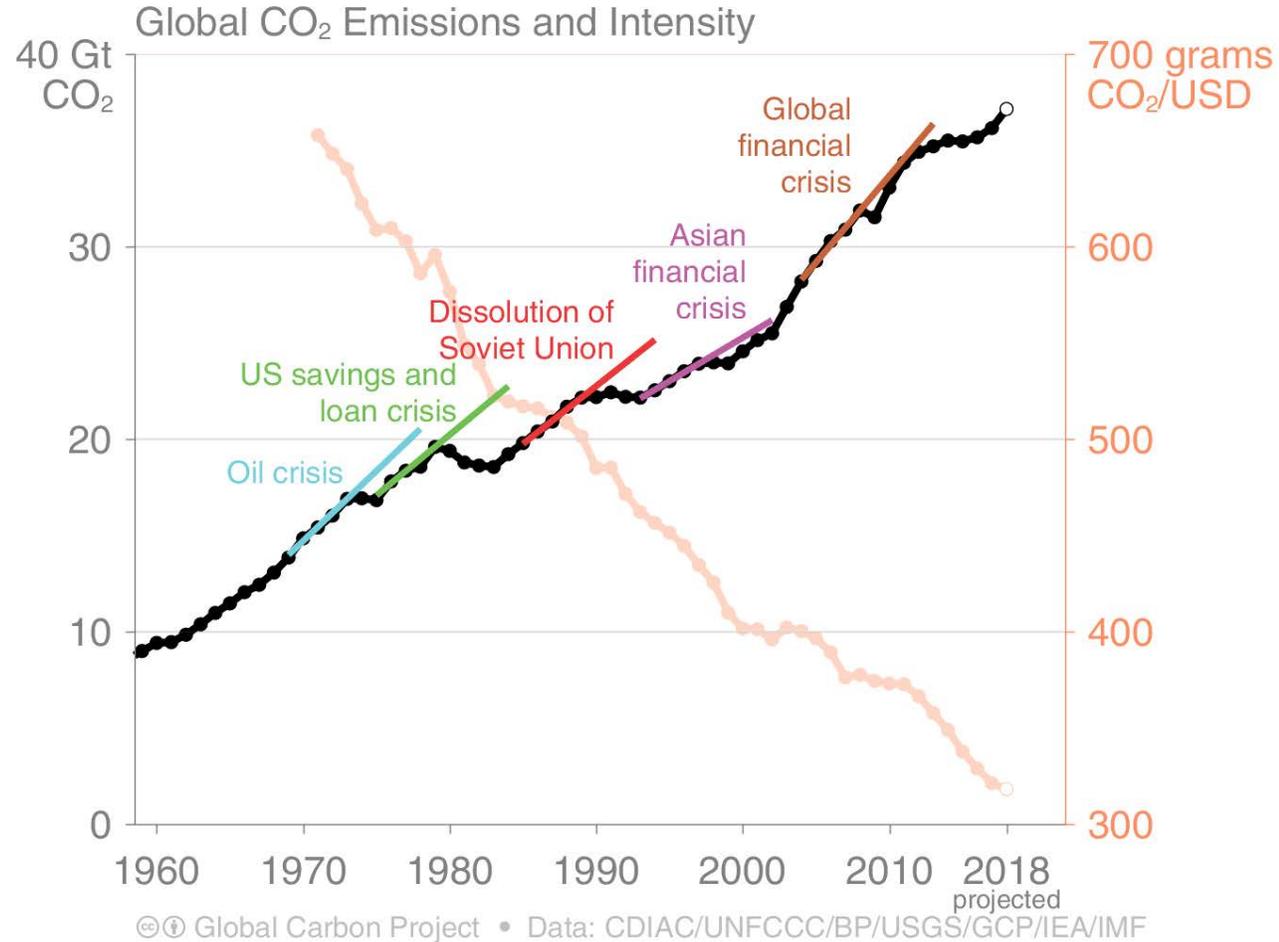


# Austria's Economic Growth Scale and Intensity 1990-2007



# Fossil CO<sub>2</sub> emission intensity

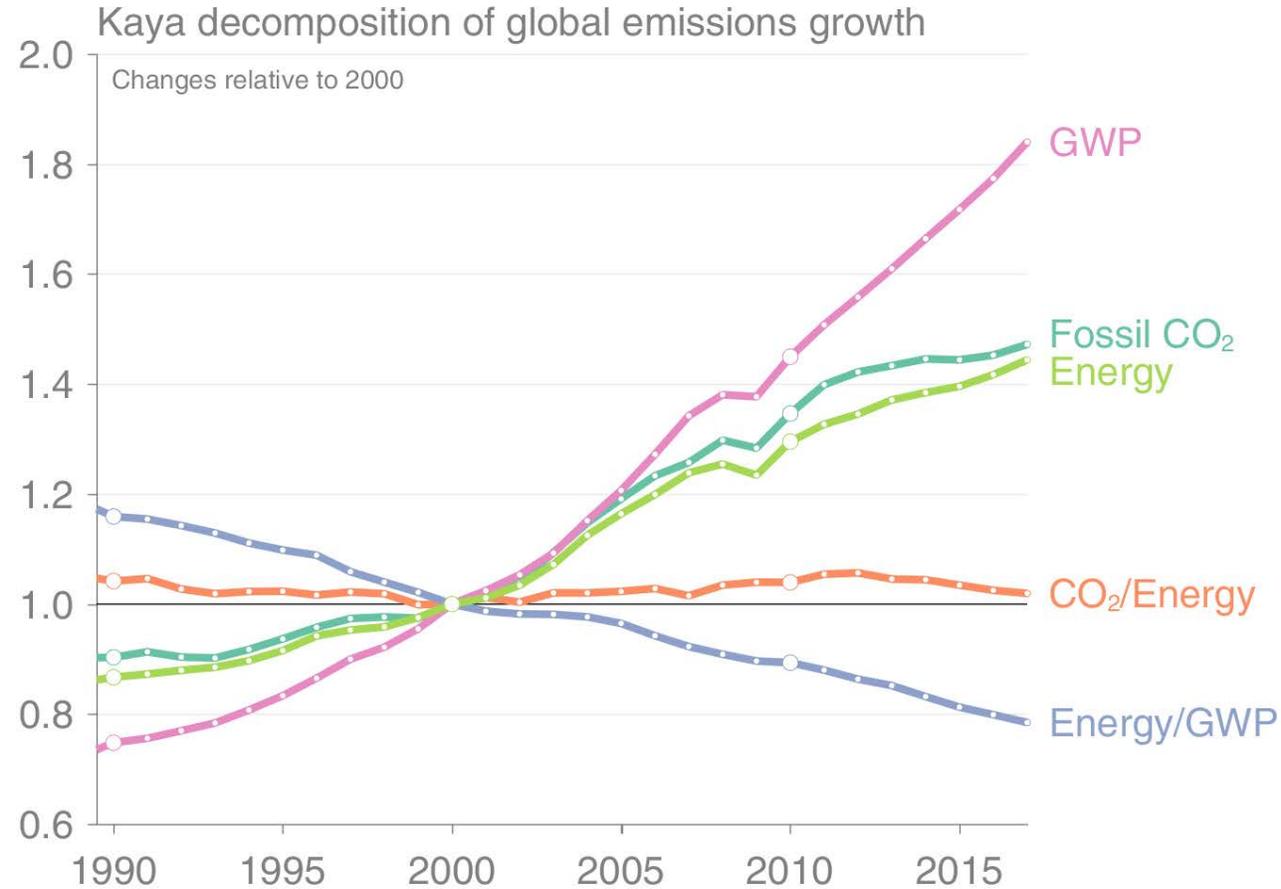
Global CO<sub>2</sub> emissions growth has generally resumed quickly from financial crises. Emission intensity has steadily declined but not sufficiently to offset economic growth.



Economic activity is measured in purchasing power parity (PPP) terms in 2010 US dollars.  
 Source: [CDIAC](#); [Peters et al 2012](#); [Le Quéré et al 2018](#); [Global Carbon Budget 2018](#)

# Kaya decomposition

The Kaya decomposition illustrates that relative decoupling of economic growth from CO<sub>2</sub> emissions is driven by improved energy intensity (Energy/GWP)



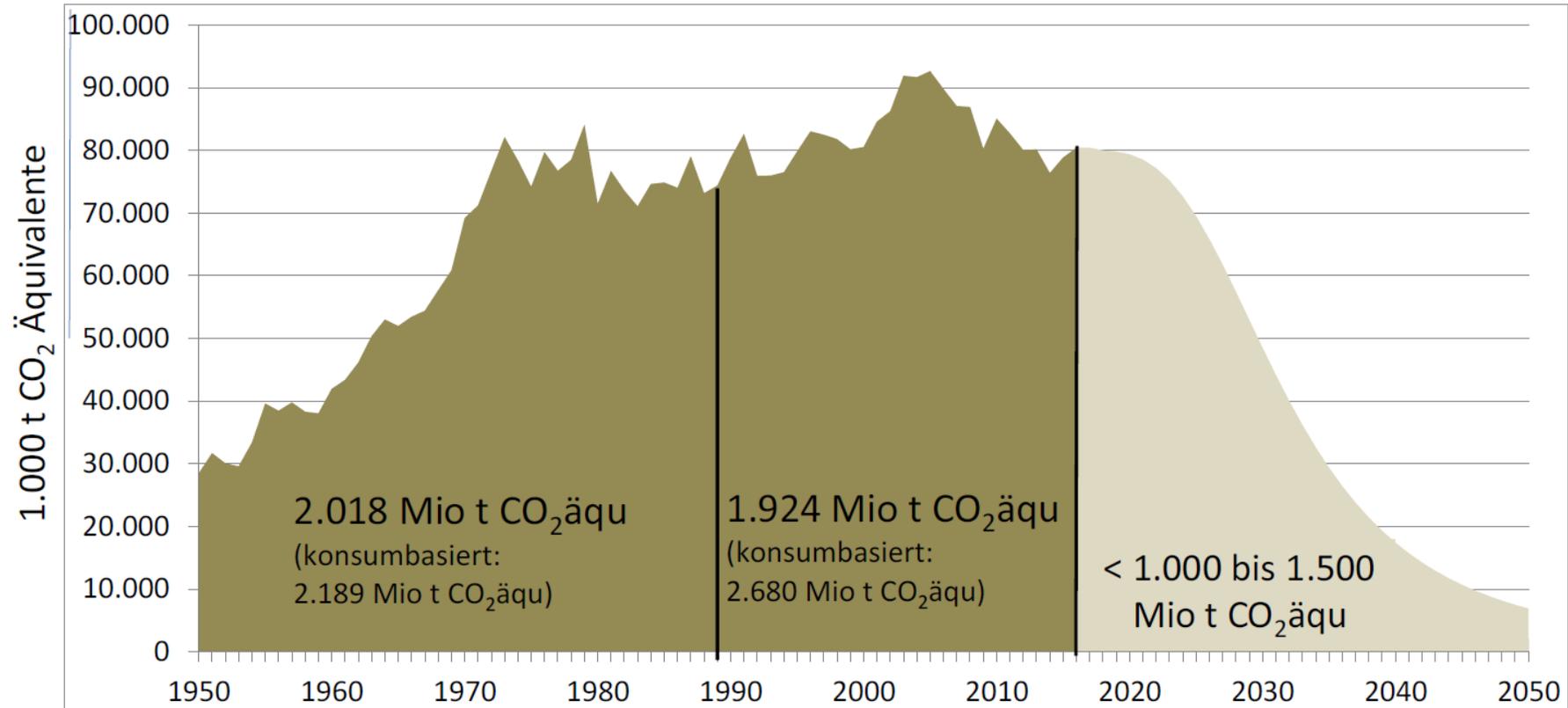
© Global Carbon Project • Data: CDIAC/GCP/IEA/BP/IMF

GWP: Gross World Product (economic activity)

Energy is Primary Energy from BP statistics using the substitution accounting method

Source: [Jackson et al 2018](#); [Global Carbon Budget 2018](#)

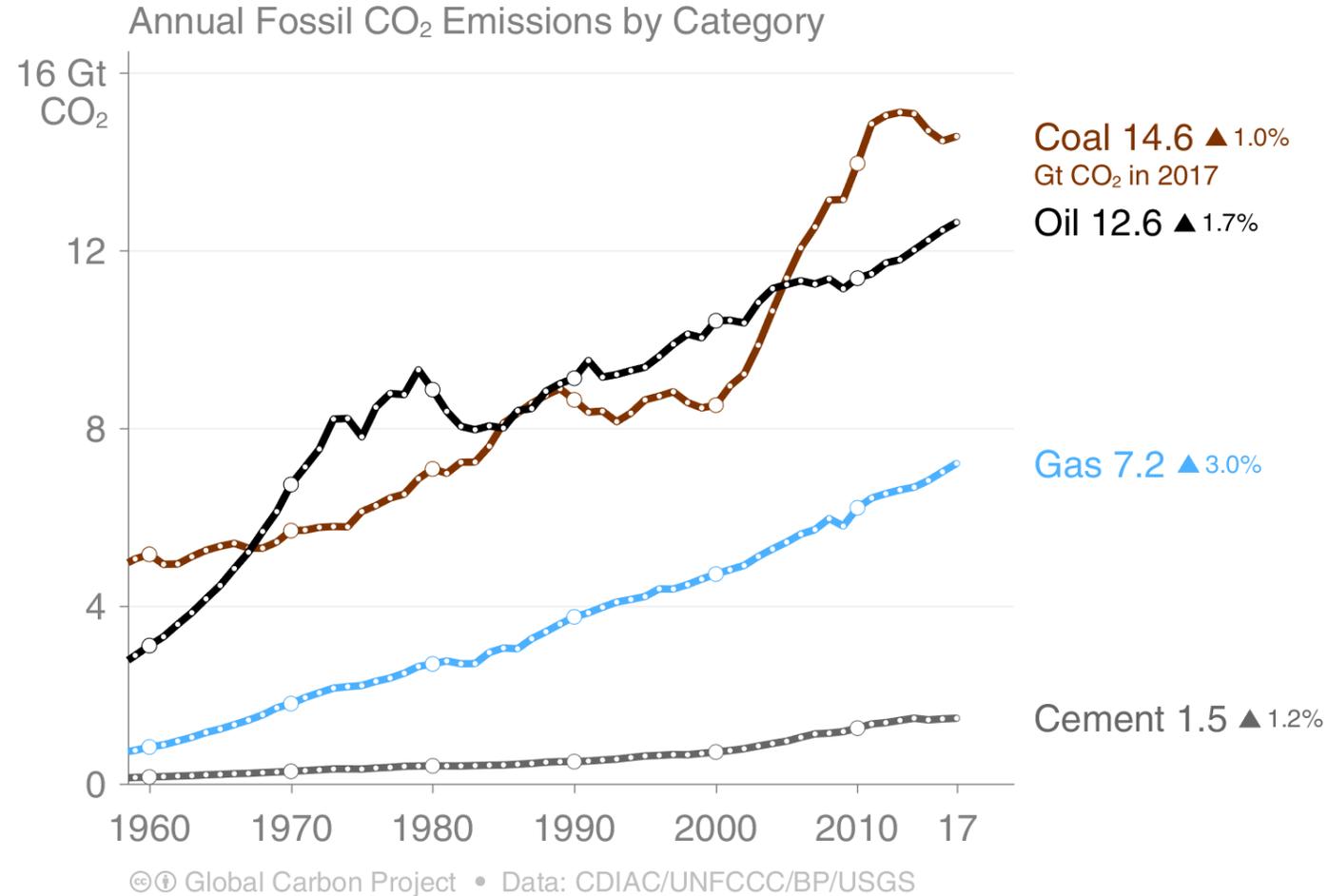
# Carbon budget for Austria



Quelle: [Meyer, Steininger 2017 Das Treibhausgas-Budget für Österreich](#)

# Fossil CO<sub>2</sub> Emissions by source

Share of global fossil CO<sub>2</sub> emissions in 2017:  
 coal (40%), oil (35%), gas (20%), cement (4%), flaring (1%, not shown)



Globally



52% of natural gas reserves

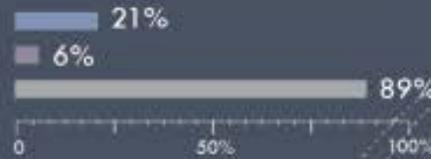


35% of oil reserves



88% of coal reserves

Europe



Former Soviet Union countries



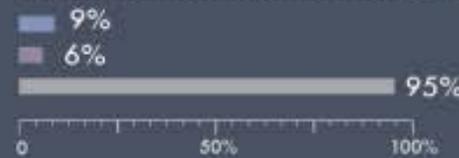
How much oil, gas and coal will we have to leave in the ground to stay under 2 degrees of warming?



Canada



US



Central and South America



Africa



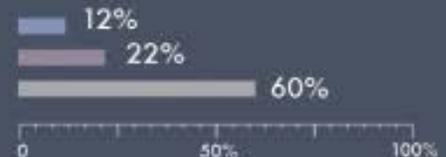
Middle East



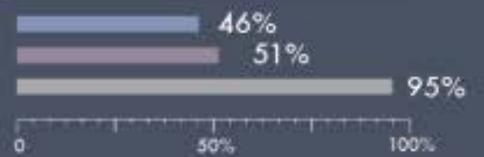
China and India



Other developing Asian countries



OECD Pacific

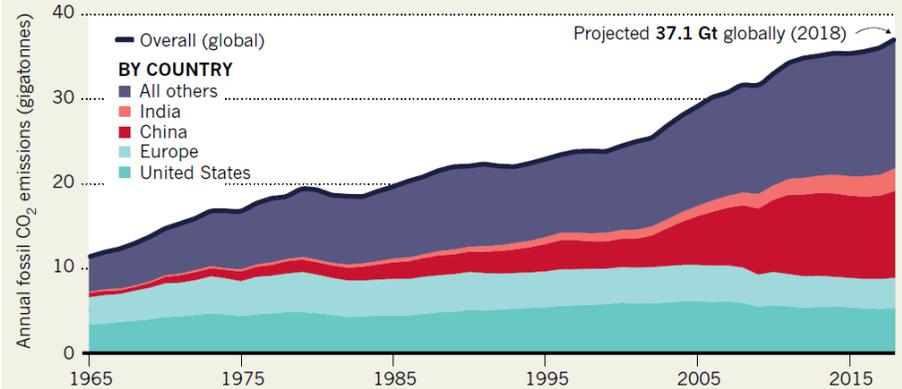


# Rising pressures

CO<sub>2</sub> emissions are growing after pausing for a few years. Clean energy sources are beginning to replace fossil fuels, as their costs become more competitive.

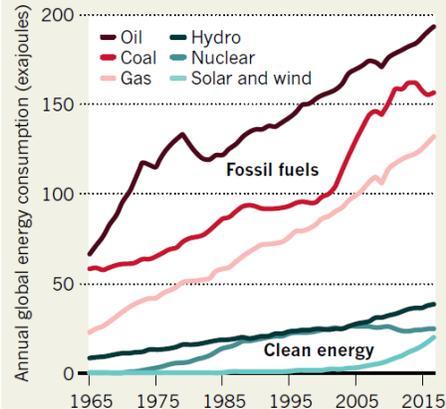
## EMISSIONS ARE STILL INCREASING

China and India still rely heavily on coal; the United States and the European Union are slowly decarbonizing.



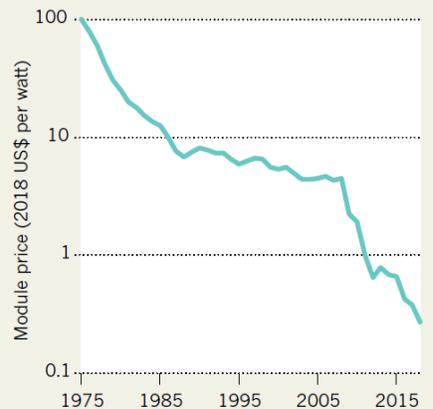
## RENEWABLES ARE PICKING UP

Half of all new energy-generation capacity is renewable. Switching to electric cars would prioritize clean energy over oil.



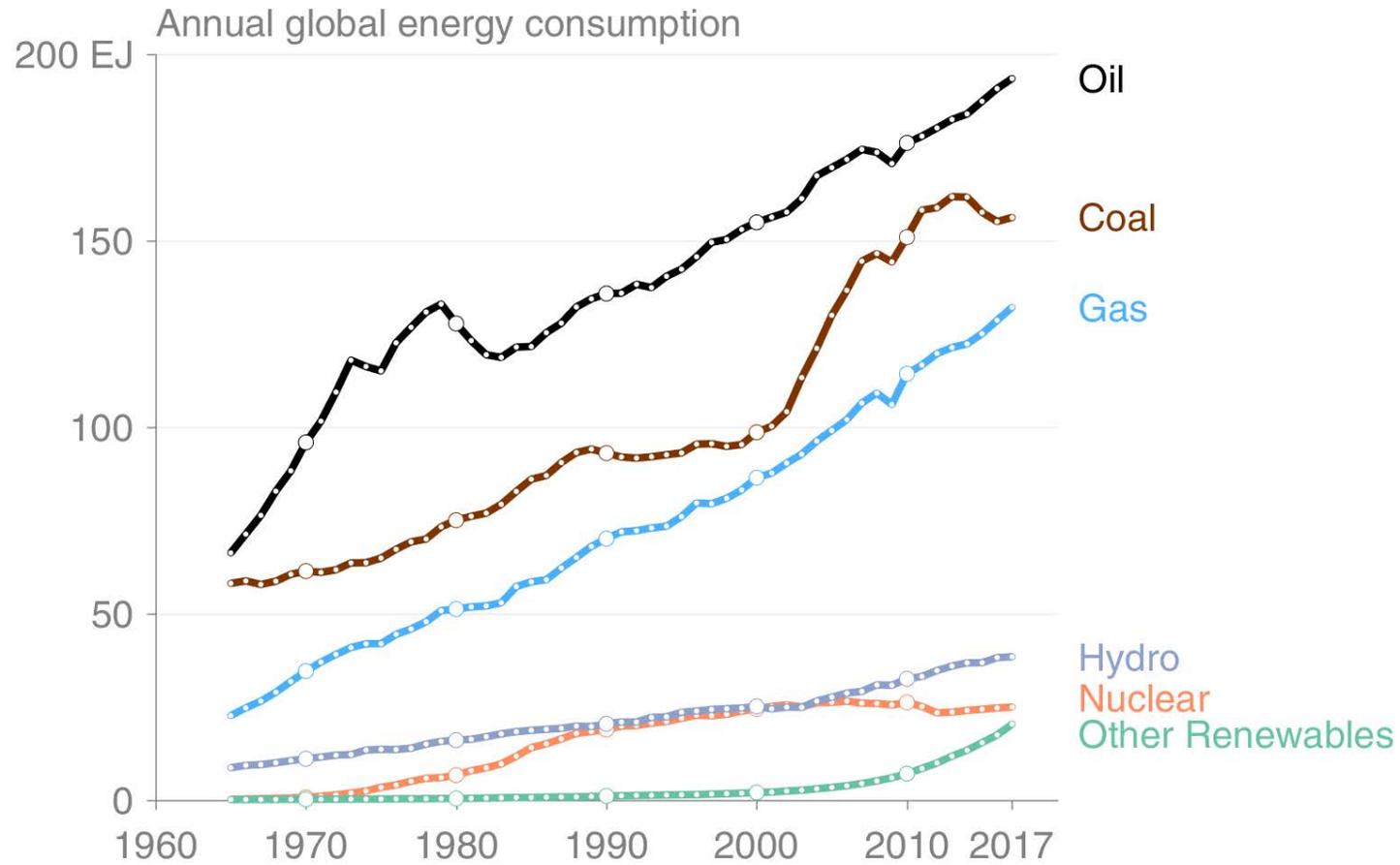
## SOLAR ENERGY IS AFFORDABLE

Costs have dropped by 80% over the past decade as solar installations have expanded.



# Energy use by source

Renewable energy is growing exponentially, but this growth has so far been too low to offset the growth in fossil energy consumption.



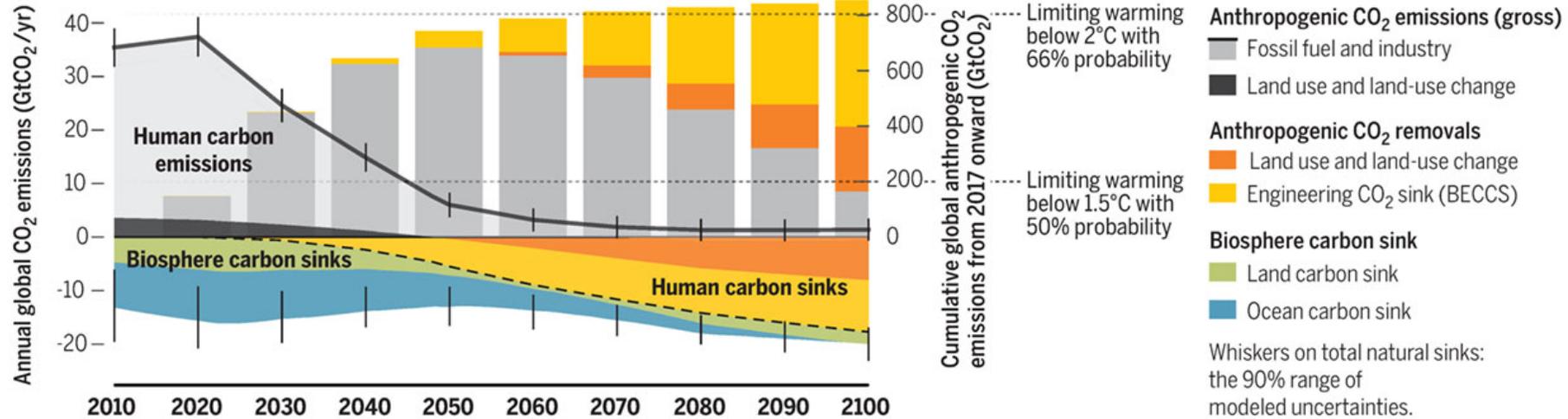
© Global Carbon Project • Data: BP

This figure shows “primary energy” using the BP substitution method (non-fossil sources are scaled up by an assumed fossil efficiency of 0.38)

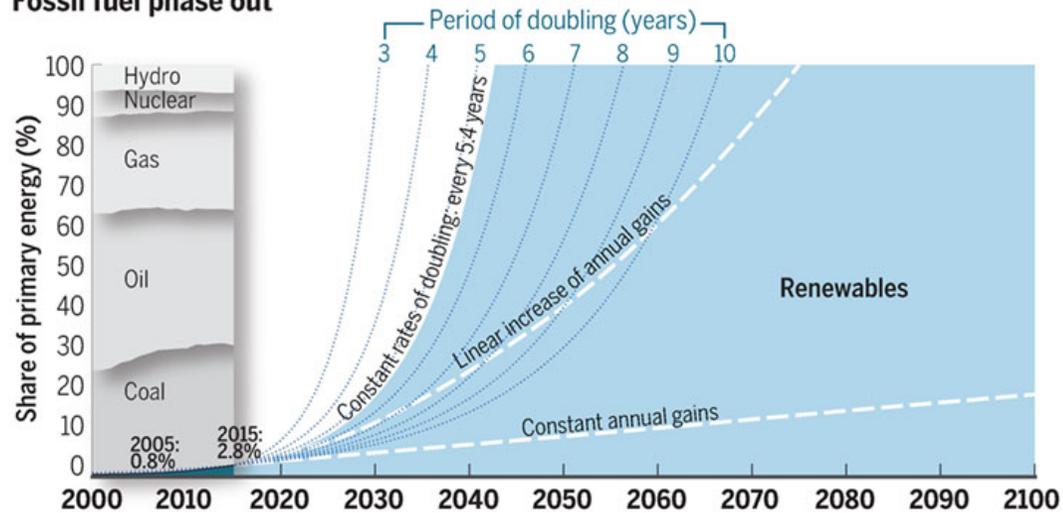
Source: [BP 2018](#); [Figueres et al 2018](#); [Global Carbon Budget 2018](#)

# A global carbon law and roadmap to make Paris goals a reality

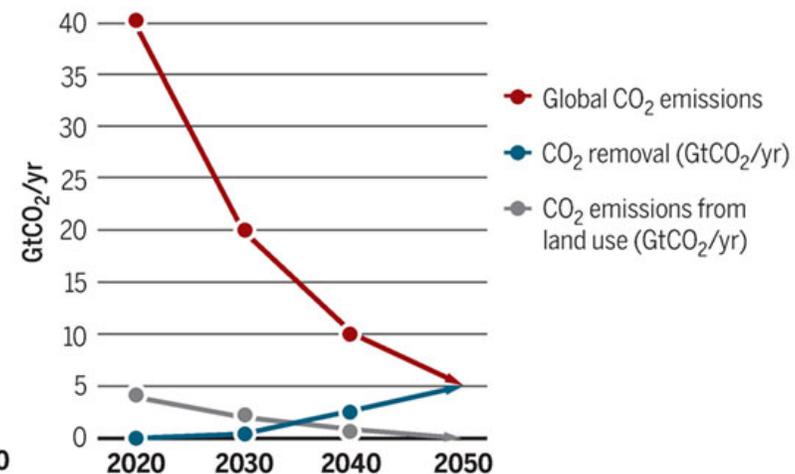
## Decarbonization pathway consistent with the Paris agreement



## Fossil fuel phase out



## Global carbon law guiding decadal pathways



## 2017–2020: NO-BRAINERS

- Annual emissions from fossil fuels must start falling by 2020. Well-proven (and ideally income-neutral) policy instruments such as carbon tax schemes, cap-and-trade systems, feed-in tariffs, and quota approaches should roll out at wide scale.
- Even these will be challenging in the emerging global political climate.
- The European Union emissions-trading scheme requires kick-starting through an appropriate floor price (>\$50/metric ton CO<sub>2</sub>).

## 2020-2030: HERCULEAN EFFORTS

- Economies must implement the no-brainer mitigation measures plus the first wave of smart and disruptive action.
- Improving energy efficiency alone would reduce emissions 40 to 50% by around 2030 in many domestic and industrial cases

## 2030-2040: MANY BREAKTHROUGHS

- By 2040, oil will be about to exit the global energy mix.
- Several vanguard countries (such as Norway, Denmark, and Sweden) should have completed electrification of all sectors and be entirely emissions-free or close to it.
- Internal combustion engines for personal transport will have become rare on roads worldwide.
- Aircraft fuel should be entirely carbon neutral. Synthesized fuels, bio-methane, and hydrogen are established alternatives.
- After 2030, all building construction must be carbon-neutral or carbon-negative.
- Promising financial mechanisms to foster investments in necessary breakthroughs include sovereign wealth funds designed for transformation; effective international corporation tax regimes (11); and inheritance reforms that account for historical wealth generated by fossil fuels without compensation of externalities (12).

## 2040-2050: REVISE, REINFORCE

- Building on successes and learning from failures of previous stages, certain mitigation strategies will be abandoned and others refined and amplified.
- All major European countries become close to net-zero carbon states early in the 2040s; market dynamics push North and South America and most of Asia and Africa to this goal by the end of the decade. Natural gas still provides some backup energy, but CCS ensures its carbon footprint is limited.
- Modular nuclear reactors may contribute to the energy mix in places.

# Carbon Pricing Dashboard

[HOME](#)[ABOUT](#)[MAP & DATA](#)[WHAT IS CARBON PRICING?](#)[RESOURCES](#)

## KEY STATISTICS ON REGIONAL, NATIONAL AND SUBNATIONAL CARBON PRICING INITIATIVE(S)

57

Carbon Pricing initiatives implemented or scheduled for implementation

46

National Jurisdictions are covered by the initiatives selected

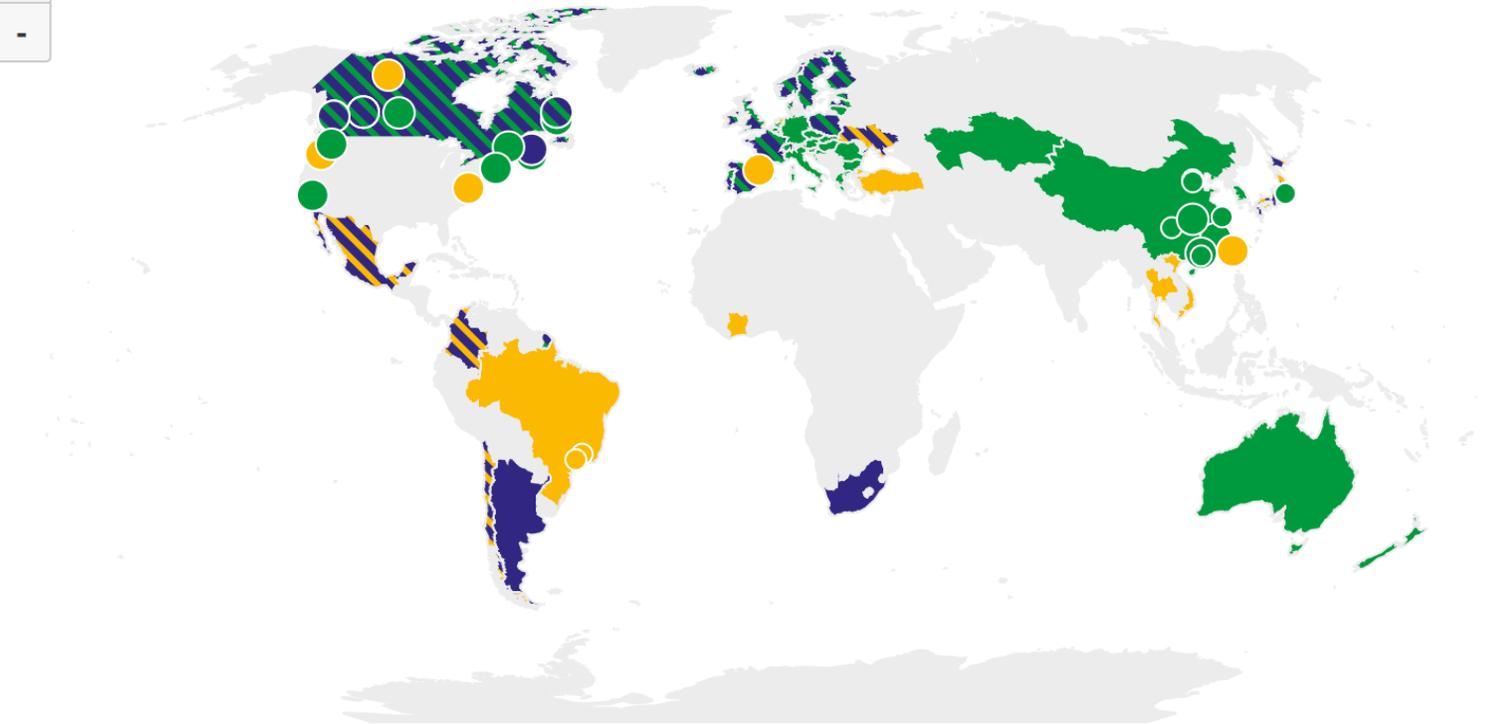
28

Subnational Jurisdictions are covered by the initiatives selected

In 2019, these initiatives would cover **11 GtCO<sub>2</sub>e**, representing **19.6%** of global GHG emissions

Total value (US\$ Bn) of carbon pricing initiatives in 2019

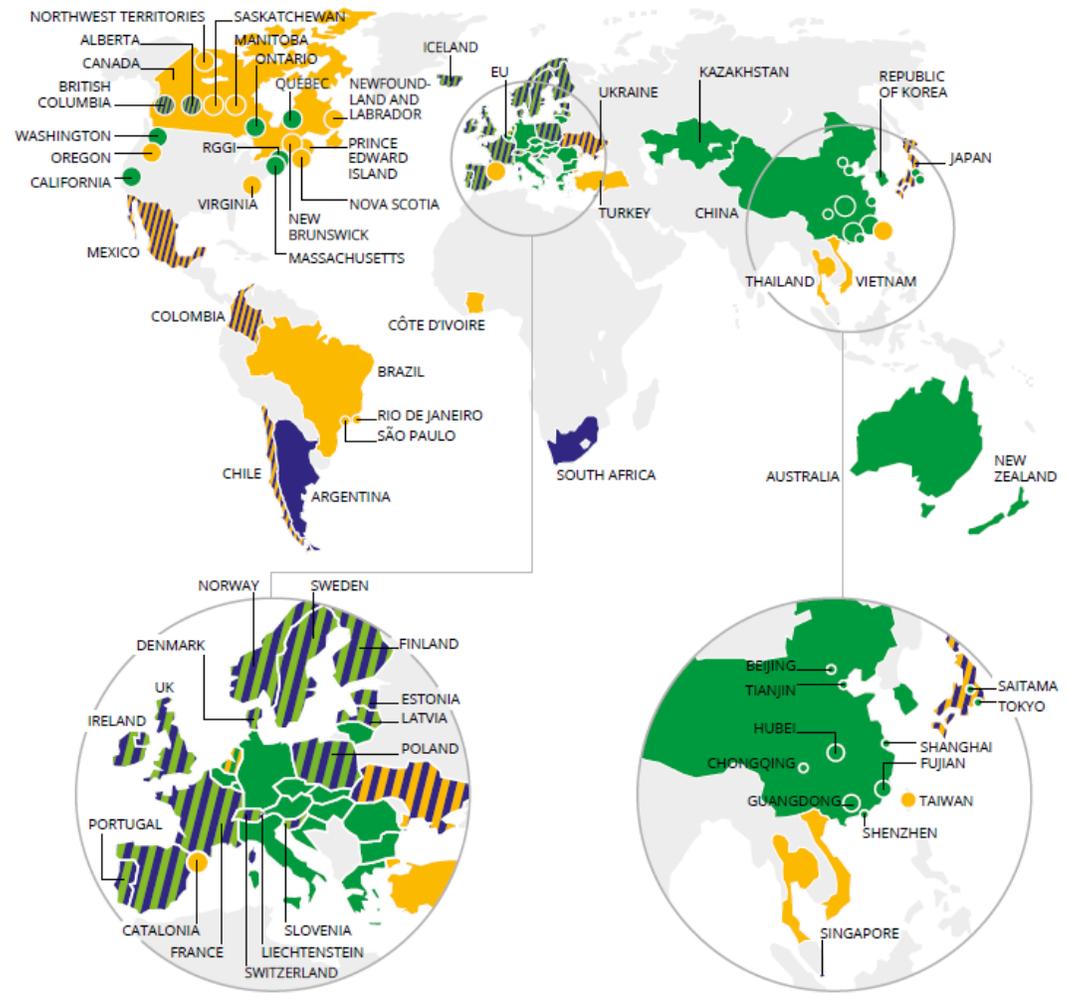
Summary map of regional, national and subnational carbon pricing initiatives



- ETS implemented or scheduled for implementation
- ETS or carbon tax under consideration
- ETS implemented or scheduled, tax under consideration

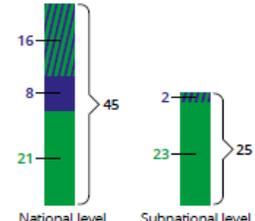
- Carbon tax implemented or scheduled for implementation
- ETS and carbon tax implemented or scheduled
- Carbon tax implemented or scheduled, ETS under consideration

**Figure 1 / Summary map of regional, national and subnational carbon pricing initiatives implemented, scheduled for implementation and under consideration (ETS and carbon tax)**



**Tally of carbon pricing initiatives implemented or scheduled for implementation**

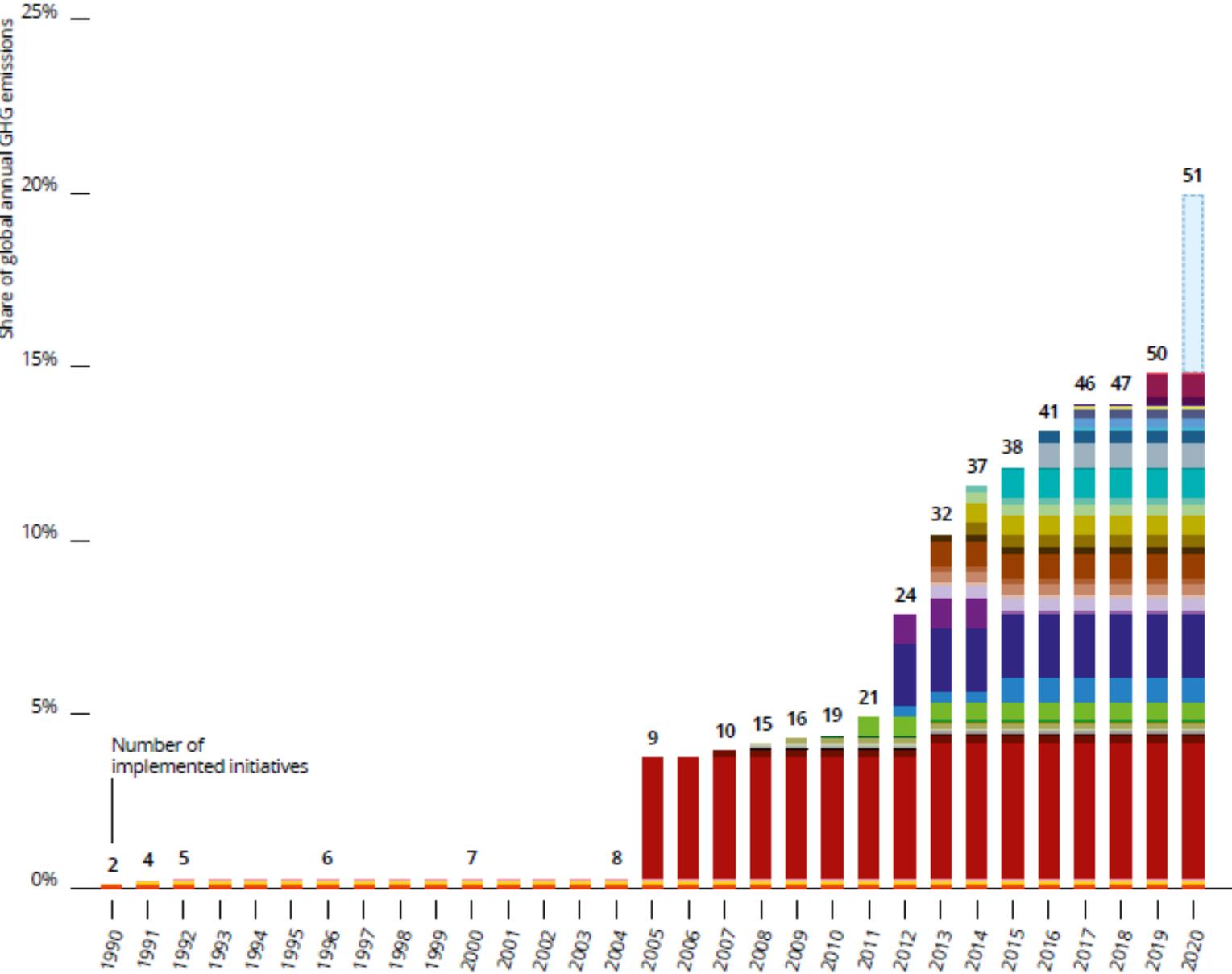
- ETS implemented or scheduled for implementation
- Carbon tax implemented or scheduled for implementation
- ETS or carbon tax under consideration
- ETS and carbon tax implemented or scheduled
- Carbon tax implemented or scheduled, ETS under consideration
- ETS implemented or scheduled, carbon tax under consideration



The circles represent subnational jurisdictions. The circles are not representative of the size of the carbon pricing instrument, but show the subnational regions (large circles) and cities (small circles).

*Note:* Carbon pricing initiatives are considered "scheduled for implementation" once they have been formally adopted through legislation and have an official, planned start date. Carbon pricing initiatives are considered "under consideration" if the government has announced its intention to work towards the implementation of a carbon pricing initiative and this has been formally confirmed by official government sources. The carbon pricing initiatives have been classified in ETSs and carbon taxes according to how they operate technically. ETS not only refers to cap-and-trade systems, but also baseline-and-credit systems as seen in British Columbia and baseline-and-offset systems as seen in Australia. The authors recognize that other classifications are possible. Due to the dynamic approach to continuously improve data quality, changes to the map not only reflect new developments, but also corrections following new information from official government sources, resulting in the addition of the carbon tax covering only F gases in Spain.

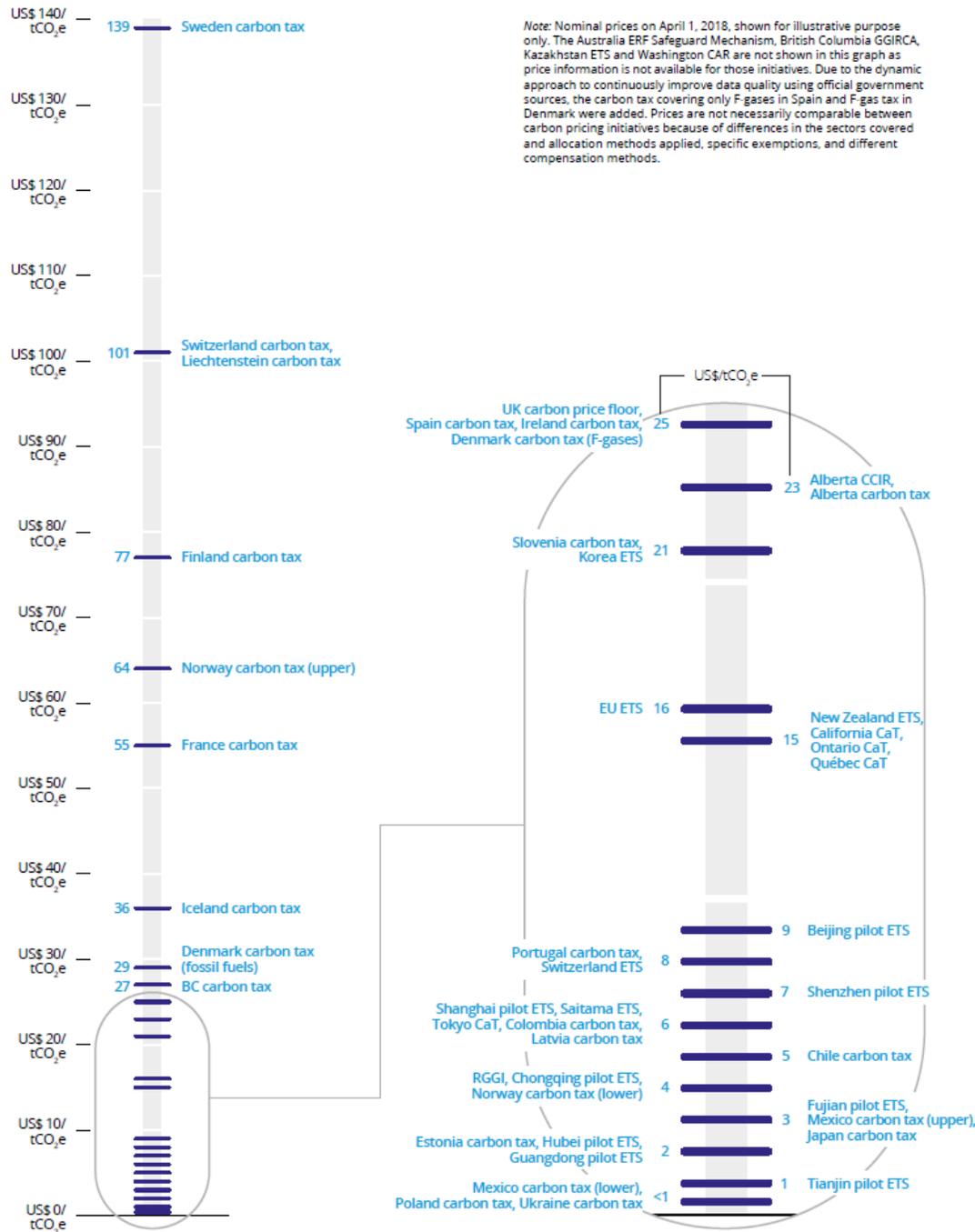
Figure 2 / Regional, national and subnational carbon pricing initiatives: share of global emissions covered



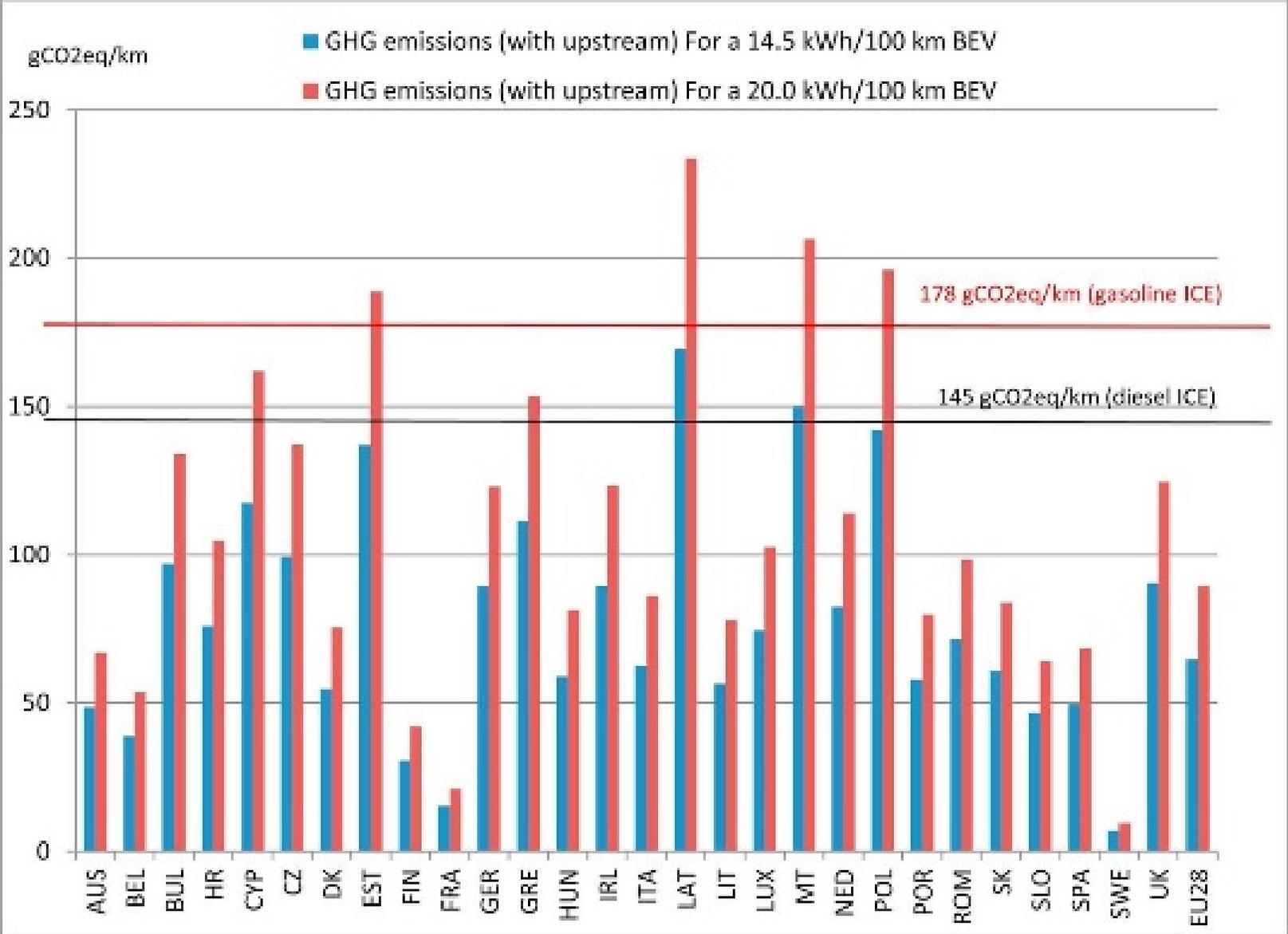
- Finland carbon tax (1990 →)
- Poland carbon tax (1990 →)
- Norway carbon tax (1991 →)
- Sweden carbon tax (1991 →)
- Denmark carbon tax (1992 →)
- Slovenia carbon tax (1996 →)
- Estonia carbon tax (2000 →)
- Latvia carbon tax (2004 →)
- EU ETS (2005 →)
- Alberta SGER (2007 →)
- Switzerland ETS (2008 →)
- New Zealand ETS (2008 →)
- Switzerland carbon tax (2008 →)
- Liechtenstein carbon tax (2008 →)
- BC carbon tax (2008 →)
- RGGI (2009 →)
- Iceland carbon tax (2010 →)
- Tokyo CaT (2010 →)
- Ireland carbon tax (2010 →)
- Ukraine carbon tax (2011 →)
- Saitama ETS (2011 →)
- California CaT (2012 →)
- Japan carbon tax (2012 →)
- Australia CPM (2012 - 2014)
- Québec CaT (2013 →)
- Kazakhstan ETS (2013 →)
- UK carbon price floor (2013 →)
- Shenzhen pilot ETS (2013 →)
- Shanghai pilot ETS (2013 →)
- Beijing pilot ETS (2013 →)
- Guangdong pilot ETS (2013 →)
- Tianjin pilot ETS (2013 →)
- France carbon tax (2014 →)
- Mexico carbon tax (2014 →)
- Spain carbon tax (2014 →)
- Hubei pilot ETS (2014 →)
- Chongqing pilot ETS (2014 →)
- Korea ETS (2015 →)
- Portugal carbon tax (2015 →)
- BC GGIRCA (2016 →)
- Australia ERF Safeguard Mechanism (2016 →)
- Fujian pilot ETS (2016 →)
- Washington CAR (2017 →)
- Ontario CaT (2017 →)
- Alberta carbon tax (2017 →)
- Chile carbon tax (2017 →)
- Colombia carbon tax (2017 →)
- Massachusetts ETS (2018 →)
- Argentina carbon tax (2019 →)
- South Africa carbon tax (2019 →)
- Singapore carbon tax (2019 →)
- China national ETS (2020 →)

Note: Only the introduction or removal of an ETS or carbon tax is shown. Emissions are presented as a share of global GHG emissions in 2012 from (EDGAR) version 4.3.2 including biofuels emissions. Annual changes in GHG emissions are not shown in the graph. Due to the dynamic approach to continuously improve data quality using official government sources, the carbon tax only covering F-gases in Spain was added. The information on the China national ETS represents early unofficial estimates based on the announcement of China's National Development and Reform Commission on the launch of the national ETS of December 2017.

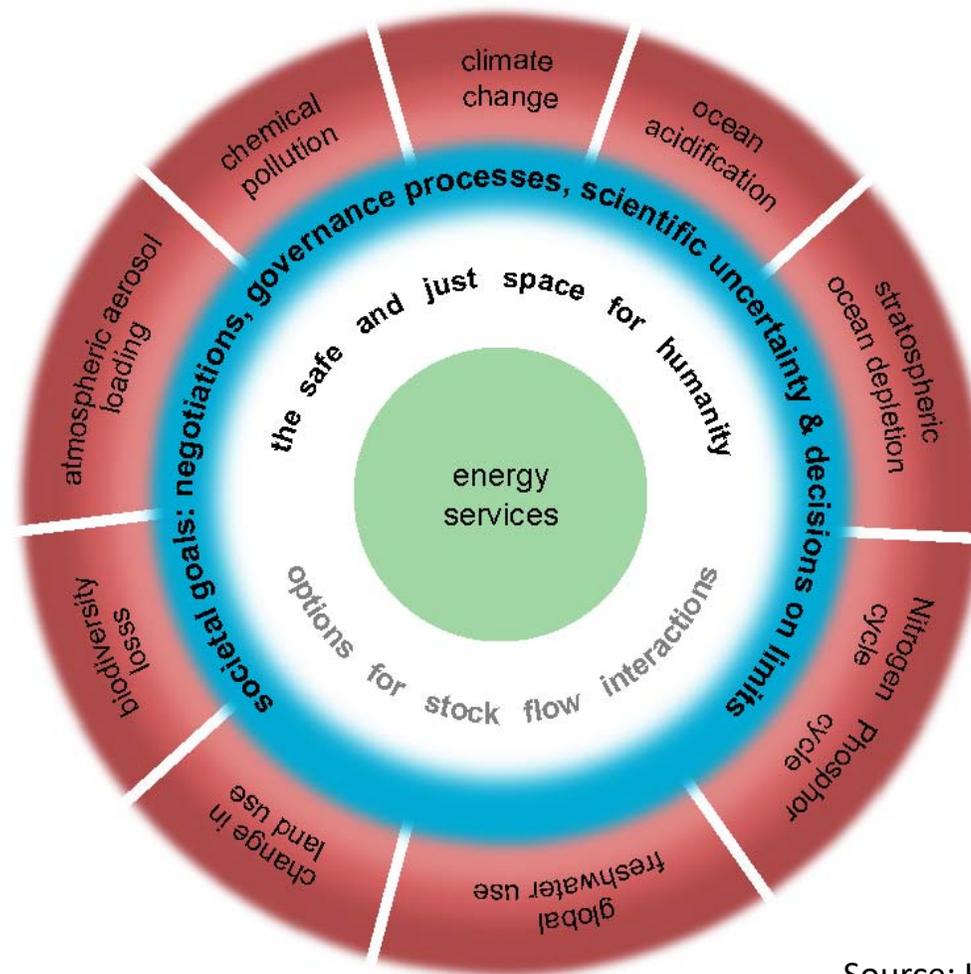
Figure 3 / Prices in implemented carbon pricing initiatives



# Well-to-Wheels emissions of electric vehicles in the Member States of the European Union



# From the socio-ecological basis to human wellbeing within biophysical limits



Source: Kettner, Köppl, Stagl 2015