The origins of sustainable energy policies

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Climate change mechanism

- Temperature of the planet is rising
  - 0,8°C in last 130 years, more than half of that in last 35 years.
- GHGs concentration is increasing.
  - CO_2 concentration increased by 40% since pre-industrial time, methane by 150%, nitrous oxide by 20%.
- This increase is (predominantly) caused by human activity.
- There is a relationship between GHGs and energy in the atmosphere (greenhouse gas effect).
- Some uncertainty due to the complexity of the issue, positive and negative feedbacks.

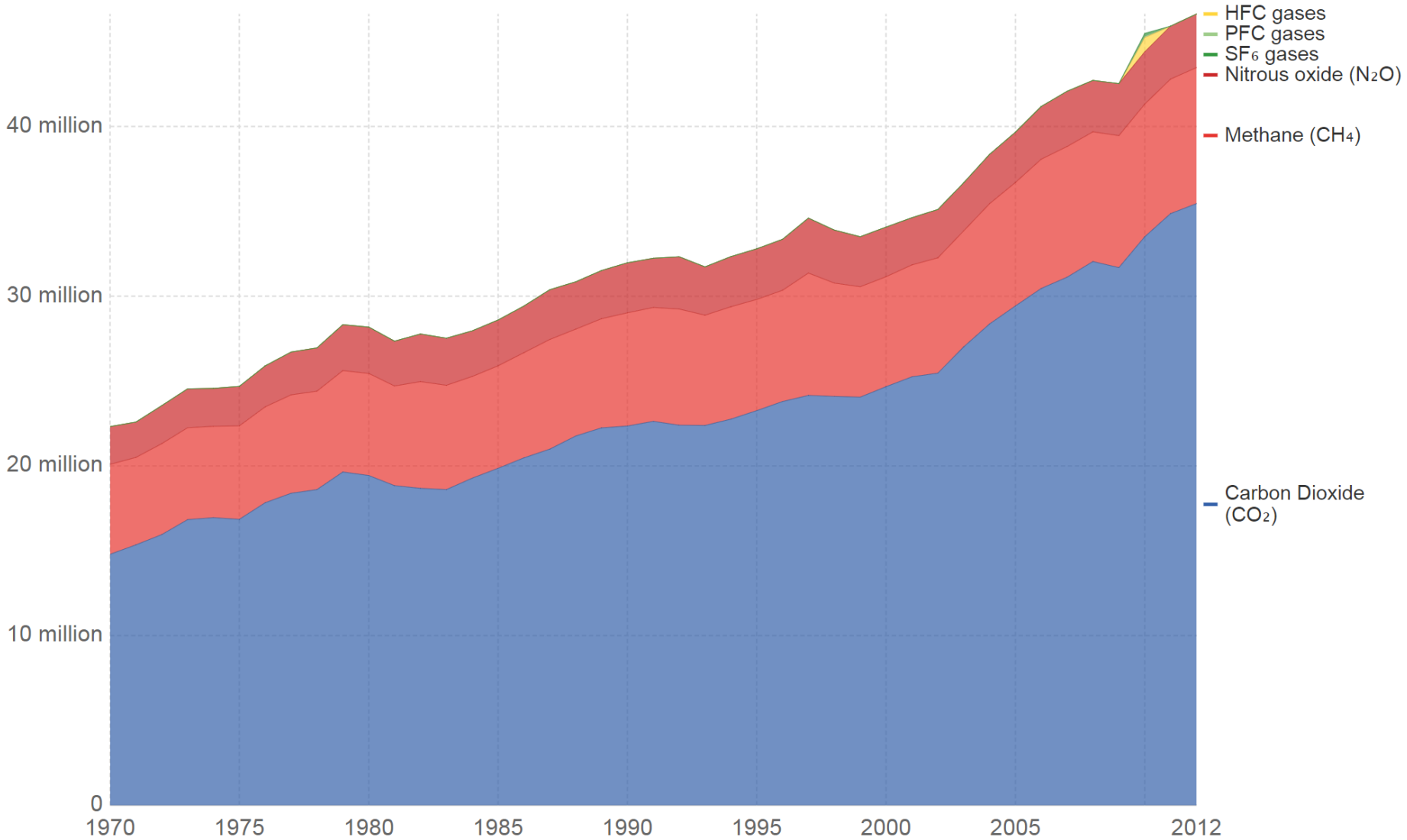
Possible Effects of Climate Change

	Eventual Temperature Rise Relative to Pre-Industrial Temperatures				
Type of Impact	**1°C**	**2°C**	**3°C**	**4°C**	**5°C**
Freshwater Supplies	Small glaciers in the Andes disappear, threatening water supplies for 50 million people	Potential water supply decrease of 20–30% in some regions (Southern Africa and Mediterranean)	Serious droughts in southern Europe every 10 years. 1–4 billion more people suffer water shortages	Potential water supply decrease of 30–50% in southern Africa and Mediterranean	Large glaciers in Himalayas possibly disappear, affecting ¼ of China's population
Food and Agriculture	Modest increase in yields in temperature regions	Declines in crop yields in tropical regions (5–10% in Africa)	150–550 million more people at risk of hunger. Yields likely to peak at higher latitudes	Yields decline by 15–35% in Africa. Some entire regions out of agricultural production	Increase in ocean acidity possibly reduces fish stocks
Human Health	At least 300,000 die each year from climate–related diseases. Reduction in winter mortality in high latitudes	40–60 million more exposed to malaria in Africa	1–3 million more potentially people die annually from malnutrition	Up to 80 million more people exposed to malaria in Africa	Further disease increase and substantial burdens on health care services
Coastal Areas	Increased damage from coastal flooding	Up to 10 million more people exposed to coastal flooding	Up to 170 million more people exposed to coastal flooding	Up to 300 million more people exposed to coastal flooding	Sea-level rise threatens major cities such as New York, Tokyo, and London
Ecosystems	At least 10% of land species facing extinction. Increased wildfire risk	15–40% of species potentially face extinction	20–50% of species potentially face extinction Possible onset of collapse of Amazon forest	Loss of half of Arctic tundra Widespread loss of coral reefs	Significant extinctions across the globe

Greenhouse gas emissions (CO_2e) by gas, World

Global greenhouse gas emissions by gas source, measured in thousand tonnes of carbon dioxide equivalents (kt CO_2e). Gases are converted to their CO_2e values based on their global warming potential factors. HFC, PFC and SF_6 are collectively known as 'F-gases'.

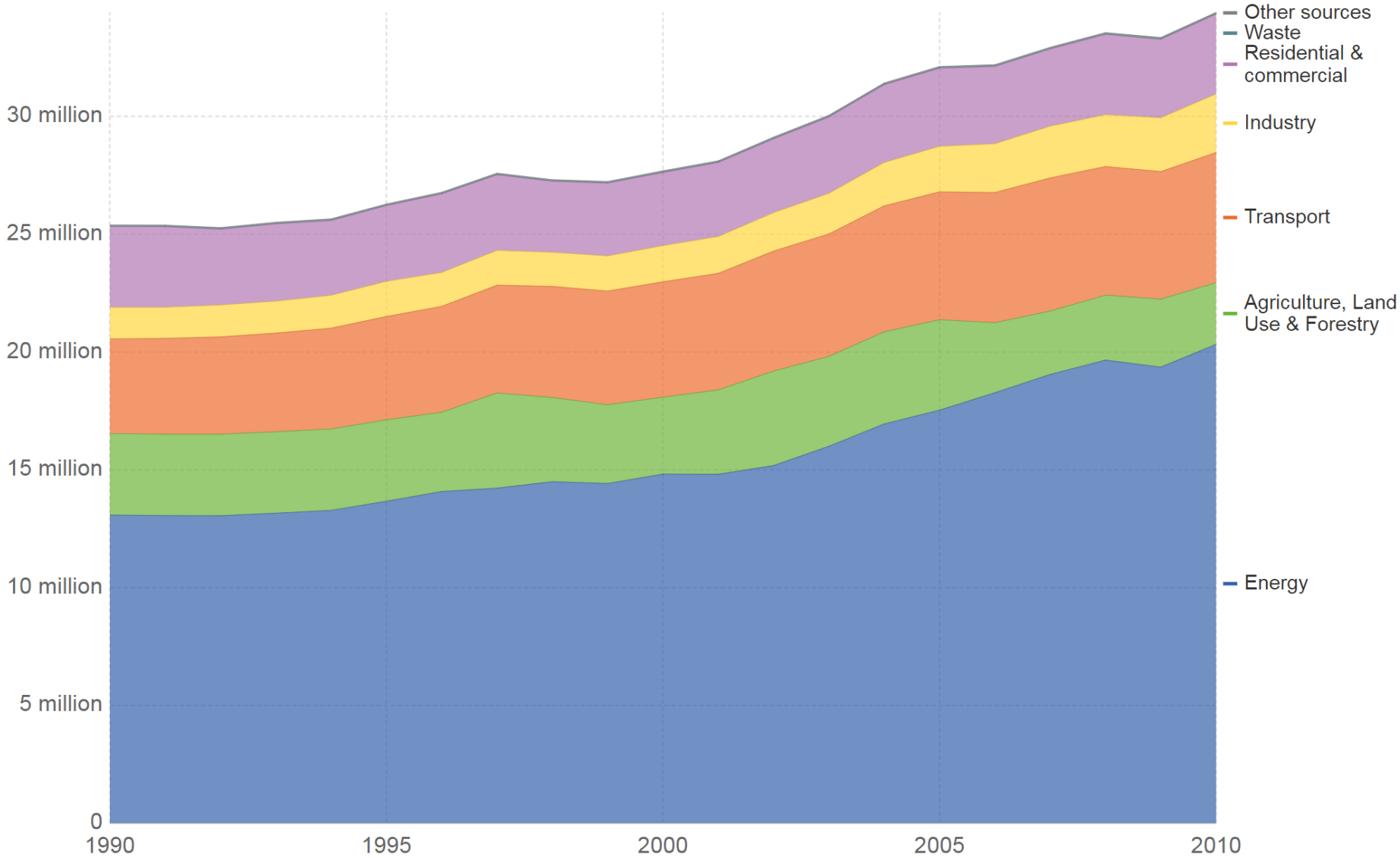
Our World in Data



Source: World Bank - World Development Indicators (WDI)

Global carbon dioxide emissions by sector (Gg CO_2)

Global carbon dioxide (CO_2) emissions, measured in gigagrams of CO_2 per year.



Source: UN Food and Agricultural Organization (FAO)

Methane emissions by sector (Gg CO_2e)

Breakdown of total global methane (CH_4) emissions by sector, measured in gigagrams of carbon-dioxide equivalents (CO_2e). Carbon dioxide equivalents measures the total greenhouse gas potential of the full combination of gases, weighted by their relative warming impacts.

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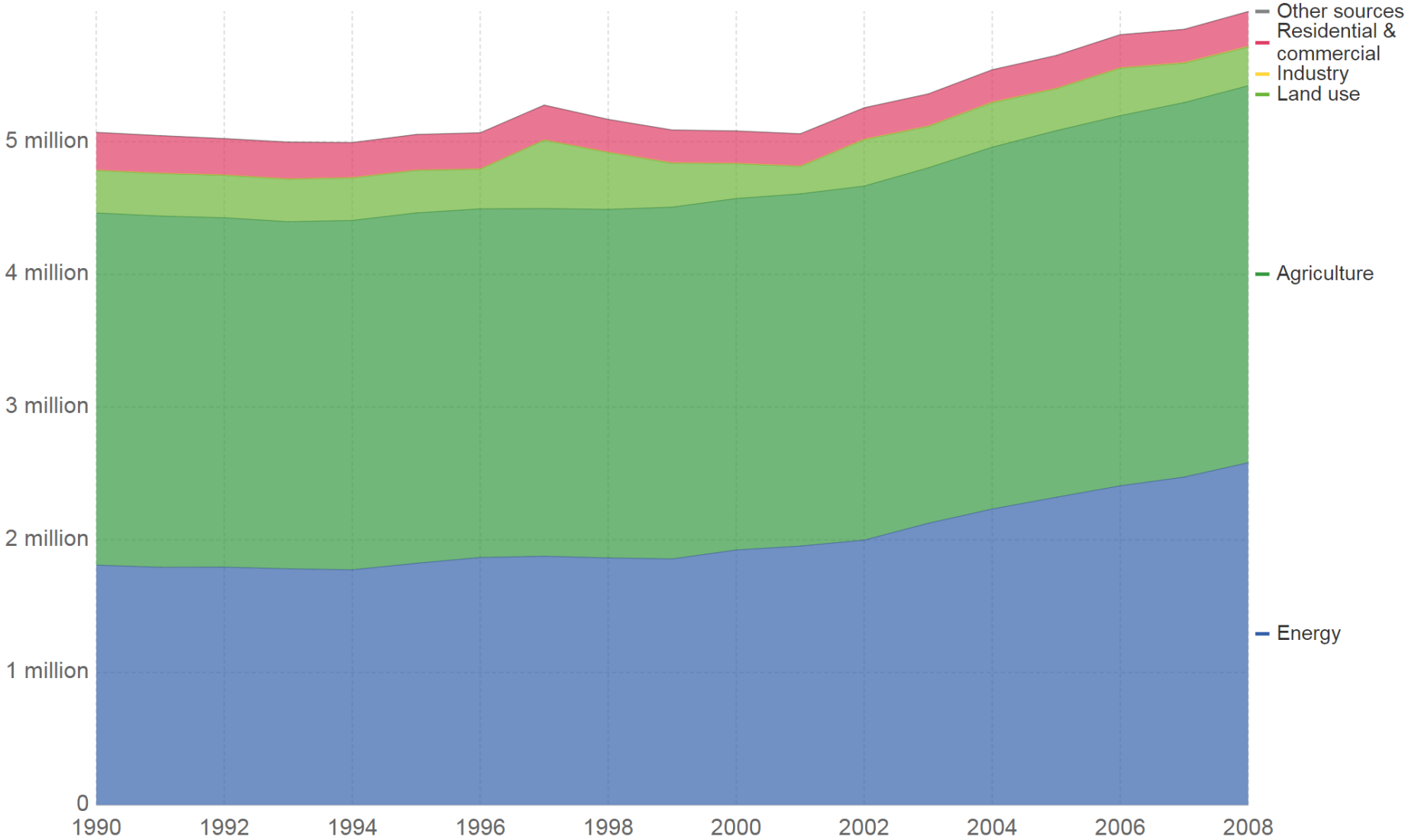

Source: UN Food and Agricultural Organization (FAO)

Nitrous oxide emissions by sector (Gg CO_2e), World

Breakdown of total global nitrous oxide (N_2O) emissions by sector, measured in gigagrams of carbon-dioxide equivalents (CO_2e). Carbon dioxide equivalents measures the total greenhouse gas potential of the full combination of gases, weighted by their relative warming impacts.

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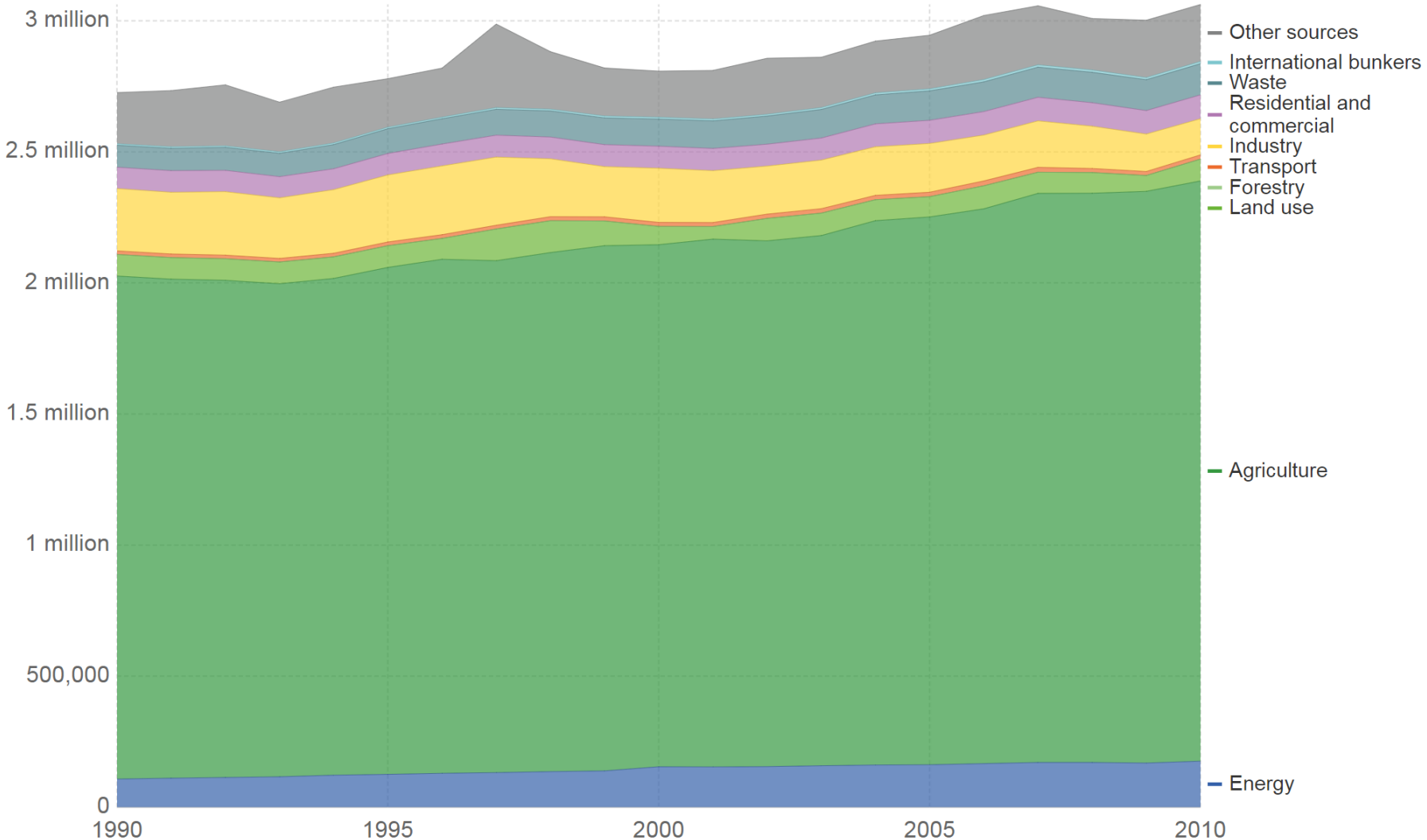


Source: UN Food and Agricultural Organization (FAO)

Important Events in International Climate Change Negotiations

Year, Location	Outcome
1992, Rio de Janeiro	UN Framework Convention on Climate Change (UNFCCC). Countries agree to reduce emissions with "common but differentiated responsibilities."
1995, Berlin	The first annual Conference of the Parties to the framework, known as a COP. U.S. agrees to exempt developing countries from binding obligations.
1997, Kyoto	At the third Conference of the Parties (COP-3) the Kyoto Protocol is approved, mandating developed countries to cut greenhouse gas emissions relative to baseline emissions by 2008-2012 period.
2001, Bonn	(COP-6) reaches agreement on terms for compliance and financing. Bush administration rejects the Kyoto Protocol; U.S.is only an observer at the talks.
2009, Copenhagen	COP-15 fails to produce a binding post-Kyoto agreement, but declares the importance of limiting warming to under 2°C. Developed countries pledge $100 billion in climate aid to developing countries.
2011, Durban	(COP-17) participating countries agreed to adopt a universal legal agreement on climate change as soon as possible, and no later than 2015, to take effect by 2020.
2015, Paris	COP-21 195 nations sign the Paris Agreement, providing for worldwide voluntary actions (INDC's) by individual countries.

International (UN) regime to fight climate change

- Intergovernmental Panel on Climate Change – 1988. (Last report 10/2018)
- Rio Summit on Earth – 1992 (UN conference on environment and development)
  - UNFCCC (UN Framework convention on Climate Change) - consensus vs. 180 parties.
  - Existence of a generally accepted consensus on the climate change as well as the contribution of human activities to this change
  - Common but differentiated responsibility
- Kyoto Protocol – approved in 1997, in force 2005.

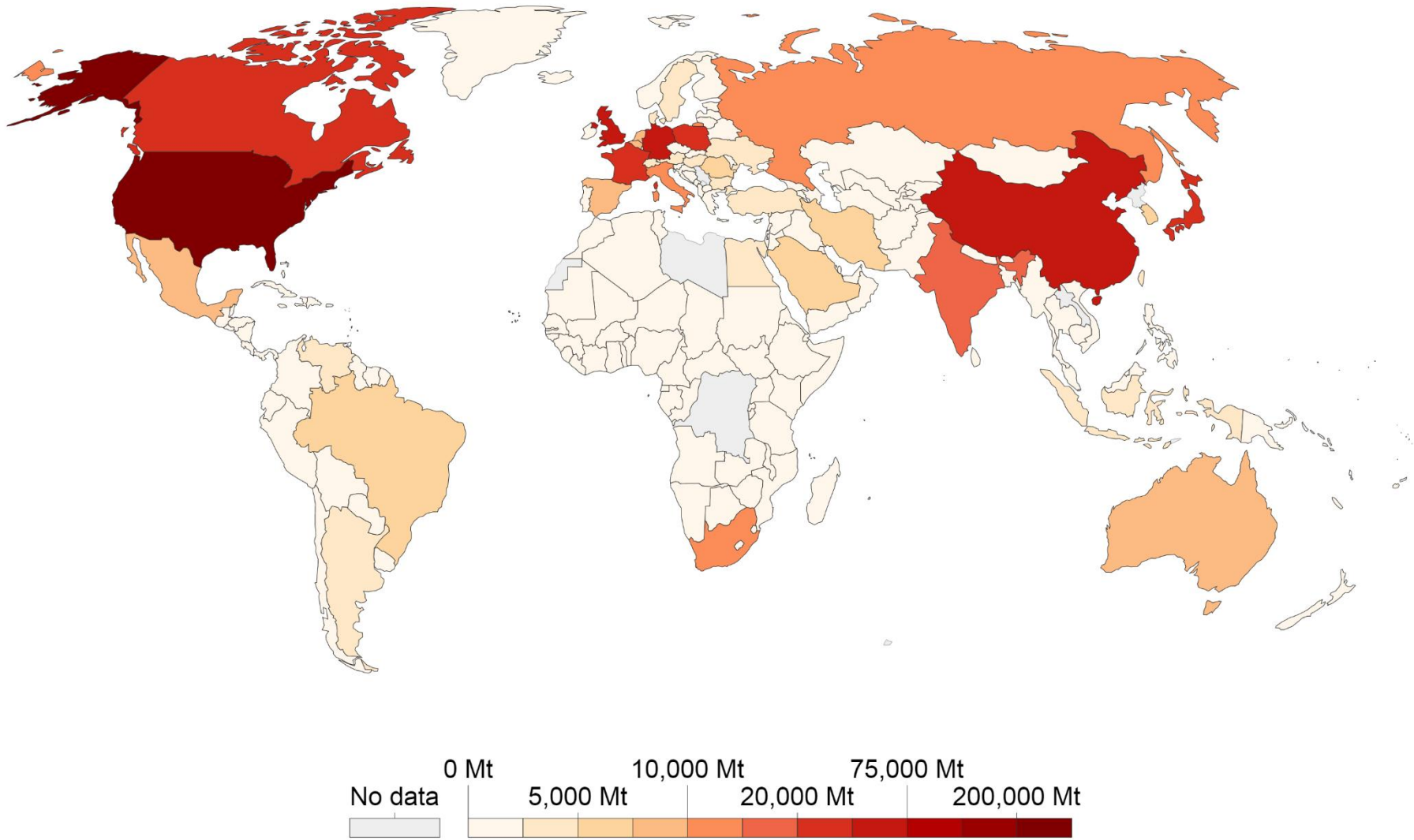
Kyoto Protocol

- 4 GHG (carbon dioxide, methane, nitrous oxide, sulphur hexafluoride) + hydrofluorocarbons and pefluorocarbons.
- Annex I. countries (37 industrialized countries + EU15), Non-annex I. parties.
- Reducing of GHG emissions by 5,2 % for the first commitment period of 2008-2012. (4,2 % after USA left). Base year 1990.
- Reduction of emissions from fossil fuel combustion; reduction emission in other sectors (land-use or direct industrial emissions); flexible mechanisms – Emission trading, CDM, JI.
- First binding international treaty on climate change mitigation, with enforceable (to some extent) targets and schedule, channeling investments into low-carbon technologies.

Cumulative CO_2 emissions, 1997

Cumulative carbon dioxide (CO_2) emissions represents the total sum of CO_2 emissions since 1751, and is measured in million tonnes.

Our World in Data



Source: Carbon Dioxide Information Analysis Centre (CDIAC)

CO_2 emissions per capita vs GDP per capita (international-$), 1997

Carbon dioxide (CO_2) emissions per capita (tonnes per year) vs GDP per capita (int.-$). The size of the bubbles represent population size.

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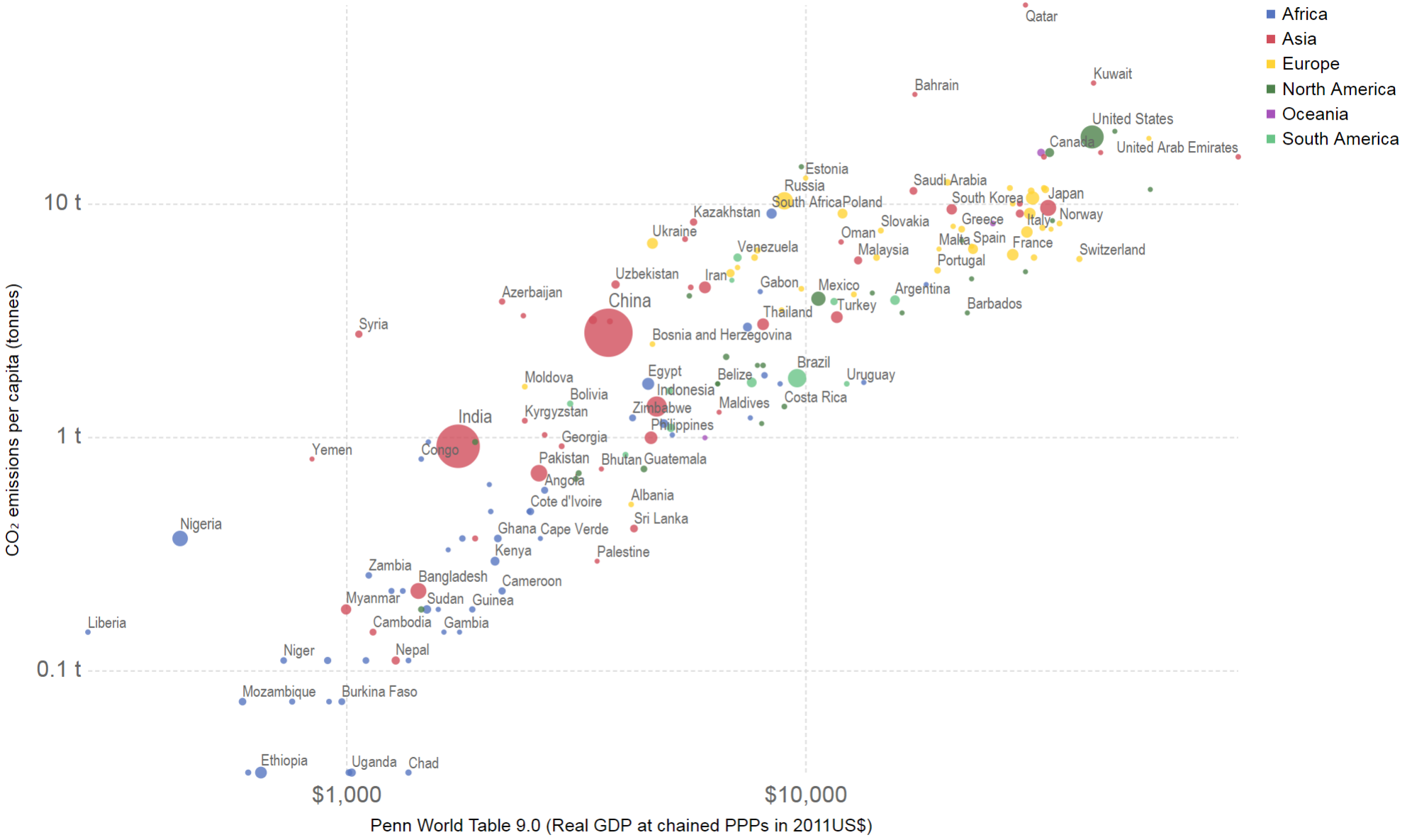
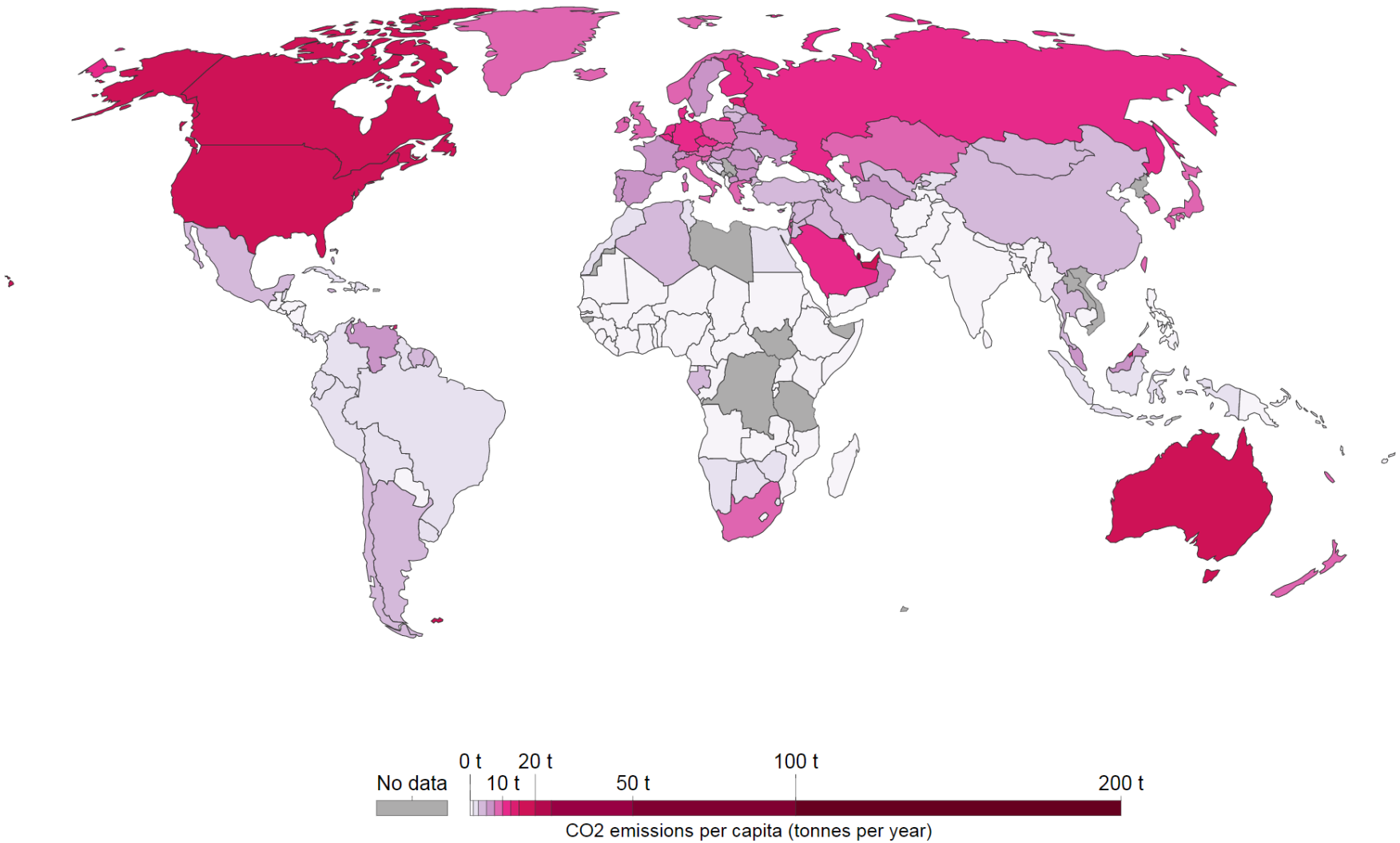


Source: Penn World Table 9.0, CO2 emissions per capita by nation- CDIAC
Note: GDP (intl-$) presented as real GDP (2011) values

CO_2 emissions per capita, 1997

Average carbon dioxide (CO_2) emissions per capita measured in tonnes per year

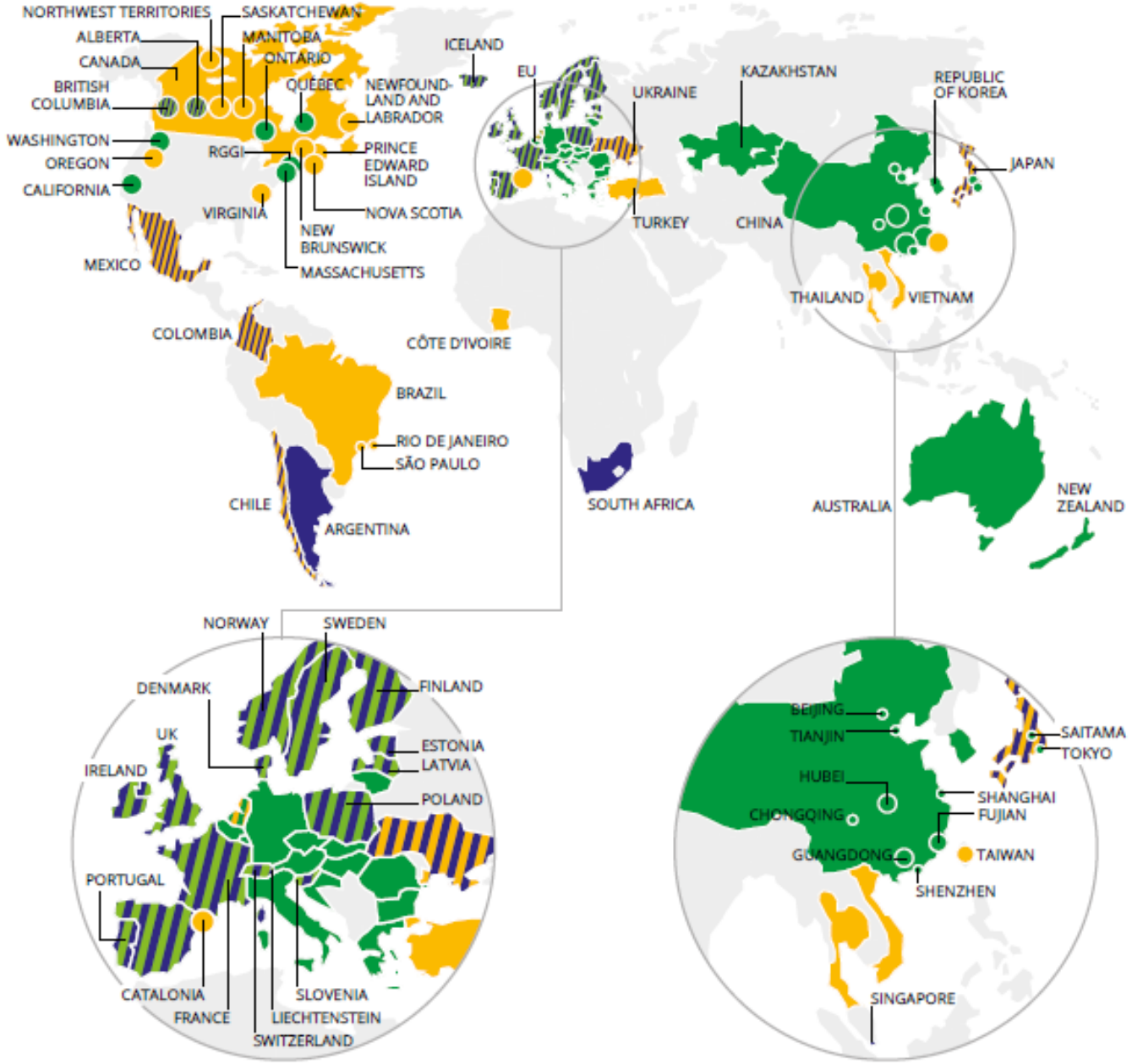
Our World in Data



Source: CDIAC

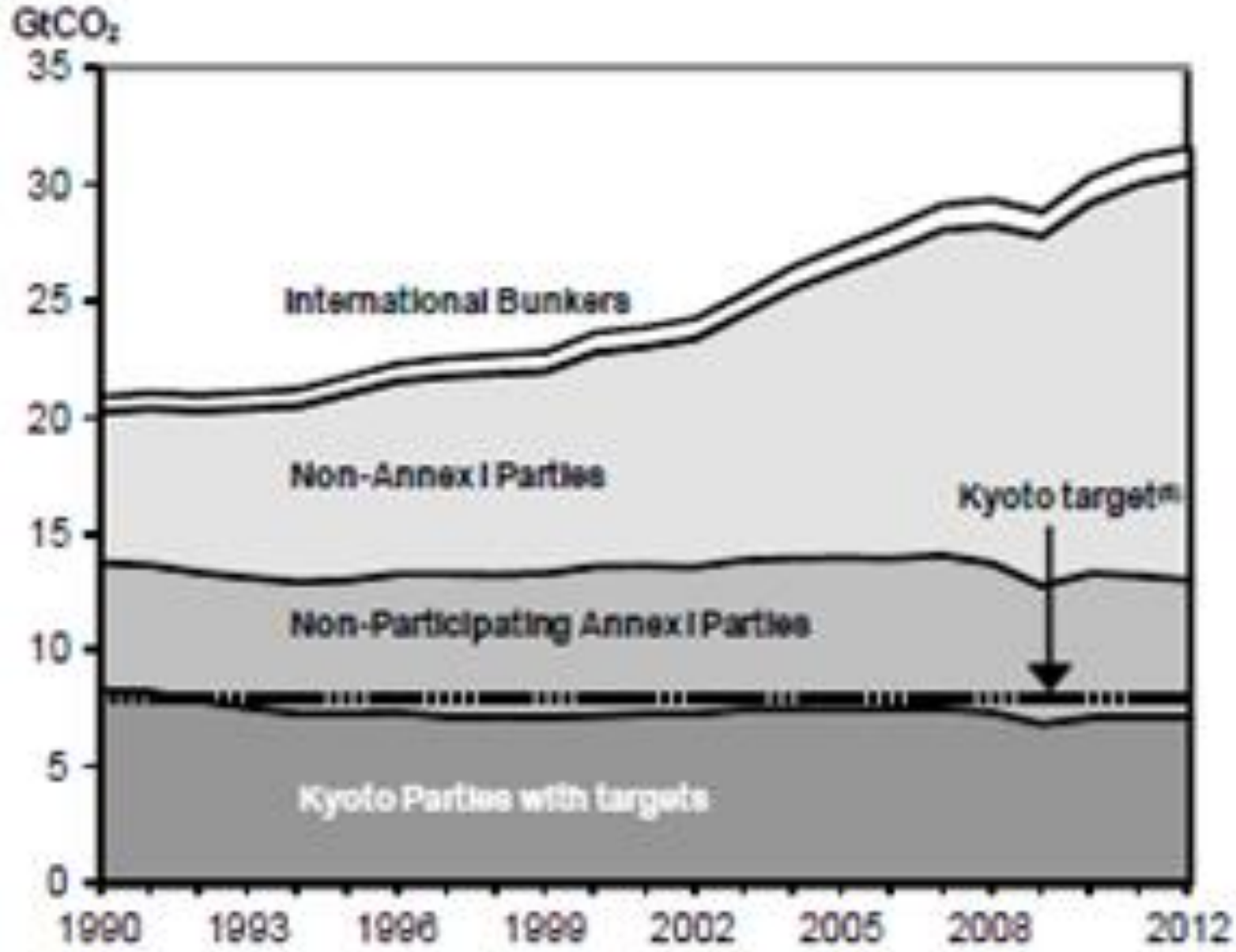
Kyoto Protocol results

- In 2012, CO2 emissions from fuel combustion across all Parties with KP targets were 14% below 1990 levels.
- Emissions in the EU-15 were 8% bellow 1990 levels.
- Some industrialised countries have seen significant increases (Australia +48%), New Zealand (+44%), Spain (+30%).
- Despite extensive participation of 192 countries the KP is limited in its potential – U.S. remains outside, developing countries do not have emission targets.
- The KP implies action on less than one-quarter of global CO2 emissions.
- However, its flexibility mechanisms the KP has made CO2 a tradable commodity, and has been a driver for the development of national emission trading schemes.



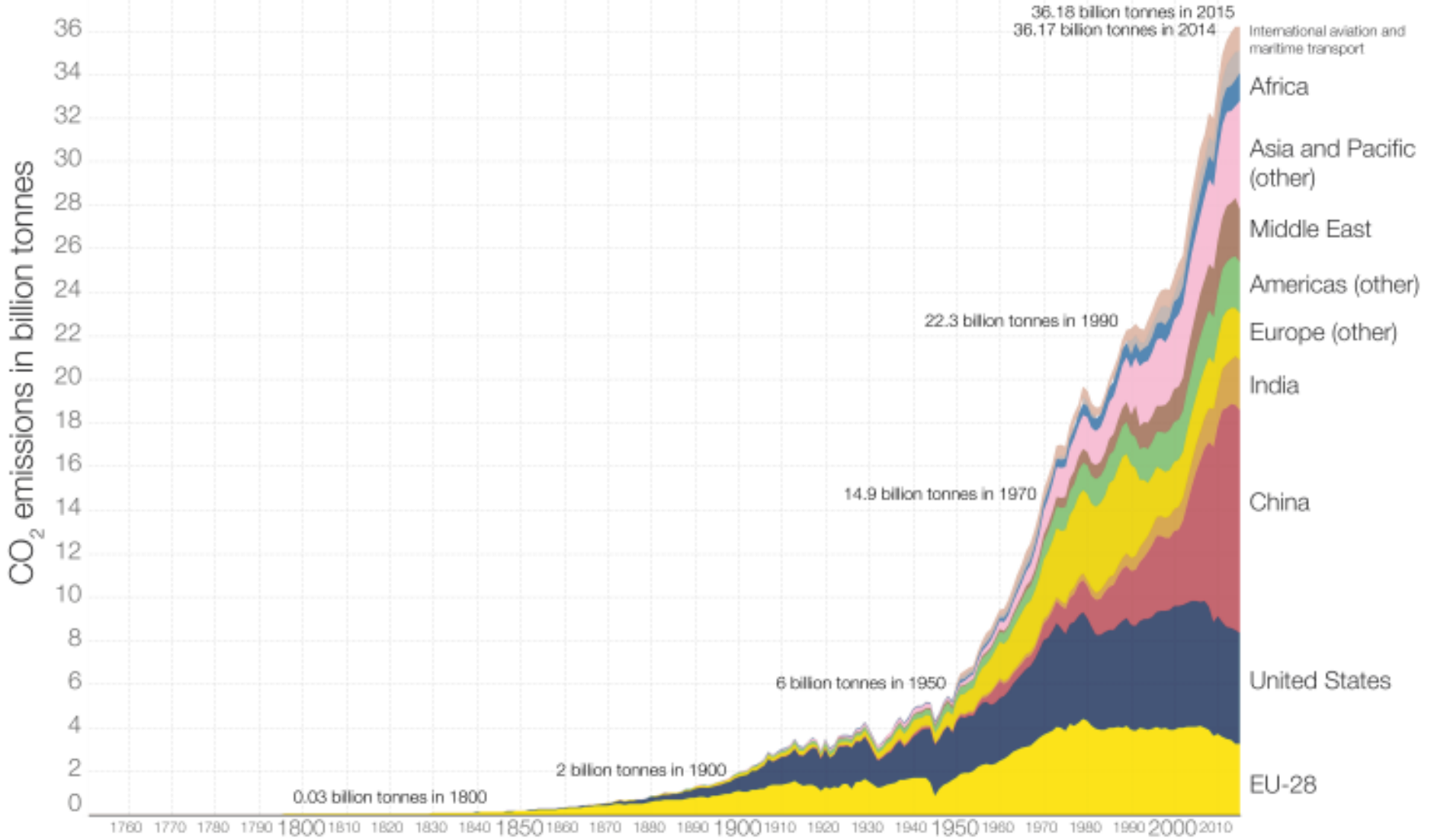
Tally of carbon pricing initiatives implemented or scheduled for implementation

- 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


GtCO2
35
30
25
20
15
10
5
0
International Bunkers
Non-Annex I Parties
Kyoto target[a]
Non-Participating Annex I Parties
Kyoto Parties with targets
1990
1993
1996
1999
2002
2005
2008
2012

Global CO_2 emissions by world region, 1751 to 2015

Annual carbon dioxide emissions in billion tonnes (Gt).



Data source: Carbon Dioxide Information Analysis Center (CDIAC); aggregation by world region by Our World In Data.
The interactive data visualization is available at OurWorldinData.org. There you find the raw data and more visualizations on this topic.

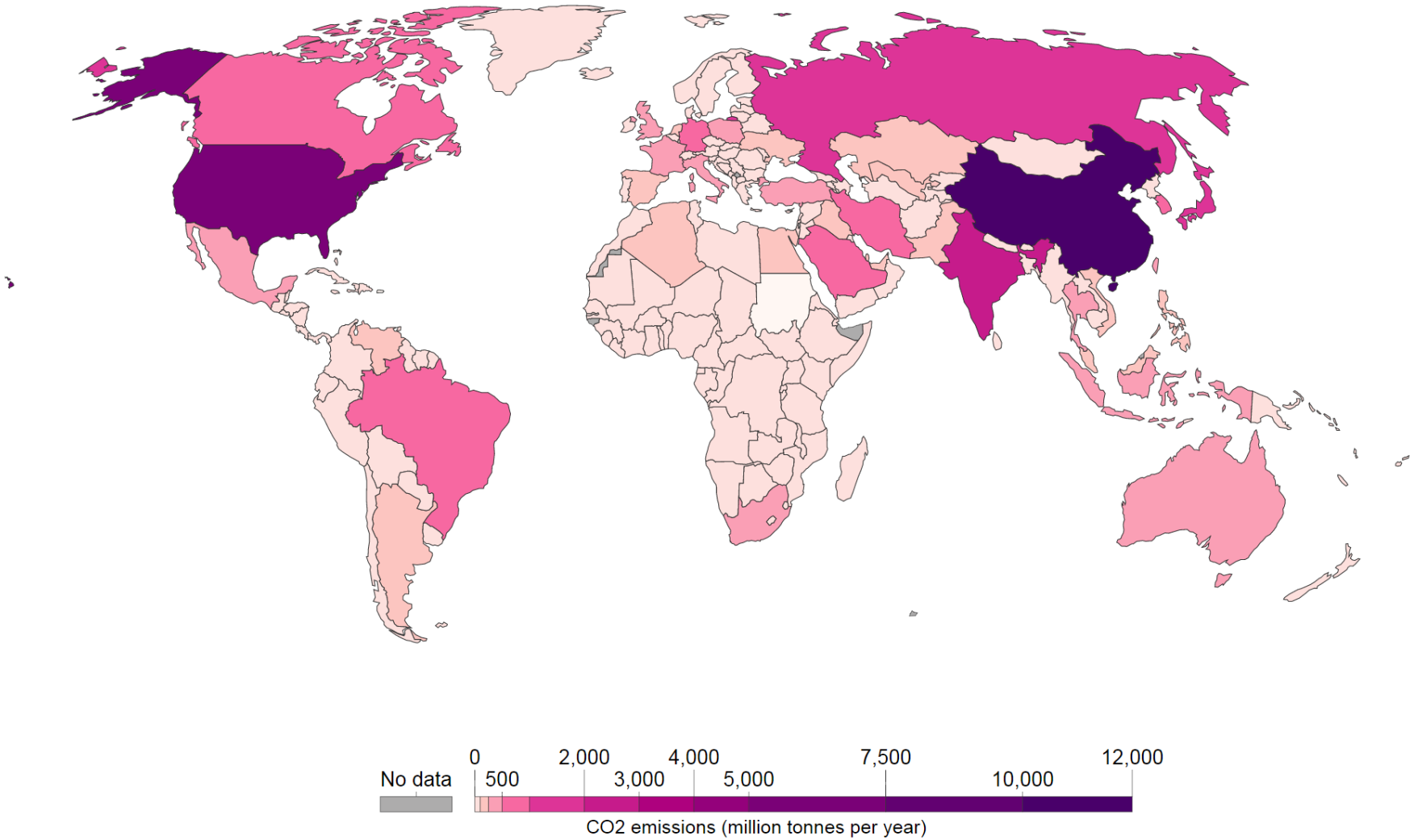
Post-Kyoto system

- Second commitment period of KP for 2013--2020 concluded in 2012 (COP 18 in Doha). Belarus, Canada, Japan, New Zealand, Russia, USA and Ukraine missing. Others reduction commitments covering 13% of global GHG emissions at 2010 levels.
- To limit global temperature increase to less than 2°C above pre-industrial level, countries are negotiating a new climate agreement (partialy finalised at COP21 in Paris 2015).
- It builds on the voluntary emission reduction goals for 2020 that were made at COP15 in Cobenhagen.
- Developed and developing countries with these aims account for over 80% of global emissions. (goals nevertheless not sufficient to fulfill 2°C limit).

Annual CO_2 emissions per country, 2014

Annual carbon dioxide (CO_2) emissions are measured in million tonnes

Our World in Data



Source: CDIAC

Note: Data converted from carbon to carbon dioxide using conversion factor of 3.67

Paris agreement (COP21)

- Legally binding treaty with reduction commitments from 187 countries starting in 2020. Again, 55 countries covering 55% of global emissions needed to enter the force. It:
- Reaffirmes the goal of limiting global temperature increase below 2 degrees, while urging efforts to limit the increase to 1.5 degrees.
- Establishes binding commitments by all parties to make "nationally determined contributions" (NDCs), and to pursue domestic measures aimed at achieving them.
- Commites all countries to report regularly on their emissions and "progress made in implementing and achieving" their NDCs, and to undergo international review.
- Commites all countries to submit new NDCs every five years, with the clear expectation that they will "represent a progression" beyond previous ones.

Paris agreement (COP21)

- Reaffirmes the binding obligations of developed countries under the UNFCCC to support the efforts of developing countries, while for the first time encouraging voluntary contributions by developing countries too.
- Extends the current goal of mobilizing $100 billion a year in support by 2020 through 2025, with a new, higher goal to be set for the period after 2025.
- Extends a mechanism to address "loss and damage" resulting from climate change, which explicitly will not "involve or provide a basis for any liability or compensation".
- Requires parties engaging in international emissions trading to avoid "double counting".
- Calls for a new mechanism, similar to the Clean Development Mechanism under the Kyoto Protocol, enabling emission reductions in one country to be counted toward another country's NDC.

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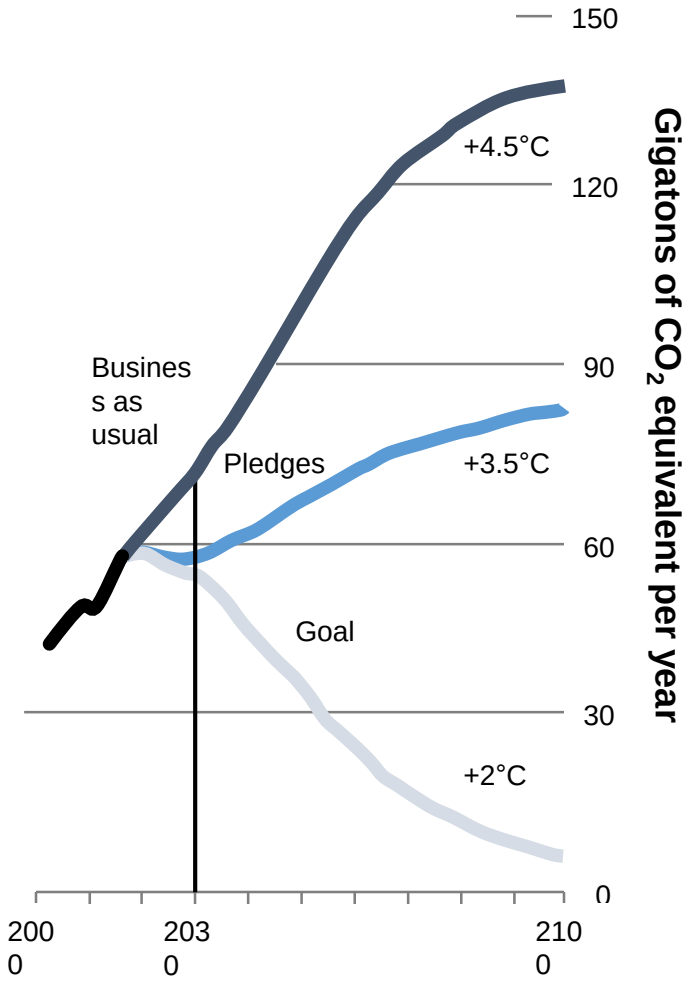
COP21 pledges vs. BaU scenario



Climate change as uniquely global public policy problem

- Environmental problems usually regional (Beijing´s smog, waste from EU´s industry).
- Climate change - impacts may be regional, but phenomenon is global.
- The global nature of climate change also complicates any sensible climate policy. It is tough to get voters to enact pollution limits on themselves, when those limits benefit them and only them, but it is tougher to get voters to enact pollution limits on themselves if the costs are felt domestically, but the benefits are global = a planetary free riding problem.
- Impact of climate change is not evenly distributed among regions and countries. Different vulnerability.

Climate change as uniquely long term public policy problem

- The past decade was the warmest in human history. The one before was the second-warmest. The one before was the third-warmest.
- Changes are evident. Arctic sea ice has lost half of its mass, three-quaters of this volume in only the past thirty years.
- But the worst consequences of climate change are still remote, often caged in global, long-term averages. The worst effects are still far off – but avoiding these predictions would entail acting now.

Climate change as uniquely irreversible public policy problem

- Stopping emitting carbon now we still would have decades of warming and centuries of sea-level rise locked in. Full melting of large West Antarctic ice sheets may be unstoppable.
- Over 2/3 of the excess CO2 in the atmosphere that wasn´t there when humans started burning fossil fuels will still be present a hundred years from now. Over 1/3 will be there in 1000 years.

Climate change as uniquely uncertain public policy problem

- Last time concentration of carbon dioxide were as high as they are today, at 400 ppm, at Pliocene (3 million years ago). Average temperatures back then were around 1-2,5°C warmer than today, sea levels were up to 20 meters higher, and camels lived in Canada.
- We wouldn´t expect any of these dramatic changes today. The greenhouse effect needs decades to centuries to come into full force, ice sheets need decades to centuries to melt, global sea levels take decades to centuries to adjust accordingly. CO2 concentrations may have been at 400 ppm 3 million years ago, whereas rising sea levels lagged decades or centuries behind.

Climate change as uniquely expensive public policy problem

- Around current climates masive investments and industrial infrastructures is build, that makes temperature increases costly.
- The current models estimates that warming of 1°C will cost 0,5% of global GDP, 2°C around 1% GDP, 4°C around 4% GDP.
- We could think about damages as a percentage of output in any given year. At a 3 percent annual growth rate, global economic output will increase almost twenty-fold in a hudred years
- Or lets assume that damages affect output growth rates faster than output levels. Climate change clearly affects labor productivity, esp. in already hot countries. Then the cumulative effects of damages could be much worse over time.

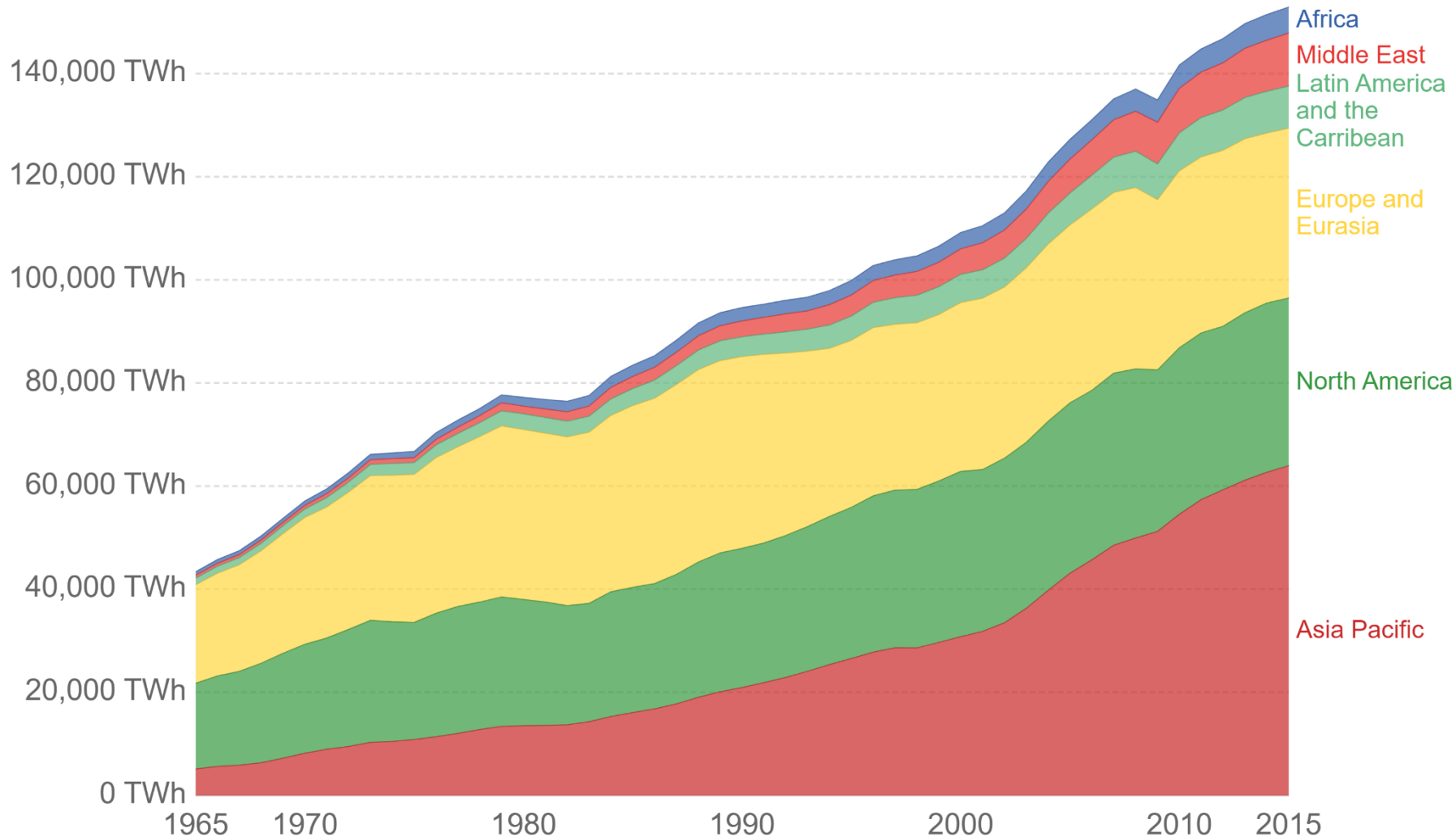
Major cleavages

- Should be a global climate agreement legally binding or nor?
- Who it should bind? (BASIC – „development first“)
- How much aid (if any) to provide to help countries adapt to climate change?
- Should compensation be given to developing countries for the damage caused by climate change? (´loss and damage´).

Primary energy consumption by world region

Global energy consumption by region, measured in terawatt-hours (TWh). Note that this data includes only commercially-traded fuels (coal, oil, gas), nuclear and modern renewables used in electricity production. As such, it does not include traditional biomass sources.

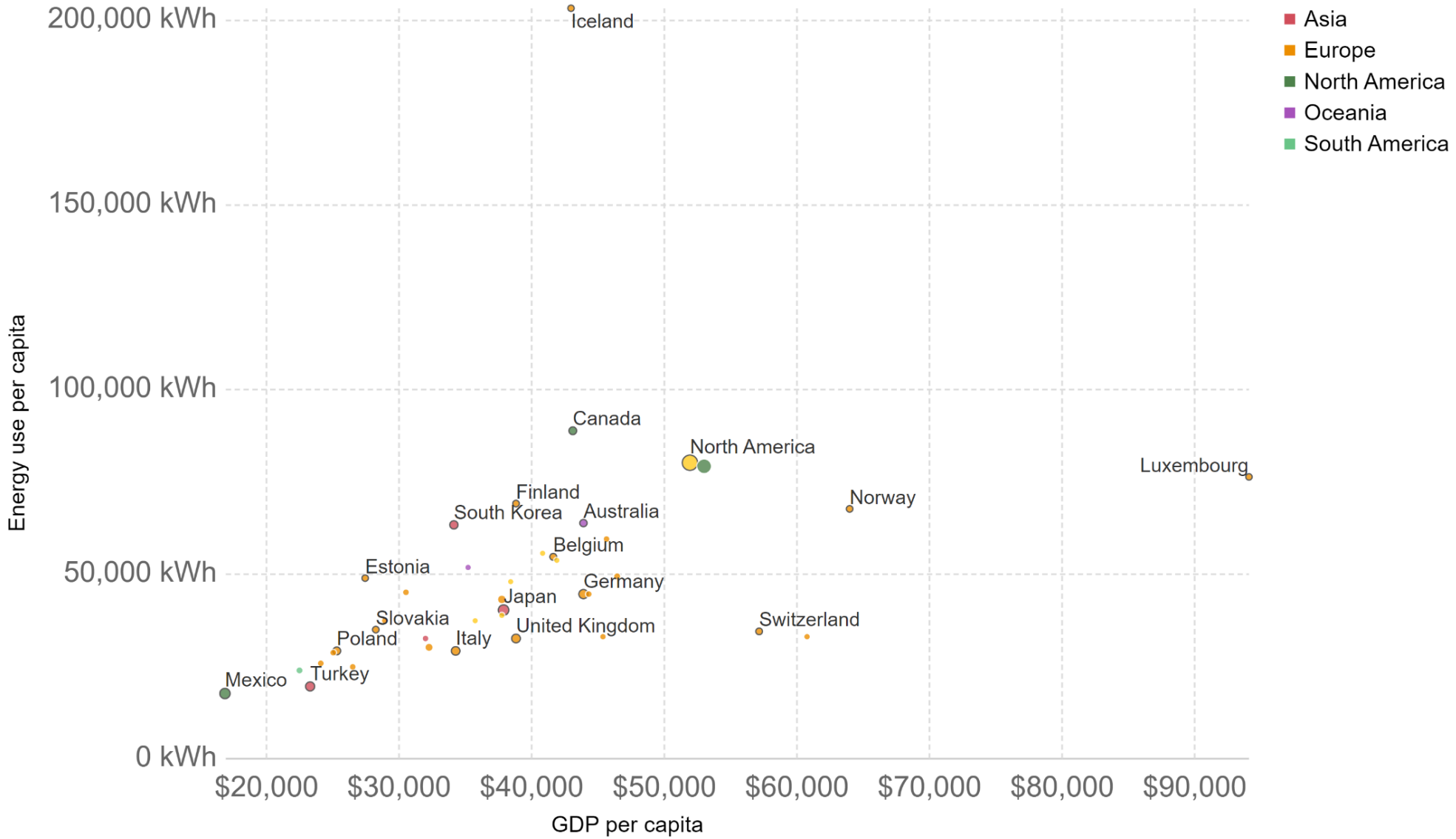
Our World in Data



Source: BP Statistical Review 2016

Energy use vs. GDP per capita, 2015

Annual energy use per capita, measured in kilowatt-hours per person vs. gross domestic product (GDP) per capita, measured as 2011 international-$.



Source: International Energy Agency (IEA) via The World Bank

- More about climate change in MEB415 Environmentální aspekty energetiky/ESS411 Environmental Aspects of Energy.

Sources

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