Climate change and fossil fuels

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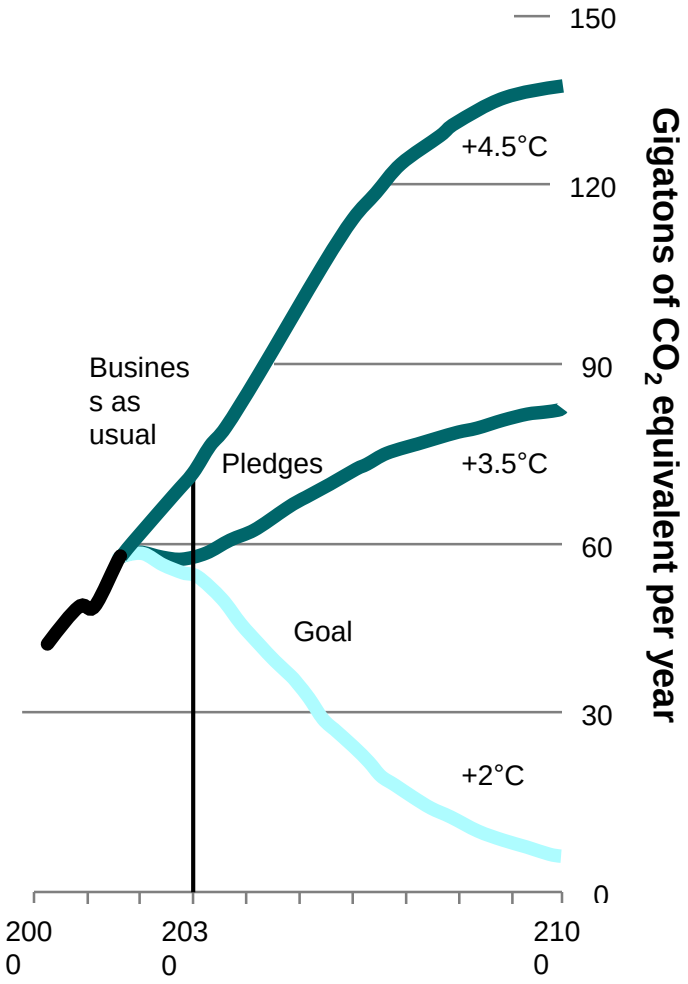
COP21 pathways



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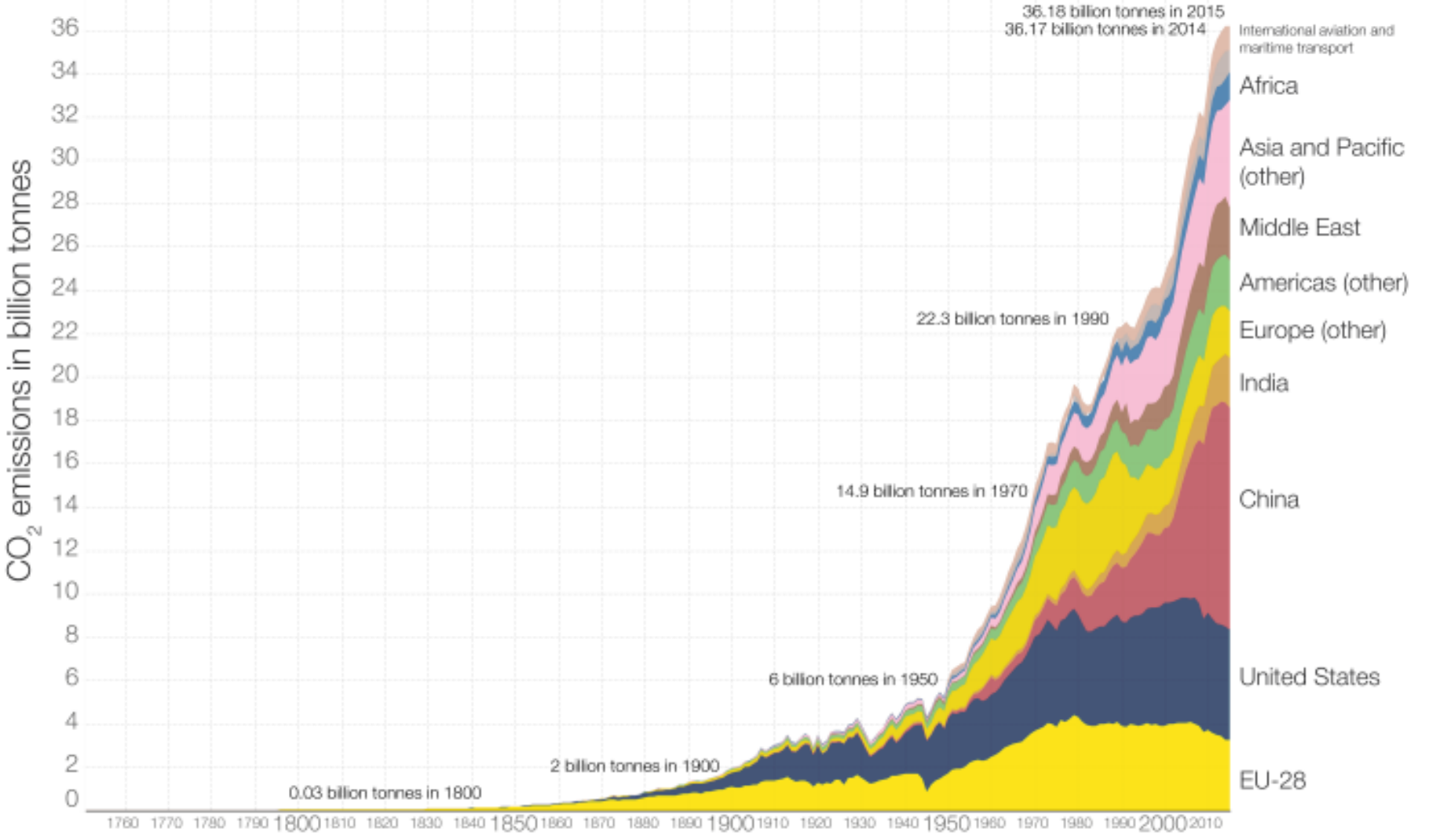
Global CO_2 emissions by world region, 1751 to 2015

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.

Climate change as a public policy problem

Is uniquely global

- Environmental problems usually regional (Beijing´s smog, EU´s industrial waste).
- 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 a public policy problem

Is uniquely long-term

- 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 a public policy problem

Is uniquely irreversible

- 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 a public policy problem

Is uniquely uncertain.

- 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.

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Climate change as a public policy problem

It is uniquely expensive

- 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.

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Mitigation tools

- **Price based instruments** (carbon pricing) - taxes on CO2; taxes on inputs or outputs of processess (fuel); subsidies for emission reducting activities; emission trading systems (cap and trade systems), feed in tariffs, green certificates…
- **Comand and control regulations** – technology standards (biofuel blend mandate, minimum energy performance standards); performance standards (fleet average CO2 vehicle efficiency); prohibition or mandating of central products or practices (bulbs, vacuum cleaners); certification, reporting requirements; land use planing…
- **Information and voluntary approaches** – rating programmes, public information campaigns, education, awards.

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Carbon pricing

- To decrease demand we need to raise its cost. Trying to find the balance of the costs and benefits of carbon production, not to reducing it entirely. To internalize the externalities.
- Instruments that reach throughout the economy, influencing all production and consumption decisions.
- 1)figuring out how much carbon we want to put into the environment. 2) Then a cost must be applied:
  - applying tax on it (Pigouvian tax)
  - cap-and-trading
- Both these systems raise some revenue that could be used to offset the negative macroeconomic impacts of energy price rises.

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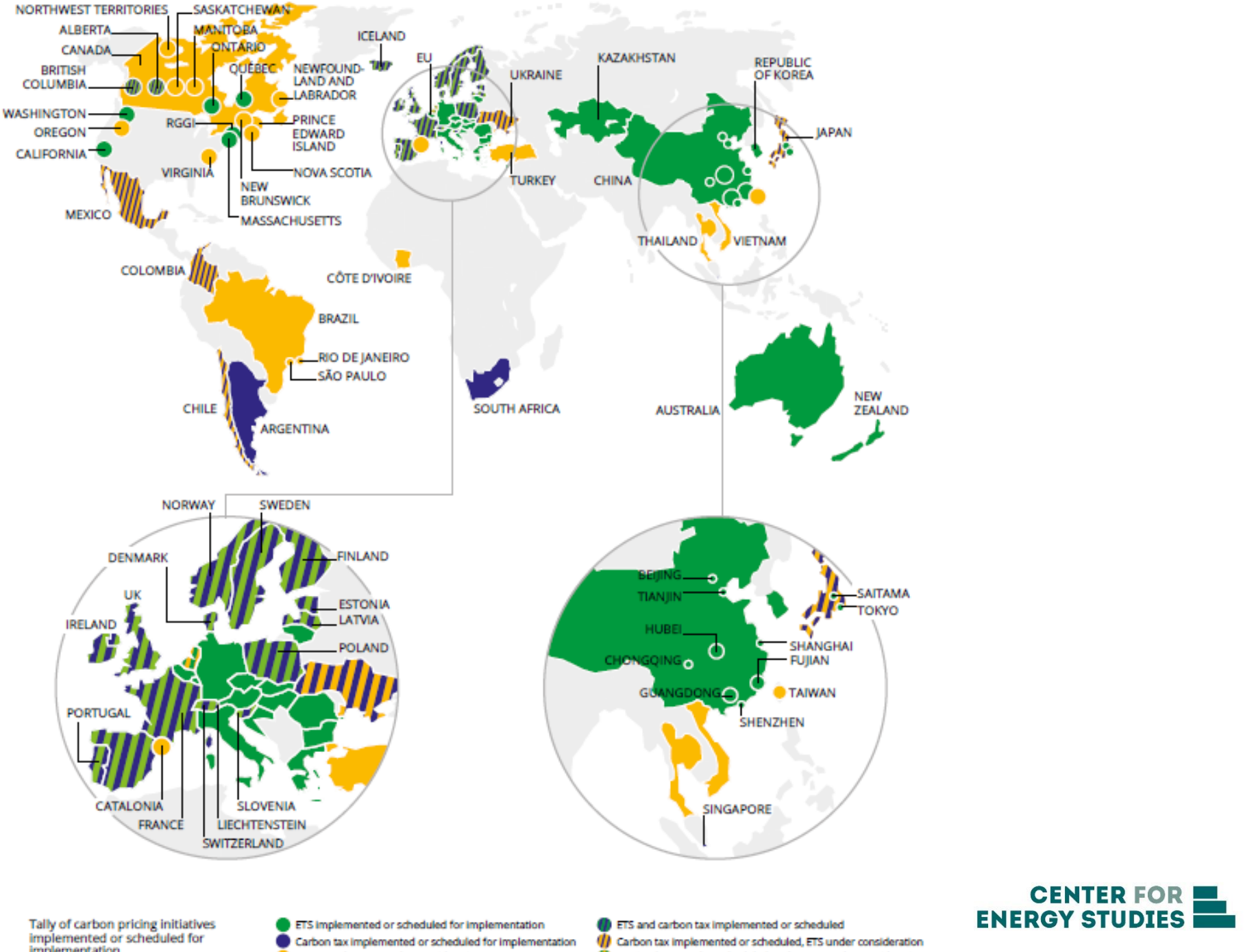
Carbon taxes

- Norway – CO2 tax introduced in 1991. Applied to oil products, emissions from oil and gas production and gas used for heating and transport. Sectors covered by EU ETS exempted from carbon tax, with exeption of the offshore oil and gas sector. From 2013 the tax level has been increased to offset the falling EUA price.
- Japan – introduced in 2012 to raise revenue for energy efficiency and RES programmes, not as a direct price incentive.
- Switzerland – CO2 levy intended as an incentive for energy efficiency and for shifting toward cleaner heating and proces fuels (not to raise revenue). In place since 2008. Increased from 12 CHF/tCO2 to 120 CHF/tCO2.
- British Columbia (Canada) – introduced in 2008 at USD10/ton, eventually reached USD30/ton. Revenue neutral, compensated by income and corporate tax cuts. Consumption fuels dropped by 5-15%, while in the rest of Canada increased by about 3%. GDP continued to increase.

Cap and trade systems

- A government assigns to itself the right to put emissions into the environment.
- It defines what it believes to be the socially optimal quantity of emissions.
- The govevernment generates a number of permits equal to the amount of allowable emissions.
- These permits are allocated to emitters to trade with them – market is created.

= economically efficient, provides incentives for efectivity of the system. To develop technology that would allow one to reduce emissions at a cost lower than that of buying a permit, that spurs innovation and technological development.



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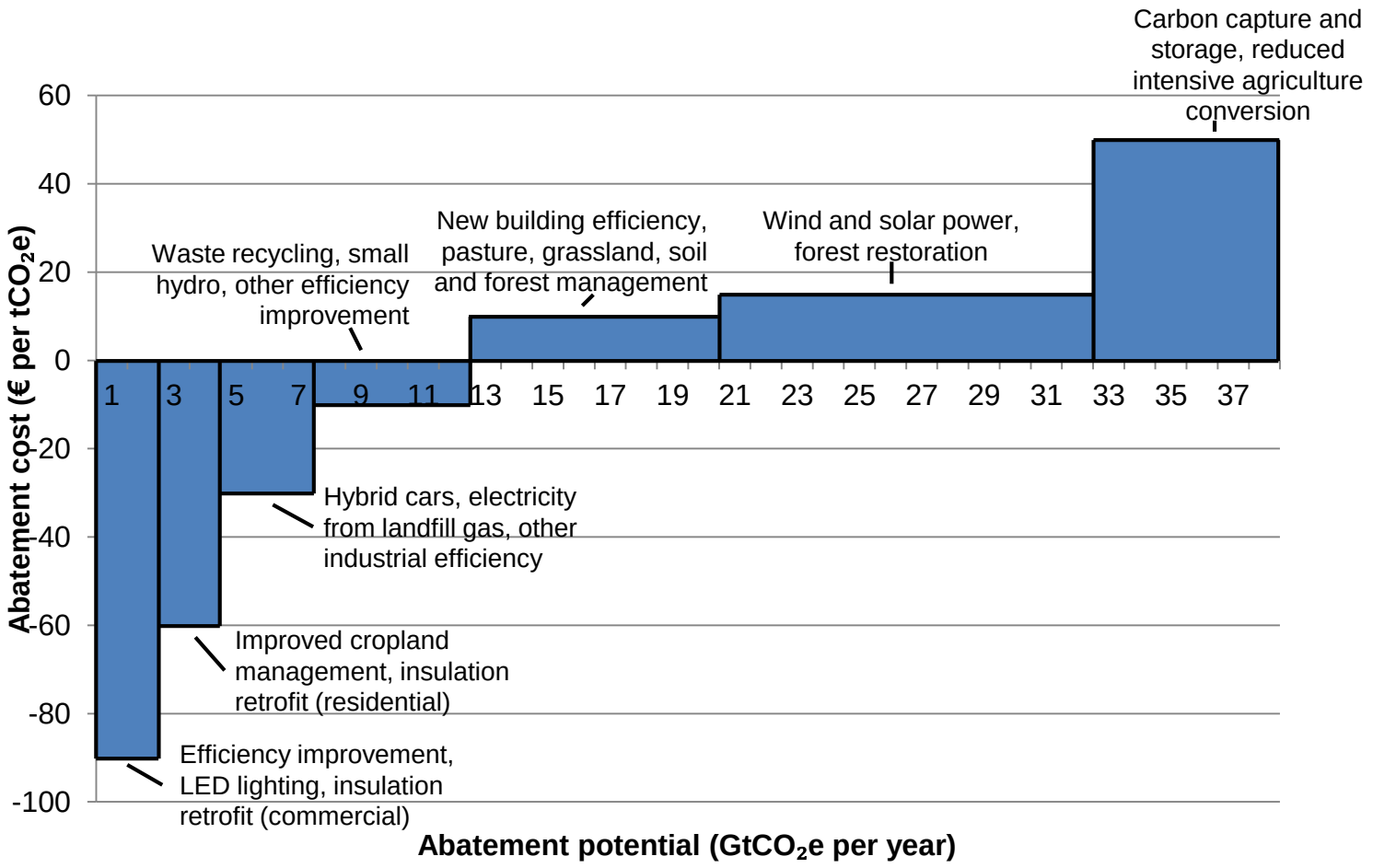
Carbon tax vs. cap and trade system

- Carbon tax:
  - Simpler to understand, easier to built, more transparent.
  - Keeps pushing for reducing the emissions despite technology development.
  - Is to be implemented more quickly.
  - Greater price predictability.
- Cap and trade system
  - Avoids negative connotation of ´tax´.
  - Some companies are effective in lobbying for exemptions.
  - Known reduction of emissions, unknown price.

Global Greenhouse Gas Abatement Cost Curve for 2030



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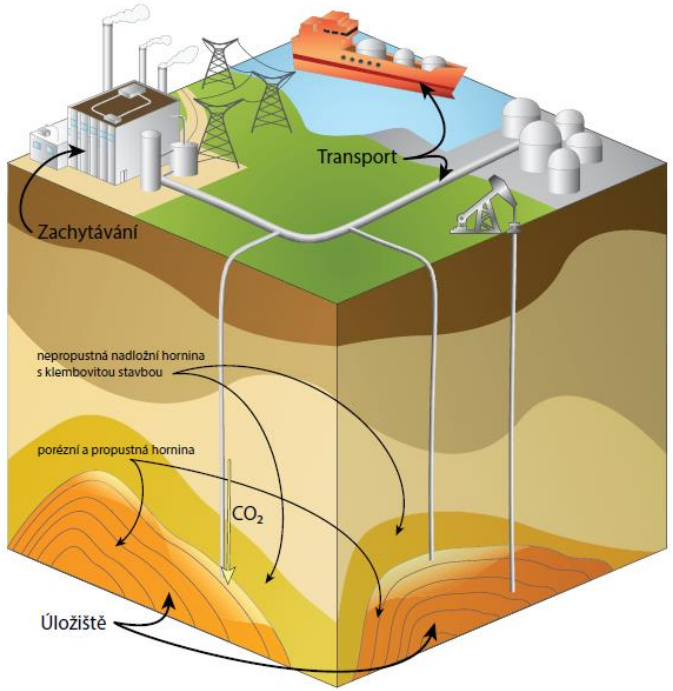
CCS technology

- May address the emissions in both energy and industrial sectors.
  - Capture
  - Transport
  - Storage



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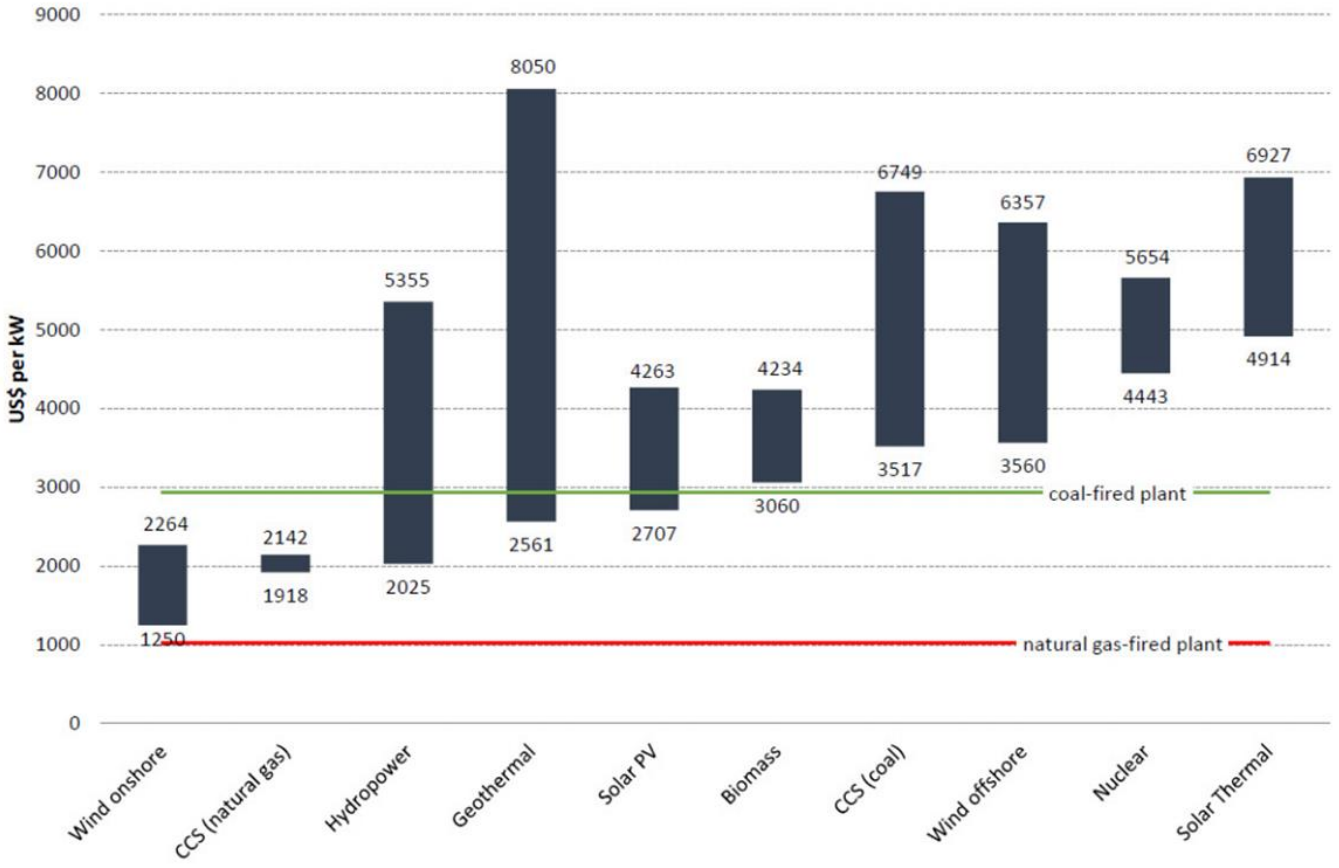
CAPEX of the US power plants (USD2014)



Source: Global CCS Institute analysis

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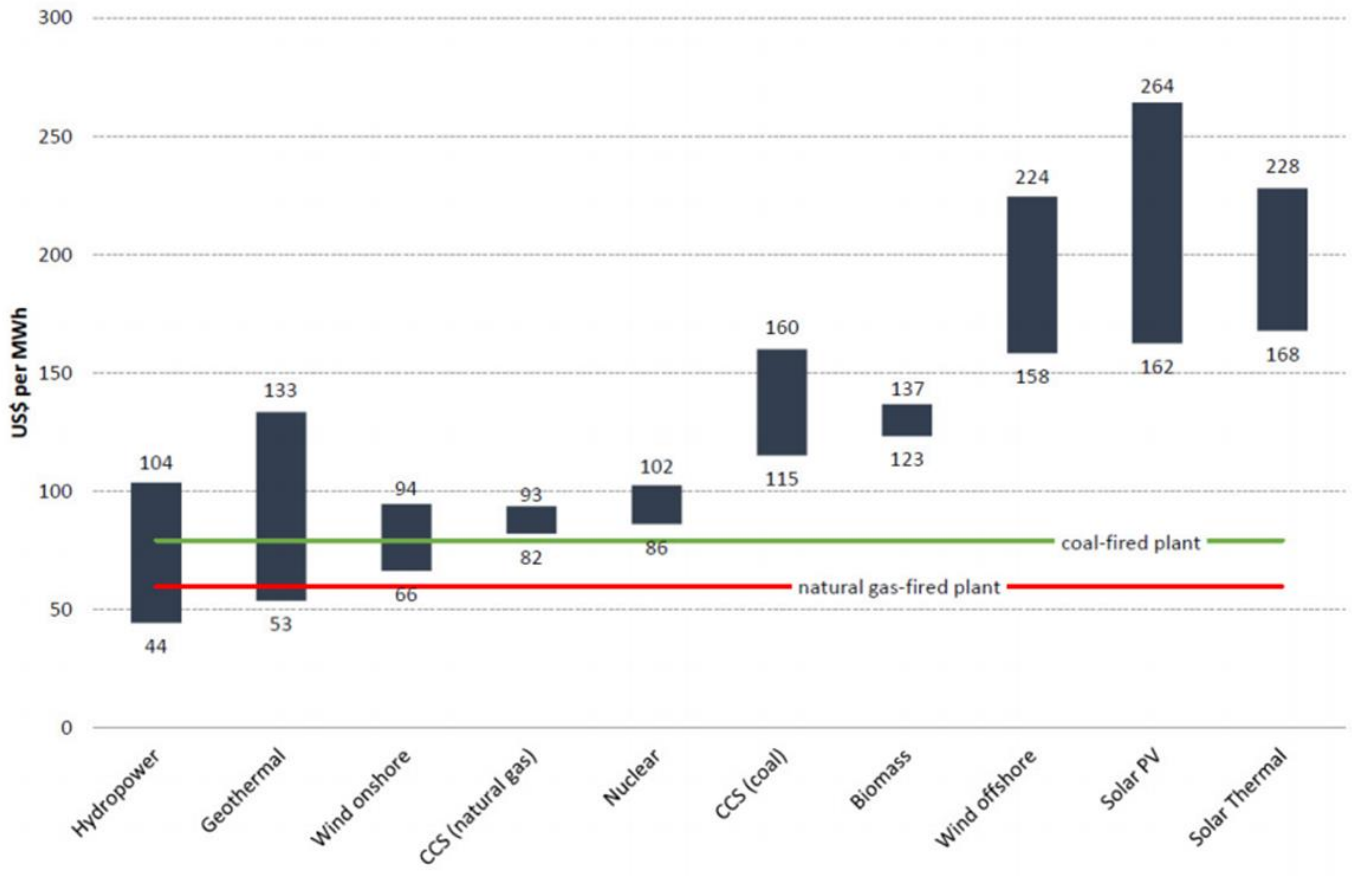
LCOE of the US power plant (USD2014)



Source: Global CCS Institute analysis

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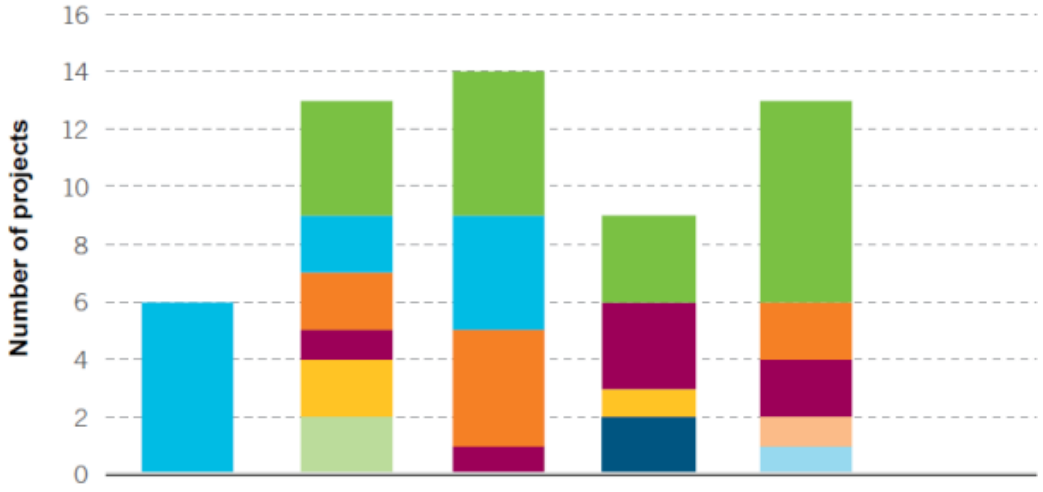
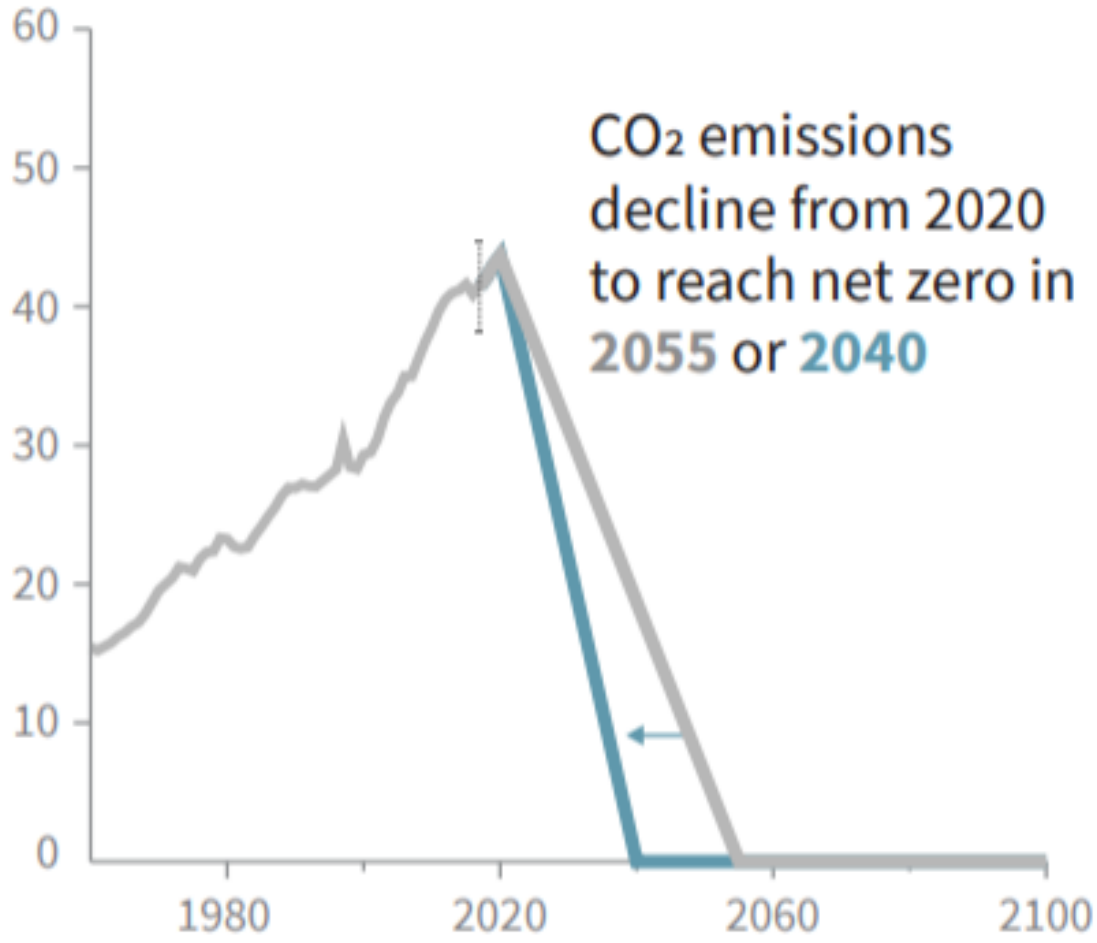
Existing units and units in preparation



	Identify	Evaluate	Define	Execute	Operate	**Total**
United States	0	4	5	3	7	**19**
China	6	2	4	0	0	**12**
Europe	0	2	4	0	2	**8**
Canada	0	1	1	3	2	**7**
Australia	0	2	0	1	0	**3**
Middle East	0	0	0	2	0	**2**
Other Asia	0	2	0	0	0	**2**
South America	0	0	0	0	1	**1**
Africa	0	0	0	0	1	**1**
Total	**6**	**13**	**14**	**9**	**13**	**55**

Stylized net global CO2 emission pathways (GtCO2/yr) – IPCC special report of 10/2018



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Climate Change Adaptation Needs, by sector

Sector	Adaptation strategies
Water	Expand water storage and desalination Improve watershed and reservoir management Increase water-use and irrigation efficiency and water re-use Urban and rural flood management
Agriculture	Adjust planting dates and crop locations Develop crop varieties adapted to drought, higher temperatures Improved land management to deal with floods/droughts Strengthen indigenous/traditional knowledge and practice
Infrastructure	Relocate vulnerable communities Build and strengthen seawalls and other barriers Create and restore wetlands for flood control Dune reinforcement
Human health	Health plans for extreme heat Increase tracking, early-warning systems for heat-related diseases Address threats to safe drinking water supplies Extend basic public health services

Climate Change Adaptation Needs, by sector

Sector	Adaptation strategies
Transport	Relocation or adapt transport infrastructure
	New design standards to cope with climate change
Energy	Strengthen distribution infrastructure
	Address increased demand for cooling
	Increase efficiency, increase use of renewables
Ecosystems	Reduce other ecosystem stresses and human use pressures
	Improve scientific understanding, enhanced monitoring
	Reduce deforestation, increase reforestation
	Increase mangrove, coral reef, and seagrass protection

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