Climate Economics for Engineers

ENV-724 (Thalmann/Vielle/Vöhringer), Session 6, 28 Oct. 2020

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Overview

23.09	Economic activity as a source of greenhouse gases, climate scenarios	Frank Vöhringer
30.09	Impacts of climate change: valuation and uncertainty	Philippe Thalmann
07.10	Impacts of climate change: net costs (aggregation, discounting)	Frank Vöhringer
14.10	Adaptation to climate change	Marc Vielle
21.10	Mitigation: abatement measures, cost curves, innovation	Frank Vöhringer
28.10	Cooperation: mitigation as a public good, international climate policy	Frank Vöhringer
04.11	Instruments for climate policy	Philippe Thalmann
11.11	Swiss climate policy	Philippe Thalmann
18.11	Solar radiation management: economics and governance	Frank Vöhringer
02.12	Final exam	all

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Overview for today

- abatement measures
- the cost of mitigation
- mitigation game
- international climate policy
  - negotiations and commitments under the UNFCCC
  - mitigation as a public good
  - equity and fairness
- economics of innovation

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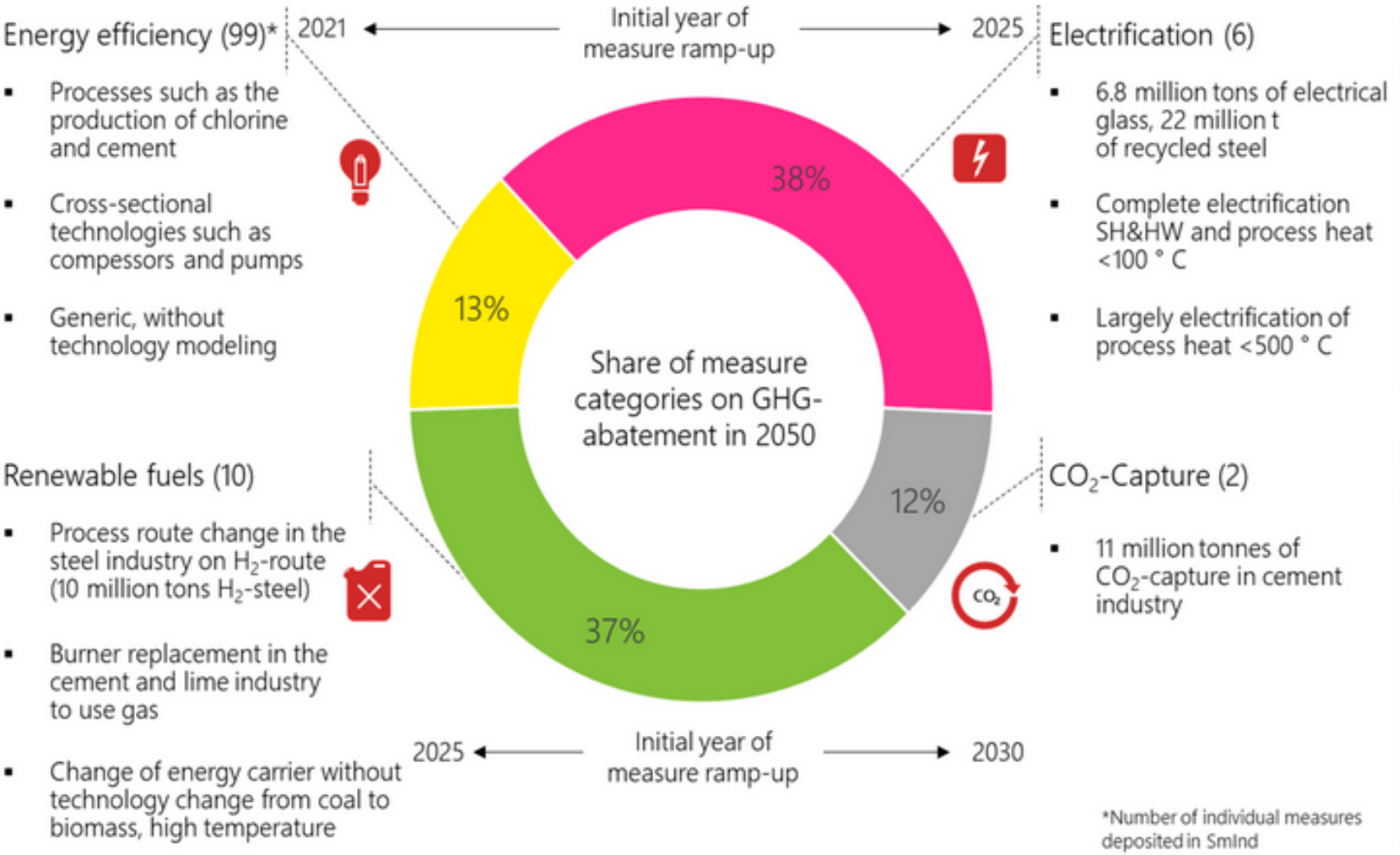
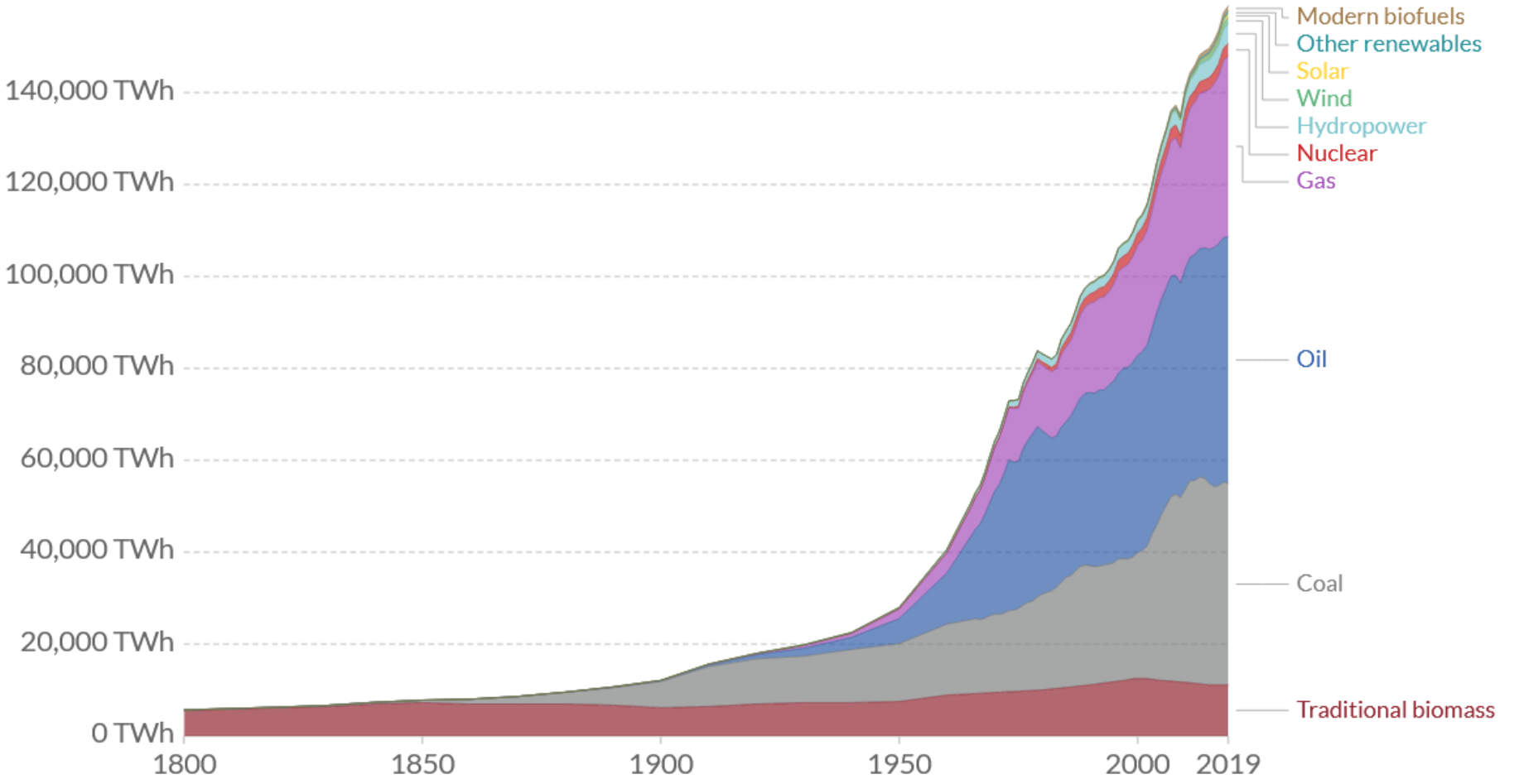
4 major levers for abatement in industry



Country: Germany
Source: Hübner 2020

Global primary energy supply



Source: Vaclav Smil (2017) and BP Statistical Review of World Energy

Net zero energy buildings

Source: General Electric

imagination at work

Carbon capture and storage (CCS)

- capture of CO_2 from large industrial emissions sources
  - power plants, cement plants, ...
- storage of the CO_2 in deep underground geological formations
  - exploited oil and natural gas reservoirs
  - saline, basalt and other formations
  - requirements
    - safety (CO_2 is invisible, odorless and fatal)
    - social and environmental sustainability
    - affordability (e.g.: transport is expensive)
    - acceptability

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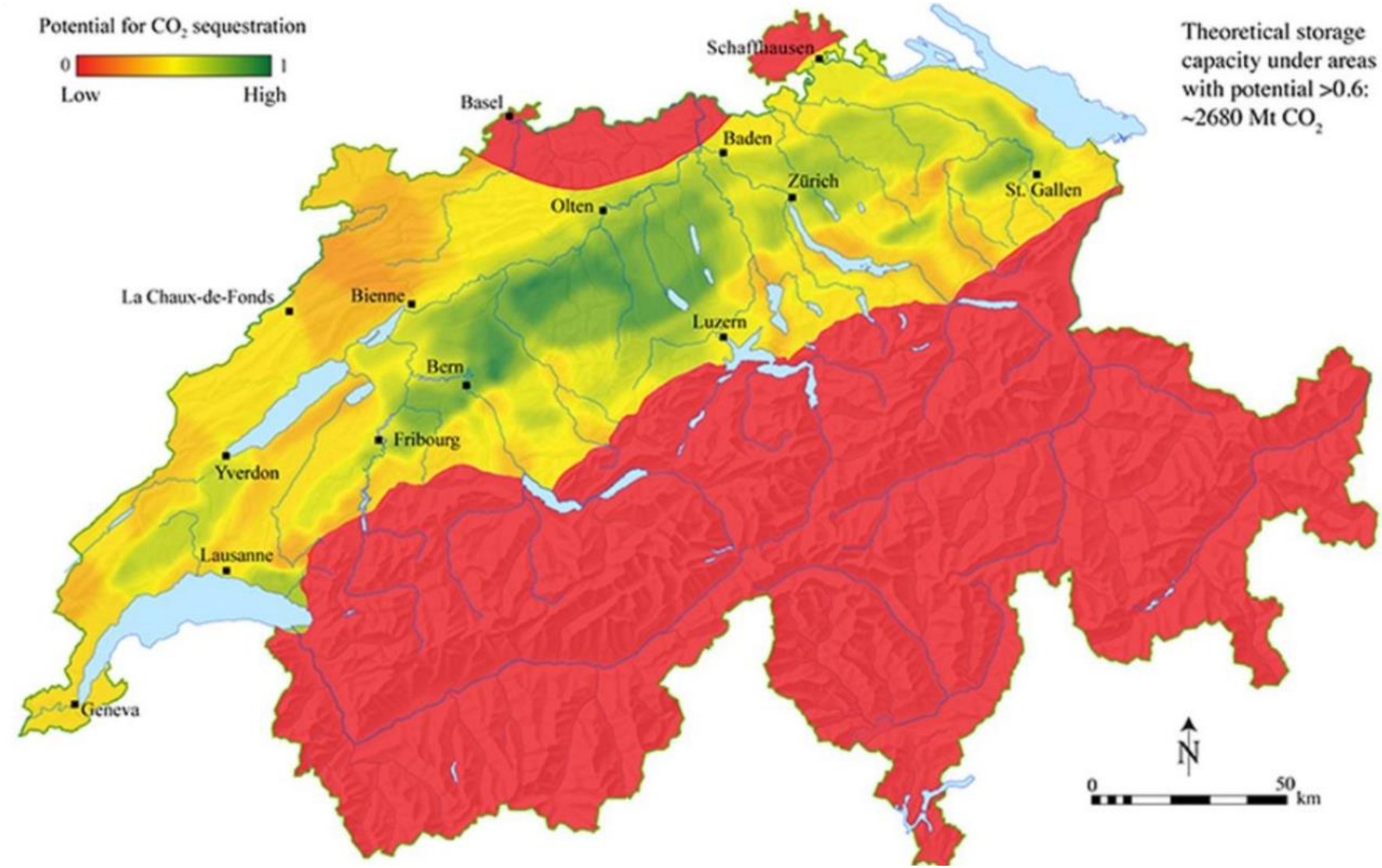
Theoretical CO_2 storage potentials in CH



Source: geologieportal.ch, based on the CARMA project

Buying time for fossil fuel based industries?

- theoretical CCS potentials are large, but how large will effective potentials be?
  - socially acceptable and safe
  - economically viable
    - no incentives without high CO_2 prices
  - timeline (so far only demonstration projects)
- negative emissions required
  - CCS, but with bioenergy instead of fossil fuels (BECCS)

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Bioenergy with CCS (BECCS)

- negative emissions
  - growing biomass sustainably captures CO_2 and stores it as carbon in both biomass and soil
  - using the biomass for electricity generation releases most of the carbon, but this doesn't increase atmospheric CO_2 concentrations when the emitted CO_2 is captured and stored
- sustainable biomass production
  - avoid prior deforestation
  - avoid local social conflict
  - competing land uses, especially food production (which may lead to deforestation elsewhere)
  - marine biomass (algae) as an alternative? (MBECCS/ABECCS)
  - incentives and instutions needed

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Land use, land use change, and forestry

- high potentials for storing carbon
  - in biomass aboveground and belowground and in soil
  - especially in tropical forests (fast growth, lower cost)
    - avoided deforestation/degradation (sustainable management?)
    - afforestation and reforestation
    - forest plantations
- issues
  - permanence
    - forest fires, land use change
    - plantation harvesting (wood as building material or furniture?)
  - institutions and incentives
  - neocolonialism?
  - sustainability

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Forests and sustainability

- benefits
  - timber and other products
  - recreation and tourism
  - environmental services
    - biodiversity, clean water and air, climate regulation
    - avoided erosion
    - carbon storage (dominant in monetizations)
- some issues
  - local development priorities and long-term commitments
  - low profitability and attractive economic alternatives
  - land conflict
    - projects with small farmers exist, but not at large scale

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Methane abatement measures (examples)

- energy
  - flaring of landfill gas
  - electricity generation from landfill gas
  - utilization of gas from coal mines
  - gas flaring or utilization in oil extraction
- agriculture
  - rice management
  - improved feeding practices
  - anaerobic digestion

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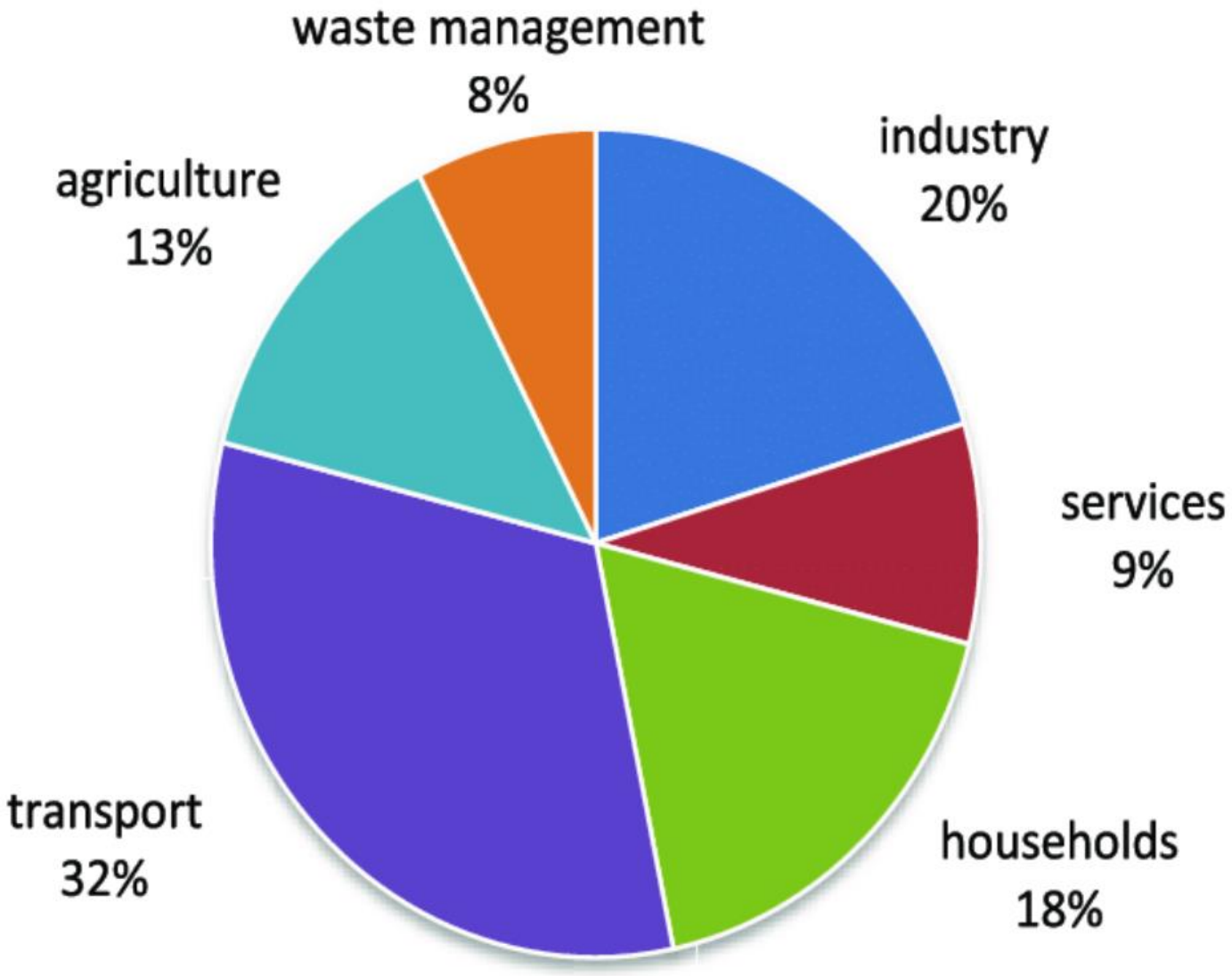
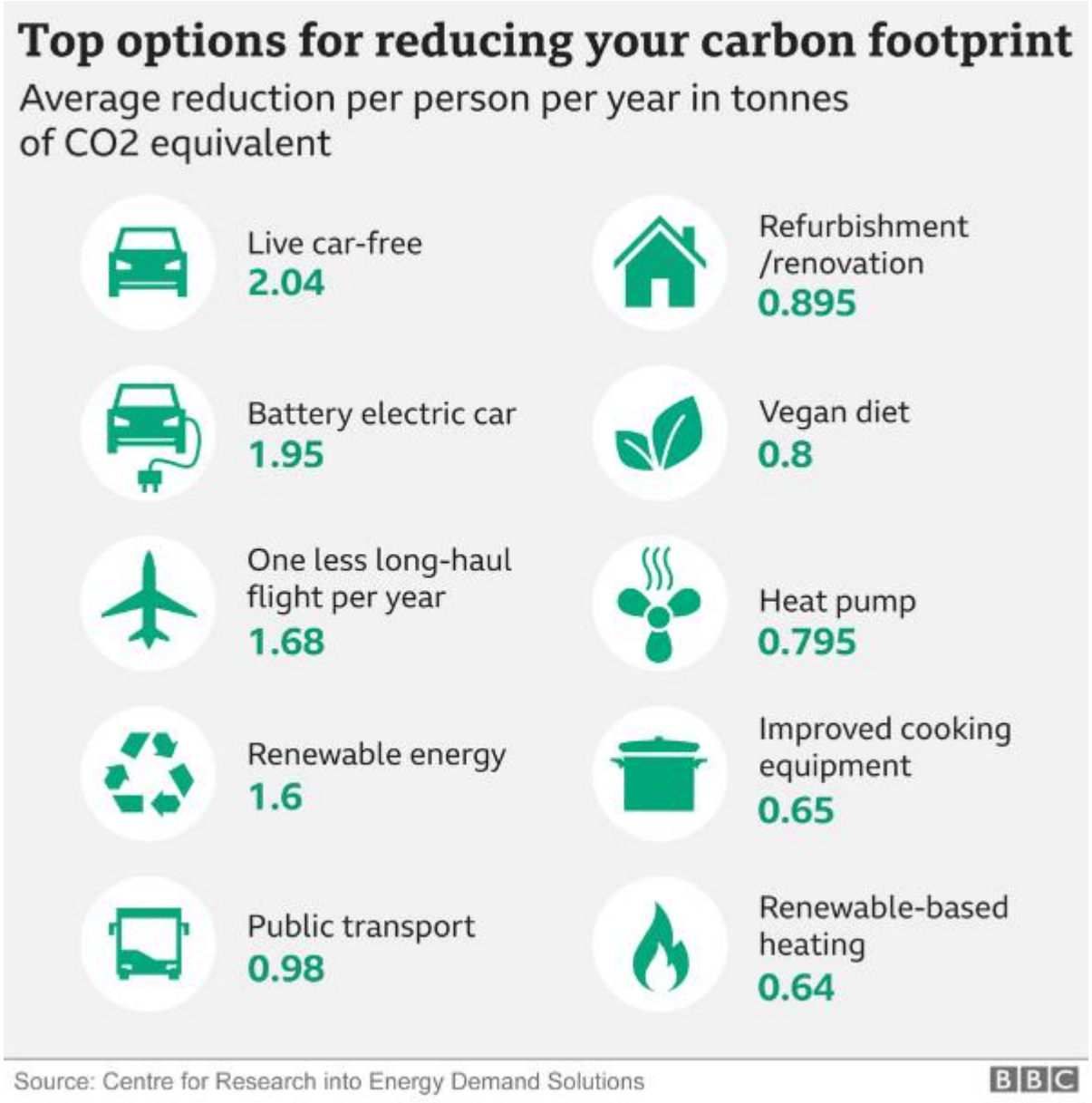
Swiss CO_2 emissions by source (2015)



Source: Baier et al. 2018 with FOEN data

Levers for abatement in consumption



And ...

buy less / reuse / repair

travel less

stream less

buy regional products (in most cases)

reduce packaging

avoid very emissions intensive products (beef)

what else?

Agricultural products

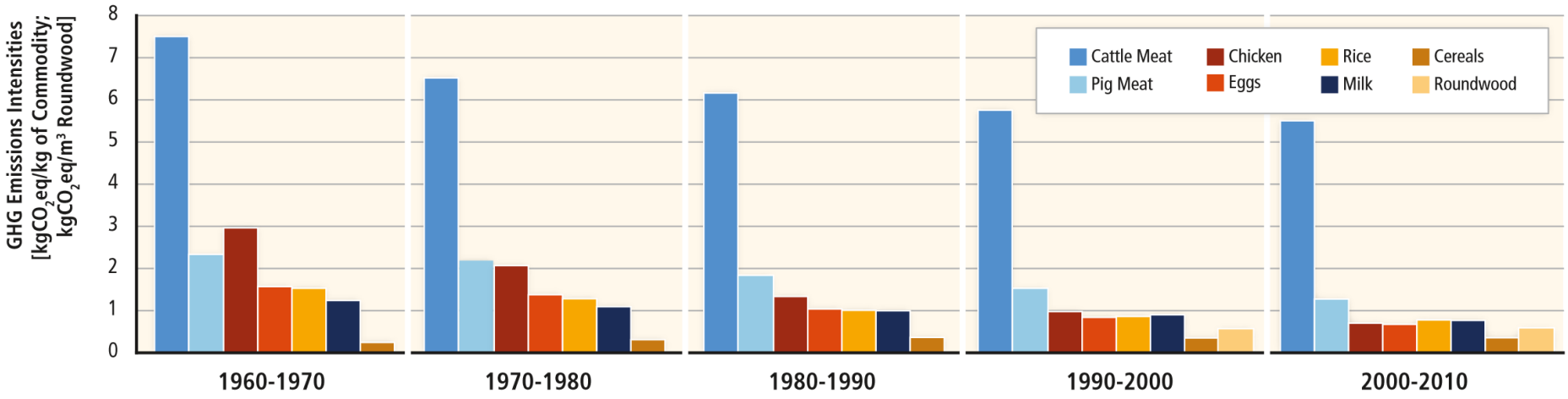


Figure TS.30 | GHG emissions intensities of selected major AFOLU commodities for decades 1960s–2000s. (1) Cattle meat, defined as GHG (enteric fermentation + manure management of cattle, dairy and non-dairy)/meat produced; (2) pig meat, defined as GHG (enteric fermentation + manure management of swine, market and breeding)/meat produced; (3) chicken meat, defined as GHG (manure management of chickens)/meat produced; (4) milk, defined as GHG (enteric fermentation + manure management of cattle, dairy)/milk produced; (5) eggs, defined as GHG (manure management of chickens, layers)/egg produced; (6) rice, defined as GHG (rice cultivation)/rice produced; (7) cereals, defined as GHG (synthetic fertilizers)/cereals produced; (8) wood, defined as GHG (carbon loss from harvest)/roundwood produced. [Figure 11.15]

Source: IPCC 5AR TS WG3

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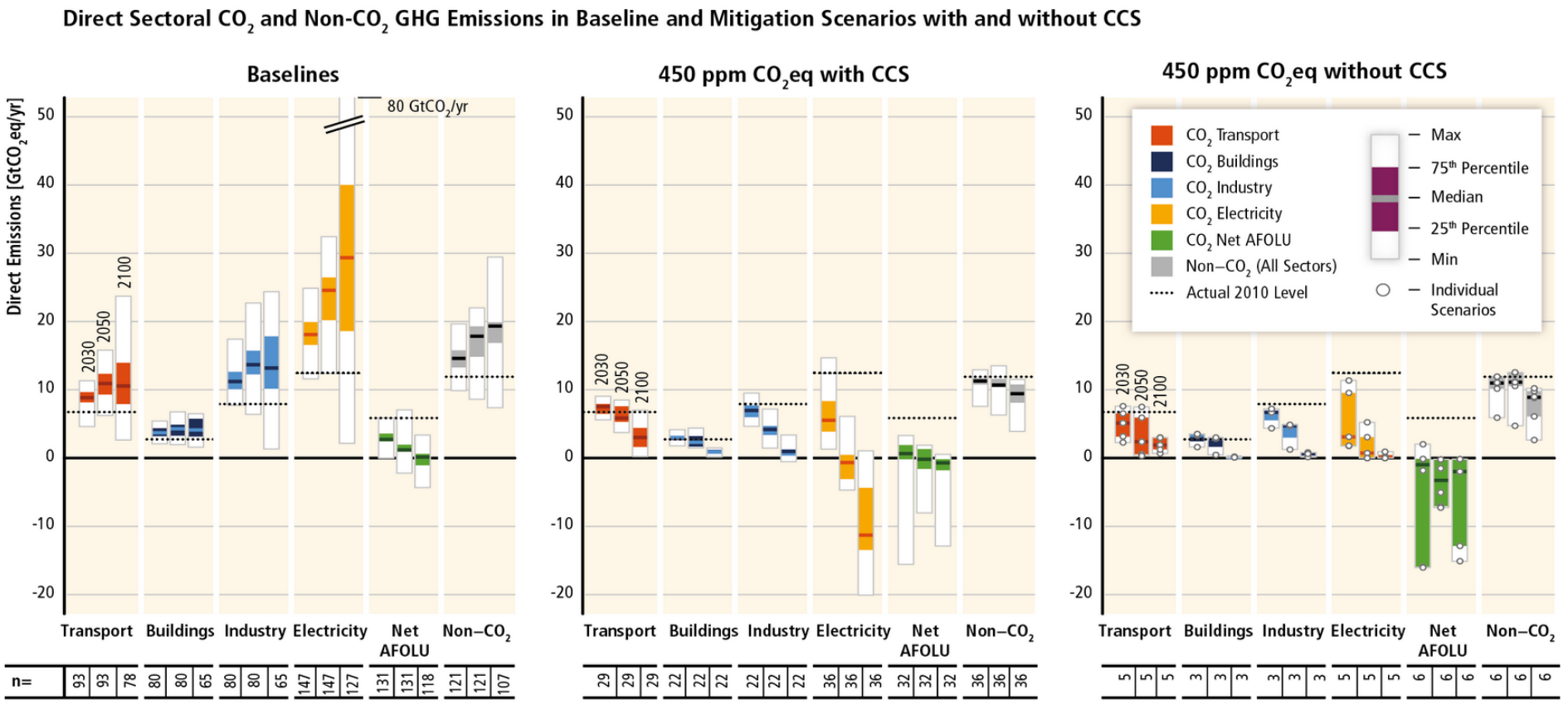
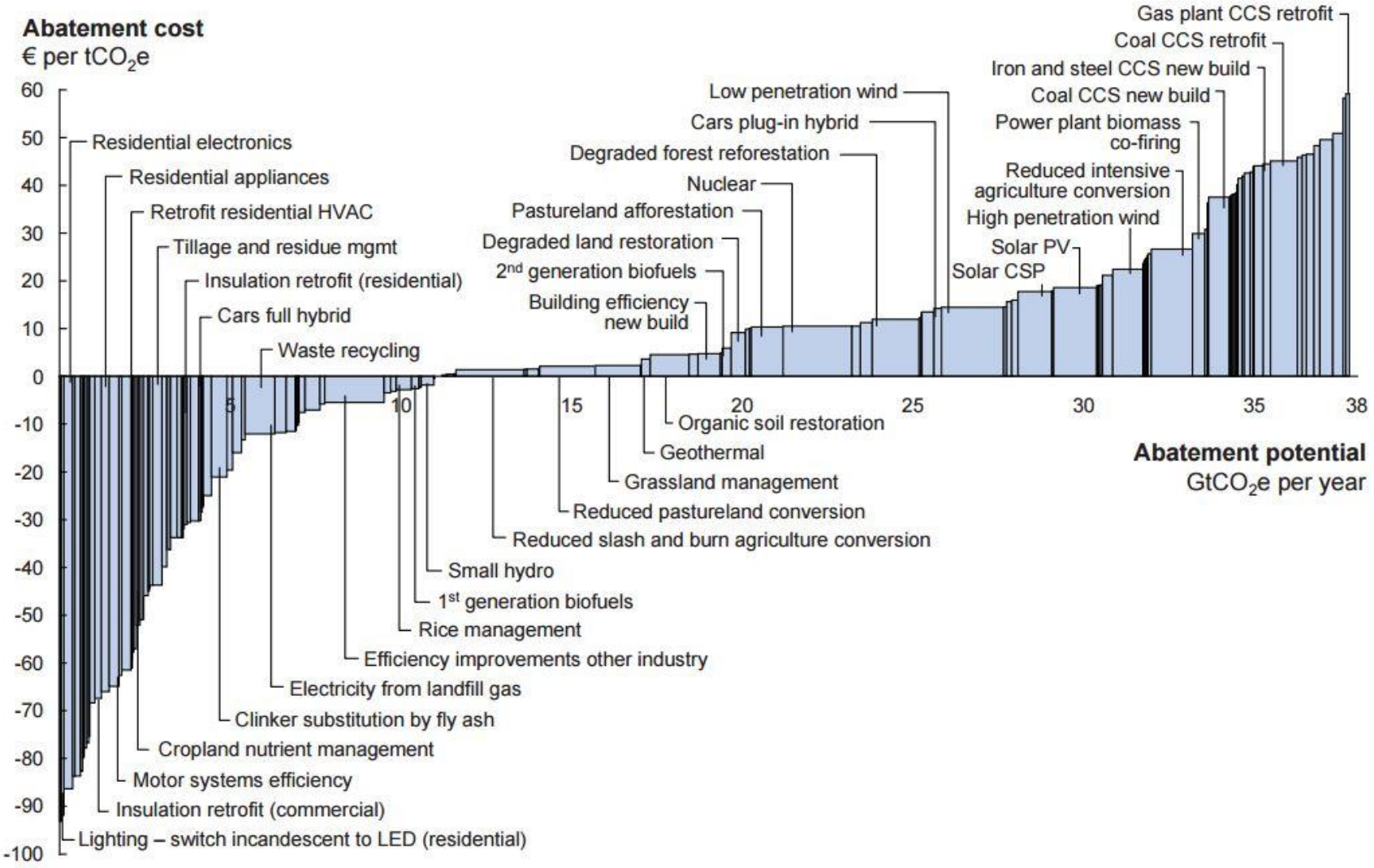
GHG emissions abatement by sector



Source: IPCC

Abatement measures

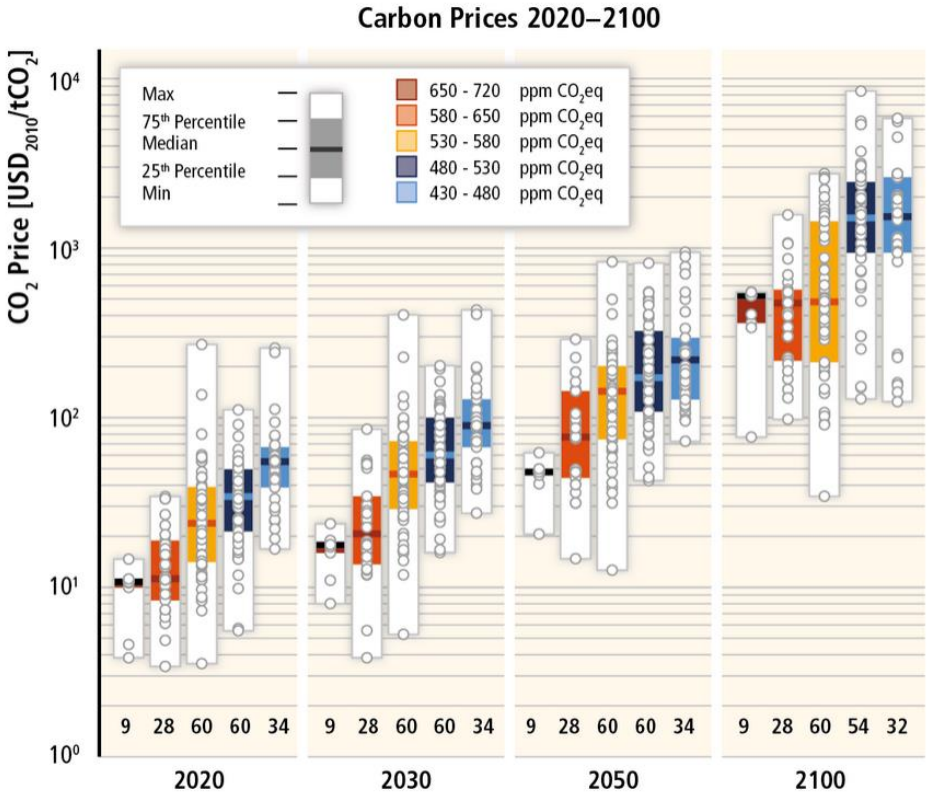
Global GHG abatement cost curve beyond business-as-usual – 2030

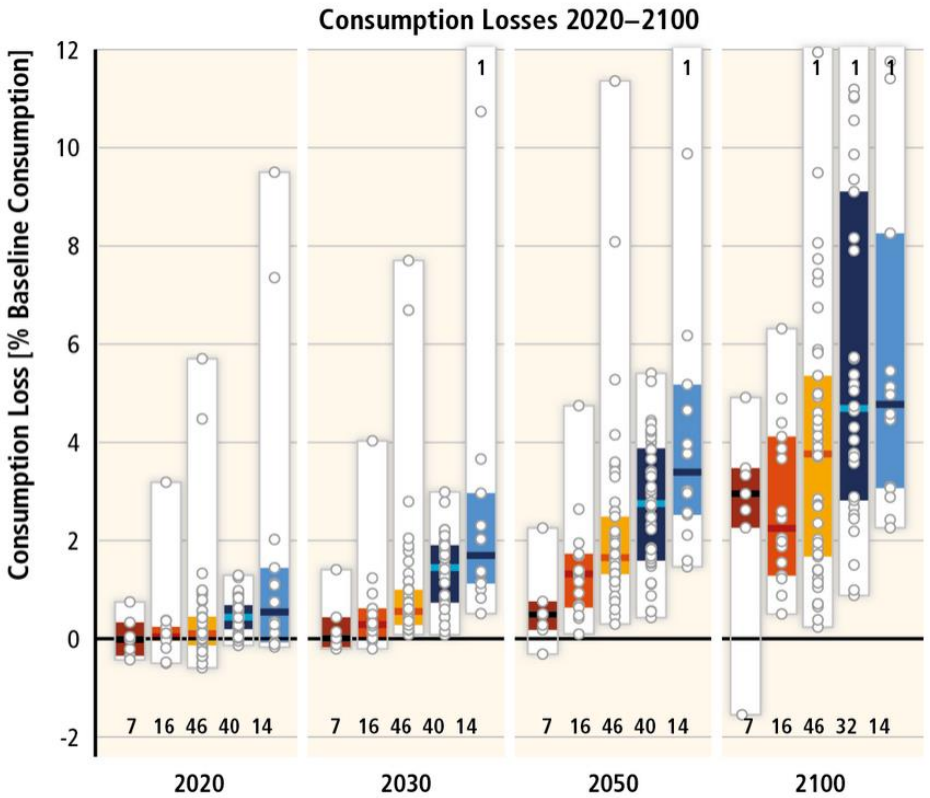


Note: The curve presents an estimate of the maximum potential of all technical GHG abatement measures below €60 per tCO_2e if each lever was pursued aggressively. It is not a forecast of what role different abatement measures and technologies will play.
Source: Global GHG Abatement Cost Curve v2.0

Source: McKinsey 2013

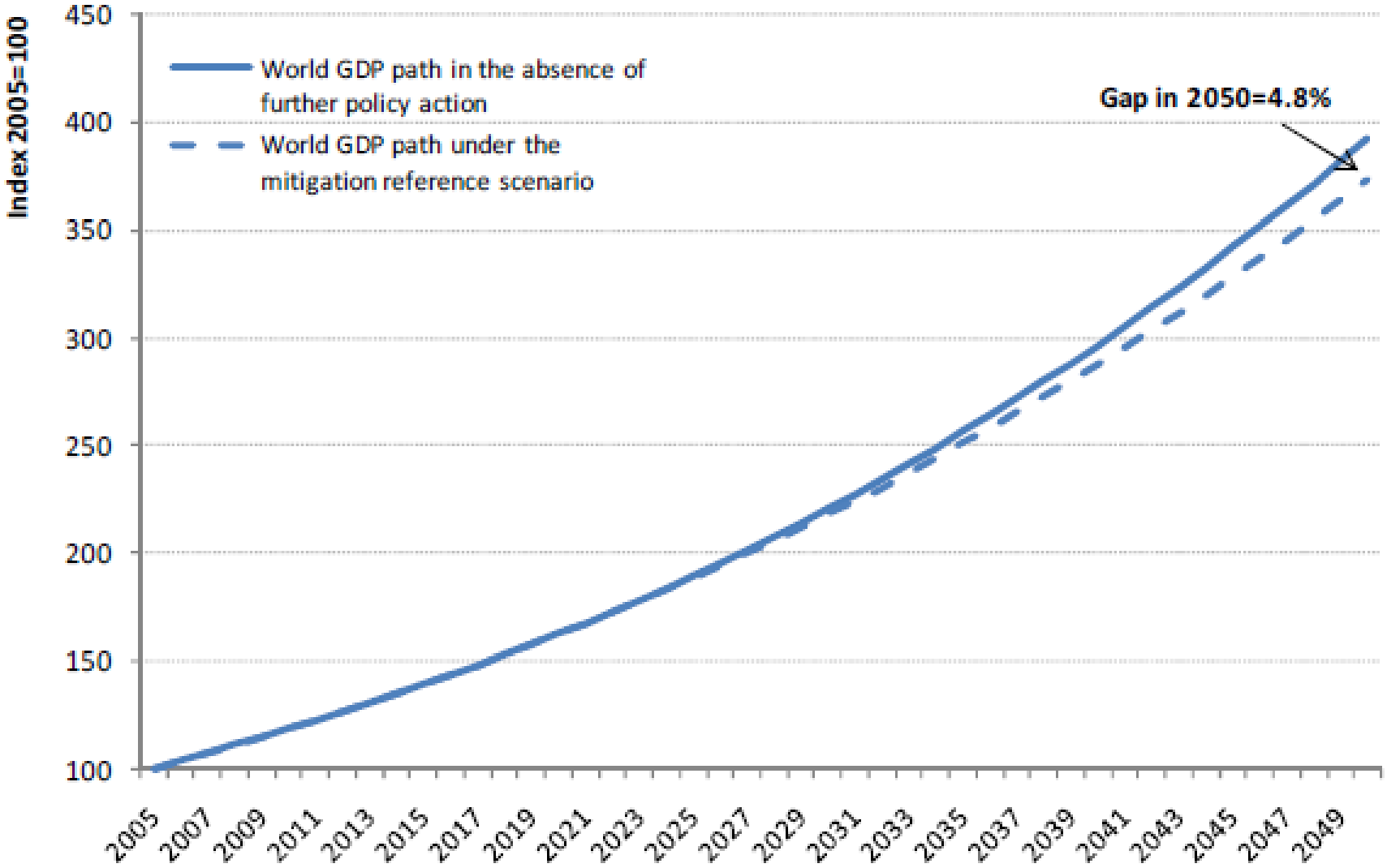
Carbon prices and consumption losses





Source: IPCC

Economic growth and abatement costs



Source: OECD 2008

Cost of mitigation

	Consumption losses in cost-effective scenarios[1]						Increase in total discounted mitigation costs in scenarios with limited availability of technologies			
	[% reduction in consumption relative to baseline]			[percentage point reduction in annualized consumption growth rate]			[% increase in total discounted mitigation costs (2015–2100) relative to default technology assumptions]			
Concentration in 2100 [ppm CO_2eq]	2030	2050	2100	2010 –2030	2010 –2050	2010 –2100	No CCS	Nuclear phase out	Limited Solar/ Wind	Limited Bioenergy
450 (430–480)	1.7 (1.0–3.7) [N: 14]	3.4 (2.1–6.2)	4.8 (2.9–11.4)	0.09 (0.06–0.2)	0.09 (0.06–0.17)	0.06 (0.04–0.14)	138 (29–297) [N: 4]	7 (4–18) [N: 8]	6 (2–29) [N: 8]	64 (44–78) [N: 8]
500 (480–530)	1.7 (0.6–2.1) [N: 32]	2.7 (1.5–4.2)	4.7 (2.4–10.6)	0.09 (0.03–0.12)	0.07 (0.04–0.12)	0.06 (0.03–0.13)	N/A	N/A	N/A	N/A
550 (530–580)	0.6 (0.2–1.3) [N: 46]	1.7 (1.2–3.3)	3.8 (1.2–7.3)	0.03 (0.01–0.08)	0.05 (0.03–0.08)	0.04 (0.01–0.09)	39 (18–78) [N: 11]	13 (2–23) [N: 10]	8 (5–15) [N: 10]	18 (4–66) [N: 12]
580–650	0.3 (0–0.9) [N: 16]	1.3 (0.5–2.0)	2.3 (1.2–4.4)	0.02 (0–0.04)	0.03 (0.01–0.05)	0.03 (0.01–0.05)	N/A	N/A	N/A	N/A

Source: IPCC 5AR TS WG3

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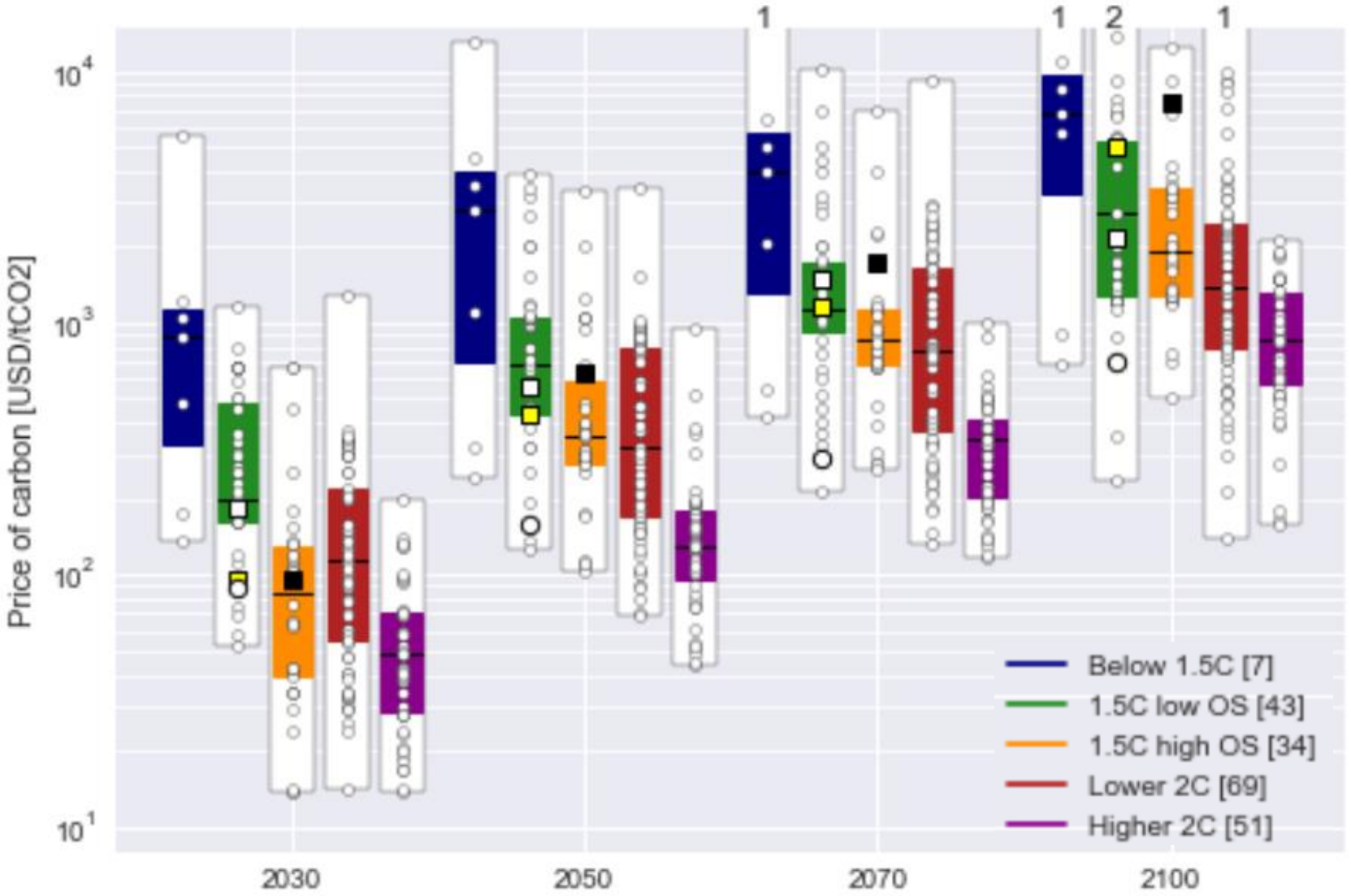
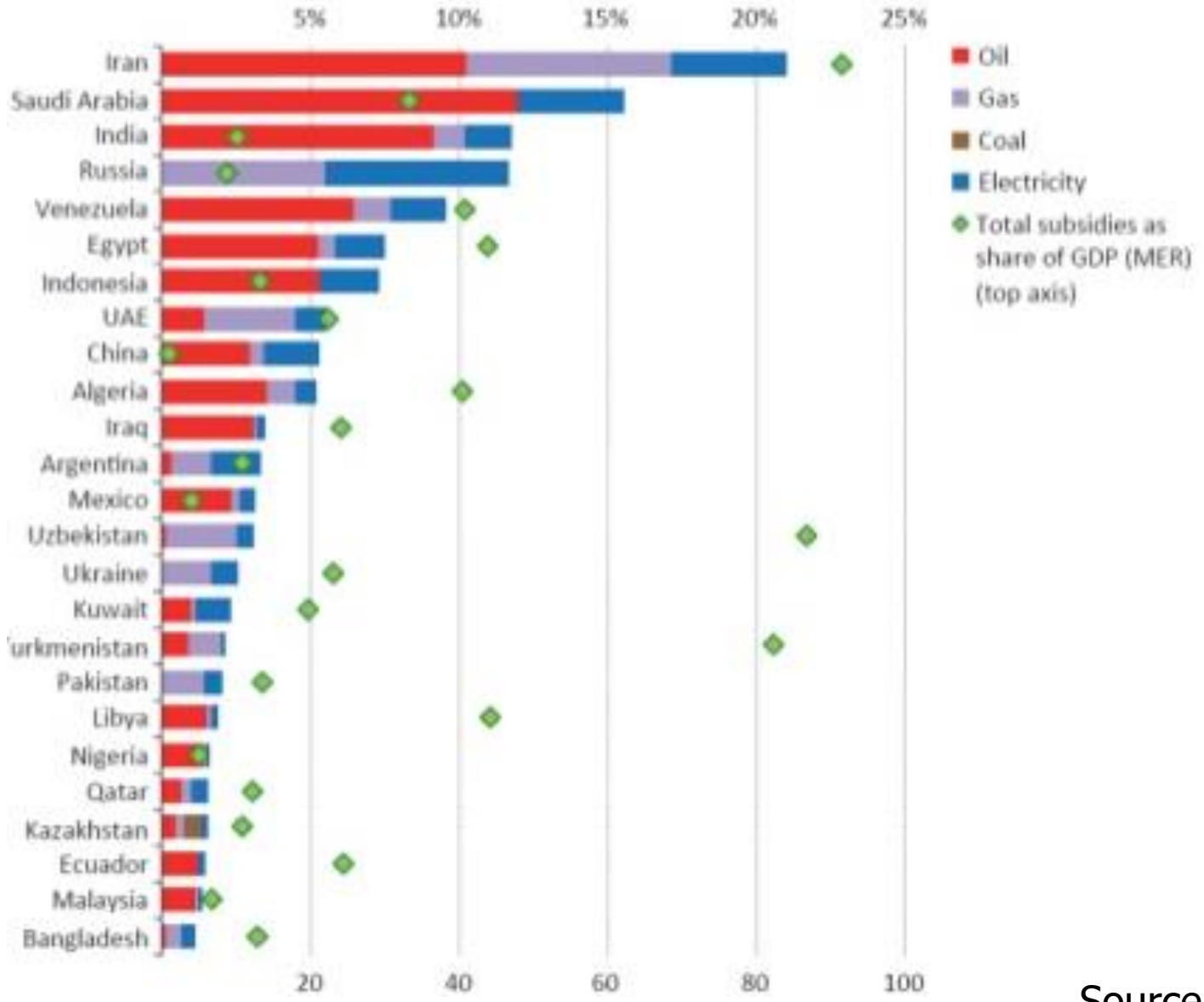
Carbon prices for 1.5°C



Source: IPCC SR1.5

Fossil fuel subsidies (in % of GDP & bio. US$, 2013)

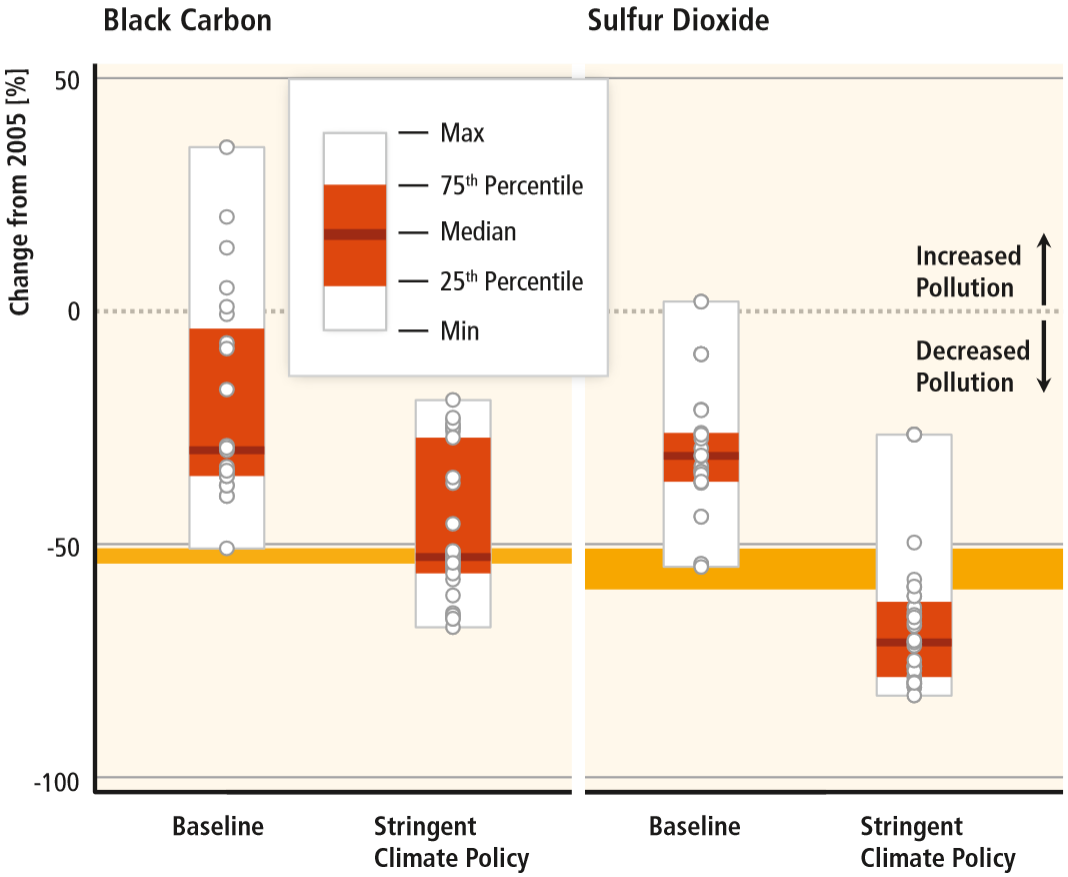


Source: OECD/IEA 2014

Ancillary benefit: reduced air pollution

IPCC AR5 Scenario Ensemble

Impact of Climate Policy on Air Pollutant Emissions (Global, 2005-2050)



Quelle: IPCC 5AR TS WG3

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Determinants of abatement cost estimates

- baseline projections
  - population
  - GDP
  - energy resources and prices
  - emissions
- technical potential
  - availability and potentials of measures
  - substitution possibilities
  - rate of technological change
- discount rate
- ancillary benefits of GHG abatement
- climate policy regime
  - stringency & flexibility
  - policy instruments and revenue recycling

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2nd round NDCs are due in 2020

- Norway increased its target from 50% to 55% relative to 1990
  - expecting the same target eventually to be announced by the EU
- Chile, who had an unsubstantial 1st NDC, submitted an ambitious 2nd NDC
- other new submissions are disappointing
  - Russia, Japan, Singapore
- only few submissions so far

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Other recent target announcements

- Switzerland has increased its share of domestic abatement for the 2030 target to 75% (revision of the CO_2 law)
  - in national legislation, not yet as an international commitment
  - net zero in 2050 also announced in UNFCCC communication
- Numerous other countries, regions, cities and firms have announced net zero emissions targets for 2050
  - including China, EU, Canada, New Zealand, Chile, Costa Rica
  - Sweden has announced a carbon neutrality target for 2045
  - most of these targets are not legally binding in international law

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