Climate Change Economics for Dummies

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Outline

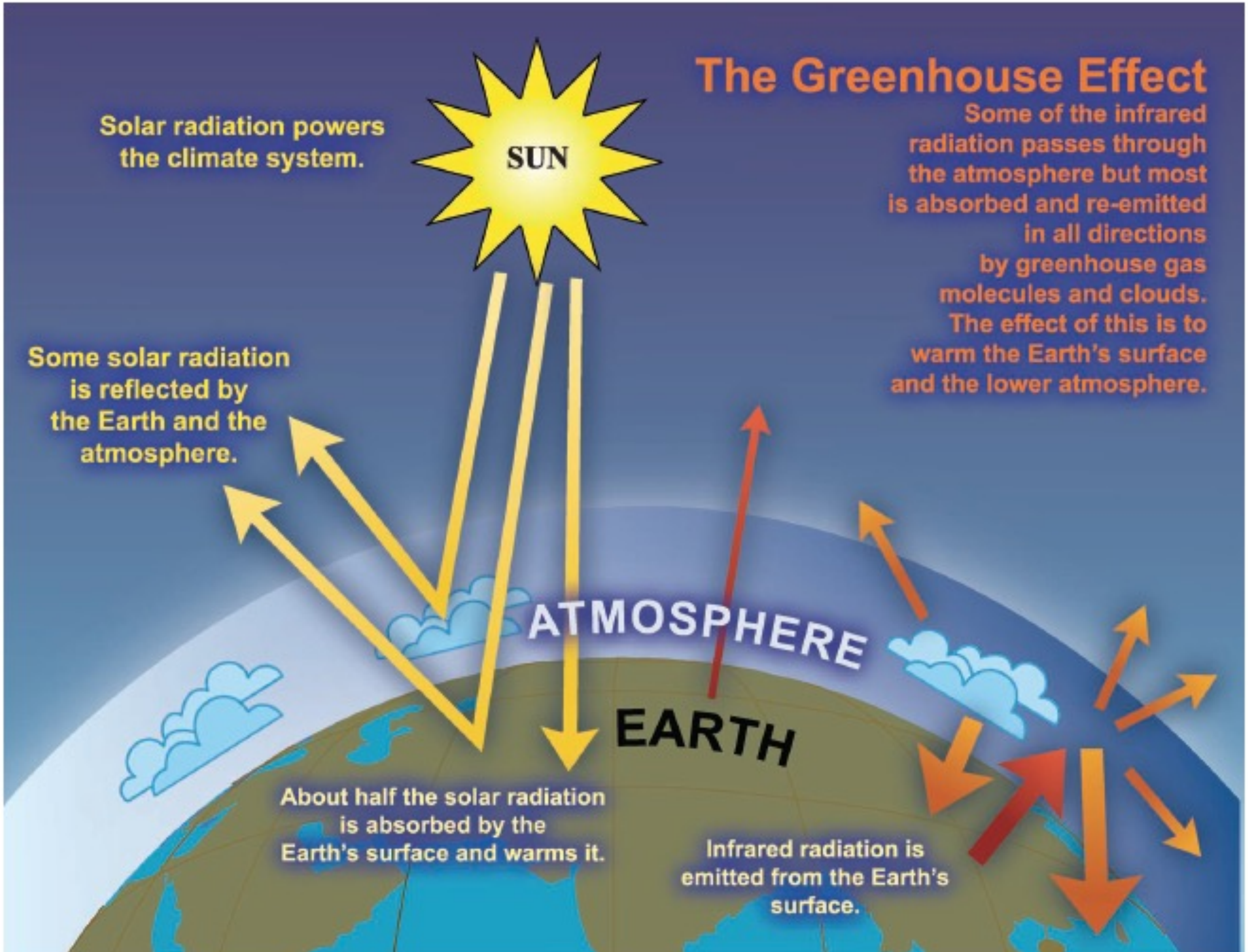
- Climate issue: what makes it difficult
- What can be expected from international agreements?
- European climate policy as a forerunner
  - Power, industry and Buildings sector
  - Transport sector
- Take away

The climate issue

- What matters for an economist?
- Sources: IPCC (2023), Nordhaus and Stern reviews
- IPCC 2023

https://www.ipcc.ch/report/sixth-assessment-report-cycle/

- *Nordhaus W. (2013b). The climate casino. Yale University Press.*
- *Stern, N. (2008). The economics of Climate Change. The American Economic Review, Papers and Proceedings, 98, 2-37.*



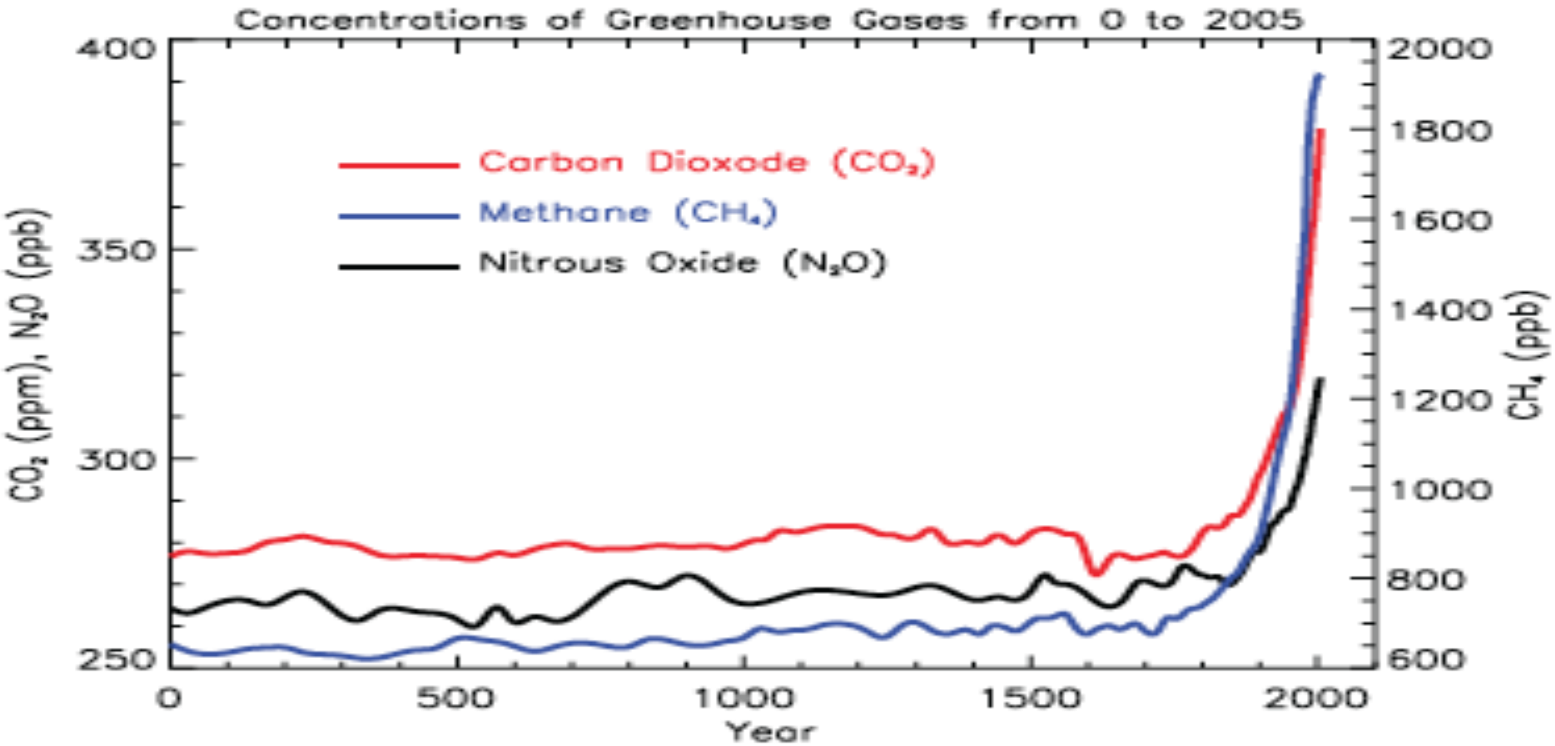
FAQ 1.3, Figure 1. *An idealised model of the natural greenhouse effect. See text for explanation.*

The 5 crucial relations

1. Human behaviour is at origin of extra GHG GreenHouseGas emissions
    - Distorted carbon cycle of the earth
    - mainly under form of CO_2 (75% of problem) but also methane, NO, HFC' s count.
2. GHG accumulate in atmosphere
3. The increased concentration (decay 0.5% / year) traps heat and generates global warming
4. Global warming generates climate change (delay 20-50 years)
5. Climate change generates damage

All these relations are uncertain

Concentration of GHG over time



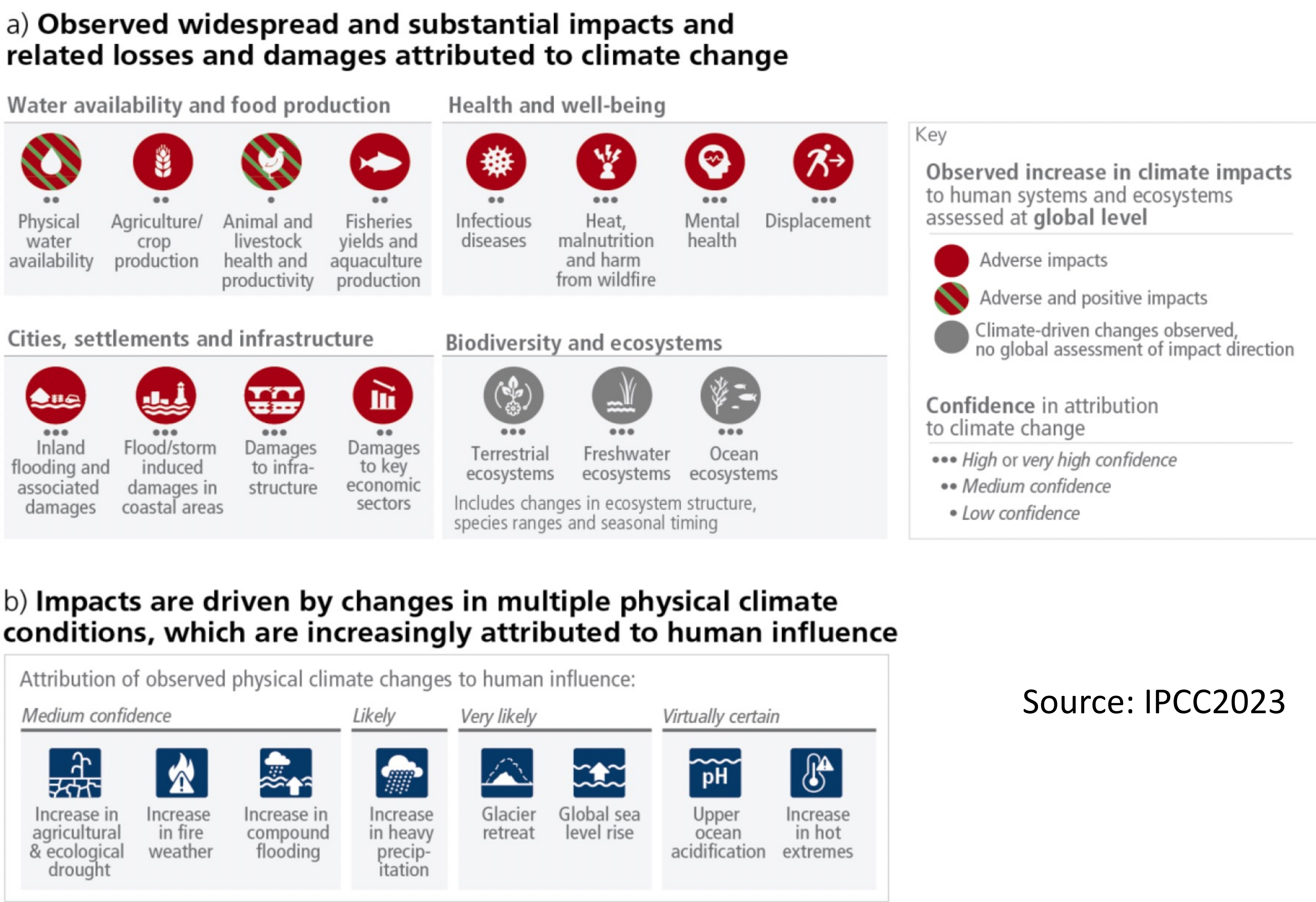
FAQ 2.1, Figure 1. *Atmospheric concentrations of important long-lived greenhouse gases over the last 2,000 years. Increases since about 1750 are attributed to human activities in the industrial era. Concentration units are parts per million (ppm) or parts per billion (ppb), indicating the number of molecules of the greenhouse gas per million or billion air molecules, respectively, in an atmospheric sample. (Data combined and simplified from Chapters 6 and 2 of this report.)*

What makes Climate Change a difficult problem for the world?

5 properties

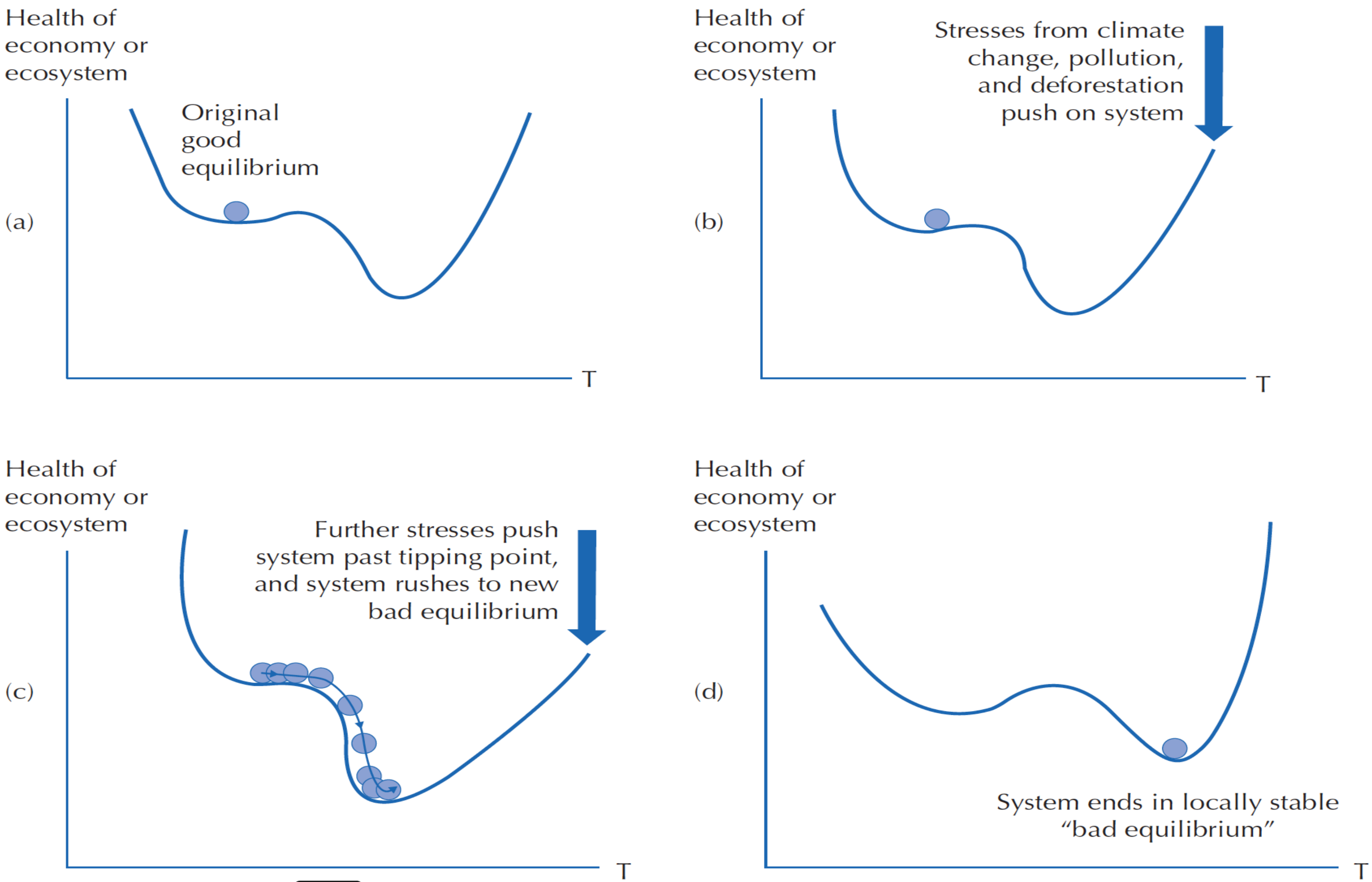
- Effects are complex and UNCERTAIN and differ by region
- Effects are DELAYED by 1 or 2 generations
- It is a CUMULATIVE pollution problem: every ton emitted will accumulate and generate effects the next few hundred years
- It is a GLOBAL pollutant: Each ton, wherever it is emitted will affect Climate in the whole world
- Not an easy fix: it is still COSTLY to reduce emissions quickly

a) Effects are complex and uncertain



Source: IPCC2023

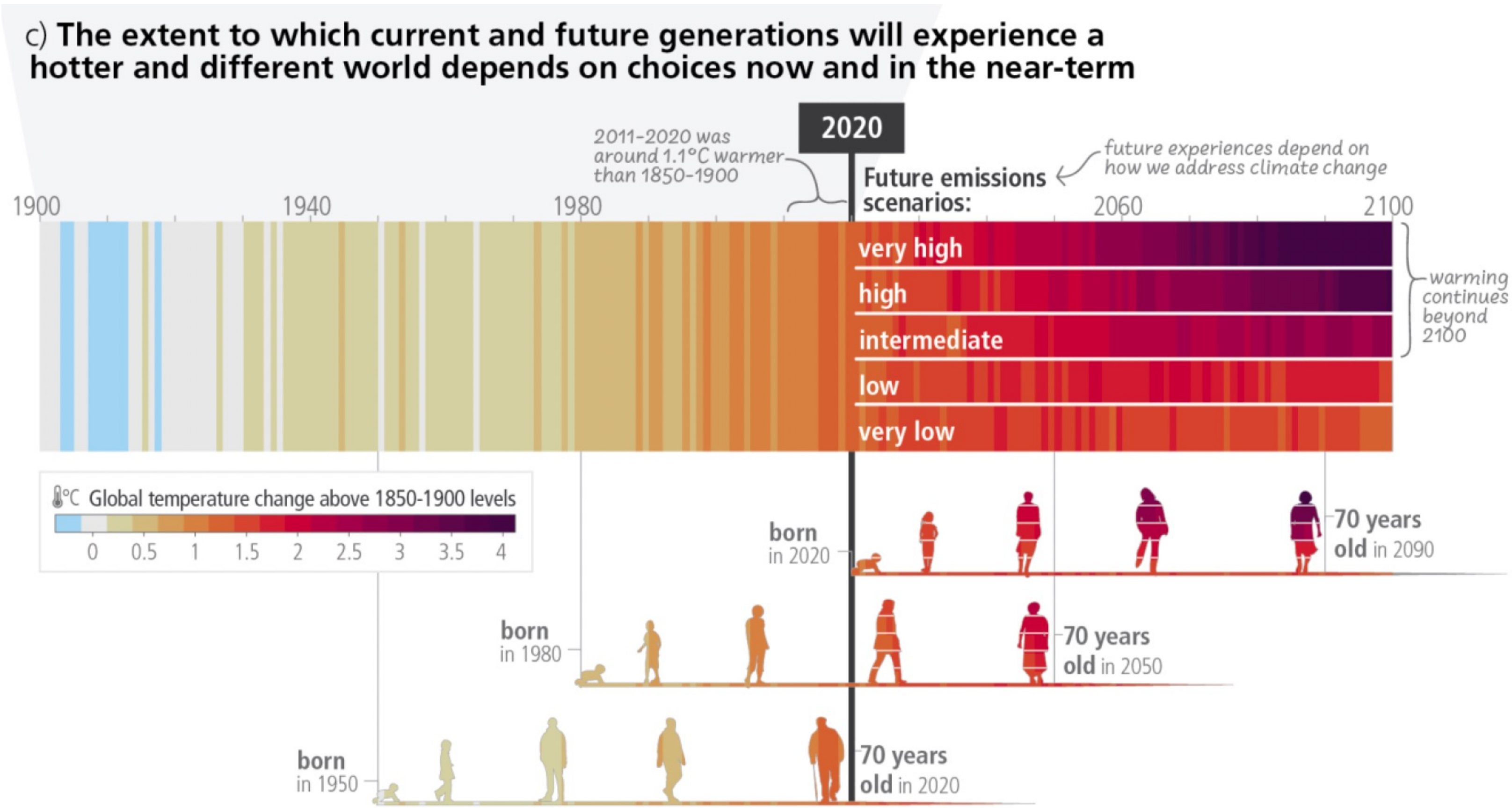
Tipping point problem



Source: Nordhaus (2015).

FIGURE 6.4. Illustration of tipping point equilibriums.

b) Effects of emissions are delayed by 1 to 2 generations



Source: IPCC 2023

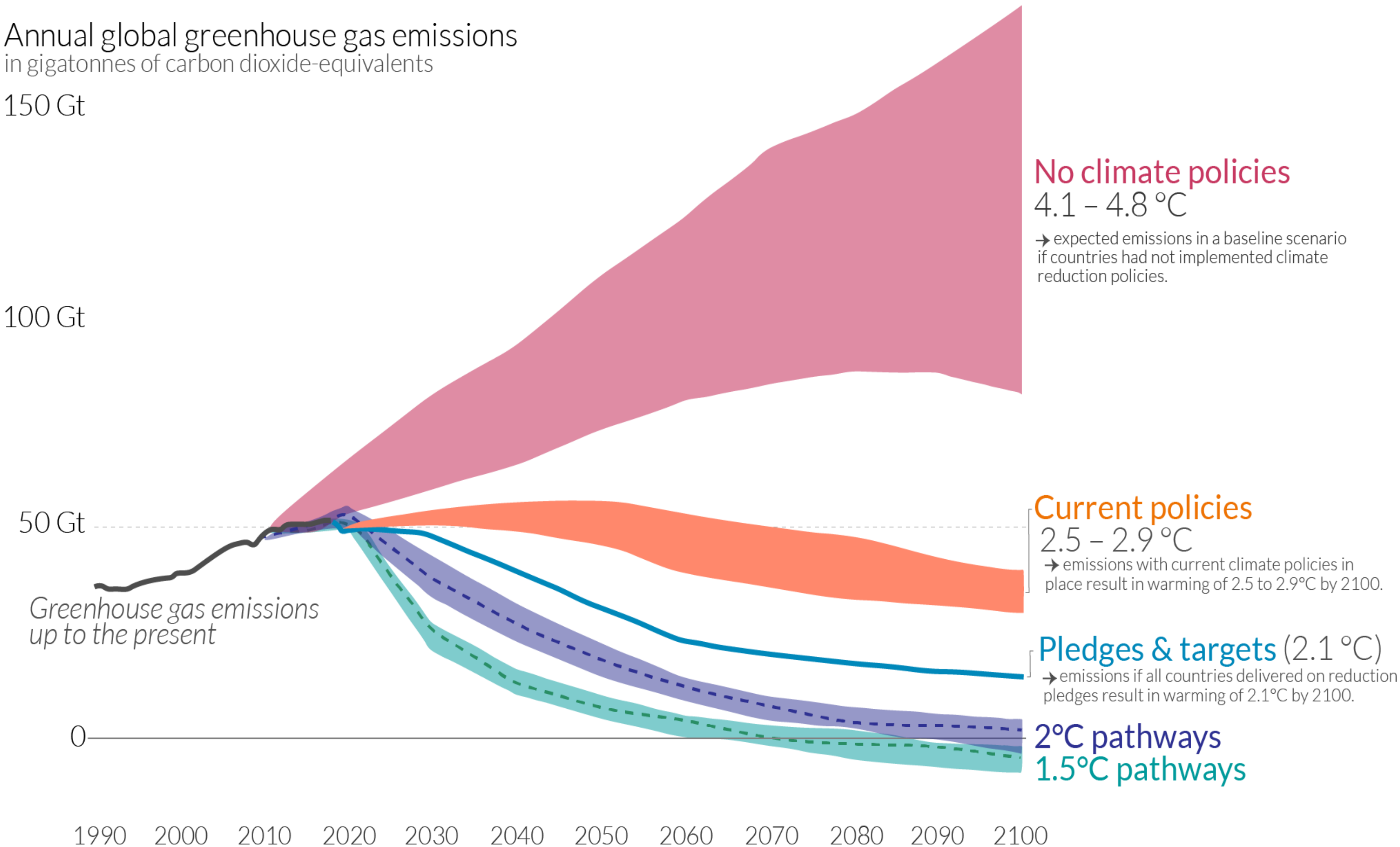
c) A CUMULATIVE pollutant requires not a stabilization of emissions but a strong reduction of emissions

- What reduction is required:
  - Stock pollutant (decay of 0.5%), so one needs strong decrease to reach an objective in 2050
- Where are emissions coming from
  - Mainly energy use (2/3), deforestation (20%), ..
- As economy in 2050 may be 3 x as large as now, emissions per unit of output have to be reduced by 80 to 85%

Global greenhouse gas emissions and warming scenarios

Our World in Data

– Each pathway comes with uncertainty, marked by the shading from low to high emissions under each scenario.
– Warming refers to the expected global temperature rise by 2100, relative to pre-industrial temperatures.

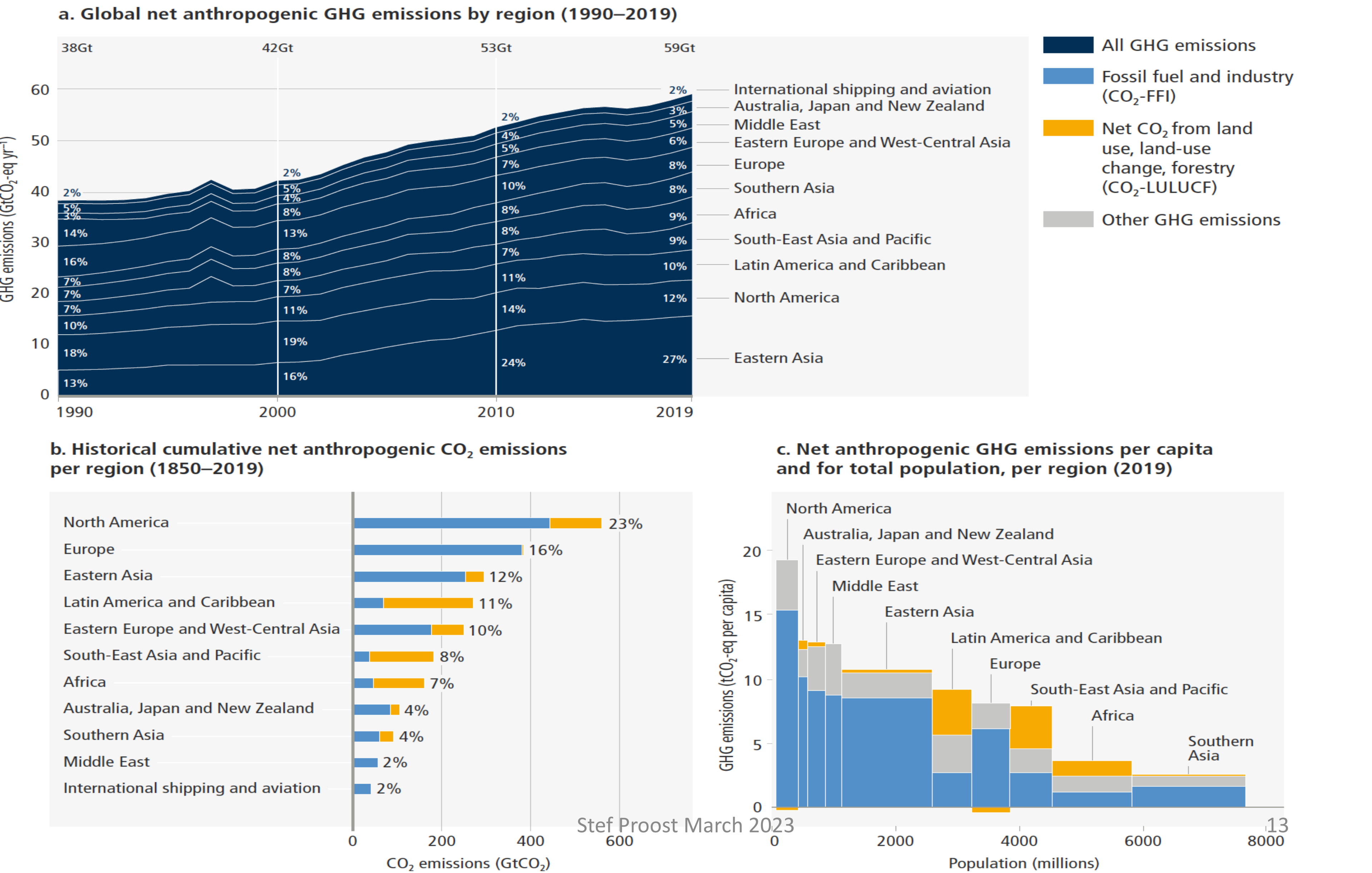


Data source: Climate Action Tracker (based on national policies and pledges as of November 2021).
OurWorldinData.org – Research and data to make progress against the world's largest problems.

Last updated: April 2022.

d) GLOBAL: All emissions count

Source: IPCC 2023



e) Not an easy fix

- Reducing emissions strongly is becoming possible
  - Mainly through switch between fossil energy
  - Adopting new technologies
  - Reduced consumption of some carbon-intensive goods
- But requires efforts in all sectors and in the whole world

Possible pathways by sector

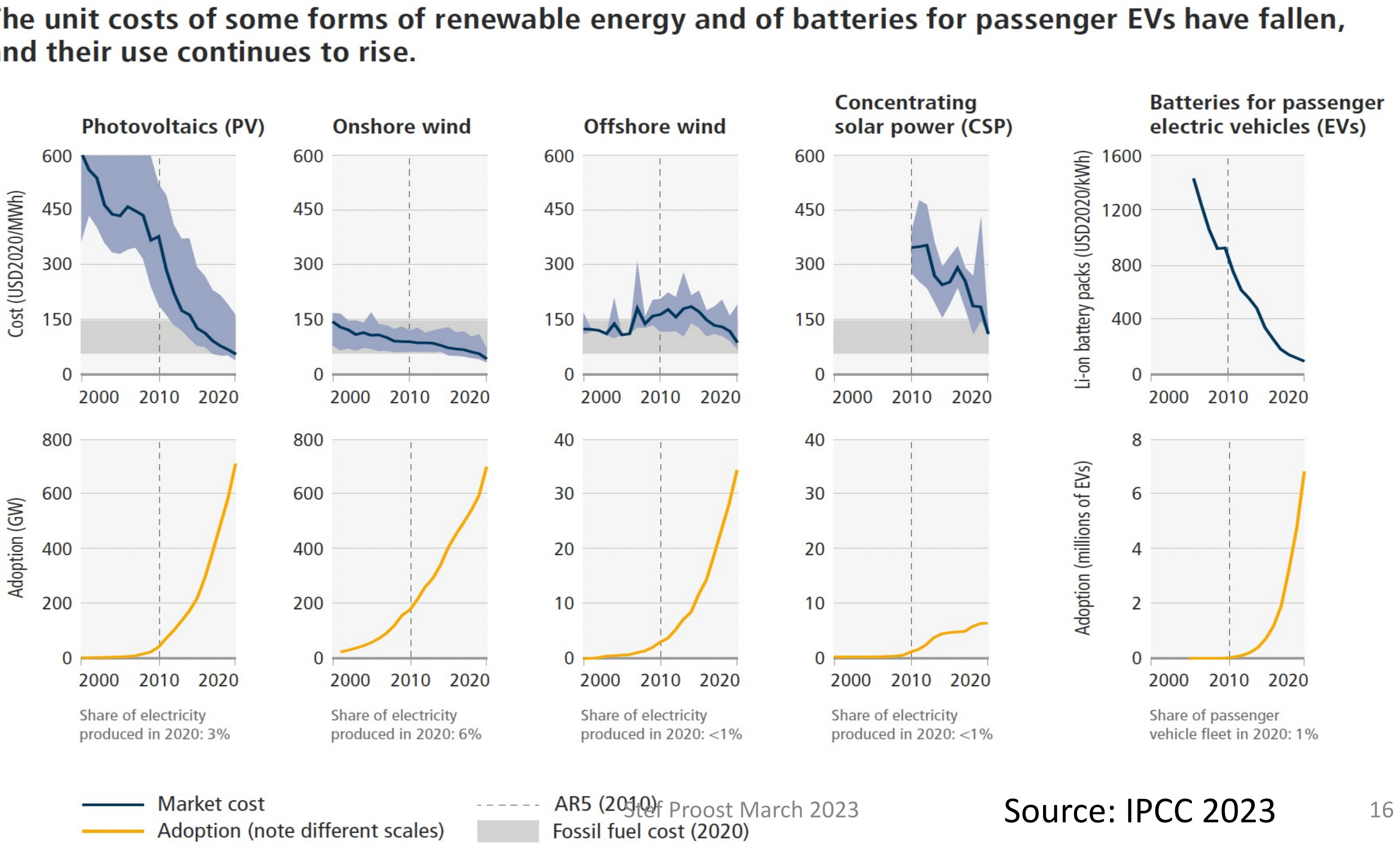
[1] The presentation of choices to consumers, and the impact of that presentation on consumer decision-making.

[2] Load management refers to demand-side flexibility that cuts across all sectors and can be achieved through incentive design like time of use pricing/monitoring by artificial intelligence, diversification of storage facilities, etc.

[3] The impact of demand-side mitigation on electricity sector emissions depends on the baseline carbon intensity of electricity supply, which is scenario dependent.

IPCC 2023

Unit costs of carbon free technologies have strongly decreased



Source: IPCC 2023

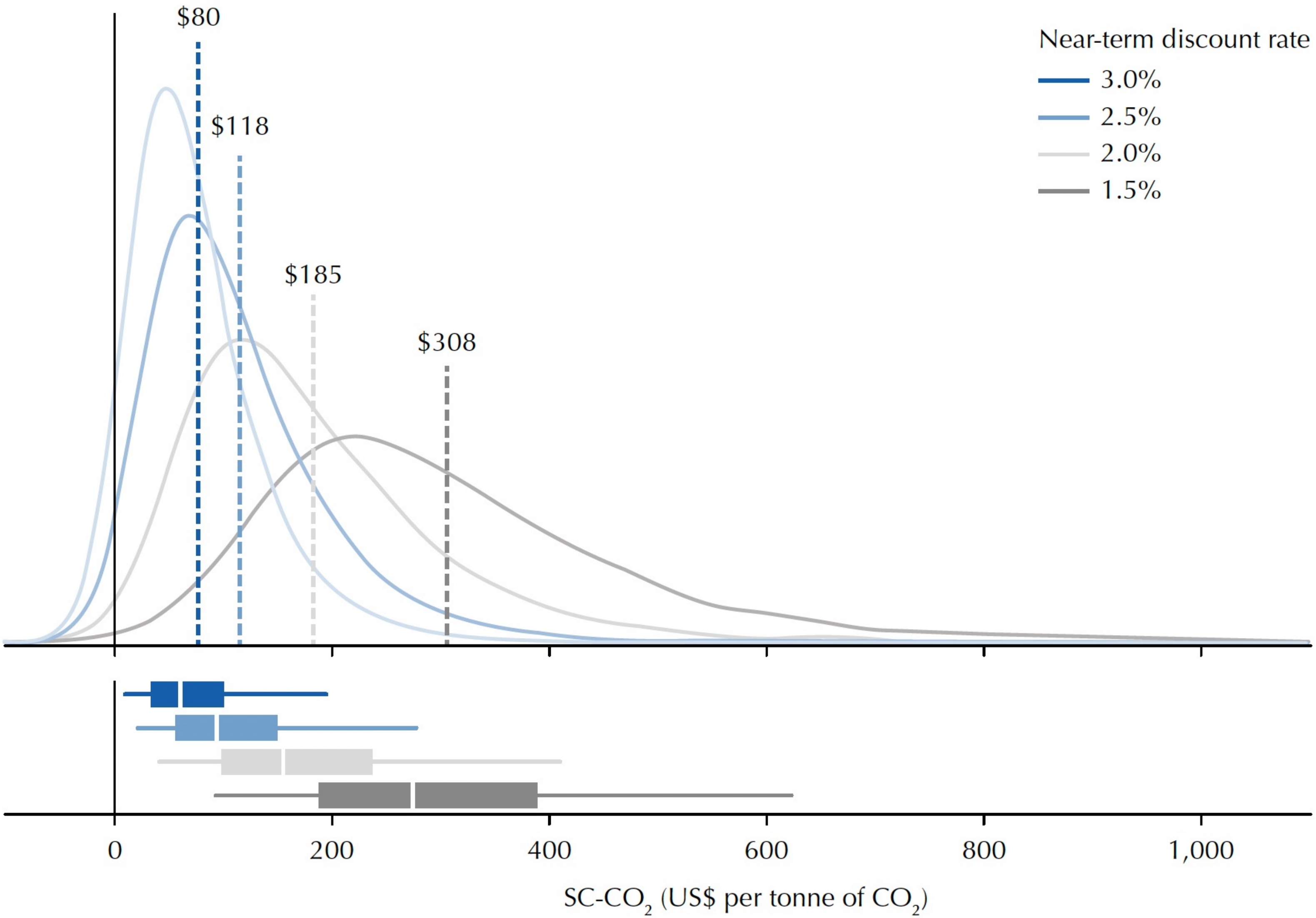
"Optimal strategy for the world"

Economist: compare Costs and Benefits of action

Approach via quantitative target: precautionary principle: avoid warming >1,5°C

Approach via marginal external cost : what is the damage to the world of emitting one more ton now?

Social marginal external cost of 1 tonne of CO2



Source: Rennert et al. (Science 2022)

What makes Climate Change a difficult problem for the world?

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What to expect from international agreements?

Why is an effective international agreement so difficult to reach?

Why do we see so many international agreements signed?

Economic Theory on International environmental policy issues (Climate Change, Acid rain..)

Effective international agreement are difficult to reach because they have to be SELF-ENFORCING

- there is no world government that can enforce them

SELF-ENFORCING: the signatories have to be as well off as the non-signatories

Based on Scott Barrett (Oxford Ec P 1994, AER 2006, JEEM 2013)

Mini-Model of international negotiations (based on Scott-Barrett, Oxford Ec P 1994)

We use optimal pollution model with endogenous determination of 3 elements:

- Number of signatories n out of max N
- Terms of agreement (efforts per signatory)
- Actions of signatories

one shot model

Results for one shot game (S.Barrett 1994)

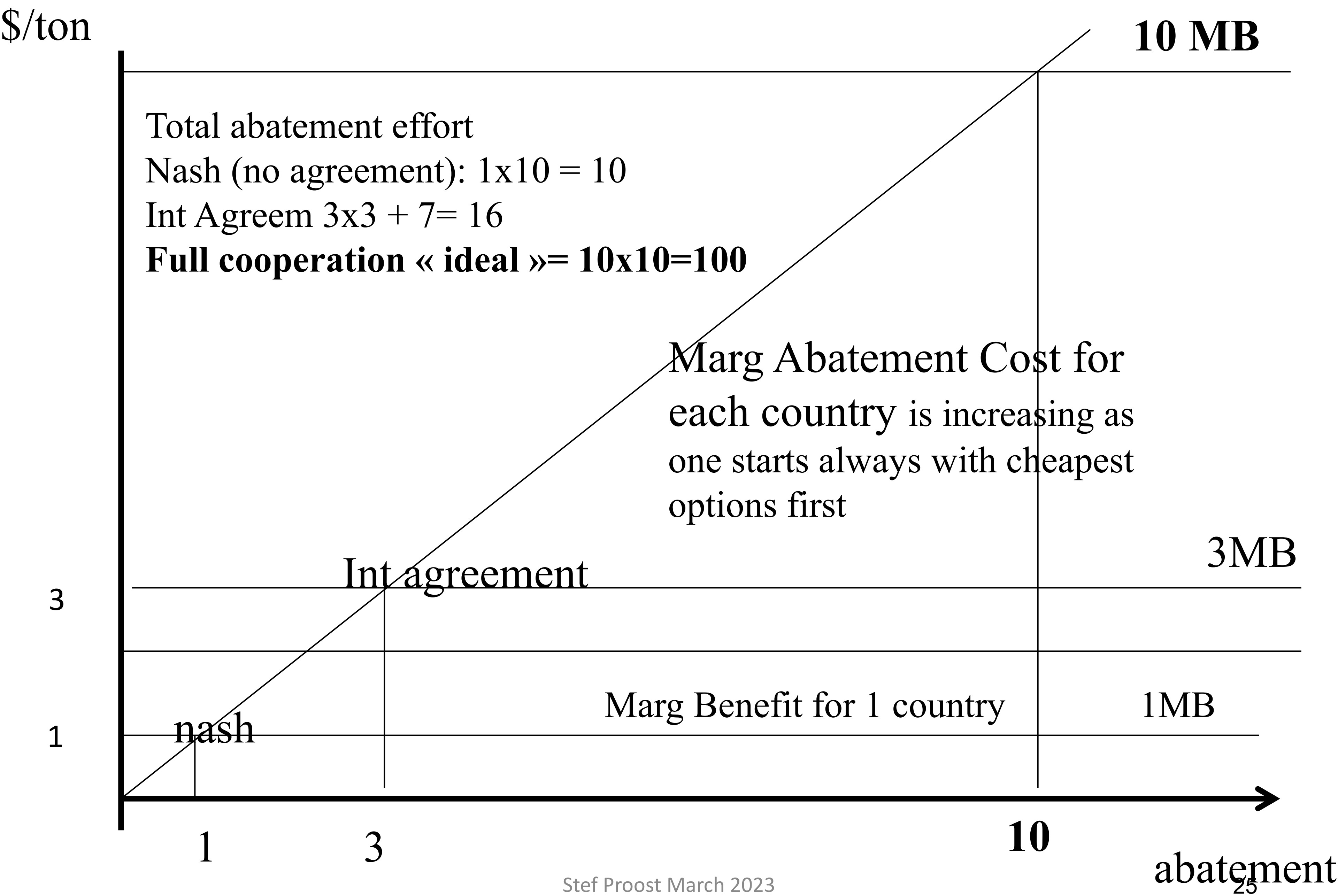
Prop: With increasing marginal cost of emission reduction and constant Marginal Benefits of emission reduction and N identical countries,

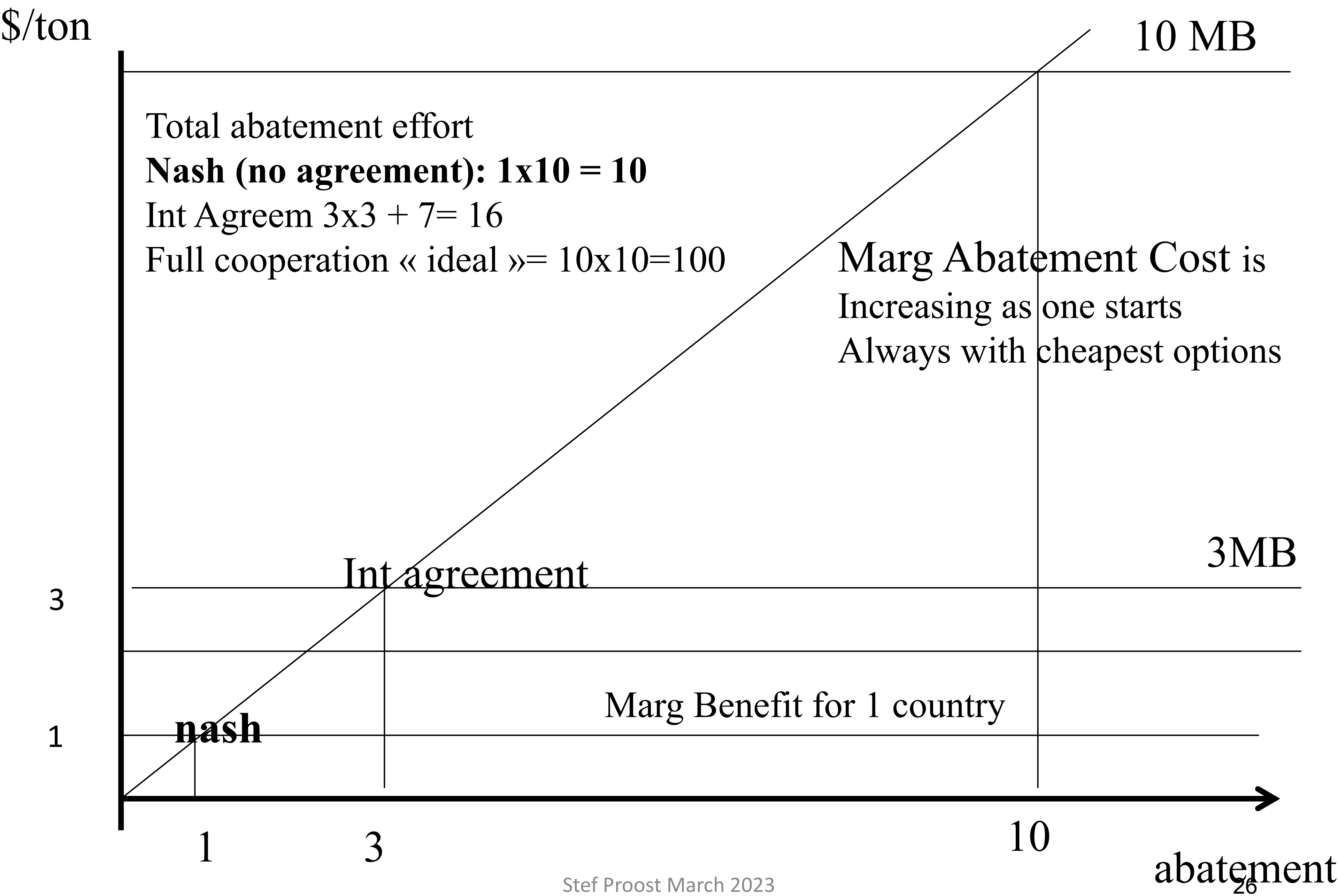
the self enforcing Int Env Agreem will consist of

2 countries if N=2

3 countries if N>2

Illustration for 10 identical countries with constant Marginal Benefit of emission reduction


$/ton
10 MB
Total abatement effort
Nash (no agreement): 1x10 = 10
Int Agreem 3x3 + 7= 16
Full cooperation « ideal »= 10x10=100
Marg Abatement Cost for each country is increasing as one starts always with cheapest options first
3MB
Int agreement
3
Marg Benefit for 1 country
1MB
nash
1
1
3
10
abatement



$/ton
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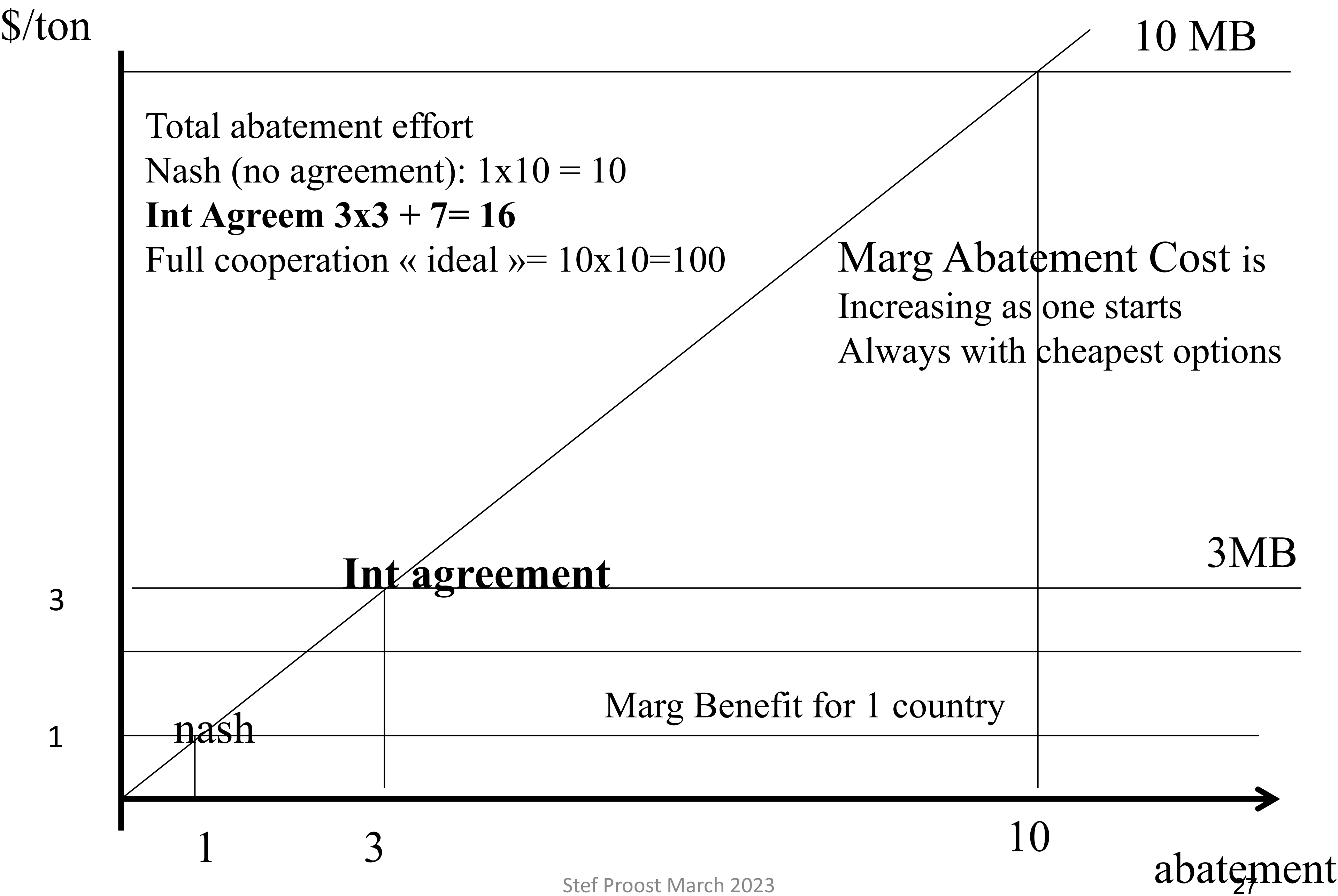

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Why do we see so many international agreements signed? (source: Battaglini & Harstad,2020, J Pol Econ)

Return to national politics that signs the international agreements

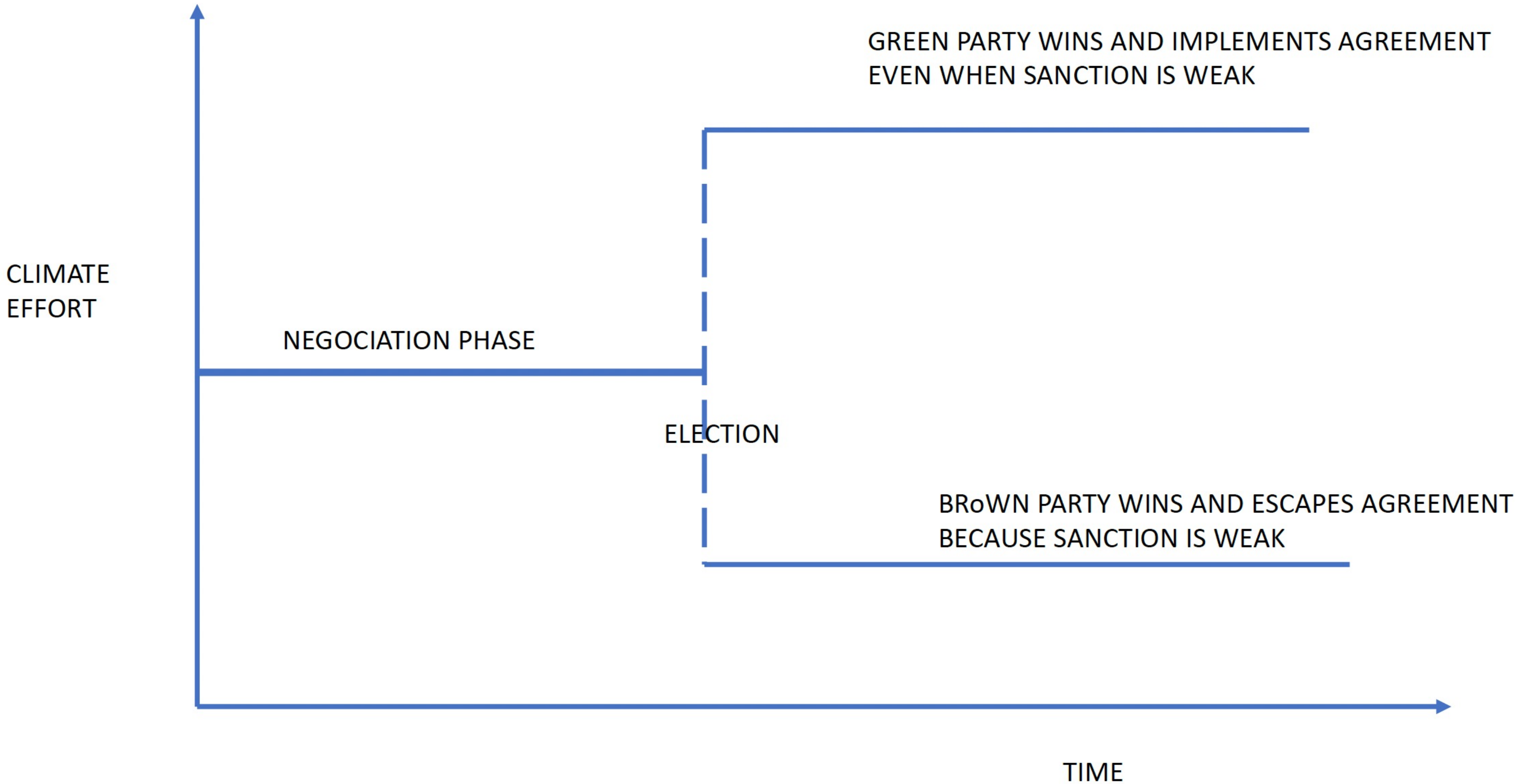
Simpel model with “green” and “brown” party

A party that is in power has to negotiate the international agreement and will try to stay in power at the next election

The election outcome will depend on the climate policy negotiated and on stochastic factors

Sanctions will always be weak in international setting

Positioning of political parties



Outcome

Green party signs the international agreement and if it wins, it will comply with the agreement

↓

Green party will not invest deeply as then this party is no longer needed at the next election

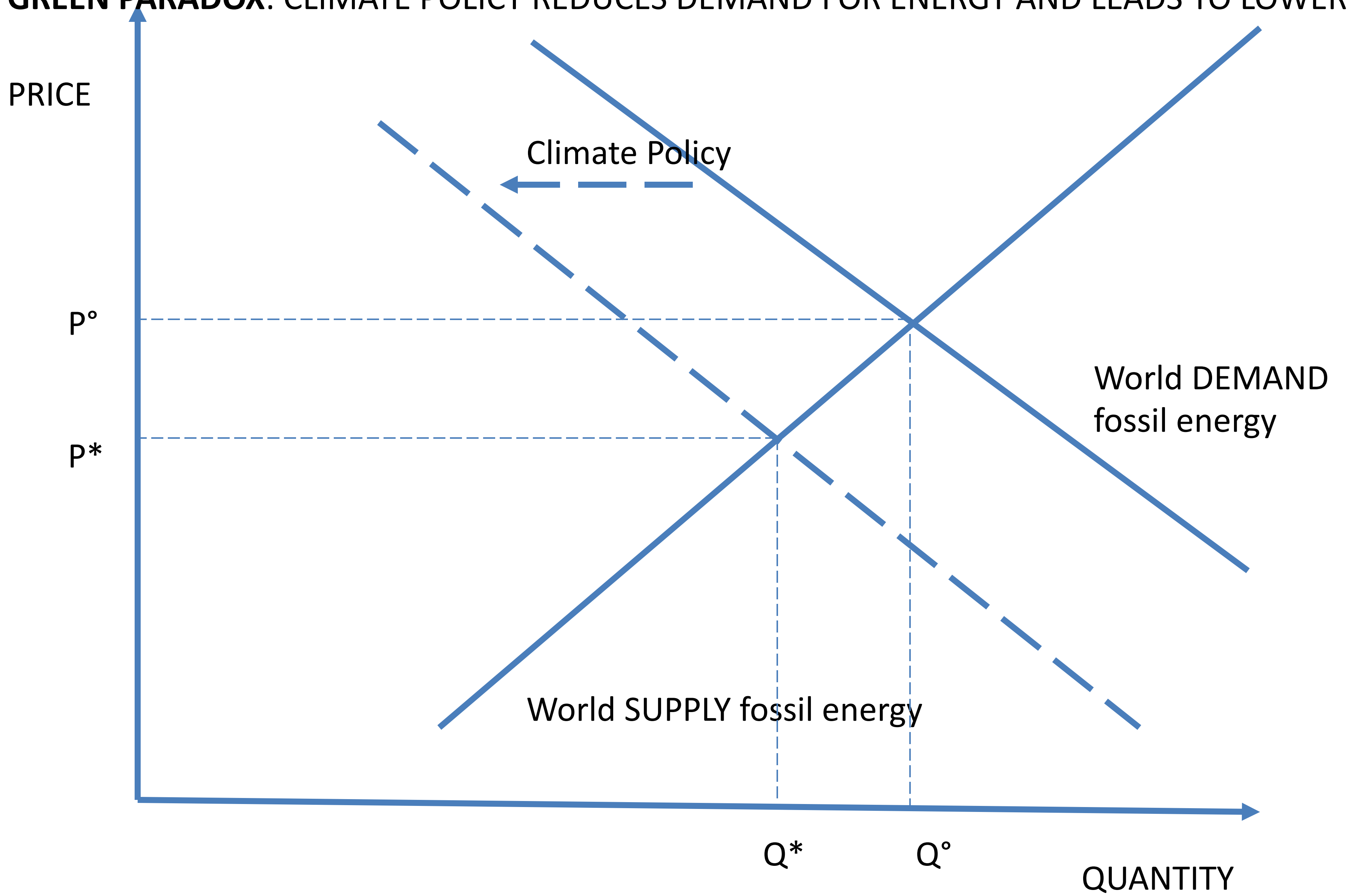
↓

Brown party signs the agreement but will not comply because sanctions are weak

Contribution of international agreements will be limited

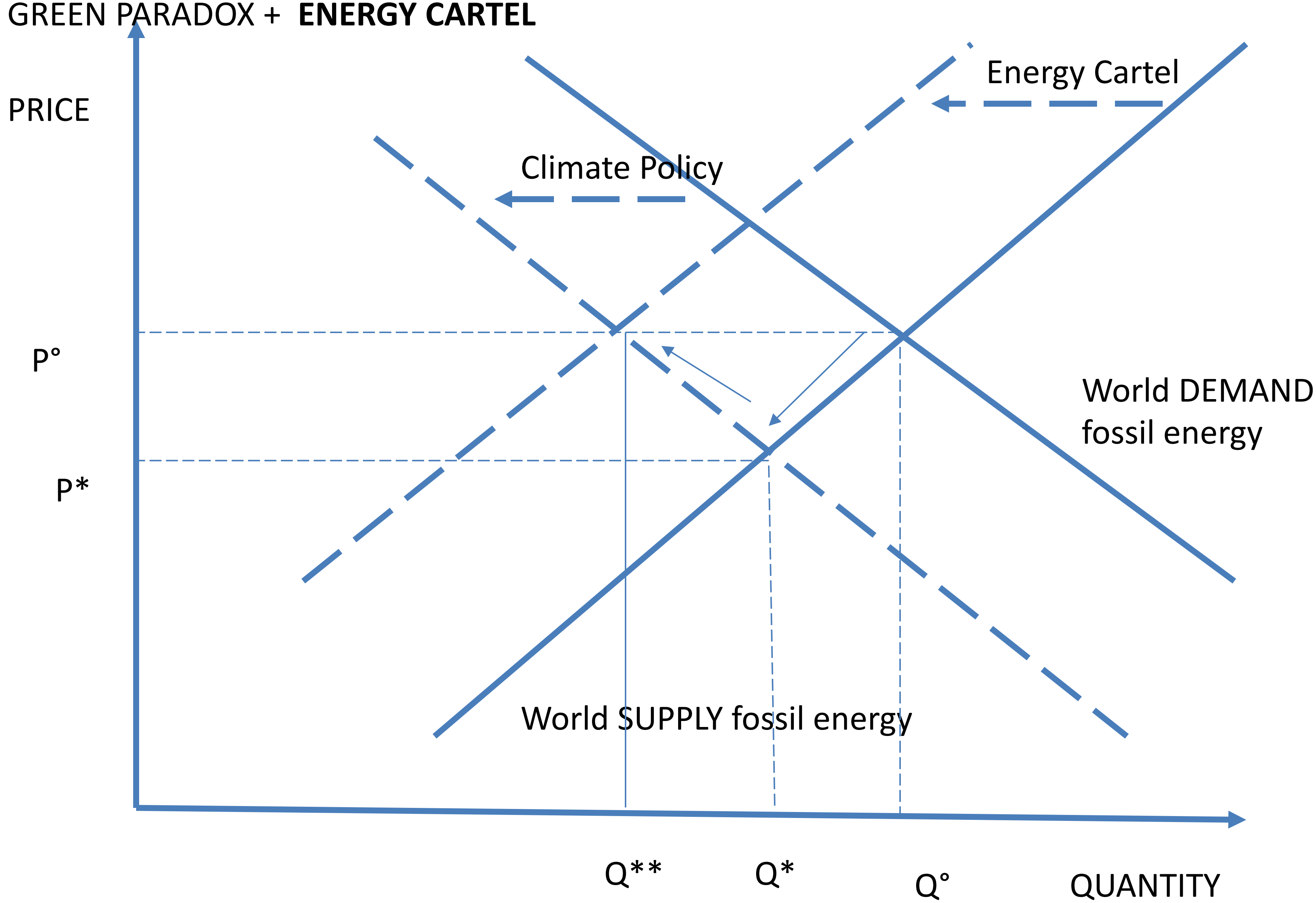
- They have to be self-enforcing because there is no enforcing international authority
- One can not exclude free-riders and one can always come up with reasons for free riding
- Agreements will be signed but national politics will decide on effective action, this can come and go (commitment problem in policy)
- What is possible:
  - Name and shame at COP's
  - Climate cartel
  - Energy and climate cartel

GREEN PARADOX: CLIMATE POLICY REDUCES DEMAND FOR ENERGY AND LEADS TO LOWER PRICE



Source: Asheim et al Science, *26 july 2019 • vol 365 issue 6451*

GREEN PARADOX + **ENERGY CARTEL**



Adaptation to climate change will not be easy but incentives are more correct

More Climate change means higher future damage one will try to avoid

Costs of adaptation are for each country but also the benefits, so incentives are more correct

Problems: uncertainty, poor countries bear a disproportional cost, benefit for future generations

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European Climate policy as case-study

European climate policy works because the EU can impose sanctions on the member states

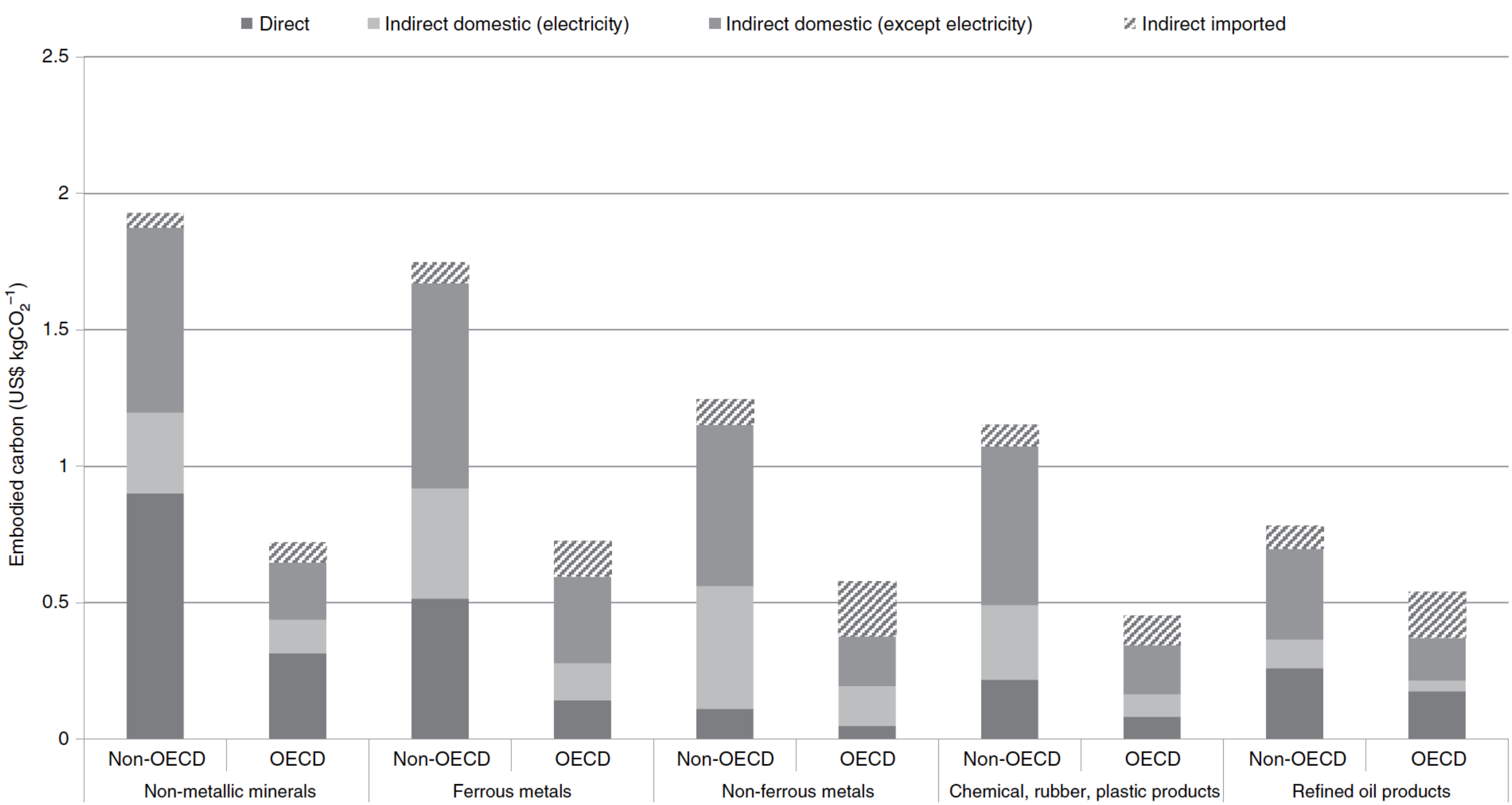
↓

Objective: net 0 in 2050, so compensation is possible via absorbtion of emissions

↓

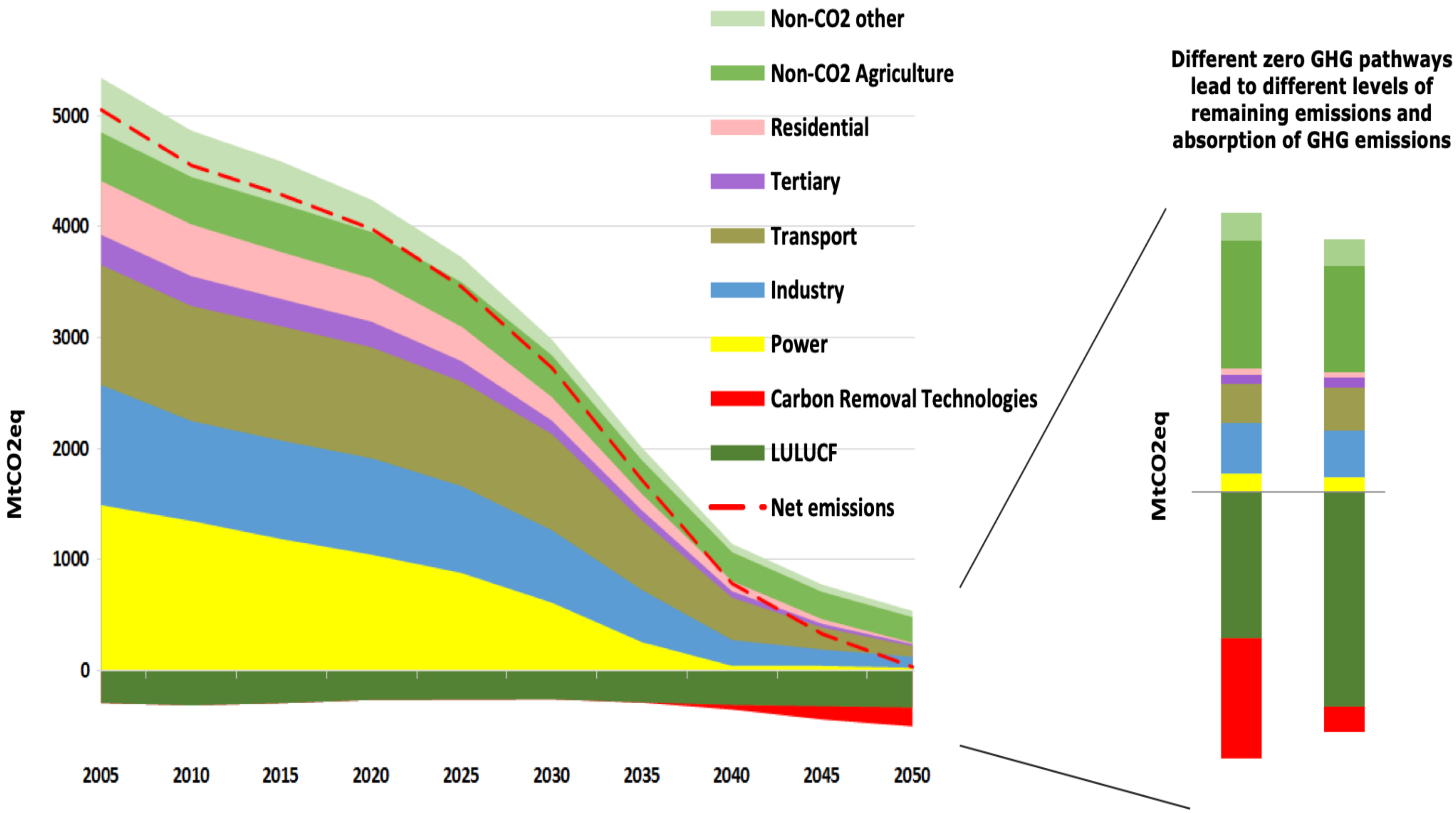
Forerunner role will be difficult when EU is to far in advance as trade sanctions on the rest of the world are difficult

Trade sanctions on the rest of the world are difficult as a) measurement is difficult b) puniishing of other countries is costly also for the EU



Source: Böhringer et al, 2022, Nature & Climate Change

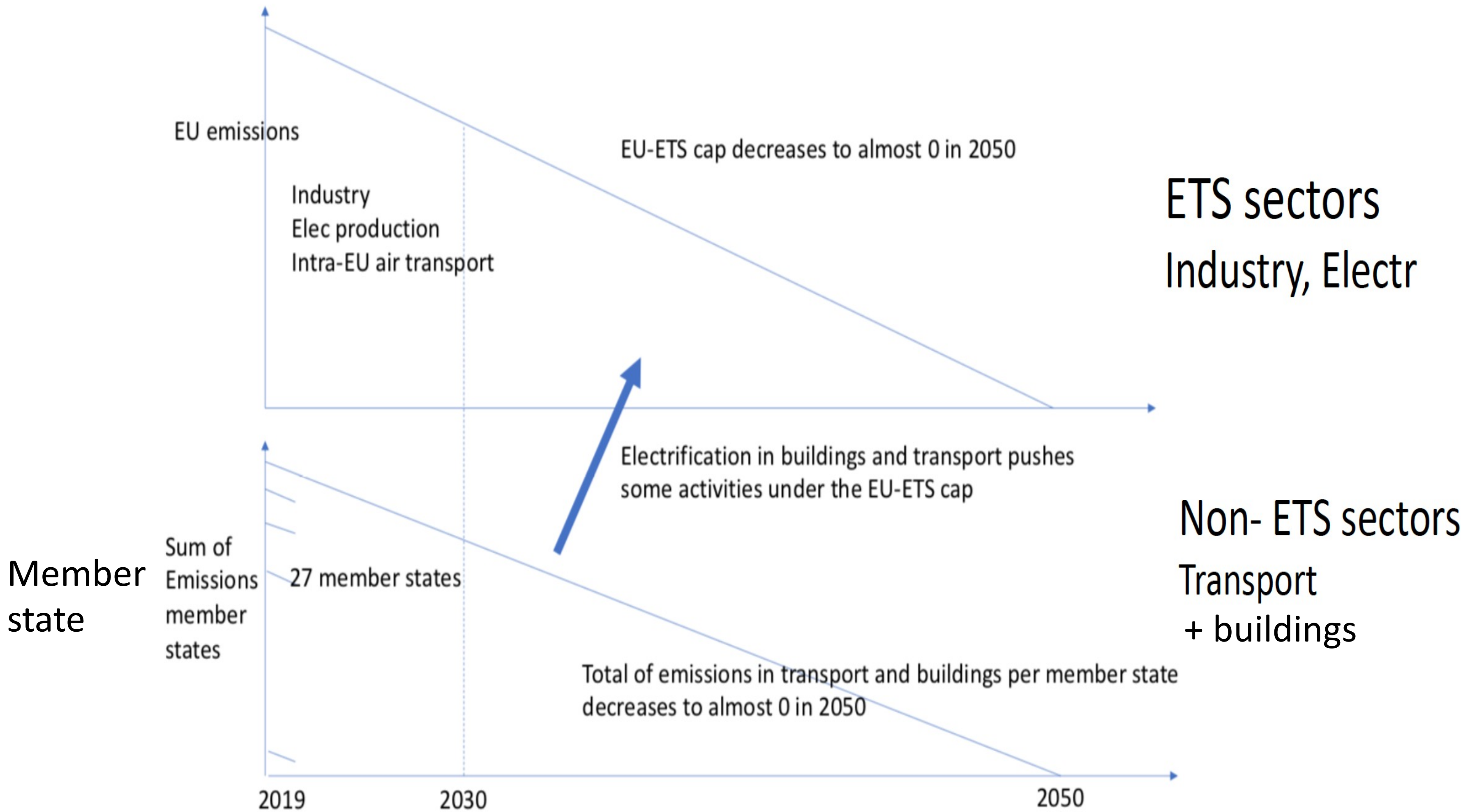
EU is Ambitious (one scenario)



European Climate Policy

- Tradeable permits (ETS) for industry, power and intra EU air transport
  - Was needed to have an EU electricity market
  - Initially accepted by distributing free permits
- Efficiency norms for appliances and cars
  - Necessary to have a EU internal market
- Building and transport: left to the member states
  - Resulted in regulations and subsidies

Structure EU climate policy



Need for a technology policy

- Ambitious objectives require better technologies stimulated by 3 instruments:
  - high long term carbon prices (taxes, permits)
  - Subsidies for pure R&D
  - Subsidies for learning by doing
- EU (member states) has
  - High long term carbon taxes in industry and road transport
  - Too many installation subsidies and not enough R&D

Tradeable permits work but are still poorly understood

Example: Adding a **new nuclear power station** in Belgium will not decrease EU emissions

- Because the lower emissions in Belgium will be compensated by higher emissions somewhere else in the EU

When there is enough competition, handing out **free permits** still raises the price of the product and gives an incentive to reduce emissions in production

Stef Proost March 2023

Electricity will become more important but requires a well functioning electricity market

Cap on total emissions

Need for a EU market where flexibility is priced

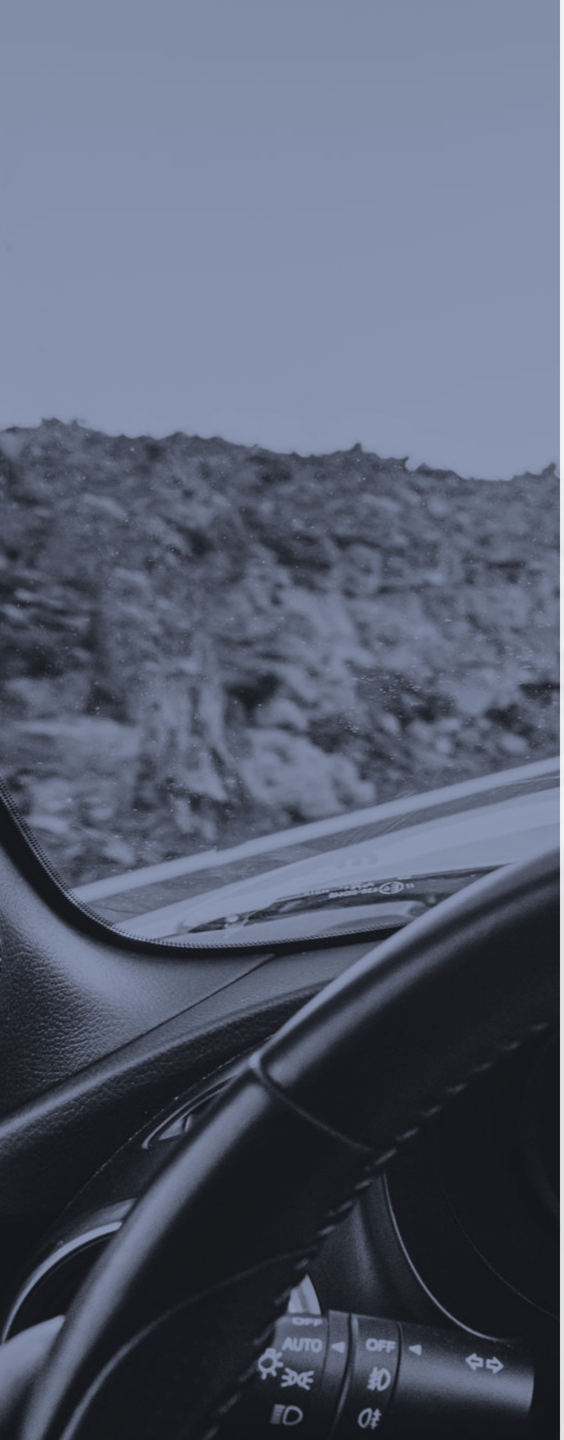
Interconnection important to exploit complementarity of different sources of renewables

Energy intensive industry

- EU-ETS is the main driving factor
- Need of proces-innovation in steel, chemical industry, building materials, ..
- Technologies not yet competitive at current permit prices : need for combining hydrogen and carbon
- Difficult to protect local production
- Some production (ex. With high needs for hydrogen) may be better left to the rest of the world

Buildings: climate neutrality requires heavy investments

- Urban areas:
  - Heat pump and/or heat network
  - Green areas for cooling – so not necessarily higher density
  - Need for spatial coordination
- Non –urban areas
  - Heat pump
  - photovoltaics
- Too slow? Renewal of building stock (1% /year) renovation (0,5% /year)

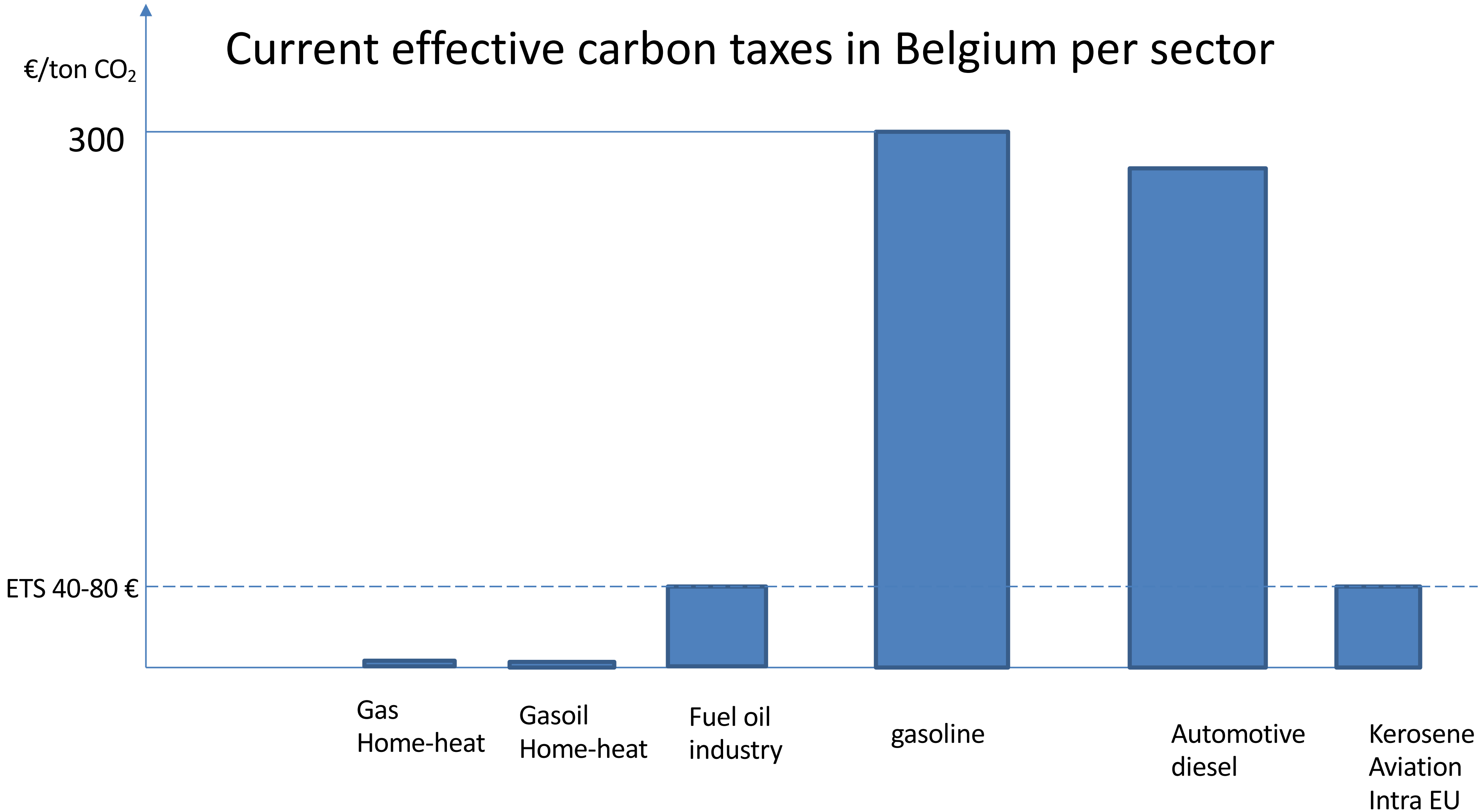


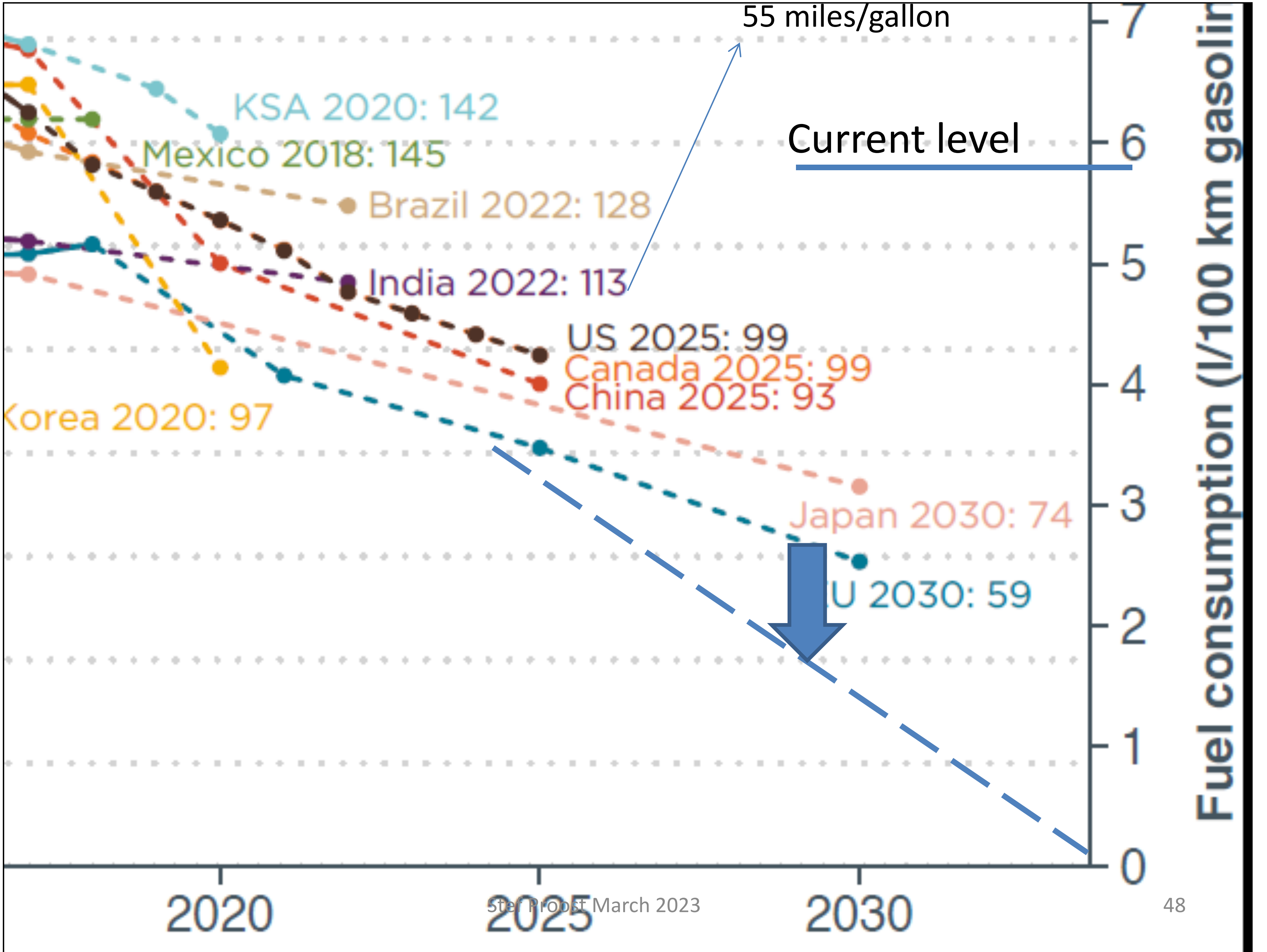
Passenger transport: not always cost-effective

Fossil cars are an important source of CO_2 emissions

- Replacement by Electric cars reduces emissions when the cars are produced in the EU (cfr. EU cap on power and industry)
- But we tax fossil fuel use in cars already at 200 €/ ton CO_2
- So this strategy is effective but costly
- Having conventional cars running on e-fuel is also effective but will also be strongly subidized because the e-fuel, like electricity, pay no excise taxes.
- We have excessive car use in the peaks but this requires road pricing etc.
- Substution of fossil cars by bus or by rail is also reducing emissions, but this policy has alread been tried for years.

Current effective carbon taxes in Belgium per sector




55 miles/gallon
KSA 2020: 142
Mexico 2018: 145
Brazil 2022: 128
India 2022: 113
US 2025: 99
Canada 2025: 99
China 2025: 93
Korea 2020: 97
Japan 2030: 74
EU 2030: 59
Current level
Fuel consumption (l/100 km gasoline
0
1
2
3
4
5
6
7
2020
2025
2030

Freight transport

new trucks have to become more fuel efficient, 0? in 2040

Technology on long term not yet clear

electric truck

- Big batteries
- Electric motorways?

Hydrogen truck is not the way to go

Substitution by inlnd waterways and rail has only limited potential for particular products

Long distance sea transport: very slow progress ..

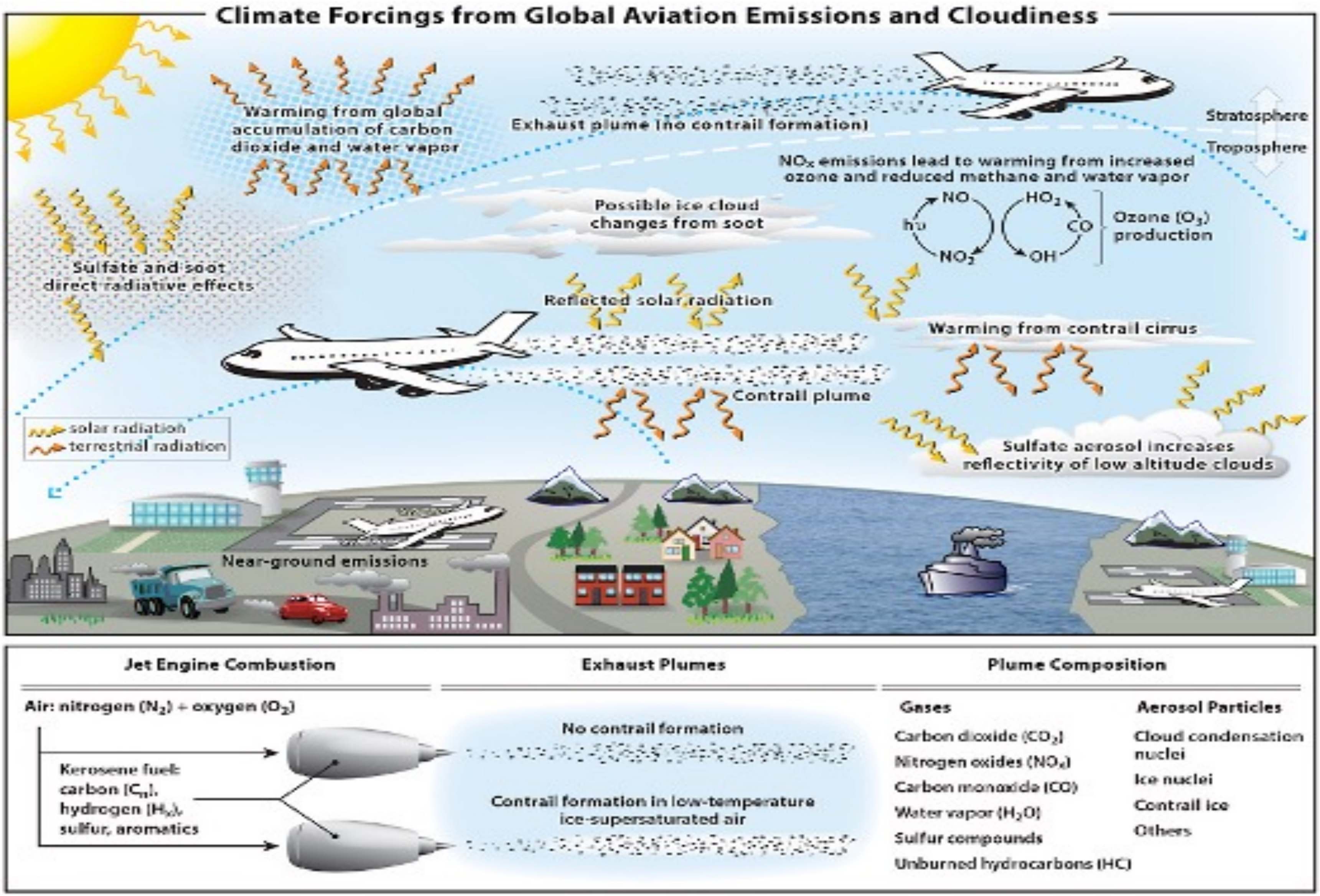
“Electric” roads with catenary trucks

Source: Akerman (Siemens) (2018).)

Long distance passenger transport

Within EU	Between continents	Elephant in the room
• HST and air transport are part of ETS cap • Works for aviation	• CORSIA agreement to cap growth of emissions between countries by offsets (compensation by extra efforts in other sectors) • Unlikely to work well	• Emissions of 1 ton CO_2 at higher altitude generate GHG equivalent of 3 ton CO_2

Lee D.S., et al., (2021), The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018, Atmospheric Environment 244 (2021) 117834



Flights	within EU	EU to ROW	ROW country to ROW country	Within ROW country
% emissions	14%	22%	? 39%	? 25%
Int Agreem	Paris	Corsia	Corsia	Paris
Policies	EU-ETS Sustainable Aviation Fuels (SAF) Fuel eff	**Offsets** (SAF) (Fuel eff)	Offsets (SAF) (Fuel eff)	....
Issues	EU-ETS Works? SAF target?	**Offset price? Participation?**	Offset price Participation?	.....

Decarbonisation of air transport

- Clean fuels or Sustainable aviation fuels (mainly e-fuels)
  - “Green ” aviation (only 2 to 5 % of green fuels)
  - Synthetic fuels remain vry expensive
- Better: improve aviation technology and limit volume

Take Away

- 5 Basic properties of the Climate Chnge problem are important: uncertainty, delayed effects, cumulative pollutant, global pollutant, no easy fix
- Climate agreements are difficult because it is aworld public bad without enforcing authority
- Climate adaptation is important and raises less incentive problems than preventing emissions
- EU is forerunner in climate policy going for net 0 in 2050: success of tradeable permits, but too much forerunning will create problems