POLITICAL ECONOMY OF CLIMATE CHANGE:

Evidence for global warming
Risks of global warming
What must be done?
Green Paradox
Stern Report & Weitzman critique
Emissions trading

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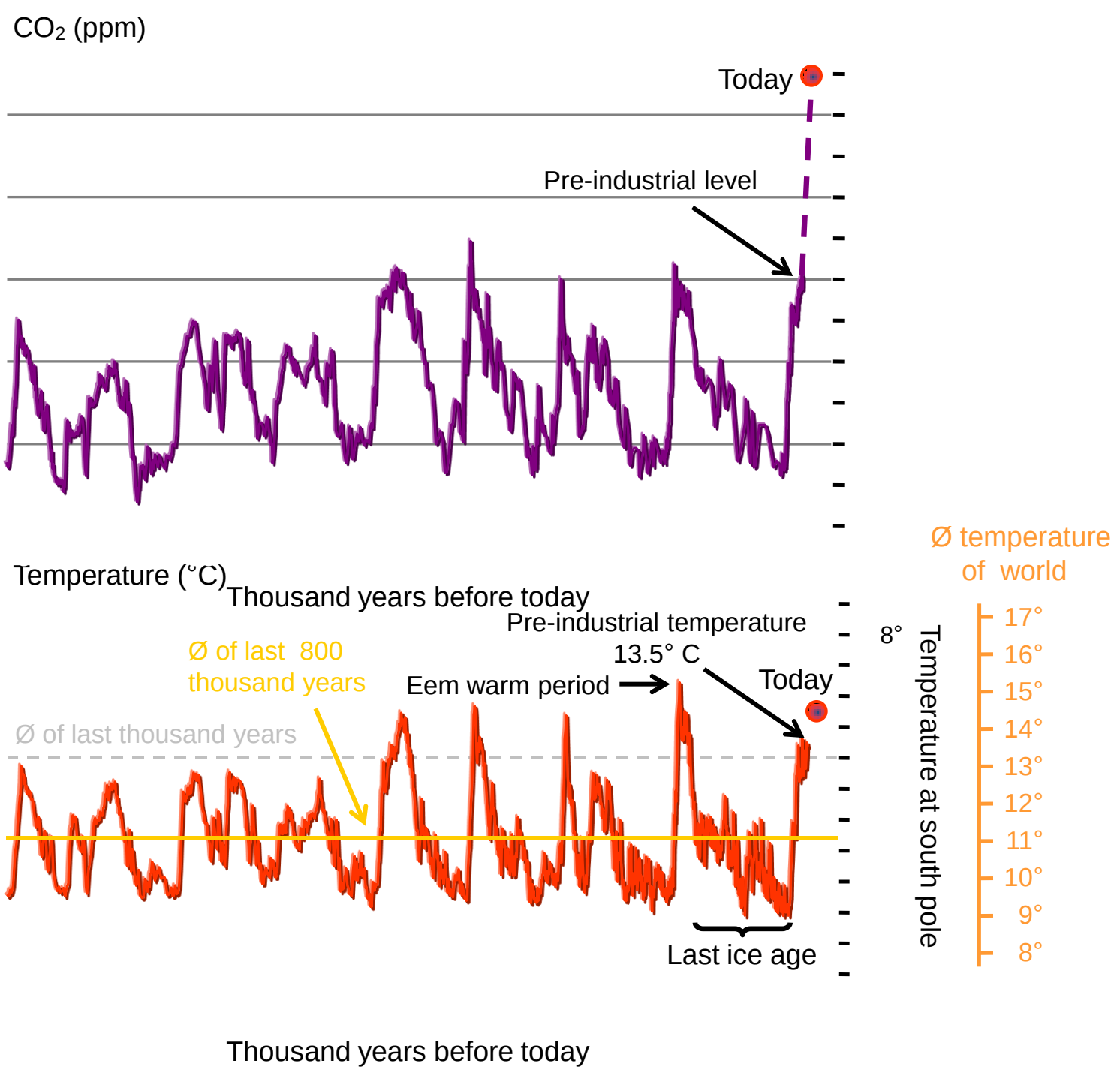
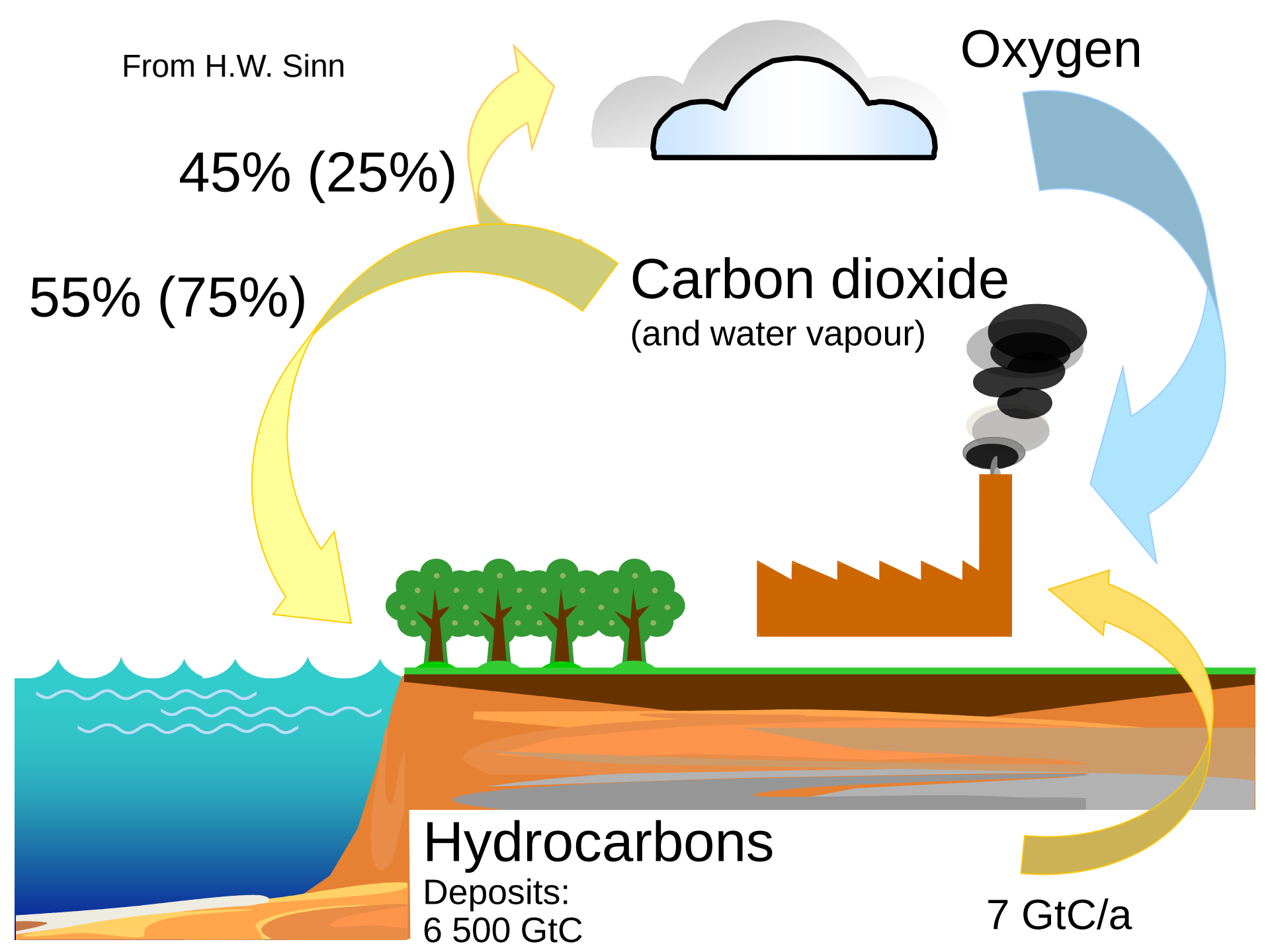
GLOBAL CLIMATE CRISIS

- Since 1750 both world population and production per person has risen tenfold. Hence, gigantic pressure on environment.
- World population will go from 6.6. to 9 billion in next forty years and all these new people need to eat, to be housed and to transported.
- During coming decades CO2 concentration in atmosphere may double: global warming.
- And it is anthropogenic – caused by human beings (Crutzen). Half of CO2 caused by vehicles, industry and especially coal-using energy companies. Rougly 20% caused by deforestation. Methane via cattle also important cause of greenhouse gas emissions.

Evidence from rocks

- 55 million years ago: massive sudden release of carbon from the ocean floors (Paleocene Thermal Maximum).
- Led to rise of temperature with 5-7 degrees Celcius, acidification of oceans, 4-5 meters higher sea level.
- Lots of species did not survive.
- Took 200,000 years to recover.
- Today much bigger rise in sea levels (cooler so more ice to melt).

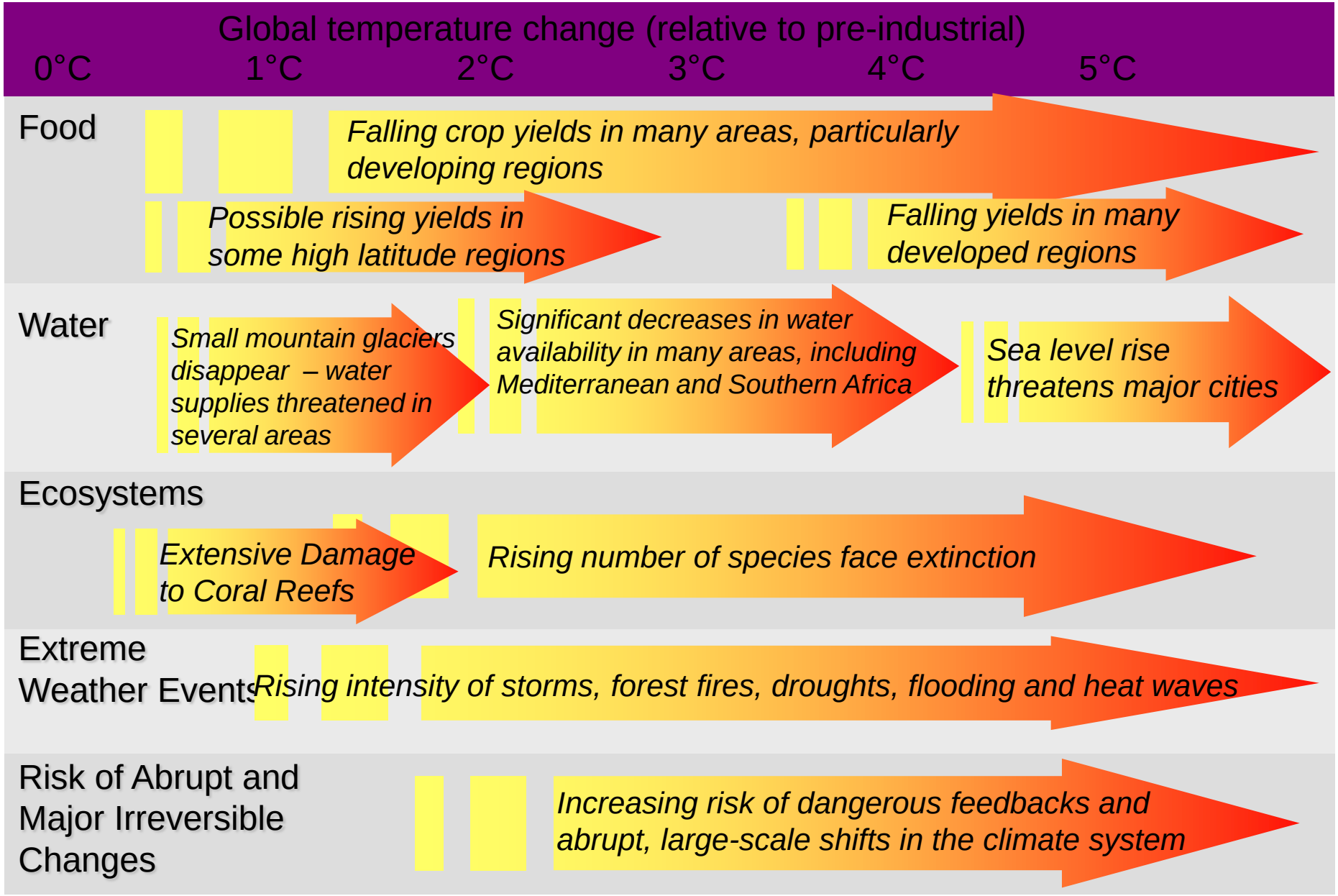

CO_2 (ppm)
Today
Pre-industrial level
Temperature (°C)
Thousand years before today
Pre-industrial temperature
13.5° C
Ø of last 800
thousand years
Eem warm period
Today
Ø of last thousand years
Last ice age
8°
Ø temperature
of world
Temperature at south pole
17°
16°
15°
14°
13°
12°
11°
10°
9°
8°
Thousand years before today


From H.W. Sinn
Oxygen
45% (25%)
55% (75%)
Carbon dioxide
(and water vapour)
Hydrocarbons
Deposits:
6 500 GtC
7 GtC/a

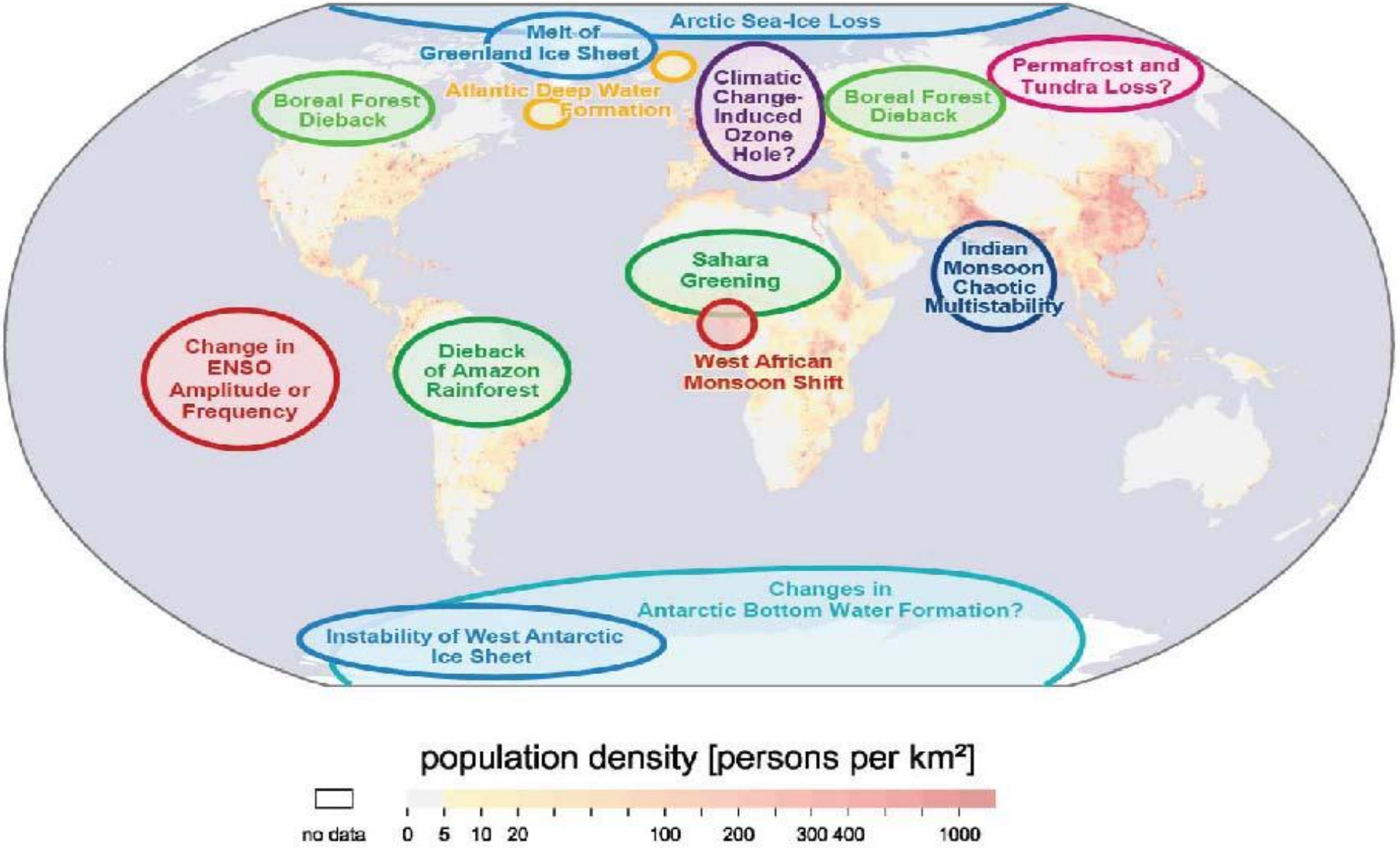
Risks of global warming

- Rising sea levels, more hurricanes, destruction of natural habitats, acidification of oceans leading to destruction of coral reefs and plankton, infectious diseases of hitherto unknown diseases, massive shortages of water (only 2.75% is fresh water and three quarters of that in icecaps etc.), desertification
- Much of burden falls on developing countries, who were not even responsible for global warming.
- Risk of tipping points and irreversible thresholds. Need not only mitigation, but also adaptation.

Disruptions from global warming



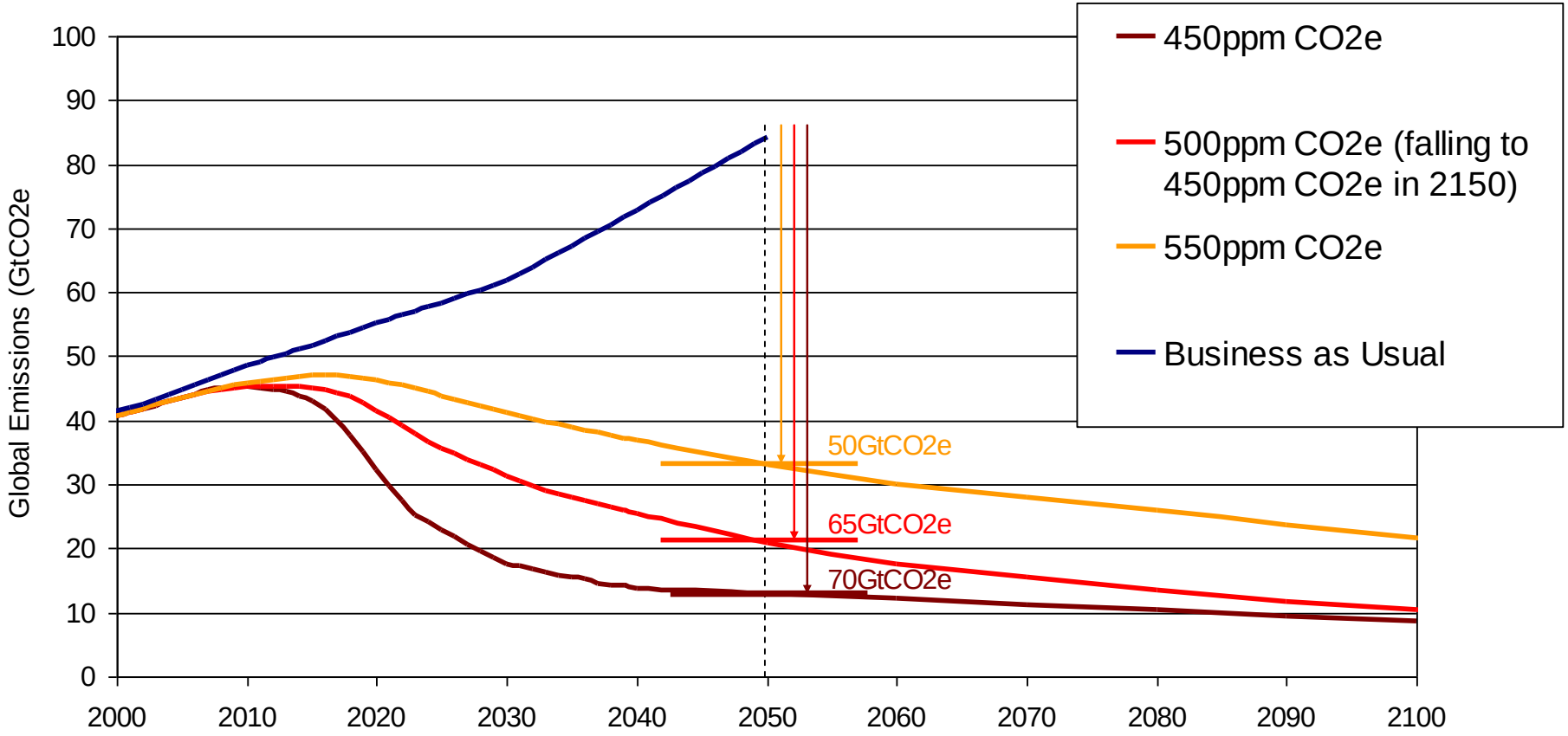
Tipping Points in the Earth System



Source: Lenton and Schnellnhuber (2007)

What must be done: 650ppm → 4°, 550→ 3°, 450→ 2.5°, 400→ 1.8°

Stock – flow dynamics



NB: currently around 380ppm, increasing 2.5ppm → 550ppm by 2035

Size of the carbon challenge

- Obama wants to cut GHH below 14% below 2005 level by 2020 and 83% by 2050 which requires 1 to 6-7 Giga tons of CO2 cuts.
- One Giga ton reduction requires 320 zero-emission 500 MW fired-power instead of coal-power plants, 127,500 wind turbines, conversion of 5.4 size of Iowa for biomass production, new forests 2.5 times the size of State of Washington.
- During 2000-7 emissions have fallen by 7% in US but have risen by 10% in India, 21% in Canada (tar sands!) and 45% in China.
- 80% of GHG emissions until 2050 will come from developing countries. Need China and India in a new Super Kyoto.
- Problem is coal, not oil/gas! Much higher CO2 content.

Green Paradox: counter-productivity of green policies

Sinn, H.-W. (2008). Public policies against global warming: a supply-side approach, International Tax and Public Finance, 15, 360-394.

Anticipation of green policies causes oil sheiks to pump oil faster, which accelerates global warming.

Carbon leakage: Green policies of Kyoto countries has no effect, since China benefits from lower oil prices. Hence, do not pursue green policies in Europe until China signs up to Kyoto.

Focus on demand for carbon ignores supply of carbon.

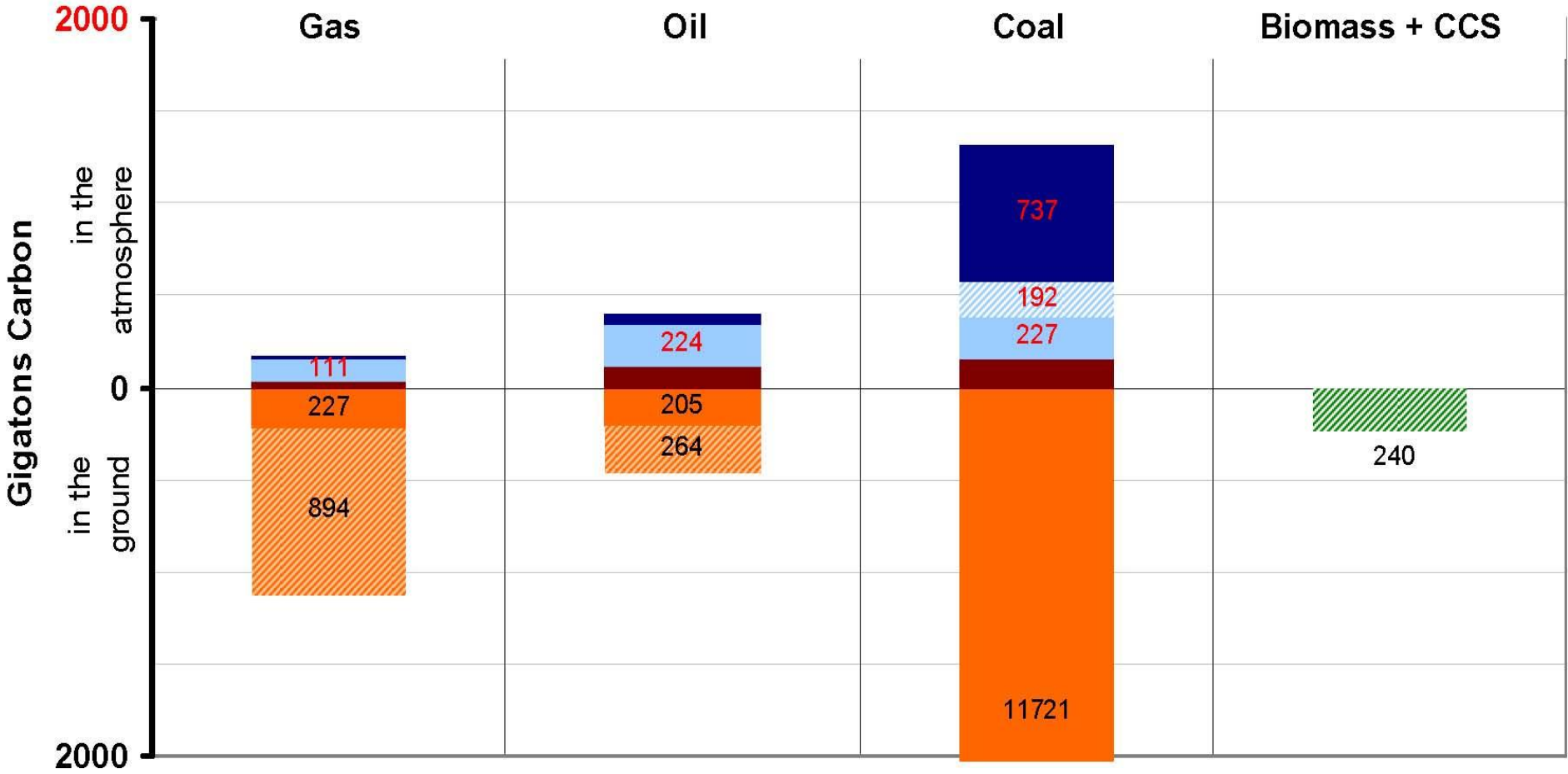
Green Paradox: Ineffectiveness of carbon policy?

- Carbon leakage: if Kyoto countries put a price on CO2 emissions, some of it will be shifted to producers especially if fuel demand is elastic and supply inelastic. Gift to non-Kyoto countries! Renders CO2 policy ineffective unless it truly is a global deal incl. at least China and India.
- There may allow be pollution flight via dirty FDI.
- If gradual policy ramp is announced a la Hotelling, then rational oil/gas owners will deplete faster to avoid capital losses and thus brings global warming forward.
- Higher prices induce substitution towards dirty coal (if it is not included for political economy reasons), CO2 intensive tar sands, and unsafe nuclear energy.

Most policies directed at curbing demand for fossil fuel

- Curbing of demand for fossil fuels: higher petrol taxes, home insulation, lighter cars
- Green electricity: wind, water, solar, biomass, hybrid cars
- Nuclear: electricity generation and hydro power
- Other green energy sources: pellet heating, biodiesel, heat pumps, solar, geothermal
- Efficient combustion: common-rail diesel engines, optimized power plants

Coal Reserves dominate Gas and Oil Reserves



unconventional and conventional resources and reserves (respectively, 894 and 227 for oil)
biomass + CCS (240; zero emissions; 400 ppm-eq scenario) under the ground.
Estimated additional consumption (737 for coal),
coal + CCS (192 for coal; zero emissions; 440 ppm-eq scenario),
estimated consumption (227 for coal; 400 ppm-eq scenario) and
cumulative historical consumption in atmosphere.
Source: Edenhofer and Kalkuhl (2009)

Optimal switch to clean backstop

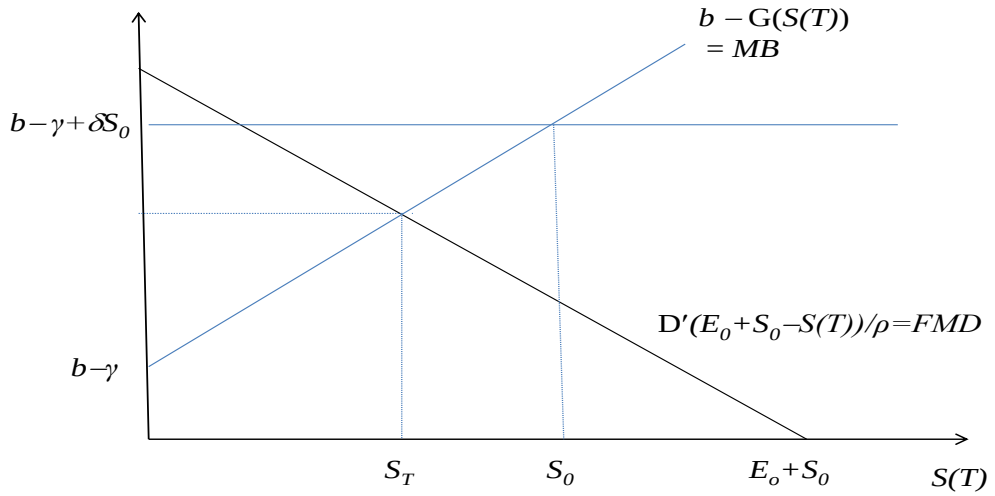
- Can show that it is not optimal to have simultaneous use of oil and backstop.
- No extraction after some *T*, but perhaps keep some oil in situ forever.
- PV of future marginal damages of CO2 emissions from *T* onwards from one unit less oil/gas in situ equals marginal benefit of using oil/gas rather than backstop:

$$FMD = \mathrm{D}'(E_0 + S_0 - S(T)) / \rho = MB = b - \mathrm{G}(S(T))$$

Partial exhaustion: leave some oil/gas in situ forever

$b < \gamma + \kappa(E_0 + S_0)/\rho$ if backstop is relatively cheap

and global warming challenge is acute

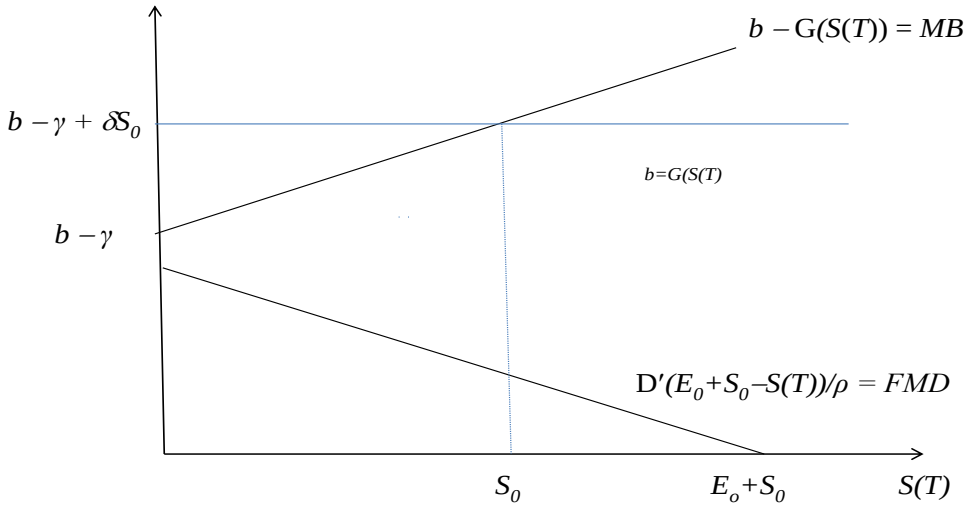


Stern Review: very low rate of discount ρ, so *FMD* is shifted out and therefore it is optimal to leave much more oil/gas in situ and have much less CO2 emissions.

Similarly, cheaper backstop shifts out MB, so keep more fossil fuels in situ and curb global warming that way).

Full exhaustion of oil/gas reserves

$b > \gamma + \kappa(E_0 + S_0)/\rho,$ if backstop is relatively expensive with respect to oil and global warming challenge is not too acute

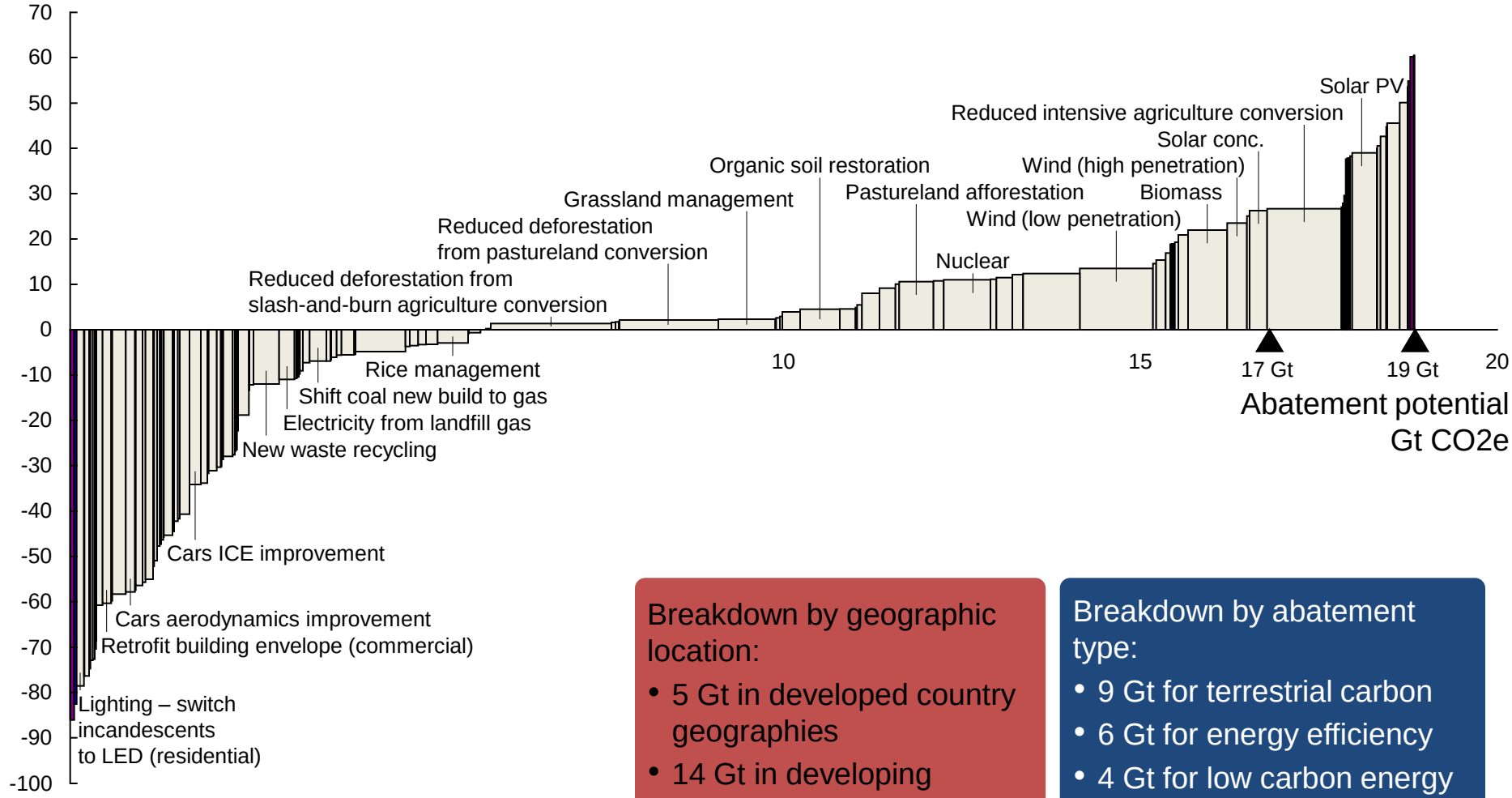


Behind supply curve: continuum of imperfectly substitutable backstops

- As oil price +carbon tax rises buildings get insulated, heat pumps, common-rail engines and wind power kick in.
- With higher oil prices hybrid engines, combined heat and power generation, and gas and steam power plant kick in.
- Then solar power, conversion roads to rail tracks, stop to international tourism, little traffic and zero-energy homes.

Opportunities for the 17 Gt required to reach a 450ppm pathway

McKinsey global GHG abatement cost curve, 2020* (up to costs of €60/t, excluding transaction costs, 4% discount rate)



Breakdown by geographic location:

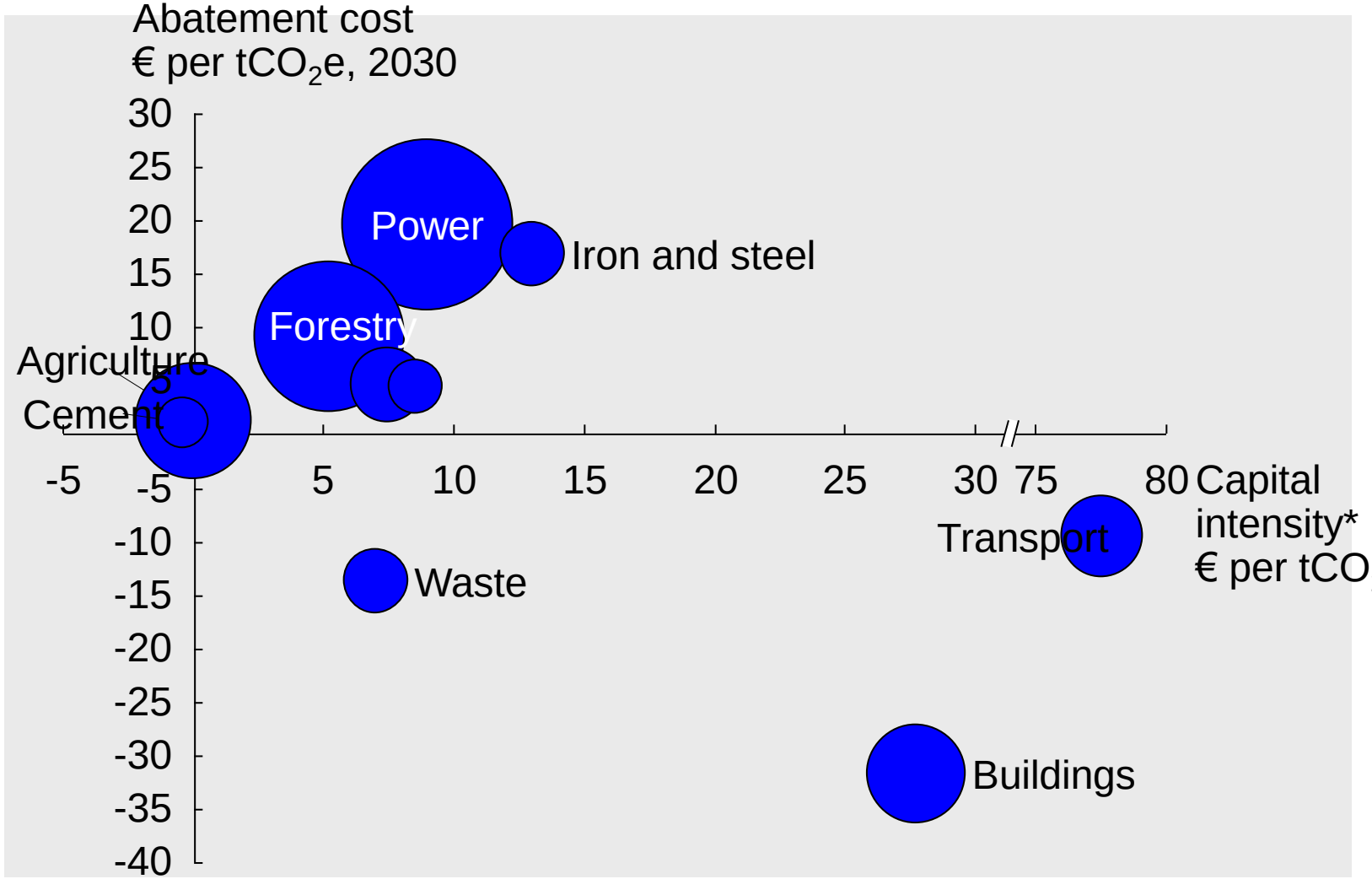
- 5 Gt in developed country geographies
- 14 Gt in developing country geographies

Breakdown by abatement type:

- 9 Gt for terrestrial carbon
- 6 Gt for energy efficiency
- 4 Gt for low carbon energy supply

Source: McKinsey Global GHG Abatement Cost Curve v2.0

Capital intensity and abatement cost



* Defined as the additional upfront capital investment compared to the BAU technology divided by the total amount of emissions avoided during the lifetime of the low carbon investment. For measures/technologies where upfront investments decrease over time with a learning rate, the weighted average investment over time has been used.

Source: Global GHG Abatement Cost Curve v2.0

Monopolies

- A period of limit pricing, i.e. ebsilon below the cost of the backstop, before switching to the backstop.
- Green Paradox and slower oil extraction than under perfect competition if backstop relatively expensive compared with initial MC of oil extraction, that is if $b > \gamma$.
- Otherwise, faster oil extraction than under perfect competition and more oil left in situ. Green Paradox need not occur.
- Monopolists and “greens” are unlikely bedfellows.

Tough dilemmas

- Alternatives to oil/gas are dirty or unsafe.
- Perhaps better to make it more attractive to keep oil/gas under the ground.
- Never enough space to be able to sequestrate all CO2 emissions: empty coal mines and oil/gas reservoirs offer only tenth of space.
- Even in EU carbon trading covers only 40% and mistake of grandfathering was made. New Super Kyoto needs to be coarser, but more comprehensive at global level.
- Tipping points and irreversible thresholds: Knightian uncertainty rather than risk.

Core of Stern Review

- Must allow for prudence in avoiding extreme events/fat tails. Precautionary principle.
- Global temperature predicted to rise by more than 3 degrees Celsius unless CO2 GHGs stabilized at 550 ppm CO2e.
- Case for immediate action rather than policy ramp tough to make unless discount rate close to zero (0.1), a low CRRA (1.0) and low growth rate of consumption are used (1.3%), mitigation costs are downplayed (1% GDP rather than double), and global climate benefits (5% rather than 0-3% GDP) a century ahead are played up. Interest rate equals 0.1+1.0*1.3=1.4% and benefit-cost ratio is 4.5. Immediate climate mitigation action is no brainer!

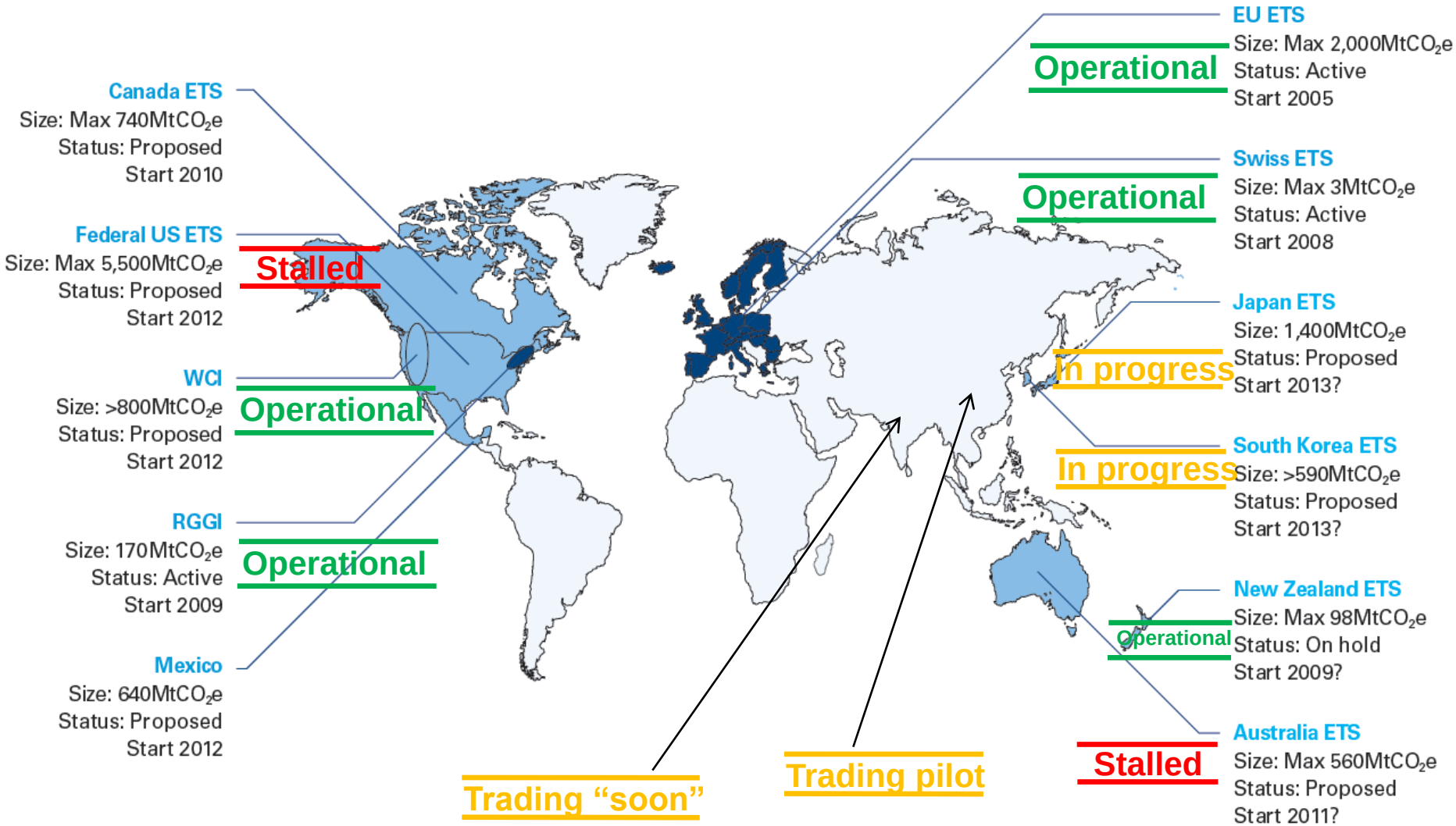
Weitzman critique

- With triplet of twos, interest rate of 2+2*2=6% (discounted benefits 100 years from now are 100 times less!) and benefit-cost ratio of 0.1. So no action on climate change.
- But with 50-50 outcomes, equivalent interest rate would be 2% not 3.7% ((1.4+6)/2!).
- IAM's correspond to market interest rate: problem for Stern Review.
- Investment climate beta matters.
- If benefits of climate change are perfectly correlated with economy a century ahead, then appropriate interest rate to use is risky rate of return, say 7%.

Developing countries and effect of financial crisis

- However, if benefits are not correlated (e.g., natural landscapes, biodiversity), use risk-free interest rate of 1% and thus case for immediate action is much stronger. The latter is especially important for developing countries.
- If investment beta is half, appropriate interest rate to use is 1.7% per annum which is not that different from the Stern Review. Case for immediate action rather than policy ramp may not be so bad.
- Alas: Relationship to Mehra-Prescott puzzle. If financial crisis drives premium on risky assets really down to, say, 0.1%, then case for immediate action disappears.

Emissions trading is advancing in EU, Japan, NZ, Switzerland; stalled federally in the US and Australia



China is rapidly implementing an emissions trading scheme

China is beginning a pilot carbon trading program in 8 cities and 5 provinces

Pilot cities

Pilot provinces

Pilot provinces : Guangdong, Hubei, Liaoning, Shaanxi, and Yunnan

Cities include: Tianjin, Chongqing, Hangzhou, Xiamen, Shenzhen, Guiyang, Nanchang, and Baoding

These pilots will help feed into a national domestic scheme

- China is expected to commit broadly to carbon trading during the ratification of its 2011-2015 Five Year Plan (March 2011), though details will likely be determined later (informed by pilots)
- Each area will be required to develop its own plan and market mechanism to reduce emissions in the near term
- Beijing and Shanghai are also independently working on trading schemes
- Domestic participation aids China's credibility in international discussions

Source: Climate Bridge (2010), using Chinese government announcements

India has announced that it will "soon" be piloting emissions trading in two states

Target

- Reduce emissions intensity by 25% by 2020 on 2005 levels

Trading scheme

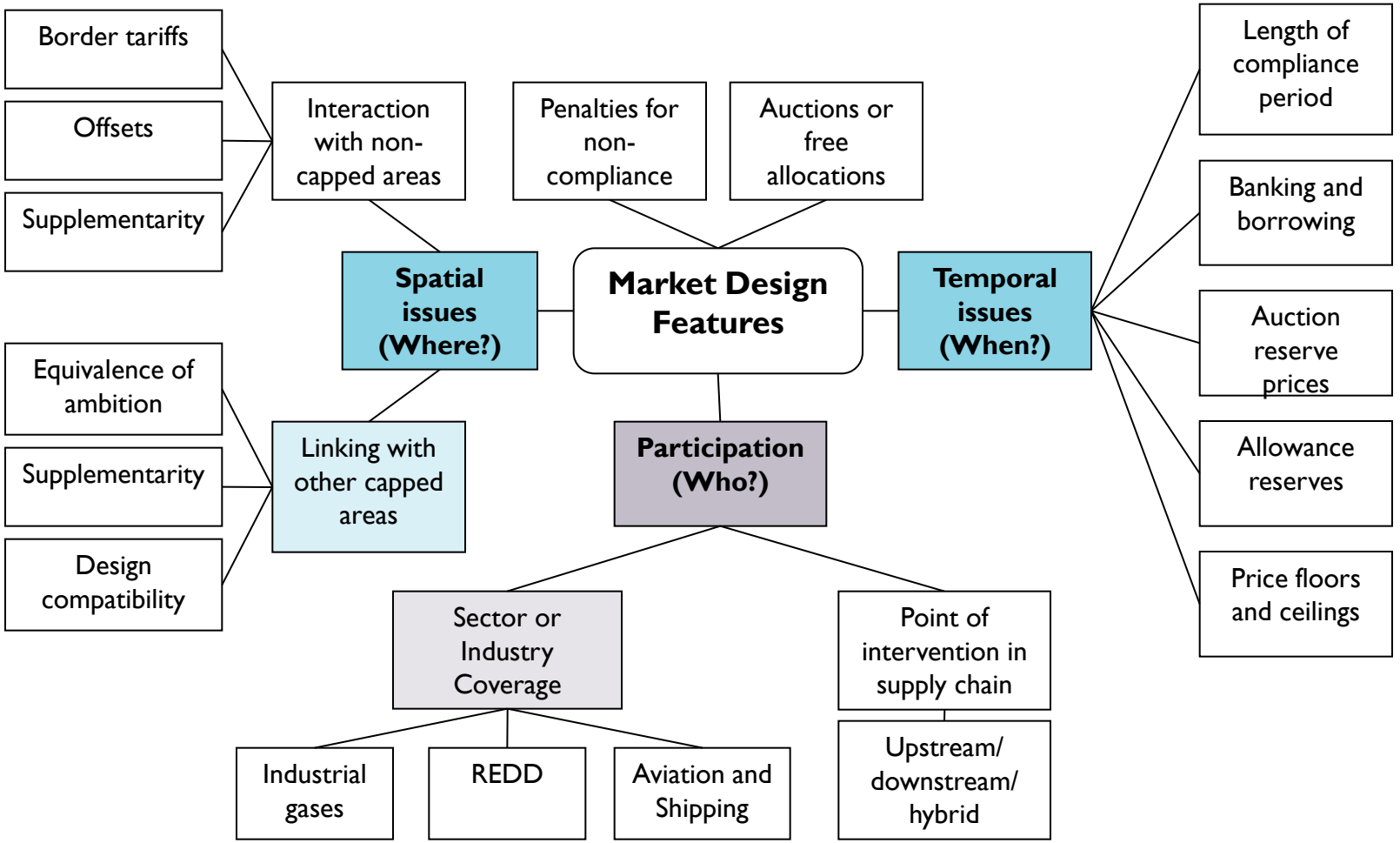
- India will "soon" start piloting emissions trading for industrial pollution (August 31, 2010)
- Pilots in Gujarat and Tamil Nadu, as these states have large industry
- Focus is on real-time emission monitoring

Carbon tax

- India imposed a levy on coal in its 2010 budget on 1 July
- Tax is at 50 Rs/t coal = A$1/t coal, equivalent to approximately A$3/t CO_2
- It is expected to raise around A$0.5 billion annually for clean energy fund

Source: Bloomberg BusinessWeek (2010) 'India to raise $535 million from carbon tax on coal', July 1st

Trading scheme design is more complicated than it first might appear

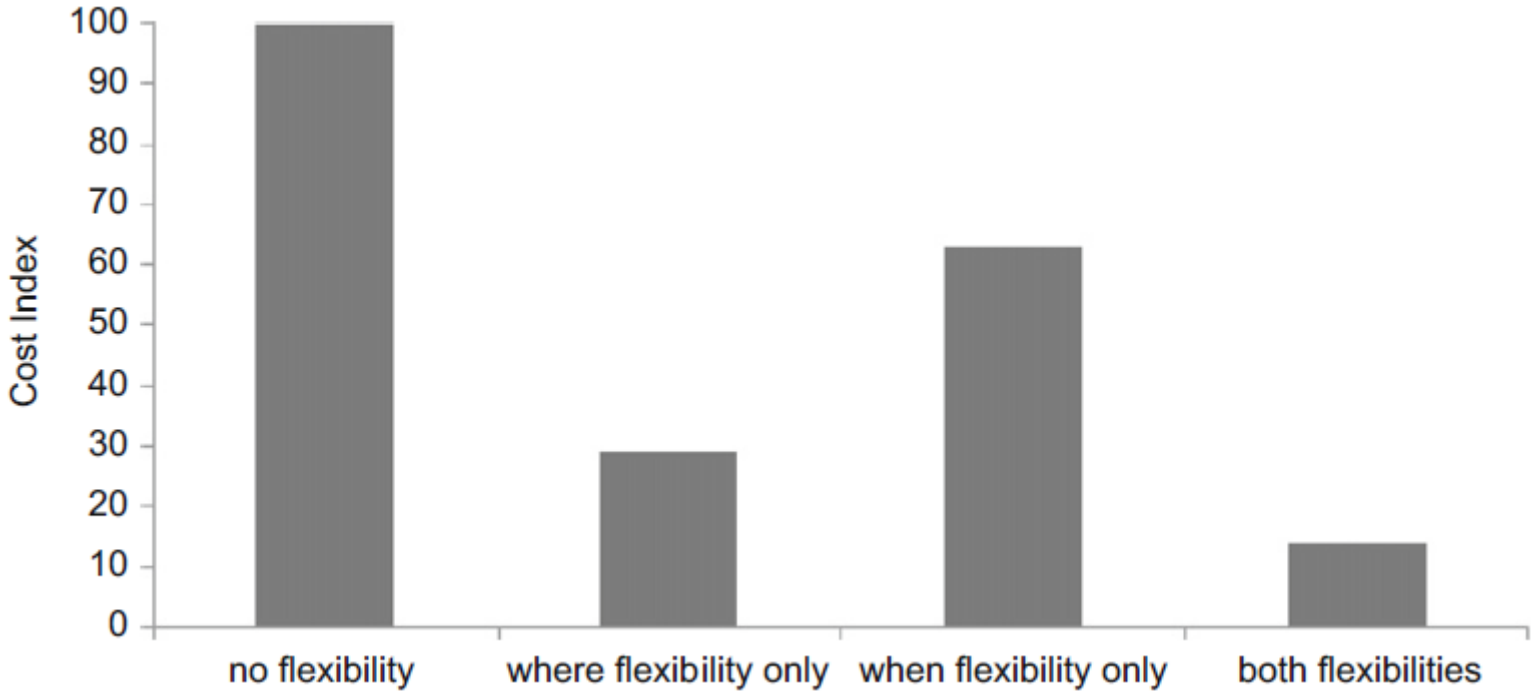


Source: Vivid Economics

A key principle is that flexibility reduces costs

— Costs of reducing emissions are minimised with:
  - Flexibility on **where** emissions are reduced (spatial flexibility); and
  - Flexibility on **when** emissions are reduced (temporal flexibility)

— Linking markets increases liquidity, which reduces transaction costs by reducing the bid-ask spread



Source: Richels, Edmonds, Gruenspecht and Wigley (1996)

So a global market would minimise abatement costs.
But a global market is highly unlikely to emerge

- Political and economic constraints prevent a truly global carbon market.
- Even markets for oil, gold and other commodities are not truly global: they are complex trading systems where location, quality and time matter.
- **Where.** There is unlikely to be a globally uniform carbon price, because of:
  - Industry idiosyncrasies (forestry, agriculture, aviation)
  - Excessive cost differentials between technologies (such as HFC)
  - Policy differences in terms of levels of national ambition
- **When.** Perfect "when" flexibility is not necessarily desirable: full borrowing would generate time-inconsistency problems (learning, procrastination)
- Determining the scope for desirable and feasible integration of carbon markets is a key challenge

Banking and borrowing prevents price crashes and spikes respectively...

- The end of a phase provides a real risk of a crash or spike unless participants can bank and borrow permits.
- Without banking, if the market is slightly over-allocated (as in Phase 1), then the marginal allowance is worthless and the price will collapse to zero (as it did)
- Without borrowing, if the market is slightly under-allocated, then the value of the marginal allowance could spike to the penalty plus expected next Phase price
  - Emission reductions require time to be delivered.
- Banking would have prevented the price crash observed in Phase 1, and is currently preventing further price falls in the current Phase 2

...but unlimited borrowing would create market integrity risks

- Borrowing allowances creates risks that the debtor won't repay (either through bankruptcy or because they wish to exert commercial or political pressure)

- Time-inconsistency problems may arise:
  - Actors may borrow in order to delay action under the assumption that targets will subsequently be softened in future.

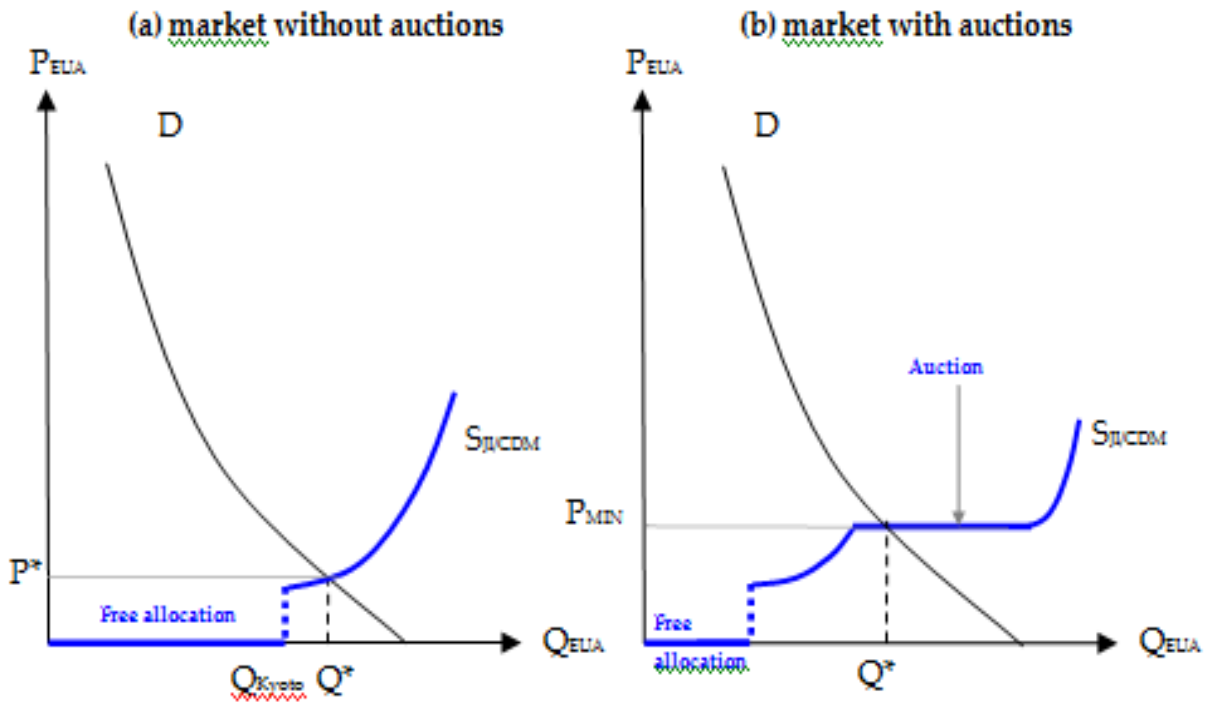
- Lieberman/Warner: allow regulator to borrow from previous periods, but firms are not allowed to borrow

- Political desire is to (be seen to) act early, so political considerations might support restrictions on borrowing

- The result is that most trading schemes have finite compliance periods and constraints on intertemporal arbitrage.

Auction reserve prices could create a soft price floor

- Reserve (or minimum) prices at EUA auctions would imply that firms would not buy EUAs if market prices were below the reserve price
- This stops the release of allowances onto the market when prices are low
- Advantage is that there is no liability on public treasuries to buy back permits



Source: Hepburn et al. (2006)

Price ceilings and floors have various advantages and some disadvantages

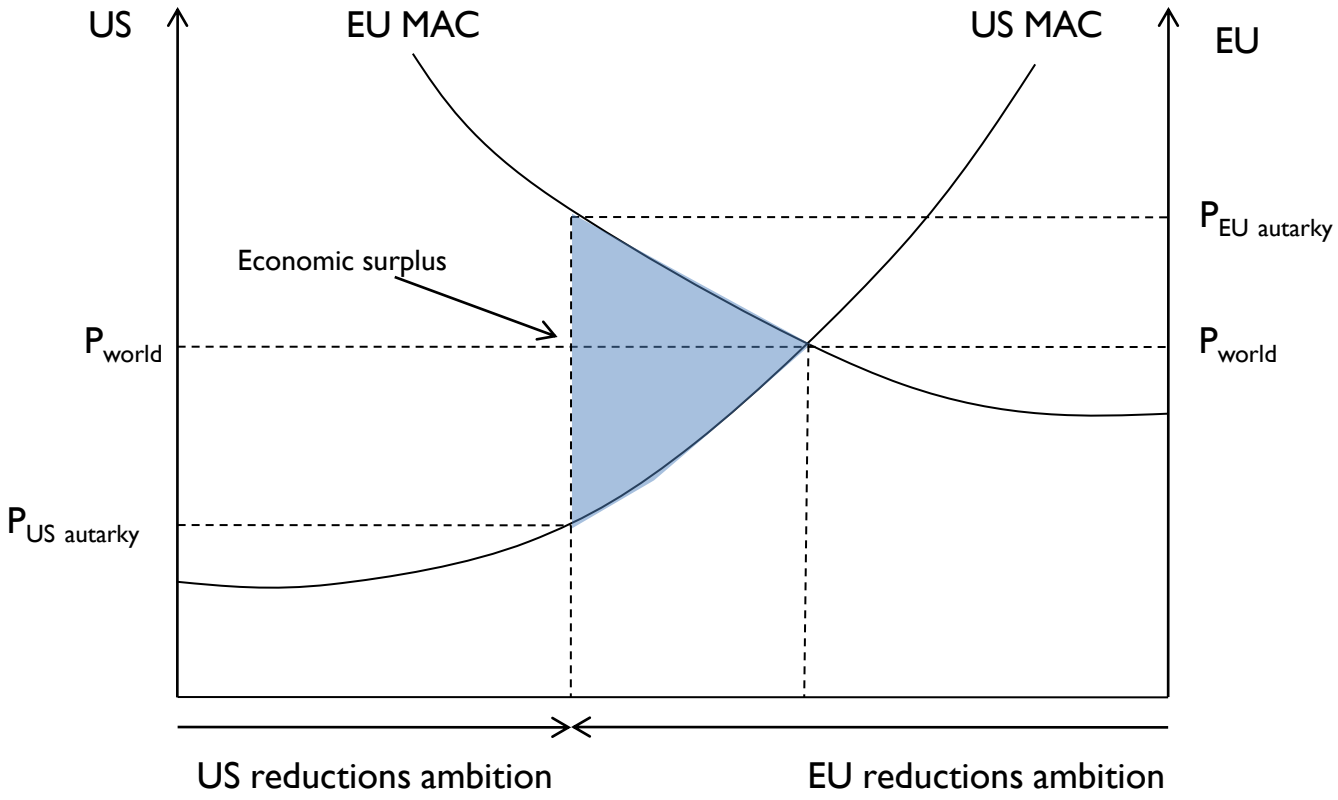
- Price instruments are likely to be **more efficient** for a long-term stock problem such as climate change. Taxes are often politically unrealistic, so a substitute objective could be to make cap and trade as "price like" as possible

- Even when there is banking and borrowing, signals to the private sector on likely prices are relatively muted, so price controls can **reduce market and policy risk**

- But they make **linking** more difficult

Linking schemes generates surplus by removing a deadweight loss

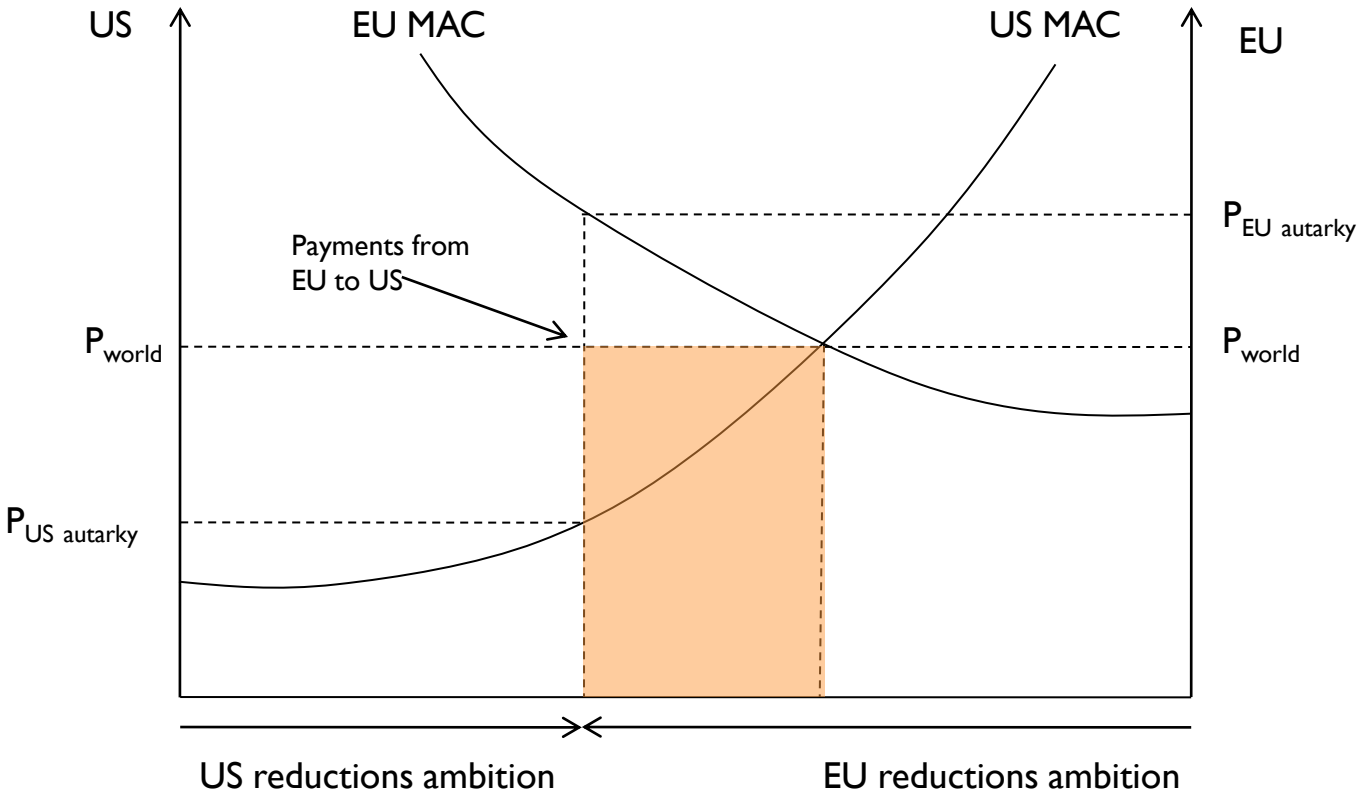
— Linking schemes yields a Harberger triangle of surplus, in this case because the US can reduce more cheaply (given the targets) than the EU



Source: Vivid Economics

But the payments from more to less ambitious schemes could be considerable

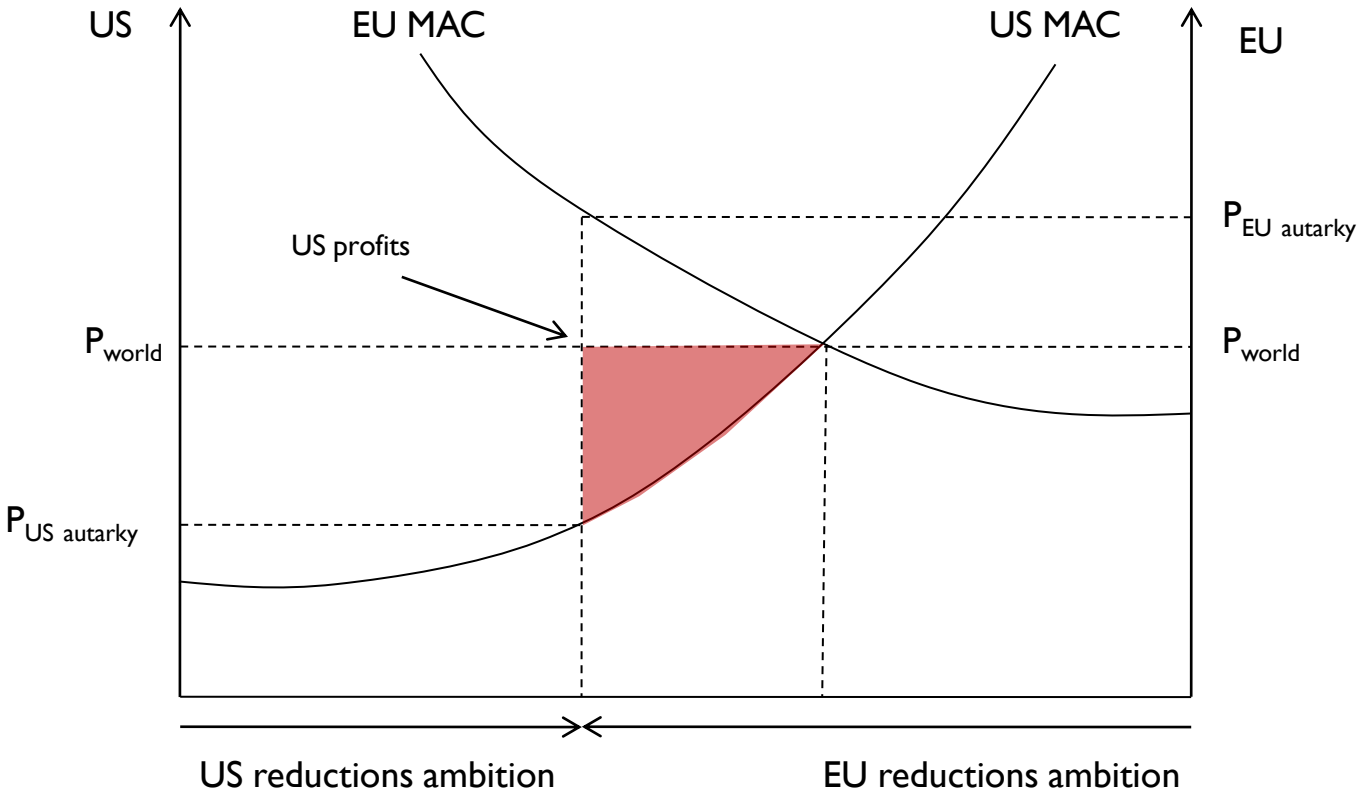
— If the EU had adopted a less ambitious target, and the US a more ambitious target, the payments from the EU to the US would be reduced



Source: Vivid Economics

So equivalence of ambition is required to minimise rent transfers

— The US profits from the fact that the EU has a more ambitious, and linked, scheme



Source: Vivid Economics

The basics: emissions trading increases costs but impact on profits depends on market structure

1. Emissions trading increases marginal costs of production
   - This is roughly **independent** of allocation method, due to opportunity cost of *not* selling permits)
2. Other things equal, this reduces profits, but firms may:
   - Reduce output and increase price ("cost pass through")
   - Substitute towards cleaner production ("abatement")
   - Receive free allocations of allowances ("lump sum windfall")
3. The first two responses are subject to strategic effects which depend upon **market structure**

Emissions trading tends to have a better chance of political success than taxes, because it allows governments to "buy" political support from business

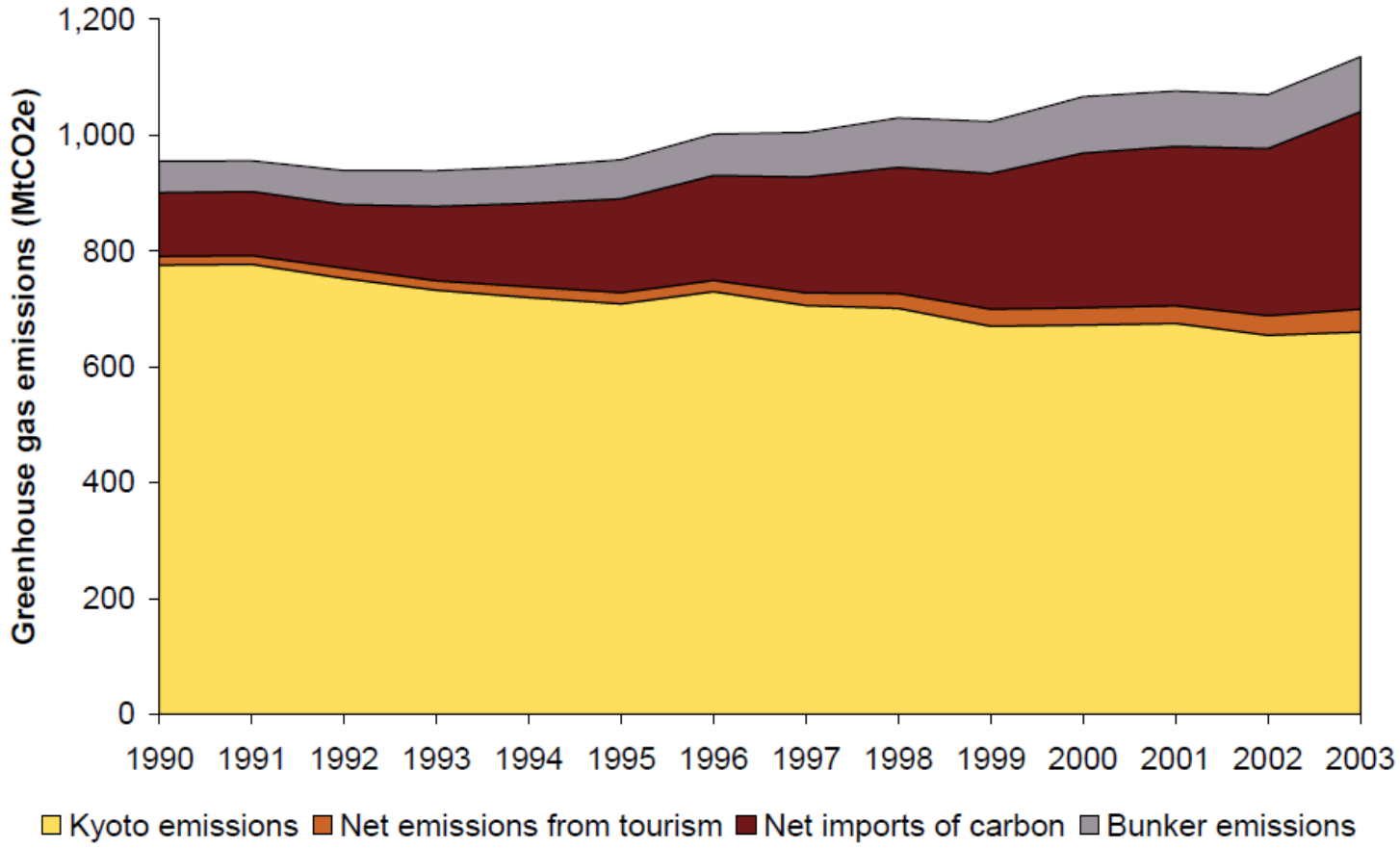
"Carbon leakage" is theoretically possible; but detailed analysis suggests it is unlikely to apply

- A good grounds for arguing for special treatment is that your industry will suffer from carbon leakage
- The Grattan Institute report (April) found that for most of the economy, carbon prices will have minor impacts on cost and competitiveness.
- Detailed analysis showed
  - Free permits may be justifiable for **steel** and **cement** (which would potentially move offshore with no emissions reduction)
  - No free permits needed for **alumina refining**, **LNG** and **most coal** as these industries will remain internationally competitive
  - **Aluminium** and **oil refining** may move offshore, but this would reduce costs and emissions, implying that these industries may no longer be competitive in Australia

Source: Daley and Edis (2010)

It is important not to confuse carbon leakage with natural shifts in comparative advantage

- UK consumption emissions have risen as production emissions have fallen
- This is less to do with carbon pricing, and more with structural shifts in comparative advantage



Source: Helm, Smale and Phillips (2007)

China is investing US $750 billion to grow their low-carbon sectors in the next ten years

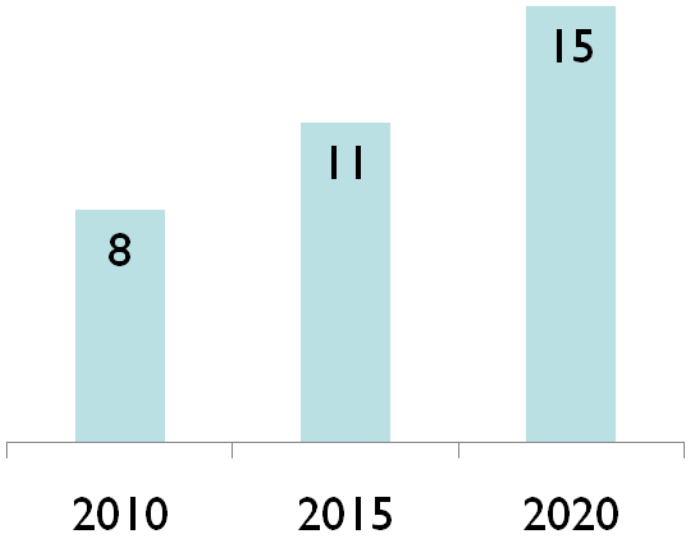
China is planning to invest ~$750B in alternative energy over the next 10 years in:

- Developing renewables technology
- Improving transmission grid infrastructure
- Deploying additional nuclear capacity
- New energy cars
- Natural gas

In Q2 2010, investment in Chinese clean technology companies and projects total $11.6 B, more than Europe and the US combined

Renewable energy targets for China

% of non-fossil based fuels



Companies with a strong position in the Chinese renewables market stand to benefit significantly from the scale up in activity

Source: Climate Bridge (2010), using Chinese government announcements and NEF analysis