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# Assessing post 2020 climate policies: emission paths, investments, financing

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Intergovernmental Panel on climate change

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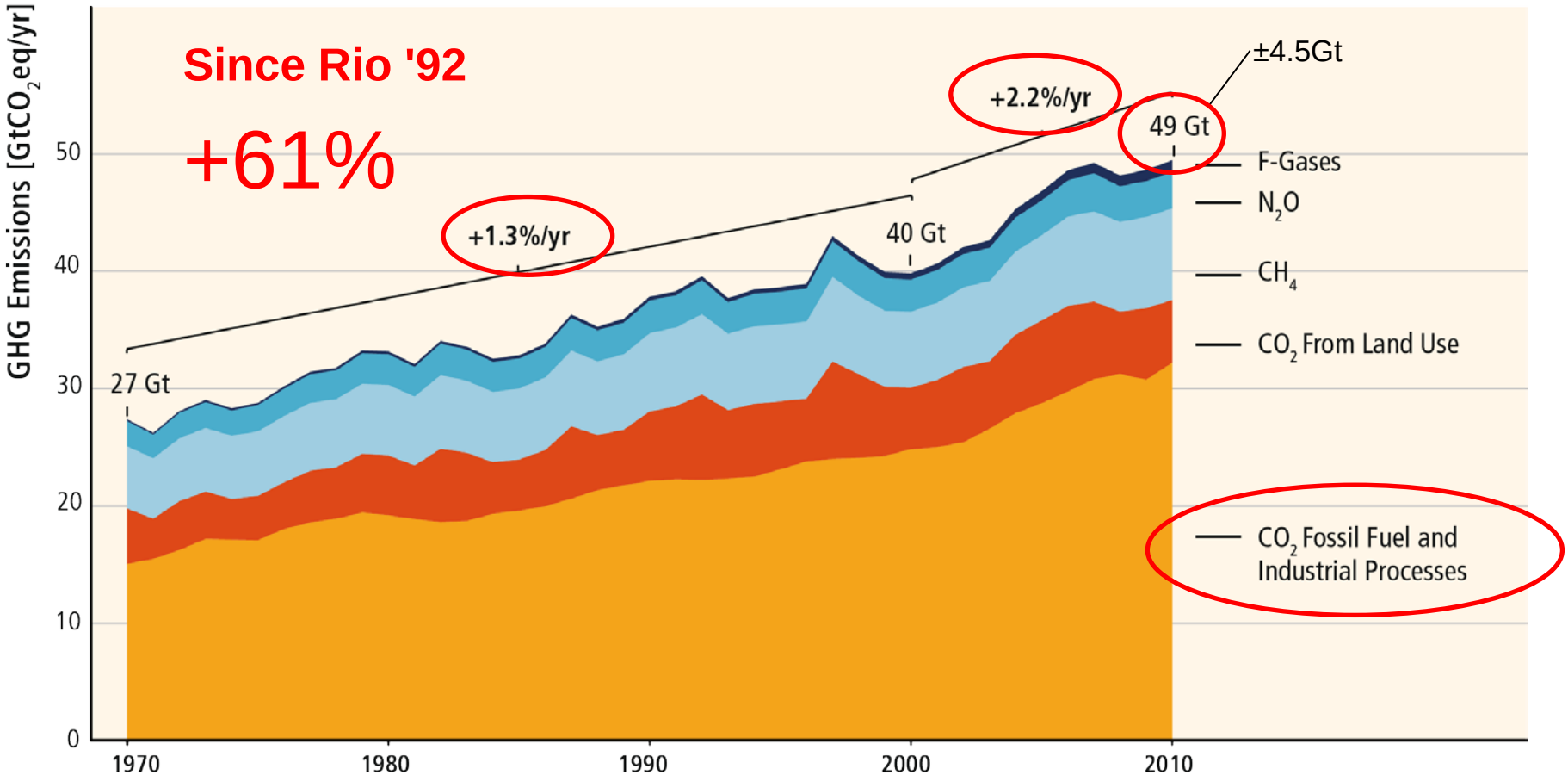
# A global paradox

- Global emissions are steadily **growing**.
- The fossil fuel mix is not improving, with a revival of coal consumption, particularly in Europe.
- Negotiations on emission control are in a stalemate. Even though there is hope for a (bottom up) agreement in Paris 2015.
- 2 degree target **unlikely to be achieved** unless major technology breakthrough. Indeed, over the years, focus of negotiations moved from mitigation to adaptation, and now to loss and damages.
- Financial resources for investments in mitigation, adaptation and damage repair are increasing.

# Likely future scenario

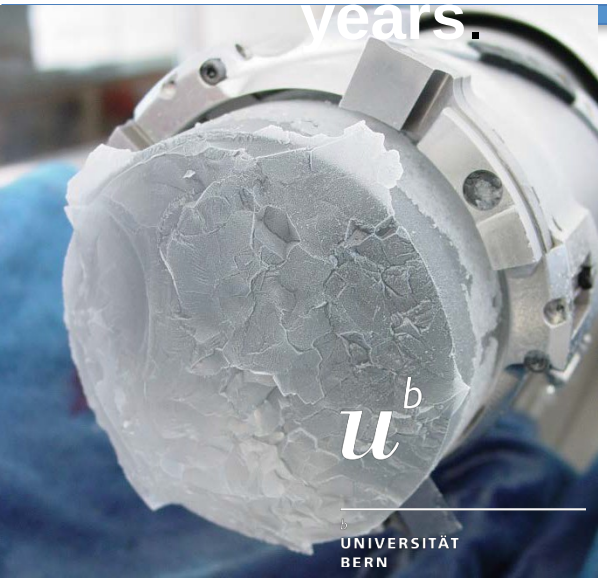
- GHG emissions will (slowly) be reduced through:
  - **Energy efficiency** gains
  - Development and diffusion of **renewables** (power plants and smart grids)
  - CO2 **capture**, **removal and storage**
- Emission reductions will be too slow to prevent climate change to heavily affect our socio economic systems, particularly in vulnerable regions (**losses and damages**). Hence:
  - Damages to repair
  - Infrastructures to re-build
- Governments are understanding that climate change can hinder economic development. Hence:
  - Expected large **expenditure in adaptation** and partly mitigation
- All this will provide important business opportunities and **stimulus to economic growth**

# GHG emissions growth between 2000 and 2010 has been larger than in the previous three decades.




Source: IPCC AR5 - WG3 "The Mitigation of Climate Change", 2014

# The concentrations of $CO_2$ have increased to levels unprecedented in at least the last 800,000 years.



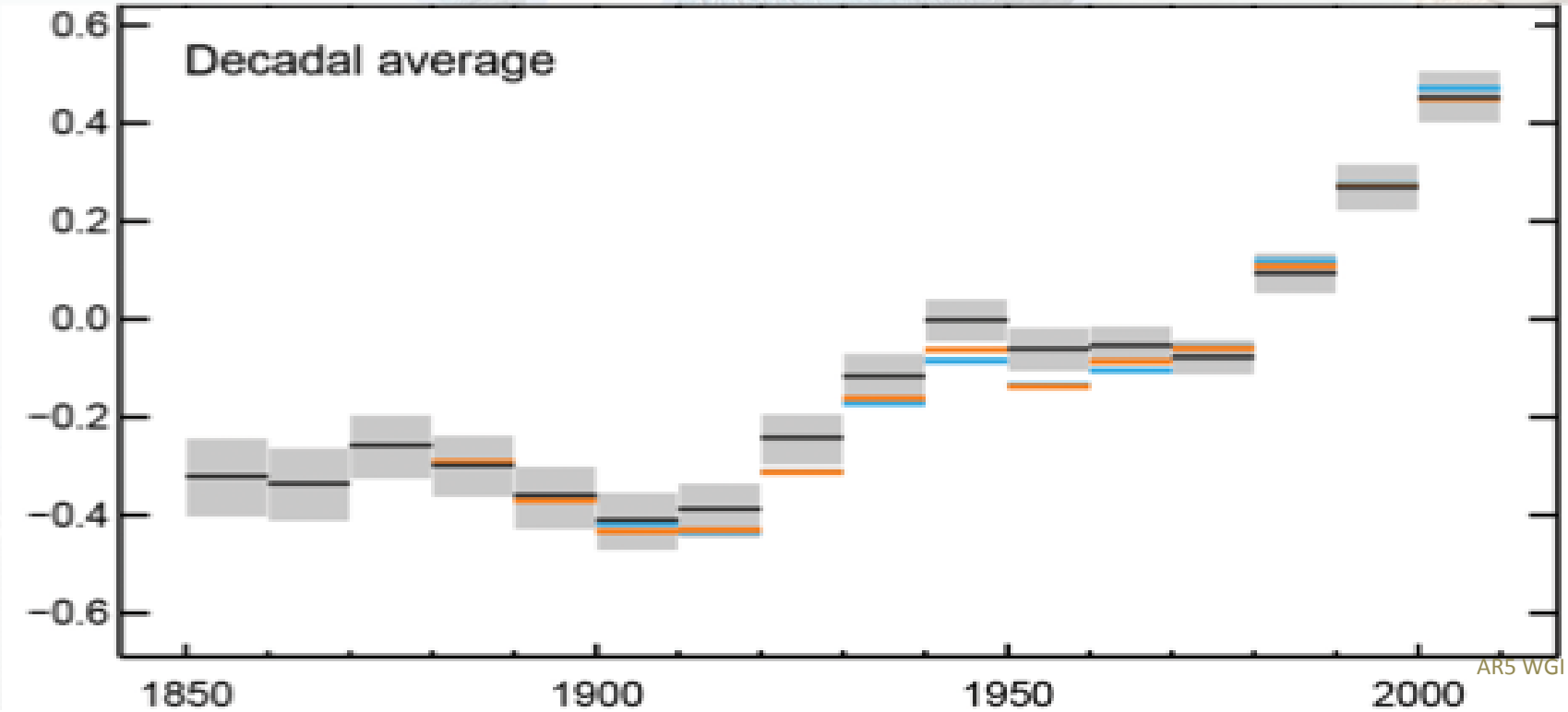




Source: IPCC AR5 - WG3 "The Mitigation of Climate Change", 2014

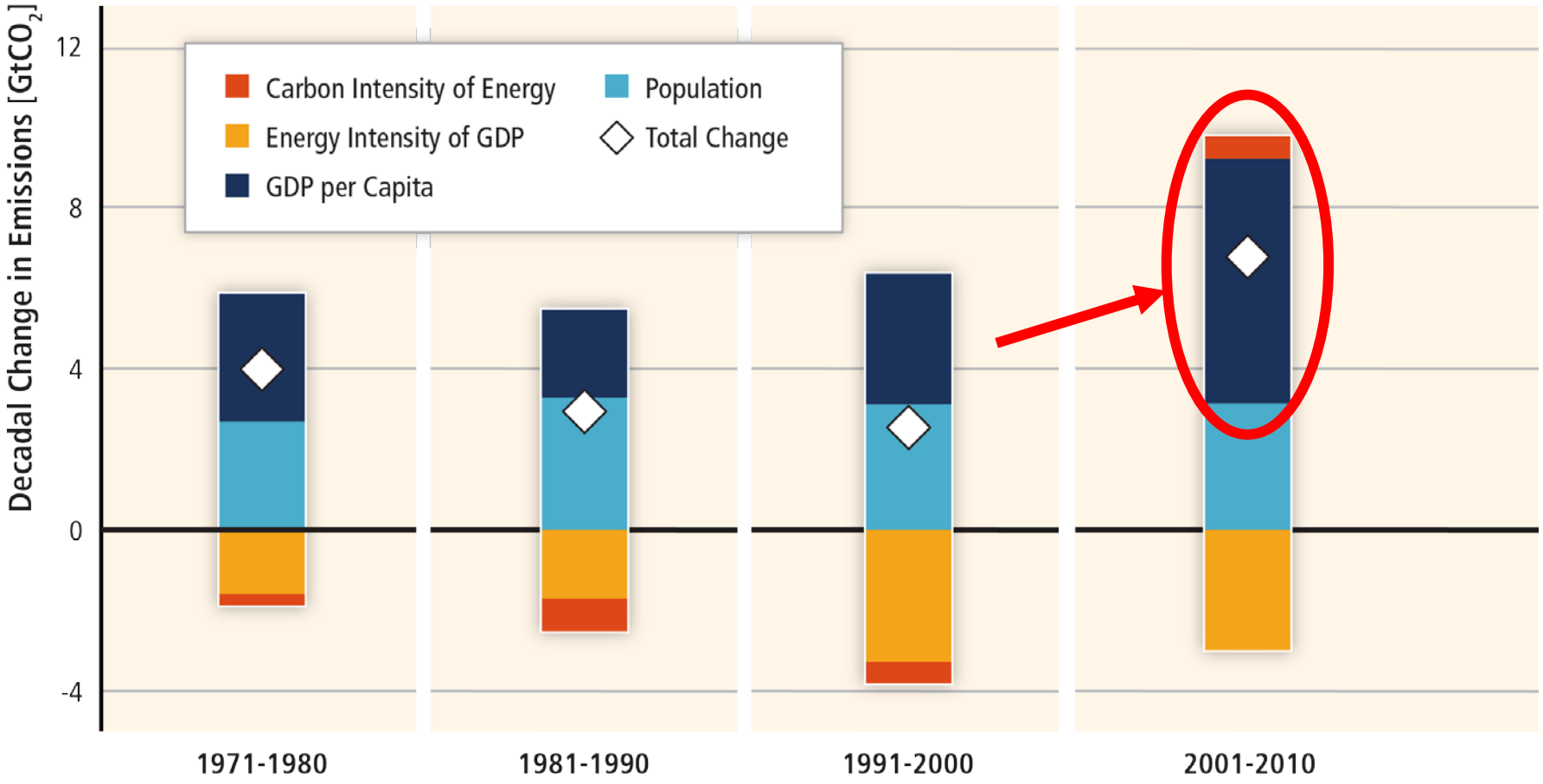
# Temperatures continue to rise

**Each of the past 3 decades has been successively warmer than the preceding decades since 1850**



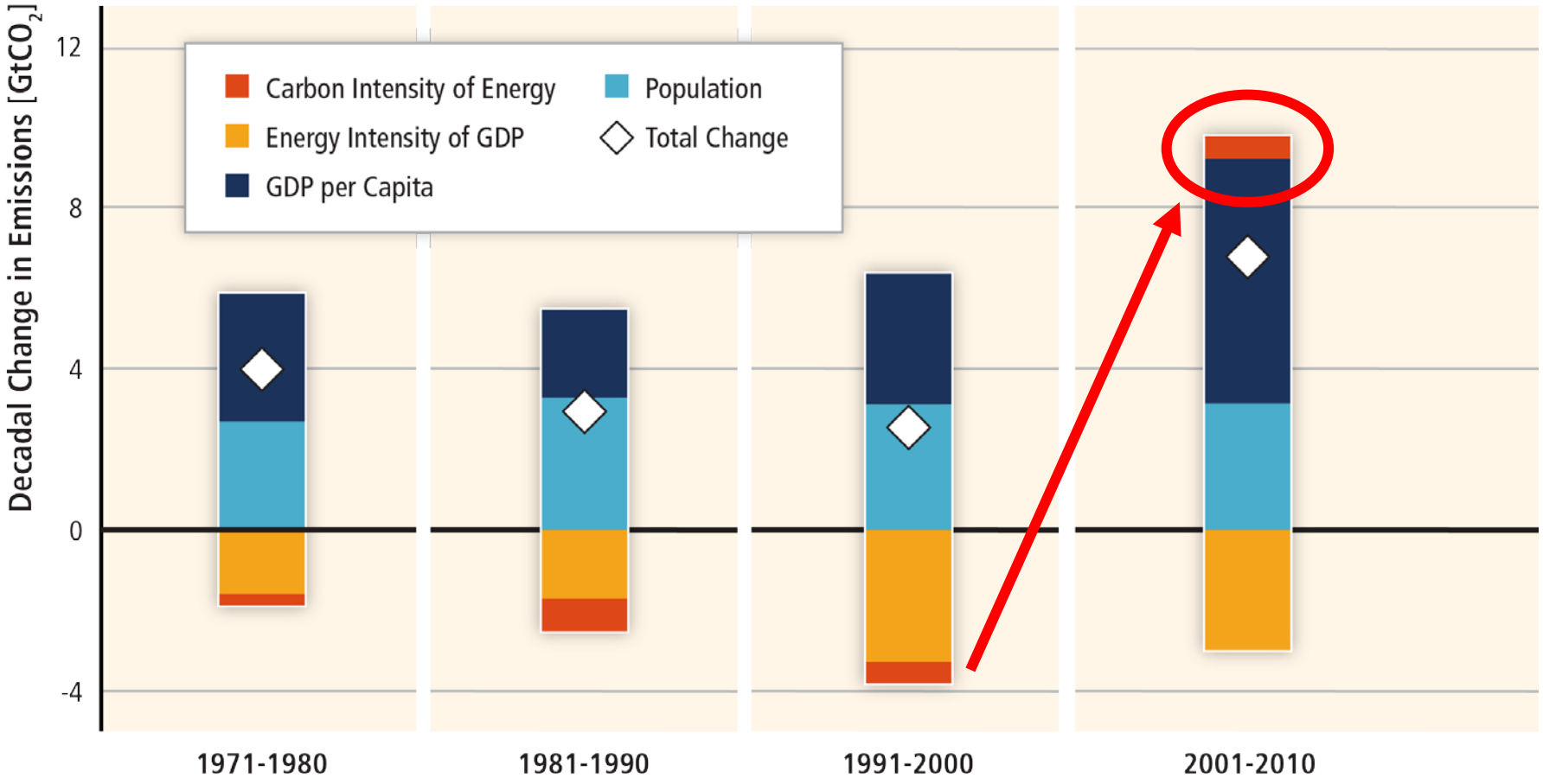

Globally averaged combined land and ocean surface temperatures

# Most of the recent GHG emissions growth has been driven by growth in economic activity.



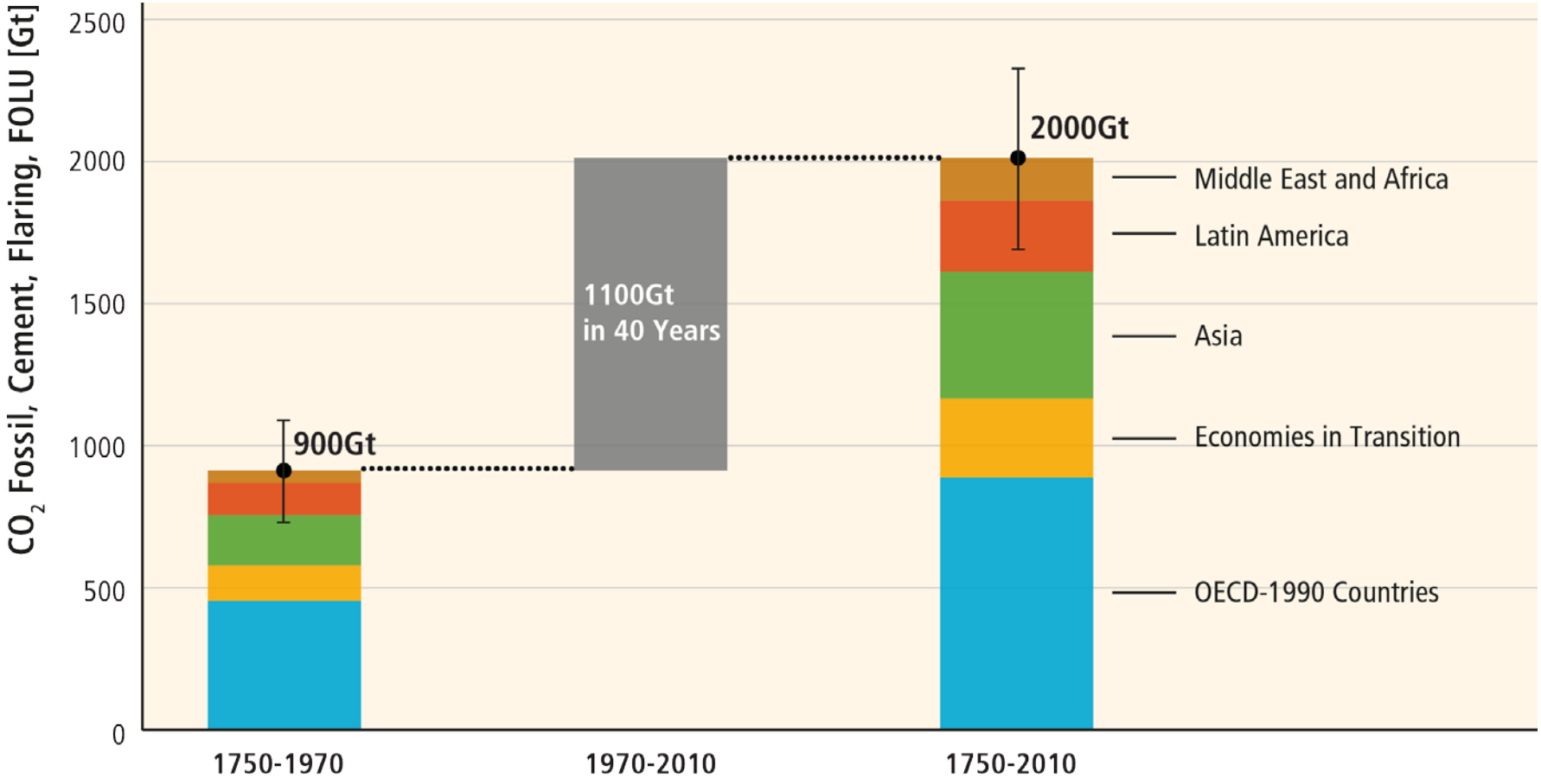

Source: IPCC AR5 - WG3 "The Mitigation of Climate Change", 2014

# The long-standing trend of gradual decarbonization of energy has reversed recently.




Source: IPCC AR5 - WG3 "The Mitigation of Climate Change", 2014

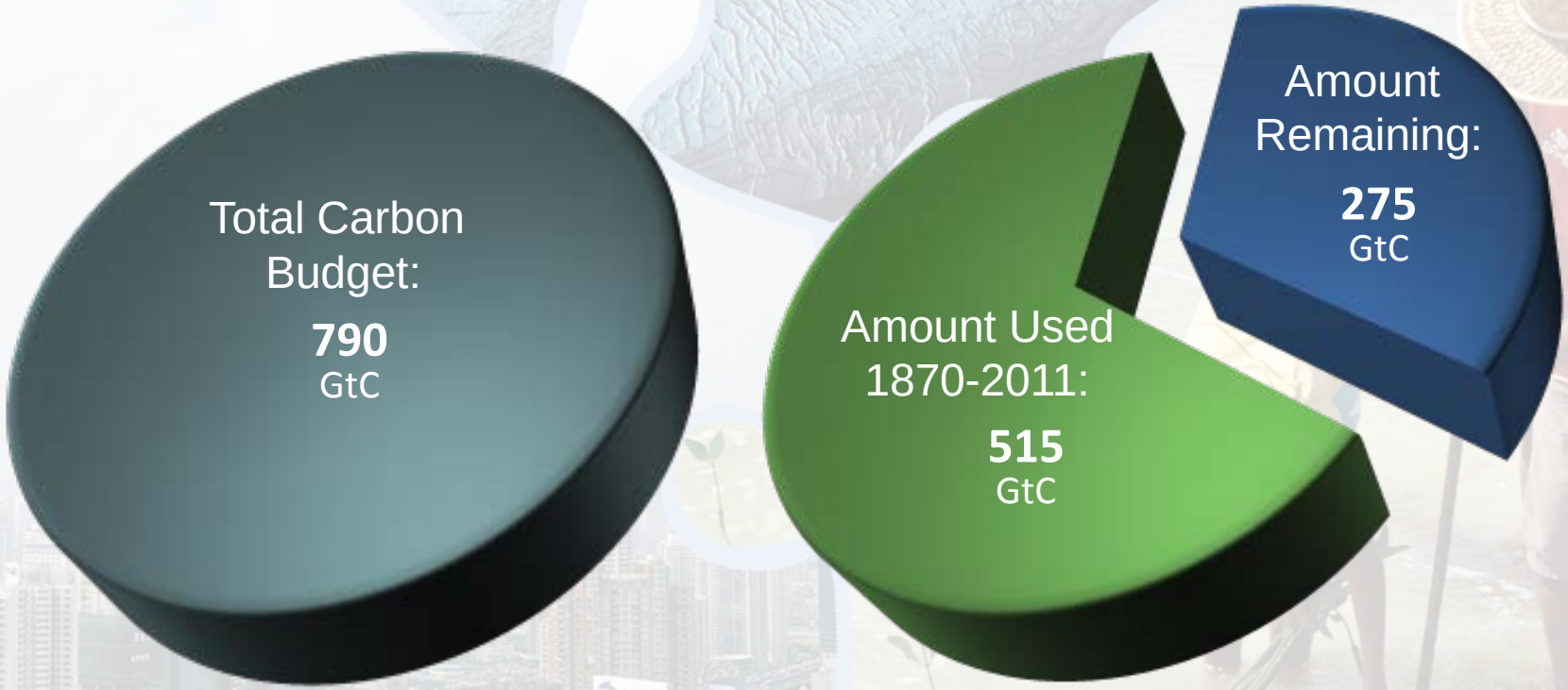
# About half of the cumulative anthropogenic $CO_2$ emissions between 1750 and 2010 have occurred in the last 40 years.




Source: IPCC AR5 - WG3 "The Mitigation of Climate Change", 2014

# The window for action is rapidly closing

**65% of our carbon budget compatible with a 2°C goal already used**




AR5 WGI SPM

**Can 1/3 of known fossil fuel reserves remain unexploited?**

IPCC AR5 Synthesis Report

ipcc INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

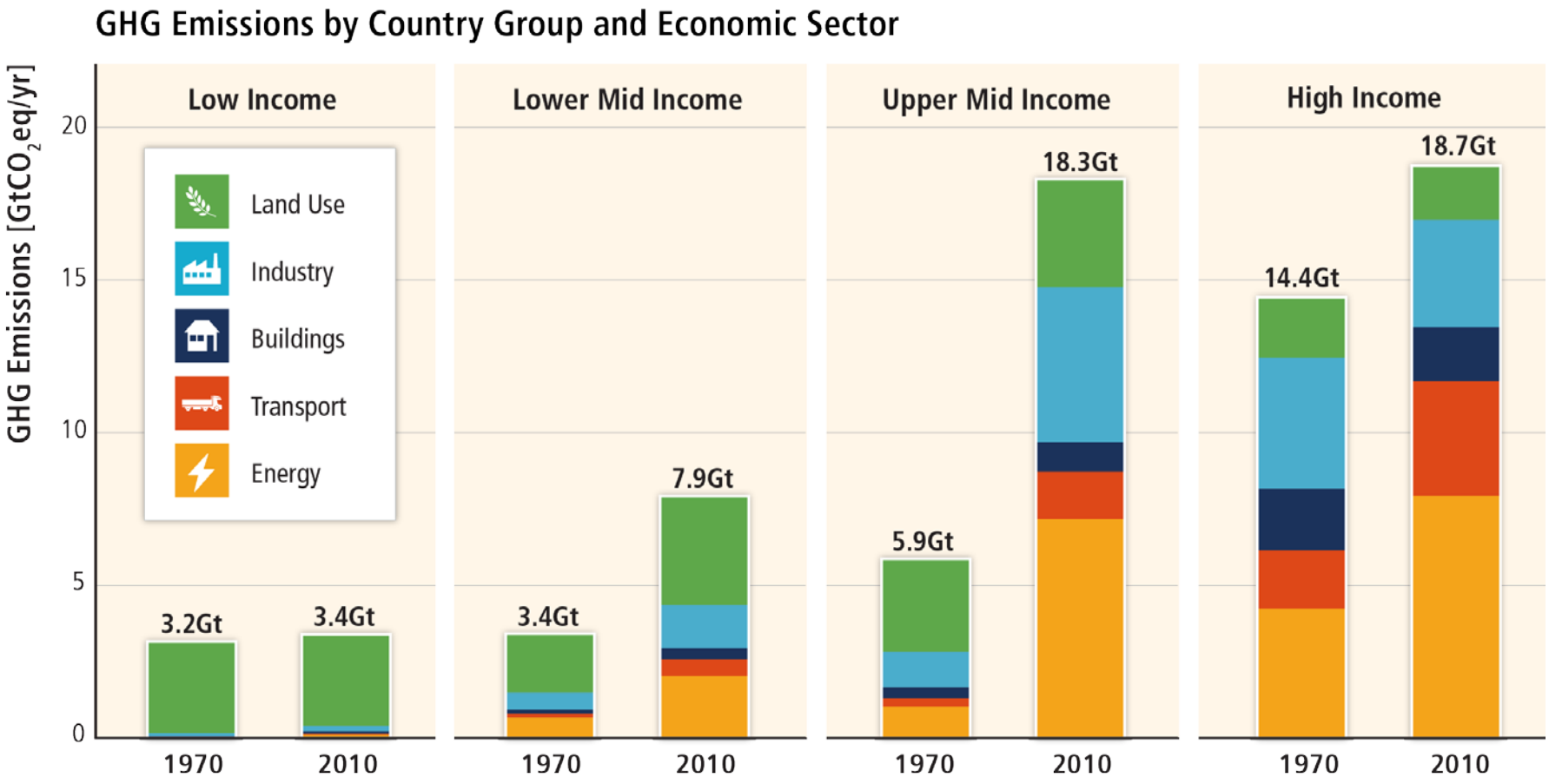
# Sources of emissions

**Energy production remains the primary driver of GHG emissions**


2010 GHG emissions

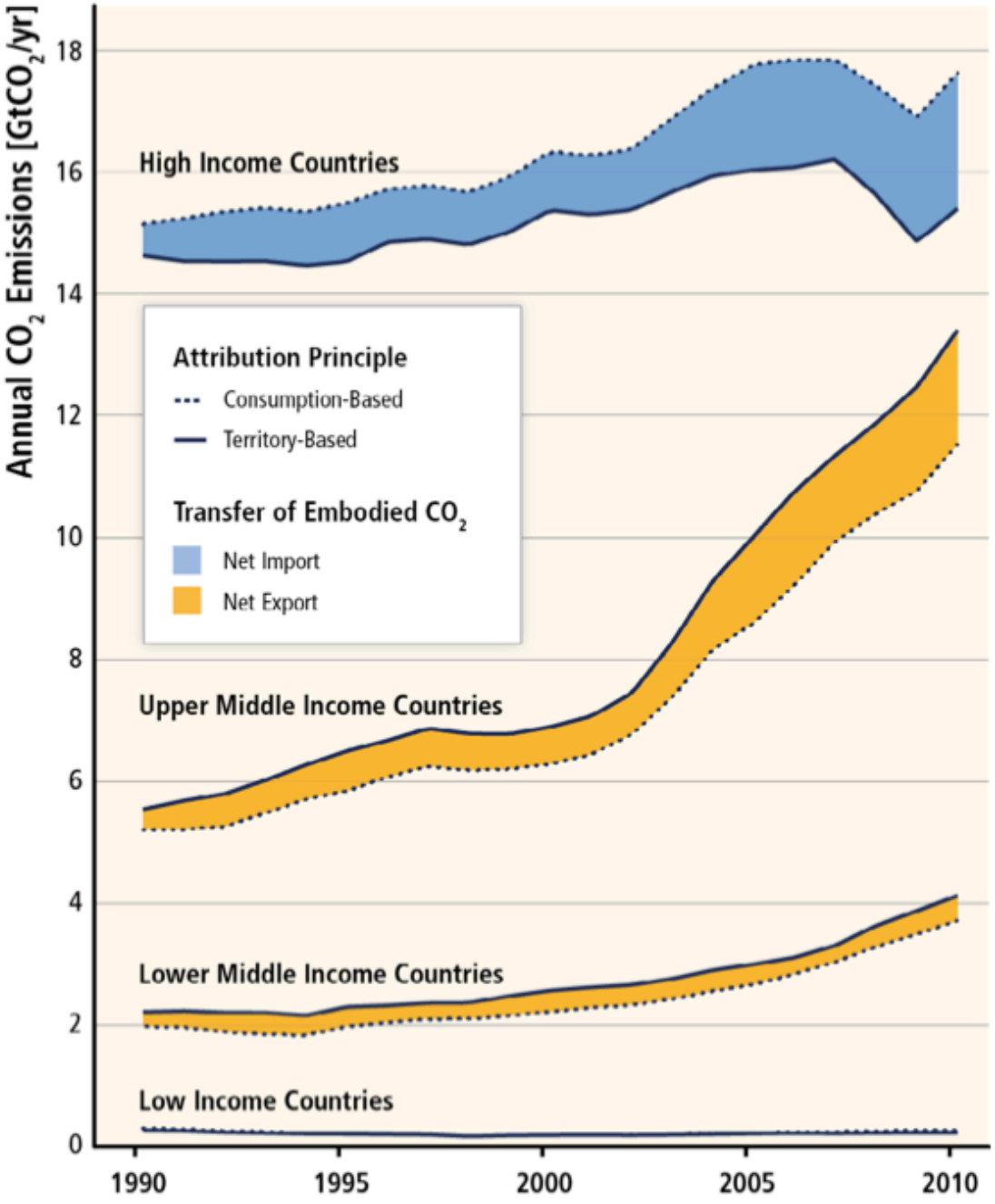
AR5 WGIII SPM

# Regional patterns of GHG emissions are shifting along with changes in the world economy.




Source: IPCC AR5 - WG3 "The Mitigation of Climate Change", 2014

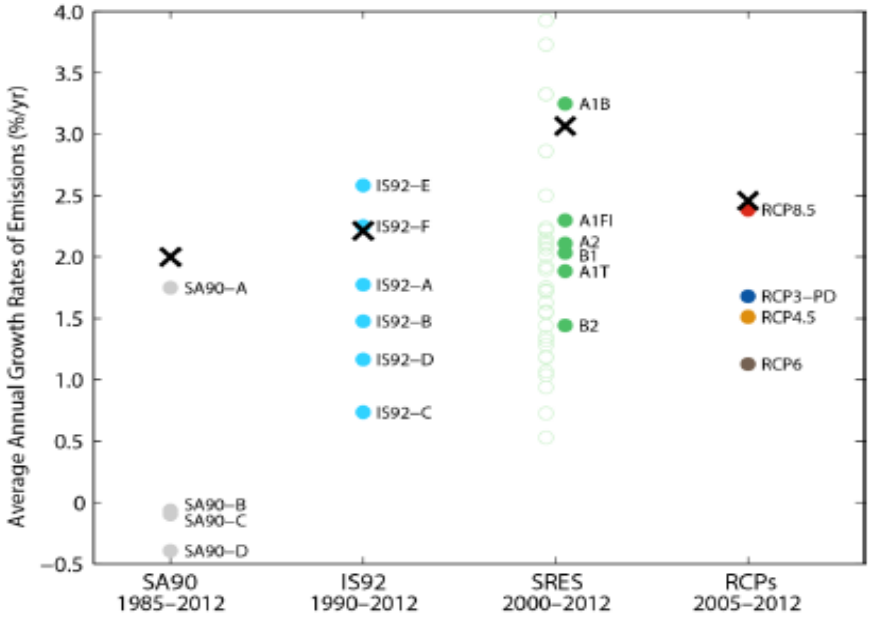
**Total annual $CO_2$ emissions ($GtCO_2$/yr) from fossil fuel combustion for country income groups attributed on the basis of territory (solid line) and final consumption (dotted line).**




Source: IPCC AR5 - WG3 "The Mitigation of Climate Change" Summary for Policy Makers, 2014

# Observed Emissions and Emission Scenarios

Observed emissions (X) continue to track the top-end of all scenarios (●)

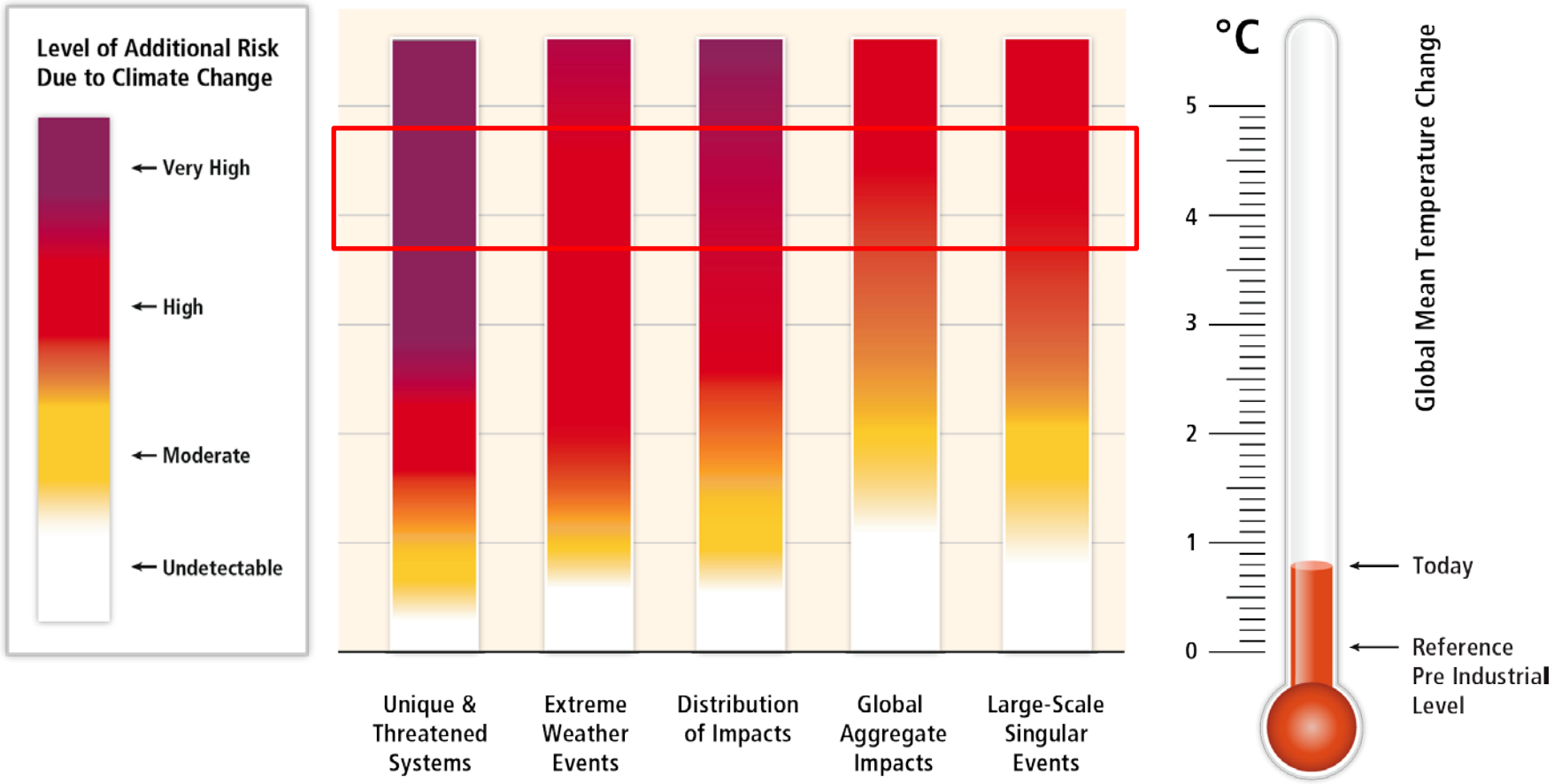



Crosses (X) : Historical emissions growth over the period in horizontal axis

Circles (●) : Scenario emissions growth over the period in horizontal axis

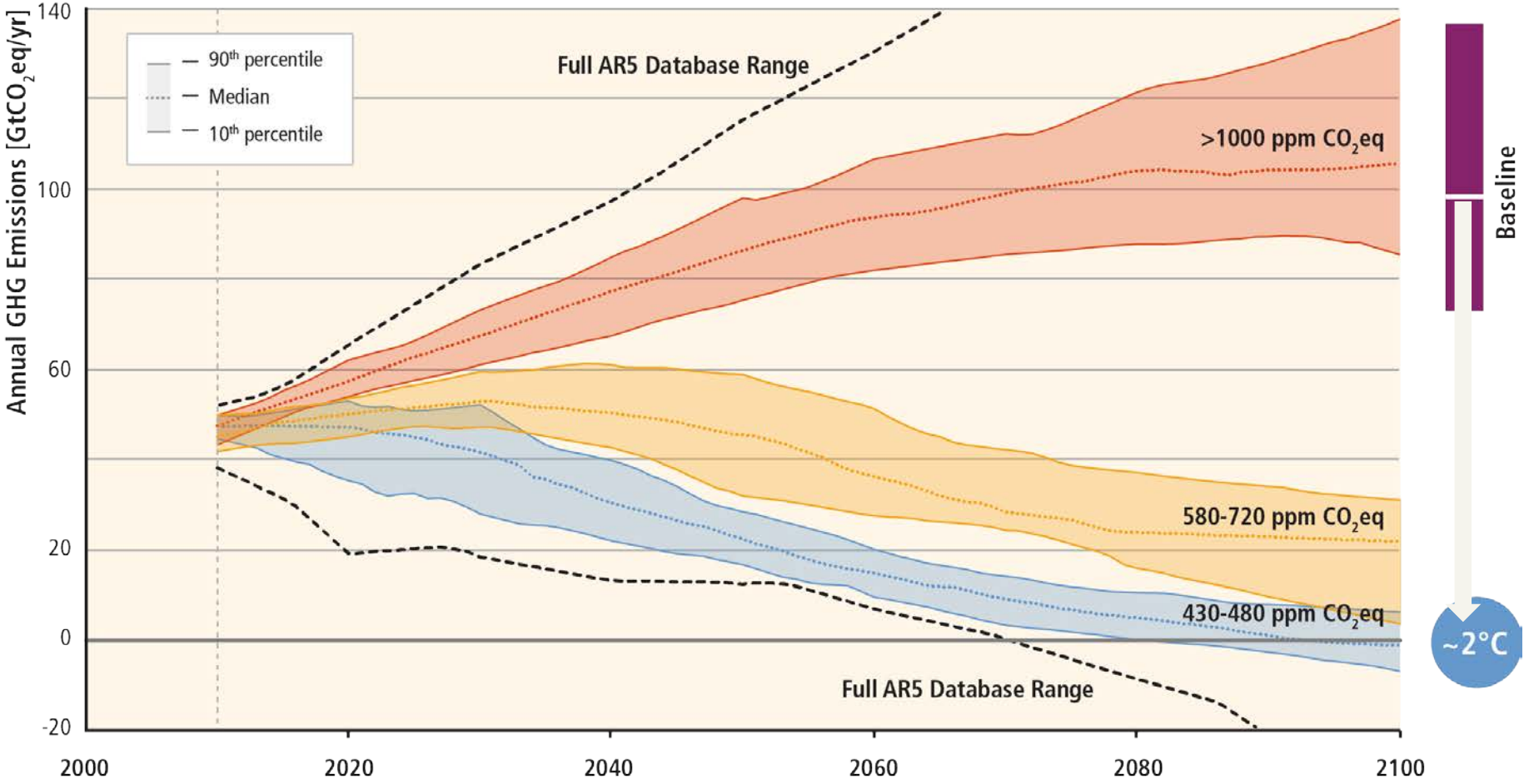
Source: Peters et al. 2012; Le Quéré et al. 2012; Global Carbon Project 2012; CDIAC Data

# Without additional mitigation, global mean surface temperature is projected to increase by 3.7 to 4.8°C (2.5 - 7.8°C) until 2100.




Source: IPCC AR5 - WG3 "The Mitigation of Climate Change", 2014

# Stabilization of atmospheric GHG concentrations requires moving away from the baseline, regardless of the mitigation goal.




Source: IPCC AR5 - WG3 "The Mitigation of Climate Change", 2014

# Are ambitious emissions reductions feasible?

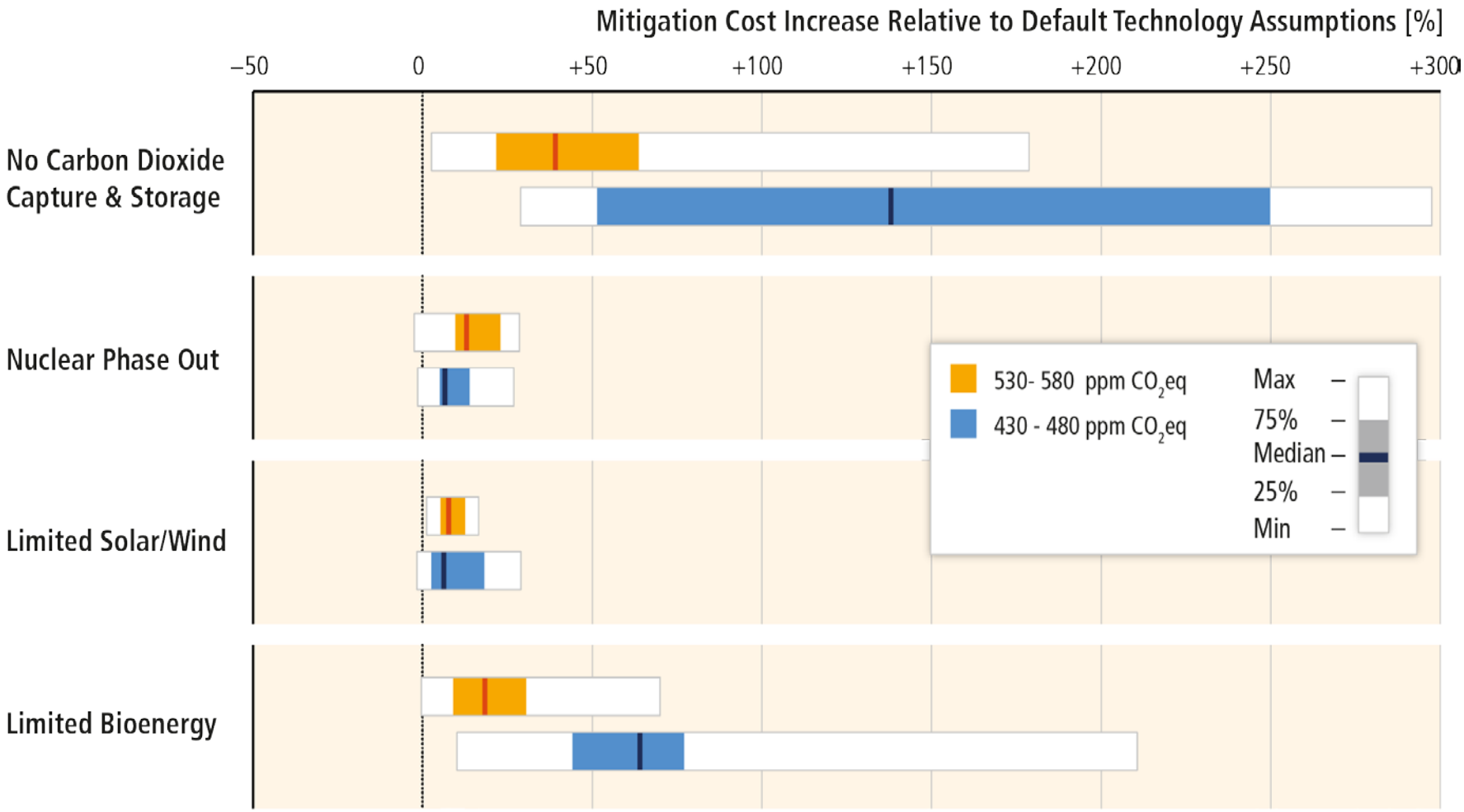
- **Two degree target** (equivalent to GHG concentrations at about 450 ppmv) can hardly be achieved because:
  - Concentrations are already above 400 ppmv (515 GtC)
  - The remaining carbon budget is therefore about 275 GtC.
  - And GHG emissions increase at 10 GtC per year...
  - No large scale CO2 absorption technology is currently available
  - Capture and storage plants allowing the use of coal and oil not yet operational
  - Large reserves of fossil fuel sources (at least 1/3) unlikely to be kept in the soil.

# Aggregate global economic costs of mitigation under different assumptions about technology and the timing of mitigation.

| | Annual mitigation costs in cost-effective implementation scenarios [% reduction in consumption relative to baseline] | | | Increase in total discounted mitigation costs in technology constrained scenarios [% increase in total discounted mitigation cost (2015-2100) relative to default technology assumptions] | | | | Increase in mid- and long term mitigation cost from reduced near term mitigation effort until 2030 [% increase in mitigation cost relative to immediate mitigation] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | <=55 GtCO2e | | >55 GtCO2e | |
| 2100 Concentration (ppm $CO_2$eq) | 2030 | 2050 | 2100 | No CCS | Nuclear phase out | Limited Solar / Wind | Limited Bio-energy | 2030-2050 | 2050-2100 | 2030-2050 | 2050-2100 |
| 450 (430-480) | 1.7 (1.0- 3.7) [N: 14 (10)] | 3.4 (2.1-6.2) | 4.8 (2.9-11.4) | 138 (29-297) [N: 4 (4)] | 7 (4-18) [N: 8 (6)] | 6 (2-29) [N: 8 (6)] | 64 (44-77) [N: 8 (6)] | 28 (14-50) [N: 34 (24)] | 15 (5-59) | 44 (2-78) [N: 29 (21)] | 37 (16-82) |
| 500 (480-530) | 1.7 (0.6-2.1) [N: 32 (24)] | 2.7 (1.5-4.2) | 4.7 (2.4-10.6) | | | | | | | | |
| 550 (530-580) | 0.6 (0.2- 1.3) [N: 46 (32)] | 1.7 (1.2-3.3) | 3.8 (1.2- 7.3) | 39 (18-78) [N: 11 (9)] | 13 (2-23) [N: 10 (8)] | 8 (5-15) [N: 10 (8)] | 18 (4-66) [N: 12 (10)] | 3 (-5-16) [N: 14 (10)] | 4 (-4-11) | 15 (3-32) [N: 10 (8)] | 16 (5-24) |
| 580-650 | 0.3 (0-0.9) [N: 16 (12)] | 1.3 (0.5-2.0) | 2.3 (1.2- 4.4) | | | | | | | | |

Source: IPCC AR5 - WG3 "The Mitigation of Climate Change" Summary for Policy Makers, 2014

# Limited availability of technologies can greatly increase mitigation costs.




Source: IPCC AR5 - WG3 "The Mitigation of Climate Change" Summary for Policy Makers, 2014

# Different estimates of costs of climate change but all agree on heterogenity of costs

Even studies predicting a small costs (or even a positive aggregate benefit) from climate change….

-1.4 % (Fankhauser 1995)

-0.5% (Bosello et al. 2013)

-0.4% (Rehdanz 2005)

-0.1 % (Maddison 2003)

+0.1% (Mendelsohn 2000)

+0.9% (Hope 2006)

…. Outline that cost are likely to be very high in some regions (developing countries) …

…as a combination of higher vulnerability and lower adaptive capacity…

-4.7 % (CHINA)

-3.2 % (SUD ASIA)

-23% (SUB SAHARAN AFRICA

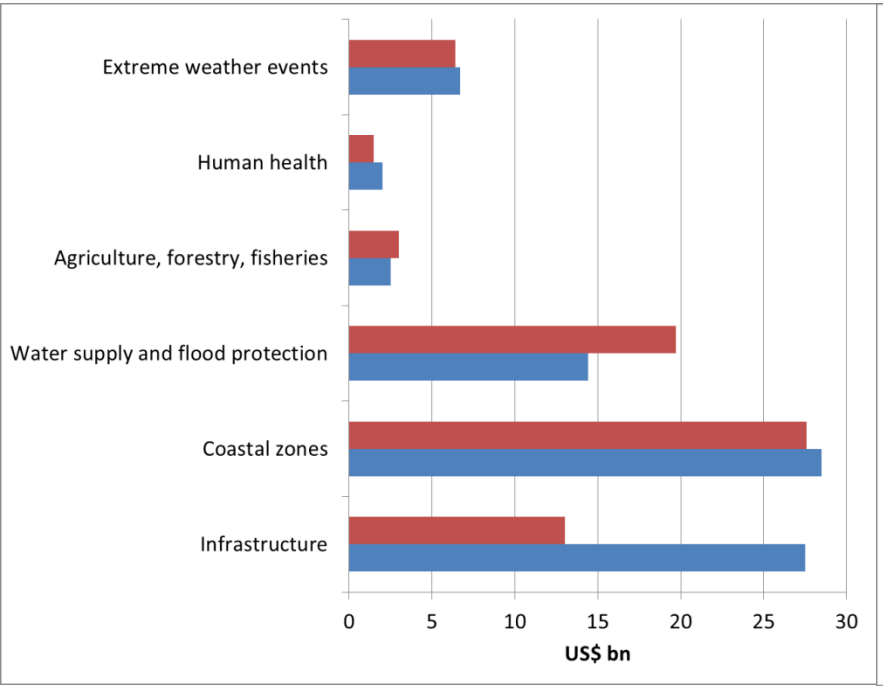
-14.6 % (SUD AMERICA)

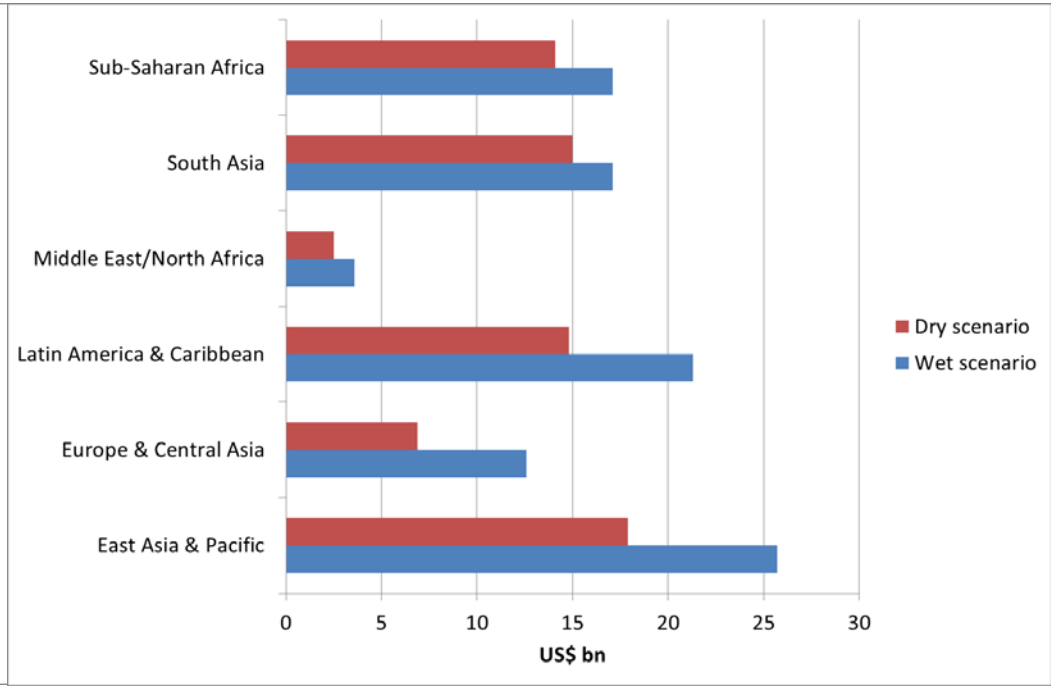
-3.6% (AFRICA)

-2.6% (ASIA)

# Predicted Annual Expenditure in Adaptation (2010-2050)

It concerns developing countries above all, and it is crucial for their economic development



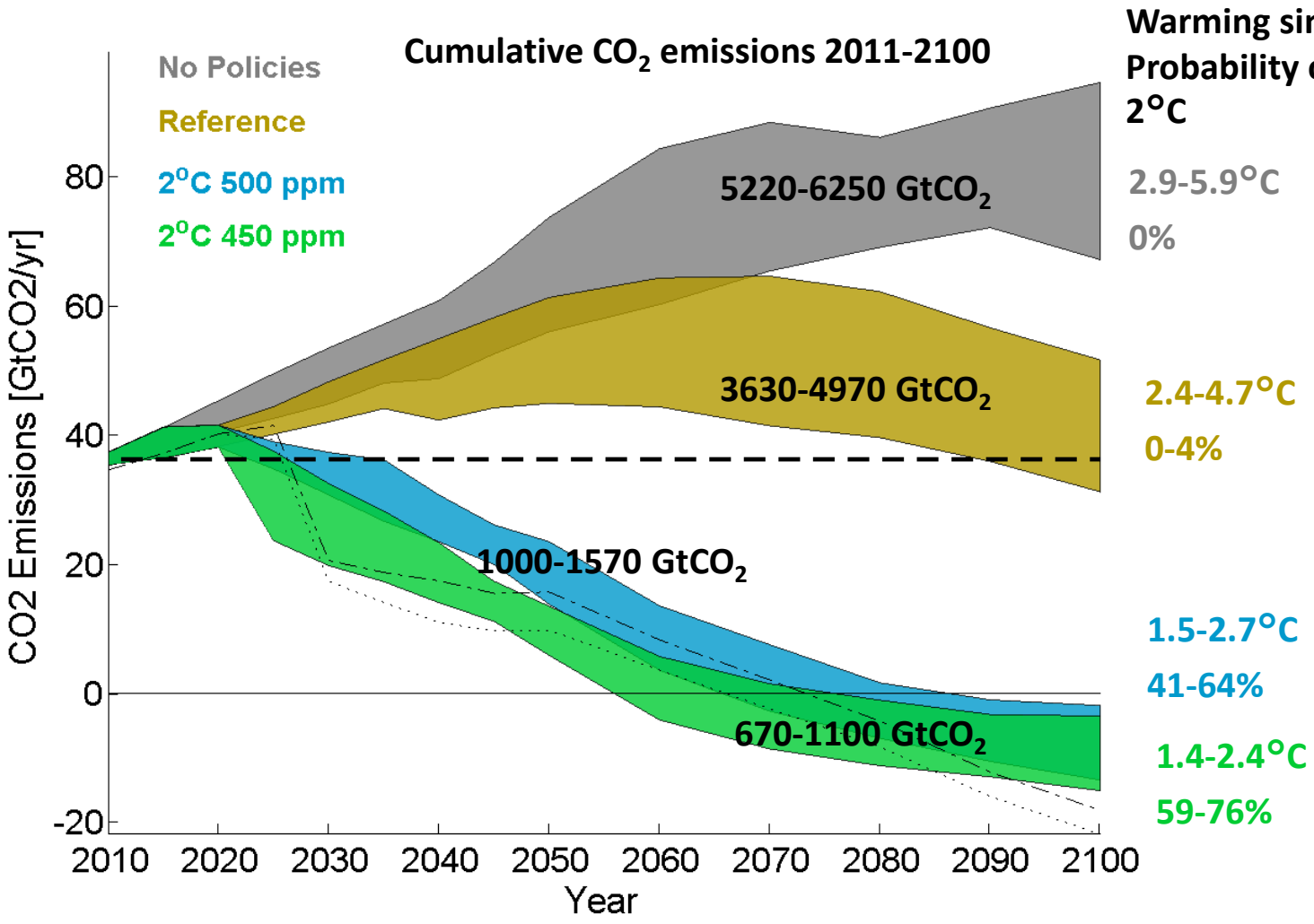

Total: 68-84 billions per year

Source: World Bank (2010)

# Post 2020 climate scenarios assessed in the LIMITS project

- No Policies: baseline
- Fragmented: national pledges extrapolated beyond 2020/2030 at two levels of ambition (‘reference’ and ‘strengthened’, with no international coordination)
- 2°C: full cooperation post 2020/2030 towards 450ppm and 500 ppm, with equal carbon pricing internationally and different burden sharing schemes

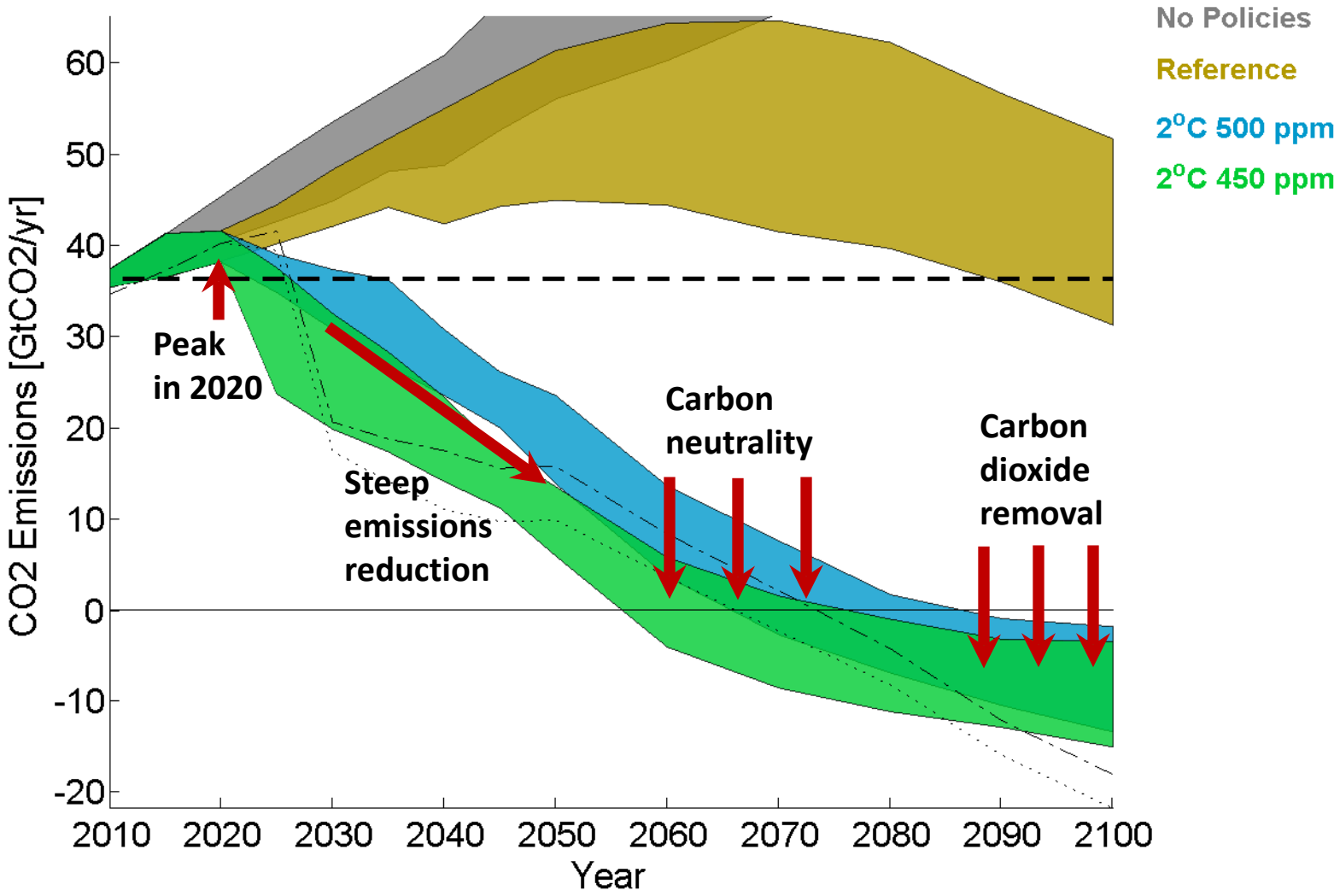
# Global emission pathways and carbon budgets




2C requires early peaking of emissions and small CO2 budgets

Kriegler et al. (2013) *Climate Change Economics*

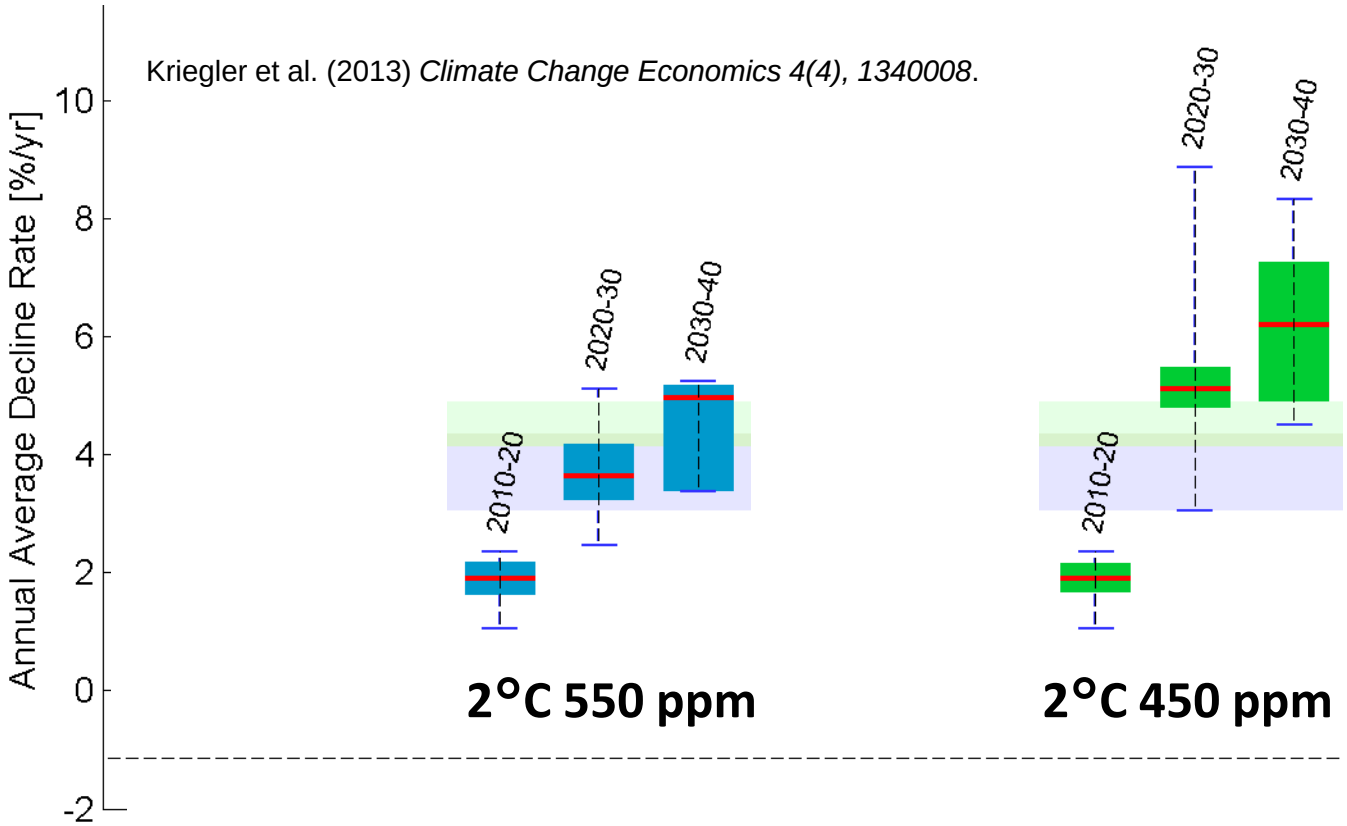
# The 4 phases of 2°C pathways




Kriegler et al. (2013) *Climate Change Economics*

# Trend break in decarbonization rates

**Rate of reduction in carbon intensity of GDP (2010-2040)**




**2020-30 decarbonization rate:**

450 ppm immediate action

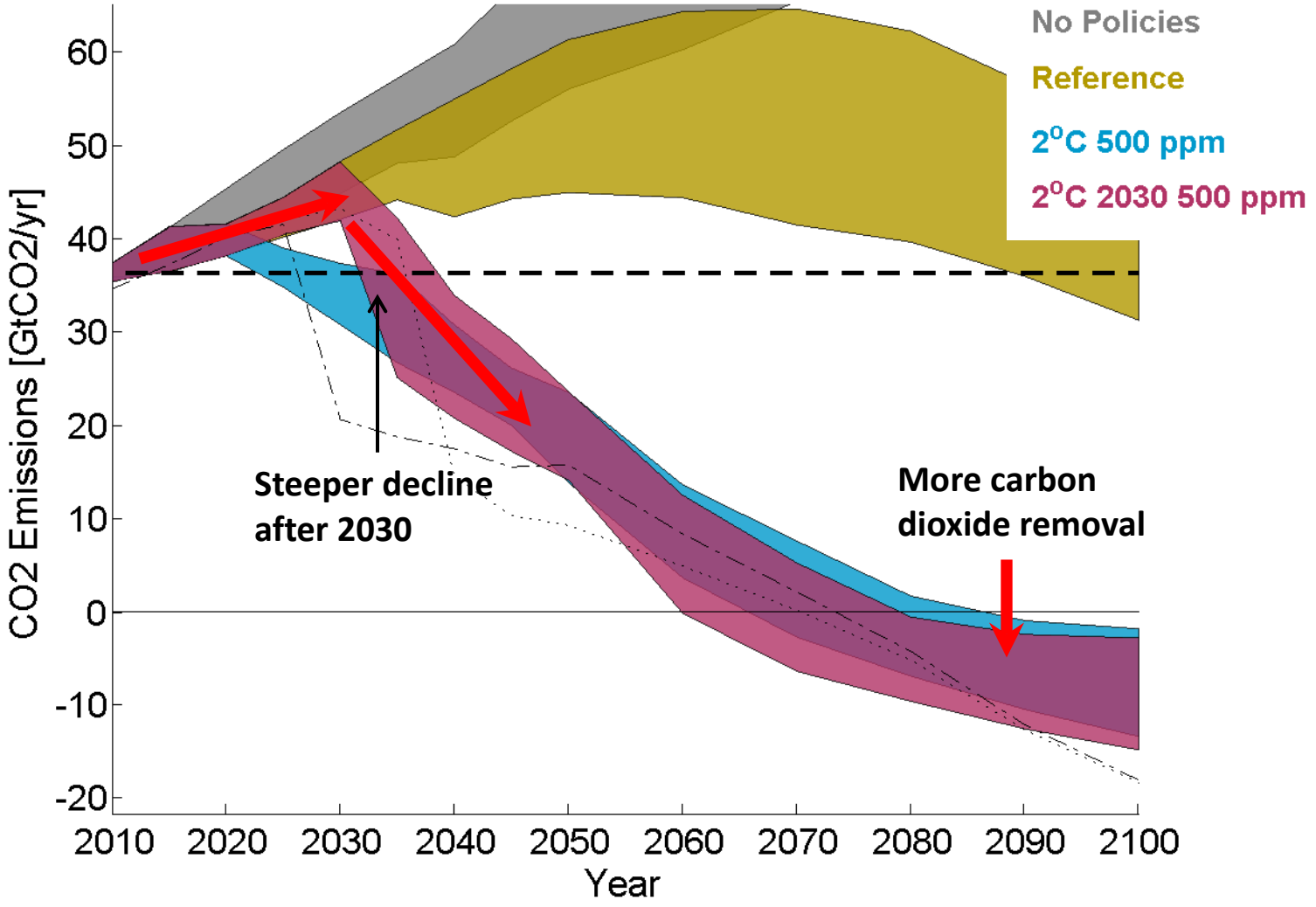
500 ppm immediate action

**2005-2010 decarbonization rate**

**Trend break in 2020 - 450 ppm:** ca. 2-3 percentage points

**500 ppm:** ca. 1-2 percentage points

# Delay until 2030 will put 2°C out of reach

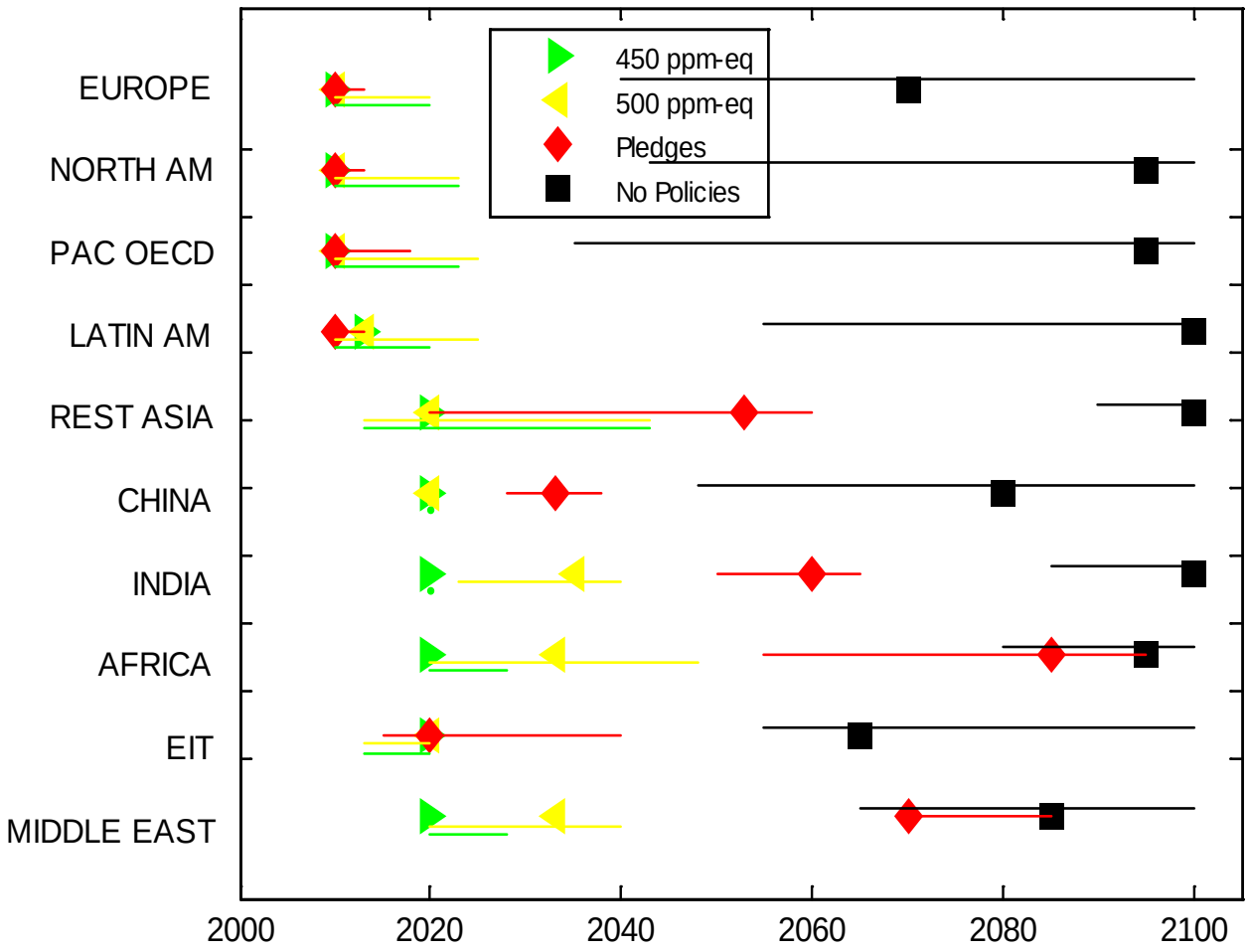



Kriegler et al. (2013) *Climate Change Economics*

## Implications for the major economies:

- Time of peaking of emissions
- Carbon budgets
- Speed of mitigation
- Costs
- Development of CO2 removal technologies

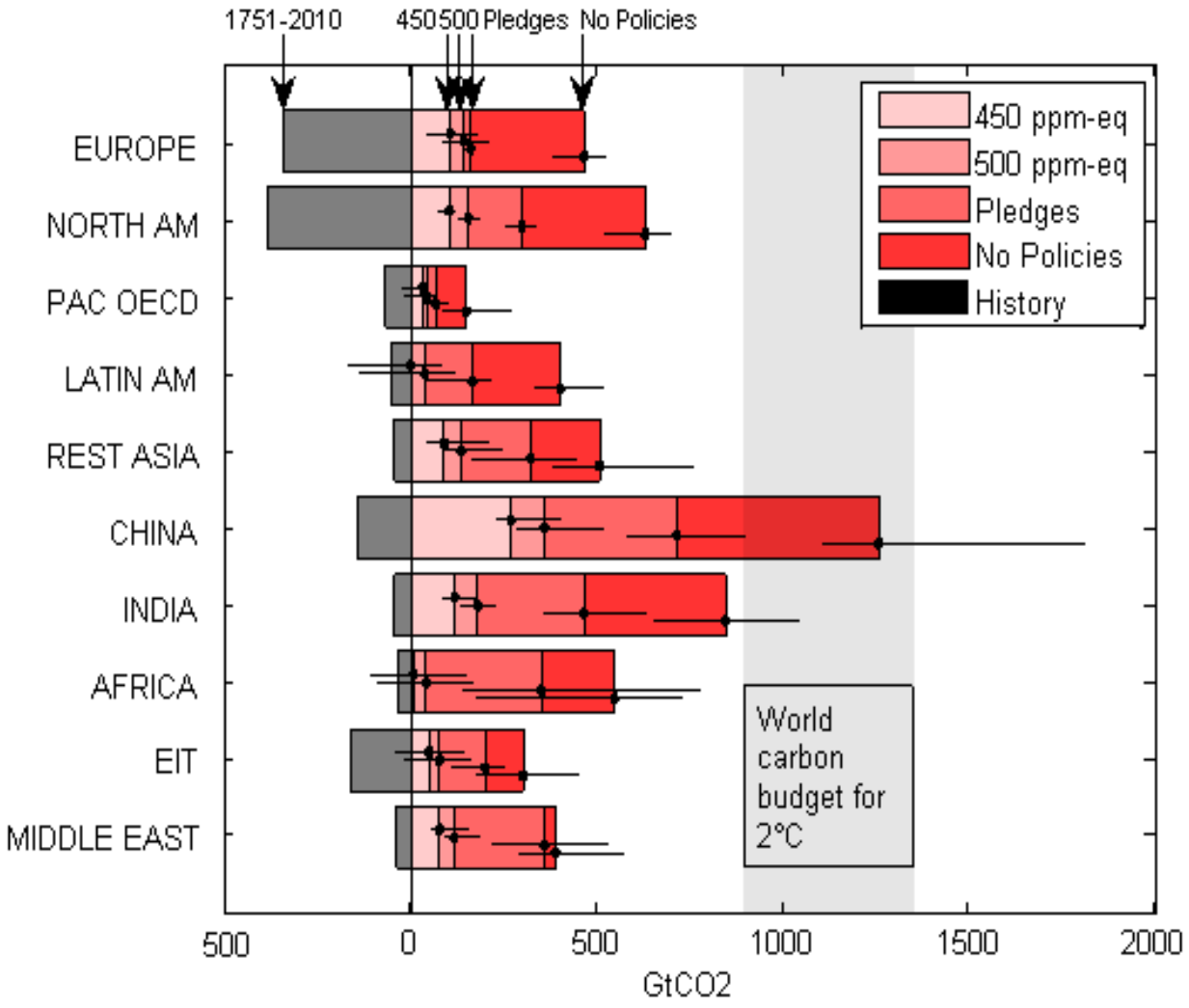
# Peaking time of emissions




Medians and 90 percentile ranges. Source: Tavoni et. al, 2014, Nature Climate Change

Pledges lead to earlier emission peaking in many major economies, but 2C would require peaking in all regions in the next 10-15 years

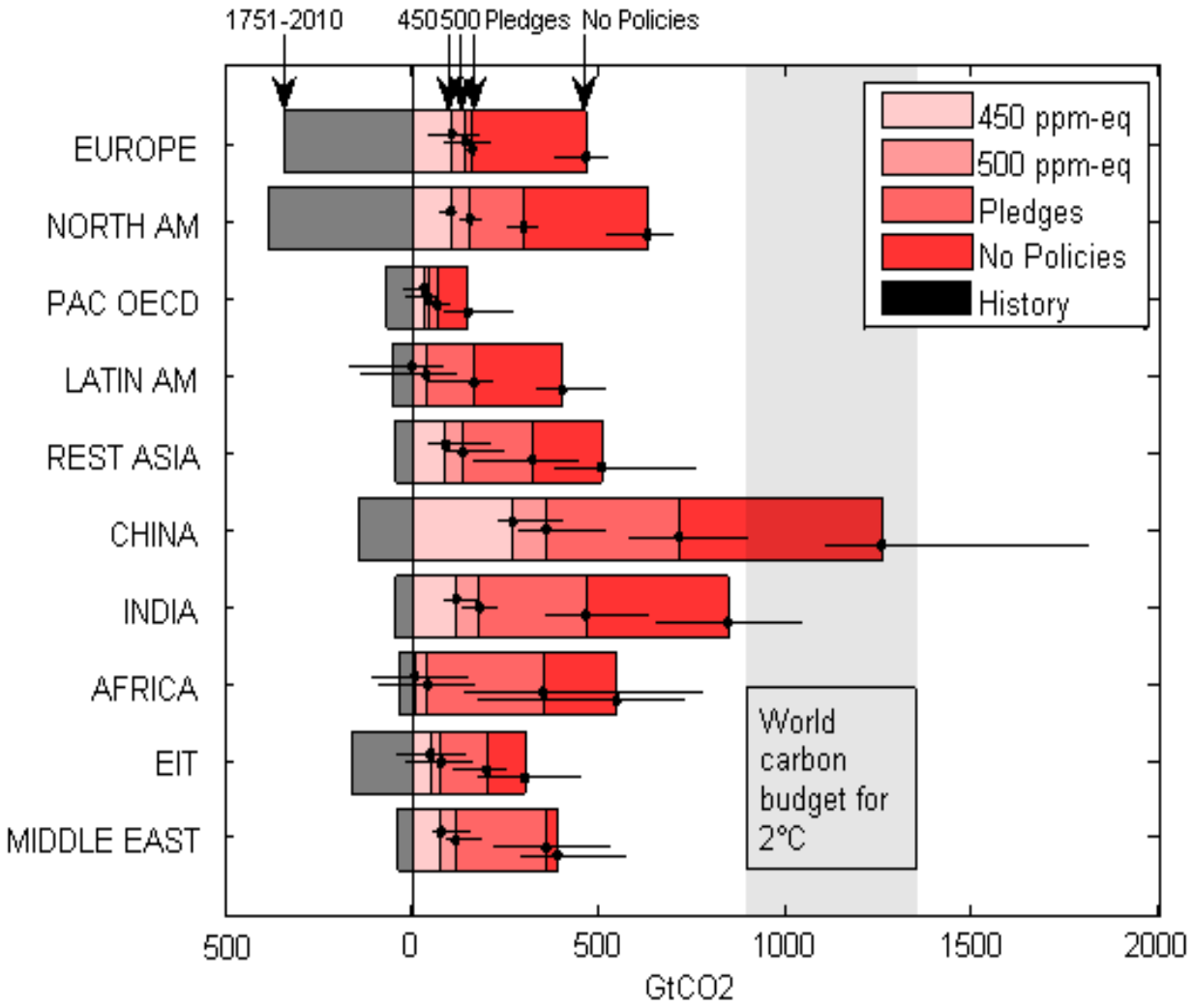
# Regional carbon budgets (2010-2100)




Medians and 90 percentile ranges. Source: Tavoni et. al, 2014, Nature Climate Change

Without climate policies, the carbon budgets of major regions like China or the OECD would by themselves exceed the budget compatible with 2C

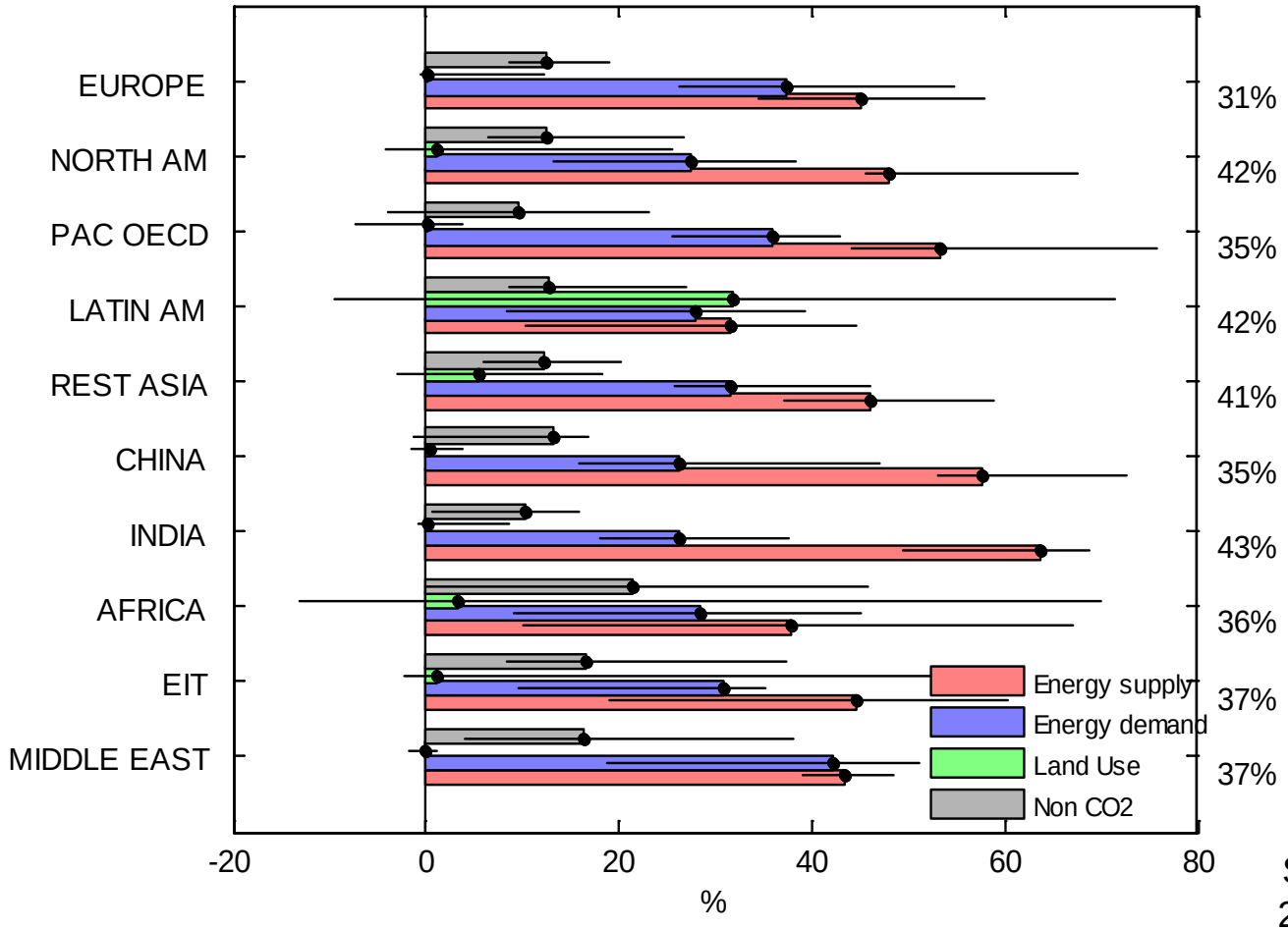
# Regional carbon budgets (2010-2100)




Medians and 90 percentile ranges. Source: Tavoni et. Al, 2014, Nature Climate Change

Pledges would roughly reduce carbon budgets by half, but not enough to meet 2C. Under 2C, no major region would have a carbon budget exceeding few hundreds GtCO2

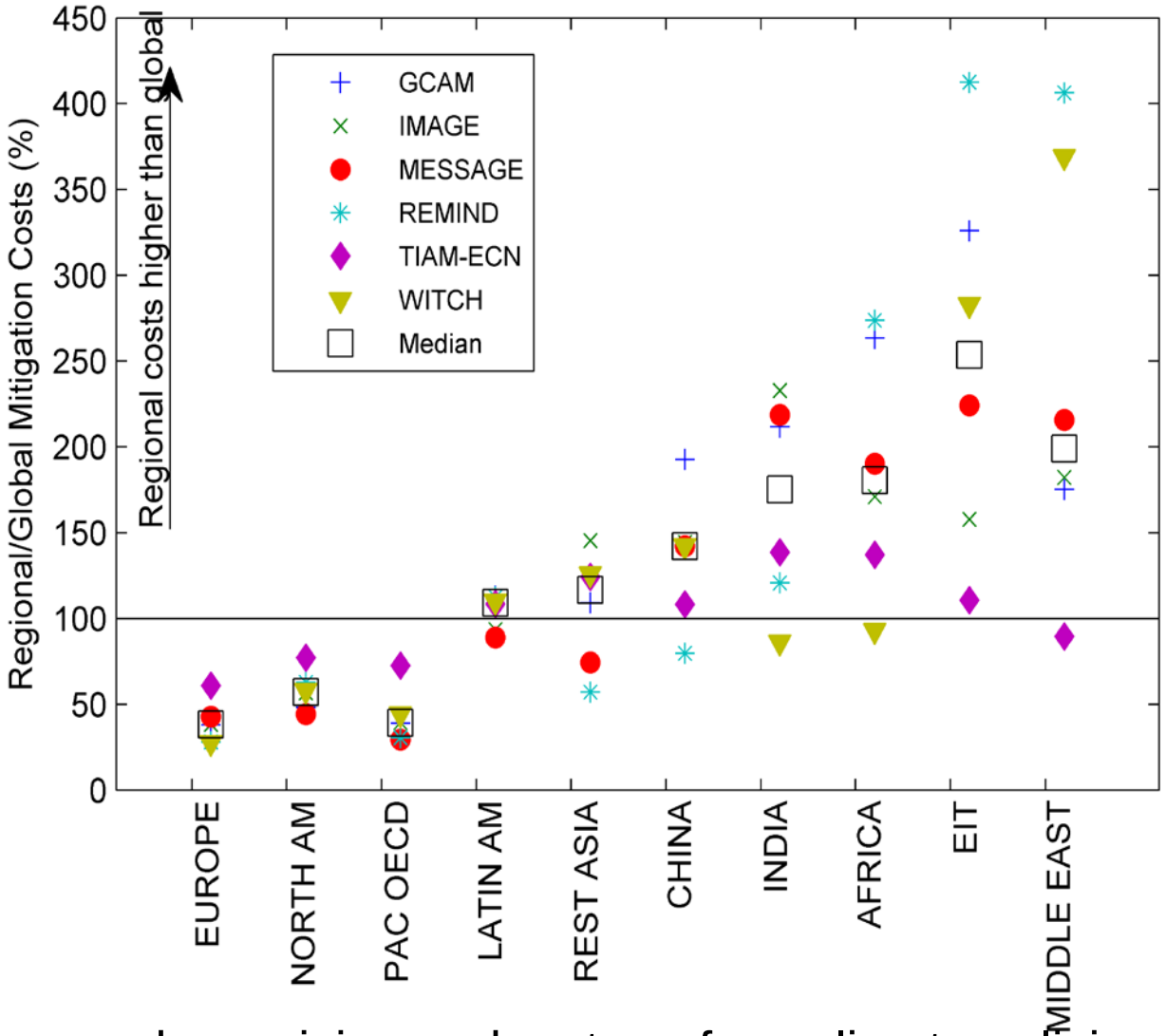
# Regional sectoral mitigation




Medians and 90 percentile ranges. Source: Tavoni et. al, 2014, Nature Climate Change

The energy supply sector hosts the largest abatement potential in most regions, but demand and land use are also important

# The distribution of mitigation costs




Source: Tavoni et. al, 2014, Nature Climate Change

With uniform carbon pricing and no transfers, climate policies are likely to be regressive across regions due to developing countries higher carbon intensity

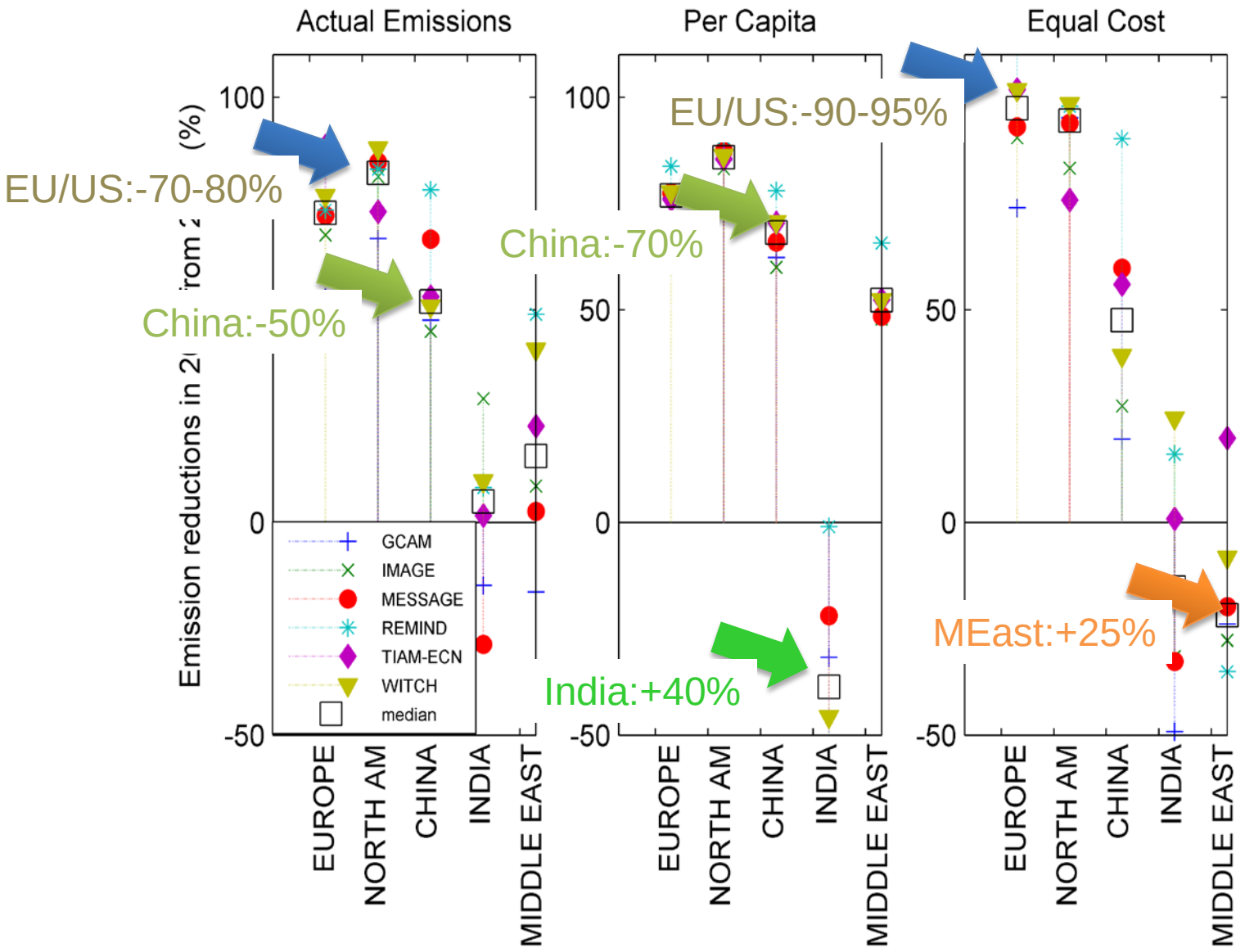
# Burden sharing schemes

Models maximize policy efficiency (equal marginal abatement costs) but mitigation doesn't need to be paid domestically => carbon markets and permit allocation trading

**Resource sharing**:
Allocation based on the equalization of regional per capita emissions by 2050

**Effort sharing**:
Allocation based on equalization of regional mitigation costs (2025 onwards)

# Actual emissions and allowances in 2050 compatible with 2°C

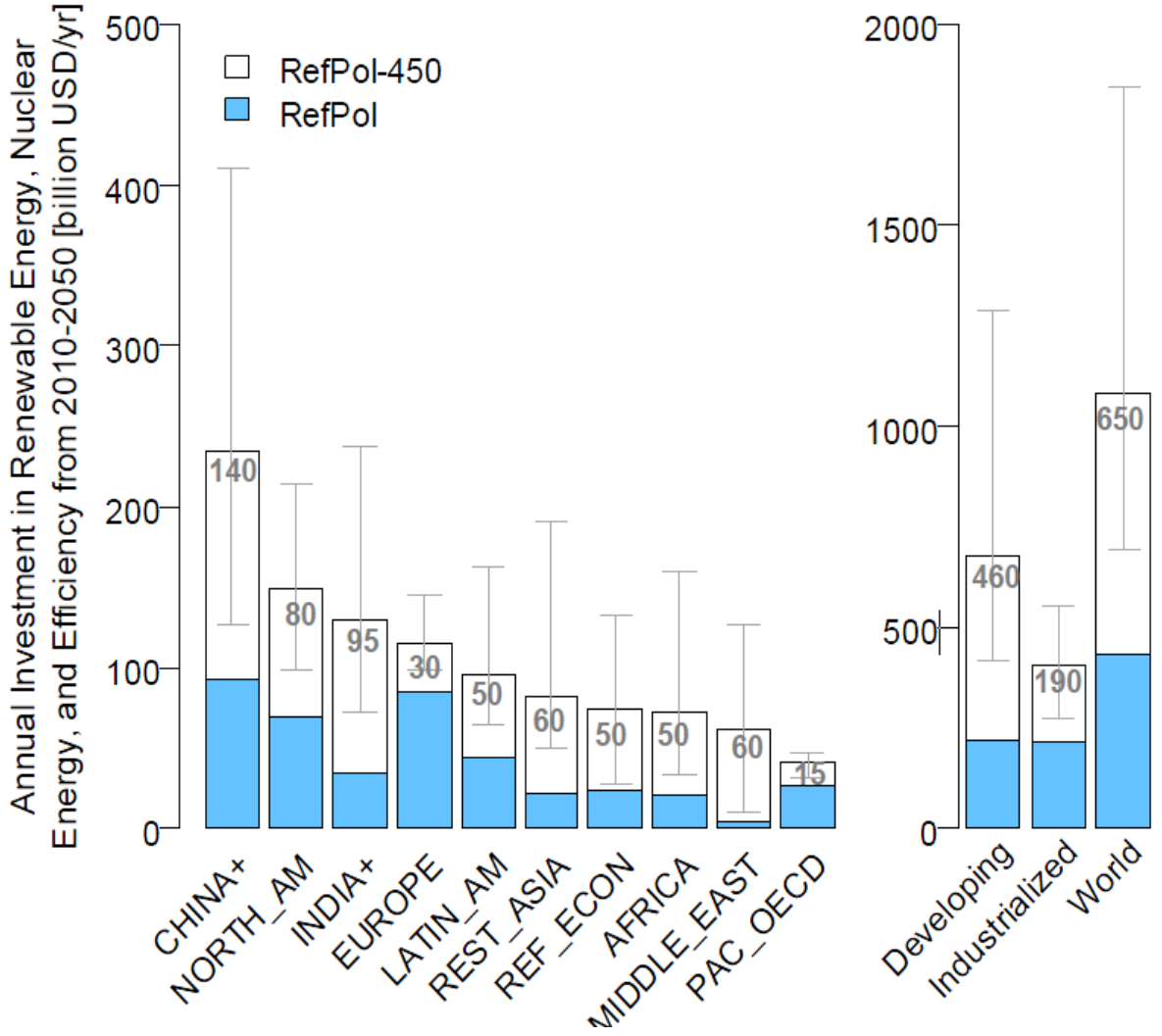


# What carbon market and transfers will be needed?

In both schemes, a large carbon market would be needed by the year **2030**

- 4 GtCO2-yr by 2030 … in every year, more than twice the CERs issued by all CDM projects to date
- 100 USD Billions-yr of transfers
- Trading positions depend on regional abatement opportunities and allocation scheme: OECD buyers, China/Russia/Middle East sellers only in the effort sharing scheme.

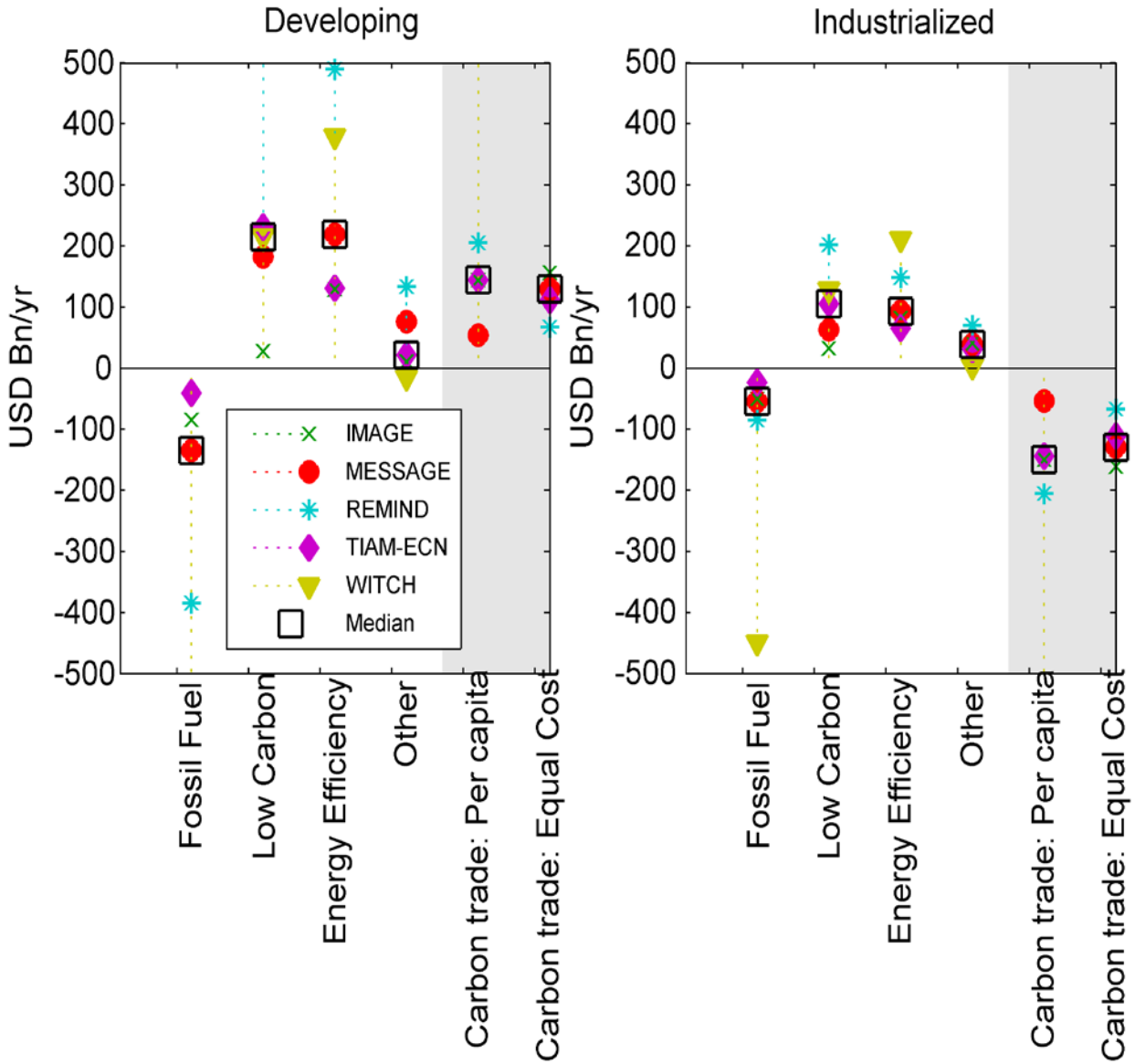
# The clean energy investment gap




McCollum et. Al 2014 Climate Change Economics

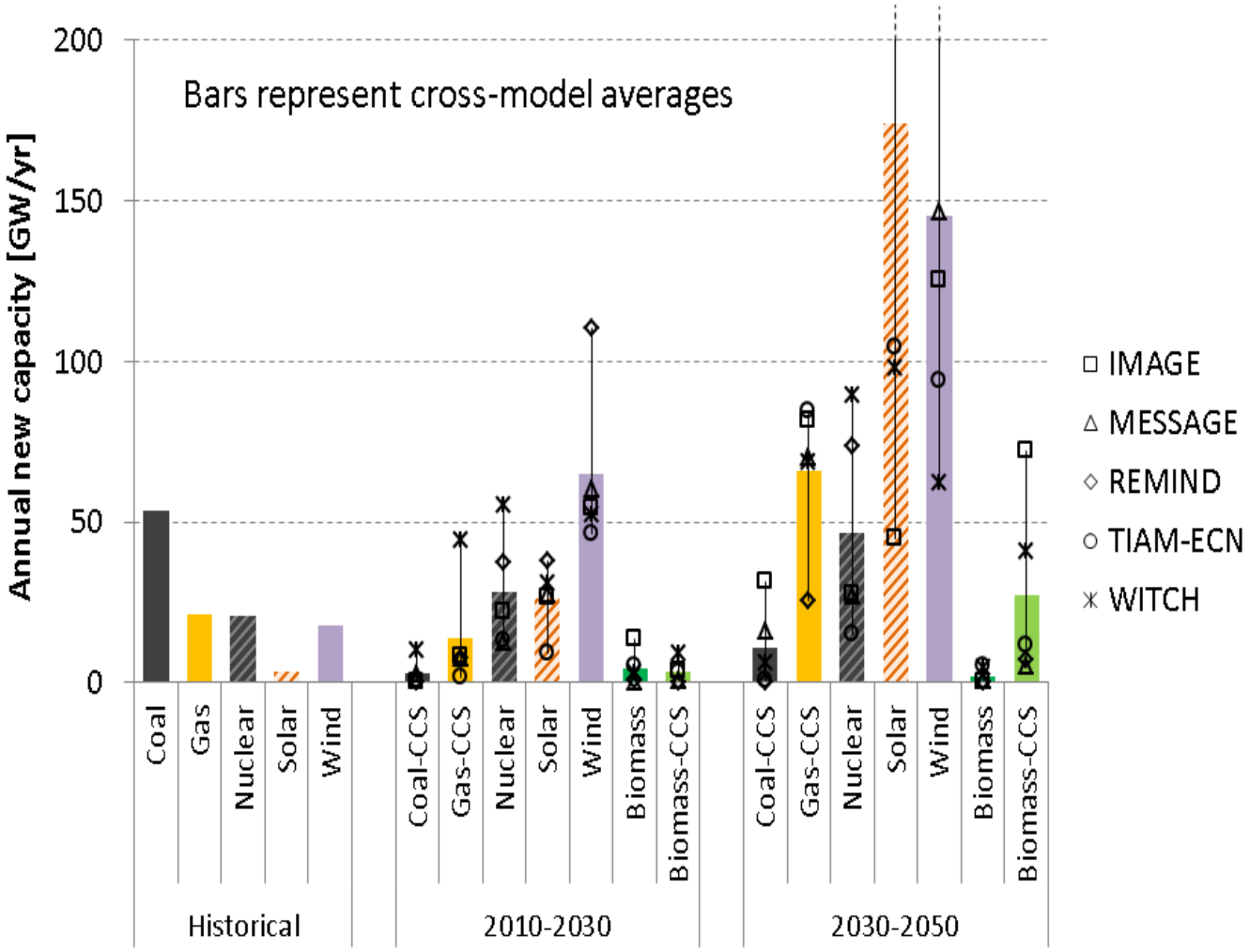
A gap of about 500 USD Billions-yr exists, 2/3 of which in developing economies

# Financing the Investment gap with carbon markets




Half of the investment gap in developing economies can be covered by carbon markets, the rest by energy subsidy removal

# Upscale of low carbon power technologies is needed




Source: van der Zwaan et al., 2014, Climate Change Economics

# Conclusions

1. Countries at all levels of income have the opportunity to build lasting economic growth at the same time as reducing the risks of climate change.
2. This is made possible by structural and technological changes unfolding in the global economy and opportunities for greater economic efficiency.
3. The capital for the necessary investments is available, and the potential for innovation is vast.
4. What is needed is strong political leadership and credible, consistent, progressive policies. The real issue is re-directing investments and expenditures. This is why long term, stable, policy signals are crucial.

# Conclusions

5. Around US$90 trillion is likely to be invested in infrastructure in the world's urban, land use and energy systems in the next two decades. Namely, about 5-6 trillion a year.
6. How these investments are managed will shape future patterns of growth, productivity and living standards.
7. Additional investments for a low carbon society are only about 0,6 trillion a year.

   (The development of cities in particular will be crucial. Cities generate around 80% of global economic output, and around 70% of global energy use and energy-related GHG emissions. How the world's largest and fastest-growing cities develop will be critical to the future path of the global economy and climate.)

# Thank you!

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