Climate Change and Economic Development

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Scope of this talk

- What actions are necessary to mitigate climate change?
  - When and how to invest in low-carbon energy and undertake other measures to limit national and ultimately global GHG emissions
- What is expected of developing countries in controlling climate change?
- What can be expected of international agreements for reducing GHG emissions?

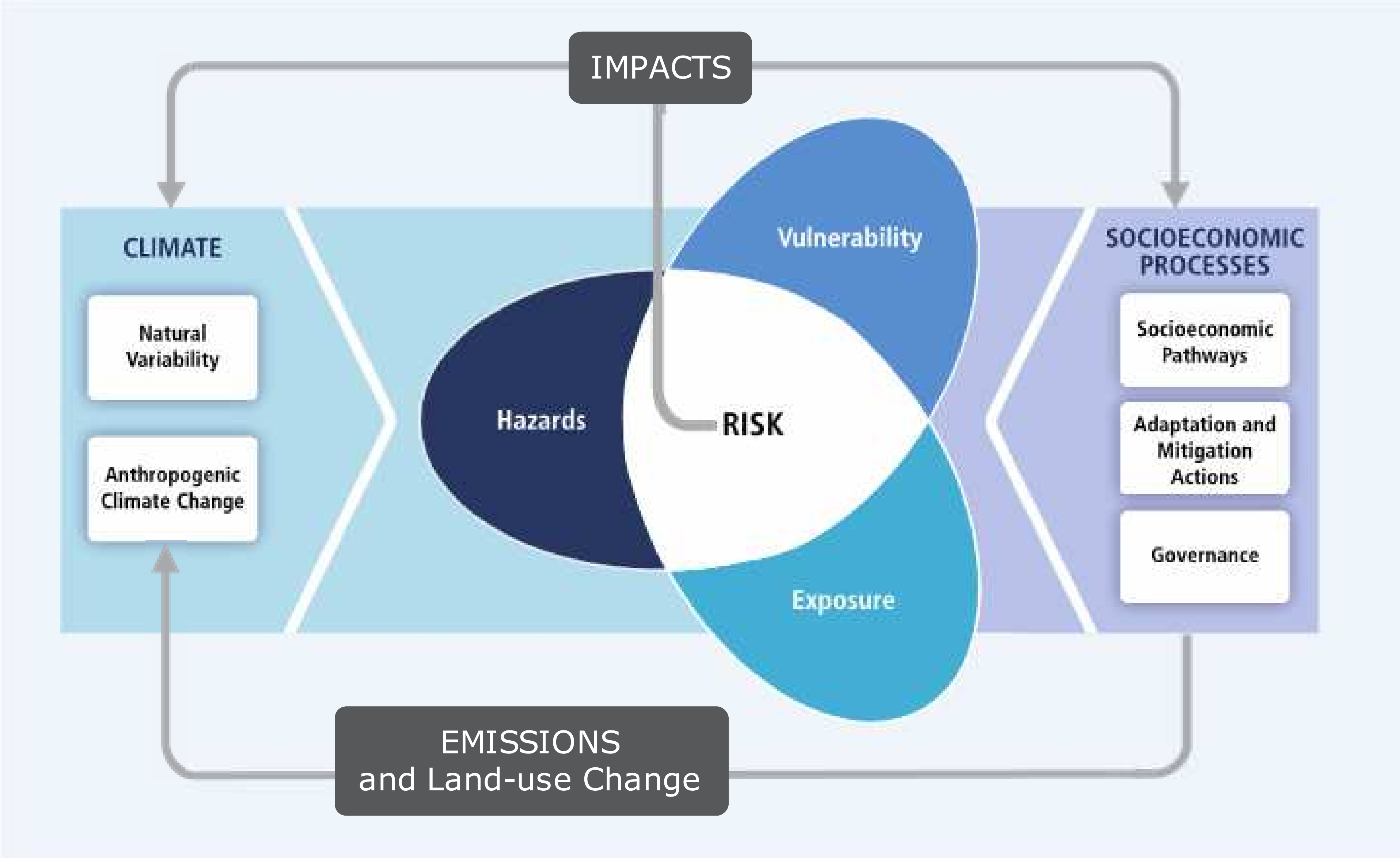
Key conclusions

- Reducing global greenhouse gases enough to significantly mitigate climate change risks will require complete global energy transformation starting soon
- This will have real costs, especially for developing countries
- Only moderate near-term actions appear to be feasible at present given difficulties in stepping up international commitments, and political risk aversion

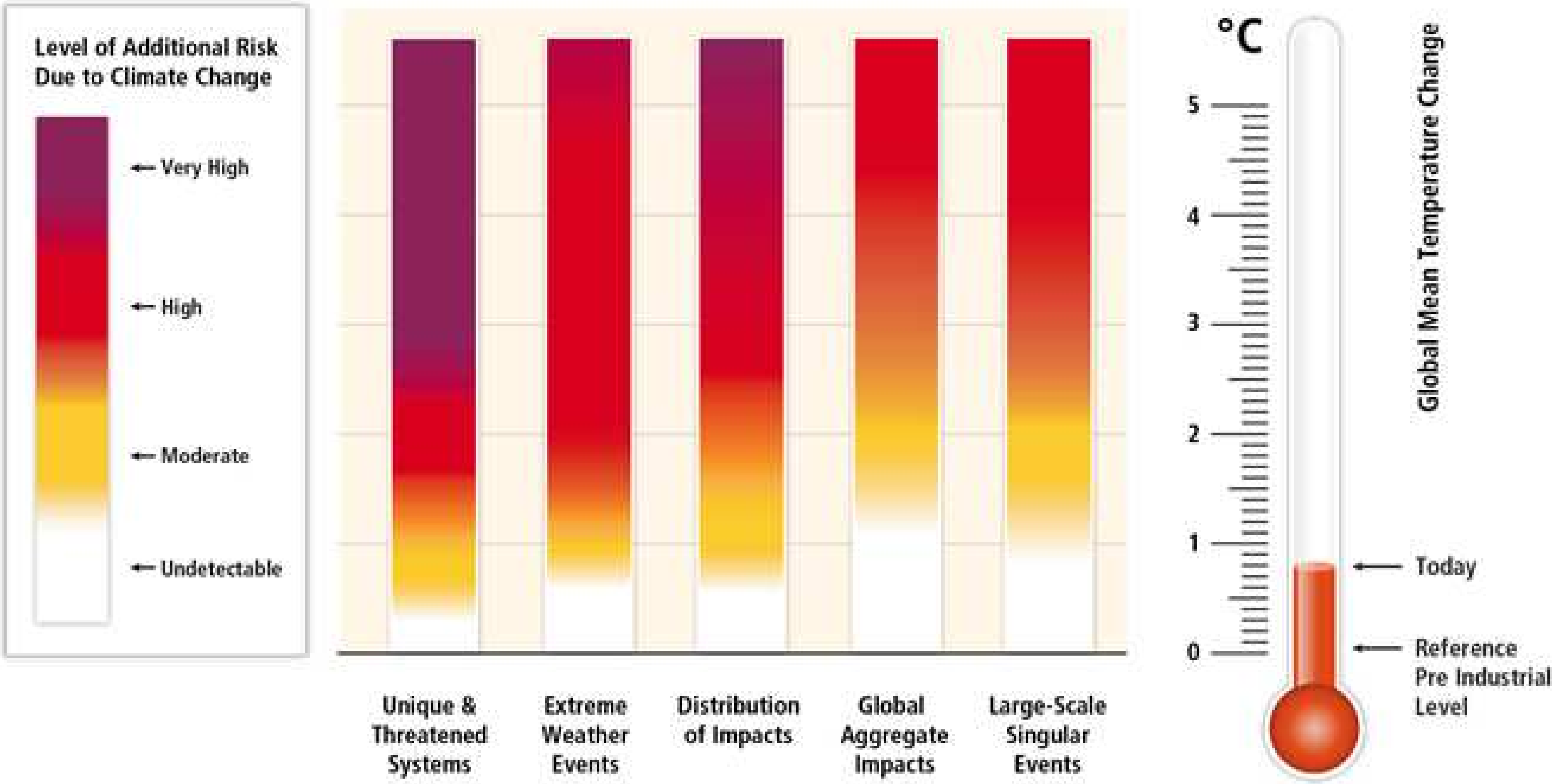
Key conclusions

- Lower-income countries still striving to meet basic needs should not be expected to bear significant cost burdens for GHG mitigation
  - Emphasis should be on low-cost, low-regret action
  - High- and middle-income countries with large emissions need to shoulder most responsibility
- Moving away from economy-wide approaches to coordinated GHG mitigation, and putting more emphasis on sectoral and technology-focused measures, may be more effective

Background on climate change risks


IMPACTS
CLIMATE
Natural Variability
Anthropogenic Climate Change
Vulnerability
Hazards
RISK
Exposure
SOCIOECONOMIC PROCESSES
Socioeconomic Pathways
Adaptation and Mitigation Actions
Governance
EMISSIONS and Land-use Change

Without additional mitigation, global mean surface temperature is projected to increase by 3.7 to 4.8°C over the 21st century – causing significant risks for the environment and human well-being.

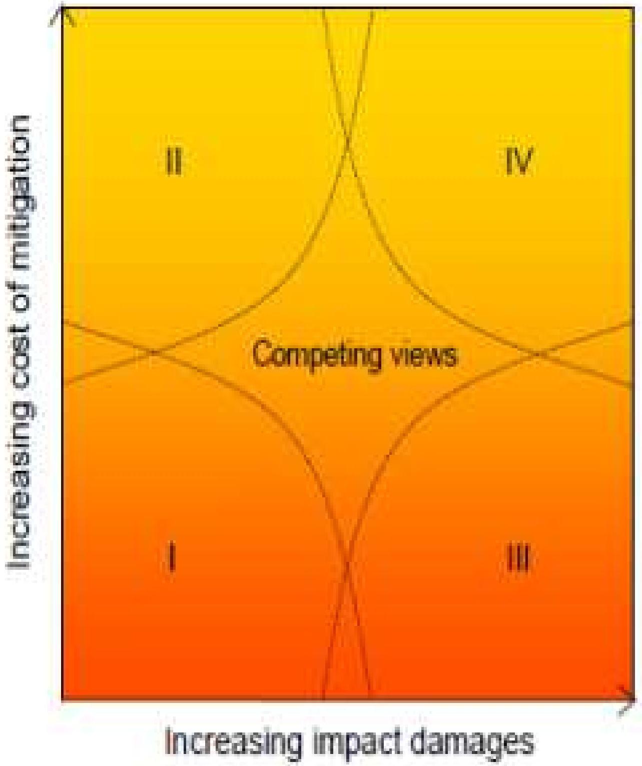


Based on WGII AR5 Figure 19.4

Challenges for risk assessment

- Risks are uncertain and unfamiliar
- Individuals often have difficulties “rationally” evaluating low-probability, high-impact events
  - Stretches the limits of standard models for evaluating choices under uncertainty
  - Importance of considering the robustness of policy actions in the face of deep uncertainty

Goals and actions need to reflect a reasoned comparison of risks and costs



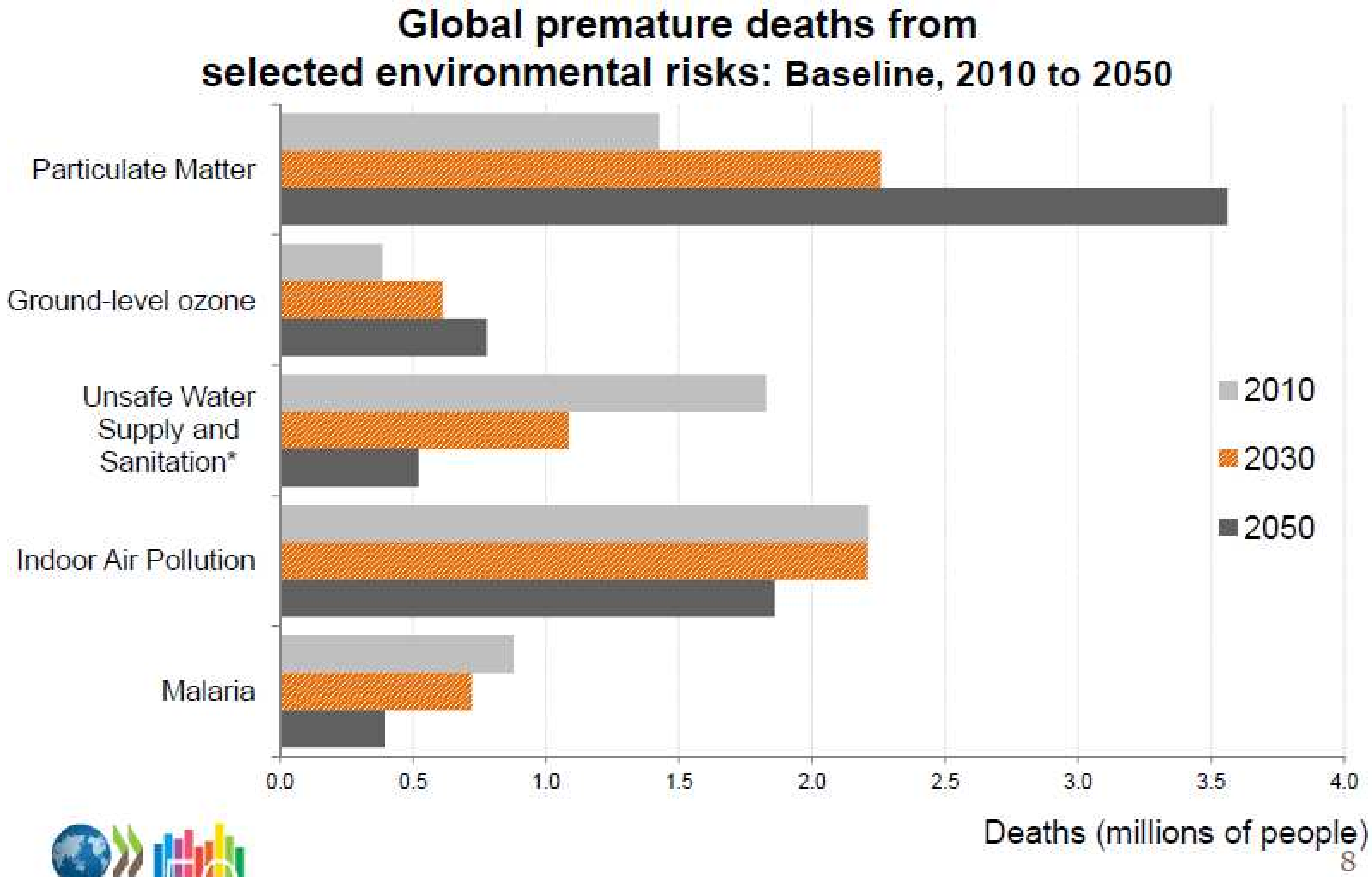
Strategy I
- Wait and see
- Reduce uncertainty through experience
- Reactive adaptation (min loss/max benefits)
- Modest mitigation – known low cost options

Strategy II
- Wait and see on climate and impacts
- Research economic, tech uncertainty
- Reactive adaptation (min loss/max benefits)
- Efforts to reduce mitigation costs

Strategy III
- Act early on mitigation
- Research climate & impact uncertainty
- Anticipatory adaptation
- Strong mitigation

Strategy IV
- Strong action to reduce mitigation costs
- Research everything to minimise losses
- Strong adaptation
- Anticipatory mitigation – develop low cost options

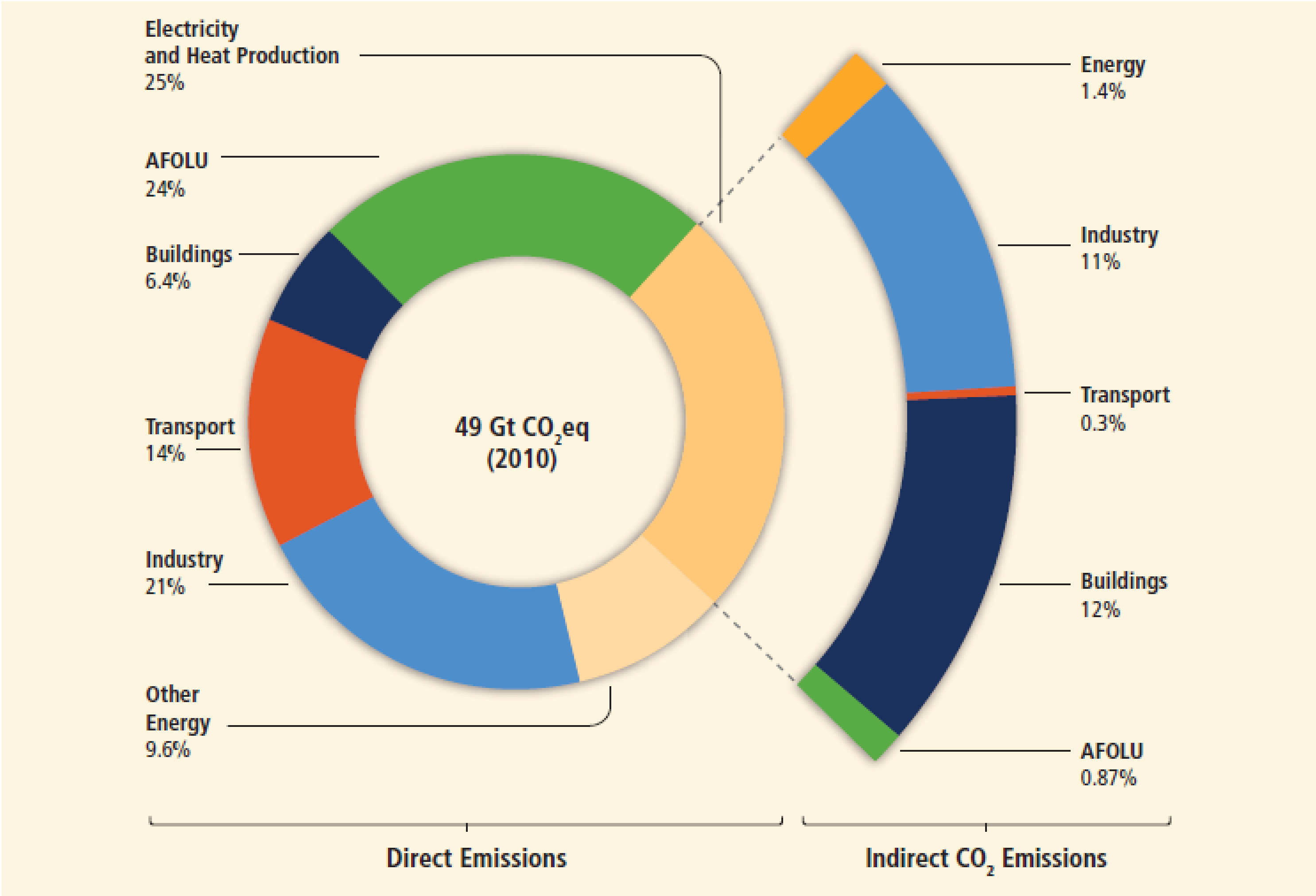
Other environmental risks matter too



Source: (OECD, 2012), OECD Environmental Outlook to 2005; output from IMAGE

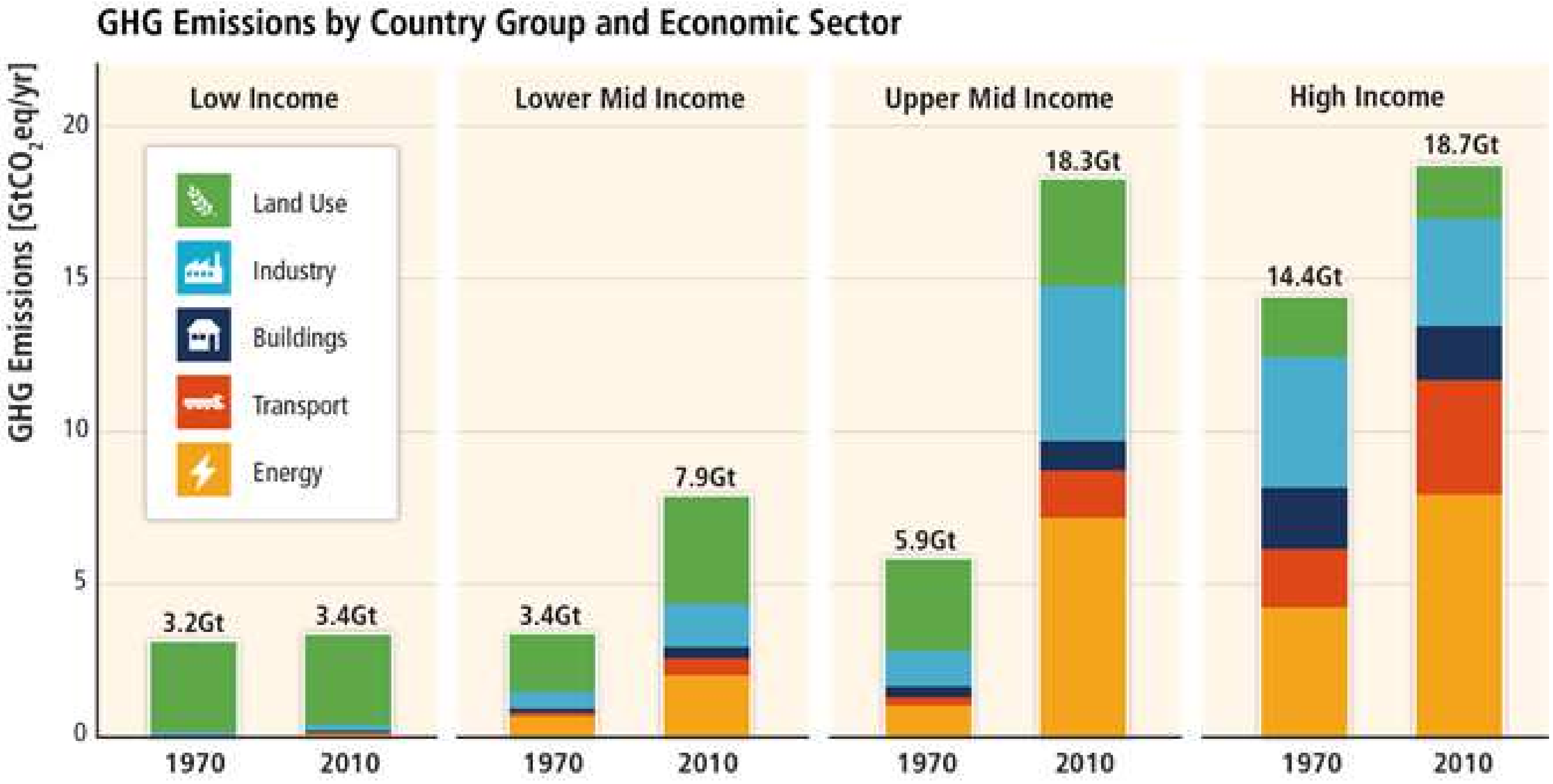
Background on GHG emissions and energy trends

Sources of GHG emissions



Globally, about two-thirds are from energy production and use

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



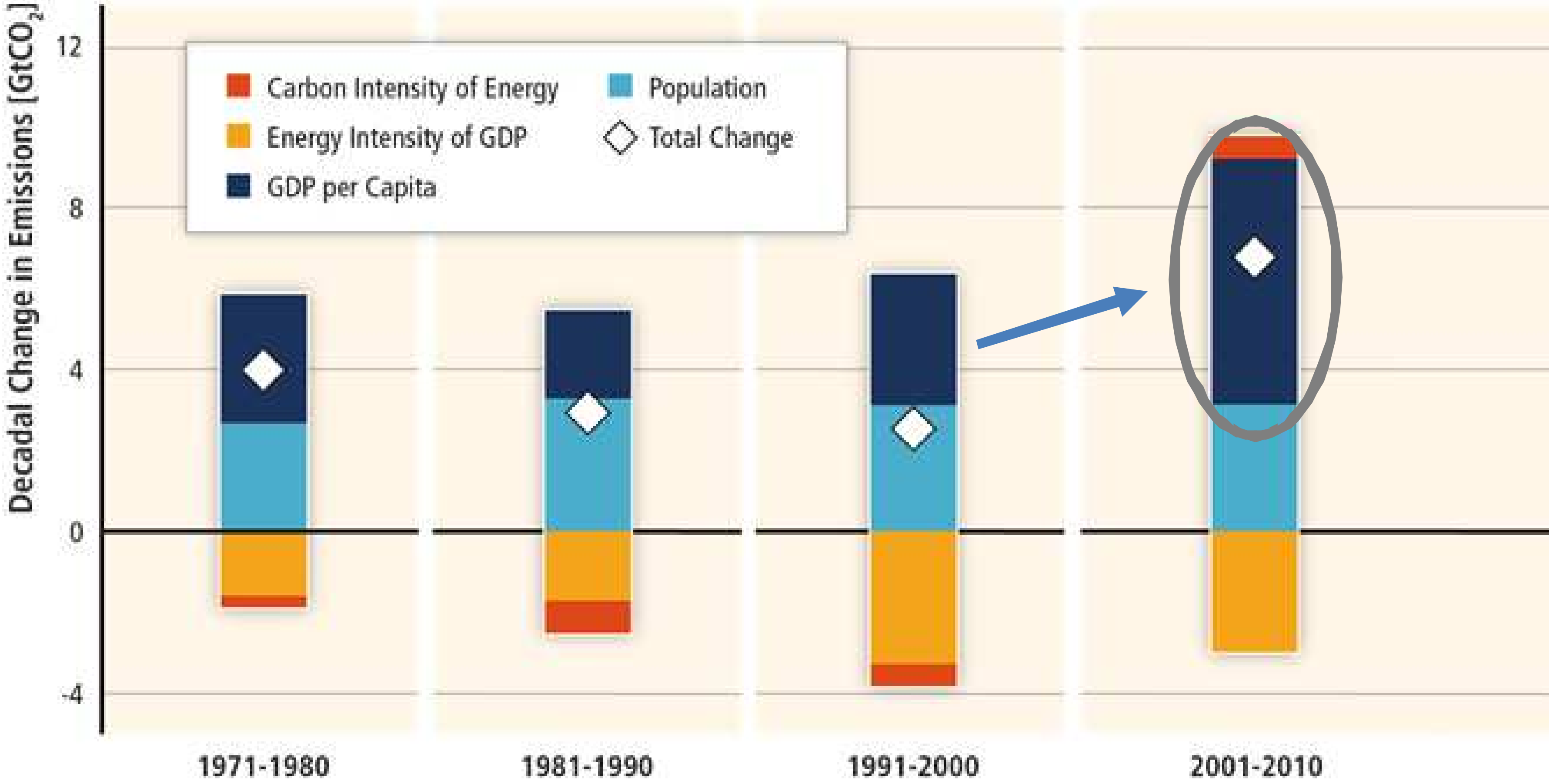
Based on Figure 1.6

Decomposition formula for growth in CO2 emissions

C=emissions, E=energy, Y=income, P=population

$$\%\Delta E = \%\Delta P * \%\Delta\left(\frac{Y}{P}\right) * \%\Delta\left(\frac{E}{Y}\right) * \%\Delta(\frac{C}{E})$$

GHG emissions rise with growth in GDP and population; long-standing trend of decarbonisation of energy reversed.



Based on Figure 1.7

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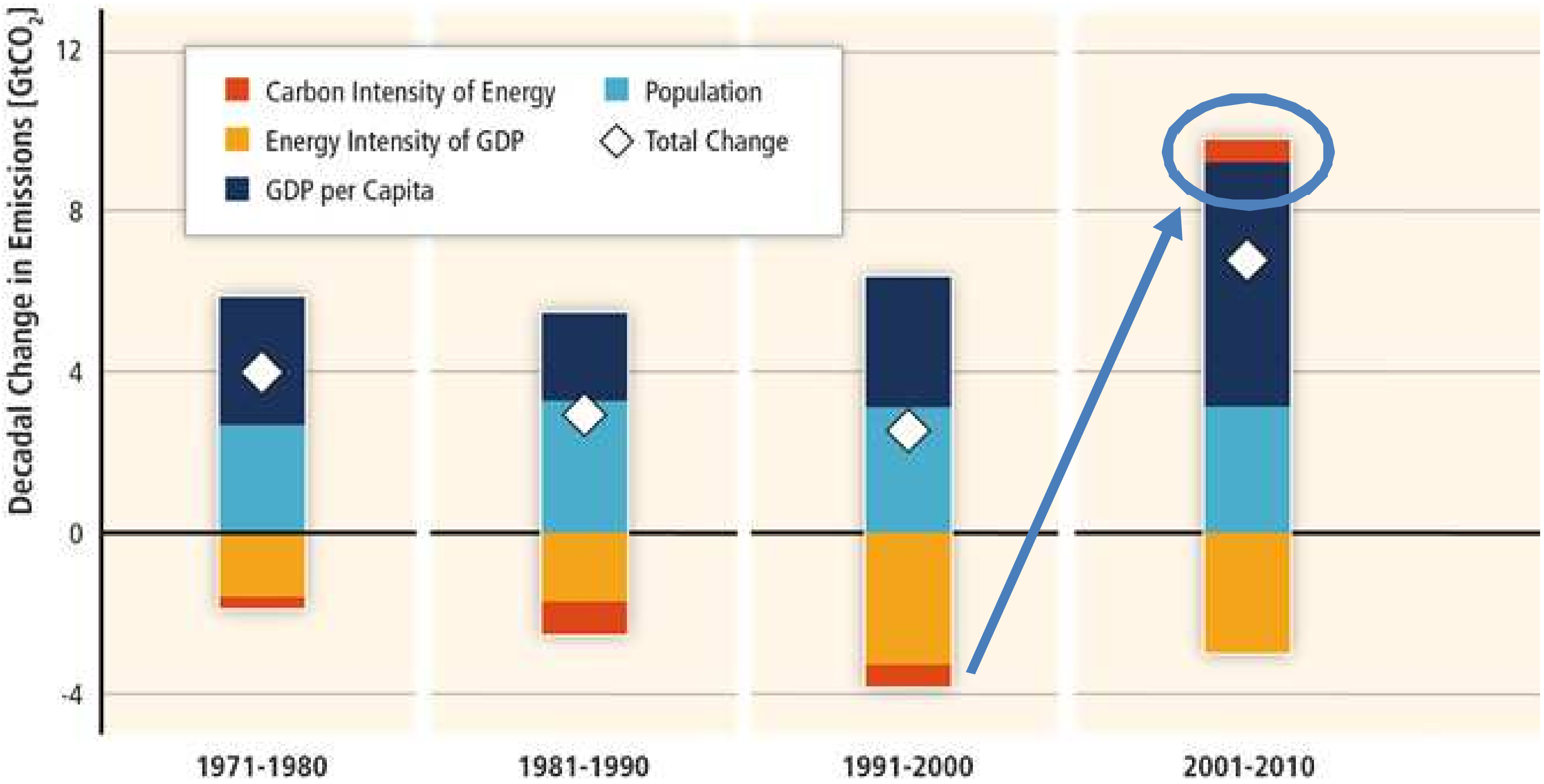
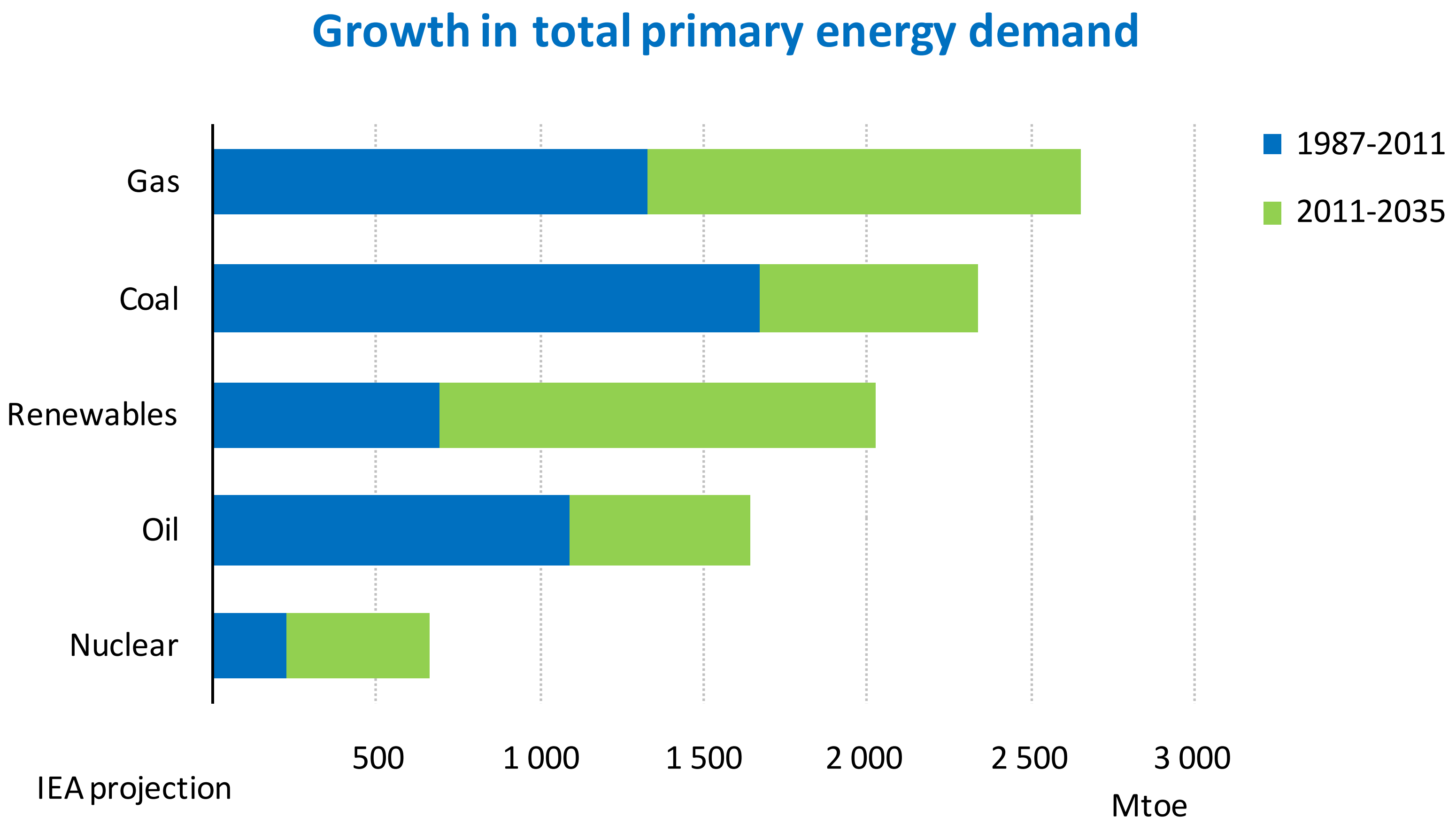


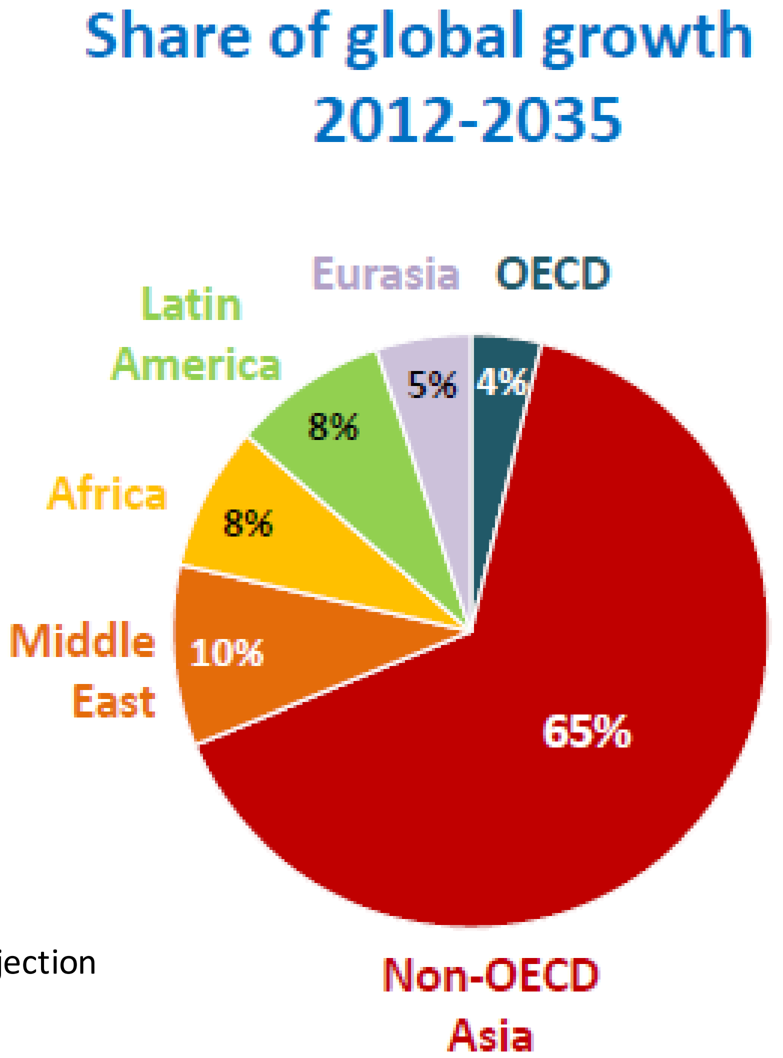
Based on Figure 1.7

Even with fairly strong renewables growth, fossil energy dominates the mix absent new policies



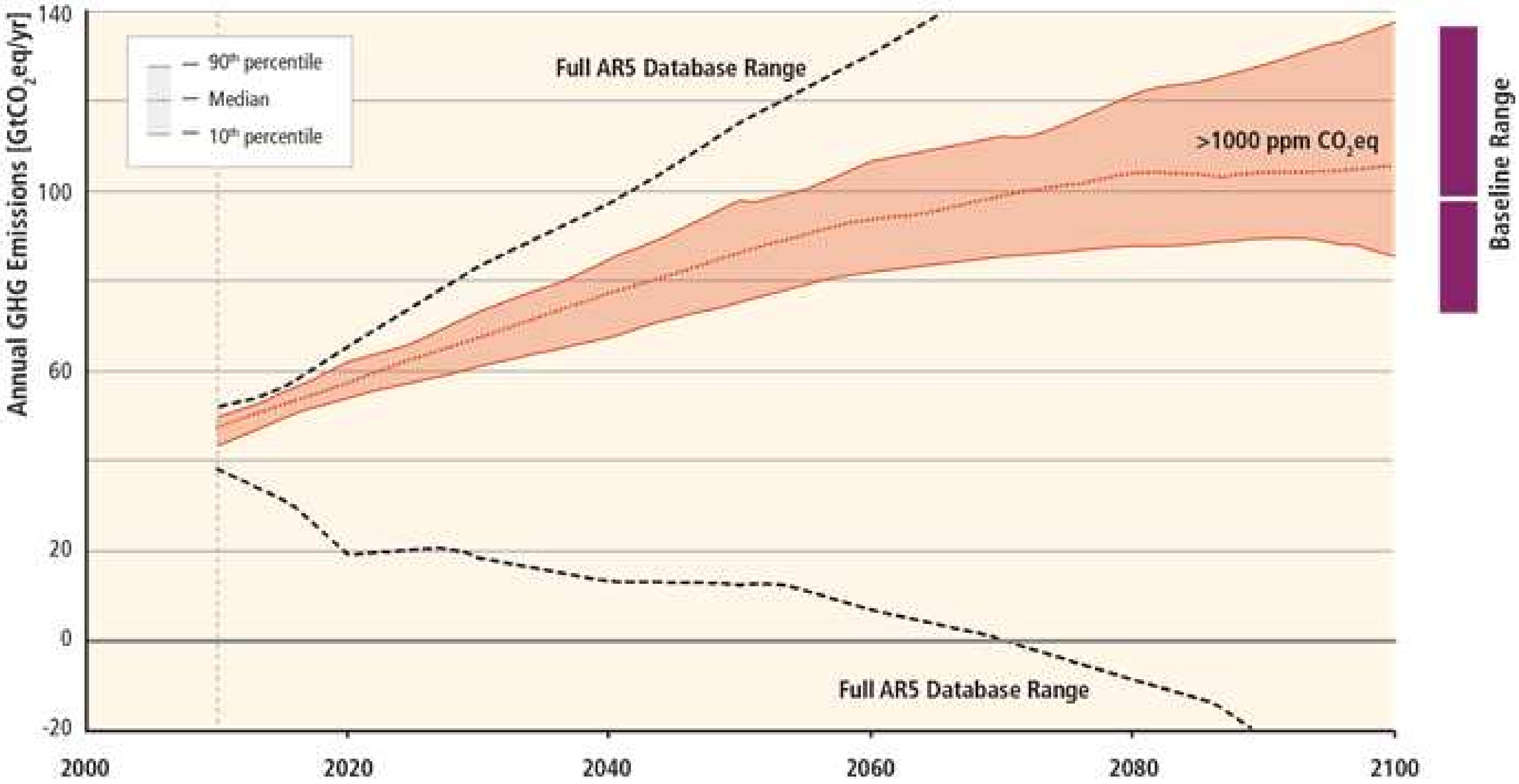
While primary energy demand roughly doubles from 2011-2035, fossil energy only shrinks from 82% to about 75% absent much more aggressive GHG emissions mitigation

Asia will dominate future energy growth



IEA projection

Stabilization of atmospheric concentrations requires moving away from the baseline – regardless of the mitigation goal.



Based on Figure 6.7

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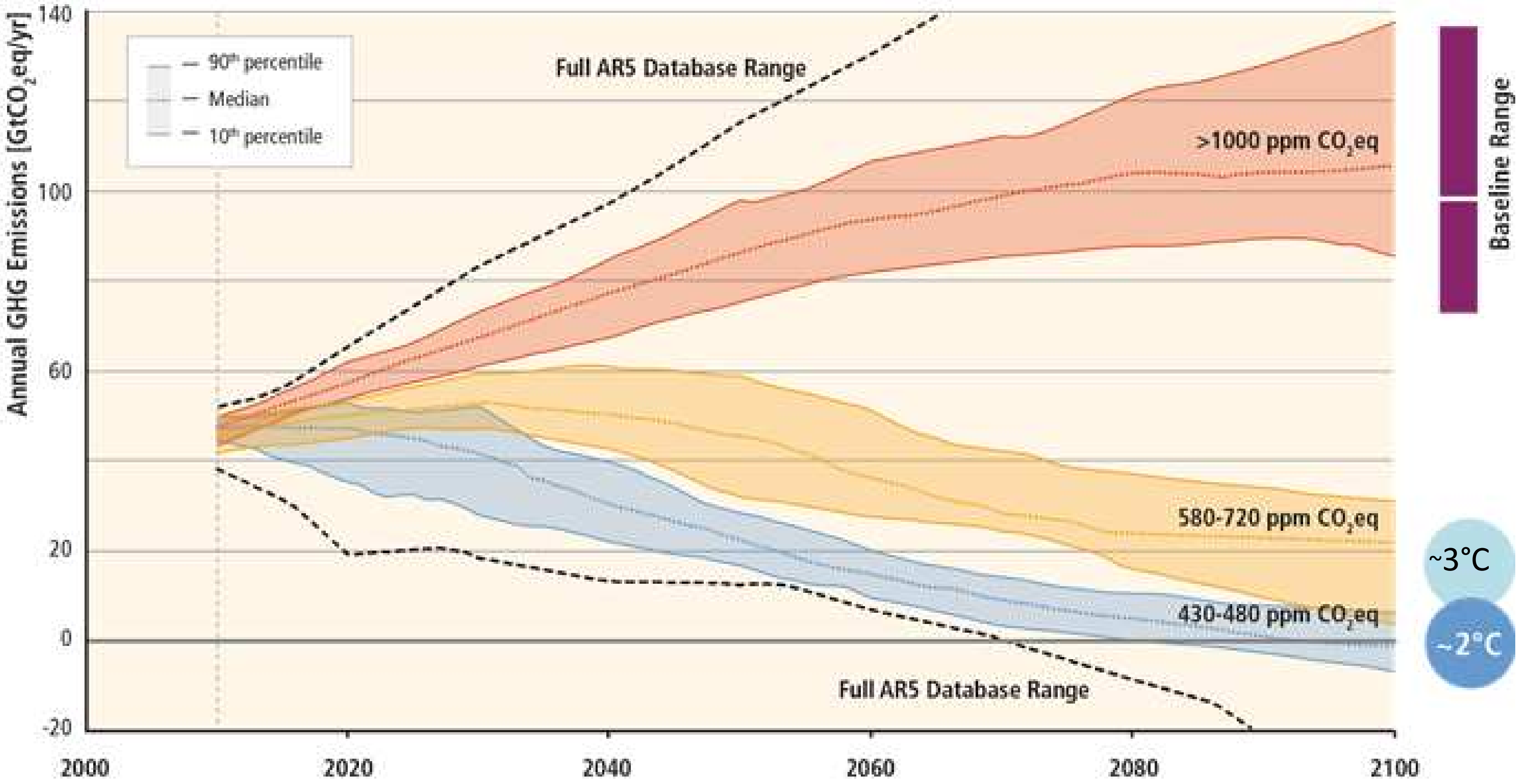
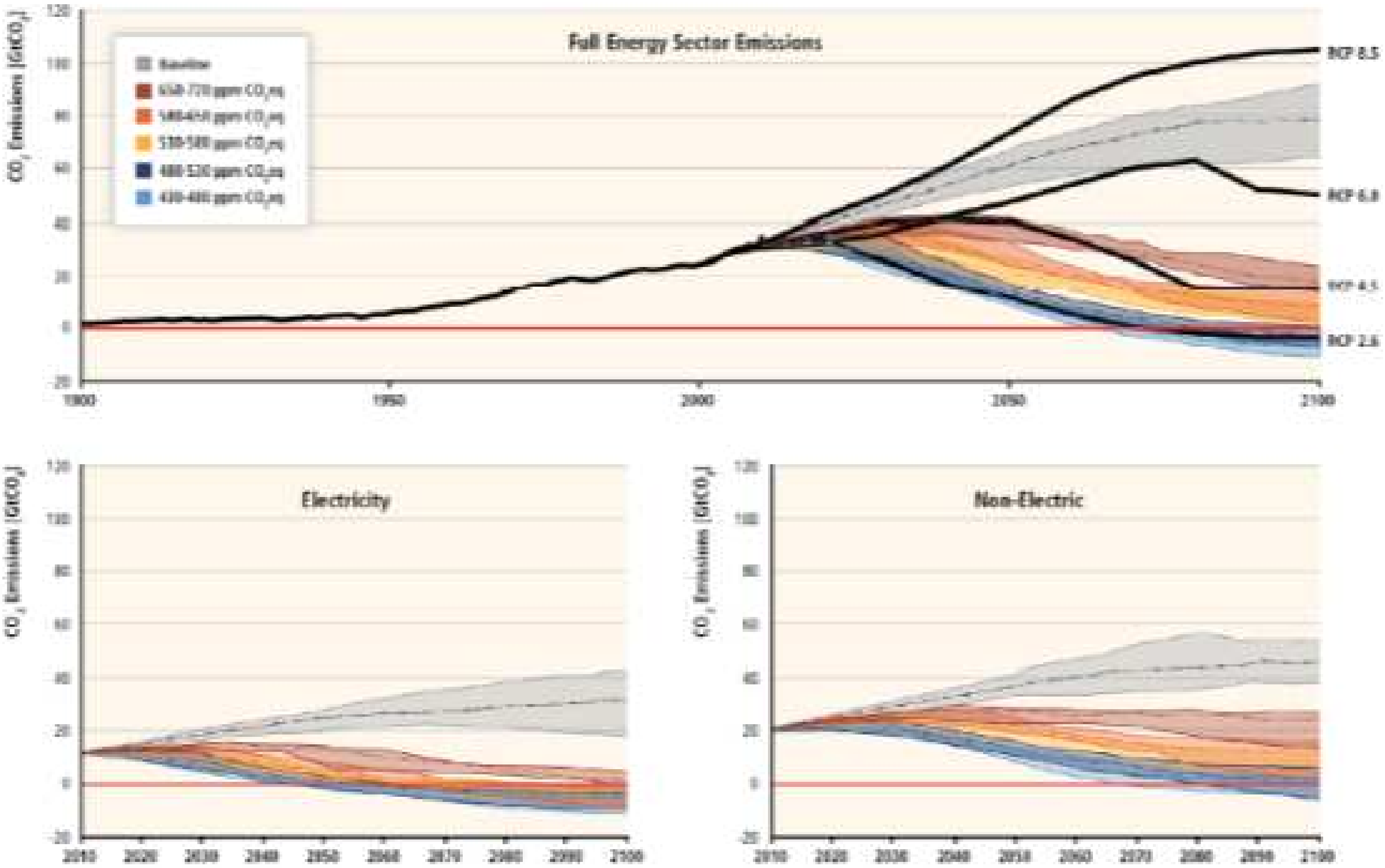
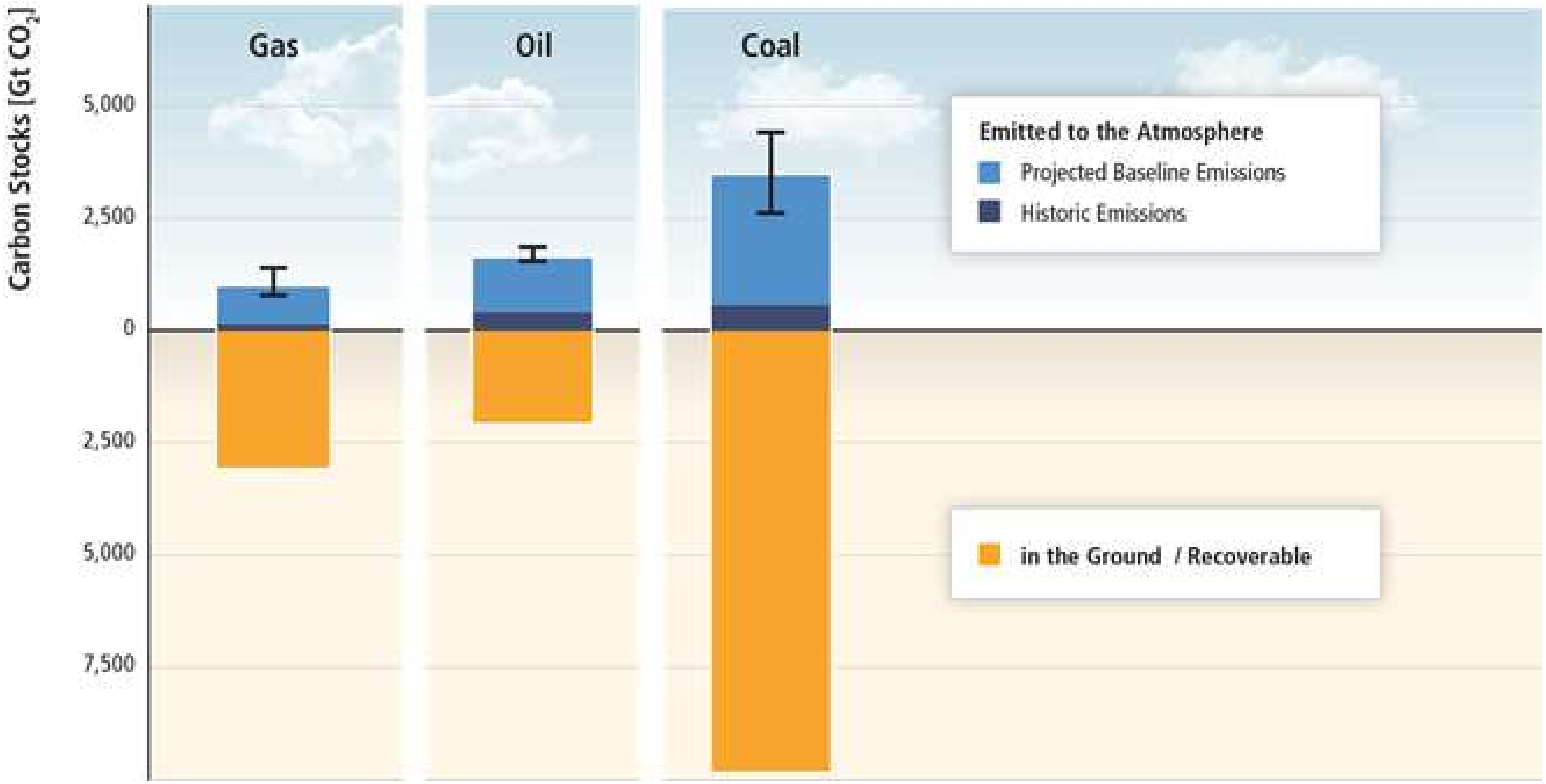


Based on Figure 6.7

Similar trends apply to energy related emissions



There is far more carbon in the ground than emitted in any baseline scenario; fuel scarcity not a major emissions constraint

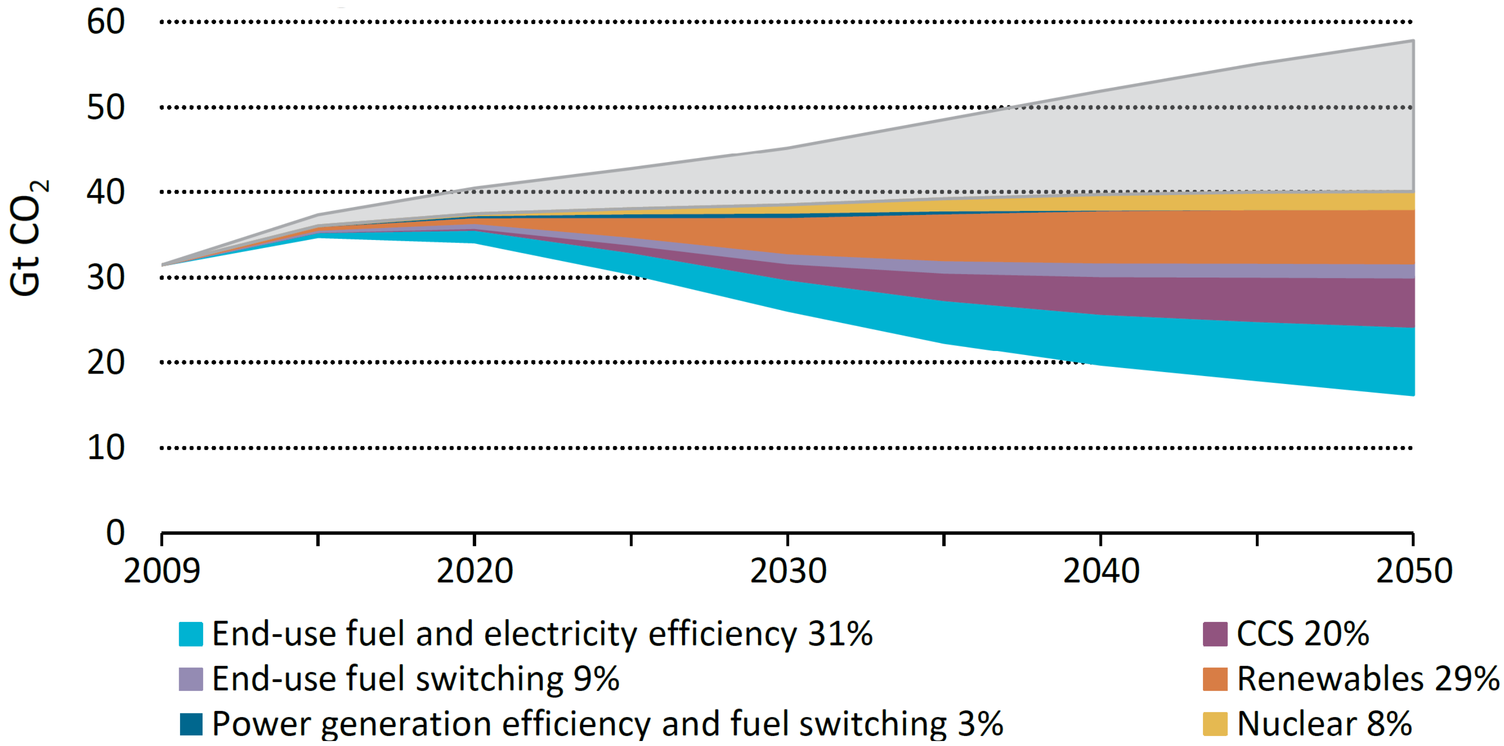


Based on SRREN Figure 1.7

Costs of GHG mitigation

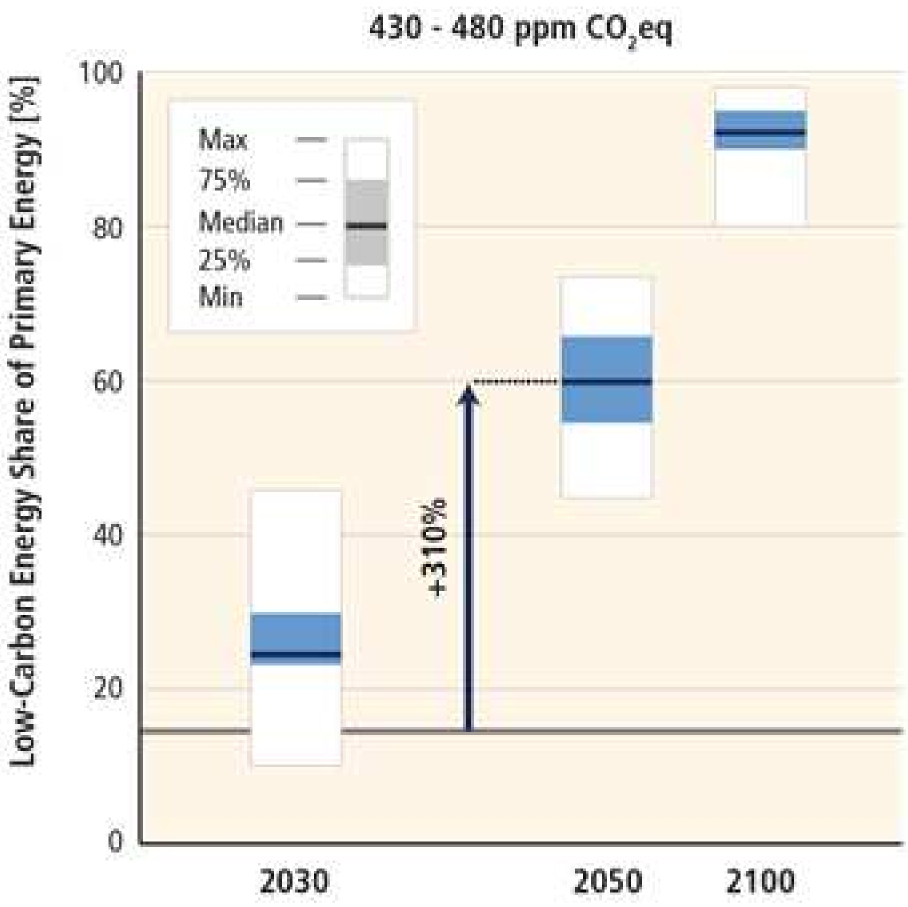
A portfolio of technologies is needed

Technology contributions to reaching the 2DS vs 4DS



Top “wedge” indicates additional effort needed to get from 6DS to 4DS

Mitigation involves substantial scaling up of low-carbon energy.



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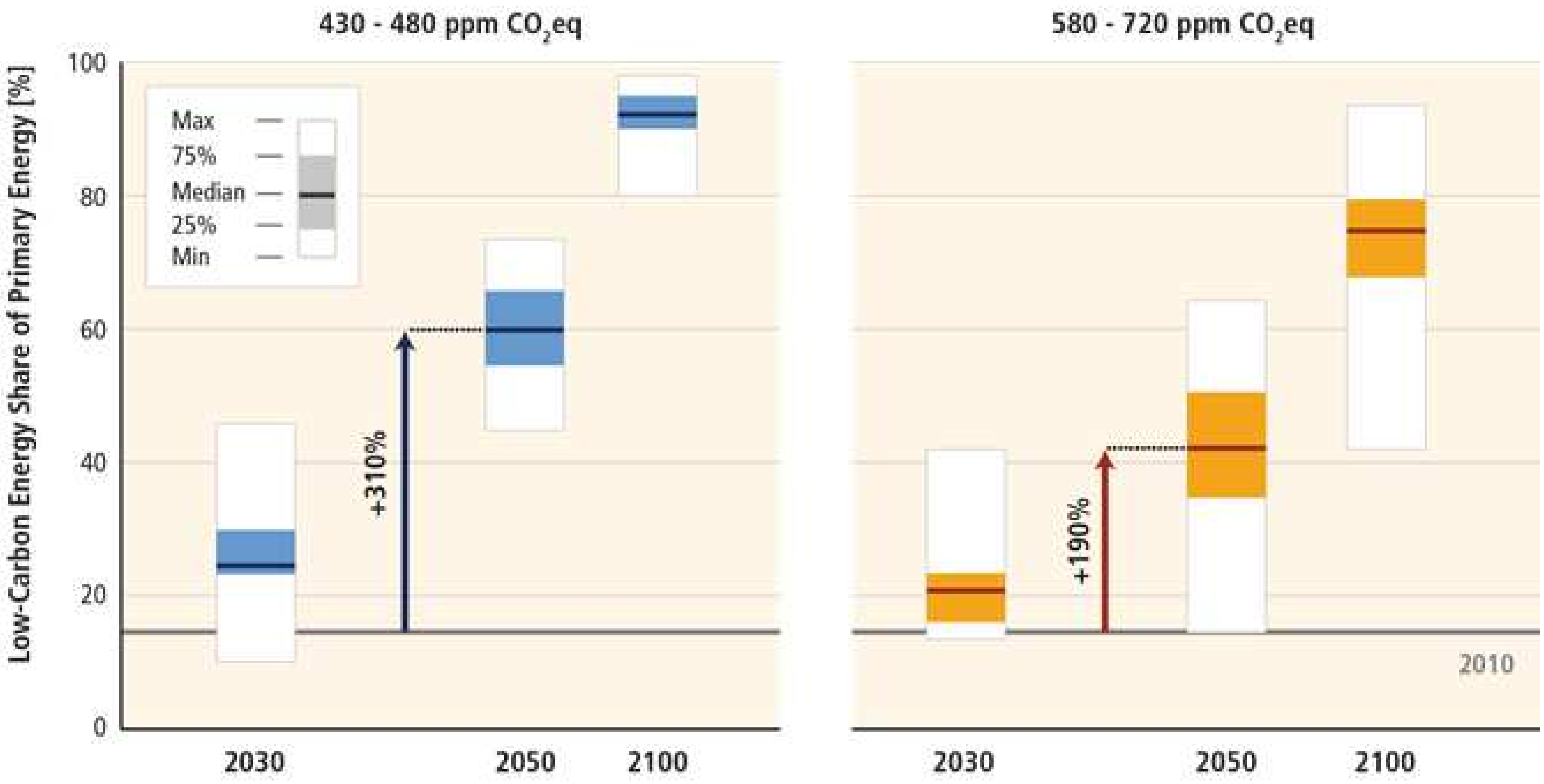
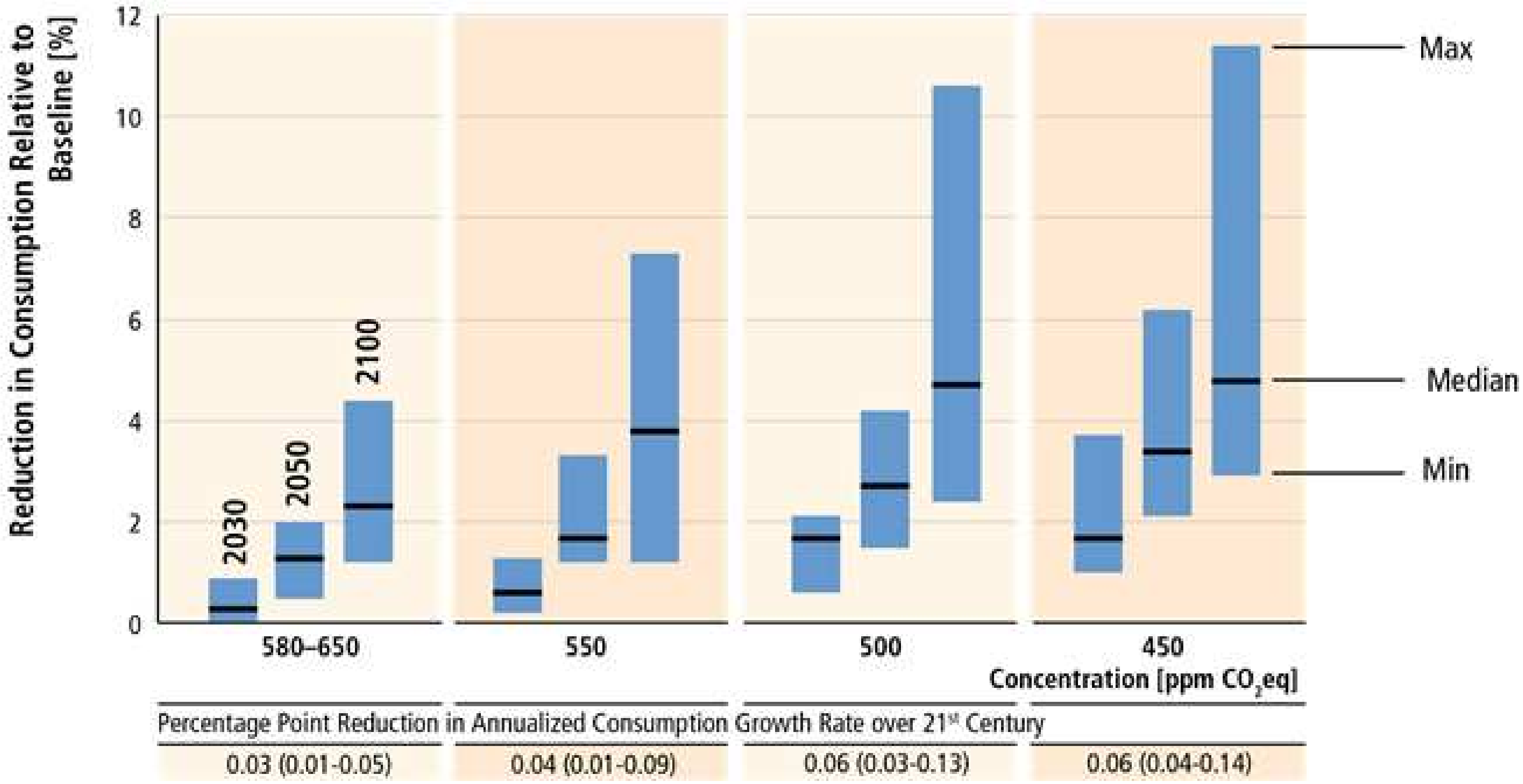


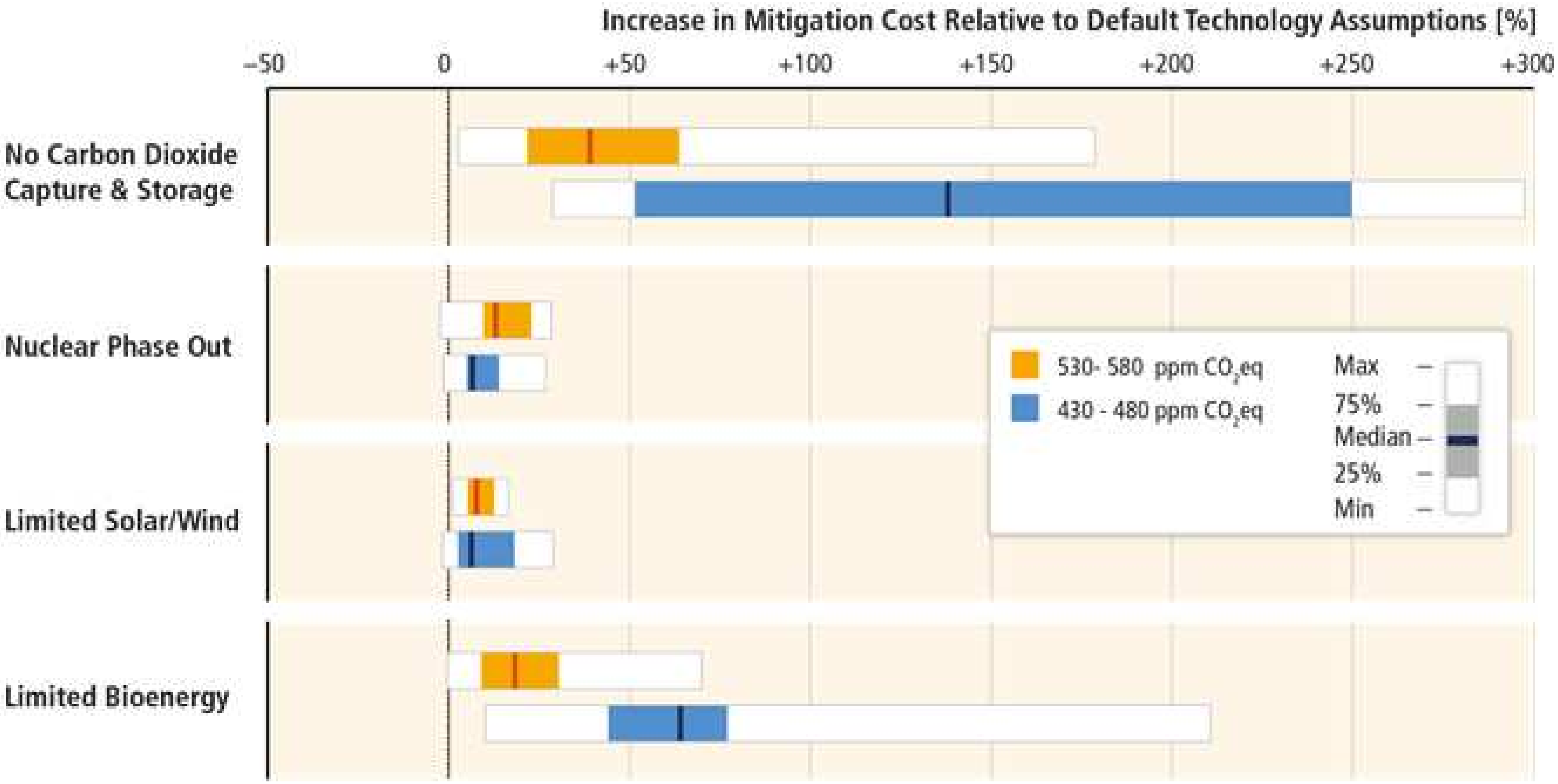
Based on Figure 7.16

Global costs rise with the ambition of the mitigation goal.



Based on Table SPM.2

Availability of technology can greatly influence mitigation costs.

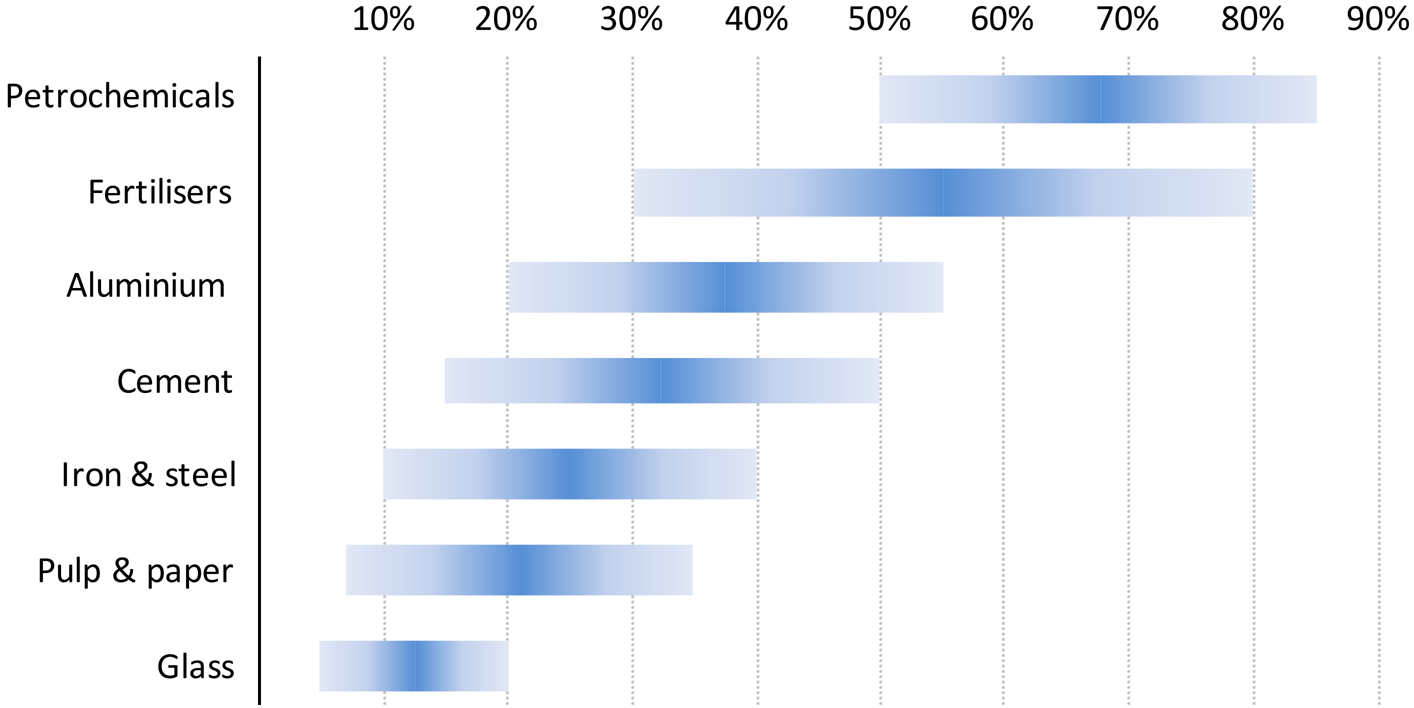


Based on Figure 6.24

How to evaluate these costs?

- While the % deviations from baseline are small, in absolute terms even a few % of (growing) future global consumption is large – especially for lower-income developing countries
- Costs will be significantly larger if all low-carbon technologies are not available – even those that are pre-commercial and controversial
- Costs will fall disproportionately on certain sectors
- Cost estimates typically assume cost-effective measures for international mitigation (i.e. international carbon price) – costs will be significantly larger without them

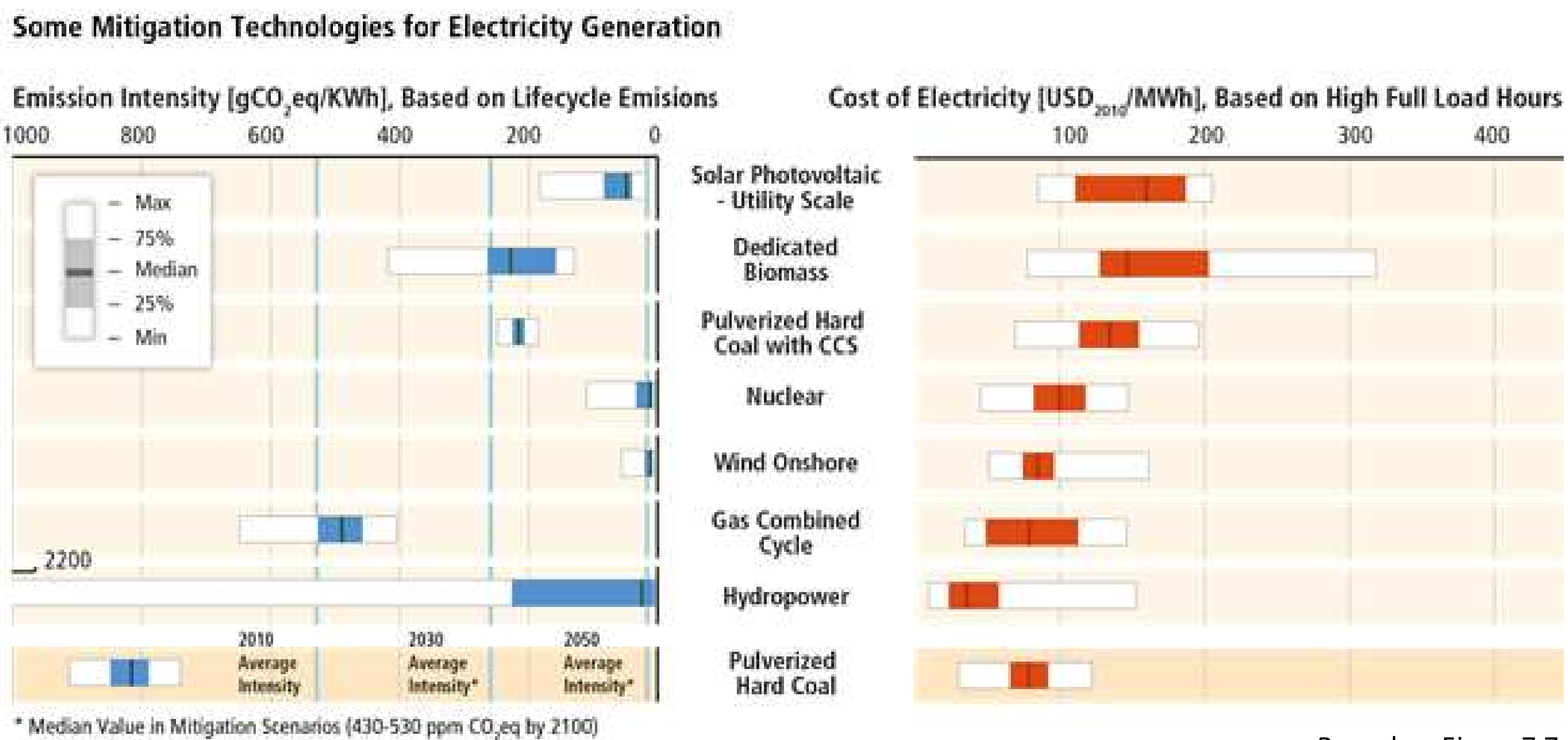
Share of energy in total production costs for selected industries



IEA calculations

Energy-intensive sectors worldwide account for around one-fifth of industrial value added, one-quarter of industrial employment and 70% of industrial energy use

Unit costs and GHG intensities of different power generation technologies



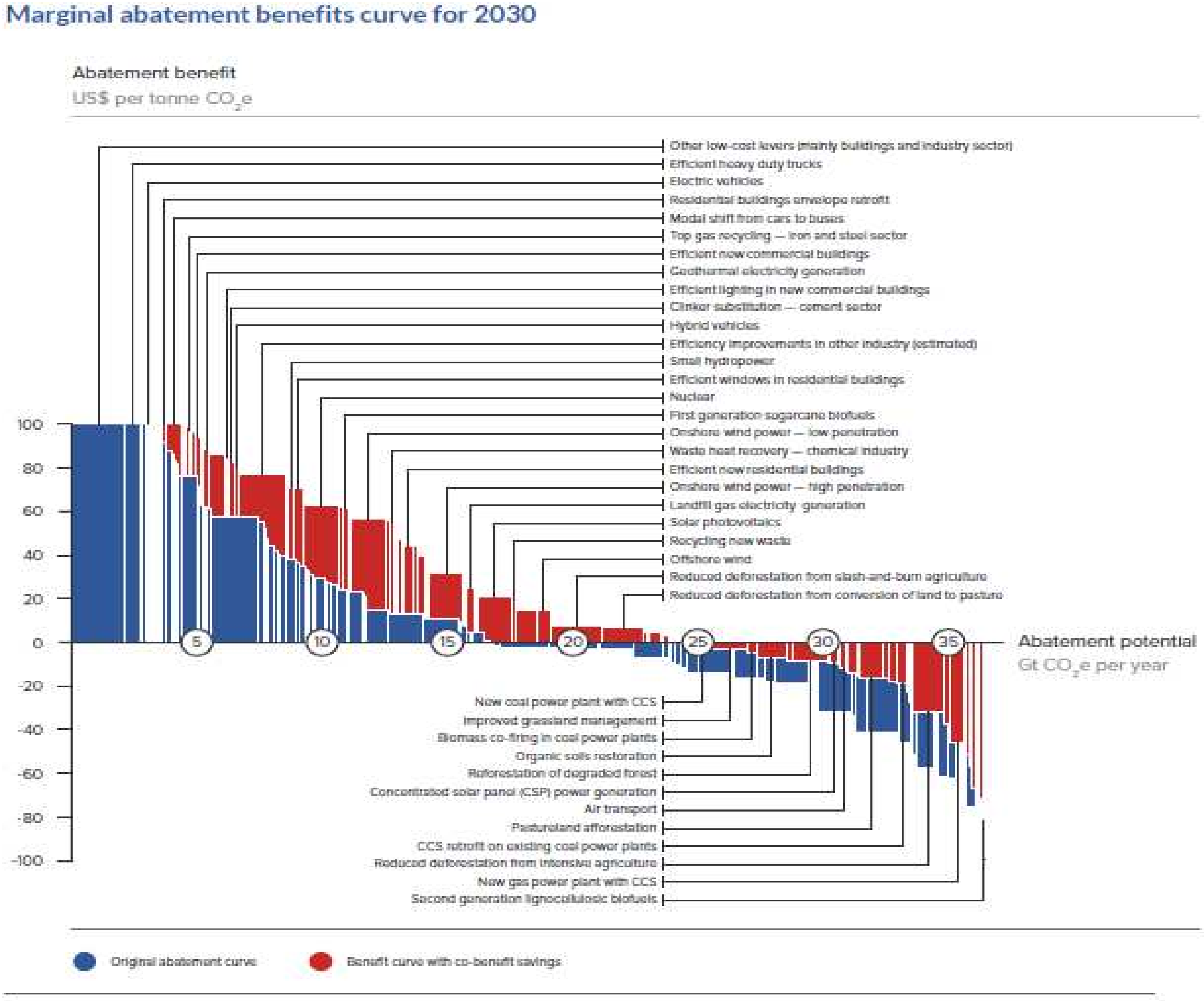
Based on Figure 7.7

Lower utilization rates and uncertain availability raise costs of intermittent renewables

Technical progress is needed to reduce costs of nontraditional renewable energy, as well as other low-carbon options (esp. nuclear)

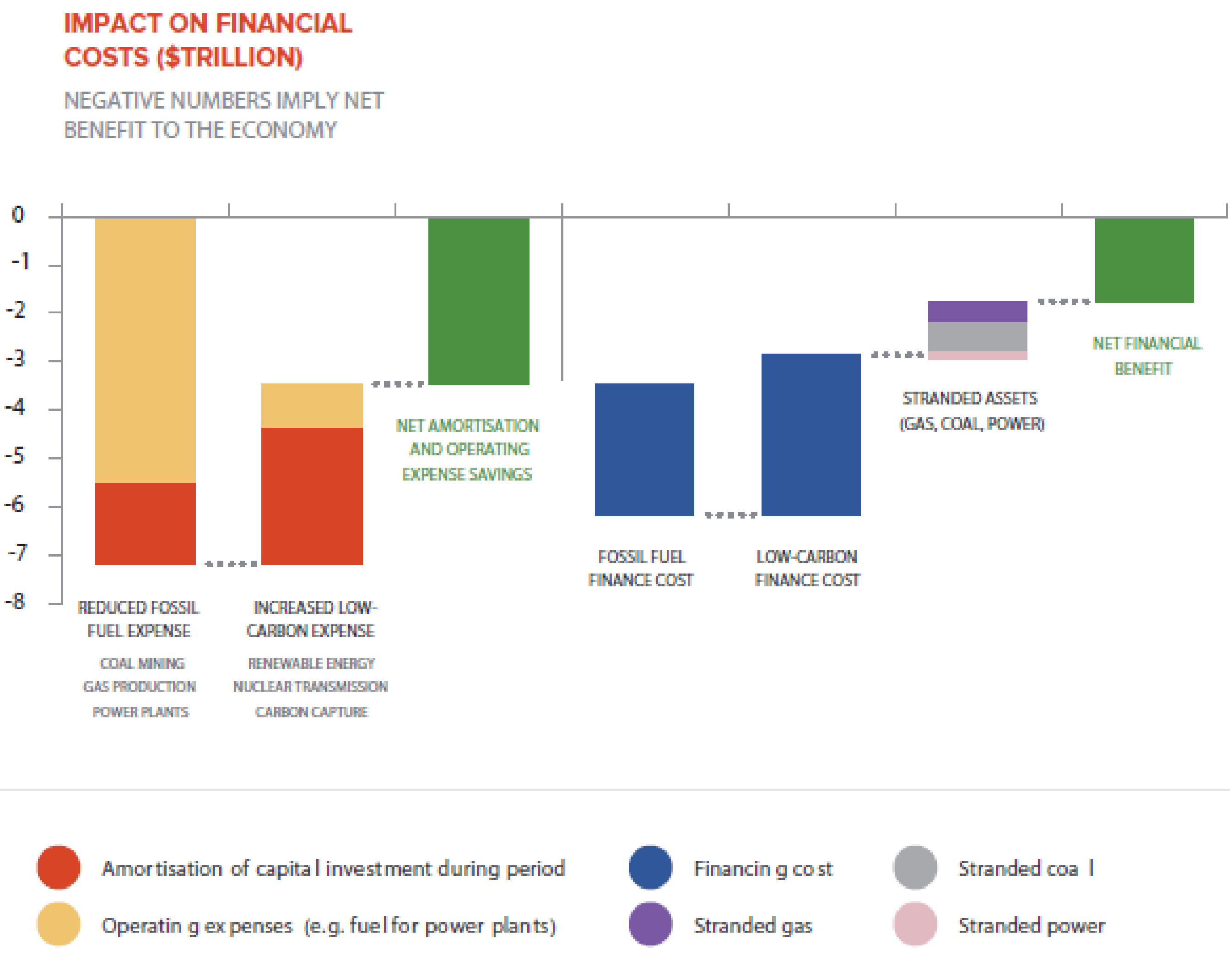
– First generation liquid biofuels are not cost-competitive with traditional petroleum (or with coal liquefaction) and have side effects; second generation still some years away
– Wind becoming competitive “at the bus bar” in certain locations but remain costly to scale up (storage, grid stabilization)
– PV is becoming much cheaper but also challenging to scale up; solar thermal still in early stage of commercial maturation and thus remains costly
– Nuclear costs remain high

“McKinsey MAC curve” shows lots of win-win



Source: New Climate Economy analysis.[72]

Increased investment in low-carbon technology is offset by avoided operating and financing costs



Source: CPI and NCE analysis based on data from IEA, 2012; IEA, 2014; Platts, and Rystad.[109]

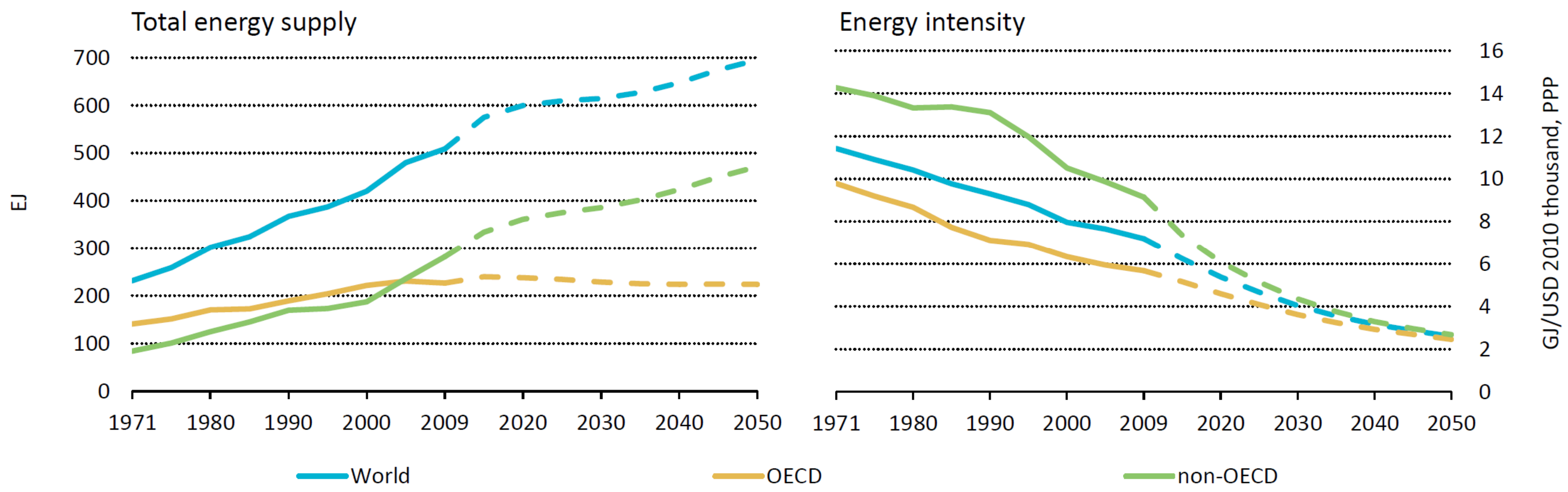
Difficulties with this narrative

- MAC curve has several flaws
  - Evaluation of individual mitigation opportunity costs
  - Interactions among mitigation components
- A large body of analysis indicates that to make deep GHG cuts we will have to make intensive use of the ostensibly more expensive options
- Counting co-benefits:
  - Often are cheaper options for pursuing co-benefits than GHG mitigation
  - If many co-benefit measures should be pursued already, why aren't they?

Is holding global mean temperature increase below 2 deg. C possible?

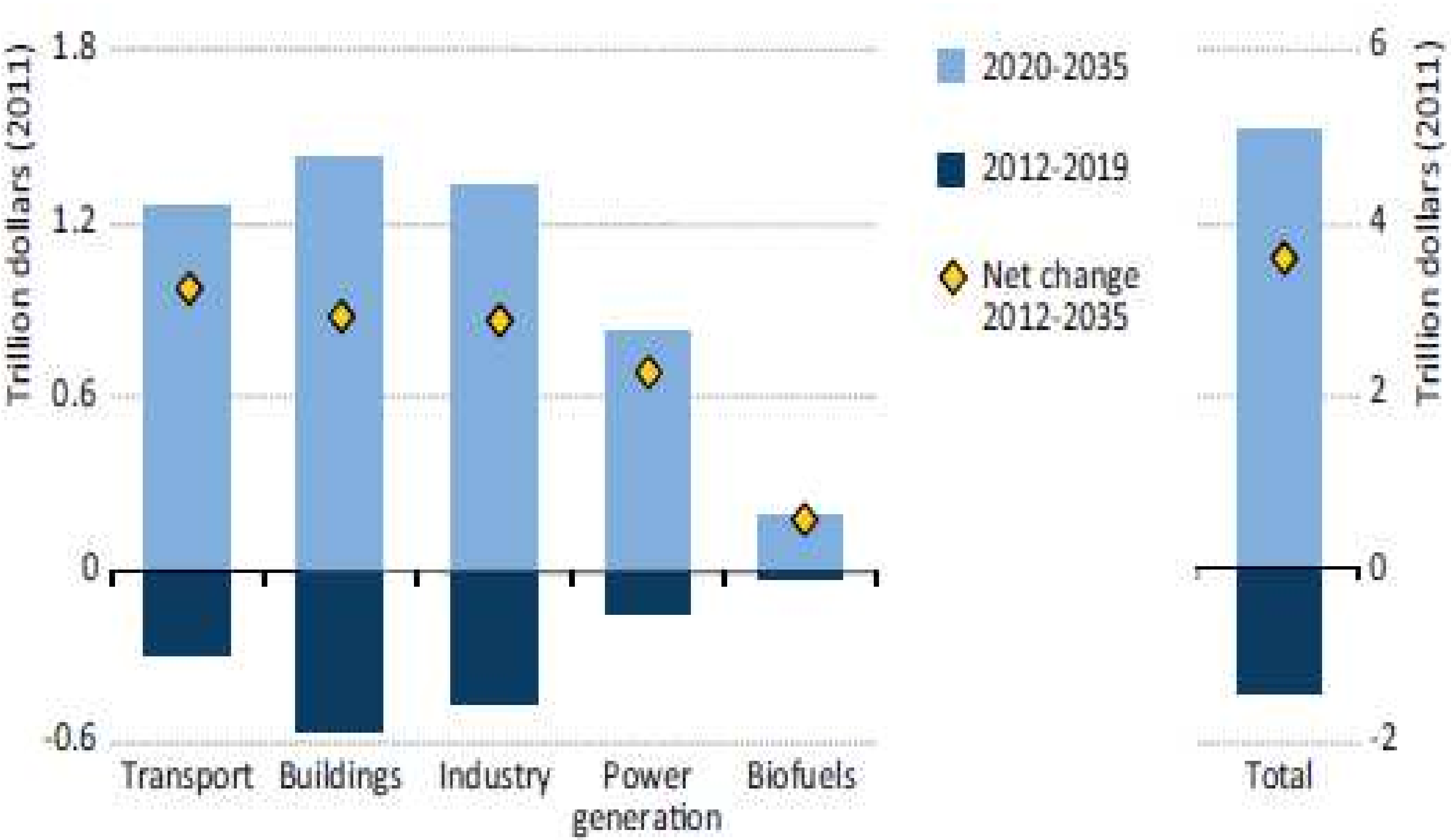
- Maybe – but it would require unprecedented speed in cutting global emissions
- All possible mitigation technology options will be needed, and cost could be quite high without major technical advance
- Need shift in political economy away from very risk-averse positions toward policies that will have near-to-medium term costs in order to achieve any serious emissions limits

Decoupling energy use from economic activity is critical



Reducing the energy intensity of the economy is vital to achieving the 2DS.

Costs of meeting GHG targets could increase considerably with delay (unless technology costs fall significantly)



Energy related mitigation outlays – IEA calculations

GHG mitigation and developing countries

Who should go first?

- Controlling climate change is and for some time should be an issue primarily for high-emitting upper and middle income countries
  - Consistent with UNFCCC
- Lower income countries – especially those not able to meet basic energy needs – should not be carrying out costly decarbonization
  - Important implications for MFI and bilateral project financing

Uses of international financial resources also need to reflect this

- “Carbon finance” will have limited effect without stronger commitments from developed and major developing countries to curb emissions (no incentives)
- Mitigation financing with Green Fund should emphasize spillover benefits
  - Global cost reduction for low-C technologies
  - Local development benefits (e.g. increased availability of lighting with high energy efficiency)

Energy priorities for most developing countries

- Improved access to affordable, clean energy
  - Basic access for cooking, heating, lighting
  - Expanded access to electricity for growth
- Improved reliability of electricity availability
  - Mitigate productivity as well as direct welfare losses
  - Increase investment in modern growth sectors
- Financial sustainability of sector
  - Subsidy, other governance reforms
- Improved energy efficiency that lowers costs

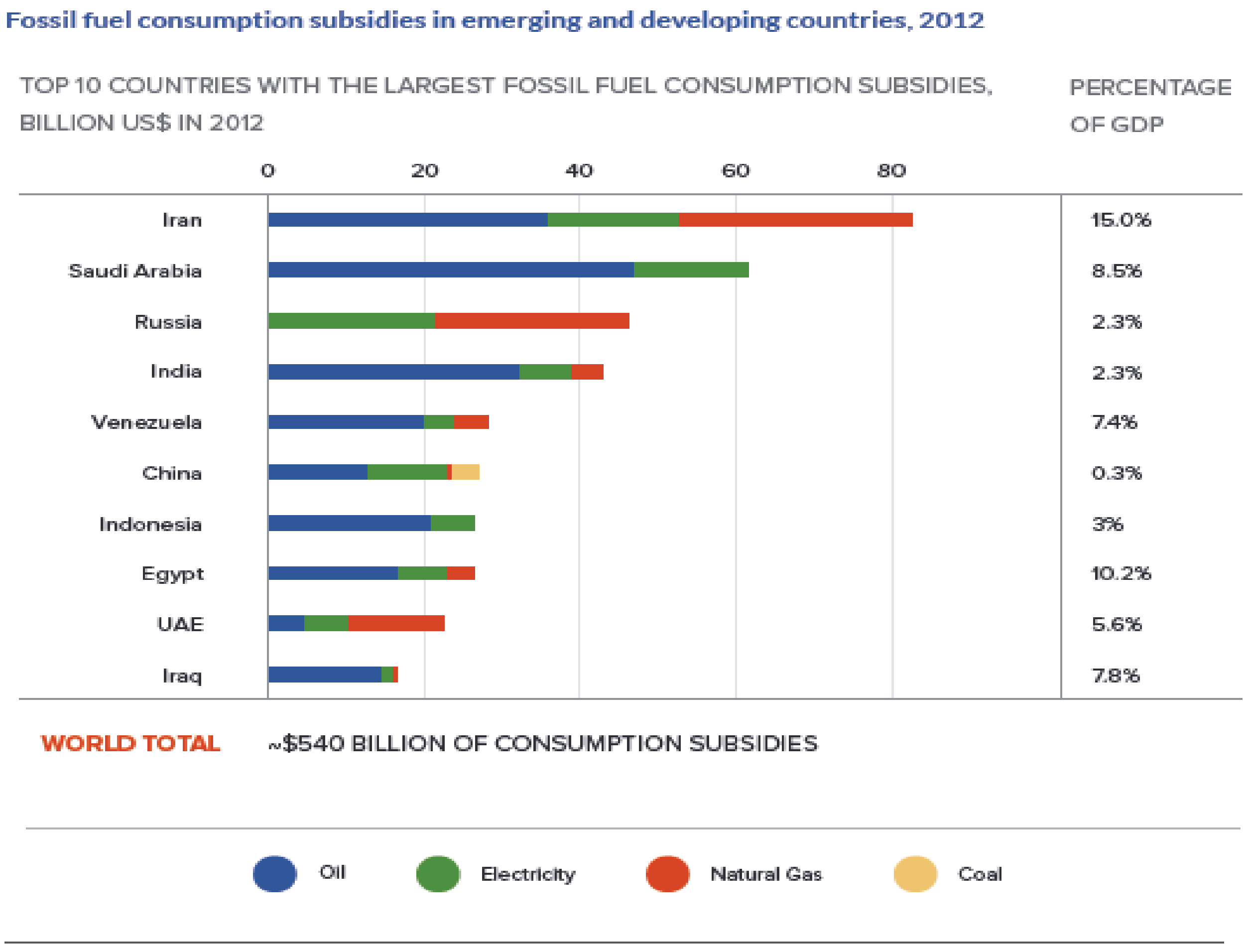
Environmental priorities for most developing countries

- Air quality improvements from reduction in conventional pollutants
- Drinking water safety
- Natural resource protection (soil retention, reduced deforestation, coastal protection)
- Surface water quality
- Hazardous contaminants

Several policies can reduce help reduce GHG emissions at relatively low cost, risk

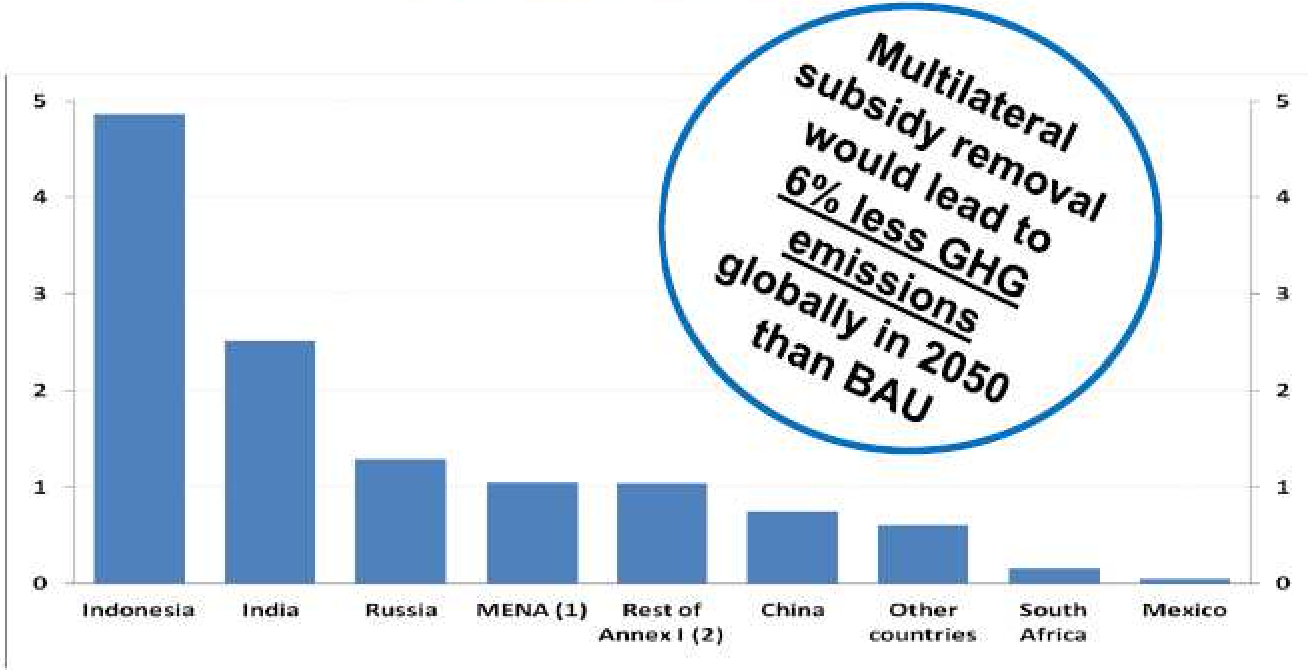
- The “paradox of energy efficiency” and role of regulatory performance standards
- Land use policies
  - Forest protection and reforestation
  - Urban development patterns
- Reform of trade policies that restrict diffusion of lower-carbon technologies
- Energy subsidy reforms
  - But political economy difficulties with this provide a cautionary lesson

Reform of energy consumption subsidies offers significant win-win opportunities – if political barriers can be overcome



Source: IEA, 2013.[97]

Impacts on GDP in 2050 of unilateral phase-out of fossil fuel consumer subsidies in emerging and developing countries (% deviation from baseline)



(1) Middle East & Northern Africa
(2) Other Asian, African and Latin American Emerging economies

Source : OECD (2012), *OECD Environmental Outlook to* 2050; OECD ENV-Linkages Model ; based IEA subsidies data for the year 2009

International cooperation for global GHG mitigation

International cooperation for global GHG mitigation

- Idealized theory: internationally coordinated carbon price with financial transfers to handle burden sharing. Unrealistic.
- Criteria for evaluating agreements:
  - Environmental effectiveness
  - Aggregate economic performance impacts
  - Distributional and social impacts
  - Institutional feasibility (participation, compliance)

International free riding problem

- When cooperation has the most value, shirking incentives also are high
  - Even though relatively few countries account for most emissions, there is still concern on their part for behavior of non-cooperators
  - Broader participation only with modest objectives and thus lower environmental effectiveness
  - Exception would be clearly demonstrated threat of major catastrophe
  - International organizations have limited leverage

Search for some commonly held view of equitable burden sharing is in vain

Equity principle	*Interpretation*	*Implied burden-sharing rule*
Egalitarian	People have equal rights to use atmospheric resources.	Reduce emissions in proportion to population or equal per capita emission.
Ability to pay	Equalize abatement costs across nations relative to economic circumstances.	Net cost proportions are inversely correlated with per capita GDP.
Sovereignty	Current rate of emissions constitutes a status quo right now.	Reduce emissions proportionally across all countries to maintain relative emission levels between them ("grandfathering").
Maxi-min	Maximize the net benefit to the poorest nations.	Distribute the majority of abatement costs to wealthier nations.
Horizontal	Similar economic circumstances have similar emission rights and burden sharing responsibilities.	Equalize net welfare change across countries so that net cost of abatement as a proportion of GDP is the same for each country.
Vertical	The greater the ability to pay, the greater the economic burden.	Set each country's emissions reduction so that net cost of abatement grows relative to GDP.
Compensation (Pareto rule)	"Winners" should compensate "losers" so that both are better off.	Share abatement costs so that no nation suffers a net loss of welfare.
Market justice	Make greater use of markets.	Create tradable permits to achieve lowest net world cost for emissions abatement.
Consensus	Seek a political solution that promotes stability.	Distribute abatement costs (power weighted) so the majority of nations are satisfied.
Sovereign bargaining	Principles of fairness emerge endogenously as a result of multistage negotiations.	Distribute abatement costs according to equity principles that result from international bargaining and negotiation over time.
Polluter pays	Allocate abatement burden corresponding to emissions (may include historical emissions).	Share abatement costs across countries in proportion to emission levels.
Kantian allocation rule	Each country chooses an abatement level at least as large as the uniform abatement level it would like all countries to undertake.	Differentiate by country's preferred world abatement, possibly in tiers or groups.

Changing focus of international negotiations for GHG mitigation

- Current emphasis is on a kind of “pledge and review” strategy for national targets, actions
  - Intent is to expand participation beyond Annex B countries (Kyoto commitments)
  - Includes hope that countries will agree to do more, if others also will act accordingly
- Includes many possibilities for sectoral policies, technology-based norms, emphasis on benefits from modernization
  - Near-term effects on global emissions likely modest

Focus on sector-specific and technology-based agreements may mitigate political economy of negotiating national targets

- Many developing countries need to improve their energy and transport systems anyway
  - Focus in financing on trade in new capital goods, expanded use of affordable lower-C options
- Can deal separately with different GHGs
  - Agriculture, land use
  - Montreal Protocol gases

Adjusting international agreements over time

- Sector-based approaches not cost-effective, but do not preclude shift toward economy-wide instruments
- Countries could graduate into higher performance standards as they grow
  - But how this would be done is as contentious as debates over current national emission commitments
- International cooperation to lower the cost and reduce barriers to diffusion of low-carbon technology is a must

Cannot lose track of need for improving adaptation

- Many pre-existing distortions limit resilience
  - Inefficient water use
  - Poor land use/hazard reduction policies (for people and structures)
  - Weaknesses in land tenure that reduce incentives for conservation
  - Agricultural market distortions
  - Inadequate investment in information provision
- International institutions need to improve performance of adaptation programs

Thank you – I look forward to comments and questions.

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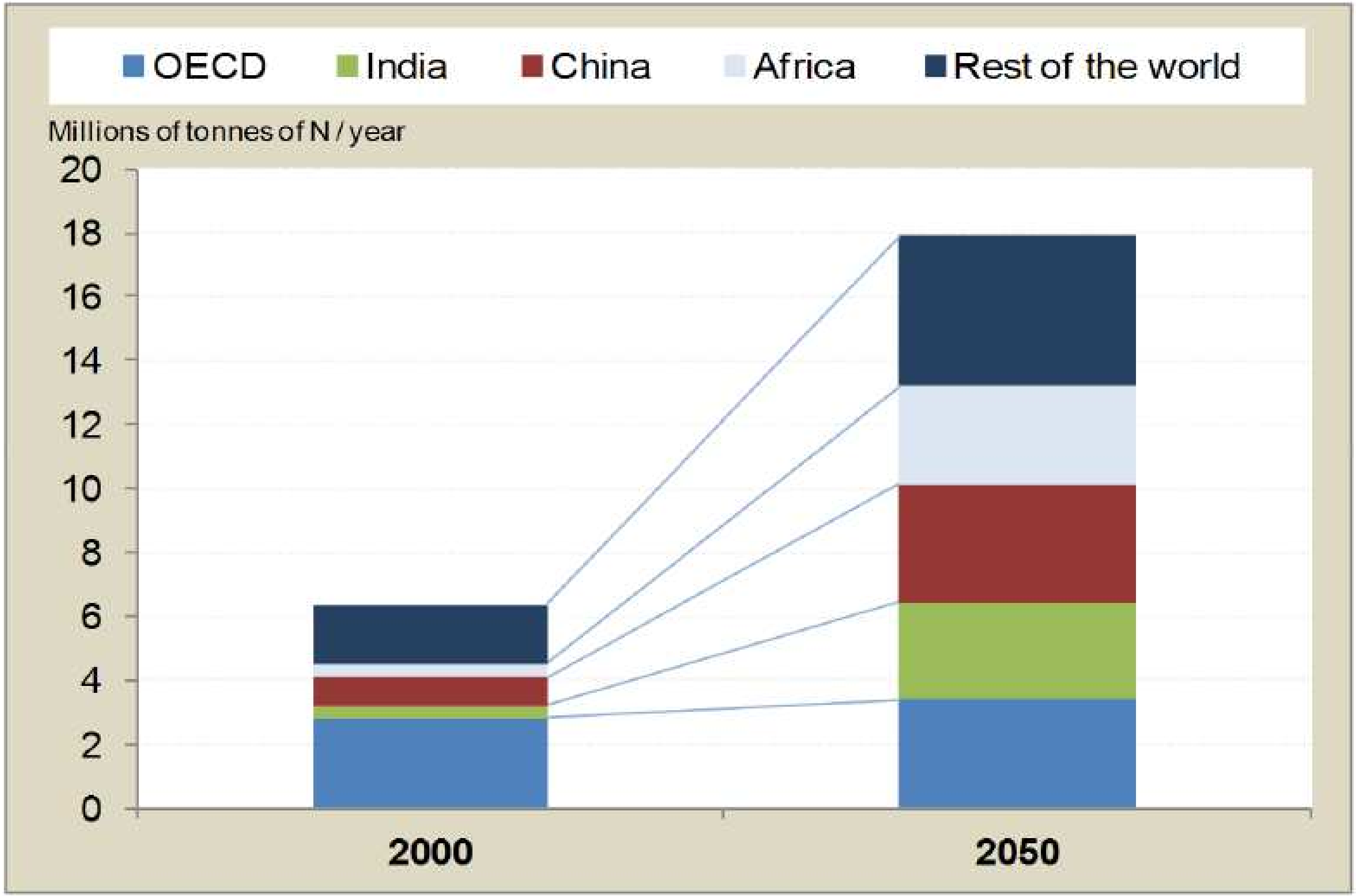
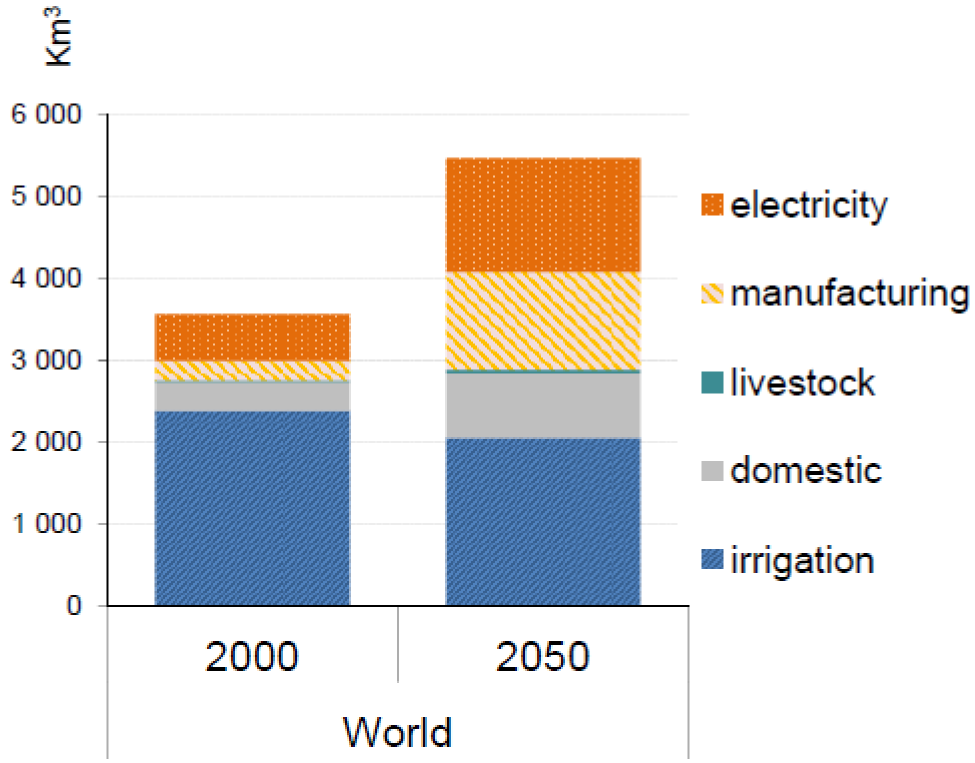
Nitrogen effluents from wastewater: baseline



Global water demand: Baseline scenario



Rapidly growing water demand from cities, industry and energy suppliers will challenge water for irrigation to 2050.

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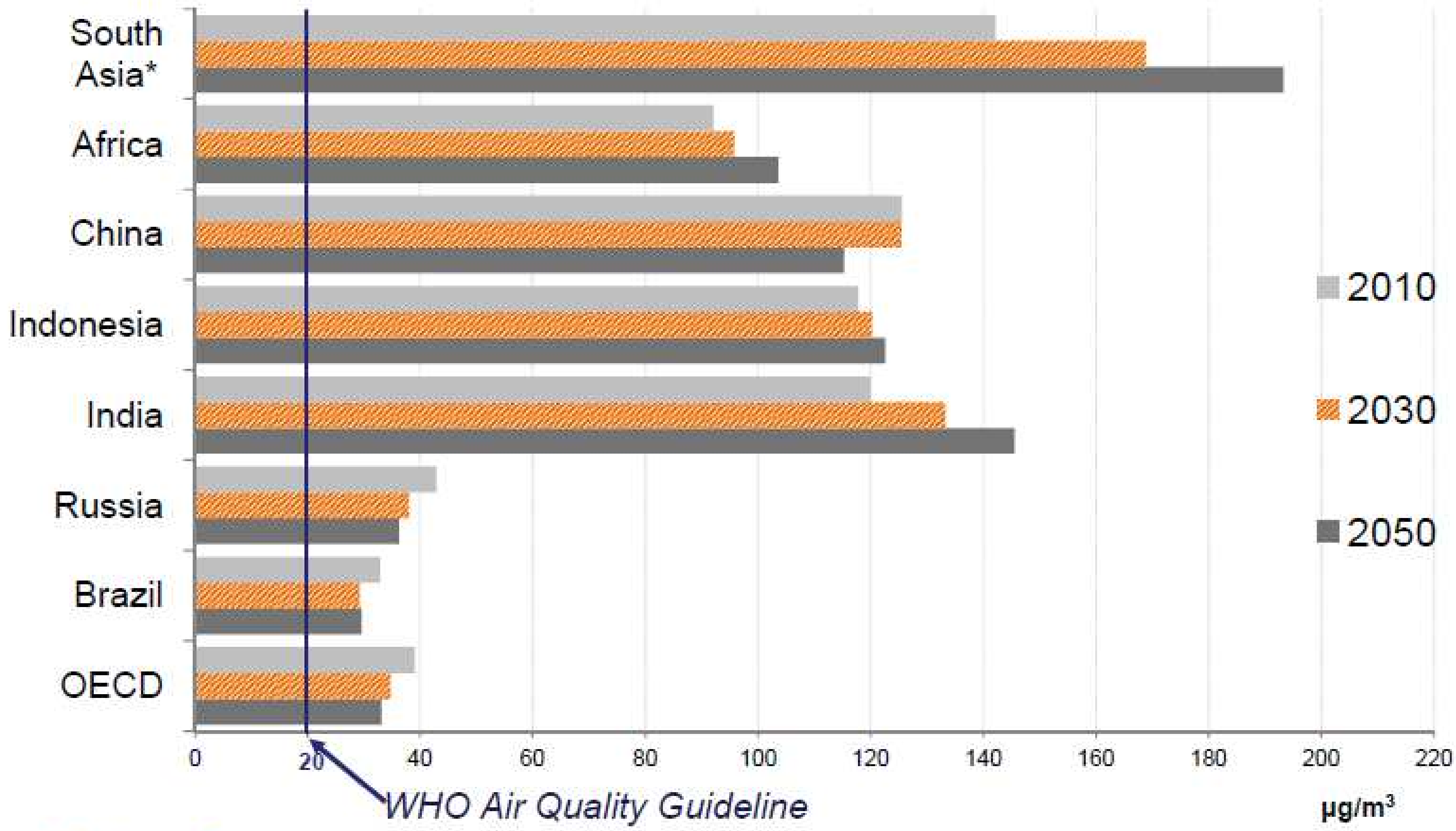
Source: (OECD, 2012), OECD Environmental Outlook Baseline; output from IMAGE

PM10 concentration in major cities: Baseline, 2010-2050



** The region South Asia excludes India*

Source: (OECD, 2012), OECD Environmental Outlook to 2050; output from IMAGE

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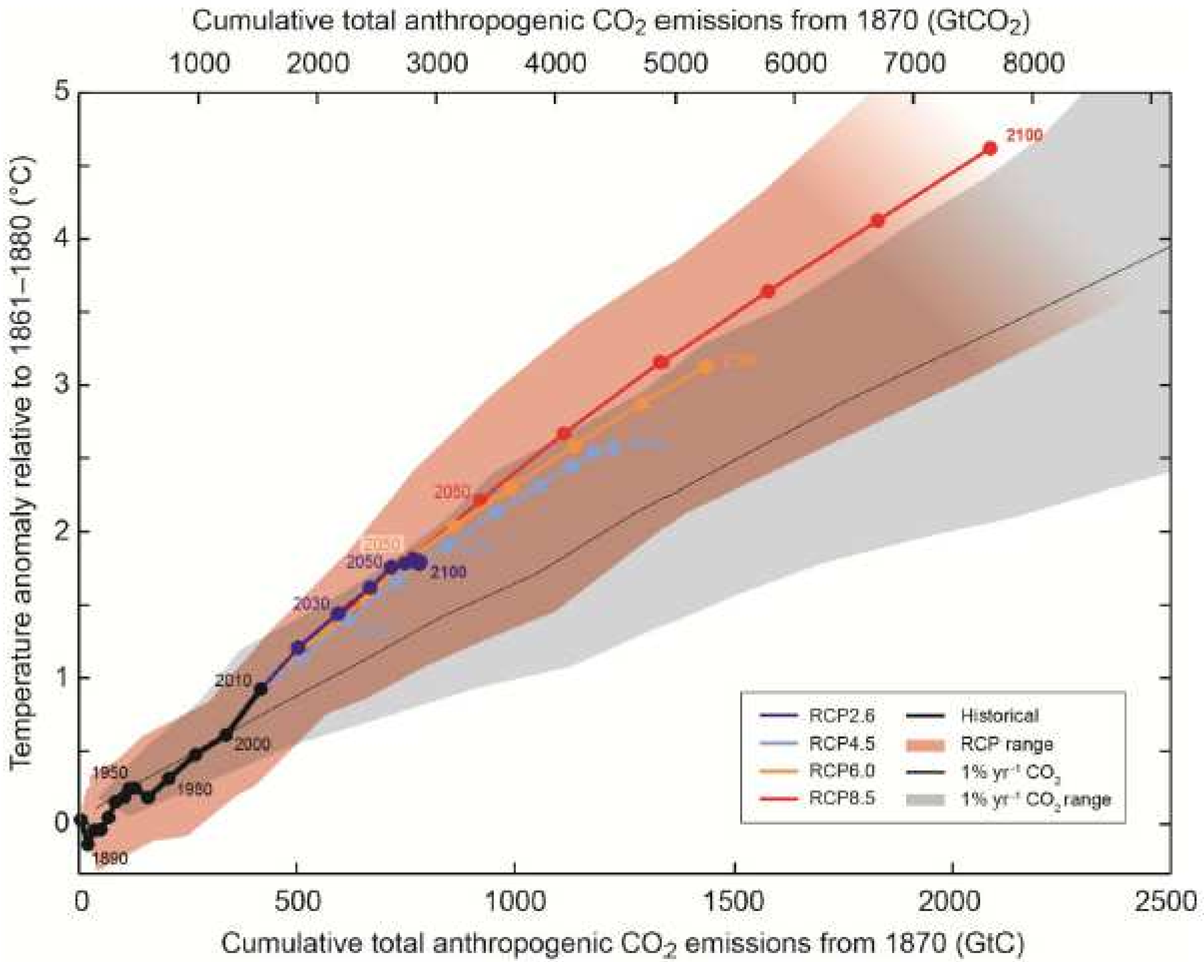
Cumulative carbon determines warming

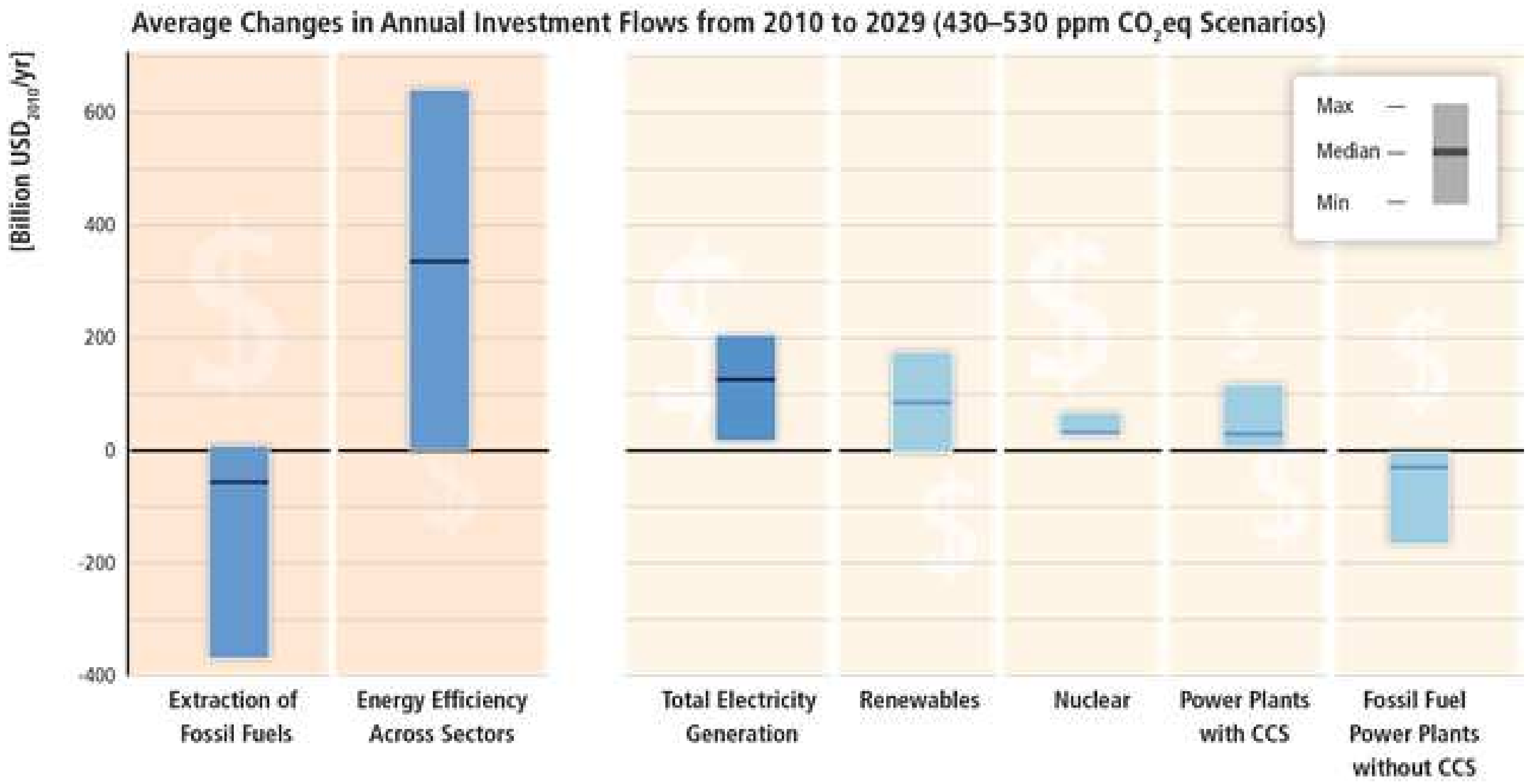


SPM.10

IPCC AR5 Working Group I
Climate Change 2013: The Physical Science Basis

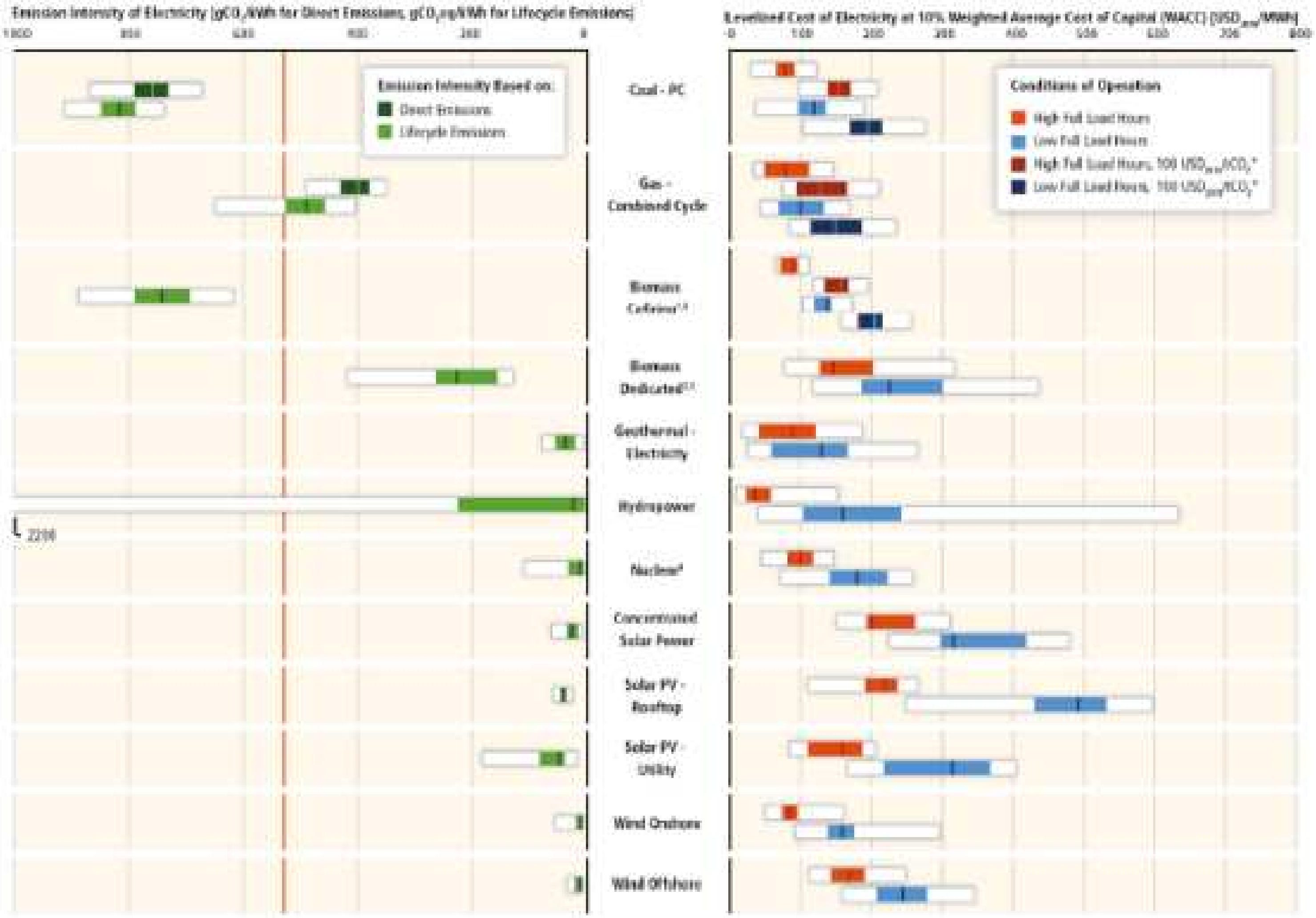
INTERGOVERNMENTAL PANEL ON climate change

Substantial reductions in emissions would require large changes in investment patterns and appropriate policies.

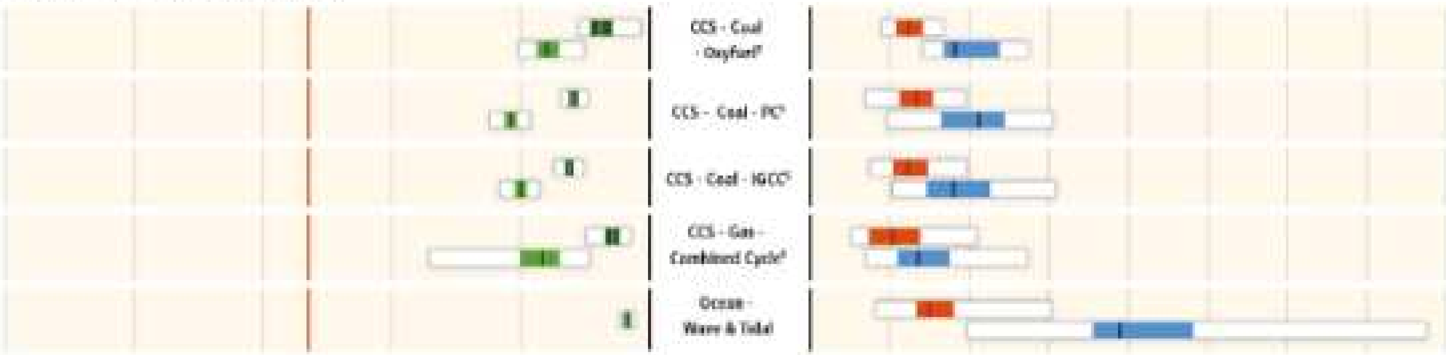


Based on Figure 16.3

Currently Commercially Available Technologies



Pre-commercial Technologies



So how much mitigation is "optimal?"

- Standard growth-theoretic "integrated assessment models" tend to show only some slowing of emissions growth is justified. BUT:
  - Risk aversion raises value of mitigation
  - So does (endogenous) probability of catastrophic shock
  - Economically efficient discount rate for uncertain long-term climate change may be very low – also raises value of LR mitigation
  - Intergenerational tradeoffs are more than discounting

So how much mitigation is "optimal?"

- Nonetheless, "as much as possible" is not an efficient mitigation policy either; need to consider pros and cons of different mitigation ramp-up strategies
- Do the prospective benefits justify the costs?
  - Impossible to fully answer quantitatively, but can make informed comparisons to costs and impacts of other risk mitigation expenditures
  - Benefits depend strongly on level of international cooperation

Putting a price on carbon is crucial (though more is also needed)

- "Law of one price" for cost-effectiveness
  - Costs are significantly higher – domestically and internationally – when marginal costs of mitigation are not equalized
- Economic instruments motivate cost-reducing innovation in low-carbon technologies
  - Important complement to public investment in new knowledge for lowering mitigation costs