Climate Change and Energy Choices

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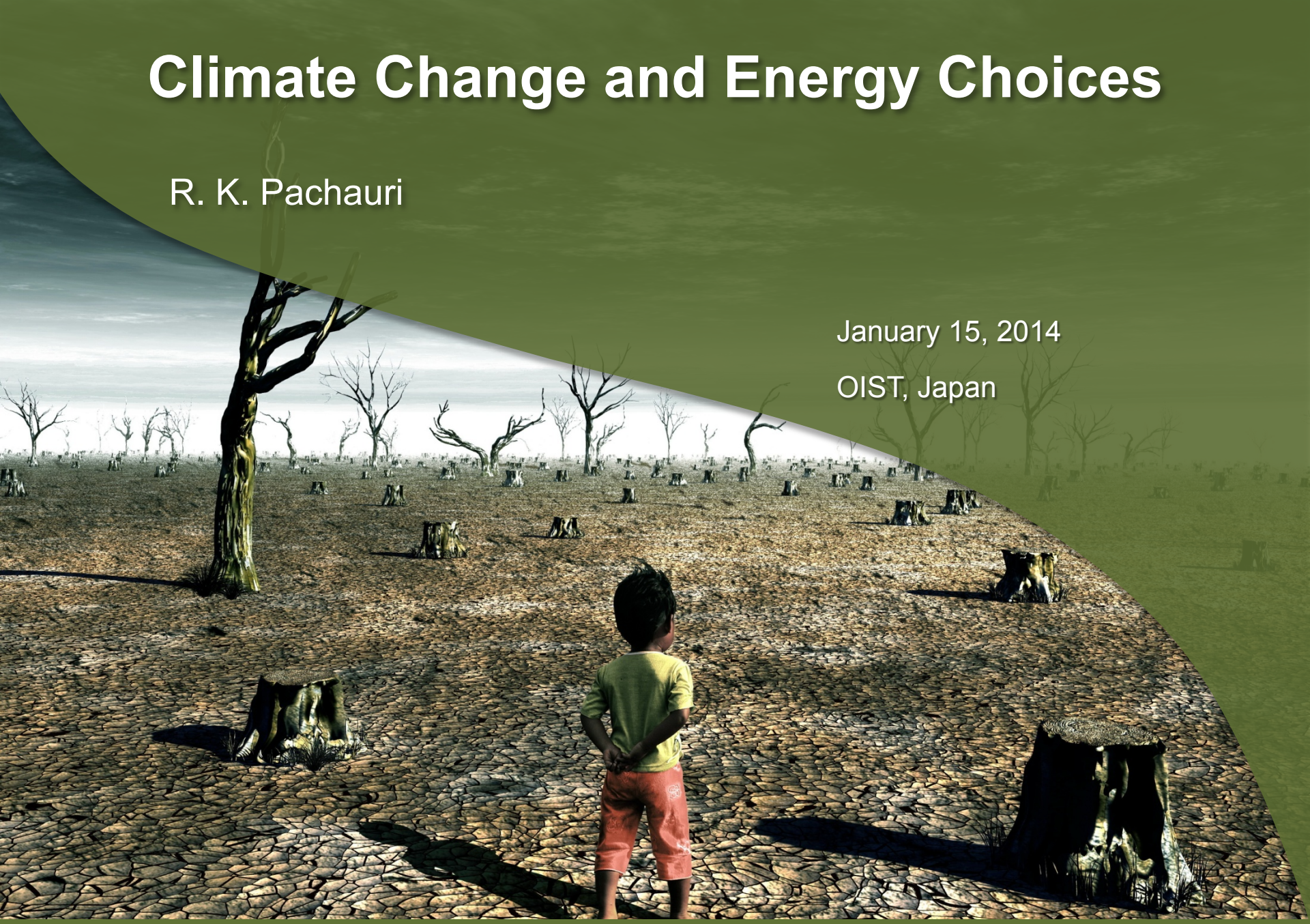
January 15, 2014

OIST, Japan



Director-General, The Energy and Resources Institute

Chairman, Intergovernmental Panel on Climate Change

The tragedy of the commons

"The tragedy of the commons develops in this way. Picture a pasture open to all. It is to be expected that each herdsman will try to keep as many cattle as possible on the commons. Such an arrangement may work reasonably satisfactorily for centuries because tribal wars, poaching, and disease keep the numbers of both man and beast well below the carrying capacity of the land. Finally, however, comes the day of reckoning, that is, the day when the long-desired goal of social stability becomes a reality. At this point, the inherent logic of the commons remorselessly generates tragedy."

- Garrett Hardin

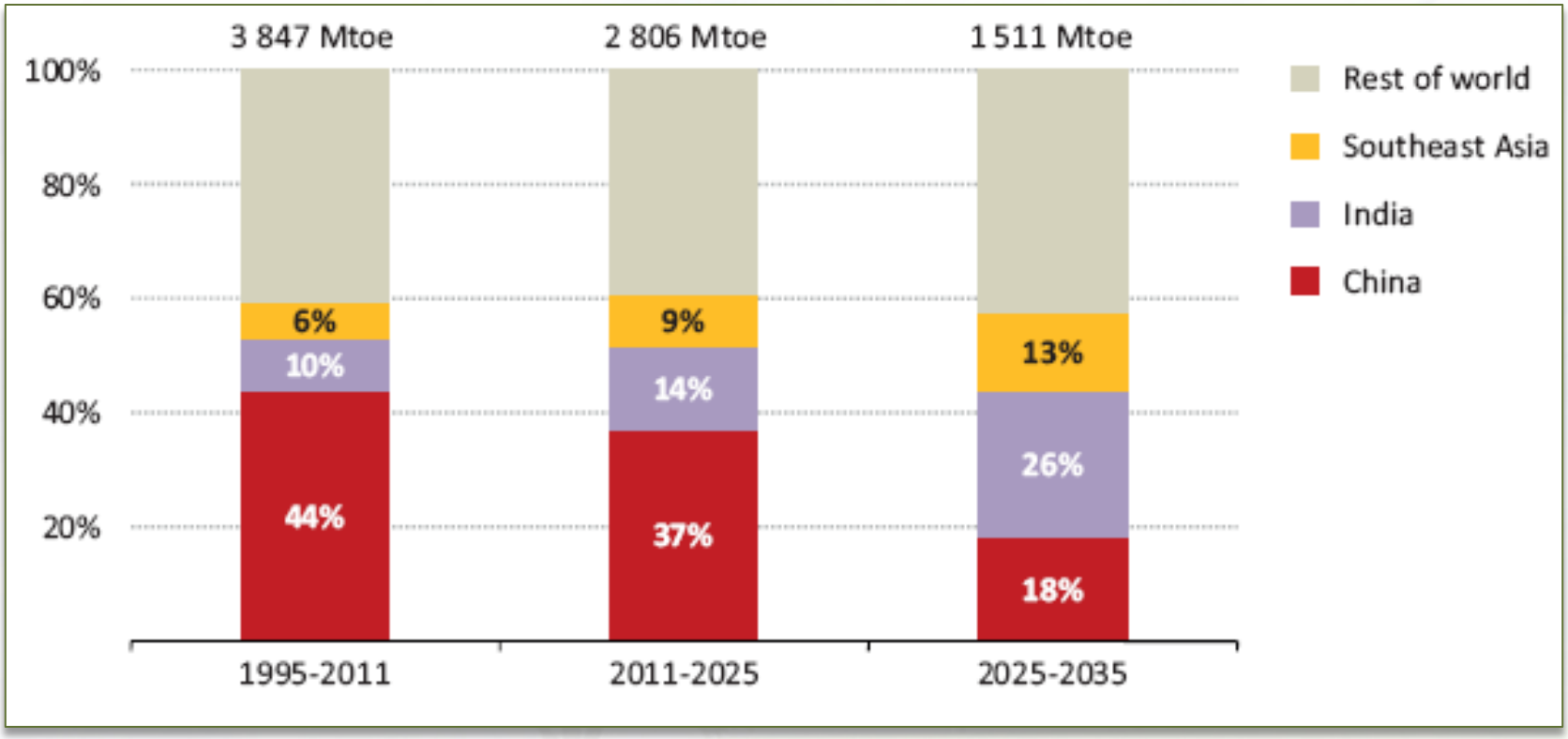
Human development, sustainability and equity

It would be a gross violation of the universalist principle, if we were to be obsessed about **inter**generational equity without at the same time seizing the problem of **intra**generational equity"

- Sudhir Anand & Amartya Sen

Source: Human Development Report 2011, UNDP

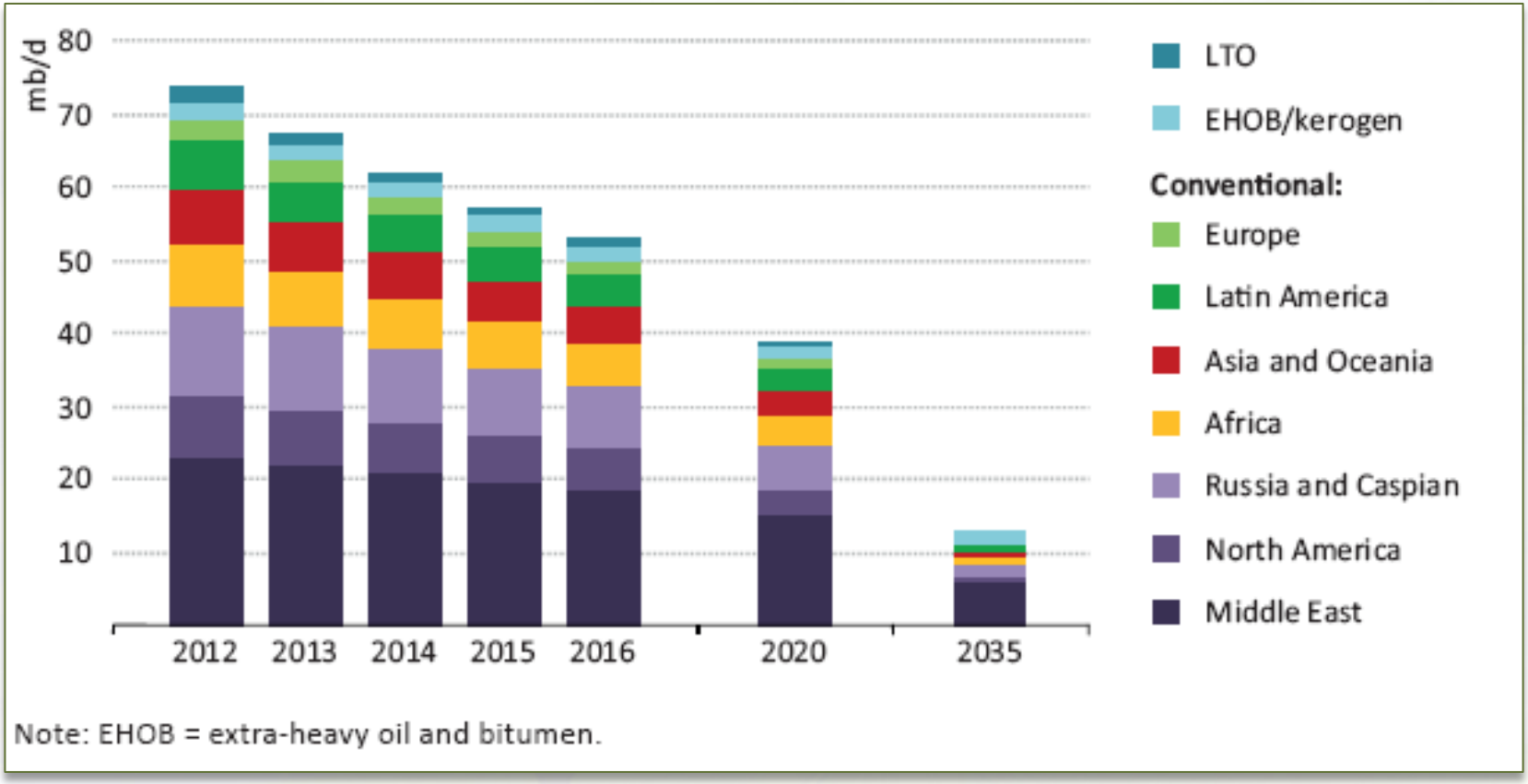
Share of the growth in world primary energy demand by region in the New Policies Scenario



Source : WEO 2013

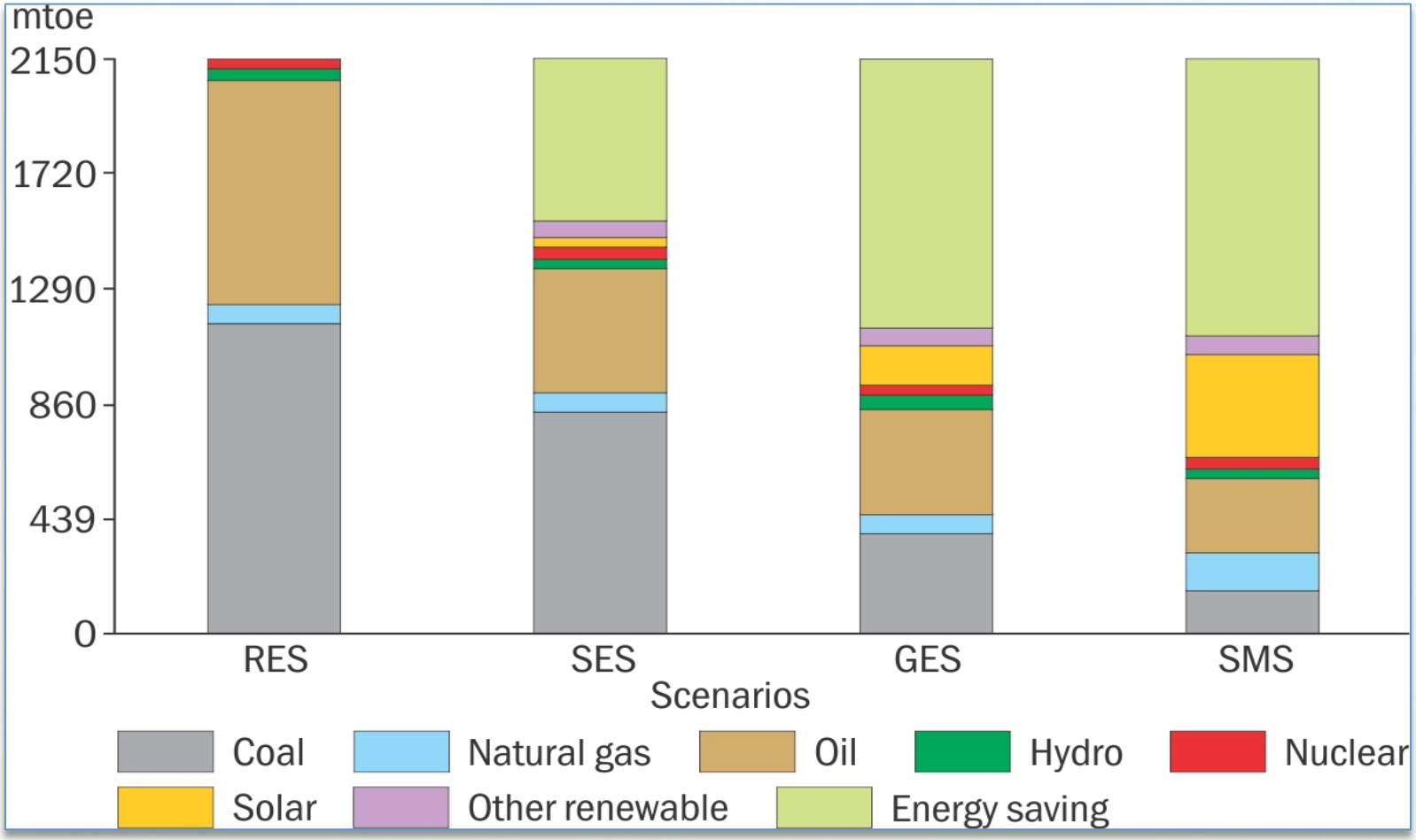
Production that would be observed from all currently producing fields in the absence of further investment

(excluding NGLs)



Source : WEO 2013

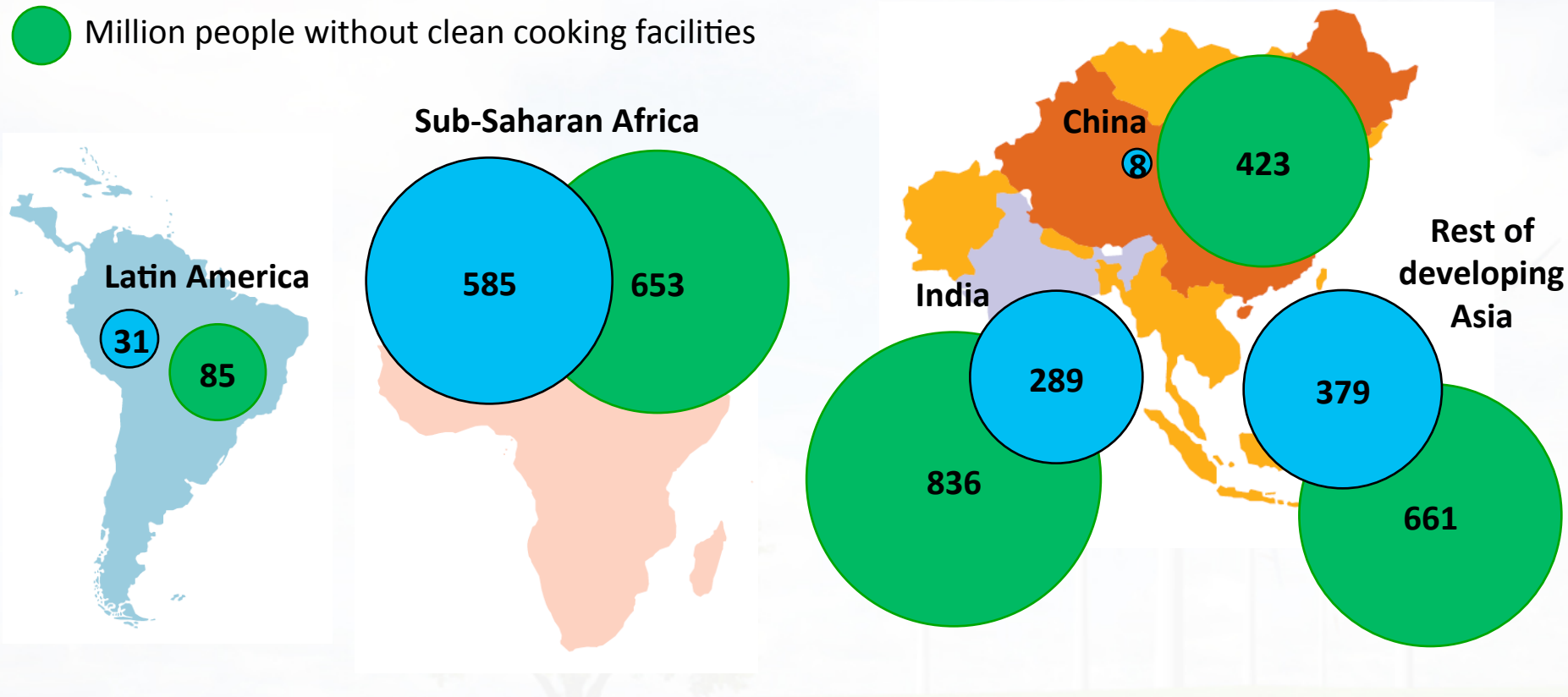
Distribution of primary commercial energy supply – 2031
India



Energy poverty is widespread

Million people without electricity

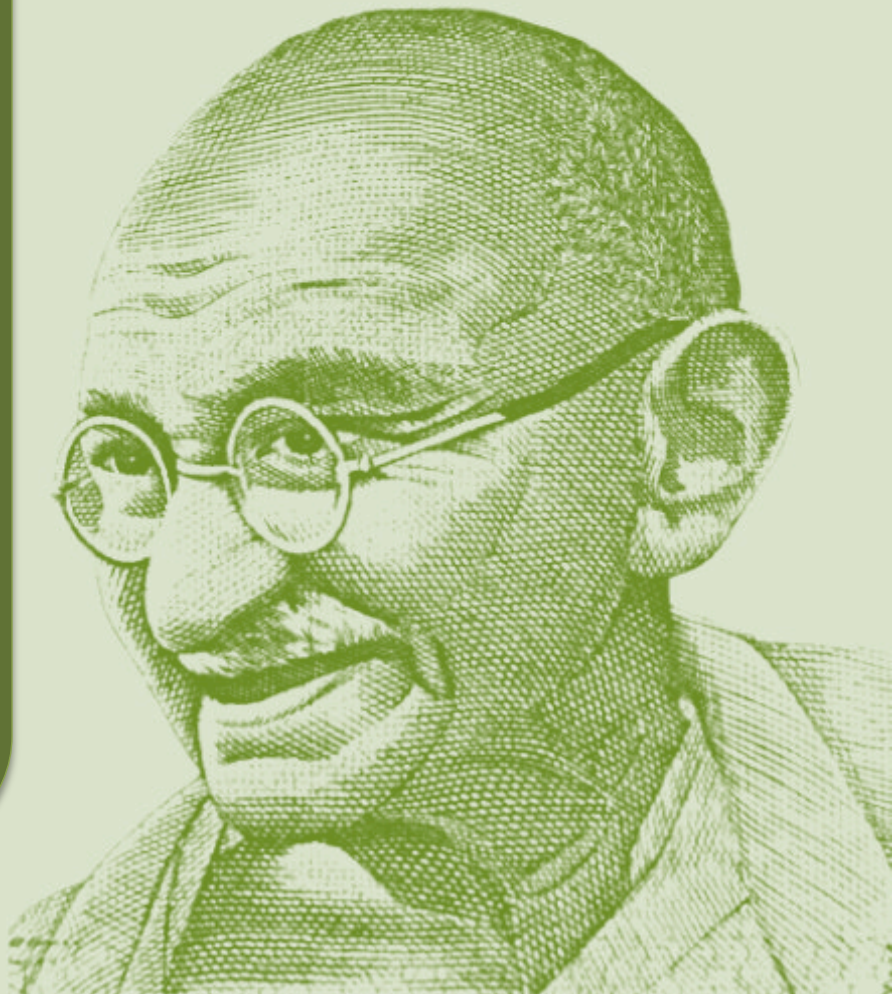
Million people without clean cooking facilities



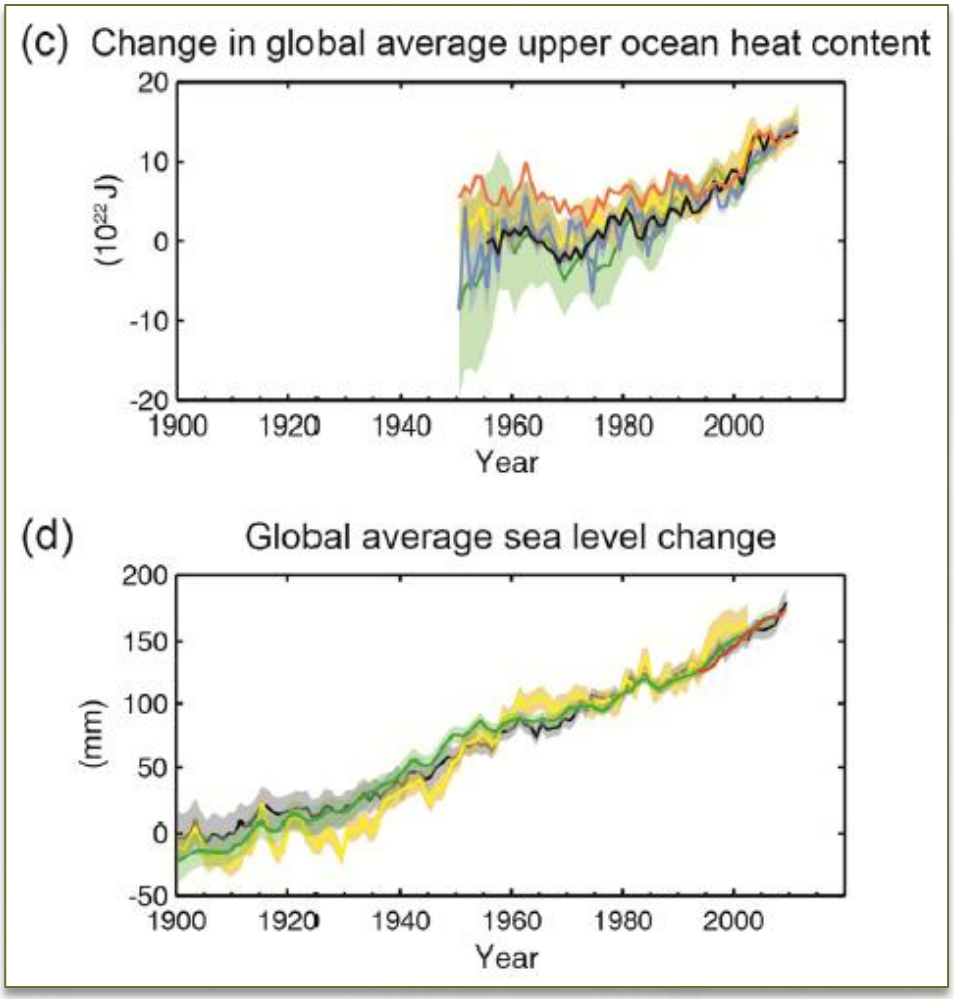
1.3 billion people in the world live without electricity & 2.7 billion live without clean cooking facilities

Source : World Energy Outlook 2011

Mahatma Gandhi was once asked if he expected India to attain the same standard of living as Britain. He replied: "It took Britain half the resources of the planet to achieve this prosperity. How many planets will a country like India require?!"



Observed changes in the climate system

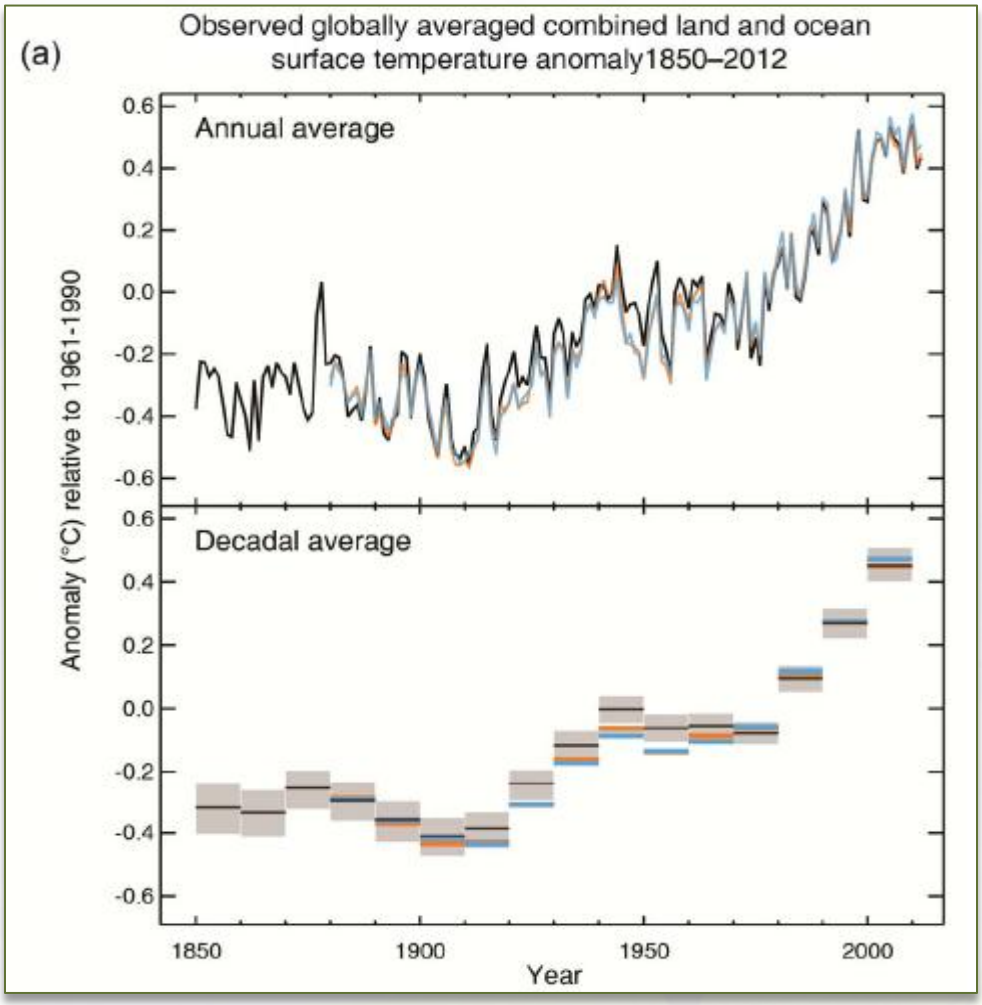


- It is virtually certain that the upper ocean (0-700m) warmed from 1971 to 2010.
- The rate of sea level rise since the mid-19th century has been larger than the mean rate during the previous two millennia.
- Over the period 1901-2010, global mean sea level rose by 19 cm.

Ocean warming dominates the increase in energy stored in the climate system, accounting for more than 90% of the energy accumulated between 1971 and 2010.

Source : IPCC AR5

Warming of the climate is unequivocal



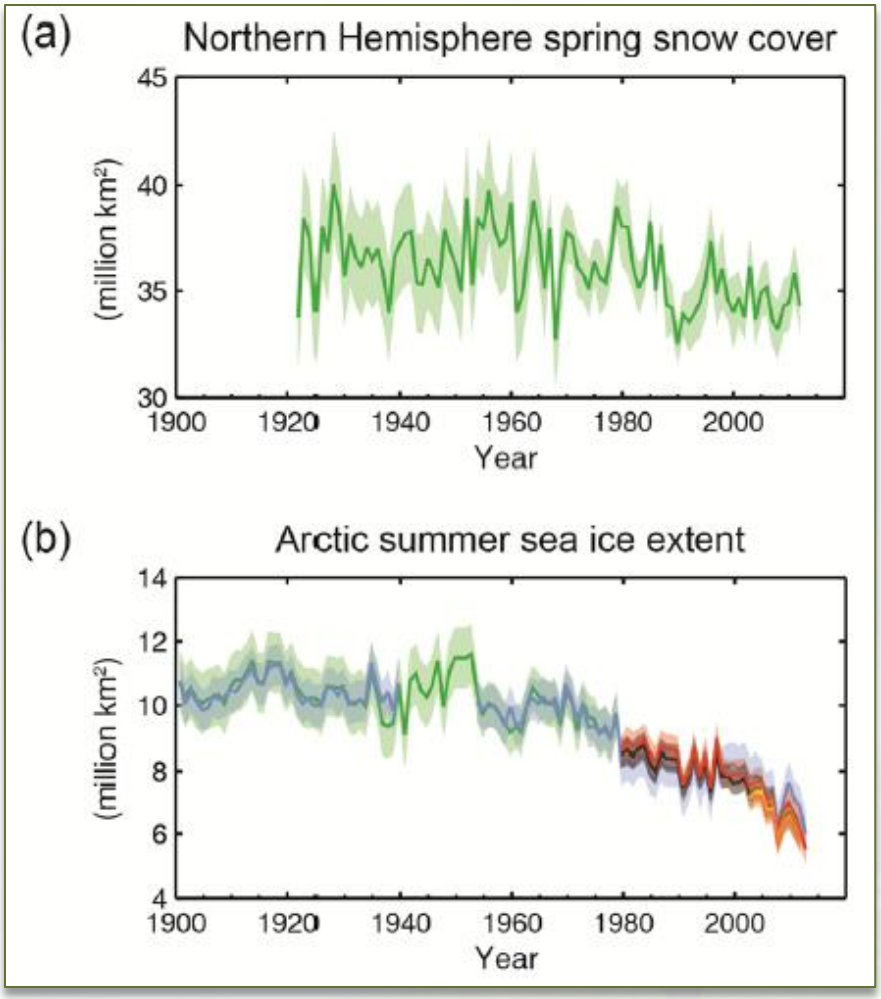
Since the 1950s many of the observed changes are unprecedented over decades to millennia:

- The atmosphere and the oceans have warmed
- The amounts of snow and ice have diminished
- Sea level has risen
- The concentrations of GHGs have increased

Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850.

Source : IPCC AR5

Observed changes in the climate system



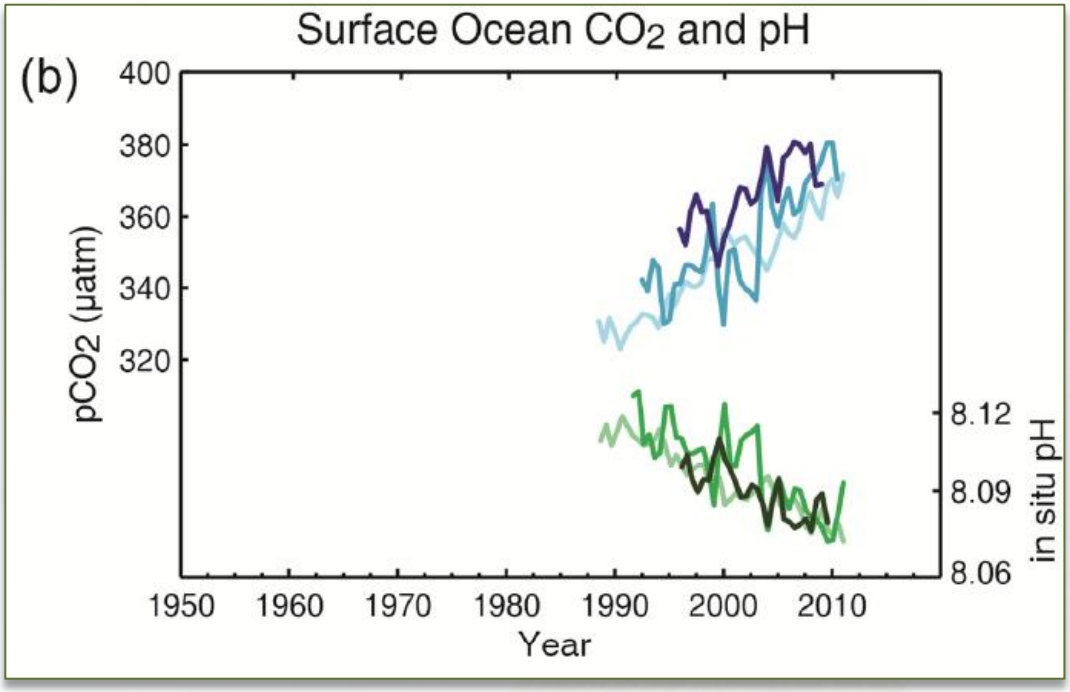
Over the last two decades:

- the Greenland and Antarctic ice sheets have been losing mass
- glaciers have continued to shrink almost worldwide
- Arctic sea ice and Northern Hemisphere spring snow cover have continued to decrease in extent.

Since the early 1970s, glacier mass loss and ocean thermal expansion from warming together explain about 75% of the observed global mean sea level rise.

Source : IPCC AR5

Understanding the causes of change



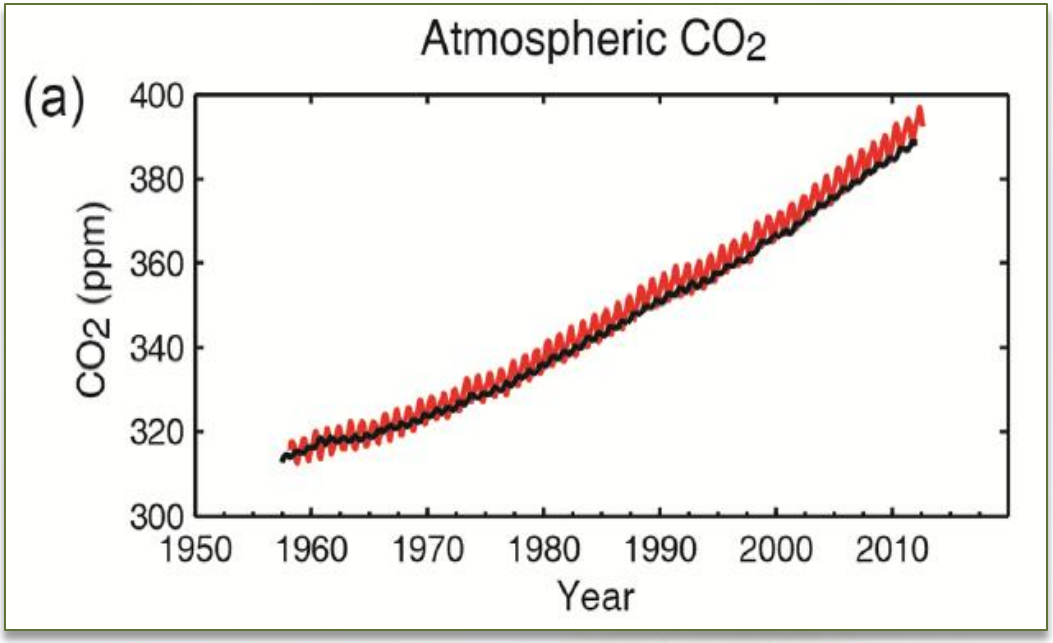
Partial pressure of dissolved CO2 at the ocean surface (blue curves) and in situ pH (green curves), a measure of the acidity of ocean water.

- CO2 concentrations have increased by 40% since preindustrial times from fossil fuel emissions and net land use change emissions.
- The ocean has absorbed about 30% of the emitted anthropogenic carbon dioxide, causing ocean acidification.

The atmospheric concentrations of CO2, methane, and nitrous oxide have increased to levels unprecedented in at least the last 800,000 years.

Source : IPCC AR5

Understanding the causes of change

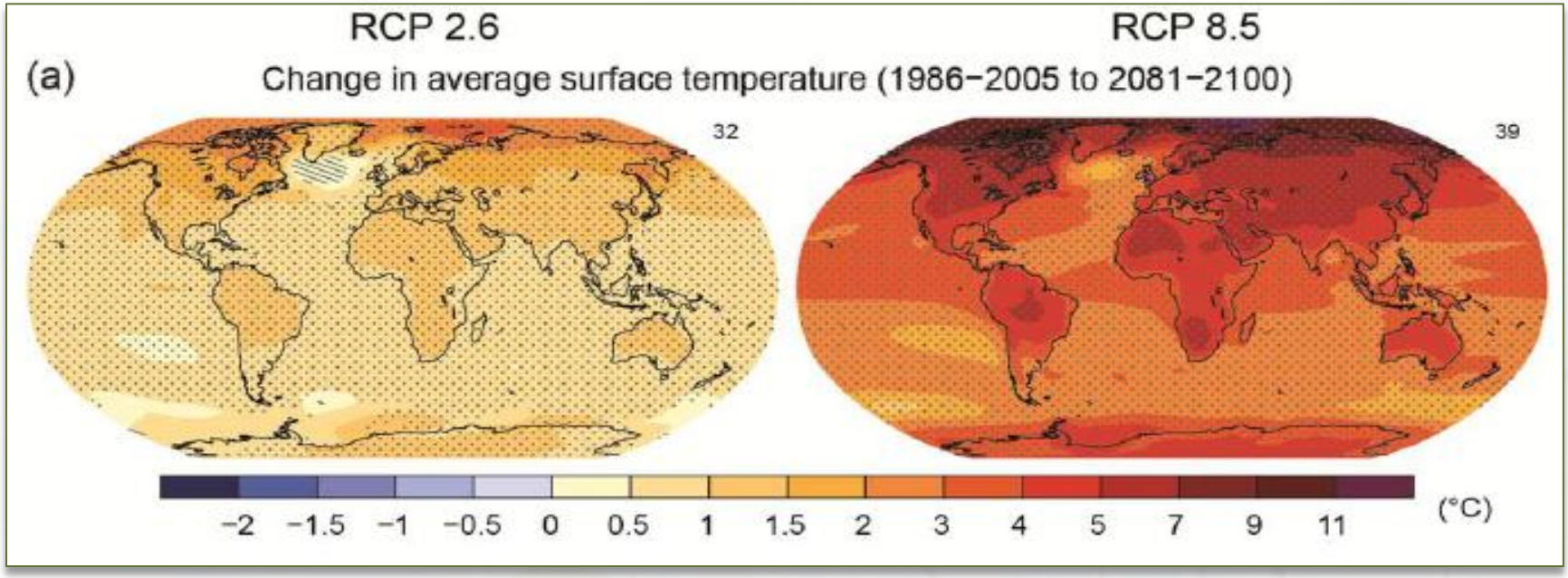


- Human influence on the climate system is clear.
- There is high confidence that changes in total solar irradiance have not contributed to the increase in global mean surface temperature over the period 1986 to 2008.
- Continued emissions of GHGs will cause further warming and changes in the climate system.

It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century.

Source : IPCC AR5

Warming will continue beyond 2100 under all RCP scenarios except RCP2.6.

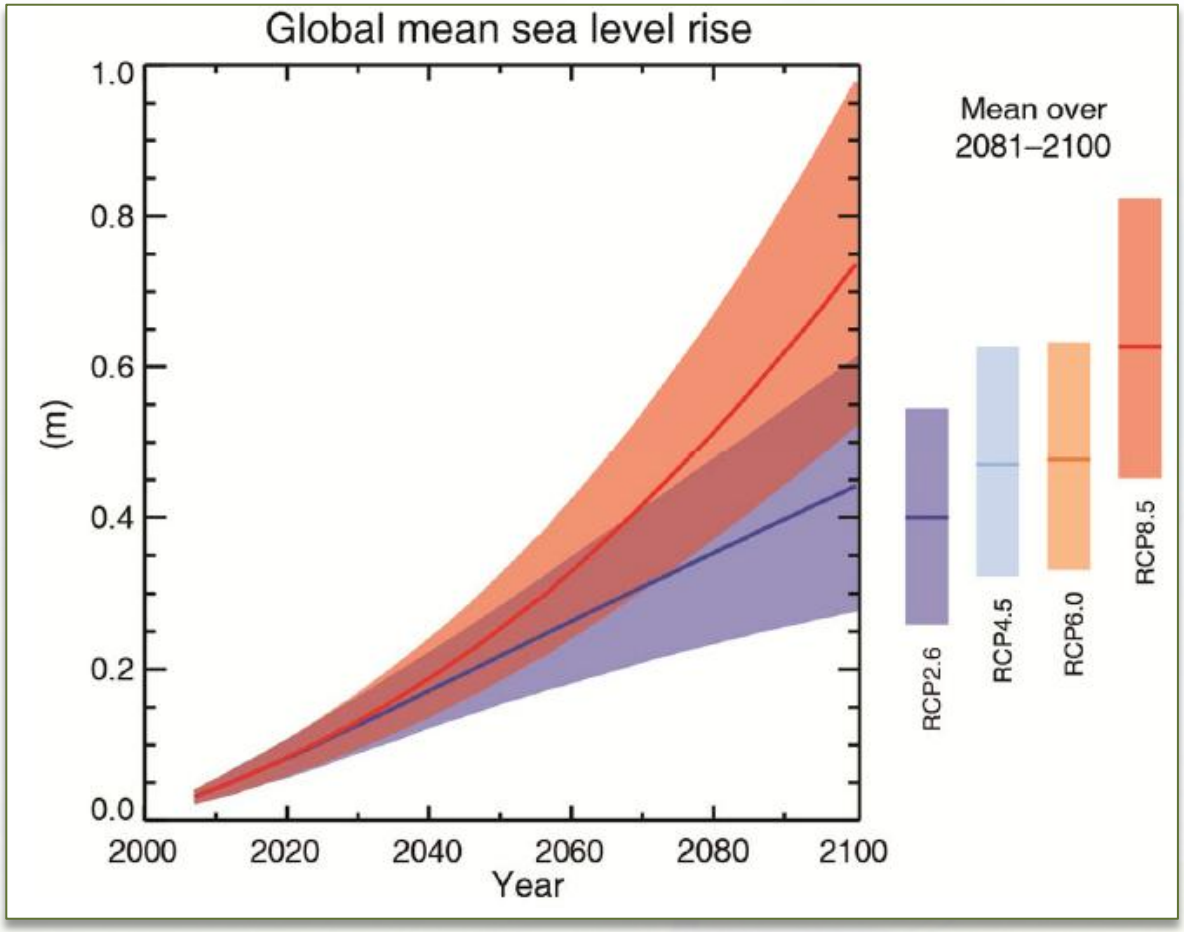


Global surface temperature change for the end of the 21st century:

- Is likely to exceed 1.5°C relative to 1850 to 1900 for all RCP scenarios except RCP2.6.
- Is likely to exceed 2°C for RCP6.0 and RCP8.5
- Is more likely than not to exceed 2°C for RCP4.5.

Source : IPCC AR5

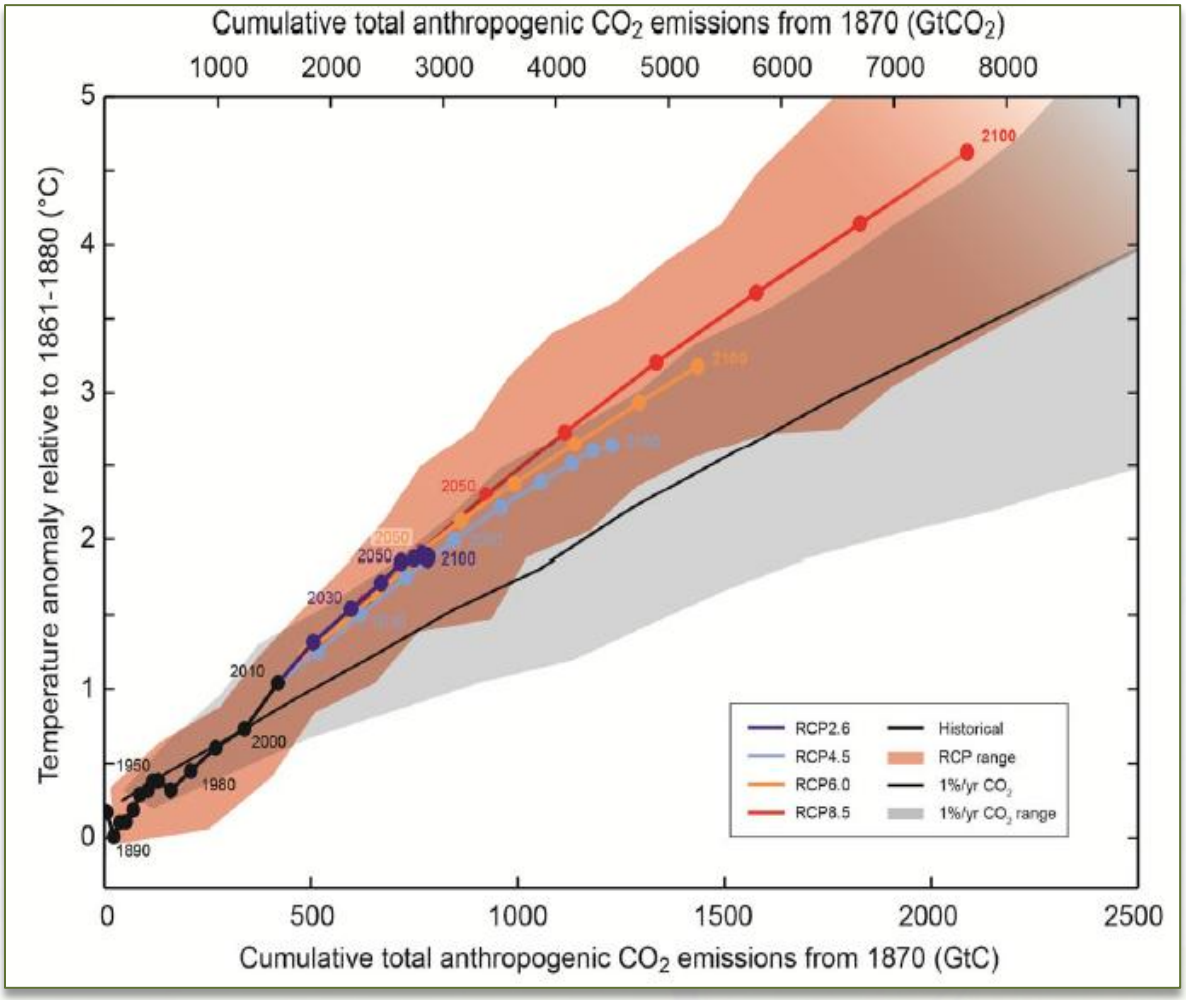
Future changes in the climate system



- The global ocean will continue to warm during the 21st century.
- It is very likely that the Arctic sea ice cover will continue to shrink and thin as global mean surface temperature rises.
- Global glacier volume will further decrease.
- Global mean sea level will continue to rise during the 21st century

Source : IPCC AR5

Future changes in the climate system



Global mean surface temperature increase as a function of cumulative total global CO2 emissions from various lines of evidence

- Climate change will affect carbon cycle processes in a way that will exacerbate the increase in CO2 in the atmosphere.
- Further uptake of carbon by the ocean will increase ocean acidification

Source : IPCC AR5

Extreme events during and by the end of the 21st century

- It is very likely that the length, frequency, and/or intensity of warm spells or heat waves will increase over most land areas
- Under some scenarios, a 1-in-20 year hottest day is likely to become a 1-in-2 year event in most regions
- It is likely that the frequency of heavy precipitation or the proportion of total rainfall from heavy falls will increase over many areas of the globe

Source : IPCC SREX

Projected Impacts On Water Resources

- Countries like Bangladesh, China and India are susceptible to **increasing salinity** of their groundwater and surface water resources, due to increases in sea level
- In India, gross per capita water availability will decline from 1820 m3/yr in 2001 to **1140 m3/yr in 2050**

As a result of rapid melting of glaciers, glacial runoff and frequency of glacial lake outbursts causing mudflows and avalanches have increased.

Source : IPCC

Projected Impacts On Human Health

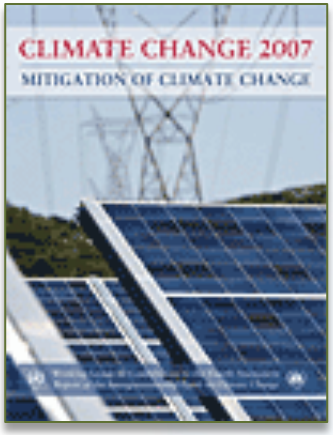
Increases in:

- **Malnutrition,** with **implications for child growth and development**.
- **Deaths, disease and injury** due to heat waves, floods, storms, fires and droughts.
- **Diarrhoeal disease.**
- Frequency of **cardio-respiratory diseases.**

Projected climate change-related exposures are likely to affect the health status of millions of people, particularly those with low adaptive capacity

Source : IPCC

Adaptation and Mitigation

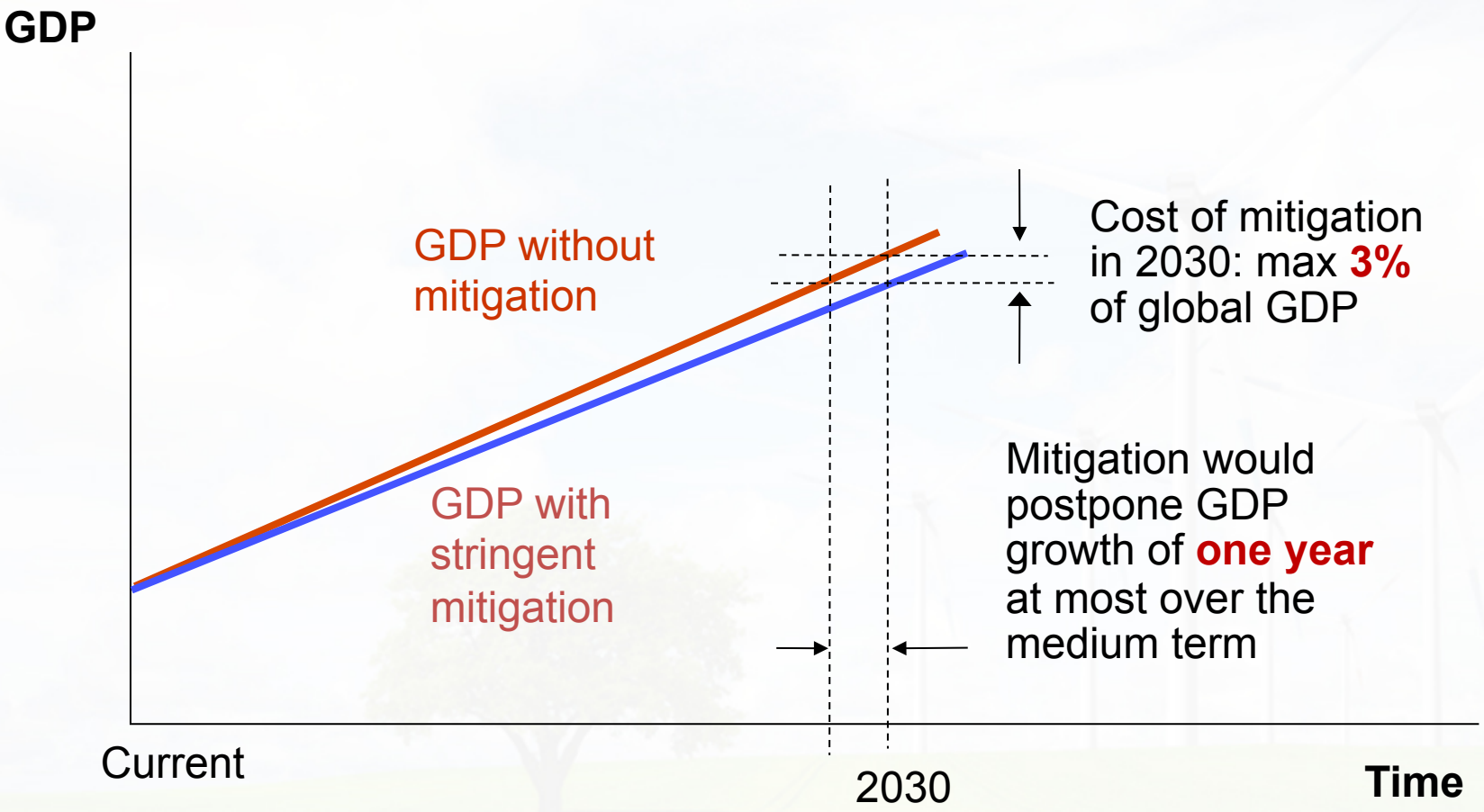


"Neither adaptation nor mitigation alone can avoid all climate change impacts; however, they can complement each other and together can significantly reduce the risks of climate change"

- IPCC Fourth Assessment Report

Source : IPCC AR4

Impacts of mitigation on GDP growth



Source : IPCC AR4

Characteristics of stabilization scenarios

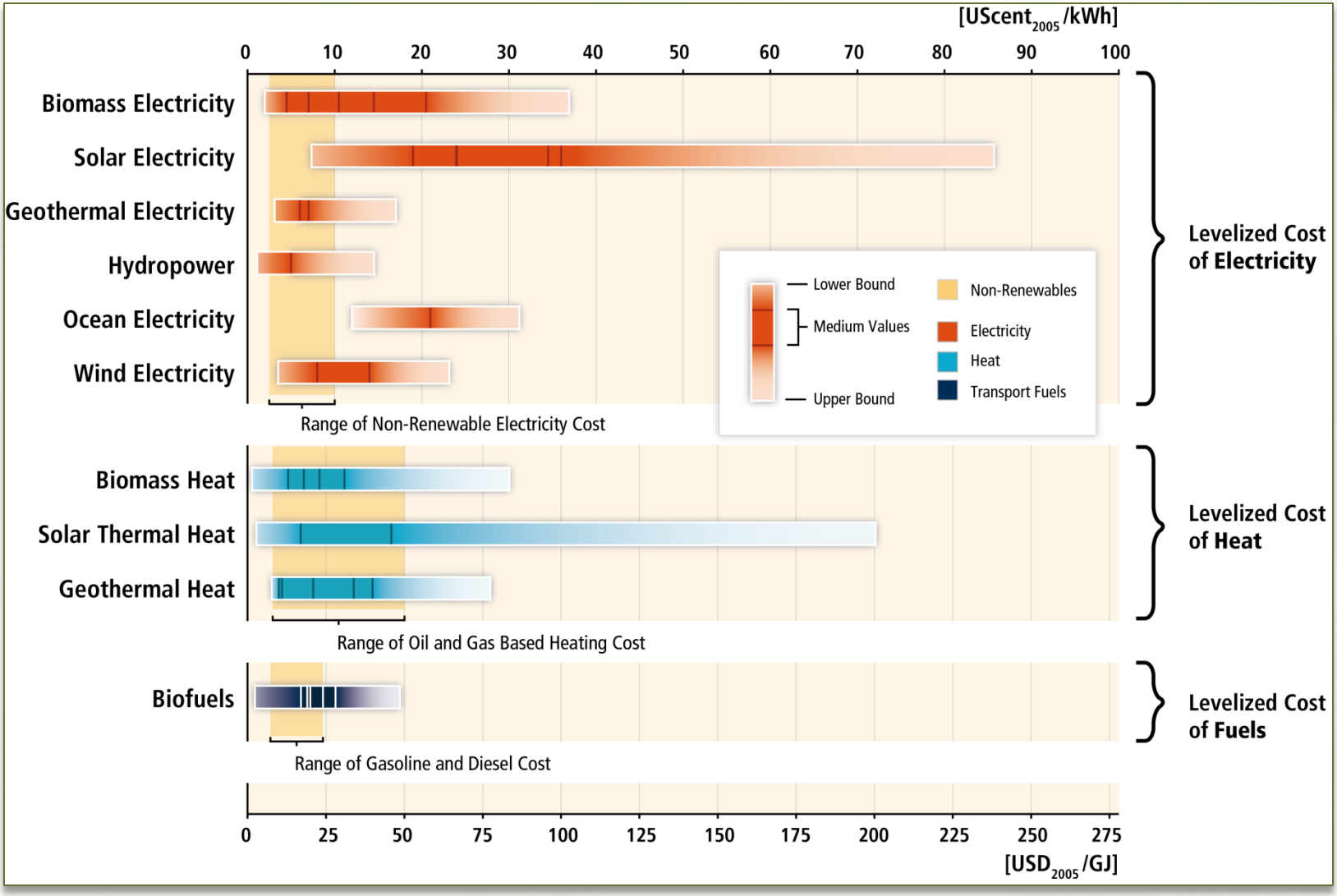
Post-tar stabilization scenarios

Stabilization level (ppm CO2-eq)	Global mean temp. increase (ºC)	**Year CO2 needs to peak**	Global sea level rise above pre- industrial from thermal expansion (m)
445 – 490	2.0 – 2.4	2000-2015	0.4 – 1.4
490 – 535	2.4 – 2.8	2000-2020	0.5 – 1.7
535 – 590	2.8 – 3.2	2010-2030	0.6 – 1.9
590 – 710	3.2 – 4.0	2020-2060	0.6 – 2.4

Delayed emissions reductions significantly constrain the opportunities to achieve lower stabilisation levels and increase the risk of more severe climate change impacts.

Source : IPCC AR4

RE costs are still higher than existing energy prices but in various settings RE is already competitive.



Source : IPCC SRREN

Co-benefits of mitigation

- Common drivers lie behind mitigation policies and policies addressing economic development, poverty, health, employment, energy security, and local environmental protection
- Linking policies provide the opportunity for no-regrets policies reducing greenhouse gases mitigation costs

CO2 mitigation potential for 2010 without net cost in India: between 13 and 23% of business as usual scenario

Source : IPCC

Overcoming barriers

A **significant increase** in the deployment of RE by 2030, 2050 and beyond is indicated **in the majority of the 164 scenarios** reviewed in this SRREN. However:

- A transition to higher shares of RE would imply increasing investments in **technologies and infrastructure**
- **Policies** play a crucial role in accelerating the deployment of RE technologies.
- Policies include regulations, financial incentives, public finance mechanisms and carbon pricing mechanisms.

'Enabling' policies support RE development and deployment

Source : IPCC SRREN

"We may utilize the gifts of Nature just as we choose but in her books, the debits are always equal to the credits."

- Mahatma Gandhi