Measuring the Economic Impacts of Low Carbon Economies: Results from the EPPA model

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April 20, 2012
http://globalchange.mit.edu/

Questions or comments?
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Low Carbon Motivation

Global Warming and Climate Change

Energy Policy Considerations - Reduction in Energy imports

Prospects for Exports of Alternative Energy (Technology)

Air Pollution

Picture: toonpool.com

MIT EPPA Model

Climate change projections

Need: Emission profiles for GHG and air pollutants

Major driver: Energy system

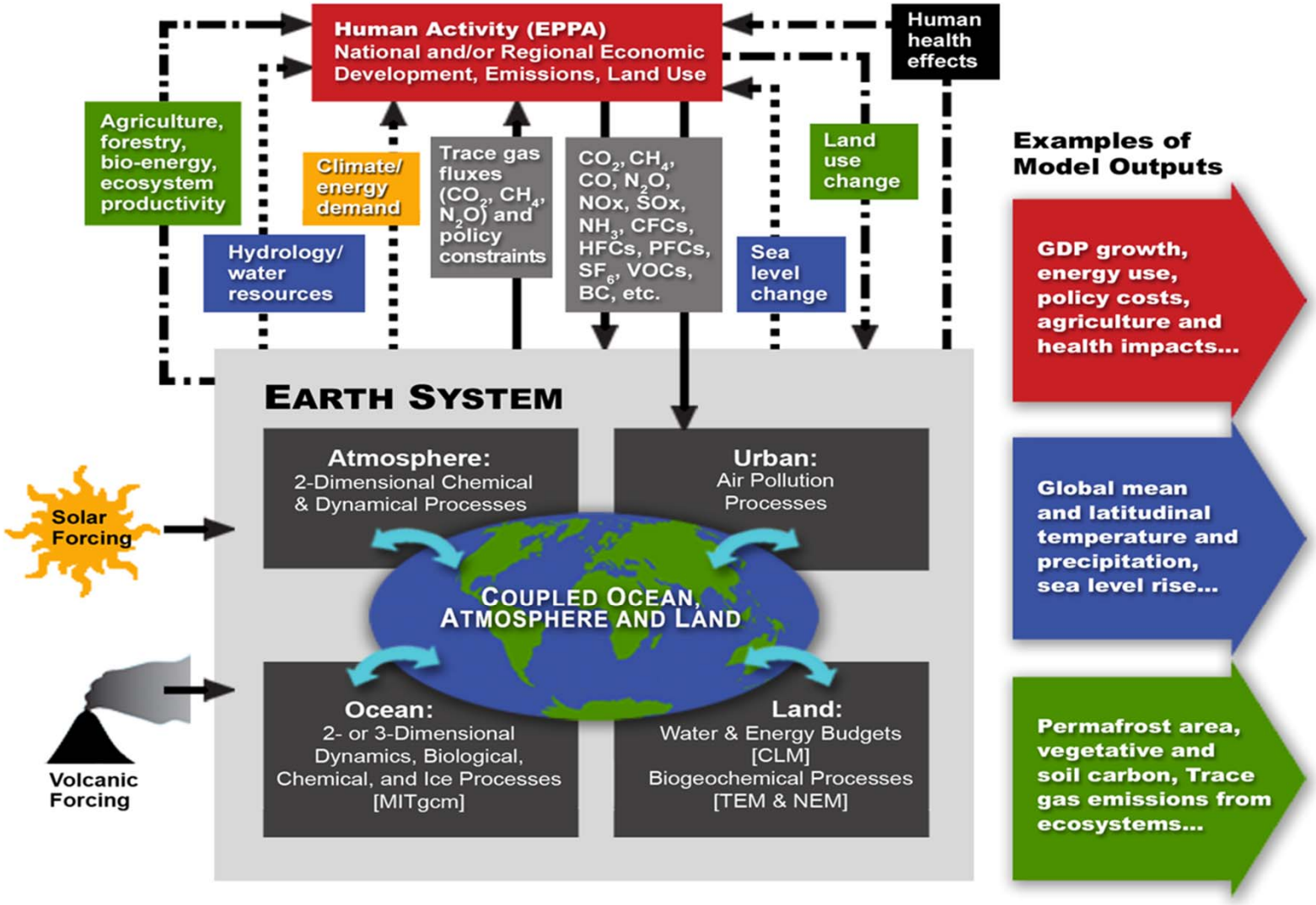
Need model: Energy Use, Alternative Technologies, Economy-wide links, International Trade links

General Equilibrium Model (CGE) with dynamics, fossil fuel resources, land resources, and corresponding physical accounts.

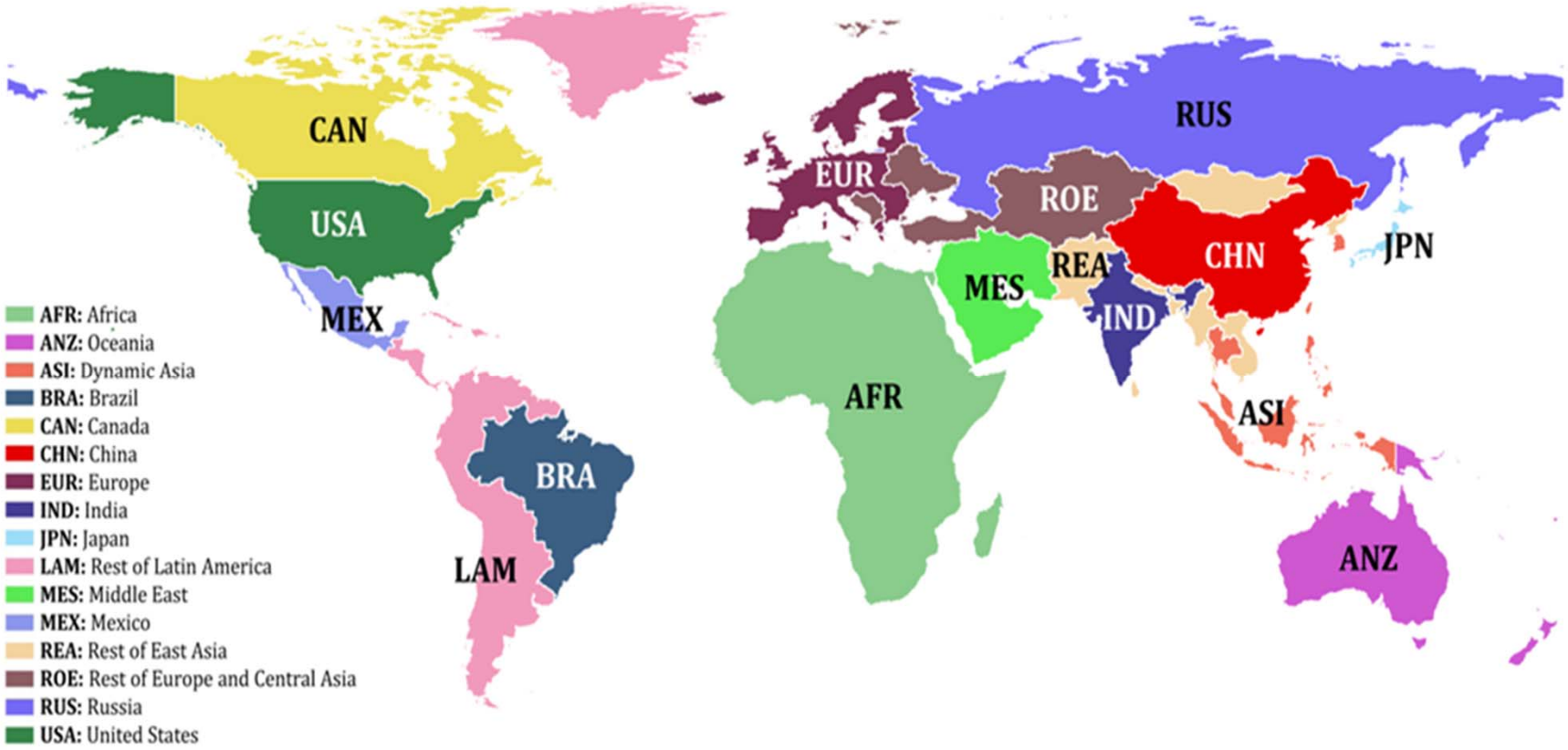
Analysis facilities

- EPPA – Emissions Prediction and Policy Analysis model
- USREP – US Regional Energy Policy model
- ChinaRep – China Province-level model

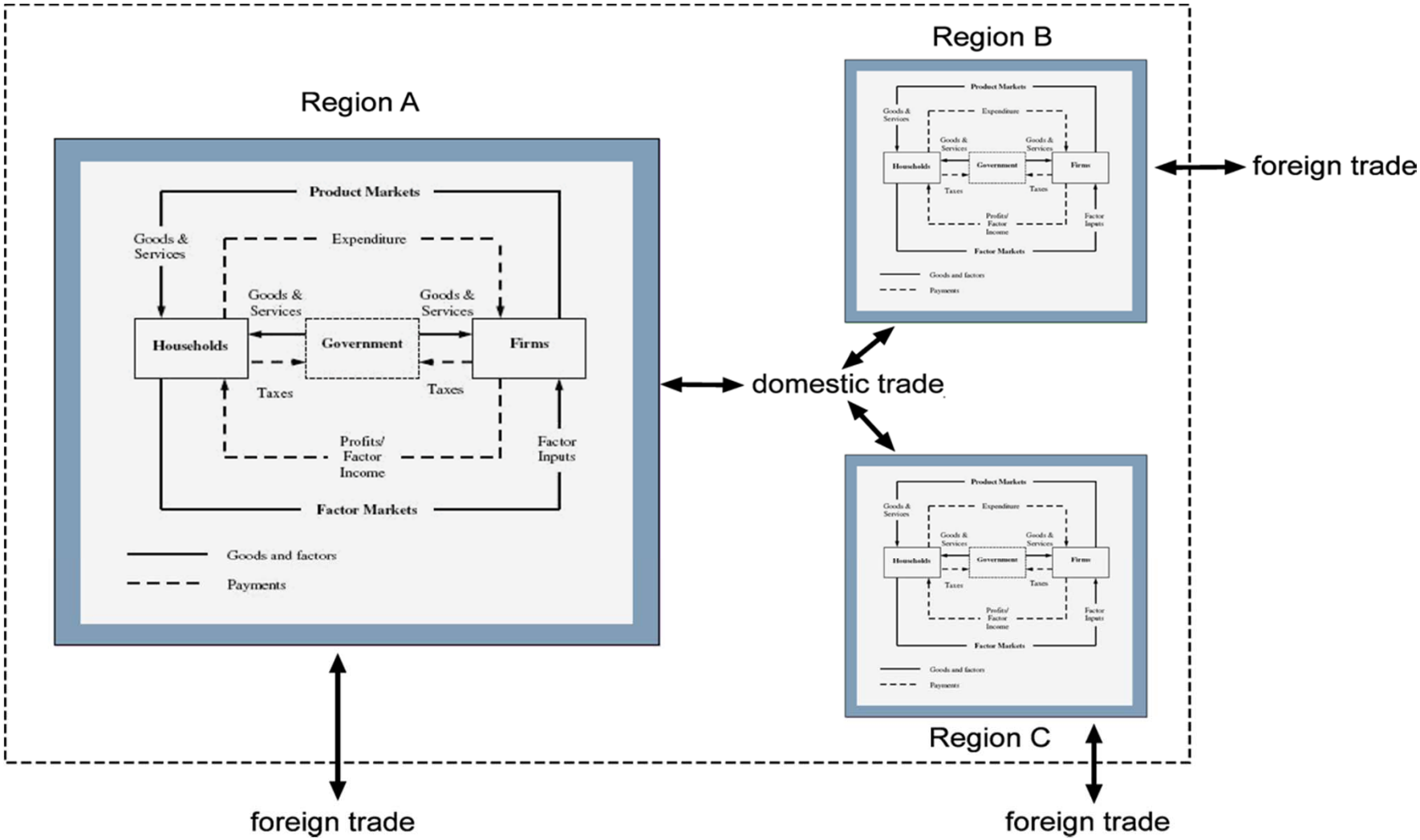
MIT Integrated Global Systems Model (IGSM)



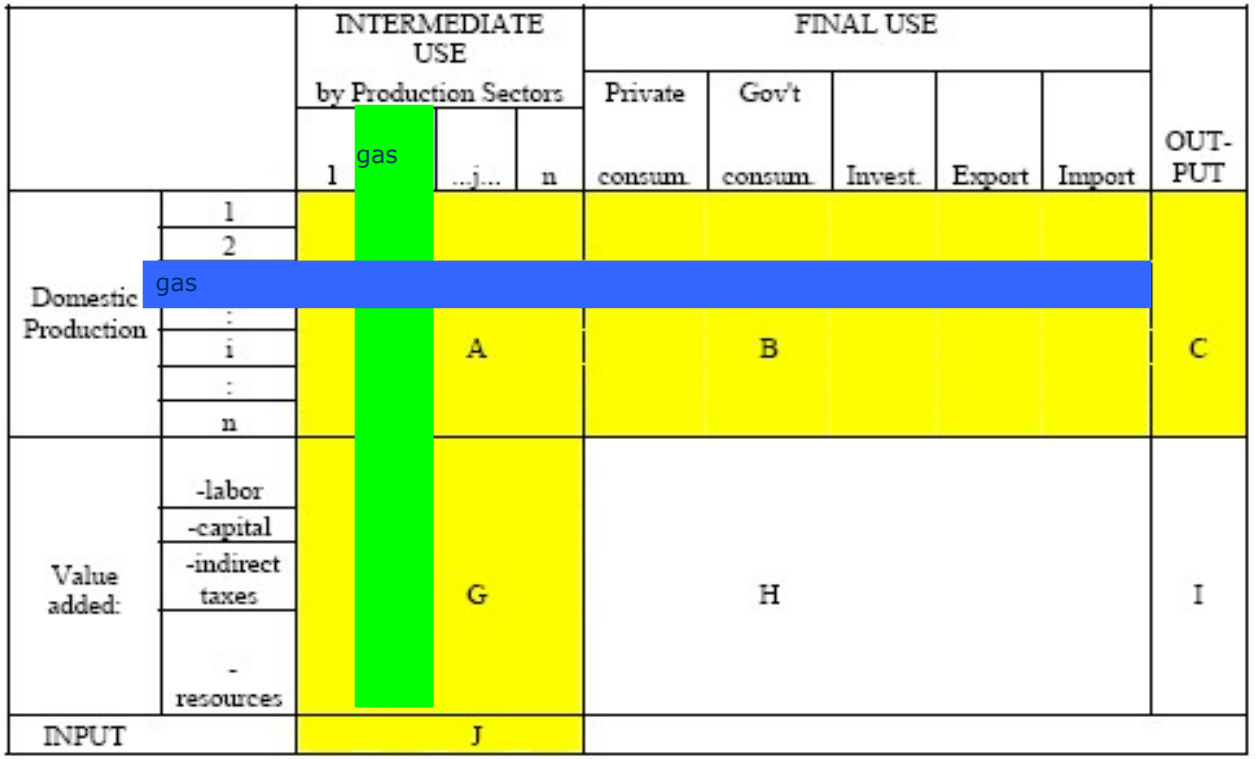
MIT EPPA Model Regions



MIT EPPA Model Basic Structure



MIT EPPA Model Basic Data Structure

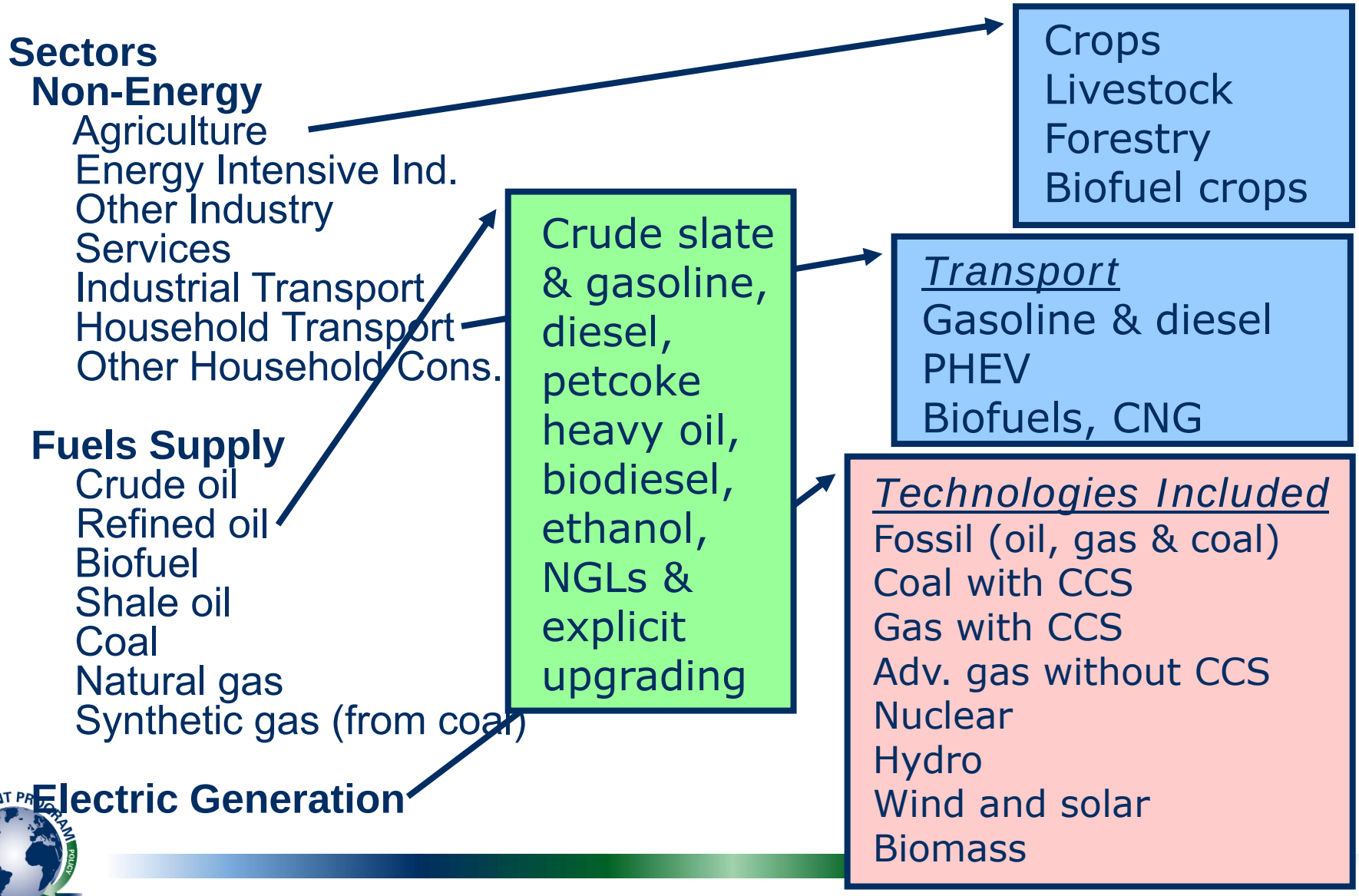


Input-Output Table provides information about production structure (inputs to production – green line) and output use (blue line).

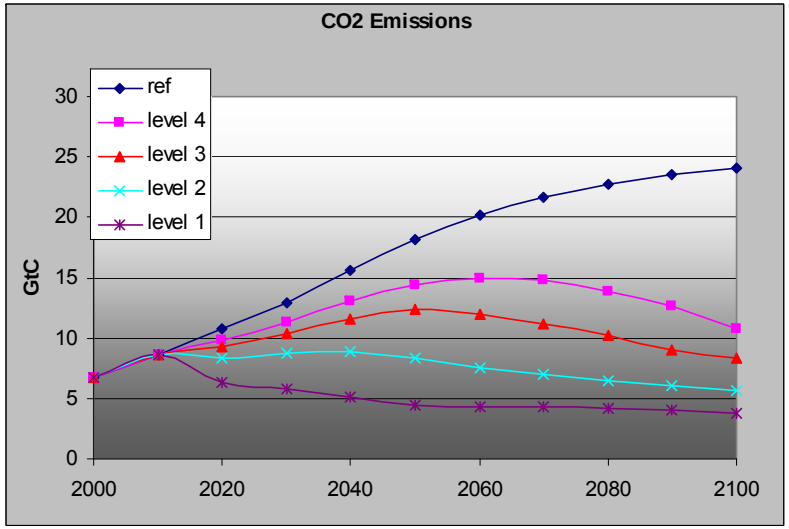
Full accounting (examples): Expansion of biofuels leads to expansion of agriculture production that uses fertilizer and energy inputs; Expansion of solar panel or wind mills production requires energy and capital.

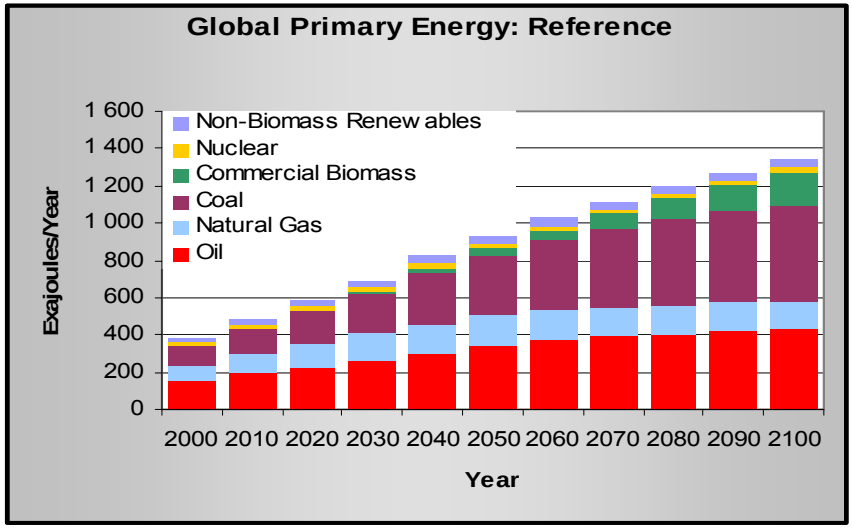
Additional information about elasticities is needed for a CGE model: in contrast to input-output models, consumers respond to price changes, firms change output and inputs as markets shift.

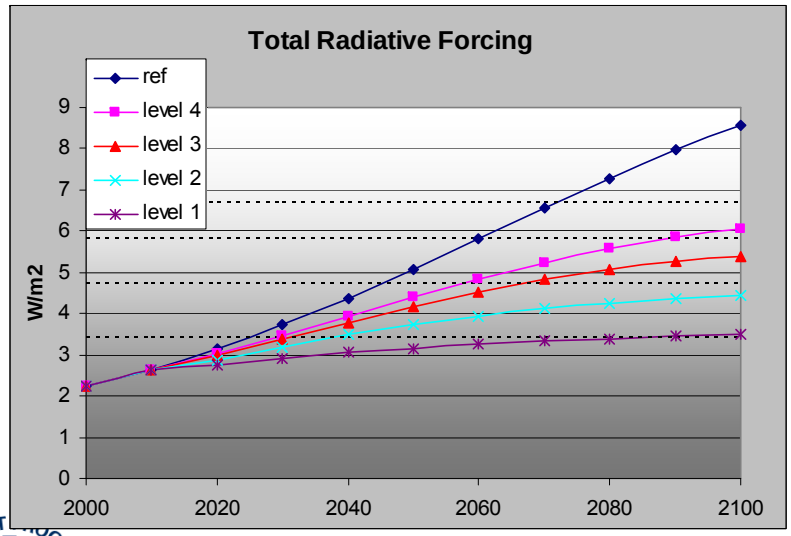
MIT EPPA Model Sectors

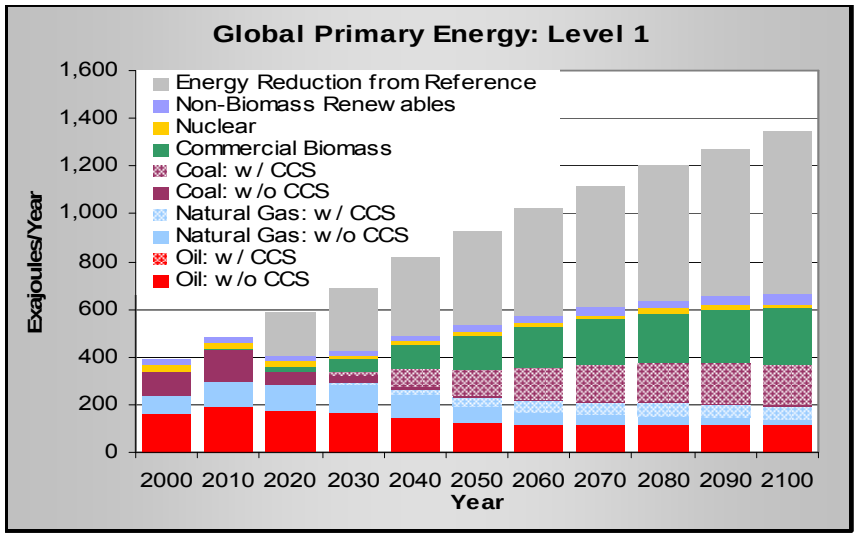


Climate Stabilization and Energy









Air Pollution Health Effects

		INTERMEDIATE USE by Production Sectors				***Household Services***		FINAL USE				OUT-
		1	2	...j...	n	***Mitigation of Pollution Health Effects***	***Labor-Leisure Choice***	Private consum.	Gov't consum.	Invest.	Export	PUT
Domestic Production	1											
	2											
	:											
	i			A					B			C
	:											
	Medical Services for Health Pollution					***Medical Services***		***Health Services***				
	n											
Imports	1											
	2											
	:											
	i			D					E			F
	:											
	n											
Leisure							***Leisure***	***Leisure***				
Value added:	-labor					***Labor***	***Labor***	***Labor***				
	-capital			G					H			I
	- natural resources											
INPUT				J								

Added components are in bold italic.

http://globalchange.mit.edu

USA: Report 113 (2004)

Europe: Report 178 (2009)

China: Report 196 (2011)

Global Aerosol: Report 203 (2011)

MIT Joint Program on the Science and Policy of Global Change

Health Damages from Air Pollution in China

Kira Matus, Kyung-Min Nam, Noelle E. Selin, Lok N. Lamsal, John M. Reilly and Sergey Paltsev

Report No. 196
March 2011

Current Policies Outlook

http://globalchange.mit.edu/Outlook2012/

Emissions in the developed countries will nearly stabilize, while global emissions will continue to grow rapidly.

Global change will accelerate with changes in temperature, precipitation and land use, and the world's oceans will warm and acidify.

Population and income growth will fuel a significant rise in vehicles and increase emissions, especially in developing regions.

While further emissions cuts in developed countries would be useful, such cuts will have less impact on global emissions over time.

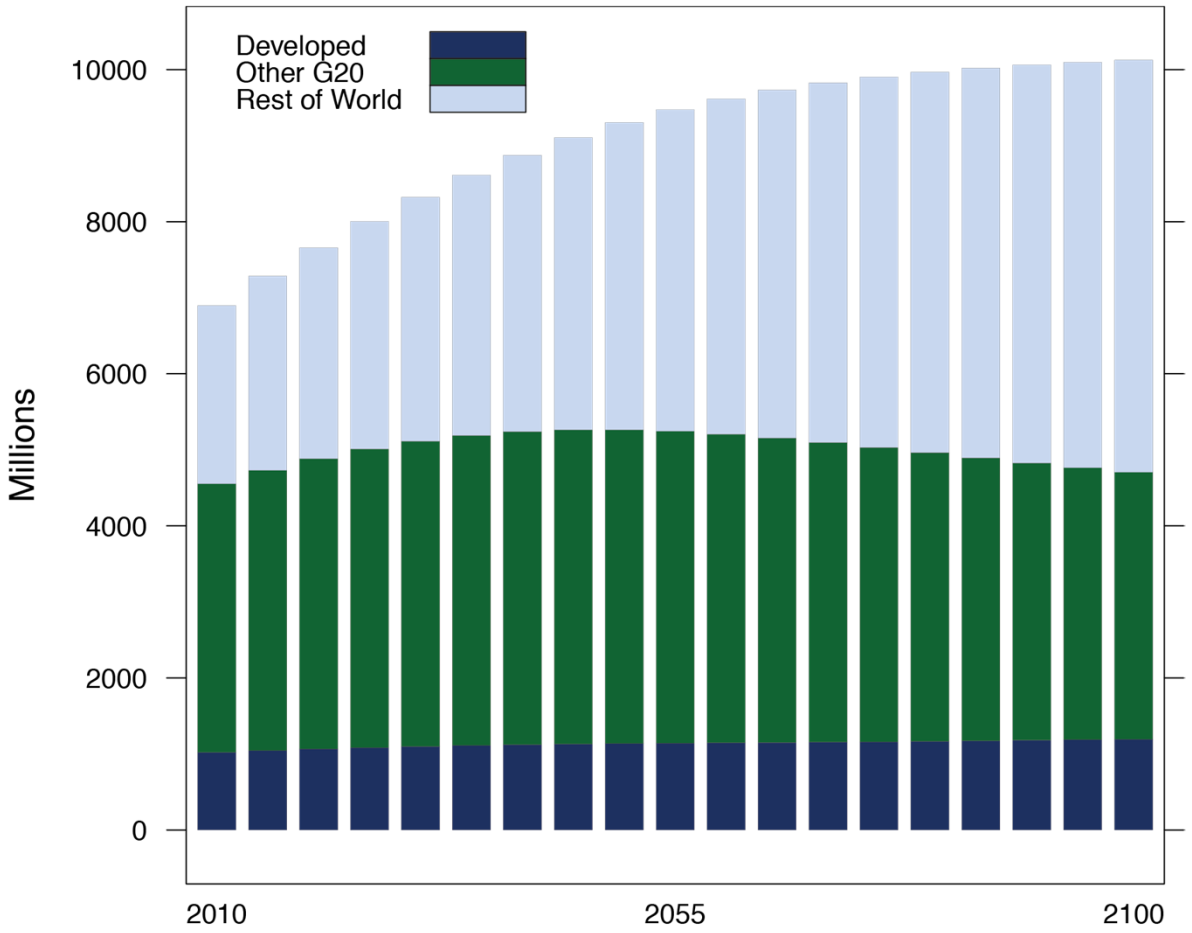
Current Policies Outlook (cont.)

http://globalchange.mit.edu/Outlook2012/

- A transition to alternative energy will occur in developed countries and China, but there will not be enough incentive to fully transform the energy system to avert dangerous levels of climate change.

- While emissions from fossil fuels are sizeable, other GHG and land-use emissions are important. If policies to reduce them fail, a major opportunity to limit climate change may be missed.

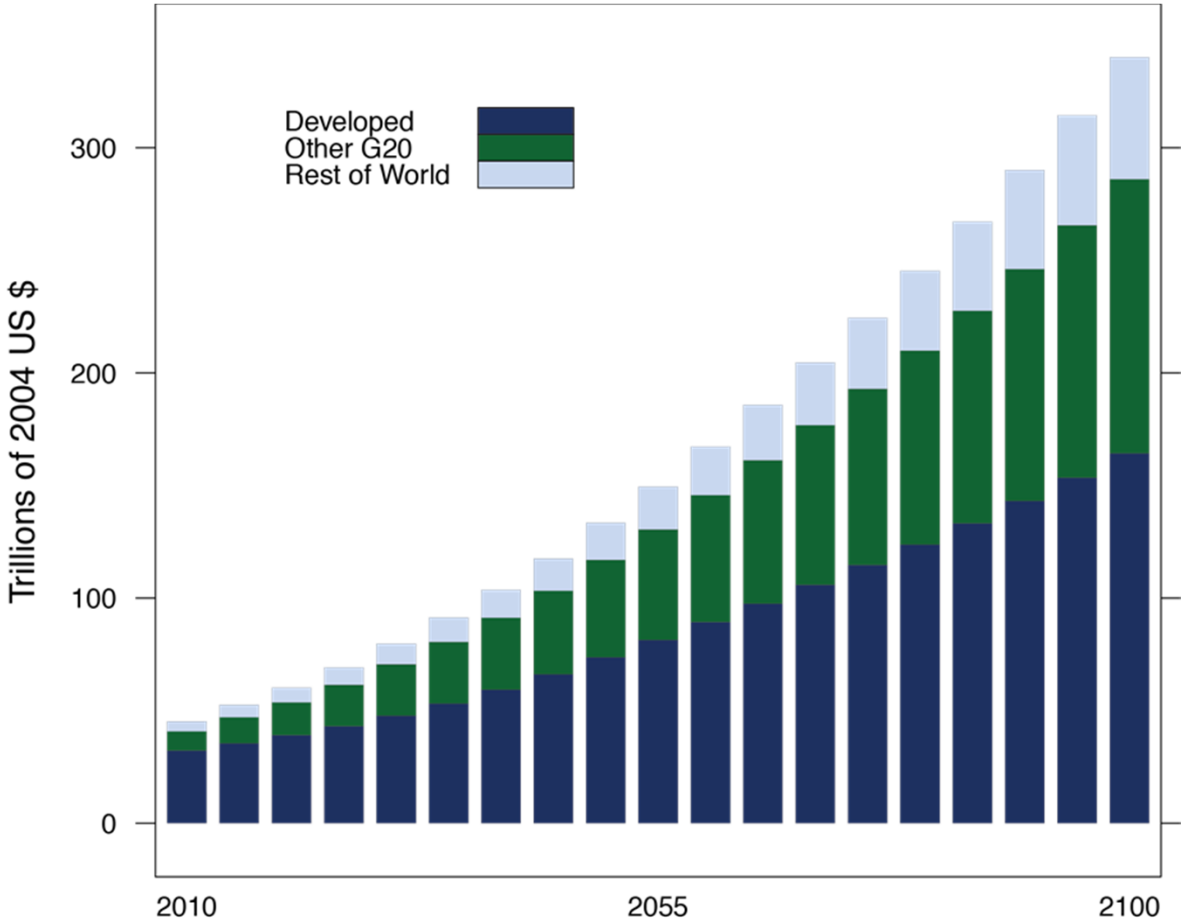
MIT Joint Program Outlook – Population



The world's population is projected to surge past 9 billion before 2050 and reach 10.1 billion by the end of the century.

Much of the growth will happen in developing regions (i.e. Middle East, Africa and Latin America).

MIT Joint Program Outlook – GDP

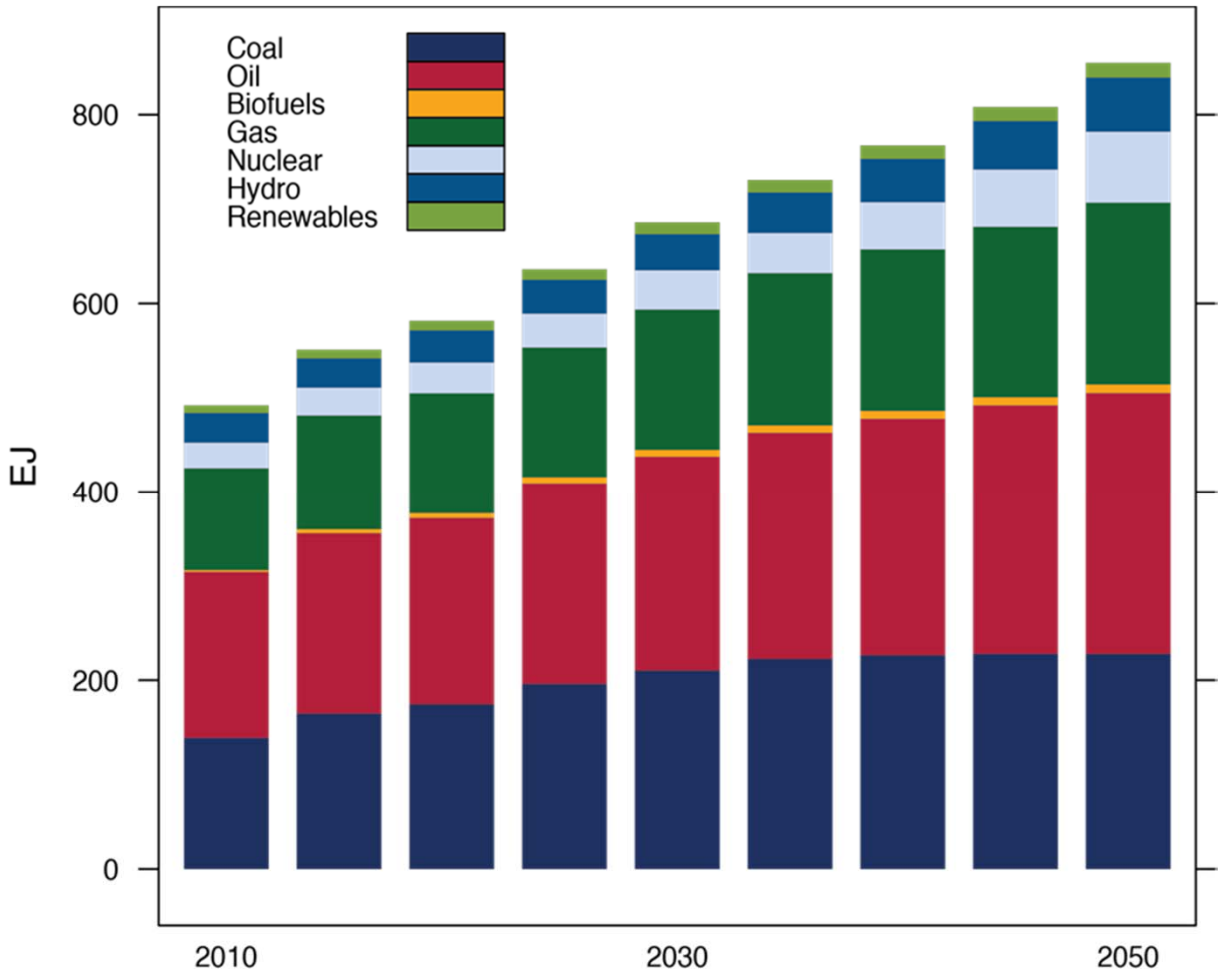


Labor productivity will continue to grow and will be a source of growth in GDP.

Global GDP will grow 7.5 times between 2010 and 2100 (real GDP growth= 2.3%).

Per capita income will grow in all regions, but that growth will be more rapid in developing regions – while income will still remain well below that of developed countries.

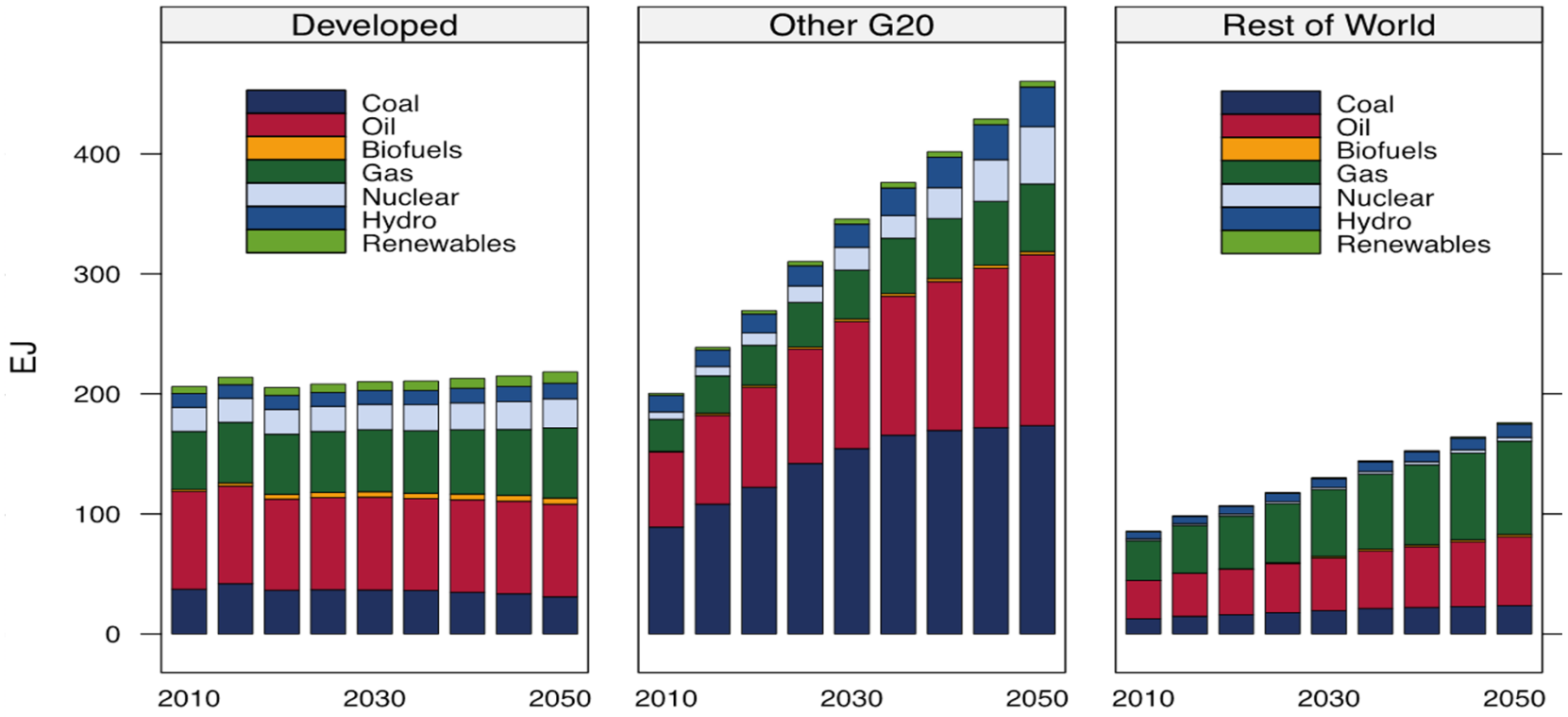
MIT Joint Program Outlook – Global Energy Use



As population and incomes increase, energy needs and desires will increase – doubling energy use by 2050.

Most energy will come from the same sources currently utilized: coal, oil and natural gas.

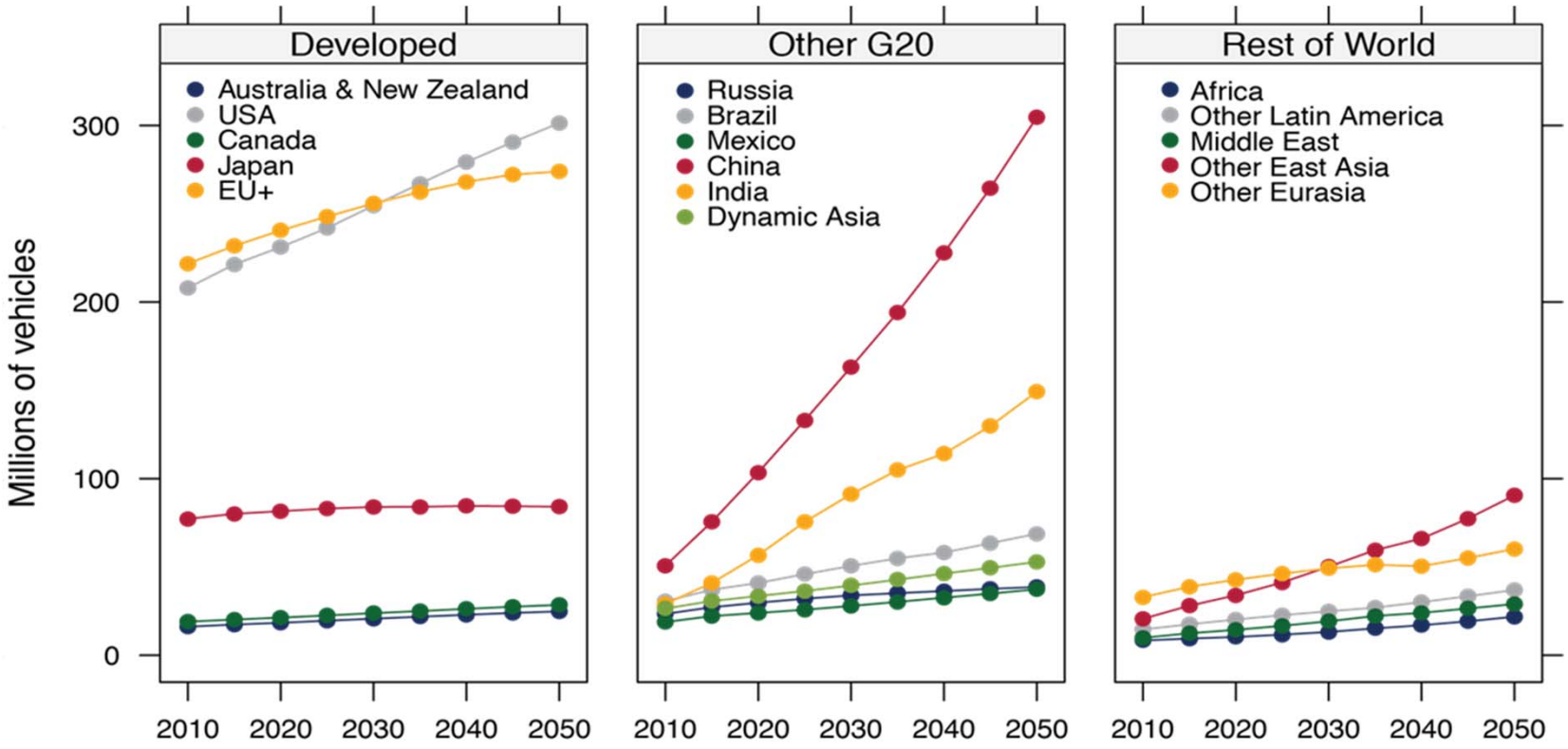
MIT Joint Program Outlook Energy Use



Nuclear and hydropower will increase mostly in developing nations, but without mandate or policy changes those potential sources will not significantly increase.

Energy use overall stabilizes in developed countries, grows substantially in other G20 nations (≈500 EJ), and grows in the rest of the world to about what is used presently by the developed world.

MIT Joint Program Outlook Vehicle Stock

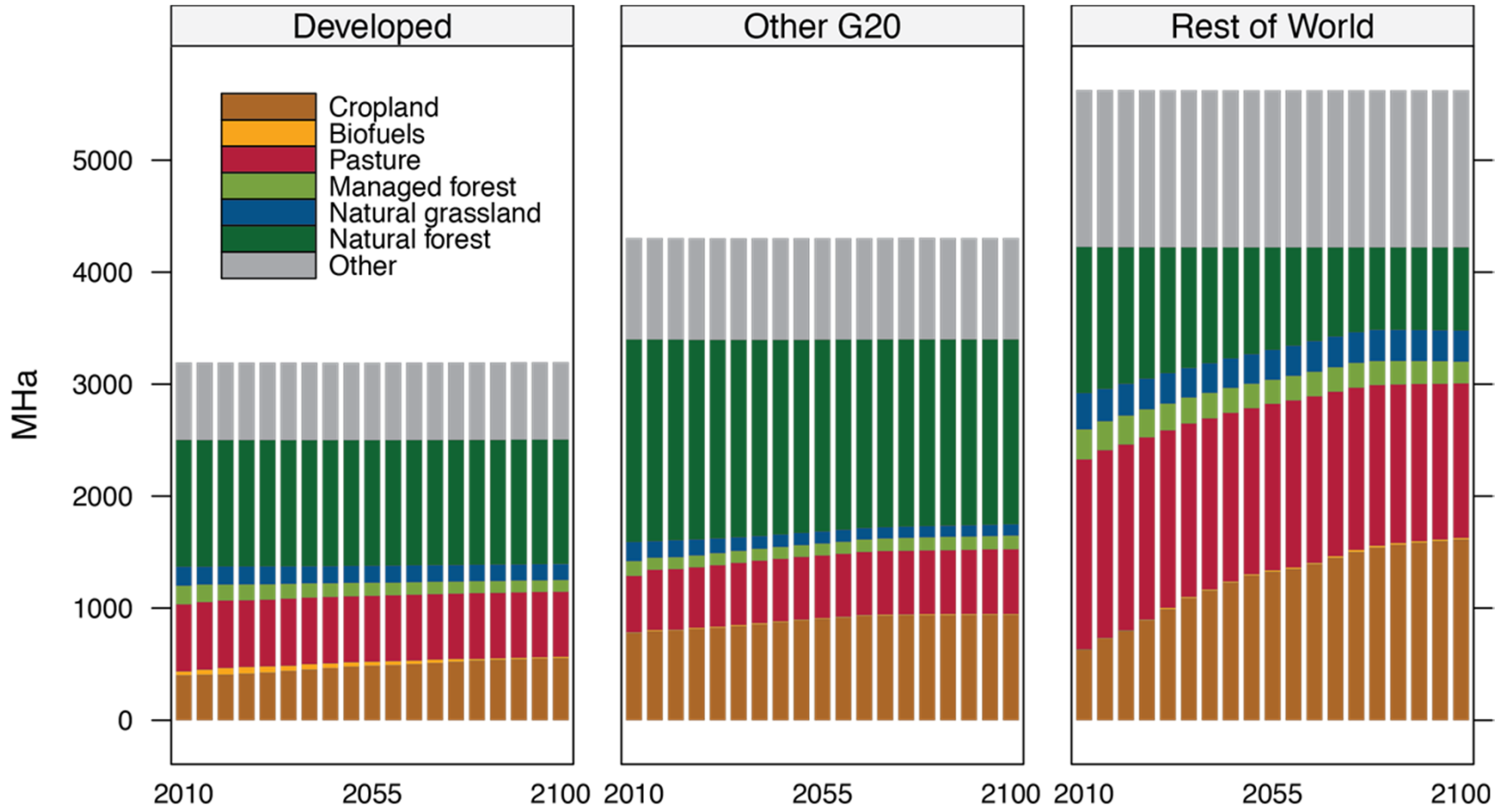


Vehicle use in developed countries will grow slightly.

4 times more automobiles will be on the road in other G20 nations by 2050.

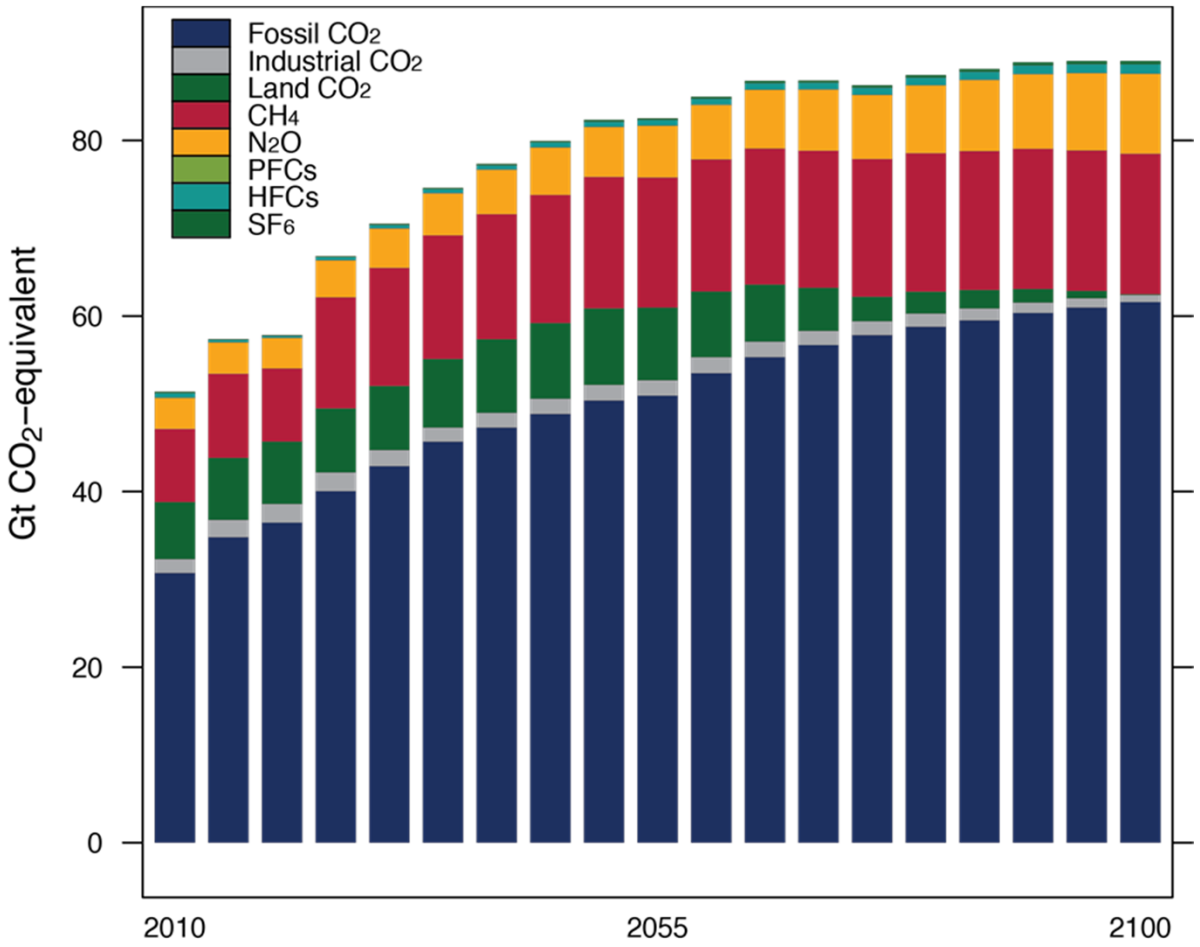
Vehicle use in the rest of the world is projected to rise moderately to more than double present-day levels by 2050.

MIT Joint Program Outlook Land Use



Most land-to-agriculture, and other changes, will occur in the less-developed regions (i.e. Africa and Latin America have significant amounts of forest and grassland that could be used for crops).

MIT Joint Program Outlook Global GHG

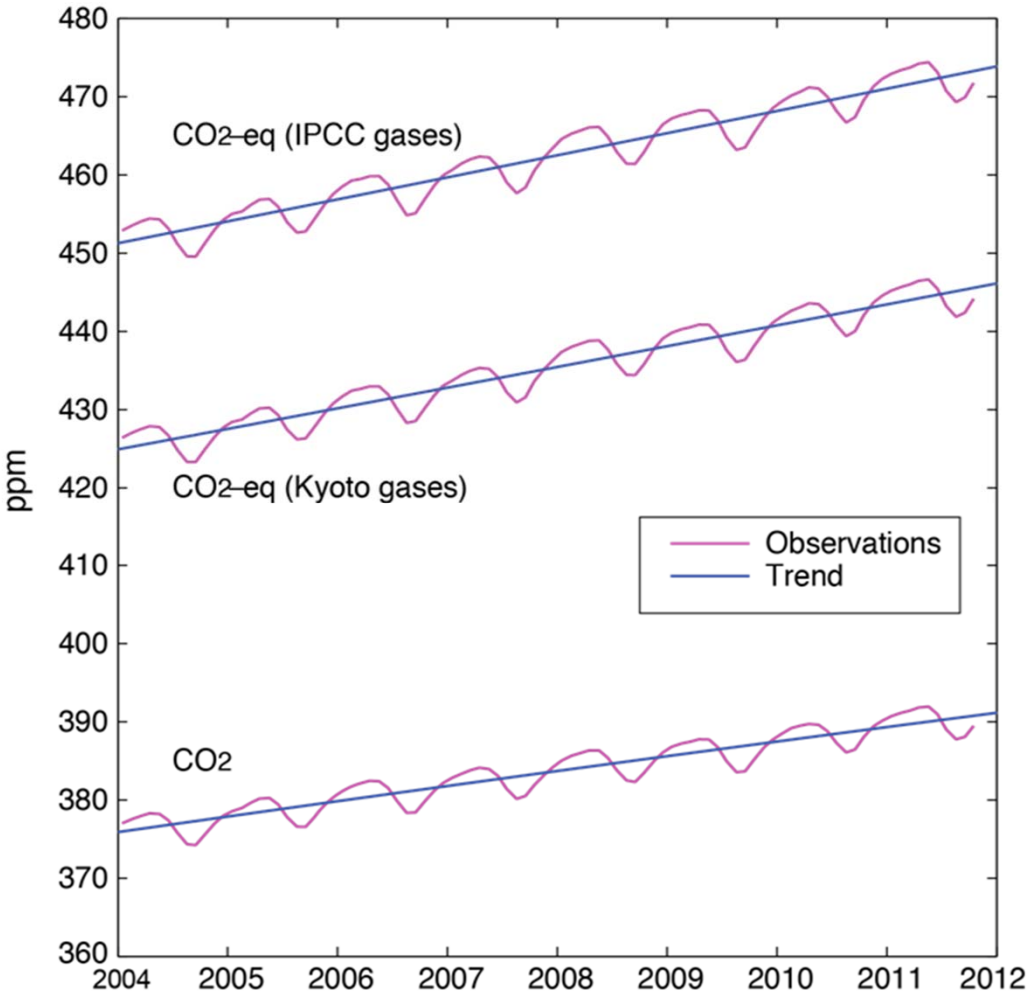


With more power plants and industrial activity, more cars and trucks on the road, and more cropland and livestock, most sources of GHGs will grow.

Fossil fuel CO2 emissions will continue to constitute about 2/3 of total emissions

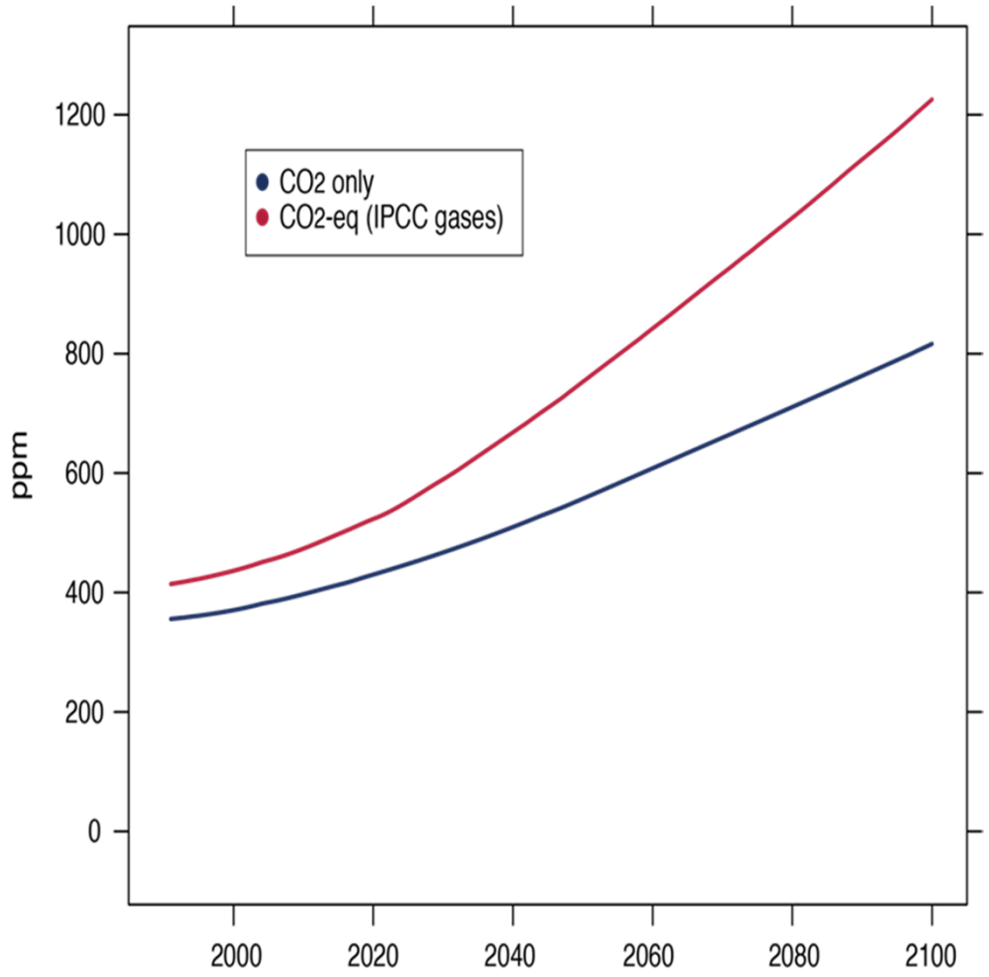
➡ Due mostly to uncontrolled emissions from agriculture, energy production and other industrial activities.

Current GHG Concentrations



- Looking at the GHG concentrations in our atmosphere, it shows that to meet the climate goals discussed broadly amongst nations, global emissions need to peak very soon. This chart shows that will not be the case.
- The well-known seasonal cycle, due largely to strong effects of northern hemisphere vegetation on CO2, is smoothed to show the underlying trend.

MIT Joint Program Outlook – CO2 and GHG Conc.

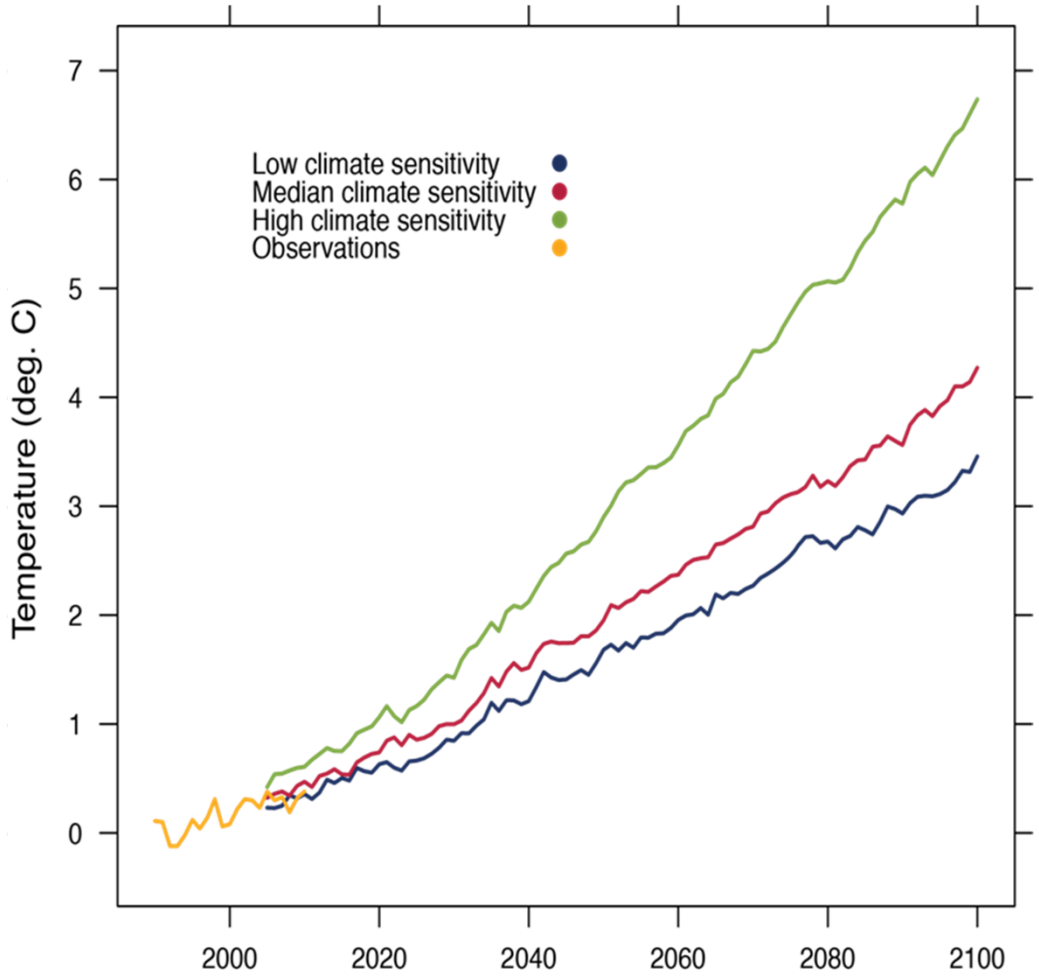


Looking at future concentrations of GHGs, CO2 and other GHGs will rise substantially as emissions rise.

CO2: From 390 ppm to 816 ppm

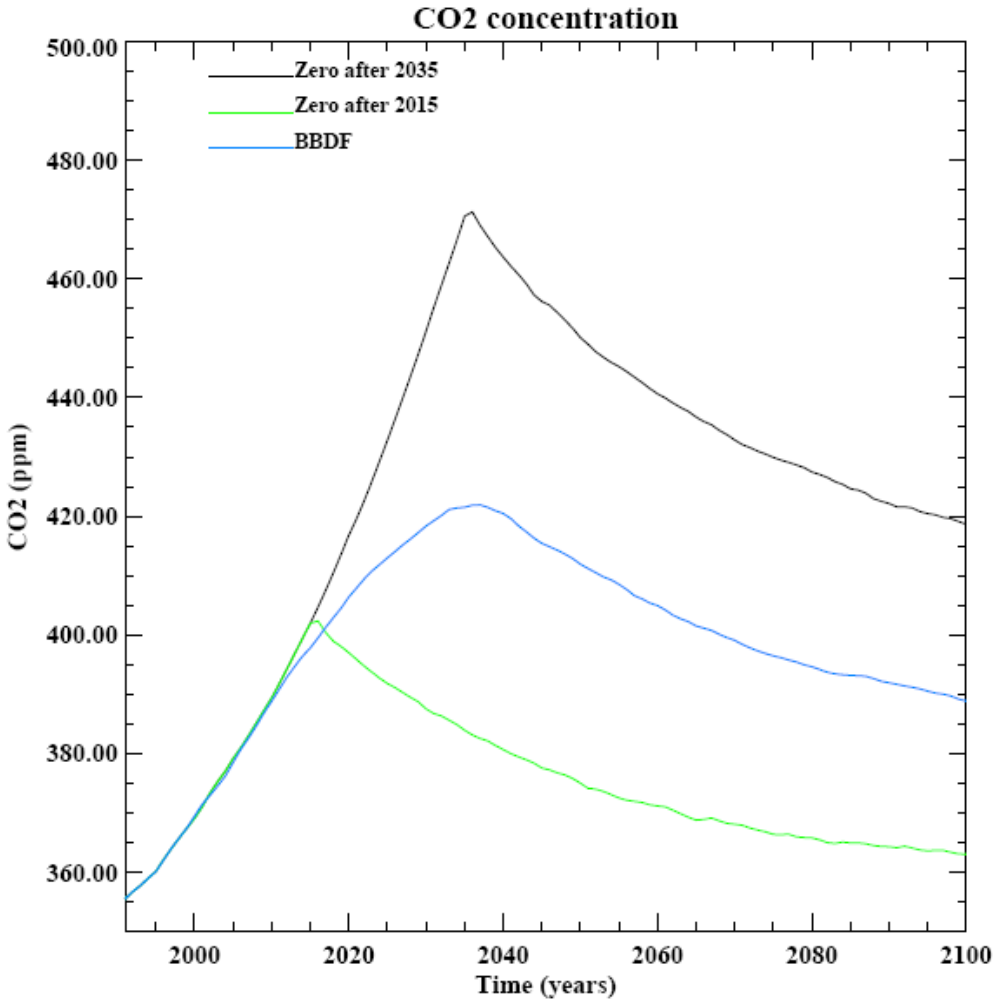
CO2-eq: 474 ppm to 1226 ppm.

MIT Joint Program Outlook – Temperature



- Using the previous 3 scenarios, the range of warming becomes:
- 2050: 1.7°-2.9°C
- Median: 2°C
- 2100: 3.5°-6.7°C
- Median: 4.3°

Realism of Climate Goals



Even in ALL (!) GHG emissions are ZERO (!) from 2015 forever, CO2 concentrations are above 350 by 2100 (temperature increase by 0.5 degree C by 2100).

Delay in reduction increases concentrations

Adaptation to climate change

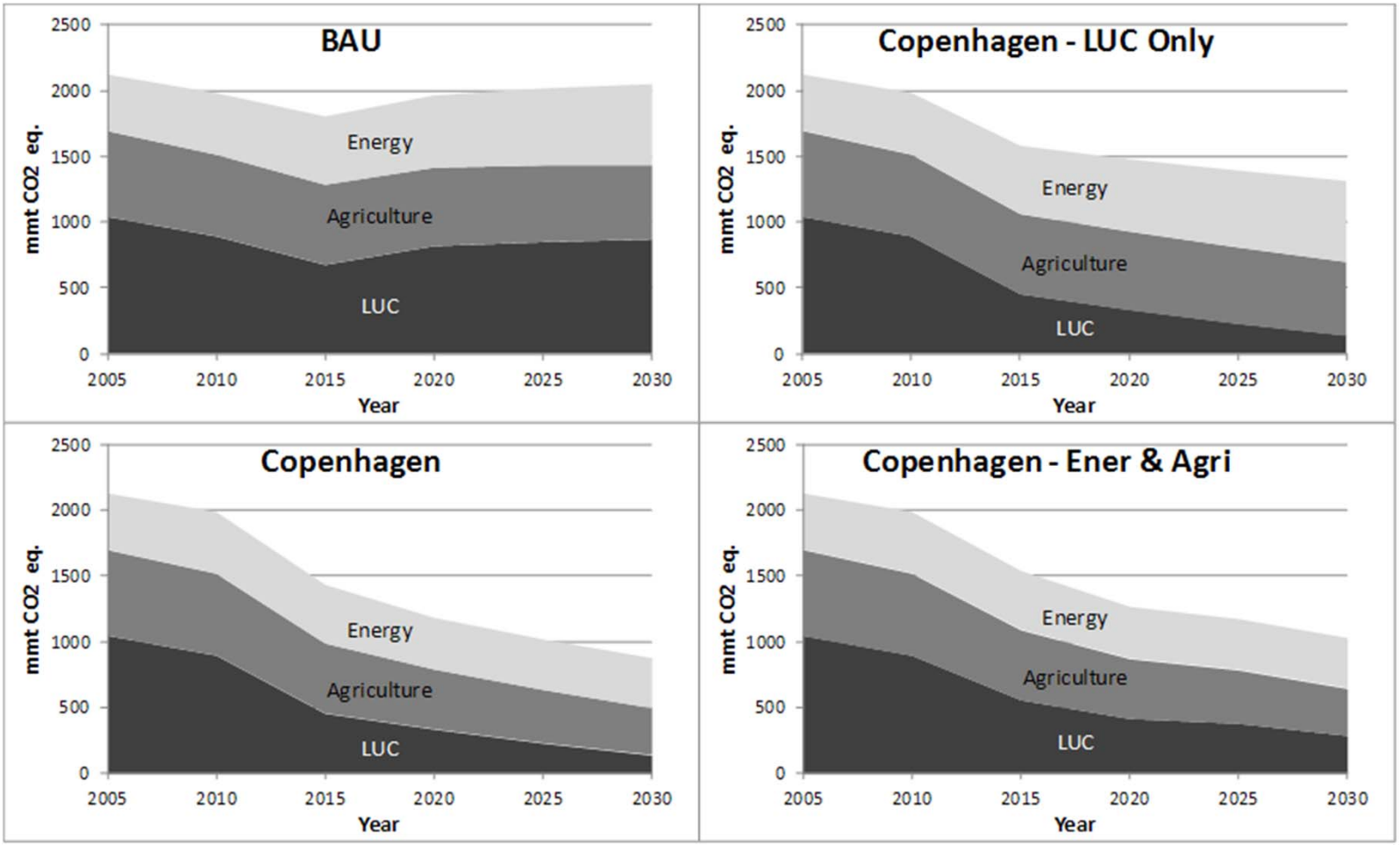
Reduction in Emissions Reduces Risks

	ΔT > 2°C (values in red relative to 1860 or pre-industrial)	ΔT > 4°C	ΔT > 6°C
No Policy at 1400	100% (100%)	85%	25%
Stabilize at 900 (L4)	100% (100%)	25%	0.25%
Stabilize at 790 (L3)	97% (100%)	7%	< 0.25%
Stabilize at 660 (L2)	80% (97%)	0.25%	< 0.25%
Stabilize at 550 (L1)	25% (80%)	< 0.25%	< 0.25%

Cumulative PROBABILITY OF GLOBAL AVERAGE SURFACE AIR WARMING from 2000 to 2100 *(400 IGSM forecasts per case)*

Source: MIT JP Reports 180, 211

Preliminary Results for Brazil (GHG emissions)



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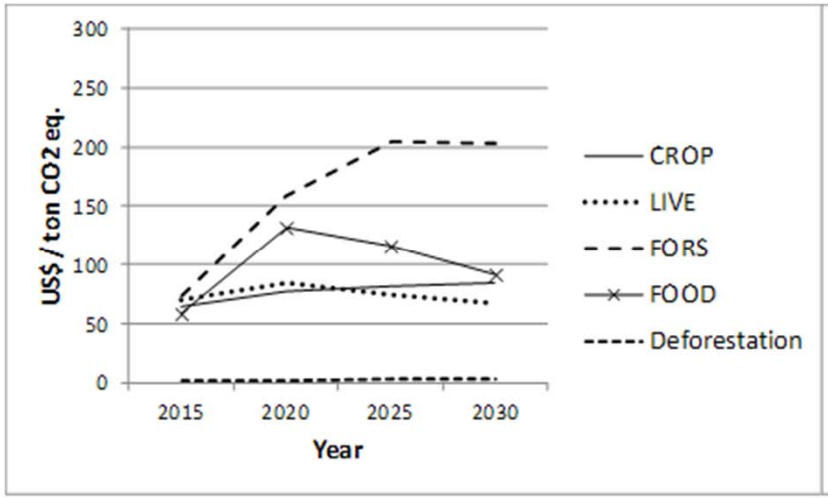
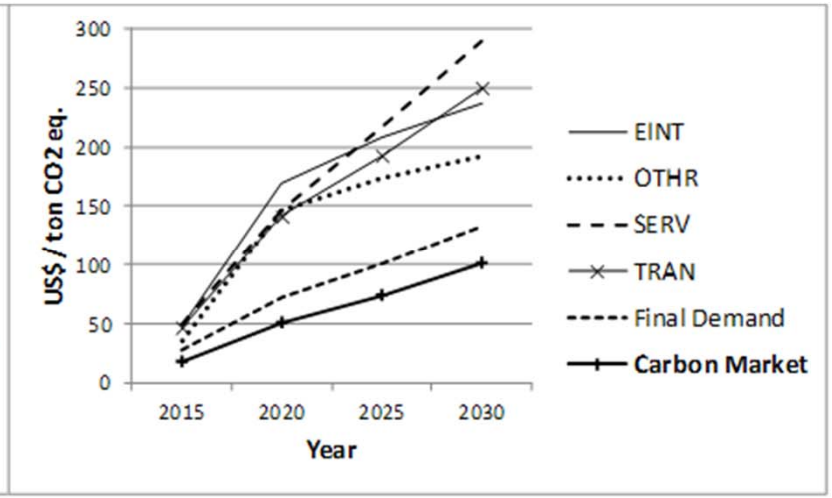
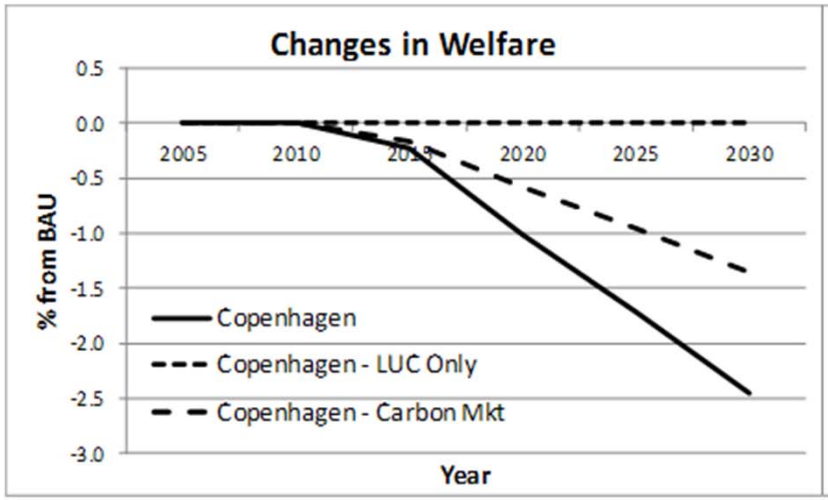
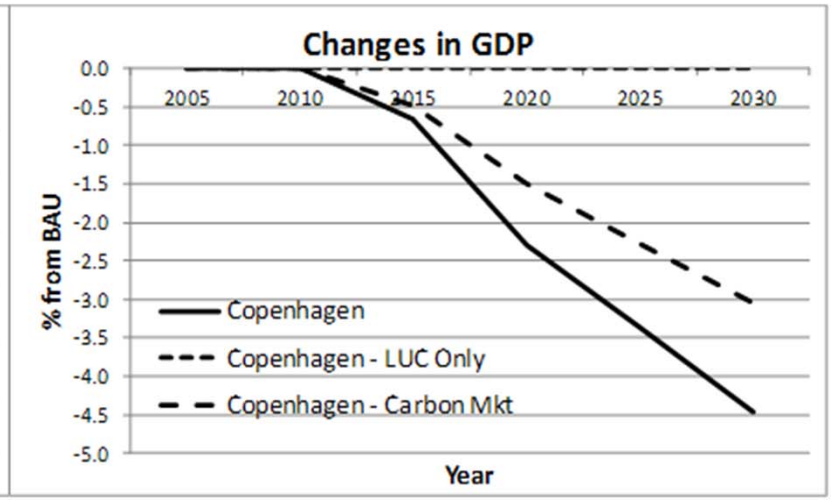
Results for Brazil (Carbon Price and GDP change)









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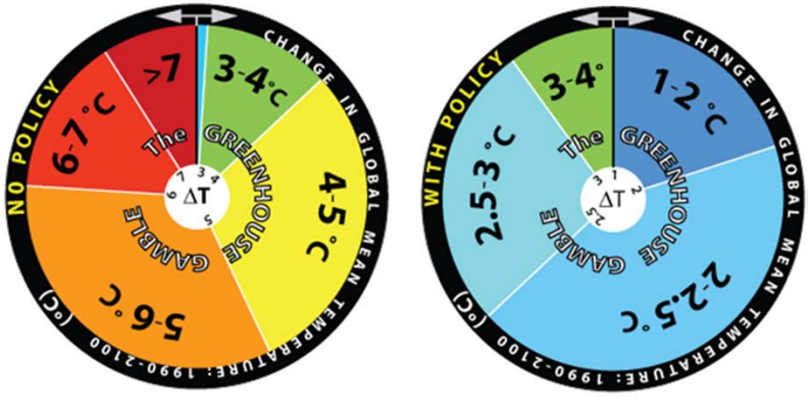
Preparing for Tomorrow Today

- While the world has made progress, much more effort is needed to avoid dangerous climate change.
- The Copenhagen pledges do not take us very far in the energy transformation ultimately needed to avoid the risk of dangerous warming.
- Even if policy efforts in developed countries are successful in holding emissions constant, the emission increases of other nations – growing and industrializing – will contribute to further increases in greenhouse gas concentrations and climate change.



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