Energy and Climate Change in China

Carlo Carraro, University of Venice and Fondazione Eni Enrico Mattei

Emanuele Massetti, Fondazione Eni Enrico Mattei and CMCC

Workshop on the Chinese Economy

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1. Introduction

1. Historical and Business-as-Usual trend in the economy, energy sector and emissions.

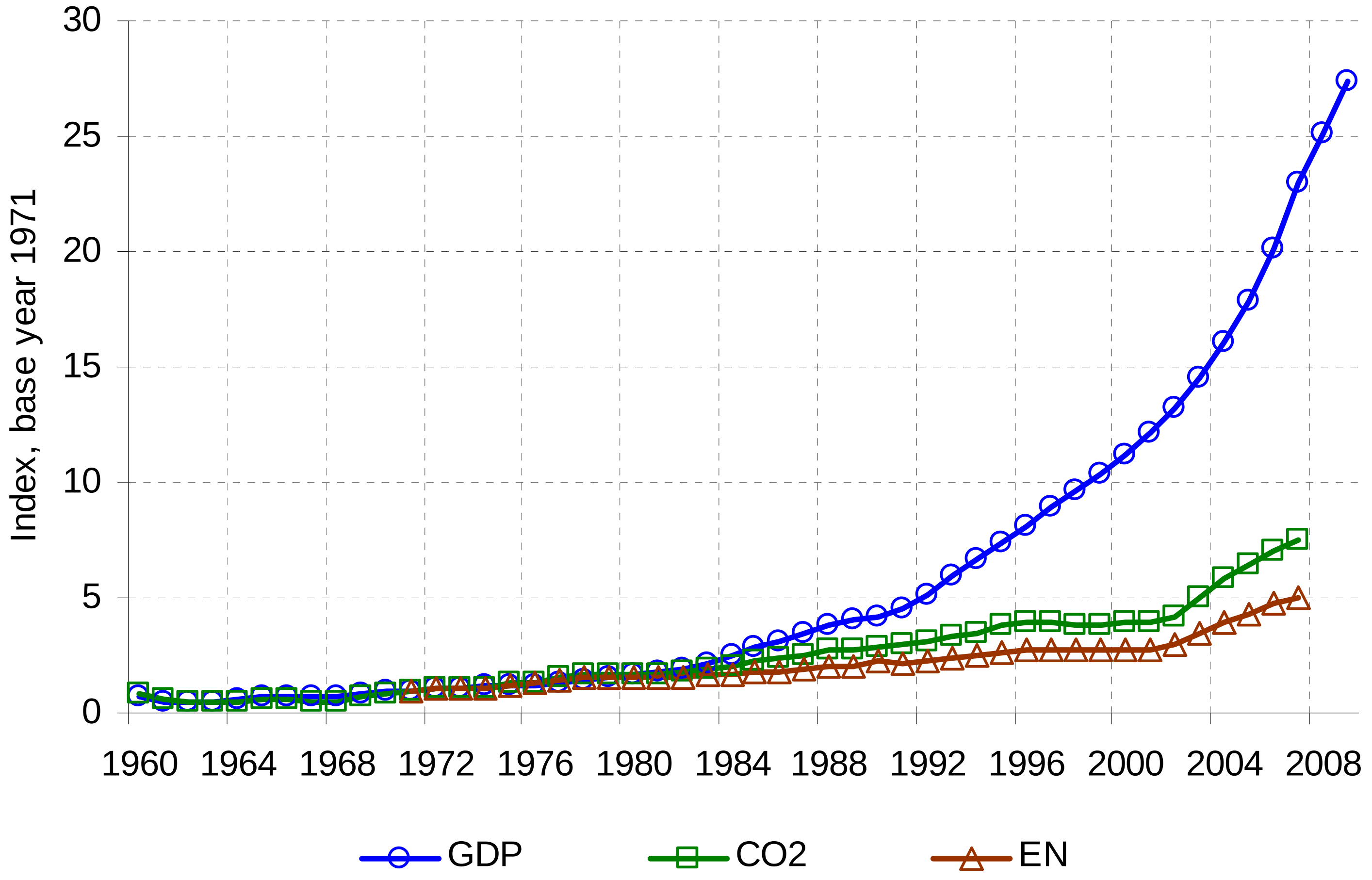
2. Analysis of the carbon intensity target pledged in the Copenhagen Accord.

3. Emissions taxes scenarios.

4. Analysis of a realistic Chinese climate policy commitment.

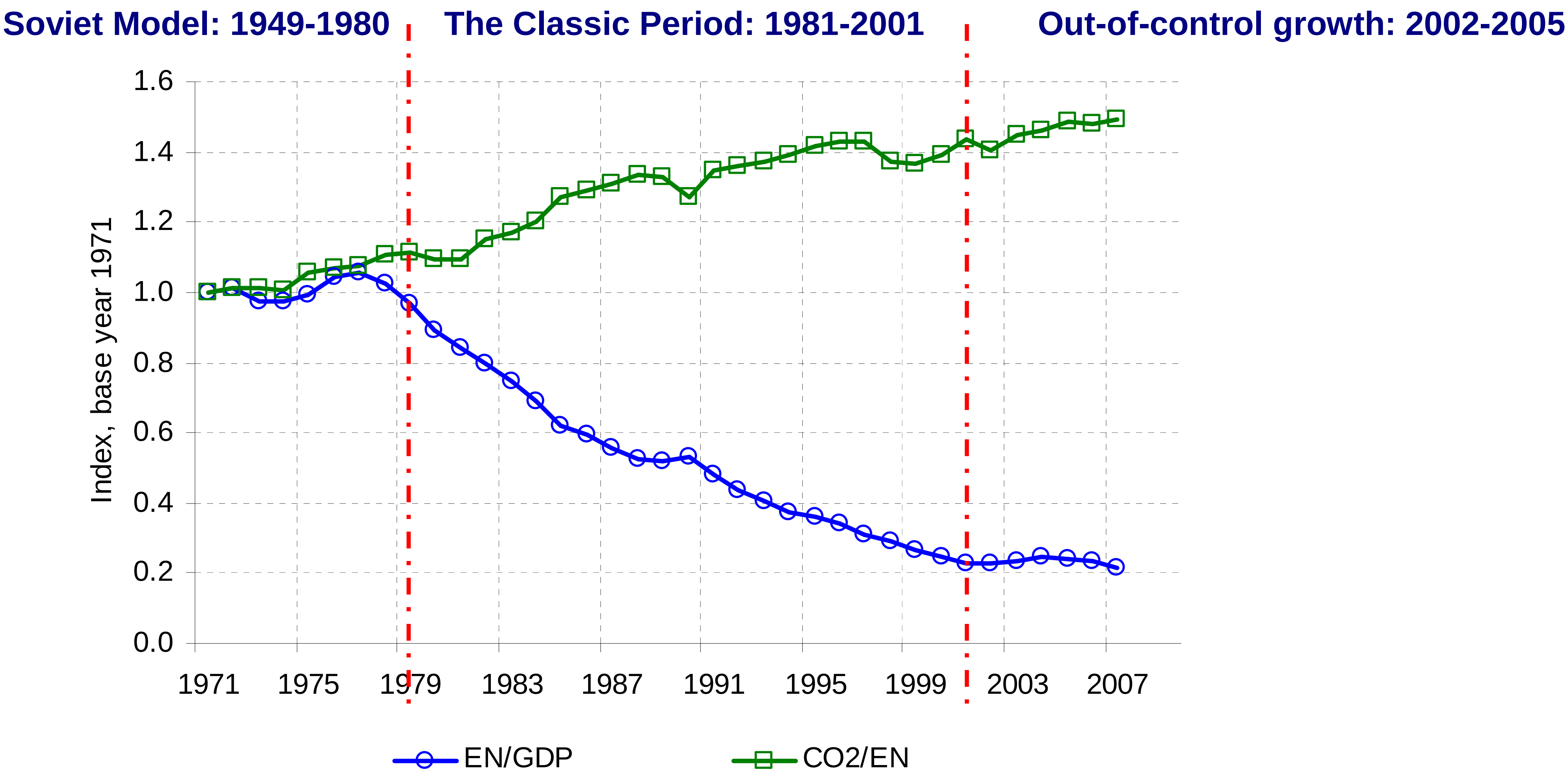
Historic data and the Business-as-Usual Scenario

3. GDP, CO_2 and energy use: 1960-2009



Data from WB Development Indicators

4. Energy intensity and carbon intensity



Levine, Zhou and Price (2009); Data from WB Development Indicators

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5. The WITCH model - www.witchmodel.org

WITCH: World Induced Technical Change Hybrid model

Hybrid I.A.M.:

- **Economy**: Ramsey-type optimal growth (inter-temporal)
- **Energy**: Energy sector detail (technology portfolio)
- **Climate**: Damage feedback (global variable)

- 13 Regions ("where" issues)
- Intertemporal ("when" issues)
- Game-theoretical set-up (free-riding incentives)

- Bosetti, V., E. Decian, A. Sgobbi and M. Tavoni (2009). "The 2008 WITCH Model: New Model Features and Baseline." FEEM Working Paper 85.09 .
- Bosetti V., E. Massetti, M. Tavoni (2007). "The WITCH Model, Structure, Baseline, Solutions", FEEM Working Paper 10.2007.
- Bosetti, V., C. Carraro, M. Galeotti, E. Massetti and M. Tavoni (2006). "WITCH: A World Induced Technical Change Hybrid Model", The Energy Journal, Special Issue. Hybrid Modeling of Energy-Environment Policies: Reconciling Bottom-up and Top-down, 13-38.

6 Distinguishing features of WITCH

- Focus on **energy sector**
- Focus on **technological change**:
  - Learning-by-Doing in W&S
  - Energy intensity R&D
  - Breakthrough Technologies (two factors learning curves)
- Focus on channels of **interactions among regions**:
  - Technological spillover
  - Environmental externality
  - Exhaustible common resources
  - Trade of emission permits
  - Trade of oil
- Focus on **strategic behaviour (open loop Nash game)**

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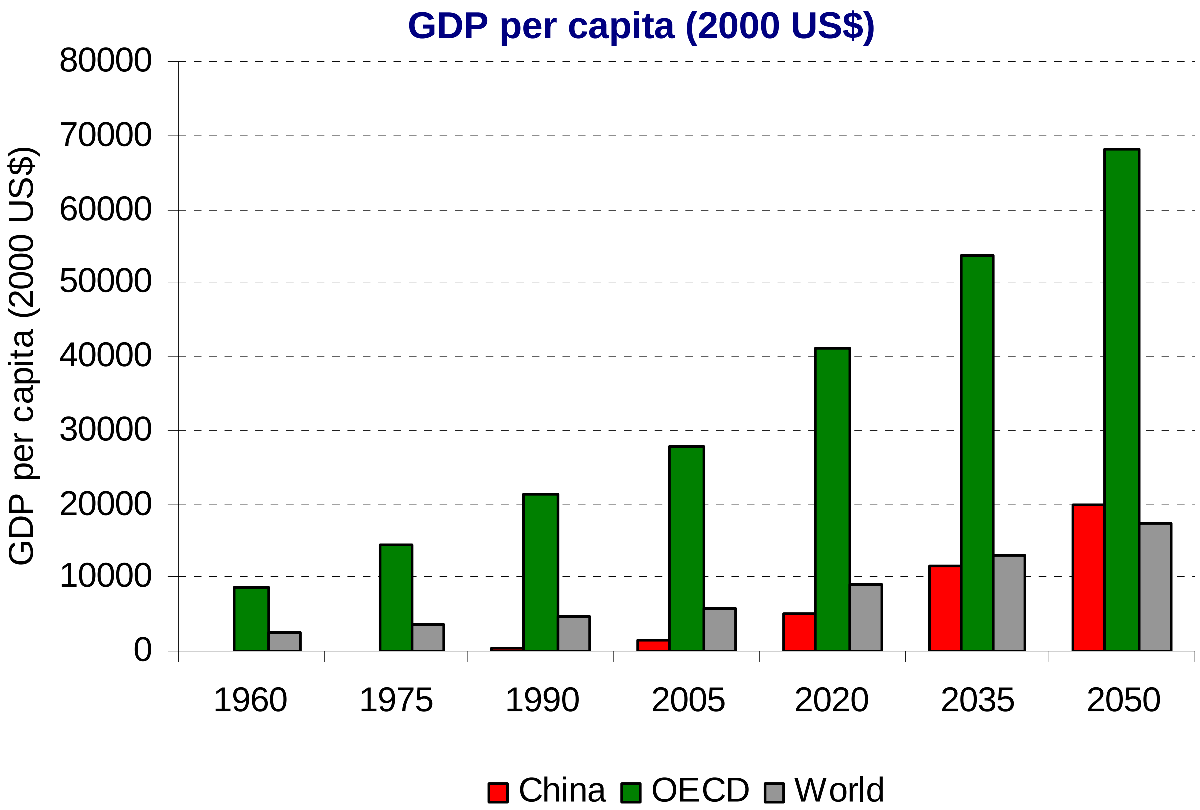
7. Economic growth



- 1960-2005 14-fold expansion of GDP per capita
- Gap with OECD: 19 times lower in 2005, 3.5 times lower in 2050

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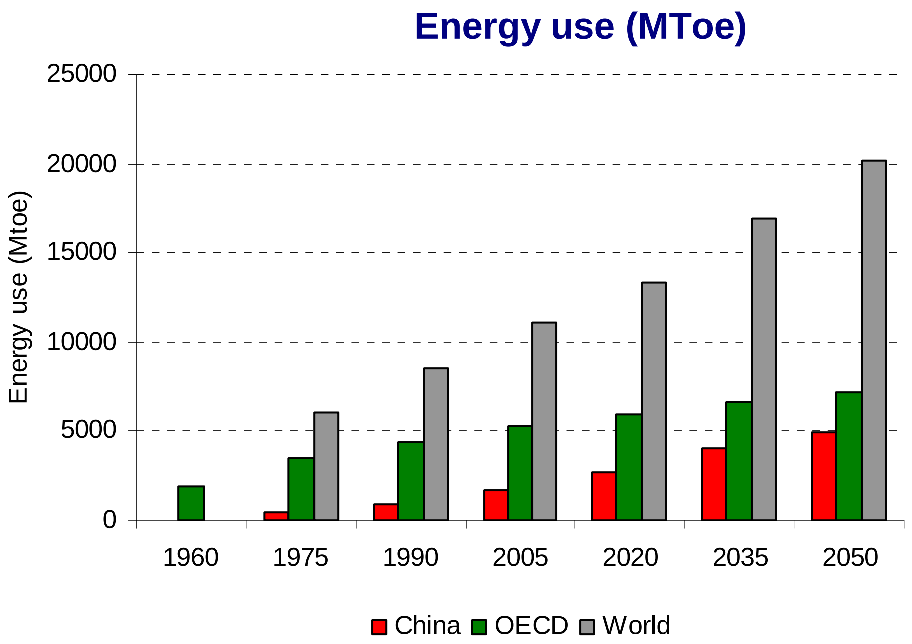
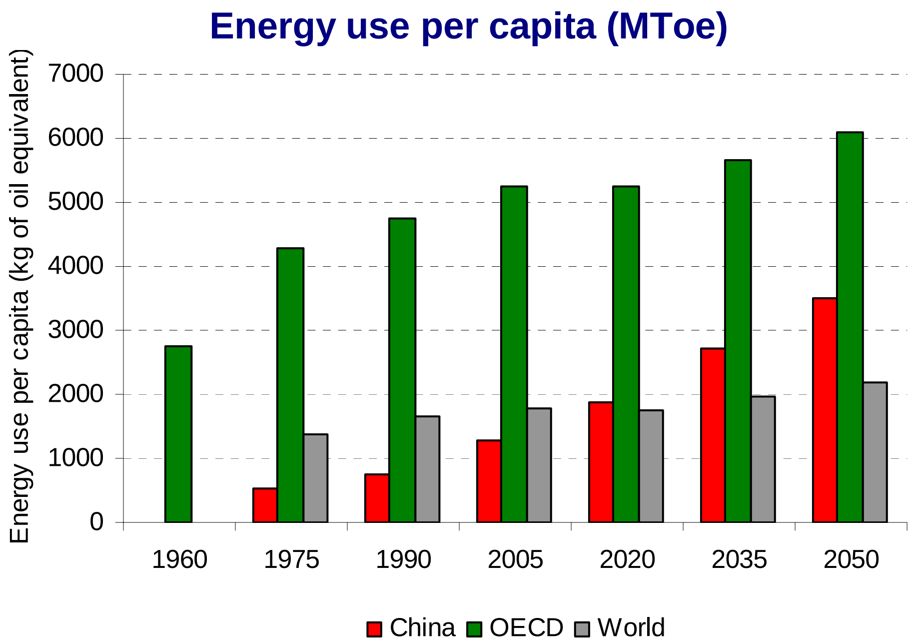
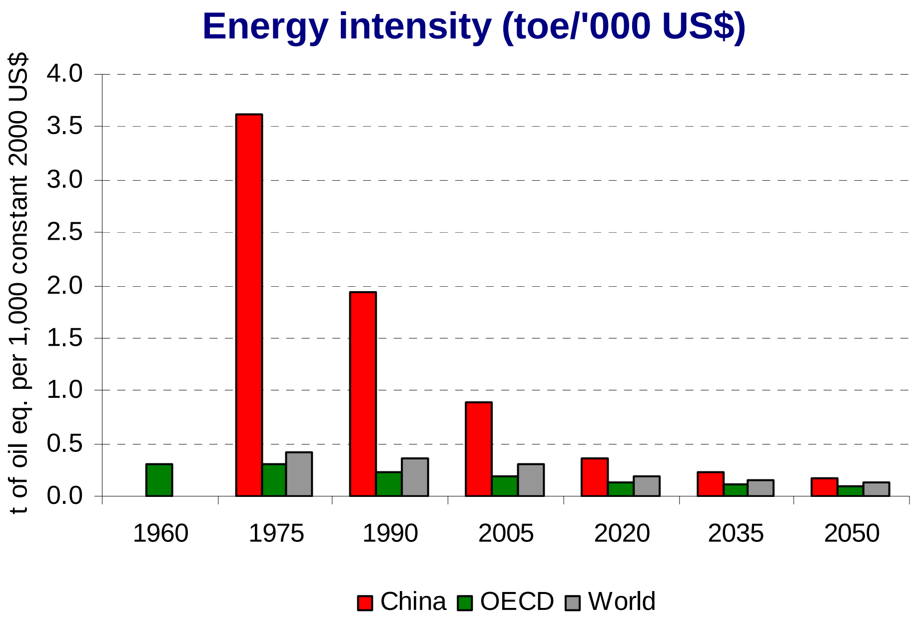
8. Energy use

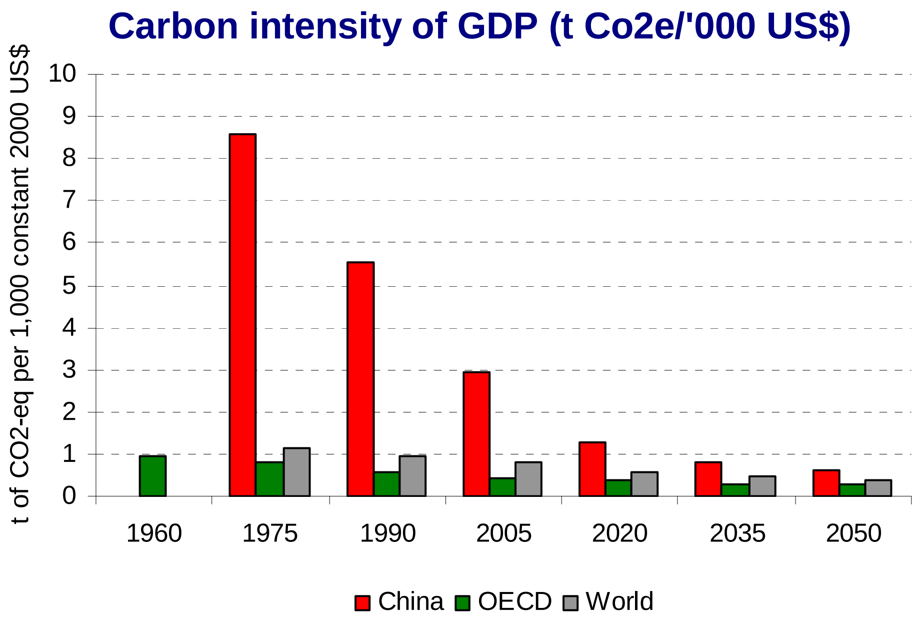




- 25% of global demand of energy in 2050 from China
- energy use per capita higher than global average, but lower than in OECD economies

9. Energy intensity and carbon intensity





- Strong energy efficiency improvements (back to "Classic period")
- Politburo: -20% reduction energy intensity in 2010 wrt 2005
- Energy intensity of GDP remains twice higher than in OECD
- Carbon intensity of GDP is more than twice than in OECD

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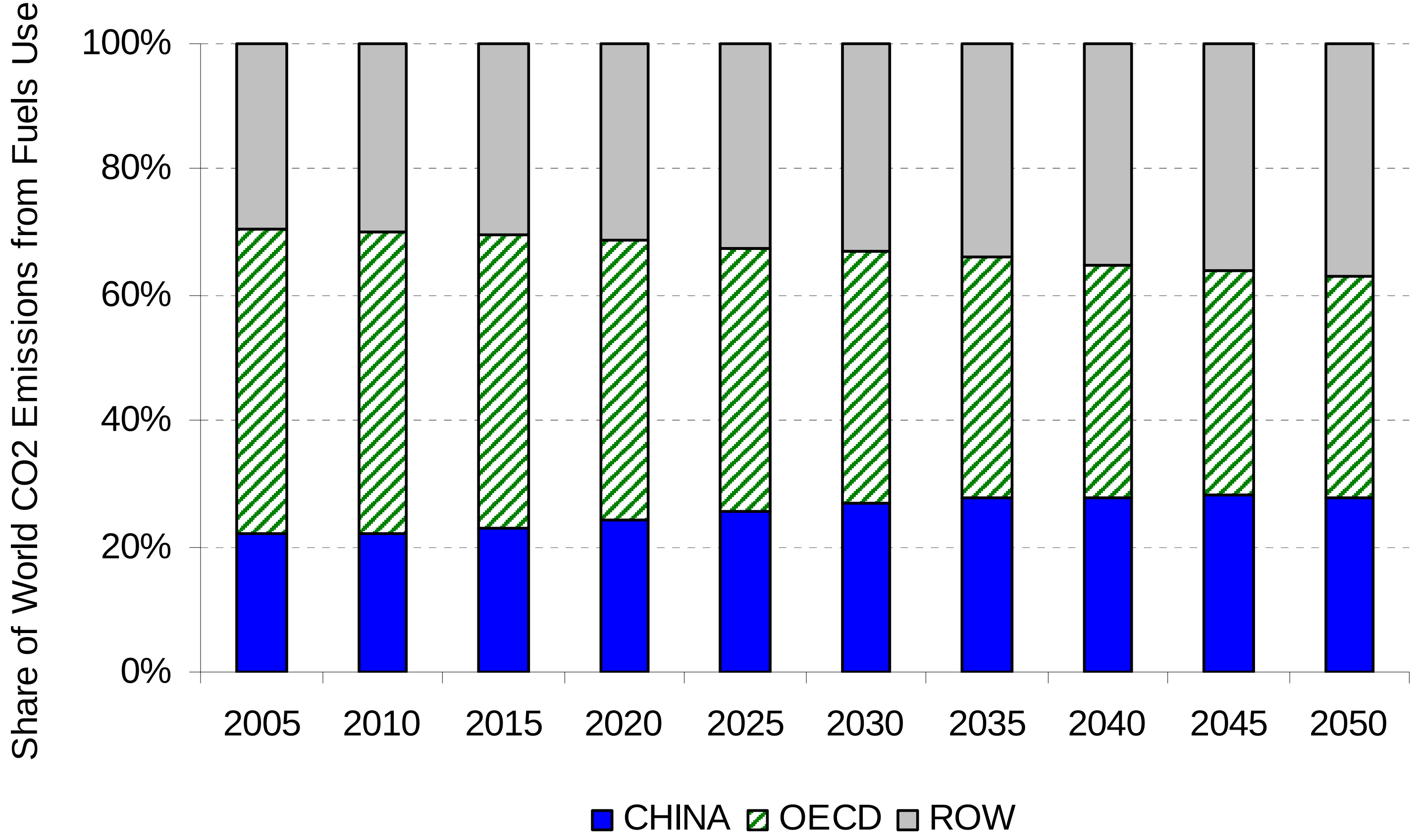
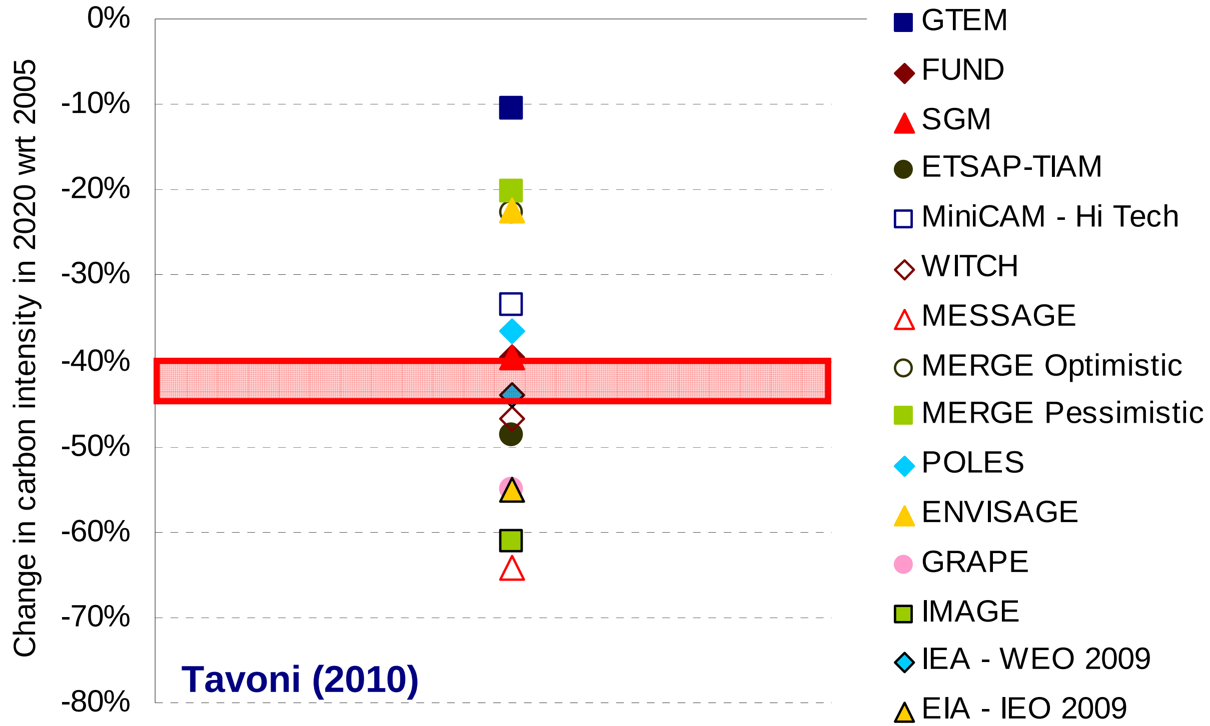
10. China's share of global CO_2 emissions



- China: from 22% (2005) to 27% (2050)
- OECD: from 48% (2005) to 35% (205)
- Global emissions: from 29.4 (2005) Gt to 62.4 Gt (2050)

11. The Copenhagen pledge

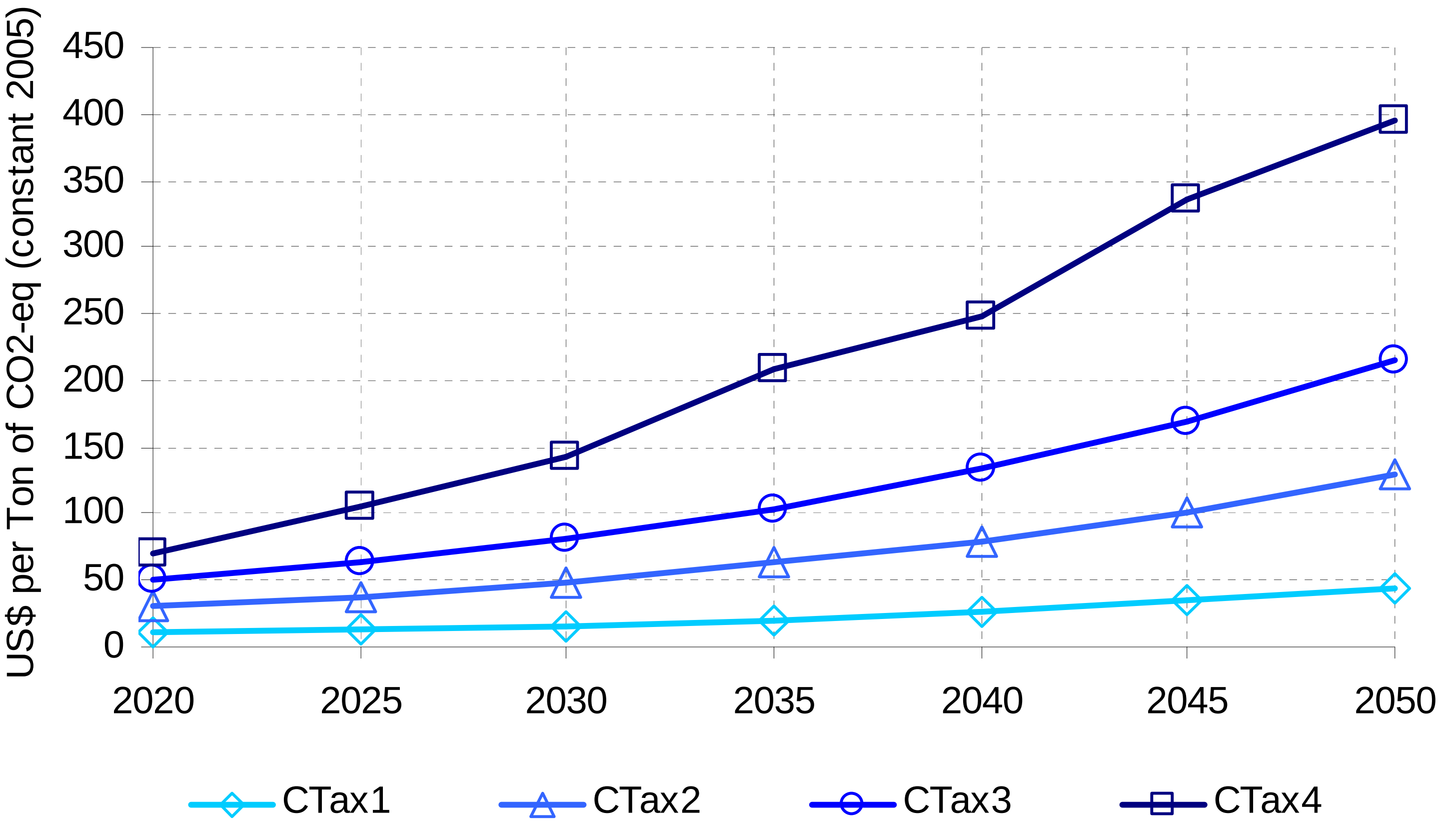


For a deeper analysis of Copenhagen Accord: Carraro and Massetti (2010), UNEP (2010)

- China pledged to reduce the emissions intensity of output by 40/45% wrt 2005
- EMF 22 data shows that target in BaU for 9 out of 15 models, median at -40%

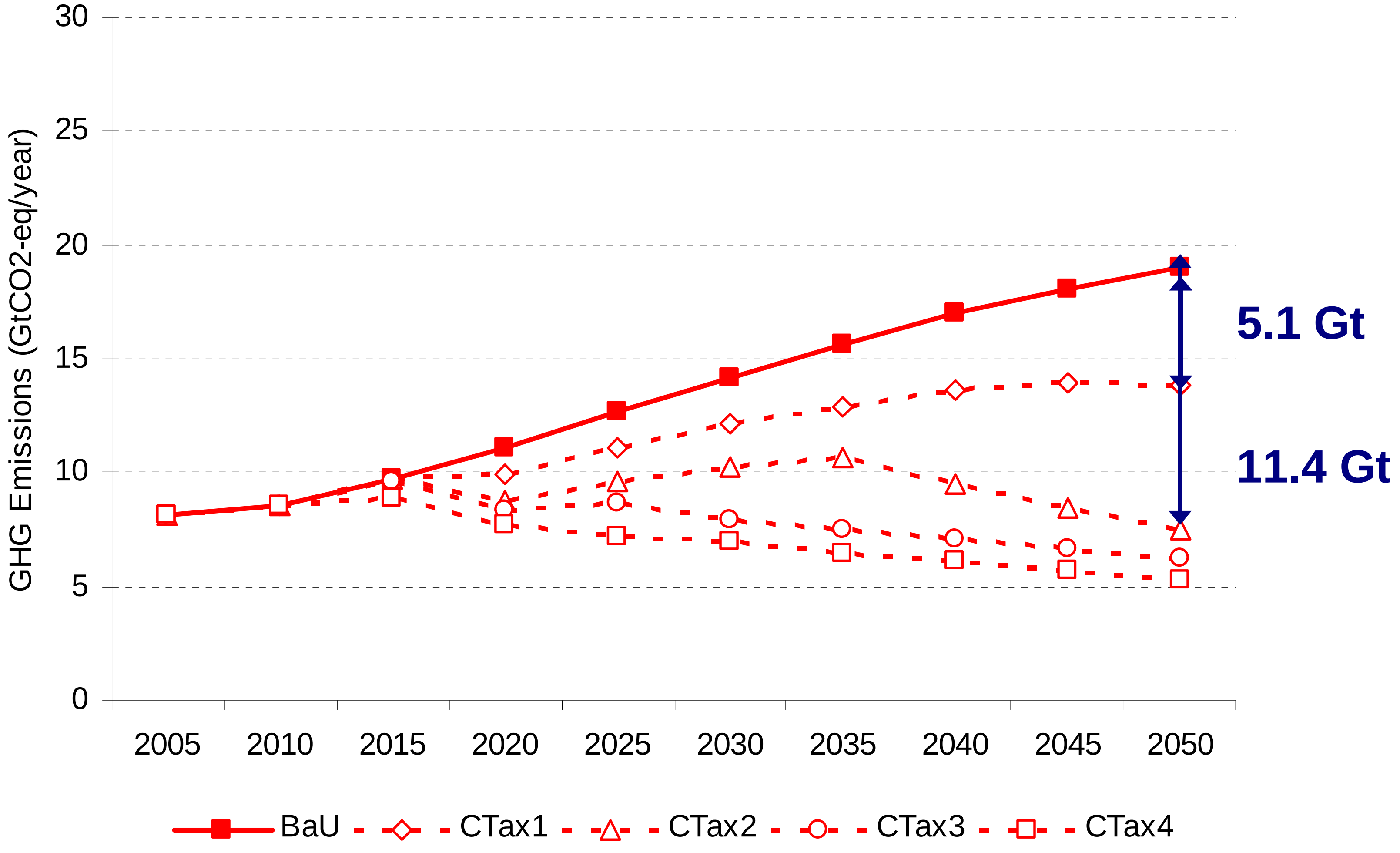
The emissions tax scenarios

13. The emissions tax scenarios

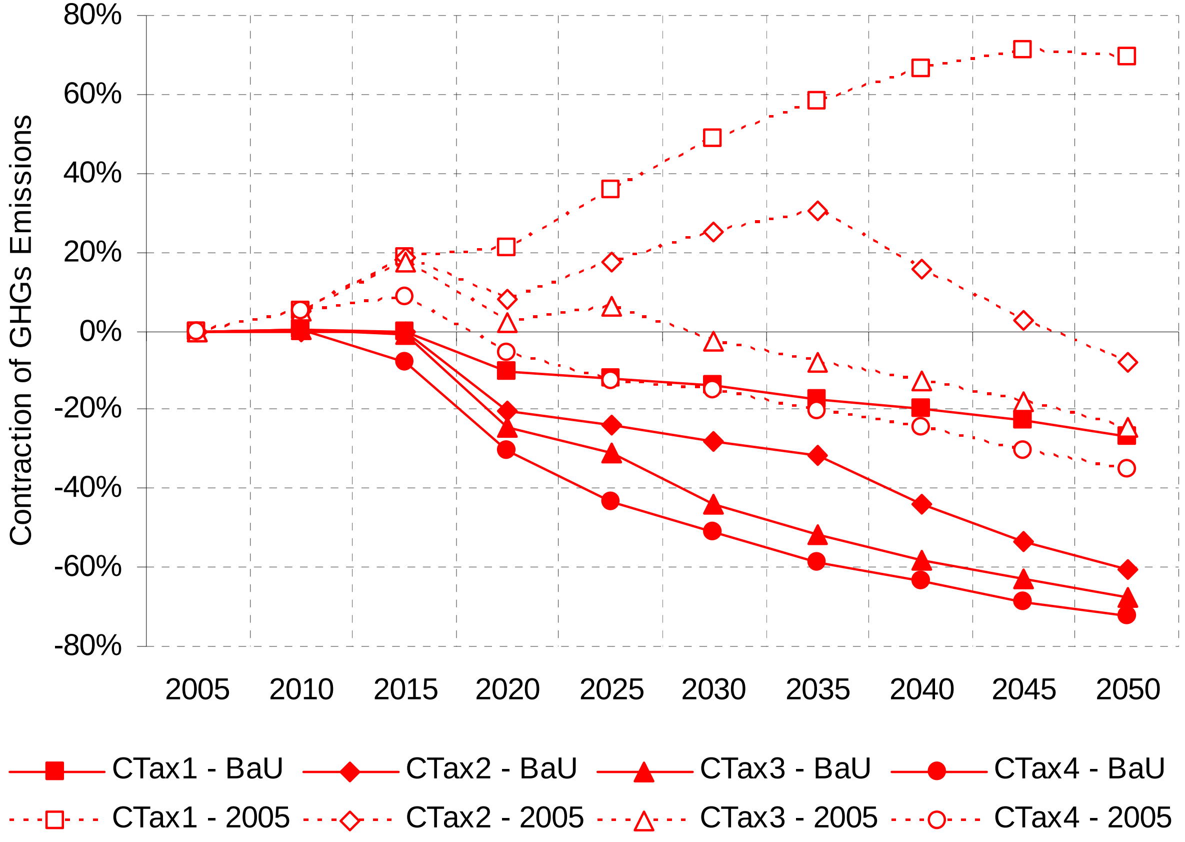


- CTax4 is coherent with 535ppm target at 2100 (median +2.5°C)
- Lump-sum domestic rebate of emissions taxes

14. GHGs emissions in China



15. GHGs emissions wrt the BaU and 2005



- G8-MEF target for 2050: -50% global, -80% G8 (wrt 2005 ?)
- Developing countries at least -25% wrt 2005.

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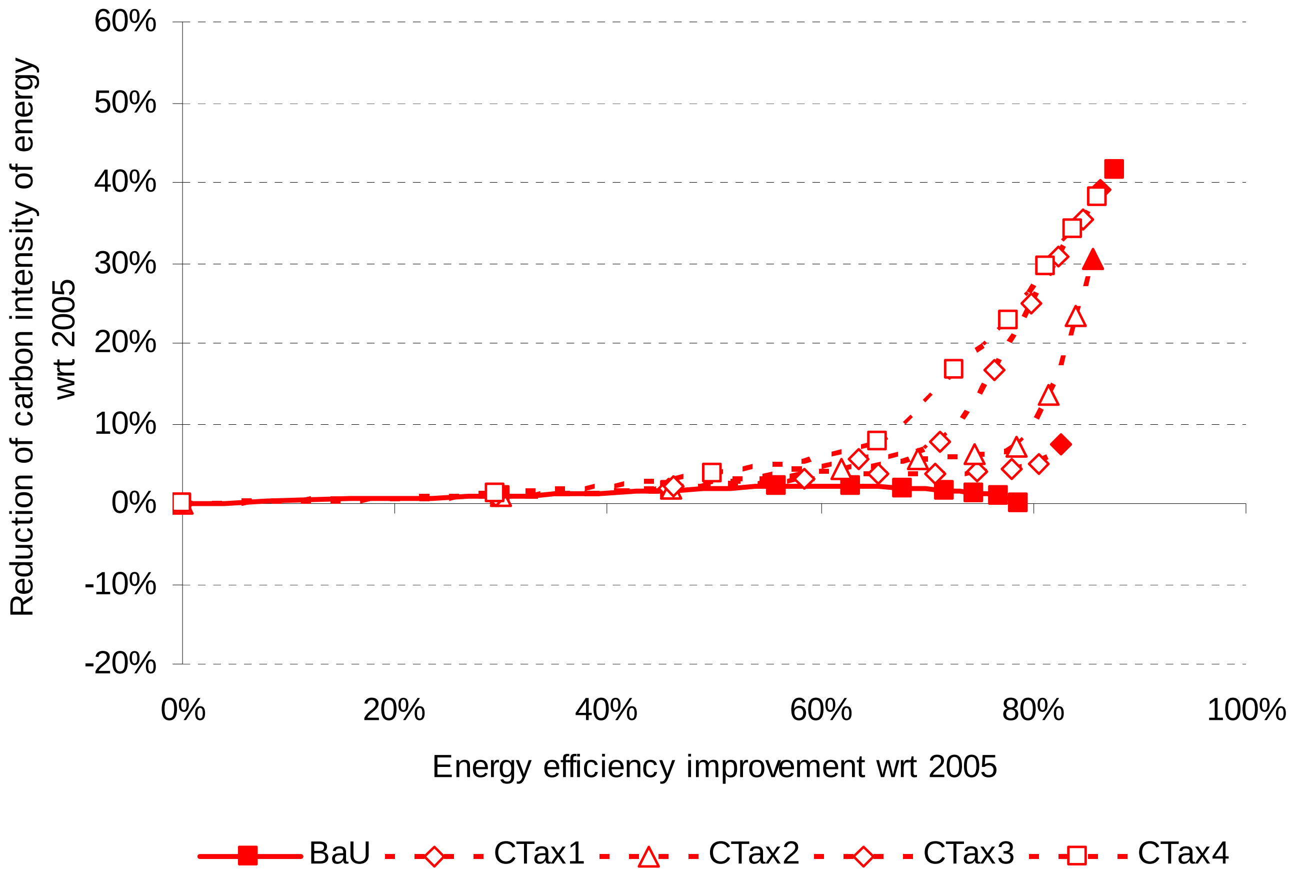
16. Two main directions for change



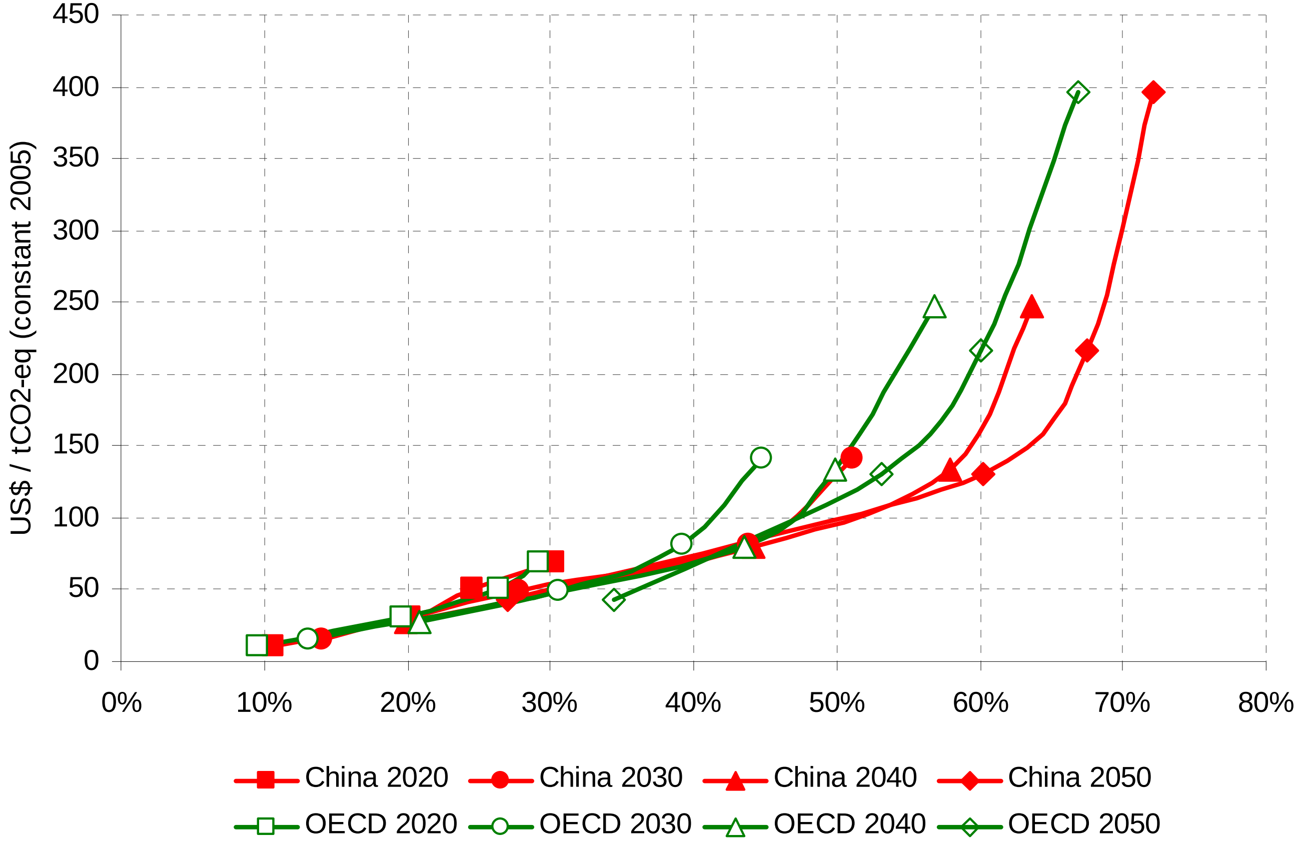
- Up-ward (down-ward) movement signals reduction (increase) of carbon intensity of Energy
- Right-ward movement signals reduction of energy intensity of GDP

17. Total primary energy supply

	COAL (NO CCS)	GAS	OIL	NUCLEAR	WIND and SOLAR	TPES
2030-2005 (average per year)						
BaU	2.5%	3.9%	3.9%	4.6%	7.9%	2.7%
CTax1	1.8%	4.0%	3.9%	5.7%	9.3%	2.3%
CTax2	0.8%	3.9%	3.6%	7.4%	11.4%	1.7%
CTax3	-0.8%	4.0%	3.6%	8.6%	12.8%	1.3%
CTax4	-1.6%	3.4%	3.1%	9.0%	13.3%	1.1%
2050-2005 (average per year)						
BaU	2.2%	2.8%	2.9%	3.8%	7.8%	2.2%
CTax1	1.3%	3.0%	2.7%	5.2%	9.6%	1.7%
CTax2	-0.5%	2.7%	2.2%	6.7%	11.6%	1.2%
CTax3	-1.2%	2.8%	1.8%	7.1%	12.2%	1.1%
CTax4	-1.4%	2.1%	1.2%	7.5%	12.8%	0.9%

- Nuclear and renewables are the two fastest growing technologies in all scenarios
- Coal without Carbon Capture and storage has steepest decline

18. Marginal abatement cost curves



- Abatement potential expressed in percentage of emissions reductions in the BaU for comparability.

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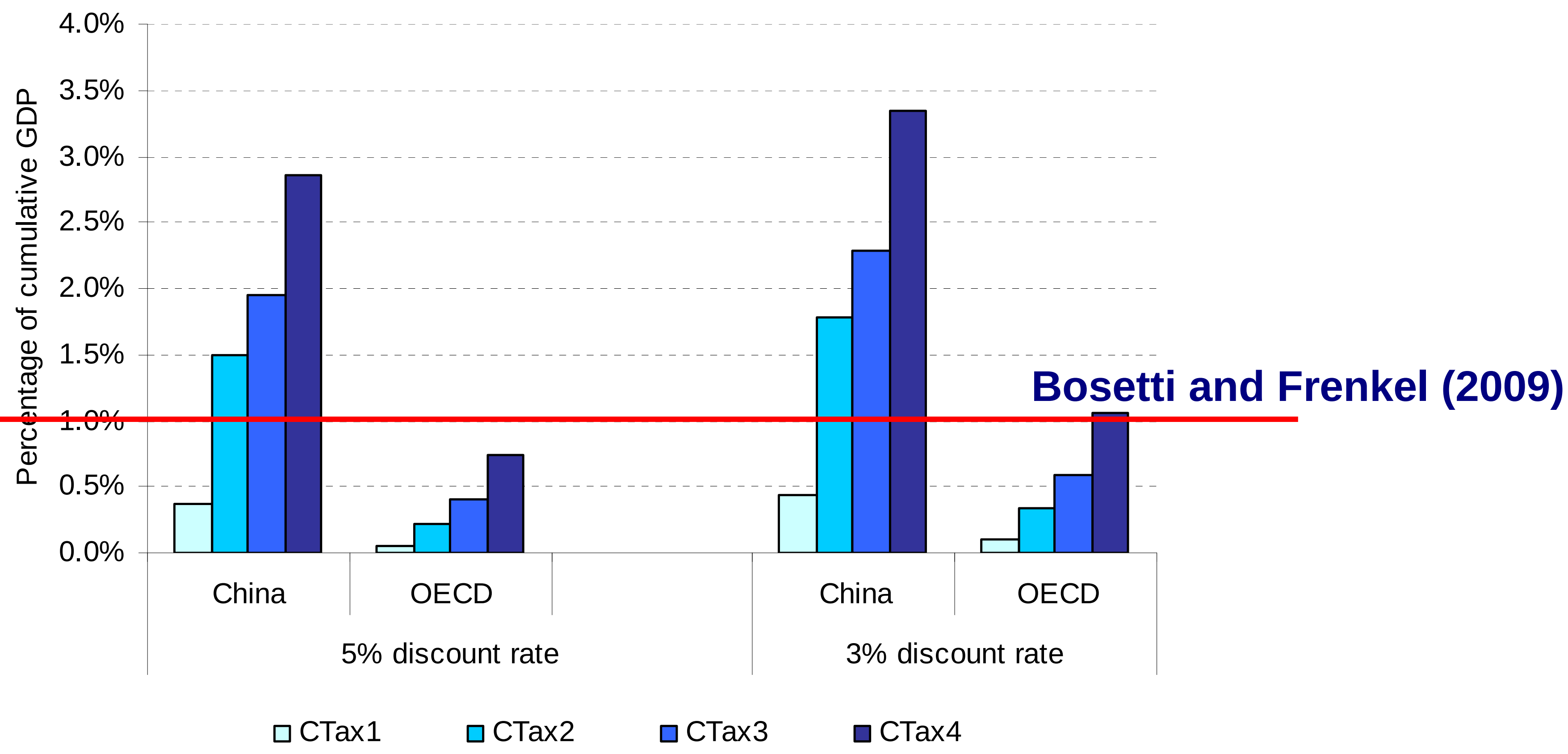
19. The cost of reducing GHGs emissions



- Costs are expressed as the ratio between the discounted sum of GDP losses with respect to the BaU scenario and cumulative discounted GDP in the BaU scenario

20. Conclusions - 1

- China’s emissions are likely to grow substantially in the next decades.

- China will therefore be in the peculiar position of being the greatest emitter of GHGs but at the same time not rich enough to afford costly abatement measures.

- The Chinese Cop15 pledge seems already embedded in reference scenarios that include strong energy efficiency improvements: domestic concerns higher than international ones.

- Marginal abatement costs lower in China than in other economies. Higher aggregate costs.

21. Conclusions - 2

- A mild commitment to introduce some sort of emissions pricing in China is much needed in a post-2020 climate architecture.
- If costs < 1%, China would accept only the lowest tax scenario.
- Emissions decline by 25% wrt BaU, but still increase by 60% with respect to 2005.
- Not compatible with G8 and MEF goal of -50% globally in 2050.
- A tax starting from 50 US$ per ton of CO_2-eq in 2020 would be needed to deliver the 25 percent reduction of emissions, but too costly for China (2.0/2.5 percent of GDP).

emanuele.massetti@feem.it
www.feem.it

www.economicsclimatechange.com

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www.witchmodel.org