# Impact of Revised $CO_2$ Growth Projections for China on Global Stabilization Goals

Geoffrey J. Blanford, Richard G. Richels
and Thomas F. Rutherford

NOTA DI LAVORO 68.2008

**SEPTEMBER 2008**

CCMP – Climate Change Modelling and Policy

Geoffrey J. Blanford, *Electric Power Research Institute, USA*
Richard G. Richels, *Electric Power Research Institute, USA*
Thomas F. Rutherford, *Centre for Energy Policy and Economics, Switzerland*

Corso Magenta, 63, 20123 Milano (I), web site: www.feem.it, e-mail: working.papers@feem.it

# Impact of Revised $CO_2$ Growth Projections for China on Global Stabilization Goals

## Summary

Recent growth in carbon dioxide emissions from China's energy sector has exceeded expectations. In a major US government study of future emissions released in 2007 (1), participating models appear to have substantially underestimated the near-term rate of increase in China's emissions. We present a recalibration of one of those models to be consistent with both current observations and historical development patterns. The implications of the new specification for the feasibility of commonly discussed stabilization targets, particularly when considering incomplete global participation, are profound. Unless China's emissions begin to depart soon from their (newly projected) business-as-usual path, stringent stabilization goals may be unattainable. The current round of global policy negotiations must engage China and other developing countries, not to the exclusion of emissions reductions in the developed world and possibly with the help of significant financial incentives, if such goals are to be achieved. It is in all nations' interests to work cooperatively to limit our interference with the global climate.

**Keywords:** Energy-Economy Modeling, China, Economic Growth Rates, Energy Intensity, International Climate Policy

**JEL Classification:** Q48, H23, O13

*We thank participants in a workshop at the Pacific Northwest National Laboratory for helpful comments. This research was funded by the Electric Power Research Institute (EPRI). The views presented here are solely those of the individual authors, and do not necessarily represent the views of EPRI or its members.*

*Address for correspondence*

Geoffrey J. Blanford
Electric Power Research Institute
Palo Alto
California 94304
USA
E-mail: gblanford@epri.com

## Introduction

Growth rates in energy-related emissions of carbon dioxide in developing countries, particularly the People's Republic of China, have increased rapidly in recent years. Emissions from the original signatories to the Kyoto Protocol (known as "Annex B countries"), essentially the developed world and economies in transition, will almost certainly be surpassed by non-Annex B emissions before 2010. This crossing point had been projected by previous analyses to occur in 2020 or later (2). The main source of unexpected emissions growth is China. According to the historical record provided by Marland *et al.* (3), since 2000 the average annual growth rate in China's emissions has exceeded 10%, compared to 2.8% in the 1990's. Globally, the average growth rate since 2000 has been 3.3%, compared to 1.1% in the 1990's.

Raupach *et al.* (4) decompose emissions growth in several regions into the factors of the Kaya identity: population, per capita income, energy intensity of gross domestic product (GDP), and carbon intensity of energy. In China, the first and last factors have been stable: population growth is slow, and carbon intensity has remained consistently high due to heavy reliance on coal. Emissions growth has been driven by a combination of rapid economic development and the reversal of the past trend of energy intensity decline. Between 1980 and 2000, energy intensity in China had been falling faster than in any other major economy. This decline has been attributed to efficiency improvements at the firm level as market reforms privatized formerly state-operated enterprises (5). However, since 2000, energy use has not only kept pace with, but slightly exceeded aggregate economic growth, driven primarily by industrial demand and coal-fired electric generation (6,7) (Fig. 1). The International Energy Agency (IEA) reports that over 100 GW of new electric generation capacity was added in 2006, of which at least 80 GW was coal-fired (8). While this rate may not be indicative of an annual average, it represents coal plant construction in a single year equivalent to one quarter of the US coal fleet. Despite some uncertainty about the accuracy of China's national data sources, it has likely become the world leader in carbon emissions, surpassing the US in 2006 (9).

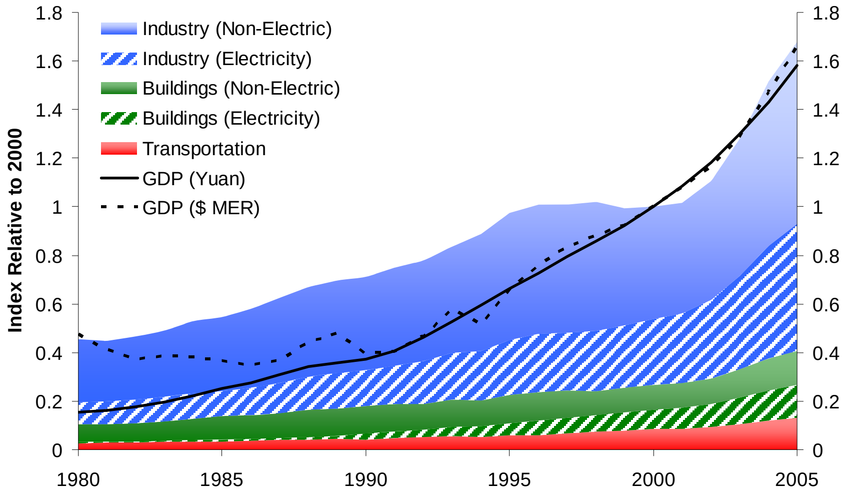

**Figure 1. Primary energy in China relative to economic growth.**

Real GDP grew faster than primary energy in China between 1980 and 2000. Since 2000, energy has grown faster than the economy. Dollar figures are converted using market exchange rates (MER). Growth in constant dollars converted using purchasing power parity (PPP) rates coincides with growth in constant local currency.

Baseline (i.e. business-as-usual) projections of growth in China's emissions in the near- to medium-term (e.g. through 2030) have until very recently been modest. The IEA's World Energy Outlook (WEO) for 2000 (10) reported an average growth rate of 3% in its reference case over its 1997 – 2020 time horizon. The 2005 edition of the WEO (11) revised the rate downwards to 2.4% between 2003 and 2030. This projection likely seemed plausible at the time, given the 1-2 year lag in accurate observations and the anomalous dip in emissions statistics in the late 1990's (3). However, as a pattern of rapid growth became evident, the 2007 WEO (8) reported a 2030 total over 50% higher than the 2005 edition's projection. The IEA's projections are significant because many modeling studies use them to calibrate baseline emissions paths, either formally or informally. A prominent example in the US was the report commissioned by the federal government's Climate Change Science Program (CCSP), written in 2006 and released in 2007 (1), comparing reference and coordinated stabilization scenarios by three economic modeling teams. Two of the models used year 2000 emissions as a starting point, while the third used 2005, but in all three the growth rates in China matched the IEA's unadjusted projections of the 2000-05 era. Fig. 2 shows the various IEA reference forecasts, along with the CCSP report range, in the context of observed historical emissions as reported by the Oak Ridge National Laboratory (ORNL) (3) [including the Netherlands Environmental Assessment Agency (MNP) figure for 2007 (12)].

The latest IEA estimates may even still be underestimating China's potential growth. Auffhammer and Carson (13) give econometric forecasts of China's emissions path through 2010 using a province-level dataset up to 2004 and applying a variety of alternative model structures. The models with the best dynamic fit to the sample data indicate the potential for annual fossil fuel emissions to reach 2.25 billion tons of carbon (GtC) by 2010 (also depicted in Fig. 2), a sharp increase from the MNP's reported total of 1.65 GtC for 2007. This estimate for 2010 is almost double the IEA's 2005 forecast of 1.25 GtC for that year, and significantly larger than the linearly interpolated 2010 level of 1.87 GtC from the 2007 forecast. Thus growth in China is so rapid that it is difficult to predict emissions just two years from now.

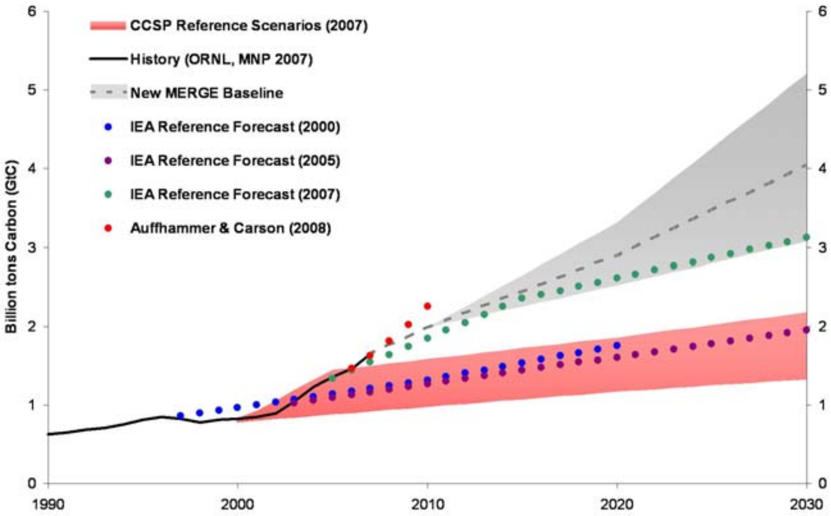

**Figure 2**. **Energy-related $CO_2$ emissions in China**.

Historical emissions began increasingly rapidly after 2001. IEA forecasts did not detect the acceleration until after 2005, and projections in the 2007 CCSP report reflected earlier forecasts. A 2008 econometric study projects an exponential extrapolation of the current annual growth rate through 2010. The new MERGE baseline projections reach 4 GtC by 2030 (dashed line) in the reference growth scenario, 3.1 GtC in the low scenario, and 5.2 GtC in the high scenario (bounds of the gray shaded region).

These observations warrant an update to assumptions about future growth used by the economic modeling community in climate policy studies. Accordingly, we have recalibrated one of the models used in the US CCSP report, the MERGE model (14,15). Fig. 2 shows new baseline energy-related carbon emissions projections in China, allowing for a range of possible growth rates. These projections are described in more detail here.

## Model Calibration

MERGE is an intertemporal optimization model with a top-down general equilibrium representation of the economy and a bottom-up process representation of energy technologies. In each region, exogenous trajectories for population and reference economic growth are used to derive a growth scenario for labor productivity (equivalent to per capita income). A nested production function is used to describe how aggregate economic output depends upon the inputs of capital, labor, electric and non-electric energy. Energy prices are determined endogenously in the model as a result of resource scarcity, technological change, and policy constraints.

The rate of increase in energy demand relative to economic growth is determined both by price-induced shifts among inputs to production (as determined by elasticities in the production function) and by autonomous (i.e. non price-induced) changes in energy intensity. Such changes can occur due to both technological progress (e.g. end-use efficiency) and structural changes in the economy (e.g. shifts away from manufactured goods toward services). All sources of non-price-induced changes in energy intensity are summarized in MERGE by a single “autonomous energy efficiency index” (AEEI) parameter, which operates as a scaling factor on the energy input into production. The exogenous choices of growth rate and AEEI are the key parameters for incorporating updated assumptions about development patterns and energy use in emerging economies.

MERGE operates in 10 year time steps with 2000 as the base year. To ensure that the model replicates observed growth during the current decade, we use GDP projections from IMF (2008) for 2010 to determine the average annual growth rate since 2000. To best capture real growth as a driver for energy demand, we observe the rate of growth in terms of constant local currency. For aggregated regions, observed growth rates are calculated using purchasing power parity (PPP) weights. However, the relative size of economies in the model's base year is measured in terms of market exchange rates. After 2010, we consider three possible growth scenarios for developing countries: a reference scenario and two outliers. Table 1 shows the annual average growth rates in aggregate GDP, population, and labor productivity / per capita income through 2030 in China and India for the three scenarios. Although MERGE runs on a 100-year timescale, we focus on the approaching decades for this study.

**Table 1: Exogenous Growth Rates in MERGE**

| | | Aggregate GDP | | | Population | | | Labor Productivity | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2000 – 2010 | 2010 – 2020 | 2020 – 2030 | 2000 – 2010 | 2010 – 2020 | 2020 – 2030 | 2000 – 2010 | 2010 – 2020 | 2020 – 2030 |
| China | Low | **9.9%** | 4.5% | 3.6% | 0.6% | 0.5% | 0.3% | **9.2%** | 4.0% | 3.3% |
| | Ref | | 6.0% | 4.8% | | | | | 5.5% | 4.5% |
| | High | | 7.5% | 6.0% | | | | | 7.0% | 5.7% |
| India | Low | **7.5%** | 4.9% | 4.1% | 1.5% | 1.2% | 0.9% | **5.9%** | 3.6% | 3.2% |
| | Ref | | 6.5% | 5.5% | | | | | 5.2% | 4.6% |
| | High | | 8.1% | 6.9% | | | | | 6.8% | 5.9% |

The reference scenario growth rates are roughly consistent with projections in IEA (2007). In the case of China, the high growth rates match those used by modelers in that country (e.g. Jiang and Hu, 2006) to represent the continued achievement of the government's goals. The low growth scenario reflects the possibility of a (relative) slowdown, perhaps due to short-term bottlenecks in material inputs as capacity expands. Population growth rates are based on the most recent central UN estimate. Over the remainder of the century, we assume that growth rates gradually decline, reaching 1% for both aggregate and per capita GDP with a stabilized population.

Choosing appropriate values for the AEEI parameter is less straightforward. The autonomous component of energy intensity change can be difficult to separate from price effects in the observed record. For the developed economies such as the US, previous work has supported the assumption of roughly 1% per year decline in energy intensity due to non-price-induced changes. This decline is the net effect of shifts toward less energy intensive industries, improvements in end-use energy efficiency (energy requirement per service unit), and increases in service demand with wealth (a diminishing effect at high income levels). For economies in earlier stages of development, the pattern could be very different. A casual observer might conclude that because developing countries tend to rely on energy intensive industries to begin building their economies, and tend to increase service demand more rapidly as incomes rise, these two effects will dominate efficiency improvements initially, leading to an autonomous *increase* in energy intensity during this stage rather than a decline. On the other hand, it has also been proposed that faster economic growth leads to a higher turnover rate in the capital stock, which in turn accelerates the introduction of end-use efficiency improvements. The latter proposal has been applied in previous MERGE studies by assuming a faster rate of autonomous decline in China and India than in the US.

The reality is that each country's experience is unique. China and India provide two very distinct pictures. As discussed above, changes in China's institutions in recent decades allowed a correction from very inefficient industrial practices, overwhelming all other effects and driving a steep decline in energy intensity from very high levels (similar to current trends in the Former Soviet Union). With the saturation of this effect and the emergence of strong growth in energy intensive industries in China, the current decade has seen an abrupt return to the more conventional model of rising energy intensity. Meanwhile, in India, energy intensity prior to the current decade had remained fairly constant, rising slightly but much lower than in China, and has fallen rapidly in the current decade, driven by a different and less energy-intensive industry mix. In choosing the AEEI parameter for developing countries, we have attempted to take into account current trends as well as judgments about the relevant stage and patterns of development.

The combined implications of our AEEI choices, elasticities, and energy prices in a no-policy baseline are reflected in Table 2, which shows average annual rates of change in primary energy and energy intensity for the decades in question in China and India. Note that while primary energy diverges across the three growth scenarios, energy intensity changes very little. There is undoubtedly uncertainty as to the future path of energy intensity, but we have elected to hold the AEEI parameter fixed and let the variation in economic growth rates determine the range of growth in primary energy and therefore emissions.

**Table 2: MERGE Results for Primary Energy and Intensity**

| | | Total Primary Energy | | | Energy Intensity | | |
|---|---|---|---|---|---|---|---|
| | | 2000 – 2010 | 2010 – 2020 | 2020 – 2030 | 2000 – 2010 | 2010 – 2020 | 2020 – 2030 |
| China | Low | **9.2%** | 2.4% | 2.1% | **-0.6%** | -1.9% | -1.3% |
| | Ref | | 3.8% | 3.4% | | -2.1% | -1.3% |
| | High | | 5.1% | 4.5% | | -2.3% | -1.4% |
| India | Low | **3.9%** | 2.8% | 2.8% | **-3.4%** | -1.9% | -1.2% |
| | Ref | | 4.2% | 4.4% | | -2.1% | -1.1% |
| | High | | 5.4% | 6.0% | | -2.5% | -1.0% |

In the new projections, emissions reach 2 GtC by 2010 and 3.1 to 5.2 GtC by 2030, two to three times higher than in the CCSP study released in 2007. The IEA's 2007 forecast follows the low end of our projected range. In comparison to previous MERGE studies, total baseline emissions projections from non-Annex B countries in the year 2030 have nearly doubled with the new reference specification; 80% of the increase is due to the revised treatment of China. Although India is often placed in the same category as China with respect to growth, its current emissions are one quarter the level of China's, and that fraction is likely to be smaller by the end of the decade.

## Historical Comparison

While current observations inform modeling choices about the beginning of the time horizon, it can be instructive to use historical experience in similar countries as a guide for future periods. The key variables are the rate of economic growth and changes in energy intensity. In the case of China, we consider time series data from four predominant Asian economies (Japan, Taiwan, Korea, and Malaysia) lagged to match China's 2006 income level of roughly $4,000 (in constant 2000 dollars using the World Bank's recently updated PPP exchange rates) (6,7,16). Per capita income in Malaysia reached this level in 1979, Korea in 1977, Taiwan in 1973, and Japan in 1959. Fig. 3 shows model projections for per capita income, energy intensity, and per capita energy use compared to the range of experience in these four countries.

From the $4,000 level, incomes in the sample countries grew over the subsequent 24 years to between $10,000 and $18,000. The central MERGE projection reaches $15,000 by 2030, and the outliers of its range correspond closely to the sample range. Thus the economic growth rates underlying our updated specification are consistent with the historical Asian experience. As discussed above, China's energy intensity was in decline prior to 2000, after which it has risen slightly. The sample countries all had lower energy intensity than China in 2006 in the year their income level stood at $4,000. However, during the subsequent period of growth, energy intensity did not decline in any of the sample countries. This observation reinforces the pattern of energy-fueled development into which China may be entering. On the other hand, China's government has stated its goals for economic rebalancing towards a less intensive mix (17,18), and energy prices for the foreseeable future (though subsidized in China) will likely be higher than in the period captured by the sample data. Therefore we assume a small net decline from 2000 in the current decade, followed by continued decline afterwards so that by 2030 China is in line with the historical range. Finally we compare total primary energy use per capita. This metric is attractive because it summarizes the implications of growth assumptions without relying on the conversion of economic quantities across time and space, which are often speculative and based on limited data. Although per capita energy use was lower in the sample countries in the starting year (a consequence of lower energy intensity at the same income level), growth in subsequent years was rapid. China appears to have taken off slightly earlier than its predecessors in the Asian sphere, but with the comparatively fast reduction in energy intensity, our projections to 2030 again correspond closely to the sample range. The MERGE reference case projects roughly 130 GJ per capita in China by 2030 (current use in Japan and Western Europe is roughly 175 GJ; in the US, 330 GJ). Whichever model China follows in the long run, our projections for energy use in the upcoming decades are entirely plausible given the experience of its neighbors.

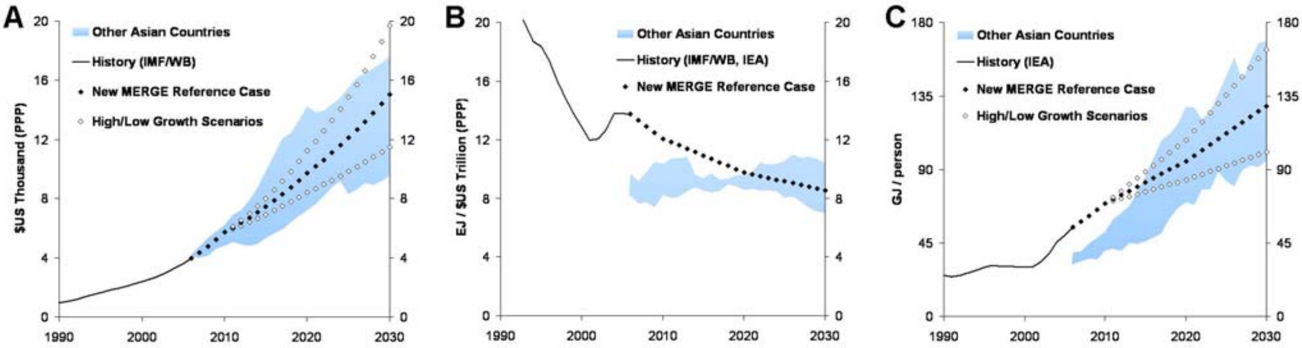

**Figure 3. MERGE projections relative to historical experience in Asia.**

(**A**) Growth rates in per capita income (measured in constant 2000 PPP dollars) in other Asian countries were similar to current projections for China. (**B**) Energy intensity changes, the net effect of structural shifts in the economy, improvements in end-use energy efficiency, and increases in service demand with wealth, were minimal in other Asian countries while decline is projected for China (only one scenario is considered). (**C**) Per capita energy use has risen more quickly in China, but it is projected to follow historical patterns as energy intensity declines.

## Global Implications

If China and other developing countries are growing much faster than anticipated, what are the implications for stabilization goals currently being discussed by policy-makers in Annex B?  The US CCSP report examined four stabilization scenarios, the two most stringent corresponding to atmospheric carbon dioxide concentrations of 450 and 550 ppmv. For each scenario, modelers calculated the pathway of global carbon emissions consistent with the stabilization target.  The updated growth rates bring a new urgency to the question of incomplete global participation in abatement.  As shown in Fig. 4, emissions from the non-Annex B countries alone meet or exceed the global allowable total for stabilization regimes in the near future.  The current and expected future rates of growth in developing countries juxtaposed with the proximity of the targets under discussion reveal a very narrow window of feasibility.  If the price of carbon outside of Annex B is effectively zero for roughly the next decade, Annex B emissions must be completely eliminated by 2020, followed by rapid reductions outside of Annex B after 2020, in order to keep atmospheric $CO_2$ concentrations below 450 ppmv.  With a 550 target, the window is only a decade wider, and both are even smaller if growth in emissions follows the high scenario.  Moreover, reductions in Annex B emissions at this pace are likely not realistic.  Global policy measures must engage developing countries, especially China, in a meaningful way soon if stringent stabilization goals are to be achieved.  Such engagement certainly must not preclude emissions reductions in Annex B, and may require significant financial incentives from the developed world, depending on the negotiated burden-sharing scheme. It is in all nations' interests to work cooperatively to limit our interference with the global climate.

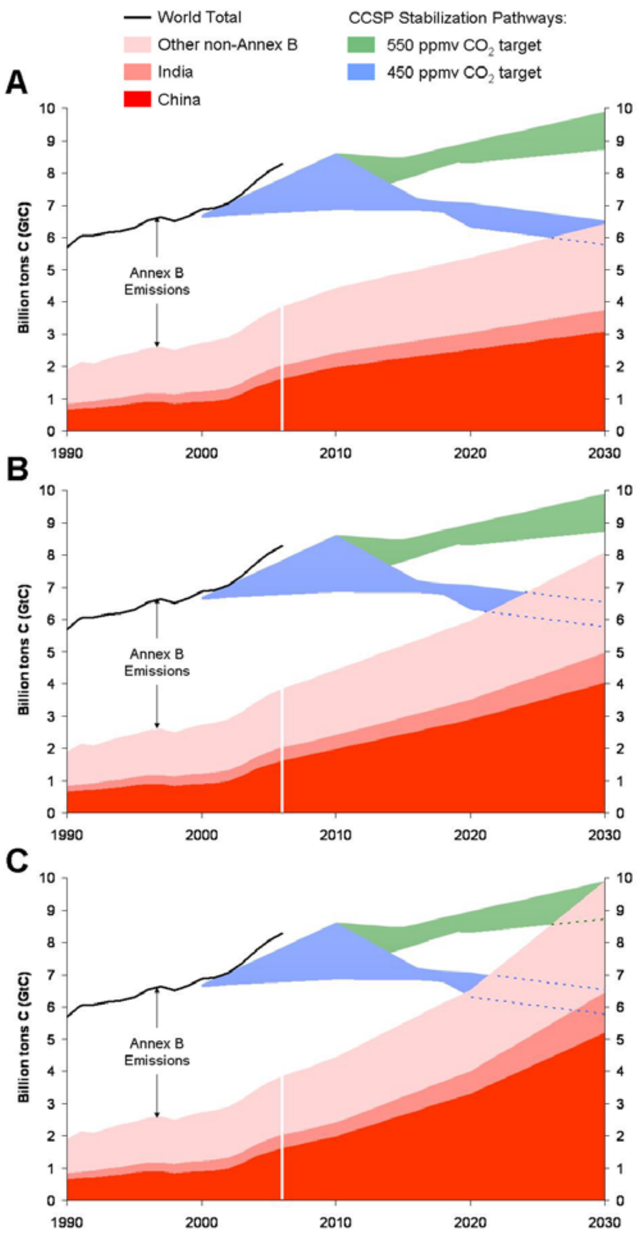

**Figure 4. New baseline emission projections relative to stabilization pathways.**

Historical global emissions allocated to Annex B, China, India, and other non-Annex B countries are shown. After 2006, the data reflect new MERGE projections for baseline emissions through 2030 in non-Annex B countries, with growth rates corresponding to the low scenario (**A**), reference scenario (**B**), and high scenario (**C**). The range of global emissions consistent with the 450 ($CO_2$ only) stabilization target in the CCSP report intersects non-Annex B baseline emissions between 2020 and 2025; for the 550 target, the intersection occurs in 2025 for the high growth scenario and after 2030 for the other scenarios.

## References

---

1. Clarke, L. *et al.* (2007). Scenarios of Greenhouse Gas Emissions and Atmospheric Concentrations. Sub-report 2.1A of Synthesis and Assessment Product 2.1 by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Department of Energy, Office of Biological & Environmental Research, Washington, DC, USA.
2. Weyant, J.P. *et al.* (1999). The costs of the Kyoto Protocol: a multi-model evaluation. *Energy Journal*, Special Issue.
3. Marland, G. *et al.* (2007). Global, Regional, and National Fossil Fuel $CO_2$ Emissions. In Trends: A Compendium of Data on Global Change. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., USA.
4. Raupach, M. *et al.* (2007). Global and regional drivers of accelerating $CO_2$ emissions. Proceedings of the National Academy of Sciences, USA.
5. Fisher-Vanden, K., G.H. Jefferson, H. Liu, and Q. Tao (2004). What is driving China's decline in energy intensity? *Resource and Energy Economics* **26**:1, pp 77-97.
6. IMF (2008). World Economic Outlook 2008. International Monetary Fund, Washington, DC, USA.
7. IEA (2007a). World Energy Statistics 2007. International Energy Agency, Paris, France.
8. IEA (2007b). World Energy Outlook 2007. International Energy Agency, Paris, France.
9. Gregg, J.S., R.J. Andres, and G. Marland (2008). China: Emissions patterns of the world leader of $CO_2$ emissions from fossil fuel consumption and cement production. *Geophys. Res. Lett.*, **35**, L08806, doi:10.1029/2007GL032887.
10. IEA (2000). World Energy Outlook 2000. International Energy Agency, Paris, France.
11. IEA (2005). World Energy Outlook 2005. International Energy Agency, Paris, France.
12. MNP (2008). Global $CO_2$ emissions: increase continued in 2007. Netherlands Environmental Assessment Agency.
13. Auffhammer, M. and R.T. Carson (2008). Forecasting the path of China's $CO_2$ emissions using province-level information. *J. Environ. Econ. Manage.*, doi:10.1016/j.jeem.2007.10.002..
14. Manne, A.S. and R.G. Richels (2005). MERGE: An Integrated Assessment Model for Global Climate Change. In *Energy and Environment*, R. Loulou, J. Waaub, and G. Zaccour, eds., pp 175-189. Springer, New York, NY, USA.
15. Richels, R.G., T.F. Rutherford, G.J. Blanford, and L. Clarke (2007). Managing the transition to climate stabilization. *Climate Policy* **7**:5, pp 409-428.
16. Heston, A., R. Summers, and B. Aten (2006). Penn World Table Version 6.2, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, USA.
17. Jiang, K. and X. Hu (2006). Energy demand and emissions in China: scenarios and policy options. *Environ. Pol. Stud.* **7** pp 233-250.
18. He, J. and L. Kuijs (2007). Rebalancing China's economy: modeling a policy package. World Bank China Research Paper No. 7.

We thank participants in a workshop at the Pacific Northwest National Laboratory for helpful comments. This research was funded by the Electric Power Research Institute (EPRI). The views presented here are solely those of the individual authors, and do not necessarily represent the views of EPRI or its members.

# NOTE DI LAVORO DELLA FONDAZIONE ENI ENRICO MATTEI

**Fondazione Eni Enrico Mattei Working Paper Series**

**Our Note di Lavoro are available on the Internet at the following addresses:**

http://www.feem.it/Feem/Pub/Publications/WPapers/default.htm
http://www.ssrn.com/link/feem.html
http://www.repec.org
http://agecon.lib.umn.edu
http://www.bepress.com/feem/

## NOTE DI LAVORO PUBLISHED IN 2008

| | | |
|---|---|---|
| CCMP | 1.2008 | *Valentina Bosetti, Carlo Carraro and Emanuele Massetti*: Banking Permits: Economic Efficiency and Distributional Effects |
| CCMP | 2.2008 | *Ruslana Palatnik and Mordechai Shechter*: Can Climate Change Mitigation Policy Benefit the Israeli Economy? A Computable General Equilibrium Analysis |
| KTHC | 3.2008 | *Lorenzo Casaburi, Valeria Gattai and G. Alfredo Minerva*: Firms' International Status and Heterogeneity in Performance: Evidence From Italy |
| KTHC | 4.2008 | *Fabio Sabatini*: Does Social Capital Mitigate Precariousness? |
| SIEV | 5.2008 | *Wisdom Akpalu*: On the Economics of Rational Self-Medication |
| CCMP | 6.2008 | *Carlo Carraro and Alessandra Sgobbi*: Climate Change Impacts and Adaptation Strategies In Italy. An Economic Assessment |
| ETA | 7.2008 | *Elodie Rouvière and Raphaël Soubeyran*: Collective Reputation, Entry and Minimum Quality Standard |
| IEM | 8.2008 | *Cristina Cattaneo, Matteo Manera and Elisa Scarpa*: Industrial Coal Demand in China: A Provincial Analysis |
| IEM | 9.2008 | *Massimiliano Serati, Matteo Manera and Michele Plotegher*: Econometric Models for Electricity Prices: A Critical Survey |
| CCMP | 10.2008 | *Bob van der Zwaan and Reyer Gerlagh*: The Economics of Geological $CO_2$ Storage and Leakage |
| KTHC | 11.2008 | *Maria Francesca Cracolici and Teodora Erika Uberti*: Geographical Distribution of Crime in Italian Provinces: A Spatial Econometric Analysis |
| KTHC | 12.2008 | *Victor Ginsburgh, Shlomo Weber and Sheila Weyers*: Economics of Literary Translation. A Simple Theory and Evidence |
| NRM | 13.2008 | *Carlo Giupponi, Jaroslav Mysiak and Alessandra Sgobbi*: Participatory Modelling and Decision Support for Natural Resources Management in Climate Change Research |
| NRM | 14.2008 | *Yaella Depietri and Carlo Giupponi*: Science-Policy Communication for Improved Water Resources Management: Contributions of the Nostrum-DSS Project |
| CCMP | 15.2008 | *Valentina Bosetti, Alexander Golub, Anil Markandya, Emanuele Massetti and Massimo Tavoni*: Abatement Cost Uncertainty and Policy Instrument Selection under a Stringent Climate Policy. A Dynamic Analysis |
| KTHC | 16.2008 | *Francesco D'Amuri, Gianmarco I.P. Ottaviano and Giovanni Peri*: The Labor Market Impact of Immigration in Western Germany in the 1990's |
| KTHC | 17.2008 | *Jean Gabszewicz, Victor Ginsburgh and Shlomo Weber*: Bilingualism and Communicative Benefits |
| CCMP | 18.2008 | *Benno Torgler, María A.GarcíaValiñas and Alison Macintyre*: Differences in Preferences Towards the Environment: The Impact of a Gender, Age and Parental Effect |
| PRCG | 19.2008 | *Gian Luigi Albano and Berardino Cesi*: Past Performance Evaluation in Repeated Procurement: A Simple Model of Handicapping |
| CTN | 20.2008 | *Pedro Pintassilgo, Michael Finus, Marko Lindroos and Gordon Munro* (lxxxiv): Stability and Success of Regional Fisheries Management Organizations |
| CTN | 21.2008 | *Hubert Kempf and Leopold von Thadden* (lxxxiv): On Policy Interactions Among Nations: When Do Cooperation and Commitment Matter? |
| CTN | 22.2008 | *Markus Kinateder* (lxxxiv): Repeated Games Played in a Network |
| CTN | 23.2008 | *Taiji Furusawa and Hideo Konishi* (lxxxiv): Contributing or Free-Riding? A Theory of Endogenous Lobby Formation |
| CTN | 24.2008 | *Paolo Pin, Silvio Franz and Matteo Marsili* (lxxxiv): Opportunity and Choice in Social Networks |
| CTN | 25.2008 | *Vasileios Zikos* (lxxxiv): R&D Collaboration Networks in Mixed Oligopoly |
| CTN | 26.2008 | *Hans-Peter Weikard and Rob Dellink* (lxxxiv): Sticks and Carrots for the Design of International Climate Agreements with Renegotiations |
| CTN | 27.2008 | *Jingang Zhao* (lxxxiv): The Maximal Payoff and Coalition Formation in Coalitional Games |
| CTN | 28.2008 | *Giacomo Pasini, Paolo Pin and Simon Weidenholzer* (lxxxiv): A Network Model of Price Dispersion |
| CTN | 29.2008 | *Ana Mauleon, Vincent Vannetelbosch and Wouter Vergote* (lxxxiv): Von Neumann-Morgenstern Farsightedly Stable Sets in Two-Sided Matching |
| CTN | 30.2008 | *Rahmi İlkiliç* (lxxxiv): Network of Commons |
| CTN | 31.2008 | *Marco J. van der Leij and I. Sebastian Buhai* (lxxxiv): A Social Network Analysis of Occupational Segregation |
| CTN | 32.2008 | *Billand Pascal, Frachisse David and Massard Nadine* (lxxxiv): The Sixth Framework Program as an Affiliation Network: Representation and Analysis |
| CTN | 33.2008 | *Michèle Breton, Lucia Sbragia and Georges Zaccour* (lxxxiv): Dynamic Models for International Environmental Agreements |

| | | |
|---|---|---|
| PRCG | 34.2008 | *Carmine Guerriero*: The Political Economy of Incentive Regulation: Theory and Evidence from US States |
| IEM | 35.2008 | *Irene Valsecchi*: Learning from Experts |
| PRCG | 36.2008 | *P. A. Ferrari and S. Salini*: Measuring Service Quality: The Opinion of Europeans about Utilities |
| ETA | 37.2008 | *Michele Moretto and Gianpaolo Rossini*: Vertical Integration and Operational Flexibility |
| CCMP | 38.2008 | *William K. Jaeger and Van Kolpin*: The Environmental Kuznets Curve from Multiple Perspectives |
| PRCG | 39.2008 | *Benno Torgler and Bin Dong*: Corruption and Political Interest: Empirical Evidence at the Micro Level |
| KTHC | 40.2008 | *Laura Onofri, Paulo A.L.D. Nunes, Jasone Cenoz and Durk Gorter*: Language Diversity in Urban Landscapes: An econometric study |
| CTN | 41.2008 | *Michel Le Breton, Valery Makarov, Alexei Savvateev and Shlomo Weber* (lxxxiv): Multiple Membership and Federal Sructures |
| NRM | 42.2008 | *Gideon Kruseman and Lorenzo Pellegrini*: Institutions and Forest Management: A Case Study from Swat, Pakistan |
| SIEV | 43.2008 | *Pietro Caratti and Ludovico Ferraguto*: Analysing Regional Sustainability Through a Systemic Approach: The Lombardy Case Study |
| KTHC | 44.2008 | *Barbara Del Corpo, Ugo Gasparino, Elena Bellini and William Malizia*: Effects of Tourism Upon the Economy of Small and Medium-Sized European Cities. Cultural Tourists and "The Others" |
| CTN | 45.2008 | *Dinko Dimitrov and Emiliya Lazarova*: Coalitional Matchings |
| ETA | 46.2008 | *Joan Canton, Maia David and Bernard Sinclair-Desgagné*: Environmental Regulation and Horizontal Mergers in the Eco-industry |
| ETA | 47.2008 | *Stéphane Hallegatte*: A Proposal for a New Prescriptive Discounting Scheme: The Intergenerational Discount Rate |
| KTHC | 48.2008 | *Angelo Antoci, Paolo Russu and Elisa Ticci*: Structural Change, Environment and Well-being: Interactions Between Production and Consumption Choices of the Rich and the Poor in Developing Countries |
| PRCG | 49.2008 | *Gian Luigi Albano, Federico Dini Roberto Zampino and Marta Fana*: The Determinants of Suppliers' Performance in E-Procurement: Evidence from the Italian Government's E-Procurement Platform |
| CCMP | 50.2008 | *Inmaculada Martínez-Zarzoso*: The Impact of Urbanization on CO2 Emissions: Evidence from Developing Countries |
| KTHC | 51.2008 | *Michele Moretto and Sergio Vergalli*: Managing Migration through Quotas: an Option-theory Perspective |
| KTHC | 52.2008 | *Ugo Gasparino, Elena Bellini, Barbara Del Corpo and William Malizia*: Measuring the Impact of Tourism Upon Urban Economies: A Review of Literature |
| ETA | 53.2008 | *Reyer Gerlagh, Snorre Kverndokk and Knut Einar Rosendahl*: Linking Environmental and Innovation Policy |
| KTHC | 54.2008 | *Oguzhan C. Dincer and Burak Gunalp*: Corruption, Income Inequality, and Poverty in the United States |
| PRCG | 55.2008 | *Carmine Guerriero*: Accountability in Government and Regulatory Policies: Theory and Evidence |
| KTHC | 56.2008 | *Tanmoyee Banerjee (Chatterjee) and Nilanjana Mitra*: Export, Assembly-line FDI or FDI with the Possibility of Technology Diffusion: Optimal Entry Mode for Multinationals |
| ETA | 57.2008 | *Xavier Pautrel*: Environmental Policy, Education and Growth: A Reappraisal when Lifetime Is Finite |
| CCMP | 58.2008 | *Natalia Zugravu, Katrin Millock and Gérard Duchene*: The Factors Behind CO2 Emission Reduction in Transition Economies |
| NRM | 59.2008 | *Benno Torgler, María A.García-Valiñas and Alison Macintyre*: Justifiability of Littering: An Empirical Investigation |
| SIEV | 60.2008 | *Paolo Rosato, Anna Alberini, Valentina Zanatta and Margaretha Breil*: Redeveloping Derelict and Underused Historic City Areas: Evidence from a Survey of Real Estate Developers |
| CTN | 61.2008 | *Ricardo Nieva*: Networks with Group Counterproposals |
| CTN | 62.2008 | *Michael Finus and Dirk T.G. Rübbelke*: Coalition Formation and the Ancillary Benefits of Climate Policy |
| SIEV | 63.2008 | *Elisabetta Strazzera, Elisabetta Cerchi and Silvia Ferrini*: A Choice Modelling Approach for Assessment of Use and Quasi-Option Values in Urban Planning for Areas of Environmental Interest |
| SIEV | 64.2008 | *Paolo Rosato, Lucia Rotaris, Margaretha Breil and Valentina Zanatta*: Do We Care about Built Cultural Heritage? The Empirical Evidence Based on the Veneto House Market |
| KTHC | 65.2008 | *Luca Petruzzellis and Antonia Rosa Guerrieri*: Does Network Matter in International Expansion? Evidence from Italian SMEs |
| NRM | 66.2008 | *Sheila M. Olmstead and Robert N. Stavins*: Comparing Price and Non-price Approaches to Urban Water Conservation |
| CCMP | 67.2008 | *Robert N. Stavins*: Addressing Climate Change with a Comprehensive U.S. Cap-and-Trade System |
| CCMP | 68.2008 | *Geoffrey J. Blanford, Richard G. Richels and Thomas F. Rutherford*: Impact of Revised $CO_2$ Growth Projections for China on Global Stabilization Goals |

(lxxxiv) This paper was presented at the 13th Coalition Theory Network Workshop organised by the Fondazione Eni Enrico Mattei (FEEM), held in Venice, Italy on 24-25 January 2008.