Executive Summary

The mitigation of noncarbon dioxide (non-CO_2) greenhouse gas emissions can be a relatively inexpensive supplement to CO_2-only mitigation strategies. The non-CO_2 gases include methane (CH_4), nitrous oxide (N_2O), and a number of high global warming potential (high-GWP) or fluorinated gases. These gases trap more heat within the atmosphere than CO_2 per unit weight. Approximately 30 percent of the anthropogenic greenhouse effect since preindustrial times can be attributed to these non-CO_2 greenhouse gases (Intergovernmental Panel for Climate Change [IPCC], 2001b); approximately 24 percent of GWP-weighted greenhouse gas emissions in the year 2000 are comprised of the non-CO_2 greenhouse gases (de la Chesnaye et al., in press; U.S. Environmental Protection Agency [USEPA], 2006).

Given the important role that mitigation of non-CO_2 greenhouse gases can play in climate strategies, there is a clear need for an improved understanding of the mitigation potential for non-CO_2 sources, as well as for the incorporation of non-CO_2 greenhouse gas mitigation in climate economic analyses. This report provides a comprehensive global analysis and resulting data set of marginal abatement curves (MACs) that illustrate the abatement potential of non-CO_2 greenhouse gases by sector and by region. This assessment of mitigation potential is unique because it is comprehensive across all non-CO_2 gases, across all emitting sectors of the economy, and across all regions of the world.

The analysis in this report is the latest refinement of the methodology on mitigation of various non-CO_2 gases, which has been underway since 1999. A significant contribution to the climate change mitigation literature is Stanford University's Energy Modeling Forum Working Group 21 (EMF-21), which focused on mitigation of multiple greenhouse gases and resulted in the publication of a special issue of the *Energy Journal* (see Weyant and de la Chesnaye, in press). The specific non-CO_2 mitigation papers in the EMF-21 study include energy- and industry-related CH_4 and N_2O (Delhotal et al., in press); agricultural-related CH_4 and N_2O (DeAngelo et al., in press); and industry-related fluorinated gases (Ottinger et al., in press). Much of the original work comes from three previous USEPA studies for the United States (2006, 2001, 1999) and a study conducted by the European Commission (EC) (2001) that evaluated technologies and costs of CH_4 abatement for European Union (EU) members from 1990 to 2010. These studies provided estimates of potential CH_4 and N_2O emissions reductions from major emitting sectors and quantified costs and benefits of these reductions.

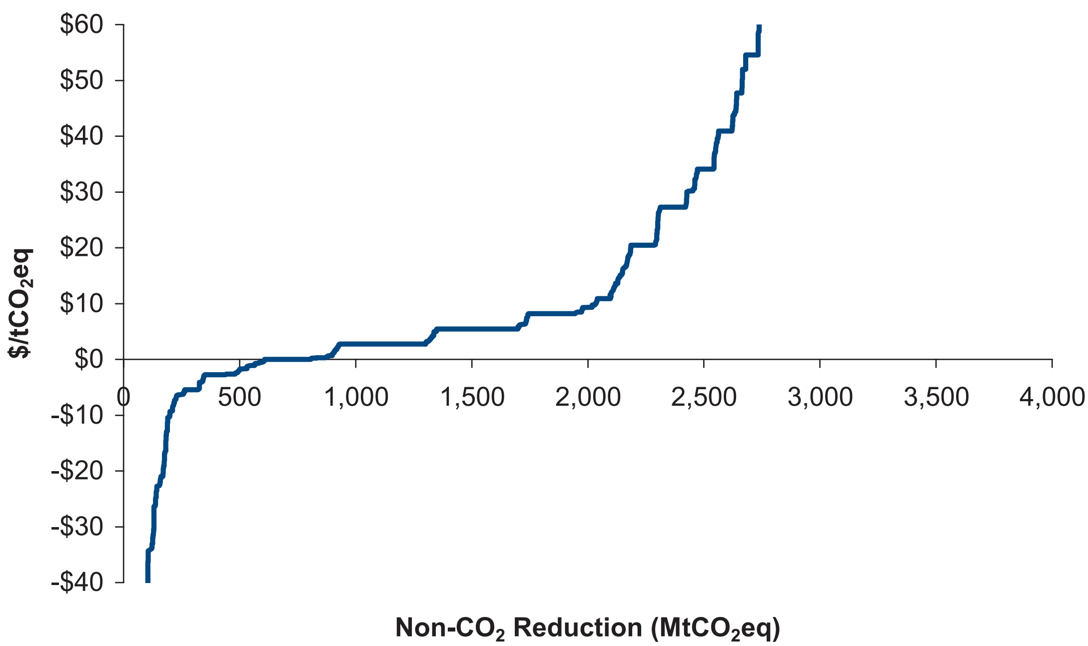
Building on the baseline non-CO_2 emissions projections from the USEPA's *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990–2020* (2006), this analysis applies mitigation options to the emissions baseline in each sector. Across all the emitting greenhouse gas sectors, for each mitigation option, the technical abatement potential and cost are calculated. The MACs are determined by the series of breakeven price calculations for the suite of available options for each sector and region. Each point along the curve indicates the abatement potential given the economically feasible mitigation technologies at a given breakeven price. This report makes no explicit assumption about policies that would be required to facilitate and generate adoption of mitigation options. Therefore, this report provides estimates of technical mitigation potential.

The result of these efforts is a set of MACs that allow for improved understanding of the mitigation potential for non-CO_2 sources, as well as inclusion of non-CO_2 greenhouse gas mitigation in economic modeling. The MAC data sets can be downloaded in spreadsheet format from the USEPA Web site at <http://www.epa.gov/nonco2/econ-inv/international.html>.

Highlights of this analysis include the following:

Mitigation of Non-CO_2 Gases Can Play an Important Role in Climate Strategies. Worldwide, the potential for "no-regret" non-CO_2 greenhouse gas abatement is significant. Figure ES-1 shows the global total aggregate MAC for the year 2020. Without a price signal (i.e., at \$0/tCO_2eq), the global mitigation potential is greater than 600 million metric tons of CO_2 equivalent (MtCO_2eq), or 5 percent of the baseline emissions (refer to Section I.3.3 of this report for a more detailed explanation of unrealized mitigation potential in the MACs). As the breakeven price rises, the mitigation potential grows. Significant mitigation opportunities could be realized in the lower range of breakeven prices. The global mitigation potential at a price of \$10/tCO_2eq is greater than 2,000 MtCO_2eq, or 15 percent of the baseline emissions, and greater than 2,185 MtCO_2eq or 17 percent of the baseline emissions at \$20/tCO_2eq. In the higher range of breakeven prices, the MAC becomes steeper, and less mitigation potential exists for each additional increase in price.

Figure ES-1: Global Total Aggregate MAC for Non-CO_2 Greenhouse Gases in 2020



Globally, the Sectors with the Greatest Potential for Mitigation of Non-CO_2 Greenhouse Gases are the Energy and Agriculture Sectors. Figure ES-2 shows the global MACs by economic sector in 2020. At a breakeven price of \$30/tCO_2eq, the potential for reduction of non-CO_2 greenhouse gases is nearly 1,000 MtCO_2eq in the energy sector, and approximately 600 MtCO_2eq in the agriculture sector. While less than that of the energy and agriculture sectors, mitigation potential in the waste and industrial processes sectors can play an important role, particularly in the absence of a carbon price incentive.

Methane Mitigation has the Largest Potential across All the Non-CO_2 Greenhouse Gases. Figure ES-3 shows the global MACs by greenhouse gas type for 2020. At or below \$0/tCO_2eq, the potential for CH_4 mitigation is approximately 500 MtCO_2eq. The potential for reducing CH_4 emissions grows to nearly 1,800 MtCO_2eq as the breakeven price rises from \$0 to \$30/tCO_2eq. While less than that of CH_4, N_2O and high-GWP gases exhibit significant mitigation potential at or below \$0/tCO_2eq.

Figure ES-2: Global 2020 MACs for Non-CO_2 Greenhouse Gases by Major Sector

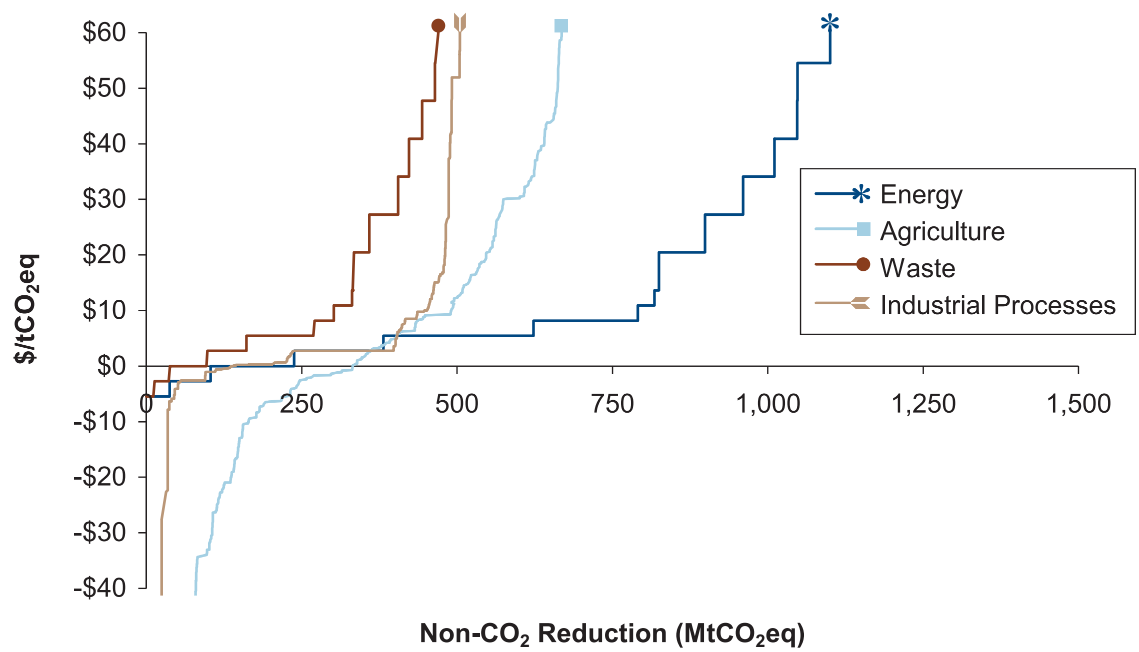
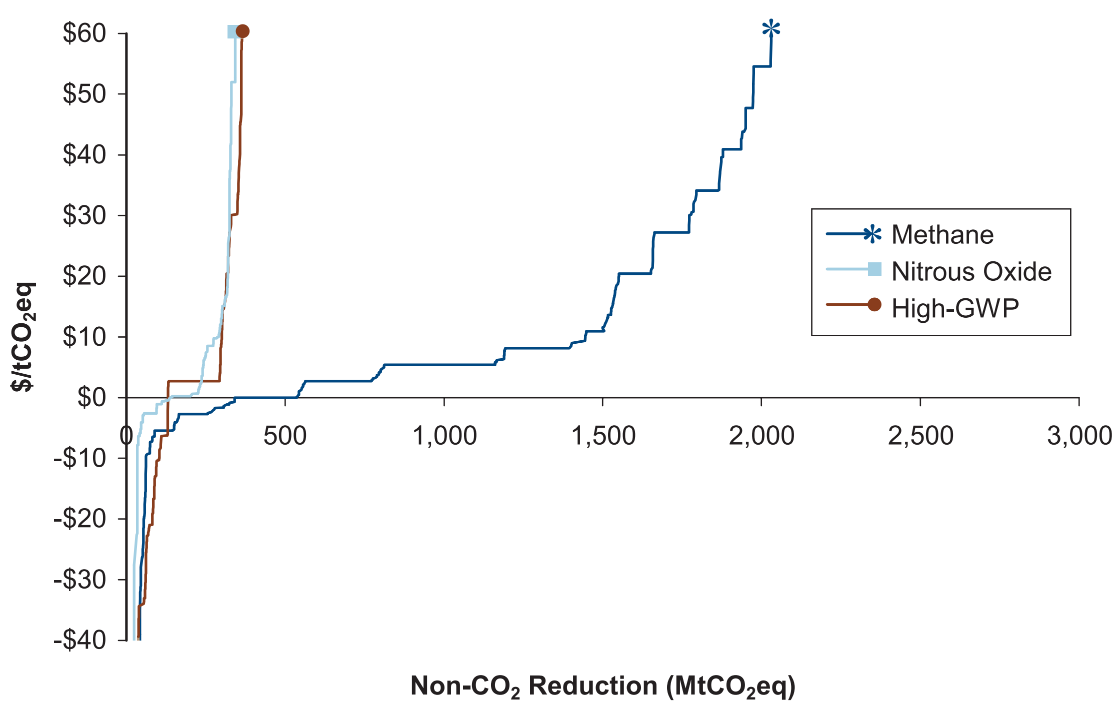
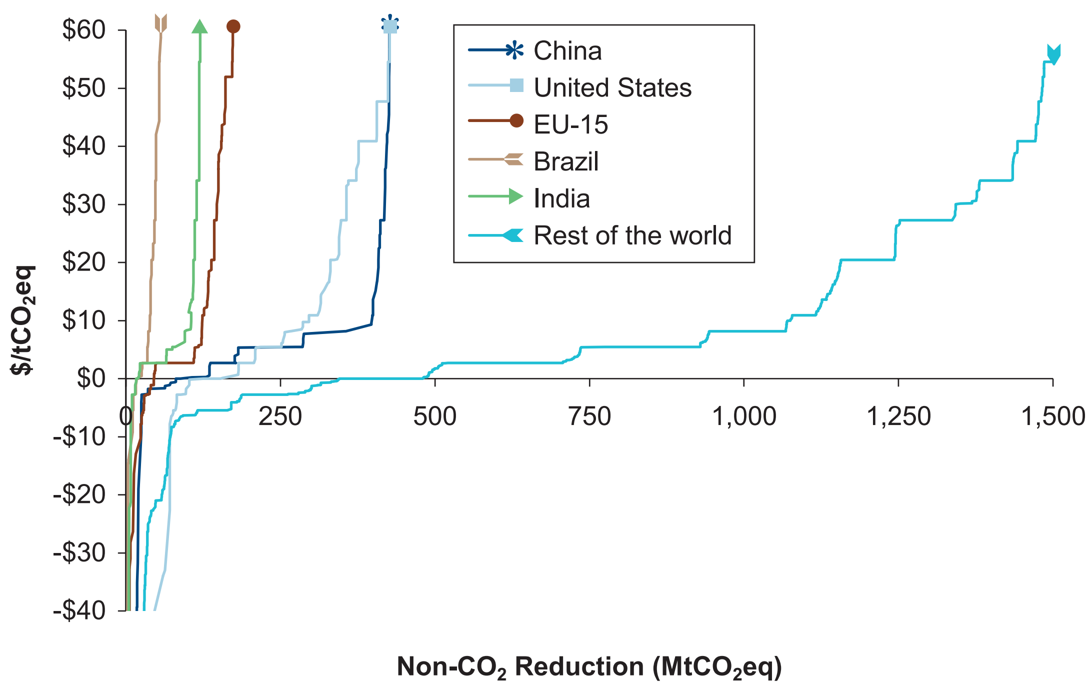


Figure ES-3: Global 2020 MACs by Non-CO_2 Greenhouse Gas Type



Major Emitting Regions of the World Offer Large Potential Mitigation Opportunities. Figure ES-4 shows the global MACs by region for 2020. China, the United States, EU, India, and Brazil are the countries or regions that emit the most non-CO_2 greenhouse gases. As the largest emitters, they also offer important mitigation opportunities. These regions show significant mitigation potential in the lower range of breakeven prices, with the MACs getting steeper in the higher range of breakeven prices as each additional ton of emissions becomes more expensive to reduce.

Figure ES-4: Global 2020 MACs for Non-CO_2 Greenhouse Gases by Major Emitting Regions



The aggregate MACs by economic sector, greenhouse gas type, and region highlight the importance of including non-CO_2 greenhouse gases in the analysis of multigas climate strategies. The MACs illustrate that a significant portion of this emissions reduction potential can be realized at zero or low carbon prices. The mitigation potential in each economic sector is examined in greater detail in this report.