

Expectations for a New Climate Agreement

Henry D. Jacoby and Y.-H. Henry Chen



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Abstract

With the objective of stimulating timely and open discussion of the current attempt to formulate a new climate agreement—to be reached at the 21st meeting of the Conference of Parties (COP-21) in Paris during November of 2015—analysis is conducted of the expected developments in the lead-up negotiations. Based on the assumption that the architecture of the agreement will likely involve voluntary pledges and ex-post review (akin to the Copenhagen Accord), the domestic policies and measures expected to underlie national negotiating positions are described. Applying a global economic model, the effect of these Nationally Determined Contributions (NDCs) on global greenhouse gas emissions is assessed. The analysis shows that an agreement likely achievable at COP-21 will succeed in a useful bending the curve of global emissions. The likely agreement will not, however, produce global emissions within the window of paths to 2050 that are consistent with frequently proposed climate goals, raising questions about follow-up steps in the development of a climate regime.

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1. STUDY DESIGN

1.1 Our Purpose

Under an agreement reached in the 2011 Durban session of the Conference of Parties (COP) of the Framework Convention on Climate Change (FCCC), the parties launched a renewed set of negotiations on greenhouse gas emissions and other matters (UNFCCC, 2011). Under the Durban Platform, a new agreement on emissions reductions is to be reached by the 21st meeting of the COP (COP-21, to be held in Paris, November 2015), with its provisions being implemented and coming into effect from 2020 forward. Discussions are organized under the Ad-Hoc Working Group on the Durban Platform (ADP) which is instructed to note “with grave concern” the gap between current efforts and a pathway consistent with holding global temperature “. . . below 2°C or 1.5°C above pre-industrial levels.”

In an effort to provide background information for those parties engaged in negotiations, and for others observing the process, we construct a picture of how the negotiations are likely to proceed in their early stages. We then compute the resulting near-decade emissions path and its relation to frequently stated global emissions goals. We have consulted widely with persons engaged in preparing for these negotiations, and with others familiar with the workings of the international climate regime, to formulate judgments regarding the efforts nations will be willing to pledge by 2015. We hope this analysis will contribute to a more effective global outcome by stimulating timely and open discussion of potential national actions and their consequences, and that this presentation will elicit responses leading to better-formed expectations for these coming developments.

In Section 1.2, we briefly summarize what we view as the likely architecture of a new agreement. Section 2 lays out the actions that we predict are likely to be put forward within this structure. Then, applying a global economic model (as described in Section 1.3), the resulting emissions pattern is computed to 2050 (detailed in Section 3). Section 4 compares this result with an IPCC summary of emissions paths in these decades that would be consistent with particular temperature targets. Our expectation is that any agreement will be based on domestic policies and measures, but in Section 5 we provide a brief analysis of the significant economic gains achievable if the same emissions result were sought using a price instrument. Finally, in Section 6 we issue a call for information that may help refine evaluations regarding the probable outcome of COP-21, and as our report predicts an unavoidable gap between pledged national actions and global goals, we ponder the future of the FCCC regime if events play out as we expect.

1.2 Expectations for the ADP Negotiations

1.2.1 The Climate Convention Process

The path that has led to the current negotiations began with the first Conference of the Parties (COP-1) in Berlin in 1995. These negotiations have continued through a two-decade search for international agreement on greenhouse emissions that includes all the main parties. Over most of

the history of these negotiations, emissions mitigation commitments have been formulated in terms of economy-wide targets and timetables—or, in the terms of the day, Quantified Emissions Limitation and Reduction Objectives (QELROs). The so-called Berlin Mandate produced guidelines for the completion of a protocol for adoption at COP-3 in Kyoto in 1997, stating that the negotiators’ aim was “. . . to set quantified limitation and reduction measures within specified time-frames such as 2005, 2010 and 2020, for their anthropogenic emissions.” (UNFCCC, 1995). Additionally, a Climate Convention principle of “common but differentiated responsibilities” was put in place, including a stipulation that the negotiations could not introduce emissions commitments for parties outside the Convention’s Annex 1 (a group of the more economically developed of the parties).

In 1997, the nations followed through, producing the Kyoto Protocol which—among other provisions—included a set of legally binding national emissions targets to be achieved in a 2008–2012 accounting period. By 2005, a sufficient number of countries had ratified the Protocol to put it into force (even without the United States, which never submitted the Protocol for ratification). There has followed years of struggle within the COP to try to bring all nations under some form of emissions obligation (including the United States and other developing countries with significant emissions), and to decide if and how to extend Kyoto Protocol commitments beyond 2012. During this time, Canada withdrew from the Protocol, and Japan, Russia and New Zealand have stated they would not participate in a second commitment period.

The process came to a crisis in 2009 at COP-15 in Copenhagen. In the face of impending failure of negotiations, a political agreement was reached in a rump meeting of heads of state from a subset of the parties, including the U.S., China, India, Brazil and South Africa (UNFCCC, 2009). Under this agreement, each FCCC party was requested to state a voluntary goal for 2020, in whatever terms it found acceptable. Some developed parties pledged economy-wide quantitative reductions below a baseline level of emissions; others stated intended reductions in emissions intensity or cuts below a self-defined business-as-usual projection.

The Copenhagen Accord had no formal status under the Convention until it was given official recognition at COP-16 in Cancún; nonetheless, it changed the terms of discussion of potential climate agreements. Though a number of parties have continued to call for a Kyoto-style agreement, the Copenhagen deal effectively marked a transition away from group negotiations of legally binding national quantitative targets, and toward an approach whereby voluntary pledges flow from decisions by national governments, allowing for more explicit account of domestic conditions. The distinction between Annex 1 and Non-Annex 1 parties was softened, with some form of mitigation effort expected from all nations, and developed countries committed to provide new and additional resources to address the needs of developing countries, with a goal of mobilizing \$100 billion per year from public and private sources by 2020. Although the Accord also calls for “. . . a formal assessment of the implementation of this Accord . . . by 2015”, the status of this provision remains unclear.

1.2.2 The Goal in Paris

With continuation of the Kyoto Protocol architecture unlikely, and the Copenhagen-Cancún agreement viewed as a temporary fix, the COP went back to the drawing board. COP-17 in Durban converged on a new approach, replacing the guidelines agreed upon in Berlin in 1995, and implemented in the Kyoto Protocol. Termed the Durban Platform, it initiated a new set of negotiations to “. . . develop a protocol or other legal instrument or agreed outcome with legal force” and established an Ad Hoc Working Group on the Durban Platform (ADP) with a mandate to produce this new agreement by fall 2015 at COP-21 in Paris.

After COP-17, two additional features were added to the negotiation process. The language of national action was changed. Previous negotiations spoke of national “commitments” to emissions reduction, but at the insistence of developing countries the operative term was changed to “contributions” to the global task. Further, a two-step process was adopted. First, parties are to present their Intended Nationally Determined Contributions (INDCs) early in 2015 for an ex-ante review process, clarifying and aggregating pledges to assess their implication for long-term goals. Then, final negotiations are to be completed by the session in Paris in the fall.

Here, we attempt to anticipate the outcome of this two-step process. Unfortunately, even after great effort in meetings of the ADP, much of the architecture of the negotiations remains to be determined, such as:

- The dates of any targets or accounting periods;
- What is to be included in the term “contribution” (e.g., reduction quantity, mitigation action, adaptation effort, financial aid, capacity building, technology transfer, R&D effort);
- Accounting rules (e.g., crediting of nuclear, CO₂ capture and storage, treatment of land use change, various forms of offsets), and whether they will be the same for all parties;
- The legal form of an agreement, provisions for entry into force, terms of compliance, and procedures for review and extension;
- With the exception of the E.U., parties have not revealed their INDCs—not unusual for this stage in a negotiation, but possibly problematic if domestic deliberations are yet at an early stage.

Thus, our exploration of plausible outcomes requires assumptions about these aspects of the process. Though uncertainty remains very great, our discussions lead to the following expectations.

1.2.3 Likely Outcomes of the Negotiations

We doubt there will be negotiation specifically on quantitative national emissions reduction targets, as under the Berlin Mandate. Furthermore, any legal provisions included in an agreement will not be of a form requiring ratification by national legislative bodies. Involvement by the United States is crucial to any future regime, and the U.S. Senate is an impassable barrier on the horizon of COP-21 negotiations. Rather, we expect that national preparation for any agreement will be based on analysis of politically constrained domestic policies and measures, perhaps

combined into Copenhagen-style voluntary pledges. Negotiations will focus on loosely harmonized domestic actions in a system of pledged contributions, with some system of ex-post review. Since a legally binding agreement on emissions targets is unlikely to occur, the Durban Platform specification of an “agreed outcome with legal force” could only require mandatory participation in a process to review progress in achieving pledged contributions.

Various dates have been discussed for assessing achievement under an agreement, including 2025, 2030 and 2035. We focus on a target date of 2030, but continue the simulation of the effects of assumed contributions through 2050.

We then formulate the policies and measures that we predict the parties are likely to put forth, particularly as they reveal their INDCs in the early months of 2015. It is important to emphasize that the focus is on our current assessment of actions that countries will be willing (and able) to pledge just in the process leading to COP-21 in Paris. These actions will, of course, be only one step in a continuing global effort to limit human influence on the climate. Nevertheless, if an agreement is reached in 2015, going into effect by 2020, the earliest review of performance along the way might not be before 2025. In this case, an effort to formulate the next agreement under the Climate Convention, or a tightening of COP-21 agreements, would not start until 2025 or after, with new targets set for a decade or more after that. If this expectation is correct, then global emissions as far out as 2045 or 2050 will be heavily influenced by achievements in the negotiations over the next 18 months.

1.3 Analysis Method

1.3.1 The EPPA Model and a Reference Case

To assess the global emissions reductions resulting from the assumed national contributions we apply the MIT Emissions Prediction and Policy Analysis (EPPA) model (Paltsev *et al.*, 2005), a recursive–dynamic multiregional general equilibrium model of the world economy. The EPPA model—comprised of sixteen nations and multination regions—is built on the Global Trade Analysis Project (GTAP) data set of world economic activity, augmented by data on greenhouse gases, aerosols and other relevant emissions, and details of selected economic sectors. The model is used to project economic variables (e.g., gross domestic product, energy use, sectoral output, consumption), and emissions of greenhouse gases (CO₂, CH₄, N₂O, HFCs, PFCs and SF₆) and other air pollutants (CO, VOC, NO_x, SO₂, NH₃, black carbon and organic carbon) from the supply and combustion of carbon-based fuels, industrial processes, waste handling and agricultural activities. As summarized in **Figure 1**, the model identifies a set of non-energy sectors that produce goods and services and their inter-sector trade, with special detail provided on personal transport, and the sectors that consume final goods and services (not shown). Energy production and conversion sectors are represented in detail, and include coal, oil, and natural gas production (including conventional gas, shale gas, tight gas and coal-bed methane), petroleum refining, and an extensive set of alternative low-carbon and carbon-free generation technologies. The model’s calculations include the effects of international trade among the sixteen regions in both energy and non-energy goods and services.

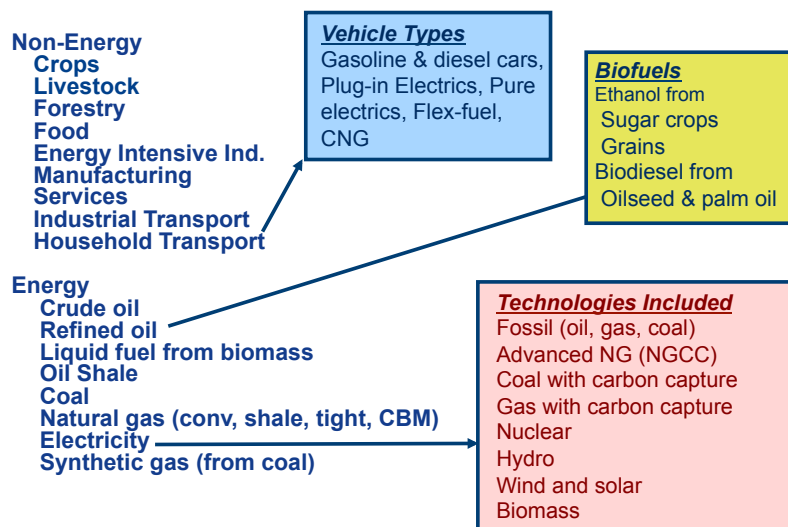


Figure 1. Sectors and technologies in the EPPA model.

To simplify the specification of expected contributions and emissions results, we aggregate the sixteen-region aggregation of the EPPA model into the three categories that are used in the *MIT 2013 Climate and Energy Outlook* (MIT Joint Program, 2013): Developed, Other G20, and Rest of World (ROW). Nations within the several regional aggregations are detailed in the Outlook.

Table 1. Classification of the sixteen EPPA regions.

Developed		Other G20		Rest of World	
ANZ	Australia-New Zealand	BRA	Brazil	AFR	Africa
CAN	Canada	CHN	China	MES	Middle East
EUR	E.U.+	ASI	Dynamic Asia	LAM	Other Latin America
JPN	Japan	IND	India	REA	Rest of East Asia
USA	United States	MEX	Mexico	ROE	Rest of Eurasia
		RUS	Russia		

We construct a no-policy Reference case for discussion of how potential contributions relate to a business-as-usual (BAU) future (see Sections 3 and 4), and for use in the cost comparison among alternative policy approaches (see Section 5). The Reference case assumes that international negotiations break down in Paris, so that only the 2020 pledges from the Copenhagen Accord remain. Further, we account for the fact that some parties (e.g., the E.U.) seem on track to meet their Copenhagen pledges, while we expect that others (e.g., Canada, Japan) will not achieve pledged reductions.

1.3.2 A Basis for Evaluating Progress Toward Climate Goals

In addition to simulating the effect of expected contributions on projected global emissions, we explore the degree to which they affect our global ability to reach the temperature targets mentioned in the Durban Platform and previous FCCC documents. **Figure 2** shows a summary by the Intergovernmental Panel on Climate Change of 21st Century (IPCC) temperature change

in response to a set of Representative Concentration Pathways, or RCPs (IPCC, 2014). The RCPs are scenarios of the stabilization levels of human-caused increase in radiative forcing in W/m^2 . Two sources of these estimates are shown. On the left is the result of uncertainty analysis applying a single simplified climate model (MAGICC), which identifies the median change (black line) and 66% and 90% confidence intervals (shaded blue bars). For comparison, on the right is the collected result of runs by climate models collected in the CMIP5 archive, with ± 1 and ± 1.6 standard deviations in shades of orange, and individual model results shown as dots.

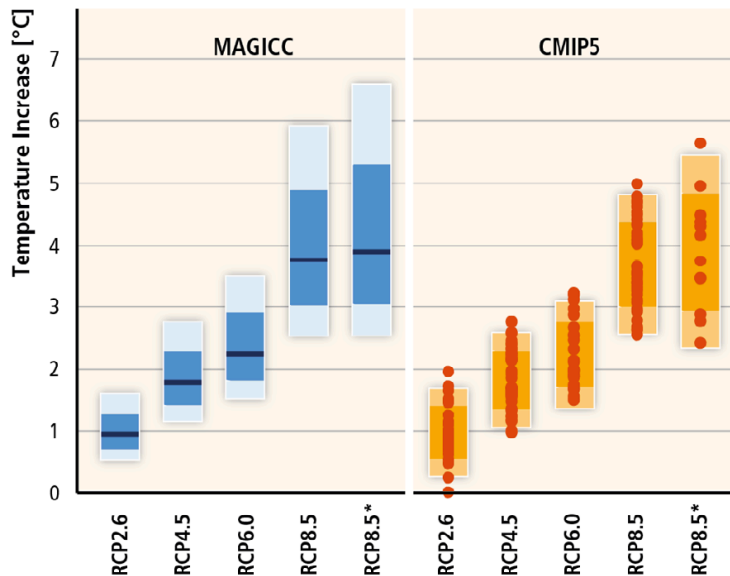


Figure 2. Relation of representative concentration pathways to global temperature increase above end-20th century level (IPCC, 2014).

For purposes of assessing potential outcomes of the negotiations we focus on RCP4.5. For an emissions reduction scenario to be considered successful, it would have to yield a mean increase of approximately 1.8°C over this century (around 2.6°C above the pre-industrial level), close to the frequently discussed goal of limiting the increase to 2°C.

We then address the matter of whether the NDCs we judge likely to be submitted in COP-21 negotiations will put global emissions on a path consistent with the RCP4.5 scenario. The IPCC provides basis for making the connection between global emissions paths and these targets for atmospheric concentrations. Its Fifth Assessment Report (IPCC, 2014) presents a summary of studies that apply integrated assessment models (including the EPPA model used here) to simulate emissions paths stabilizing global concentrations at various levels. The result is the colored bands in **Figure 3**, each associated with a particular range of concentrations, with non-CO₂ gases converted to their CO₂ equivalent forcing and the total expressed in parts per million CO₂ equivalents (ppm CO₂-eq). RCP4.5 is associated with an all-gas concentration of 530 to 580 ppm CO₂-eq, and the color of the emissions band that is consistent with this outcome is shown in the table at the left of the figure. Because we consider the effects of the current negotiations only up to

2050, the portion of the figure after 2050 is shaded. In Section 4, we reproduce the 530–580 ppm band for comparison with expected results of country mitigation actions.

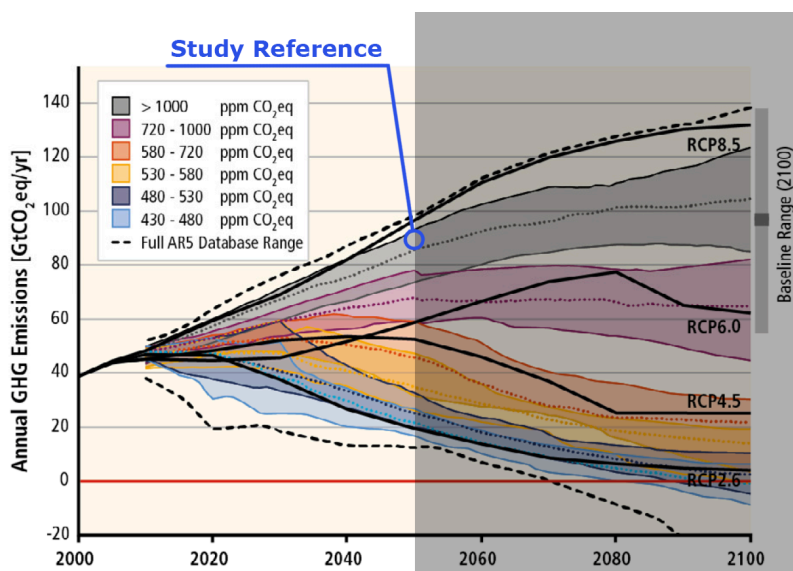


Figure 3. Emissions pathways consistent with alternative stabilization levels (IPCC, 2014).

2. EXPECTED NATIONAL CONTRIBUTIONS

2.1 Sources and Qualifications

Our evaluation of the contributions likely to be put forward by individual nations is based on clues we find in national communications, discussions with observers of conditions in various countries, and—by necessity—a good deal of guesswork. We hope these assumptions come close enough to the parties’ ultimate positions to serve as a basis for a wider conversation about potential outcomes.

Our focus is on the largest emitting sectors, and on policies and measures that have the potential to yield substantial reductions. The two biggest contributors to greenhouse emissions are electric power and transportation, which are both frequent targets of policy proposals. Non-transport household energy consumption also is a common focus of regulatory and subsidy-based measures. We also consider the effect of measures to limit land-use CO₂ emissions, and activities that could lower emissions of methane. For the E.U. and China, we also take account of current national-level targets in terms of emissions quantity or emissions intensity (measured in tons per unit of GDP).

2.2 Policies and Measures

The aggressiveness of implementation of the policies and measures likely to be put forward during negotiations will differ according to the economic position of each individual party. In our global scenario, therefore, we distinguish between levels of possible effort in the three groups of regions in Table 1. Our predictions about pledges by less-developed parties (those in the Other G20 and the Rest of World groups) are influenced by our view of the level of external aid they can count on, because much of the discussion by these countries of possible emissions

mitigation is conditioned on financial support from Developed regions. We expect that aid from the Green Climate Fund, or other efforts to meet the \$100 billion Copenhagen-Cancún goal, will be insufficient to have a substantial influence on the pledges the Other G20 and Rest of World groups consider in the lead-up to Paris.

2.2.1 Electric Power

Electric power generation is the single largest emitting sector in most countries. Many different measures to reduce these emissions have been proposed, or are in place and could be augmented. The majority of policy effects on emissions can be covered with just two options: controls on coal-fired generation and renewable energy mandates.¹

Coal-Fired Generation. Coal generation is the largest source of electric sector CO₂ emissions, and is the obvious target of emissions-reducing measures. Depending on the country or region, proposals for reducing these emissions range from limits on the emissions rate of new plants (even to the point of requiring some level of CO₂ capture and storage) to a gradually increasing squeeze on the emissions of the existing fossil fueled generation fleet (often by national or supranational action, but sometimes by state/provincial and local regulations). In many regions, air pollution control is a major motivation for regulations that force out coal generation. While the policy specifics may differ among countries, the net effect, at least on the horizon of this study, is to limit the building of new coal generation and to gradually take the oldest and least efficient units out of service.

Table 2. Expected pledges regarding retirement of old coal plants and constraint on new build.

Region	Predicted COP-21 Pledge	Details
Developed		
Australia-New Zealand	Restricted coal generation	
Canada	Restricted coal generation	
E.U.+	---	Subject to pre-existing national target
Japan	Restricted coal generation	
USA	Restricted coal generation	
Other G20		
Brazil	---	Insignificant coal generation
China	---	Subject to pre-existing national target
Dynamic Asia	Restricted coal generation	
India	---	Expected to reject restraint on coal use
Mexico	Restricted coal generation	
Russia	Restricted coal generation	
Rest of World	---	No pledges expected from regions AFR, MEA, REA, ROA or LAM

Table 2 catalogs our predictions for pledges of restriction on coal generation. We approximate the effect of the various measures they will apply by a simple rule: only new coal plants with CO₂ capture and storage will be built in these regions, and existing plants will be

¹ The Obama administration has proposed a program of reductions in emissions from existing power plants that would lower sector CO₂ emissions by 30% below the 2005 level (US EPA, 2014). The electric sector measures assumed here, combined with household efficiency improvement discussed below, reduce U.S. electric sector CO₂ emissions by about 40% from this base period.

retired at age 60. We exclude the E.U. because it is subject to a national target discussed below, but all other regions in the Developed category are affected—particularly the U.S. Among the G20 regions, Brazil is omitted because its coal generation is insignificant. India is assumed to reject any restraint on its coal use in the period to 2030, and therefore its coal generation emissions grow over this period. China is not separately constrained, but its intensity target, also discussed below, limits its coal use. For the Rest of World regions, the main source of current emissions from coal-fired generation and projected growth is South Africa. We assume that South Africa, and the other nations in this group, will not pledge to reduce their coal use over the study period.

Renewable Energy Mandates. These common measures applied in the power sector are intended to increase levels of renewable generation (e.g., renewable portfolio standards, feed-in tariffs, tax subsidies). Depending on the region, these measures have been applied by both national and sub-national jurisdictions. Imposition of these measures is motivated by a number of concerns other than reduction of greenhouse gases, including air pollution control, energy security and the long-term sustainability of the energy system; however, in recent years the issue of climate change has weighed more heavily in their justification.

We expect that these measures will appear in the negotiations as proposed contributions at levels shown in **Figure 4**. We assume the Developed regions (E.U. excluded) will pledge to bring renewables to 10% of electric generation in 2020, rising to 15% by 2030 and 20% by 2050. The European Commission has proposed a target for 2030 of 27% renewables in total energy consumption (European Commission, 2014), and we expect that at least this percentage will apply to the electric sector. Given that goal, it is further assumed the E.U. percentage will increase to 35% by 2050. The Other G20 and Rest of World regions are expected to start at a lower percentage in 2030—5% and 2.5% respectively—rising to 10% and 5% by 2050.

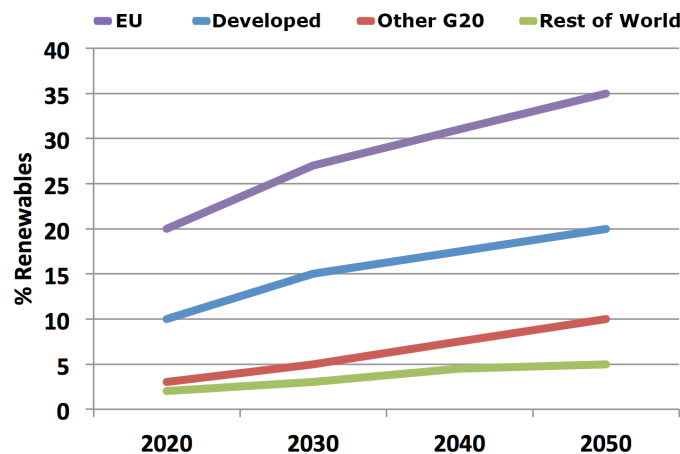


Figure 4. Assumed renewable portfolio standards.

Current renewables mandates usually limit the technologies that can be credited, sometimes even specifying particular percentages of each. As implemented in the EPPA model, the portfolio standard applies to the total contribution of wind and solar generation.

2.2.2 Transport

In wealthier countries like the U.S., personal vehicles are by far the primary source of transport emissions, while in other regions commercial vehicles (particularly large trucks) are the main source. Policies and measures undertaken in the transport sector are expected to address both categories.

Personal Vehicles. Many nations have adopted (or are considering) design standards for new vehicles, some based on fuel efficiency and others on greenhouse gas emissions (ICCT, 2014). Most of these standards differentiate between automobiles and sport utility vehicles used for personal transportation, though some nations (e.g., the U.S.) apply a common standard based on weight or vehicle footprint. We expect that imposition and tightening of these standards will be part of the pledged contribution of all nations. Though the more developed countries tend to lead in this area, vehicle design and manufacturing is a global industry, so efficiency measures will influence all countries regardless of a political commitment to bear the cost of emissions reduction.

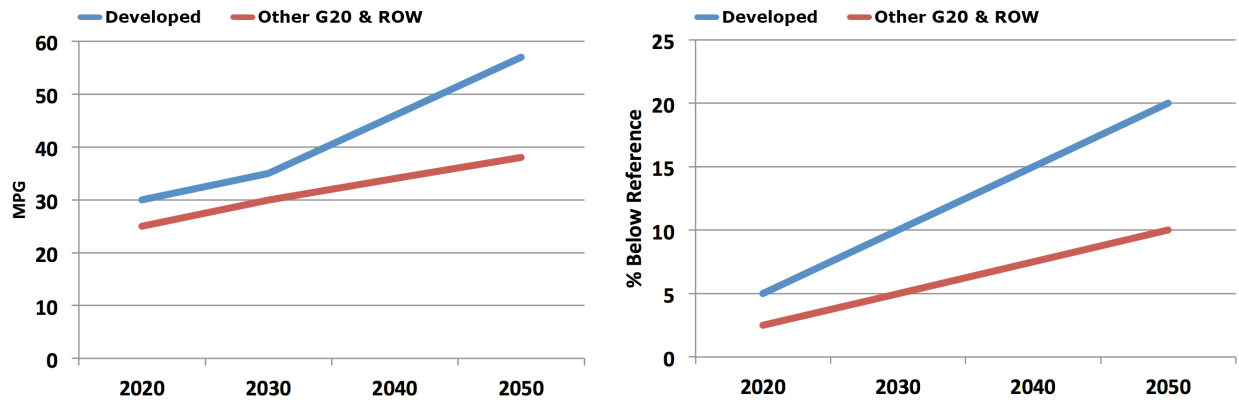


Figure 5. Transport sector measures. Left: Mileage standards for personal vehicles. Right: Reduction in oil use below Reference for commercial vehicles.

Our expectations for personal transport are shown in **Figure 5** (Left). The measure is stated in terms of fuel efficiency, and it is assumed that from 2020 forward the efficiency of new vehicles (in mi/gal including the effect of some substitution of hybrid- and all-electric units) will decline by 2% per year. For Other G20 and Rest of World regions, the decline rate is 1% per year. The assumed vehicle efficiencies represent on-road performance, which is found to be worse than as measured by standard test procedures. Also note that these are new vehicle standards; the EPPA model also takes account of the rate at which more efficient vehicles enter the vehicle fleet.

Commercial Transport. In the EPPA model, commercial transport is one aggregate sector including road, water and air transport, though it is worth noting that around 80% of commercial transport CO₂ emissions are from commercial trucks. Nearly all transport energy, now and likely for the next few decades, is oil based. A number of measures have been adopted or proposed in various countries to lower the emissions of this sector, including efficiency standards intended to improve engine design and lower wind resistance, efforts to improve the efficiency of delivery networks, and measures to shift freight from truck to rail or water.

We expect efforts to lower the emissions of this sector to be included among policies and measures pledged in the negotiations, and we reflect these measures in terms of a percentage reduction in oil use below the reference level.² As shown in Figure 5 (Right), we assume that the reduction below reference levels for the Developed regions will be around 5% by 2020, rising to 10% in 2030, and up to 20% by 2050. Because of the limited opportunities for mode shift and the fact that used trucks from developed countries tend to find their way into less-developed regions, the improvement in performance in the Other G20 and Rest of World is assumed to be only about half that in the Developed regions.

2.2.3 Household Efficiency

For many decades, a common theme in energy policy discussions is that various market failures (e.g., poor information, principal-agent problems, high transactions cost) and inattentive consumers lead to substantial inefficiencies in the household sector. As a result, most countries apply a range of regulations and incentives in an effort to lower their energy use and, more recently, cut their greenhouse emissions. Examples include building codes, appliance standards, household financial incentives for weatherization, and mandated electric and gas utility efficiency programs.

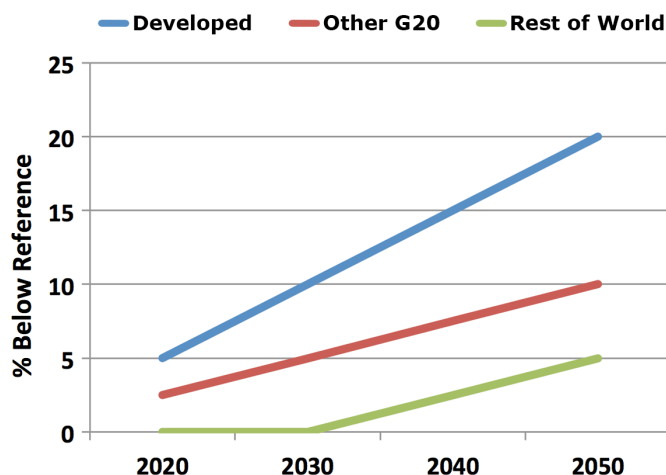


Figure 6. Efficiency improvement in household energy use, as a reduction below Reference.

Opportunities exist almost everywhere to push harder on policies and measures designed to improve household efficiency, and **Figure 6** shows our assumption of the gains to be realized, stated as a reduction below the Reference level. We predict Developed regions are likely to attain a 10% reduction by 2030, rising to 20% in 2050, with the Other G20 realizing roughly half this improvement. We further expect that the Rest of World group will not be in a position to attempt any reduction below Reference in the period to 2030, but will begin programs in this area in the decades after.

² In the EPPA model, the efficiency of the Commercial Transport sector—like others—is assumed to improve year-to-year, independent of any efforts spurred by the climate negotiations. For details, see Paltsev *et al.* (2005).

2.2.4 Land Use

A long-standing effort has been underway to reduce the emissions from land use, with a main focus on forest destruction under a program on Reducing Emissions from Deforestation and Forest Degradation (REDD). Three EPPA regions are responsible for the largest contributions to these land-use emissions: East Asia (ASI), which includes Indonesia and other forested Asian regions; Brazil (BRA); and Other Latin America (LAM), which includes a number of countries sharing the Amazon rain forest and other forested regions. Our expectation is that nations of these regions will, as in the Copenhagen Accord, put forward reductions in their emissions from forest destruction.

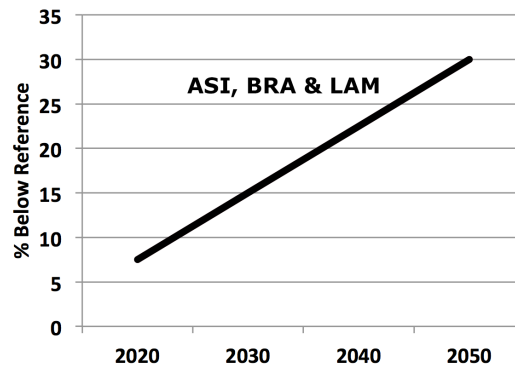


Figure 7. Reduction in land-use use CO₂ emissions, percent below Reference.

Their expected contributions are plotted in **Figure 7**. The reductions are below the reference or BAU level, starting at around 7.5% in 2020, achieving 15% in 2030, and rising further to 30% in 2050.

2.2.5 Methane Reduction

Recent years have seen increased domestic and international efforts to address the emissions of short-lived greenhouse gases, with programs such as the multi-nation Climate and Clean Air Coalition for Reducing Short-Lived Climate Pollutants. These programs focus on methane, hydrofluorocarbons (HFCs) and black carbon aerosols. We consider only the most prevalent of these climate influences: methane. The two main methane emissions sources are the agriculture sector and the energy sector (including the natural gas production, transmission and distribution system, and oil and coal production).

We expect that, in the process leading to COP-21, pledges will include control of fugitive emissions from the natural gas system, and of gas leakage from oil production facilities. Control of methane in coalmines has long been an important activity, but augmented efforts toward methane capture and use are likely to emerge as well. Emissions of methane from agriculture come mainly from flooded crops, like rice, and from ruminant animals. We expect that pledged policies and measures will include changes in crop practices, irrigation patterns, and animal feed, as well as expanded efforts to control emissions from animal feed lots. Finally, efforts to control emissions from municipal waste dumps are likely to expand worldwide.

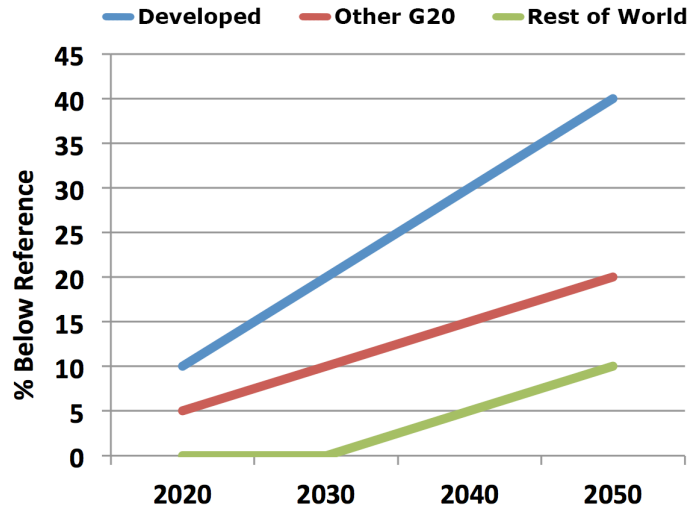


Figure 8. Reduction in methane emissions, percent below Reference.

The contributions from these methane control efforts are shown in **Figure 8**, expressed as a percentage reduction below the Reference level. We assume that Developed regions will pledge a 20% reduction in these emissions by 2030, rising to 40% by 2050. We also expect that Other G20 regions will pledge action in this area, but for only half the reduction of the Developed regions. We assume the Rest of World regions will take specific action on methane emissions only after 2030.

2.3 Existing National Quantitative and Intensity Targets

2.3.1 European Union

The E.U. is well on its way to attain its 20/20/20 targets for greenhouse emissions, renewable energy and energy savings, and the European Commission (2014) has proposed a policy framework for the period to 2030. This framework involves a 2030 all-greenhouse-gas reduction target of 40% below the 1990 level. Achieving this result will require an estimated 43% reduction by the sectors within the European Trading System (ETS), which would be accomplished by increasing annual reduction in the ETS cap from 1.74% to 2.2%. One effect of this measure will be the reduction of E.U. coal generation. A 30% reduction will be required in the non-ETS sectors, which will be implemented under a system involving the review of member state plans by the Commission and negotiation of revisions where needed. Recall that the E.U. is assumed to undertake policies and measures in the transport, renewable energy and household efficiency, and in the EPPA model an overall 40% cap is imposed in addition to ensure the E.U.-wide target is met.

2.3.2 China

Under the Copenhagen-Cancún agreement, China pledged a reduction in energy intensity of between 40% and 45% below its 2005 level by 2020. A reduction in energy intensity of about 40% every 15 years is a common assumption in studies of the overall effect of China's likely

policies in air pollution control, energy measures and climate goals (Zhang *et al.*, 2014). We expect that a reduction of this magnitude will be sought by China in the following 15 years (to 2035) and that its effects by 2030 will be reflected in any pledges by China in negotiations leading to COP-21. We further assume that an additional 40% reduction will be achieved in the following 15 years, to 2050. It is worth noting that, even if this sequence of reductions is achieved, China’s energy intensity in 2050 will not have been reduced to the U.S. level today. Also recall that, in addition to this overall target, we expect that China will undertake specific policies and measures in renewable electricity, transport, household energy and methane along with other regions in the Other G20 group.

3. EMISSIONS RESULTS IN 2030

3.1 Total and Regional Emissions

Figure 9 shows the net reduction in 2030 emissions in relation to the Reference case described above. Implementation of the expected policies and measures leads to lower emissions by the Developed and Other G20 region groups. However, emissions by the nations aggregated in the Rest of World category remain about the same in 2030, with or without assumed agreements under the Durban Protocol. This result holds even though these nations are assumed to at least pledge adoption of automobile and renewable portfolio standards—unfortunately, any emissions reduction these actions would yield is almost exactly offset by emissions leakage caused by lower fossil fuel prices as a result of policies adopted in other regions and subsequent adjustments in international trade flows.



Figure 9. Global emissions (CO₂-eq) in 2030 under the Reference Case and expected contributions.

The importance of these Rest of World (ROW) nations (plus India) and their potential contribution to emissions reduction is emphasized by **Figure 10**, which shows emissions by region from 2005–2050 under the policies and measures laid out above. In Figure 10, China and India are separated from the Other G20 regions. Emissions of the Developed regions fall over time, and Chinese emissions stabilize around 2025–2030 under the policies and measures

assumed; combined with the others in the Other G20 group (except India) the emissions of these nations are roughly flat from 2015 forward. However, to the emissions of these nations is added the contribution of India (large population and continuing per-capita growth) and the ROW group, including members with large populations (e.g., Africa, Indonesia) and rapid per-capita growth. The low level of contribution from these nations reflects our expectation that they cannot anticipate substantial assistance from developed countries to help pay for emissions-mitigating expenditure. These results point to the great importance of finding ways to achieve credible funding for the Green Climate Fund and support for other financial commitments such as those included in the Copenhagen-Cancún agreement.

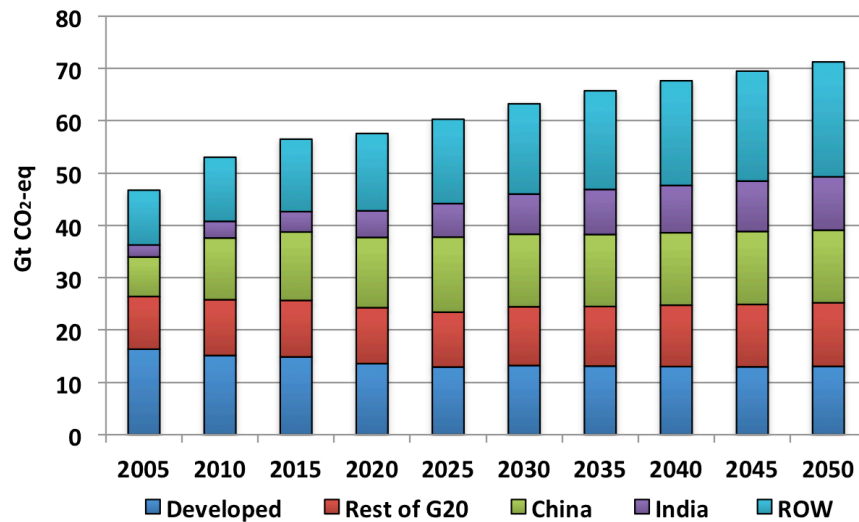


Figure 10. Expected emissions, CO₂-eq by region, 2005 to 2050.

3.2 Potential Aggregation of Pledged Actions

The negotiations have not resolved questions regarding the information to be submitted with INDCs in early 2015, nor have they provided any guidance on the form of final NDC declarations for COP-21. Therefore, it is not known how NDCs might be aggregated for purposes of comparing effort among nations. If the pattern established in the Copenhagen Accord is followed, discussions on the path to COP-21—and even a follow-up review of performance—can be expected to use a variety of measures. These measures are illustrated in **Figure 11**, which summarizes the emissions effects in 2030 of our assumed policies and measures (stated in terms of absolute change, CO₂ intensity, or reduction below some reference projection). Most likely there will be a desire to aggregate such national statements into a single measure, but it may well be that no summary indicator would be fully acceptable to all parties.

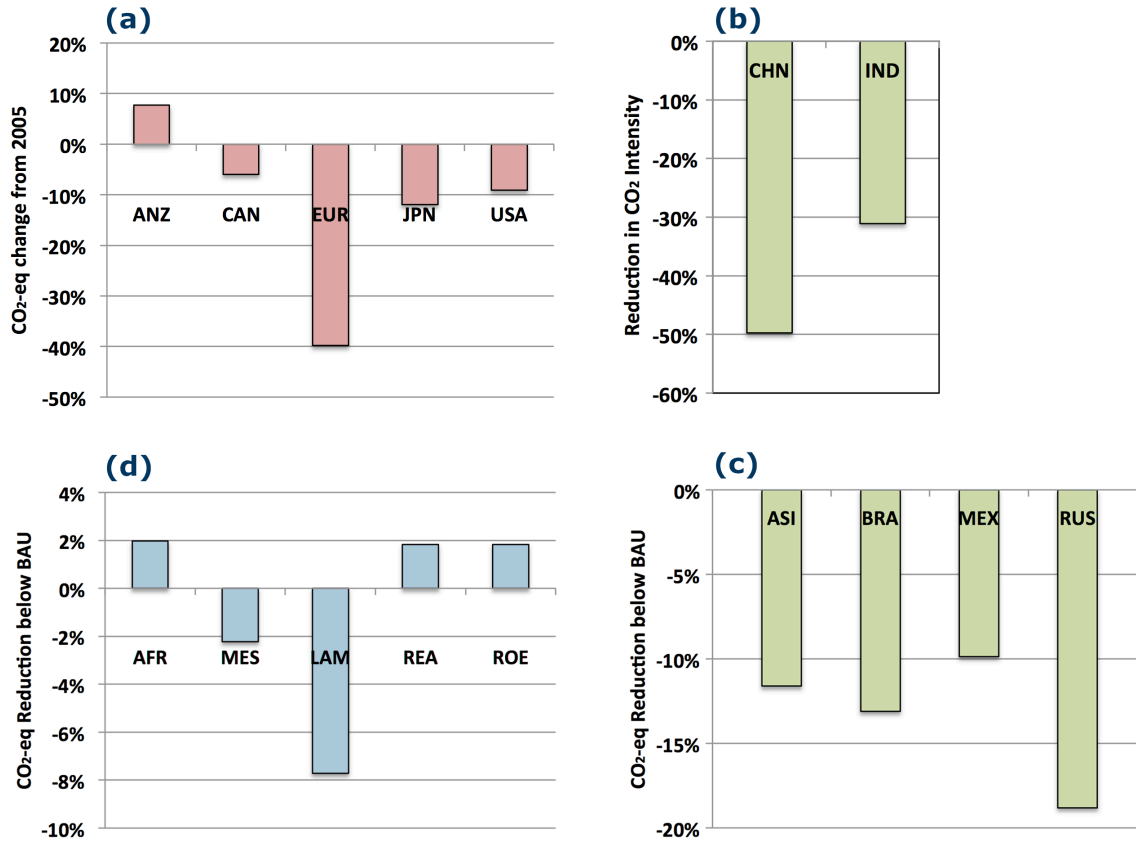


Figure 11. Anticipated pledges for 2030, illustrating the variety of contributions put forth by different parties. (a): Developed regions' expected pledges. (b): Other G20 regions with pledges expected in terms of CO₂ intensity reduction. (c): Other G20 regions with pledges expected in terms of reduction below BAU. (d): Rest of World regions' expected pledges.

The Developed regions will likely be willing to state pledged contributions in terms of a reduction below a base year. The E.U.'s already-announced commitment is shown, along with the results of the policies and measures we believe are likely to be undertaken by the other Developed regions, in Figure 11a. Others may be willing to state pledges only in terms of CO₂ intensity (tons per \$GDP), or perhaps energy intensity (tons per energy unit). As an example, Figure 11b shows the intensity results for the measures expected from China and India.

As in the response to the Copenhagen Accord, still others may only be willing to summarize national performance in terms of a reduction below a Reference or BAU future—presumably a projection the individual nation will make. Using the reference case discussed above as the BAU case, results under this procedure are shown for the Other G20 (except China and India) in Figure 11c, and the Rest of World regions in Figure 11d. For the Other G20 group, our expected measures yield an emissions reduction below a baseline scenario. For members of the ROW, on the other hand, the influence of leakage is again revealed. For Africa, the Rest of East Asia and Rest of Eurasia the leakage is sufficient to overwhelm the emissions-reducing effects of the expected policies and measures, ultimately yielding an increase in emissions above that of the Reference case (where there are no commitments beyond the Copenhagen 2020 targets).

4. CLIMATE EFFECTS

4.1 Progress toward RCP4.5

Figure 12 presents the effect of the assumed policies and measures on global greenhouse emissions, shown as the “Expected” projection in the figure. This outcome is compared with two other projections. One is the Reference case used throughout this analysis.³ Also shown, for comparison purposes, is our estimate of emissions to 2050 if commitments made in Copenhagen are met in 2020 and sustained thereafter. Our expected policies and measures yield a substantial lowering of the projection of global emissions compared to the Reference case, and even in relation to the more optimistic extended Copenhagen scenario. Also note that the projections are mean estimates; because of feedback in the climate system, any reduction in global emissions has its greatest effect on the upper tail—the most dangerous region of uncertain future change (Webster *et al.*, 2012).

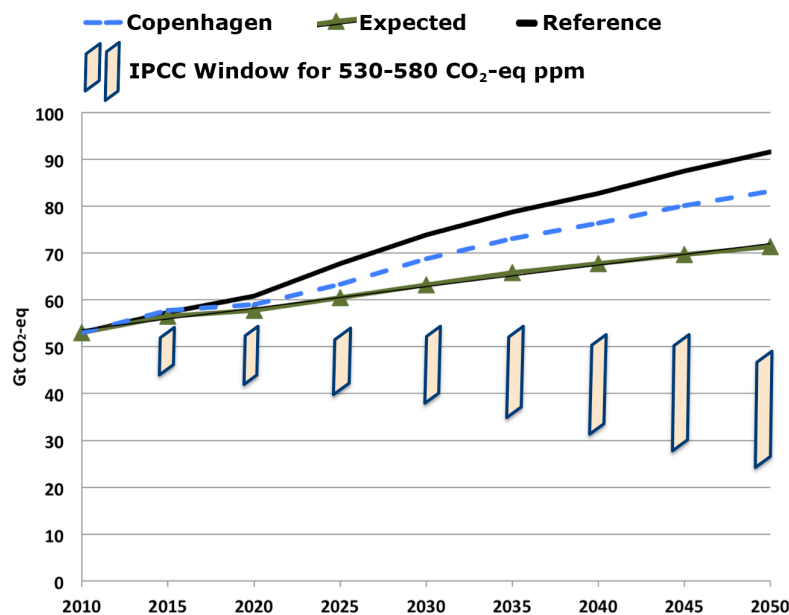


Figure 12. Emissions projections and a 530–580 ppm target window.

While these reductions would represent a substantial step toward meeting the long-term challenge of reduced human influence on the climate, they would not be sufficient to meet the 530–580 ppm target scenario. Our estimate of the contribution of current negotiations to this global task is demonstrated in Figure 12, by the relationship of our Expected scenario to a set of windows representing one possible long-term target. Previously, in Figure 2, the IPCC analysis associated RCP4.5 with a median global temperature increase of 1.8°C over this century (about 2.6°C above the pre-industrial level). Then, Figure 3 plotted the window of emissions over decades that would

³ Recall that the assumptions underlying our Reference case are that Copenhagen commitments do not extend beyond 2020, negotiations leading to COP-21 fail, and actions taken under the Copenhagen Accord gradually fade away.

stabilize atmospheric concentrations at the 530–580 ppm CO₂-eq –the target underlying RCP4.5. This emissions path is approximated in Figure 12 by the set of IPCC windows.⁴ By this analysis, the expected contributions from current negotiations will bring the nations part way toward such a target path, but will also leave much to be done in subsequent efforts.⁵

In Section 6, we address the question of what will happen if, in mid-2015, something like the Figure 12 projection of the COP-21 outcome becomes not just privately understood but also publicly recognized by the negotiating parties.

4.2 Effect on the IPCC Carbon Budget

In its Fourth Assessment Report the IPCC suggests another way to assess progress toward proposed policy targets: by constructing a budget of total CO₂ emissions that must not be overspent if particular levels of temperature change are to be avoided. Climate analysts have observed that, when their models are simulated over many decades, the global temperature increase over the pre-industrial level is roughly linear in the cumulative CO₂ emissions since 1870. This relationship is shown in **Figure 13**. (Note that the IPCC states the budget in carbon (C) rather than CO₂, or CO₂-e as in Figure 3.)

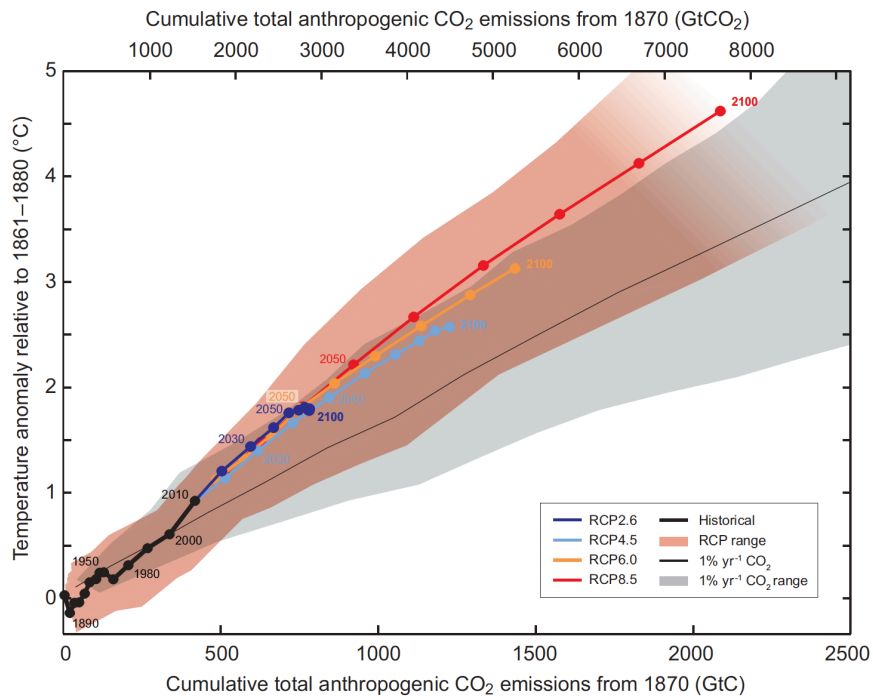


Figure 13. The IPCC carbon budget (IPCC, 2013).

⁴ The IPCC survey includes models that allow overshoot of the RCP concentration limit, and some that assume negative emissions are possible late in the century by large-scale application of biomass energy with capture and storage of CO₂.

⁵ By the construction of Figure 3, the existence of each window assumes that the emissions level was within the previous one, beginning in 2015. With each missed window, subsequent windows only move farther away; following the Expected path, the rate of emissions reduction necessary to attain the 530–580 ppm goal becomes ever greater.

The figure plots lines for various RCP scenarios; the shaded pathway shows the range of possible results from different climate models. Carbon emissions to date sum to 500 GtC, and the mean of the model estimates of the total carbon budget associated with a median temperature increase of 2°C is about 1000 GtC. That is, in a world where CO₂ was the only human-caused greenhouse agent, violation of the 1000 GtC total would lead to a temperature change greater than the commonly stated 2°C target by century's end.⁶

Because CO₂ is not the only greenhouse substance, a correction is made for the non-CO₂ gases that are not included in these calculations. The IPCC report suggests that if a projection of these gases is taken into account, the carbon budget associated with a 2°C temperature limit (for the mean of the model estimates) is 820 GtC (IPCC, 2013).

The effect of the expected policies and measures on this carbon budget is shown in **Figure 14**. Under the Reference case, global emissions will exhaust this budget by around 2035. The expected policies and measures are expected to extend this period by substantially less than a decade. For a greater temperature change above pre-industrial, perhaps 3°C, the shift in the budget limit by efforts we assume likely in the COP-21 agreement is longer, and more time becomes available for subsequent emissions control agreements.

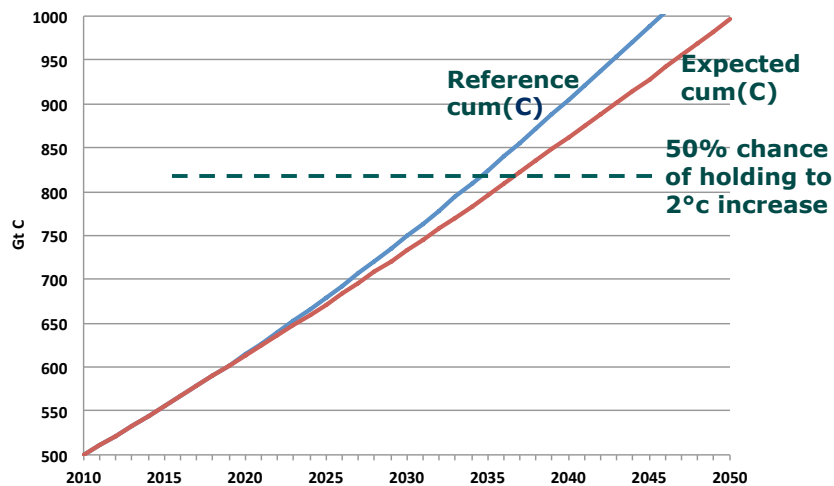


Figure 14. Budget delay from expected CO₂ reductions.

5. THE ADVANTAGE OF A PRICE MECHANISM

One cause for the relatively weak response expected from most nations in response to the objectives of continued FCCC negotiations is concern about the cost of measures to lower greenhouse gas emissions. With cost as primary motivation, the policies and measures laid out above would not be the preferred approach to emissions control. Although in some instances market failures can only be cured by regulatory measures, substantial literature documents the

⁶ The IPCC suggests that the 1000 GtC budget leads to a 50% chance of meeting the 2°C target, but this probability statement should be viewed with caution. It is based not on an uncertainty analysis, but on a count of the models that yield an estimate above or below the target temperature level. Additionally, the manner in which the IPCC procedure deals with the influence of aerosols is not well documented.

potential advantage of using a price instrument applied to all sectors (e.g., Aldy and Stavins, 2012; Rausch and Karplus, 2014). This characteristic of alternative regimes can be illustrated using the policies and measures studied here.

It is not likely that we will see a global GHG trading regime or uniform global tax; however, some sub-set nations may agree to some form of common pricing regime. Here we construct an example where four regions—Australia-New Zealand, Canada, the E.U. and Mexico—reach such a deal, assuming they impose a common emissions target equal to the reduction achieved in 2030 by their policies and measures as assumed above. Because there is no common marginal price of emissions under a regime of policies and measures (indeed, this fact is one indicator of their inefficiency) a comparison cannot be prepared on this basis. We can, however, compute a comparison based on the average cost per ton of CO₂-eq reduced, dividing the welfare loss (under Reference *minus* that under expected measures) by the achieved total change in emissions.

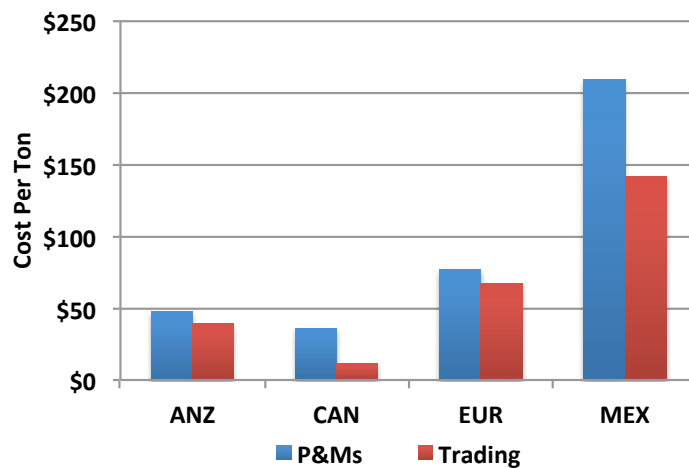


Figure 15. Average cost per ton policies and measures compared to a price-based instrument, 2030.

The result of this computation is shown in **Figure 15**. Note first that the assumed policies and measures produce more reductions from some than from others because of differences in economic structure, assumed growth rate, and in the particular policies and measures assumed to be pledged by each. Then, as expected, all would benefit from a shift to a common-price regime, though some would benefit more than others for the reasons above.

6. CONCLUSION AND NEXT STEPS

Based on our expectations for the architecture of a COP-21 agreement, and our predictions about the national contributions likely to come forth under it, our analysis concludes that these international efforts will indeed bend the curve of global emissions. However, our results also show that these efforts will not put the globe on a path consistent with commonly stated long-term climate goals. This result raises three concerns about coming steps in the FCCC process and the analysis needed to inform them.

First, we have limited insight into ongoing national deliberations and the dynamics of international diplomacy, which are evolving week to week. Therefore, our analysis leads to a call for information that can lead to a better-informed update. In particular,

- Are our expectations correct regarding the architecture of agreement likely to be reached in Paris, and if not what evidence is there that some different structure will emerge?
- At this preliminary stage in the negotiations, what information is available that would lead us to revise our expectations about contributions that parties will be willing and able to pledge?

Second, our assessment is, in effect, an attempted Step 0 of the FCCC's planned two-step process. Our analysis reveals some serious problems facing Step 1—the *indicated* contribution (INDC) procedure. It seems likely that some nations will resist submitting serious INDC information (or may not be able to resolve domestic issues on this time scale). Even those that do submit INDCs may not provide this information until well into 2015. Thus, to provide useful input to the discussions that will intensify as the November 2015 meeting in Paris nears, any ex-ante review will have to be completed in a very short time. Further complicating this task is the fact that details of the agreement architecture may not be resolved until the last minute; if there is no standard structure for INDCs, they will likely be submitted in very different forms—not easily compared by a common measure of effort or achievement.

Furthermore, because of price and trade interactions, assessment of the global implications of any set of INDCs requires some form of integrated assessment framework, such as the EPPA model used here. Such facilities exist in many agencies and research groups around the world, but it is unlikely that a coordinated analysis effort can be carried out on such a short time scale.

Third, if such analyses as do become available make it impossible to ignore the gap between expected achievements and stated climate goals, a variety of outcomes seem possible. For example:

- An agreement is reached, under sound accounting procedures, capturing those NDCs that are possible under current economic and political conditions. Review of progress and another round of negotiations would not be initiated until some years of experience with this agreement, possibly after 2025, in effect locking in the COP-21 agreement for many years.
- An agreement is reached, without sound accounting procedures. Creative accounting and flexible review procedures are facilitated by the terms of the agreement, and employed by key parties in an attempt to gain public confidence that the Framework Convention is an effective process for managing the climate change threat.
- Plans are set for sequential negotiations to update the NDCs on a five or ten year schedule, creating a continuous diplomatic process.
- The attempt to reach an effective new agreement collapses. Meetings of the FCCC and its subsidiary bodies go on, but the drive for effective action on climate shifts even further

toward other venues such as bilateral deals, club arrangements, and a collection of other international agencies.

These outcomes, and many others that could be envisioned, have varying implications—not only for the future global climate and attempts to moderate damage that cannot be prevented, but also for the types of assessments that may inform domestic and international efforts to control human influence on the global climate. We hope that our effort stimulates intensified discussion of these issues, leading to clarification of expectations for what is to come, and guidance for subsequent efforts to inform the policy process.

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